Provence Structure Plan

Bussell Highway & Vasse Highway, Yalyalup

August 2022

Endorsement Page

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

21 April 2006

In accordance with Schedule 2, Part 4, Clause 28 (4) and refer to Part 1, 2. (b) of the Planning and Development (Local Planning Schemes) Regulations 2015.

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Rev 4	Structure Plan	L McCaffrey	J Cousins	11.07.18
Rev 5	Structure Plan (WAPC Amendments)	J Ross (TBB)	J Ross (TBB)	10.08.22
Rev 6	Structure Plan (Completion of Remaining Modifications For Final Approval)	DPLH Officer	WAPC	04.08.23

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Table 1 – Table of Amendments

Amendment No.	Summary of the Amendment	Amendment type	Date approved by WAPC
1.	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

Executive Summary

The proposed Structure Plan (refer **Appendix A**) establishes the future land use and development framework for the subject land that will be developed in a manner that responds to the existing site features, and reflects the character of the surrounding locality.

Those properties included in the proposed Structure Plan are detailed within Table 2 below.

Table 2: Participating Properties

Lot Description	Ownership
Lot 9033 on P409180	East Busselton Estate Pty Ltd
Lot 9032 on P406716	East Busselton Estate Pty Ltd
Lot 2 on D28764	East Busselton Estate Pty Ltd
Part Lot 75 on P410411	Provence 2 Pty Ltd
Part Lot 76 on P410411	Provence 2 Pty Ltd
Lot 501 on P23800	Brian Arthur & Dorothy Alice Blum
Lot 6 on D33959	Silverbay Enterprises Pty Ltd

As far as possible, and for contextual purposes, the revised structure plan also recognises the physical opportunities and constraints of non-participating properties as well as any planning initiatives known at time of writing.

The proposed Structure Plan has been informed by a comprehensive programme of technical investigations that addresses the key site constraints and is consistent with the land use framework prescribed in the City of Busselton Local Planning Scheme No.21, draft Local Planning Strategy and other relevant State Policies and legislation.

Details of the proposed Local Structure Plan are as follows:

Table 3: Structure Plan

Item	Data/ Supporting Comments
Total area covered by the Structure Plan	249.52 ha
Area of each land use proposed: Residential Primary School Bussell Highway/Vasse/Bypass Buffer Commercial (Local Centre) Public Purpose Public Open Space(Credited) Total 'Green Space' (Credited/Uncredited/Buffer)	 124.52 ha 4.5 ha 11.054 ha 1.6 ha 0.40 ha 27.45 ha 61.52ha
Estimated lot yield Provence Estate: Entire Structure Plan Area:	 2020 Lots 2320 Lots
Estimated Residential Site Density Gross Urban Zone Land (Structure Plan): Gross Urban Zone Density: Net Residential Land: Net Residential Zone Density	 249.52ha 9.3 Dwellings/ha 124.52 ha 18 Dwellings/ha
Estimated population	5,000 – 6,000 people
Number of high schools	Nil
Number of primary schools	1
Estimated commercial/ retail floor space	3,450m² inclusive of 2500m^2 NLA for the supermarket component
Estimated area of public open space: Total area	 23.58 ha (Refer Section 3.2)

PART ONE – IMPLEMENTATION

1.0 Structure Plan Area

This Structure Plan applies to Lots 9033 and 2 Bussell Highway, Lots 9032 and Cable Sands Road, and Lot 501, and Part Lots 75 and 76 Vasse Highway, Yalyalup being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map.

The Structure Plan Map is provided in **Attachment A.**

This Structure Plan is identified as the Provence Structure Plan, Bussell Highway and Vasse Highway, Yalyalup(PSP).

2.0 Operation

The date the structure plan comes into effect is the date the structure plan is approved by WAPC. This Structure Plan replaces the Development Guide Plan (DGP) Busselton Airport (North) dated 4 November, 2014 and approved on 17 December, 2014.

3.0 Interpretation and Relationship with the Scheme

The Provence Structure Plan, Bussell Highway and Vasse Highway, Yalyalup constitutes a Structure Planpursuant to Part 4 of the deemed provisions of the City of Busselton Local Planning Scheme No. 21.

The Structure Plan Map (**Attachment A**) outlines future land use and zones applicable within the structure plan area.

Pursuant to the Planning and Development (Local Planning Schemes) Regulations 2015, Schedule 2 – Deemed provisions for local planning schemes, a decision maker of an application for development approval or subdivision approval is to have due regard to the provisions of this Structure Plan, including the Structure Plan Map, Implementation Report, Explanatory Report and Technical Appendices.

4.0 Subdivision/Development

4.1. Land use

a) The subdivision and development of land is to be generally in accordance with the zones and reserves which appear in the structure plan map.

b) Residential densities applicable to the structure plan area shall be those residential densities shown on the structure plan map.

4.2. Vegetation Survey

a) Identification and retention of scattered stands of native tress within reserves and other land parcels – including widening of road reserves – is to be undertaken prior to subdivision to enhance the local area character, provide a stronger sense of place, provide visual relief and soften the urban landscape.

4.3. Hazards and separation areas

Bushfire Management

a) 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 Bush Fire Hazard as identified in the Bushfire Management Plan (BMP) contained within **Appendix E**.

b) Building setbacks and construction standards to achieve a Bushfire Attack Level -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 Bush Fire Hazard as identified in the Bushfire Management Plan.

Noise Management

(a) 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 transportation noise as identified in Noise Assessment contained within **Appendix I**.

(b) Construction standards to achieve quiet housing design in accordance with State Planning Policy 5.4 *Road and Rail Transportation Noise and Freight Consideration in Land Use Planning* (as amended) shall be complied with for lots that are deemed to be affected by transportation noise as identified in the Noise Assessment.

(c) Aircraft Noise - A notification to be placed on the Certificate(s) of Title(s) and advice to purchasers will be required as a condition of subdivision approval where land or lots are deemed to be affected by aircraft noise in accordance with the provisions of State Planning Policy SPP5.1 and 5.3.

Water Quality Management

(d) Specific Water Quality Management measures and monitoring are required to address the future water quality environment of the footprint lake, prior to subdivision or development to the satisfaction of the local government.

Mosquito and Midge Breeding Mitigation

(e) 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.

Extractive Industries

(f) While any unmined resource remains within 1,000m of the subject land, any future subdivisions are likely to be subject to a notification being required on title.

(g) Measures are to be applied to mitigate or remove any potential for land use conflict prior to subdivision.

4.4. Residential Densities

a) The residential densities which appear in the structure plan map are consistent with residential density targets under the Commission's Liveable Neighbourhoods Policy (LN) and the

required low density development around the southern and western periphery of the Structure Plan Area.

b) The subdivision and development of land is to be generally in accordance with the densities which appear in the structure plan map.

4.5. Traffic Modelling

a) Prior to any further stages of subdivision, traffic modelling to the forecast year of 2040 is required, with all assumptions and inputs verified to the specification of Main Roads WA and to the satisfaction of the WAPC.

5.0 Local Development Plans

Local Development Plans (LDP's) shall be prepared and implemented for lots comprising one or more of the following site attributes:

a) Lots with direct boundary frontage (primary or secondary) to an area of Public Open Space

b) All land identified as 'Local Centre' on the structure plan map. The LDP should address the following principles:

- Delivery of a sustainable, vibrant and fully functional ‘main street’ outcome in accordance with Liveable Neighbourhoods;
- Orientation and public entry of the supermarket and retail/commercial elements to/from the main street;
- No internal pedestrian malls or internal walkways;
- No rear access to the supermarket from car parks;
- Specially designed slow vehicle speed and pedestrian crossings for the street separating the Local Centre and Primary School; and
- Raised pedestrian crossings.

6.0 Staging

The progressive development of the Structure Plan area will be dictated by market demand, provision of new or upgraded road connections and will be delivered consistent with servicing efficiencies and contained to those areas forming a logical progression of development. Areas remote from services or the current development front are likely to be avoided unless determined otherwise for commercial and/ or sound planning reasons. This will assist to ensure that existing and future facilities are used to maximum efficiency, and can continue to operate effectively.

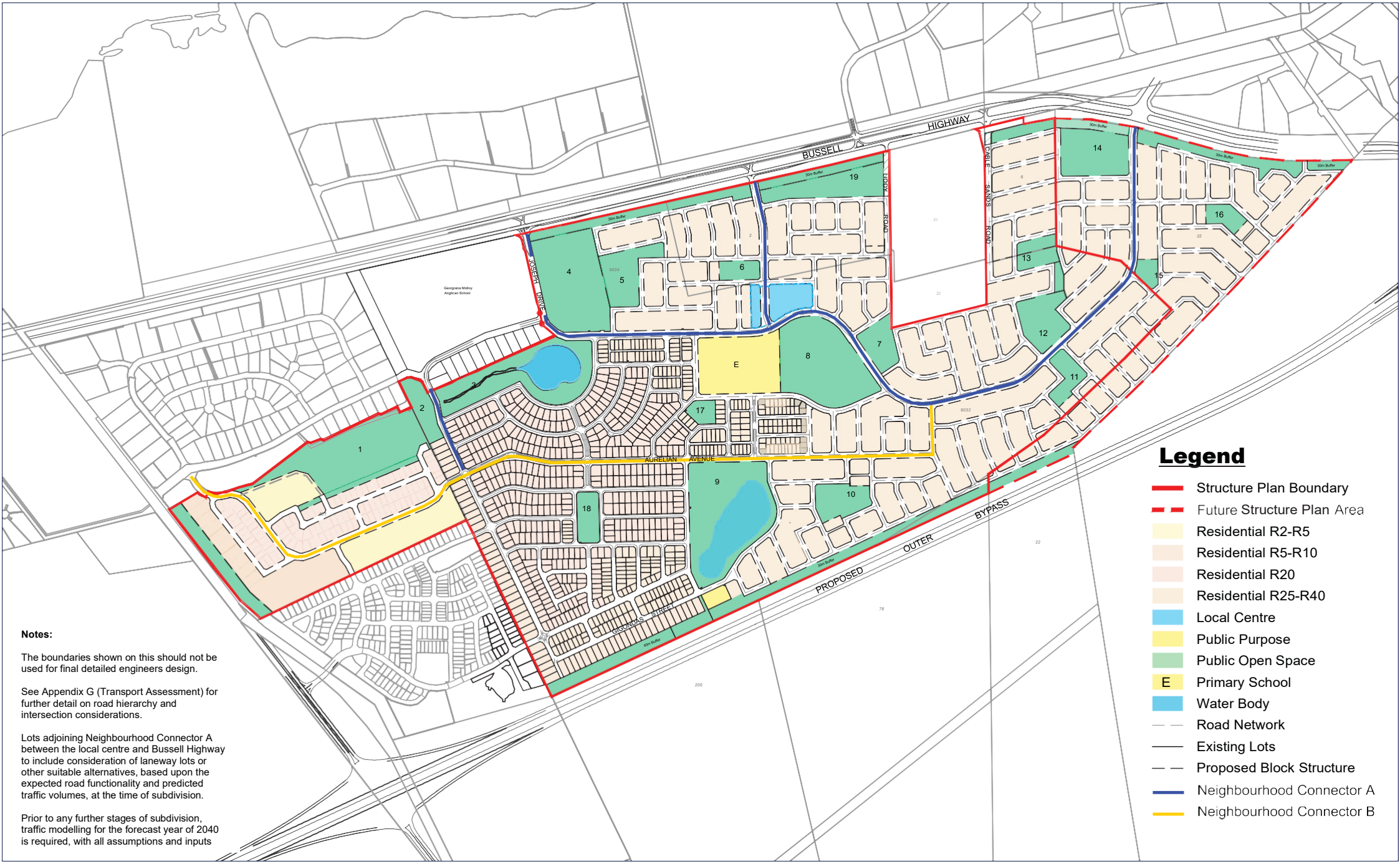
The undeveloped areas of the Structure Plan area will be designed and implemented to a high quality, including provision of community facilities and ‘hard’ infrastructure to correspond with land release and development.

The implementation of ‘soft’ infrastructure items are typically demand-driven and will be delivered as the population and catchment grows. While there is often a lot of uncertainty around the timing and responsibility of delivering community infrastructure, developer contribution plans are generally accepted as a means to levy and recoup costs towards district and local community facilities and key infrastructure items that are required as a consequence or provided in anticipation of development. This approach has been adopted for the existing Structure Plan area through the adoption of the “Yalyalup Developer Contribution and Staging Plan”. This document will need to be updated and adopted for the future urban expansion areas as a clear statement of the scope, process and method of exacting equitable developer contributions to ensure that demands are fairly apportioned to the share of the need created by each landowner’s subdivision and/or development of their respective landholding.

In determining both ‘hard’ and ‘soft’ infrastructure requirements, attention needs to be given to ensuring that

any requirements that add costs to development can be borne by the market and not act as a disincentive to land development. This is critical in ensuring an adequate land supply is created that does not adversely affect housing affordability.

Attachment A – Structure Plan Map



Legend

- Structure Plan Boundary
- Future Structure Plan Area
- Residential R2-R5
- Residential R5-R10
- Residential R20
- Residential R25-R40
- Local Centre
- Public Purpose
- Public Open Space
- E — Primary School
- Water Body
- Road Network
- Existing Lots
- Proposed Block Structure
- Neighbourhood Connector A
- Neighbourhood Connector B

Notes:

The boundaries shown on this should not be used for final detailed engineers design.

See Appendix G (Transport Assessment) for further detail on road hierarchy and intersection considerations.

Lots adjoining Neighbourhood Connector A between the local centre and Bussell Highway to include consideration of laneway lots or other suitable alternatives, based upon the expected road functionality and predicted traffic volumes, at the time of subdivision.

Prior to any further stages of subdivision, traffic modelling for the forecast year of 2040 is required, with all assumptions and inputs

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PROVENCE **STRUCTURE PLAN**

Bussell Highway & Vasse Highway, Yalyalup

PART TWO - EXPLANATORY SECTION AND TECHNICAL APPENDICES

1.0 Background

1.1 Introduction and Purpose

The Provence Structure Plan, Bussell Highway and Vasse Highway, Yalyalup has been prepared to provide the City of Busselton with a statutory framework to guide the orderly future subdivision and development of the subject site. The following consultants have been involved with the preparation of the Structure Plan, and were responsible for the various technical reports and studies that underpin the Structure Plan design:

- RPS (Planning and Development) – Town Planning and Urban Design
- Taylor Burrell Barnett Town Planning & Design – Town Planning and Urban Design (Amendments only)
- RPS (Environment) – Environmental
- JDA Consultant Hydrologists – Hydrology
- Hyd2o Hydrology – Hydrology (Addendum Only)
- Wood & Grieve Engineers – Engineering and Servicing
- Emerge Associates – Landscaping Design
- Ecosystem Solutions Pty Ltd – Fire Management Planning
- JBS&G – Fire Management Planning (Addendum Only)
- Transport Assessment (Addendum Only)
- Herring Storer Acoustics – Noise Assessment
- Macroplan Dimasi – Retail Demand Analysis
- Marketplace – Product Mix Analysis

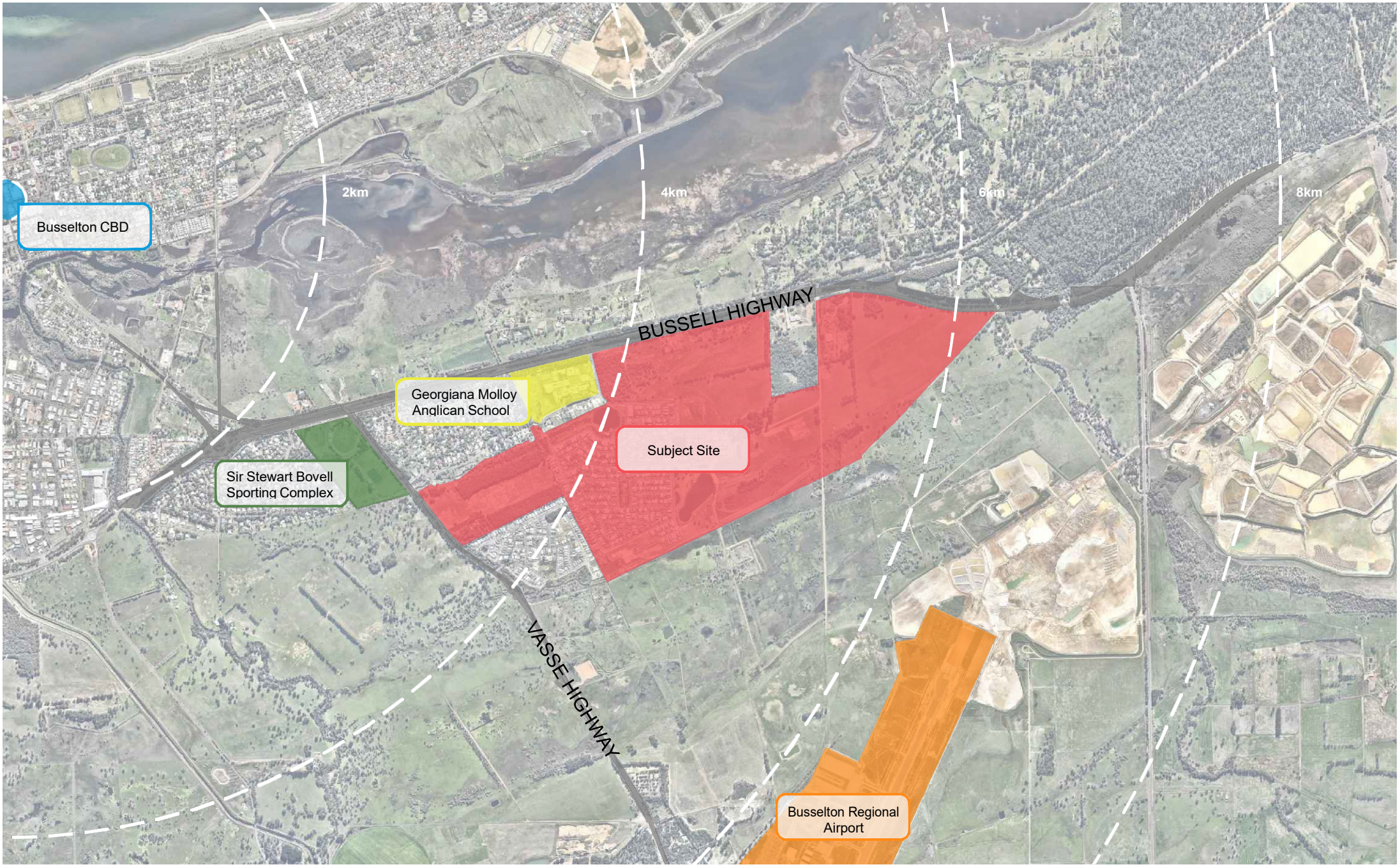
Once developed, the Structure Plan area will provide for a variety of housing choice through the provision of a range of densities and lot sizes accommodating a population of approximately 5,000 – 6,000 people through the provision of up to 2,320 lots.

The Structure Plan incorporates sustainable land use and lot design principles, and provides for an integrated open space, conservation and drainage network, balancing environmental, recreational and social objectives.

1.2 Site Location

The land is located approximately five (5) kilometres south east of the Busselton Town Centre. The land is situated on the southern side of Bussell Highway and is currently accessed primarily from Joseph Drive. Bussell Highway provides regional transport connections between Bunbury, Dunsborough and Margaret River. The future Busselton Outer Bypass forms the site's southern boundary. Willow Grove Estate and Via Vasse are located to the north and west, respectively. **Refer Figure 1**

The entire Structure Plan area is approximately 249.52ha, of which approximately 50ha has already been developed for residential development and public open space purposes. A further 37.46ha of land associated with Provence Estate (part of Lot 75 on P410411) which is presently zoned Tourist, Recreation and Road Purposes has been included in the Structure Planning analysis and design process for the preparation of this structure plan to ensure seamless and cohesive design with the balance landholdings for Provence. However due to the current underlying zoning this land has been excluded from the Provence Estate Structure Plan at this time, and will be subject to a separate future complementary Structure Planning process.



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PROVENCE **FIGURE ONE LOCATION PLAN**

The Structure Plan area comprises the following landholdings:

Table 4: Landholdings

Lot Description	Ownership	Land Area
Lot 9033 on P409180	East Busselton Estate Pty Ltd	30.7221ha
Lot 9032 on P406716	East Busselton Estate Pty Ltd	86.481ha
Lot 2 on D28764	East Busselton Estate Pty Ltd	20.1458ha
Part Lot 75 on P410411	Provence 2 Pty Ltd	2.383ha
Part Lot 76 on P410411	Provence 2 Pty Ltd	0.94ha
Lot 501 on P23800	Brian Arthur & Dorothy Alice Blum	31.506ha
Lot 6 on D33959	Silverbay Enterprises Pty Ltd	7.7512ha

1.3 Existing and Surrounding Land Use

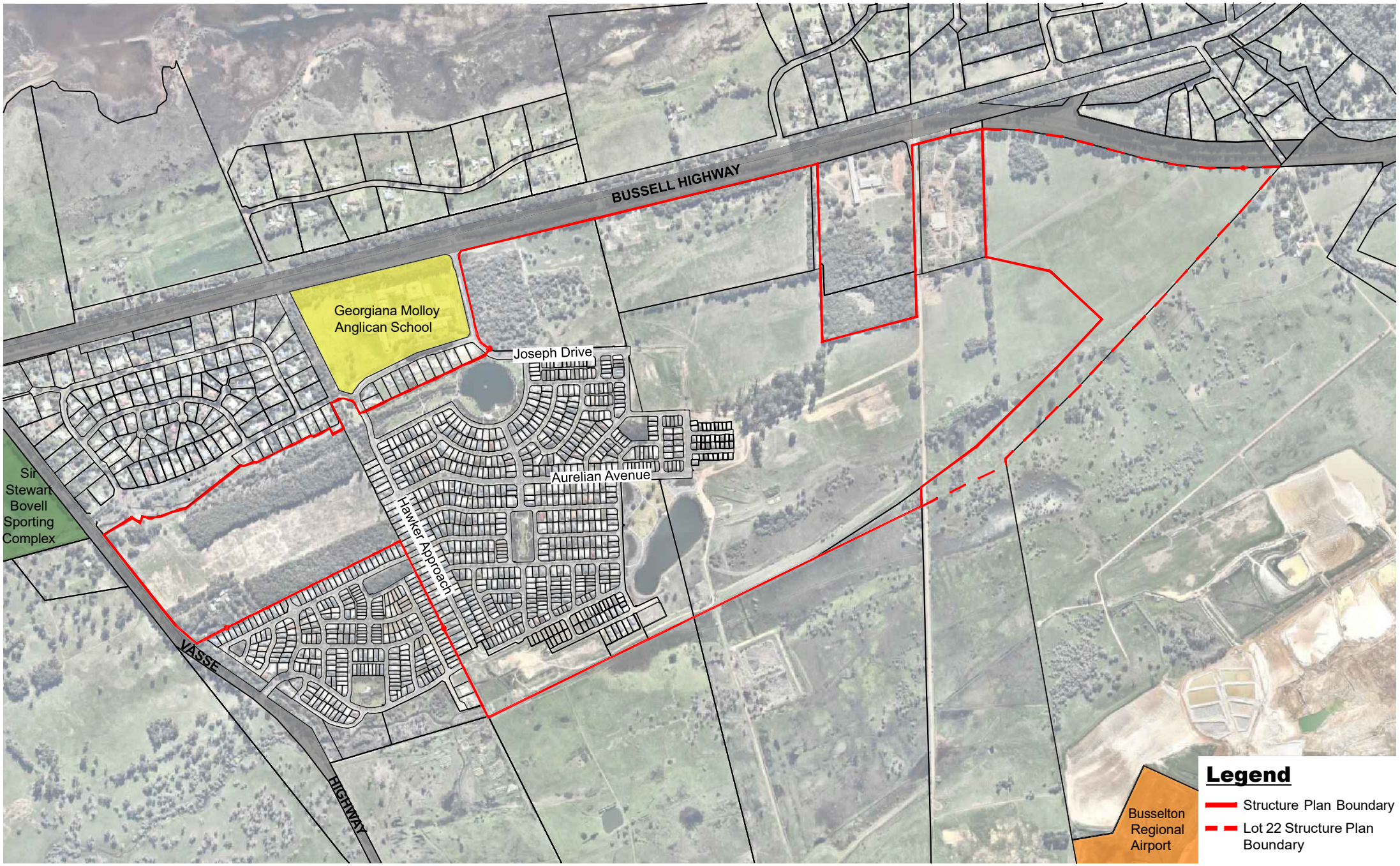
The site currently comprises largely of grassed paddocks and the constructed stages of the existing Provence Residential Estate. Remnant vegetation is predominately located within Lots 9032, 501 and 9033. In addition to the approved residential development within Provence Estate, there is also an approved subdivision over Part of Lot 501.

The land to the north of the site, on the opposite side of Bussell Highway, has predominantly been subdivided for rural residential purposes. To the west, Willow Grove and Country Road Estates comprise a number of residential lots ranging in area from 2000m^2 to 4000m^2. Bovell Park, comprising district level sporting facilities, is situated nearby on the western side of Vasse Highway.

The Busselton Margaret River Regional Airport situated approximately 1.5 km to the south. The Sabina River is located approximately 350 m east of the site and the existing Cable Sands mineral sands mine is operating 1 km east of the site.

The land is relatively flat with a gradual ridge that ascends north to south with the higher ground ranging in height of between 15m and 20m AHD. The northern half of the land is very flat with height ranging between 6m and 10m AHD, with the site being previously cleared for agricultural and sand mining purposes.

Whilst the site remains predominantly cleared, some remnant vegetation, with denuded understorey, remains in isolated pockets throughout the site **(refer Figure 2 – Aerial Photograph)**.



PROVENCE **FIGURE TWO AERIAL PLAN**

2.0 Planning Framework

2.1 Busselton Urban Growth Strategy (Shire of Busselton – 1999)

The Busselton Urban Growth Strategy identifies the major residential areas Council considers will be developed in the next 5 to 15 years. The residential component of the proposed Structure Plan falls within the short to mid-term development (5 to 10 years).

The Growth Strategy acknowledges that the Structure Plan area represents one of the last major landholding in close proximity to the Busselton CBD and it has excellent district level access afforded by Bussell and Vasse Highways. It also identifies the Structure Plan area as being a major component of the compact urban form emerging from the Busselton townsite.

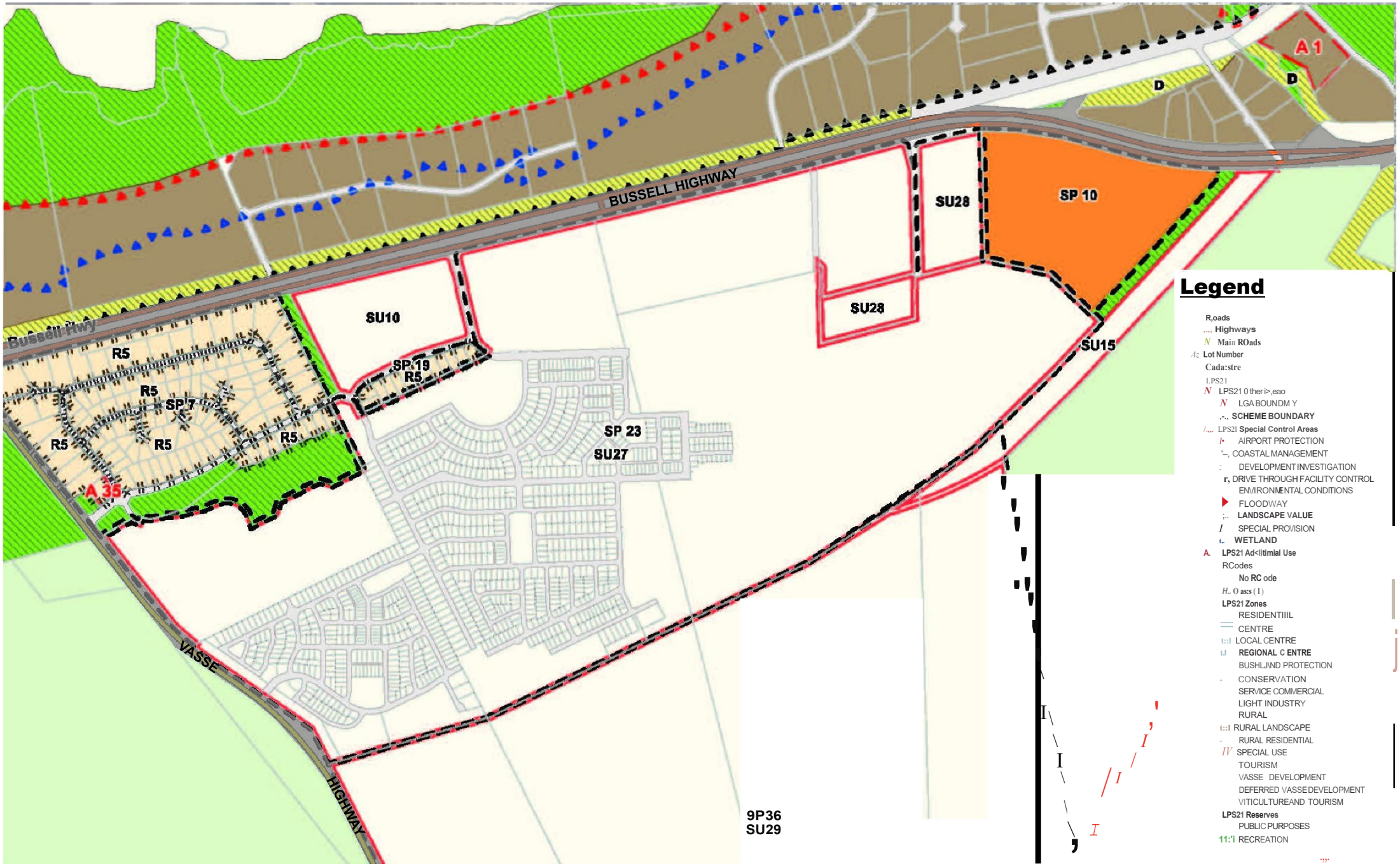
The Growth Strategy also highlights the amenity values of the eastern entrance to the Busselton townsite along Bussell Highway. The City of Busselton is committed to the retention of the attractive approach to Busselton and believes the retention of the current amenity can be readily addressed within the context of conventional residential density by incorporation of landscape buffers, retention of important natural linkages and protection of remnant vegetation through the Structure Plan design process.

2.2 City of Busselton Local Planning Scheme No.21

The subject land is included within the City of Busselton Local Planning Scheme and is currently zoned as follows:

- Lots 9033, 9032 and 2 are currently zoned 'Special Purpose (Yalyalup Development)' and are subject to the special provisions contained within 'SP23', Schedule 3 of the Scheme;
- Lot 501 is zoned 'Special Purpose (Yalyalup Development)' and is subject to the special provisions contained within 'SP23', Schedule 3. The Scheme also designates a portion of the land as a 'Reserve' for recreation purposes and subject to the special provisions contained within 'SP7 & SP23', Schedule 3 of the Scheme;
- Lot 6 is currently zoned 'Special Purpose (Yalyalup Deferred Development)' and subject to the special provisions within 'SP23' Schedule 3 of the Scheme.
- The included portion of Lots 75 and 76 (subject to the Structure Plan) are zoned 'Special Purpose (Yalyalup Industrial Development) and subject to the special provisions with 'SP38', Schedule 3 of the Scheme. **Refer Figure 3**

The northern portion of Lot 75 has been included in the structure plan design and considerations of capacity and servicing as a future part of Provence Estate. However as it is currently zoned 'Tourist' (and is subject to the special provisions within 'SP10', Schedule 3 of the Scheme); 'Special Purpose – Road Purposes' and 'Reserve' for recreation purposes it has not been included in this Strucutre Plan. Discussions with the City of Busselton have confirmed that the rezoning of the Lot 75 land from 'Tourist' to 'Special Purpose (Yalyalup Development)' zone can be supported given that tourism in this location is no longer seen as a viable proposition and future residential is considered the most logical land use as a longer term extension of the existing Provence Estate. However recent advice is that this will need to be undertaken as a separate Structure Planning exercise once the rezoning has been finalised.



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PROVENCE **FIGURE THREE EXISTING ZONING PLAN**

The northern portion of Lot 76 will also be the subject of a rezoning in response to the realignment of the proposed Busselton Outer Bypass.

The rezoning submission will be submitted separately and considered concurrently alongside the assessment of the proposed Structure Plan.

Clause 7.4.3 of the Scheme outlines the information that is required to inform the City's consideration of a Structure Plan. The proposed Structure Plan has been prepared following detailed and thorough consideration of the site and its attributes, together with the matters detailed within the Local Planning Scheme and previously endorsed Airport North DGP.

2.3 Draft City of Busselton Local Planning Strategy (LPS)

The City of Busselton has recently prepared a Draft Local Planning Strategy for public consultation.

The Strategy sets out set out the long-term (25 years-plus) broad planning direction for the whole of the District of the City of Busselton and will provide a strategic rationale for decisions related to the planning and development of the District, especially decisions related to the progressive review and amendment of the local planning scheme over the next 10 -15 years.

The LPS recognises the Provence Estate Structure Plan area as 'Current Urban Growth' and 'Medium Term Urban Growth' which is consistent with the anticipated timeframe to develop the extent of land identified. Therefore, the preparation and implementation of the proposed structure plan is appropriate for this area and is consistent with the vision of the City's draft LPS.

2.4 Liveable Neighbourhoods

The Western Australian Planning Commission's (WAPC) Liveable Neighbourhoods Policy is intended to guide the subdivision and development of land in Western Australia. The key principles of this policy include:

- Providing a variety of lots sizes and housing types to cater for the diverse housing needs of the community at a density that can ultimately support the provision of local services;
- To ensure cost-effective and resource efficient development to promote affordable housing; and
- To maximise land efficiency.

Liveable Neighbourhoods provides guidance for the design and development of greenfield subdivision through eight design elements; community design, movement networks, lot layout, public parkland, urban water management, utilities, activity centres and employment, and schools. These various elements have been considered in the preparation of the proposed Structure Plan.

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

This Policy sets out the principles and considerations which apply to the planning of urban growth settlements in Western Australia. The Policy aims to facilitate sustainable patterns of urban growth and settlement and recognises that the State is undergoing rapid growth and change which is expected to continue. The policy acknowledges that the spread of urban development intensifies pressures on valuable land and water

resources, imposes costs for the provision of infrastructure and services, increases dependence on private cars and creates potential inequities for those living in the outer suburbs where job opportunities and services are not so readily available.

The following summary of policy objectives and corresponding Structure Plan response to each is provided in Table 5 below.

Table 5 – SPP No.3 Policy Objectives and Structure Plan Response

SPP No.3 Objective	Provence Residential Structure Plan Response
To promote a sustainable and well planned pattern of settlement with sufficient and suitable land to provide for a wide variety of housing, employment, recreation facilities and open space.	The Structure Plan provides for a wide variety of housing densities and typologies, recreation facilities and open space requirements.
To build on existing communities with established local and regional economies, concentrate investment on the improvement of services and infrastructure and enhance the quality of life in those communities.	The subject land is located within an existing identified urban development area earmarked for urban subdivision and development. The planning and development of the land will make best use of existing infrastructure already present in the locality.
To manage the growth and development of urban areas in response to the social and economic needs of the community and in recognition of relevant climatic, environmental, heritage and community values and constraints.	The needs of the community have been established through previous district and local level structure planning for the locality.
To promote the development of a sustainable and liveable neighbourhood form which reduces energy, water and travel demand whilst ensuring safe and convenient access to employment and services by all modes, provides choice and affordability of housing and creates an identifiable sense of place for each community.	The proposed Structure Plan layout seeks to maximise energy efficient and climate responsive design by ensuring all lots can be provided in a north-south or east-west configuration. Sustainable urban water management principles have been applied to the treatment of stormwater and design of Public Open Space. Travel demand will be reduced through the provision of local employment opportunities and services, and a permeable local movement network that encourages walking and cycling.
To coordinate new development with the efficient, economic and timely provision of infrastructure and services.	The progressive development of the Structure Plan area will utilise established infrastructure and utility services that will be extended to service future development precincts.

2.6 State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning

This policy aims to promote a system in which sustainable land use and transport are mutually compatible.

For the purposes of applying this policy, Bussell Highway and the proposed Busselton Outer Bypass are considered to be a State Road and the Structure Plan area represents a noise sensitive development.

In accordance with the SPP, the proposed Structure Plan has considered the potential for land use conflict between the adjacent existing and future road corridors. The Noise Assessment undertaken (**refer Appendix I**) includes an estimate of transport noise levels, taking into account traffic volumes and distance separation from the major roads. These estimates have then been used to determine whether noise assessment and

mitigation measures may be necessary under this Policy. The assessment has also provided further information about the extent of noise-affected areas within the Structure Plan area.

The assessment concludes that the affected Lots can achieve acceptable noise levels both externally and internally during the day and night.

3.0 Proposed Structure Plan

The proposed Structure Plan provides the foundation that will guide the future detailed planning and development of the subject land with a focus on the key social, economic and environmental considerations. The resultant Structure Plan is a progression of the previously endorsed Airport North (Yalyalup) DGP, which has been designed in response to detailed technical investigations across all disciplines. It also follows extensive consultation and design workshop discussions with the City of Busselton.

The Provence Residential Structure Plan achieves the project vision objectives and has been designed adopting the principles relating to:

- Walkability;
- Connectivity;
- Mixed-use and Diversity;
- Mixed housing opportunities;
- Quality architecture and urban design outcomes;
- Traditional Neighbourhood Structure;
- Increased density;
- Sustainability; and
- Quality of life

The proposed Structure Plan is included as Figure 4 and Annexure 1.

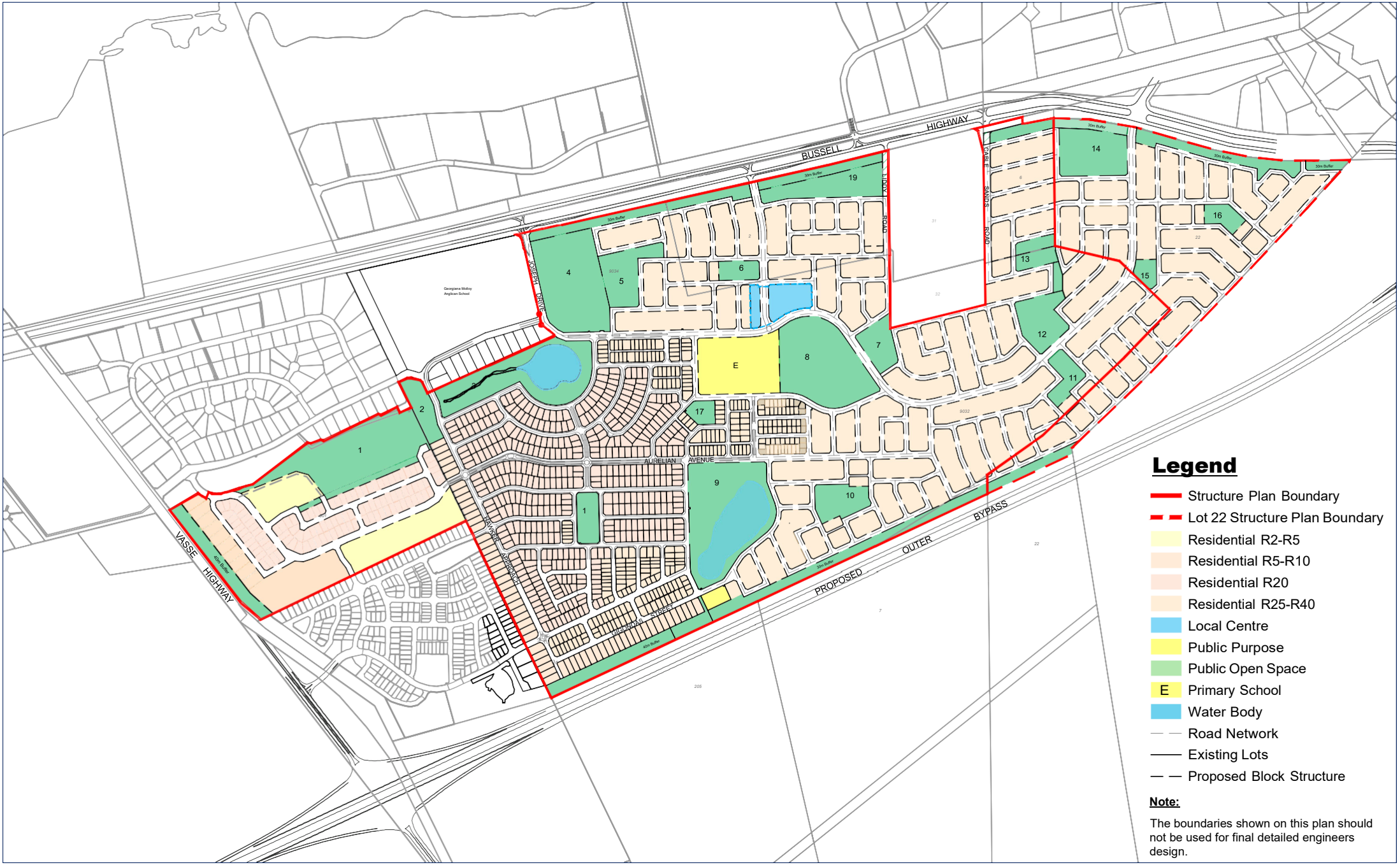
3.1 Design Overview

The community will be connected to the surrounding areas with a series of main entry points from Bussell and Vasse Highway. The residential street network is highly interconnected with a predominant road orientation north to south. The network is legible and will promote efficient movement throughout the site connecting key land use precincts.

The local centre will contain shopping, small business/ retail, medical and community facilities in conjunction with active and passive open space opportunities immediately to the south. The aim is to create a distinct character that is reflective of Busselton coastal ‘village’ feel. The retail/commercial centre is centrally located in close proximity to all residential precincts with excellent walking and cycling opportunities to reduce vehicle demand.

Featuring active sporting fields, the district open space has been located central to the Structure Plan core in conjunction with the primary school site to stimulate permanent activity during the week and on weekends when the facility is most utilised. The facility is located on the main entry from Bussell Highway providing good accessibility for the wider community and has the potential to incorporate a multi-purpose community facilities and associated parking to meet user requirements. Existing vegetation will be retained on site in conjunction with the open space activities with a strong relationship to the retail/commercial centre.

The subdivision of the Structure Plan area will result in the creation of approximately 2,320 residential lots ranging in size from around 300m^2 to 4000m^2. This mix will deliver a range of density and housing product that



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PROVENCE **FIGURE FOUR - STRUCTURE PLAN OVERALL**

will provide for affordable housing opportunities in order to appeal to the wider residential market. The road system will provide for predominantly north-south and east-west oriented, regular shaped lots, with smaller lots clustered around the local centre and POS. Generally, lots will be progressively larger towards the periphery of the site.

The overall density proposed is considered to be appropriate for the character of the locality. The historical planning intent for this locality and the character and constraints of the land has established a density of R2-R5 on part of the westernmost section of the Structure Plan Area. There are also precincts of the estate at R5-10 which were established to provide larger lots as a transition to adjacent properties. Additionally this Structure Plan sits over existing areas of residential subdivision within the early stages of Provence which had a historical DAP density of R15-R20. The resulting density within the structure plan area therefore does not meet the preferred urban residential density within Liveable Neighbourhoods, but it is consistent with the reference in Element 1 of Liveable Neighbourhoods noting that "*on the edge of neighbourhoods or in physically constrained areas, and in smaller country towns"* a lower residential density may be appropriate.

The land use breakdown and associated areas is detailed in Table 6 'Land Use Schedule'.

Table 6: Land Use Schedule

Land Use	Structure Plan Land Area (Ha)
Residential	124.528
Education	4.5
Local Centre	1.60
POS / Buffer / Drainage / Community Purpose	58.19
Road Network	61.92
Total Structure Plan Area	**249.52**

3.2 DGP Design Elements

3.2.1 Working with Nature

The site contains a number of key environmental features that have been recognised as a significant opportunity for the Structure Plan area to preserve and compliment the rural and natural characteristics of the site through retention, rehabilitation, fauna linkages, open space networks and landscaping. The guiding landscape objectives for the project are as follows:-

- To create interesting spaces and promote community interaction via a variety of landscape character and experience;
- To protect and restore natural ecosystems on site;
- Develop suitable landscape and rehabilitation strategies to assist in the overall drainage scheme for the site;
- To adopt the principles of sustainability and promote appropriate, water wise planting and species that are endemic to the region;
- Minimise required maintenance; and
- Retain and enhance key views through the site.

An itemisation of the public open space illustrated in the proposed Structure Plan is as follows:-

Parks and Public Open Space

In addition to the district sporting oval, a network of extensive parkland and useable local open space opportunities have been provided for in the Structure Plan. Categories of open space will include conservation areas, formal public open space, informal public open space, integrated and shared facilities with schools.

A key open space feature will be a large district sporting facility located immediately south of the retail/commercial precinct that will retain existing vegetation around the south-eastern edge.

A series of local open space 'kick and throw' areas will be provided throughout each residential precinct to achieve equitable access for all residents.

Drainage and Water Management

Appropriately located stormwater management solutions will be incorporated into the proposed Structure Plan to convey and manage stormwater flows across the development. The design and function of these features will vary depending on the nature of its use i.e. a narrow drainage channel or wider open space opportunity. These drainage areas will be celebrated with appropriate landscape outcomes featuring picnic areas, walking and cycle paths and informal active areas. The system will connect and provide a passive link to all elements of the community integrating differing landscape character into a single cohesive public open space system. Wherever possible, it is intended that endemic vegetation types within the proposed open space areas will be incorporated into the landscape outcomes.

Retention of Significant Vegetation

The significant vegetated bushland areas will be retained and enhanced for their long term protection. Vegetation linkages will be provided across the northern boundary of the site to facilitate fauna movement. Scattered stands of vegetation will be retained in proposed parkland and sporting areas, and civic spaces. Vegetation retention adds to the creation of character, visual relief and a softening of the urban landscape.

District and Local Sporting Fields

The need for additional District Open Space in Busselton, with associated multi-purpose community facilities and parking, has been highlighted by the City of Busselton. The creation of a 5.85ha district open space facility in association with the primary school and retail/ commercial precinct will provide the future development of the Structure Plan area with significant impetus.

Shared use arrangements with the proposed primary school facilities will provide other formal active opportunities for the community for after school and weekend activity.

A summary of the POS provision for the Structure Plan area is detailed in Table 7 'POS Schedule' and Table 8 'POS Allocation Schedule' below. The POS areas allocated in Table 8 are illustrated on Figure 5.

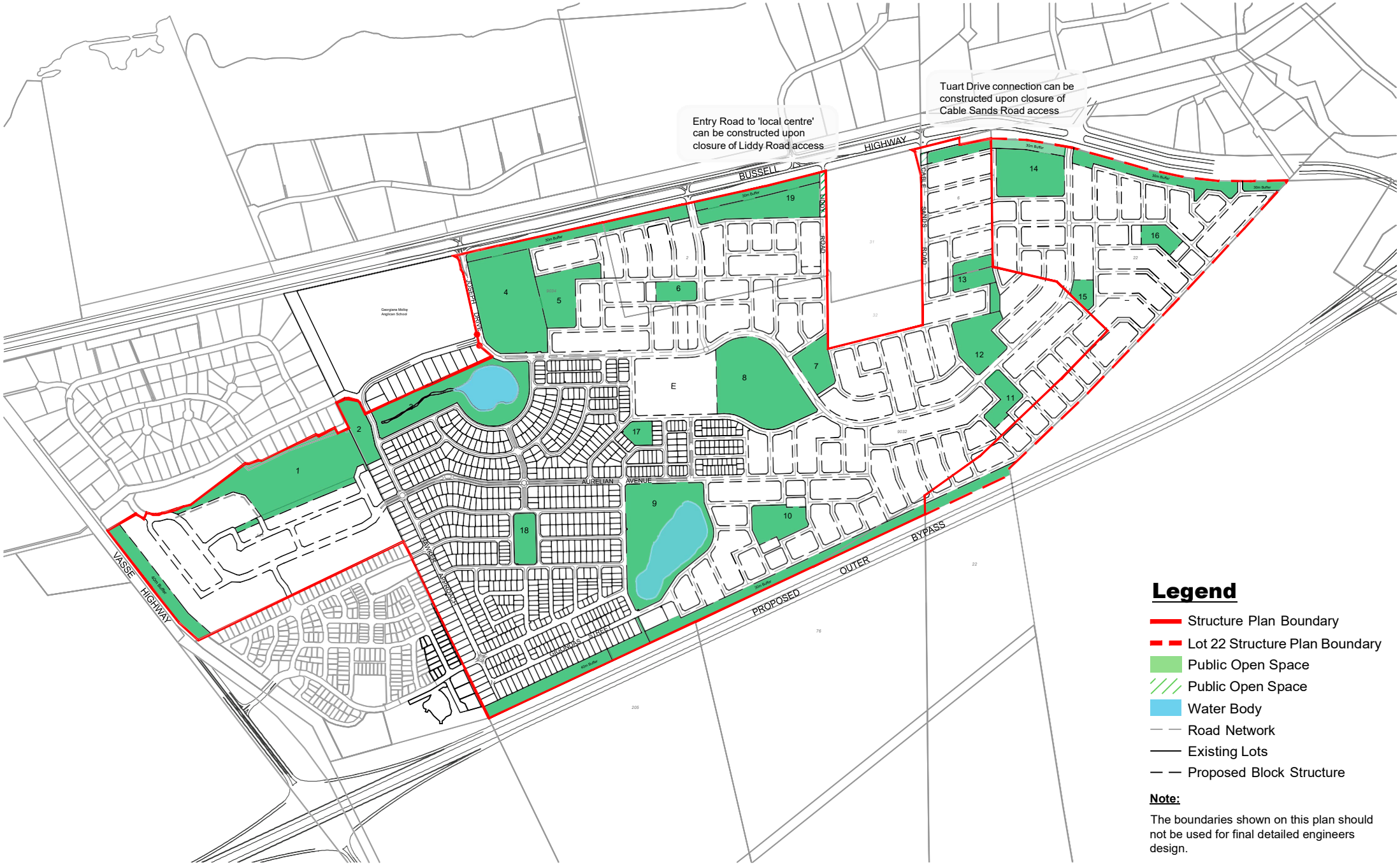
Table 7: POS Schedule

Developable Area (*Area in Hectares*)			**Site Area**
Lots	***Total***		***249.52***
Deductions	1:1 Year Drainage (Taken from LWMS)	3.27	
	1:1-1:5 Year Drainage Uncredited	0.00	
	Primary School	4.50	
	Bussell Highway / Vasse / Bypass Buffer	11.05	
	Pump Station	0.40	
	Local Centre	1.60	
	Conservation Non Credited (Excess of 20%)	17.00	
	Water Body (Excess of 20%)	1.97	
	Total Deductions		39.79
Gross Subdivisible Area (GSA)			**209.73**

Public Open Space Requirement		
	10% of Gross Subdivisible Area	**20.97**
	80% Unrestricted	16.78
	20% Restricted	4.19
Open Space Provided (On Structure Plan)		
	Unrestricted	21.23
	Restricted	6.22
	Total	27.45
	**** Surplus / Shortfall***	**6.48**
	* Area may be reduced at time of detailed design	
POS / Green Space Development Table		
Green Space Required (POS + Drainage)	***Uncredited***	***22.24***
	Drainage 1:1 (*LWMS*)	3.27
	Conservation Uncredited	17.00
	Uncredited Waterbody	1.97
	Restricted POS	***7.00***
	Credited Drainage 1:1 – 1:5 (Restricted POS) (*LWMS*)	7.00
	Conservation Credited	0.00
	Lakes (Body) Credited POS	2.90
	Unrestricted POS	***21.23***
	Unrestricted POS	21.23
	Perimeter Buffer / Bund	***11.05***
	Non Credited Bund and Buffer Edge	14.83
Total Green Space Required		***61.52***

Table 8: POS Allocation Schedule

Open Space Allocation Table (*Areas in Hectares*)				
POS	**Area**	**Total Credit POS**		
		Restricted	**Unrestricted**	**Total**
1	7.314	0.00	0.31	0.31
2	1.25	0.00	0.05	0.05
3	6.35	0.64	3.70	4.34
4	5.93	0.00	0.03	0.03
5	2.19	0.02	0.11	0.13
6	0.75	0.25	0.31	0.56
7	1.38	0.14	1.02	1.16
8	6.18	0.44	5.38	5.83
9	7.99	2.96	3.98	6.94
10	1.60	0.13	0.42	0.55
11	1.06	0.12	0.80	0.92
12	2.05	0.06	1.78	1.84
13	1.41	0.10	1.14	1.24
15	0.51	0.09	0.24	0.33
17	0.57	0.00	0.57	0.57
18	1.07	0.19	0.73	0.92
19	2.59	1.20	0.88	2.07
Total	**50.194**	**6.34**	**21.45**	**27.45**



Legend

- Structure Plan Boundary
- Lot 22 Structure Plan Boundary
- Public Open Space
- Public Open Space
- Water Body
- Road Network
- Existing Lots
- Proposed Block Structure

Note:

The boundaries shown on this plan should not be used for final detailed engineers design.

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PROVENCE **FIGURE FIVE PUBLIC OPEN SPACE PLAN**

3.2.2 Local Centre

The proposed retail / commercial Local Centre precinct aspires to offer a major point of difference from its competitors, yielding greater economic benefit to its owner, whilst also benefiting the community in a social context.

The Local Centre aims to:

- Engender a strong sense of community and a safe environment;
- Be a visually interesting and architecturally attractive, with its own distinct character;
- Integrate a broad range of uses together into one exciting urban environment, rather than separate them out into different land-use precincts;
- Complement the existing Busselton Town Centre and allow for growth and change over time; and
- Deliver on sustainable development principles with minimal impact on the environment.

The proposed centre will serve the wider Yalyalup locality where the community can easily walk or drive to get their daily needs and local services. The range and mix of uses will include retail, commercial, lifestyle/leisure, community and civic amenity. Based on the retail floorspace analysis (**Appendix F**), the Provence Neighbourhood Centre could support approximately 3,450m² of retail floorspace at 2021.

Street trees will shade the footpath and will be planted to visually narrow the streets and slow the traffic. Footpaths within the centre will be wide enough for outdoor dining opportunities.

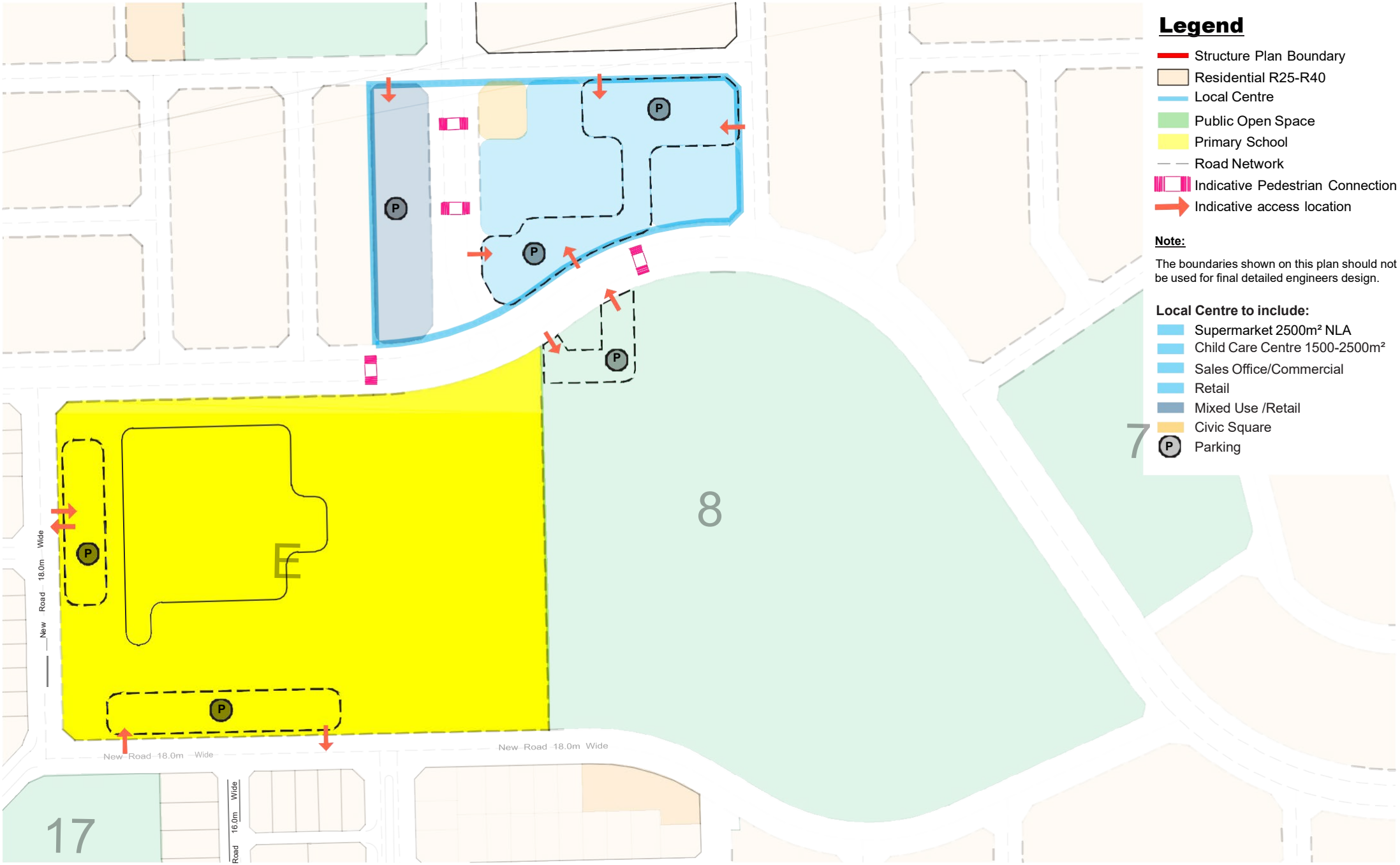
On and off-street parking will be available, though, primary parking facilities will be screened at the rear of shop fronts to ensure the character of the development is maintained and is not dominated by extensive open areas of parking associated with a typical shopping centre.

Architecture within the centre will be carefully considered achieving a high standard of quality that reflects the character and climate of its setting. Variety in building height, façade treatment and materials and the creation of iconic buildings in strategic locations will be a key driver to achieving a good design outcome.

A ‘Concept Layout’ of how the commercial may be developed to incorporate ‘main street’ elements has been included as Figure 6, and demonstrates how the retail floor space identified by the retail analysis (**Appendix F**) may be delivered. The main elements that have been included in this layout are;

- Orientation of ‘supermarket’ to address north-south entry road
- Carpark located behind main retail element
- Civic square on north east corner of site
- Mixed use development to frame western side of ‘main street’

The concept plan illustrates the location of key elements of the local centre and will be subject to the preparation and approval by the City of Busselton of a Local Development Plan that addresses the principles set out under Part One, Section 5.0(a).



PROVENCE **FIGURE 6 LOCAL CENTRE**

3.2.3 Movement Systems – Road Networks and Bicycles/Pedestrians

The key focus of the proposed Structure Plan was to plan and design a street network that is legible and would facilitate ease of movement throughout the development - a system that is highly interconnected with the surrounding community and the Busselton Town Centre. Other key traffic management and movement objectives for the proposed Structure Plan are as follows:-

- Encourage the 'movement economy' towards the retail/commercial centre;
- Reduce local travel distances;
- The provision a road hierarchy that will distribute traffic evenly and fulfil the functional traffic requirements required;
- Designed to incorporate a user friendly network for pedestrian and cyclists; and
- Designed to provide an integral part of a more sustainable urban water management system.

The key movement elements of the proposed DGP are as follows:-

Main Site Entry

The main entry will be achieved from Bussell Highway. The position and alignment of these entry roads are intended to provide direct and convenient access to the retail/ commercial centre to maximise the commercial viability and vibrancy of the precinct. The key entry roads will adopt high landscaping standards and will take on a typical south west landscape character.

A further three (3) access points will be obtained via Bussell Highway and a single entry point from the west through the 'Blum' land from Blum Boulevard. As development of the Structure Plan will progress in stages, the delivery of the connections to Bussell Highway and Blum Boulevard will occur as demand requires and will depend on the capacity of the existing entry.

Residential Streets

The intention is to create 'streets' not 'roads' within the new development. Most streets will have generous footpaths and shade trees to promote walkability. Where appropriate, the intention is to reduce road reserve widths to help slow traffic and contribute to the character of the residential precincts. The local road network is predominantly orientated north-south to implement a suitable stormwater management solution to the site's major flooding and drainage issues.

Pedestrian and Cycle Movements

Opportunities for residents to walk and cycle throughout the development were an important consideration in the design of the proposed DGP. The interconnected street network will form the main walking and cycling networks. In addition, there will be walking and cycle paths through open space, parkland and along the landscape buffer corridors providing direct links to the residential precincts, district open space, retail/ commercial centre and educational precincts.

Providing a suitable pedestrian connection external to the site to the Busselton Town Centre and Geographe Bay is a key design outcome for the project. These opportunities to cross the Busselton Inner Bypass will continue to be explored through the subsequent detailed planning phases of the project.

Busselton Outer Bypass

The proposed Structure Plan has assumed the current alignment of the Busselton Outer Bypass and it does not provide any connection onto this proposed road.

3.2.4 Housing Diversity (Typologies)

A fully inclusive range of housing opportunities will be a key component of the proposed Structure Plan area. The conventional suburban brick and tile design in the wider south-west region is a style that could be improved within the Structure Plan area using an appropriate level of control through Building Design Guidelines. The aim is to provide choice, including affordable housing opportunities, and create its own identity and contemporary design character that is site responsive using a palette of building materials and colour.

The categories of housing that could potentially occur within the Structure Plan area include:-

- Grouped Housing
- Studios above garages
- Duplexes
- Single detached dwellings
- Special residential lots (between 0.2 - .4ha)

Medium – High Density Housing

The introduction of medium – higher density residential opportunities close to key activity nodes is a key driver to add character and vibrancy to the proposed centre. It will also help to produce a diverse and convenient community that has the added benefit of reducing daily vehicle trips. This type of product will provide an affordable housing option for the residents of the development who are close to high amenity areas and enjoy the ease of maintenance of medium - higher density housing.

Traditional Family Home

The built form for the majority of the Structure Plan area will comprise the traditional family home with lots ranging between 300 - 800m². The primary aim is to create an identity and design character that is responsive to the site's attributes and regional climate, different in style and design to the conventional brick and tile design that is prominent in the wider south west region.

In order to maintain control over the appearance of the future dwellings on site, it is intended that Building Design Guidelines will be adopted to outline performance objectives and controls that will ensure the development achieves its intended future character and makes a positive contribution to the streetscape. In addition to the typical design controls i.e. building height, setbacks, bulk and scale, style and design, landscaping etc., it is imperative to incorporate key sustainability, solar passive design and water management issues i.e. cross ventilation, rainwater tanks, deep eaves and shaded windows. These initiatives will continue to be developed as the project progresses towards the detailed planning and design stages.

Special Residential Lots

The western portion of the Structure Plan area currently contains significant vegetation. As a balanced response to this issue, the proposed Structure Plan has identified the introduction of larger residential lots (anticipated between 0.2ha - .4ha) in this location to ensure the vegetation is retained. Vegetation will be retained within individual lots and suitable building locations will be identified to ensure the values of this portion of the site are respected. The lot configuration shown on the proposed Structure Plan is indicative only and is subject to further detailed investigation during the subdivision phase to follow.

Approaches have also been made to the Department of Housing to explore opportunities for public rental housing, with the vision of responsibly integrating public housing with private ownership. These discussions are ongoing and further detailed planning will be required in the subsequent phases of development.

3.2.5 Educational Opportunities

The Structure Plan has acknowledged the importance of education in designing and establishing communities. In addition to the existing Georgiana Molloy Anglican School, a single public primary school site has been included within the proposed design.

The primary school site has been located to maximise accessibility as well as managing traffic congestion at drop-off and pick-up times by providing the facility with road frontages on three sides. Furthermore, it has been located centrally to the wider neighbourhood precincts to promote walkability and cycling.

The Department of Education and Training (DET) support the notion of co-locating educational requirements with open space and associated facilities for use by pupils during school areas and sporting groups/clubs in the evenings and on weekends. This will help to improve land efficiency and allow for the provision of smaller school sites. This concept can be delivered through the Structure Plan design. The use of school buildings for evening adult education, sharing of sporting facilities and libraries is also envisaged to deliver a wide range of community facilities to the future residents.

4.0 Technical Considerations

4.1 Environment

RPS has been commissioned to prepare an Environmental Assessment Report (EAR) (**refer Appendix C**) to inform the preparation of the Structure Plan. The EAR identifies the key environmental features present within the structure plan area, and numerous strategies to manage the key environmental assets on site. In addition to the EAR a Flora, Vegetation and Fauna Assessment was undertaken by Ecosystem Solutions to update previous surveys undertaken within the structure plan area. Copies of both reports are enclosed as **Appendix C**).

A summary of the report's findings is as follows:

4.1.1 Flora/ and Vegetation

The survey conducted by Ecosystems Solutions concluded that the following vegetation types are present within the structure plan area:

- Blackbutt/Flooded Gum/Peppermint Woodland (Degraded to Good Condition)
- Flooded Gum/Tuart/Peppermint (Degraded Condition)
- Melaleuca Woodland (Degraded to Good Condition)
- Melaleuca/Flooded Gum/Non-native Eucalypts (Degraded Condition)
- Melaleuca/Peppermint Woodland (Degraded Condition)
- Melaleuca/Flooded Gum trees (Completely Degraded Condition)
- Non-native Eucalypts/Peppermint woodland (Degraded Condition)
- Non-native Eucalypts/Melaleuca/Peppermint Woodland (Degraded to Good Condition)
- Peppermint/Marri Woodland (Good Condition)
- Tuart/Peppermint Forest (Good Condition).

The investigations confirm that no Threatened or Priority species of vegetation/flora were recorded in the site.

4.1.2 Fauna

Three Western Ringtail Possum habitat areas were identified within the site, which will be primarily retained in POS reservations and vegetated highway buffers.

Eighty-one trees were found to provide potential habitat for black cockatoos (diameter at breast height greater than 500 mm). However, only five of these contained hollows usable by black cockatoos. Given that the surrounding natural environment within the locality provides far more favourable habitat, it is unlikely that the proposed structure plan will create any significant impact on Black Cockatoo habitat. No Black Cockatoo species were observed within the subject site as part of the survey, although it is likely that the species would utilise the site opportunistically from time to time.

Although the Western Grey Kangaroo is not listed as protected under State of Commonwealth legislation, a Western Grey Kangaroo Management and Relocation Strategy is required under Schedule 3 of the Scheme.

In June 2015 the Western Grey Kangaroo Management and Relocation Strategy was reviewed and updated by Ecosystem Solutions.

4.1.3 Landform and Soils

The site can be divided into three distinct areas consisting of the northern (Zone 1), central (Zone 2) and the southern (Zone 3) area. The Busselton Sheet of the 1:50,000 Environmental Geology Series maps shows that these areas are underlain by the following geology types:

- Zone 1 – Comprises primarily sandy soil overlying variably cemented limestone.
- Zone 2 – Primarily sandy soil with interbedded zones of fines residue overlying loose to dense limestone in the northern areas.
- Zone 3 – Comprises loose sand over clayey soil.

4.1.4 Groundwater and Surface Water

A DWMS was prepared by JDA in 2009 for the Busselton Airport Structure Plan Area. The Provence Estate residential development falls within the study area of this DWMS. This document outlines the following:

- The overarching urban water management strategy for the development; and
- A framework for the application of total water cycle management.

An LWMS has been prepared by JDA Consultants to support the Provence Estate Structure Plan (refer **Appendix D**), and makes the recommendations in relation to stormwater management, flood management and water quality management and water source and sustainability initiatives within the Structure Plan area.

The report also provides a number of recommendations in relation to the implementation of the LWMS, in particular information and reporting requirements relating to:

- Urban Water Management Plan;
- Dewatering and Acid Sulfate Soils water monitoring requirements;
- Structural and non-structural controls for stormwater management;
- Sewerage and water supply;
- Water efficiency; and
- Groundwater Management.

The proposed Structure Plan has taken into consideration the recommendations and general information contained within the LWMS during the design process, and will comply with the requirements of the LWMS during the subdivision and development stages.

A detailed explanation of the stormwater management regime is outlined within the Local Water Management Strategy (LWMS) enclosed as **Appendix D**.

4.1.5 Heritage

No areas of European or Aboriginal Heritage significance fall within the Structure Plan Area.

4.1.6 Coast and Foreshores

The structure plan area does not fall within close proximity to any coastal or foreshore set-back.

4.1.7 Context and other land use constraints and opportunities

The subject land is adjacent to an active mining lease and is within a 500m separation and 1,000m notification zone for a titanium-zircon deposit, as shown in **Figure 7**.

DMIRS recommends consultation with the tenement holder in relation to the timing of mining cessation prior to future subdivision and development.

The potential for noise from future mining operations to impact the subdivision of land shall be considered at the subdivision stage.'

4.2 Bushfire Management

Ecosystem Solutions were commissioned to review the development of the Structure Plan area and review the current level of bushfire risk present within the undeveloped parts of the site. This report assesses the current vegetation, slope and other parameters present on the site under the criteria outlined in Australian Standard AS 3959-2009 *Construction of Buildings in Bushfire Prone Land*. The assessment has also been carried out in accordance with *State Planning Policy 3.7: Planning in Bushfire Prone Areas (SPP3.7) (WAPC, 2015)*.

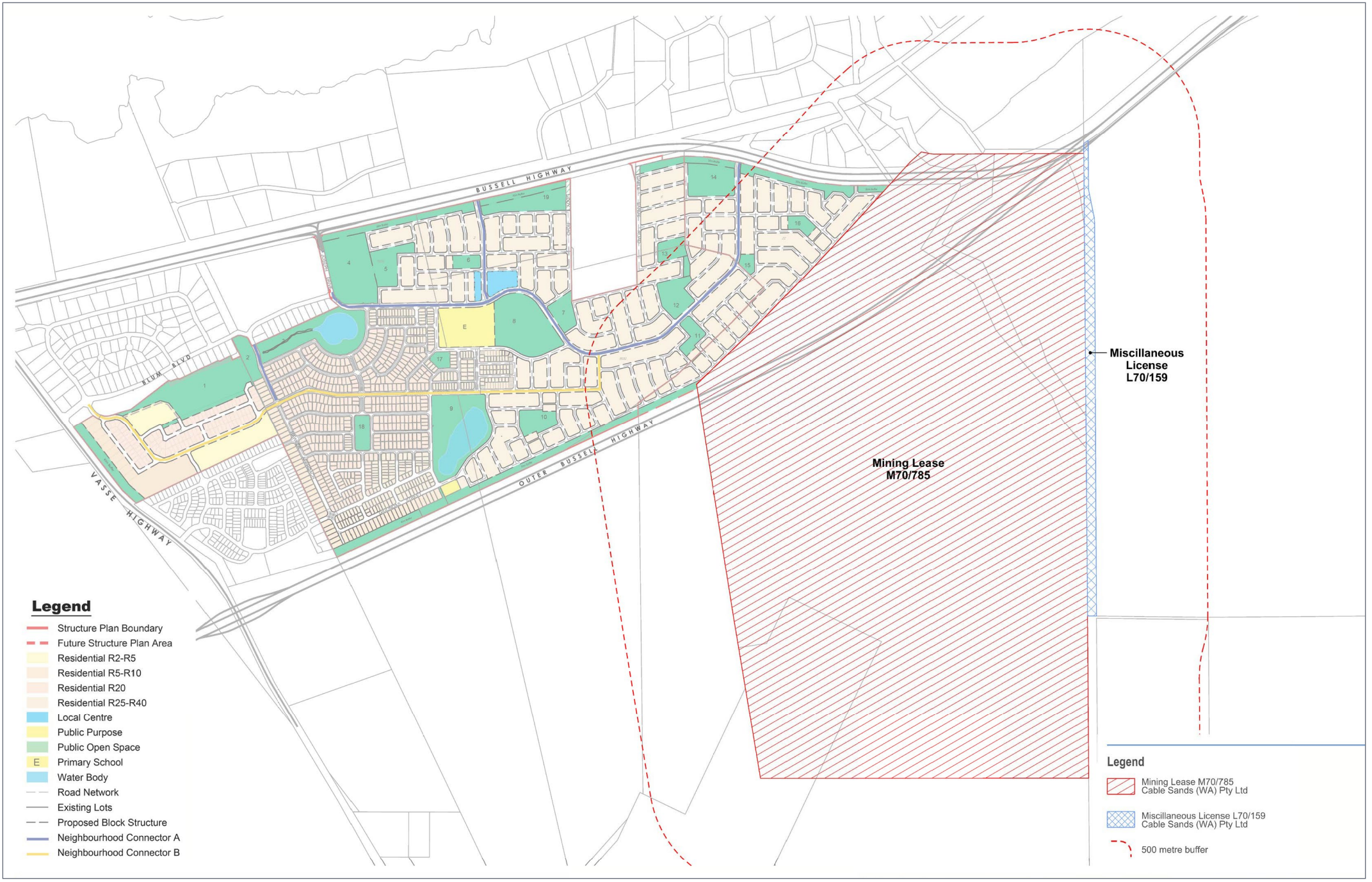
The assessment concludes that, with the inclusion of appropriate management measures, no dwelling will attract a BAL rating that exceeds BAL-29.

A detailed explanation of the recommended bushfire management regime is outlined within the Bushfire Assessment Report enclosed as **Appendix E**.

4.3 Retail Demand

MacroPlan Dimasi has been commissioned to undertake a Retail Demand Analysis to inform the size, planning and design of the commercial precinct within the Structure Plan area. The findings and recommendations of the report area as follows:

- The proposed centre will become the main community hub for food and grocery shopping and other convenience orientated purposes for residents within Provence and immediate surrounds;
- By 2021, the main trade area population is forecast to grow to 5,400 residents, from 3,170 at 2015. This population is forecast to continue to grow and can easily support the proposed commercial precinct;
- Primary sector residents will generate the majority of the retail expenditure, estimated at around $70 million at 2021;
- Based on the retail floorspace analysis, the Provence Neighbourhood Centre could support approximately 3,450m² of retail floorspace at 2021;
- The centre is estimated to be able to generate sales of $21.7 million (in constant 2014/15 dollars) at 2021, growing to $29.2 million at 2026, and around $40 million at 2031. Supermarket sales are estimated at $15.7 million at 2021;
- Gross rental potential for the retail specialty stores is estimated at around $670 per m² at an average occupancy cost ratio of 10.7%; and



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PROVENCE **FIGURE SEVEN Mining Tenement Wonnerup (L70/157) and Wonnerup South Mine (M70/785)**

- A smaller food store offer will be supportable at Provence at an earlier date.

The Retail Demand Assessment confirms that there is an opportunity for the structure plan area to accommodate a significant commercial development in the near future.

A detailed explanation of the retail demand findings is outlined within the Retail Demand Analysis enclosed as **Appendix F**.

4.4 Traffic Engineering

Jacobs was originally commissioned by the proponent to investigate and provide advice on the transport and traffic management matters associated with the proposed internal road network and the site's connectivity to the Busselton Town Centre and the wider Busselton region.

The traffic investigations involved the modelling of road network including all the major routes proposed,being the majority of the proposed access roads, neighbourhood connectors and district distributors, within the area. Main Roads WA did not accept that transport assessment and Transcore provided further details to address transport assessment related matters for the overall estate.

As a result, an access strategy has been prepared in the context of discussions between the Department of Planning, Lands and Heritage, Main Roads WA and the developer. Importantly, Main Roads WA requires further modelling and additional assessment of the standard and functionality of the internal road network links to Bussell and Vasse Highways. This forms a required implementation strategy for the implementation of agreed staged intersection upgrades and provision of new intersections. Completion of the additional transport modelling will need to be undertaken by the proponent prior to further stages of subdivision.

These details are set out in **Appendix G**.

4.5 Landscape Assessment

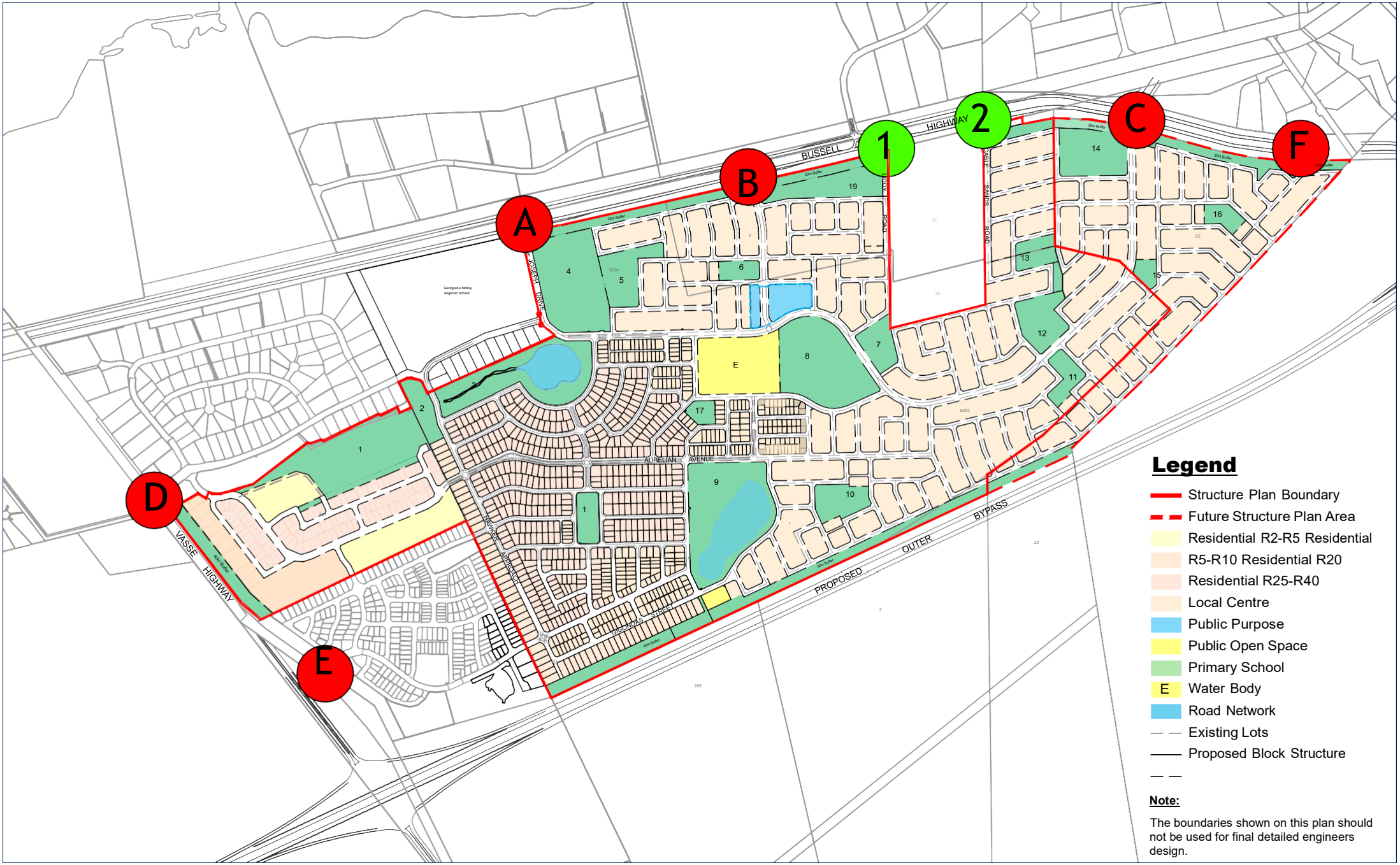
Emerge Associates have been commissioned to undertake a landscape assessment of the site's natural attributes to build upon and support the creation of a new Provence community through the provision of facilities, places, spaces, character and elements appropriate to the community's needs.

The landscape design outcomes have been closely aligned with other project disciplines, specifically civil engineering, planning, environmental and hydrology input which has served to provide an integrated design response that capitalises on the site's natural assets.

Local and district public open space provides a focal point for the development. Distribution, sizing and access will be equitable throughout and will encourage community gathering, informal recreation and activity. Where appropriate, the open space areas will include (but not limited to) vegetation and habitat retention, public facilities, barbeque facilities, interpretive signage, water features, public art and playground equipment that will compliment and soften the surrounding built form.

The following points summarise the inherent site opportunities and the intent of the Structure Plan design:

- Retain and protect existing stands of intact vegetation
- Retain and protect existing significant trees in desirable locations
- Maximise exposure to the site entry off the Busselton Bypass



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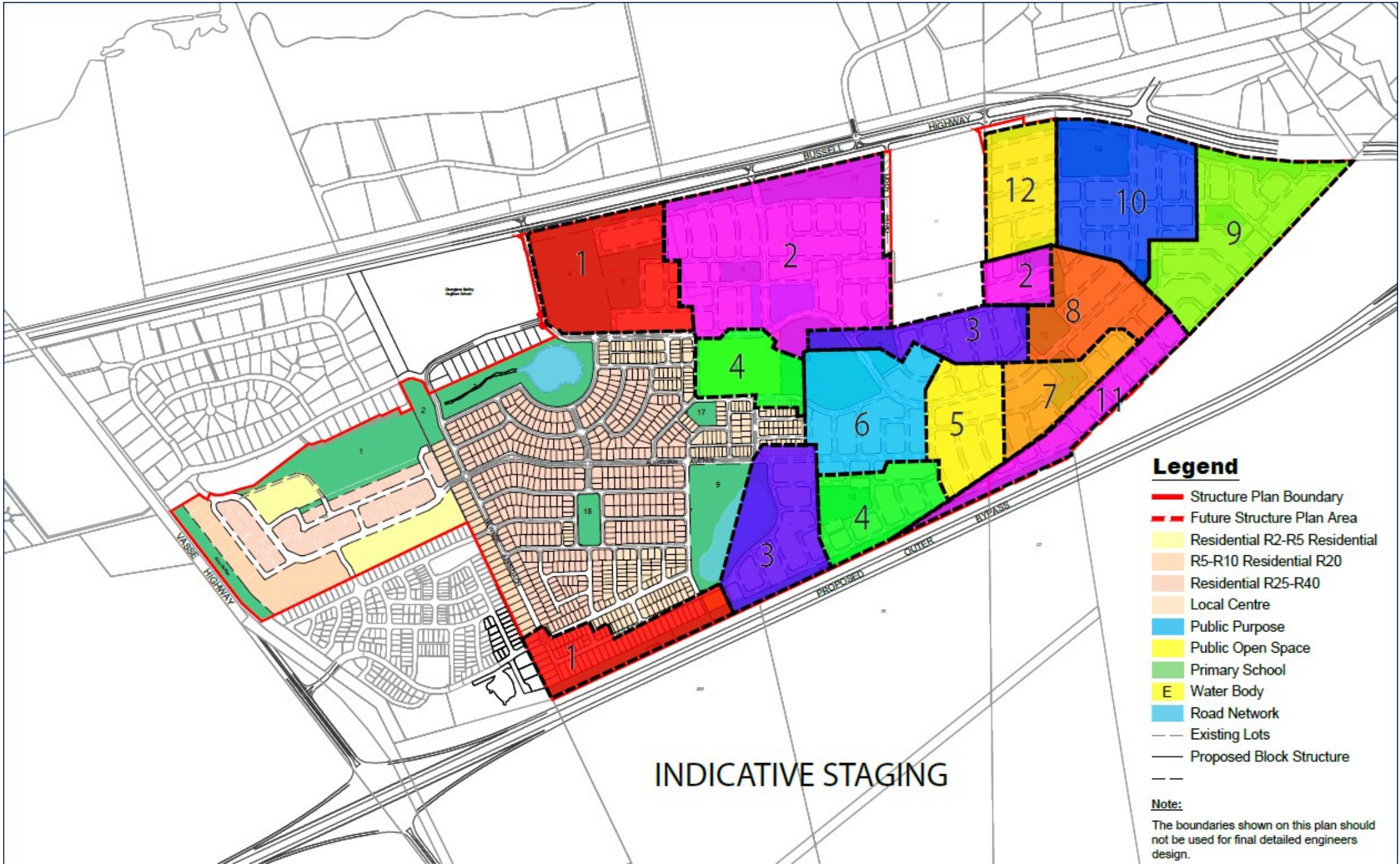
PROVENCE **FIGURE 8 ACCESS ARRANGEMENTS**

Bussell Highway & Vasse Highway, Yalyalup



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PROVENCE **STRUCTURE PLAN FIGURE 9**

Bussell Highway & Vasse Highway, Yalyalup

- Maximise pedestrian linkages throughout the development, particularly to significant attractants including shops, town centre, schools and similar.
- Maximise legibility of planning layout and access through the road hierarchy
- Provide shade, shelter and respite from the effects of the south west seasons
- Provide a wide range of recreational options and locations for residents
- Provide areas of informal open space
- Define and highlight existing open water bodies
- Utilise open space to accommodate drainage and water quality improvements
- Maximise opportunities for safe ringtail possum movement through natural areas
- Provide interpretive material reflective of the local environment and ecology
- Maximise integrated planting approach between historic, cultural and native plantings; and
- Ensure the agreed design approach extends through many elements and materials

A detailed explanation of the landscape assessment findings and recommendations is outlined within the Landscape Assessment Report enclosed as **Appendix H**.

4.6 Noise Impact

Herring Storer Acoustics were engaged to investigate potential noise impacts on the proposed Structure Plan area and to determine the required design parameters that will need to be considered during the subsequent detailed design phases of the project.

The major noise sources were categorised in terms of transport infrastructure (road/ freight and air) and future industry within the adjacent land area. The assessment was carried out in accordance with *State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning.*

The need for attenuation buffers and noise mitigation requirements to traffic and transport infrastructure has been recognised in the proposed Structure Plan. The attenuation methods outlined in the technical reporting will require further refinement during detailed investigations at the subdivision stage to follow.

The existing bushland reserve and vegetation stands along Bussell Highway road corridor will assist to provide a significant natural barrier to noise in the north. However, further planting will be carried out along this boundary in a 30m wide buffer to provide for a more effective visual and noise mitigation barrier to the development. The treatment of the landscape buffer for the residential areas immediately adjacent to the proposed Busselton Outer Bypass has been given careful design consideration to reduce noise levels and facilitate pedestrian/ cycle movement and future maintenance requirements. Cross-sections showing the treatment of this buffer are included in the Landscape Assessment Report enclosed as **Appendix H**.

A summary of the findings and recommendations of the Noise Assessment is as follows:

"The acoustic analysis indicates that for future residential Lots effected by noise from the proposed outer bypass, noise levels will be a LAeqday of 55 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."

"For residential lots adjoining the Bussell Highway, buffer zones previously determined have been included in the design of the LSP. With the inclusion of the buffers, noise levels at these façade Lots would be a LAeqday of 59 dB(A) or less. At this noise level, in strict accordance with SPP 5.4, "Quiet House" design in the form of Package A, is normally required. However, based on experience of similar projects, an external noise level of 59 dB(A), generally achieves the internal noise level criteria with standard construction.

For aircraft noise associated with the Busselton Margaret River Regional Airport (in the future) the ANEC20 noise contour is the appropriate criteria. As all parts of the Provence residential LSP are not within the stipulated criteria, there are no acoustic amelioration requirements for future residential development."

A detailed explanation of the acoustic assessment findings and recommendations is outlined within the Noise Assessment Report enclosed as **Appendix I**.

4.7 Essential Infrastructure

Wood & Grieve Engineers has been commissioned to investigate the engineering and servicing constraints for the land and present preliminary servicing strategies for the future development of the Structure Plan area.

A complete copy of the Servicing and Infrastructure Report is contained within **Appendix J** of this submission, a summary of which is outlined below.

4.7.1 Earthworks

Preliminary earthworks calculations indicate there is a shortfall of suitable fill material on site, and will therefore require imported fill. There may be an opportunity to utilise existing material from unsuitable stockpiles, although this will subject to blending testing. The subject site has been classified into three separate zones, all of which will require fill prior to development. Other options to achieve appropriate site classification can also be considered.

4.7.2 Sewerage Reticulation

The structure plan area is contained within the Water Corporation's Busselton SD090 long term scheme planning area, and as such will be serviced by a gravity fed reticulated sewer. This sewer reticulation will gravitate to a number of waste water pump station (WWPS) sites throughout the development, two of which are already constructed.

An additional WWPS is required to service the eastern areas of the development, and is currently referred to as Busselton PS "U" (PSU). The Water Corporation's planning indicates that ultimately, PSU and PS18 will both pump wastewater back up to the gravity sewer network that flows to PS20.

In order for the north-eastern area of the development to be serviced, the future Pump Station (PSU) must be constructed. This Station will be pre-funded infrastructure and it is recommended that discussions are commenced with the Water Corporation to ensure it is placed on the Corporations Capital Works Program.

4.7.3 Water Reticulation

The proposed residential area will be serviced via internal water reticulation, as is the case with the existing residential areas.

This water reticulation will be developed in accordance with Busselton Water standards for residential areas.

4.7.4 Stormwater Drainage

Stormwater drainage design will need to be established as discussed in the District Water Management Strategy (DWMS) (2009) and Local Water Management Strategy (LWMS) prepared by JDA Consultant Hydrologists. These will need to comply with relevant guidelines by relevant government authorities.

The drainage design aims to address major and minor stormwater events. Stormwater from major and minor storm events will be collected and conveyed through a network of drainage systems. In areas of relatively high groundwater the use of sub-soil drains will be considered to limit the volume of imported fill required for separation distances.

4.7.5 Telecommunications

It is likely that the Structure Plan area will be serviced by NBNCo, who will require fibre ready pit and conduit to be installed by the developer. NBNCo will undertake the fibre optic cabling installation as well as any off site headworks that may be required.

In addition to the above, there may be off site headworks to which the developer may be required to contribute. These costs are expected to be of a minor nature and can only be determined prior to commencement of the development.

4.7.6 Road Construction / Upgrades

The road network within the proposed development will connect to, and extend from, the existing road network within the existing stages of the Provence Estate. Three intersections are proposed onto Bussell Highway, with Joseph Drive existing and the others being proposed.

Intersection designs onto Bussell Highway will be undertaken in accordance with Main Roads Design and construction standards (due to control of these roads being with MRWA).

Internal roads will generally be in accordance with the City of Busselton and Liveable Neighbourhoods standards.

4.7.7 Gas Supply

ATCO Gas has confirmed that the high pressure gas network within the existing stages of the Provence Estate has capacity to supply the proposed development. As development continues east, the internal gas mains will be extended to supply future stages.

This advice is on the basis that development continues in an easterly direction, with future stages being developed adjacent to existing stages and the existing gas network. If development does not occur adjacent to the existing infrastructure, the extension of the high pressure gas mains will be required, along with installation of high pressure reducers.

4.7.8 Power

The proposed development will be serviced via underground power using standard Western Power equipment and street lighting consistent with previous stages.

A high voltage masterplan has been developed and will be updated in accordance with the project staging and lot configuration. The masterplan ensures that HV cabling and equipment use are optimised and that there is sufficient capacity for future stages. It also ensures that there are sufficient isolation/interconnection points which enhance the security of supply during network fault conditions.

5.0 Conclusion

The proposed Structure Plan aims to deliver a development outcome that embodies ‘best practice’ methods and innovative design ideas to achieve vibrant and active neighbourhoods.

The design process has embraced and adopted many of the community design principles and objectives to promote an urban structure based on walkable, mixed use neighbourhoods with individual identities and community focal points.

The Structure Plan recognises the importance and responsibility of ensuring the most efficient use of land for urban purposes, whilst respecting the ecological, environmental and conservation values of the site. Furthermore, it responds appropriately to the site’s key elements and has addressed the site specific constraints and opportunities identified.

The proposed Structure Plan is also consistent with the land use framework prescribed in the City of Busselton Local Planning Scheme No.21, draft Local Planning Strategy and other relevant State Policies and legislation.

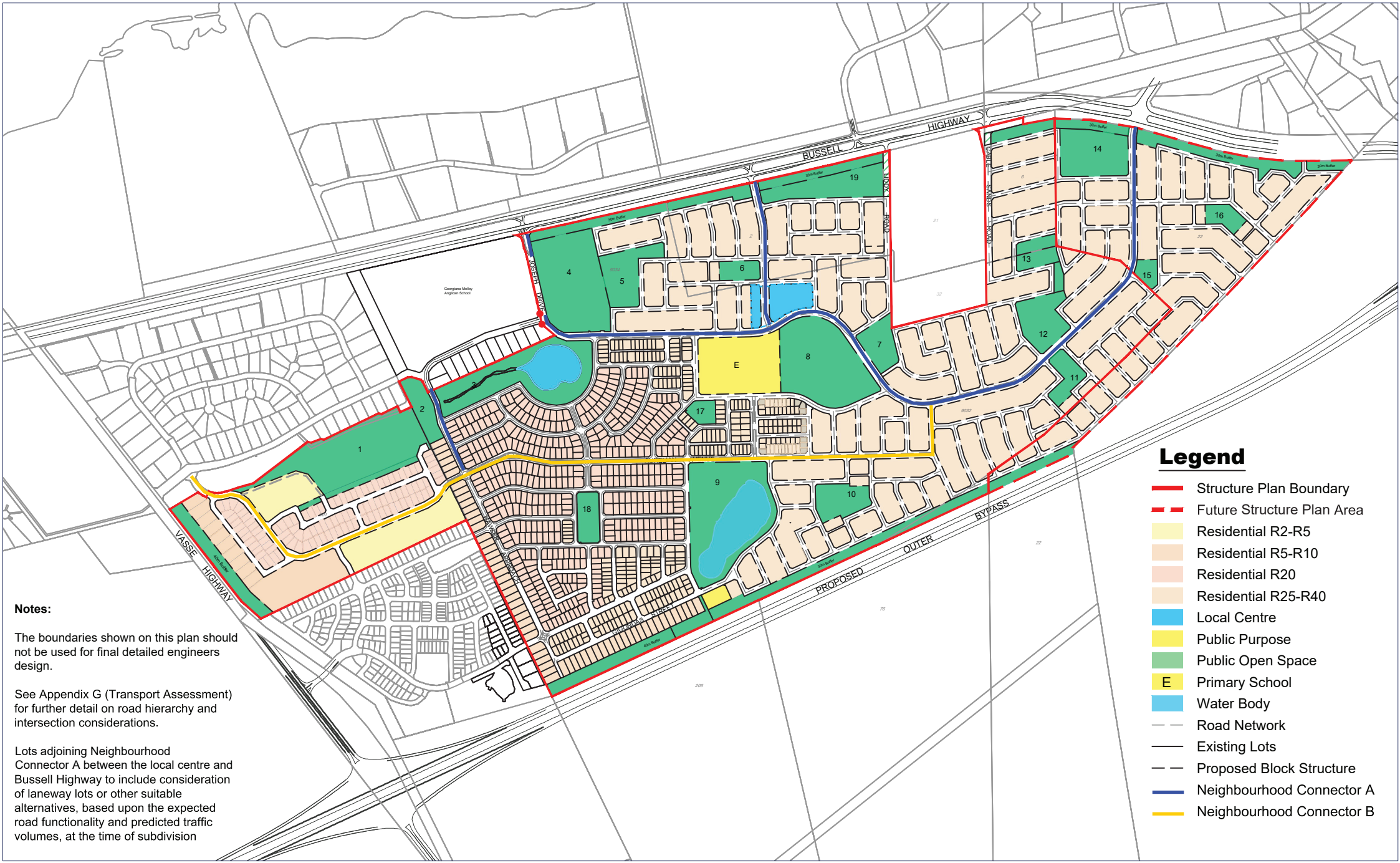
Council’s support for the proposed Provence Estate Structure Pan is therefore respectfully requested.

APPENDIX A

Proposed Structure Plan

Prepared by RPS

Amendment prepared by Taylor Burrell Barnett to address resolution of the Statutory Planning Committee (SPC)



Notes:

The boundaries shown on this plan should not be used for final detailed engineers design.

See Appendix G (Transport Assessment) for further detail on road hierarchy and intersection considerations.

Lots adjoining Neighbourhood Connector A between the local centre and Bussell Highway to include consideration of laneway lots or other suitable alternatives, based upon the expected road functionality and predicted traffic volumes, at the time of subdivision

0 100 200 300 400 500 600 700

1 : 15,000 @ A4

PROVENCE **STRUCTURE PLAN**

Bussell Highway & Vasse Highway, Yalyalup

APPENDIX B

Certificate of Title

WESTERN AUSTRALIA

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

RECORD OF CERTIFICATE OF TITLE

VOLUME 1791 FOLIO 729

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.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 2 ON DIAGRAM 28764

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

EAST BUSSELTON ESTATE PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(T I445650) REGISTERED 11 APRIL 2003

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

1. TITLE EXCLUDES THE LAND SHOWN ON DIAGRAM 28764 AS DEDICATED.
2. J181043 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 14.2.2005.
3. *K739466 MEMORIAL. CONTAMINATED SITES ACT 2003 REGISTERED 13.10.2008.
4. L393762 MORTGAGE TO BANK OF QUEENSLAND LTD REGISTERED 5.8.2010.
5. L393763 MORTGAGE TO CARINE NOMINEES PTY LTD, JOONDEL DEVELOPMENTS PTY LTD, SATTERLEY PROPERTY GROUP PTY LTD REGISTERED 5.8.2010.
6. *M447767 CAVEAT BY MINISTER FOR EDUCATION AS TO PORTION ONLY. LODGED 30.10.2013.

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

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WESTERN AUSTRALIA

REGISTER NUMBER	
6/D33959	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

VOLUME 2226 FOLIO 801

UNDER THE TRANSFER OF LAND ACT 1893

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 6 ON DIAGRAM 33959

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SILVERBAY ENTERPRISES PTY LTD OF POST OFFICE BOX 837, BUSSELTON
(T I999749) REGISTERED 27 AUGUST 2004

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

1. I999750 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 27.8.2004.

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: 2099-9 (6/D33959).
PREVIOUS TITLE: 2099-9.
PROPERTY STREET ADDRESS: 19 CABLE SANDS RD, YALYALUP.
LOCAL GOVERNMENT AREA: CITY OF BUSSELTON.

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WESTERN AUSTRALIA

REGISTER NUMBER	
203/DP32475	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	30/10/2007

RECORD OF CERTIFICATE OF TITLE

VOLUME 2223 FOLIO 978

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REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 203 ON DEPOSITED PLAN 32475

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

PROVENCE 2 PTY LTD OF 18 BOWMAN STREET, SOUTH PERTH
(T K378773) REGISTERED 16 OCTOBER 2007

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

1.	*H278093	MEMORIAL. TOWN PLANNING AND DEVELOPMENT ACT 1928. AS TO PORTION ONLY. REGISTERED 12.11.1999.
2.	*I445639	MEMORIAL. TOWN PLANNING AND DEVELOPMENT ACT 1928. REGISTERED 11.4.2003.
3.	I445640	EASEMENT TO WESTERN POWER CORPORATION. SEE INSTRUMENT I445640. REGISTERED 11.4.2003.
4.	K378774	MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 16.10.2007.

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.

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STATEMENTS:

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SKETCH OF LAND:	2223-978 (203/DP32475).
PREVIOUS TITLE:	2197-610.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	CITY OF BUSSELTON.

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WESTERN AUSTRALIA

REGISTER NUMBER	
501/P23800	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

VOLUME 2219 FOLIO 673

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REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 501 ON PLAN 23800

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

BRIAN ARTHUR BLUM
DOROTHY ALICE BLUM
BOTH OF POST OFFICE BOX 211, BUSSELTON
AS JOINT TENANTS

(A I060773) REGISTERED 18 APRIL 2002

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

1. H027671 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD AS TO THE PORTION FORMERLY COMPRISED IN CERTIFICATE OF TITLE VOLUME 2015 FOLIO 807 ONLY. REGISTERED 16.2.1999.
2. EASEMENT BURDEN CREATED UNDER SECTION 27A OF T. P. & D. ACT - SEE PLAN 23800.

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: 2219-673 (501/P23800).
PREVIOUS TITLE: 2015-808, 2015-807, 2015-806.
PROPERTY STREET ADDRESS: 113 VASSE HWY, YALYALUP.
LOCAL GOVERNMENT AREA: CITY OF BUSSELTON.

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WESTERN AUSTRALIA

REGISTER NUMBER	
9031/DP406537	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	19/11/2015

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 2887 FOLIO 585

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REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9031 ON DEPOSITED PLAN 406537

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

EAST BUSSELTON ESTATE PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF N151145) REGISTERED 19 NOVEMBER 2015

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 406537 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 406537 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 406537 AS CREATED ON DEPOSITED PLAN 54275.
4. J181043 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 14.2.2005.
5. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 60344.
6. L393762 MORTGAGE TO BANK OF QUEENSLAND LTD REGISTERED 5.8.2010.
7. L393763 MORTGAGE TO CARINE NOMINEES PTY LTD, JOONDEL DEVELOPMENTS PTY LTD, SATTERLEY PROPERTY GROUP PTY LTD REGISTERED 5.8.2010.
8. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR SEWERAGE PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 75743.
9. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 75743.
10. M330459 EASEMENT TO CITY OF BUSSELTON FOR PUBLIC ACCESS PURPOSES - SEE SKETCH ON DEPOSITED PLAN 406537. REGISTERED 11.7.2013.
11. *M447767 CAVEAT BY MINISTER FOR EDUCATION AS TO PORTION ONLY. LODGED 30.10.2013.
12. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 402320.
13. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR SEWERAGE PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 403469.
14. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR ELECTRICITY PURPOSES TO ELECTRICITY NETWORKS CORPORATION - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 403469.

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15. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 403664.
16. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 406537 AS CREATED ON DEPOSITED PLAN 403664.
17. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO LOCAL AUTHORITY - SEE DEPOSITED PLAN 406537
18. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR ELECTRICITY PURPOSES TO ELECTRICITY NETWORKS CORPORATION SEE DEPOSITED PLAN 406537

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SKETCH OF LAND:	DP406537.
PREVIOUS TITLE:	2862-581.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	CITY OF BUSSELTON.

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WESTERN AUSTRALIA

REGISTER NUMBER	
9032/DP406716	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	17/12/2015

RECORD OF CERTIFICATE OF TITLE

VOLUME 2891 FOLIO 698

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.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9032 ON DEPOSITED PLAN 406716

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

EAST BUSSELTON ESTATE PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF N151102) REGISTERED 11 DECEMBER 2015

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

1. J181043 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 14.2.2005.
2. 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.
3. L393762 MORTGAGE TO BANK OF QUEENSLAND LTD REGISTERED 5.8.2010.
4. L393763 MORTGAGE TO CARINE NOMINEES PTY LTD, JOONDEL DEVELOPMENTS PTY LTD, SATTERLEY PROPERTY GROUP PTY LTD REGISTERED 5.8.2010.
5. *M447767 CAVEAT BY MINISTER FOR EDUCATION AS TO PORTION ONLY. LODGED 30.10.2013.
6. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO LOCAL AUTHORITY - SEE DEPOSITED PLAN 406716
7. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR SEWERAGE PURPOSES TO WATER CORPORATION SEE DEPOSITED PLAN 406716
8. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER PURPOSES TO WATER CORPORATION SEE DEPOSITED PLAN 406716
9. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR ELECTRICITY PURPOSES TO ELECTRICITY NETWORKS CORPORATION SEE DEPOSITED PLAN 406716
10. N199278 EASEMENT TO CITY OF BUSSELTON FOR DRAINAGE PURPOSES SEE DEPOSITED PLAN 406716 REGISTERED 11.12.2015.

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Lot as described in the land description may be a lot or location.

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STATEMENTS:

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SKETCH OF LAND:	DP406716.
PREVIOUS TITLE:	2734-827.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	CITY OF BUSSELTON.

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APPENDIX C

Environmental Assessment Report

Prepared by RPS

ENVIRONMENTAL ASSESSMENT REPORT

Provence residential estate structure plan

EEL12334.009
Environmental assessment report
Rev 5
12 February 2020

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Draft A	Draft for client review	CliBen	GilGla	NA	01/02/2016
Rev 0	Final for issue	CliBen	GleYea	SteRol	06/04/2016
Rev 1	Final for issue	GleYea	SteRol	SteRol	03/03/2017
Rev 2	Final for issue	GleYea	SteRol	SteRol	24/08/2017
Rev 3	Final for issue	GleYea	GilGla	SteRol	11/06/2019
Rev 4	Final for issue	GleYea	GilGal	SteRol	24/06/2019
Rev 5	Final for issue	MarMcC	GleYea	SteRol	11/02/2020

Approval for issue

S. Roles 12 February 2020

This report was prepared by RPS within the terms of RPS' engagement with its client and in direct response to a scope of services. This report is supplied for the sole and specific purpose for use by RPS' client. The report does not account for any changes relating the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report. RPS does not accept any responsibility or liability for loss whatsoever to any third party caused by, related to or arising out of any use or reliance on the report.

Prepared by:

RPS

Margaret McCormack
Environmental Scientist

Level 2, 27-31 Troode Street
West Perth WA 6005

T +61 8 9211 1111
E margaret.mccormack@rpsgroup.com.au

Prepared for:

Satterley Property Group

Brenton Downing
General Manager Development (WA)

Level 2, 27-31 Troode Street
West Perth WA 6005

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Key environmental influences 2
Key environmental outcomes 2
Management commitments 3

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EXECUTIVE SUMMARY

Satterley Property Group (Satterley) has Commonwealth planning approval and is obtaining staged local and state government approvals to develop Lots 501, 9033, 9032, 2 and 6 Vasse Highway, Yalyalup for urban purposes. The 249 hectare (ha) site is in the City of Busselton, approximately 4 kilometres (km) south-east of the Busselton town site (Figure A).

The Development Guide Plan – Busselton Airport (North) (DGP) provides the current framework for future land use and development of land within the site (Figure B). The original DGP was modified and endorsed by the City of Busselton (CoB) and WAPC on 1 June 2012. Further minor "interim" revisions of the DGP have since been undertaken and endorsed by the Western Australian Planning Commission (WAPC) to ensure that all subdivision works can be completed in a manner that meets the developer's ambitions, current market demand, and development timeframes moving forward.

Seeking to create efficiencies in the urban design framework of Provence, Satterley is proposing to further modify the DGP. A revised Structure Plan (SP) has been prepared for Provence (Figure C). Areas subject to redesign included Lots 9033, 9032, and 2.

The revised SP is intended to facilitate the ongoing development in a manner that embodies best practice methods and innovative design ideas to achieve vibrant and active neighbourhoods.

Planning context

The site was formerly zoned "Agriculture", "Residential" and "Rural Residential" under the City of Busselton's (CoB) Town Planning Scheme (TPS) No. 20. TPS No. 20 was superseded by Local Planning Scheme (LPS) No. 21 in October 2014.

Under Local Planning Scheme (LPS) No. 21, the site is zoned "Special Use – Yalyalup Development", "Special Use – Yalyalup Deferred Development" and "Special Use – Yalyalup Industrial Development". A portion of the site is also reserved for "Recreation" under LPS No. 21 (Figure D).

The majority of land subject to the SP is included within the "Special Purpose – Yalyalup Development" zone and has received state and local government planning approvals to develop the land for a range of residential densities, open space, commercial, retail and educational land uses.

Existing environmental approvals

In November 2004, Provence (comprised of Lots 501, 9033, 9032, 2 and 6) was referred to the (then) Commonwealth Department of Environment and Heritage (DEH) (now the Department of the Environment and Energy (DEE)) for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The DEH approved the project, subject to conditions.

In April 2006, DEH instructed that the conditions must be implemented to ensure that significant impacts are avoided to:

- Wetlands of international importance
- Listed threatened species and communities
- Listed migratory species.

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 (DEWHA, formerly DEH). The DEH and DEWHA approvals are provided in Appendix A.

In October 2004, the CoB 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*. In August 2005, the EPA considered 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 are:

- Contamination

- Environmental Protection Policy (EPP) wetland (policy now revoked)
- Nutrient export and drainage
- Noise.

Structure plan

The DGP provides the current framework for future land use and development within Provence. The DGP divides the site into several Detailed Area Plan (DAP) precincts requiring further detailed planning prior to subdivision and/or development.

The revised SP presents the proposed modifications to the DGP and will provide guidance and context for future development at the site. The revised SP promotes the following key land uses:

- Residential
- Retail / business
- Public purpose
- POS
- Primary school
- Easement
- Water body
- Roads.

Purpose of this report

The purpose of this Environmental Assessment Report (EAR) is to:

1. Describe the existing environmental attributes of the site in accordance with the EPA's environmental factors.
2. Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development.
3. Facilitate the approval of the revised SP to provide a framework to coordinate residential subdivision and development.

Key environmental influences

Historically the site was used primarily for agricultural purposes, was previously cleared for agriculture, and therefore has limited environmental values. It has also been subject to extensive sand mining activities, which has resulted in the creation of an artificial lake.

In this context the key environmental factors considered were:

- Flora and vegetation
- Terrestrial environmental quality
- Terrestrial fauna
- Inland waters
- Social surroundings.

Key environmental outcomes

The revised SP recognises the importance of the key environmental and landscape attributes of the site and incorporates these in an urban forum that creates an environmentally responsive urban development that meets the EPA's environmental objectives.

The key environmental outcomes achieved in the revised SP are:

- Increase in the protection of western ringtail possum and black cockatoo habitat within POS reservations when compared to the previous SP. Specifically
  - 1.82 ha of additional western ringtail possum habitat has been retained
  - two additional potential black cockatoo habitat trees have been retained
- Revegetation to improve the availability of western ringtail possum habitat and creation of a northern "ecological linkage"
- Implementation of best practice water sensitive urban design and stormwater drainage management
- Implementation of management measures to reduce potential noise and fire impacts on future residences.

Management commitments

Table 1 summarises the potential environmental impacts to the key environmental factors and the proposed mitigation measures.

This EAR concludes that through the implementation of the proposed mitigation measures the subdivision and development of the site, in accordance with the revised SP, will meet the EPA's environmental objectives for the assessed environmental factors.

Table 1: Summary of environmental factors, potential impacts and proposed mitigation measures

Flora and vegetation		
Potential impacts	The site's historical use for sand mining and agriculture has resulted in the clearing and fragmentation of vegetation and reduction of native vegetation cover to minimal areas. Consequently, it is anticipated that the SP would have very little impact on flora and vegetation values.	
Mitigation	• Revised SP has resulted in a 1.55 ha increase in native vegetation retention. • Remnant vegetation within POS reservations will be retained. • Remnant trees will be retained where practicable within POS reservations and road reserves. • Access restrictions using fences and signage to prevent unauthorised access to native vegetation retained within POS reservations. • Revegetation with local native species where possible.	
Terrestrial environmental quality		
Potential impacts	Acid sulfate soils	Acidification and release of heavy metals from Acid Sulfate Soils (ASS) into the terrestrial environment, underlying groundwater and surrounding freshwater environments.
	Potential contamination	The site has been historically used for 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 following management and treatment plans, which outline the soil and dewatering effluent treatment measures, environmental monitoring requirements and contingency measures to minimise any environmental impacts to the satisfaction of the Department of Water and Environmental regulation (DWER): – 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) – Acid Sulfate Soils and Dewatering Management Plan Addendum – Provence Stage 13 (RPS 2018). • Revised Addendum / ASS Management Plan is required to be approved by DWER to regulate the future management of ASS outside of Stage 13.
	Potential contamination	Remediation of contaminated land will be undertaken in accordance with the *Contaminated Sites Act 2003* to ensure the site is suitable for residential land uses.
Terrestrial fauna		
Potential impacts	• Permanent loss of up to 10 potential black cockatoo habitat trees. • Permanent loss of up to 1.39 ha of western ringtail possum habitat. • 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	• Revised SP has resulted in a 1.82 ha increase in western ringtail possum habitat retention with 2 additional potential Black Cockatoo habitat trees retained. • Implementation of the Western Ringtail Possum (*Pseudocheirus occidentalis*) Management Plan (Coffey 2009) and Western Grey Kangaroo Survey and Management Plan (Ecosystem Solutions 2015). • Highway buffers will be revegetated using species known to be of habitat value for western ringtail possums to create an ecological linkage along the site's northern boundary	

Flora and vegetation		
	• 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. • Variation to EPBC 2004 / 1878 is proposed to be prepared and referred to the DEE	
Inland waters		
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) are required to be completed at subdivision stage to the satisfaction of the CoB, on advice from the DWER.	
Social surroundings		
Potential impacts	Aboriginal heritage and culture	Excavation / construction activities may unearth and/or damage artefacts or other items of Aboriginal cultural significance.
	Noise	Noise associated with current and future road traffic, and the Busselton-Margaret River Regional Airport, has the potential to impact the amenity of future residents.
	Mosquitoes	Wetlands and low-lying areas susceptible to high groundwater levels can support mosquito breeding. Mosquitoes are known to cause nuisance and serious health risks to people.
	Fire	• Damage to property and infrastructure from fire. • Death and/or injury of people/fauna due to fire.
Mitigation	Aboriginal heritage and culture	• Apply for approval to disturb Hill's Campsite (Place ID: 18985) under Section 18 of the *Aboriginal Heritage Act 1972* (if required). • 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	An acoustics assessment will be undertaken to support of the SP. The noise mitigation measures recommended in the acoustics assessment will be incorporated into the subdivision design and / or 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	Outcomes identified in the Bushfire Management Plans (Ecosystem Solutions 2017 and 2019) will be incorporated into the future subdivision design and construction framework.

1 INTRODUCTION

1.1 Background

Satterley Property Group (Satterley) has Commonwealth planning approval and is obtaining staged local and state government approvals to develop Lots 501, 9033, 9032, 2 and 6 Vasse Highway, Yalyalup for urban purposes. The 249 hectare (ha) site is in the City of Busselton, approximately 4 kilometres (km) south-east of the Busselton town site (Figure A).

The Development Guide Plan – Busselton Airport (North) (DGP) provides the current framework for future land use and development of land within the site (Figure B). The original DGP was modified and endorsed by the City of Busselton (CoB) and WAPC on 1 June 2012. Further minor "interim" revisions of the DGP have since been undertaken and endorsed by the Western Australian Planning Commission (WAPC) to ensure that all subdivision works can be completed in a manner that meets the developer's ambitions, current market demand and development time frames moving forward.

Development of the endorsed DGP area has been facilitated through the approval of Detailed Area Plans (DAPs) and conditional subdivision approvals issued. DAPs 1 to 4 have previously been adopted by Council in accordance with provisions of the Scheme. Approximately 665 lots have been constructed and sold including the delivery of extensive feature lakes, public open space and conservation reserve areas. This represents approximately 25% of the estate.

Seeking to create efficiencies in the urban design framework of Provence, Satterley is proposing to further modify the DGP. A revised Structure Plan (SP) has been prepared for Provence that presents the revised planning framework for the site (Figure C). Areas subject to redesign included Lots 9033, 9032, and 2.

The revised SP is intended to facilitate the ongoing development in a manner that embodies best practice methods and innovative design ideas to achieve vibrant and active neighbourhoods. Urban development of the land will occur in accordance with the proposed scheme amendment, and subdivision of land to follow. This approach allows for specific portions of the SP area to be progressed based on individual landowner intentions.

1.1.1 Local planning scheme context

The site was formerly zoned "Agriculture", "Residential" and "Rural Residential" under the CoB's Town Planning Scheme (TPS) No. 20. TPS No. 20 was superseded by Local Planning Scheme (LPS) No. 21 in October 2014.

Under Local Planning Scheme (LPS) No. 21, the site is zoned "Special Use – Yalyalup Development", "Special Use – Yalyalup Deferred Development" and "Special Use – Yalyalup Industrial Development". A portion of the site is also reserved for "Recreation" under LPS No. 21 (Figure D).

The majority of land subject to the SP is included within the "Special Purpose – Yalyalup Development" zone and has received state and local government planning approvals to develop the land for a range of residential densities, open space, commercial, retail and educational land uses.

1.1.2 Environmental assessment approvals

1.1.2.1 *Environment Protection and Biodiversity Conservation Act 1999*

In November 2004, Provence (comprised of Lots 501, 9033, 9032, 2 and 6) was referred to the (then) Commonwealth Department of Environment and Heritage (DEH) (now the Department of the Environment and Energy (DEE)) for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The DEH approved the project subject to conditions.

In April 2006, DEH instructed that the conditions must be implemented to ensure that significant impacts are avoided to:

- Wetlands of international importance
- Listed threatened species and communities
- Listed migratory species.

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 (DEWHA, formerly DEH). The DEH and DEWHA approvals are provided in Appendix A.

1.1.2.2 Planning scheme amendment

In October 2004, the CoB 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*. In August 2005, the EPA considered 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 are:

- Contamination
- Environmental Protection Policy (EPP) wetland (policy now revoked)
- Nutrient export and drainage
- Noise.

The EPA's advice is provided in Appendix B.

1.1.2.3 Subdivision approval context

In addition to the western ringtail possum (*Pseudocheirus occidentalis*) Management Plan and Water Management Strategy, prior to and during subdivision the following management plans have been prepared and implemented:

- 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 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 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).

1.2 Purpose of this report

The purpose of this Environmental assessment report (EAR) is to:

1. Describe the existing environmental attributes of the site in accordance with the EPA's environmental factors.
2. Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development.
3. Facilitate the approval of the revised SP to provide a framework to coordinate residential subdivision and development.

1.3 Abbreviations

ASS	Acid sulfate soils
DAP	Detailed area plans
DEH	Department of Environment and Heritage
DER	Department of Environmental Regulation
DFES	Department of Fire and Emergency Services
DWER	Department of Water and Environmental Regulation
DEWHA	Department of Environment, Water, Heritage, and the Arts
DGP	Development guide plan
DEE	Department of the Environment and Energy
EPA	Environmental Protection Authority
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
LPS	Local planning scheme
SP	Structure plan
m AHD	metres Australian Height Datum
POS	Public open space
TPS	Town planning scheme
WAPC	Western Australian Planning Commission.

2 STRUCTURE PLAN

2.1 Description

The DGP provides the current framework for future land use and development within Provence. The DGP divides the site into several Detailed Area Plan (DAP) precincts requiring further detailed planning prior to subdivision and/or development.

The revised SP presents the proposed modifications to the DGP and will provide guidance and context for future development at the site. The revised SP promotes the following key land uses:

- Residential
- Retail / business
- Public purpose
- POS
- Primary school
- Easement
- Waterbody
- Roads.

The land is strategically located at the south-eastern edge of the existing Busselton urban front and central to the future development of the Shire of Busselton region. The site affords 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.

2.1.1 Response to Environmental Protection Bulletin No. 20

The revised SP 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):

- Locating proposed future development in historically cleared parts of the site
- Protecting the consolidated naturally vegetated areas 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.

2.2 Key environmental influences

The key environmental influences of the revised SP were:

- Western ringtail possum habitat
- Water quality and drainage in the Vasse-Wonnerup Estuary catchment
- Wetland management.

2.3 Land use

2.3.1 Previous and existing land uses

A review of historical aerial photography, from 1996 to 2014, shows that most of the site has been cleared of native vegetation since 1996 (or before) and used primarily for agricultural purposes. The site has also been subject to extensive sand mining activities, which resulted in the creation of an artificial lake.

The Busselton Meats Facility was formerly located within Lot 2.

The site currently comprises largely of grassed paddocks and the constructed stages of the Provence residential estate. Small areas of remnant vegetation are predominately located within Lots 501, 9033 and 9032.

2.3.2 Surrounding land uses

The site is generally bordered by agricultural paddocks on the western and southern boundaries. The north of the site is generally bordered by Bussell Highway.

The Vasse-Wonnerup Estuary is located approximately 750 metres to the north of the site, with the Busselton-Margaret River Regional Airport situated approximately 1.5 km to the south.

The Sabina River is located approximately 350 m east of the site and the Cable Sands mineral sands mine is operating 1 km east of the site.

3 LEGISLATIVE AND POLICY FRAMEWORK

3.1 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 2.

Table 2: Key state and Commonwealth legislation and regulations

State legislation	
Aboriginal Heritage Act 1972	*Fire and Emergency Services Act 1998*
Biodiversity Conservation Act 2016	*Health Act 1911*
Contaminated Sites Act 2003	*Heritage Act 2018*
Environmental Protection Act 1986	*Land Administration Act 1997*
Environment Protection Regulations 1987	*Planning and Development Act 2005*
Environmental Protection (Noise) Regulations 1997	*Rights in Water and Irrigation Act 1914*
Commonwealth legislation	
Environment Protection and Biodiversity Conservation Act 1999	Environment Protection and Biodiversity Conservation Regulations 2000

3.1.1 Applicable guidelines and standards

Development of the site is required to comply with applicable guidelines and standards developed by the EPA. These guidelines and standards 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. Table 3 details the key EPA standards, guidelines and state planning policies relevant to the site.

Table 3: 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
State Planning Policy (SPP) 5.4: Road and Rail Transport Noise
SPP No. 3.7: Planning in Bushfire Prone Areas

4 LAND FACTORS

4.1 Flora and vegetation

A flora and vegetation assessment of the site was undertaken by ATA Environmental in 2003 (ATA Environmental 2004a). Given that a significant period of time has elapsed since the ATA survey, RPS considered it appropriate to re-survey the site to inform this Environmental Assessment Report. A supplementary Level 1 Flora and Vegetation Survey, conducted in accordance with the EPA's Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia (EPA 2004a), was undertaken by Ecosystem Solutions in December 2015–January 2016 (Appendix C). 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).

4.1.1 Vegetation

Vegetation mapping undertaken by Havel and Mattiske (2000) described one vegetation complex within the site:

- Ludlow (Lw) – Open woodland of *Melaleuca rhaphiophylla* and sedgelands of Cyperaceae and Restionaceae species on broad depressions in the subhumid zone.

Vegetation types are considered underrepresented if there is less than 30% of their original distribution remaining. It is estimated that 24% of the Ludlow vegetation type remains (Webb et al. 2009, cited in Ecosystem Solutions 2016).

4.1.1.1 Flora and vegetation survey

Ecosystem Solutions (2016) found that 10 vegetation types of varying condition occurred within the site (Figure E):

- Blackbutt/flooded gum/peppermint woodland (Degraded to Good Condition)
- Flooded gum/tuart/peppermint (Degraded Condition)
- Melaleuca woodland (Degraded to Good Condition)
- Melaleuca/flooded gum/non-native eucalypts (Degraded Condition)
- Melaleuca/peppermint woodland (Degraded Condition)
- Melaleuca/flooded gum trees (Completely Degraded Condition)
- Non-native eucalypts/peppermint woodland (Degraded Condition)
- Non-native eucalypts/melaleuca/peppermint woodland (Degraded to Good Condition)
- Peppermint/marri woodland (Good Condition)
- Tuart/peppermint forest (Good Condition).

Ecosystem Solutions (2016) identified that no Threatened or Priority species were recorded in the site.

4.1.1.1.1 Structure plan context

Table 4 provides a summary of the extent of remnant vegetation provided by the previous SP compared to the revised SP.

Table 4: Summary of remnant vegetation retention

Land use	Area (ha)	Percentage (%)	Variance with previous SP (ha)
Previous SP			
Remnant vegetation within POS	12.79	56	-
Remnant vegetation outside of POS	10.13	44	-

Land use	Area (ha)	Percentage (%)	Variance with previous SP (ha)
Revised SP			
Remnant vegetation within POS	14.34	66	+1.55
Remnant vegetation outside of POS	7.26	34	-2.87

Table 4 shows the revised SP results a 1.55 ha increase in remnant vegetation retention within POS areas.

4.2 Landforms

4.2.1 Topography

The site is characterised by low-lying flat topography with a slight slope increasing to the south (Coffey 2010). Elevation ranges from approximately 3.5 metres Australian Height Datum (m AHD) in the north to approximately 7.0 m AHD in the south (Figure F).

4.2.2 Soils and geology

The Ludlow Plain land system underlies the site (Coffey 2010). Ludlow Plain is formed on aeolianite and calcaranite of the Tamala limestone (Tille and Lantske 1990, cited in Coffey 2010).

Geology within the site is characterised by four geological units (Figure F6):

- Limestone (LS7) – light yellow brown fine, fine to coarse grained, sub-angular to well-rounded quartz, shell and corals common, of marine origin.
- Clayey Peatey 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.

4.3 Terrestrial environmental quality

4.3.1 Acid sulfate soils

According to the Department of Water and Environmental Regulation's (DWER) Acid Sulfate Soil (ASS) risk mapping, most of the site is characterised by soil with a "moderate to low" risk of encountering ASS within depths greater than three metres (Figure G). A narrow corridor of soil with a "high to moderate" risk of encountering ASS at depths greater than three metres is in the northern portion of the site, orientated in an east-west direction.

The entire SP area, has been subject to ASS investigations:

- In August 2005, ATA Environmental collected soil samples from 43 locations and identified Potential ASS at 24 locations in the field, typically 0–1.5 metres below ground level (mbgl) and 4–5 mbgl. These results informed the development of an Acid Sulfate Soil Management Plan (ASSMP) (ATA Environmental 2006).
- Coffey Environments undertook a further ASS investigation in February 2010. They collected soil samples at 15 locations. Their results were generally consistent with the ATA's findings. Based on Coffey's findings an updated ASSMP (Coffey 2010) was prepared. The updated ASSMP was approved by the (then) Department of Environment and Conservation on 4 February 2011 and valid for a period of two years. Subsequently, a two-year extension to the approval was granted on 1 February 2013.
- In 2013, RPS reviewed the specific management requirements for DAP 3 and 4. No further field assessments were included in this investigation.

On 7 December 2015, an Addendum (RPS 2015a) to the ASSMP was submitted to the (then) Department of Environmental Regulation (DER; now the Department of Water and Environmental Regulation (DWER)). The Addendum updated the management component of the ASSMP in accordance with the DER guideline Treatment and Management of Soil and Water in Acid Sulfate Soils Landscapes (DER 2015a). The DER approved the Addendum on 13 January 2016 and provided an extension to the ASSMP for a further two years. The DER advised that the Addendum is suitable to cover works in DAP 3 and DAP 4 only and works outside these areas will require further ASS investigations.

Another Addendum (RPS 2018) for Stage 13 was submitted to the DWER on 28 November 2018, prior to the expiry of RPS (2015a). The DWER approved the Addendum on 14 December 2018. A revised Addendum / ASSMP is required to be approved by DWER to regulate the future management of ASS outside of Stage 13.

4.3.2 Potential contamination

A search of DWER's Contaminated Sites Database was undertaken in January 2020. No matches were recorded for the site.

4.3.2.1 Busselton Meats Facility

The Busselton Meats Facility formerly occupied a 1.9 ha area in the north-west corner of Lot 2 (Figure H). A series of contamination assessment reports for this site were undertaken in 2004 by ATA Environmental, which confirmed 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, the DER classified the site under the *Contaminated Sites Act 2003* as "Possibly Contaminated – Investigation Required".

Given the initial investigations completed by ATA were prior to enforcement of the Contaminated Sites Regulations, additional assessments must be undertaken in accordance with the Contaminated Sites Management Series, in order to reclassify the site to allow urban development to proceed.

4.3.2.2 DAP 3

The area of the site covered by approved Detailed Area Plan 3 has not been classified under the *Contaminated Sites Act 2003*. However, it is subject to Condition 13 of WAPC application No. 151654, which relates to contamination. An investigation into potential soil and groundwater contamination has been undertaken to address this condition. This has included a Preliminary Site Investigation (PSI), a Sampling and Analysis Plan (SAQP) and targeted Detailed Site Investigation (DSI) (RPS 2015b).

On 16 September 2016 the DER advised that the DAP 3 area had been classified as "Not contaminated – unrestricted use".

4.3.2.3 Proposed inert waste recycling facility

An inert waste recycling facility has been proposed for operation in Lot 6, Cable Sands Road (Figure H). There is potential for this facility to generate dust containing contaminants such as asbestos that could impact on the site. An Asbestos Management Plan and Dust Management Plan have been proposed for this facility, to minimise the risk of asbestos and dust emissions to surrounding land users.

4.4 Terrestrial fauna

In February 2003, ATA Environmental undertook a targeted western ringtail possum survey for the site (ATA Environmental 2004b). Given fauna species are 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 Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia (EPA 2004b) in December 2015–January 2016 (Appendix C; 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).

4.4.1 Conservation significant fauna species

4.4.1.1 Western ringtail possum

Ecosystem Solutions (2016) identified three key western ringtail possum habitat areas within the site (Figure I) (Appendix C). These key habitat areas will primarily be retained by the revised SP in POS reservations, which include vegetated extents in highway buffers.

4.4.1.2 Black cockatoos

Eighty-one trees were found to provide potential habitat for black cockatoos (diameter at breast height greater than 500 mm) (Ecosystem Solutions 2016). However, only five of these contained hollows usable by black cockatoos. The five trees with suitable hollows to support potential breeding activities have been retained by the revised SP.

No black cockatoos were seen or heard during any of the surveys and no signs of feeding or feathers was recorded (Ecosystems Solutions 2016). Better quality habitat exists in the Tuart Forest National Park (2 km north-east) and other state forests nearby (10 km south). Since the broader area contains a large amount of potential habitat, it is unlikely that black cockatoos are reliant on habitat in the site (Ecosystems Solutions 2016).

4.4.1.3 Other conservation significant species

Other species of conservation significant fauna, identified by the desktop review, were not detected during the field survey. Ecosystem Solutions (2016) concluded that these species would be unlikely to be impacted by the development of the site.

4.4.1.4 Structure plan context

Table 5 provides a summary of the extent of fauna habitat provided by the previous SP compared to the revised SP.

Table 5: Summary of key fauna habitat retention

Land use	Area (ha)	Percentage (%)	Variance with previous SP (ha)
Previous SP			
Western ringtail possum habitat within POS	8.53	75	-
Western ringtail possum habitat outside of POS	2.77	25	-
Potential black cockatoo habitat trees within POS	65	80	-
Potential black cockatoo habitat trees outside of POS	16	20	-
Revised SP			
Western ringtail possum habitat within POS	10.35	88	+1.82 / +13%
Western ringtail possum habitat outside of POS	1.39	12	-1.38 / -13%
Potential black cockatoo habitat trees within POS	67	87	+2 trees
Potential black cockatoo habitat trees outside of POS	10	13	-6 trees

Table 5 shows the revised SP results a 1.82 ha increase in western ringtail possum habitat retention and an increase of two potential black cockatoo habitat trees.

4.4.2 Other fauna

4.4.2.1 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.

4.4.3 EPBC Act approval

In conditionally approving the (then) proposed Provence action (EPBC 2004 / 1878) in April 2006 and variation in July 2008, the DEH (now DEE) has regulated the environmental impacts to Matters of National Environmental Significance, including western ringtail possums and black cockatoos, at the site.

A variation to EPBC 2004 / 1878 is proposed to be prepared and referred to the DEE to address the amendments to the SP.

5 WATER FACTOR

5.1 Inland waters

5.1.1 Groundwater

The site is located within the Busselton-Capel Groundwater Area and within the Busselton-Yarragadee sub-area.

Groundwater beneath the site is characterised by an unconfined superficial aquifer that overlies the Leederville and Yarragadee formations at depth. The superficial aquifer has a saturated thickness of approximately five metres. and a shallow water table with a seasonal variation in elevation of between 0.5 m and 2 m (JDA Consulting Hydrologists 2008).

Recharge is by direct rainfall infiltration and upward discharge from the underlying Leederville Formation (JDA Consulting Hydrologists 2008).

Groundwater monitoring has been undertaken within the site during preliminary ASS investigations and monitoring for construction of the initial stages of the estate. Groundwater elevation has been shown to range from 1 m AHD to 5 m AHD across the site and flows in a north to north-west direction towards the coast at Geographe Bay. Groundwater discharge also occurs to the Vasse Wonnerup Estuary and existing tributary drains (JDA Consulting Hydrologists 2008).

5.1.2 Surface water

The key natural surface water features 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 its intrinsic value as habitat for waterbirds and fish, the Vasse-Wonnerup Estuary has been listed under the Ramsar Convention as a wetland of international importance.

Two artificial lakes are located within the site.

5.1.3 Drainage

The DEH EPBC approval conditions require a Water Management Strategy to be prepared and implemented during development of the site (Appendix B). The updated Water Management Strategy was approved by DEWHA in 2008.

To comply with the provisions contained in Better Urban Water Management (WAPC 2008), Urban Water Management Plans (UWMPs) are to be prepared at subdivision stage.

5.1.4 Wetlands

Table 6 identifies the management objectives for all the three categories of geomorphic wetland.

Table 6: Wetland management categories and objectives

Management category	General description	Management objectives
Conservation	Wetlands support a high level of ecological attributes and functions	Highest priority wetlands. Objective is preservation of wetland attributes and functions through various mechanisms including: • Reservation in national parks, Crown reserves and state-owned land • Protection under environmental protection policies • Wetland covenanting by landowners. These are the most valuable wetlands and the Commission will oppose any activity that may lead to the further loss or degradation. No development.

Management category	General description	Management objectives
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is for management, restoration and protection towards improving their conservation value. These wetlands have the potential to be restored to conservation category. This can be achieved by restoring wetland structure, function and biodiversity. Protection is recommended through several mechanisms.
Multiple Use	Wetlands with few important ecological attributes and functions remaining	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through land care. Should be considered in strategic planning.

Source: Water and River Commission 2001

5.1.4.1 Swan Coastal Plain geomorphic wetland mapping

Figure J presents the current Swan Coastal Plain geomorphic wetland mapping for the site and identifies that linear Multiple Use wetlands are mapped across the site, generally orientated in an east to west direction. The southern boundary of the site intersects the northern perimeter of a large palusplain.

A wetland on the northern margin of the site was formerly protected by the Environment Protection (Swan Coastal Plain Lakes) Policy Approval Order 1992. In accordance with the Environmental Protection Policy (EPP), when issuing their advice in 2004 the EPA considered that a buffer of at least 50 metres was appropriate for this wetland (Appendix B).

According to ATA Environmental (2004a), this wetland has been inaccurately mapped and was considered unlikely to be of conservation significance.

On 20 November 2015, the EPA revoked the Environment Protection (Swan Coastal Plain Lakes) Policy Approval Order 1992, which removed the statutory protection afforded to the former EPP wetland.

6 PEOPLE FACTOR

6.1 Social surroundings

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 January 2020. No Registered Heritage Places were recorded; however one Other Heritage Places intersects the site.

Hill's Campsite (ID 18985) is located within a POS reservation in Lot 501 (Figure K).

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 January 2020. No matches were recorded for the site.

6.1.3 Amenity

6.1.3.1 Noise

Bussell Highway borders the site's northern boundary and the proposed outer bypass lies directly to the south of the site (Figure A). Noise associated with current and future road traffic has the potential to impact the amenity of future residential development within the site.

An inert waste recycling facility has been proposed for operation in Lot 6, Cable Sands Road (Figure H). Existing residents could be impacted by noise (plant and truck movements) from the facility. 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 Provence have historically been assessed at the subdivision stage, and previous stages have been 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.

An acoustics assessment will be undertaken to support the SP. The noise mitigation measures recommended in the acoustics assessment will be incorporated into the subdivision design and / or the constructed development.

6.1.3.2 Mosquitoes

The SP area 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 serious health risks and cause considerable nuisance to residents and visitors to the City of Busselton (ATA Environmental 2007). 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.

6.1.3.2.1 Mosquito management plan

The key objectives of the ATA Environmental (2007) 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 carried out 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 are 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 will be managed in accordance with the endorsed Mosquito Management Plan, Provence Estate, Busselton (ATA Environmental 2007).

6.1.3.3 Bushfire risk

A search of the Department of Fire and Emergency Services' (DFES) Bush Fire Prone Areas Map was undertaken in January 2020, which identified portions of site as bushfire prone (Figure L).

6.1.3.3.1 Bushfire management plan

A Bushfire Management Plan, inclusive of a Bushfire Hazard Level assessment, was prepared in support of the previous SP by Ecosystem Solutions (Appendix D; Ecosystem Solutions 2017). Ecosystem Solutions (2017). Subsequently a Bushfire Management Plan has also been prepared for Part Lot 75 (Appendix D; Ecosystem Solutions 2019).

The aim of the Ecosystem Solutions (2017 and 2019) plans is to reduce the impacts to residents and fire fighters in the event of bushfire within or near the site. The Ecosystem Solutions (2017 and 2019) plans 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.

The outcomes identified in the Ecosystem Solutions (2017 and 2019) plans will be incorporated into the future subdivision design and construction framework of the Provence residential development.

7 POTENTIAL IMPACTS AND PROPOSED MITIGATION

Potential environmental impacts associated with Provence were originally assessed to support the Amendment No. 83 and were based on the proposed DGP design.

Table 7 details potential environmental impacts and proposed mitigation measures associated with the revised SP. Each environmental factor is addressed in the same format, using a series of four sub-headings as follows:

- EPA objective: States the EPA's objective for the environmental factor in accordance with Statement of Environmental Principles, Factors and Objectives (EPA 2018).
- Policy and guidance: Places the environmental factor in context of the appropriate policy framework.
- Potential impacts: Describes the potential environmental impacts that might arise from the proposed development. This may take the form of impacts of the development on the environment, or constraints the environment might represent to successfully realise the project.
- Mitigation: Details proposed environmental management response to address the potential impacts.

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 use for sand mining and agriculture has resulted in the clearing and fragmentation of vegetation and reduction of native vegetation cover to minimal areas. Consequently, it is anticipated that the SP would have very little impact on flora and vegetation values.	
Mitigation	• Revised SP has resulted in a 1.55 ha increase in native vegetation retention. • Remnant vegetation within POS reservations will be retained. • Remnant trees will be retained where practicable within POS reservations and road reserves. • Access restrictions using fences and signage to prevent unauthorised access to native vegetation retained within POS reservations. • Revegetation with local native species 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	Acidification and release of heavy metals from Acid Sulfate Soils (ASS) into the terrestrial environment, underlying groundwater and surrounding freshwater environments.
	Potential contamination	The site has been historically used for 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 following management and treatment plans, which outline the soil and dewatering effluent treatment measures, environmental monitoring requirements and contingency measures to minimise any environmental impacts to the satisfaction of the Department of Water and Environmental regulation (DWER): – 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) – Acid Sulfate Soils and Dewatering Management Plan Addendum – Provence Stage 13 (RPS 2018). • Revised Addendum / ASS Management Plan is required to be approved by DWER to regulate the future management of ASS outside of Stage 13.

Flora and vegetation		
	Potential Contamination	Remediation of contaminated land will be undertaken in accordance with the *Contaminated Sites Act 2003* to ensure the site is suitable for residential land uses.
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	• Permanent loss of up to 10 potential black cockatoo habitat trees. • Permanent loss of up to 1.39 ha of western ringtail possum habitat. • 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	• Revised SP has resulted in a 1.82 ha increase in western ringtail possum habitat retention with 2 additional potential Black Cockatoo habitat trees retained. • Implementation of the Western Ringtail Possum (*Pseudocheirus occidentalis*) Management Plan (Coffey 2009) and Western Grey Kangaroo Survey and Management Plan (Ecosystem Solutions 2015). • Highway buffers will be revegetated using species known to be of habitat value for western ringtail possums to create an ecological linkage along the site's northern boundary • 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. • Variation to EPBC 2004 / 1878 is proposed to be prepared and referred to the DEE.	
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) are required to be completed at subdivision stage to the satisfaction of the CoB, on advice from the DWER.	

Flora and vegetation		
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	Excavation / construction activities may unearth and/or damage artefacts or other items of Aboriginal cultural significance.
	Noise	Noise associated with current and future road traffic, and the Busselton-Margaret River Regional Airport, has the potential to impact the amenity of future residents.
	Mosquitoes	Wetlands and low-lying areas susceptible to high groundwater levels can support mosquito breeding. Mosquitoes are known to cause nuisance and serious health risks to people.
	Fire	• Damage to property and infrastructure from fire. • Death and/or injury of people/fauna due to fire.
Mitigation	Aboriginal heritage and culture	• Apply for approval to disturb Hill's Campsite (Place ID: 18985) under Section 18 of the *Aboriginal Heritage Act 1972* (if required). • 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	An acoustics assessment will be undertaken to support of the SP. The noise mitigation measures recommended in the acoustics assessment will be incorporated into the subdivision design and / or 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	Outcomes identified in the Bushfire Management Plans (Ecosystem Solutions 2017 and 2019) will be incorporated into the future subdivision design and construction framework.

8 MANAGEMENT COMMITMENTS 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 SP 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 SP are:

- Increase in the protection of western ringtail possum and black cockatoo habitat within POS reservations when compared to the previous SP. Specifically
  - 1.82 ha of additional western ringtail possum habitat has been retained
  - two additional potential black cockatoo habitat trees have been retained
- Undertaking of revegetation to improve the availability of western ringtail possum habitat and creation of a northern "ecological linkage"
- Implementation of best practice water sensitive urban design and stormwater drainage management
- Implementation of management measures to reduce potential noise and fire impacts on future residences.

This EAR concludes that through the implementation of the proposed mitigation measures the subdivision and development of the site, in accordance with the revised SP, will meet the EPA's environmental objectives for the assessed environmental factors.

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FIGURES

Figure A

Site location

GDA 1994 MGA Zone 50

0 125 250 500 m

Job Number: L12334-013_ER (I)
Doc Number: 001
Date: 06.02.20
Scale: Map 1:20,000 Overview 1:2,000,000 @ A4
Created by: RL
Source: Imagery - Landgate

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LEGEND

- STRUCTURE PLAN AREA
- RESIDENTIAL R2.5
- RESIDENTIAL R5
- RESIDENTIAL R10
- RESIDENTIAL R15/R20
- RESIDENTIAL R25/R30
- VILLAGE CENTRE
- P.O.S./DRAINAGE
- EXISITING AND PROPOSED WATER BODY/FEATURE
- DUAL USE PATH
- (FUTURE) BUS ROUTE
- D.A.P. BOUNDARY
- EXISTING VEGETATION
- EXISTING SURVEYED TREES

THE NEW PROPOSED ACCESS ROAD TO THE 'VILLAGE CENTRE' CAN ONLY BE ESTABLISHED UPON THE CLOSURE OF LYDDY ROAD. ALSO, CABLE SANDS ROAD IS TO BE CLOSED UPON THE TUART DRIVE CONNECTION BEING ESTABLISHED.

NEIGHBOURHOOD NODE

TOURIST DEVELOPMENT SITE

NEIGHBOURHOOD NODE

CONNECTION TO TUART DRIVE SUBJECT TO FURTHER INVESTIGATION OF THE OUTER BYPASS ALIGNMENT

LOT SIZES AND CONFIGURATIONS WILL BE DETERMINED IN CONSULTATION AND TO THE SATISFACTION OF THE CALM, DOE AND THE SHIRE OF BUSSELTON TO PROVIDE FOR WILDLIFE MOVEMENTS AND THE ESTABLISHMENT OF LINKAGES TO EXISTING AND FUTURE VEGETATED AREAS.

LOT SIZES AND CONFIGURATIONS WILL BE DETERMINED IN CONSULTATION AND TO THE SATISFACTION OF THE CALM, DOE AND THE SHIRE OF BUSSELTON TO PROVIDE FOR WILDLIFE MOVEMENTS AND THE ESTABLISHMENT OF LINKAGES TO EXISTING AND FUTURE VEGETATED AREAS.

POSSIBLE CONNECTION TO BE DETERMINED AT THE D.A.P. STAGE

NEIGHBOURHOOD NODE

STRUCTURE PLANNING "BY OTHERS"

EXISTING ANGLICAN SCHOOL

PROPOSED SCHOOL

EXISTING LAKE

DAP 1

DAP 2

DAP 3

DAP 4

DAP 5

DAP 6

VILLAGE CENTRE

VILLAGE CENTRE

HIGHWAY

BUSSELL

HIGHWAY

OUTER BYPASS

PROPOSED

CABLE SANDS ROAD

LYDDY ROAD

L'ASSE

40m LANDSCAPE BUFFER

40m RESERVE FOR LANDSCAPE PROTECTION

40m RESERVE FOR LANDSCAPE PROTECTION

40m RESERVE FOR LANDSCAPE PROTECTION

P.O.S

EPP WETLAND

P.O.S.

SUMMARY TABLE

LOT SIZE	AREA	LOT YIELD (approx.)	AVERAGE LOT SIZE	AREA
R 2.5	25.67 ha	64	4000 m^2	10.15%
R 5	12.15 ha	60	2000 m^2	4.81%
R 10	16.34 ha	160	1000 m^2	6.45%
R 15/ R 20	69.74 ha	1250	450-650 m^2	27.17%
R 25/ R 30	8.23 ha	253	300 - 350m^2	3.26%
ROADS	52.01 ha	-		20.56%
SCHOOL	9.85 ha	1		3.89%
VILLAGE	5.20 ha	-		2.05%
RESERVES				
LANDSCAPE PROTECTION	23.64ha	-		9.34%
POS	31.19ha	-		12.32%
TOTAL :	253.04 ha	1787		100%

This is the Development Guide Plan adopted by the Shire of Busselton pursuant to Clause 25 of District Town Planning Schema No. 20 on the 13th day of April 2011

Chief Executive Officer

Date 2/5/11

ENDORSED STRUCTURE PLAN
To provide a framework for future detailed planning at the subdivision and development stage.

Date 1/6/2012

Delegated under S.16 of the Planning & Development Act 2005

AIRPORT NORTH DGP

PLANNING POLICY STATEMENTS

1. This Development Guideline Plan provides a framework for future subdivision and development of the land. Actual subdivision may vary from the Development Guide Plan, and requires approval from the WA Planning Commission. Such variations may include minor adjustment to road configurations, lot density and public open space boundaries providing that the variations do not compromise the fundamental principles of the Development Guide Plan.
2. Prior to subdivision, the proponent will be required to:
   (i) Prepare a Western Ringtail Possum management plan to the satisfaction of the Commonwealth Department of Environment and Heritage as well as the Department of Conservation and Land Management prior to the commencement of works.
   (ii) Prepare an appropriate fire risk assessment in conjunction with FESA prior to the commencement of works. Undertake an archaeological and ethnographic survey to the satisfaction of the Department of Indigenous Affairs prior to the commencement of works.
   (iii) Undertake investigations into acid sulphate soils and include management proposals in a construction management programme to the satisfaction of the DOE and the Shire of Busselton prior to the commencement of works
   (iv) Undertake investigations into contaminated sites for land previously used for industrial purposes and develop management strategies as necessary to the satisfaction of the Shire of Busselton and the DOE prior to subdivision approval.
   (v) Prepare a comprehensive drainage, nutrient and pollution management plan to the satisfaction of the Shire of Busselton prior to approval of a Detailed Area Plan.
   (vi) Prepare Local Area Plans for particular development precincts in accordance with the provision of the Shire of Busselton District Town Planning Schema No 20
3. Fill programmes for the land at the subdivision stage are to demonstrate that existing vegetation will be protected where possible.
4. All residential lots are to be connected to urban services i.e.; reticulated water and sewer, underground power and telecommunications.
5. Street tree planting shall consist of predominantly endemic native species.
6. 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 and prospective purchasers of
   i) possible aircraft and traffic noise with respect to the Busselton Airport and future Outer Bypass road respectively, and
   ii) the risk of exposure to Ross River Virus disease and nuisance mosquitos.
7. Provision being made to accommodate a community facility to be located in the Local Village Centre and is to be identified on the Detailed Area Plan in accordance with the Shire of Busselton requirements.
8. A contribution to the preparation of an overarching drainage management plan for the Busselton Airport Structure Plan area which shall be prepared to the satisfaction of the Shire and the DOE prior to approval of a DAP for any area.
9. Preparation of a mosquito management plan to the satisfaction of the Shire of Busselton that in addition to other matters includes on and off site mosquito breeding sites and implementation.
10. Demonstration that subdivision design outcomes and lot orientation proposed by DAPs provide an acceptable level of solar access / orientation, prior to approval of DAPs, to the satisfaction of the Shire of Busselton. The minimum acceptable level will be in compliance with the requirements of current Liveable Neighbourhoods Policy.
11. The proponent will be required to prepare and implement a Western Grey Kangaroo Management and Relocation Strategy to the satisfaction of the Department for Conservation and Land Management and Shire of Busselton.
12. Prior to lodgement of an application for subdivision approval:
   (i) Lot sizes adjacent to Vasse Highway are to be determined to address adequate building areas (for dwelling and outbuildings); adequate lot frontages (minimum 30m) and a 40m wide landscape buffer adjacent to Vasse Highway;
   (ii) Preparation of a revegetation, rehabilitation and landscape plan to the specification and satisfaction of the Department of Environment and Conservation and the Shire of Busselton;
   (iii) Access to Vasse Highway from lot 505 is to be determined, and
   (iv) Detailed design of the interface between the Reserve for Landscape Protection and future development is to be determined (this may require a redesign and/or alternative road alignment).

Figure B

Endorsed Development Guide Plan

GDA 1994 MGA Zone 50

0 300 600 m

Job Number: L12334-13_ER (I)
Doc Number: 002
Date: 06.06.19
Scale: 1:10,000 @ A3
Created by: MA
Source: Development Guide Plan - RPS 10971-4-001 Op1 Rev0 (Endorsed Structure Plan 01.06.12)

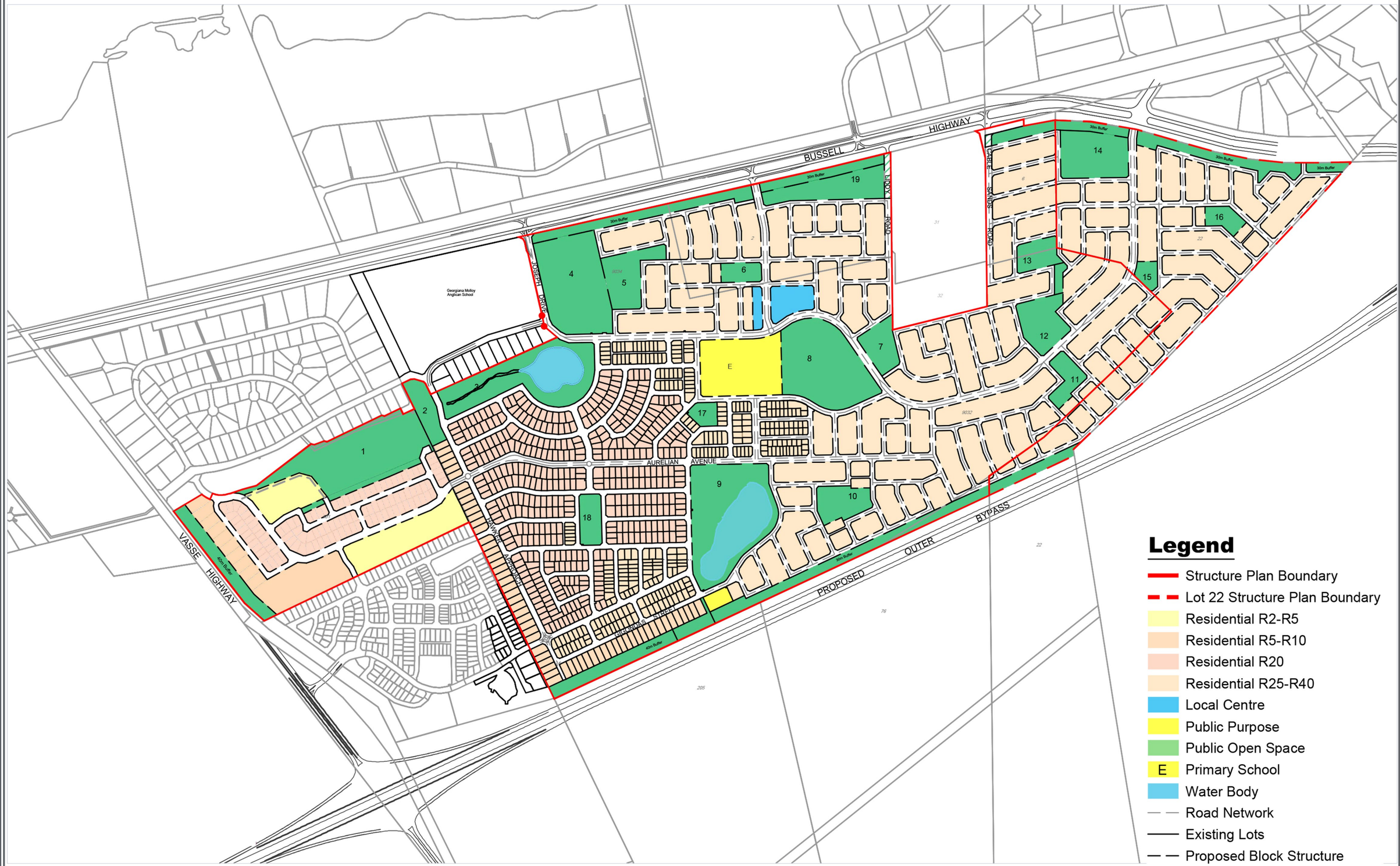

Figure C

Structure plan

Job Number: L12334-013_ER (I)
Doc Number: 003
Date: 24.01.20
Scale: NTS @ A3
Created by: RL
Source: RPS Urban Design - Structure Plan - 130316-2-003M Fig 4, 23.10.19

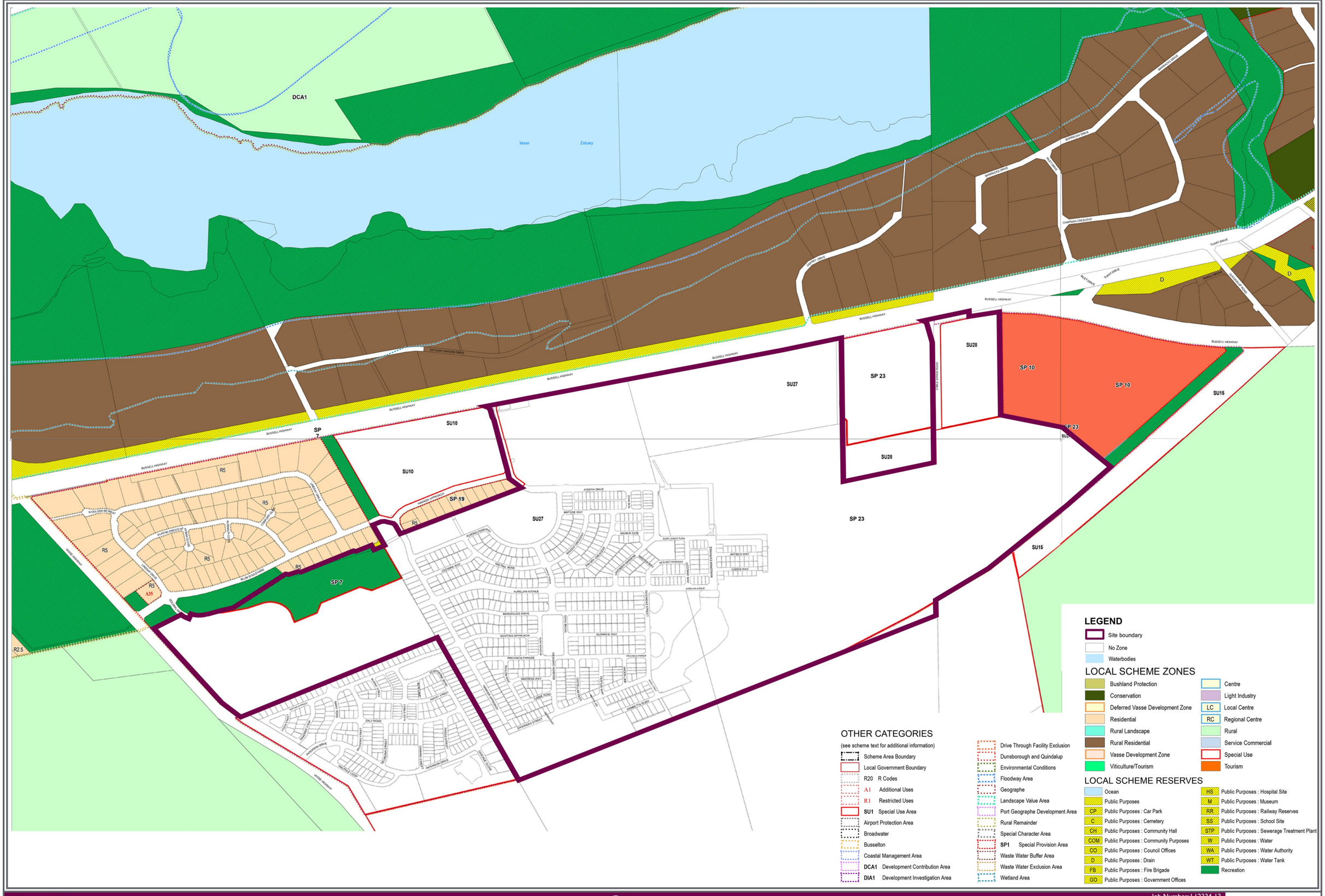

Figure D

Local Planning Scheme No. 21 Zoning

Job Number: L12334-13
Doc Number: 004
Date: 24.01.20
Scale: NTS @ A3
Created by: RL
Source: Local Planning Scheme No 21 Map 30, 31, 33 - DoP, 27.06.19

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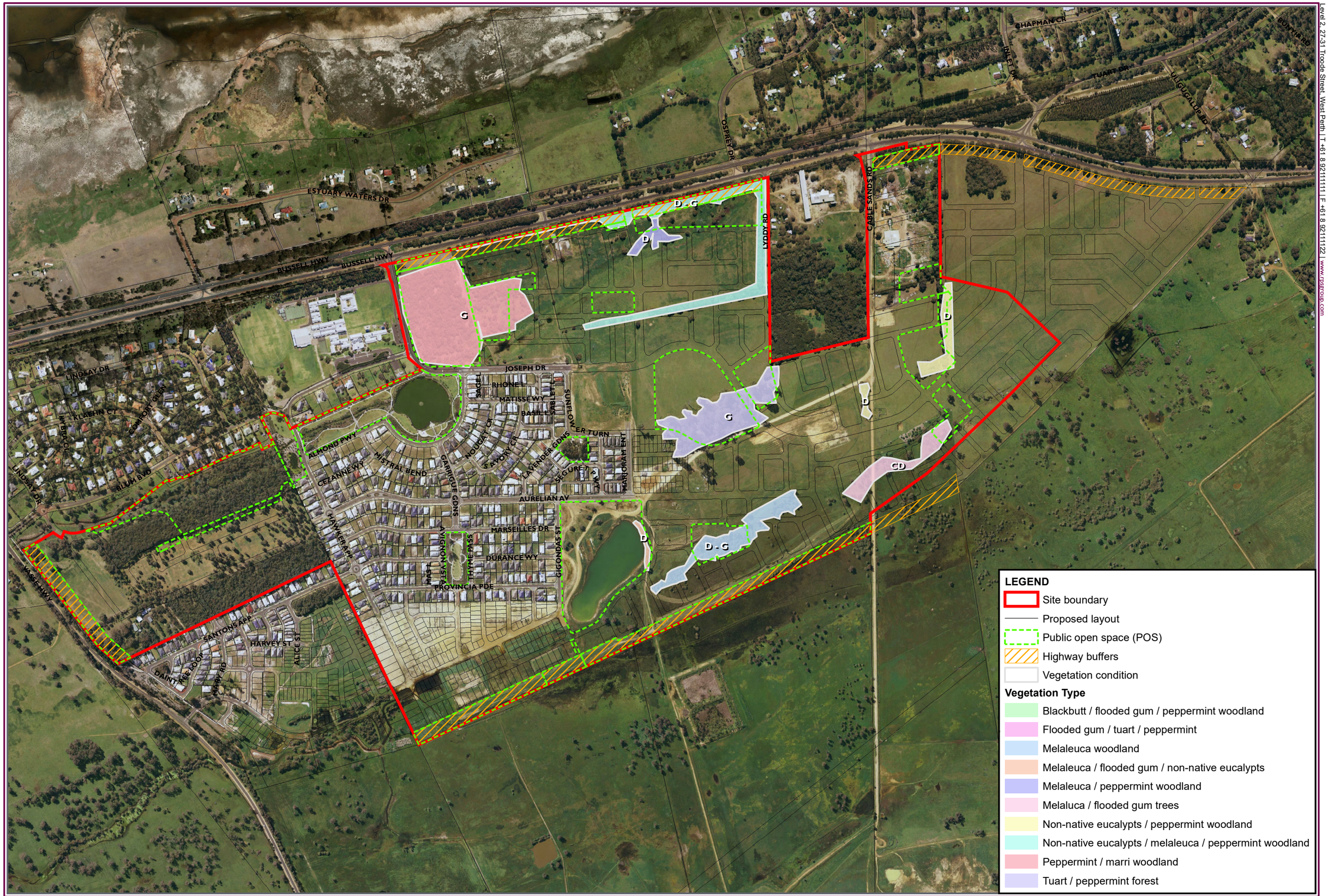


LEGEND

- Site boundary
- Proposed layout
- Public open space (POS)
- Highway buffers
- Vegetation condition

Vegetation Type

- 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-native eucalypts / peppermint woodland
- Non-native eucalypts / melaleuca / peppermint woodland
- Peppermint / marri woodland
- Tuart / peppermint forest

Figure E

Vegetation types and condition

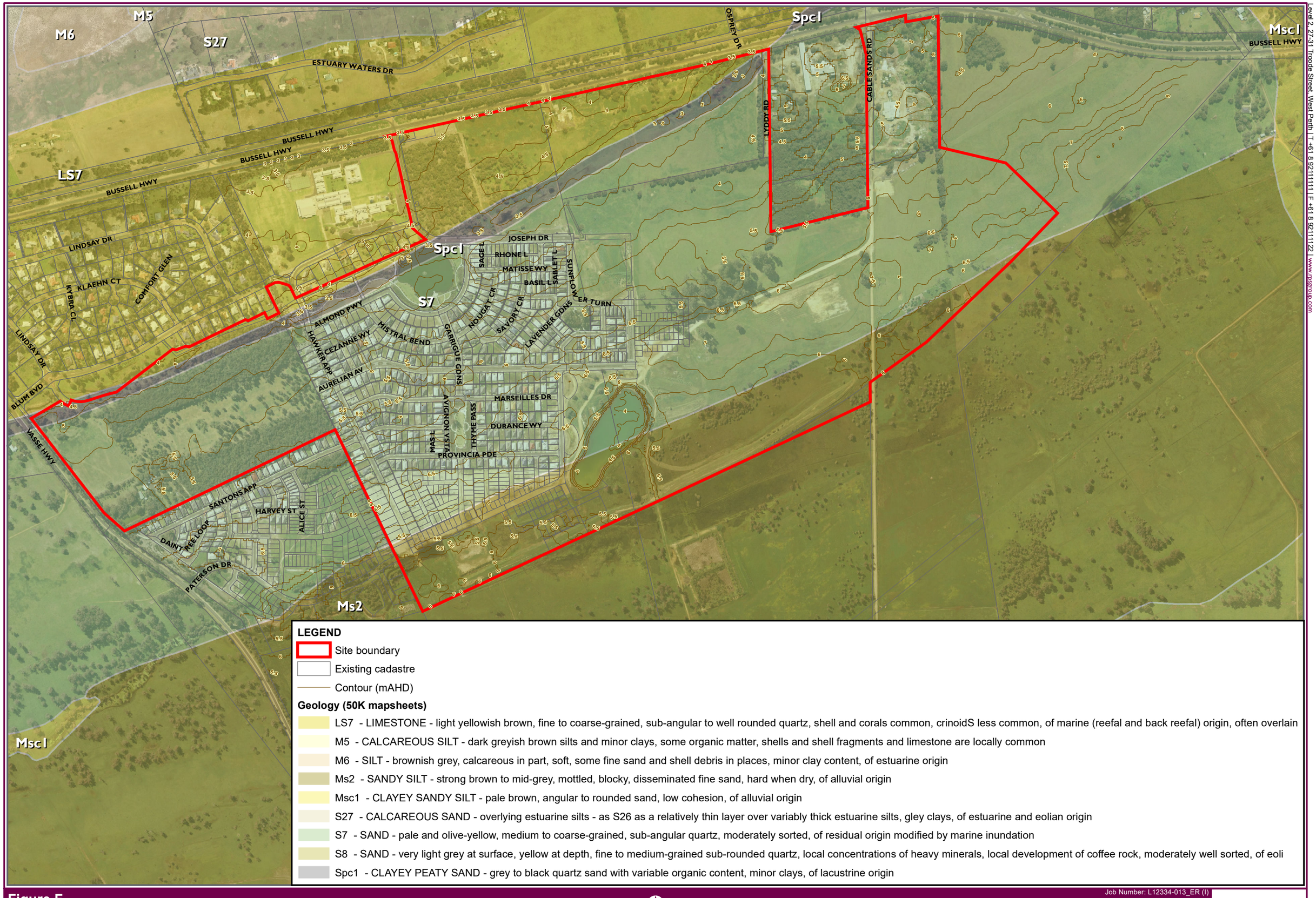
Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Source: Vegetation mapping - Ecosystem Solutions, 2016 Structure Plan - RPS, 130316-2-003M, 2019 Orthophoto - Landgate, 2019

Job Number: L12334-013_ER (I)
Doc Number: 005
Date: 23.01.20
Scale: 1:10,000 @ A3
Created by: RL

Document Path: G:\Jobs\l_Jobs\l12334 - Environmental Advice Provence\Figures L1233413 - 2020 EAR revision - ER\L1233413_ER_005_FigE Vegetation mapping_200123.mxd



LEGEND

- Site boundary
- Existing cadastre
- Contour (mAHD)

Geology (50K mapsheets)

- LS7 - LIMESTONE - light yellowish brown, fine to coarse-grained, sub-angular to well rounded quartz, shell and corals common, crinoidS less common, of marine (reefal and back reefal) origin, often overlain
- M5 - CALCAREOUS SILT - dark greyish brown silts and minor clays, some organic matter, shells and shell fragments and limestone are locally common
- M6 - SILT - brownish grey, calcareous in part, soft, some fine sand and shell debris in places, minor clay content, of estuarine origin
- Ms2 - SANDY SILT - strong brown to mid-grey, mottled, blocky, disseminated fine sand, hard when dry, of alluvial origin
- Msc1 - CLAYEY SANDY SILT - pale brown, angular to rounded sand, low cohesion, of alluvial origin
- S27 - CALCAREOUS SAND - overlying estuarine silts - as S26 as a relatively thin layer over variably thick estuarine silts, gley clays, of estuarine and eolian origin
- S7 - SAND - pale and olive-yellow, medium to coarse-grained, sub-angular quartz, moderately sorted, of residual origin modified by marine inundation
- S8 - SAND - very light grey at surface, yellow at depth, fine to medium-grained sub-rounded quartz, local concentrations of heavy minerals, local development of coffee rock, moderately well sorted, of eoli
- Spc1 - CLAYEY PEATY SAND - grey to black quartz sand with variable organic content, minor clays, of lacustrine origin

Figure F

Topography and geology

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Job Number: L12334-013_ER (I)
Doc Number: 006
Date: 06.02.20
Scale: 1:10,000 @ A3
Created by: MA

Source: Structure Plan - RPS, 130316-2-003I, May 2019 Cadastre - Landgate, 2019 Orthophoto - Landgate, 2019

Document Path: G:\Jobs\I_Jobs\I12334 - Environmental Advice Provence\Figures L1233413 - 2020 EAR revision - ER\L1233413_ER_006_FigF Topo and Geology_200206.mxd

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ESTUARY WATERS DR
BUSSELL HWY
BUSSELL HWY
OSPREY DR
INLET DR
TUART DR
ULGUGALUP RD
CABLE SANDS RD
GRADY CT
LINDSAY DR
KLAEHN CT
KYBRA CL
COMFORT GLEN
LINDSAY DR
BLUM BVD
VASSE HWY
JOSEPH DR
RHONE L
MATISSE WY
BASIL L
SAGE L
SABLET L
SUNFLOWER TURN
ALMOND PWY
CEZANNE WY
MISTRAL BEND
GARRIGUE GDNS
NOUGAT CR
SAVORY CR
LAVENDER GDNS
SEGURET PL
MARJORAM ENT
AURELIAN AV
HAWKER APP
MARSEILLES DR
AVIGNON VSTA
THYME PASS
DURANCE WY
MAST L
PROVINCIA PDE
GIGONDAS ST
SANTONS APP
HARVEY ST
ALICE ST
DAINTREE LOOP
MARY RD

LEGEND

- Site boundary
- Existing cadastre

Acid sulfate soil risk mapping (DWER, 2017)

- High to moderate risk
- Moderate to low risk

Figure G

Acid sulfate soil risk mapping

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Job Number: L12334-013_ER (I)
Doc Number: 007
Date: 06.02.20
Scale: 1:10,000 @ A3
Created by: MA

Source: Structure Plan - RPS, 130316-2-003I, May 2019 Cadastre - Landgate, 2019 Orthophoto - Landgate, 2019

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FORMER BUSSELTON MEAT WORKS

PROPOSED INERT WASTE RECYCLING FACILITY

ESTUARY WATERS DR
BUSSELL HWY
BUSSELL HWY
OSPREY DR
CABLE SANDS RD
INLET DR
TUART DR
ULLGUGALUP RD
LINDSAY DR
KLAEHN CT
COMFORT GLEN
IVY BROOK CT
LINDSAY DR
BELUB BVD
VASSE HWY
JOSEPH DR
SAGE L
RHONE L
MATISSE WY
BASIL L
SUNFLOWER TURN
ALMOND PWY
CEZANNE WY
MISTRAL BEND
GARRIGUE GDNS
NOUGAT CR
SAVORY CT
LAVENDER GDNS
SEGURET WY
MARJORAM ENT
AURELIAN AV
HAWKER APP
AVIGNON VSTA
MARSEILLES DR
THYME PASS
DURANCE WY
GIGONDAS ST
PROVINCIA PDE
SANTONS APP
HARVEY ST
ALICE ST
DAINTREE LOOP
MARY RD

LEGEND

- Site boundary
- Existing cadastre
- Contaminated site investigation location

Figure H

Potentially contaminated sites

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Job Number: L12334-013_ER (I)
Doc Number: 008
Date: 06.02.20
Scale: 1:10,000 @ A3
Created by: MA

Source: Structure Plan - RPS, 130316-2-003I, May 2019 Cadastre - Landgate, 2019 Orthophoto - Landgate, 2019

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Figure I

Significant fauna habitat

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Source: Vegetation mapping - Ecosystem Solutions, 2016 Structure Plan - RPS, 130316-2-003M, 2019 Orthophoto - Landgate, 2019

Job Number: L12334-013_ER (I)
Doc Number: 009
Date: 24.01.20
Scale: 1:10,000 @ A3
Created by: RL

Document Path: G:\Jobs\l_Jobs\l12334 - Environmental Advice Provence\Figures L1233413 - 2020 EAR revision - ER\L1233413_ER_009_FigI Significant fauna habitat_200124.mxd

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UFI 206
UFI 15214
UFI 15214
UFI 386
UFI 240
UFI 211
UFI 182
ESTUARY WATERS DR
RUSSELL HWY
RUSSELL HWY
OSPREY DR
INLET DR
TUART DR
ULIGUGALUP RD
CABLE SANDS RD
UFI 392
UFI 383
LINDSAY DR
KLAEHN CT
COMFORT GLEN
IVYBRAE CL
BLUM BVD
UFI 394
JOSEPH DR
SAGELL
RHONE L
MATISSE WY
BASIL L
SABLET L
SUNFLOWER TURN
NOUGAT CR
SAVORY CR
LAVENDER GDNS
SEGURET CL
MARJORAM ENT
ALMOND PWY
CEZANNE WY
MISTRAL BEND
GARRIGUE GDNS
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MARSEILLES DR
GIGONDAS ST
HAWKER APP
AVIGNON VISTA
MAST
THYME PASS
PROVINCIA PDE
UFI 468
DURANCE WY
VASSE HWY
SANTONS APP
HARVEY ST
ALICE ST
DAINTREE LOOP
MARY RD
UFI 466
UFI 15809
UFI 469
UFI 470
UFI 194
UFI 376
UFI 377
UFI 190

LEGEND

- Site boundary
- Existing cadastre

Geomorphic wetlands (DBCA, 2019)

- Conservation
- Multiple use
- Resource enhancement

Figure J

Geomorphic wetlands

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Job Number: L12334-013_ER (I)
Doc Number: 010
Date: 06.02.20
Scale: 1:10,000 @ A3
Created by: MA

Source: Structure Plan - RPS, 130316-2-003I, May 2019 Cadastre - Landgate, 2019 Orthophoto - Landgate, 2019

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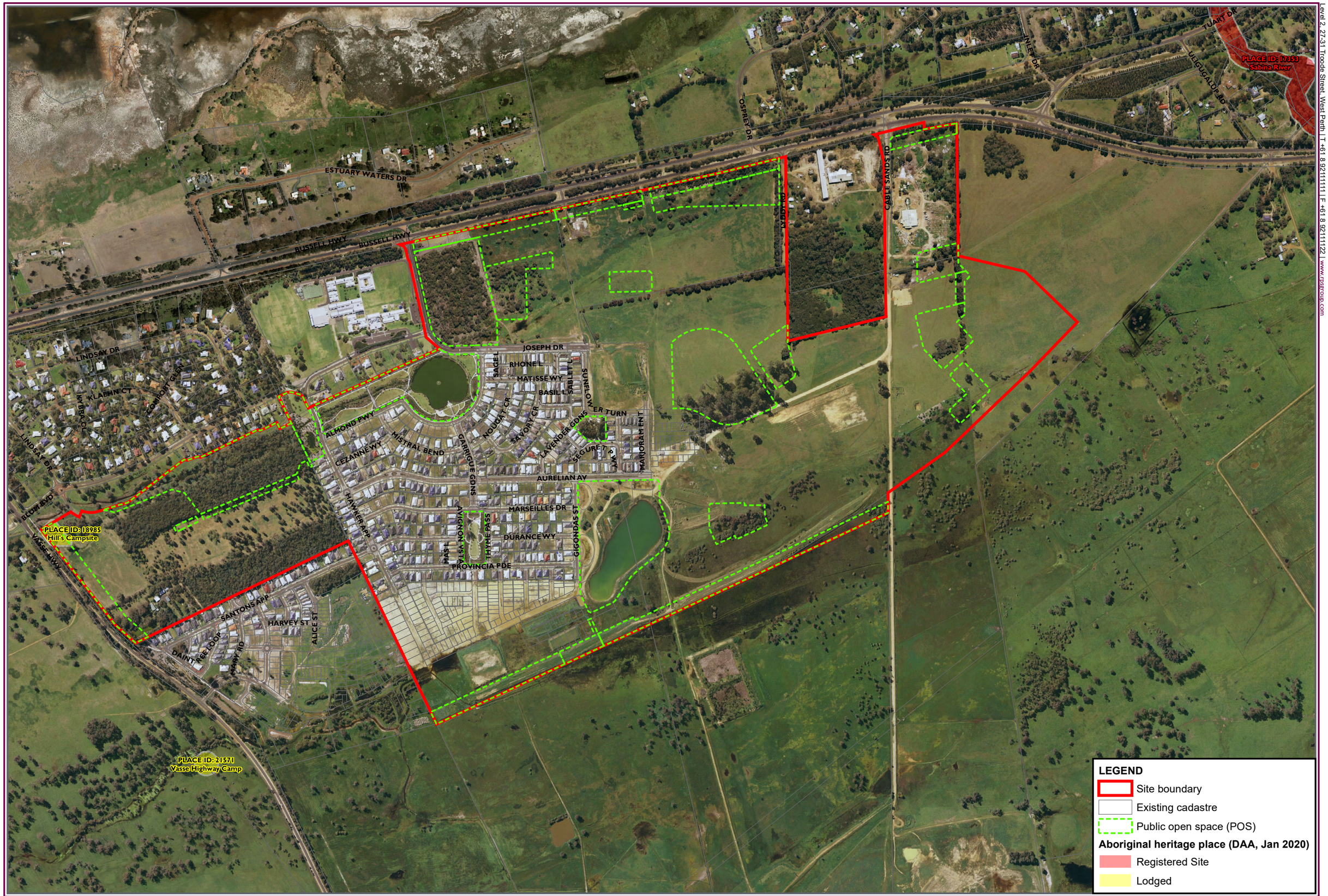

Figure K

Aboriginal heritage places

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Source: Structure Plan - RPS, 130316-2-003I, May 2019 Cadastre - Landgate, 2019 Orthophoto - Landgate, 2019

Job Number: L12334-013_ER (I)
Doc Number: 011
Date: 24.01.20
Scale: 1:10,000 @ A3
Created by: MA

Document Path: G:\Jobs\l_Jobs\l12334 - Environmental Advice Provence\Figures L1233413 - 2020 EAR revision - ER\L1233413_ER_011_FigK Aboriginal heritage_200124.mxd

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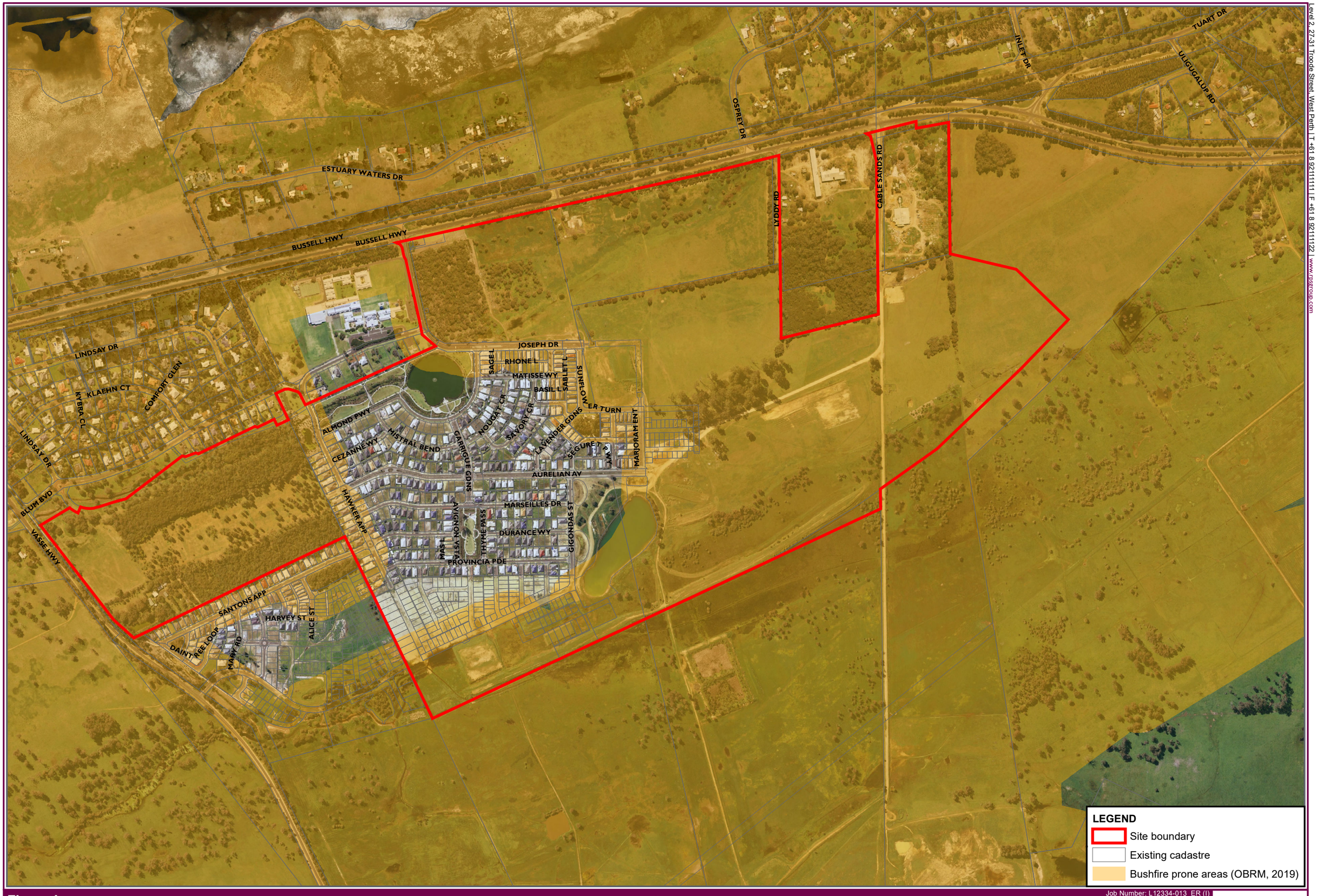


Figure L

Bushfire prone areas

Busselton Coastal Grid 1994 BCG94

0 125 250 500 m

Job Number: L12334-013_ER (I)
Doc Number: 012
Date: 05.06.19
Scale: 1:10,000 @ A3
Created by: MA

Source: Structure Plan - RPS, 130316-2-003I, May 2019 Cadastre - Landgate, 2019 Orthophoto - Landgate, 2019

Document Path: G:\Jobs\I_Jobs\I12334 - Environmental Advice Provence\Figures L1233413 - 2020 EAR revision - ER\L1233413_ER_012_FigL Bushfire prone areas_200206.mxd

Appendix A

DEH / DEWHA 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.

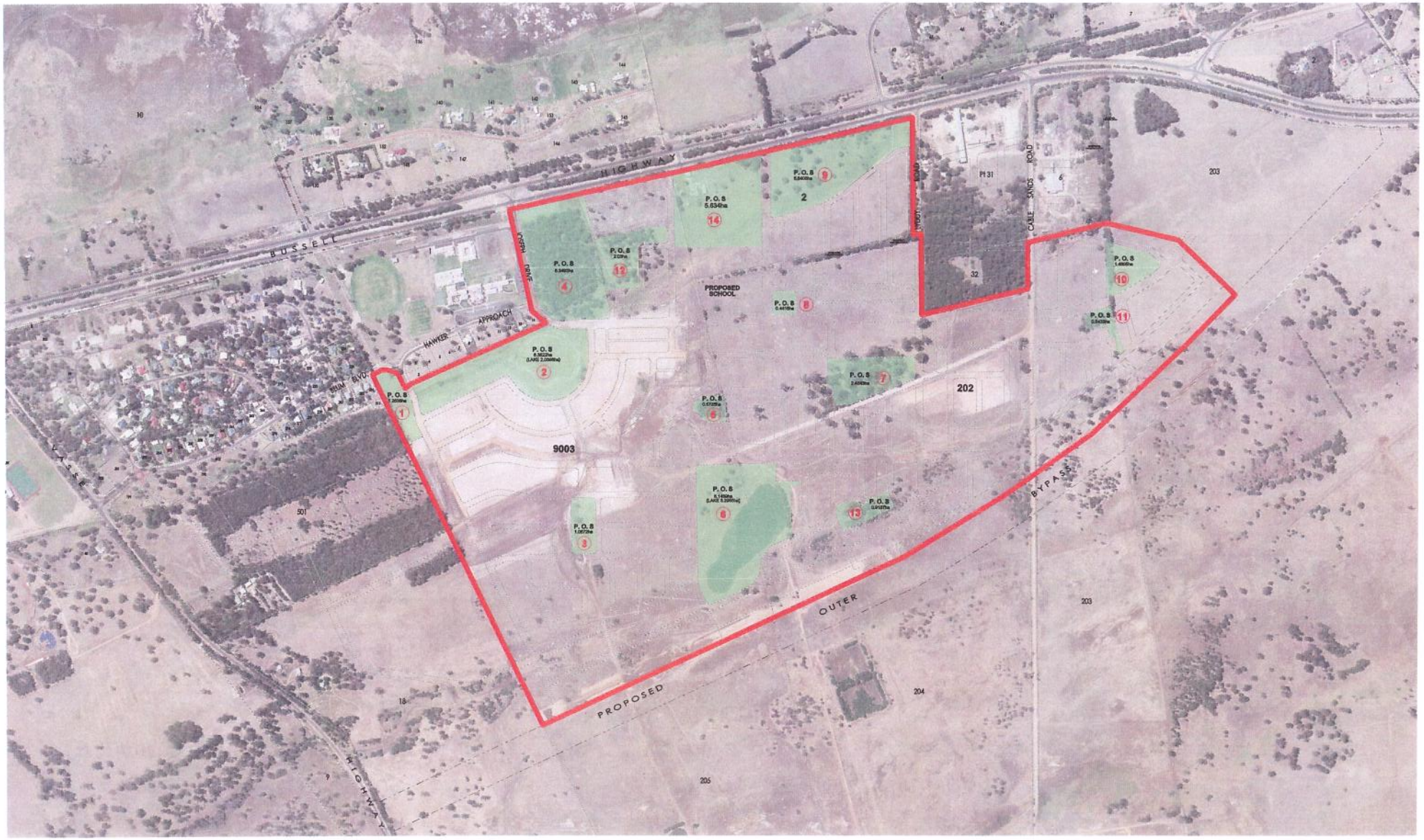
   The CMP is to be effective for the duration of the project, and for a period of five years following transfer of responsibility for the project to a land management authority. The proponent will provide funds to that land management authority to implement the CMP for the first two years of that five 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



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 approval

Environmental Protection Authority
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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

OFFICE OF SHIRE CLERK
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 assessment

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.

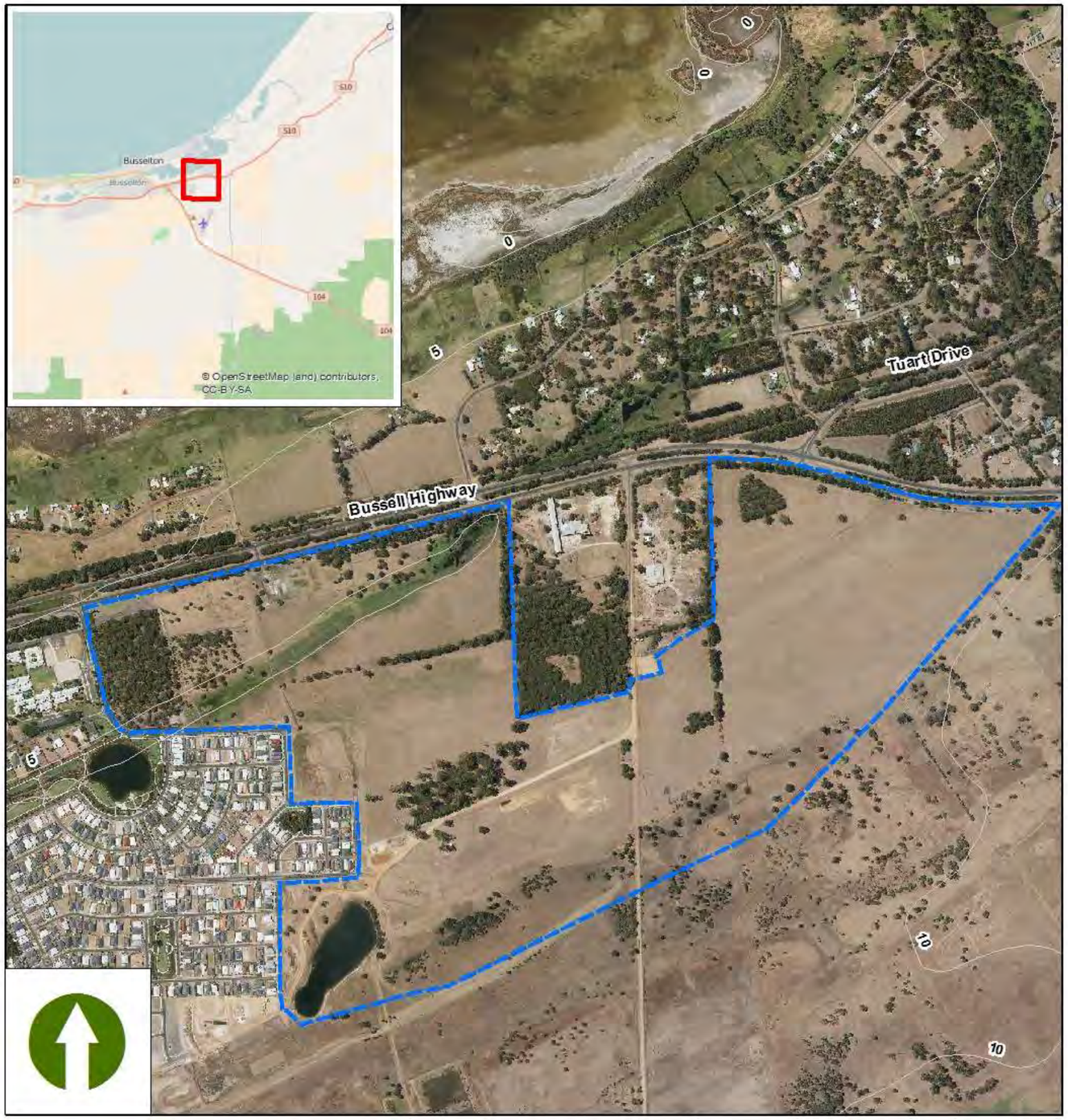
It is recommended that a referral pursuant to the EPBC Act is not required for the components of the development within the subject site, as actions involved do not constitute a significant impact on any of the threatened species present.

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.

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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

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Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
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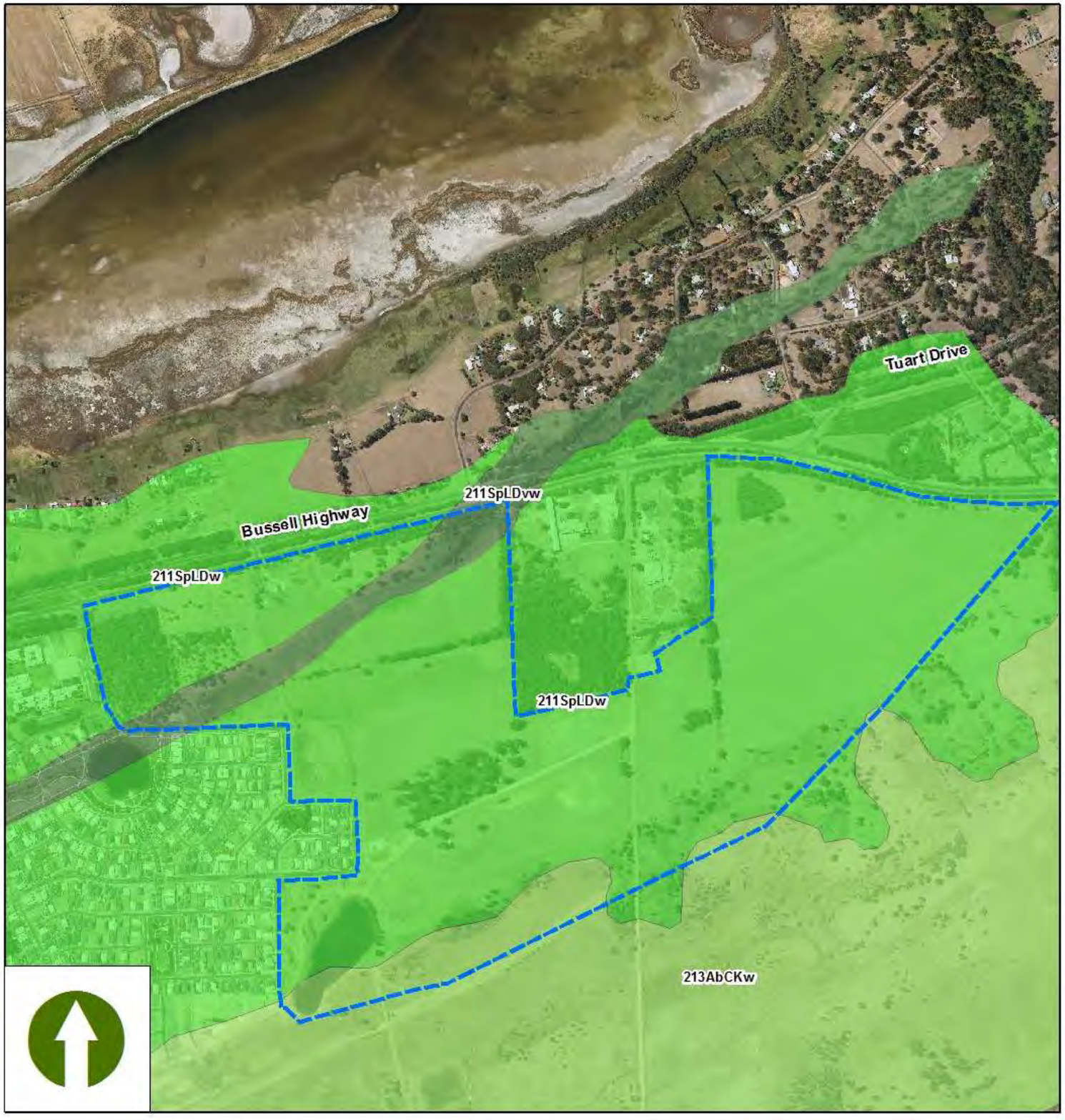

Map 3	Soil Landscapes
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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
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Datum - GDA94
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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

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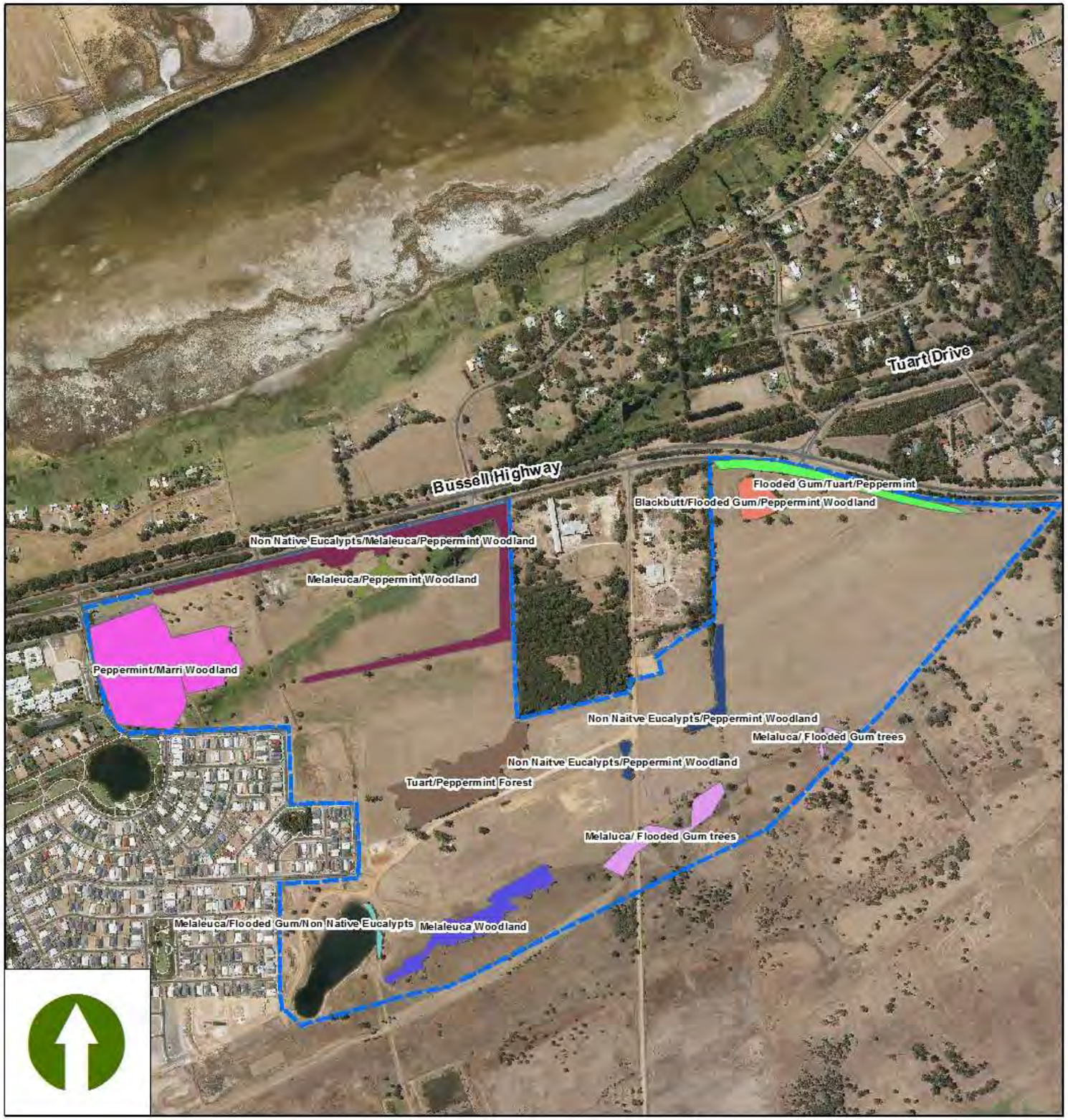

Map 5	Vegetation
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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

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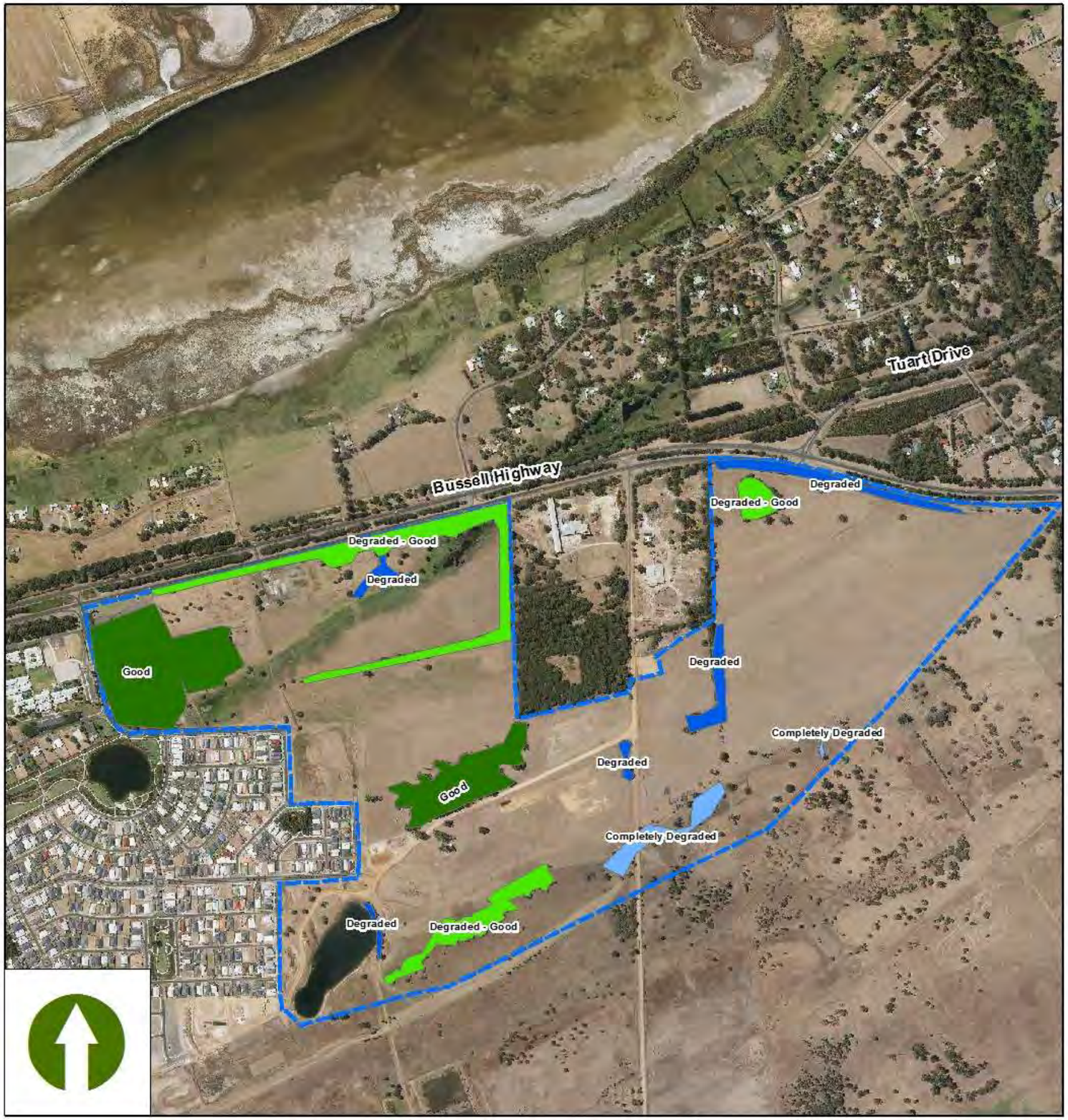

Map 6	Vegetation Condition
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

- Study Area Boundary

Condition

- Good
- Degraded - Good
- Degraded
- Completely Degraded

0 170 340 680 1,020

Metres

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Projection - MGA50
Datum - GDA94
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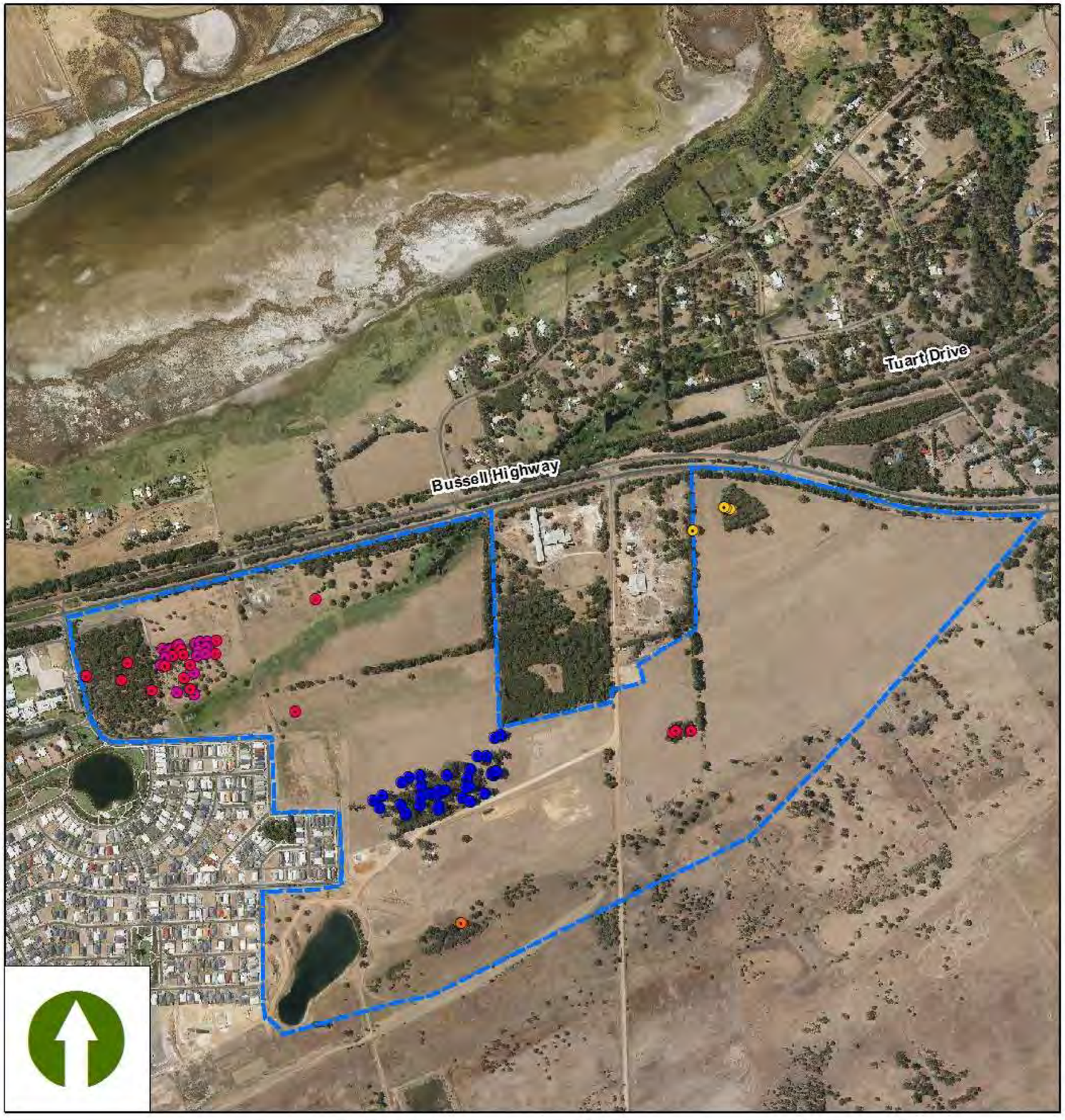

Map 7	Trees Observed
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

SPECIES

- Blackbutt
- Flooded Gum
- Marri
- Peppermint
- Tuart

0 170 340 680 1,020

Metres

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January 2016
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Datum - GDA94
The details on this map have not been surveyed.
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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

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Projection - MGA50
Datum - GDA94
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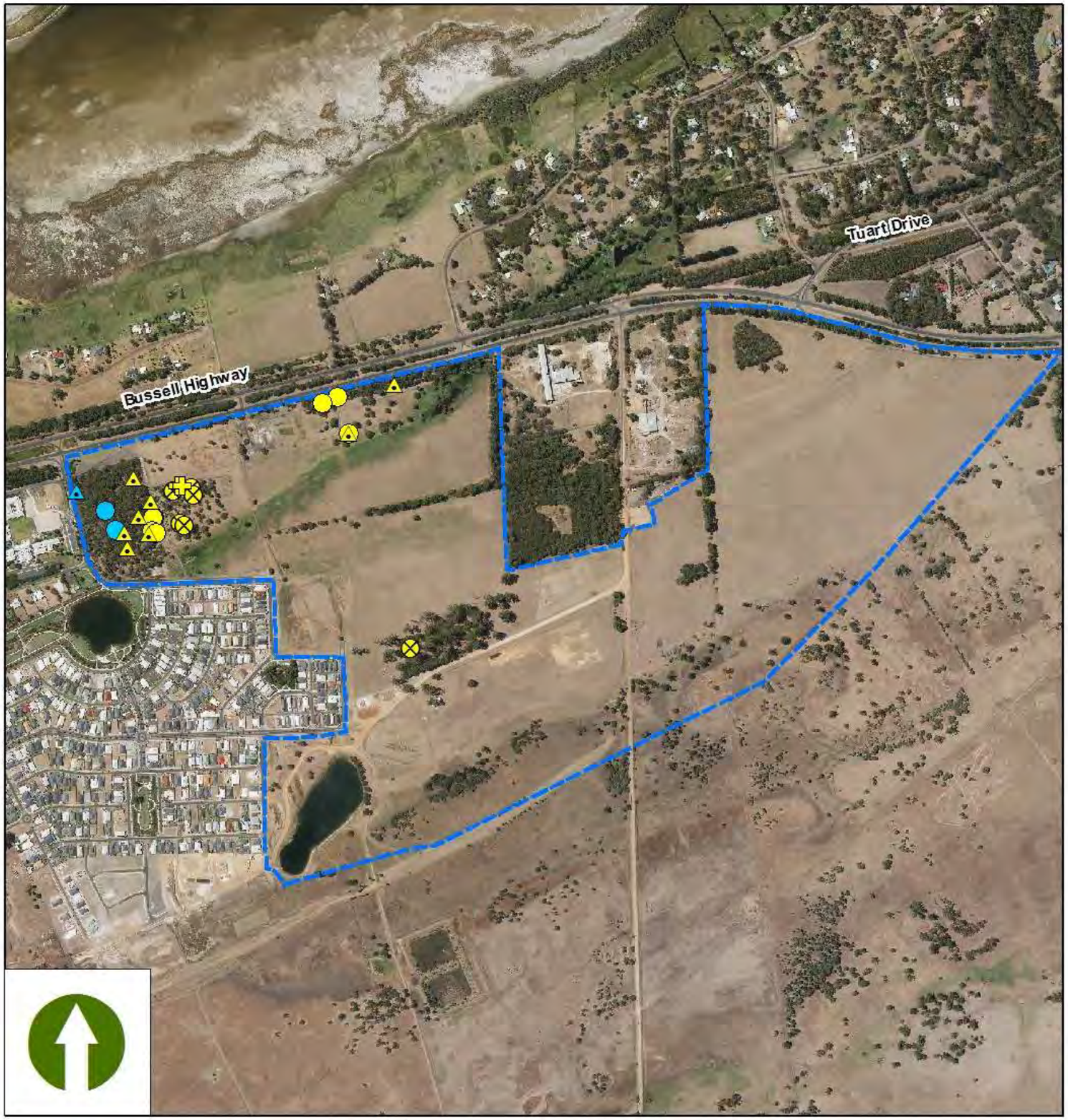

Map 9	Nocturnal Fauna Observations
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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

0 170 340 680 1,020

Metres

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January 2016
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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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January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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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
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17	Marri	730	30	Healthy	350473	6274407
18	Peppermint	790	17	Healthy	350428	6274398
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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
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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

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Environment – Land and Infrastructure

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&

Satterley Property Group

25 May 2018

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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 22

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.

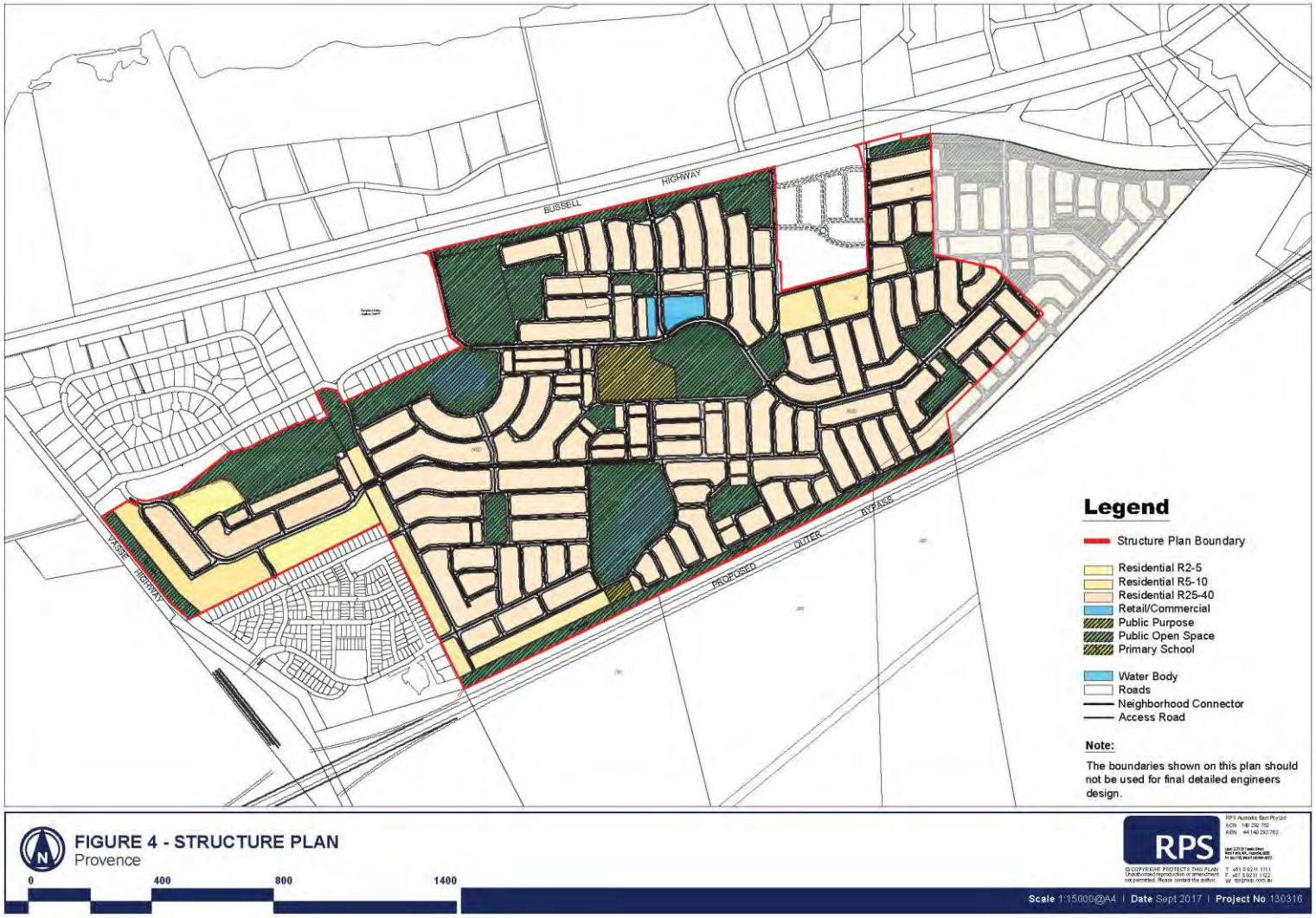

Figure 1 Provence Estate Structure Plan Design Revised 2018

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
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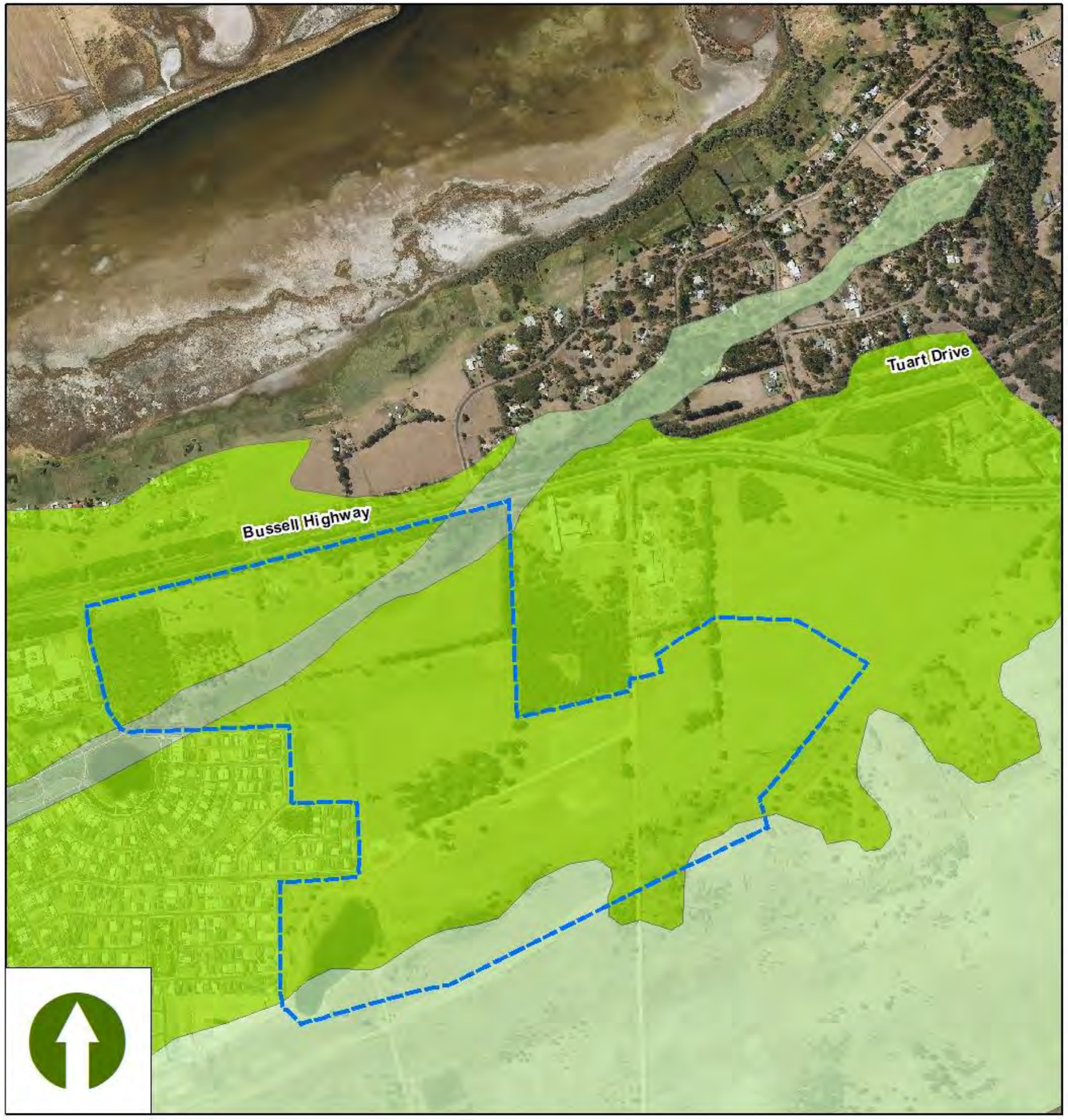

Map 3	Soil Landscapes
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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
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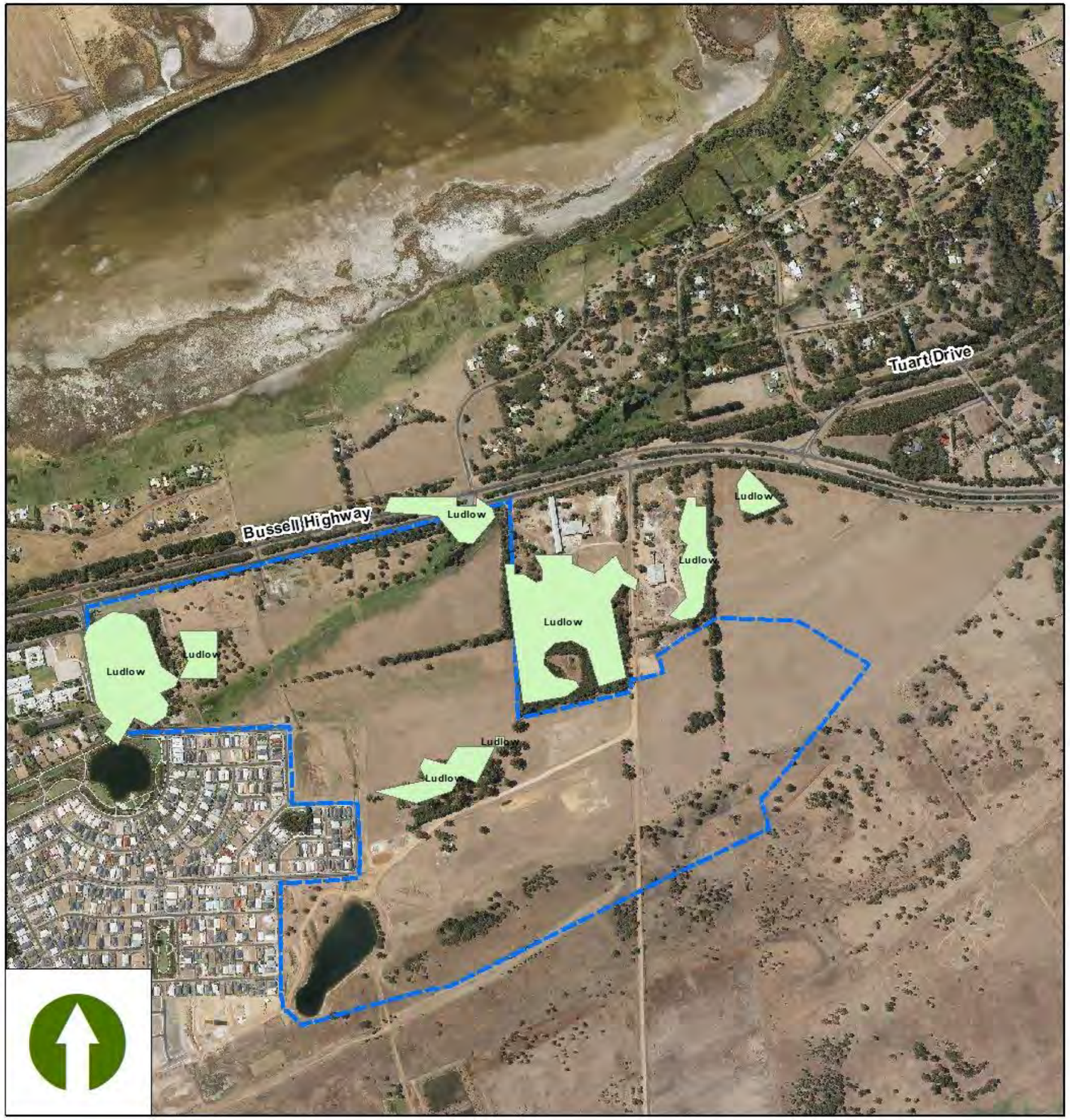

Map 4	RFA Vegetation
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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
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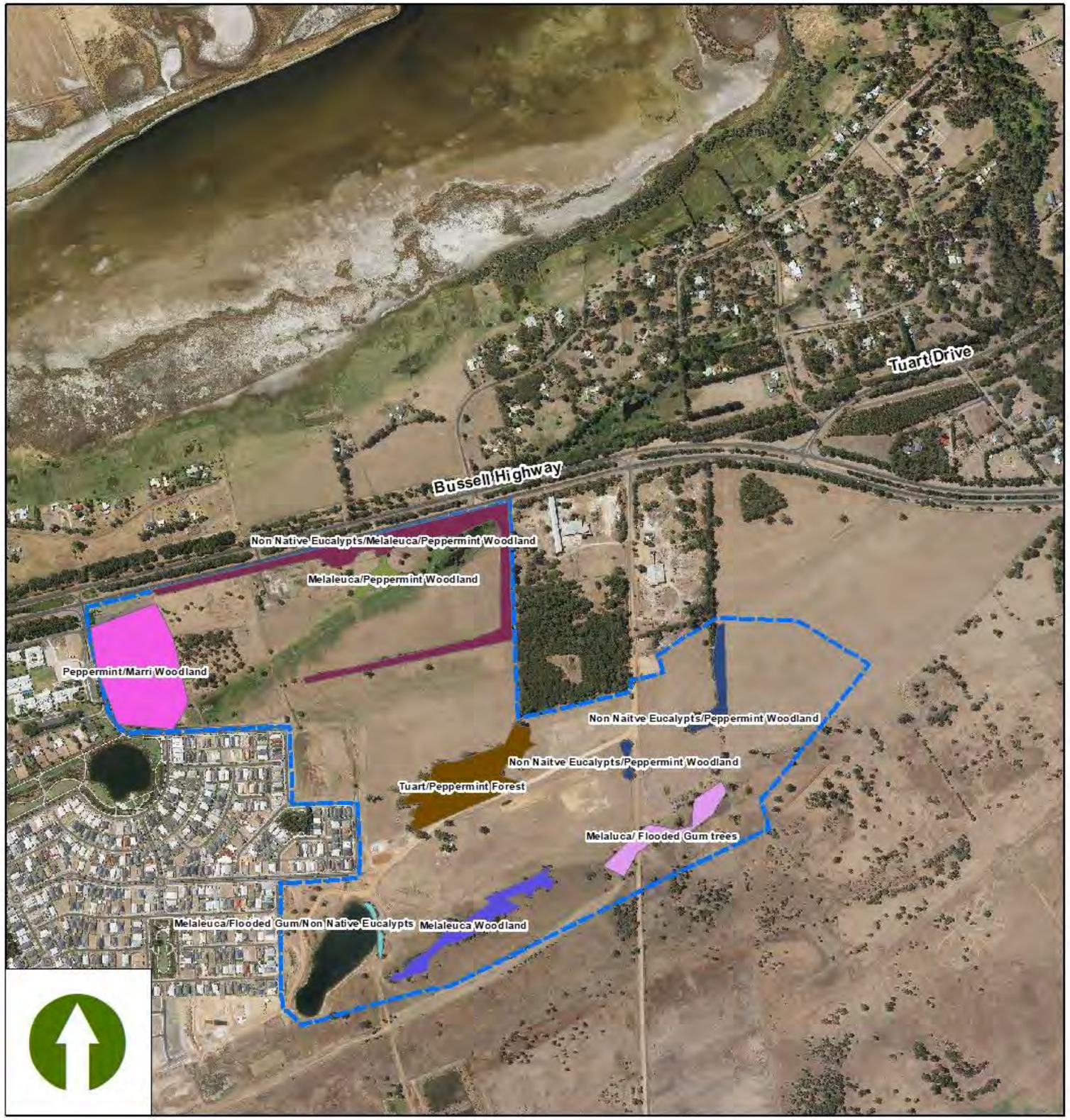

Map 5	Vegetation
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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
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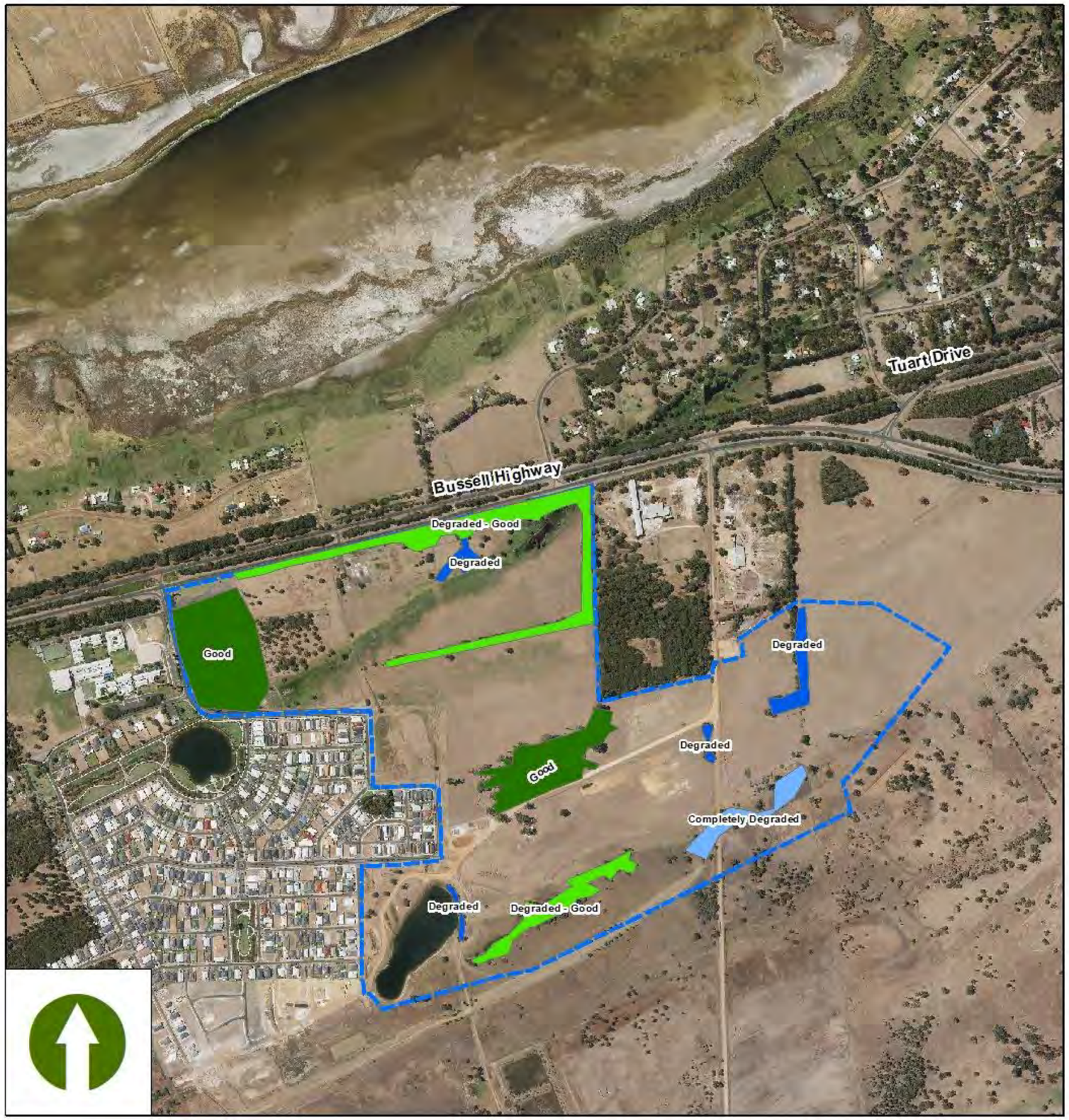

Map 6	Vegetation Condition
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

- Study Area Boundary

Condition

- Good
- Degraded - Good
- Degraded
- Completely Degraded

0 170 340 680 1,020

Metres

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May 2018
Projection - MGA50
Datum - GDA94
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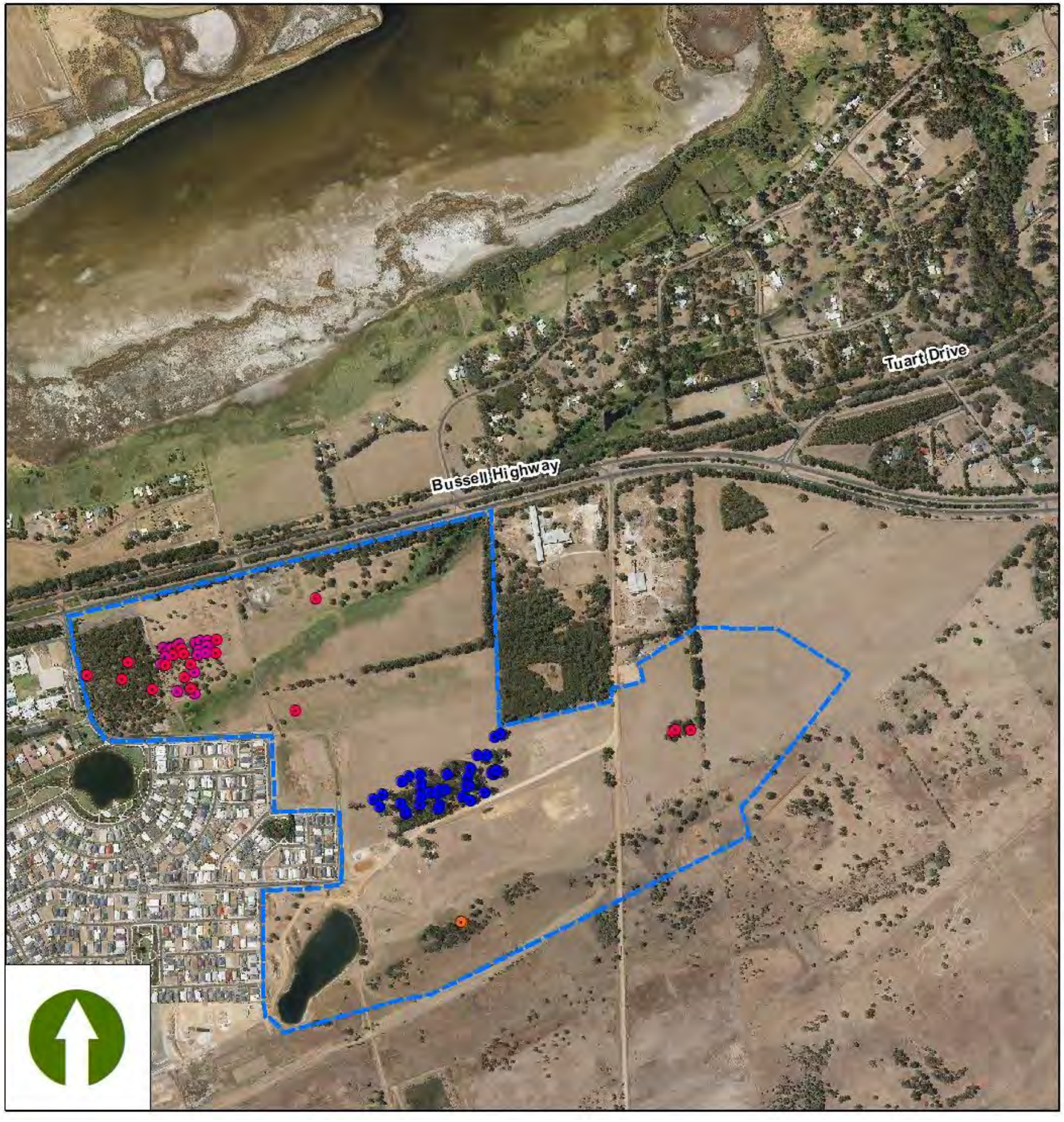

Map 7	Trees Observed
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

SPECIES

- Flooded Gum
- Marri
- Peppermint
- Tuart

0 170 340 680 1,020

Metres

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.

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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

Prepared by Danae Plowman
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May 2018
Projection - MGA50
Datum - GDA94
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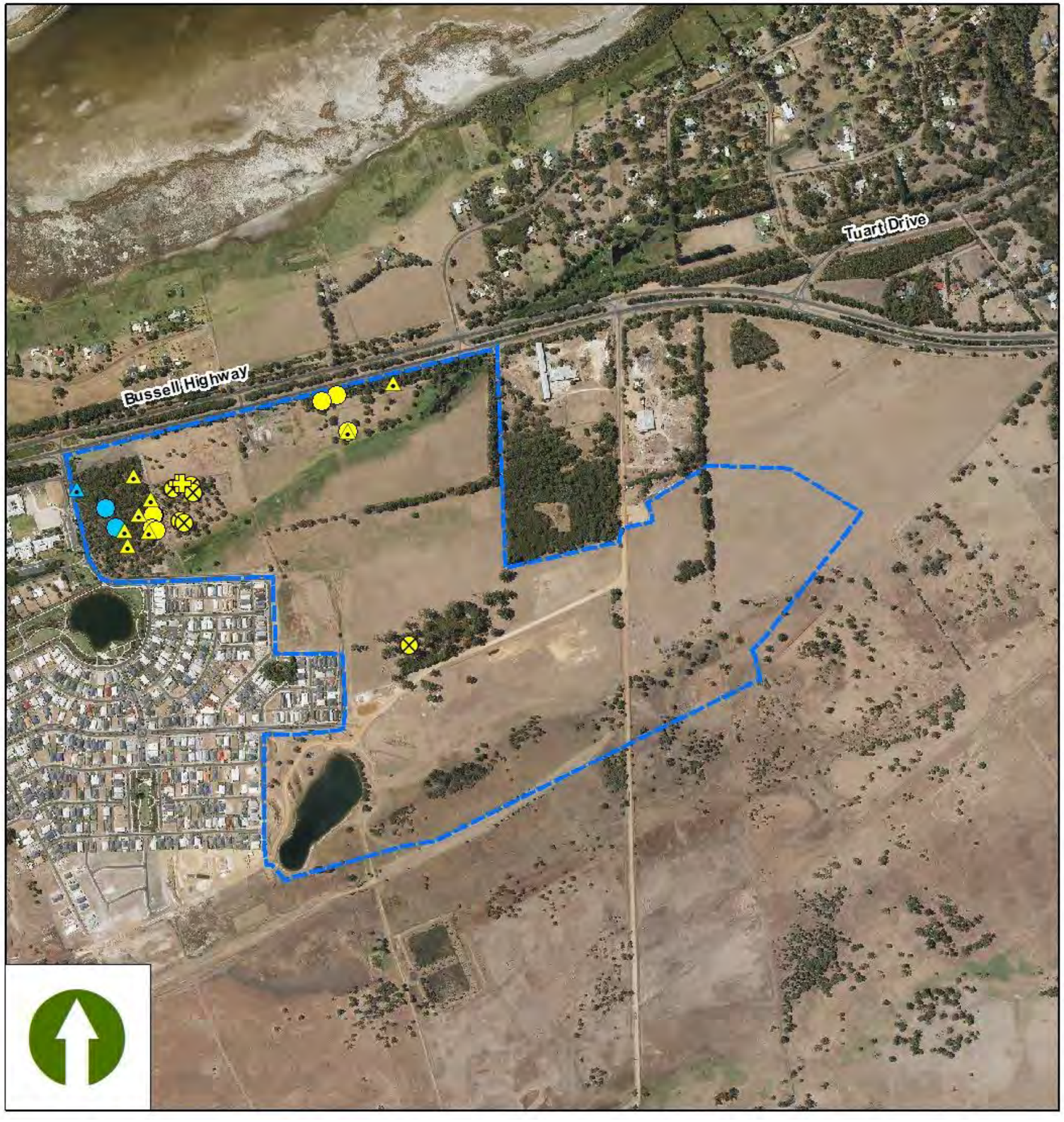

Map 9	Nocturnal Fauna Observations
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

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
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

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

Bushfire management plan

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Provence Estate, Yalyalup

Bushfire Management Plan

3 April 2017

Prepared for:
Satterley Property Group
C/- RPS Australia Asia Pacific

Limitations Statement

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1 Introduction

This Bushfire Management Plan (BMP) has been prepared by Ecosystem Solutions Pty Ltd, as part of the process of the owners of Provence Estate, Yalyalup to proceed with the latest stage of the development (Figure 1, hereafter called the "Site"). This report has been prepared by Gary McMahon (B.Sc. M. Env Mgmt. PG Dip Bushfire) and Kelly Paterson (B.Sc. Hons. Nat Rs Mgmt).

The purpose of this BMP is to detail the fire management methods and requirements that will be implemented within the site as part of the structure plan. The aim of the BMP is to reduce the threat to residents and fire fighters in the event of a fire within or near the Site.

Figure 1 Structure Plan for Provence Estate

2 Site Description

2.1 Location

The property is located within the City of Busselton and is situated approximately 4 km to the south-east of the Busselton town site, Western Australia (Map 1).

Main access to Proposed Lots will be via Joseph Drive and the roading to be constructed during the development (Figure 1).

2.2 Landscape Elements

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 2).

The structure plan area consists of approximately 293.5 hectares currently comprised of existing residential development, mixed pasture and bushland areas.

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 the Perth Coastal Zone and the Pinjarra Zone. There are four individual soil-landscape types within the Study Area (Map 3). These are described as:

- Ludlow flats Phase (211SpLD1) – *Sandplain and very low dunes on coastal limestone in the Swan Coastal Plain between Capel and Busselton. Yellow and Brown deep sands. Tuart-peppermint forest and woodland.*
- *Ludlow flats Phase (211SpLDvw) – 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 soils and Brown deep sands. Flooded gum woodland.*
- *Ludlow flats Phase (211SpLDw) – Poorly drained flats on sand over coastal limestone in the Swan Coastal Plain between Capel and Dunsborough. Yellow deep sands and Semi-wet soils. Flooded gum-peppermint woodland.*

- *Cokelup wet clayey flat Phase (213AbCKw) – 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, Saline wet soils, Alkaline grey shallow sandy and loamy duplexes and Hard cracking clays. Paperbark-flooded gum woodland and barley grass flats.*

3 Statutory Conditions

The Western Australian Planning Commission (WAPC) developed State Planning Policy 3.7: Planning in Bushfire Prone Areas and Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015).

The objectives of this new policy are to:

- Avoid any increase in the threat of bushfire to people, property and infrastructure;
- Reduce the vulnerability to bushfire through the identification and consideration of bushfire risks in decision making at all stages of the planning and development process;
- Ensure higher order strategic planning documents, strategic planning proposals, subdivision and development applications take bushfire protection requirements into account; and
- Achieve an appropriate balance between bushfire risk management measures, biodiversity conservation values, environmental protection and landscape amenity.

The policy determines those areas that are most vulnerable to bushfire and where development is appropriate and not appropriate. The provisions and requirements contained in the new Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015) are used in for this determination.

These guidelines form the foundation for fire risk management planning in WA at a community and land development level.

The Bushfires Act (1954) sets out provisions to reduce the dangers resulting from bushfires, prevent, control and extinguish bushfires and for other purposes. The Act addresses various matters such as prohibited burning times, and enables Local Government to require landowners/occupiers to maintain fire breaks, to control and extinguish bushfires and to establish and maintain Bushfire Brigades.

This Bushfire Management Plan (BMP) demonstrates that all fire protection requirements for issues including fire suppression response, development design, access, water supply, building locations and other relevant performance criteria contained in Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015) can be achieved to the satisfaction of the WAPC.

4 Fire Risk

Numerous elements affect building survival in a bushfire event. Some of these factors relate to the bushfire behaviour experienced at the Site, others relate to the design and the construction materials used in the building and the development's surrounding landscape. Infrastructure, utilities, climate and human behaviour also contribute to the overall risk.

Within this plan, the assessment of fire risk takes into account the layout of the development and the conditions that exist at the Site. These include:

- Vegetation Type and cover;
- Topography, with particular reference to ground slopes and accessibility;
- Climate; and
- Relationship to surrounding development.

4.1 Vegetation and Topography

A site inspection was conducted on 2nd February 2017 by Gary McMahon (B.Sc. M. Env Mgmt, CEnvP. BPAD Level 3) from Ecosystem Solutions. An assessment of the composition of the vegetation and the slope of the land under that vegetation was conducted for a minimum distance of 100 m from the edge of the proposed area of development.

There are seven main vegetation plots within and immediately surrounding the Study Area.

Plot 1 is a *Agonis flexuosa* (WA Peppermint) Woodland that has been revegetated in areas. The understory is sparse and therefore this vegetation plot is Class B – Woodland. The current structure plan includes plans to revegetate areas of public open space adjacent to this vegetation plot. Sufficient setbacks from adjacent residential lots will need to be maintained.

Plot 2 is a large Forest area comprising *Agonis flexuosa*, *Eucalyptus gomphocephala* (Tuart), *E. marginata* (Jarrah) and *Corymbia calophylla* (Marri) within an area to the north of the site (Figure 2). This vegetation plot is Class A – Forest.

Plot 3 is a dense Tuart forest with an understory dominated by Arum lilies (**Zantedeschia*

aethiopica). This vegetation plot is Class A – Forest (Figure 3).

Plot 4 is an area of open Woodland of *Melaleuca* species (Figure 4) and is seasonally wet and hence has minimal understory. This vegetation plot is less than 1 ha in size and more than 100m from any other classified vegetation. It is therefore excluded from classification under AS3959-2009 Section 2.2.3.2 (b).

Plot 5 is a mix of Agonis, Marri and *E. megacarpa* (Bullich) woodland (Figure 5), with annual and perennial grass weed understorey. This vegetation plot is Class B – Woodland. The current structure plan includes plans to revegetate areas of public open space adjacent to this vegetation plot. Sufficient setbacks from adjacent residential lots will need to be maintained.

Plot 6 is a patch of Bullich Woodland, with minimal understory apart from annual and perennial grass weeds. This vegetation plot is less than 1 ha in size and more than 100m from any other classified vegetation. It is therefore excluded from classification under AS3959-2009 Section 2.2.3.2 (b).

Plot 7 is a remnant area of Peppermint and Marri trees, with minimal understorey. This vegetation plot is Class B – Woodland. This vegetation will require modification to achieve the setbacks from the adjacent residential lots.

Plot 8 is the remainder of the site, which has been excluded from classification under AS 3959-2009 Section 2.2.3.2. Non-vegetated areas including roads and buildings have been excluded under Section 2.2.3.2 (e). Low threat vegetation including reticulated lawns and gardens, windbreaks and nature strips have been excluded under Section 2.2.3.2 (f).

While there is some slight variation in ground topography, the slope under the assessed vegetation is on average flat, with the land being at approximately 5 m above sea level.

Map 4 shows the classification of the vegetation under AS 3959-2009.

Figure 2 Plot 2 – Class A Forest of Peppermint, Tuart, Marri and Jarrah.

Figure 3 Plot 3 – Class A Forest of Tuart and Arum Lily.

Figure 4 Plot 4 – Area of Melaleuca trees excluded under AS 3959-2009 Section 2.2.3.2 (b).

Figure 5 Plot 5 – Class B – Woodland of Peppermints.

4.2 Fire Climate

Bush fire behaviour is significantly affected by weather conditions. They will burn more aggressively when high temperatures combine with low humidity and strong winds. Generally, the greatest fire risk occurs from summer through to autumn, when the moisture levels in the soil and vegetation are low.

The Site is located within the southern area of south-west Western Australia which experiences hot dry summers and cool wet winters (commonly called a Mediterranean climate). Data from the Bureau of Meteorology at Busselton Regional Airport (approximately 3 kms to the south-east of the Site) confirms that the area experiences hot dry summers with an average December to February temperature of 28-300C with 12-15 mm of rain per month over summer. Winters are cooler with a mean maximum temperature through June, July and August of 180C and an average July rainfall of 130mm (Figure 6 - BOM, accessed March 2017).

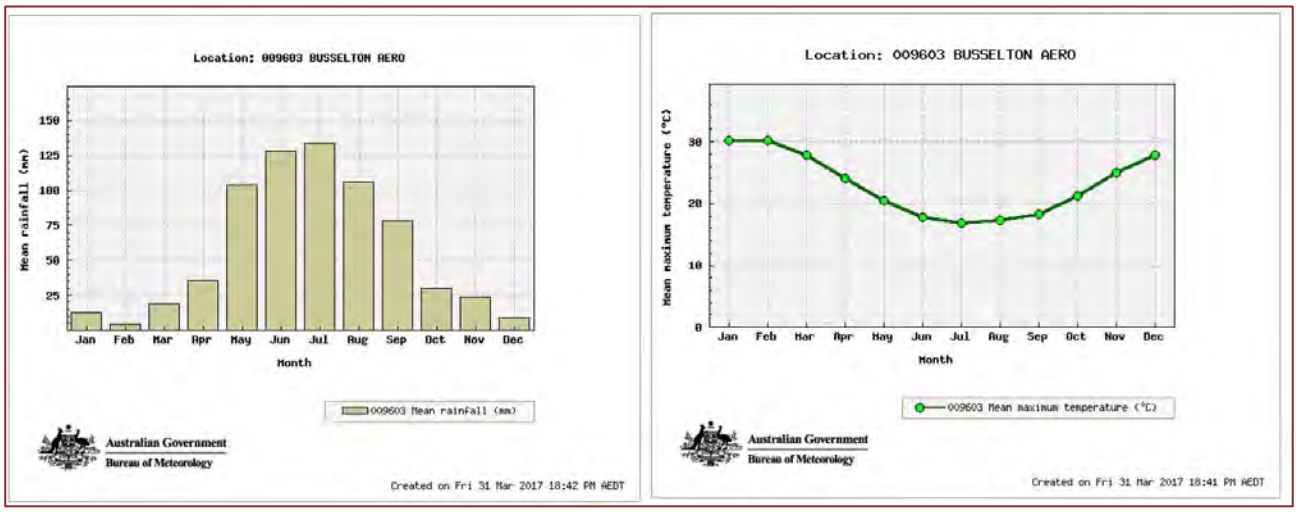


Figure 6 Mean Maximum recorded temperatures and Monthly rainfall for Busselton.

The 3pm December and January wind rose for Busselton Airport shows that the afternoon sea breeze from the south dominates 30-40 % of the time at between 30 and 40 km/h. This decreases in February to just under 30% of the time, though the wind also comes from the NW ~20% of the time at between 20-30 km/h. (Figure 7).

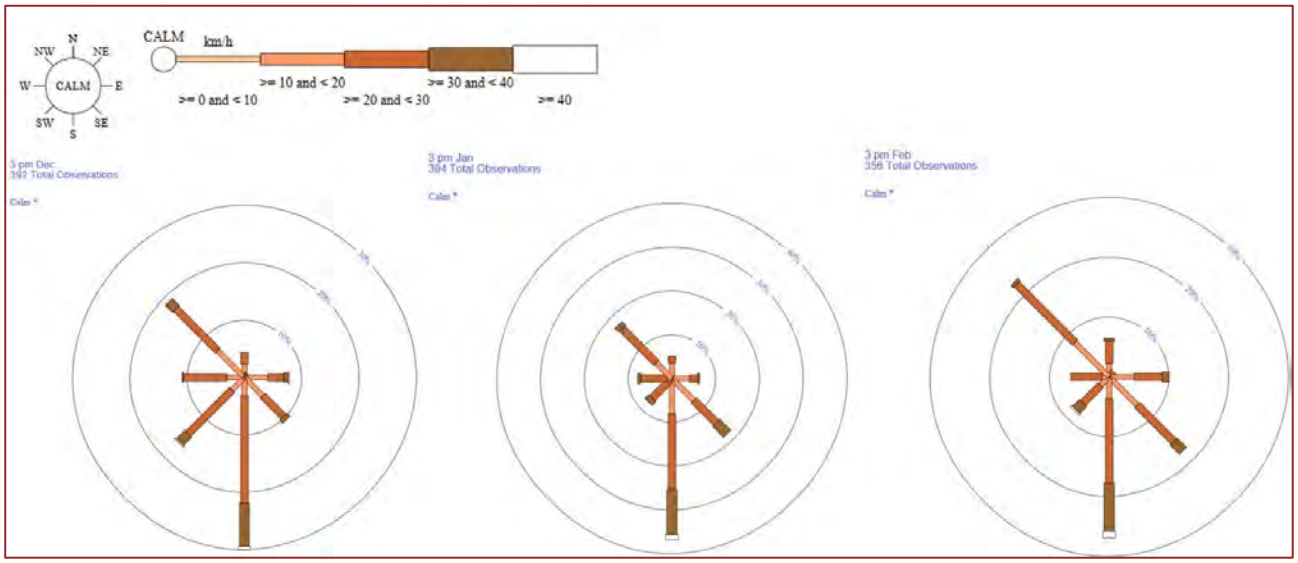


Figure 7 Wind Rose for Busselton in km/h for December, January and February

The combination of hot dry summers, prevailing winds and dry vegetation poses a bushfire risk. Bushfire prevention is considered essential for the protection of life and property and to ensure that frequent and uncontrolled burning does not degrade the vegetation and conservation values of the property.

4.3 Surrounding Landscape and History

To the west of the lots are areas of residential development, posing a Low bushfire risk. To the north is Bussell Highway and rural residential lots within minimal remnant vegetation remaining, also posing a Low Bushfire Hazard. To the south and east of the site are areas that have been cleared for mining or agricultural purposes which are mainly devoid of native vegetation, also posing a Low bushfire hazard.

The fire risk to people and property within the Site is considered Moderate due to the small areas of remnant vegetation remaining within the site. By complying with the requirements of this BMP, this risk can be appropriately managed.

4.4 Bushfire Hazard Level Assessment

Bushfire Hazard Level (BHL) is determined by rating the vegetation type against Appendix 2 of *Guidelines for Planning in Bushfire Prone Areas* (2015) which is based on the methodology used in Australian Standards AS3959: Construction of Buildings in Bushfire-Prone Areas (AS 3953-2009). A vegetation classification map has been prepared which defines the boundaries of vegetation throughout the Site (Map 4).

A Bushfire Hazard Level Assessment map has been prepared which considers vegetation type and structure, and the topography of the Site (Map 5). The Bushfire Hazard for the Class A - Forest vegetation is considered to be Extreme and the Class B - Woodland is considered to be Moderate. Any areas that are within 100m of a Moderate or Extreme bushfire hazard are also considered to be a Moderate hazard to reflect the increase in risk due to proximity. Areas of Class G - Grassland, excluded vegetation or non-vegetated areas which are further than 100m from any Moderate bushfire hazard are considered a Low hazard.

5 Bushfire Management Plan

The aim of the Bushfire Management Plan is to reduce the impacts to residents and fire fighters in the event of bushfire within or near the Site.

The Site will need to be developed to incorporate fire management measures outlined within this plan. This includes the following bushfire protection elements as outlined in *Guidelines for Planning in Bushfire Prone Areas* (WAPC, 2015):

- Location;
- Siting and Design of Development:
- Vehicular Access;
- Water sources and storage; and
- Dwelling Construction Standards.

Maps 6 to 8 show the elements of the Bushfire Management Plan as mentioned below.

5.1 Element 1: Location

Intent

To ensure that the development is located in an area with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.

Performance Principle

The intent of this element may be achieved where the development 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.

Acceptable Solutions

To achieve compliance with this element using an acceptable solution approach, acceptable solutions A 1.1 must be met:

A1.1 – Development Location

The development is located in an area that is, or will be on completion, be subject to either a moderate or low bushfire hazard level or BAL-29 or lower.

Background

Australian Standard (AS) 3959-2009 requires that properties exposed to a potential bushfire risk, be assessed to determine a "Bushfire Attack Level" (BAL). The standard defines BAL as:

A means of measuring the severity of a building's potential exposure to ember attack, radiant heat and direct flame contact, using increments of radiant heat expressed in kilowatts per metre squared, and the basis for establishing the requirements for construction to improve protection of building elements from attack by bushfire. (Standards Australia, AS 3959-2009).

Once assigned, a BAL will determine the appropriate construction requirements for a block or property.

AS 3959-2009 specifies 6 Bushfire Attack Levels (BAL), ranging from Low to Extreme. There are increasing construction requirements ranging from ember protection to direct flame contact protection as the BAL level increases. A BAL assessment determines the appropriate construction requirements for the property. The determination of a property's BAL in accordance with AS 3959 for bushfire prone areas, is a site-specific assessment that considers a number of factors including the slope of the land, the types of surrounding vegetation and its proximity to other building or structures on the Site. A BAL-LOW rating is considered to be a low bushfire hazard land classification. BAL- 12.5, BAL-19 and BAL-29 ratings are considered to be areas with a moderate bushfire hazard and BAL-40 and BAL-FZ are rated as areas with extreme bushfire hazard levels and these are not normally approved as suitable building sites by the decision-making authorities.

Acceptable Solutions

Assessing bushfire hazards in the landscape requires classification of lots within a minimum of 100m from a bushfire risk. Modification to the edges of some vegetation plots within the site will be required to achieve the setbacks listed below. The minimum setbacks to achieve a BAL-29 rating are 14 metres from any Class B – Woodland vegetation and 21 metres from any Class A – Forest vegetation.

The below tables outline the separation distances required to achieve each BAL rating, according to vegetation classification and topography. Map 8 illustrates the BAL-29 contour level.

The category of Bushfire attack has been determined in accordance with Table 2.4.3 of AS 3959-2009 using a Fire Danger Index (FDI) of 80 as outlined in Guidelines for Planning in Bushfire Prone Areas (2015) and Table 2.1 of AS 3959-2009.

For Class B - Woodland upslope or flat, the separation distances and BALs are shown in Table 1.

Table 1 BAL Separation distances Class B – Woodland Vegetation: Upslope or Flat Land.

Veg Class	BAL-FZ (m from veg)	BAL-40 (m from veg)	BAL-29 (m from veg)	BAL-19 (m from veg)	BAL 12.5 (m from veg)
Class B – Woodland	<10m	10 - <14m	14 - <20m	20 - <29m	29 - <100m

These separation distances are shown in Map 6.

For Class A - Forest upslope or flat, the separation distances and BALs are shown in Table 2.

Table 2 BAL Separation distances Class A – Forest Vegetation: Upslope or Flat Land.

Veg Class	BAL – FZ (m from veg)	BAL-40 (m from veg)	BAL-29 (m from veg)	BAL-19 (m from veg)	BAL-12.5 (m from veg)
Class A Forest	<16m	16 - <21m	21 - <31m	31 - <42m	42-100m

These separation distances are shown in Map 7.

By maintaining these distances construction of any dwellings within the site, the

performance principle for this element is met. The final BAL ratings depend on the housing design and the orientation and location within each lot. Once the building design has been finalised, a separate BAL assessment will be conducted and a certificate from a qualified Bushfire Consultant submitted at the building application stage.

5.2 Element 2: Siting & Design of Development

Intent

To ensure that the siting and design of development minimizes the level of bushfire impact.

Performance Principle

The intent of this element may be achieved where the siting and design of the development, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. That it minimizes the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.

Acceptable Solutions

To achieve compliance with this element acceptable solution A2.2 must be met to the extent that it satisfies Element 1 - Location.

A2.1 – Asset Protection Zone

Background

The WAPC (2015) states that the Asset Protection Zone (APZ) is a low fuel area immediately surrounding a habitable or specified building, and is designed to minimise the likelihood of flame contact with buildings. All of the requirements prescribed in A2.1 are essential and must be achieved to ensure compliance.

Non-flammable features such as driveways, lawns, landscaped gardens and vegetable patches can form part of the APZs. Isolated trees and shrubs may be retained within APZs.

All APZs should be accommodated within the boundaries of the subject lot, except in situations where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity. The presence of a wall between the bushfire hazard and the

site does not alone preclude the need for an Asset Protection Zone (WAPC, 2015).

The size of the APZ from each external wall, supporting post or column of a dwelling needs to be sufficient to provide adequate protection to ensure the potential radiant heat impact of a fire does not exceed 29kW/m2. The size of the zone is dependent on the adjacent vegetation type and topography, with the distance increasing as the slope increases (WAPC, 2017).

Acceptable Solutions

a. Every building will be surrounded by an APZ, depicted on submitted plans, which meets the following requirements:

b. Width: measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m2 (BAL-29) in all circumstances;

c. Location: the APZ should be contained solely within the boundaries of the lot on which the building is situated, expect in situations where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, into perpetuity;

d. Fences: within the APZ are constructed from non-combustible materials (eg. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

e. Objects: within 10 metres of a building combustible object must not be located close to vulnerable parts of the building i.e. windows and doors.

f. Fine Fuel load: combustible dead vegetation matter less then 6mm in thickness reduced to and maintained at an average of two tonnes per hectare.

g. Trees (>5m in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and/or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy.

h. Shrubs (0.5m – 5m in height): should not be located under trees or within 3 metres of

buildings, should not be planted in clumps greater than 5m2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated at trees.

i. Ground covers (<0.5 m in height): can be planted under trees but must be property maintained to remove dead plant material and any parts within 2 meters of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 100 millimetres in height are to be treated as shrubs.

j. Grass: should be managed to maintain a height of 100 millimetres or less.

Within this development, Asset Protection Zones will meet the acceptable solutions requirements of A2.1.

5.3 Element 3: Vehicular Access

Intent

To ensure that the vehicular access serving a development is available and safe during a bushfire event.

Performance Principle

The intent of this element may be achieved where the internal layout, design and construction of public and private vehicular access and egress in the subdivision/development allow emergency and other vehicles to move through it easily and safely at all times.

Acceptable Solutions

To achieve the intent, all applicable 'acceptable solutions' must be addressed.

A3.1 – Two Access Routes

Joseph Drive and the roads to be constructed during the development process allow for three access/egress options for the lots onto Bussell Highway (Figure 1). Bussell Highway can then be taken to the west towards Busselton or to the east towards Capel (Map 8).

A3.2 – Public Roads

Public Roads will meet the following requirements as outlined in Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015) Table 4, Column 1:

- Minimum trafficable surface: 6 metres
- Horizontal clearance: 6 metres
- Vertical clearance: 4.5 metres
- Maximum grade over <50 metres: 1 in 10
- Minimum weight capacity: 15 tonnes
- Maximum crossfall: 1 in 33
- Curves minimum inner radius: 8.5 metres

Bussell Highway, Joseph Drive and all roads to be constructed during the development process are/will be built to public road standards and allow easy access for both vehicles and emergency appliances.

A3.8 - Firebreaks

Lots within this development will be less than 0.5 ha and are not required to have firebreaks under the Guidelines for Planning in Bushfire Prone Areas or the City of Busselton's Bushfire Notice.

The compliance period for the completion of the firebreaks and other fire requirements on residential lots in the Busselton region is the 16th of November each year and these requirements must be maintained until the 12th of May. These dates can change due to seasonal fire conditions. If this does occur, changes will be published in the local newspapers. It is the responsibility of the individual property owner to maintain in good order and condition, their firebreaks, gates and property fences.

The site will be classified as Category 2 – Urban Residential and Industrial - Commercial. The requirements of this category as per the City of Busselton 2016-2017 Fuel Hazard Reduction

and Fire Break Notice are:

- Code A – Firebreak requirements for Category 2 lands states: Where the area of land is 2042 m2 (1/2 acre) or less, hazardous material must be removed in accordance with Section B – Fuel Reduction.
- Code B – Requirement for Category 2 land states: 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).
- Code D - Fuel Storage and Haystack Protection Zones requirements for Category 6 lands state: A 3 m 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 materials (living or dead).
- Code E1 – Trees: 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.

During the field visit, firebreaks had been maintained around the internal perimeter of the existing lot.

5.4 Element 4: Water Sources & Storage

Intent

To ensure that water is available to the development to enable people, property and infrastructure to be defended from bushfire.

Performance Principle

The development is provided with a permanent and secure water supply that is sufficient for firefighting purposes.

Acceptable Solutions

A4.1: Reticulated Areas

Fire services require quick and ready access to and adequate water supplies during fire emergencies. The area will be provided with reticulated water to Water Corporation and Department of Fire and Emergency Services Standards.

The Water Corporation of WA's Water Reticulation Standard No. 63 is considered to be the baseline criteria for developments and will be applied to this site.

5.5 Dwelling Construction

Any dwelling that is to be constructed or additions planned to existing dwellings shall be designed and built to conform with:

- The City of Busselton's specifications and requirements;
- Australian Standards AS3959-2009 (Recommendations)- with a BAL-29 rating, construction sections 3 & 7 of AS 3959-2009 apply; with a BAL-19 rating construction sections 3 & 6 of AS 3959-2009 apply; with a BAL 12.5 rating construction sections 3 & 5 apply; and
- The Homeowners Bushfire Survival Manual (FESA, 2007) & Prepare, Act, Survive (FESA, 2011) guidelines.

The owners should note that a low-pitched roof, with closed eaves, metal mesh flyscreens and vent covers will provide optimum safety protection in bushfire prone area.

5.6 Fire Fighting Facilities

The site is serviced by the Hithergreen Districts Bushfire Brigade. This is a volunteer brigade and turn out times cannot be assured. The current Fire Control Officer[1] for the area is located in Hithergreen/Tutunup. The owners should make themselves aware of any changes to this by contacting the City of Busselton prior to each fire season or noting changes listed in the City of Busselton's Annual Bushfire Notice, which is published and distributed to landowners annually.

It is recommended that representatives from the Hithergreen Districts Bushfire Brigade are invited to the site before the start of the fire season so that they are familiar with the internal access areas and firefighting resources (including water supplies), whenever prescribed burning or fire-fighting is conducted in the vicinity of the development.

[1] As at March 2017, the Fire Control Officer for the location is Oscar Negus Snr (ph: 9753 2112). This information should be updated by the owners annually. DoFES Emergency Information Line is 1300 657 209

6 Conclusion

This plan provides acceptable solutions and responses to the performance criteria outlined in Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015).

There are areas of remnant vegetation remaining within the site which pose a Moderate to Extreme bushfire hazard. The surrounding landscape is mainly devoid of native vegetation and is a Low bushfire hazard.

Bushfire safety is a shared responsibility between governments, fire agencies, communities and landowners. The planning and building controls outlined in the plan will reduce the risk of bushfire to people and property. It will not remove all risk however. People interpret risk differently. The way they prepare and maintain their properties, buildings and assets and the actions they take (e.g. evacuate early or stay and defend) greatly influence their personal safety. Should any residents eventuate within the proposed Site, they need to maintain self-reliance and not wait or expect warnings or assistance from emergency services.

7 Summary

7.1 Overall Fire Threat

The design of the proposed expansion and the facilities to be established at the time of development are such that, with the implementation of this Bushfire Management Plan, fire threat to people and property within this development is significantly reduced.

7.2 Landowner's Responsibilities

The landowners' in succession will be responsible for:

- Being aware of the bushfire risk potentially affecting their property, with an understanding that bushfire threat can never be fully removed;
- Reading, understanding and complying with this Bushfire Management Plan;
- Ensuring the ongoing implementation of this Bushfire Management Plan, including providing successive landowners with a copy of this Bushfire Management Plan, and making them aware of the responsibilities outlined in this Bushfire Management Plan;
- Preparing and implementing contingency measures in the event a bushfire should occur onsite;
- Responding to and complying with fire protection or hazard management notices issued by the local government;
- Maintaining, in good order and condition, all access gates and property fencing;
- Preparing a hazard reduction programme with physical removal of flammable material;
- Ensuring that all dwellings are designed and constructed in full compliance with Australian Standards AS3959-2009 (Recommendations) and the requirements of the City of Busselton.

7.3 Developer's Responsibilities

The developer shall be required to carry out works that include the points listed below.

- Install all access ways as described;

- Install Asset Protection Zones as described;
- Lodging a section 70A Notification on each Certificate of Title proposed by the subdivision. The notification shall alert purchasers of land and successors in Title of the responsibilities of this Bushfire Management Plan;
- Maintaining the existing fire breaks to the required standard until individual lots are sold;
- Supply a copy of this Bushfire Management Plan and the Bushfire Survival Manual to each property owner on sale of the allotment. A copy of the approved Bushfire Management Plan must be attached to all Contracts of Sale for the Lot.

7.4 City of Busselton's Responsibilities

The responsibility for compliance with the law rests with individual property owner and occupiers and the following conditions are not intended to necessarily transfer some to the responsibilities to the City of Busselton.

The City of Busselton shall be responsible for:

- Monitoring bush fuel loads in road reserve, public reserves, POS areas and other areas of bushfire risk and maintaining fuel loads at safe levels;
- Maintain public roads to appropriate standards ensuring compliance with standards.
- Developing and maintaining District Fire-Fighting Facilities.
- Maintaining, in good order, the condition of the district water tanks and fire hydrants and the apparatus for firefighting purposes.
- Enforcement of the Annual Firebreak Notice.
- Provision of fire prevention and preparedness advice to landowners upon request.

8 Compliance Checklist

The following comprises the completed checklist for performance criteria and acceptable solutions as stipulated in Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015).

Element			
1: Location	**Yes**	**No**	**Comment**
Does the proposal comply with the performance criteria by applying acceptable solution A1.1?	✓		
2: Siting and design of development	**Yes**	**No**	**Comment**
Does the proposal comply with the performance criteria by applying acceptable solution A2.1	✓		
3: Vehicular access	**Yes**	**No**	**Comment**
Does the proposal comply with the performance criteria by applying acceptable solution A3.1	✓		
Does the proposal comply with the performance criteria by applying acceptable solution A3.2	✓		
Does the proposal comply with the performance criteria by applying acceptable solution A3.3			N/A
Does the proposal comply with the performance criteria by applying acceptable solution A3.4			N/A
Does the proposal comply with the performance criteria by applying acceptable solution A3.5			N/A
Does the proposal comply with the performance criteria by applying acceptable solution A3.6			N/A
Does the proposal comply with the performance criteria by applying acceptable solution A3.7			N/A
Does the proposal comply with the performance criteria by applying acceptable solution A3.8	✓		
4: Water sources and storage	**Yes**	**No**	**Comment**
Does the proposal comply with the performance criteria by applying acceptable solution A4.1	✓		
Does the proposal comply with the performance criteria by applying acceptable solution A4.2			N/A
Does the proposal comply with the performance criteria by applying acceptable solution A4.3			N/A

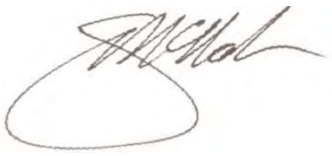
Applicant Declaration

This Bushfire Management Plan meets the requirements of SPP 3.7 and the Guidelines for Planning in Bushfire Prone Areas (WAPC, 2015).

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

Gary McMahon (B.Sc. M. EnvMgmt. PG Dip Bushfire) for Ecosystem Solutions Pty Ltd.

3rd April 2017



BPAD 35078

9 References

DFES (2015). Map of Bush Fire Prone Areas. Department of Fire and Emergency Services. [available at www.dfes.wa.gov.au/bushfireproneareas].

FESA, WAPC & Dept of Planning (2010). Planning for Bushfire Protection. Edition 2. May, Government of Western Australia, Perth. WA.

FESA (2012). Visual Fuel Load Guide for Scrub Vegetation of the Swan Coastal Plain and Darling Scarp, including Geraldton Sandplains & Leeuwin Ridge Regions of Western Australia. Bushfire and Environmental Protection Branch, Fire and Emergency Services Authority of Western Australia.

WAPC (2015). Guidelines for Planning in Bushfire Prone Areas. Western Australian Planning Commission, Perth. WA.

WAPC (2015a). State Planning Policy 3.7: Planning in Bushfire Prone Areas (SPP 3.7). Western Australian Planning Commission, Perth. WA.

10 Glossary

AS 3959: Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas.

Asset Protection Zone (APZ): A low fuel area immediately surrounding a building.

BAL: Bushfire Attack Level (BAL) as set out in the Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas (AS 3959), as referenced in the Building Code of Australia (as amended).

BAL Assessment: An assessment prepared in a manner and form set out in AS 3959 to determine a BAL. It is strongly recommended that BAL assessments are prepared by accredited Level 1 BAL Assessors, unless otherwise exempted in these Guidelines.

BAL Contour Map: A BAL Contour Map is a scale map of the subject lot/s illustrating the potential radiant heat impact and associated indicative BAL ratings in reference to any classified vegetation remaining within 100 metres of the assessment area after the development is complete. The intent of the BAL contour map is to identify land suitable for development based on the indicative BAL rating. It is strongly recommended that BAL Contour Maps are prepared by an accredited Bushfire Planning Practitioner.

Bushfire: An unplanned fire burning in vegetation. A generic term which includes grass fires, forest fires and scrub fires both with and without a suppression objective.

Bushfire hazard: The potential or existing flammability of vegetation that, in association with topography and slope, when ignited may cause harm to people and/or damage property and/or infrastructure.

Bushfire Hazard Level (BHL) assessment: A BHL assessment provides a measure of the likely intensity of a bushfire and the likely level of a bushfire attack on a site determined by categorising and mapping land as having a low, moderate or extreme Bushfire Hazard Level in accordance with the methodology set out in the Guidelines. It is strongly recommended that Bushfire Hazard Level assessments are prepared by an accredited Bushfire Planning Practitioner.

Bushfire Management Plan (BMP): A document that sets out short, medium and long term

risk management strategies for the life of the development. It is strongly recommended that Bushfire Management Plans are prepared by accredited Bushfire Planning Practitioners in accordance with the requirements set out in the Guidelines on behalf of the landowner/proponent with the assistance of the responsible authority for emergency services where required.

Bushfire Planning Practitioner: A person who holds Level Two or Level Three accreditation under the Western Australian Bushfire Association Framework.

Bushfire prone area: An area that has been designated by the Fire and Emergency Services Commissioner under s. 18P of the Fire and Emergency Services Act 1998 as an area that is subject, or likely to be subject, to bushfires. Such areas are identified on the Map of Bush Fire Prone Areas and can be found on the Department of Fire and Emergency Services website.

Bushfire Protection Criteria: A performance based system of assessing bushfire risk management measures contained in the Guidelines and applied to all strategic planning proposals, subdivisions and development applications.

Bushfire risk: The chance of a bushfire igniting, spreading and causing damage to people, property and infrastructure.

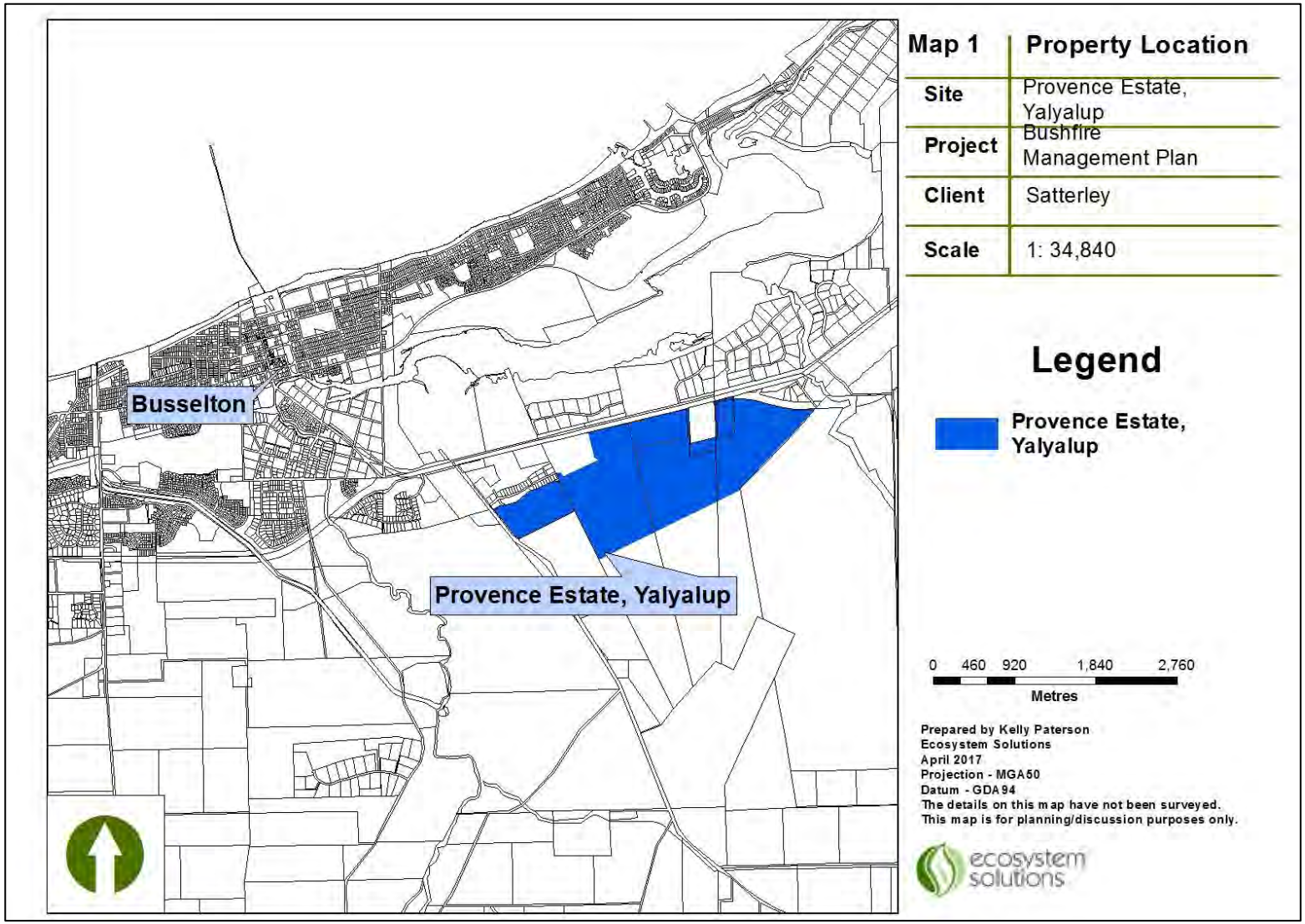
Bushfire risk management: Means the application of the bushfire protection criteria contained in the Guidelines.

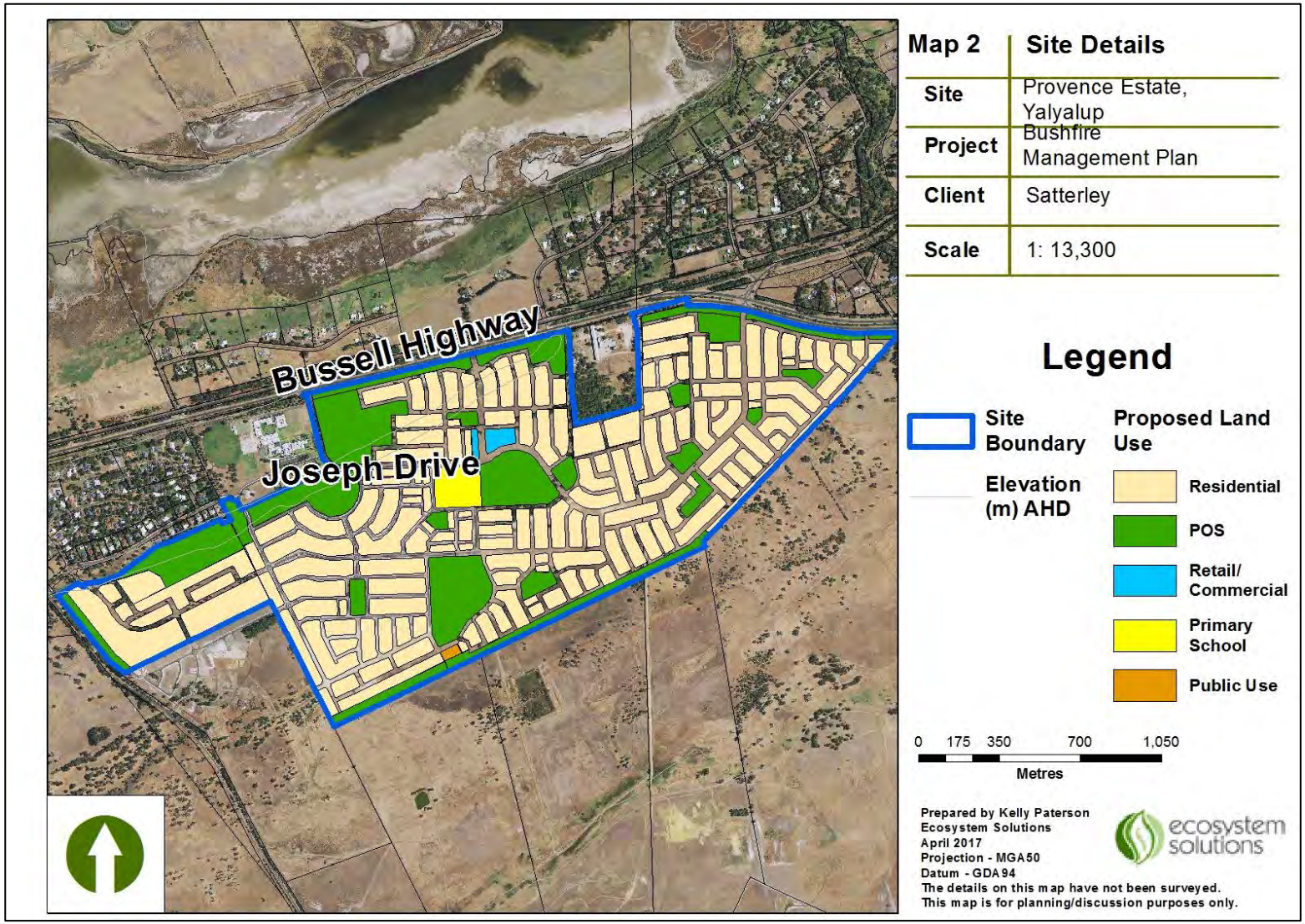
Development application: An application for approval to carry out development or change a land use under either a local planning scheme or region planning scheme. This includes local development plans but excludes application for single houses and ancillary dwellings on a lot or lots less than 1,100m^2.

Guidelines: Refers to the Guidelines for Planning in Bushfire Prone Areas (WAPC 2015), as amended.

WAPC: Western Australian Planning Commission.

11 Maps


Busselton
Provence Estate, Yalyalup
Map 1 | Property Location
Site | Provence Estate, Yalyalup
Project | Bushfire Management Plan
Client | Satterley
Scale | 1: 34,840
Legend
Provence Estate, Yalyalup
0 460 920 1,840 2,760
Metres
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.
ecosystem solutions


Bussell Highway
Joseph Drive
Map 2
Site Details
Site
Provence Estate, Yalyalup
Project
Bushfire Management Plan
Client
Satterley
Scale
1: 13,300
Legend
Site Boundary
Elevation (m) AHD
Proposed Land Use
Residential
POS
Retail/ Commercial
Primary School
Public Use
0 175 350 700 1,050
Metres
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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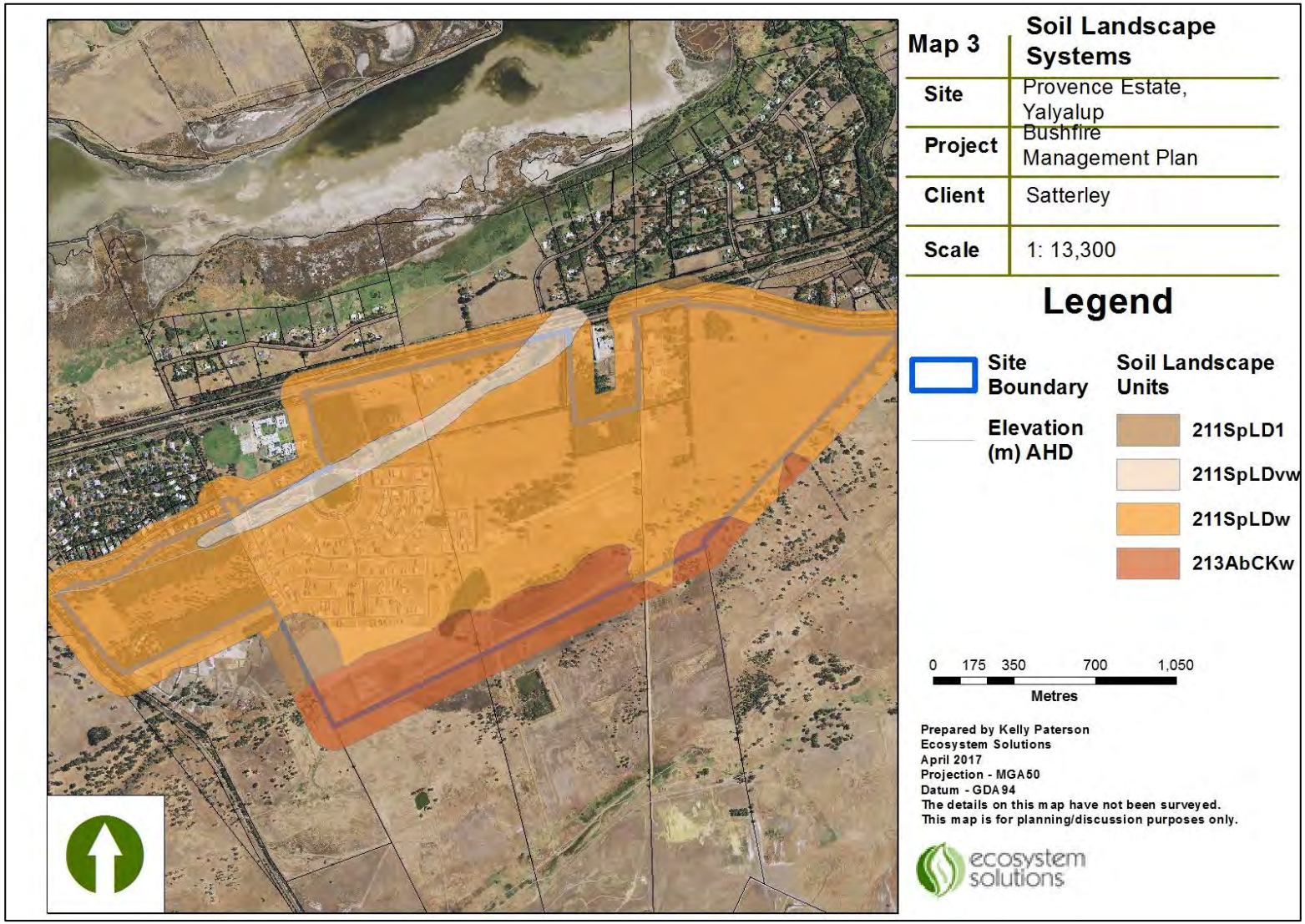
Map 3
Soil Landscape Systems
Site
Provence Estate, Yalyalup
Project
Bushfire Management Plan
Client
Satterley
Scale
1: 13,300
Legend
Site Boundary
Elevation (m) AHD
Soil Landscape Units
211SpLD1
211SpLDvw
211SpLDw
213AbCKw
0 175 350 700 1,050
Metres
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
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Map 4	Vegetation Classification
Site	Provence Estate, Yalyalup
Project	Bushfire Management Plan
Client	Satterley
Scale	1: 14,110

Legend

- Site Boundary
- Elevation (m) AHD
- 100m Buffer

Vegetation Classification

- Class A - Forest
- Class B - Woodland
- Excluded

0 175 350 700 1,050

Metres

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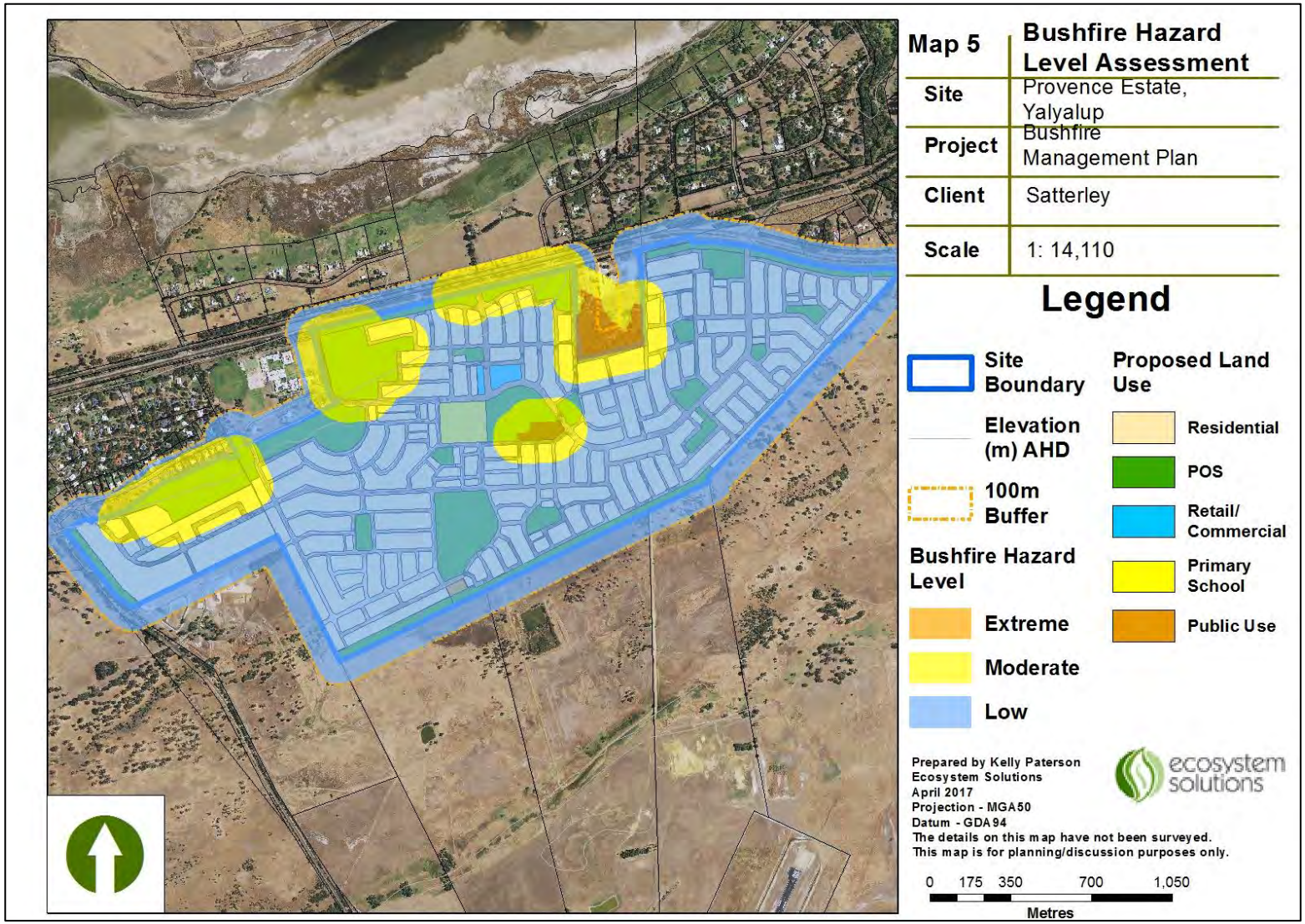
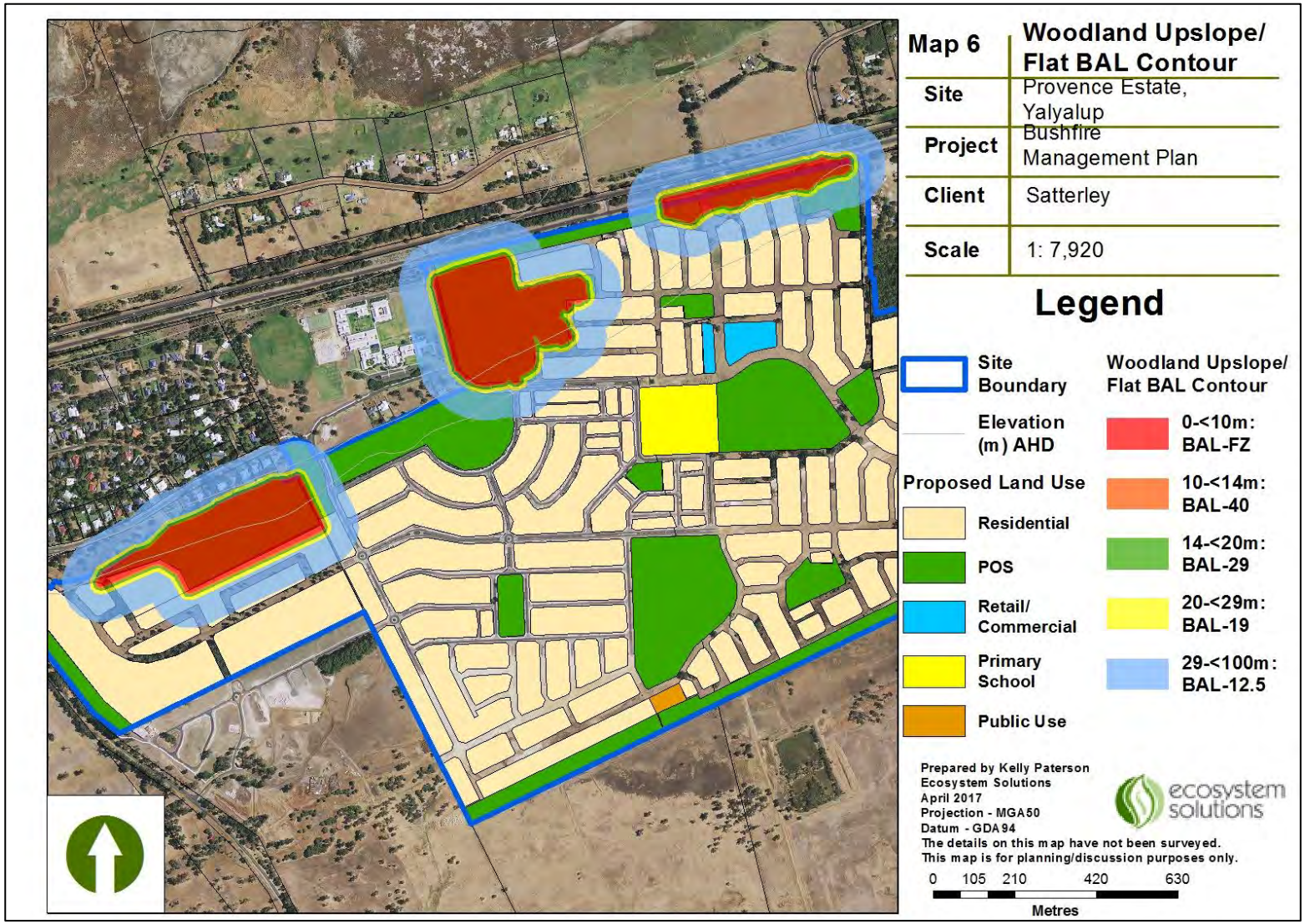

Map 5
Bushfire Hazard Level Assessment
Site
Provence Estate, Yalyalup
Project
Bushfire Management Plan
Client
Satterley
Scale
1: 14,110
Legend
Site Boundary
Elevation (m) AHD
100m Buffer
Bushfire Hazard Level
Extreme
Moderate
Low
Proposed Land Use
Residential
POS
Retail/ Commercial
Primary School
Public Use
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.
ecosystem solutions
0 175 350 700 1,050
Metres


Map 6
Woodland Upslope/ Flat BAL Contour
Site
Provence Estate, Yalyalup
Project
Bushfire Management Plan
Client
Satterley
Scale
1: 7,920
Legend
Site Boundary
Elevation (m) AHD
Proposed Land Use
Residential
POS
Retail/ Commercial
Primary School
Public Use
Woodland Upslope/ Flat BAL Contour
0-<10m: BAL-FZ
10-<14m: BAL-40
14-<20m: BAL-29
20-<29m: BAL-19
29-<100m: BAL-12.5
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
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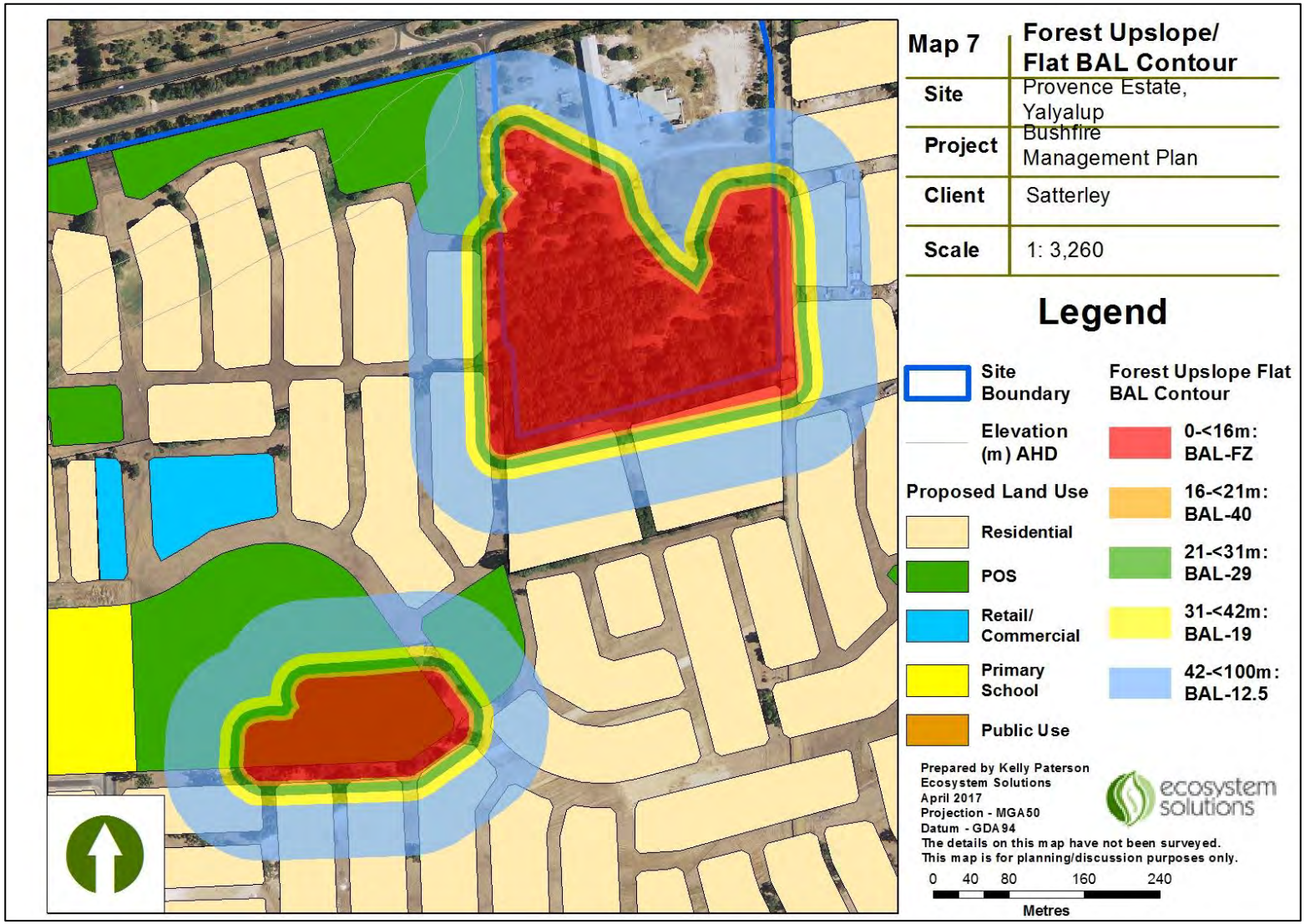
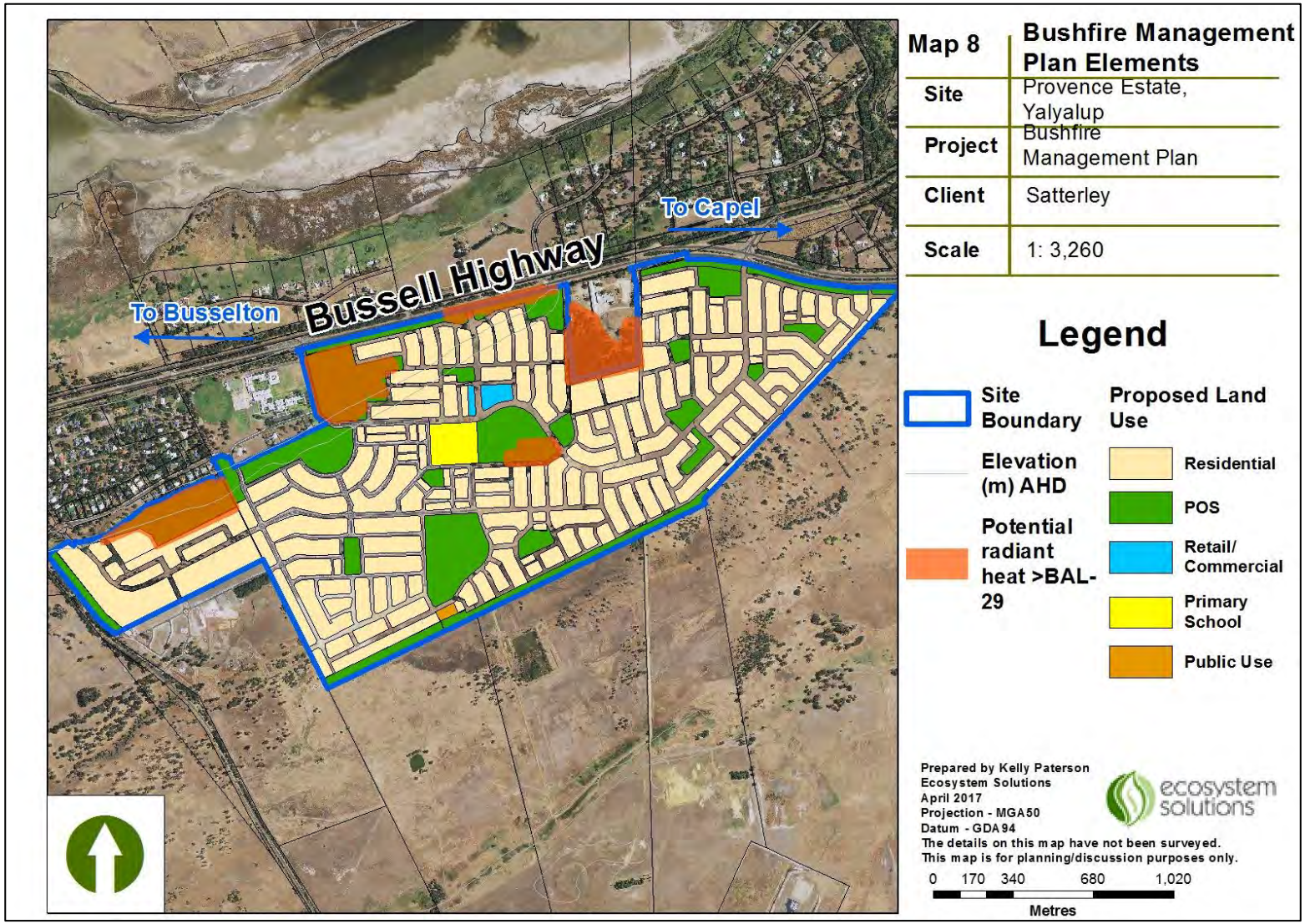
This map is for planning/discussion purposes only.
ecosystem solutions
0 105 210 420 630
Metres


Map 7
Forest Upslope/ Flat BAL Contour
Site
Provence Estate, Yalyalup
Project
Bushfire Management Plan
Client
Satterley
Scale
1: 3,260
Legend
Site Boundary
Elevation (m) AHD
Proposed Land Use
Residential
POS
Retail/ Commercial
Primary School
Public Use
Forest Upslope Flat BAL Contour
0-<16m: BAL-FZ
16-<21m: BAL-40
21-<31m: BAL-29
31-<42m: BAL-19
42-<100m: BAL-12.5
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.
ecosystem solutions
0 40 80 160 240
Metres


To Busselton
Bussell Highway
To Capel
Map 8
Bushfire Management Plan Elements
Site
Provence Estate, Yalyalup
Project
Bushfire Management Plan
Client
Satterley
Scale
1: 3,260
Legend
Site Boundary
Elevation (m) AHD
Potential radiant heat >BAL-29
Proposed Land Use
Residential
POS
Retail/ Commercial
Primary School
Public Use
Prepared by Kelly Paterson
Ecosystem Solutions
April 2017
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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ecosystem solutions
0 170 340 680 1,020
Metres

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: Part Lot 75 Bussell Highway		
Suburb: Yalyalup	**State:** WA	**P/code:** 6281
Local government area: City of Busselton		
Description of the planning proposal: Rezoning (scheme amendment) and amendment to Structure Plan		
BMP Plan / Reference Number: 19720	**Version:** Rev A	**Date of Issue:** 20/06/2019
Client / Business Name: Satterley Property Group C/- RPS Australia Asia Pacific Att: Lachlan McCaffrey		

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.)?

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
Kelly Paterson	Level 2	38253	02/2020
Company Ecosystem Solutions		**Contact No.** (08) 9759 1960	

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

Signature of Practitioner **Date** 20/06/2019

ecosystem solutions

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www.ecosystemsolutions.com.au

Bushfire Management Plan

Provence Estate, Part Lot 75 Bussell Highway, Yalyalup

20 June 2019

Prepared for:
Satterley Property Group
C/- RPS Australia Asia Pacific
Att: Lachlan McCaffrey

Limitations Statement

This report has been prepared for Satterley Property Group , C/- RPS Australia Asia Pacific Att: Lachlan McCaffrey and remains the property of Ecosystem Solutions Pty Ltd. 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.

STATEMENT OF CONFORMITY - PLANNING AND DEVELOPMENT ACT 2005

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

Kelly Paterson
B.Sc Hons. Nat Rs Mgmt., BPAD Level 2 (38253)

The signatory declares that this Bushfire Management Plan meets the requirements of State Planning Policy 3.7.

Document Control

Client - Satterley Property Group

C/- RPS Australia Asia Pacific

Att: Lachlan McCaffrey

Site - Provence Estate, Part Lot 75 Bussell Highway, Yalyalup

Version	Purpose	Author	Reviewer	Approver	Submitted	
					Form	Date
Rev A	Initial Report	KP (BPAD 38253 – Level 2)	DP (BPAD 46554 – Level 1)	GM (BPAD 35078 – Level 3)	Electronic (email)	20/06/2019

Filename: Z:\PROJECTS\19720 Lot 75 Bussell Highway, Yalyalup BMP\Reports\Lot 75 Bussell Hwy Yalyalup.docx

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Appendix A City of Busselton Firebreak & Fuel Hazard Reduction Notice
Appendix B APZ Requirements
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1 Proposal

This Bushfire Management Plan (BMP) has been prepared by Ecosystem Solutions Pty Ltd, Kelly Paterson (B.Sc. Hons. Nat Rs Mgmt, BPAD 38253 – Level 2), as part of the process of the owners of Lot 75 Bussell Highway, Yalyalup (Figure 1) to support a rezoning (scheme amendment) and amendment to the Provence Structure Plan for this stage of the development (Portion of Lot 75, hereafter called the "Site"). The land is currently zoned 'Tourist and Special Provision' and rezoning to permit urban residential development is being sought.

The Site is located within the City of Busselton and is situated approximately 6 km to the south-east of the Busselton town Site, Western Australia. The main access to the Proposed Lots will be via Joseph Drive and the roading to be constructed during the development (Figure 1).

The Site is predominantly flat, sitting at approximately 10 m above sea level (Australian Height Datum – AHD).

The Site is approximately 40 ha, being the portion of Lot 75 within the Structure Plan highlighted as subject to rezoning (Figure 1). There is an additional fragmented portion of Lot 75 to the north of Bussell Highway (Proposed Lot 500 Uligugalup Road) that is subject to a previous BMP (Bushfire Prone Planning, 2018). Satterley are currently completing a subdivision to excise this area from the remainder of Lot 75.

Portions of the Site are located within a bushfire prone area, as declared by *State Planning Policy 3.7: Planning in Bushfire Prone Areas* (Figure 2).

The purpose of this BMP is to detail the fire management methods and requirements that will be implemented within the Site as part of the structure plan. The aim of the BMP is to reduce the threat to residents and fire fighters in the event of a fire within or near the Site.

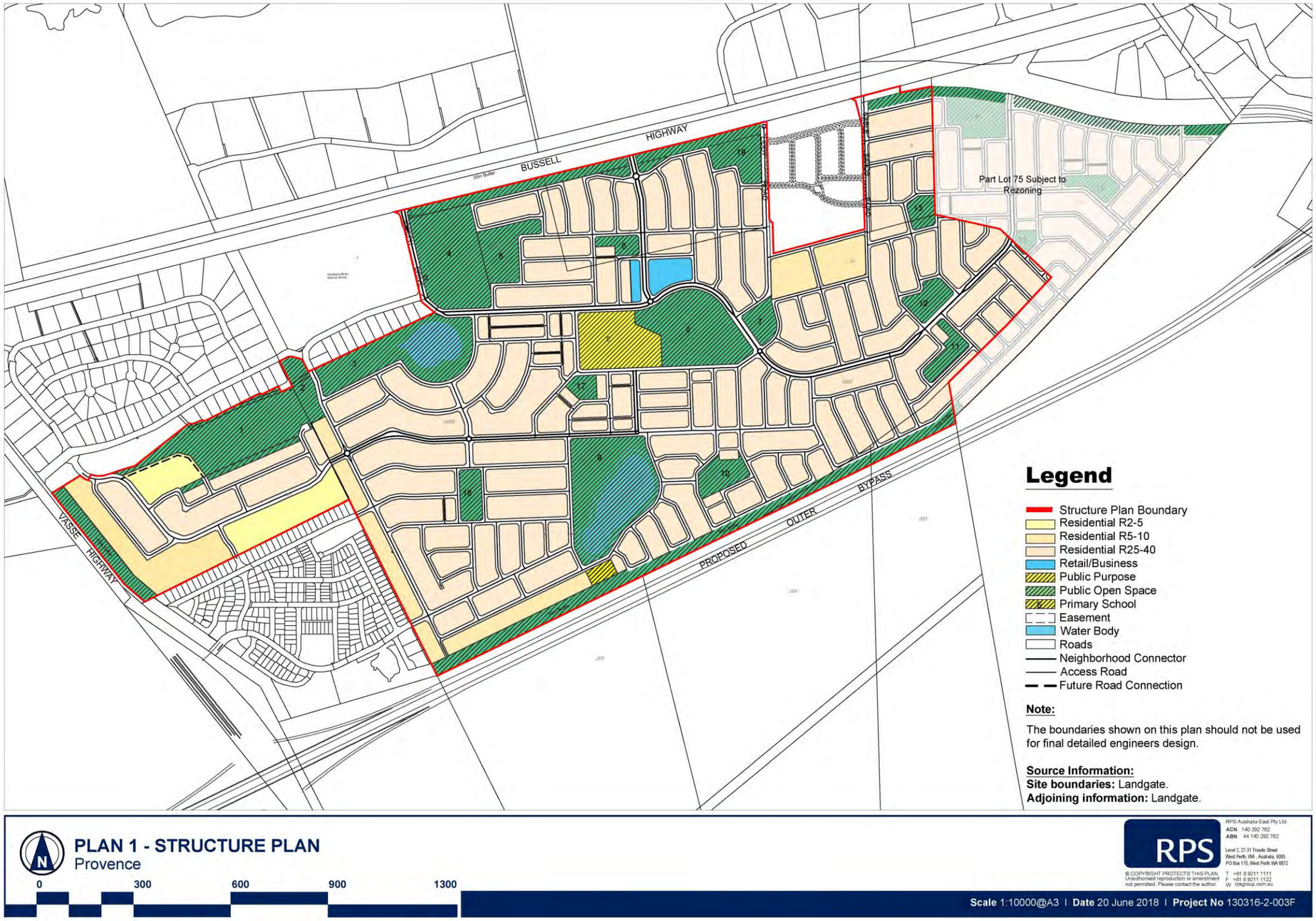


Figure 1 Structure Plan for Provence Estate

Figure 2 Map of Bushfire Prone Areas for Provence Estate, Part Lot 75 Bussell Highway, Yalyalup, within the blue polygon

2 Bushfire Assessment Results

2.1 Assessment Inputs

A Site inspection was conducted on 28th May 2019 by Kelly Paterson (B.Sc Hons, Nat Rs Mgmt., BPAD Level 2) and Dani Cuthbert (Dip Bus & Dip TM, BPAD Level 1), for the purpose of determining the Bushfire Attack Level in accordance with AS 3959-2018 Simplified Procedure (Method 1).

All vegetation within 150 m of the Site was classified and the slope under the vegetation determined in accordance with AS 3959-2018, shown in the photos below with map provided in Figure 3.

Plot	1	Vegetation Classification or Exclusion Clause	Class A Forest Upslope / Flat

Photo ID: 1

Photo ID: 2

Description / Justification for Classification:	Overstorey of trees 10 - 20 m in height, including *Eucalyptus gomphocephala* and *Agonis flexuosa,* with canopy greater than 30%. Understorey including introduced grasses and native shrubs. Post development this vegetation will also include the areas of POS 14, the Outer Bypass Landscape Buffer and the Bussell Highway Landscape Buffer, which are to be revegetated as part of the approved Landscape Plan (Appendix C).

Plot	2	Vegetation Classification or Exclusion Clause	Class B Woodland Upslope / Flat

Photo ID: 3

Photo ID: 4

Description / Justification for Classification:	Canopy including *Corymbia calophylla, Agonis flexuosa* and mixed introduced *Eucalyptus* spp., with cover of 10 - 30% and understorey of introduced grasses. Portions of this vegetation will be modified as development proceeds within the portion of the Provence development to the west of the Site (eg. Photo 4).

Plot	3	Vegetation Classification or Exclusion Clause	Class G Grassland Upslope / Flat

Photo ID: 5

Photo ID: 6

Description / Justification for Classification:	Unmanaged paddocks, including introduced grasses and other pasture species with scattered *Melaleuca* and *Corymbia calophylla* trees. Post development, the grasses within the Site will be managed at under 10cm in height in perpetuity, with the majority of the land becoming roads, houses, managed gardens in the future and therefore excluded under S 2.2.3.2 (e) or (f). Portions of this vegetation will be modified as development proceeds within the portion of the Provence development to the west of the Site.

Plot	4	Vegetation Classification or Exclusion Clause	Class A Forest Upslope / Flat (post development)

Photo ID: 7

Photo ID: 8

Description / Justification for Classification:	Vegetated area of Public Open Space 14 - this area is currently Class B - Woodland with 30% canopy of *Agonis flexuosa,* with understorey of introduced grasses, as is reflected in Figure 3 - Vegetation Classification Current Extent. The vegetated area of POS 14 is subject to revegetation according to the approved Landscape Plan (Appendix C), and post development this vegetation is likely to become Class A - Forest, which is reflected in Figure 4 - Vegetation Classification Post Development.

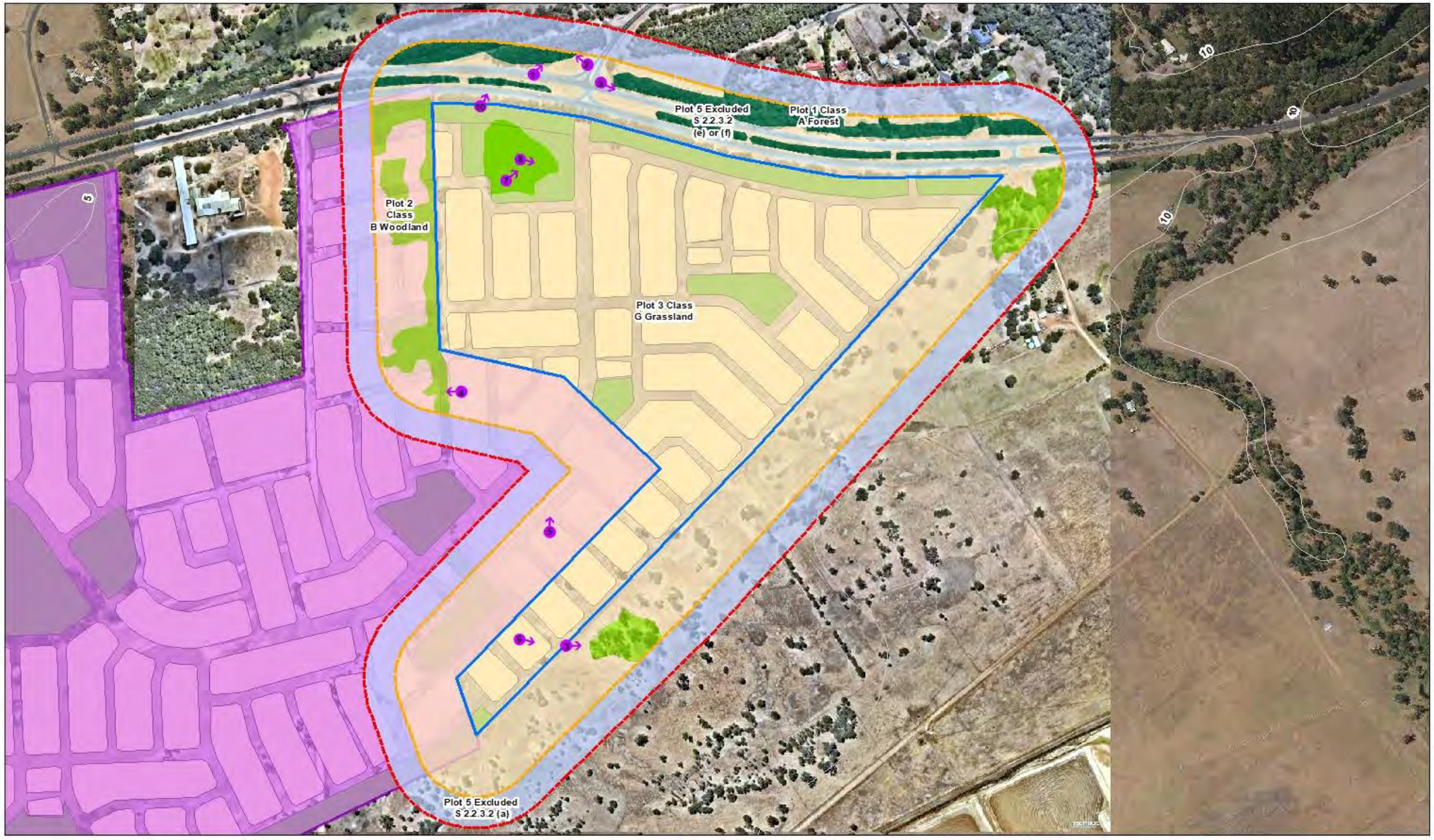
Plot	5	Vegetation Classification or Exclusion Clause	Excluded S 2.2.3.2 (a), (b), (e) or (f)

Photo ID: 9

Photo ID: 10

Description / Justification for Classification:	Areas greater than 100m from the Site are excluded under S 2.2.3.2 (a). Non-vegetated areas including roads are excluded under S 2.2.3.2 (e). Low threat vegetation including grasses managed at under 10cm in height, managed lawns and gardens and single lines of trees are excluded under S 2.2.3.2 (f). The Post Development Vegetation Map shows that the majority of the Site is excluded under S 2.2.3.2 (e) or (f) post development, with the developer being responsible for maintaining all grasses at under 10cm in height until individual lots are sold, when this will become the responsibility of the individual landowners, with the City of Busselton's Firebreak Notice (which may be subject to review from time to time) requiring vegetation within Category 2 lots to be maintained at under 10cm in height. Public Open Space 15 and 16, are currently grassland and will be landscaped according to the Landscape Plan (Appendix C), which states that these areas will be predominately turf. These areas are therefore excluded in the Post Development Vegetation Map under S 2.2.3.2 (f). The Landscape Plan for the Bussell Highway Landscape Buffer and Outer Bypass Landscape Buffer includes sufficient area to ensure a 21m setback between classified vegetation and any residential lot, with this low fuel area excluded under S 2.2.3.2 (f). To the west of the Site is another stage of the Provence development. Once this development goes ahead, the land within these adjacent lots will be excluded from classification under S

2.2.3.2 (e) or (f). The vegetation within Public Open Space 11 and 13 will contain standing vegetation of less than a hectare in size, with a setback of more than 100m from any other areas of classified vegetation and can therefore will be excluded under S 2.2.3.2 (b).



Location details: Lot 75 Bussell Highway, Yalyalup

Project: 19720

Assessment date: May 2019

Prepared by: K Paterson BPAD Accreditation: Level 2

Accreditation number: 38253, Accreditation expiry date: Feb 20

Date aerial photo: Feb 2019

Vegetation Classification - Current Extent

0 55 110 220 330 Meters

N

Legend

- 150m Assessment
- 100m Assessment
- Site Boundary
- Adjacent Provence development
- Residential
- Public Open Space
- Photo Points

Vegetation Classification

- Class A Forest
- Class B Woodland
- Class G Grassland
- Excluded S 2.2.3.2 (a)
- Excluded S 2.2.3.2 (e) or (f)

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Figure 3 Vegetation Classification - Current Extent

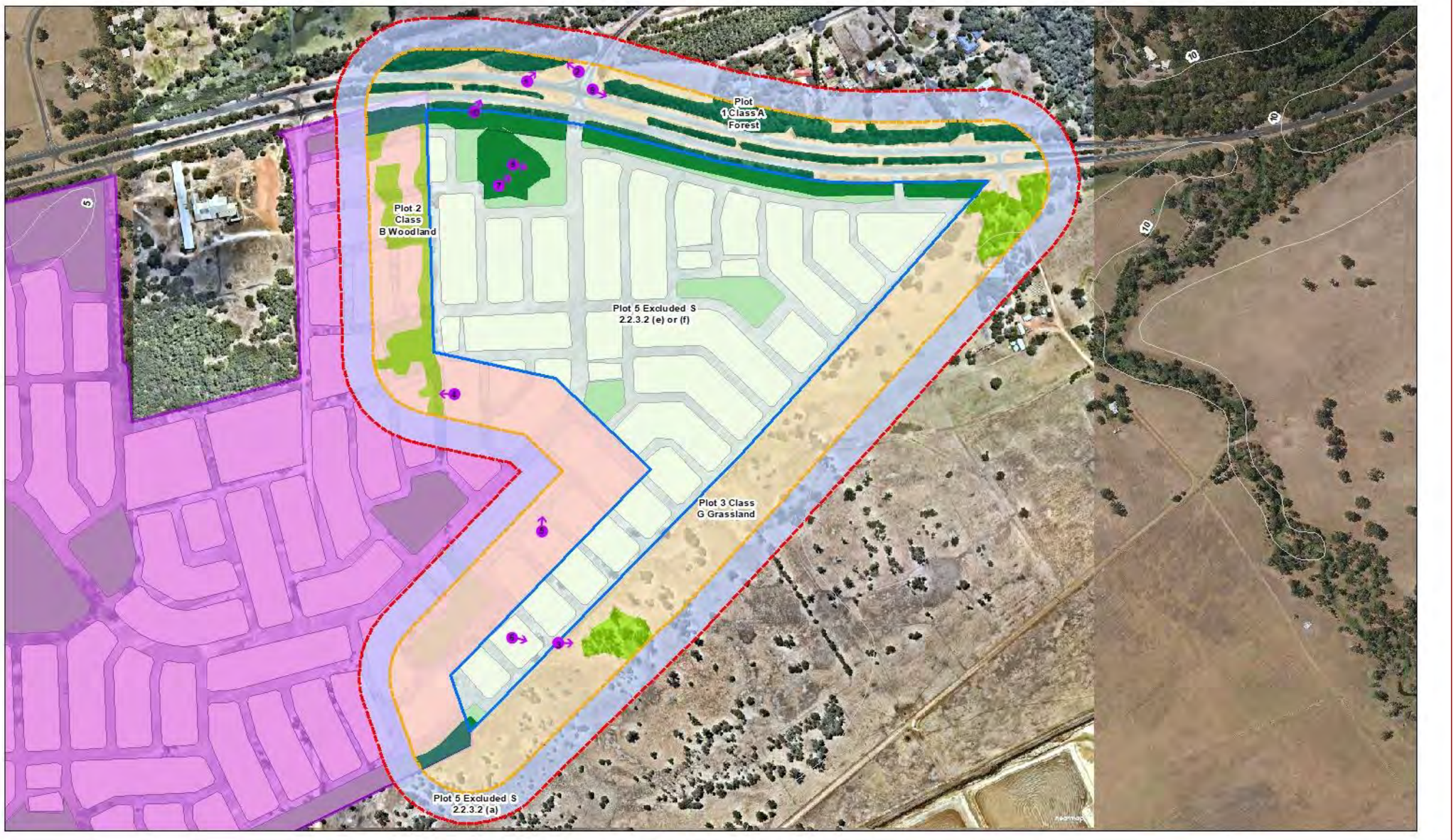


Figure 4 Vegetation Classification - Post Development

2.2 Assessment Outputs

The results from the Site assessment are provided in Table 1. The Determined Bushfire Attack Level (highest BAL) for the Site has been determined in accordance with clause 2.5 of AS 3959- 2018 with map provided in Figure 5 with a detailed BAL Contour map, showing the area of residential lots >BAL-29 rating, provided in Figure 6.

Table 1 Site Assessment Results

Method 1 BAL Determination				
Fire Danger Index - 80 (AS 3959-2018 Table 2.1)				
Plot	Vegetation Classification	Effective Slope Under the Classified Vegetation (degrees)	Required Separation Distance to the Classified Vegetation (metres)	Bushfire Attack Level
1	Class A - Forest	Upslope/Flat	Min 21 m	BAL-29
2	Class B - Woodland	Upslope/Flat	Min 28 m^	BAL-19
3	Class G Grassland	Upslope/Flat	Min 15 m^	BAL-19
4	Class A - Forest	Upslope/Flat	Min 21 m*	BAL-29
5	Excluded S 2.2.3.2 (a), (b), (e) & (f)	N/A	N/A	BAL-LOW
Determined Bushfire Attack Level				BAL-29**

^ Class B - Woodland and Class G - Grassland vegetation within an adjacent area of Provence (to the west of the Site) currently impacts on some areas of residential lots (Figures 7 through to 9 below). Any residential lots impacted by a BAL rating greater than BAL-29 will not form part of the Form 1C until such time that the neighbouring vegetation has been subject to development and excluded from classification under AS 3959-2018.

* Some lots include a restrictive covenant excluding building within BAL-40 or BAL-FZ areas to ensure no dwelling is constructed in an area over BAL-29.

** A lower BAL rating can be achieved based on an increased separation distance from the classified vegetation, depending on the location of the dwelling within the Lot. A detailed BAL assessment may be required prior to the construction of any dwelling.

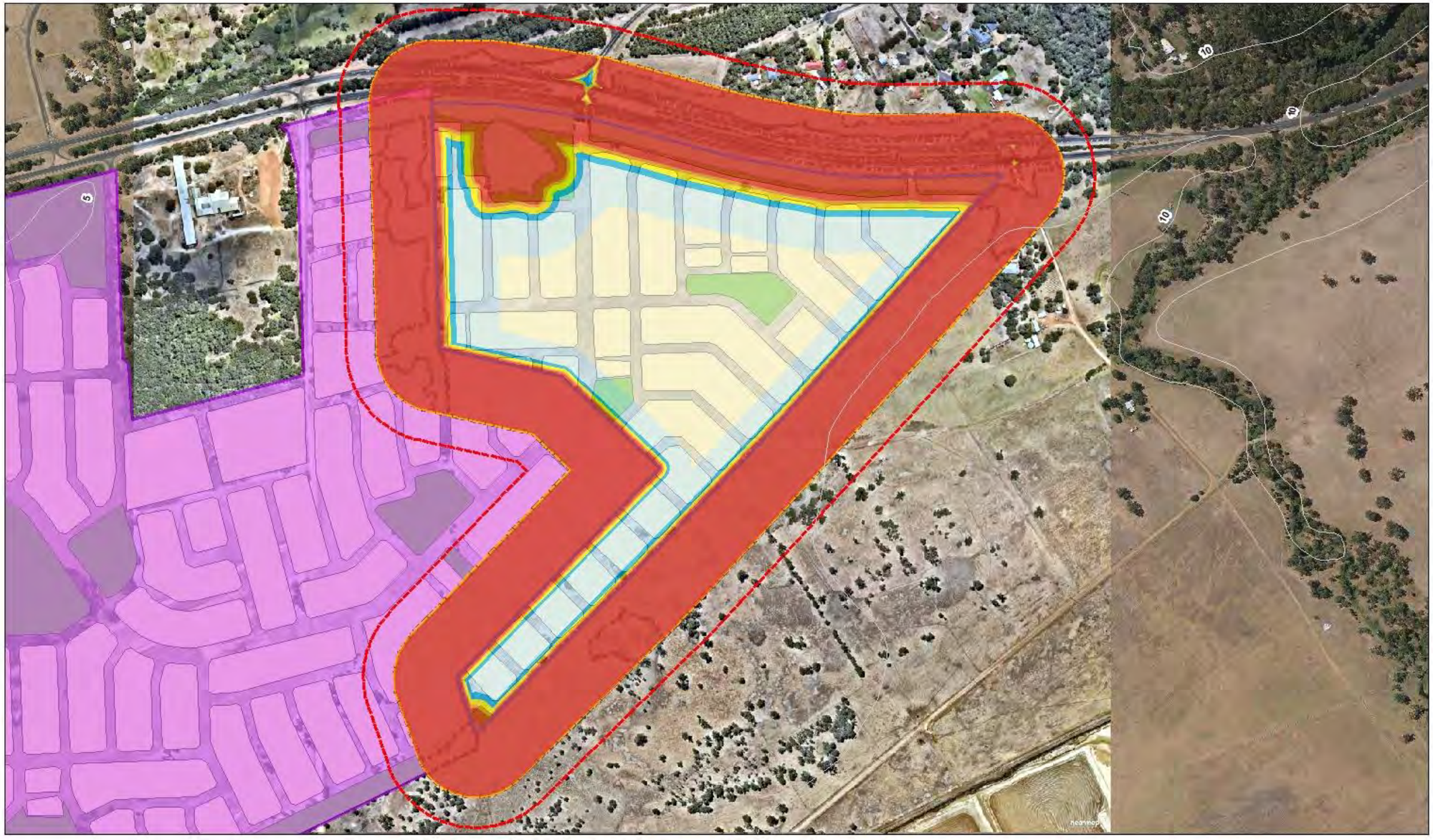


Figure 5 Post Development BAL Contour for Provence Estate

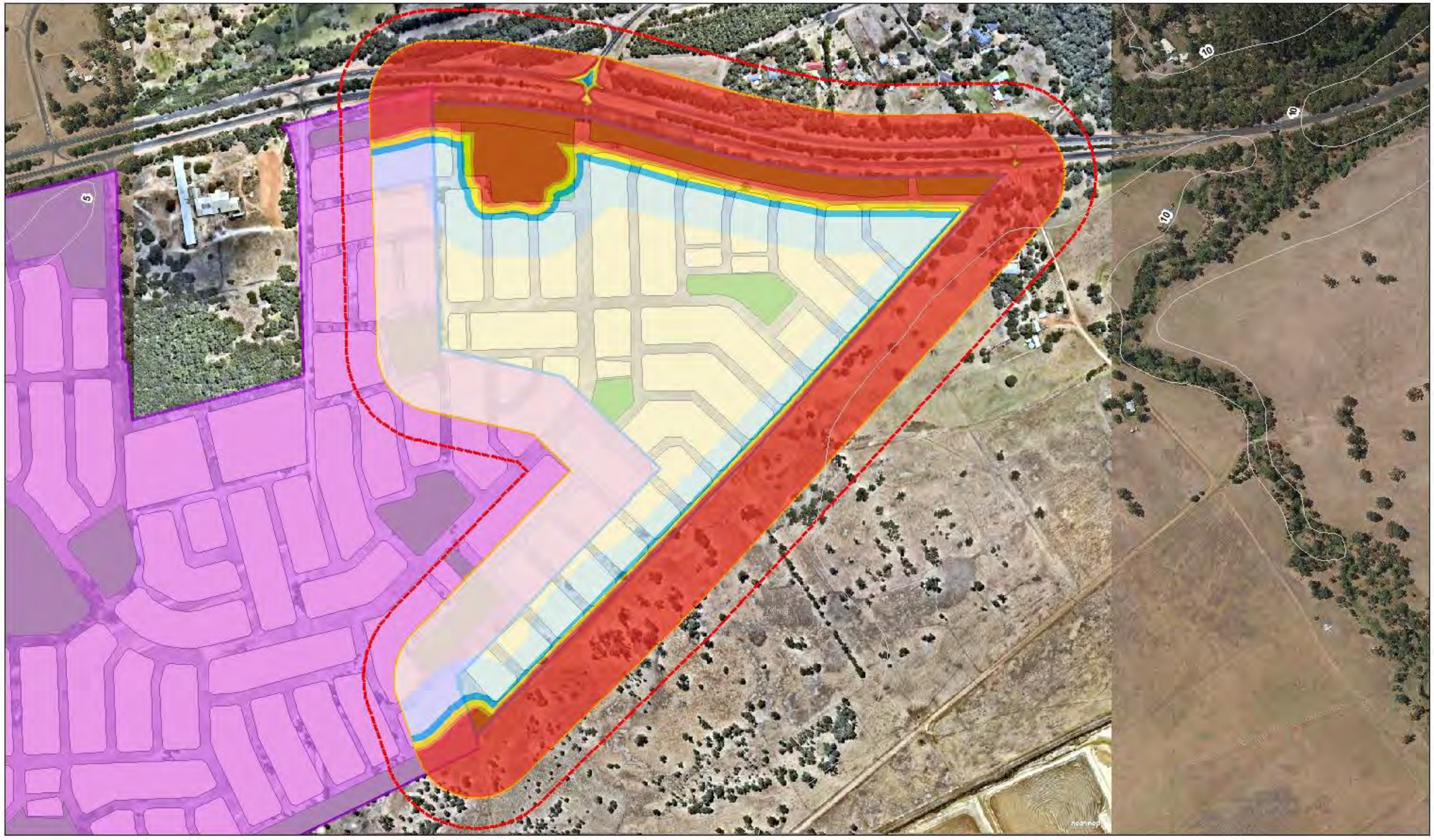


Figure 6 BAL Contour based lot to the west being developed

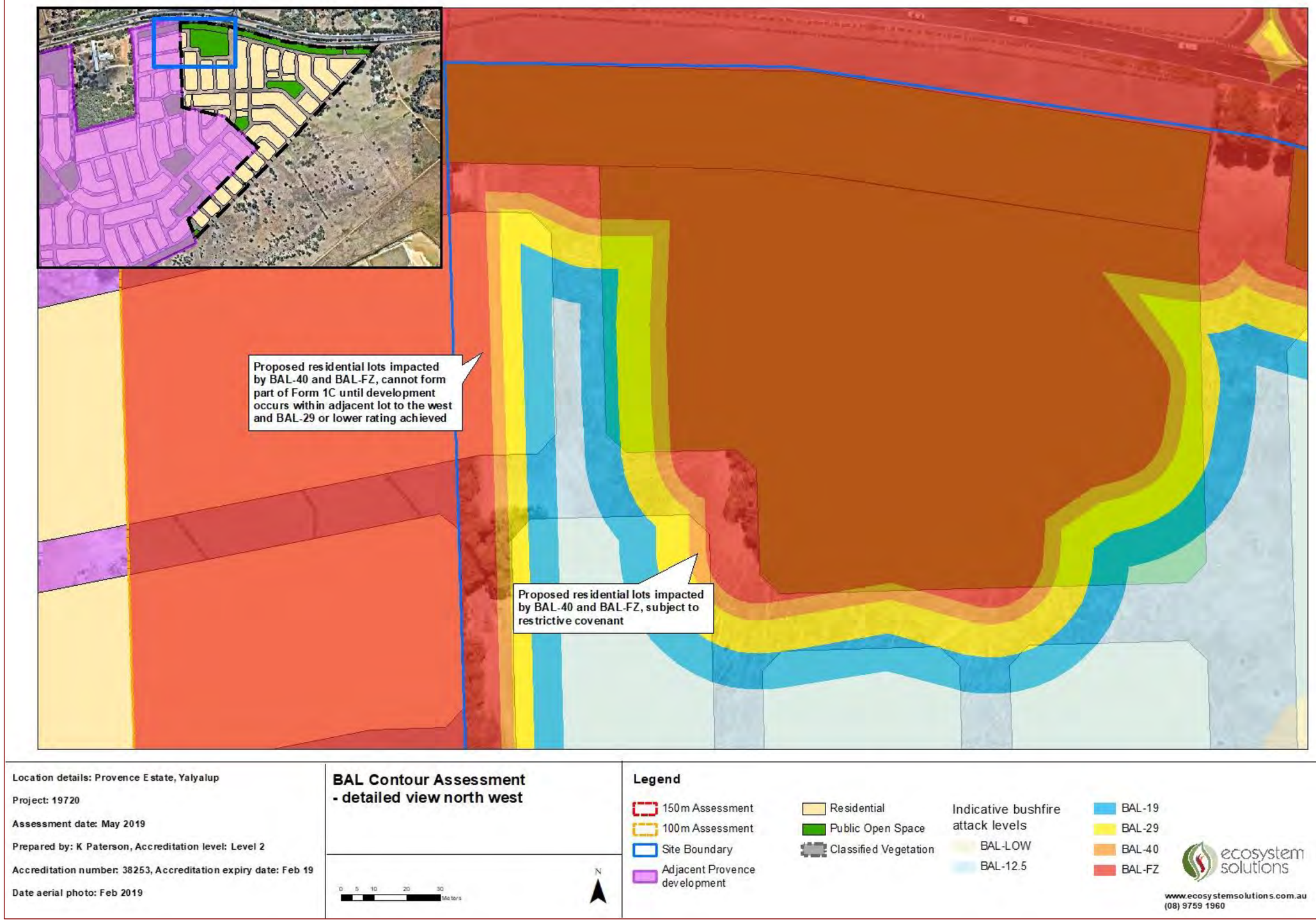


Figure 7 BAL Contour - detailed view of areas >BAL-29 rating within the north west of the Site

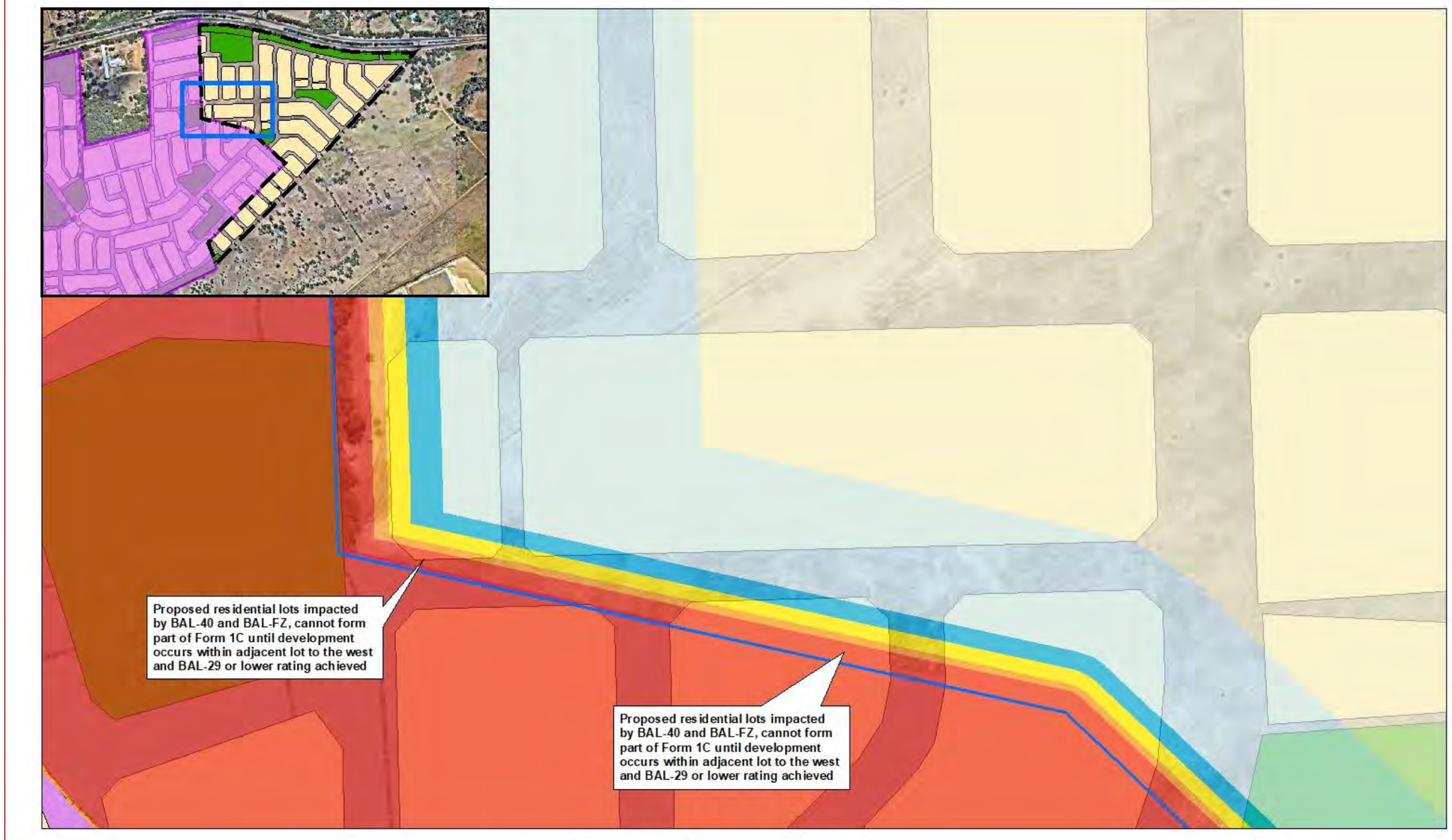


Figure 8 BAL Contour - detailed view of areas >BAL-29 rating to the west of the Site

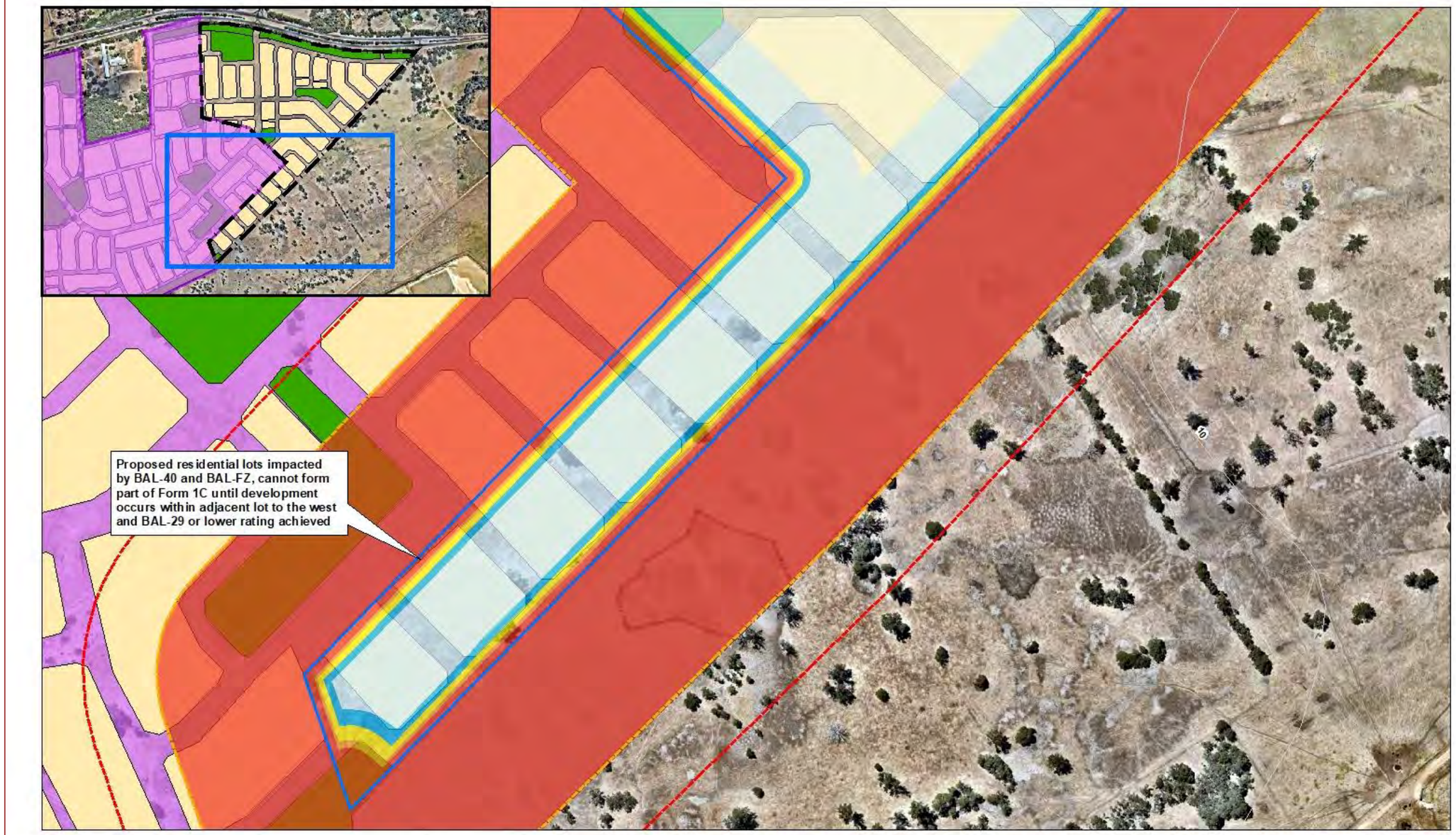


Figure 9 BAL Contour - detailed view of areas >BAL-29 rating within the south west of the Site

3 Environmental Considerations

3.1 Native Vegetation - modification and clearing

Provence Estate, Yalyalup contains grassland previously cleared for agriculture, with scattered trees and a small pocket of remnant vegetation. The remnant vegetation to the north west of the Site is to be retained within an area of Public Open Space.

The Site and the surrounding 150m buffer have been assessed for environmental values using a simple desktop review (Table 2). A Protected Matters Search identified 18 threatened flora species are likely to occur in the area and two threated ecological communities. No vegetation representative of either of the TECs was observed during the site assessments. A review of the SLIP data identifies a geomorphic wetland adjacent to the Site.

Table 2 Significant environmental values identified within the Site

Environmental Value	Yes or No	If Yes - describe
Conservation Covenants	No	Not applicable
Bushfire Forever Sites	No	Not applicable
Conservation Category Wetlands and Buffer	Yes	A geomorphic wetland runs through the Site (SLIP 17/01/19).
Threatened Ecological Communities (TECs)	Yes	Banksia Woodlands of the Swan Coastal Plain ecological community and Subtropical and Temperate Coastal Saltmarsh communities are likely to occur within the area.
Declared Rare Flora (DRF)	Yes	18 DRF species or species habitat are likely to occur within the area (PMST Report, 17/01/19).
Significant through Local Planning or Biodiversity Strategy	No	Not applicable

3.2 Re-vegetation / Landscape Plans

The approved Landscape Plan for Provence Estate is provided in Appendix C, with an excerpt provided in Figure 10. Further details for the landscaping within the Bussell Highway Landscape Buffer and Outer Bypass Landscape Buffer, describing the low fuel zones to be implemented within these areas, are also included within Appendix C. The landscape plan has informed the vegetation classification within this BMP, with the mature state of any plantings used to determine the appropriate classification. The areas of Public Open Space will be established by the developers and maintained according to the landscape plan for a minimum of two years, when management will become the responsibility of the City of Busselton in perpetuity.

Table 3 details and justifies the vegetation classification of each area of Public Open Space within the Site and assessment area.

Table 3 Classification of areas of Public Open Space within the development and surrounding Vegetation Assessment Area

Public Open Space Name	Exclusion / Classification Clause	Justification
POS 11	Excluded S 2.2.3.2 (b)	Within 100 m Assessment area of the Site. Area has standing vegetation of less than a hectare in size with a setback of more than 100m from any other areas of classified vegetation and can therefore be excluded under AS3959-2018 S 2.2.3.2 (b) as development within the adjacent Provence area proceeds.
POS 13	Excluded S 2.2.3.2 (b)	Within 100 m Assessment area of the Site. Area has standing vegetation of less than a hectare in size with a setback of more than 100m from any other areas of classified vegetation and can therefore be excluded under AS3959-2018 S 2.2.3.2 (b) as development within the adjacent Provence area proceeds.

Public Open Space Name	Exclusion / Classification Clause	Justification
POS 14	Class A - Forest and Excluded S 2.2.3.2 (f)	The area of standing vegetation within POS14 is to be retained, this is currently open in nature and represents Class B - Woodland vegetation. Revegetation is to occur within the remnant bushland as part of the landscape plan, therefore the post development classification of this vegetation is Class A - Forest. The remainder of the POS will be turf and concrete paths, allowing exclusion under S 2.2.3.2 (e) and (f)
POS 15	Excluded S 2.2.3.2 (f)	This area of POS does not include any existing trees and will be predominately turf, allowing for exclusion under S 2.2.3.2 (f)
POS 16	Excluded S 2.2.3.2 (f)	This area of POS does not include any existing trees and will be predominately turf, allowing for exclusion under S 2.2.3.2 (f)
Bussell Highway Landscape Buffer	Class A - Forest and Excluded S 2.2.3.2 (f)	Buffer to be planted with indigenous trees and shrubs. A low fuel zone will be provided as detailed in the Landscape Plan (Appendix C) to ensure 21m setback between classified vegetation and any residential lot.
Outer Bypass Landscape Buffer	Class A - Forest and Excluded S 2.2.3.2 (f)	Buffer to be planted with indigenous trees and shrubs. A low fuel zone will be provided as detailed in the Landscape Plan (Appendix C) to ensure 21m setback between classified vegetation and any residential lot.

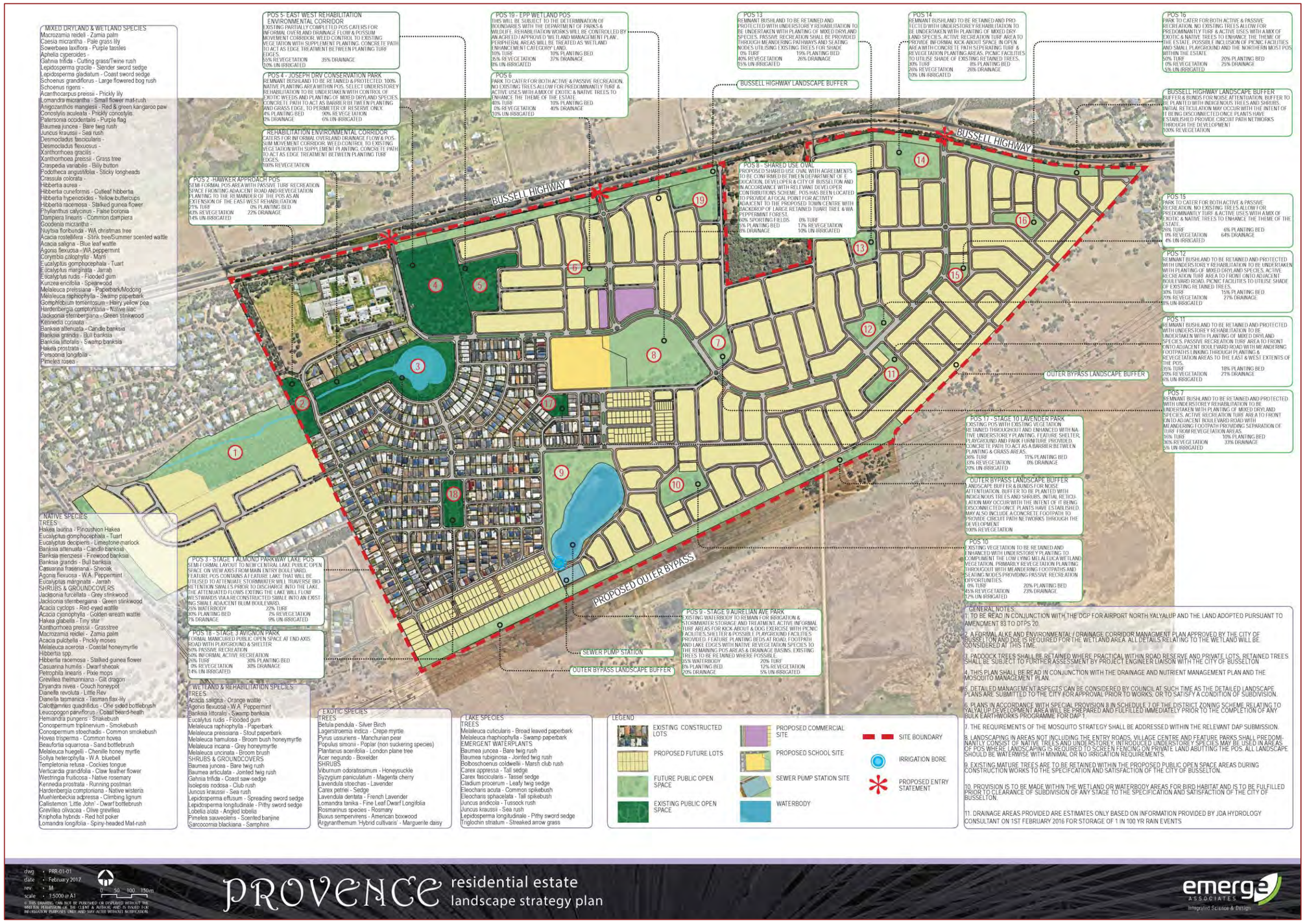


Figure 10 Landscape Strategy Plan for Provence Estate

4 Assessment Against the Bushfire Protection Criteria

4.1 Compliance with the Acceptable Solutions for each Element

Bushfire Protection Criteria – Element 1 - Location		
Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.		
Performance Principle P1: The intent may be achieved where the strategic planning proposal, subdivision or 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 applies 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 DFES and the decision-maker.		
Acceptable Solution	Compliance	Assessment Statements
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.	Compliance with this element is achieved.	A portion of the residential lots to the south west of Public Open Space 14 includes areas of BAL-40 and BAL-FZ along their boundaries (Figure 7). All lots that have BAL-40 or BAL-FZ along their boundary from this Public Open Space will have a restrictive covenant on their titles excluding the construction of dwellings within any BAL-40 or BAL-FZ area. This ensures that no dwelling will be constructed in an area over BAL-29. The road reserve separating these lots from the adjacent Class A - Forest is a minimum width of 15 m therefore the maximum BAL-40 and BAL-FZ encroachment is 7 metres. The adjacent stage of the Provence development (Lots 6, 9032 and Part Lot 75) currently impacts on the Site as the currently unconstructed areas result in Class B - Woodland or Class G - Grassland vegetation classification, which results in BAL-40 and BAL-FZ falling across residential lots (Figures 7 through to 9). Once the adjacent

	area is developed, this vegetation will no longer be a bushfire threat and these areas of the Site will then satisfy the requirements of BAL-29 or lower. This can be managed / controlled at a future planning stage (subdivision), and implemented through a condition of subdivision, in ensuring that the lots are only created where they have a bushfire attack level rating of BAL-29 or lower. This ensures that if the adjacent land has not been developed and the bushfire threat remains, the lots directly adjoining cannot be created as a Deposited Plan and exposed to a BAL-40 or BAL-FZ rating. The BAL Contours across the Site show that the remainder of the residential lots are within areas of BAL-29 or lower. The entire Site will be maintained by the developer with grassland under 10 cm as per the City of Busselton Firebreak Notice (which may be subject to review from time to time) for Category 2 Lots until they are sold, when this maintenance will become the responsibility of the individual landowner. Low fuel areas within public open space must also be established in a low fuel state prior to the sale of the adjacent lots and maintained in this state in perpetuity, as detailed in the Landscape Plan (Appendix C).

Bushfire Protection Criteria – Element 2 – Siting and Design		
Intent: To ensure that the siting and design of development minimises the level of bushfire impact.		
Performance Principle 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. That it 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.		
Acceptable Solution	Compliance	Assessment Statements
A2.1 Asset Protection Zone (APZ) Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements: • Width: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m² (BAL-29) in all circumstances. • Location: the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes). • Management: the APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones'. (see Schedule 1).	Compliance with this element is achieved.	As illustrated in the BAL Contour, and detailed in A1.1 above, all dwellings will have a sufficient setback from the classified vegetation to achieve a BAL-29 or lower rating. Asset Protection Zones will be achieved with all proposed lots being established and maintained in perpetuity as a low fuel zone as part of the development process, ensuring that any areas of an APZ that extends into a neighbouring lot will also be maintained in a low fuel state in perpetuity. The Asset Protection Zones of some lots extend into areas of Public Open Space, these areas will be established and maintained in a low fuel state in perpetuity to ensure compliance with the requirements for an Asset Protection Zone, as detailed in the Landscape Plans (Appendix C). In addition to the requirements of the Guidelines, the City of Busselton's Firebreak and Fuel Hazard Reduction Notice (which may be subject to review from time to time) for Category 2 lots must be complied with, including maintaining grasses at under 10cm in height.

Bushfire Protection Criteria – Element 3 – Vehicular Access		
Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.		
Performance Principle P3: The internal layout, design and construction of public and private vehicular access and egress in the subdivision/ development allow emergency and other vehicles to move through it easily and safely at all times.		
Acceptable Solution	Compliance	Assessment Statements
A3.1 Two Access Routes Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.	Compliance with this element is achieved.	All proposed lots will have two access/egress routes on a public road network. The roads to be constructed during the development process allow for multiple access/egress options for the lots onto Bussell Highway (Figure 1). Bussell Highway can then be taken to the west towards Busselton or to the east towards Capel.
A3.2 Public Road A public road is to meet the requirements in Table 6, Column 1 (Figure 11).	Compliance with this element is achieved.	Public roads will be constructed to meet the requirements of the Guidelines by the Developer (Figure 7).
A3.3 Cul-de-sac (including a dead-end road)	Not applicable to this Site.	There are no proposed cul-de-sacs within this development.
A3.4 Battle-axe	Not applicable to this Site.	There are no proposed battle-axe lots within this development.

Bushfire Protection Criteria – Element 3 – Vehicular Access		
A3.5 Private driveway >50m • Requirements in Table 6, Column 3 (Figure 11); • Required where a house site is more than 50 m from a public road; • Passing bays: every 200 m with a minimum length of 20 m and a minimum width of 2 m; • Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 m (i.e. kerb to kerb 17.5 m) and within 50 m of a house; • Any bridges or culverts are able to support a minimum weight capacity of 15 t; and • All-weather surface (i.e. compacted gravel, limestone or sealed).	Compliance with this element is achieved.	Given the size of the lots within this development, it is unlikely that the location of the dwelling within any of the lots will result in a private driveway greater than 50 m. Any driveway over 50 m will comply with the requirements in the Guidelines.
A3.6 Emergency Access Way	Not applicable to this Site.	
A3.7 Fire Service Access Routes (perimeter roads)	Not applicable to this Site.	
A3.8 Firebreak Width Lots greater than 0.5 ha must have an internal perimeter firebreak of a minimum width of 3 m or to the level as prescribed in the local firebreak notice issued by the local government.	Compliance with this element is achieved.	According to the City of Busselton Firebreak and Fuel Hazard Reduction Notice (which may be subject to review from time to time) for Urban Residential lots (Category 2): • Under 2,024 m^2, firebreaks are not required, • 2,042 m^2 and over, require a minimum 3 m wide trafficable firebreak within 6 metres of all lot boundaries.

TECHNICAL REQUIREMENTS	1 Public road	2 Cul-de-sac	3 Private driveway	4 Emergency access way	5 Fire service access routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 metres	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5
*Refer to E3.2 Public roads: Trafficable surface					

Figure 11 Vehicular access technical requirements (Guidelines for Planning in Bushfire Prone Areas Table 6)

Bushfire Protection Criteria – Element 4 - Water		
Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.		
Performance Principle P4: The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for fire fighting purposes.		
Acceptable Solution	Compliance	Assessment Statements
A4.1 Reticulated Areas The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.	Compliance with this element is achieved.	The Site will be reticulated. Reticulated water will be supplied in accordance with the Water Corporation's No. 63 Water Reticulation Standard. Fire hydrants will be supplied in accordance with Water Corporation requirements.
A4.2 Non-reticulated Areas	Not applicable to this Site.	
A4.3 Individual lots within non-reticulated areas (only for 1 additional lot)	Not applicable to this Site.	

4.2 Performance Based Solutions

The Site assessment was conducted in accordance with AS 3959-2018 Simplified Procedure (Method 1). The Proposal meets all the compliance requirements for the four Bushfire Protection Criteria Elements. There are no performance-based solutions proposed.

4.3 Summary of the Assessment Outcomes

This plan provides acceptable solutions and responses to the performance criteria outlined in the *Guidelines for Planning in Bushfire Prone Areas* (WAPC, Dec 2017).

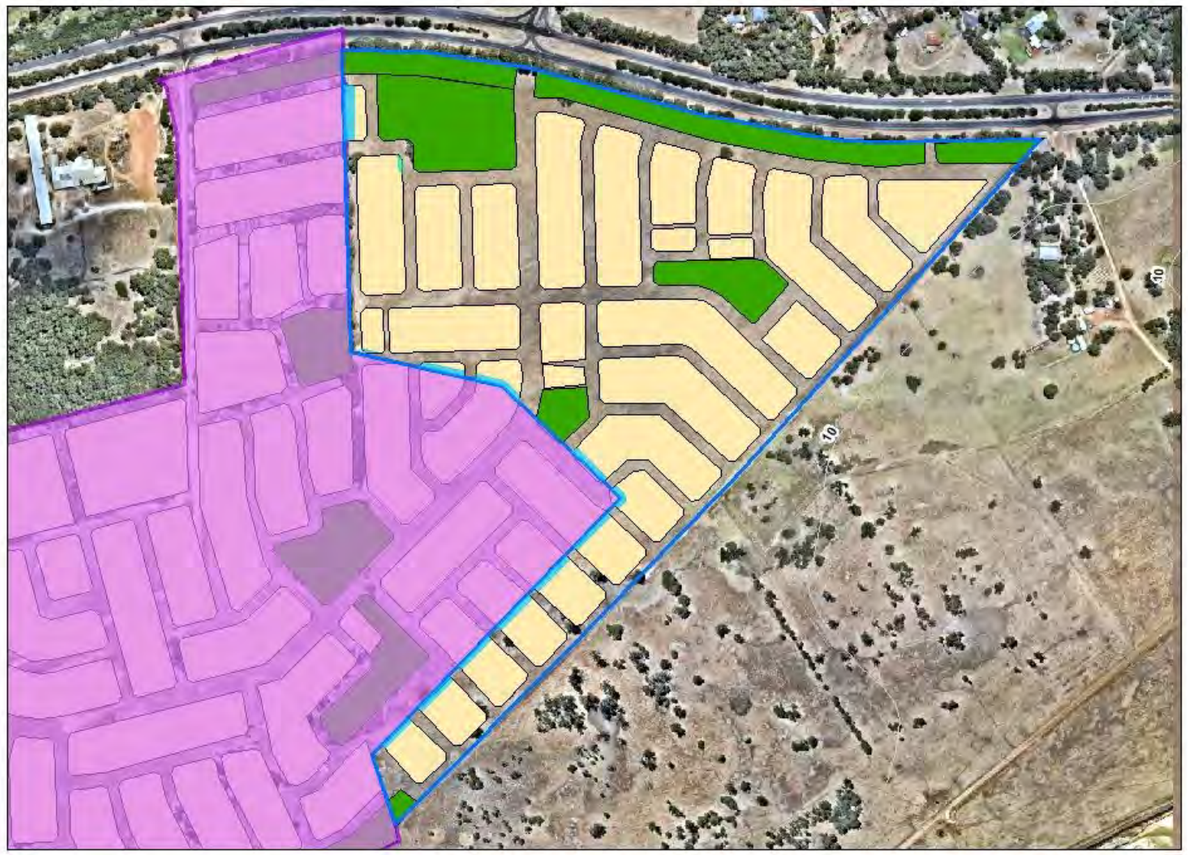
The layout and design of the development is such that no structure will be required to be exposed to a radiant heat flux in excess of 29kW/m^2 (BAL-29) provided the management as outlined in this Plan is adopted.

Any class 1, 2, 3 or associated 10a structure that are to be constructed, or additions planned to existing dwellings shall be designed and built to conform with Australian Standards AS 3959-2018:

- BAL-29: sections 3 & 7;
- BAL-19 sections 3 & 6; and
- BAL 12.5 sections 3 & 5.

A summary of the Bushfire Management Strategies to be implemented is provided in Figure 12. An individual BAL assessment may achieve a lower BAL rating, based on the exact location of a dwelling within a lot, or the development of areas adjacent to the Site that are currently vegetated.

Spatial representation of the proposed risk management measures



PROPERTY / ASSESSMENT DETAILS

Property Address: Lot 75 Bussell Highway, Yalyalup
Project No: 19720
Prepared by: K Paterson
Accreditation Level: Level 2
Accreditation Number: 38253
Accreditation Expiry Date: 02/20

N
0 2550 100 150 200
Meters

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(08) 9759 1960

LEGEND

- Site Boundary
- Elevation (m) AHD
- Adjacent Provence development
- Residential
- Public Open Space

Areas >BAL-29

- >BAL-29 and subject to a restrictive covenant
- >BAL-29 and will not be developed until BAL-29 or lower can be achieved

NOTES

The minimum width for the Asset Protection Zone (APZ) for this Site is the distance required to meet the BAL-29 setback.

Vegetation within the APZ is to comply with Schedule 1 Element 2 of the Guidelines noting that:

- Trees >5m in height are to be setback a minimum distance of 6m from the building with no branches overhanging the roof.
- Shrubs >5m in height are to be setback a minimum distance of 3m from the building, and not planted in clumps greater than 5 sqm
- Grass is to be maintained at less than 100mm in height.

No dwelling is to be constructed in an area with a BAL-40 or BAL-FZ rating. Lots within this development with boundaries subjected to a BAL-40 or BAL-FZ rating due to the adjacent POS 14 will include a restrictive covenant prohibiting the construction of a dwelling within areas >BAL-29. Lots within this development currently subject to a BAL-40 or BAL-FZ rating due to vegetation within the adjacent stage of Provence will not become part of an endorsed deposited plan until such time as the adjacent land is no longer a bushfire hazard and they can achieve a BAL rating of BAL-29 or less.

The Developer will maintain all public open space in accordance with the approved Landscape Plan for a minimum of two years, when ownership and management responsibility is handed over to the City of Busselton. The Asset Protection Zones of some lots extend into the public open space. These areas must be maintained in a low fuel state in perpetuity, as detailed in the landscape plans for the development.

Reticulated water and fire hydrants will be provided in accordance with the Water Corporation No.63 Water Reticulation Standard.

Public Roads will be constructed to the requirements in the Guidelines.

Any driveway 50 m or longer will comply with the requirements of the Guidelines A3.5.

For any lots 2,024sqm and above, firebreaks will be installed and maintained according to the City of Busselton's Firebreak and Fuel Hazard Reduction Notice.

Installation and upkeep of the APZ, compliance with the City of Busselton's Firebreak Notice, driveways and construction to BAL standards are the responsibility of the landowner. The measures listed above shall be implemented prior to the occupation of any dwelling within the Site and shall continue to be maintained in perpetuity.

Figure 12 Map of Bushfire Management Strategies

5 Responsibilities for Implementation and Management of the Required Bushfire Measures

The responsibilities for the Developer, Builder, Landowner/Occupier and Local Government are outlined in Table 4, Table 5, Table 6 and Table 7 respectively.

Table 4 Developer Responsibilities

Number	Action	Due	Completed
1	Establish lots to the dimensions and standard stated in this Bushfire Management Plan.	Post planning approval and prior to lot sale	☐
2	Construct public roads (A3.2) to the dimensions and standard stated in the Bushfire Management Plan.	Post planning approval and prior to lot sale	☐
3	Install reticulated water supply in accordance with Water Corporation's No. 63 Water Reticulation Standards.	Post planning approval and prior to lot sale	☐
4	Install fire hydrants in accordance Water Corporation's requirements.	Post planning approval and prior to lot sale	☐
5	Provide a copy and obtain endorsement of this Bushfire Management Plan by those with responsibility under this plan including Builders, Landowners/Occupiers and City of Busselton.	Post planning approval and prior to lot sale	☐
6	Establish and maintain all public open space to the standard detailed in the Landscape Plans (Appendix C) until the lots are sold and the public open space is handed responsibility over to the City of Busselton.	Post planning approval and prior to lot sale / handover to City of Busselton	☐
7	Establish Restrictive Covenants over all lots with areas >BAL-29 from Public Open Space 14, prohibiting the construction of dwellings within any BAL-40 or BAL-FZ area, to ensure any dwelling constructed within the lot is BAL-29 or less.	Creation of titles and deposited plan	☐
8	Ensure that lots adjacent to Lot 6, Lot 9032 and Part Lot 75 (Provence development) to the west are only created where they have a bushfire attack level of BAL-29 or lower.	Creation of titles and deposited plan	☐

Number	Action	Due	Completed
9	Where WAPC condition a subdivision application approval with a requirement to place a notification onto the certificate(s) of title and a notice of the notification onto the diagram or plan of survey (deposited plan). This will be done pursuant to Section 165 of the *Planning and Development Act 2005* ('Hazard etc. affecting land, notating titles as to:') and applies to lots with a determined BAL rating of BAL-12.5 or above. The notification will be required to state: 'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land'.	Creation of titles and deposited plan	☐

Table 5 Builder Responsibilities

Action	Action	Due	Completed
1	Be aware of the existence of any BMP that refers to the Site	Prior to any building work.	☐
2	Ensure the building or incidental structure to which a building permit applies is compliant on completion with the bushfire provisions of the Building Code of Australia (BCA) as it applies in WA.	Prior to any building work.	☐

Table 6 Landowner / Occupier Responsibilities

Number	Action	Due
1	Install and maintain any driveways longer than 50 m in compliance with the Guidelines (A3.5).	Prior to occupancy & ongoing
2	Maintain an Asset Protection Zone (APZ) according to the standard in the Guidelines or according to a detailed BAL assessment.	Ongoing
3	For lots 2,024 m^2 and above, install and maintain firebreaks according to the City of Busselton's Firebreak and Fuel Hazard Reduction Notice.	Prior to occupancy & ongoing
4	Comply with the relevant local government annual firebreak notice (which may be subject to review from time to time) issued under s33 of the *Bush Fires Act 1954*.	Ongoing
5	Ensure that any builders (of future structures on the Lot) are aware of the existence of this Bushfire Management Plan and the responsibilities it contains regarding the application of construction standards corresponding to the determined BAL rating.	Ongoing

Number	Action	Due
6	Ensure all future buildings the landowner has responsibility for, are designed and constructed in full compliance with: (a) the requirements of the *Building Act 2011* (WA) and the bushfire provisions of the Building Code of Australia (BCA) as applicable to WA; and (b) with any identified additional requirements established by this BMP or the relevant local government.	Ongoing
7	Ensure no habitable buildings are constructed in areas above a BAL-29 rating.	Ongoing
8	Updating the Bushfire Management Plan may be required to ensure that the bushfire risk management measures remain effective. Bushfire plans do not expire and are a 'living document'. Updating is required in certain circumstances, including (but not limited to) if site conditions change, if further details are required at subsequent development stages or to reflect new technologies or methodologies in best practice bushfire risk management ('Guidelines' s4.6.4).	Ongoing

Table 7 City of Busselton Responsibilities

Number	Action	Due
1	Monitor landowner compliance with the annual firebreak notice.	Ongoing
2	Develop and maintain district bushfire fighting services and facilities.	Ongoing
3	Promote education and awareness of bushfire prevention and preparation measures though the community.	Ongoing
4	Administer the requirements of the *Bush Fires Act 1954*, *Planning and Development Act 2005* and the *Building Act 2011*.	Ongoing
5	Maintain areas of Public Open Space to the level prescribed in the Landscape Plans (Appendix C), including low fuel zones, in perpetuity.	Once responsibility is transferred from Developer

6 References

DFES (2015). Map of Bush Fire Prone Areas. Department of Fire and Emergency Services. [available at www.dfes.wa.gov.au/bushfireproneareas].

FESA, WAPC & Dept of Planning (2010). Planning for Bushfire Protection. Edition 2. May, Government of Western Australia, Perth. WA.

WAPC (V1.3, Dec 2017). Guidelines for Planning in Bushfire Prone Areas. Western Australian Planning Commission, Perth. WA.

WAPC (2015a). State Planning Policy 3.7: Planning in Bushfire Prone Areas (SPP 3.7). Western Australian Planning Commission, Perth. WA.

7 Glossary

AS 3959: Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas.

Asset Protection Zone (APZ): A low fuel area immediately surrounding a building.

BAL: Bushfire Attack Level (BAL) as set out in the Australian Standard 3959 Construction of Buildings in Bushfire-Prone Areas (AS 3959), as referenced in the Building Code of Australia (as amended).

BAL Assessment: An assessment prepared in a manner and form set out in AS 3959 to determine a BAL. It is strongly recommended that BAL assessments are prepared by accredited Level 1 BAL Assessors, unless otherwise exempted in these Guidelines.

BAL Contour Map: A BAL Contour Map is a scale map of the subject lot/s illustrating the potential radiant heat impact and associated indicative BAL ratings in reference to any classified vegetation remaining within 100 metres of the assessment area after the development is complete. The intent of the BAL contour map is to identify land suitable for development based on the indicative BAL rating. It is strongly recommended that BAL Contour Maps are prepared by an accredited Bushfire Planning Practitioner.

Bushfire: An unplanned fire burning in vegetation. A generic term which includes grass fires, forest fires and scrub fires both with and without a suppression objective.

Bushfire hazard: The potential or existing flammability of vegetation that, in association with topography and slope, when ignited may cause harm to people and/or damage property and/or infrastructure.

Bushfire Hazard Level (BHL) assessment: A BHL assessment provides a measure of the likely intensity of a bushfire and the likely level of a bushfire attack on a Site determined by categorising and mapping land as having a low, moderate or extreme Bushfire Hazard Level in accordance with the methodology set out in the Guidelines. It is strongly recommended that Bushfire Hazard Level assessments are prepared by an accredited Bushfire Planning Practitioner.

Bushfire Management Plan (BMP): A document that sets out short, medium and long term risk management strategies for the life of the development. It is strongly recommended that Bushfire Management Plans are prepared by accredited Bushfire Planning Practitioners in accordance with the requirements set out in the Guidelines on behalf of the landowner/proponent with the assistance of the responsible authority for emergency services where required.

Bushfire Planning Practitioner: A person who holds Level Two or Level Three accreditation under the

Western Australian Bushfire Association Framework.

Bushfire prone area: An area that has been designated by the Fire and Emergency Services Commissioner under s. 18P of the Fire and Emergency Services Act 1998 as an area that is subject, or likely to be subject, to bushfires. Such areas are identified on the Map of Bush Fire Prone Areas and can be found on the Department of Fire and Emergency Services website.

Bushfire Protection Criteria: A performance based system of assessing bushfire risk management measures contained in the Guidelines and applied to all strategic planning proposals, subdivisions and development applications.

Bushfire risk: The chance of a bushfire igniting, spreading and causing damage to people, property and infrastructure.

Bushfire risk management: Means the application of the bushfire protection criteria contained in the Guidelines.

Development application: An application for approval to carry out development or change a land use under either a local planning scheme or region planning scheme. This includes local development plans but excludes application for single houses and ancillary dwellings on a lot or lots less than 1,100m^2.

Guidelines: Refers to the Guidelines for Planning in Bushfire Prone Areas (WAPC 2015), as amended.

WAPC: Western Australian Planning Commission.

Appendix A City of Busselton Firebreak & Fuel Hazard Reduction Notice

BUSH FIRES ACT 1954

PROPERTY COMPLIANCE REQUIREMENTS

Compliance inspections of land will be carried out from 16 November 2018, to assess landowner(s) or occupier(s) of land compliance with the City of Busselton Firebreak and Fuel Hazard Reduction Notice.

- **Rural Residential, Urban and Industrial Land requirements must be compliant by 16 November 2018**
- **Rural Land requirements must be compliant by 15 December 2018**

Local Government may serve a notice pursuant to Section 33 of the Bush Fire Act 1954, requiring the property owner to undertake any extra work to reduce the impact of a fire

- **Rural Residential, Urban and Rural Land requirements must be maintained in accordance with the table overleaf until 12 May 2019** or a later date if the compliance period is extended, in which case a notice will be placed in the local newspaper

FIRE PERMITS

- Permits to burn are required for the whole of the restricted periods and can only be obtained from the Fire Control Officer for your area
- Permits are to be obtained before burning commences (the permit holder must be in possession of the permit during the burn)

FIRE PERMIT APPLICATION

Before you call a Fire Control Officer ensure you have the following information

- Who will be the three able bodied persons in attendance at all times whilst the fire is alight including contact phone number?
- What is the address of the property for which the permit applies?
- What fire fighting equipment and resources will you have at the fire front and is it in good working order?
- What is the size of burn to take place?
- Are there firebreaks installed and can a fire unit get access to the area?
- What material are you burning? Is it dry? Are there any plastics, tyres, treated posts or woods in the piles or area to be burnt? If so, remove them to a safe place.
- Ensure you give 72 hours notice to the Fire Control Officer first; and
- Ensure you notify neighbours 72 hours prior to commencing your burn

For further advice, contact your local Fire Control Officer, as advertised in the City of Busselton's Community Directory or on the City of Busselton website www.busselton.wa.gov.au

GENERAL REQUIREMENTS

- **Garden Refuse Urban Areas (Town sites):** No garden refuse is permitted to be burnt on the ground, in the open air or in an outdoor incinerator within the urban areas of Busselton and Dunsborough town sites at any time of the year
- **Garden Refuse Rural Residential Areas (non-Town sites):** The burning of garden refuse is prohibited from 14 December to 28 February. **During the restricted burning period**, 2 November to 14 December and 1 March to 12 May each year, permits are required to be obtained from the Fire Control Officer in your area for the burning of any garden refuse
- **Burning of toxic materials** and **rubbish** is prohibited at all times
- **Camp fires** are prohibited within the City during the restricted and prohibited burning period
- **Wood** and **coal fuelled barbecues,** including wood fired pizza ovens and chimineas are banned during a total fire ban or in any period when the fire danger forecast is 'Very High' or above
- **Wood fired pizza ovens** must have a spark arrestor fitted
- **Warning:** The use of electric fences during periods of 'Very High' or above may cause fire
- **Owners of tractors** with down swept exhaust systems are encouraged to have an approved spark arrestor fitted as provided in the Bush Fires Act 1954 Regulations
- **Welding, Cutting** and **Grinding Equipment:** A person shall not operate this equipment during the restricted/prohibited burning times on land which is under crop, pasture, stubble and bush unless one working fire extinguisher is provided, work area is clear of flammable materials and there is compliance with any other controls required by a Fire Control Officer.
- **Welding, cutting** and **grinding equipment** is **not permitted** to be used anywhere within the City of Busselton when the fire index is '**extreme**' or above

FIRE DANGER RATING

For the current fire danger rating visit Department of Fire & Emergency Services (DFES) website www.dfes.wa.gov.au or Bureau of Meteorology (BOM) website www.bom.gov.au

CONTRACTORS

Please be advised, if you engage a contractor to gain compliance with this notice it is the property owner, **not the contractor**, who is responsible for the standard and quality of the fire prevention work undertaken and required to be compliant by 16 November (or 15 December if Rural Land) each year and maintained as per this notice throughout whole the fire season.

CONTACT US

For further fire safety information visit the City of Busselton website www.busselton.wa.gov.au or Department of Fire & Emergency Services (DFES) website www.dfes.wa.gov.au

IMPORTANT DATES

The below dates may change due to seasonal fire conditions in which case details will be published in the local newspaper.

RESTRICTED

BURNING PERMITS ARE REQUIRED FROM
2 November 2018 to 14 December 2018 inclusive
and
1 March 2019 to 12 May 2019 inclusive

BURNING PROHIBITED

ALL FIRES PROHIBITED
15 December 2018 to 28 February 2019 inclusive

COMPLIANCE DATE

- **Completion of firebreaks/fuel hazard reduction on all rural residential, urban and industrial land is required to be completed by 16 November 2018 and must be maintained until 12 May 2019**
- **Completion of firebreaks/fuel hazard reduction on all rural land is required to be completed by 15 December 2018 and must be maintained until 12 May 2019**
- **Burning on public holidays during the restricted fire season is prohibited**

Applications for a variation of this the Firebreak and Fuel Hazard Reduction Notice, where ground considerations or environmental concerns prevent compliance with the requirements of this Notice, must be lodged in writing together with a Firebreak and Fuel Hazard Reduction Notice Variation form, prior to 31 October 2018

The hardest aspect of fire prevention is explaining to your family why you didn't undertake any!

Actions speak louder than words and actions save lives

Should you require further clarification of the information contained in this notice please do not hesitate to contact the City's Ranger and Emergency Services Department on (08) 9781 0444.

City of Busselton
Geographe Bay

FIREBREAK AND FUEL HAZARD REDUCTION NOTICE

ARE YOU BUSHFIRE READY?

2018/2019 BUSH FIRE SEASON

FIRST AND FINAL NOTICE

Bush Fires Act 1954

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 the City of Busselton Firebreak and Fuel Hazard Reduction Notice.

Failure to comply with this notice may result in a

$5,000 FINE

Fire Prevention Starts with You!

RING 000 FOR ALL FIRES

Version: 2, Version Date: 06/08/2018

FIREBREAK CATEGORY CODE AND SUMMARY OF REQUIREMENTS

ALL REQUIREMENTS IN THIS NOTICE ARE TO BE MAINTAINED THROUGHOUT THE ENTIRE DURATION OF THE FIRE SEASON (1 DECEMBER TO 12 MAY EACH YEAR).

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 *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.*	A	B	C	D
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.**

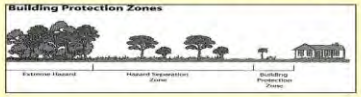
C - Building Protection Zones (BPZ)

– 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

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Version: 2, Version Date: 06/08/2018

Appendix B APZ Requirements

Any habitable building eventuating within the Site will be surrounded by an APZ which meets the following requirements:

a. Width: measured from any external wall or supporting post or column of the proposed building, (developable area/building envelope for a subdivision) and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m^2 (BAL-29) in all circumstances;

b. Location: the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in situations where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, into perpetuity;

c. Fences: within the APZ are constructed from non-combustible materials (eg. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

d. Objects: within 10 metres of a building combustible object must not be located close to vulnerable parts of the building i.e. windows and doors.

e. Fine Fuel load: combustible dead vegetation matter less then 6mm in thickness reduced to and maintained at an average of two tonnes per hectare.

f. Trees (>5m in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and/or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy.

g. Shrubs (0.5m - 5m in height): should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m^2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated at trees.

h. Ground covers (<0.5m in height): can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 meters of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs.

i. Grass: should be managed to maintain a height of 100 millimetres or less.

Appendix C Landscape Plan - including updated concept plans detailing low fuel zones

PROVENCE 1 - RESIDENTIAL SUBDIVISION
Part 1: local structure plan - landscape assessment report

Satterley

Provence

emerge ASSOCIATES
Integrated Science & Design

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scale • n/a

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PROVENCE

local structure plan: part 1
landscape asessment report

emerge ASSOCIATES Integrated Science & Design

1.0 The Project Summary

GENERALLY

1.1 PROJECT LOCATION

The project site is located approximately 4 km south east of the Busselton townsite in southwest Western Australia within the Shire of Busselton off the Bussell Highway and approximately 230km south of Perth. The site is on the main eastern approaches to Busselton town and is visible to the majority of traffic heading into the southwest. The project is in a major urban growth corridor which will see the conversion of surplus rural land to residential and support uses.

1.2 PROJECT SCOPE

The proposed development is anticipated to consist of residential lots and commercial development to be distributed along the southern side of the Busselton Bypass. The project proposes to contain the following elements.

- Commercial precinct / Town Centre
- Between 2100 residential lots total of various densities
- Private High School
- Primary School
- New public open space areas
- Streetscapes of various hierarchies
- Pockets of retained vegetation
- Open water bodies (existing and proposed)
- Creek lines and seasonal flow corridors

The project commenced construction of its first Stages in 2004 with completion of approximately 600 lots up to December 2015. These proposed changes to the existing Structure Plan propose a further 1,500 lots approximately of various sizes.

1.3 ADJACENT LAND USES & INFLUENCES

The development is affected by various adjacent land uses and influences which may require particular design responses in order to relate to or screen off various effects. Adjacent land uses and influences include the Business Park, the Busselton Aiport and declining rrual uses each with possible landscape and project responses to be considered as part of the site design process.

1.4 BUSSELTON BYPASS & FUTURE OUTER BYPASS

The effects of highway noise and movement may have detrimental affects on adjacent residential areas adversely effecting price and lifestyle.

1.5 PROTECTED WETLANDS

Adjacent protected wetland are locally significant and may not be adversely affected by the development including water levels, pollutants, unauthorised access and the like.

1.6 RURAL USES

Adjacent rural uses, while declining, can have a longer term affect on the development through the leaching of high nutrient loads through groundwater across the development. Potential historic contamination of small areas with pesticides, fertilisers and the like may be possible. Immediate issues relating to adjacent rural uses such as odour may also periodically affect parts of the site.

1.7 TYPICAL LOCAL CLIMATE AND RAINFALL

The local area climate is characterised as a mild Mediterranean climate with cool wet winter and generally hot summer with cooling afternoon sea breezes. The key data is as follows:

Summer	-Mean Daily Maximum Temperature	29.5 oC
	-Mean Daily Minimum Temperature	13.8 oC
	-Maximum Temperature	41.0 oC
Winter	-Mean Daily Maximum Temperature	17.4 oC
	-Mean Daily Minimum Temperature	7.2 oC
	-Minimum Temperature	-1.0 oC

Monthy Rainfall (millimetres)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10.8	3.1	16.0	35.4	104.7	128.8	131.2	104.1	79.0	29.8	24.6	9.0

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1.8 SITE TOPOGRAPHY

The site is relatively flat and low lying. Natural surface elevation ranges from 3.5mAHD in the north increasing to approximately 8mAHD in the south of the site.

1.9 SITE WATER RESOURCES

Existing groundwater is generally high compared to the existing ground level. This may impact on footings, structural location, vegetation types and species success. High variation in existing groundwater must be considered in detail (while allowing for development pressures) during design to ensure an optimum outcome.

The existence of the groundwater and stream flows provide an opportunity to reinforce the presence of the natural system within the design of the estate. The journey along the water corridor becomes one of the key design elements for the development.

There are six dampland areas within the site that are classified as Multiple Use Wetlands. A portion of one of the damplands has also been identified as an EPP Wetland.

The existence of the groundwater and stream flows provide an opportunity to reinforce the presence of the natural system within the design of the estate. The journey along the water corridor becomes one of the key design elements for the development.

1.10 Existing Site Vegetation

There are only two significant remnants of native vegetation that remain within the site since a significant portion of the area has been cleared for past grazing and mineral sand mining. Retention of this resource is highly desirable and work should allow opportunities to enhance the existing vegetation. These remnants of native vegetation include:

- an area approximately 4.5ha remnant Peppermint (Agonis flexuosa) Low Closed Forest with scattered Marri (Corymbia calophylla) located on the north-eastern boundary of Lot 9003.
- An area approximately 2ha remnant Tuart (Eucaptus gomphocephala) and Peppermint (A.flexuosa)Tall Woodland located in the centre of Lot 202.

Although the majority of the remaining project area has been cleared scattered Marri, Peppermint and Tuart trees exist on site. The EPP wetland, located in the north-eastern corner of Lot 2, is associated with scattered Paperbark (Melaleuca rhaphiophylla).

1.11 EXISTING SITE FAUNA

Surveys of the remnant vegetation areas have identified habitats for the Western Ringtail Possum, along with the existence of the Western Grey Kangaroo. Measures are in place to accommodate for the native fauna, with all site work needing to comply with the Western Ringtail Possum Management Plan and Western Grey Kangaroo Management Plan.

1.12 KEY SITE ASSET SUMMARY LIST

The following key assets and elements are evident upon examination of the existing site. These elements should be considered, promoted and integrated into the design process to best ensure success of the project, meshing new design in with existing retained site elements and minimised cost in recreation of existing assets. Key site assets include;

- Ease of main access off the Busselton Bypass
- Retained in tact bushland and habitat areas
- Retained significant individual trees
- Retained site dams from past rural uses
- Retained and protected creek lines and drainage corridors
- Western Ringtail Possum habitat / access corridor
- Seasonally high groundwater levels may require use and or mitigation

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1.13 KEY POINTS & OPPORTUNITIES

The following key points summarise inherent site opportunities and the projects intent. These points form the basis of the projects design brief and are to be referenced and considered when embarking on future design processes.

1. Retain and protect existing stands of intact vegetation
2. Retain and protect existing significant trees in desirable locations
3. Maximise exposure to the site entry off the Busselton Bypass
4. Maximise pedestrian linkages throughout the development, particularly to significant attractants including shops, town centre, schools and similar.
5. Maximise legibility of planning layout and access through the road hierarchy
6. Provide shade, shelter and respite from the effects of the south west seasons
7. Provide a wide range of recreational options and locations for residents
8. Provide areas of informal open space
9. Define and highlight existing open water bodies
10. Utilise open space to accommodate drainage and water quality improvements
11. Maximise opportunities for safe ringtail possum movement through natural areas
12. Provide interpretive material reflective of the local environment and ecology
13. Maximise integrated planting approach between historic, cultural and native plantings
14. Ensure the agreed design approach extends through many elements and materials
15. Ensure all works proposed are compliant and consistent with the required Bush fire Mangement Plan

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2.0 GUIDING LANDSCAPE PRINCIPLES

2.1 LANDSCAPE AIM

To create a sustainable community and a place that is derived from the local areas history, culture, commerce and ecology which resonates with residents and visitors as local, desirable, legible and true.

2.2 LANDSCAPE OBJECTIVES

The following objectives have been determined to support the above aim at various levels.

- To support the existing and nuture the creation of a new community through provision of facilities, places, spaces, character and elements appropriate to the communities views and needs.
- To engende a community with an aspirational and self reliant outlook and a sense of ownership based on quality planning and design,
- To balance or improve upon existing site environmental qualities following development,
- The creation of this place is to be demonstrated and supported through all facets of the landscape across all effected disciplines to best ensure design harmony across responsibilities.
- To ensure the ongoing delivery of quality design and construction outcomes based on rigorous thought, process, selection and detailing.
- To maximise the use of sustainability principles and measurable outcomes

3.0 LANDSCAPE CHARACTER

3.1 GUIDING CHARACTER

The guiding character of the projects landscape elements and overall theme is based on a fusion of French provincial character and the existing south west rural character.

It is proposed that both of these background themes are similar in many respects pertaining to detail, materials, scale, form and both convey a relaxed and informal character. This is in part reflective of the local southwest semi-rural outdoor and vineyard culture and also draws on historic themes via French explorers and remnant French influences and naming that exists across southwest Western Australia. Vestiges of former rural uses and materials are evident in both the provincial and southwest landscapes and built form.

It is therefore proposed that the base French provincial character is not in conflict with the broad aims of the local authority and is not alien to the local southwest area or its residents. It is also proposed that this provincial theme will build upon reinforcing the local areas existing relaxed rural appeal to current and new residents. The proposed preferred theme is conveyed here forward by this document and its contents.

3.2 LANDSCAPE CHARACTER

The character of public open space is proposed to be expressed through the following elements;

- Landform and contouring to reflect a rolling rural landscape,
- Planting to reflect past cultural and rural uses,
- Planting to embrace the local environment,
- Recreational uses in communal and human scaled spaces,
- Domestic elements eg; pots and urns which convey a pedestrian scale and resemble a private garden in content and character,
- Informal elements with a clear functional design basis,
- Finishes that are indicative of continued and historic use,
- Rammed earth in rich colour tones,
- Limestone coloured rough textured render,
- Natural limestone cladding in random pattern,
- Precast concrete block set in a stone look,
- Precast concrete cobbles in various sizes and earthy colours,
- Wrought Iron look detailing and highlights,
- Galvanised permeable metal fencing with detail highlights in neutral colours,
- Thick local timber framing in feature locations,

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3.3 FORM & ELEMENTS

The form and scale of various landscape elements is influenced by and builds upon the guiding character as outlined above. Various forms and elements are to be characterised by;

- Thick set posts or ornate light structures,
- Heavy set and grounded elements,
- Landmark elements,
- Informal edges or trimmed edges with informal infill,
- Small openings,
- Earthy tones with highlight colours,
- Robust and Solid Materials,
- Weathered, rumbled and rustic finishes,
- Oversized wall and plinth widths

3.4 GUIDING MATERIALS

The following material selection recommendations are made reflecting the inspiration of the guiding character as outlined previously.

Recommended material design selections may include;

- Limestone coloured rough textured render
- Natural limestone and Donnybrook stone cladding in random mosaic pattern
- Rough sawn and recycled oversize hardwood timbers
- Precast concrete block set in a stone look
- Precast concrete cobbles in various sizes and earthy colours
- Precast concrete sleepers in various sizes and earthy colours
- Wrought Iron look detailing and highlights
- Galvanised permeable metal fencing with detail highlights in neutral colours
- Natural stone in highlight locations
- Galvanised metal shutters with neutral coloured finish
- Brushwood screen fencing in long runs or feature locations
- Corrugated Steel in agreed locations
- Granite cobble sets - subject to budget

Refer attached 'Provence 1: Residential Subdivision Part 2 - Landscape Character & Material Palette' for detail information on material and landscape palette selections.

4.0 PUBLIC OPEN SPACE

4.1 INTENT

Public open space is the focal point for the developments creation of character, community gathering and activities, informal recreation, habitat, public facilities, visual relief and urban softening. Refer Appendix A 'Provence - Landscape Strategy Plan' Revision M dated September 2016.

4.2 LOCATION & DISTRIBUTION

The location of public open space can demonstrate and highlight the lifestyle and character of the development on offer. Distribution and sizing of public open space is determined by broad town planning principles and various approvals as evident in the current attached master plan.

4.3 POS FOCAL POINTS & AXIS VIEWS

Open space should aim to locate and display popular various facilities, feature elements at focal points easily visible from vehicles and by pedestrians and cyclists. This maximises marketing return for budgets spent, provides passive surveillance, clearly conveys the facilities available.

4.4 LIFESTYLE & FACILITIES

Various facilities proposed for creation within the public realm may include;

- Adventure level playgrounds
- Discovery and learning playgrounds
- Shelters and Arbors
- Viewing platforms
- BBQs and gathering spaces
- Boardwalks
- Integrated path systems
- Feature lighting
- Security and safety lighting
- Informal open recreation spaces
- Fitness trails
- Smaller contemplative spaces
- Interpretive signage
- Public art

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4.5 PUBLIC OPEN SPACE CATEGORIES

The West Australian Planning Commission document 'Liveable Neighbourhoods: A Western Australian Government Sustainable City Initiative' published in January 2009 provides a basic definition for the categorisation of public open space areas broadly based on size, proximity to dwellings and servicable population. These include:

- Local Parks
- Neighbourhood Parks
- District Open Space
- Community Facilities Sites
- Natural Areas and Cultural Features
- Foreshore Reserves and Regional Open Space

The layout and planning for public open space within the Provence residential development has been undertaken in accordance with the Liveable Neighbrouhood Guidelines and subsequently proposes to deliver a series of public open spaces incorporating the above landscape categories.

Further to this, the local government authority City of Busselton uses these POS categories to guide the delivery of public facilities such as turf areas, park furniture, playgrounds, and picnic facilities as well as the subseqent on-going maintenance requirements associated with the upkeep of the public open space areas. The following public open space area descriptions have therefore been organised into the Liveable Neighbourhood public open space categories.

4.6 PUBLIC OPEN SPACE MAINTENANCE

It is a standard process for the local government authority to require a Developer Maintenance Period to establish the various landscape works and elements constructed within the public open space areas prior to the ceding of land to the Crown and all responsibility to be transferred to the local government authority. The City of Busselton have previously required that the developer undertake a 5 year developer maintenance of public open space and streetscapes for completed public open space at Provence. This has also required a Landscape Maintenance Agreement to be developed to guide the maintenance and subsequent handover to the City.

The policy of the City has recently been revised and the developer maintenance period has been reduced to 2 years and provided all conditions and requirements of the Landscape Maintenance Agreement are acheived.

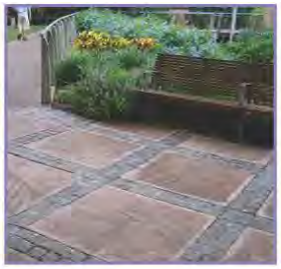

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FIGURE 1 - LANDSCAPE MASTER PLAN

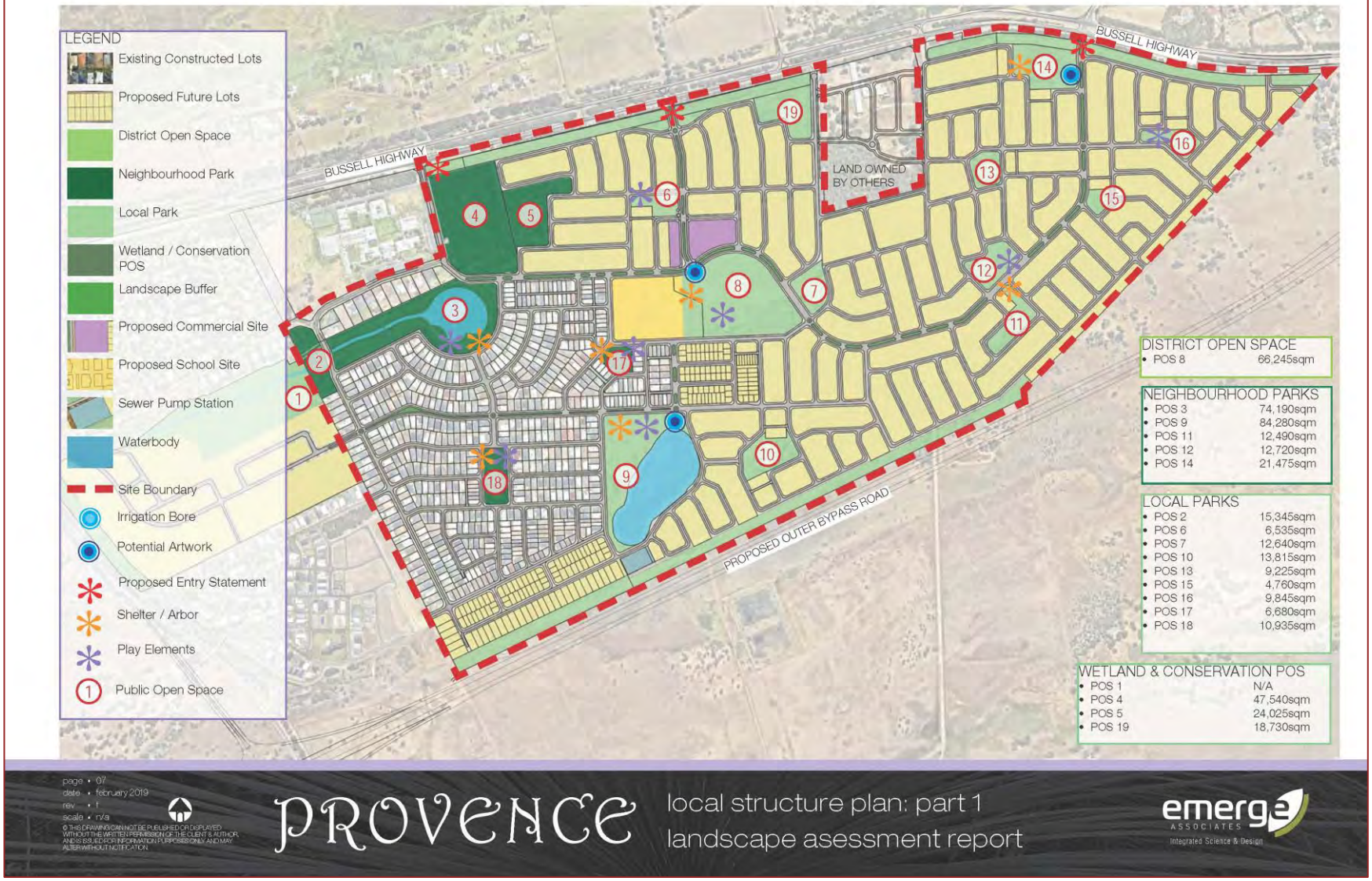

FIGURE 2 - STORMWATER TREATMENT

POS DETENTION STORAGE

	BASIN	1 IN 1 YR	1 IN 5 YR
• POS 1	N/A	0.320Ha	0.660Ha
• POS 2	Existing	-	-
• POS 3	Existing	-	-
• POS 4	Existing	-	-
• POS 17	Existing	-	-
• POS 18	Existing	-	-
• POS 5	C	0.043Ha	0.062Ha
• POS 6	B	0.200Ha	0.330Ha
• POS 7	G	0.220Ha	0.270Ha
• POS 8	D	0.350Ha	0.410Ha
• POS 9	E	0.850Ha	0.922Ha
• POS 10	F	0.170Ha	0.310Ha
• POS 11	M	0.144Ha	0.271Ha
• POS 12	L	0.210Ha	0.290Ha
• POS 13	K	0.170Ha	0.270Ha
• POS 14	H	0.320Ha	0.660Ha
• POS 15	J	0.180Ha	0.280Ha
• POS 16	I	0.110Ha	0.220Ha
• POS 19	A	0.520Ha	0.840Ha

DRAINAGE CONSIDERATIONS

Proposed drainage figures are as per JDA Hydrologist Provence: :LWMS. Basin quantities based on basin designs to be 300mm depth with 1 in 6 side slopes. Refer Softscape Typologies for suitable proposed landscape treatments and nominated plant species.

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4.7 POS STRATEGY- DISTRICT OPEN SPACE

4.7.1 Brief Description

POS 8 is the largest and most signficant POS area for the Provence development and has therefore been centrally located between the proposed Village Centre commerical / retail precinct and the proposed Department of Education public Primary School site. Negotiations are required between the Developer, Department of Education and City of Busselton to confrim the various steps for the delivery of this space and its uses and facilities to be provided.

4.7.2 Functions

- Large formalised turf playing fields for organised sports and community events
- Possible clubhouse, changeroom, toilet & kiosk facilities
- Possible inclusion of hardcourts and other sporting uses e.g. lawn bowls
- Off-street carparking
- Picnic facilities such as BBQ's, picnic settings, shelters and drink fountains
- Play elements for all ages including possible exercise stations
- Maximise shade trees
- Path network connecting to the broader path network
- High level finishes and inclusion of feature planting areas

4.7.3 Environmental Considerations

- Limit planting of feature and exotic species to key nodes and high finish areas
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the sportsfields and playing surfaces.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.8 POS STRATEGY - NEIGHBOURHOOD PARKS

4.8.1 Brief Description

Located centrally to the development and at a max. 400m walking distance from most dwellings, the Neighbourhood Parks provide residents with more active recreational opportunities as well as picnic, BBQ and play space facilites. The parks have connections internally and a broader network to the surrounding POS areas.

4.8.2 Functions

- Large turf informal kick-about areas and connecting expanses of turf
- POS 2 & POS 6 contain irrigation lakes for storage and treatment of irrgation water source (bore)
- Picnic facilities for family / friend gatherings
- Play elements for all ages including possible exercise stations
- Maximise shade trees
- Mixture of exotic and native waterise planting to reinforce project character & landscape themes
- Path network connecting to the broader path network
- High level finishes limited to feature node and picnic areas
- Drainage

4.8.3 Environmental Considerations

- Limit planting of feature and exotic species to key nodes and high finish areas
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to informal turf kick-about areas.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

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4.9 POS STRATEGY- LOCAL PARKS

4.9.1 Brief Description

The Local Parks provide residents with open space in close proximity to their dwellings. The parks have areas of turf for passive play and informal kick-about area with nodes of seating and shelter either provided by trees or built structure. A path network through and around the POS allows footpath connection to surrounding streets and POS areas.

4.9.2 Functions

- Consolidated areas of turf for informal active play
- Internal footpath network
- Path network connecting to broader path networks
- Limited picnic facilities
- Seating nodes and bench seating
- Water wise planting
- Drainage

4.9.3 Environmental Considerations

- Water wise planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to turf areas but garden beds and revegetation areas able to be disconnected once panting is established.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.10 POS STRATEGY - WETLAND & CONSERVATION POS

4.10.1 Brief Description

The Wetland and Conservation POS are located along the northern boundary of the site and contain largely retained existing vegetation identified as being regionally significant or containing protected fauna. They form a larger East-West Rehabilitation Environmental Corridor providing for fauna movement across the project site. Each individual POS must comply with specific management plans relating to vegetation and fauna protection and management.

4.10.2 Functions

- Path networks connecting to the broader path network
- Conservation fencing and gates to control access
- Interpretive signange for education
- Shaded seating nodes
- Maximise shade trees
- Local endemic plant species for revegetation and rehabilitation
- Drainage

4.10.3 Environmental Considerations

- Local endemic waterwise plant species only
- Temporary irrigation considered to assist with establishment of revegetation works and removed after first two summers
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

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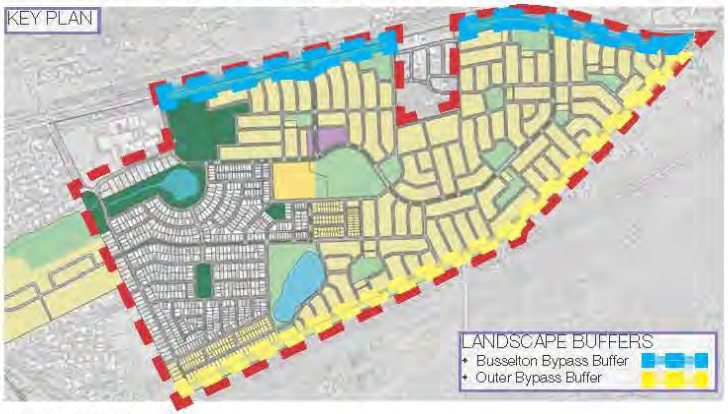
4.11 POS STRATEGY- LANDSCAPE BUFFERS



4.11.1 Brief Description

The Lanscape Buffers are located along the northern and southern boundaries of the site directly adjacent to Busselton Bypass and proposed Busselton Outer Bypass Roads. Varying in width from min. 30m the buffers are located to provide visual screening of the development as well as noise mitigation where required by traffic noise assessments

4.11.2 Functions

- Dense layered native vegetation planting for visual screening
- Noise bunds and walls for noise mitigation as may be required
- Fitness path network connecting to the broader path network
- Retain vegetation linkages and connections off-site

4.11.3 Environmental Considerations

- Local endemic waterwise plant species only
- Temporary irrigation considered to assist with establishment of revegetation works and removed after first two summers
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

4.12 POS STRATEGY - ENTRY STATEMENTS

4.12.1 Brief Description

Entry locations to the estate are located along the Busselton Bypass. Existing intersections are proposed to be upgraded to cater for increased traffic volumes & to provide safe access. Feature signage, artwork and landscape treatments are proposed at these key entry locations for way finding, visual queues for residents and visitors. They will also introduce the landscape character and themes being the developments first point of contact.

4.12.2 Functions

- Feature signage, flags and vertical elements
- Artwork and scupltural elements for way finding and visual queues
- Feature walls and retaining walls for signage and elevation
- Mixture of exotic and native planting species to introduce landscape character and themes
- Consolidated turf areas for clear sightlines to signage and traffic clear zones

4.12.3 Environmental Considerations

- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to turf areas but garden beds and revegetation areas able to be disconnected once panting is established.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

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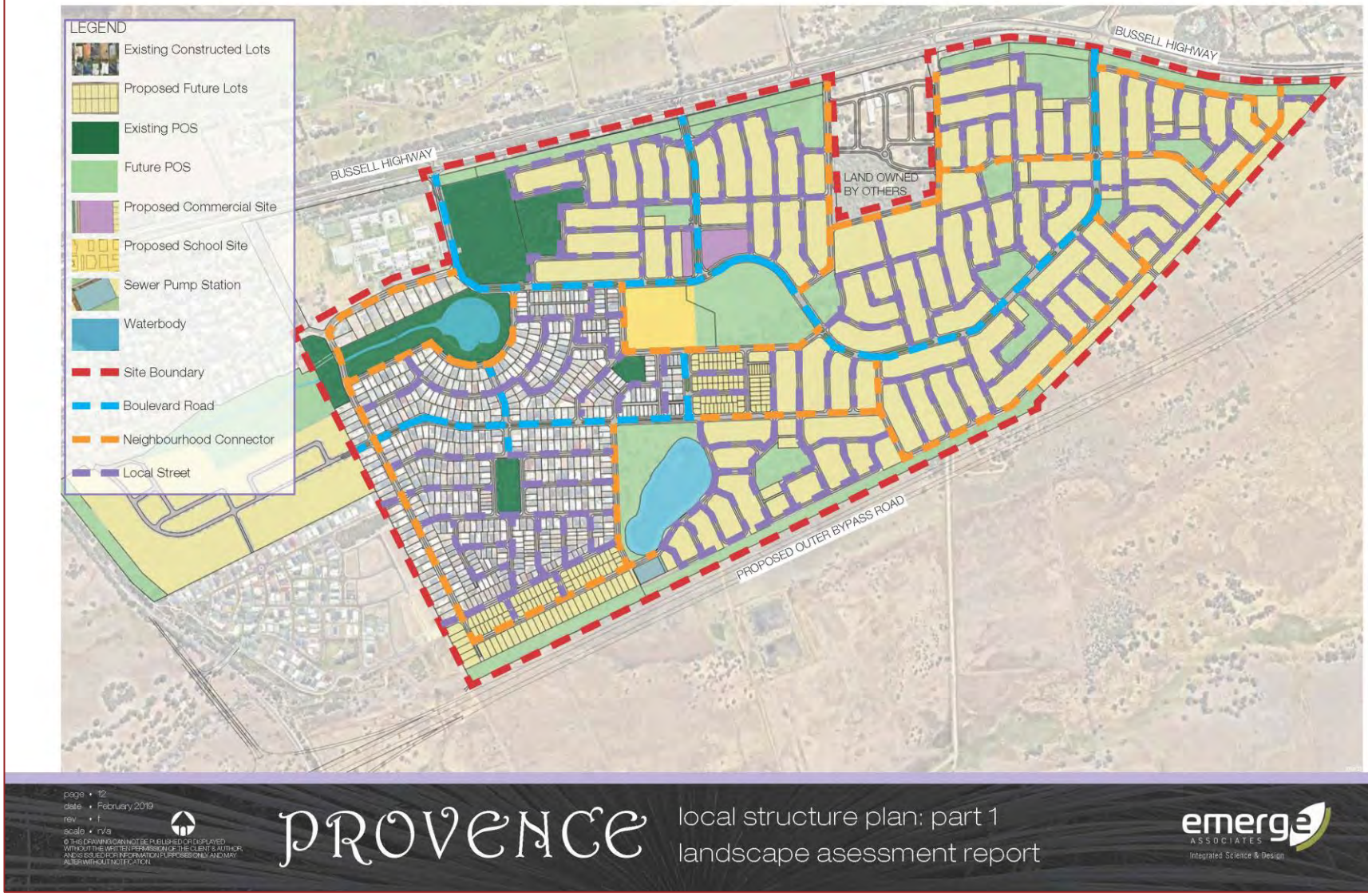
FIGURE 3 - STREET TREE MASTER PLAN



5.0 STREETSCAPES

5.1 BOULEVARD ROADS

5.1.1 Brief Description

The Boulevard Roads proposed within the development are the major roads connecting through the estate and projected to carry the highest volumes of traffic. They link the major entry statements off the Busselton Bypass to the Village Centre, District Open Space, School Site and most Neighbourhood Parks. These are to be a key feature of the development with exotic deciduous tree planting to create avenues and materials to reinforce the landscape character and theming where appropriate. A central median is proposed to assist with stormwater management.

5.1.2 Functions

- Typical road reserve widths 24.0m
- Dual use footpaths to verges and formalised crossing points
- Exotic, deciduous avenue tree planting
- Central median with flush kerbing and swale
- Feature planting at intersections and nodes with native rush and sedge planting to central median swale

Refer attached Appendix B - 'Street Tree Masterplan' Revision D dated February 2017 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

5.2 NEIGHBOURHOOD CONNECTORS

5.2.1 Brief Description

The Neighbourhood Connector roads are proposed to link from the Boulevard Roads to carry residents and visitors to the local parks and their homes. Some opportunites for feature planting within verges and key intersections will occur with the tree planting to continue avenues where possible. It is anticpated that the majority of tree planting shall occur within the private lot verges.

5.2.2 Functions

- Typical road reserve width of 18.0m
- Footpaths to verges providing connection to the broader footpath networks
- Mixture of native and exotic tree planting to create avenues or at spacing of one tree per lot
- Feature planting at intersections and nodes

Refer attached Appendix B - 'Street Tree Masterplan' Revision D dated February 2017 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

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5.3 LOCAL STREETS

5.3.1 Brief Description

The local streets provide access to private residents and carry the lowest traffic volumes. The majority of tree planting shall occur adjacent to private lots and form part of the residents private lot landscaping.

5.3.2 Functions

- Typical road reserve width of between 15.0m and 16.0m
- Footpaths to verges providing connection to the broader footpath networks
- Native tree planting to create avenues or at spacing of one tree per lot
- Verge landscaping to be undertaken by private lot owners as part of private lot landscaping packages.

Refer attached Appendix B – 'Street Tree Masterplan' Revision D dated February 2017 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

6.0 IRRIGATION

An irrigation and water supply to the development has been established with the initial stages of construction works that have been completed since 2004. It is proposed to continue to be extended and upgraded as the development progresses and in accordance with the approved 'Irrigation and Lake Water Management Strategy' Revision 7 dated October 2009 and prepared by Emerge Associates (formerly MNLA). This document can be briefly summarised as follows:

6.1 WATER SOURCE & STORAGE

The development has an existing water source being a Yarragadee Bore. This is currently located to the south of the development land and is required to be relocated into a future public open space area to allow handover and on-going maintenance by the City of Busselton. The bore is currently proposed to be relocated to POS 9 Aurelian Ave Park where it will run through a rip rap system to filter any iron particles from the bore water. It is then transferred to the POS 2 Almond Parkway Lake to be pumped by the existing irrigation pump station to the required POS and streetscape areas.

6.2 WATER LICENCE

The developer has secured a Licence to Take Water from the Department of Water to draw water from the Yarragadee aquifer. This allows 168,300kL per annum to drawn from the aquifer and used for irrigation of up to 23Ha of public open space. The licence is valid until 30 August 2020. Refer attached Appendix D 'Irrigation Strategy Plan' Revision G dated February 2017 and Appendix F 'Provence Irrigation, Water Use and Allocation Schedule' for a detailed summary of the proposed irrigation requirements of this revised structure plan design.

7.0 APPENDICES

7.1	Appendix A	Provence - Landscape Strategy Plan, Revision M, dated February 2017
7.2	Appendix B	Provence - Street Tree Masterplan, Revision D, dated February 2017
7.3	Appendix C	Provence - Typical Road Cross-sections, Revision A, dated January 2016
7.3	Appendix D	Provence - Irrigation Strategy Plan, Revision G, dated February 2017
7.3	Appendix E	Provence - Irrigation, Water Use and Allocation Schedule, Revision K, dated March 2017

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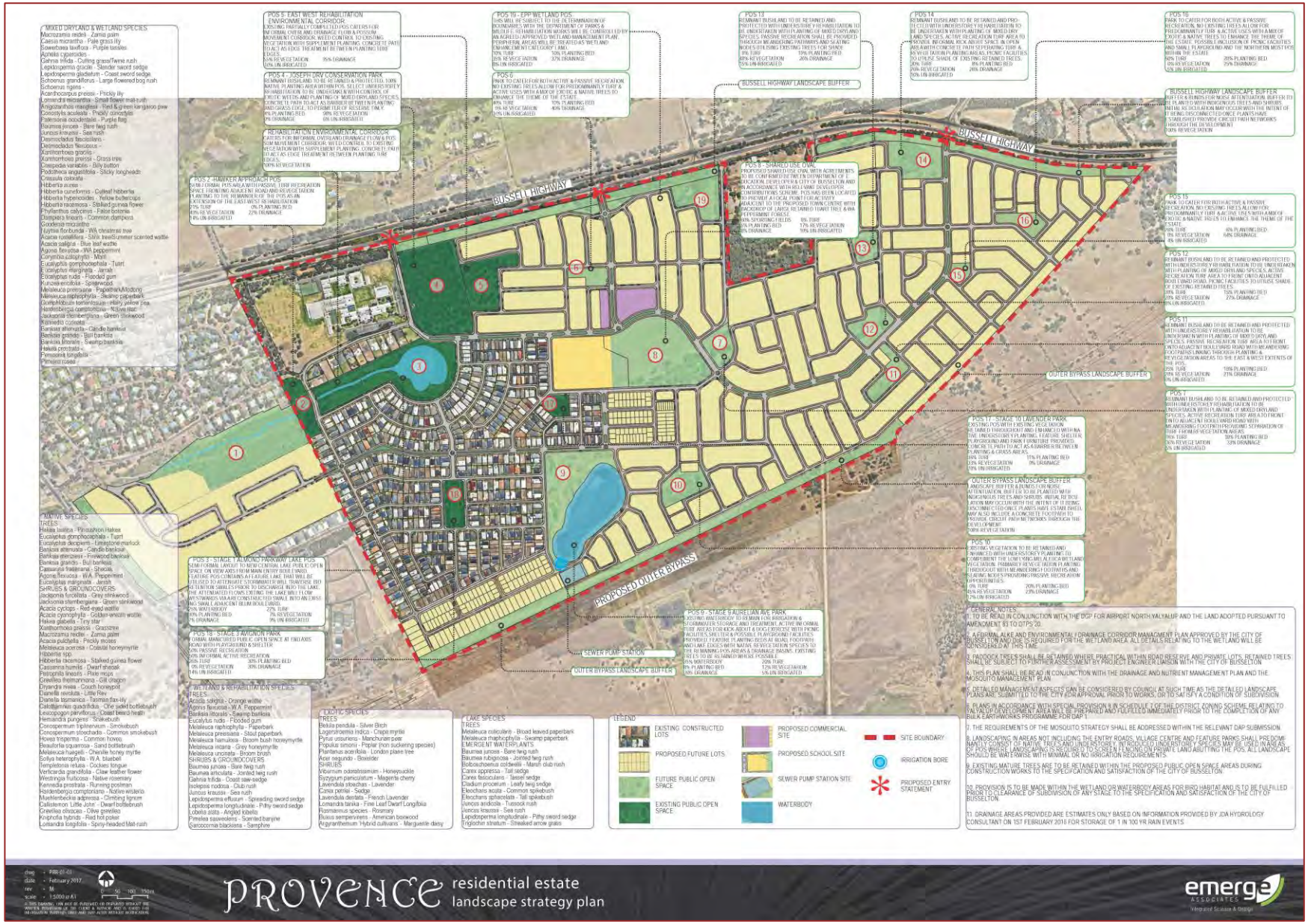
7.1 APPENDIX A

Provence - Landscape Strategy Plan, Revision M, dated February 2017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ASSOCIATES
BUSSELL HIGHWAY
PROPOSED OUTER BYPASS
OUTER BYPASS LANDSCAPE BUFFER
SEWER PUMP STATION
BUSSELL HIGHWAY LANDSCAPE BUFFER
POS 1 - MIXED DRYLAND & WETLAND SPECIES
POS 2 - HAWKER APPROACH POS
POS 3 - SHARED USE OVAL
POS 4 - JOSEPH DRY CONSERVATION PARK
POS 5 - EAST WEST REHABILITATION ENVIRONMENTAL CORRIDOR
POS 6
POS 7 - STAGE 1 ALMOND PARKWAY LAKE POS
POS 8 - STAGE 2 AVIGNON PARK
POS 9 - STAGE 3 AUREILIAN AVE PARK
POS 10
POS 11
POS 12
POS 13
POS 14
POS 15
POS 16
POS 17 - STAGE 10 LAVENDER PARK
POS 18
POS 19 - EPP WETLAND POS
NATIVE SPECIES
WETLAND & REHABILITATION SPECIES
EXOTIC SPECIES
LAKE SPECIES
LEGEND
EXISTING CONSTRUCTED LOTS
PROPOSED FUTURE LOTS
FUTURE PUBLIC OPEN SPACE
EXISTING PUBLIC OPEN SPACE
PROPOSED COMMERCIAL SITE
PROPOSED SCHOOL SITE
SEWER PUMP STATION SITE
WATERBODY
SITE BOUNDARY
IRRIGATION BORE
PROPOSED ENTRY STATEMENT
GENERAL NOTES:

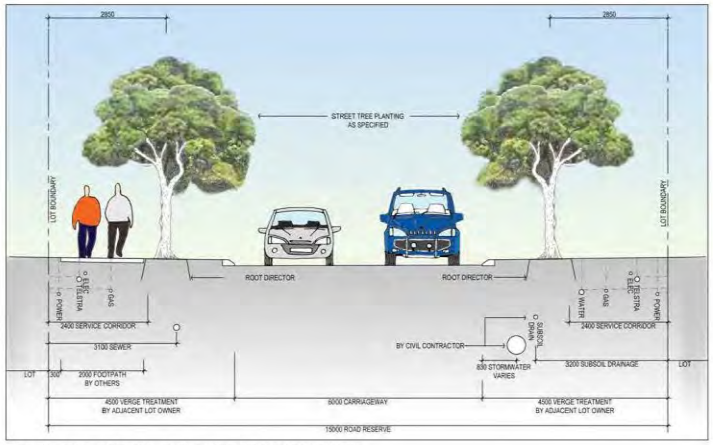
7.2 APPENDIX B

Provence - Street Tree Masterplan, Revision D, dated February 2017

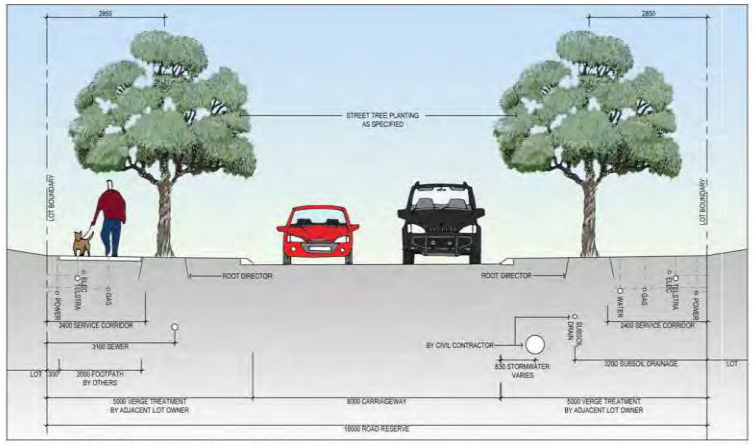
BUSSELL HIGHWAY
BUSSELTON OUTER BYPASS
NEIGHBOURHOOD CONNECTOR TREE SPECIES
Betula pendula
SILVER BIRCH
Hakea laurina
PINCUSHION HAKEA
Agonis flexuosa
WA PEPPERMINT
Pyrus usseriensis
MANCHURIAN PEAR
Melaleuca quinquenerva
BROAD-LEAFED PAPERBARK
Melaleuca rhaphiophylla
SWAMP PAPERBARK
EXISTING
PROPOSED
LEGEND
EXISTING CONSTRUCTED LOTS
PROPSOED FUTURE LOTS
EXISTING PUBLIC OPEN SPACE
PROPOSED PUBLIC OPEN SPACE
WATERBODY
PROPOSED COMMERCIAL SITE
PROPOSED SCHOOL SITE
SITE BOUNDARY
BOULEVARD ROAD TREE SPECIES
Pyrus usseriensis
MANCHURIAN PEAR
Platanus acerifolia
LONDON PLANE TREE
Populus simonii fastigata
SIMON'S POPLAR
Betula pendula
SILVER BIRCH
LOCAL STREET TREE SPECIES
Melaleuca quinquenerva
BROAD-LEAFED PAPERBARK
Hakea laurina
PINCUSHION HAKEA
Agonis flexuosa
WA PEPPERMINT
Melaleuca rhaphiophylla
SWAMP PAPERBARK
dwg - PRR-01-02
date - February 2017
rev - D
scale - 1:5000 @ A1
PROVENCE residential estate
street tree masterplan
emerge ASSOCIATES
Integrated Science & Design

7.3 APPENDIX C

Provence - Typical Road Cross-sections, Revision A, dated January 2016



SECTION - TYPICAL 15.0m WIDE ROAD RESERVE



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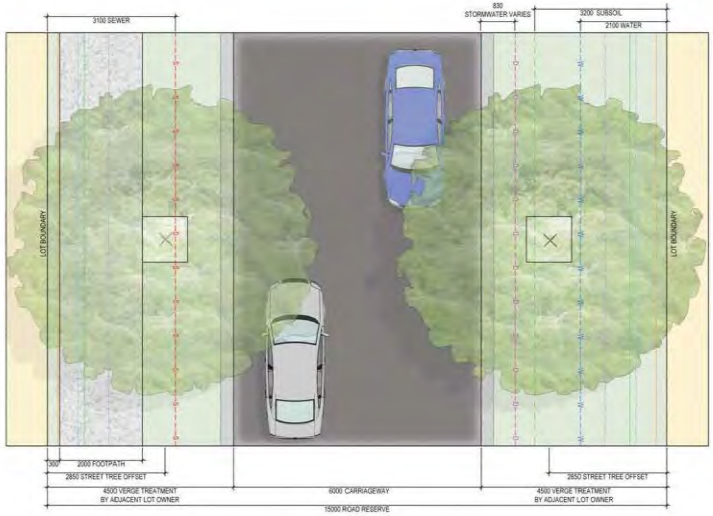
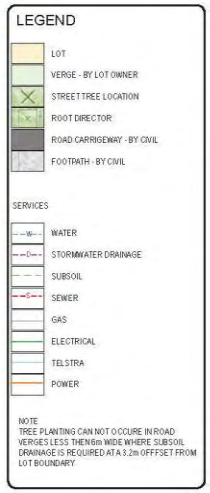


PLAN - TYPICAL 15.0m WIDE ROAD RESERVE

PLAN - TYPICAL 16.0m WIDE ROAD RESERVE



dwg • PRR01-08
date • January 2016
rev • B
scale • 1:50@A1

0 625 1600 1250mm

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PROVENCE residential estate
typical road cross-sections

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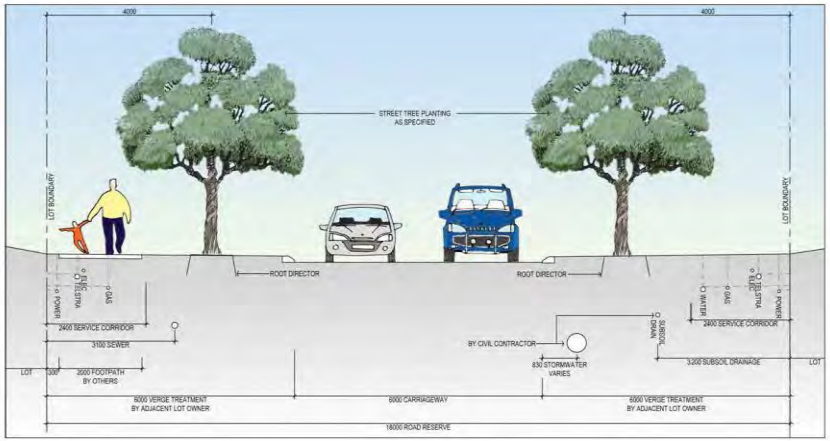
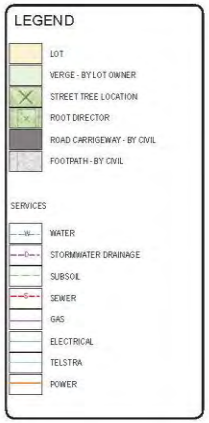


SECTION - TYPICAL 18.0m WIDE ROAD RESERVE

PLAN - TYPICAL 18.0m WIDE ROAD RESERVE



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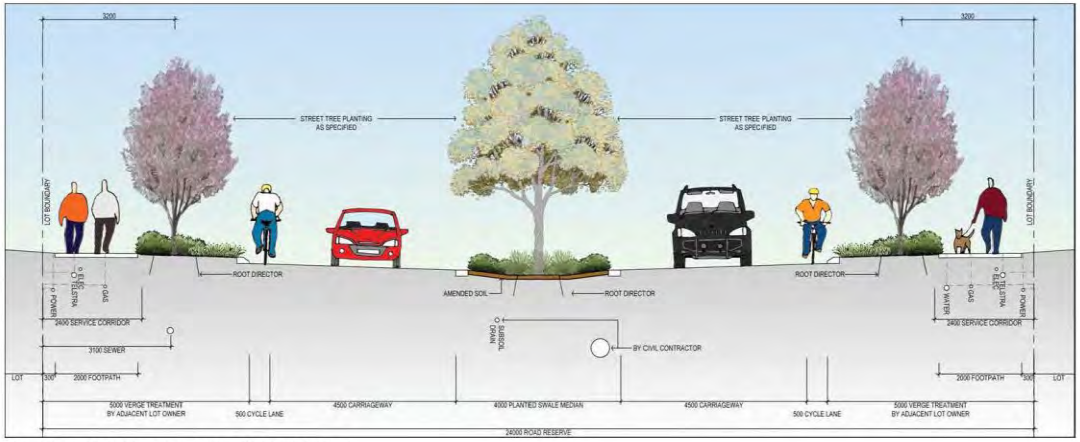
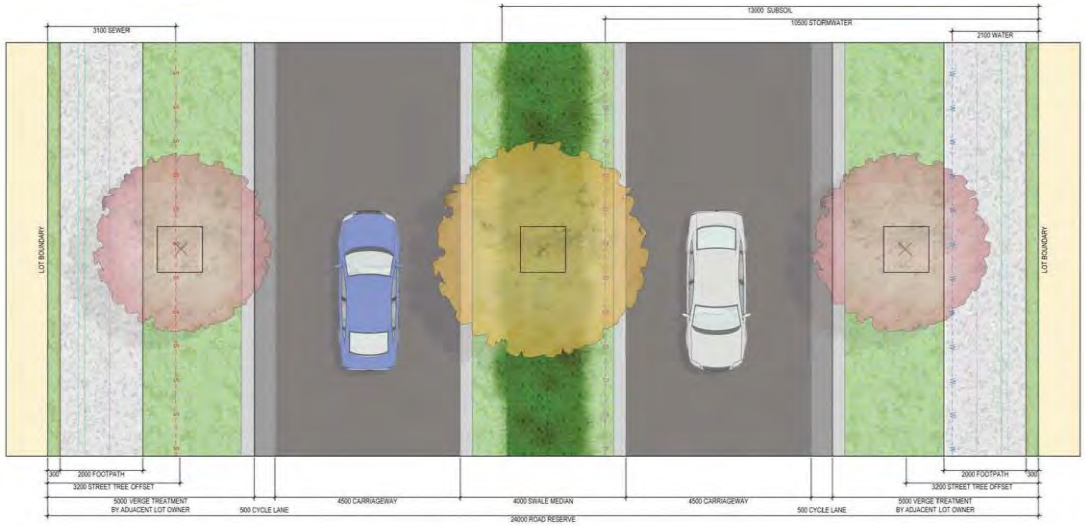
PROVENCE residential estate
typical road cross-sections

emerge ASSOCIATES Integrated Science & Design



SECTION - TYPICAL 24.0m WIDE ROAD RESERVE



PLAN - TYPICAL 24.0m WIDE ROAD RESERVE

dwg • PRP01-05
date • January 2016
rev • B
scale • 1:50@A1

0 625 1600 12.5m

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PROVENCE residential estate
typical road cross-sections

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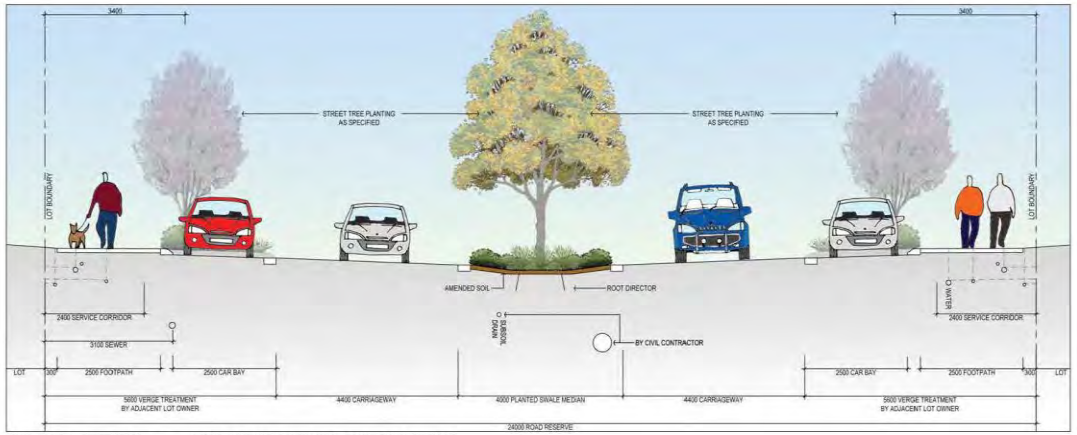

SECTION - TYPICAL 24.0m WIDE ROAD RESERVE WITH PARKING

PLAN - TYPICAL 24.0m WIDE ROAD RESERVE WITH PARKING

PROVENCE residential estate
typical road cross-sections

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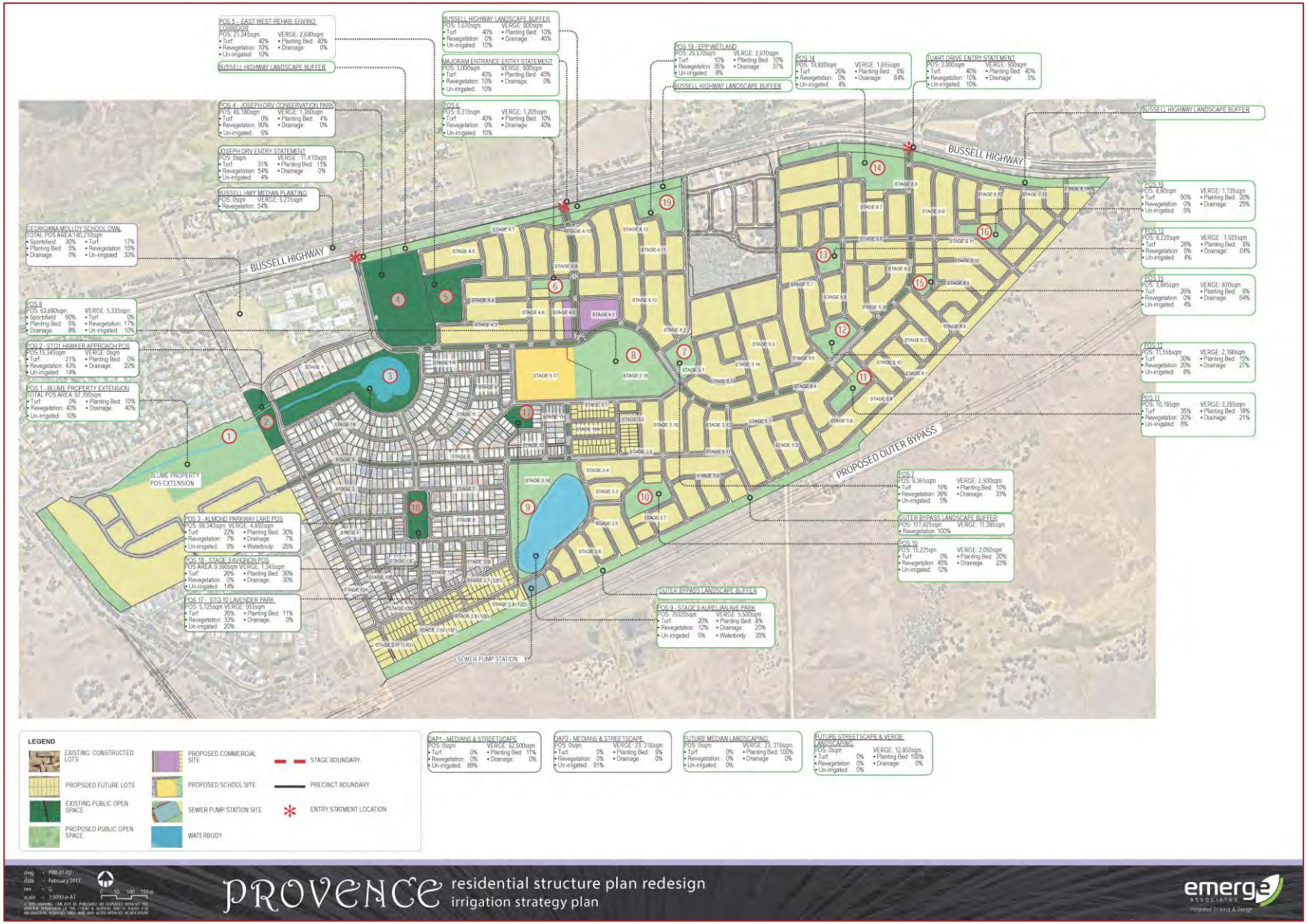
7.4 APPENDIX D

Provence - Irrigation Strategy Plan, Revision G, dated February 2017


BUSSELL HIGHWAY
PROPOSED OUTER BYPASS
BLUME PROPERTY POS EXTENSION
SEWER PUMP STATION
LEGEND
EXISTING CONSTRUCTED LOTS
PROPSOED FUTURE LOTS
EXISTING PUBLIC OPEN SPACE
PROPOSED PUBLIC OPEN SPACE
PROPOSED COMMERCIAL SITE
PROPOSED SCHOOL SITE
SEWER PUMP STATION SITE
WATERBODY
STAGE BOUNDARY
PRECINCT BOUNDARY
ENTRY STATMENT LOCATION
PROVENCE
residential structure plan redesign
irrigation strategy plan
emerge ASSOCIATES

7.5 APPENDIX E

Provence - Irrigation, Water Use and Allocation Schedule, Revision K, dated March 2017

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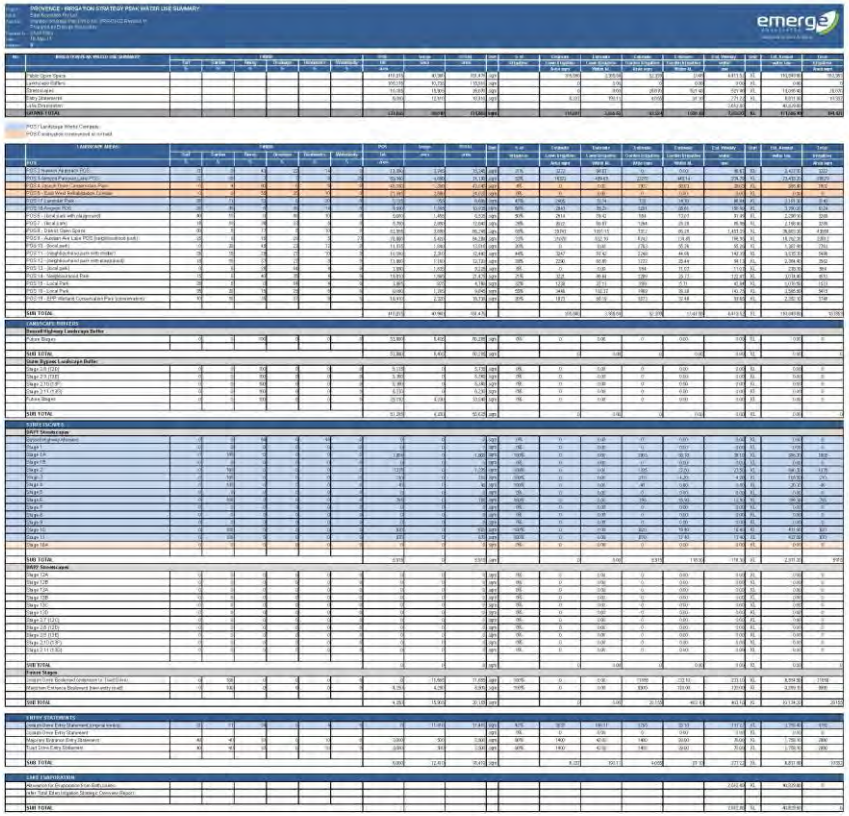

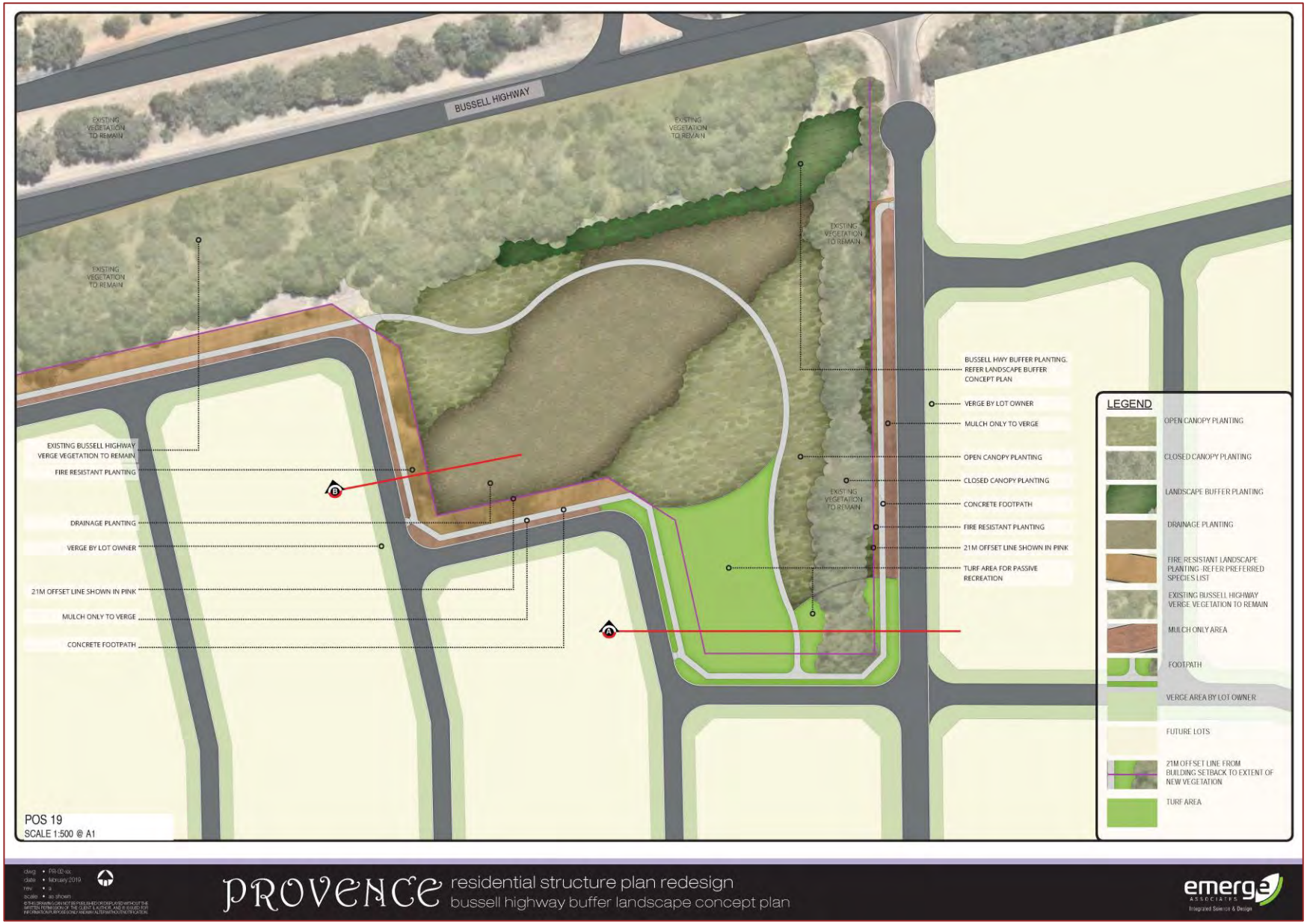
BUSSELL HIGHWAY
EXISTING VEGETATION TO REMAIN
EXISTING VEGETATION TO REMAIN
EXISTING VEGETATION TO REMAIN
EXISTING VEGETATION TO REMAIN
EXISTING BUSSELL HIGHWAY VERGE VEGETATION TO REMAIN
FIRE RESISTANT PLANTING
DRAINAGE PLANTING
VERGE BY LOT OWNER
21M OFFSET LINE SHOWN IN PINK
MULCH ONLY TO VERGE
CONCRETE FOOTPATH
BUSSELL HWY BUFFER PLANTING. REFER LANDSCAPE BUFFER CONCEPT PLAN
VERGE BY LOT OWNER
MULCH ONLY TO VERGE
OPEN CANOPY PLANTING
CLOSED CANOPY PLANTING
CONCRETE FOOTPATH
FIRE RESISTANT PLANTING
21M OFFSET LINE SHOWN IN PINK
TURF AREA FOR PASSIVE RECREATION
LEGEND
OPEN CANOPY PLANTING
CLOSED CANOPY PLANTING
LANDSCAPE BUFFER PLANTING
DRAINAGE PLANTING
FIRE RESISTANT LANDSCAPE PLANTING -REFER PREFERRED SPECIES LIST
EXISTING BUSSELL HIGHWAY VERGE VEGETATION TO REMAIN
MULCH ONLY AREA
FOOTPATH
VERGE AREA BY LOT OWNER
FUTURE LOTS
21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION
TURF AREA
POS 19
SCALE 1:500 @ A1
PROVENCE
residential structure plan redesign
bussell highway buffer landscape concept plan
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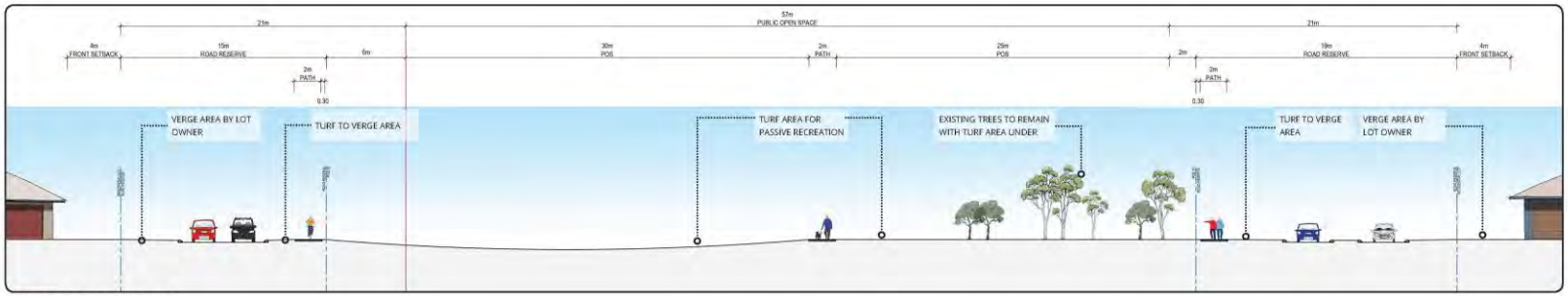
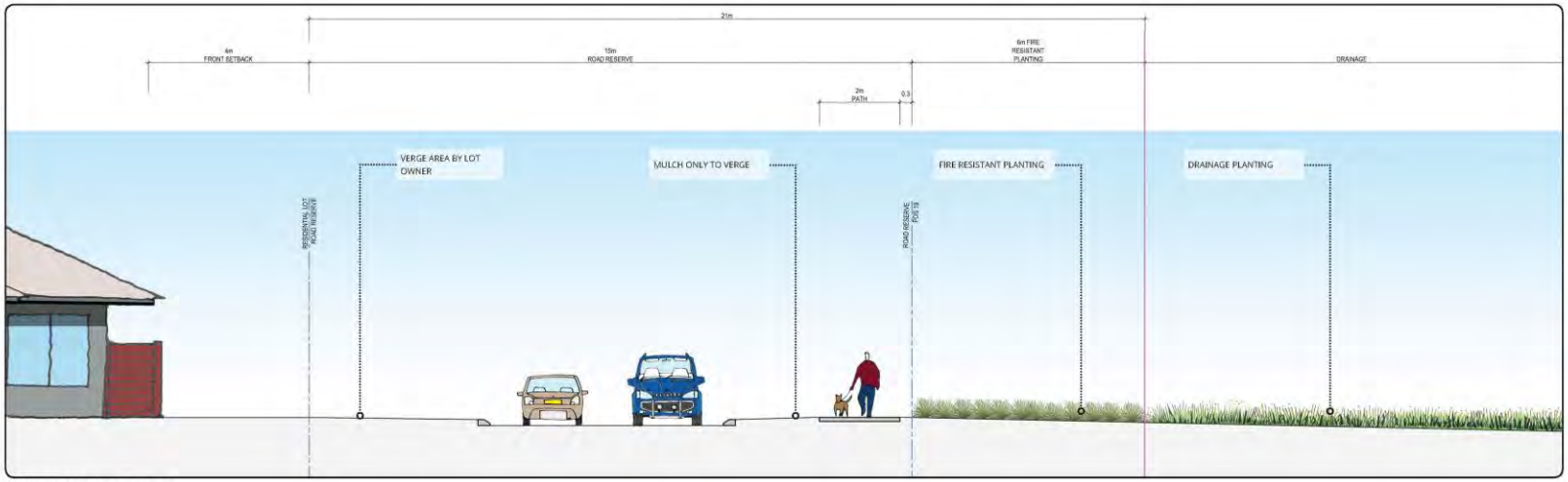


LANDSCAPE SECTION - A
SCALE 1:150 @ A1



LANDSCAPE SECTION - B
SCALE 1:50 @ A1

RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA

PROVENCE residential structure plan redesign
typical landscape cross sections

emerge ASSOCIATES Integrated Science & Design

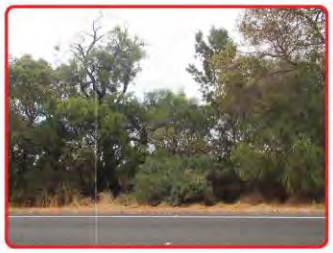


PHOTO A
Bussell Hwy Median - 32m total width from edge of bitumen to edge of bitumen

A mix of upper tree canopy species, middle storey shrub layer species and lower ground cover species planted across approximately 20m of the 32m median area. The middle storey shrub layer is more dominant and this provides 90% to 100% visual screening across to the Busselton Bypass south bound lanes.

PHOTO B
Bussell Hwy Median - 32m total width from edge of bitumen to edge of bitumen

A mix of upper tree canopy species, middle storey shrub layer species planted across approximately 15m of the 32m median area. The lower groundcover layer is very sparse primarily due to the more dominant upper tree canopy layer. This provides 80% - 90% screening to Busselton Bypass south bound lanes.

PHOTO C
Bussell Hwy Median - 32m total width from edge of bitumen to edge of bitumen

A mix of upper tree canopy species, midle storey shrub layer species and lower groundcover layer species planted across aproximatly 15m of the 32m median area. The middle storey shrub layer is very dense but there the upper tree canopy and groundcover layers still have presence. This provides 100% screening to Busselton Bypass south bound lanes.

PHOTO F
Main Roads W.A Verge - 17m

Primarily middle storey shrub layer species and lower groundcover layer species planted across approximately 10m of the 17m verge area with some upper storey tree planting. This provides 70% to 80% screening to the abutting future development land behind.

PHOTO E
Main Roads W.A Verge - 17m total width

A relatively even mix of upper tree canopy species, middle stirey shrub layer species and lower ground layer species planted across approximatly 10m of the 17m verge area. Density of planting is quite low and could be increased. This currently provides 90% screening to the abutting future development land.

PHOTO D
Main Roads W.A Verge - 17m
+
Existing Landscape Buffer - 20m

An even mix of upper tree canopy species, middle storey shrub layer species and lower groundcover layer species planted across approximatly 30m of the combined 37m verge and buffer area provides 100% screening to the abutting future development land.

dwg • PR-02-06
date • february 2019
rev • b
scale • not to scale

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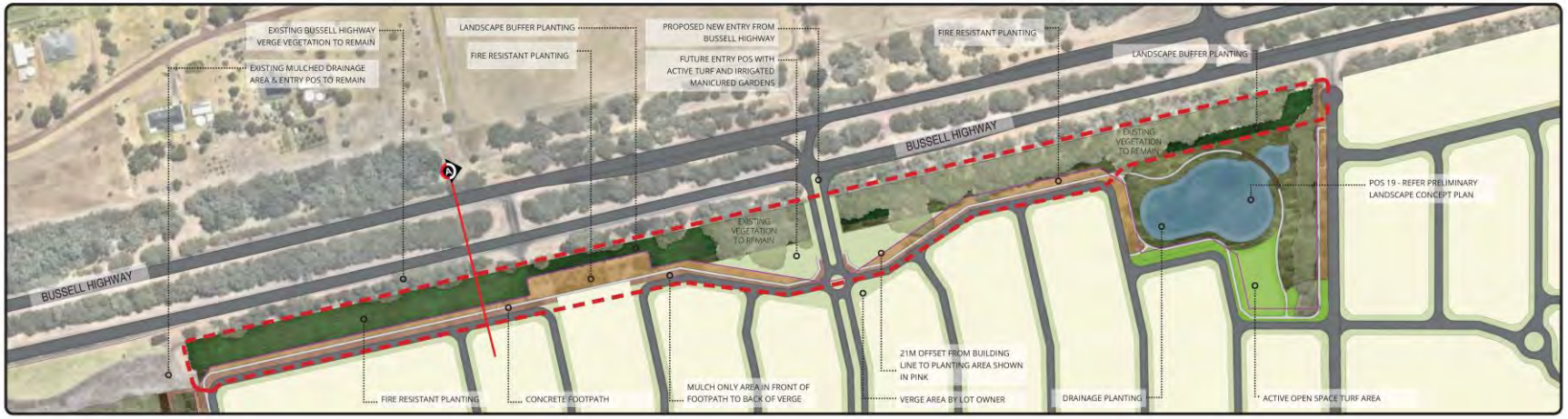
PROVENCE residential structure plan redesign
bussell highway existing verge photos

emerge ASSOCIATES Integrated Science & Design

RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA



LEGEND

- EXISTING TREE PLANTING TO BE RETAINED WITHIN LANDSCAPE BUFFER WITH INFILL PLANTING MANAGED TO CITY OF BUSSELTON STANDARDS
- EXISTING TREES AND VERGE VEGETATION TO BE RETAINED AND MANAGED TO CITY OF BUSSELTON STANDARDS
- LANDSCAPE BUFFER AND INFILL PLANTING TO ACHIEVE VISUAL SCREEN. TO BE MANAGED AND MAINTAINED TO CITY OF BUSSELTON STANDARDS
- DRAINAGE PLANTING
- FIRE RESISTANT LANDSCAPE PLANTING - REFER PREFERRED SPECIES LIST
- PROPOSED TURF AREA
- EXISTING BUSSELL HIGHWAY VERGE VEGETATION TO REMAIN
- MULCH ONLY AREA
- FOOTPATH
- VERGE AREA BY LOT OWNER
- FUTURE LOTS
- 21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION

dwg • PR-02-07
date • february 2019
rev • b
scale • 1:2000 @ A1

PROVENCE residential structure plan redesign
bussell highway buffer - landscape concept plan

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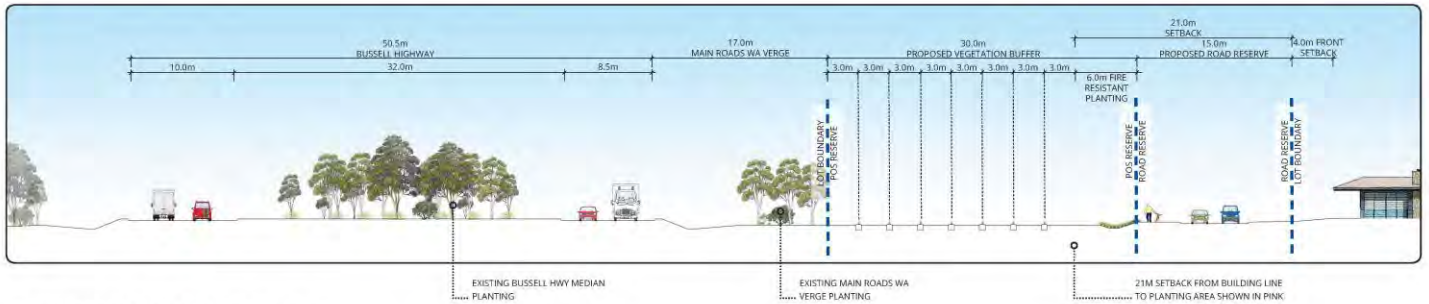
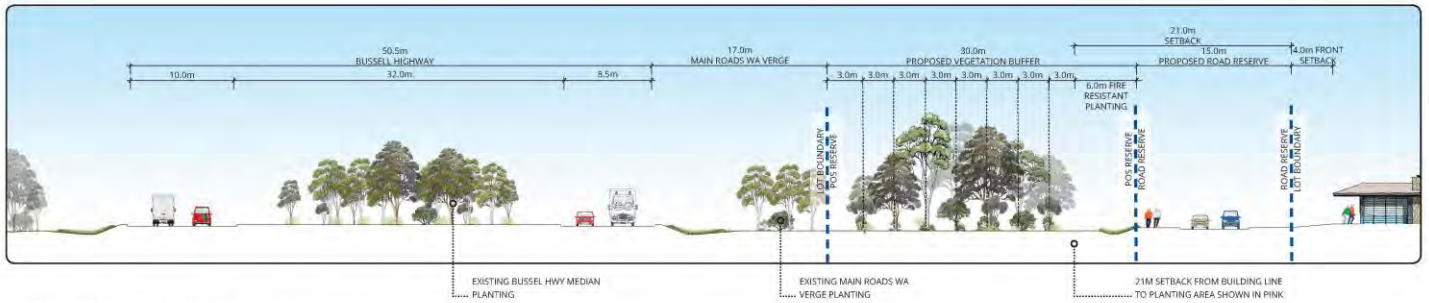


LANDSCAPE SECTION - INITIAL INSTALLATION
SCALE 1:200 @ A1



LANDSCAPE SECTION - MATURITY
SCALE 1:200 @ A1

PROVENCE residential structure plan redesign
bussell highway buffer - typical cross sections

emerge ASSOCIATES Integrated Science & Design

BUSSELTON OUTER BYPASS LANDSCAPE BUFFER AND NOISE BUND
SCALE 1:2500 @ A1

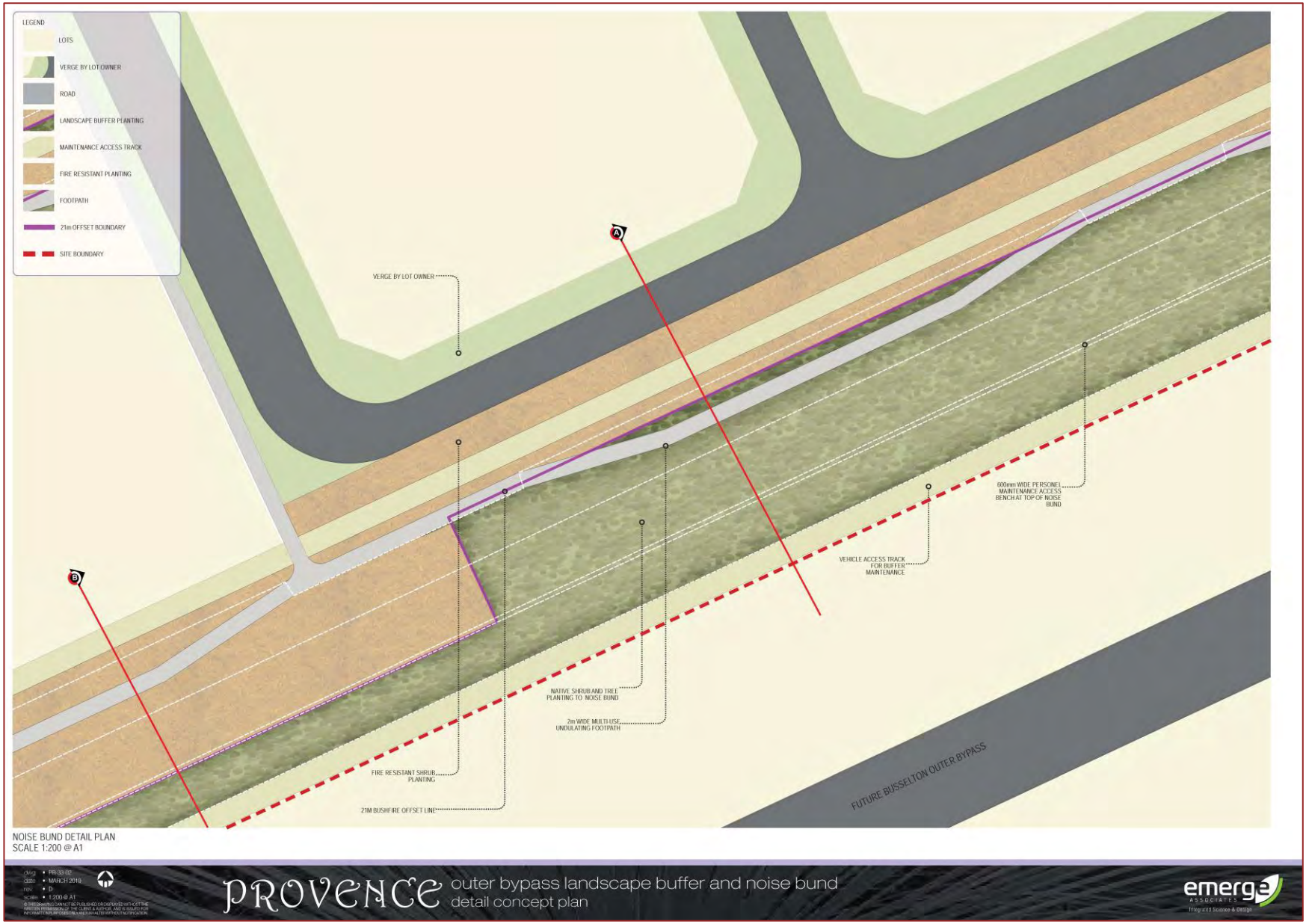
RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA

dwg • PR-20-01
date • MARCH 2019
rev • D
scale • 1:2500 @ A1

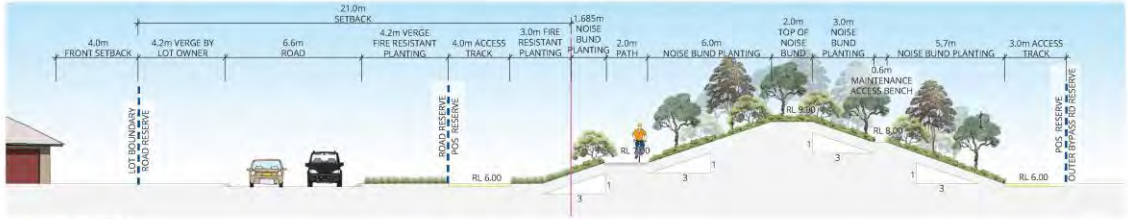
PROVENCE outer bypass landscape buffer and noise bund
overall landscape concept plan

emerge ASSOCIATES Integrated Science & Design

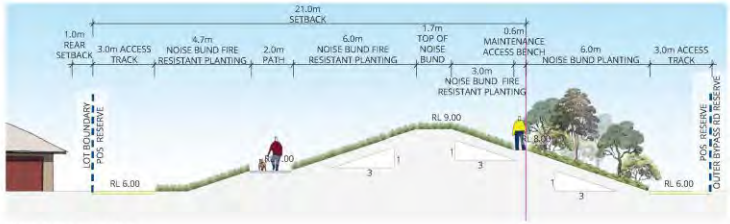


NOISE BUND DETAIL PLAN
SCALE 1:200 @ A1

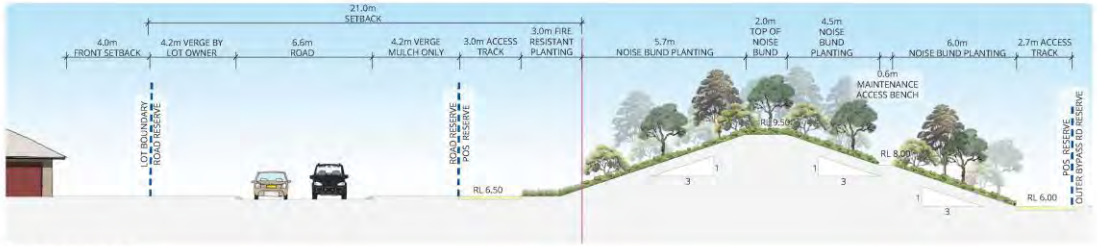
PROVENCE outer bypass landscape buffer and noise bund detail concept plan



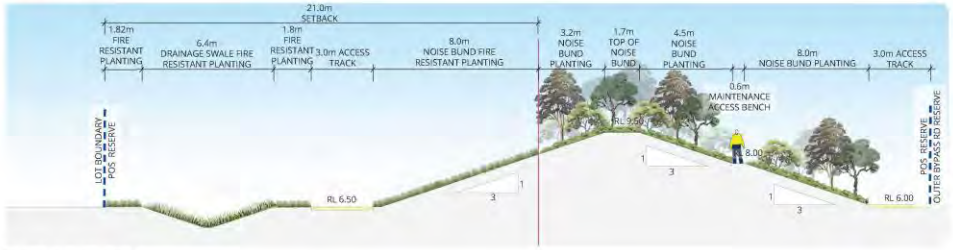
NOISE BUND SECTION A
SCALE 1:100 @ A1



NOISE BUND SECTION B
SCALE 1:100 @ A1



NOISE BUND SECTION C
SCALE 1:100 @ A1



NOISE BUND SECTION D
SCALE 1:100 @ A1

PROVENCE outer bypass landscape buffer and noise bund
typical landscape cross-sections

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APPENDIX D

Local Water Management Strategy

Prepared by JDA Consultants

Addendum prepared by Hyd2o Hydrology to address resolution of the Statutory Planning Committee (SPC)

Prepared for:

EAST BUSSELTON ESTATE PTY LTD

Provence

Local Water Management Strategy

December 2019

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JDA Consultant Hydrologists

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This Report is based on the current edition of Australian Rainfall & Runoff – A Guide to Flood Estimation (2019) as is referred to in this report as ARR19.

QUALITY ASSURANCE

The JDA quality control system has been in place since 1997 and meets the requirements of AS/NZS ISO 9001:2008. JDA is committed to maintaining and improving the quality management system.

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J6049f	23 September 2016
J6049g	9 March 2017
J6049h	23 December 2019

	Name	Signature	Date
Author	Alex Rogers		23/12/19
Checked by	Jim Davies		23/12/19
Approved by	Jim Davies		23/12/19

EXECUTIVE SUMMARY

JDA has been engaged by Satterley Property Group to complete a Local Water Management Strategy (LWMS) for Provence at Busselton.

Table 1 below provides a summary of the key elements of the LWMS.

TABLE 1: SUMMARY OF LOCAL WATER MANAGEMENT STRATEGY

Principle	Key LWMS Elements
Water Quantity To maintain the total water cycle balance within development areas relative to the pre-development conditions.	• Maintain flow paths for existing catchments; • Maintain 1yr ARI event post development discharge relative to pre-development conditions; • Manage 5yr and 100yr ARI peak flows from the site; • Stormwater detention areas outlets set above AAMGL; • Installation of sub-soil drainage at a controlled watertable level; and • Maximise infiltration opportunities (where possible) for frequent events.
Water Quality To maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.	• Change in land use and WSUD to reduce nutrient input in the site; • Use of treatment train approach to stormwater management; • Application of source controls – including street sweeping, education to reduce nutrient application, native plantings, swales and lot soakwells; and • Application of structural controls – retention/detention areas and Park Avenues.
Water Conservation To maximise the reuse of stormwater	• Encourage implementation of water efficiency and demand management measures both internal and external of buildings; • Maximise stormwater infiltration opportunities where possible; and • Use of native plantings in drainage areas to minimise irrigation.
Ecosystem Health To retain natural drainage systems and protect ecosystem health	• Maintain 1yr ARI event post development discharge relative to pre-development conditions; and • Manage 5yr and 100yr ARI peak flows from the site.
Economic Viability To implement stormwater systems that are economically viable in the long term	• Use of proven structural WSUD technology; and • Use of source control techniques to minimise cost of nutrient management.
Public Health To minimise the public risk, including risk of injury or loss of life to the community	• Design in accordance with relevant design standards, best management practices, council regulations and government agency requirements.
Protection of Property To protect the built environment from flooding and waterlogging	• Identification of 100yr ARI flood levels for site; • Protection of downstream areas by managing stormwater discharge; and • Sub-soil drainage to be implemented to control seasonal groundwater rise to a controlled watertable level.
Social Values To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater	• Integration of drainage and POS functions.
Development To ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability & precautionary principles.	• Urban water management in accordance with Better Urban Water Management (WAPC, 2008); and • Development of the LWMS in accordance with government agency guidelines and best management practice recommendations.

CONTENTS

1. INTRODUCTION 1

1.1 BACKGROUND 1

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2. PREVIOUS STUDIES AND REFERENCE DOCUMENTS 3

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1. INTRODUCTION

1.1 Background

This Local Water Management Strategy (LWMS) has been prepared by JDA Consultant Hydrologists on behalf of East Busselton Estate Pty Ltd Pty Ltd for the Provence development at East Busselton (Figure 1).

This document builds on the Provence Water Management Strategy (JDA, 2008) approved by Department of Water (DoW), now Department of Water and Environmental Regulation (DWER), and the Federal Department of the Environment Water Heritage and the Arts (DEWHA), now Department of the Environment and Energy (DEE), in 2008. That (2008) document included:

- the provision of additional information required to provide compliance with water related development conditions set by the Commonwealth Minister for the Environment through the then Department of the Environment and Heritage (DEH) in March 2005 (Appendix B);
- variations to these Conditions as requested by the Department of the Environment Water Heritage and the Arts (DEWHA) in July 2008 (Appendix C); and
- a table of compliance, detailing where the conditions were addressed in the WMS (Appendix J)

This LWMS maintains consistency with local requirements and commitments under the approved Provence WMS (JDA, 2008). The LWMS aims to ensure development at Provence does not negatively impact the Vasse Wonnerup Ramsar Wetland.

The LWMS provides an understanding of the existing surface water and shallow groundwater and provides advice on seasonal groundwater variation, flow regime of wetlands, water quality considerations and stormwater drainage issues. The LWMS provides a framework for the application of total water cycle management to the development and protection of environmental values.

1.2 Statutory Framework

This LWMS provides a framework to apply total water cycle management to Provence, consistent with DWER principles of Water Sensitive Urban Design (WSUD). This document details stormwater, groundwater and water quality management, at a level of detail suitable for the purposes of local structure planning.

The preparation of this document in relation to the requirements of Better Urban Water Management (BUWM) (WAPC, 2008) is shown in Table 2.

This LWMS draws its key principles and objectives from the Busselton Airport Structure Plan District Water Management Strategy (DWMS) (JDA, 2009) and is an extension of the approved concepts it presents.

A completed copy of the BUWM (WAPC, 2008) LWMS Checklist has been included as Appendix A to assist in review of this document.

TABLE 2: INTEGRATED PLANNING AND URBAN WATER MANAGEMENT

Planning Phase	Planning Document	Urban Water Management Document and Status
Regional	-	Geographe Bay Coastal Catchment Land Capability Assessment for Managing the Impact of Land Use Change on Water Resources (Acacia Springs Environment et al., 2005)
District	Busselton Airport District Structure Plan	Busselton Airport Structure Plan District Water Management Strategy (JDA, 2009)
Local	Provence Local Structure Plan	Provence LWMS **THIS DOCUMENT**
Subdivision	Subdivision Application **FUTURE PREPARATION**	Urban Water Management Plans (UWMP) **FUTURE PREPARATION**

2. PREVIOUS STUDIES AND REFERENCE DOCUMENTS

Key objectives and general criteria for water quality management, groundwater management, and flood management for the Study Area are detailed in this Chapter. The objectives and criteria have been developed with consideration of current DWER stormwater management objectives, and the following key reference documents:

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality National Water Quality Management Strategy (ANZECC, 2000a);
- Australian Guidelines for Water Quality Monitoring and Reporting, National Water Quality Management Strategy (ANZECC, 2000b);
- Australian Guidelines for Urban Stormwater Management (ANZECC, 2000c);
- Stormwater Management Manual for Western Australia, Department of Water (2007);
- South West Regional Strategy for Natural Resource Management, South West Catchments Council (2005);
- Draft Water Resources Management Strategy for the Busselton-Dunsborough Region, Summary. Department of Environment (2003);
- Geographe Bay Coastal Catchment Land Capability Assessment for Managing the Impact of Land Use Change on Water Resources (Acacia Springs et al, 2005);
- Busselton Regional Flood Study Review (JDA, 1998);
- Local Government Guidelines for Subdivisional Development (IPWEA, 2009);
- Water Resource Considerations when Controlling Groundwater Levels in Urban Development (DoW, 2013);
- Vasse Wonnerup Wetlands and Geographe Bay WQIP (DoW, 2010);
- Reconnecting Rivers flowing to the Vasse Estuary (DWER, 2018)
- Guidelines for Soil Filter Media in Bioretention System, Stormwater Biofiltration Systems (FAWB, 2008 & 2009);
- Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia (Monash, 2014); and
- Provence Drainage and Nutrient Management Plan, JDA (2005).

2.1 Provence Water Management Strategy (JDA, 2008)

The Provence Water Management Strategy (WMS) was developed in 2006, with significant input from the Provence Drainage and Nutrient Management Plan (JDA, 2005). The WMS was finalised and formally endorsed in 2008, consistent with meeting DEWHA conditions.

The WMS predates BUWM but addresses most components of an LWMS, including stormwater, groundwater and water quality management at a conceptual level, suitable for a Structure Plan.

The document provided estimation of groundwater levels for design, flood storage levels, volumes and areas and BMPs to address water quality targets.

2.2 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) was introduced by the Commonwealth, State and Territory Governments in 1992 as a response to growing community concern about the condition of the nation's water bodies and the need to manage them in an environmentally sustainable way. The Strategy has three main elements: policies, process, and guidelines.

The NWQMS guidelines consist of a series of 21 documents prepared by the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand. Of these documents, three related to urban stormwater quality management are:

- Guideline 4 : Australian and New Zealand Guidelines for Fresh and Marine Water Quality
- Guideline 7 : Guidelines for Water Quality Monitoring and Reporting
- Guideline 10 : Guidelines for Urban Stormwater Management

Responsibilities for implementing the NWQMS falls across a number of West Australian state government agencies including the Department of Water and Environmental Regulation, Environmental Protection Authority (EPA), and the Health Department of Western Australia.

2.2.1 Australian & New Zealand Guidelines for Fresh and Marine Water Quality

The main objective of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000a) is to provide an authoritative guide for setting water quality objectives required to sustain current, or likely future, environmental values (uses) for natural and semi-natural water resources in Australia and New Zealand.

While ANZECC (2000a) indicates that the guidelines are not intended to be directly applied to stormwater quality, they are applicable where stormwater systems are regarded as having conservation value. Default trigger values (concentrations below which there is a low risk of adverse biological effects) are derived from ecosystem data for unmodified or slightly-modified ecosystems, and are not based on any objective biological criteria. It is recommended they should only be applied where site-specific values do not exist or until site-specific values can be derived.

ANZECC (2000a) also provides water quality guideline trigger values for toxicants (including metals, pesticides, hydrocarbons, and industrial chemicals) to provide alternative levels of protection.

The current NWQMS approach recommends moving away from relying solely on chemical guideline values for managing water quality to the use of integrated approaches comprising chemical specific guidelines coupled with water quality monitoring, direct toxicity assessment, and biological monitoring. This approach will help ensure that the water management focus keeps in view the goal of protecting the environment and does not merely shift to meeting numbers.

2.2.2 Australian Guidelines for Urban Stormwater Management

The Australian Guidelines for Urban Stormwater Management (ANZECC, 2000c), aims to provide a nationally consistent approach for managing urban stormwater in an ecologically sustainable manner, and provides details of current best practice in stormwater management and planning in Australia. The document highlights the need for a more holistic approach to stormwater management which addresses issues of stormwater quality and aquatic ecosystem health, and recognises the environmental impacts of urbanisation, the linkages between land and water management and the importance of community values and involvement.

The document references the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000a) to provide water quality objectives, but acknowledges that objectives for urban stormwater management are complicated by:

- water quality being affected by other pollution sources, such as point sources, agricultural runoff and sewer overflows
- difficulties in establishing relationships between ambient water quality concentrations and wet weather stormwater discharges.

2.2.3 Australian Guidelines for Water Quality Monitoring and Reporting

The Australian Guidelines for Water Quality Monitoring and Reporting sets out an overall framework for the establishment of monitoring programs, and presents methods and routines for the setting of monitoring objectives, study design, field sampling, laboratory analyses, data analysis and the reporting and dissemination of information.

Similarly to the Australian Guidelines for Urban Stormwater Management (ANZECC, 2000c), the document references the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000a) to provide water quality objectives.

2.3 Stormwater Management Manual for Western Australia (DoW, 2004-2007)

The Water and Rivers Commission (now DWER) released A Manual for Managing Urban Stormwater Quality in Western Australia in 1998 to define and describe in practical terms Best Management Practices (BMP's) to reduce pollutant and nutrient inputs to stormwater drainage systems. The Manual also aimed to provide guidelines for the incorporation of water sensitive design principles into urban planning and design, which would enable the achievement of improved water quality from urban development.

The document was released not as a statutory requirement, but to provide a guideline for best planning and management practices, and was intended for use not only by Water and Rivers Commission, but also by other State and Local Government Authorities and sectors of the urban development industry. The Manual did not provide details of design objectives and performance criteria for stormwater quality, and provides only a qualitative comparison of pollutant removal efficiencies and associated costs. The Manual also relied only on the use of "in-transit" and "end of pipe" stormwater treatment rather than adopting a whole of catchment approach to water quality management which includes source control measures.

DoW completed a major review of the manual in consultation with a working team comprising industry and government representatives, published in August 2007.

Principal objectives for managing urban water in WA are stated as:

- **Water Quality**
  To maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.
- **Water Quantity**
  To maintain the total water cycle balance within development areas relative to the pre-development conditions.
- **Water Conservation**
  To maximise the reuse of stormwater.

- **Ecosystem Health**
  To retain natural drainage systems and protect ecosystem health.
- **Economic Viability**
  To implement stormwater systems that are economically viable in the long term.
- **Public Health**
  To minimise the public risk, including risk of injury or loss of life to the community.
- **Protection of Property**
  To protect the built environment from flooding and waterlogging.
- **Social Values**
  To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater.
- **Development**
  To ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

2.4 Better Urban Water Management (WAPC, 2008)

The guideline document Better Urban Water Management (WAPC, 2008), focuses on the process of integration between land use and water planning and specifying the level of investigations and documentations required at various decision points in the planning process, rather than the provision of any specific design objectives and criteria for urban water management.

This LWMS complies with the BUWM process.

2.5 Regional Water Resources Management Strategy

In 2005, DoW released the water resources management strategy for the region, titled Geographe Bay Coastal Catchment Land Capability Assessment for Managing the Impact of Land Use Change on Water Resources (Acacia Springs Environmental et al 2005). The Executive Summary provides a summary list of guiding principles and detailed recommendations as follows:

Guiding Principles

- Protect and enhance natural water systems within urban developments.
- Integrate stormwater treatment into the landscape by incorporating multiple use corridors that maximise the visual and recreational amenity of developments.
- Protect quality of water drainage from urban developments.
- Reduce runoff and peak flows from urban development by local detention measures and minimising impervious areas.
- Add value while minimising development costs through cost effective use of natural systems within the drainage infrastructure.

Detailed Recommendations

- Direct drainage or discharge of stormwater shall not be permitted into any wetland (receiving environment), including its designated buffer area.

- Stormwater runoff from at least a 1 hour 1 year average recurrence interval (ARI) rainfall event shall be retained and treated within the development area. Overflow from larger rainfall events may be permitted subject to the pre development hydrologic regime of the wetland not being altered.
- Stormwater runoff should be retained on site using vegetated swales or shallow depressions that have capacity to contain the runoff from at least a 1 hour 1 year ARI rainfall event.
- Stormwater runoff within road reserves generated from up to 1 hour 1 year ARI rainfall events shall be retained using techniques such as soakwells, vegetated swales, or shallow depressions. Overflow of runoff from larger rainfall events, to the regional drainage system, shall be by overland flow paths.

These recommendations provide an emphasis on retention and infiltration of frequently occurring storm events (where possible) with larger storm events conveyed to the regional drainage system by overland flow paths. The recommendations are generally consistent with DoW (2007).

2.6 SWCC Natural Resource Management Strategy

The South West Catchments Council (SWCC) is a cooperative regional organisation which identifies and coordinates strategic opportunities to achieve sustainable natural resource management (NRM) in the South West of Western Australia. SWCC members include community and public agency representatives, with public agencies represented including the Departments of Environment, Agriculture, Planning and Infrastructure, Conservation and Land Management, the South West or Peel Development Commission and the WA Local Government Association.

In 2005, SWCC released the South West Regional Strategy for Natural Resource Management (SWCC, 2005) as a statement by community, industry, and government stakeholders within the south west region of the value of our natural resource assets. The strategy is intended to provide an integrated, cooperative, and adaptive approach to guide strategic investment in the sustainable management of the Region's land, water, biodiversity, marine, coastal, air and climatic resources.

Section 3 of SWCC (2005) defines targets and actions for a range of assets including waterways, wetlands and estuaries. Management action targets potentially relevant to development within the Study Area include:

- All new subdivision in the region to incorporate urban stormwater management water sensitive design principles by 2006.
- 55% of priority waterways and all Ramsar wetlands and estuaries to have comprehensive plans prepared and implemented addressing a range of issues including biodiversity, restoration, indigenous culture, instream health by 2007.

Resource condition targets specified in SWCC (2005) also potentially relevant to development within the Study Area include:

- Improved health and extent of Ramsar, Directory of Important Wetlands in Australia, Register of the National Estate, Environmental Protection (Swan Coastal Plain) Policy Wetlands, and Conservation Category wetlands by 2008.
- Decrease levels of water quality parameters including turbidity and levels of TN, TP and soluble nutrient in priority waterways, wetlands, and estuaries by 2024
- Significant algal blooms in priority waterways and estuaries reduced by 10% by 2010
- A progressive reduction in fish kills throughout the region by 20% by 2010 and 60% by 2020.

The above targets specified in SWCC (2005) are consistent with DWER's key objectives and guiding principles for urban stormwater management. It should be noted that SWCC (2005) does not define target concentrations for individual water quality parameters.

In summary, while the targets are general in nature, they aim toward an improvement in water quality compared to current water quality under existing land use.

2.7 Local Government Guidelines for Subdivisional Development (IPWEA, 2016)

The Institution of Public Works Engineering Australia Subdivisional Guidelines (Edition 2.3 – June 2016) aims to achieve best practice for managing both water quantity and quality in a sustainable way as required by the State Planning Policy 2.9.

Design criteria are to be used as a guide for development of the urban water management system for strategic planning, subdivision and development. Water management requires consideration of water quality and quantity.

Post-development annual discharge (the critical 1 Exceedance per Year [EY] event) volume and peak flow should be maintained relative to pre-development conditions in all parts of the catchment where there are identified impacts on significant ecosystems. The built environment also needs to be protected from flooding (up to the 1% Annual Exceedance Probability [AEP]) and waterlogging, minimising the public risk.

Surface and groundwater quality should be at least maintained at pre-development levels (winter concentrations) and, if possible, improved. This should be achieved through a treatment train approach including non-structural measures (e.g. community education), on-site retention of the first 15 mm of rainfall and bio-retention structures/systems sized at 2% of the constructed impervious areas. As compared to a development that does not actively manage stormwater quality; the following design objectives are required:

- At least 80% reduction of the total suspended solids;
- At least 60% reduction of total phosphorus;
- At least 45% reduction of total nitrogen; and
- At least 70% reduction of gross pollutants.

Key elements of the water-sensitive design include water conservation, flood protection, management of frequent events, groundwater drainage and general drainage design principles.

2.8 Water Resource Considerations when Controlling Groundwater Levels in Urban Development (DoW, 2013)

Integrated land and water planning is based on the principle of total water cycle management, as outlined in Stage Planning Policy 2.9: Water Resources (WAPC, 2006) and Better Urban Water Management (WAPC, 2008). This document supports the land planning process. It identifies factors to be considered when setting a controlled groundwater level (CGL) and provides advice on assessing the groundwater regime and the risk it poses to the proposed urban form. The document also discusses management of discharged groundwater and maintenance considerations.

2.9 City of Busselton Water Sensitive Urban Design Guidelines (CoB, 2014)

The WSUD guidelines provide guidance on measures to be used for individual lots scale for stormwater management, as required by CoB (2015) below. The document provides direction on soakwells, rainwater

tanks, landscaping techniques, infiltration trenches, raingardens / biofiltration systems, vegetated swales, permeable paving and retention of remnant vegetation.

While the document is intended for individual lots, some of the information (raingardens, vegetated swales) is also relevant to larger scale water management.

The document also provides a calculation sheet to estimate volume of runoff to be managed on the lot, and capacity of the different infiltration devices.

2.10 City of Busselton Local Planning Policy 8C: Stormwater Management Provisions (CoB, 2015)

This document is part of a Local Planning Policy for general development and process standards. The policy aims to ensure the safe and effective management of the quantity and quality of stormwater runoff. The provisions have the following principles:

- Manage stormwater efficiently and effectively to provide adequate protection for people and property from flooding;
- Mimic the predevelopment hydrology through the application of water sensitive urban design (WSUD) principles; and
- Avoid stormwater runoff adversely impacting the quality of the receiving waters, including groundwater, waterways, wetlands, Lower Vasse River and the Geographe Bay.

These principles are similar to those applied by DWER.

The policy provides design principles and deemed-to-comply requirements for single houses, commercial, industrial, mixed use, group and multiple residential, as well as rural industry.

For single houses there is a requirement to infiltrate within the lot at a rate of 1 m^3 per 40 m^2 impervious area (5 year ARI, 1 hour duration event), or at 1 m^3 per 65 m^2 impervious area (1 year ARI, 1 hour duration event) if contribution to the City is made in accordance with Local Planning Policy 6F Drainage Contributions. The 1 m^3 storage per 65 m^2 impervious area as identified in CoB (2015) is used in this LWMS.

2.11 Vasse Wonnerup Wetlands and Geographe Bay WQIP (DoW, 2010)

The Vasse Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan (DoW, 2010) was developed to guide management strategies to reduce nutrient loads being delivered to the downstream wetlands. DoW used water quality modelling to provide a breakdown of each catchment's nutrient sources and to estimate nutrient reduction required to prevent or alleviate water quality problems in each system. The WQIP provides target concentrations for areas draining to the wetlands downstream of Provence.

Provence is predominantly in the Lower Sabina River catchment, with a portion of the south west within the Lower Vasse River catchment. The target concentration criteria are 0.1 mg/L for total phosphorus and 1 mg/L for total nitrogen.

2.12 Guidelines for Soil Filter Media in Bioretention systems; Stormwater Biofiltration Systems (FAWB, 2008 & 2009)

The Facility for Advancing Water Biofiltration (FAWB) at Monash University conducted research into the design of biofiltration systems (also known as biofilters, bioretention systems or raingardens). Biofiltration systems are one of the accepted WSUD elements. The documents detail design considerations for biofiltration (planning and technical) as well implementation.

The intent of biofiltration is to improve water quality though filtration and plant uptake of nutrients.

The system includes a vegetated flood detention storage, overlying an unsaturated filter media layer (0.3-0.5m thick), which then overlies a submerged zone.

Biofiltration of one form or another has been adopted in WA, and is generally required by DWER.

2.13 Vegetation guidelines for Stormwater Biofilters in the south-west of Western Australia (Monash, 2014)

Biofilter function relies on both the filtering properties of the soil media and the pollution uptake and/or transformation capacity of the plants and associated microbial community. This document provides guidance for selection of plant species specific to south-west Western Australia.

3. KEY DESIGN PRINCIPLES AND OBJECTIVES

3.1 Groundwater Management

The DWMS identified the following design objectives for groundwater management:

1. Maintain groundwater levels within their current natural regime particularly with respect to environmental water requirements or provisions for protection of significant wetlands; and
2. Provide sufficient clearance above groundwater in developed areas to provide protection from flooding due to seasonal groundwater rise.

Key criteria for groundwater management adopted for this LWMS are:

- Controlled groundwater level (CGL) to be established at the pre development AAMGL.
- Subsoil drainage will be used to control groundwater rise above CGL/AAMGL;
- Any existing drains which are located below the CGL/AAMGL are permitted to remain to allow existing hydrological regimes to continue;
- Importation of fill to provide necessary clearance between groundwater and finished lot levels;
- New drainage routes, if existing natural drainage systems are not available, will be located to minimise impacts on any significant wetlands and their buffers; and
- For areas requiring a CGL to limit the seasonal peak rise of groundwater levels due to engineering considerations, the proponent will provide detailed mapping of the areas of proposed CGL including detail of modelling and calculations considering any potential impacts on wetlands and groundwater to the satisfaction of DWER and City of Busselton.

Minimum separation distance between groundwater and finished floor levels will be achieved by filling of lots, with the CGL/AAMGL maintained post development by installation of subsoil drainage. If clean fill is to be imported, testing of the fill in terms of its permeability and phosphorus retention capability should be undertaken.

General criteria and objectives for groundwater management are summarised in Table 3.

3.2 Flood Management

Proposed development within the Study Area will require discharge to the Lower Vasse River, Sabina River and Vasse-Wonnerup Estuary.

DWER's generally adopted design criteria for new development areas is that post development flows are attenuated to pre-development flows. Flood management for the Study Area has therefore been based on maintaining the peak flow and volume at the downstream boundary of the Study Area with existing design peak flow and volume, to protect downstream areas and existing adjacent development areas from flooding and erosion, in particular the downstream Reinscourt rural residential lots (between Bussell Hwy and Sabina River), as discussed previously with CoB and DWER.

Finished lot levels will be a minimum of 0.3 m above the 1% AEP (100 year ARI) event flood levels of the local stormwater drainage system.

In general, runoff from the site will be minimised by maximising infiltration opportunities. Consistent with current DWER policy, local infiltration techniques will be adopted (where possible) to infiltrate the first 15 mm of rainfall.

General criteria and objectives for flood management are summarised in Table 3.

3.3 Water Quality Management

Water quality management for the Study Area is based on improving the water quality which discharges from the site to the Vasse Wonnerup Estuary. This is consistent with the recommendations from the Vasse-Wonnerup Wetlands and Geographe Bay WQIP (DoW, 2010) in relation to urban development:

"achieving no net increase or a net reduction in nutrients loads from large new urban developments"

The WQIP also recommends reducing nutrient use and export risk, and ensuring new urban developments incorporate WSUD.

To this end, the approach adopted for water quality management for the Study Area is based on an assessment of regional indicators, determining existing water quality by monitoring pre-development, establishing targets based on predevelopment monitoring with reference to ANZECC (2000a), implementing water sensitive urban design measures to achieve targets, and monitoring post development (including construction) to assess performance.

For water quality management the following general criteria are therefore proposed (Table 3):

- Where possible retain and rehabilitate natural drainage lines and valuable ecosystems such as natural channels, wetlands and riparian vegetation.
- Minimise pollutant input to surface water and groundwater by use of non-structural and structural source control techniques and WSUD BMP's, with a view to contributing toward improvement of water quality within the Vasse Wonnerup Estuary system.
- Water quality objectives based on predevelopment monitoring data to date and DoW (2010), with reference to ANZECC (2000a).

In regard to small event management (first 15 mm of rainfall) the following is proposed:

- Maximise infiltration opportunities;
- Use of soakwells, open base manholes, and vegetated swales to infiltration the first 15 mm rainfall at source;
- Treatment areas (biofilters) within basin storages to maximise nutrient uptake; and
- Treatment of all subsoil drainage prior to discharge from site.

TABLE 3: LWMS KEY OBJECTIVES AND CRITERIA

Category	Objective	Criteria
Groundwater Management	• Maintain ground water levels within their current natural regime particularly with respect to environmental water requirements or provisions for protection of significant wetlands. • Provide sufficient clearance above groundwater in developed areas to provide protection from flooding due to seasonal groundwater rise.	• Existing drains which are located below the CGL/AAMGL are permitted to remain to allow the existing hydrological regime of wetlands within and downstream of the Study Area to continue. • New drainage routes, where existing natural drainage systems are not available, be located to minimise impacts on significant wetlands and their buffers. • Subsoil drainage will be used to control groundwater rise above CGL/AAMGL. • For areas requiring a CGL to limit the seasonal peak rise of groundwater levels due to engineering considerations, the proponent will provide detailed mapping of the areas of proposed CGL including detail of modelling and calculations considering any potential impacts on wetlands and groundwater to the satisfaction of the DWER and City of Busselton. • Earthworks (and possibly use of fill) to provide adequate separation between groundwater and finished lot levels. Required separation distance will be agreed with City of Busselton.
Flood Management	• To provide flood protection to developed areas. • Protect downstream areas from flooding and erosion.	• Maximise infiltration opportunities. • Runoff from lots to be infiltrated on site consistent with CoB (2015) guidelines, using soakwells or similar infiltration devices. • Where possible, stormwater runoff within road reserves generated from the first 15 mm of rainfall shall be retained using techniques such as soakwells, open based manholes, vegetated swales, or shallow depressions. • Overflow of runoff from larger rainfall events, to the regional drainage system, shall be by overland flow paths. This flow may be permitted to enter wetlands subject to the pre development hydrologic regime of the wetland not being altered. • Attenuation of rainfall runoff rates post development to the rates which presently discharge from the Study Area. • Finished lot levels to be 0.3 m above the 1% AEP (100 year ARI) flood level for the local stormwater drainage system, and 0.5 m above the 1% AEP flood level for regional flooding (Vasse and Sabina Rivers).
Water Quality Management	• Provide improved water quality management compared to existing land use. • Improved management of existing wetlands.	• Water quality targets are to be based on predevelopment monitoring data, DoW (2010) and ANZECC (2000a). • Retain and restore natural drainage lines and valuable ecosystems such as natural channels, wetlands and riparian vegetation. • Minimise pollutant input to surface water and groundwater by the use of a treatment train approach including source control techniques, infiltration, and WSUD BMP's. • Contribute toward improving water quality and reducing nutrient input to the Vasse-Wonnerup Estuary. • Infiltrate or treat first 15 mm of rainfall at source (or close to). Maximise infiltration potential. • Post development monitoring and reporting for compliance and informing future stages.
Water Supply and Conservation	• Minimise the use of potable water where drinking water quality is not essential. • Apply waterwise landscaping measures to open space areas to reduce irrigation demand.	• Adopt waterwise practices to reduce water demand. • Support and encourage the use of water efficient fixtures and fittings and rainwater tanks. • POS landscaping based on waterwise principles. • POS irrigation to be supplied via Yarragadee aquifer. • Lot scale landscaping packages to be based on waterwise landscaping principles. • Ensure that evaporative water loss from artificial lake surfaces is managed within the total water budget. • Minimise the use of potable water where drinking water quality is not essential, particularly ex-house use.

4. PROPOSED DEVELOPMENT

The proposed Structure Plan for Provence is shown in Figure 2 and covers lots 2, 203, 9021, 9029 and 501 (excluding currently developed portion of site). Total area of the Structure Plan is 248 ha.

The proposed Structure Plan is a revision of the current approved Development Guide Plan (RPS, 2011). In the revised Plan the location of the retail / commercial area and primary school has been adjusted.

The proposed Structure Plan has approximately 1,500 lots to the east of the currently developed area, with an average lot size of 500 m^2.

Key elements of the Structure Plan related to urban water management include:

- Use of distributed POS areas for stormwater detention and treatment;
- Swales located within central median of distributor roads for conveyance and treatment of road runoff;
- Lot scale infiltration for at source management of small rainfall events; and
- Subsoil drainage to manage groundwater levels.

5. DESCRIPTION OF STUDY AREA

5.1 Location & Land-use

The Study Area is located on the Swan Coastal Plain approximately 4 km south-east of the Busselton townsite, and approximately 230 km south of Perth. The location of the Study Area is shown in Figure 1.

The Study Area is approximately 289 hectares in size and is located within the Busselton Airport Structure Plan Area (Chappell & Lambert, 1998). It is generally bounded by Bussell Highway to the north and Vasse Highway to the west.

The Study Area has been partly developed, consistent with the currently approved DGP (RPS, 2011) and WMS (JDA, 2008). The remainder of the site is predominantly cleared and is currently pasture used for grazing, with isolated pockets of vegetation (Figure 3, Plate 5). Prior to grazing, a large portion of the southern region of the Study Area was mined for mineral sands.

The Willow Grove subdivision, to the north-west of the Study Area, is also located in the Busselton Airport Structure Plan Area (Chappell & Lambert, 1998), and has been partly developed with lot sizes typically 2000 m^2.

5.2 Topography

The Study Area is generally flat and low-lying. Natural surface elevation is approximately 3.5 m AHD in the north increasing to approximately 7.0 m AHD in the south of the site as shown on Figure 4.

Across the northern section of the site a naturally occurring swale is present, falling towards the northeast.

In the southern section of the site a shallow ridge exists, with some sections above 7.5 mAHD at its eastern extent.

5.3 Climate

Busselton has a Mediterranean climate with warm dry summers and cool wet winters. The long term (1907-2018) average annual rainfall at the Bureau of Meteorology's Busselton Shire Station (009515), located approximately 5 km east of the Study Area, is 813 mm.

The average rainfall for Busselton Shire Station has decreased significantly since 1975, with the average annual rainfall of 722 mm, reflecting an 11% reduction compared to the long-term average (Figure 5). This is consistent with decreasing rainfall across south-west Western Australia (DoW, 2015).

The rainfall distribution throughout the year has also altered since 1975, with a reduction of average monthly rainfall in the winter months (Figure 5). November rainfall has increased slightly compared to the long-term average. However, the remainder of the summer months is similar to the long-term average.

The average annual pan evaporation is approximately 1100 mm (Luke *et al.*, 1988). Monthly pan evaporation is shown in Figure 5.

5.4 Geology

Figure 6 shows the surface geology at the site.

The surface of the site is mapped as being predominantly medium to coarse grained sands derived from Tamala Limestone (approximately 800 m wide strip). A 400 m wide strip of Tamala Limestone extends along the northern western boundary, a 50 m strip of clayey peaty sand and a 200 m wide band of fine sandy silts (Guildford Formation) extends along the southern boundary, parallel to the coastline.

5.5 Regional Hydrogeology

The superficial formations present at the Study Area are the Guildford Formation and Tamala Limestone (Hirschberg, 1989). Tamala Limestone occurs in the north of the site and the Guildford Formation in the south (Figure 6). The superficial formations are between 6 m (Guildford Formation) and 15 m (Tamala Limestone) in thickness.

A continuous unconfined groundwater aquifer extends beneath the Study Area within these formations. This aquifer has a saturated thickness of generally 5 m or less, and a shallow water table with a seasonal variation in elevation of between 0.5 m and 2 m (Hirschberg, 1989).

Recharge is by direct rainfall infiltration and upward discharge from the underlying Leederville Formation.

The groundwater flows north towards the coast where it discharges over a salt-water wedge into the ocean. Evaporation is likely to be substantial due to the shallow water table (Hirschberg, 1989). Groundwater discharge also occurs to the Vasse Wonnerup Estuary and tributary drains.

The Leederville Formation underlies the superficial formation (Hirschberg, 1989). Beneath the Study Area it has a thickness of about 150 m. It consists of generally fine to medium-grained quartz sandstone and interbedded grey shale, which form a multilayered, confined aquifer. Individual beds are usually up to 5 m in thickness and are not persistent (Hirschberg, 1989).

Recharge to the Leederville Formation aquifer occurs by direct infiltration of rainfall on the Blackwood Plateau (outside of the Study Area) and by downward leakage from the superficial formations (also outside the Study Area). Groundwater flow is north towards the coast. Discharge occurs offshore and also, due to an upward hydraulic gradient, by upward leakage to the superficial formations (Hirschberg, 1989).

The Yarragadee Formation underlies the Leederville Formation beneath the Study Area. It consists predominantly of medium to coarse grained sandstone and shales of Late Jurassic age (Hirschberg, 1989).

5.6 Groundwater

In Sections 5.6.1 to 5.6.3 below the calculation of the existing pre-development average annual maximum groundwater level (AAMGL) for Provence is detailed. Calculations are based on field investigations conducted by JDA over a period of 2 years from November 2002 to October 2004. This is the AAMGL calculation from the Provence DNMP (JDA, 2005) and the Provence WMS (JDA, 2008).

In Sections 5.6.4 and 5.6.5 the data record of the two DWER monitoring bores (18s and 19s) with long-term time series is examined to provide an assessment of maximum groundwater levels and seasonal variation.

In Section 5.6.6 the estimated AAMGL values are compared to the monitor bore time series record collected from 2005 to 2011, with an assessment made as to any required adjustments to values.

In Section 5.6.7 groundwater quality data is discussed.

5.6.1 Groundwater Level Data

On 11 November 2002, 4 February and 5 February 2004, JDA installed a total of 19 groundwater monitoring bores (labelled BA1 to BA8, & BA11 to BA21) by 75 mm hand auger within the Study Area (Figure 7). These bores consisted of 50 mm PVC capped at both ends and slotted for the lower 1 m. Natural surface and top of casing levels were surveyed to Australian Height Datum (mAHD) by McMullen Nolan and Partners Surveyors (MAPS). Lithological logs for the bores are presented in Appendix D, showing typically sand overlying limestone in the northern region of the Study Area, and sandy clays evident along the southern boundary.

The DWER superficial aquifer bores located nearest to the Study Area are bores 18s, located west of the Study Area adjacent to Vasse Highway near the entrance to the Willow Grove subdivision, and bore 19s located east of the Study Area (Figure 7). Both bores have long term record dating back to 1987 (Figure 8), although water level readings are recorded only twice yearly when water levels are near their seasonal maximum and minimum.

Water levels were measured in DWER and JDA bores on 8 occasions between November 2002 and October 2004 (Appendix E). The majority of this monitoring was undertaken fortnightly over winter 2004 as part of a comprehensive monitoring program to determine the Study Area AAMGL for the Provence DNMP (JDA, 2005).

Analysis of winter 2004 water level data indicated DWER bores peak at different times of the year to each other and show different seasonal variation (Figure 9). Bore 18s west of the Study Area had a seasonal variation of approximately 1.3 m with the groundwater level peaking at the end of August. Bore 19s east of the Study Area had a seasonal variation of approximately 0.9 m with the groundwater level peaking almost three weeks later in September.

Similar trends were observed for JDA bores which also showed different seasonal variation between bores located in the eastern and western regions of the Study Area (Figure 9).

5.6.2 Analysis of DWER Historical Bore Water Levels

Figure 10 shows a comparison of same day winter groundwater levels at bores 18s and 19s for the period of available data since 1987, including the JDA recording from 2004. This figure highlights the maximum water levels for DWER bores occur at different times of the year. It appears that Bore 18s peaks in August whereas 19s peaks in September or October by which time 18s has declined by approximately 0.5 m. Therefore DWER readings generally taken on the same day in September/October of bores 18s and 19s tend to underestimate the peak of 18s but are fairly close to the 19s peak.

The physical reasons for this are not fully understood but relate to the differing rainfall recharge regimes and sediments at the two bores.

For determining the AAMGL for the Study Area, DWER's winter water level readings are therefore not considered to be an accurate representation of winter maximum water levels, particularly for 18s.

Based on regression analysis of JDA data from 2004, estimates of maximum groundwater level for each year since 1987 are made by calculating an adjustment to apply to each DWER winter recording. This is calculated as a function of the timing of the DWER recording from the likely date at which the peak water level occurred. Calculations are shown in Appendix F. Figure 11 shows the estimated average maximum values calculated on this basis to be consistent with JDA recordings in 2004.

Based on the estimated average maximum values (Appendix F), AAMGL's for DWER bores 18s and 19s are calculated as 3.84 mAHD and 4.11 mAHD respectively (1987-2004).

5.6.3 Estimation of Existing AAMGL

Based on the above analysis, an AAMGL map for the Study Area is shown in Figure 12.

For the eastern region JDA bores, an adjustment of +0.28m was applied to the 2004 maximum winter readings to estimate the AAMGL. This was based on DWER bore 19s maximum in 2004 being 0.28 m below its AAMGL as calculated above.

For the western region JDA bores, an adjustment of +0.04 m was applied based on DWER bore 18s maximum in 2004 being 0.04 m below its AAMGL.

The AAMGL is shown as a depth to groundwater map for the Study Area in Figure 13. Depth to AAMGL varies, with groundwater at natural surface in some areas, ranging to a depth of 3 to 4 m near the eastern Study Area boundary.

5.6.4 Seasonal Groundwater Variation

The average annual lowest groundwater level (AALGL) for DWER bores 18s and 19s for the period from 1987 to 2004 are 2.53 mAHD and 3.16 mAHD respectively. Based on AAMGL values calculated in Section 5.6.2, these AALGL's indicate an average seasonal variation for bores 18s and 19s of 1.31 m and 0.95 m respectively.

Figure 14 shows the water level time series for 18s and 19s up to winter 2019. The plot shows both DWER and JDA measurements of the bores – these measurements are generally consistent.

For 18s, the time series 2006 – 2019 is similar to the pre-2005 plot (Figure 8) with no obvious trends in winter maximums or summer minimums. The higher maximum in 2013 is due to the higher rainfall received that year (see Figure 5). Therefore an estimated seasonal variation of 1.3 m is still considered to be representative.

For 19s, the time series 2006 – 2019 shows slightly lower water levels compared to the pre-2005 data. Examining the annual rainfall in Figure 5, annual rainfalls have been lower since 2005 (except 2013), and groundwater levels are correspondingly low. Seasonal variation for each year, however, is similar to pre-2005.

On this basis, seasonal variation of groundwater levels in the western region of the Study Area is estimated to be 1.3 m compared with 1.0 m in the eastern region.

5.6.5 Maximum Groundwater Levels

Historical records (Figure 14) for DWER bores 18s and 19s show both these bores with a highest maximum recorded groundwater level approximately 0.39 m (at 4.23 mAHD) in 2013 and 0.70 m (at 4.81 mAHD) in 1996 respectively above their AAMGL's. The October 2009 water level in 19s has not been used as it is not consistent with JDA measurements and appears to be an erroneous (possibly by 1 m).

Given the 28 years of historical record for these bores, the highest maximum level is estimated to have a recurrence interval of 28 years.

5.6.6 Assessment of Groundwater Regime (post-2005)

Since the AAMGL was estimated in 2004, there has been (mostly) monthly monitoring of groundwater levels by JDA from 2005 to 2011, see Figures 15 and 16. Also plotted is the AAMGL based on 2004 data. Over this period there has been a significant variation in annual rainfall (Figure 5). Rainfall in 2005 was slightly above the long-term average, while 2006 and 2010 were significantly below average. Rainfall in 2007 was similar to the shorter term (1975-2015) average. Rainfall in 2008, 2009 and 2011 was below the shorter term average rainfall.

<u>BA4 (referring to Figure 16 showing western bore data)</u>

Monitor bore BA4 has a good continuous data record from winter 2005 to late 2011. The bore is located away from any development to date and so is not impacted by any change in land-use. Peak groundwater levels occurred in winter 2005 and winter 2009, with values slightly higher than the estimated AAMGL. While rainfall in 2005 was relatively high, 2009 wasn't particularly wet. Rainfall in 2006 and 2010 was very low, and so winter peaks in these years were low and groundwater levels in the following summer were lower than usual. Based on observed time series data a revised AAMGL of 5.0 mAHD is recommended.

BA5

Monitor bore BA5 has an interrupted data record with little data recorded after 2006, except for winter 2009. Water levels that have been recorded seem to suggest that the estimated AAMGL of 3.14 mAHD is reasonable.

BA6

Monitor bore BA6 has a good data record for winter months, however the bore dries out during summer months, preventing minimum level readings. The data that has been recorded indicates that the estimated AAMGL of 3.01 mAHD is reasonable.

BA14

Monitor bore BA14 has a reasonable data record, however winter peaks in a number of years are not necessarily recorded. The data collected are all below the estimated AAMGL of 3.87 mAHD and so no change is made to this estimate.

BA15

Monitor bore BA15 also has a good record for winter months, but also dries out during summer months. Groundwater levels in 2005 and 2011 are similar to the 2004 estimate of AAMGL. A slightly increased value of 3.0 mAHD is suggested.

In the western section of the Study Area, monitor bore BA1 (Figure 16) dries out during the late summer months, so summer minimum values are not picked up. Winter maximums in 2005, 2008 and 2009 are similar to the estimated AAMGL. A slight increase in AAMGL to 3.1 mAHD has been made.

BA3 (referring to Figure 15 showing eastern bore data)

Monitor bore BA3 is located at the eastern extent of the current development. In 2009 the bore was reinstalled approximately 100 m south of its original location. The reinstalled bore is located within POS adjacent to Sunflower Turn and Lavender Garden. Groundwater levels in winter from 2009 onwards are similar to the 2004 estimated AAMGL. Levels in the reinstalled bore may be slightly higher than the original due to the bore being located up-gradient. Levels may also be higher due to restrictions on the outlet of the subsoil system, resulting in slightly higher groundwater levels.

BA7

Monitor bore BA7 is located at the western extent of the currently developed area of Provence (Figure 16). Except for a period during late 2008 and early 2009, the data record is generally good. All recorded data is less than the estimated AAMGL, and appears to suggest that the estimate of 5.06 mAHD is reasonable.

BA8

Monitor bore BA8 has a good data record, with similar peak levels each year – annual rainfall does not appear to have much effect on peak levels. Water levels that have been recorded seem to suggest that the estimated AAMGL of 5.89 mAHD is reasonable.

BA17

Monitor bore BA17 is located in the western area, adjacent to a surface water flow path (Figure 16). Peak groundwater levels are constrained by natural surface, also so winter levels are similar across the 2004 to 2011 monitoring period. The estimated AAMGL of 4.36 mAHD is therefore reasonable.

BA21

Monitor bore BA21 is located in the south-western corner, and is also adjacent to a flow path, and so winter groundwater levels are constrained by natural surface and consistent across the 2004 to 2011 period. The estimated AAMGL of 5.84 mAHD is therefore reasonable.

The data for the eastern bores appears to suggest that the seasonal variation of the above bores would appear to be 1.0 m, which is similar to the variation found in 19s (1.0 to 1.2 m).

In general the data collected between 2005 and 2011 confirms the AAMGL estimated from 2004 data. A slightly modified AAMGL is shown in Figure 17. The monitor data also confirms seasonal variation across the site, with approximately 1.0 m in the eastern bores, grading to 1.3 m in the western bores.

5.6.7 Groundwater Quality

Predevelopment groundwater water quality sampling was initially undertaken in November 2002 and 6 February 2004, with a more regular program of quarterly monitoring since September 2005. Monitoring sites were selected based on obtaining coverage across the Study Area and to provide a representation of groundwater quality at both upstream and downstream boundaries.

Water quality data for the Study Area is contained in Appendix G with results summarised in Table 4 below. This summary is based on monitoring data collected to 2011.

For pH, mean and median are similar, and the quartiles indicate most data is between 6.7 and 7.3, indicating the groundwater is not significantly acidic or alkaline.

EC and TDS shows significant differences between mean and median values, indicating the impact the high outliers have on the mean values. High values primarily occur at BA21, located to the south-west of the Study Area.

For nutrients, groundwater is similar to other areas which have been used for pasture and grazing. In the Provence WMS (JDA, 2008) targets were provided for TN, DIN, TP and DIP – these were 8.9, 6.9, 0.29 and 0.04 mg/L respectively.

Total Nitrogen is generally less than the target value (mean, median and 75th quartile all below the target). BA8 had several elevated TN concentrations during 2010 and 2011, however a concentration of 100 mg/L in July 2011 is likely to be a sampling error. Similarly DIN is generally less than the target value, and is similarly affected by elevated NO_x in July 2011.

Concentrations of TP and DIP are also mostly below the target value, with mean, median and 75th quartile below the target value.

These results reflect the impacts of the historical land use of the Study Area.

TABLE 4: GROUNDWATER QUALITY DATA SUMMARY

Parameter and Unit	Study Area Monitoring Results June 2002- October 2011						
	Total Samples	Minimum	Maximum	Median	Mean	25th Quartile	75th Quartile
pH	135	5.81	8.90	7.10	7.06	6.77	7.30
EC (mS/cm)	136	0.04	17.63	1.81	4.08	1.08	7.66
TDS (mg/L)	15	225	11,000	1,100	2,864	479	4750
Ammonia–N (mg/L)	109	0.005	2.70	0.10	0.23	0.03	0.26
NOx (mg/L)	107	0.005	82.00	0.53	5.05	0.07	6.35
TKN (mg/L)	117	0.05	26.00	2.10	3.28	0.91	3.40
Total N (mg/L)	149	0.25	100.00	3.00	7.99	1.68	6.88
DIN (mg/L)	115	0.015	82.03	0.84	4.92	0.27	5.33
FRP (DIP) (mg/L)	65	0.005	0.64	0.010	0.036	0.005	0.03
Total P (mg/L)	142	0.01	3.10	0.14	0.22	0.06	0.23
As (mg/L)	8	0.001	0.073	0.002	0.011		
Cd (mg/L)	8	0.002	0.010	0.002	0.004		
Cr (mg/L)	8	0.010	0.010	0.010	0.010		
Cu (mg/L)	8	0.010	0.010	0.010	0.010		
Hg (mg/L)	8	0.0002	0.0004	0.0002	0.0003		
Ni (mg/L)	8	0.010	0.020	0.010	0.011		
Pb (mg/L)	8	0.010	0.010	0.010	0.010		
Zn (mg/L)	8	0.010	0.030	0.010	0.014		
Fe (mg/L)	9	0.02	3.90	2.00	1.80		

Note: where parameter values are less than limit of detection, limit of detection used for calculation purposes.

5.6.8 Water Resources

The Department of Water and Environmental Regulation manages the groundwater of the State under the Rights in Water and Irrigation Act 1914 (RIWI Act). The Study Area is located within the Busselton-Capel Groundwater Management Area and the South West Groundwater Areas Allocation Plan sets out the allocation limits (DoW, 2009a).

Department of Water and Environmental Regulation groundwater allocation limits and remaining available abstractions from the relevant aquifers in the Busselton-Capel and Busselton-Yarragadee sub-areas as at 08 November 2019 is described below:

- In the Superficial aquifer the total allocation is 6.74 GL/yr, of which 0.77 GL/yr is available;
- In the Leederville aquifer the total allocation is 10.0 GL/yr, of which 0.90 GL/yr is available and 1.78 GL/yr requested; and
- In the Yarradagee aquifer the total allocation is 27.6 GL/yr, of which 0 GL/yr is available.

While a significant amount of water is available in the superficial aquifer, water is generally difficult to abstract in large volumes in many areas due to the nature of the soils.

East Busselton Estate Pty Ltd currently has a licence to abstract 168,300 kL (GWL157168(3)) from the Yarragadee aquifer for irrigation of POS (Appendix I).

5.7 Acid Sulphate Soils

According to published mapping, Provence is generally classified as having a moderate to low risk of Acid Sulphate Soils (ASS) occurring less than 3 m from the surface (DEC, 2010), see Figure 22.

Across the northern section of the site is a band which is classified as having a high to moderate risk of ASS occurring less than 3 m from the surface. This coincides with the location of the natural swale.

Where the environment is not generally suitable for ASS formation or where ASS is highly localised or sporadic, it has been classified by DEC (2010) as having moderate to low risk of occurrence. Where ASS is present, it may be close to the surface or buried by many metres of alluvium or windblown sand, and most of these landforms are not expected to contain ASS (WAPC, 2003).

Site-specific investigations at Provence have been performed by ATA Environmental (ATA, 2006).

An ASS Management Plan has been prepared for the site (ATA, 2006; Coffey, 2010). The scope of work comprised the following:

- Collection of soil samples at 15 sample locations spaced on a 500 m grid within the "Moderate to Low" ASS risk areas;
- Collection of soil samples at 28 sample locations spaced on a 50 m grid within the "High" ASS risk area;
- Analysis for all soil samples collected using the field testing procedure for ASS;
- Laboratory analysis of selected soil samples;
- Installation of groundwater monitoring wells at 7 of the soil sample locations;
- Collection and analysis of one round of groundwater sampling to assess water quality; and
- Preparation and submission of a Detailed Site Investigation report (DSI) (ATA, 2006).

ATA (2006) found the following:

- Soil results indicate that there is PASS at 24 sites, generally at 0 – 1.5 m and 4 – 5 m depths, and soils with maximum potential acidity concentrations above the ASSMP trigger values were encountered in all of the soil horizons that were logged; and
- Groundwater results indicate water quality is consistent with regional superficial aquifer water quality. EC, pH and TDS are within normal range (<1.5 mS/cm, 6.8-8.0 and <1100 mg/L respectively). While nutrients are high, they are consistent with the land-use of pasture and cattle grazing. The chloride/sulphate and alkalinity/sulphate ratios suggest that groundwater might have been affected by oxidation of sulphides, however as all bores have pH much greater than 5, aluminium concentrations are below 1 mg/L and alkalinity concentrations are high, groundwater vulnerability to acidification is classified as "lop".

And concluded the following:

- Acid soils will require soil management with treatment and verification testing; and
- Groundwater quality beneath the site may be impacted by dewatering (lowering of pH or increased metals concentrations). Proposed dewatering treatment systems have been designed to treat low pH waters. Monitoring will be required.

5.8 Surface Hydrology

5.8.1 Regional Setting

The Study Area represents approximately 0.4% of the 96,000 ha catchment of the Vasse Wonnerup Estuary, which includes the catchments of the Ludlow, Abba, Sabina, Vasse and Buayanyup Rivers and Locke Swamp. It forms part of the Geographe Bay catchment which has total area of 204,700 ha.

Based on 0.1 m surveyed contours within the Study Area (MAPS, 2002) and 0.5 m contours outside via DWER floodplain maps, the Study Area is defined as partly draining towards the Lower Vasse River subcatchment (*Vasse3* in Figure 23) and partly to the Sabina River subcatchment of the Vasse Wonnerup Estuary (*Sabina4* in Figure 23).

The drainage of part of the Study Area toward the Sabina River subcatchment is contrary to previous planning studies, including the Busselton Airport Structure Plan (Chappell and Lambert, 1998), which shows all of this area draining towards the Lower Vasse River in a south-westerly direction.

The catchment divide between the Lower Vasse River subcatchment and Sabina River subcatchment is located near the boundary of the Willow Grove subdivision (Figure 24). The linear depression behind the Willow Grove subdivision flows in a south-westerly direction before travelling along the boundary of the Sir Stewart Bovell Sporting Complex (Plate 1) and then toward Bussell Highway (Graeme Jones, City of Busselton, pers comm).

5.8.2 Local Catchments Runoff

The main existing drainage channel of the Sabina River sub-catchment is a broad shallow depression (Plate 2) that is not well defined through much of the Study Area. Ponded water observed in the channel during field investigations undertaken by JDA in November 2002 and August-October 2004 is considered to be groundwater rather than surface water.

Along the northern boundary of the Study Area there are a number of culverts located below Bussell Highway. These culverts receive runoff from Bussell Highway, which are infiltrated in swales contained within the road reserve. No external catchment drains into the Study Area along this boundary.

Drainage from the Willow Grove subdivision located west of the Study Area drains either to a compensating basin located adjacent to the Bussell Highway road reserve (Plate 3), or to the linear depression along its southern boundary (Graeme Jones, City of Busselton, pers comm). It is understood the capacity of the compensating basin adjacent to the Bussell Highway road reserve has been increased with further development of Willow Grove. Catchment boundaries for the Willow Grove area, as provided by the City of Busselton, are shown in Figure 23.

The existing lake (Plate 4) located centrally along the southern Study Area boundary, is a man-made water table lake and currently has no external surface water catchment. It is generally referred to as “Footprint Lake” or “Iluka Lake”.

Downstream of the Study Area in Reincourt is a low-lying linear natural swale (with some modifications by landowners) running south-west to north-east through Provence to the Sabina River. Figure 25 shows a zoomed-in plan with spot heights providing detail of the flow constraints formed by the topography. This area is of concern to CoB and DWER, with discussions with these agencies held in 2015 and since then. A more detailed study of this area has been performed, as discussed below.

There are a number of high points within the swale, shown as TC points on Figure 25, which do not appear to culverts. The high points tend to be crossing points across the swale. There may be additional low flow culverts in place which are not observable from roads or aerial imagery. The flow path between Bussell Hwy and the Sabina River is all within private landholding, with no drainage reserve present. In addition to the shallow gradient of the swale, these high points are an additional constraint upon flow.

The City of Busselton does not have as-constructed information for existing local authority drainage downstream of the Study Area (Jim McFarlane [City of Busselton], pers comm). Similarly Main Roads WA were unable to provide any information regarding design flow estimates used for calculation of culvert crossings for Vasse Highway and Bussell Highway (Jerome Goh [Main Roads WA], pers comm).

DWER floodplain mapping of the Vasse-Wonnerup system is based on the *Busselton Regional Flood Study* (WAWA, 1987). The 100 year ARI (1% AEP) Flood Level of the Vasse-Wonnerup Estuary from WAWA (1987) is 1.35 mAHD and assumed no inflow from the Vasse Diversion Drain. Further modelling in WAWA (1987) considered the consequence of blocking-off either the Wonneup or Vasse surge barriers and thereby forcing flow from the Estuary through the remaining barrier. Blocking of the latter producing a

peak flood level of 1.50 mAHD, of which the designed flood level in DWER floodplain mapping appears to be based on. The *Busselton Regional Flood Study Review* (JDA, 1998) provided a similar level flood level of the Estuary.

A MIKE 11 model was created of the lower Vasse and Sabina Rivers and the Vasse-Wonnerup Estuary as part of the *Reconnecting Rivers* project (DWER, 2018). The model was calibrated using logger data from the Vasse and Wonnerup surge barriers between 2004 and 2014. The modelled 1% AEP design flood level of the Vasse-Wonnerup Estuary was 1.45 mAHD; consistent with previous modelling of the Vasse-Wonnerup system.

Impact of sea level rise on water levels within the estuary is considered in Section 5.8.5 below.

5.8.3 Peak Flow Estimates

Previous versions of this LWMS adopted broadacre runoff coefficients based on site inspections and calibration to known flood events from the region contained in the Busselton Regional Flood Study (JDA, 1998).

In discussions with City of Busselton and DWER, the area downstream of Provence between Bussell Hwy and the Sabina River, Figure 25, was identified as subject to regular flooding and inundation. Point TC1 is the highest constraint in the downstream system, at 3.28 mAHD, although visual inspection of this local showed a channel through this high point in the LiDAR. The culverts at Bussell Hwy have an invert level of 2.9 mAHD. The impact of that high point is seen in aerial imagery from winter 2018, showing winter inundation, particularly upstream from TC1 (Figure 26).

The City and DWER required assurances that the Provence development does not further exacerbate the downstream flooding.

On this basis, the catchment within Provence, down to the Sabina River, was remodelled for pre-development conditions to determine flow constraints to discharge at the Bussell Hwy culverts.

Given the topographic complexity of the path between the highway and the river, a 2D flow model was developed using the LiDAR data for the undeveloped portions of the catchment and pre-development ground elevation data for the developed portions. A rain on grid approach was taken, with runoff characteristics consistent with modelling in previous versions of this LWMS and detailed in Table 5 below. Flood levels for the 1% AEP and 20% AEP events for the Sabina River downstream were based on JDA (1998), with values of 2.25 mAHD and 1.90 mAHD, respectively.

TABLE 5: PRE-DEVELOPMENT CATCHMENT DATA

	Vasse River		Vasse Estuary		Sabina River
	VRa	VRb	VEa	VEb	SR
Catchment Data					
Total Catchment Area	70.1	225.8	12.1	19.6	101.9
Rural (ha)	39.8	218.9	12.1	17.0	90.7
R2.5/R5 (ha)	2.2	0.0	0.0	0.0	0.0
Native Vegetation	28.1	0.0	0.0	2.6	11.2
Dam (ha)	0.0	6.9	0.0	0.0	0.0
Catchment Slope (%)	0.2	0.2	0.3	0.1	0.35
63% AEP (1 Year) Runoff Rate (%)	16	19	20	19	19
20% AEP (~ 5 Year) Runoff Rate (%)	20	27	28	26	26
10% AEP (10 Year) Runoff Rate (%)	21	29	30	27	28
1% AEP (100 Year) Runoff Rate (%)	24	34	35	32	32

Notes: 1. Runoff rates presented are averages based on each land use.

Flood water depth for the 5 and 100 year ARI (~ 20% AEP and 1% AEP) storm events are shown in Figures 27 and 28. In the 1% AEP, the water level on the upstream side of Bussell Hwy is 3.55 mAHD, a water depth of 0.65 m at the culvert.

Figure 29 presents the flow hydrographs at Bussell Hwy for the 1% and 20% AEP events. Also included is total flow volume through the culverts. Flow criteria is as follows:

- The peak flow for the 1% AEP is 0.492 m^3/s and the total flow volume is 35,600 m^3.
- The peak flow for the 20% AEP is 0.10 m^3/s and the total flow volume is 6,500 m^3.

These rates and volumes will be used as the criteria for the post-development modelling.

5.8.4 Water Quality

Surface water monitoring (Figure 30) has been performed from November 2005 to October 2011, when flowing. Results of the sampling is presented in Table 6, with data in Appendix G.

Guideline trigger values for protection of aquatic ecosystems in south-west Australia based on Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000a) are also shown in Table 6. Note that ANZECC trigger values are derived from ecosystem data for unmodified or slightly-modified ecosystems, and are not based on any objective biological criteria, and ANZECC (2000a) recommends they should only be applied where site-specific values do not exist or until site-specific values can be derived.

Data in Table 6 is also compared to DWER water quality data analysed by JDA for the period 2001 to 2006.

Table 6 also provides a comparison of monitoring data from the Study Area with Australian Runoff Quality (ARQ, Institution of Engineers Australia, 2006) mean stormwater concentration estimates for Australia, and typical mean concentrations of urban runoff on the Swan Coastal Plain based on local data (Martens *et al.*, 2004). Post-development stormwater quality for the Study Area is considered likely to similar to Martens *et al.* (2004).

Stormwater runoff quality from future urban development within the Study Area will therefore be better than ARQ mean stormwater concentration estimates for Australia and DWER water quality monitoring results for nutrients in the Lower Vasse River from 1996-2000.

Martens *et al.* (2004) found vertical leaching of fertiliser to the groundwater table at the domestic scale rather than local authority drainage stormwater system to be the major pathway for nutrients to groundwater on the Swan Coastal Plain. Based on predevelopment monitoring data, this is considered likely to be the case for Provence. Analysis of the likely impact of land use change on groundwater quality is assessed in Section 6.6 on the basis of comparing nutrient inputs for existing and proposed development.

For pH, observed data was consistent with ANZECC (2000a) guideline values, and very similar to the Lower Vasse and Sabina site data. EC is significantly higher than the ANZECC guidelines. TSS is generally lower than the data from the Lower Vasse and Sabina sites and the ARQ values.

Nitrogen species are generally higher than the ANZECC (2000a) guideline levels but are similar to the Lower Vasse and Sabina site data. Total phosphorus and FRP are also higher than the ANZECC (2000a) guideline values, but generally lower than the Lower Vasse and Sabina sites and ARQ.

TABLE 6: SURFACE WATER QUALITY DATA SUMMARY

Parameter and Unit	ANZECC Guideline Values [1]	DoW 2001-2006 [2]	ARQ (IEAust 2006)	Martens *et al* (2004)	Study Area Monitoring Results November 2005 - October 2011						
					Total Samples	Min	Max	Median	Mean	25th Quartile	75th Quartile
pH	6.5-8.0	7.57	6.8	7.0	36	6.4	8.9	7.47	7.49	7.08	7.77
EC (mS/cm)	0.12-0.30	-	-	0.6	34	0.66	2.67	1.15	1.29	0.98	1.60
TSS (mg/L)	-	32	52	-	39	1	43	4	8.3	1	10.5
Turbidity					34	0.6	24.4	5.3	7.2	2.6	9.6
NH_3–N (mg/L)	0.08	3.1	-	-	34	0.005	0.91	0.062	0.119	0.02	0.11
NOx (mg/L)	0.15	0.81	-	-	28	0.005	3.1	0.033	0.25	0.005	0.15
TKN (mg/L)	-	3.1	-	-	37	0.21	4.1	1.8	1.7	0.97	2.3
DIN (mg/L)	-				35	0.008	3.12	0.085	0.32	0.041	0.35
Total N (mg/L)	1.2	2.2	2.7	1.1	41	0.24	4.1	2.1	2.05	1.1	2.7
FRP (mg/L)	0.040	0.12	-	-	31	0.005	0.38	0.035	0.072	0.02	0.0935
Total P (mg/L)	0.065	0.31	0.29	0.21	31	0.01	1.1	0.15	0.21	0.08	0.24

1. Values adopted for Lowland River, South West Australia. ANZECC (2000a) trigger values for freshwater for a 95% level of protection (slightly to moderately disturbed ecosystem)
2. Based on JDA analysis of DWER data for Lower Vasse River and Sabina River sites (refer Appendix G). Note all sites not measured for full suite of nutrients on same day, hence sum of nutrient components for TN do not equate. TN not measured on days with elevated Ammonia - actual TN therefore higher than component parts in above table.
3. Lower Vasse River is sometimes brackish with EC to 3.3 mS/cm.

5.8.5 Impact of Sea Level Rise

SPP 2.6 (WAPC, 2013) provides guidance for decision making within coastal areas and ensures that development takes into account coastal processes and hazards and climate change. SPP 2.6 encourages urban development to be concentrated in and around urban settlements.

In relation to SPP 2.6, *Sea Level Change in Western Australia, Application to Coastal Planning* (Department of Transport [DoT], 2010) reviews current (to 2009) information on mean sea level variation along the Western Australian coastline, including the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) and additional work by CSIRO (2007) of local variations around the Australian Coastline. The Fifth IPCC Assessment Report was published in 2014, with the Sixth Assessment Report due in April 2022.

DoT (2010) recommends that as estimates of global CO_2 emissions since 2004 (to 2009) have approximated the fossil fuel intensive A1F1 scenario and there is significant uncertainty in future planning, the A1F1 scenario, representing the 95% percentile, provides the best available precautionary trend for future global emissions.

DoT (2010) recommends the A1F1 scenario vertical sea level rise of +0.3 m to 2060 and +0.9 m to 2110 be adopted for assessing the impact of coastal processes over a 100 year planning timeframe.

While flow between the Vasse-Wonnerup system the ocean is controlled by a surge barrier, future operation (with sea level rise) of the barrier is unknown.

The Vasse-Wonnerup Estuary is listed under the 1990 Ramsar Convention (WRM, 2007) for its significant waterbird population and breeding habitat for the Black Swan and provides significant economic benefits for the region from grazing on the southern banks of the Estuary. Although future operation of the barriers is not known, JDA considers it likely that the operation of the surge barriers will, in the short term at least, be maintained at their current level of operation, and remain functional in controlling water levels within the

Estuary to support both waterbird breeding habitat and limit inundation and salinity ingress to the low lying grazing land.

With the surge barriers providing protection during storm events, water levels in the Vasse-Wonnerup Estuary are estimated to match predicted sea level rise, thus for the 1% AEP event, for 2070 an estuary water level of 1.85 mAHD is predicted, and 2.35 mAHD for 2110.

As described in Section 5.8.2 above, the proposed Provence subdivision discharges under Bussell Hwy and flows north east to the Sabina River. In the modelling a 1% AEP water level of 2.25 mAHD was used in the Sabina River at the confluence, based on a level of 1.45 mAHD in the Estuary.

With a rise in level in the Estuary (due to sea level rise), there will be a rise in level at the confluence point in Sabina River. There will be a transition zone between the Estuary and further upstream Sabina River (where river hydraulics fully determine flood levels, and downstream water level has no impact). In this transition zone, the change in flood level will be less than that seen in the Estuary. Modelling of the Sabina River with varied Vasse-Wonnerup Estuary levels would be required to accurately estimate flood levels in the transition zone.

Notwithstanding the absence of flood levels for sea level rise conditions, observations about potential impact can be made based on topographic constraints.

For the 2070 case, there is a predicted 0.4 m rise in the Estuary. Although the rise in flood level at the confluence will be less than this, as an upper limit, this would see a level of 2.65 mAHD at the confluence (2.25 + 0.4). Based on the topographic constraints between Bussell Hwy and Sabina River (Figure 25), there are a number of topographic high points upstream of the confluence which will exert a greater influence at Bussell Hwy.

For the 2110 case, there is a predicted 0.9 m rise in the Estuary. Again, the rise in flood level at the confluence will be less than this, however as an upper limit, a level of 3.05 mAHD (2.25 + 0.9) at the confluence may be considered. Again, there are several topographic constraints which will impact on upstream flood levels (noting again that flood level rise will be less than 0.9 m).

Therefore it is estimated that the impact of sea level rise on storm water systems will be negligible.

5.9 Wetlands

The Department of Environment and Conservation's (DoEC) Geomorphic Swan Coastal Plan Wetlands dataset locations and boundaries are shown in Figure 31. Wetlands within the Study Area are classified as follows:

- Palusplain - sustainable use, multiple use (M)
- Dampland - sustainable use, multiple use (M)

Less than 20 % of the Study Area is classified as a Multiple Use wetland, and no Conservation Category Wetlands (CCW's) or Resource Enhancement wetlands exist within the Study Area. The narrow area of dampland through the central Study Area is the existing main drainage channel. Existing wetlands are highly degraded, unfenced to cattle access, and without fringing vegetation.

The Vasse-Wonnerup estuarine system, located north of the Study Area is of considerable social and ecological importance. It is listed under the Ramsar Convention as a wetland of International Importance due to its significance as habitat for water birds, and is an important fish habitat supporting commercial and recreational fisheries taking place within Geographe Bay. The wetlands represent the most nutrient enriched water bodies in the south west of Western Australia (EPA, 1989), consequently water quality in the system is degraded and frequent algal blooms and fish deaths in the area have become important

issues for management and the community. Two main problems are nutrient enrichment and deoxygenation of water.

Geocatch, the DoEC, and the City of Busselton have developed a Lower Vasse River Cleanup Program to improve the ecological health of the lower Vasse River, to which part of the Study Area discharges.

The Vasse Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan (DoW, 2010) seeks to manage and improve water quality being discharged to the Vasse-Wonnerup estuarine system.

6. LOCAL WATER MANAGEMENT STRATEGY

6.1 Proposed Water Management System

An integrated approach to stormwater management is fundamental to water sensitive urban design.

The proposed water management system for Provence is consistent with water sensitive design practices and meets key LWMS objectives and criteria as detailed in Table 1.

It will consist of a series of pipes, swales, multiple use corridors, and basins to attenuate and infiltrate peak surface water flows from the proposed development prior to discharge from the Study Area. Basins are to be vegetated and located within POS areas and designated landscape buffers.

To address flood management, the stormwater drainage system will be designed using a major/minor approach to convey and detain stormwater. The minor drainage system is defined as the system of underground pipes, swales, kerbs, gutters etc. designed to carry and/or infiltrate runoff generated by low frequency ARI storms, typically less than 0.2 EY (5 year ARI). The major drainage system is defined as the arrangement of roads, drainage reserves and flood storage multiple use areas, planned to convey the stormwater runoff from extreme events which exceeds the capacity of the minor system.

Stormwater runoff generated by the impervious areas of the road reserve will be collected in gully or side entry pits with flow by a formal piped drainage system to multiple use corridors and flood storage multiple use areas located in each catchment. Where possible, roof drainage and road drainage will be connected to soakwells to promote at-source infiltration.

The use of infiltration basins for regional stormwater retention is generally not considered possible due to the proximity of the groundwater table to natural surface over a large proportion of the Study Area however opportunities for infiltration at individual basin locations will be assessed and maximised where possible.

Basins have been designed to contain runoff from the 1% AEP storm event, with basin discharge for the 0.2 EY and 1% AEP events designed to match estimated pre-development levels for protection of downstream environments. Subcatchments for each basin have been defined by existing topography and proposed cadastre and land use. Provision for overland flow paths within road reserves and Public Open Space to accommodate larger storm events will be provided at the subdivision stage.

Minimum separation between building floor levels and groundwater will be achieved by filling of house pads. Minimum building floor levels will have a 1.2m clearance above AAMGL/CGL or approved/negotiated alternative, and a 0.3 m clearance above the estimated 100 year ARI flood level.

The AAMGL/CGL will be maintained post development by installation and maintenance of subsoil drainage.

Water quality management will be achieved through a treatment train approach including the application of source controls, stormwater detention, and maximising infiltration opportunities.

It is proposed the existing lake located near the southern boundary (“Iluka” or “Footprint” Lake) of the Study Area will be retained within the development for landscape water source balancing storage, though it is proposed that the lake be reshaped. Exposure of the water table to evaporation by excavation for this lake will be offset by increased recharge through land use change and an emphasis on infiltration practices in the development area. The other lake (Almond Parkway Lake) is a lined lake, and is also used for irrigation storage. Part of the groundwater licence allocation is to replace water lost through evaporation from this lake

These permanent lakes will not receive stormwater inflow from frequent storm events (1 hour 1 year ARI).

6.2 Water Balance

The water balance of the site will be influenced by the frequency and intensity of rainfall and evapotranspiration. As the most reliable estimates of rainfall, evaporation, transpiration and recharge are at a regional scale, for the purpose of this water balance assessment average annual values have been assumed and Provence has been considered as a whole.

Pre-development Water Balance

The pre-development water balance assumptions are as follows:

- Rainfall-based on the long term annual average for Busselton Station of 722 mm;
- Approximately 30% of rainfall will recharge the shallow groundwater (Davidson & Yu, 2006);
- Groundwater flow has been estimated based on water table gradient, aquifer thickness and estimated hydraulic conductivity;
- Evapotranspiration for pasture is estimated to be 400 mm/yr;
- Evapotranspiration for native bush is estimated to be 400 mm/yr (Silberstein et al, 2007); and
- The balance of inputs is discharged as surface runoff.

Post-development Water Balance

Assumptions for the post-development water balance are as follows:

- Water supply for all POS irrigation will be met by local groundwater supplies. Irrigation rate of 6,750kL/ha/yr is assumed, consistent with DWER allocation;
- Evapotranspiration for residential / school areas is assumed to be 350 mm/yr (Silberstein et al, 2007);
- Evapotranspiration for buffer / passive POS, retained vegetation assumed to be 400 mm/yr (Silberstein et al, 2007);
- Evaporation from lakes assumed to occur as pan evaporation rate of 1,100 mm/hr (Luke et al, 1988);
- Groundwater recharge from rainfall for urban to be 40% with increase in infiltration;
- Surface runoff matches pre-development flows; and
- The balance of inputs will be discharged via sub-soil drainage.

Results of the water balance are presented in Table 7.

In pre development recharge to the shallow groundwater and evapotranspiration loss through the cleared, pasture areas are the main components of the balance. Groundwater flow is small, consistent with the shallow gradient and thin aquifer thickness.

For post development, there is a slight decrease in evapotranspiration losses with groundwater recharge estimated to remain constant. Subsoil discharge is estimated to be low – this is consistent with greater separation to groundwater for many areas (see Sections 6.4.2 and 6.5.3).

TABLE 7: SITE WATER BALANCE

Pre-Development		Use	Area (ha)	Quantity mm/yr		Total ML/yr	% (Approx)
Inputs	Rainfall		287	722		2.07	100
					Input total	2.07	
Outputs							
	Evapotranspiration	*Native Vegetation*	44	400		0.18	8.7
		Cleared Pasture	243	400		0.97	46.8
	Superficial aquifer recharge					0.72	35
	Surface Runoff					0.15	7.2
	Net Groundwater Outflow					0.05	2.3
					Output total	2.07	100
					Balance	0	

Post Development		Use	Area (ha)	Quantity mm/yr		Total ML/yr	
Inputs	Rainfall		287	722		2.07	93
	Water supply						
	Groundwater abstraction	*POS*	22.44			0.15	7
					Input total	2.22	100
Outputs							
	Evapotranspiration	*Residential/School*	154.02	350		0.62	28
		Active POS	22.44	1000		0.22	10
		Passive POS/Buffer	45.11	400		0.18	8.1
		Lakes	5.1	1100		0.06	2.7
	Superficial aquifer recharge					0.89	40
	Surface Runoff					0.15	6.8
	Net Groundwater Outflow					0.05	2.2
	Subsoil Discharge					0.05	2.2
					Output total	2.22	100
					Balance	0	

6.3 Water Sources & Sustainability Initiatives

Development of Provence will lead to an increased demand for water for new residents as well as irrigation of public open spaces. Water conservation measures to be implemented to reduce scheme water consumption within the development will be consistent with Water Corporation's "Waterwise" land development criteria, and include:

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets and appliances, rainwater tanks, waterwise landscaping);
- Use of groundwater bores for irrigation of POS and common areas; and
- Maximising on-site retention of stormwater.

Agreed measures to achieve water conservation and efficiencies of use including sources of water for non-potable uses and detailed designs, controls, management and operation of any proposed system will be detailed in the UWMP.

6.3.1 Water Supply & Sewerage

Public Open Space Water Supply & Licencing

The Study Area is located within the Busselton-Capel Groundwater Area (Busselton-Capel Subarea – Yarragadee Aquifer). East Busselton Estate Pty Ltd currently has a licence to abstract 168,300 kL/yr (GWL157168(3)) for the irrigation of 22.44 ha of POS at Provence and for the maintenance of the Almond Parkway Lake. The licence is for the irrigation of the whole Provence Estate (Appendix I).

The irrigation system will be designed to water wise standards with local native plants making up at least 50% of plantings.

Any irrigation licences required to sustain POS areas will be ultimately transferred to the CoB on handover.

Residential Lot Water Supply

Water supply to households will be via extension of the integrated water supply system provided by Busselton Water reticulated pipe system.

Therefore there is adequate water supply for the future development of the site and a water supply network can be developed and upgraded progressively during development.

Residential Lot Sewerage Reticulation

The proposed wastewater strategy for the Study Area will consist of collecting sewage utilising the Water Corporation reticulated sewer pipe system.

6.3.2 Water Efficiency Measures

The objective for water conservation is to minimise use of water and maximise water use efficiency where possible. This objective can be achieved at both the development and household scale and has been identified by the State Government as part of the State Water Plan (Government of Western Australia, 2007) as a priority item for potable water. It has set a target for household water use of 100 kL/person/year, with a consumption target for scheme water of 40-60 kL/person/year.

The main objectives for the development are:

- Avoid use of potable water for irrigation in POS areas;
- Household water use to be less than 100 kL/person/year;
- Minimise use of potable water where drinking water quality is not essential, particularly ex-house; and
- Household consumption targets for in-house potable water use of 40-60 kL/person/yr.

Improvements in water conservation and efficiency to meet these objectives at both the development and household scale through various mechanisms and measures are described further below.

Development Scale

Strategic planning of land use and the ultimate design form (orientation, shape, elevation etc.) of areas such as active and passive public open space areas, road reserves and other areas that require irrigation can significantly influence water requirements. In addition, use of waterwise landscaping practices including hydrozoning, xeriscaping, mulching, application of soil amendments and water retention products and installation of appropriate irrigation fixtures will significantly reduce water requirements.

Water conservation can be achieved by using non-potable water to meet roadside swale and POS irrigation requirements. The Water Corporation (2008) has also developed *Waterwise Land Development Guidelines* to assist land developers in meeting the objectives of improving water conservation and water use efficiency. The guidelines provide measures for achieving water efficiency throughout a development including inside and outside all buildings and management of POS irrigation and design. These guidelines will form the basis for water use within the development.

Household Scale

To achieve water efficiency targets, households are to be built consistent with current Building Codes of Australia (BCA) water efficiency standards and the State Government 5 Star Plus Scheme. These include using AAA rated appliances such as toilets, washing machines, dishwashers etc, water saving showerheads, taps and toilets, sub-surface irrigation etc. The Water Corporation's Waterwise Rebate Program will also assist in encouraging the purchase of waterwise AAA rated appliances.

The Water Corporation's Domestic Water Use Study (Loh & Coghlan, 2003) identified that through the use of waterwise appliances, in-house water demand could be reduced by up to 50%.

Loh & Coghlan (2003) and Water Corporation (2008) also identifies that 30% to 50% (dependent upon lot yields) of water use is applied ex-house for irrigation purposes where potable water is not required. Consequently, use of an alternative non-potable water supply such as rainwater tanks or greywater reuse can significantly reduce household water requirement. Further water conservation can also be achieved by adoption of waterwise landscaping practices including hydrozoning, xeriscaping, mulching, application of soil amendments and water retention products and installation of appropriate irrigation fixtures.

Mandatory commitment to the use of rainwater tanks and/ or grey water reclamation will not be implemented however households will be encouraged and supported to implement such waterwise practices and measures within the development.

6.4 Stormwater Management

6.4.1 Stormwater Management System

The proposed stormwater management system for Provence is shown in Figure 32.

Basins have been designed to contain runoff from the 0.2 EY and 1% AEP (5 and 100 year ARI) storm events, with discharge from the site for the 1% AEP (100 year ARI) event designed not to exceed estimated pre-development (existing) flow rates. Basin inverts were set 300 mm above the pre-development AAMGL, consistent with City of Busselton requirements.

Small Event (Up to 1 EY) Management

At lot scale, most of the Study Area will be suitable for the installation of soakwells. City of Busselton Stormwater Provisions (CoB, 2015) requires that at least the 1 year ARI 1 hour runoff from impervious surfaces must be infiltrated on site. This matched the retention criterion from DoW's *Decision Process for Stormwater Management in Western Australia* (2009). The current (2017) decision process from DWER recommends management of the first 15 mm of rainfall at-source as much as practical (DWER, 2017).

Recent soakwell infiltration testing by JDA (JDA, 2015a, b – see Appendix K) has found that soakwell systems sized for the 1 year 1 hour event are generally capable of infiltrating much more than the 1 year ARI event (in sandy soils). This testing also found that having the base of the soakwell at the water table did not significantly impact on the infiltration rate.

Therefore there will be little to no runoff from frequent events up to the 1 year ARI event.

For road runoff, where possible central median swales will be used for the storage, conveyance and treatment of frequent events.

All runoff from roads in frequent events will be discharged to treatment areas within the flood storage basins within POS areas. Basin inverts will be set 300 mm above the AAMGL/CGL. Amended soil will be used as filter media beneath these treatment areas and the areas will be planted with suitable plant species (consistent with vegetation guidelines for biofilters in SW WA (Monash, 2014)). Basin outflow inverts will be located above the 1 year ARI peak flood level, so that all stormwater will infiltrate through the soil media. The treatment areas will be underlain with subsoil drainage pipes to control groundwater levels and prevent the basins from becoming water logged.

Minor Event (Pipe Design) Management

The stormwater drainage network will be designed based on the 0.2 EY (5 year ARI) event. All flow for events up to the 0.2 EY event will be discharged through the stormwater pipe system.

The stormwater system will receive runoff from lots (excess from the lot soakwell systems) as well as road runoff.

Stormwater will discharge to the stormwater basins, where flow will be attenuated prior to discharge to the downstream network. Events greater than the 1 EY event will overflow from the treatment areas to the higher, turfed areas.

The 0.2 EY flood level in each basin will be used as the downstream condition for design of the contributing road pipe stormwater system.

Major Event (Flood) Management

Management of major events up to the 1% AEP (100 year ARI) storm will include runoff from lots (excess from lot soakwell systems) and road runoff. In major events there may be periods of inundation on the road system as the pipe network is only designed to 0.2 EY capacity. The road network will generally also provide flood conveyance to the flood storage basins and downstream flow path, with roads graded towards the downstream receiving environment.

The flood storage basins within POS areas are designed to contain and attenuate flow from the local catchment. Engineering and landscaping design of the basins may be required to take into account any access and safety issues associated with basin depth in the 1% AEP event and side slopes. Safety structures may be required in some circumstances.

Minimum lot finished levels are to be 0.3 m above the estimated 1% AEP flood level.

6.4.2 Modelling Parameters

Constructed Catchments

In the approved WMS (JDA, 2008), post development land-use were applied over catchment areas to reflect the proposed subdivisional drainage design. The following runoff coefficients applied for various land uses:

- Residential (R10 to R30) 20%
- Tourist Development Area 20%
- Rural/Special Residential 10%
- Active POS 10%
- Passive POS 0%

- Drainage Basins 100%
- Town Village 75%
- Road & Road Reserve 80%

These runoff coefficients were used for the catchments and basins that have been constructed to date – catchments VR1b, VR1c, VR1d, VE1 and VE2. Basin design for these catchments is also consistent with the approved WMS.

Future Catchments

For future proposed catchments, a revised set of loss coefficients was agreed upon between the City, DWER and JDA (emails dated 14/12/18 and 14/2/19). These are detailed in Table 8 below.

TABLE 8: RUNOFF LOSS MODEL COEFFICIENTS

Land-Use	Initial Loss (mm)	Proportional Loss (%)
Residential Lots	15	40
Road Reserves	15	20
Village Centre	15	10
Basins	0	0
School	0	65
Rural / Special Residential	15	70
Active POS	15	70
Passive POS	0	80

Basin Design

Basin flood rises were designed with consideration of the flat topography of the Study Area to minimise fill requirements over the site. Basin side slopes of 1 in 6 (v:h) have been assumed for modelling purposes. Catchment boundaries were determined based on estimated AAMGL informing road catchments.

Basin invert levels were estimated based on minimum pipe gradients connecting to the downstream outlet. This has resulted in separation to AAMGL for more than 0.5 m for most basins, with up to 1.8 m separation in some basins.

Design Rainfall

The stormwater management system has been modelled by JDA using XP-Storm with reference to the methodology in *Australian Rainfall & Runoff* 2019 [ARR2019] (Ball *et al.*, 2019). In ARR2019, there are 30 temporal patterns for each duration which are separated into 3 bands of 10 temporal patterns each. A set of 10 temporal patterns is modelled for each combined EY/AEP and duration with the mean of the 10 temporal patterns used for reporting.

The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 30 minutes to 72 hours.

Downstream Conditions (Sabina Catchment)

As discussed in Section 5.8.3, and shown in Figure 25, there are topographic constraints to flow downstream of Bussell Hwy. Most of these constraints are between 2.8 and 2.95 mAHD (TC1 value of 3.28 mAHD disregarded following visual inspection). TC5 and TC10 are both 3.09 mAHD (Bussell Hwy

culverts have invert level of 2.9 mAHD). An analysis using the 63% AEP indicated a water level at the Bussell Hwy culverts of 3.10 mAHD.

This level was used to inform the design of Basin A (most downstream basin). The treatment area of this basin will be used to treat both the first 15 mm rainfall from the local catchment, as well as subsoil drainage flow from the upstream area. The invert level of this basin was set to 3.3 mAHD. The AAMGL at the basin location is estimated to be 2.9 mAHD. Subsoil drainage will be located under the basin to control levels and provide an outflow for small events (discussed further in Section 6.5). The outlet invert of the subsoil drainage will be set to 3.1 mAHD, with shallow grade under the basin. The main storage for stormwater in Basin A will occur above 3.5 mAHD.

6.4.3 Conceptual Stormwater System Design

Detention volume estimates, basin areas and flood rise estimates for each of the catchments are shown in Tables 9 and 10. Figures 33, 34 and 35 show the 1% AEP (100 year ARI), 0.2 EY (5 year ARI) and 63% AEP (1 year ARI) event plans.

Storm volumes for the 63% AEP (1 year ARI) 1 hour event are provided in Tables 9 and 10 to indicate storage requirements for infiltration of this event (where possible) within each catchment.

Note that storage shapes shown in this report are indicative only for determination of area requirements, and representation of storage areas required in relation to POS areas allocated in the structure plan.

The final basin configuration (side slopes, etc) and locations will be dependent on final earthworks, drainage, and road design levels for the development.

The following comparison of pre and post development flow rates and volumes from the Sabina River catchment to the outlet at Bussell Hwy can be made:

- The 1% AEP discharge rate is 0.417 m^3/s for the post development case, which is slightly less than the pre-development rate of 0.492 m^3/s;
- The 0.2 EY discharge rate is 0.10 m^3/s, which is the same as the pre development peak flow rate;
- The 1% AEP flow volume is 35,080 m^3 for the post development case (24 hour event), which is slightly lower compared to 35,600 m^3 for the pre development case; and
- The 0.2 EY flow volume is 6,780 m^3 for the post development case, which is slightly higher compared to 6,500 m^3 for the pre development volume, though less than 5% difference.

The modelling shows that the post development flows and volumes are less than the pre development for the 1% AEP event, and meets the criteria for flow rate for the 0.2 EY event, with 0.2 EY flow volume less than 5% higher than pre development volume.

Long sections through the Sabina River catchment are shown in Figures 36 to 40. These show AAMGL, basin invert and 0.2 EY and 1% AEP flood levels along each section. As stated in Section 6.4.2, basin invert levels are constrained by minimum pipe gradients to the downstream outlet invert level, resulting in a number of basins having significant separation to groundwater (including the eastern section of the proposed development) – in these areas subsoil drainage under basins will not be required.

TABLE 9: ESTIMATED DETENTION STORAGES: VASSE RIVER & VASSE ESTUARY CATCHMENTS

Catchments	Vasse River				Vasse Estuary	
	VR1a	VR1b	VR1c	VR1d	VE1	VE2
Catchment Data [1]						
Total Catchment Area (ha)	36.5	27.7	16.1	6.6	4.0	17.2
Residential R10-R30 (ha)	6.8	15.8	9.8	3.5	1.4	1.5
Rural Residential R2.5-R5 (ha)	15.6	0.0	0.0	0.0	0.0	5.1
Village Centre (ha)	0.0	0.0	0.0	0.0	0.0	0.0
Active POS (ha)	9.8	5.6	1.5	1.3	1.7	1.4
Passive POS (ha)	0.0	0.0	0.0	0.0	0.0	6.4
Road & Road Reserve (ha)	4.3	6.2	4.8	1.9	0.8	2.8
School (ha)	0.0	0.0	0.0	0.0	0.0	0.0
Post Development Runoff Rate %	28	38	40	36	30	20
Catchment Slope %	0.5	0.5	0.5	0.5	0.5	0.5
Basin Outlet Data						
Basin Outlet (m AHD)	4.0	4.1	4.8	4.2	3.7	3.4
Basin Outlet Diameter (mm)	375	375	300	375	300	450
1 Year ARI						
1 year 1 hour Storm Volume (m^3) [2]	1690	1740	1060	400	200 [6]	570
10 Year ARI						
Top Water Level Area (ha) [3]	2.91	1.49	0.67	0.30	0.09	0.19
Flood Storage (m^3)[4]	5450	6890	2610	530	110	710
Flood Rise (m) [5]	0.19	0.48	0.42	0.18	0.25	0.42
Peak Outflow (m^3/s)	0.14	0.06	0.04	0.07	0.08	0.07
Critical Duration (hrs)	24	72	24	48	1	36
100 Year ARI						
Top Water Level Area (ha) [3]	2.94	1.52	0.70	0.31	0.11	0.20
Flood Storage (m^3) [4]	6670	8770	3860	590	180	1000
Flood Rise (m) [5]	0.23	0.60	0.60	0.20	0.33	0.57
Peak Outflow (m^3/s)	0.19	0.07	0.05	0.09	0.10	0.08
Critical Duration (hrs)	24	36	24	48	1	6

1. **Catchments VR1b, VR1c, VR1d, VE1, and VE2 and have all been constructed to date – results presented are consistent with the Provence WMS (JDA, 2008).**
2. Based on 16.5 mm rainfall (1 year 1 hour storm event)
3. Top water level area calculated based on 1:6 side slopes
4. Flood storage refers to flood attenuation storage above the basin invert.
5. Flood rise refers to the difference between Top Water Level and basin invert.
6. Linear Swale (approx. 280m length)

TABLE 10: ESTIMATED DETENTION STORAGES: SABINA RIVER CATCHMENTS

	Sabina River – Provence Western Catchment							Sabina River – Provence Eastern Catchment					
	A	B	C	D	E	F	G	H	I	J	K	L	M
Catchment Data													
Total Catchment Area (ha)	26.21	17.77	6.20	20.71	29.97	10.05	14.25	25.62	4.78	10.70	14.66	12.72	9.28
Residential Lots (ha)	12.33	8.93	2.49	7.45	13.01	4.66	7.86	12.31	2.57	7.11	9.51	6.37	5.36
Road / Road Reserve (ha)	7.28	5.05	1.45	4.76	5.42	2.50	4.47	7.04	1.46	3.08	3.73	3.63	2.66
Village Centre / Pump Station (ha)	1.21	0.4			0.03								
School (ha)		2.33		2.17									
Basin (ha)	1.91	0.60	0.12	1.01	1.34	0.48	0.58	1.54	0.28	0.42	0.39	0.45	0.43
Active POS - Turf (ha)	0.35	0.47		3.58	0.76		0.30		0.47	0.09		0.83	0.45
Passive POS / Lake (ha)	0.35		2.14	1.74	5.89	1.11	0.58	1.39			1.03	0.76	0.17
Study Area Buffer (ha)	2.77				3.52	1.30	0.46	3.34				0.67	0.21
Basin Data													
AAMGL (mAHD)	2.9	3.4	3.5	3.9	4.30	4.6	3.7	3.1	4.3	3.9	3.4	3.7	4.1
Basin Invert (mAHD)	3.30	3.70	4.33	4.04	4.27	5.47	4.6	3.90	5.70	5.70	4.92	5.40	5.97
Basin Low Outlet (mAHD)	3.50	3.90	4.53	4.24	4.30	5.67	4.80	4.10	5.90	5.90	5.12	5.60	6.17
Basin Low Outlet Diameter (mm)	200	120	225	200	300	150	180	225	200	225	300	200	150
Basin High Outlet (mAHD)	4.05	4.35	-	4.64	-	5.87	5.25	4.40	-	6.20	5.47	5.90	6.47
Basin High Outlet Size (mm)	600x200	600x200	-	270x300	-	300x150	300x300	600x200	-	600x200	600x450	600x300	600x150
63% AEP (1 year ARI) [1]													
63% AEP 1 hour Storm Volume (m^3)	915	610	180	720	740	420	530	800	250	410	570	530	330
63% AEP 1 hour Treatment Area (ha)	0.52	0.20	0.043	0.35	0.85	0.17	0.22	0.32	0.11	0.18	0.17	0.21	0.144
0.2 EY (5 Year ARI)													
Flood Level (mAHD)	3.95	4.30	4.79	4.66	4.66	5.82	5.10	4.33	5.88	6.07	5.40	5.79	6.28
Flood Depth (m)	0.65	0.60	0.46	0.62	0.39	0.35	0.50	0.43	0.18	0.37	0.48	0.39	0.31
Top Water Level Area (ha)	1.72	0.445	0.061	0.794	0.94	0.30	0.36	1.017	0.105	0.267	0.267	0.27	0.259
Flood Storage (m^3)	8200	2270	230	4460	2590	720	1640	3690	190	770	1200	880	540
Peak Outflow (m^3/s)	0.054	0.019	0.031	0.056	0.024	0.019	0.038	0.51	0.002	0.042	0.090	0.034	0.015
Critical Duration (hrs)	24	12	6	12	12	6	12	12	3	6	6	6	6
1% AEP (100 Year ARI)													
Flood Level (mAHD)	4.46	4.84	5.52	5.24	5.23	6.23	5.69	5.05	6.20	6.41	6.02	6.32	6.74
Flood Depth (m)	1.16	1.14	1.19	1.20	0.96	0.76	1.09	1.15	0.50	0.71	1.10	0.92	0.77
Top Water Level Area (ha)	1.80	0.54	0.093	0.93	1.17	0.43	0.52	1.44	0.24	0.37	0.34	0.40	0.38
Flood Storage (m^3)	17100	4930	820	9620	7210	2170	4370	12350	860	1770	3050	2660	1970
Peak Outflow (m^3/s)	0.280	0.183	0.034	0.136	0.036	0.043	0.097	0.194	0.023	0.199	0.264	0.404	0.027
Critical Duration (hrs)	24	12	6	12	12	6	12	12	6	6	6	6	6

1. Based on 15 mm rainfall (1 year 1 hour storm event)

6.5 Groundwater Management

6.5.1 Post-Development AAMGL

Existing land use within the Study Area is predominately pasture with some areas of woodland. The proposed post development land use will be a mixture of residential housing (various densities), POS (grassed and existing woodland) and road reserves. This change in land use is expected to result in a net increase of approximately 10% in rainfall recharge to the water table.

The change in recharge was modelled using Modflow to estimate the increase in groundwater levels across the development site. Modelling results indicate that in areas where subsoil drainage is not used, groundwater levels may rise up to 0.5 m from existing levels.

6.5.2 Managing Changes to Groundwater Levels

To minimise changes to the winter groundwater level, subsoil drainage will be set at a controlled groundwater level (CGL) for the Study Area based on the pre development AAMGL for the Study Area where separation between finished floor level and AAMGL is less than 2 m. Groundwater management within the Study Area will focus on controlling variable groundwater levels.

Post development groundwater levels will be managed using subsoil drainage where separation is less than 2 m, which will be installed within the road reserves throughout the Study Area. Subsoil drainage inverts will be set at pre development AAMGL or higher to minimise groundwater discharge.

For basins where the separation to AAMGL is less than 0.6 m, it is intended that the basin will be underlain with subsoil to drain the treatment area and prevent turfed areas of the POS becoming waterlogged during winter months. Based on Table 10, this applies for Basins A, B, and D. Basin E is already constructed. It is also recommended that Basin H have subsoil drainage (although separation is estimated to be 0.8 m) giving the size of the basin, and likely infiltration volumes.

Subsoil drainage will be treated in a downstream water quality treatment area in Basin A prior to discharge from the Study Area (approx. invert level of 3.3 mAHD). Subsoil drainage under Basin A treatment area will discharge to an outlet invert of 3.1 mAHD, with subsoil in the batter slopes of the basin.

6.5.3 Lot Scale Groundwater Separation

With the CGL set to AAMGL, allowing for 300 mm clearance to the base of soakwells gives a minimum soakwell invert of 0.3 m above AAMGL. With a 900 mm high soakwell and 200 mm cover on the soakwell, minimum clearance between finished lot level and AAMGL is 1.4 m.

Maximum spacing between the subsoil drains is 65 m. JDA groundwater modelling of subsoil systems assessing different spacings, hydraulic conductivities, porosities and recharge rates indicates a maximum mounding of 0.3 m between the subsoil drains during storm events.

6.6 Water Quality Management

6.6.1 Water Quality Concentration and Load Targets

DoW (2010) provides the following guidance for target setting in its Executive Summary with respect to future urban developments:

"achieving no net increase or a net reduction in nutrient loads from large new urban developments"

Consistent with DoW (2010), water quality management for the Study Area is therefore based on improving the water quality which discharges from the site to the Vasse Wonnerup Estuary.

The methodology used to establish surface water quality targets below is consistent with the methodology previously adopted at Provence as documented in the Provence WMS (JDA, 2008) approved by the Department of Water, Commonwealth Department of Water Heritage and the Arts, and the City of Busselton.

The approach adopted for water quality management for the Study Area is to determine existing water quality by predevelopment monitoring, establishing targets on the basis of this monitoring and other published information, implementing water quality measures to achieve targets, and monitoring post development to assess performance.

Monitoring to-date (Sections 5.6.7 and 5.8.4) has shown some water quality parameters are outside ANZECC (2000a) guideline values, but consistent with other DWER monitoring results in the general area which reflects the impacts of historical land use activities. Table 6 presents results of JDA monitoring within the Study Area which indicates monitored water quality from the Study Area to be similar to longer term DWER monitoring programs in the Lower Vasse River. As the WQIP aims to improve the water quality in the receiving waterbodies, use of the monitored predevelopment water quality as the basis of establishing post development targets is considered appropriate.

Based on these results and consistent with DoW (2010) objectives, it is recommended water quality concentration targets for surface water discharge from the Study Area for Phosphorus and Nitrogen be set based on mean concentrations from pre development surface water monitoring, which is generally consistent with DWER monitoring data.

For groundwater it is recommended water quality concentration targets be set as average concentrations based on JDA predevelopment monitoring results (Table 4), with improvement in existing water quality proposed as the initial target.

With respect to load based targets, DoW (2010) has been used to provide an estimate of the allowable nutrient loads based on existing average annual emissions from the Lower Vasse and Sabina catchments (expressed as kg/ha/yr). As stated above (from DoW, 2010), for new urban developments the aim is to not increase nutrient loads. Therefore current nutrient loads from DoW (2010) have been used.

The current P load for the Lower Vasse catchment is 4.72 tonnes/yr, or 2.95 kg/yr/ha (based on estimated catchment area of 1,600 ha, from DoW, 2010). The current N load for the Lower Vasse catchment is 33.8 tonnes/yr, or 21.1 kg/yr/ha.

The current P load for the Sabina River catchment is 3.57 tonnes/yr, or 0.51 kg/yr/ha (based on estimated catchment area of 7,000 ha, from DoW, 2010). The current N load for the Sabina River catchment is 39.5 tonnes/yr, or 5.64 kg/yr/ha.

As can be seen, there is a significant difference in load per contributing area for the two catchments. The average of the two catchments has been used to estimate load targets.

Target concentrations and loads for groundwater and surface water are shown in Table 11.

These targets will be reviewed on an annual basis as part of the ongoing performance review process submitted to DWER and CoB for assessment. Overall performance compliance against water quality targets will require careful consideration as both surface and groundwater quality will be a function of inter seasonal and inter annual variability and historical land use practices not only within the Provence development area, but over the entire upstream catchment.

Monitoring of compliance with targets will be conducted consistent with the assessment frequency and methodology specified in Section 7.

TABLE 11: WATER QUALITY OBJECTIVES – CONCENTRATIONS AND LOADS

Parameter	Concentration		Loads			Assessment Frequency
	Basis of Target	Target (mg/L)	Basis of Target	Lower Vasse & Sabina Mean Total Load (kg/yr/ha)	Derived Study Area Target (kg/yr)	
Groundwater						
Total N	Annual mean of JDA Study Area predevelopment monitoring data	8.0	-	-	-	Quarterly Sampling and Annual Assessment
Dissolved Inorganic Nitrogen (DIN) – NOx, Ammonia		4.9		-	-	
Total P		0.22		-	-	
Dissolved Inorganic Phosphorus (DIP) – FRP		0.04		-	-	
Surface Water						
Total N	Annual mean of JDA Study Area predevelopment monitoring data	2.05	Average Annual Load Estimates via DoW (2010) based on Lower Vasse and Sabina Catchments	13.46	3860	Monthly Winter Sampling and Annual Assessment
Dissolved Inorganic Nitrogen (DIN) – NOx, Ammonia		0.32		-	-	
Total P		0.21		1.73	500	
Dissolved Inorganic Phosphorus (DIP) - FRP		0.07		-	-	
TSS [1]		8.3		-	-	

1. With respect to TSS, construction activities subject to ongoing management review by the contractor to minimise concentration. Any monitoring which provides a reading in excess of the target concentrations subject to immediate corrective action.

6.6.2 Design Approach

Water quality management will be achieved through a treatment train approach including the application of both structural and non-structural controls. Water quality management for the Study Area is based on improving the water quality which discharges from the site to the Vasse Wonnerup Estuary.

6.6.3 Non-Structural Controls

Control of pollutants at source using non-structural measures by minimisation or prevent of input, has potential to be an efficient cost effective water quality management option.

Non-structural source controls for the Study Area will include:

- **Education Campaigns**
  Distribution of leaflets & newsletters. Topics include but will not be limited to drains to rivers, fertilising habits (if appropriate), techniques for minimising stormwater runoff pollutants.

- **Refinement of Management and Maintenance Activities**
  Education of staff and regular review of work practices.
  Ongoing review and refinement of street sweeping programmes and practices.

- **Inclusion of Native Plantings**
  Retention of existing native vegetation in passive POS areas.
  Partial use of native plantings in other POS areas.

- **Street Sweeping**
  Develop and undertaking co-ordinated street cleaning programs to remove sediments

6.6.4 Structural Controls

Many pollutant treatments, particularly those targeting fine pollutants, require a number of measures used in sequence to be effective. The proposed integrated water sensitive urban design provides primary, secondary and tertiary treatment.

Structural source controls for the Study Area will include:

- Stormwater run-off from lots will be directed to soakwells or other infiltration devices to provide the opportunity for infiltration where possible.
- Traditional kerbed pavements collecting stormwater via side entry pits and conveying stormwater via pipes within road reserves with double lot frontage. All pits will be trapped with open bases (subject to City of Busselton approval).
- One-way crossfall pavements and grassed swales will be incorporated within road reserves abutting public open space areas to treat the first 15 mm of rainfall (small event management).
- Landscaped/vegetated bioretention systems and/or swales within median islands along Boulevard roads.
- Gross pollutant traps (including oil/grease separators) will be incorporated as part of the treatment train before discharge of stormwater off site.
- Flood detention storage areas to be provided to detain stormwater flows and attenuate flows. These areas will be ephemeral, have permanent low flow relief, and will likely be landscaped with endemic native species and used as active Public Open Space and or landscape buffers.
- Multiple-use corridors including wetland rehabilitation areas.

Sizing and design of structural control measures to be applied to the Study Area will be provided in the UWMP.

Note that any open based manholes, swales, and bioretention/detention areas to infiltrate at source will be designed to maintain a 0.3 m separation from their base to the CGL.

6.6.5 Post Development Nutrient Inputs

The UNDO (Urban Nutrient Decision Outcomes) decision support tool (DoW, 2016) is a simple conceptual decision support model that evaluates nutrient reduction decisions for urban developments on the Swan Coastal Plain is south-west Western Australia.

It is a progression of the Nutrient Input Decision Support System (NiDSS) tool that was developed by JDA, which was originally developed as part of the Southern River / Forrestdale / Wungong / Brookdale Structure Plan Urban Water Management Strategy (JDA, 2002).

The limitation of the UNDO model have been outlining in DoW (2016), including that UNDO:

- Does not set water quality targets;
- Is not a detailed design tool;
- Provides a steady state solution;
- Does not provide sub-annual solutions;
- Does not consider pre development nutrient loads; and
- Does not replace existing DWER policies and procedures.

UNDO has been used to help quantify the nutrient inputs and nutrient exports for the post-development scenario. The UNDO tool analyses inputs for Total Phosphorus and Total Nitrogen only, with calculations provided in Appendix L. Subregions have been delineated based on land use category, soil type, drainage vector, clearance from groundwater and groundwater gradient.

Prior to the implementation of the proposed structural and non-structural controls, the total Nitrogen and Phosphorus input rates from the future urban land use are 11.84 kg/ha/yr and 0.62 kg/ha/yr respectively.

With the structural treatment controls in place the total export loads of Nitrogen and Phosphorus are reduced by 30% for Nitrogen and 36% for Phosphorus, compared to urban development without WSUD. These estimates correspond to a reduced Nitrogen input of 8.26 kg/ha/yr and a reduced Phosphorus input of 0.40 kg/ha/yr. Greater detail on the UNDO modelling inputs, exports and results are provided in Appendix L. A breakdown of the three catchments is provided in Table 12.

Water quality targets set for other developments discharging to the Vasse Wonnerup system are 0.3 kg/ha/yr for Phosphorus and 2.7 kg/ha/yr for Nitrogen.

TABLE 12: UNDO MODELLING RESULT SUMMARY

Catchments	Pre-Treatment Load (kg/ha/yr)		Load Removed (kg/ha/yr)		Load Removed (%)	
	Nitrogen	Phosphorus	Nitrogen	Phosphorus	Nitrogen	Phosphorus
Sabina River Catchment West	3.26	0.19	1.08	0.07	33	37
Sabina River Catchment East	2.51	0.07	0.68	0.02	27	29
Vasse River & Estuary Catchment	6.07	0.36	1.82	0.13	30	36
Total	11.84	0.62	3.58	0.22	30	36

6.6.6 Assessment of Proposed Structural BMP's to Design Criteria

Table 13 details a summary from DoW's Stormwater Management Manual for Western Australia (2007) of expected pollutant removal efficiencies for bioretention and detention/retention systems. Expected nutrient input reduction via non-structural measures calculated in Section 6.6.3 are also reported in Table 13. For comparison purposes these results are presented against typical water quality design criteria adopted by DWER for other development areas on the Swan Coastal Plain.

While DoW (2007) does not provide expected pollutant removal efficiencies for all BMP's, application of a treatment train approach using a combination of non-structural and structural measures detailed in Section 6.6.3 and 6.6.4 will therefore clearly achieve design objectives for water quality.

Specific details on the location, scale of application, and responsibilities for individual BMP's are to be assessed for individual development areas within the Study Area during preparation of Urban Water Management Plans (UWMP's).

TABLE 13: BMP WATER QUALITY PERFORMANCE IN RELATION TO DESIGN CRITERIA

Parameter	Design Criteria via DNMP (required removal as compared to a development with no WSUD)	Non Structural Controls (refer Section 5.5.5) Nutrient Input Reduction	Structural Controls Nutrient Output Reduction [1]	
			Bioretention System	Detention/ Retention Measures
Total Suspended Solids	80%	-	80%	65-99%
Total Phosphorus	60%	85%	60%	40-80%
Total Nitrogen	45%	65%	50%	50-70%
Gross Pollutants	70%	-	-	>90%

1. Typical Performance Efficiencies via DoW (2007)

6.7 Iluka "Footprint" Lake Management

Iluka Lake (also known as Footprint Lake) is located in the southern section of Provence. It is an existing lake constructed in the past during a previous lake use. The lake is currently being used for irrigation storage, receiving groundwater from the Yarragadee bore prior to discharge to Almond Parkway Lake (APL) and hence for irrigation.

Iluka Lake is an expression of the shallow, superficial groundwater aquifer. It is not lined.

A lake assessment study has been completed by JDA, performing the following components:

- Lake water quality monitoring;
- Monitoring of shallow groundwater quality upstream and downstream of lake;
- Assessment of lake, shallow groundwater and Yarragadee abstraction bore quality results;
- Hydrogeological assessment of shallow aquifer;
- Water balance of lake;
- Salt balance of lake;
- Nutrient balance of lake;
- Assessment against Interim Constructed Lakes Guideline (DoW, 2007); and
- Assessment of potential lake management options.

The report has been included as Appendix M.

The following comments can be made in relation to the outcomes from the study:

- The aquifer immediately south of the lake can be classed as Guildford Formation, having a high clay content and low permeability. The aquifer north of the lake is predominately sand, and part of the Tamala Limestone Formation;
- The lake intersects a significant portion of the superficial aquifer depth, and therefore 100% of the groundwater flow will flow through the lake;
- Shallow groundwater and Yarragadee inflow have similar concentrations of TN (0.23 mg/L), however TP concentrations are higher in the Yarragadee inflow (0.46 mg/L cf 0.37 mg/L for shallow groundwater);
- Shallow groundwater outflow has similar concentrations of TN to inflow (0.23 mg/L) and raised concentrations of TP (0.57 mg/L). Pumping to APL has higher TN (1.12 mg/L) and lower TP (0.13 mg/L);
- Due to the lower permeability upstream of the lake, groundwater inflow only constitutes 1.5% of the inflow balance, compared to 57% for the Yarragadee inflow. Direct rainfall on the lake contributes 24%, with the remainder being surface inflow;
- Of the outflows from the lake, transfer to APL is 54%, evaporation 38% with the remainder groundwater outflow;
- The salt and nutrient balance of the lake indicates that, based on the collected data, that there is a nett outflow of salt (the lake is getting fresher from Yarragadee inflow), TN is reducing, however TP is increasing. Phosphorus is not remaining in the water column but precipitating and being bound in the lake sediments.

The outcome of the study was that Iluka Lake will require management for algae. A number of options are being considered, including:

- Oxygenation – adding oxygen to the lake from bed diffusers to reduce stratification. A similar method was used in the Vasse Estuary by DWER in 2018;
- Filtration of flow from Yarragadee bore – use of an inline filter to reduce nitrogen and phosphorus particulates from entering the lake. Phosphorus in particular is high;
- Aeration by fountain – using a pump to create a fountain to reduce stratification; and
- Lowering of offtake – lower the outflow offtake (to APL) to reduce stratification.

These options are still being assessed and costed to determine the best method of future management.

7. IMPLEMENTATION

7.1 Roles and Responsibilities

Table 14 details the roles and responsibilities to undertake the implementation plan.

The operation and maintenance of the stormwater management system will initially be the responsibility of the developer but will ultimately revert to the Local Authority. Preparation of the UWMP and post development monitoring will be the responsibility of the developer.

TABLE 14: IMPLEMENTION RESPONSIBILITIES

IMPLEMENTATION		RESPONSIBILITY	
LWMS Section	**Action**	**Developer**	**City of Busselton**
7.2	Preparation of an Urban Water Management Plan to support subdivision	✓	
7.6	Construction of stormwater / subsoil system	✓	
7.5	Construction of irrigation system	✓	
7.5	Groundwater licence responsibility Initially Following hand over	✓	✓
7.6	Stormwater system operation and maintenance Initially Following hand over	✓	✓
7.7	Monitoring Program – Post Development	✓	

7.2 Urban Water Management Plan

Further work that is identified for inclusion in the UWMP is as follows:

- Design of treatment structures, and vegetated swales as outlined in the Stormwater Management Manual (DoW, 2007);
- Refine the final configuration (storage side slopes etc) and exact location of the flood storage basins dependent on final earthworks, drainage and road design levels for the development;
- Confirmation of sub-soil location and levels.

7.3 Staging

Construction of future stages will need to consider downstream flow paths and flood attenuation, where downstream areas are not yet constructed. A draft Master Staging Plan is provided in Appendix N, with a simplified stage reference area plan in Figure 43. The stage reference areas combine several of the stage areas – Table 15 provides a summary of the stage breakdown.

For example, for construction of R1, a downstream flow path to future basin A will be required, with a temporary basin in this location. Likewise, a temporary basin at basin D will be required to drain R6 and R7 as the basin is part of the R10 reference area. In the eastern section of the Study Area, a temporary basin at H will be needed to attenuate flow from R12 and R13, prior to construction of final basin in R17.

To assist in future design, the outflow hydrographs for each basin have been included in Appendix O to inform flow constraints if there are future changes to the design.

TABLE 15: STAGING REFERENCE AREAS

Stage Reference Area	Master Staging Plan Stages
R1	4.1 – 4.4
R2	4.5 – 4.6
R3	4.7 – 4.9
R4	4.10 – 4.12
R5	4.13 – 4.14
R6	3.1 – 3.3
R7	3.4 – 3.7
R8	3.8 – 3.11
R9	3.12 – 3.13
R10	3.14 – 3.15
R11	3.16
R12	5.1 – 5.4
R13	5.5 – 5.7
R14	5.8 – 5.11
R15	6.1 – 6.3
R16	6.4 – 6.6
R17	6.7 – 6.9
R18	6.10 – 6.13

7.4 Construction Management

7.4.1 Dewatering

Dewatering of the Superficial Aquifer is likely to be required for some elements of development construction. Where it is identified that dewatering is required greater than 10 L/s for 30 consecutive days to a maximum of 25,000 kL described under the Rights in Water and Irrigation Exemption (Section 26C) (Dewatering) Order 2010, prior to the commencement of any dewatering activities, construction contractors will be required to apply for and obtain a 5C 'Licence to Take Water' from DWER.

7.4.2 Acid Sulfate Soils

Management of ASS will be addressed as a separate process to the urban water management document approvals process (LWMS/UWMP).

All assessment and management of ASS will be conducted in accordance with the Acid Sulfate Soil Guideline Series: *Identification and Investigation of Acid Sulphate Soils and Acidic Landscapes* (DEC, 2009). An Acid Sulfate Soil Management Plan (ATA, 2006; Coffey Environment, 2010) has already been

completed and will accompany subsequent UWMP's. Any construction management will need to be in accordance with this approved document.

During construction, appropriate handling methods will need to be employed by the construction contractor to manage any potential acid sulphate soils. Handling should be in accordance with the Acid Sulfate Soils Guidelines Series Treatment and Management of Disturbed Acid Sulfate Soils (DoE, 2003). These guidelines specify holding times and specific methods for treatment of such soils.

To confirm the status of soils, the site engineer or scientist will regularly inspect the excavations and spoil, and ensure such soils where encountered are appropriately tested and managed before reuse or disposal off-site.

7.5 Irrigation

The irrigation system will be constructed by the proponent as new POS areas are constructed. The current licence for Provence (Appendix I) covers irrigation of all existing and future POS within the development.

As sections of the irrigation system are handed over to CoB, an agreement will be included as part of the licence to take water. There is currently an agreement on the licence (AGR200682(1)) between the proponent and CoB for supply of irrigation water to APL, with CoB managing irrigation of existing POS from APL. A transfer of 39,640 kL to CoB has been submitted.

7.6 Maintenance Schedule

The surface drainage system will require regular maintenance to ensure its efficient operation. Operating and maintenance practices itemised in Table 16 will be periodically required to ensure the achievement of water quality objectives.

Annual reporting will include review of the maintenance schedule of the LWMS and its adequacy in relation to system performance.

TABLE 16: MAINTENANCE SCHEDULE FOR WSUD INFRASTRUCTURE

Item	Maintenance Interval			
	Monthly	Quarterly	Biannually	As required
Local Drainage				
Street sweeping		✓		
Education of sediment and rubbish in manholes			✓	
Education of sediment and rubbish in GPT's			✓	
Subsoil Drainage				
Check on function (via monthly GW level monitoring)	✓			
Bioretention Systems and Swales				
Inspect for erosion			✓	
Mowing of grassed areas and removal of clippings.	✓			
Maintenance of vegetation. Remove dead vegetation and replace where necessary.				✓
Inspect for standing water 1 week after rainfall events.				✓
Remove excessive sediment build-up.				✓
Detention Storages/POS Areas				
Removal of debris to prevent blockages				✓
Remove excessive sediment build-up.				✓
Use of slow release/low P fertilisers in turf areas			✓	
Community Education Campaigns				
Leaflets Promoting Source Control Practices				✓

7.7 Monitoring Program

The monitoring program has been designed to allow quantitative assessment of hydrological impacts of proposed development within the Study Area. In particular the programme addresses the monitoring of surface water discharges and groundwater quality within the development area.

Monitoring will be performed up to 2 years post practical completion for each stage/area.

The program may need to be modified as data are collected to increase or decrease the monitoring effort in a particular area or to alter the scope of the programme itself.

The program is designed to operate over the development period including construction to allow for time lag for full impacts of development on the receiving environment to occur. The program will be periodically reviewed to ensure suitability and practicality, and some modifications may result from negotiation with DWER and CoB depending on results of sampling and monitoring.

All water quality testing will be conducted by a NATA approved laboratory. Laboratory analysis results will be typically obtained within 1 month of sample submission.

Surface and groundwater monitoring are described below and summarised in Table 17. Ongoing tracking of environmental performance against targets will be undertaken as monitoring data becomes available through a series of consolidated data spreadsheets.

7.7.1 Surface Water

Surface water monitoring includes both quality and quantity parameters at flood storages multiple use control areas in order that both nutrient concentrations and loads can be established.

Discharge at the outlet points of the Study Area to the downstream receiving drains will be monitored. Outflow monitoring stations will be established and loggers installed to provide a continuous flow record at each discharge point from the Study Area.

Water quality sampling will initially be undertaken monthly (when flowing) for analysis by a NATA registered laboratory.

Monitoring of the following parameters is proposed:

- In situ - pH, EC and Temperature
- TP, TN (with components including FRP, TKN, Nitrate/Nitrite), TSS

The frequency of surface flow water quality monitoring will be reviewed following the first 12 months of sampling.

7.7.2 Groundwater

Quarterly monitoring of water levels and quality is proposed. Dataloggers will be installed within four bores to provide a continuous record. Water quality monitoring at eight sites: BA1, BA3, BA4, BA6, BA7, BA14, BA18 and BA21 is proposed.

Monitoring bores will be 50mm PVC casing completed into the regional water table, approximately 1 m below the minimum summer water table. Any of the bores disturbed during development will be replaced as near as possible to existing bore sites, and surveyed to Australian Height Datum (AHD).

The depth to water table will be measured by electrical depth probe or an alternative suitable device. Water samples are to be taken after purging the bores to ensure a fresh sample is obtained.

Water quality parameters to be measured initially are as described above for surface water monitoring.

TABLE 17: MONITORING SCHEDULE AND REPORTING

Monitoring Type	Parameter	Location	Method	Frequency and Timing	Reporting
Groundwater Level	Water Level (m AHD)	8+ monitoring bores providing spatial coverage	Electrical depth probe or similar	Quarterly (typically Jan, Apr, Jul & Oct)	Annual assessment reports to be submitted to CoB, and DWER.
Groundwater Quality	pH, EC Nitrogen Phosphorus	8 monitoring bores providing spatial coverage	Pumped bore samples	Quarterly (typically Jan, Apr, Jul & Oct)	
Surface Water Flow	Discharge Flow Rate	5 outflow locations from the development area to receiving environment	Continuous flow measurement via water level recorder and data logger	Continuous	
Surface Water Quality	pH, EC, TSS Nitrogen Phosphorus	5 outflow locations from the development area to receiving environment	Collected grab samples	Monthly sampling when flowing, typically April to November. Sampling to capture first flush in April/May (if possible). Frequency to be reviewed following initial 12 month sampling period.	

7.8 Reporting & Contingency Mechanisms

7.8.1 TSS during Construction

With respect to construction activities, TSS will be subject to ongoing management review by the contractor to minimise concentrations. Any monitoring which provide a reading in excess of the target concentrations will be subject to immediate corrective action using engineering controls and stopping work where necessary.

7.8.2 Notification of Criteria Exceedance

When undertaking TSS monitoring, should a monitored value be exceeded (or be predicted to exceed), DWER will be notified with 72 hours and advised of measures that have been taken to mitigate or prevent that exceedance.

Within 14 days of notifying DWER of the exceedance (or predicted exceedance), DWER will then be notified that measures have been taken to mitigate or prevent that exceedance, and the effectiveness of those measures. DWER will also be advised of measures to be taken to prevent and/or minimise the likelihood of similar future exceedances.

7.8.3 Reporting

Reporting is proposed to be a detailed annual monitoring report to be co-ordinated by the developer and submitted to CoB and DWER for review.

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 of the LWMS in relation to system performance, and a summary of any criteria exceedances and actions taken.

As previously stated in Section 6.6.1, assessment of performance compliance against water quality criteria will require careful consideration to account for inter seasonal and inter annual variability, and as both surface and groundwater quality will be a function of historical land use practices not only within the Provence development area, but over the entire upstream catchment.

As part of the annual review process, review of pollutant load targets will be made. Pollutant load targets contained in the LWMS will be reviewed in relation to overarching government agency targets via the Vasse-Geographe Water Quality Improvement Plan (WQIP).

7.8.4 Contingency Mechanisms

The proposed process for contingency action in the assessment of overall performance compliance is

- Assess if an isolated, development area or regional occurrence.
- Determine if due to the development or other external factors.
- Perform appropriate contingency action as required, which may include:
  a) Identify and remove any point sources.
  b) Reinforce Community Education/Awareness program.
  c) Review constructional, operational and maintenance (e.g. fertilising) practices.
  d) Consider alterations to POS areas including landscape regimes and soil amendment.
  e) Consider modifications to the stormwater system.
  f) Consider initiation of community based projects.
- Record in the annual report any action taken, and notify CoB and DWER accordingly.
- If necessary, inform residents of any required works and their purpose.

It should be noted that Provence 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 of the development.

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FIGURES

Data Source:

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049

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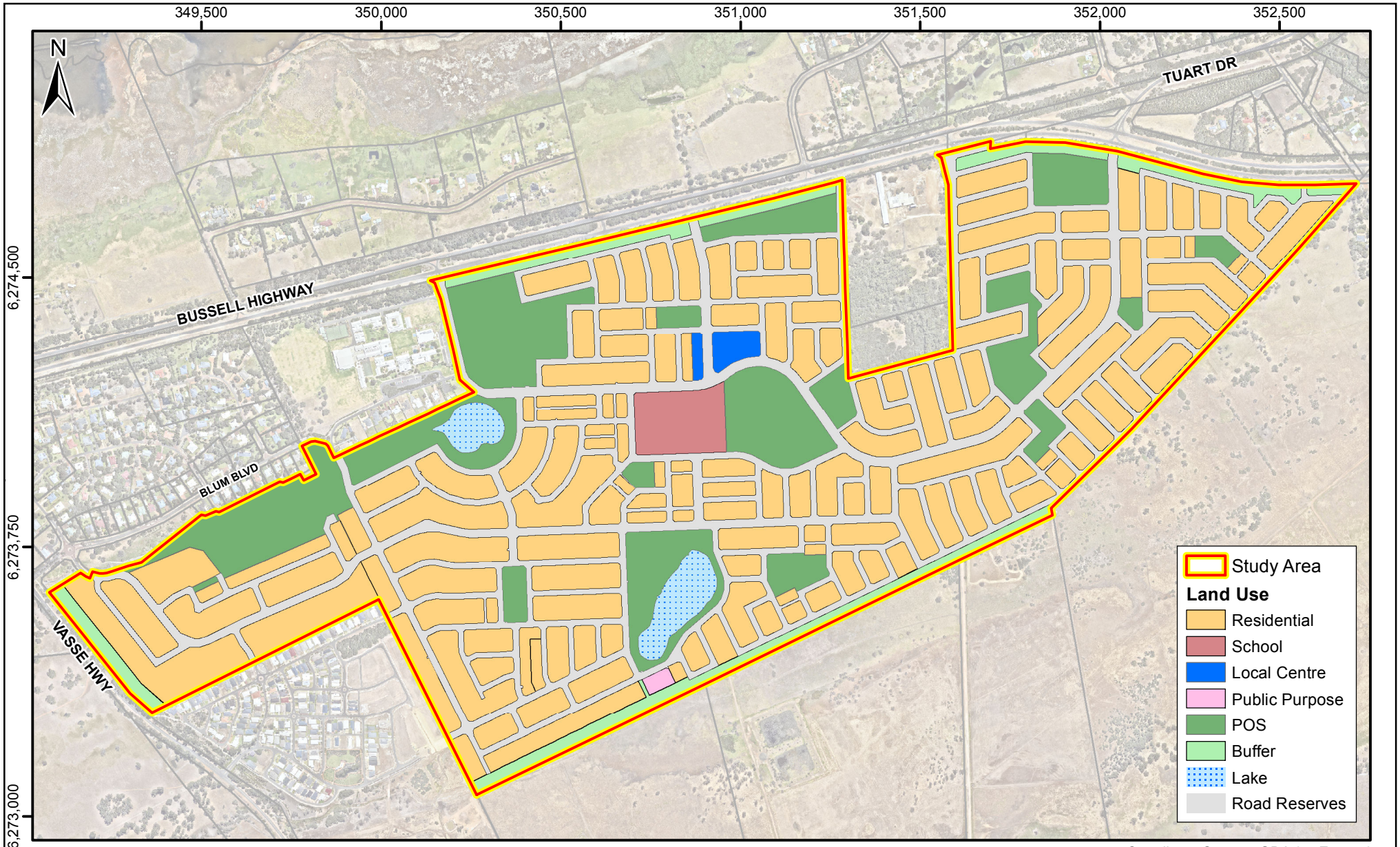
East Busselton Estate Pty Ltd

Provence: LWMS

Figure 1: Location Plan



Data Source: Nearmap Digital Imagery, December 2015; RPS (2019) *Provence Structure Plan*, Plan Ref. 130316-2-003M , 23 October 2019

Coordinate System: GDA 94, Zone 50

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Job No. J6049

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Provence: LWMS

Figure 2: Proposed Structure Plan

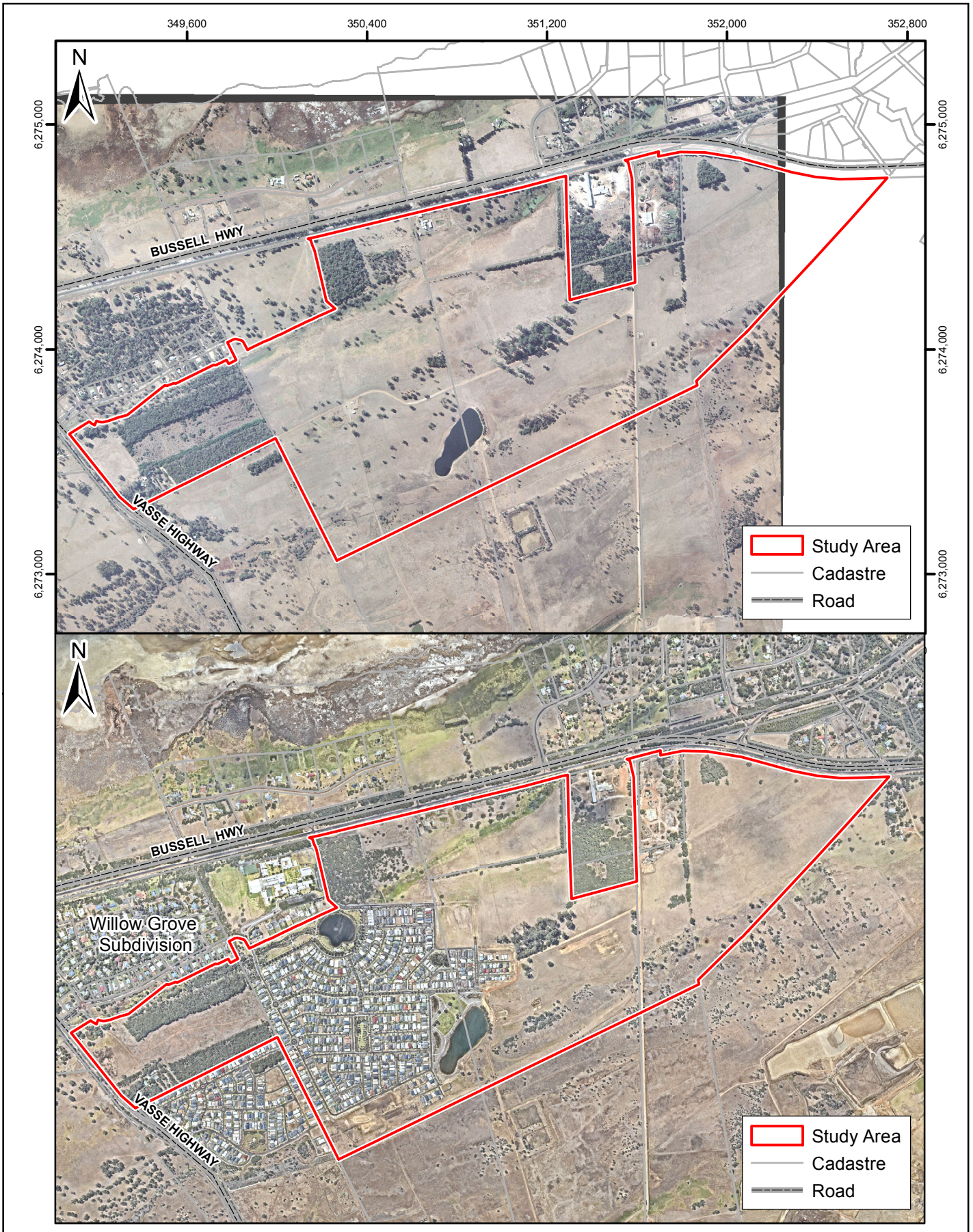

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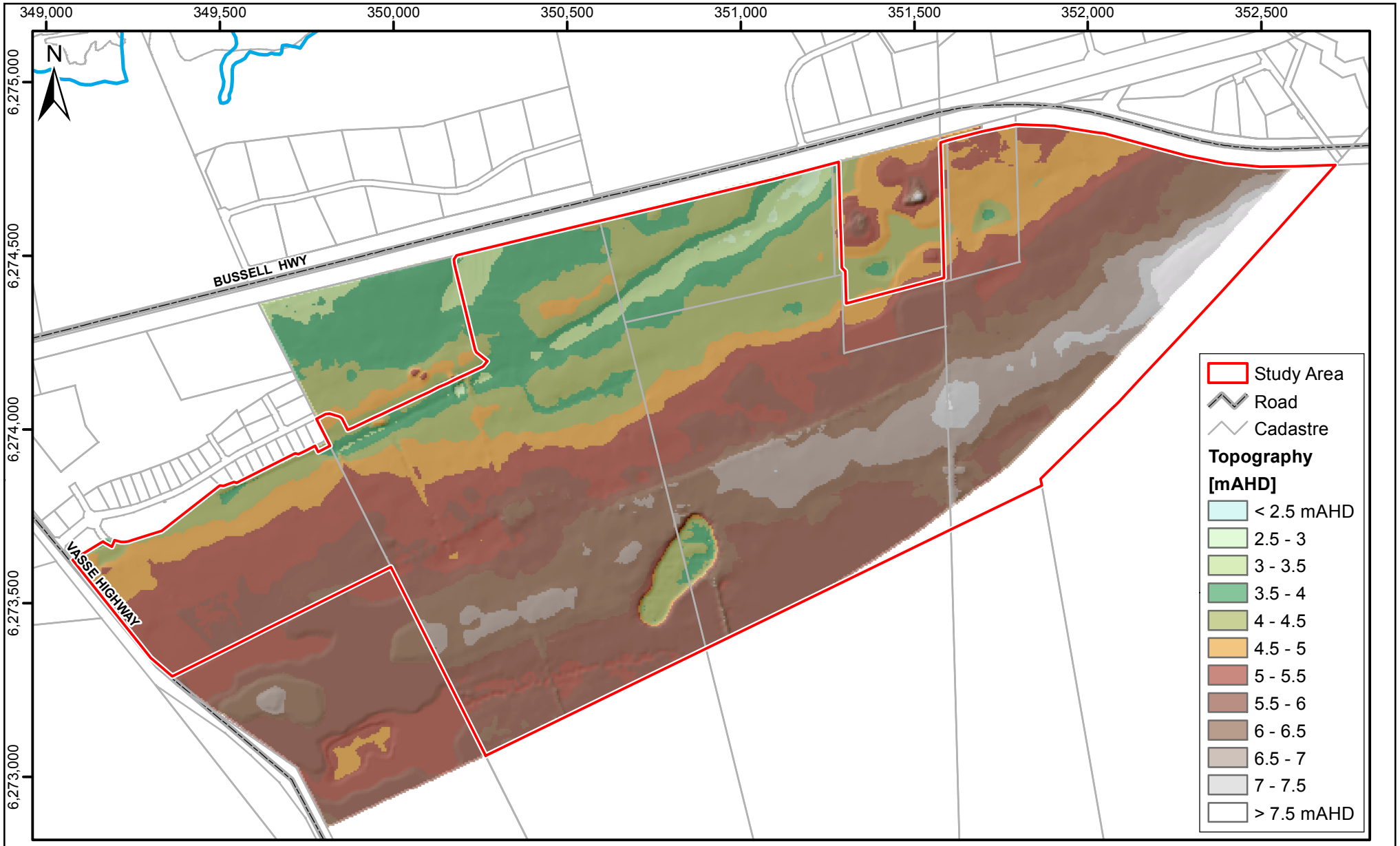
Figure 3: Aerial Photography: Pre (Above) & Current (Below)



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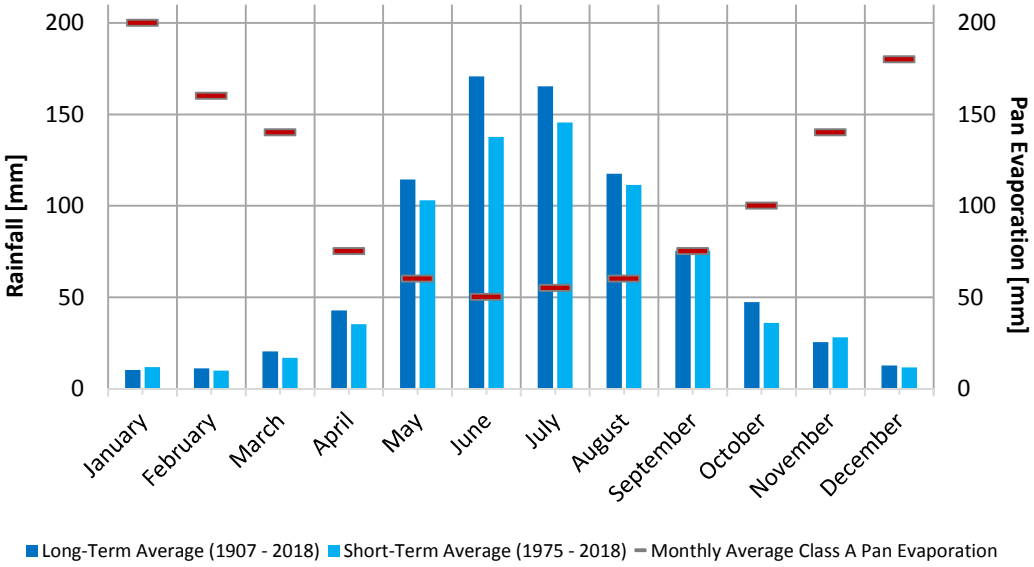
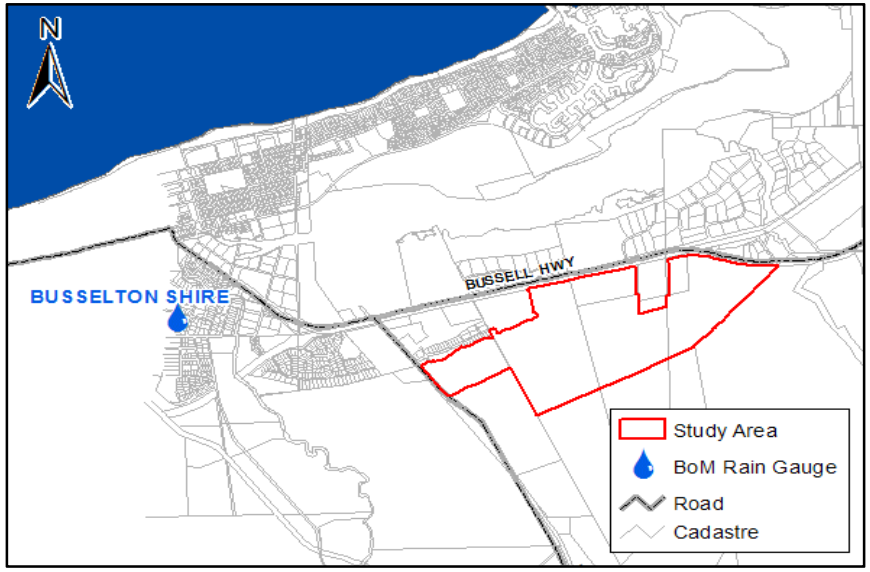
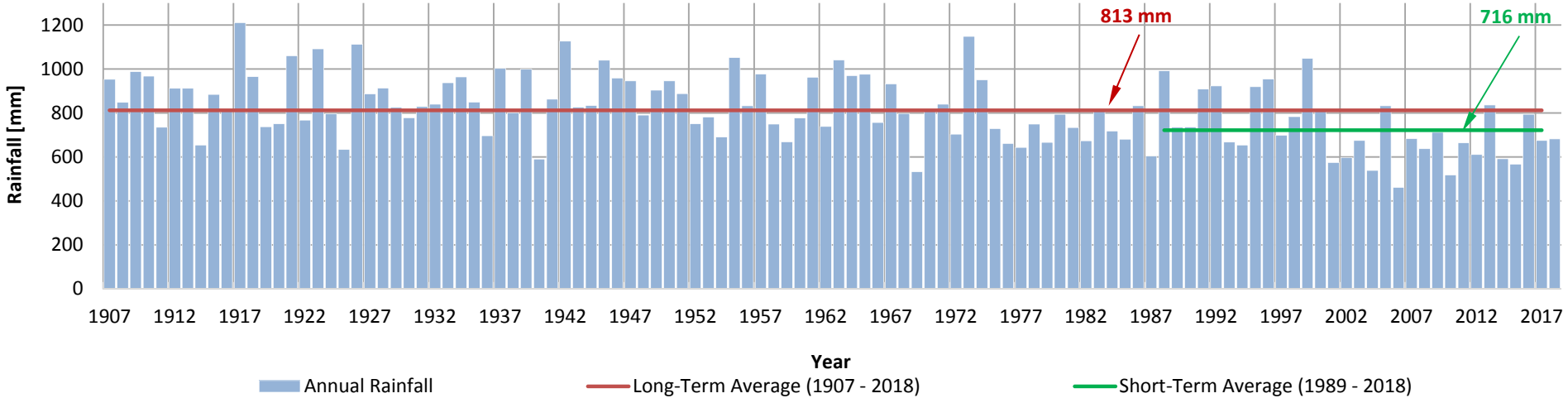
Provence: LWMS

Figure 4: Topography







Data Source: Bureau of Meteorology (BoM, 2019) - Busselton Shire Gauging Station (BoM ID: 009515); Australian Pan Evaporation (Luke *et al.*, 1988)

Job No. J6049

East Busselton Estate Pty Ltd
Provence: LWMS

Figure 5: Annual and Monthly Rainfall Data

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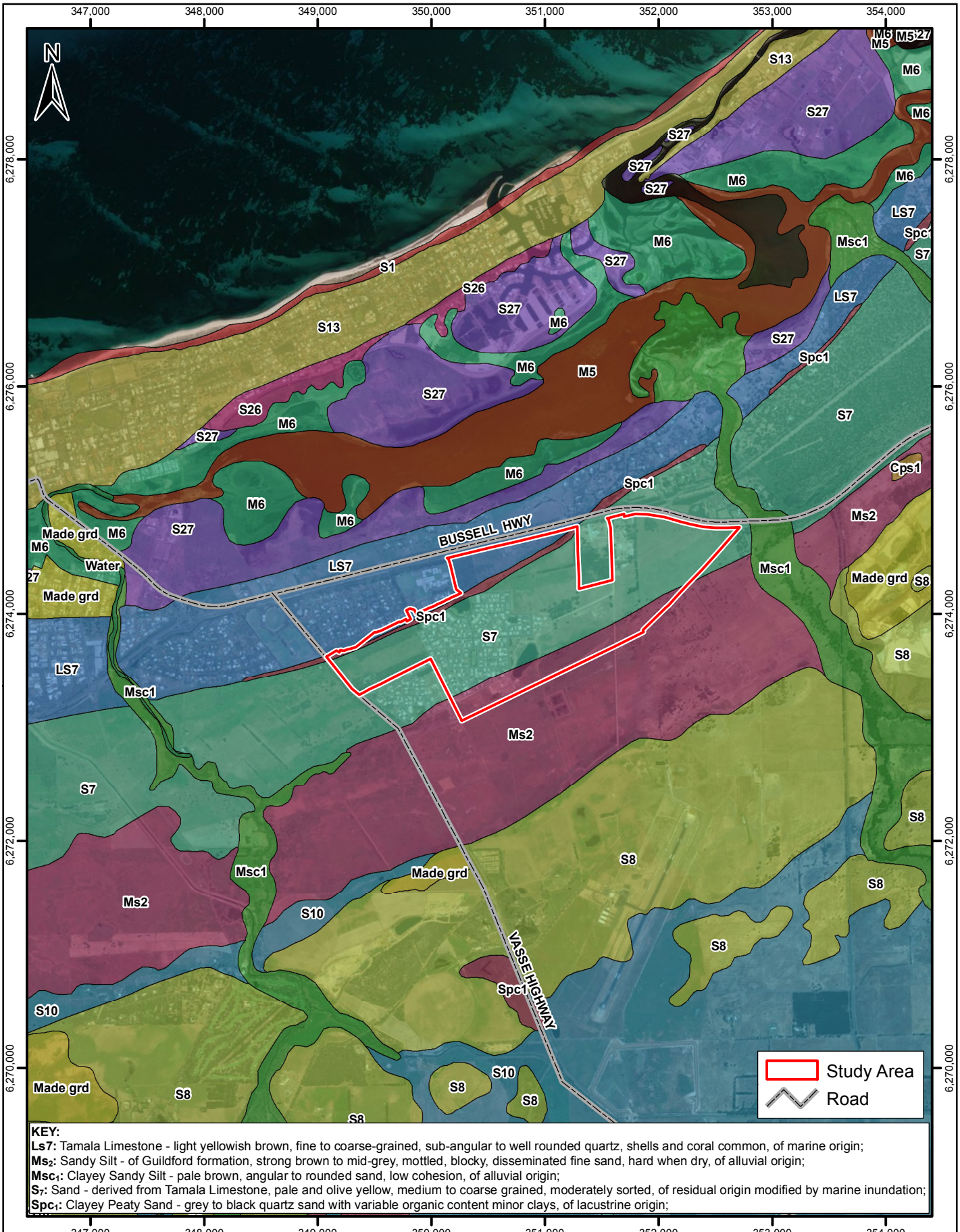

KEY:
Ls7: Tamala Limestone - light yellowish brown, fine to coarse-grained, sub-angular to well rounded quartz, shells and coral common, of marine origin;
Ms_2: Sandy Silt - of Guildford formation, strong brown to mid-grey, mottled, blocky, disseminated fine sand, hard when dry, of alluvial origin;
Msc_1: Clayey Sandy Silt - pale brown, angular to rounded sand, low cohesion, of alluvial origin;
S_7: Sand - derived from Tamala Limestone, pale and olive yellow, medium to coarse grained, moderately sorted, of residual origin modified by marine inundation;
Spc_1: Clayey Peaty Sand - grey to black quartz sand with variable organic content minor clays, of lacustrine origin;

Data Source: Geological Survey of Western Australia (1987)
Environmental Geology Series - 1: 50,000 Busselton Sheet 1930 I

0 1,000 2,000 Metres

Job No. J6049
Scale 1:45,000 @A4
Coordinate System: GDA 94, Zone 50
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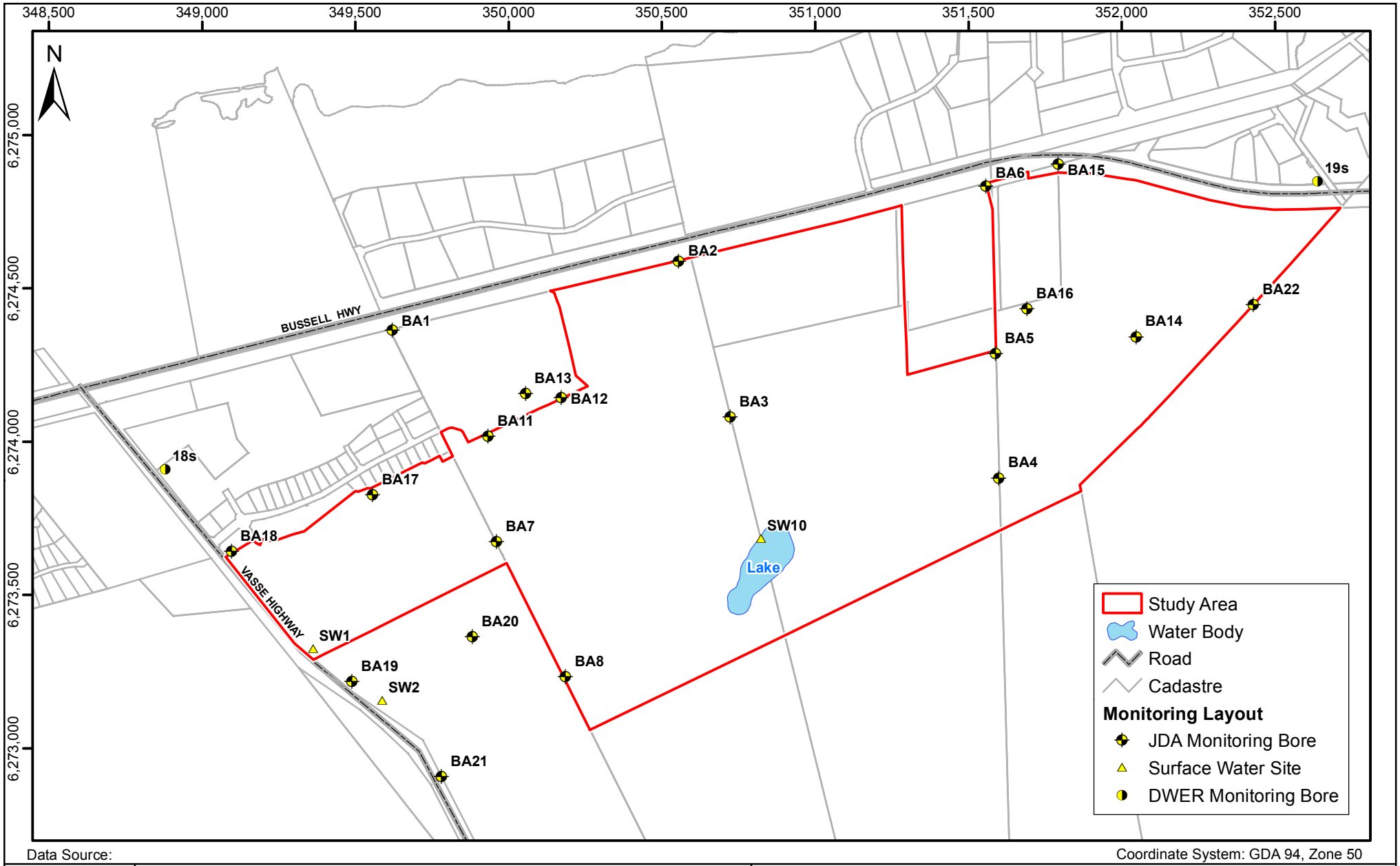
Provence: LWMS

Figure 6: Surface Geology



Data Source:

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049
Scale: 1:17,000 @A4

0 250 500 750 1,000 Metres

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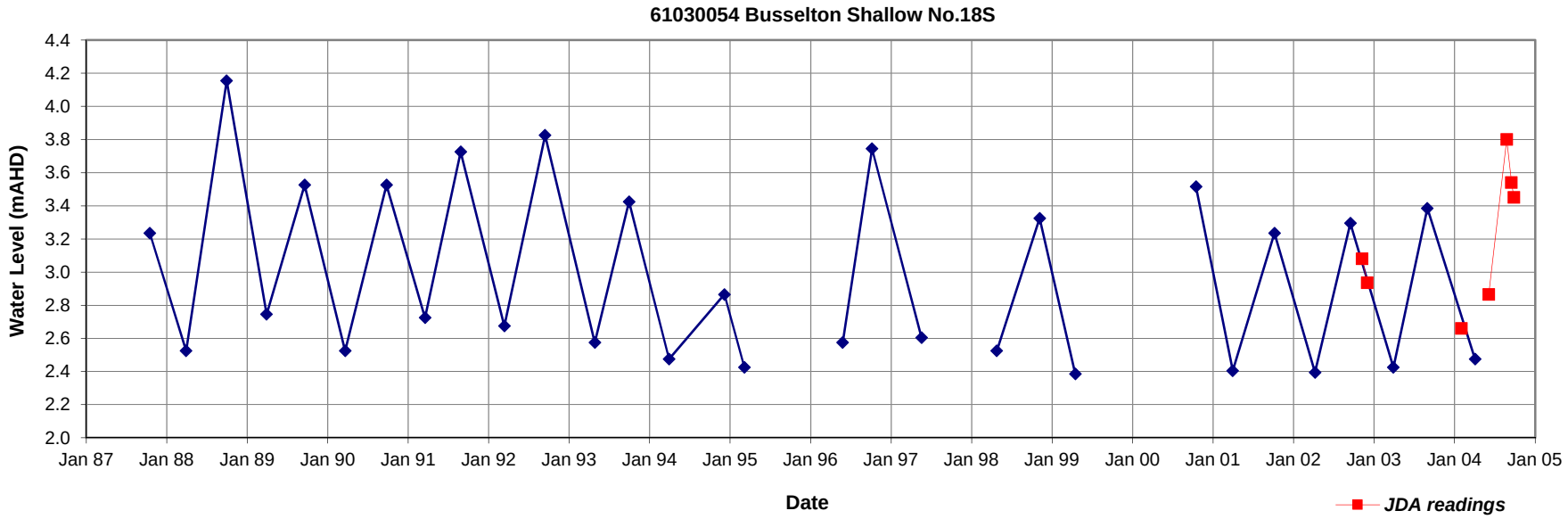
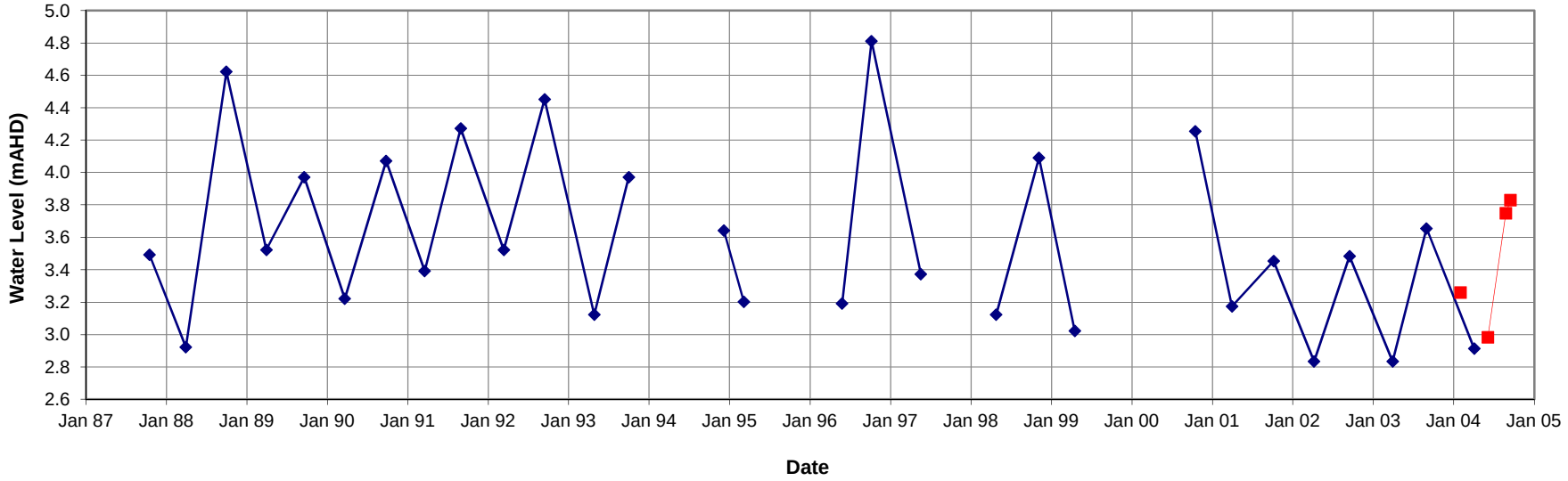
Figure 7: Monitoring Bore Locations





Data Source:

Job No. J6049

East Busselton Estate Pty Ltd

Provence: LWMS

Figure 8: DWER Monitoring Bores 18S & 19S Hydrographs

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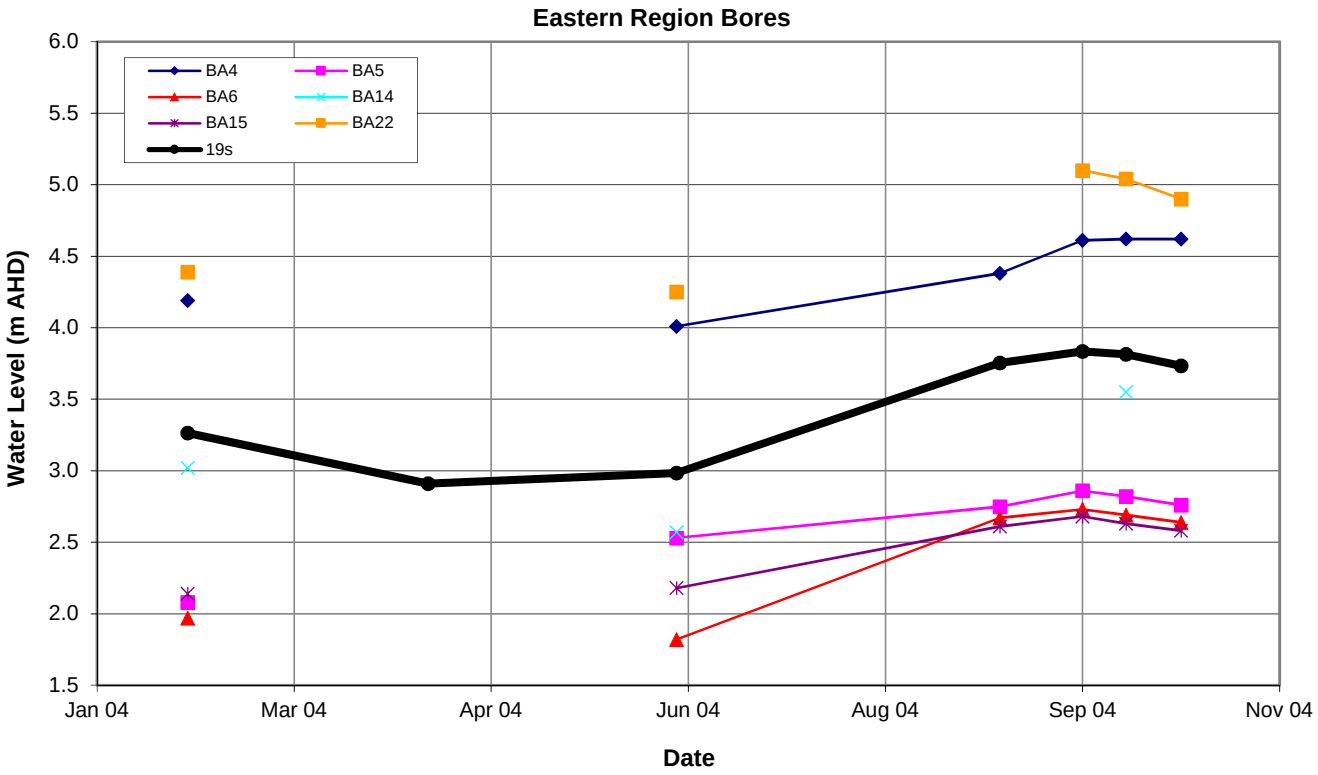

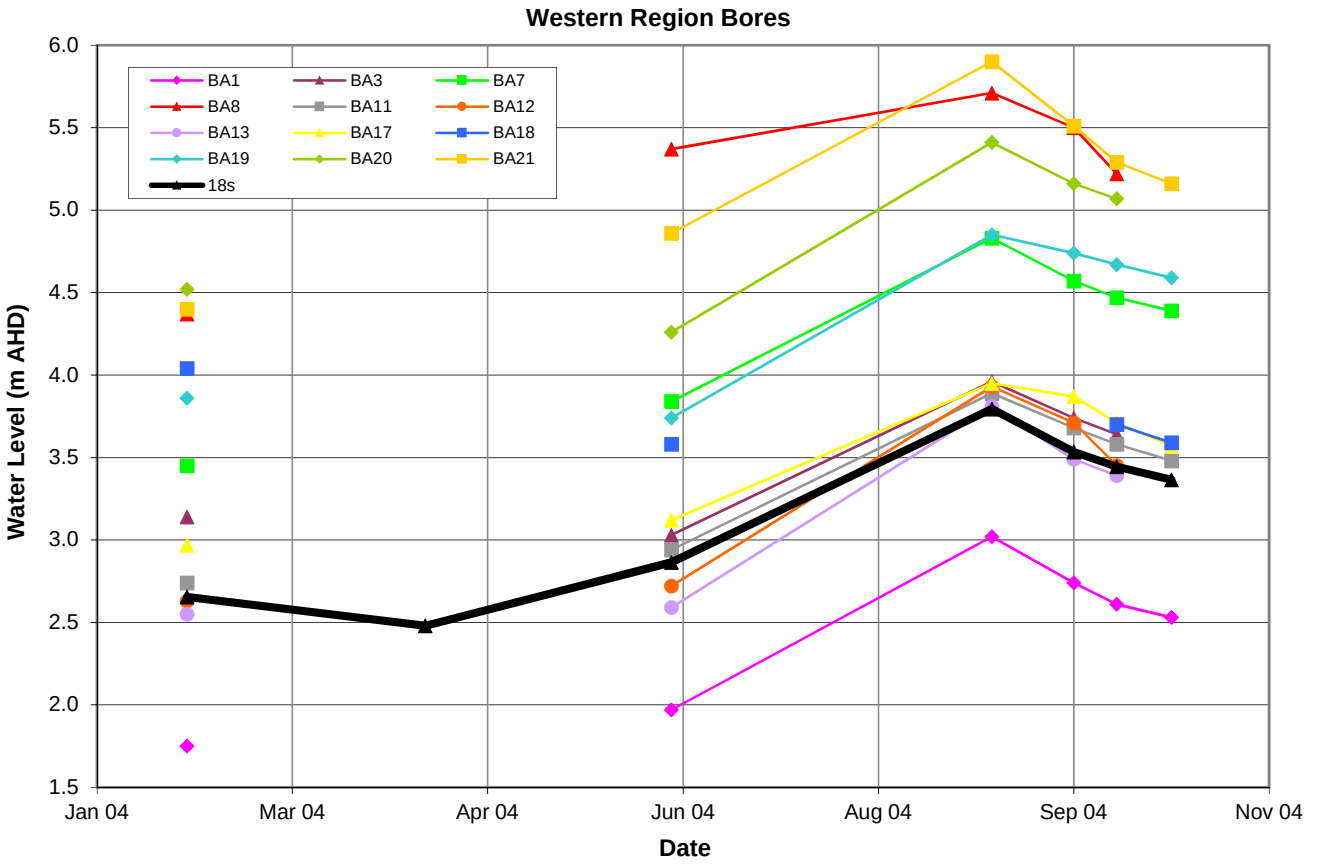

Data Source:

Job No. J6049

East Busselton Estate Pty Ltd

Provence: LWMS

Figure 9: Water Level Monitoring Data 2004 Timeseries

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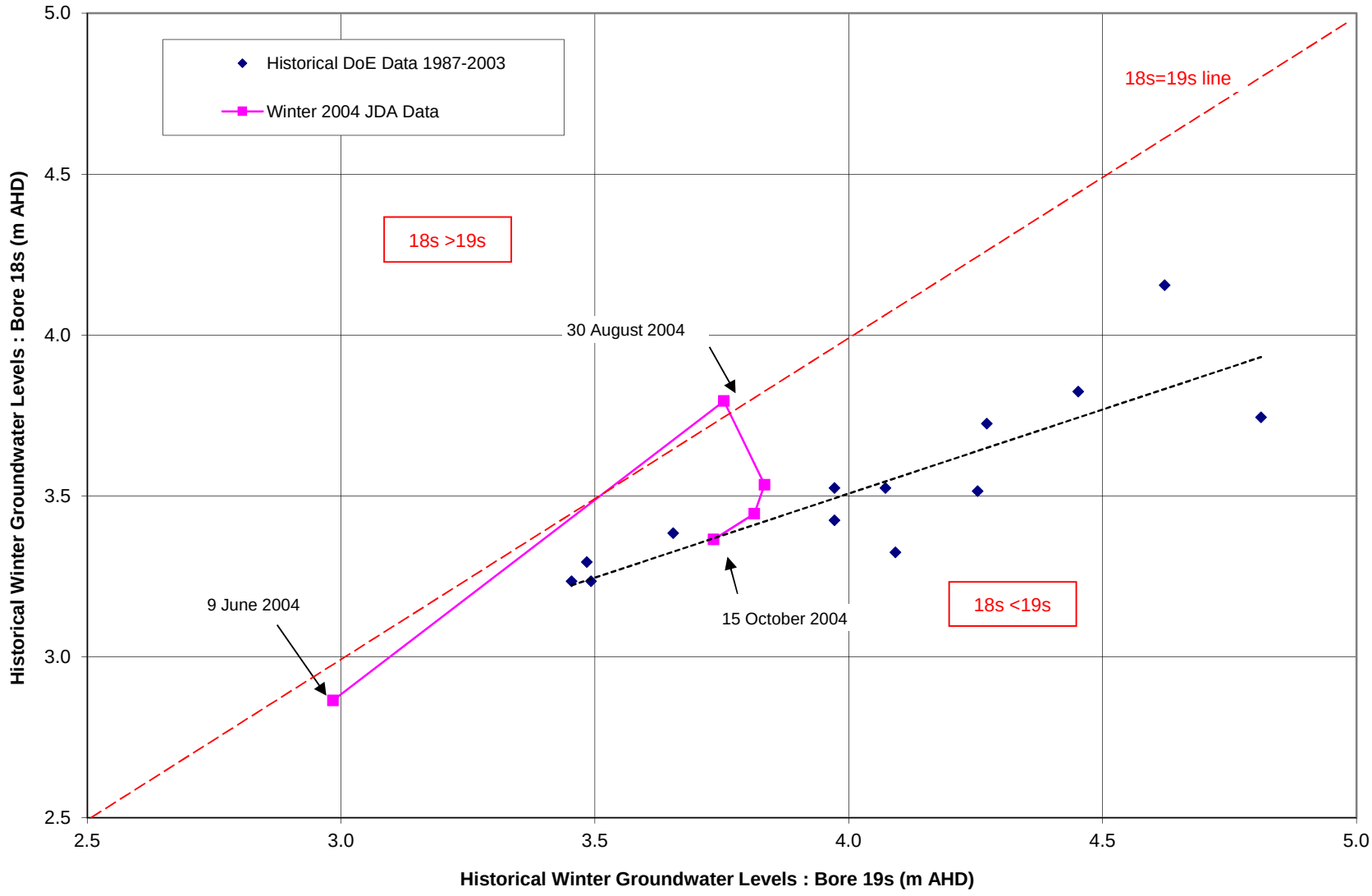

Data Source:

Job No. J6049

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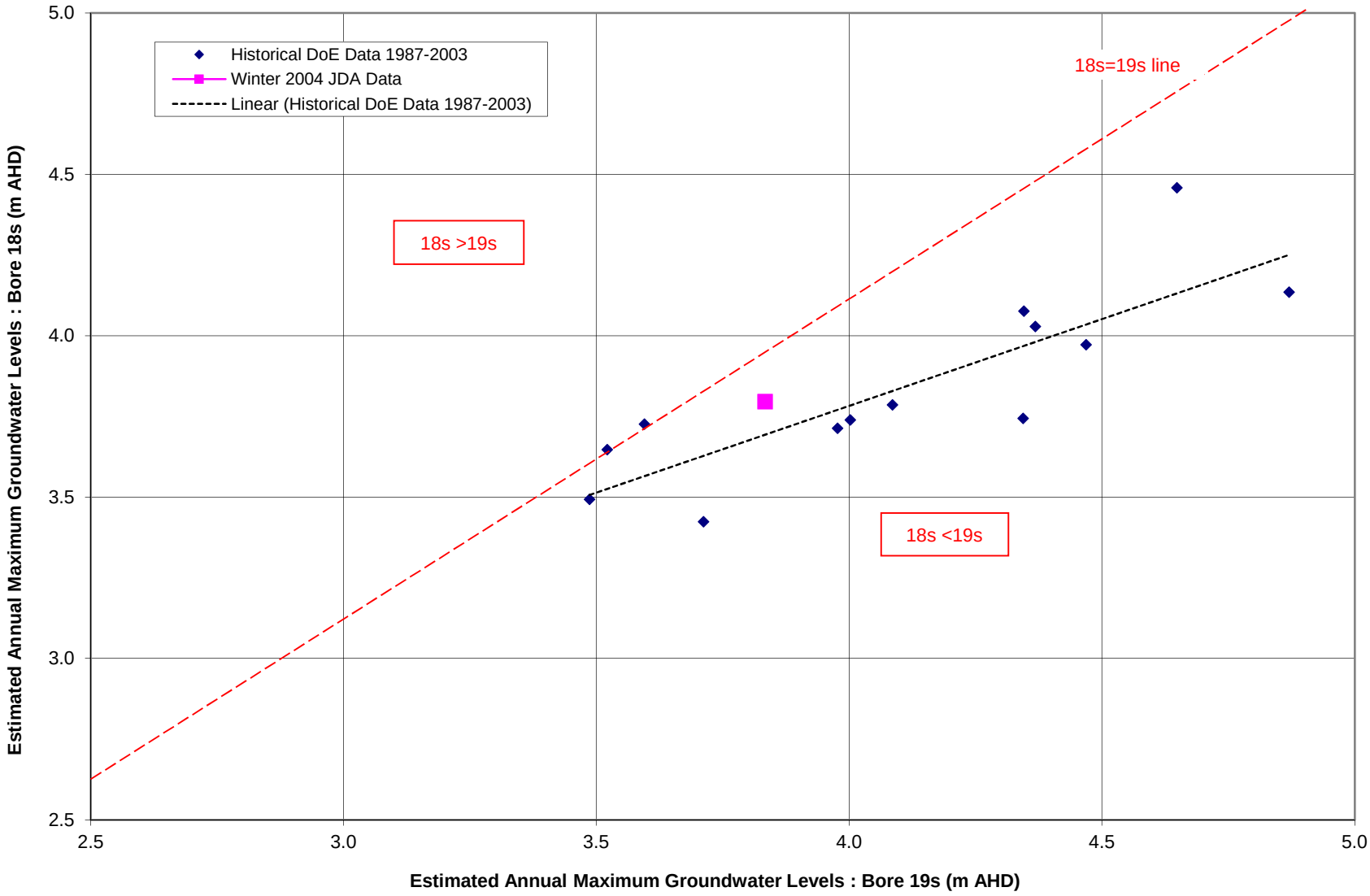
Figure 10: DWER Monitoring Bores Winter Groundwater Level Regression



Data Source:

Job No. J6049

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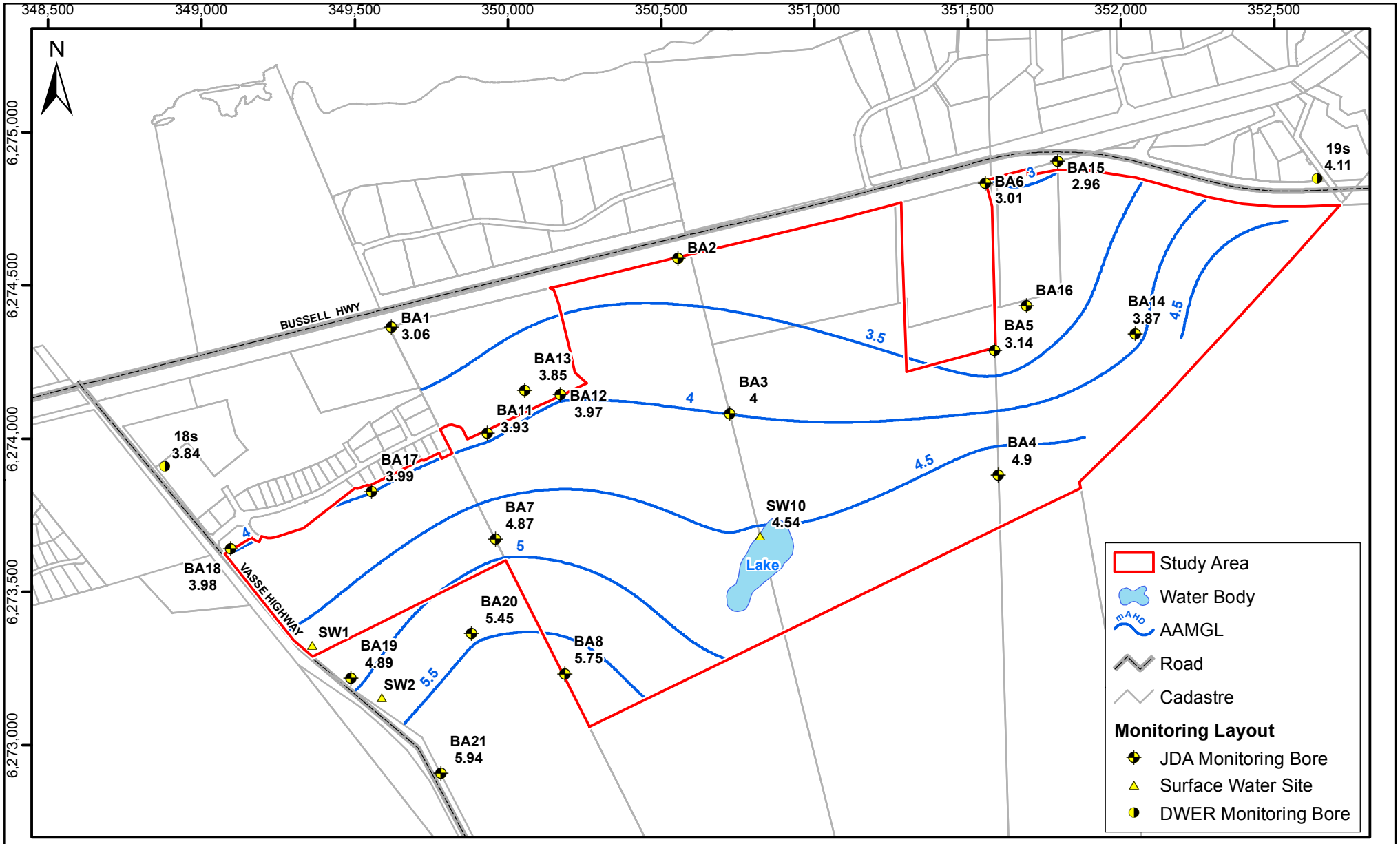
Figure 11: DWER Monitoring Bores Estimated Annual Maximum Groundwater Level Regression



Data Source:

Coordinate System: GDA 94, Zone 50

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Job No. J6049
Scale: 1:17,000 @A4

0 250 500 750 1,000 Metres

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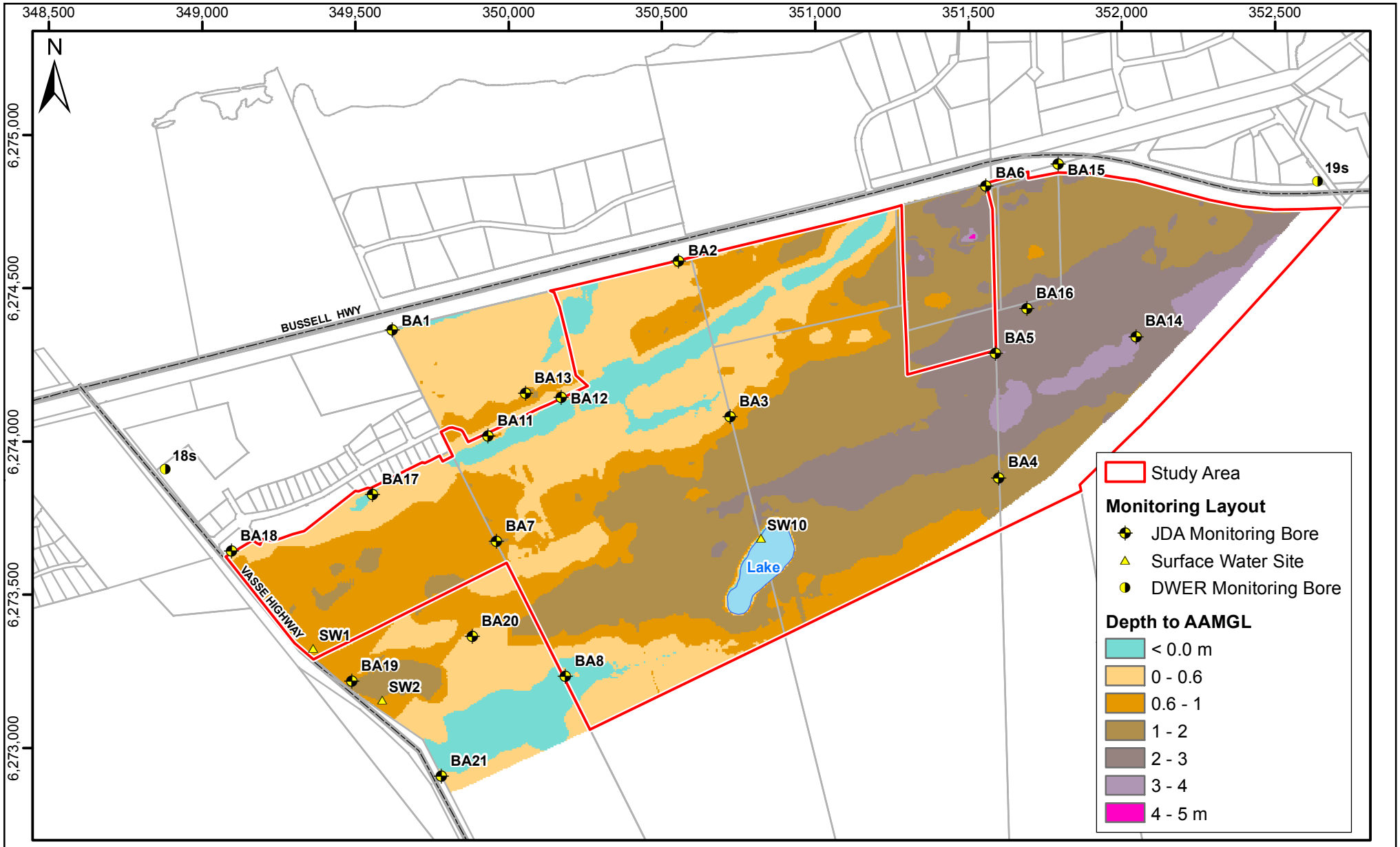
Figure 12: Estimated 2004 AAMGL



Data Source:

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:17,000 @A4

0 250 500 750 1,000 Metres

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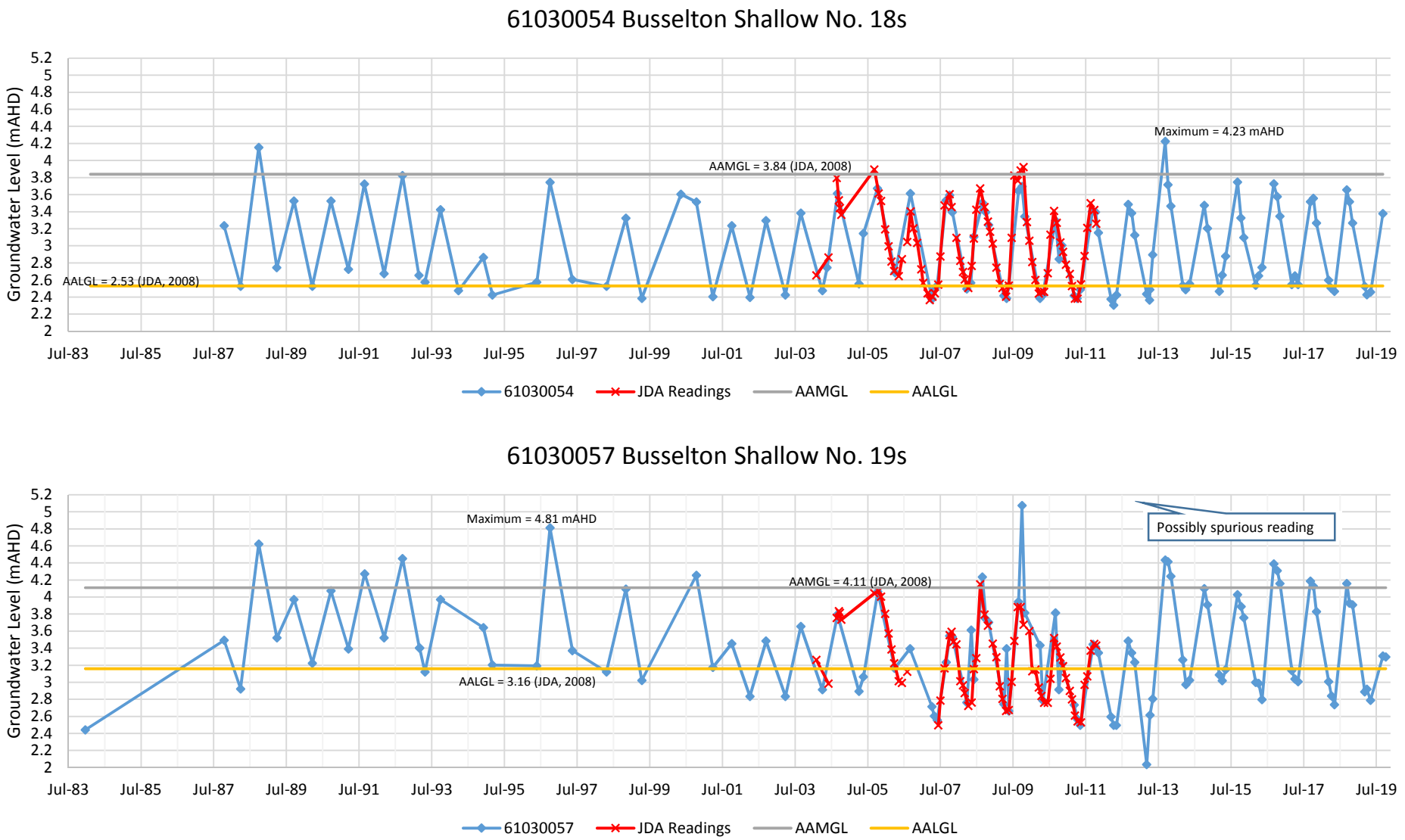
Figure 13: Estimated Depth to Groundwater (AAMGL)



Data Source: Department of Water; Water Information Reporting Portal (2019)

Job No. J6049

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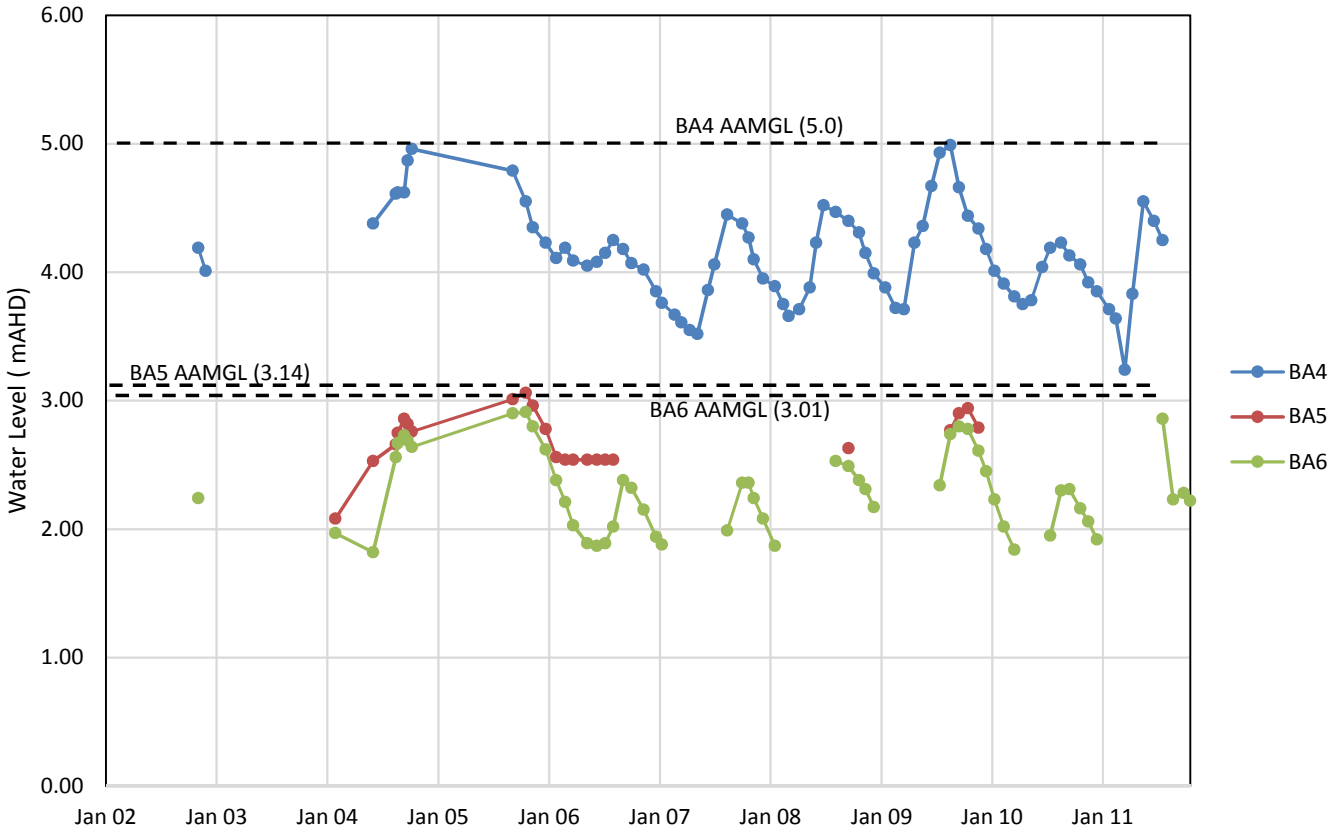
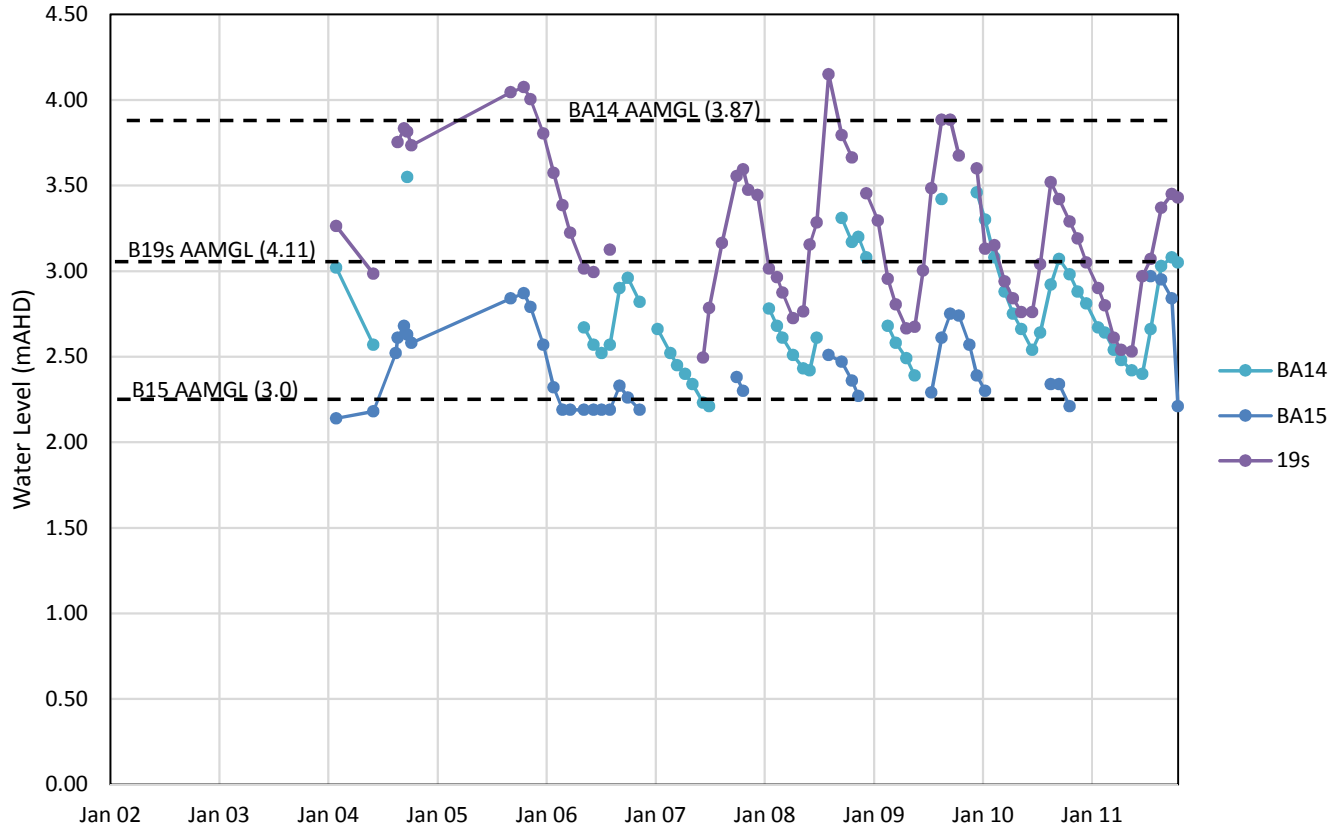
Figure 14: DWER Monitoring Bores 18s & 19s Hydrographs





Data Source:

Job No. J6049

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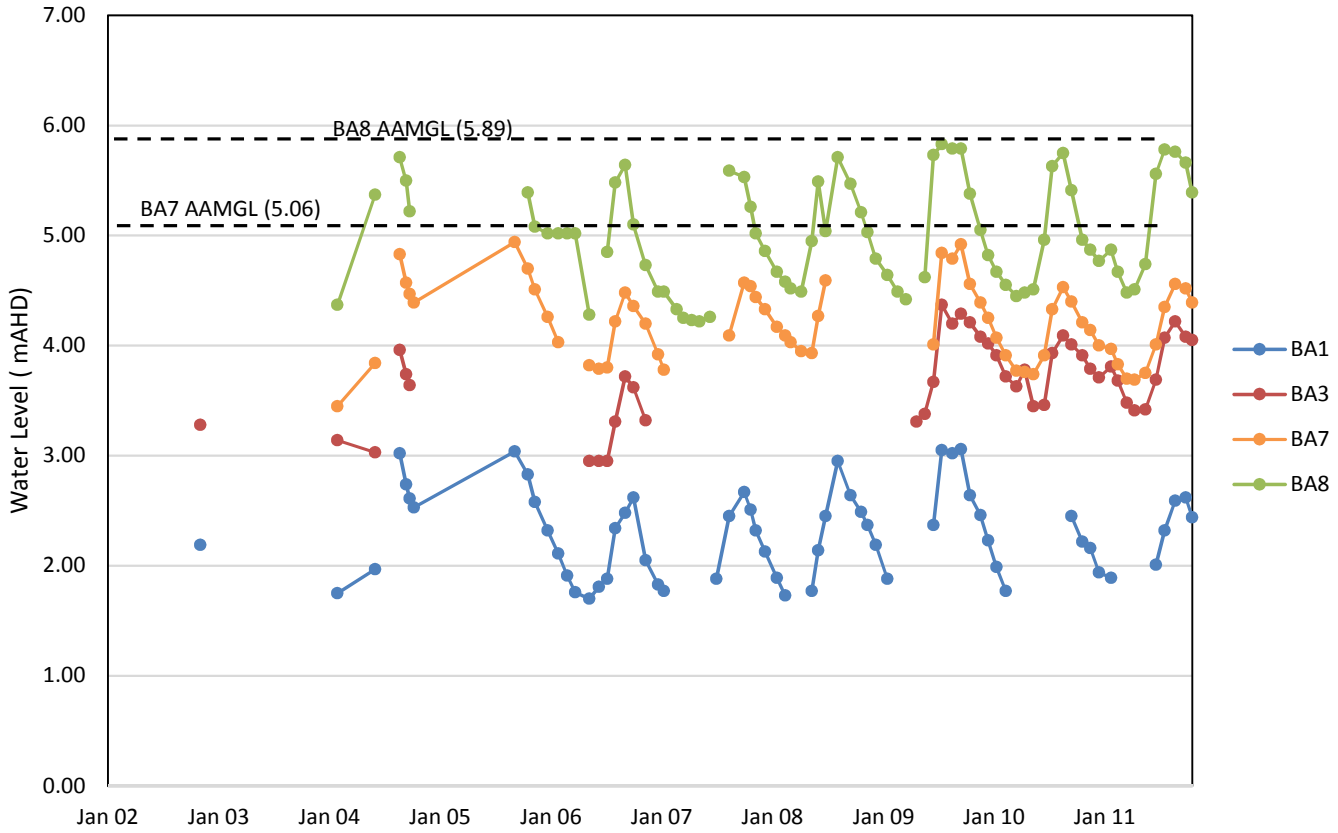
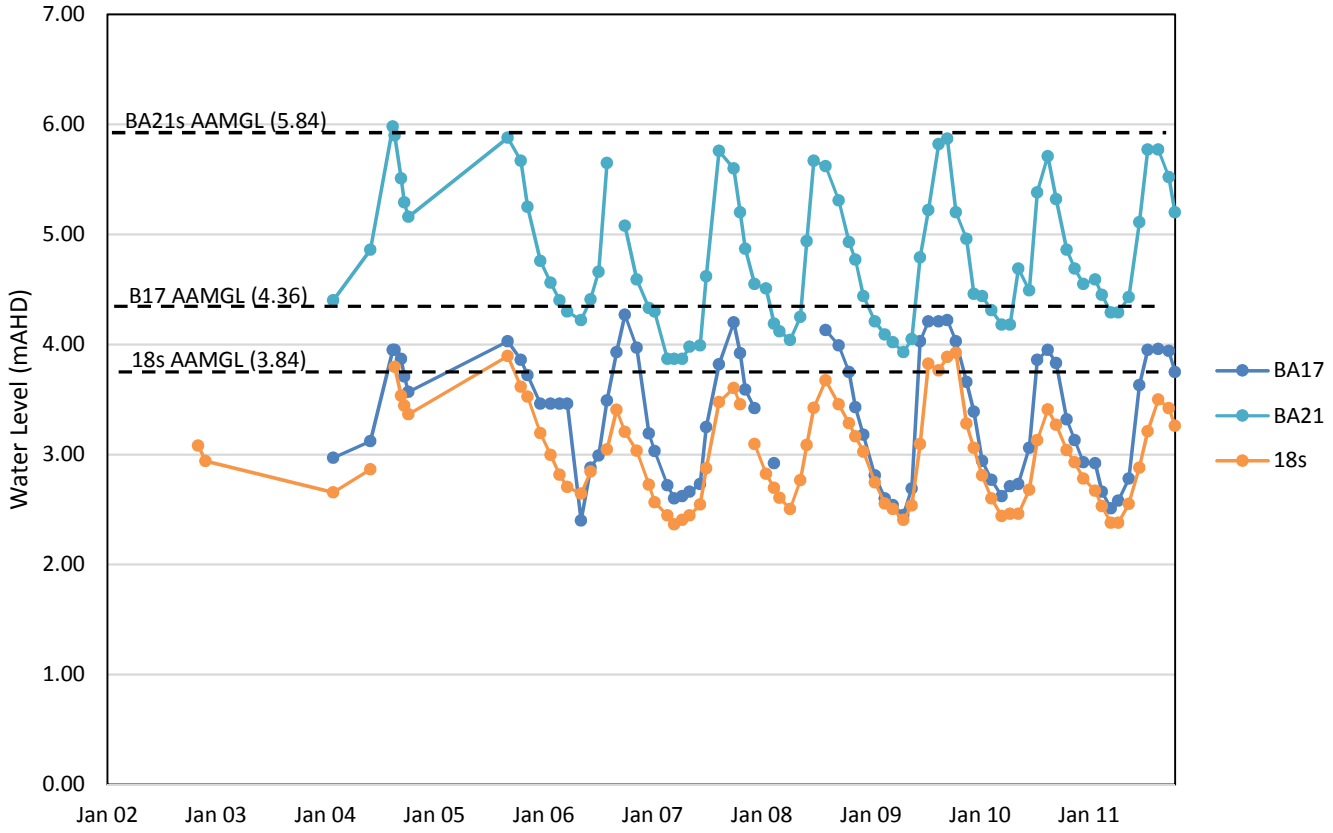
Figure 15: Eastern Bore Level Time Series: 2002 - 2011





Data Source:

Job No. J6049

East Busselton Estate Pty Ltd
Provence: LWMS

Figure 16: Western Bore Level Time Series: 2002 - 2011

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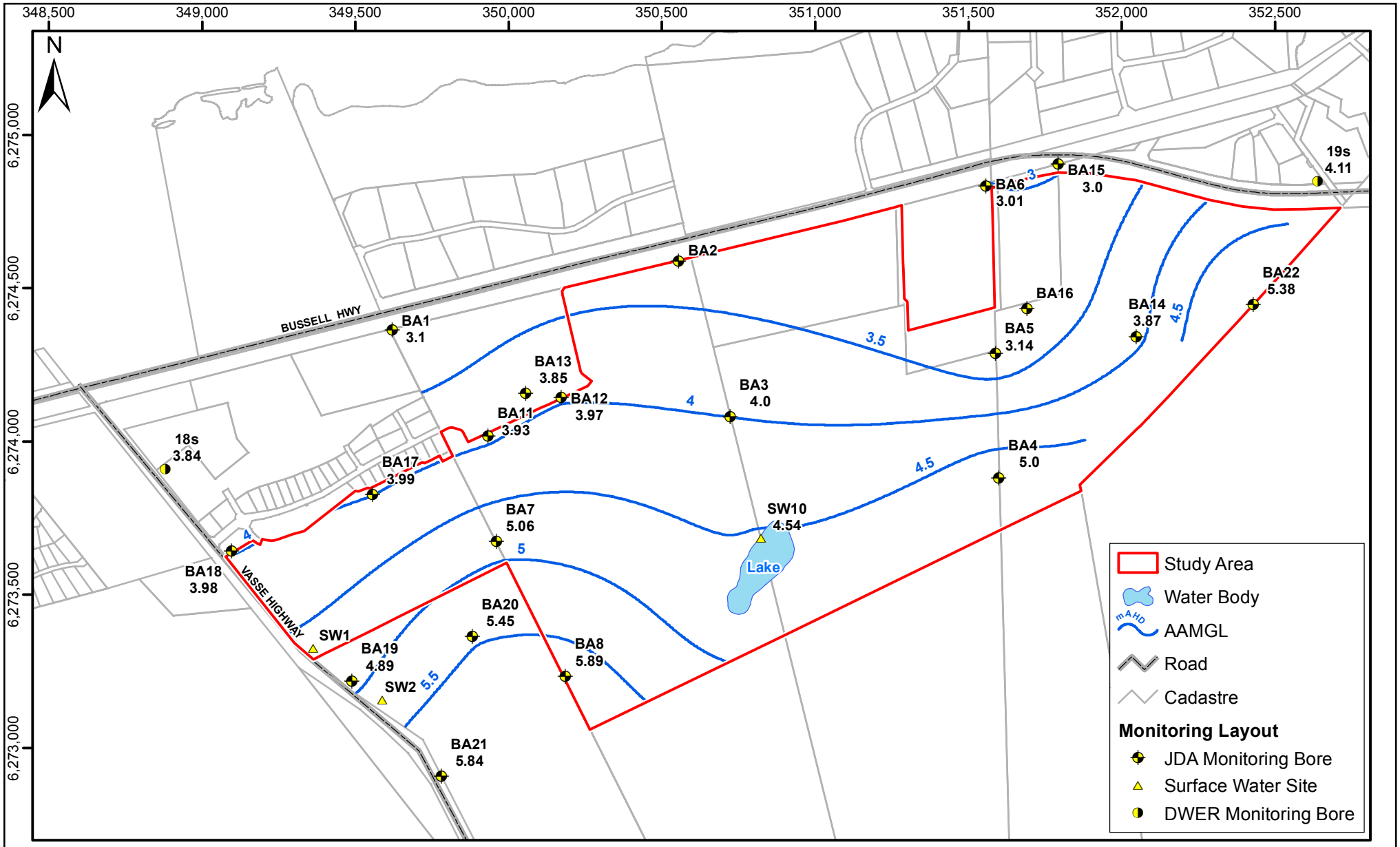

Data Source:

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049
Scale: 1:17,000 @A4

0 250 500 750 1,000 Metres

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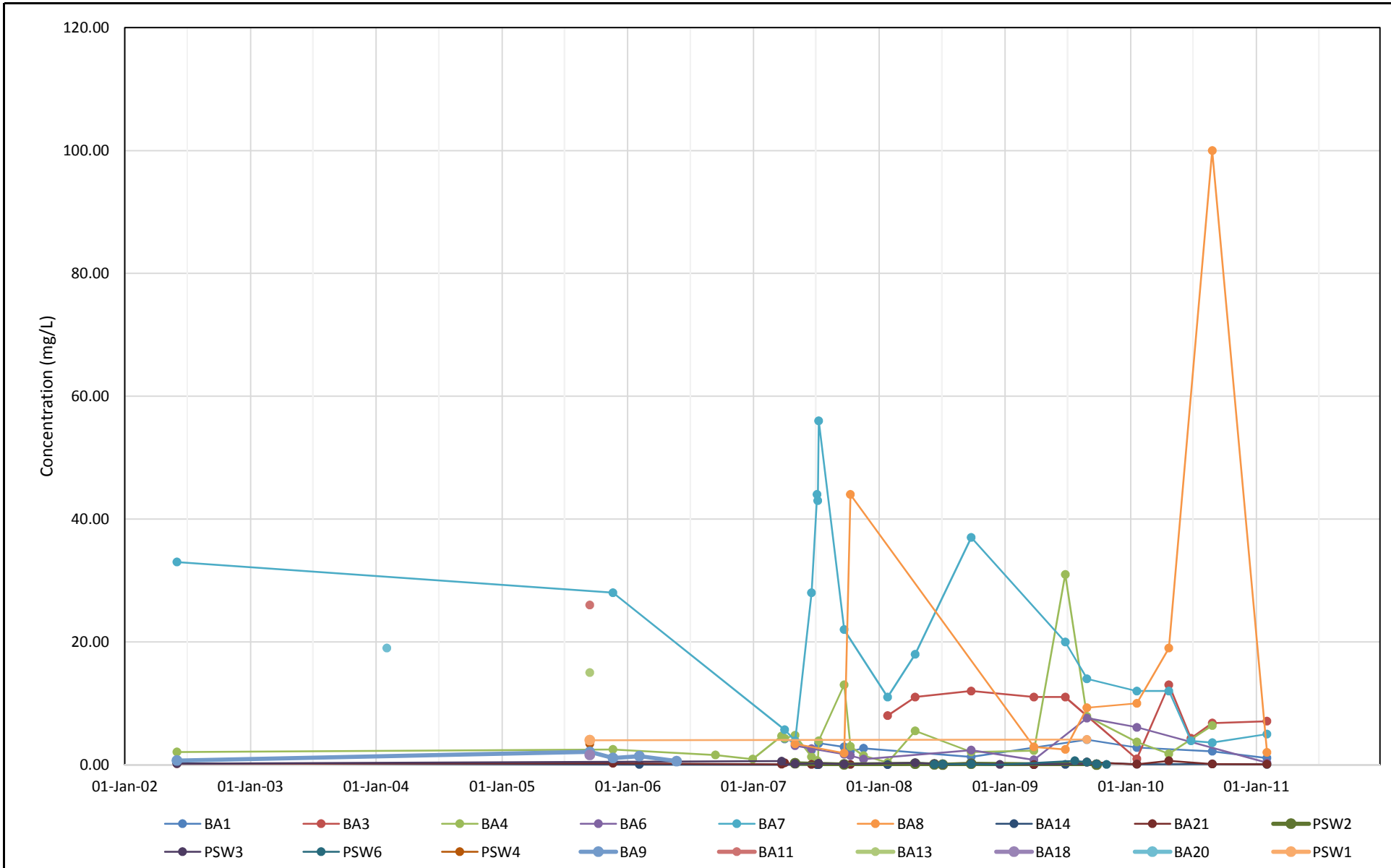
Figure 17: Revised AAMGL



Data Source:

Job No. J6049

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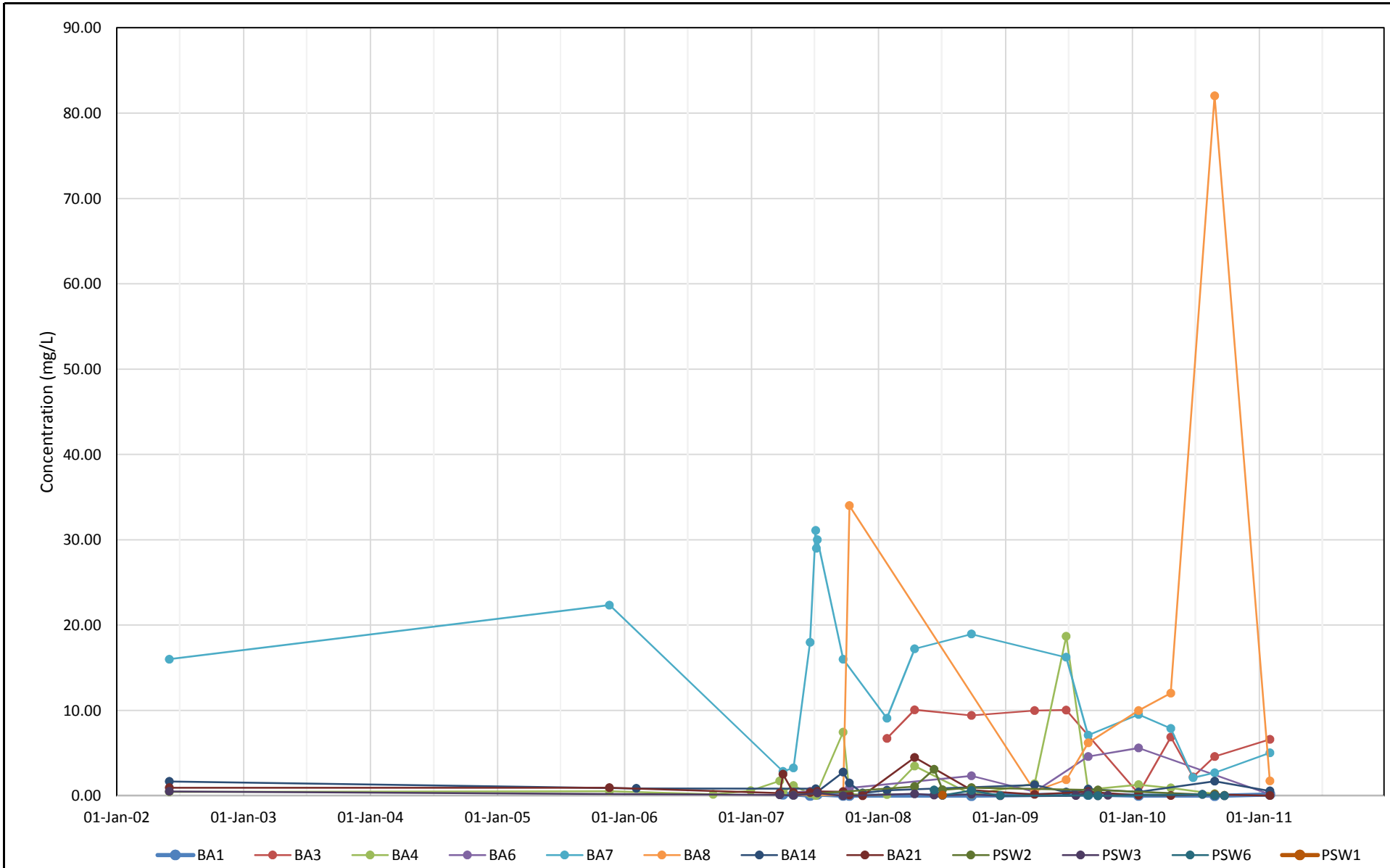
Figure 18: Total Nitrogen (TN) Groundwater Concentration Time Series



Data Source:

Job No. J6049

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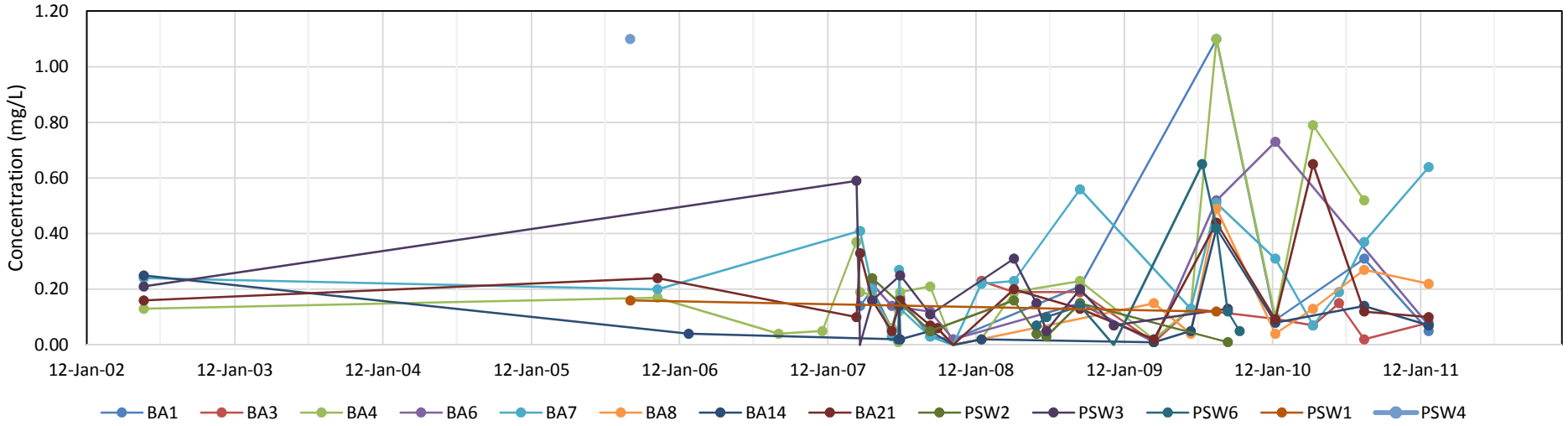
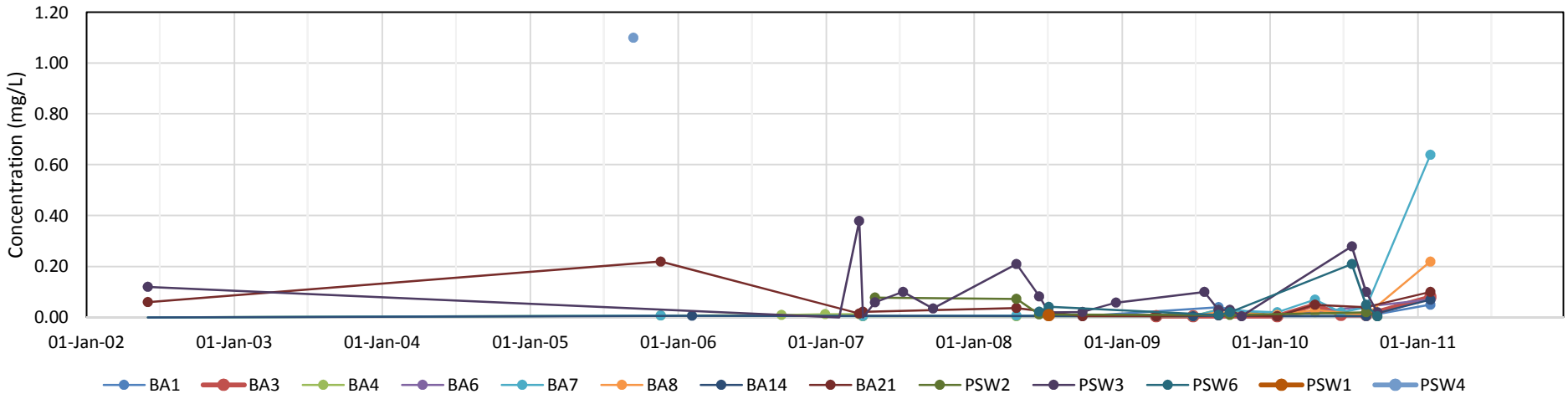
Figure 19: Dissolved Inorganic Nitrogen (DIN) Groundwater Concentration Time Series





Data Source:

Job No. J6049

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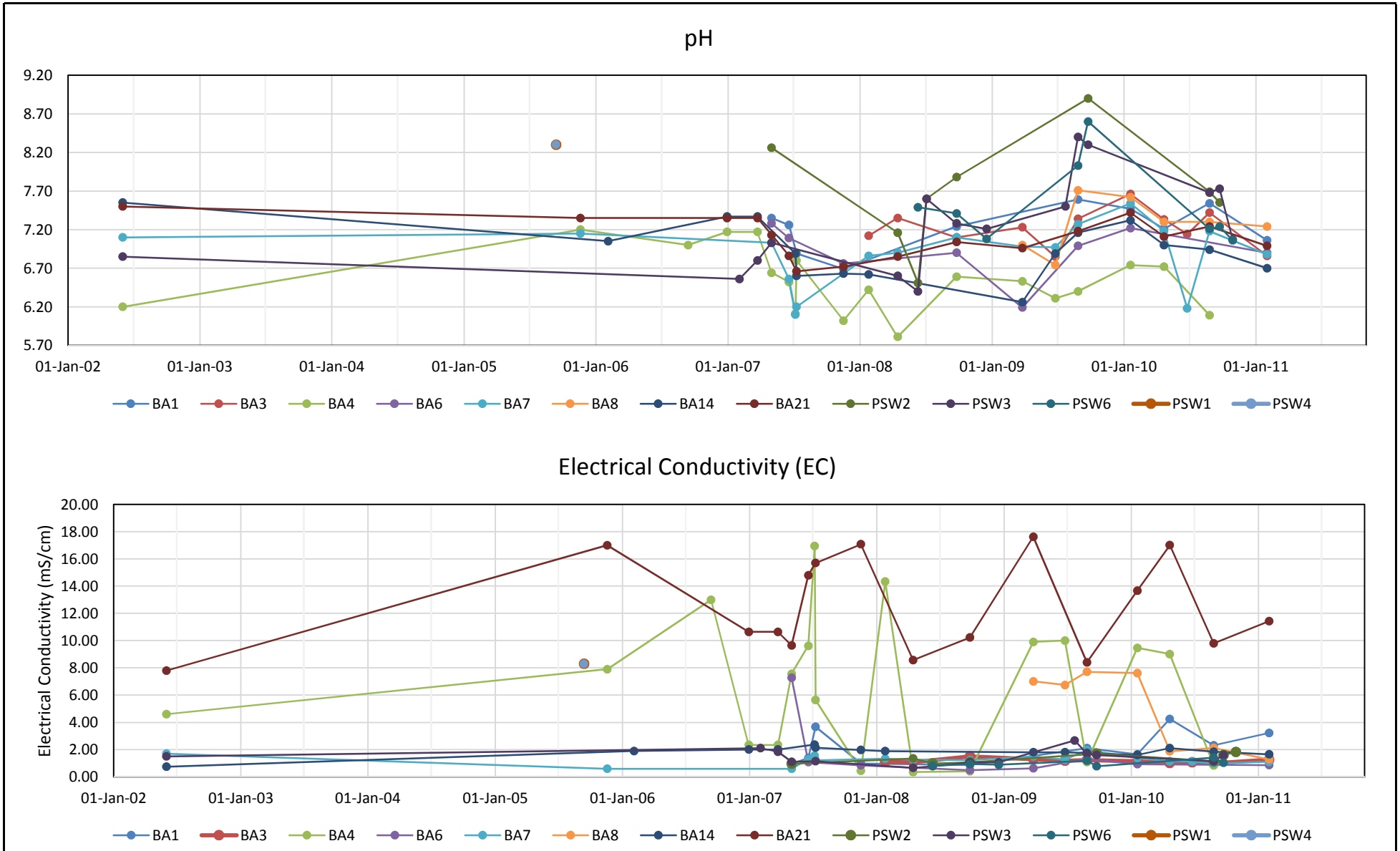
Figure 20: Total Phosphorus (TP) & Dissolved Inorganic Phosphorus (FRP or PO_4-P) Groundwater Concentration Time Series



Data Source:

Job No. J6049

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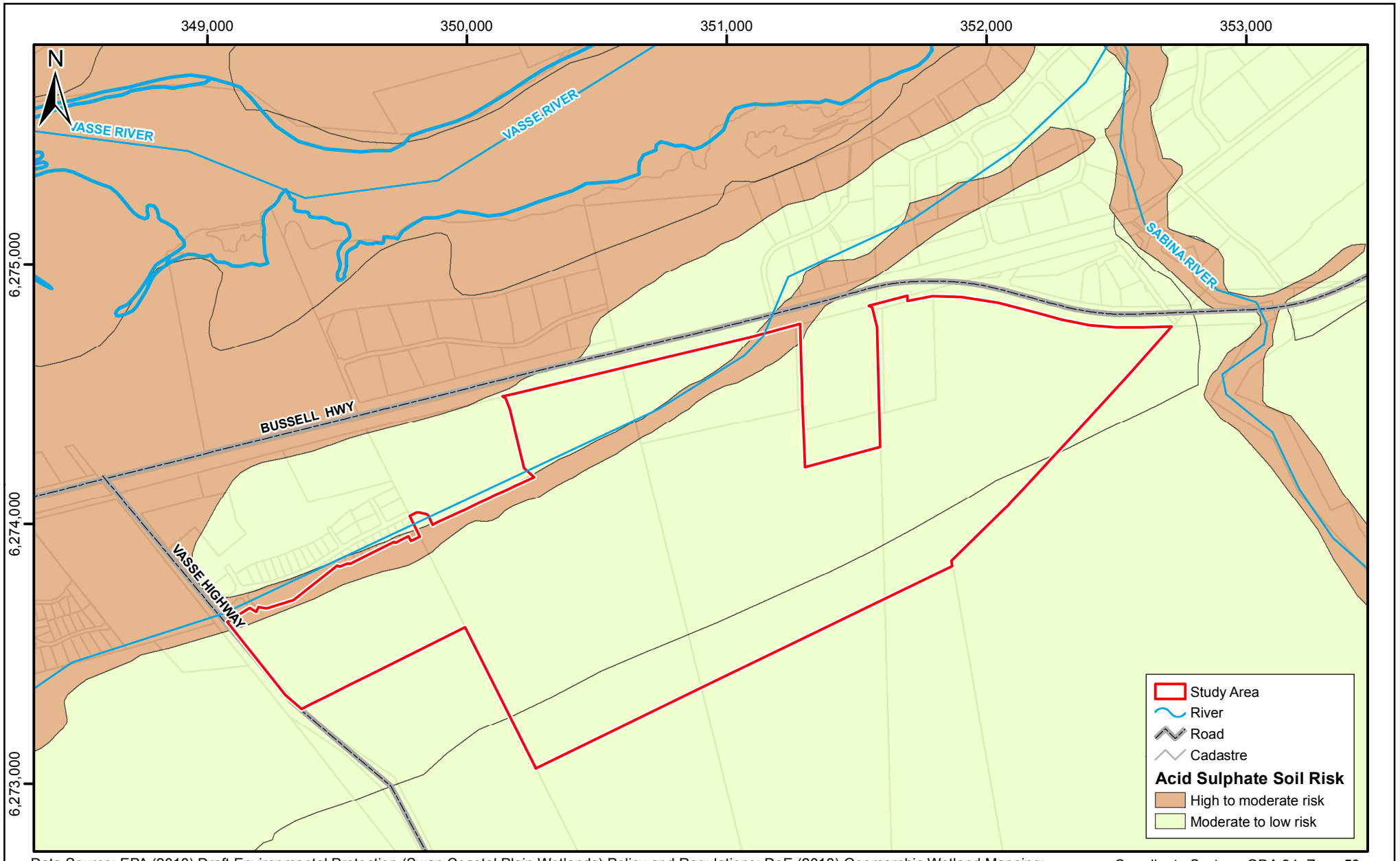
Figure 21: pH & Electrical Conductivity (EC) Groundwater Concentration Time Series



Data Source: EPA (2013) Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations; DoE (2013) Geomorphic Wetland Mapping;

Coordinate System: GDA 94, Zone 50

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Job No. J6049
Scale: 1:20,000 @A4

0 250 500 750 1,000 Metres

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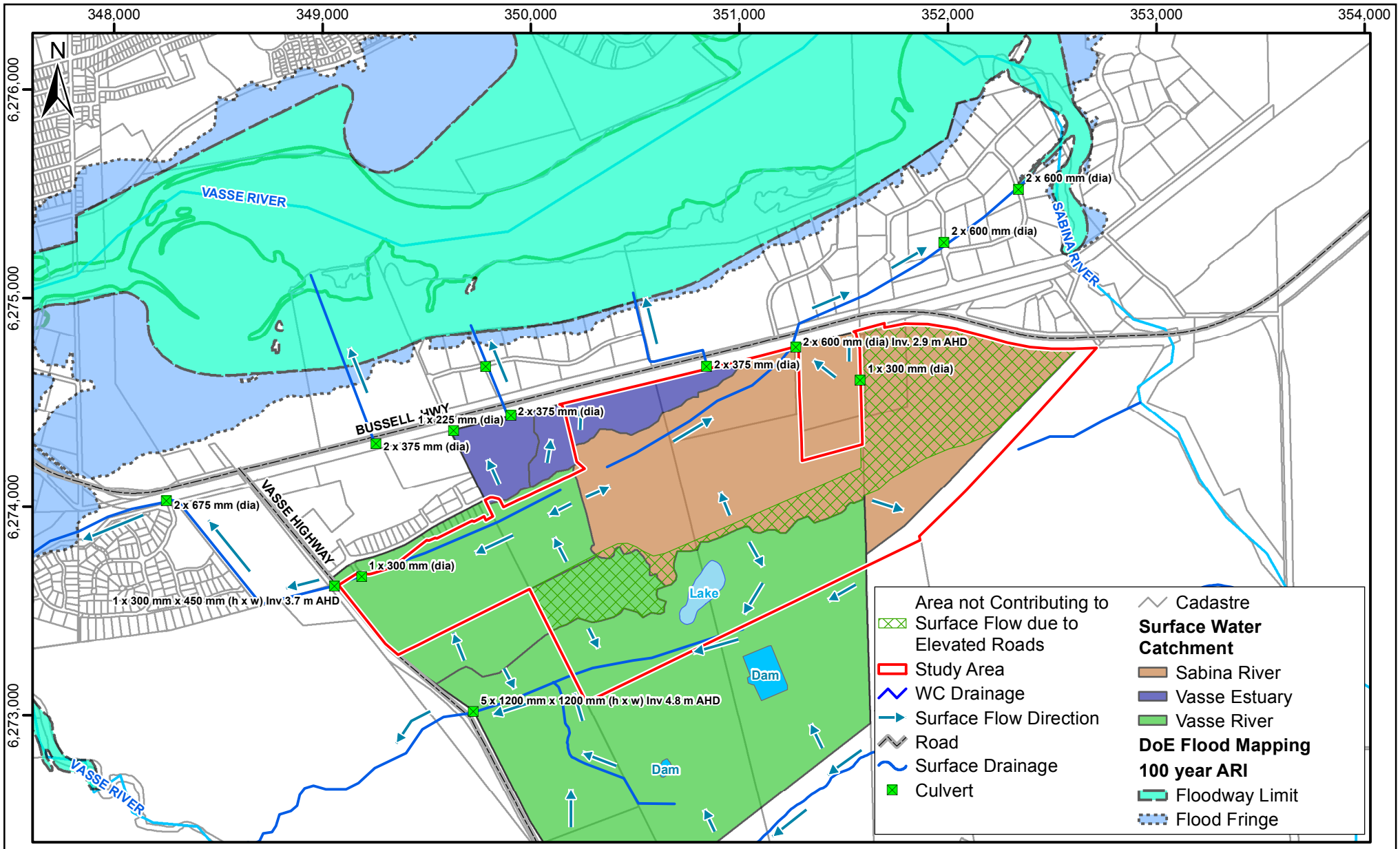
Figure 22: Acid Sulphate Soil Mapping



Data Source: WC (2001) Drainage; DoE Busselton Regional Flood Study, Floodplain Mapping;

Coordinate System: GDA 94, Zone 50

JDA

Job No. J6049

Scale: 1:25,000 @A4

0 250 500 750 1,000 Metres

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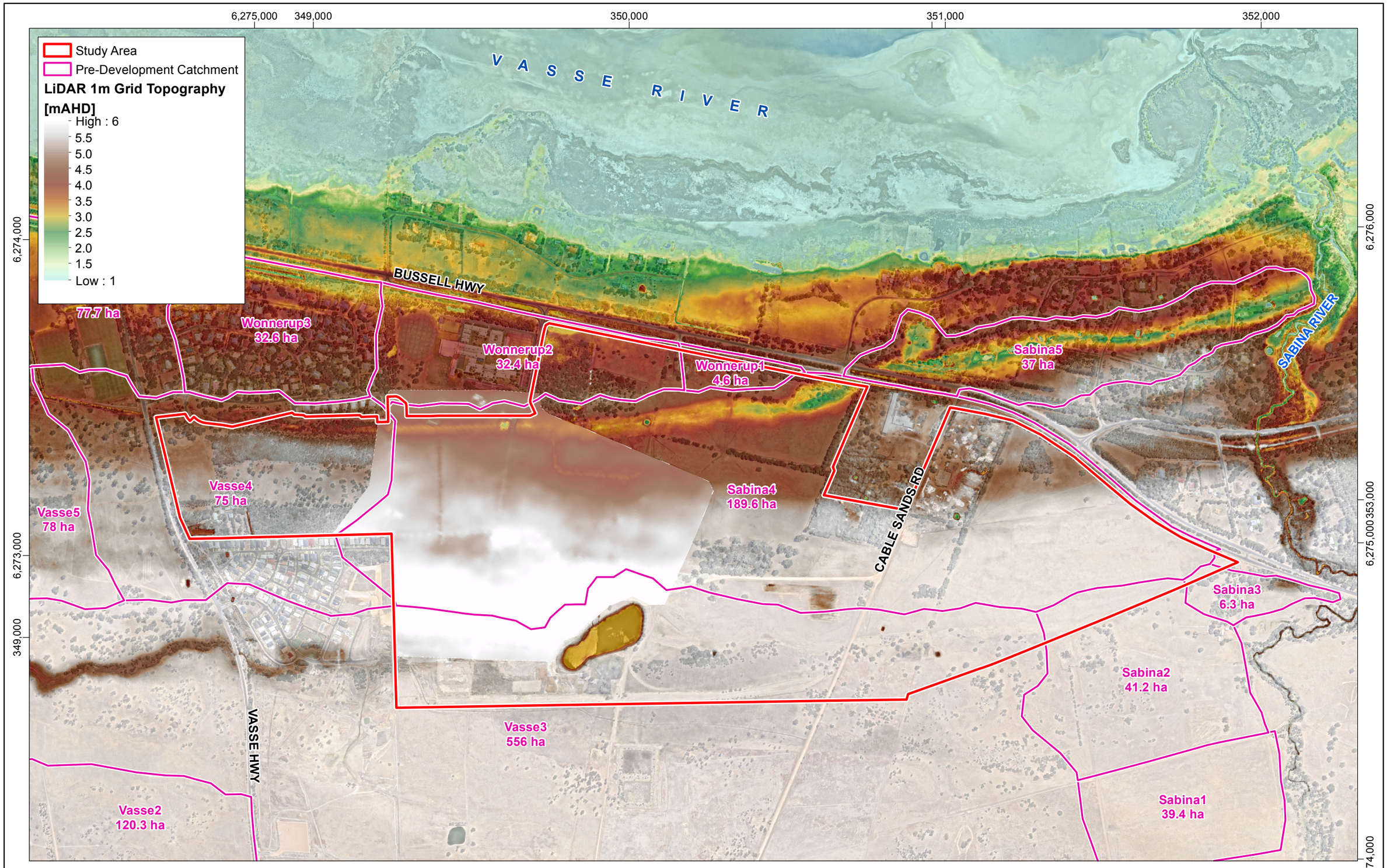
Figure 23: Pre Development Surface Drainage Features



Data Source:

Coordinate System: GDA 94, Zone 50

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Job No. J6049
Scale: 1:12,500 @A3

0 500 1,000 1,500 2,000 Metres

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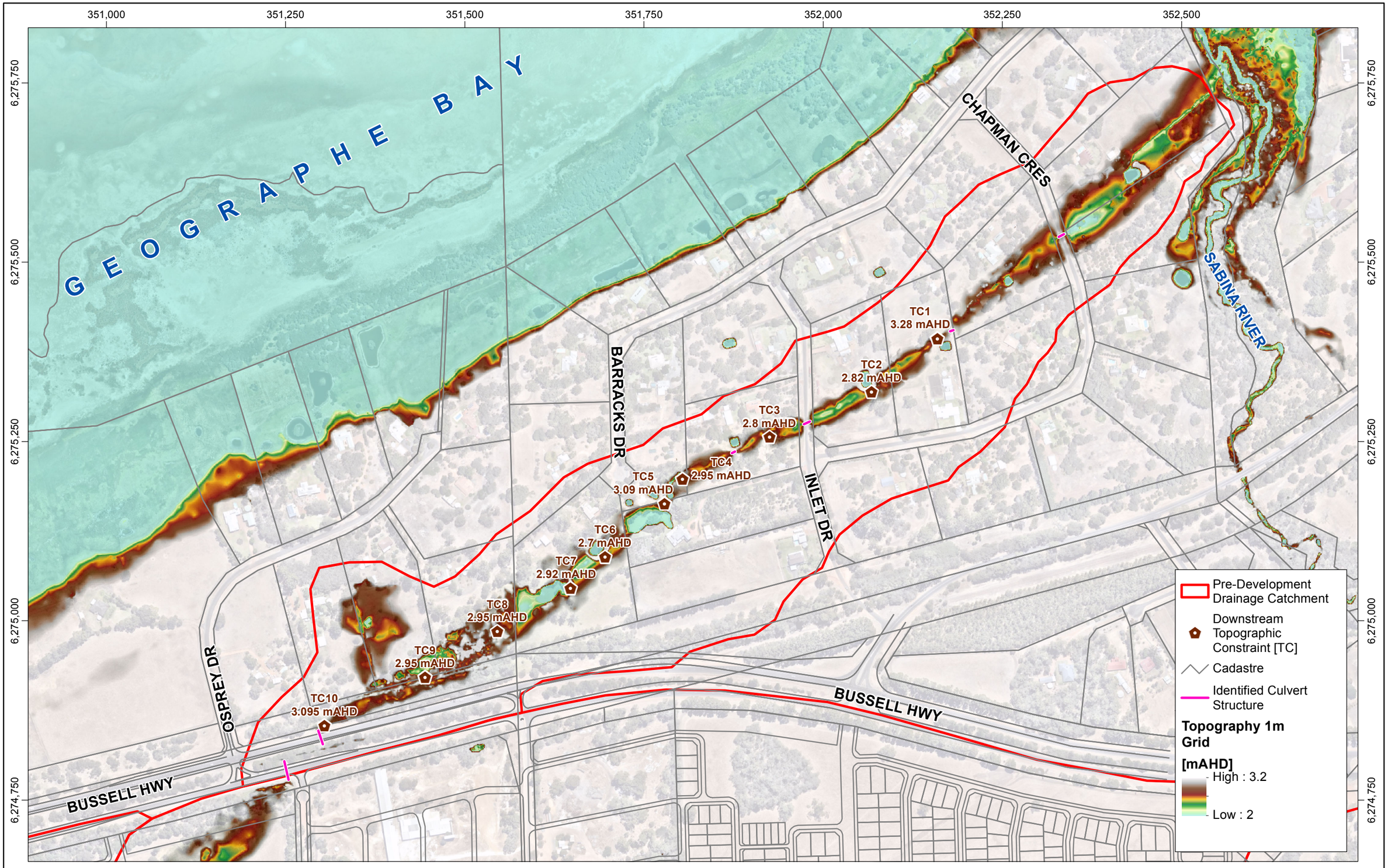
Figure 24: Surface Water Drainage, Pre-Development Catchments



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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Figure 25: Surface Water Drainage, Downstream Topographic Constraints

Data Source: Nearmap Digital Imagery, 19 August 2018;

Coordinate System: GDA 94, Zone 50

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Job No. J6049
Scale: 1:5,000 @A3

0 250 500 750 1,000 Metres

N

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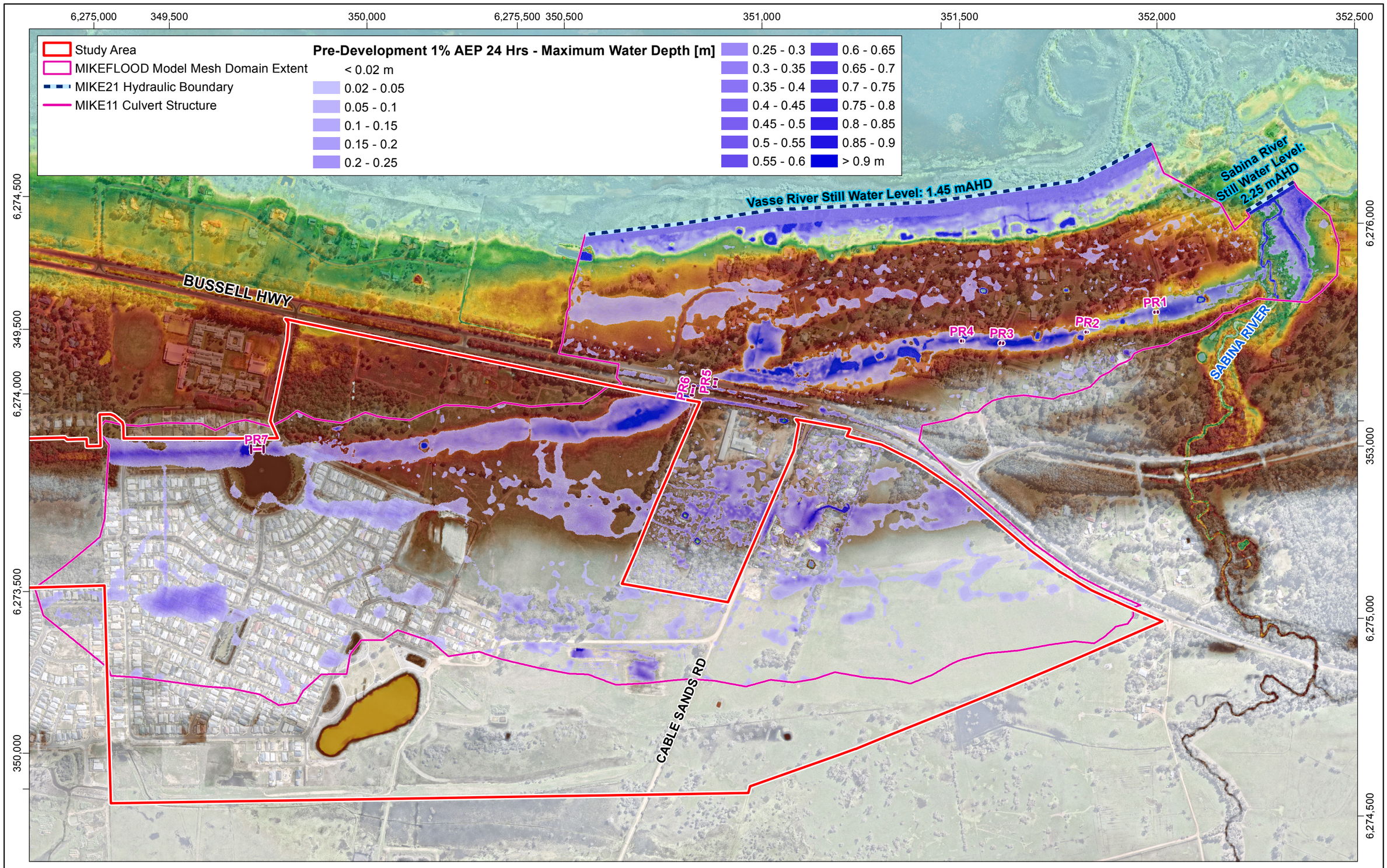
Figure 26: Downstream Swale Aerial Imagery, 19 August 2018



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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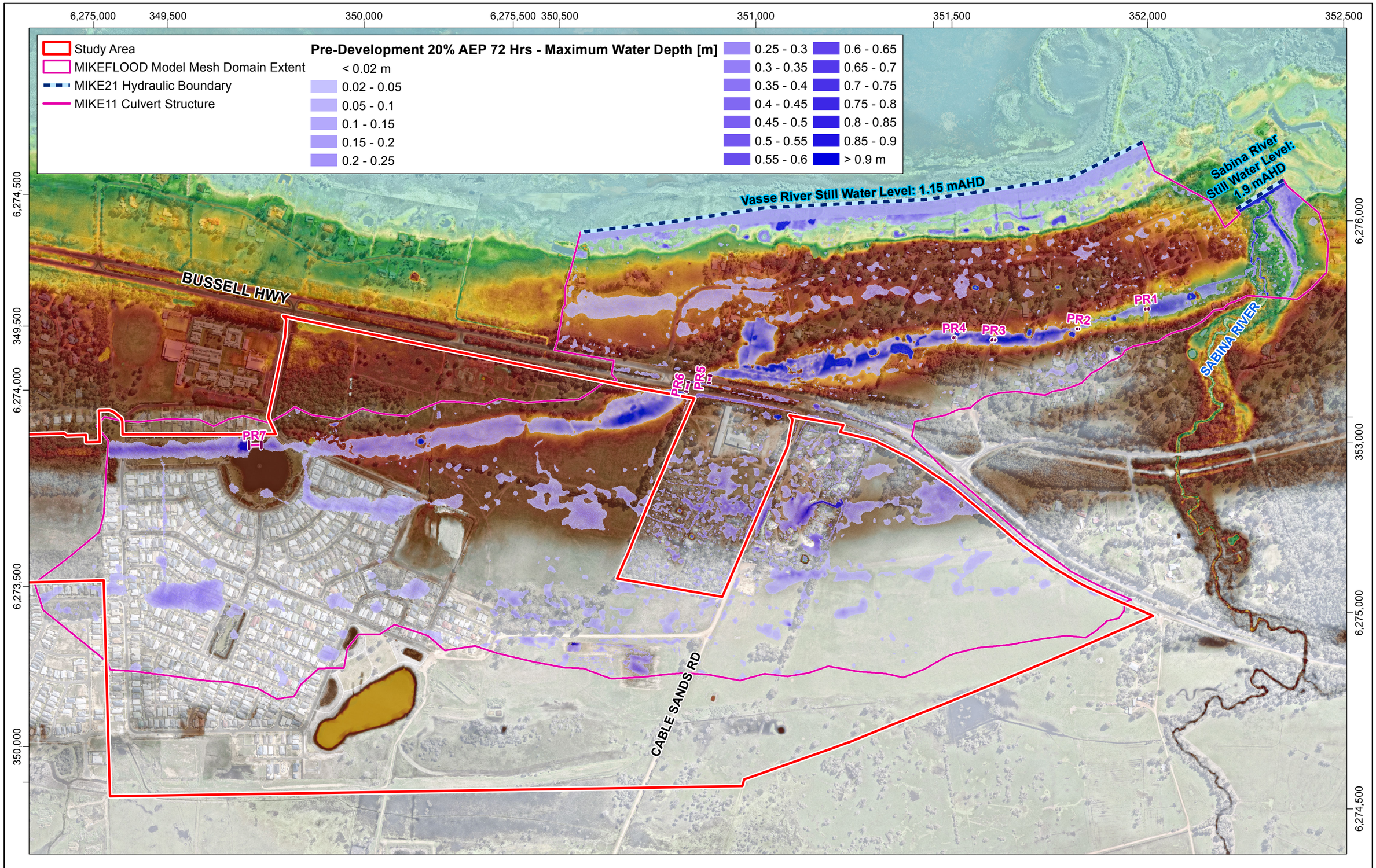
Figure 27: Pre-Development 1% AEP (100 yr ARI) Flood Mapping of Catchment to Sabina River



Data Source: Nearmap Digital Imagery, 19 August 2018;

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049
Scale: 1:10,000 @A3

0 200 400 600 800 Metres

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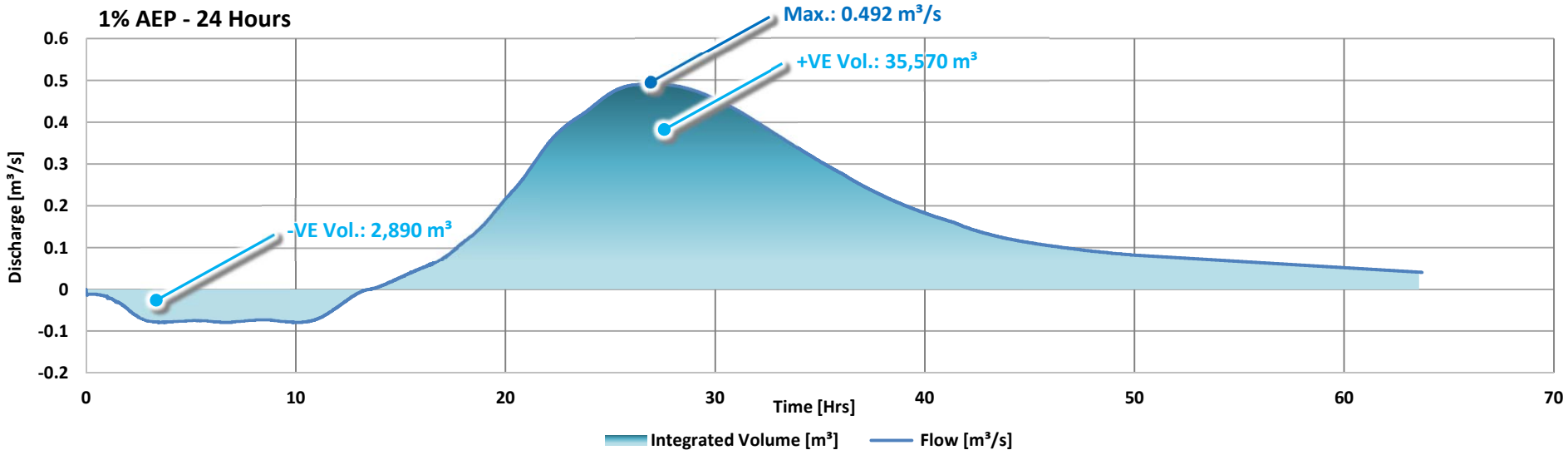
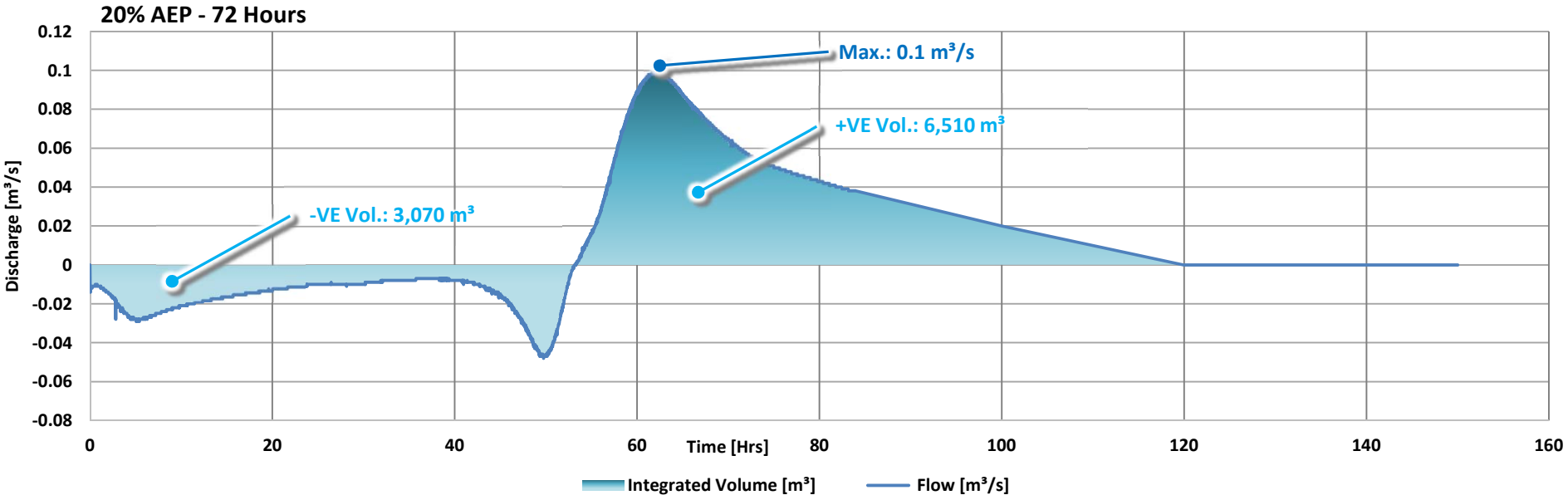
Provence: LWMS

Figure 28: Pre-Development 20% AEP (5 yr ARI) Flood Mapping of Catchment to Sabina River





Data Source:

Job No. J6049

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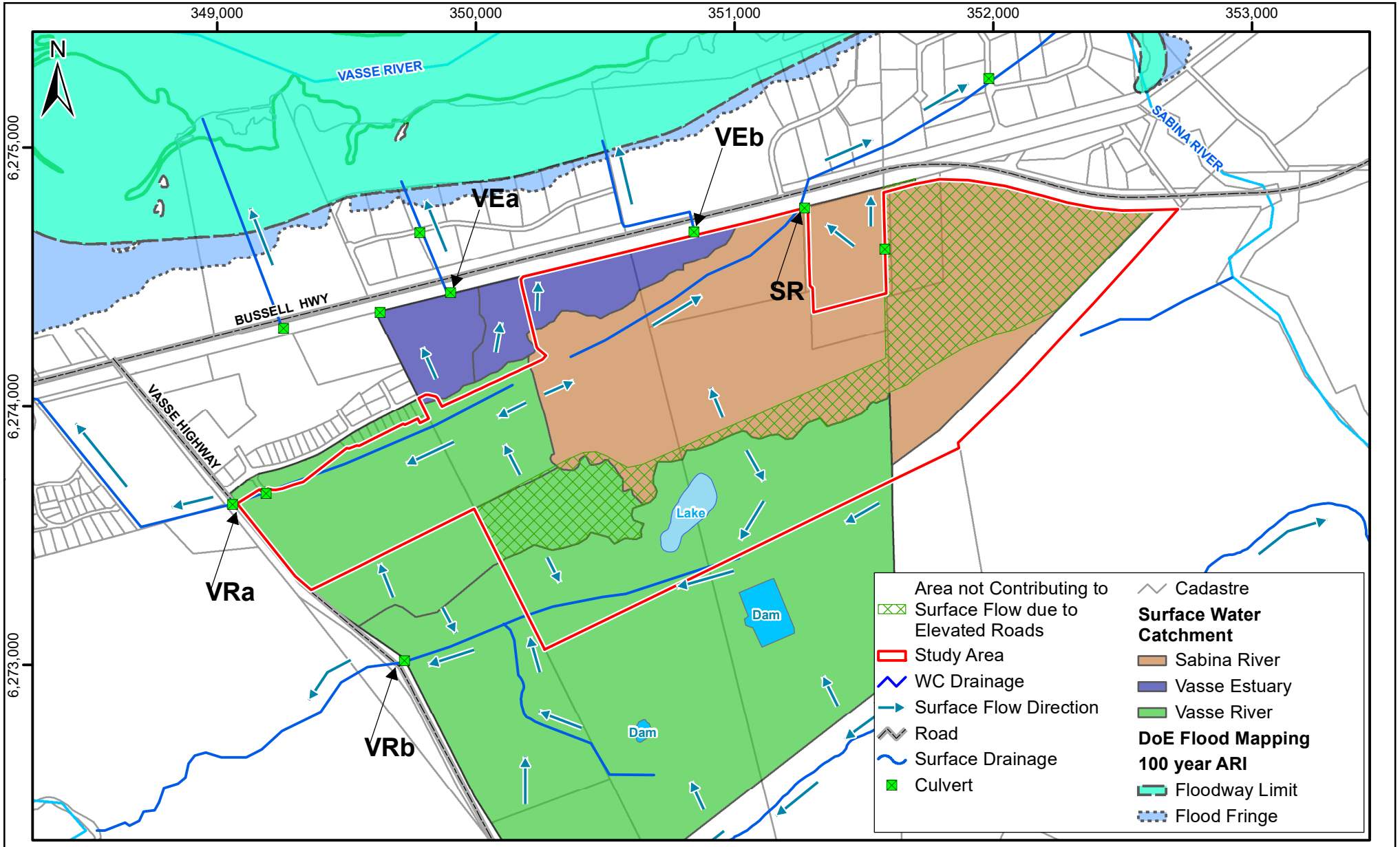
Provence: LWMS

Figure 29: Pre-Development Discharge Hydrographs at Bussell Hwy



Data Source: WC (2001) Drainage; DoE Busselton Regional Flood Study, Floodplain Mapping;

Coordinate System: GDA 94, Zone 50

JDA

Job No. J6049

Scale: 1:20,128 @A4

0 250 500 750 1,000 Metres

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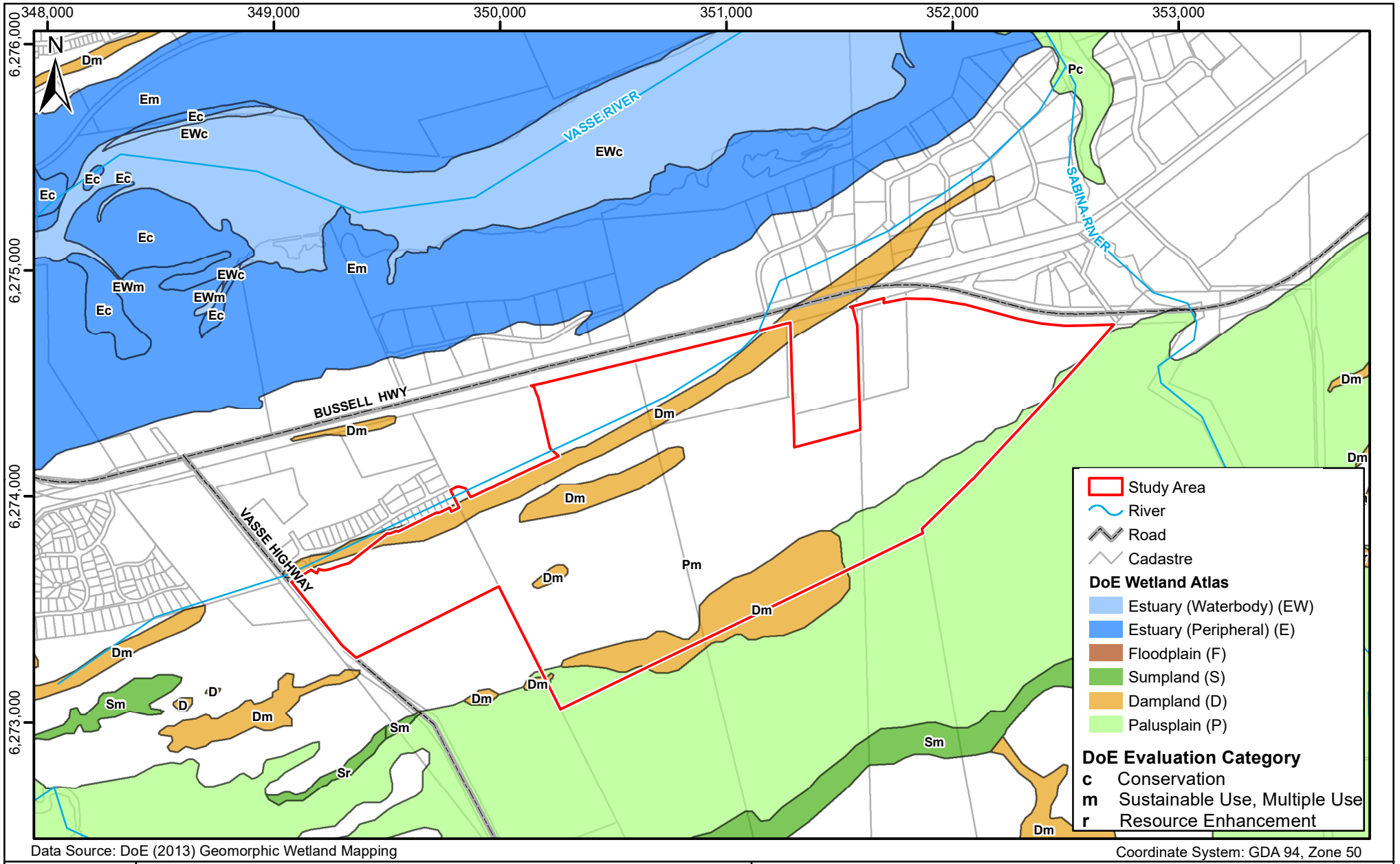
Figure 30: Surface water Monitoring & Catchment Outlets



Data Source: DoE (2013) Geomorphic Wetland Mapping

Coordinate System: GDA 94, Zone 50

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Job No. J6049

Scale: 1:23,000 @A4

0 250 500 750 1,000 Metres

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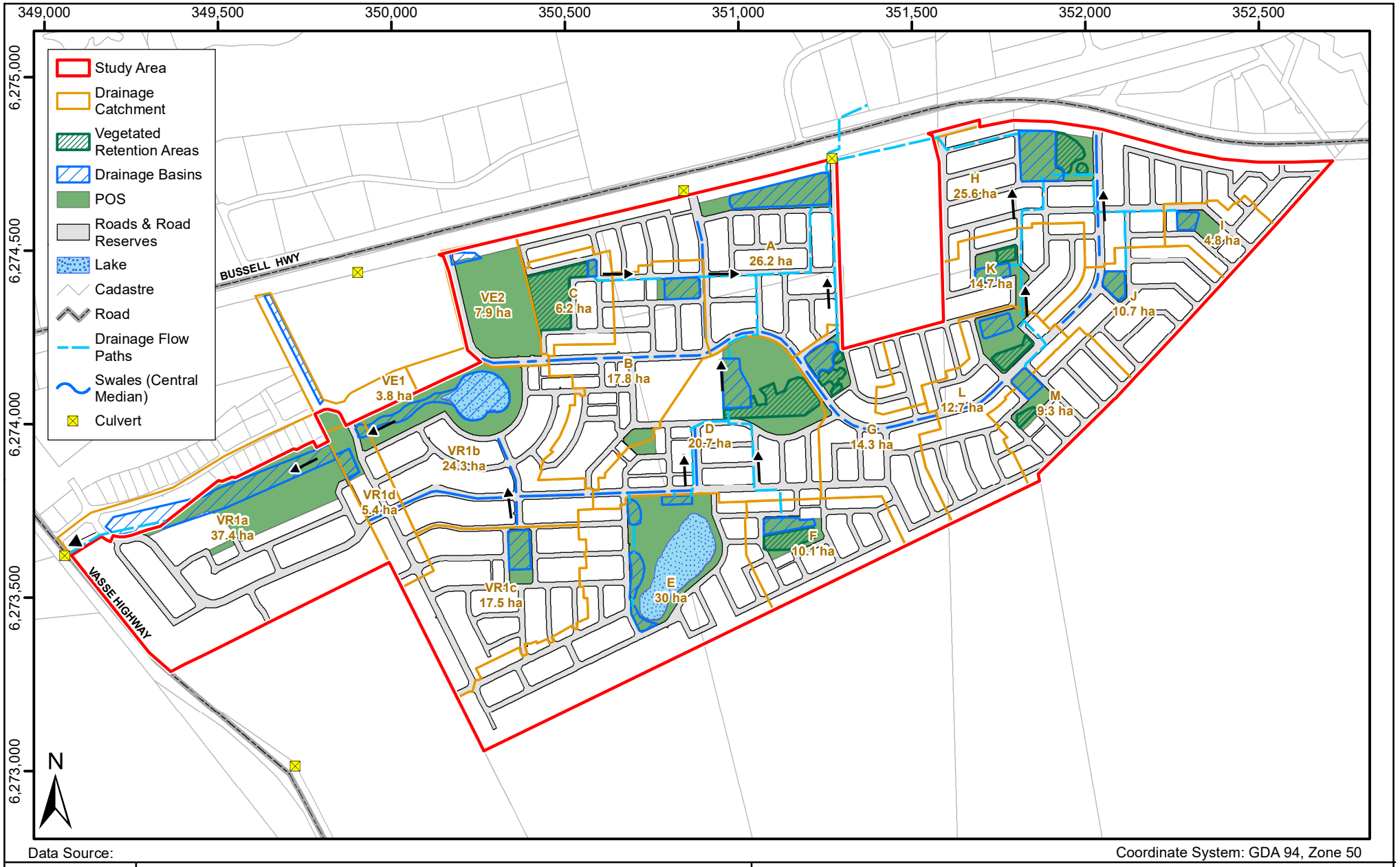
Figure 31: Wetland Mapping



Data Source:

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:15,000 @A4

0 250 500 750 1,000 Metres

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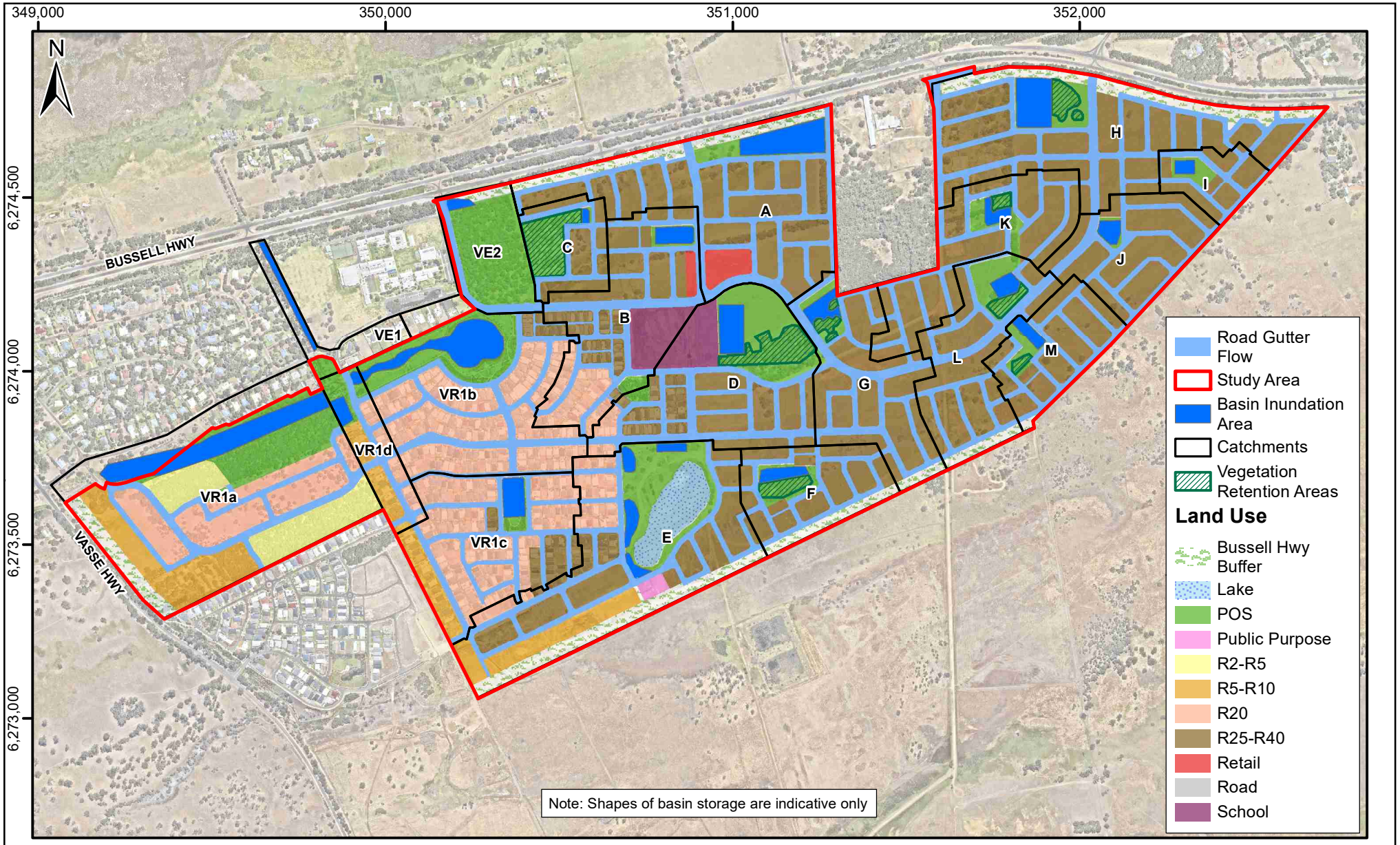
Figure 32: Proposed Stormwater Management System



Data Source: Nearmap Digital Imagery, 2 December 2015; RPS (2019) Structure Plan Overall, Plan Ref. 130316-2-003M, 23 Oct 2019.

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049

Scale: 1:15,000 @A4

0 400 800 1,200 1,600 Metres

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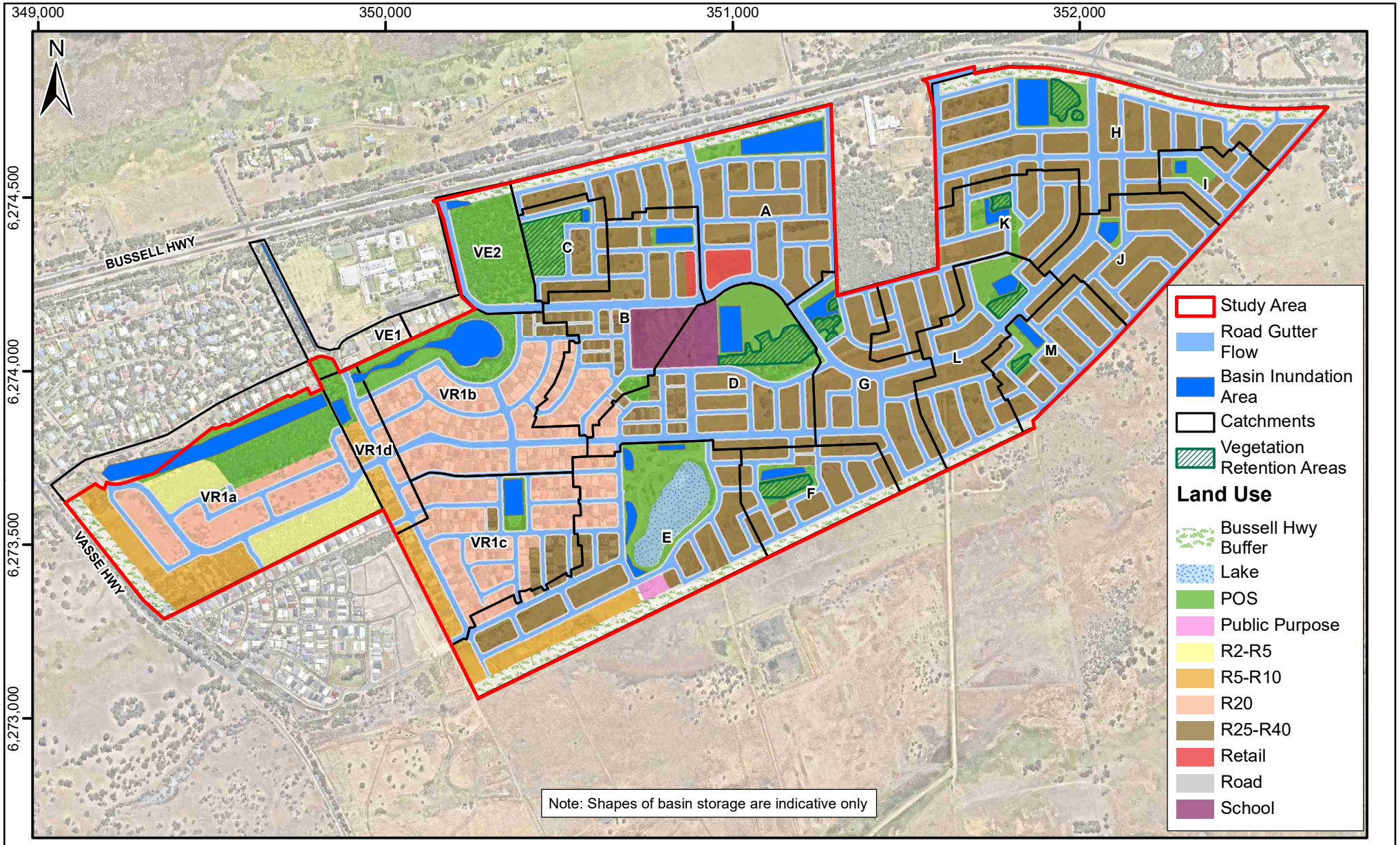
Figure 33: 1% AEP (100 Year ARI) Flood Event Plan (Major Event)



Data Source: Nearmap Digital Imagery, 2 December 2015; RPS (2019) Structure Plan Overall, Plan Ref. 130316-2-003M, 23 Oct 2019.

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049

Scale: 1:15,000 @A4

0 400 800 1,200 1,600 Metres

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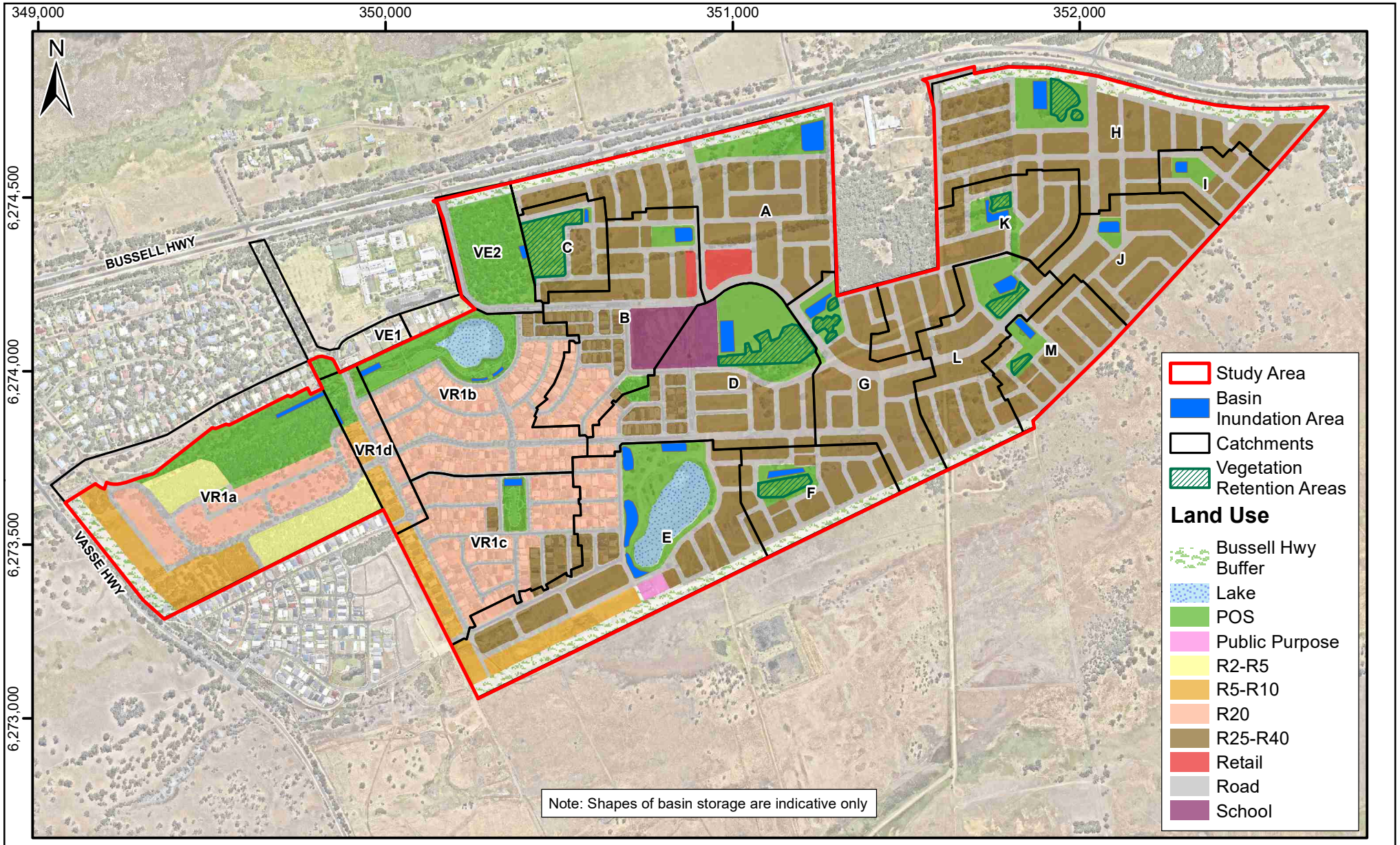
Figure 34: 20% AEP (5 Year ARI) Flood Event Plan (Minor Event)



Data Source: Nearmap Digital Imagery, 2 December 2015; RPS (2019) Structure Plan Overall, Plan Ref. 130316-2-003M, 23 Oct 2019.

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049

Scale: 1:15,000 @A4

0 300 600 900 1,200 Metres

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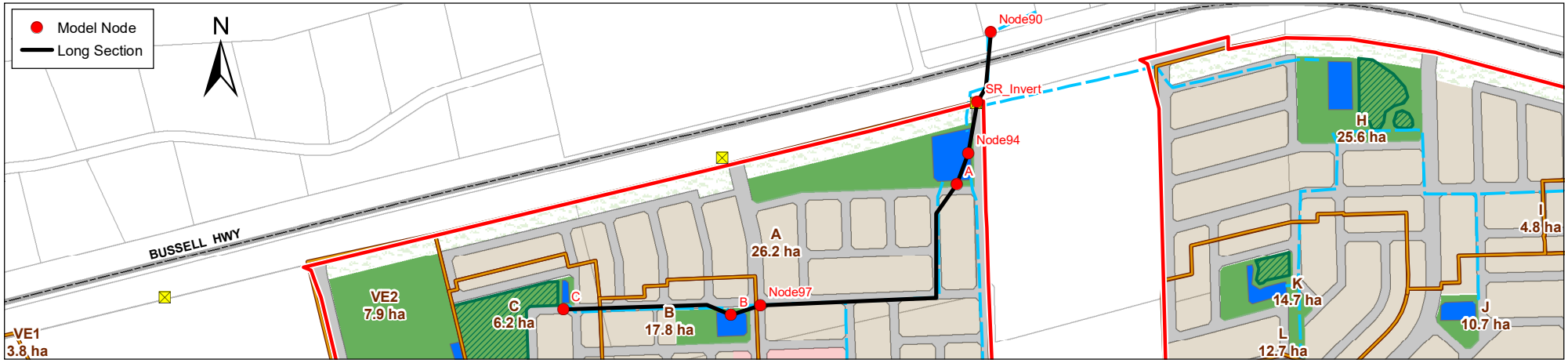
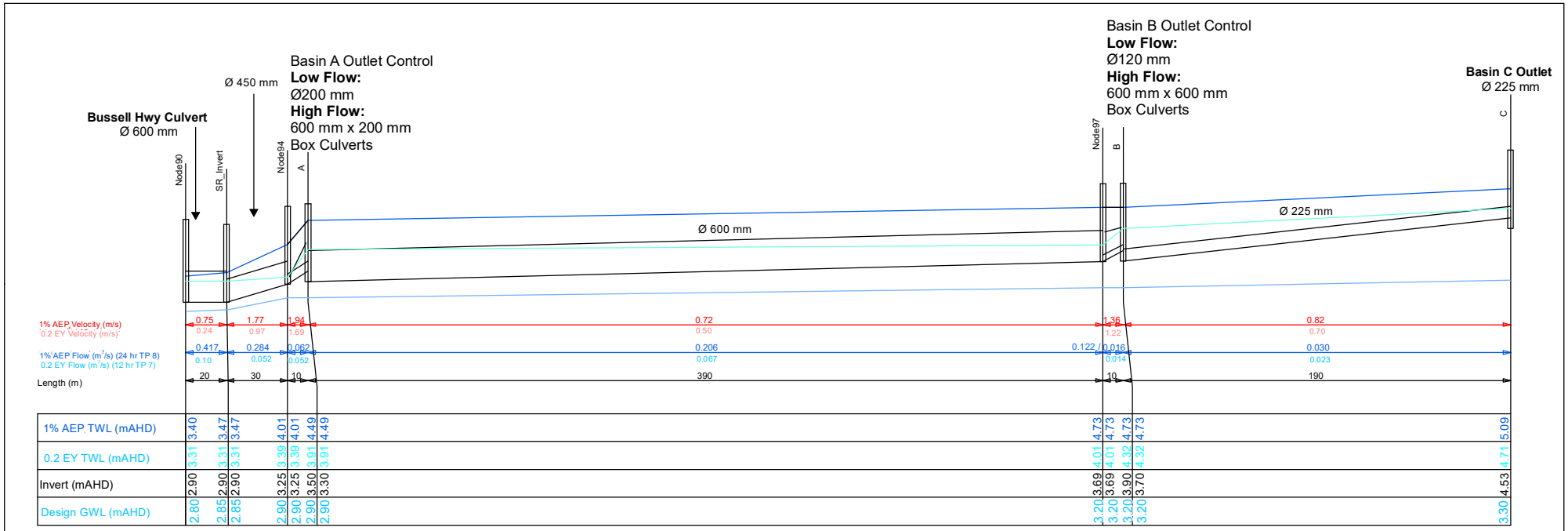
Provence: LWMS

Figure 35: 63% AEP (1 Year ARI) 1 Hour Flood Event Plan (Small Event Management)





Critical Duration at Bussell Hwy Culvert: 0.2 EY (12 hr), 1% AEP (24 hr)
Mean Temporal Pattern at Outlet: 0.2 EY (TP 7), 1% AEP (TP 8)

Data Source: JDA (2019) XP Model

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049
Scale: 1:10,000 @A4

0 100 200 300 400 Meters

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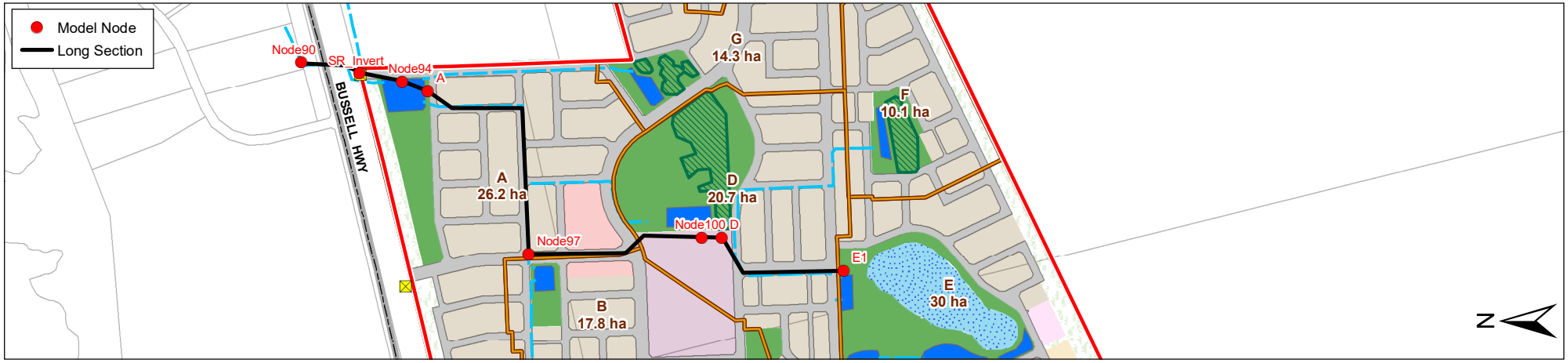
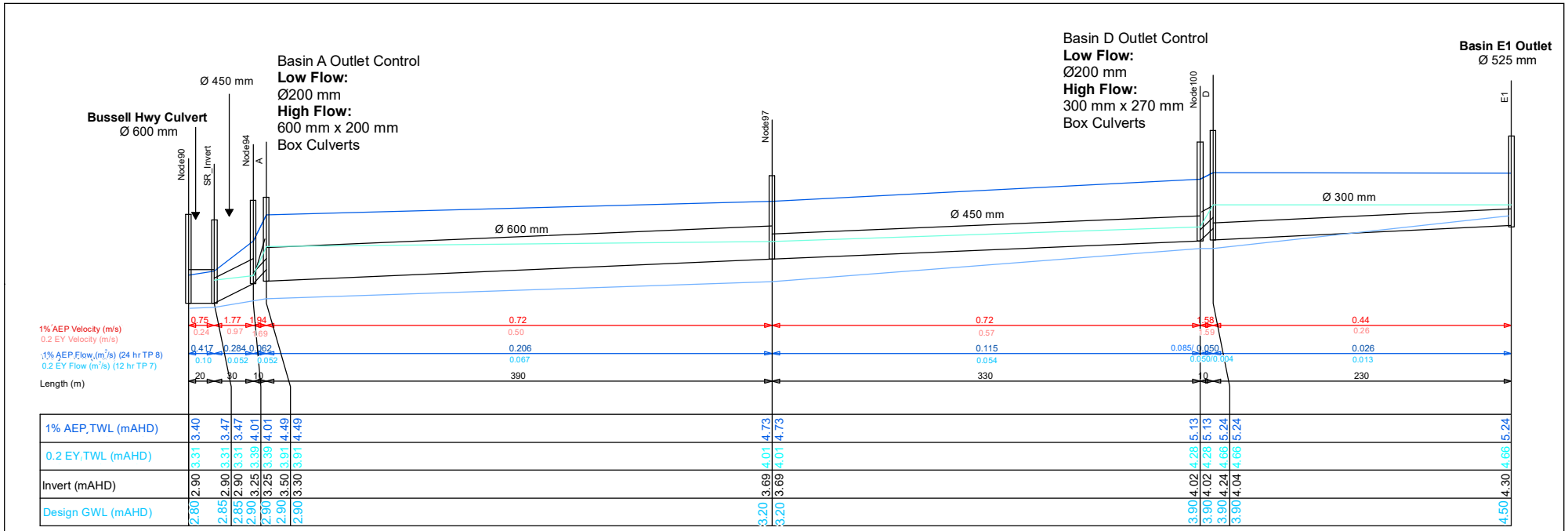
Satterly Property Group
Provence - Revised Stormwater Modelling

Figure 36: Drainage Long Section, Basin C to Bussell Hwy Outlet





Critical Duration at Bussell Hwy Culvert: 0.2 EY (12 hr), 1% AEP (24 hr)
Mean Temporal Pattern at Outlet: 0.2 EY (TP 7), 1% AEP (TP 8)

Data Source: JDA (2019) XP Model

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049
Scale: 1:12,000 @A4
0 100 200 300 400
Meters

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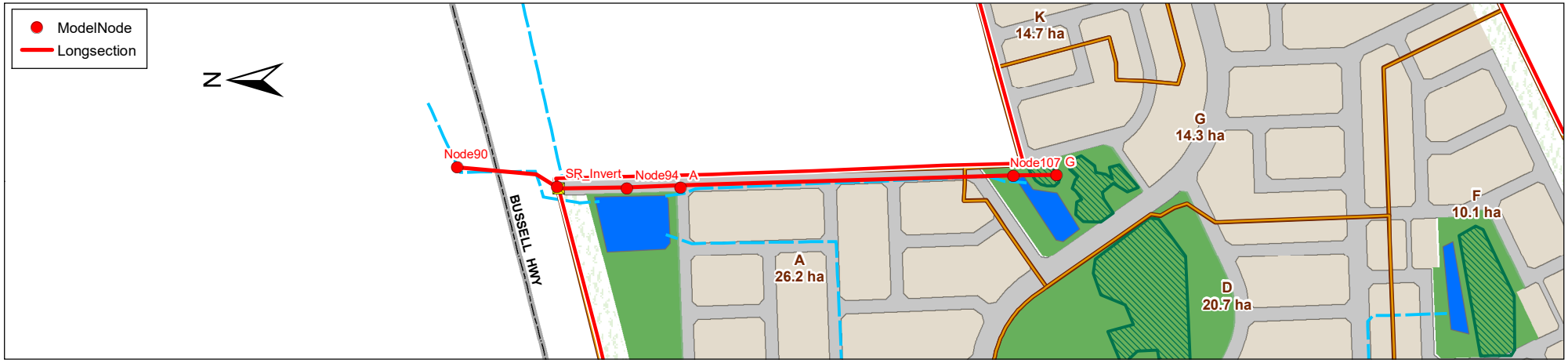
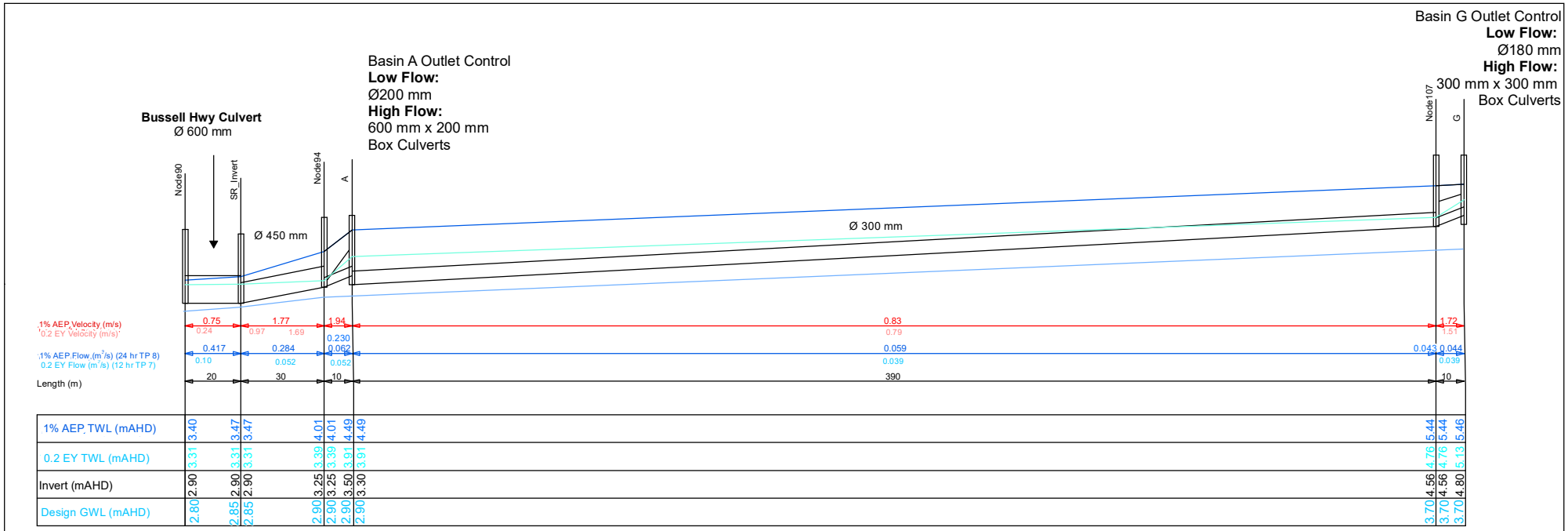
Provence - Revised Stormwater Modelling

Figure 37: Drainage Long Section, Basin E1 to Bussell Hwy Outlet





Critical Duration at Bussell Hwy Culvert: 0.2 EY (12 hr), 1% AEP (24 hr)
Mean Temporal Pattern at Outlet: 0.2 EY (TP 7), 1% AEP (TP 8)

Data Source: JDA (2019) XP Model

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:7,000 @A4

0 100 200 300 400 Meters

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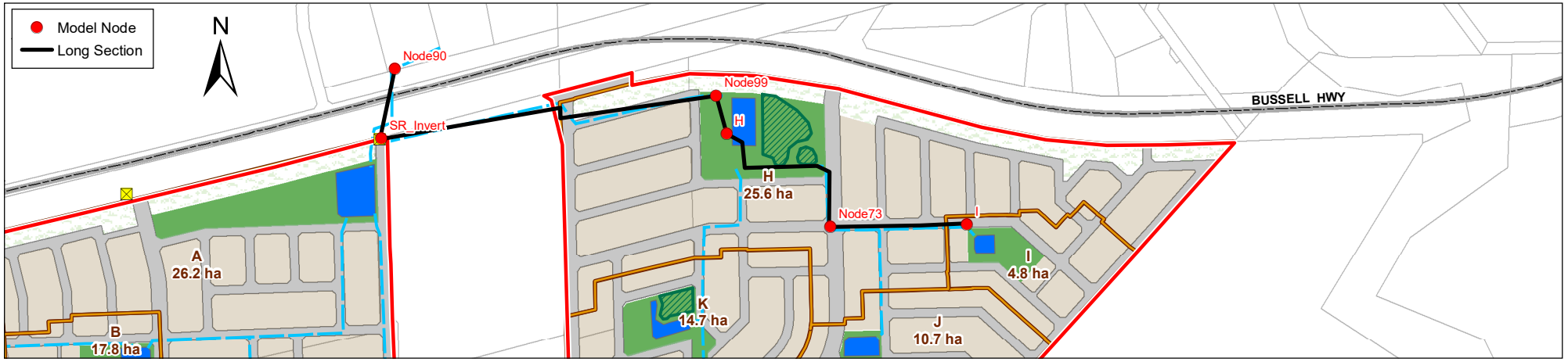
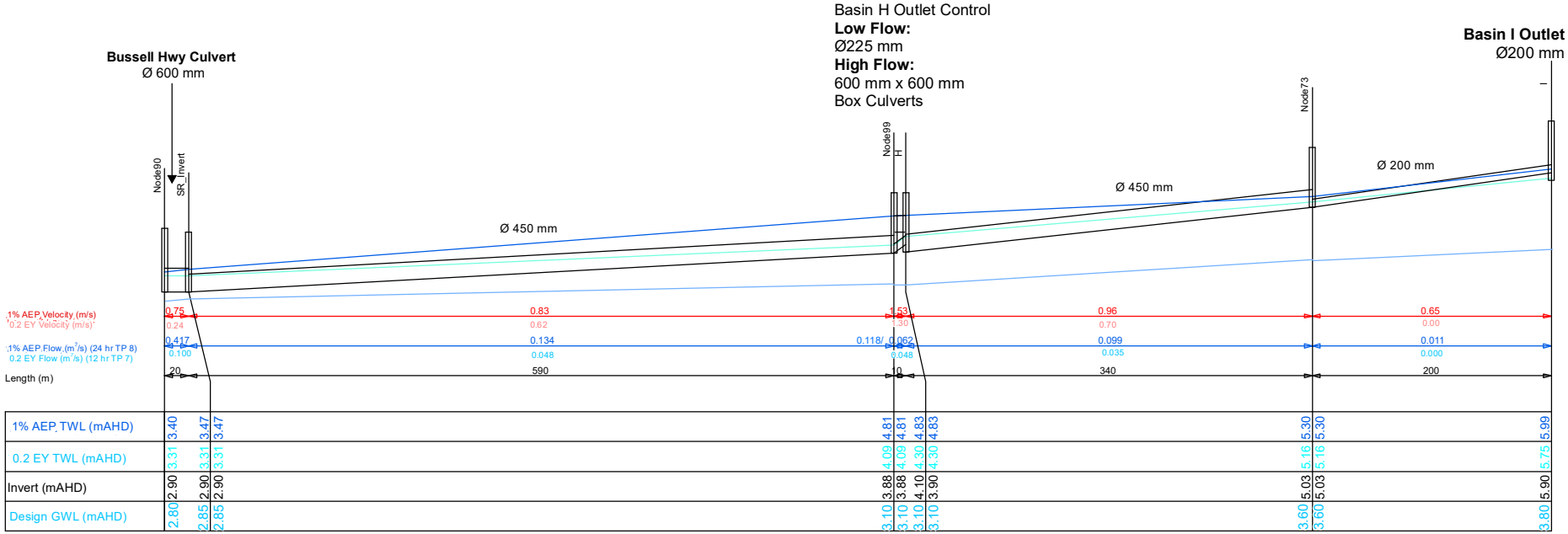
Satterly Property Group
Provence - Revised Stormwater Modelling

Figure 38: Drainage Long Section, Basin G to Bussell Hwy Outlet





Critical Duration at Bussell Hwy Culvert: 0.2 EY (12 hr), 1% AEP (24 hr)
Mean Temporal Pattern at Outlet: 0.2 EY (TP 7), 1% AEP (TP 8)

Data Source: JDA (2019) XP Model

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:10,000 @A4

0 100 200 300 400 Meters

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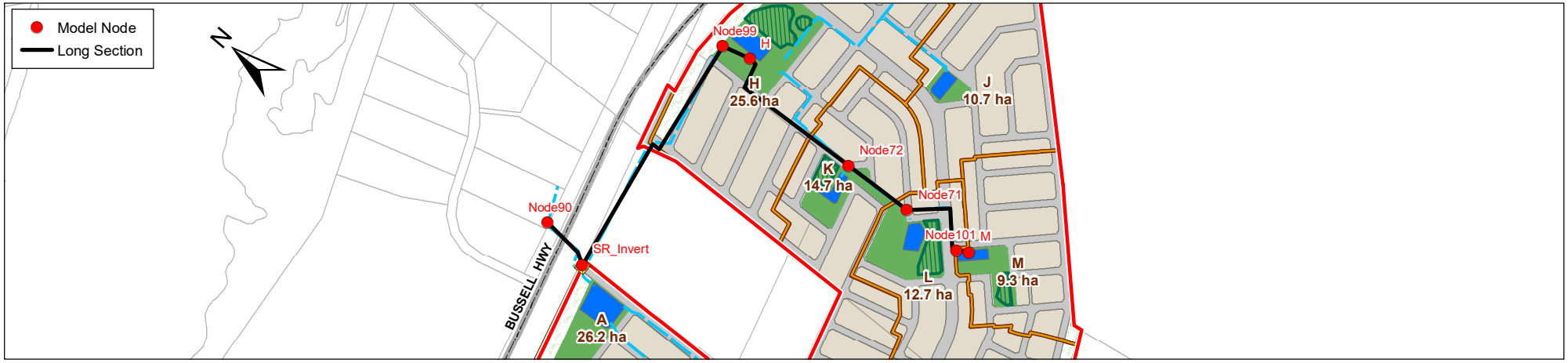
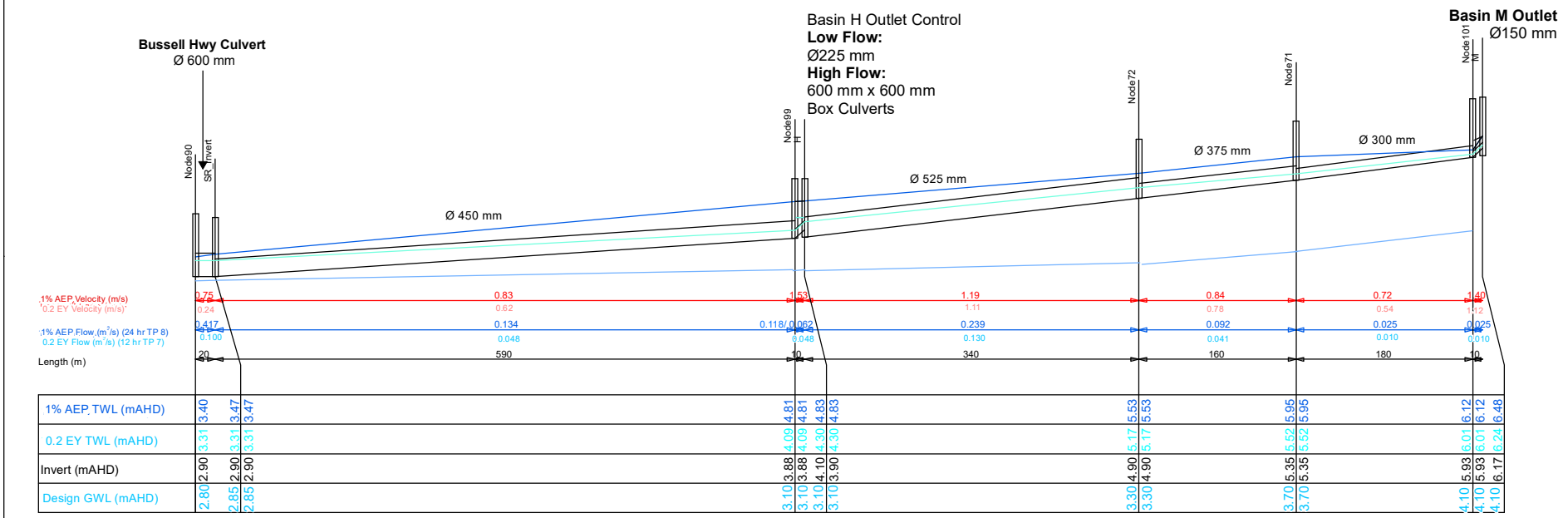
Provence - Revised Stormwater Modelling

Figure 39: Drainage Long Section, Basin I to Bussell Hwy Outlet





Critical Duration at Bussell Hwy Culvert: 0.2 EY (12 hr), 1% AEP (24 hr)
Mean Temporal Pattern at Outlet: 0.2 EY (TP 7), 1% AEP (TP 8)

Data Source: JDA (2019) XP Model

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:13,000 @A4
0 100 200 300 400 Meters

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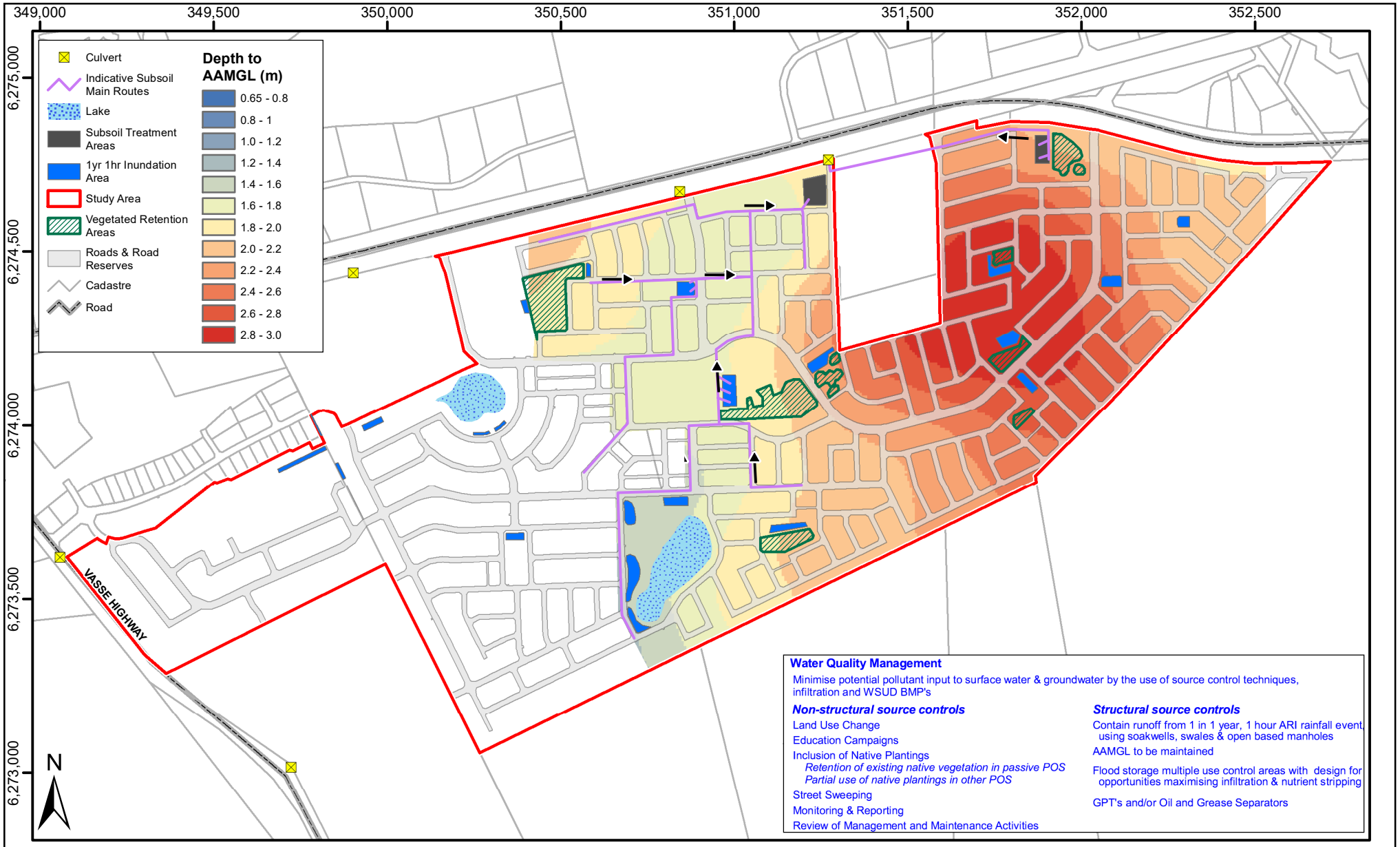
Satterly Property Group
Provence - Revised Stormwater Modelling

Figure 40: Drainage Long Section, Basin M to Bussell Hwy Outlet



Data Source:

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049

Scale: 1:15,000 @A4

0 250 500 750 1,000 Metres

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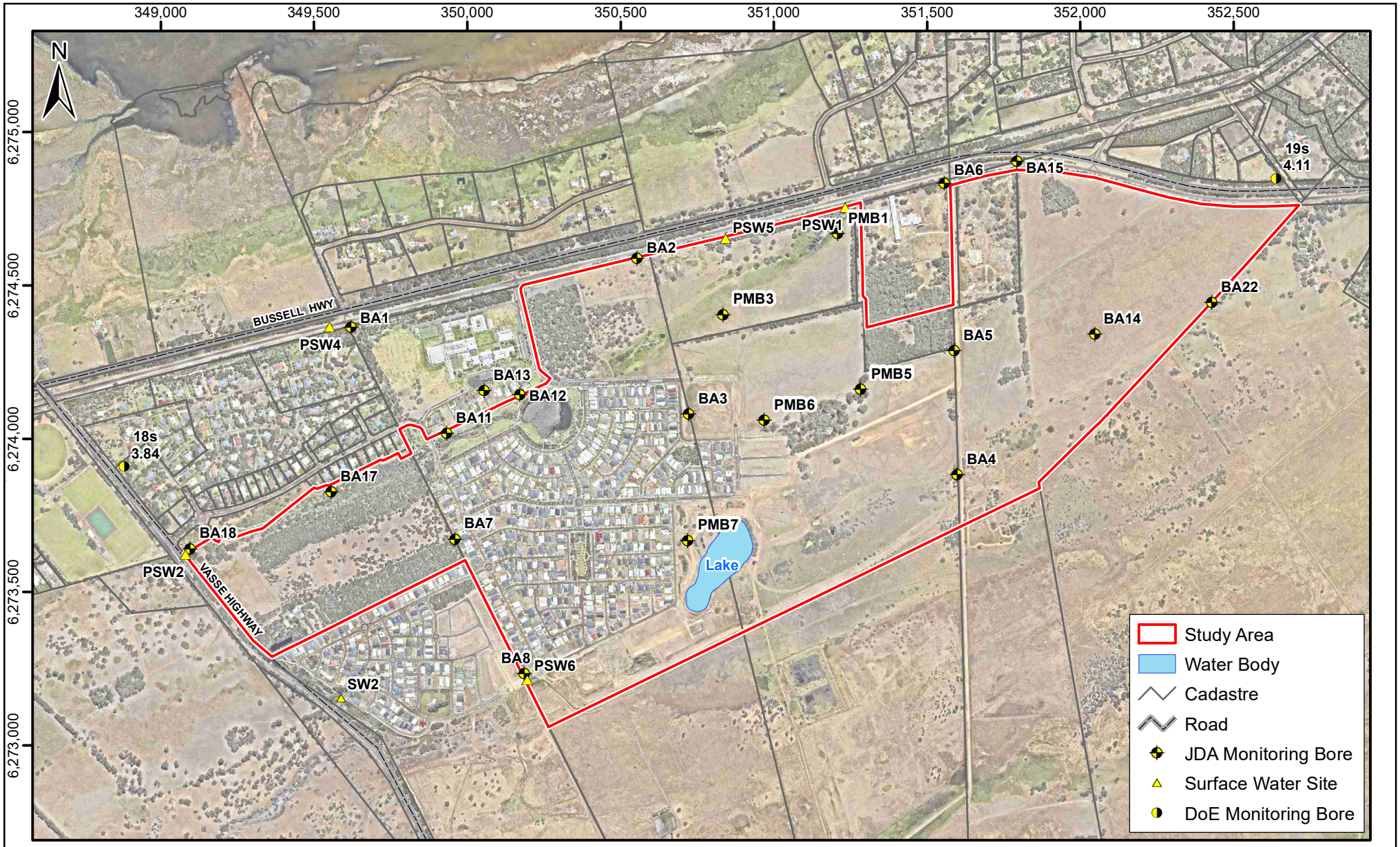
East Busselton Estate Pty Ltd

Provence: LWMS

Figure 41: Proposed Groundwater Management System



Data Source:Nearmap Digital Imagery, December 2015

Coordinate System: GDA 94, Zone 50

Job No. J6049

Scale:1:17,000 @A4

0 250 500 750 1,000 Metres

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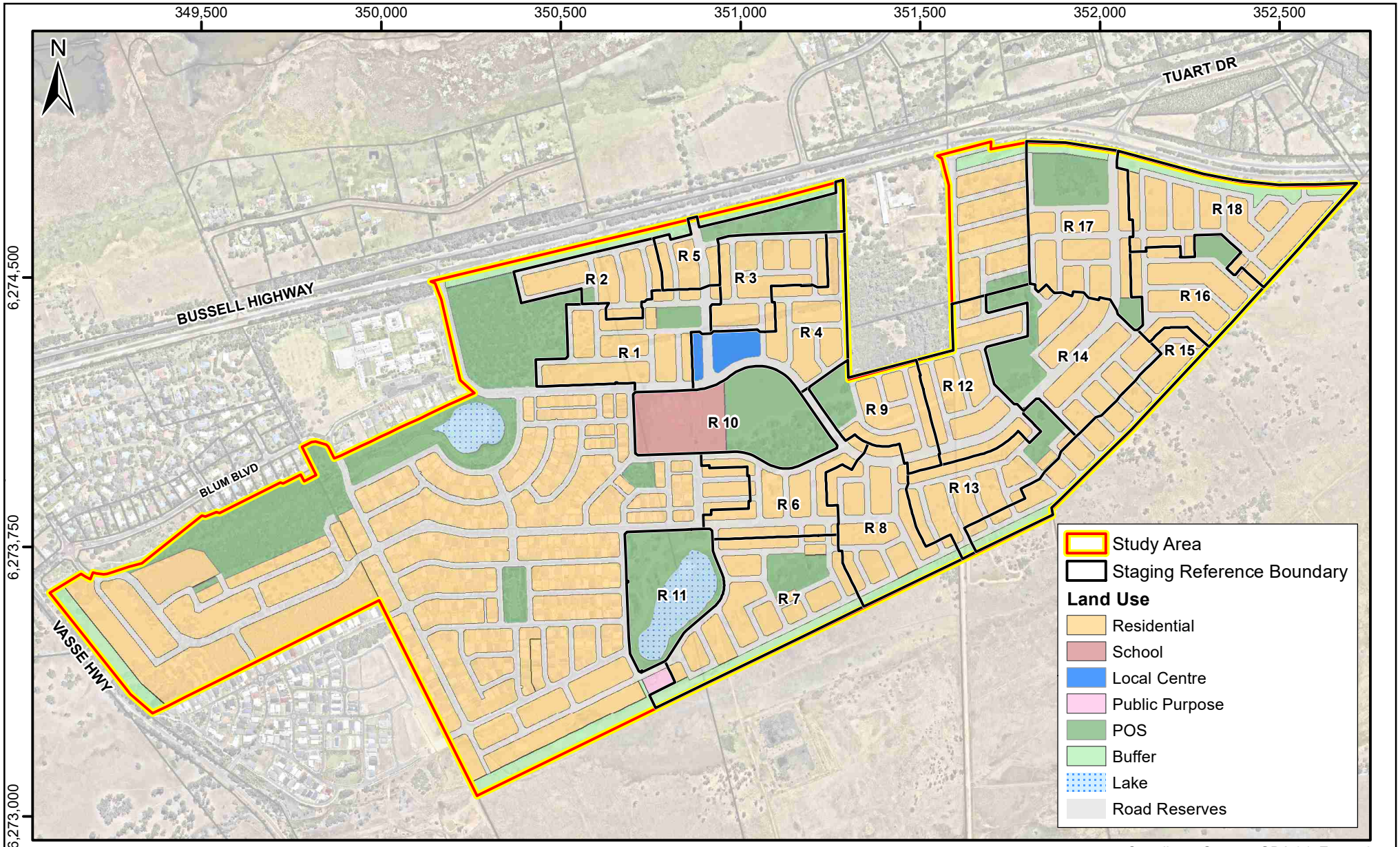
East Busselton Estate Pty Ltd

Provence: LWMS

Figure 42: Proposed Monitoring Locations



Data Source: Nearmap Digital Imagery, December 2015; RPS (2019) *Master Staging Plan*, Plan Ref. 130316-2-001H, 3 December 2019.

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049

Scale: 1:14,500 @A4

0 250 500 750 1,000 Metres

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East Busselton Estate Pty Ltd

Provence: LWMS

Figure 43: Staging Reference Plan

APPENDIX I

Groundwater Licence 157168(3)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	East Busselton Estate Pty Ltd		
Description of Water Resource	Busselton-Capel Perth - Yarragadee South.	**Annual Water Entitlement**	168,300kL
Location of Water Source	Lot 9032 On Plan 406716 Volume/Folio 2891/698 Lot 9032 Cable Sands Rd Yalyalup LOT 9033 ON PLAN 409180 - Volume/Folio 2908/309 - Lot 9033		

The annual entitlement above is a maximum and includes all the water taken by third parties under Agreements that relate to this Licence. The Authorised Activities may only be exercised if this volume is not excceded. The Authorised Activities, Water Sources, terms, conditions and restrictions include those recorded in any Approved Agreements To Take Water endorsed on this licence.

Agreements approved under clause 30 of schedule 1 of the Act:

Number	Third Party	Agreement Period
AGR200682(1)	City of Busselton	From 19 December 2017 to 19 December 2027

Authorised Activities	Taking of water for	Location of Activity
	Irrigation of up to 10 ha of public open space	Lot 8001 On Plan 59382 Volume/Folio Lr3155/224 Lot 8001 Lot 8002 On Plan 59382 Volume/Folio Lr3155/287 Lot 8002 Lot 8003 On Plan 62834 Volume/Folio Lr3158/809 Lot 8003 Thyme Pass Yalyalup Lot 8004 On Plan 62834 Volume/Folio Lr3158/810 Lot 8004 Seguret Pwy Yalyalup Lot 9032 On Plan 406716 Volume/Folio 2891/698 Lot 9032 Cable Sands Rd Yalyalup LOT 9033 ON PLAN 409180 - Volume/Folio 2908/309 - Lot 9033
	Water requirements to maintain pool and lake levels	Lot 8001 On Plan 59382 Volume/Folio Lr3155/224 Lot 8001
Duration of Licence	From 19 December 2017 to 19 December 2027	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 July to 30 June twelve months later.
2. The licensee must not, in any water year, take more water than the annual water entitlement specified in this licence.
3. The volume of all water taken under this licence must be metered using an approved meter fitted to each drawpoint.
4. The licensee must ensure the installed meter(s) accuracy is maintained to within plus or minus 5% of the volume metered, in field conditions.
5. Unless otherwise approved by the Department of Water and Environmental Regulation, all meter readings must be recorded monthly via the Department of Water and Environmental Regulation's 'Water Online Portal' or on an approved Department of Water and Environmental Regulation 'Meter Water Use Card'. The meter readings must be reported via the 'Water Online Portal' or submitted via a completed 'Meter Water Use Card' to the Department of Water and Environmental Regulation every 12 Months, commencing 31/07/2018.
6. The licensee must notify the Department of Water and Environmental Regulation in writing of any water meter malfunction within seven days of the malfunction being noticed.

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

This Licence is subject to the following terms, conditions and restrictions:

7. The licensee must obtain authorisation from the Department of Water and Environmental Regulation before removing, replacing or interfering with any meter required under this licence.

8. The licensee shall have a comprehensive analysis carried out on water samples from each Yarragadee production well every 12 Months in March or April.

9. All monitoring and reporting shall be carried out in accordance with Operational Policy 5.12 'Hydrogeological reporting associated with a groundwater well licence'.

10. Every 12 Months the licensee shall provide to the Department of Water and Environmental Regulation a Groundwater Monitoring Summary for the preceding water year. The first report is due 31/07/2018.

11. The Licensee is to provide an annual water balance to include abstraction volumes from the Yarragadee production bore to Iluka Lake, from Iluka Lake to Almond Parkway Lake and from Almond Parkway Lake to the irrigation line to the Department of Water and Environmental Regulation by 31 July each year.

12. The licensee shall not use water for sprinkler irrigation of parks and gardens between 9 am and 6 pm except for the establishment of newly planted areas. For newly planted areas water may be used within these hours for a period of up to 28 consecutive days, commencing from the date of planting.

13. Between 1 June and 31 August in any year, the licence-holder must not water a lawn, garden, or grass-covered area ("turf") by reticulation, provided always that this restriction shall not apply to watering with a hand held hose; or watering, by way of reticulation: newly planted areas for a period of up to 28 days from the date of planting; for renovating turf; or for maintenance of reticulation systems.

14. The third party agreement holder is to comply with the terms and conditions of the licence and any amendments made by or with the approval of the Department.

End of terms, conditions and restrictions

Government of **Western Australia**
Department of **Water**

looking after all our water needs

Your ref:
Our ref: RF2269-02

Enquiries: James Thomas 08 9781 0121

Mitchell Dodson
Satterley Property Group
PO Box 410
SOUTH PERTH WA 6951

CC:
Glenn Yeatman
RPS Australia Asia Pacific
PO Box 749
BUSSELTON WA 6280

Dear Mr. Dodson

Re: Issue of a Licence to Take Water – GWL160990
Property: Lot 2, Bussell Hwy and Lot 9022, Joseph Drive, Yalyalup

Please find enclosed your *Licence to Take Water*, issued under section 5C of the *Rights in Water and Irrigation Act 1914*. This licence entitles you to take water, subject to certain terms, conditions or restrictions. It does not absolve the licensee from responsibility for compliance with the requirements of all Commonwealth and State legislation.

Please note that the requirement to meter any take of water under this licence remains a condition of the licence. Metered bores are to be read monthly, with readings submitted annually as per the date specified in licence conditions.

It is important that you read the conditions of your licence carefully. If you do not understand your licence, please contact the Department as soon as possible, as there are penalties for failing to comply with all of your licence conditions. Under Section 26GG(2) of the *Rights in Water and Irrigation Act 1914*, you have a right to apply to the State Administrative Tribunal to request a written statement of reasons for the period for which the licence is granted or for a review of any term, condition or restriction included in the licence. You have 28 days from the date you received this letter to request that the decision be reviewed

For further information please contact the State Administrative Tribunal:

State Administrative Tribunal
12 St Georges Terrace
PERTH WA 6000

Geographe-Capes District Office
72 Duchess Street Busselton Western Australia 6280
PO Box 269 Busselton Western Australia 6280
Telephone (08) 9781 0111 Facsimile (08) 9754 4335
www.water.wa.gov.au

XDWAL013

GPO Box U1991
PERTH WA 6845

Telephone: (08) 9219 3111
Toll-free: 1300 306 017
Facsimile: (08) 9325 5099
www.sat.justice.wa.gov.au

If you wish to continue taking water after this *Licence to Take Water* expires, it is your responsibility to apply to the Department of Water for its renewal. If this licence expires and you have not applied to renew it, then the taking of water must cease, or you will be in breach of *the Rights in Water and Irrigation Act 1914*. It is suggested that an application for renewal be made at least one month in advance of the *Licence to Take Water* expiry date.

Should legal access to the land cease, for example you decide to sell your property, before the Licence to Take Water expiry date, you are required to inform the Department using Form 6 - Notice that Licence Holder is not or may not be Eligible to Hold a Licence and return the enclosed licence within 30 days. Failure to comply is a breach of the *Rights in Water and Irrigation Act 1914.*

You may apply to amend or transfer the *Licence to Take Water* at any time. The Department may also amend, suspend or cancel this licence in certain circumstances. For further information, please refer to the Frequently Asked Questions (FAQ's) on the Departments website
http://www.water.wa.gov.au/Doing+business+with+us/Water+licensing/Water+licensing+frequently+asked+questions/default.aspx

Please note that the Department maintains a 'Water Register' containing information on Western Australia's water availability and licensing details. An extract of this licence has been placed on the register and can be viewed online at;
http://www.water.wa.gov.au/ags/WaterRegister/.

If you have any queries relating to the above matter, please contact James Thomas on telephone 08 9781 0121.

Yours sincerely

Julian Woodward

Julian Woodward
Natural Resource Management Officer
Geographe-Capes District Office

11/3/2013

Encl. Licence to Take Water GWL160990

Instrument No. GWL160990(4)

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	East Busselton Estate Pty Ltd		
Description of Water Resource	Busselton-Capel Perth - Leederville.	**Annual Water Entitlement**	34300 kL
Location of Water Source	Lot 2 on Diagram 28764 Certificate of Title Volume/Folio 1791/729		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Dust suppression for earthworks and construction purposes Earthwork and construction purposes	Lot 9022 On Plan 62834 - Volume/Folio 2734/828 - Lot 9022 Joseph Dr Yalyalup

Duration of Licence	From 11 March 2013 to 1 December 2020

This Licence is subject to the following terms, conditions and restrictions:

1 That should any bore be abandoned it shall be cemented off to the satisfaction of the Department of Water within 30 days of being abandoned.

2 The licensee must ensure the installed meter(s) accuracy is maintained to within plus or minus 5% of the volume metered, in field conditions.

3 The licensee must notify the Department of Water in writing of any water meter malfunction within seven days of the malfunction being noticed.

4 The licensee must obtain authorisation from the Department of Water before removing, replacing or interfering with any meter required under this licence.

5 The annual water year for water taken under this licence is defined as 12:00 pm at 1 July to 12:00 pm at 1 July twelve months later.

6 The licensee must not, in any water year, take more water than the annual water entitlement specified in this licence.

7 The licensee must take and record the reading from each meter required under this licence at the beginning and another at the end of the water year defined on this licence.

8 In addition to taking and recording the reading(s) at the beginning and the end of the water year, the licensee must, as close as practicable to the end of each month (other than the month in which the water year ends), take and record the reading from each meter required under this licence.

9 All meter readings must be recorded on the "Meter Water Use Card".

10 The completed Meter Water Use Card must be returned to the Department of Water by 31 July each year.

End of terms, conditions and restrictions

APPENDIX L

UNDO Modelling Results

Government of Western Australia
Department of Water and Environmental Regulation

Project:	J6049 Vasse River & Estuary Catchment	Date:	18/12/2019
		Version:	Version 1.2.0.19289

Subregion name: Roads_VR1a

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	4.32	96.77	12.96

Total area (ha)	Total percent (%)
4.32	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	3.46
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.86
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
4.32	100

Nitrogen input (kg)	Phosphorus input (kg)
96.77	96.77

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**1.1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.9**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_VR1a**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	70	22.68	1686.84	405.27
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	30	9.72	641.52	19.44
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
32.40	30

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
77.09	13.26

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
7.09	0.39

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	0	0.00	0.00	0.00
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	100	22.68	1686.84	405.27
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
22.68	70

Nitrogen input (kg)	Phosphorus input (kg)
1686.84	405.27

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	9.72
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
9.72	30

Nitrogen input (kg)	Phosphorus input (kg)
641.52	19.44

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**1.1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.9**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_VR1b

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	6.48	145.15	19.44

Total area (ha)	Total percent (%)
6.48	6

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.76	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	5.18
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.30
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
6.48	100

Nitrogen input (kg)	Phosphorus input (kg)
145.15	145.15

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**1.1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.9**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_VR1b**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	74	15.98	1501.36	381.75
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	26	5.62	252.05	7.64
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
21.60	20

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
86.41	18.18

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
7.94	0.54

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	4	0.64	41.95	10.72
501-600 m²	15	2.40	236.66	63.29
601-730 m²	62	9.91	996.87	253.47
>730 m²	19	3.04	225.88	54.27
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
15.984	74

Nitrogen input (kg)	Phosphorus input (kg)
1501.36	381.75

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	68	3.82
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	32	1.80

Total area (ha)	Total percent (%)
5.62	26

Nitrogen input (kg)	Phosphorus input (kg)
252.05	7.64

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**1.1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.9**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_VR1c

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	4.32	96.77	12.96

Total area (ha)	Total percent (%)
4.32	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	3.46
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.86
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
4.32	100

Nitrogen input (kg)	Phosphorus input (kg)
96.77	96.77

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.4**	Fill depth (m)	**0.6**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**8.4**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_VR1c**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	87	9.40	799.05	204.64
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	13	1.40	92.66	2.81
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
10.80	**10**

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
87.80	**19.36**

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
8.26	**0.54**

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	6	0.56	13.24	3.88
400-500 m²	15	1.41	92.47	23.62
501-600 m²	23	2.16	213.32	57.04
601-730 m²	36	3.38	340.26	86.52
>730 m²	20	1.88	139.77	33.58
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
9.396	87

Nitrogen input (kg)	Phosphorus input (kg)
799.05	204.64

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	1.40
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
1.40	13

Nitrogen input (kg)	Phosphorus input (kg)
92.66	2.81

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.4**	Fill depth (m)	**0.6**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**8.4**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_VR1d

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	2.16	48.38	6.48

Total area (ha)	Total percent (%)
2.16	2

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.78	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	1.73
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.43
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
2.16	100

Nitrogen input (kg)	Phosphorus input (kg)
48.38	48.38

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.5**	Fill depth (m)	**0.6**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**8.6**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_VR1d**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	73	3.15	269.57	67.04
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	27	1.17	76.98	2.33
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
4.32	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
85.45	16.21

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
8.36	0.40

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	0	0.00	0.00	0.00
400-500 m²	0	0.00	0.00	0.00
501-600 m²	9	0.28	28.02	7.49
601-730 m²	34	1.07	107.86	27.42
>730 m²	57	1.80	133.69	32.12
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
3.1536	73

Nitrogen input (kg)	Phosphorus input (kg)
269.57	67.04

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	1.17
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
1.17	27

Nitrogen input (kg)	Phosphorus input (kg)
76.98	2.33

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.5**	Fill depth (m)	**0.6**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**8.6**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_VE1

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	1.08	24.19	3.24

Total area (ha)	Total percent (%)
1.08	1

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.78	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	0.86
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.22
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
1.08	100

Nitrogen input (kg)	Phosphorus input (kg)
24.19	24.19

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.4**	Fill depth (m)	**0.7**
Groundwater slope (%)	**0.2**	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: **Others_VE1**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	45	1.46	108.44	26.05
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	55	1.78	117.61	3.56
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
3.24	3

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
75.00	9.29

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
7.40	0.31

Residential

Input load				
Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	0	0.00	0.00	0.00
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	100	1.46	108.44	26.05
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
1.458	45

Nitrogen input (kg)	Phosphorus input (kg)
108.44	26.05

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	1.78
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
1.78	55

Nitrogen input (kg)	Phosphorus input (kg)
117.61	3.56

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.4**	Fill depth (m)	**0.7**
Groundwater slope (%)	**0.2**	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: Roads_VE2

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	3.24	72.58	9.72

Total area (ha)	Total percent (%)
3.24	3

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	2.59
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.65
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.24	100

Nitrogen input (kg)	Phosphorus input (kg)
72.58	72.58

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**0.5**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**9.1**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_VE2**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	46	6.46	535.14	137.42
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	54	7.58	114.94	2.73
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
14.04	13

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
51.53	10.13

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
4.78	0.18

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	23	1.49	34.90	10.22
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	77	4.97	500.24	127.20
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
6.4584	46

Nitrogen input (kg)	Phosphorus input (kg)
535.14	137.42

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	82	6.22
Sport	0	0.00
Recreation	18	1.36
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
7.58	54

Nitrogen input (kg)	Phosphorus input (kg)
114.94	2.73

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**0.5**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**9.1**	**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

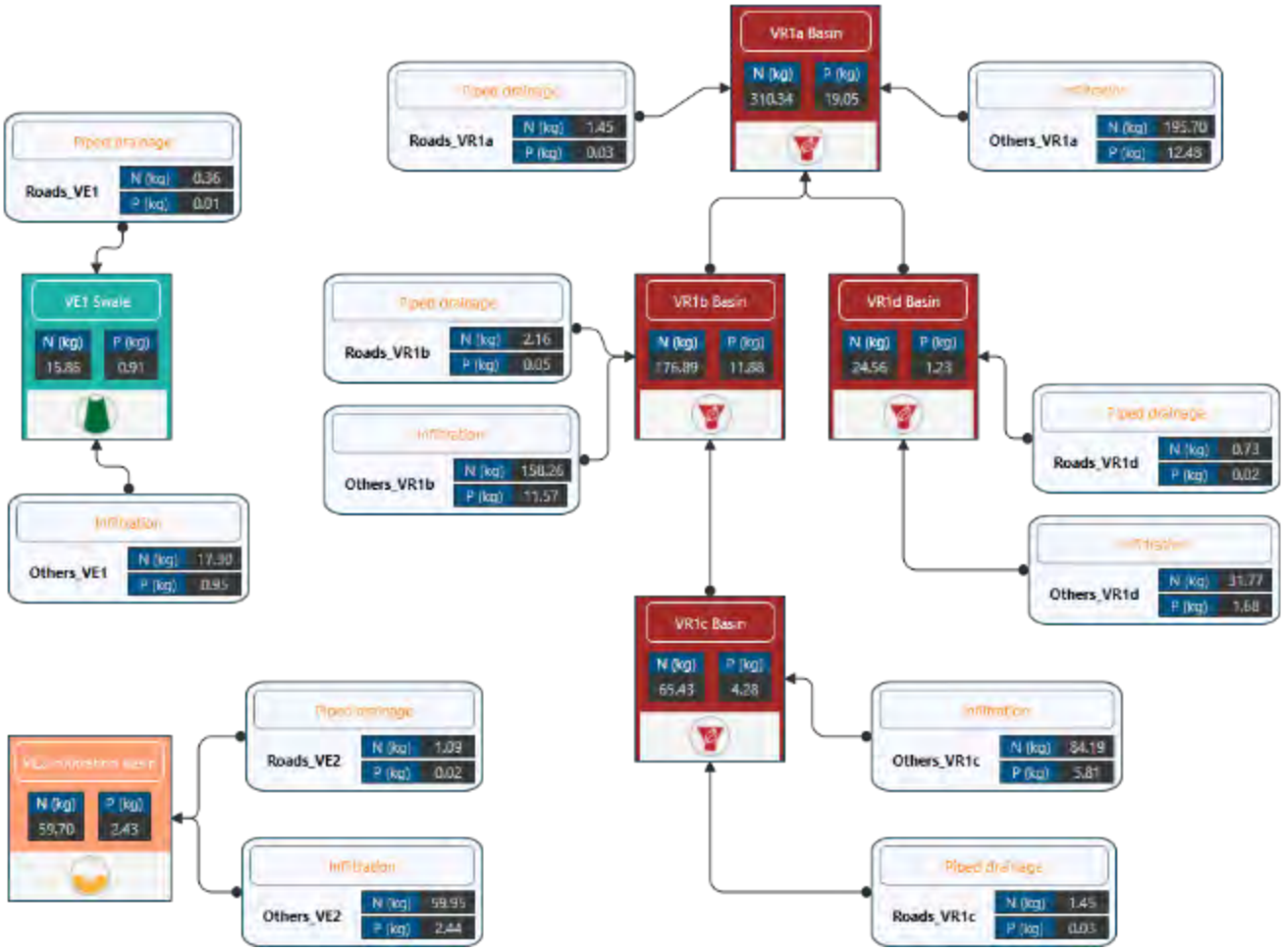
Treatment	Name	Size (m²)	Treated area (ha)	Treating	N removed (kg/ha/yr)	P removed (kg/ha/yr)
Swale	VE1 Swale	1000.00	4.32	Sandy soils – Runoff only (infiltration on lots)	0.94	0.02
Detention / infiltration basin	VE2 Infiltration Basin	1600.00	17.28	Sandy soils – Runoff only (infiltration on lots)	0.14	0.00
Biofilter	VR1a Basin	28000.00	86.40	Sandy soils – Runoff only (infiltration on lots)	6.67	0.48
Biofilter	VR1b Basin	13000.00	43.20	Sandy soils – Runoff only (infiltration on lots)	3.77	0.31
Biofilter	VR1c Basin	6000.00	15.12	Sandy soils – Runoff only (infiltration on lots)	2.37	0.19
Biofilter	VR1d Basin	2850.00	6.48	Sandy soils – Runoff only (infiltration on lots)	2.48	0.15
Load removed					**1.82**	**0.13**
Net export					**4.25**	**0.23**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/ha/yr)	N export (kg/ha/yr)
Roads_VR1a	4.32	0.16	1.77
Others_VR1a	32.40	0.39	7.09
Roads_VR1b	6.48	0.16	1.76
Others_VR1b	21.60	0.54	7.94
Roads_VR1c	4.32	0.16	1.77
Others_VR1c	10.80	0.54	8.26
Roads_VR1d	2.16	0.16	1.78
Others_VR1d	4.32	0.40	8.36
Roads_VE1	1.08	0.16	1.78
Others_VE1	3.24	0.31	7.40
Roads_VE2	3.24	0.15	1.77
Others_VE2	14.04	0.18	4.78

PRE-TREATMENT LOAD (kg/ha/yr)		LOAD REMOVED (kg/ha/yr)		NET LOAD EXPORT (kg/ha/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
6.07	0.36	1.82	0.13	4.25	0.23

Treatment diagram



Government of **Western Australia**
Department of **Water and Environmental Regulation**

Project:	J6049 Sabina Catchment West	Date:	18/12/2019
		Version:	Version 1.2.0.19289

Subregion name: Roads_A

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	7.51	168.22	22.53

Total area (ha)	Total percent (%)
7.51	6

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.76	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	6.01
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.50
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
7.5096	100

Nitrogen input (kg)	Phosphorus input (kg)
168.22	168.22

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**7.3**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_A**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	65	12.20	286.69	83.99
Industrial, commercial & schools	6	1.13	29.74	7.21
Rural living	0	0.00	0.00	0.00
Public open space	29	5.44	100.29	2.82
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
18.77	**15**

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.43	**5.16**

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.52	**0.14**

Residential

Input load				
Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	12.20	286.69	83.99
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 (%)
12.2031	65

Nitrogen input (kg)	Phosphorus input (kg)
286.69	83.99

Commercial, Industry and Schools

Landuse	Percent (%)	Area (ha)
Light industrial	0	0.00
Heavy industrial	0	0.00
Commercial / Offices	100	1.13
Schools	0	0.00
Public buildings	0	0.00

Total area (ha)	Total percent (%)
1.13	6

Nitrogen input (kg)	Phosphorus input (kg)
29.74	7.21

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	42	2.29
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	51	2.78
Sport	0	0.00
Recreation	7	0.38
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
5.44	29

Nitrogen input (kg)	Phosphorus input (kg)
100.29	2.82

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.6**	Fill depth (m)	**1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**7.3**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_B

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	5.01	112.14	15.02

Total area (ha)	Total percent (%)
5.01	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.17

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	4.01
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
5.0064	100

Nitrogen input (kg)	Phosphorus input (kg)
112.14	112.14

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.3**	Fill depth (m)	**1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.4**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_B**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	70	8.76	467.16	123.27
Industrial, commercial & schools	21	2.63	236.05	47.43
Rural living	0	0.00	0.00	0.00
Public open space	9	1.13	50.37	1.56
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
12.52	10

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
65.44	13.91

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
6.11	0.74

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	50	4.38	102.91	30.15
400-500 m²	20	1.75	114.96	29.37
501-600 m²	8	0.70	69.18	18.50
601-730 m²	16	1.40	141.01	35.85
>730 m²	6	0.53	39.10	9.39
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
8.7612	70

Nitrogen input (kg)	Phosphorus input (kg)
467.16	123.27

Commercial, Industry and Schools

Landuse	Percent (%)	Area (ha)
Light industrial	0	0.00
Heavy industrial	0	0.00
Commercial / Offices	15	0.39
Schools	85	2.23
Public buildings	0	0.00

Total area (ha)	Total percent (%)
2.63	21

Nitrogen input (kg)	Phosphorus input (kg)
236.05	47.43

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	56	0.63
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	44	0.50
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
1.13	9

Nitrogen input (kg)	Phosphorus input (kg)
50.37	1.56

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.3**	Fill depth (m)	**1**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.4**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_C

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	1.25	28.04	3.75

Total area (ha)	Total percent (%)
1.25	1
Nitrogen input (kg/ha/yr)	**Phosphorus input (kg/ha/yr)**
27.63	3.15
Nitrogen export (kg/ha/yr)	**Phosphorus (kg/ha/yr)**
1.78	0.16

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	1.00
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.25
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
1.2516	100
Nitrogen input (kg)	**Phosphorus input (kg)**
28.04	28.04

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.9**	Fill depth (m)	**1.4**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.6**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Others_C

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	52	2.60	61.16	17.92
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	48	2.40	15.96	0.24
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
5.01	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
20.63	3.78

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.01	0.09

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	2.60	61.16	17.92
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 (%)
2.603328	52

Nitrogen input (kg)	Phosphorus input (kg)
61.16	17.92

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	11	0.26
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	89	2.14
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 (%)
2.40	48

Nitrogen input (kg)	Phosphorus input (kg)
15.96	0.24

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.9**	Fill depth (m)	**1.4**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**6.6**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_D

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	5.01	112.14	15.02

Total area (ha)	Total percent (%)
5.01	4
Nitrogen input (kg/ha/yr)	**Phosphorus input (kg/ha/yr)**
27.63	3.15
Nitrogen export (kg/ha/yr)	**Phosphorus (kg/ha/yr)**
1.77	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	4.01
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
5.0064	100
Nitrogen input (kg)	**Phosphorus input (kg)**
112.14	112.14

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Spearwood Dune**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**1.7**		
Groundwater slope (%)	**0.2**		
Soil PRI	**11.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Others_D

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	47	7.65	323.05	88.53
Industrial, commercial & schools	13	2.12	213.64	42.52
Rural living	0	0.00	0.00	0.00
Public open space	40	6.51	281.03	8.36
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
16.27	13

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
55.49	8.72

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
5.10	0.09

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	72	5.51	129.35	37.90
400-500 m²	5	0.38	25.09	6.41
501-600 m²	16	1.22	120.78	32.30
601-730 m²	4	0.31	30.77	7.82
>730 m²	3	0.23	17.06	4.10
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
7.647276	47

Nitrogen input (kg)	Phosphorus input (kg)
323.05	88.53

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	2.12
Public buildings	0	0.00

Total area (ha)	Total percent (%)
2.12	13

Nitrogen input (kg)	Phosphorus input (kg)
213.64	42.52

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	16	1.04
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	27	1.76
Sport	0	0.00
Recreation	57	3.71
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
6.51	40

Nitrogen input (kg)	Phosphorus input (kg)
281.03	8.36

Soil and drainage information

Type of drainage	**Infiltration**
Soil type	**Spearwood Dune**
Depth to groundwater (m)	**1.7**
Groundwater slope (%)	**0.2**
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: Roads_E

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	5.01	112.14	15.02

Total area (ha)	Total percent (%)
5.01	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	79	3.96
Road reserve - impervious	1	0.05
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
5.0064	100

Nitrogen input (kg)	Phosphorus input (kg)
112.14	112.14

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.4**	Fill depth (m)	**0.2**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**10.2**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Others_E

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	53	12.60	696.85	180.52
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	47	11.18	174.58	5.09
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
23.78	19

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
41.87	7.96

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
3.85	0.15

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	47	5.92	139.17	40.77
400-500 m²	6	0.76	49.61	12.67
501-600 m²	8	1.01	99.53	26.62
601-730 m²	13	1.64	164.82	41.91
>730 m²	26	3.28	243.72	58.56
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
12.603612	53

Nitrogen input (kg)	Phosphorus input (kg)
696.85	180.52

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	35	3.91
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	30	3.35
Sport	0	0.00
Recreation	7	0.78
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	28	3.13

Total area (ha)	Total percent (%)
11.18	**47**

Nitrogen input (kg)	Phosphorus input (kg)
174.58	**5.09**

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**1.4**	Fill depth (m)	**0.2**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**10.2**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_F

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	2.50	56.07	7.51

Total area (ha)	Total percent (%)
2.50	2
Nitrogen input (kg/ha/yr)	**Phosphorus input (kg/ha/yr)**
27.63	3.15
Nitrogen export (kg/ha/yr)	**Phosphorus (kg/ha/yr)**
1.78	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	2.00
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.50
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
2.5032	100
Nitrogen input (kg)	**Phosphorus input (kg)**
56.07	56.07

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.1**	Fill depth (m)	**0.8**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**8.7**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Others_F

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	62	4.66	109.38	32.04
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	38	2.85	34.02	0.85
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
7.51	6

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
24.33	4.53

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.33	0.05

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	4.66	109.38	32.04
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 (%)
4.655952	62

Nitrogen input (kg)	Phosphorus input (kg)
109.38	32.04

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	33	0.94
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	67	1.91
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 (%)
2.85	38

Nitrogen input (kg)	Phosphorus input (kg)
34.02	0.85

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.1**	Fill depth (m)	**0.8**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**8.7**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_G

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	5.01	112.14	15.02

Total area (ha)	Total percent (%)
5.01	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	4.01
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
5.0064	100

Nitrogen input (kg)	Phosphorus input (kg)
112.14	112.14

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.2**	Fill depth (m)	**0.5**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**9.7**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Others_G

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	80	8.01	188.19	55.13
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	20	2.00	46.34	1.34
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
10.01	8

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
28.65	5.79

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.71	0.05

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	8.01	188.19	55.13
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 (%)
8.01024	80

Nitrogen input (kg)	Phosphorus input (kg)
188.19	55.13

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	41	0.82
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	44	0.88
Sport	0	0.00
Recreation	15	0.30
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
2.00	20

Nitrogen input (kg)	Phosphorus input (kg)
46.34	1.34

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.2**	Fill depth (m)	**0.5**
Groundwater slope (%)	**0.2**	Approximate PRI of imported fill	**5**
Soil PRI	**9.7**	**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/ha/yr)	P removed (kg/ha/yr)
Biofilter	Basins E	8500.00	28.79	Sandy soils – Runoff only (infiltration on lots)	1.21	0.08
Biofilter	Basin F	1700.00	10.01	Sandy soils – Runoff only (infiltration on lots)	0.78	0.05
Biofilter	Basin D	3500.00	60.08	Sandy soils – Runoff only (infiltration on lots)	2.48	0.13
Biofilter	Basin C	430.00	6.26	Sandy soils – Runoff only (infiltration on lots)	0.66	0.05
Biofilter	Basin B	2000.00	23.79	Sandy soils – Runoff only (infiltration on lots)	1.93	0.24

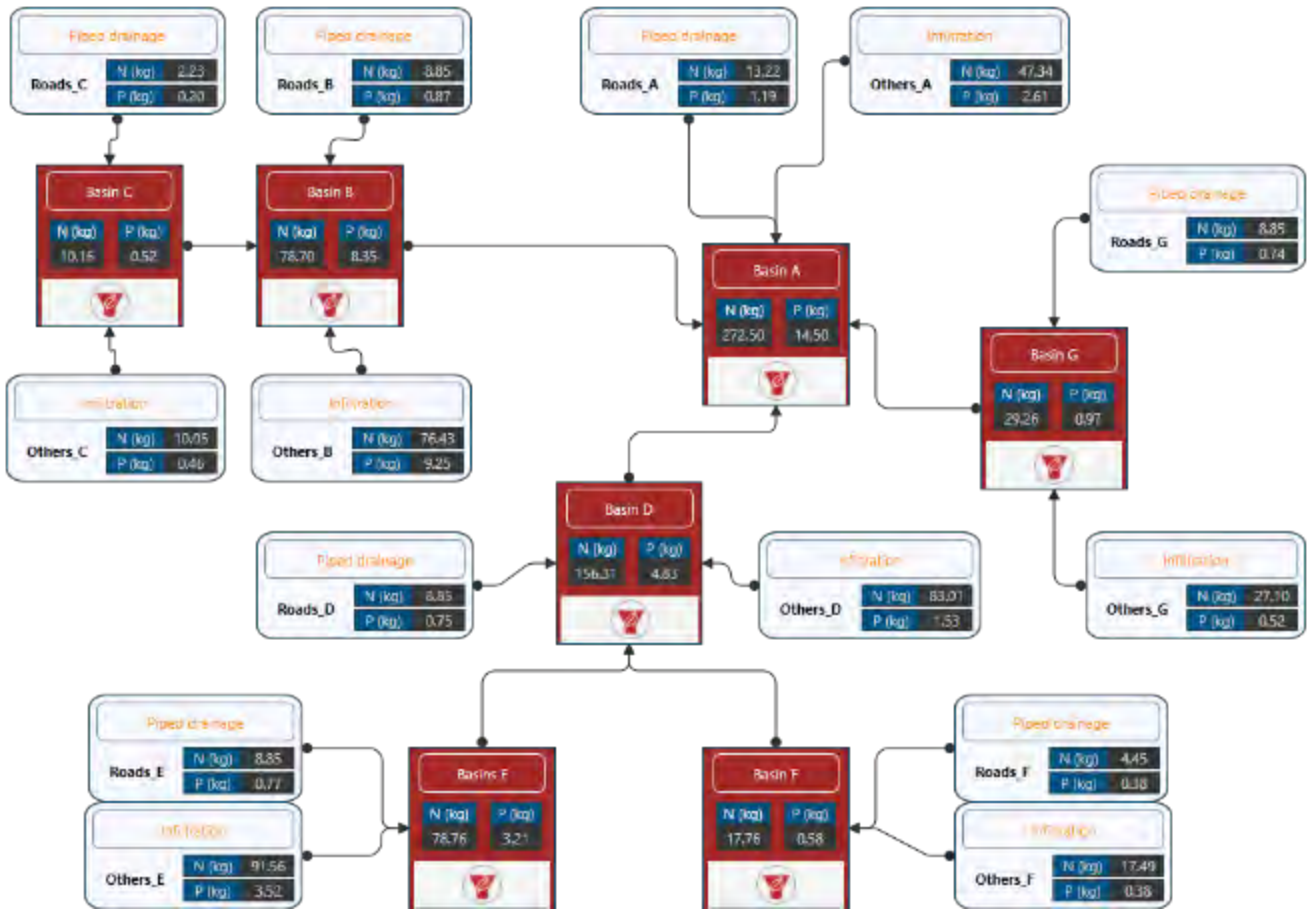
Biofilter	Basin A	5200.00	125.17	Sandy soils – Runoff only (infiltration on lots)	4.69	0.35
Biofilter	Basin G	2200.00	15.02	Sandy soils – Runoff only (infiltration on lots)	0.83	0.05
Load removed					**1.08**	**0.07**
Net export					**2.18**	**0.12**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/ha/yr)	N export (kg/ha/yr)
Roads_A	7.51	0.16	1.76
Others_A	18.77	0.14	2.52
Roads_B	5.01	0.17	1.77
Others_B	12.52	0.74	6.11
Roads_C	1.25	0.16	1.78
Others_C	5.01	0.09	2.01
Roads_D	5.01	0.15	1.77
Others_D	16.27	0.09	5.10
Roads_E	5.01	0.15	1.77
Others_E	23.78	0.15	3.85
Roads_F	2.50	0.15	1.78
Others_F	7.51	0.05	2.33
Roads_G	5.01	0.15	1.77
Others_G	10.01	0.05	2.71

PRE-TREATMENT LOAD (kg/ha/yr)		LOAD REMOVED (kg/ha/yr)		NET LOAD EXPORT (kg/ha/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
3.26	**0.19**	**1.08**	**0.07**	**2.18**	**0.12**

Treatment diagram



Government of Western Australia
Department of Water and Environmental Regulation

Project: J6049 Sabina River Catchment East

Date: 18/12/2019

Version: Version 1.2.0.19289

Subregion name: Roads_H

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	7.00	156.74	20.99

Total area (ha)	Total percent (%)
7.00	9

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.77	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	5.60
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	1.40
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
6.9975	100

Nitrogen input (kg)	Phosphorus input (kg)
156.74	156.74

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.4**	Fill depth (m)	**0.5**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**9.8**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_H**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	66	12.32	289.33	84.76
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	34	6.34	78.67	2.00
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
18.66	24

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
24.95	4.80

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.39	0.04

Residential

Size (m²)	Percent (%)	Input load Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	12.32	289.33	84.76
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 (%)
12.3156	66

Nitrogen input (kg)	Phosphorus input (kg)
289.33	84.76

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	35	2.22
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	65	4.12
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 (%)
6.34	34

Nitrogen input (kg)	Phosphorus input (kg)
78.67	2.00

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.4**	Fill depth (m)	**0.5**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**9.8**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_I

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	1.56	34.83	4.67

Total area (ha)	Total percent (%)
1.56	2

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.79	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	1.24
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.31
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
1.555	100

Nitrogen input (kg)	Phosphorus input (kg)
34.83	34.83

Soil and drainage information

Type of drainage	**Piped drainage**	**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 (%)	**0.3**		
Soil PRI	**11.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_I**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	77	2.39	56.26	16.48
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	23	0.72	37.15	1.14
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
3.11	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
35.27	5.82

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
3.55	0.05

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	2.39	56.26	16.48
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 (%)
2.3947	77

Nitrogen input (kg)	Phosphorus input (kg)
56.26	16.48

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	37	0.26
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	63	0.45
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.72	23

Nitrogen input (kg)	Phosphorus input (kg)
37.15	1.14

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 (%)	**0.3**		
Soil PRI	**11.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_J

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	3.11	69.66	9.33

Total area (ha)	Total percent (%)
3.11	4

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.78	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	2.49
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.62
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.11	100

Nitrogen input (kg)	Phosphorus input (kg)
69.66	69.66

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**No**
Soil type	**Spearwood Dune**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**2.5**		
Groundwater slope (%)	**0.3**		
Soil PRI	**11.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_J**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	93	7.23	169.87	49.77
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	7	0.54	18.96	0.60
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
7.78	10

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
29.52	6.63

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.91	0.05

Residential

Size (m²)	Percent (%)	Input load Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	7.23	169.87	49.77
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 (%)
7.23075	93

Nitrogen input (kg)	Phosphorus input (kg)
169.87	49.77

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	82	0.45
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	18	0.10
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	7

Nitrogen input (kg)	Phosphorus input (kg)
18.96	0.60

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)	**2.5**		
Groundwater slope (%)	**0.3**		
Soil PRI	**11.0**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_K

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	3.89	87.08	11.66

Total area (ha)	Total percent (%)
3.89	5

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.78	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	3.11
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.78
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.8875	100

Nitrogen input (kg)	Phosphorus input (kg)
87.08	87.08

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.8**	Fill depth (m)	**0.6**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**9.7**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_K**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	87	9.47	222.48	65.18
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	13	1.42	34.53	1.08
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
10.89	14

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
28.84	6.24

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
2.81	0.05

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	9.47	222.48	65.18
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 (%)
9.46995	87

Nitrogen input (kg)	Phosphorus input (kg)
222.48	65.18

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	85	1.20
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	15	0.21
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 (%)
1.42	13

Nitrogen input (kg)	Phosphorus input (kg)
34.53	1.08

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.8**	Fill depth (m)	**0.6**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**9.7**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_L

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	3.89	87.08	11.66

Total area (ha)	Total percent (%)
3.89	5
Nitrogen input (kg/ha/yr)	**Phosphorus input (kg/ha/yr)**
27.63	3.15
Nitrogen export (kg/ha/yr)	**Phosphorus (kg/ha/yr)**
1.78	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	3.11
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.78
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.8875	100
Nitrogen input (kg)	**Phosphorus input (kg)**
87.08	87.08

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.6**	Fill depth (m)	**0.1**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**10.8**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_L**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	70	6.53	153.43	44.95
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	30	2.80	84.47	2.47
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
9.33	12

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
30.73	5.23

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
3.01	0.04

Residential

Size (m²)	Percent (%)	Input load Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	6.53	153.43	44.95
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 (%)
6.531	70

Nitrogen input (kg)	Phosphorus input (kg)
153.43	44.95

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	29	0.81
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	40	1.12
Sport	0	0.00
Recreation	31	0.87
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
2.80	30

Nitrogen input (kg)	Phosphorus input (kg)
84.47	2.47

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.6**	Fill depth (m)	**0.1**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**10.8**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Roads_M

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	0	0.00	0.00	0.00
Public open space	0	0.00	0.00	0.00
Road reserve	100	2.33	52.25	7.00

Total area (ha)	Total percent (%)
2.33	3

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
27.63	3.15

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
1.79	0.15

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	1.87
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	20	0.47
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
2.3325	100

Nitrogen input (kg)	Phosphorus input (kg)
52.25	52.25

Soil and drainage information

Type of drainage	**Piped drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.7**	Fill depth (m)	**0.7**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**9.5**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Others_M**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	81	5.04	118.36	34.68
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	19	1.18	41.03	1.22
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
6.22	8

Nitrogen input (kg/ha/yr)	Phosphorus input (kg/ha/yr)
30.86	5.92

Nitrogen export (kg/ha/yr)	Phosphorus (kg/ha/yr)
3.06	0.04

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	5.04	118.36	34.68
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 (%)
5.0382	81

Nitrogen input (kg)	Phosphorus input (kg)
118.36	34.68

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	35	0.41
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	29	0.34
Sport	0	0.00
Recreation	36	0.43
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
1.18	19

Nitrogen input (kg)	Phosphorus input (kg)
41.03	1.22

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2.7**	Fill depth (m)	**0.7**
Groundwater slope (%)	**0.3**	Approximate PRI of imported fill	**5**
Soil PRI	**9.5**	**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

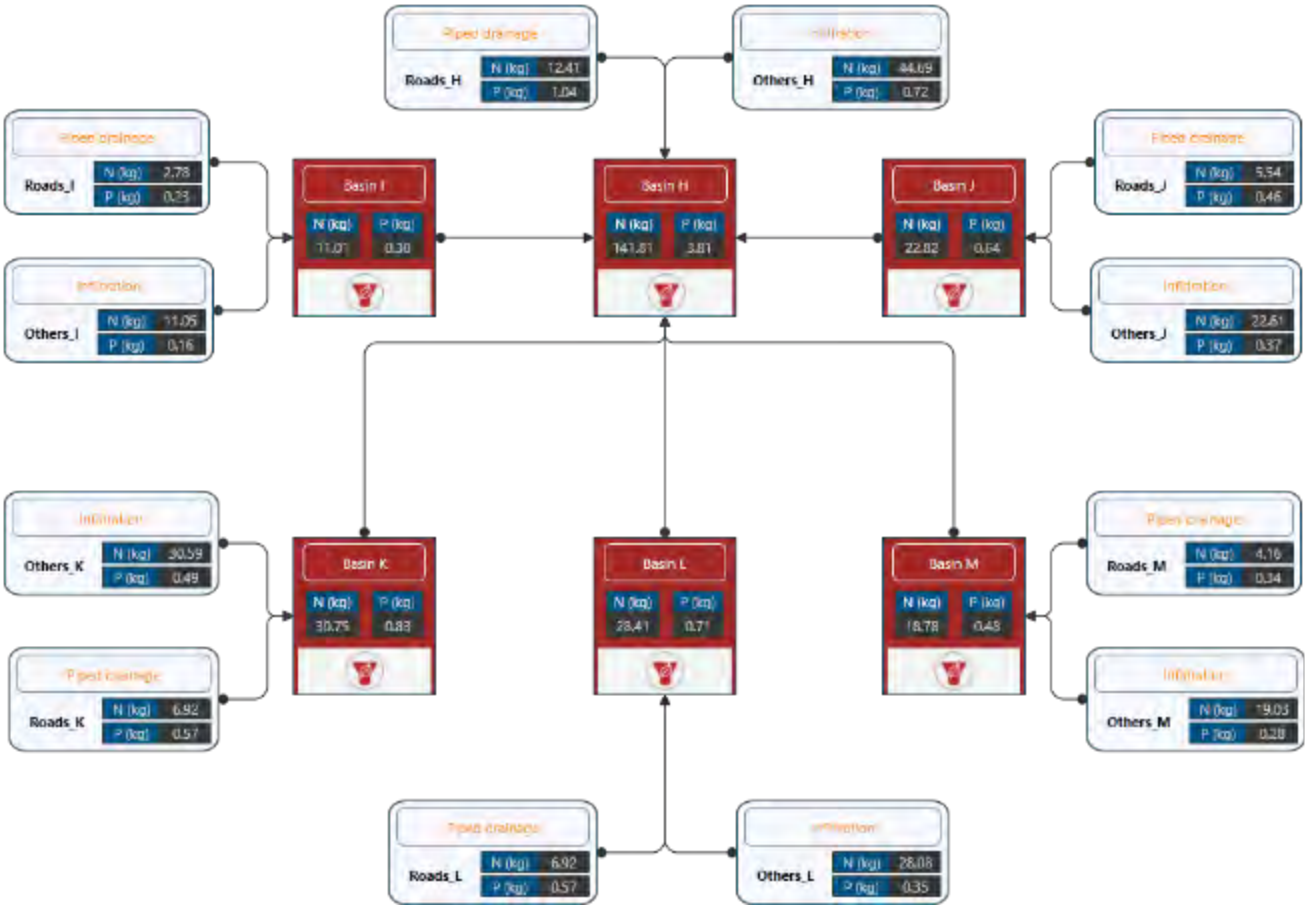
Treatment	Name	Size (m^2)	Treated area (ha)	Treating	N removed (kg/ha/yr)	P removed (kg/ha/yr)
Biofilter	Basin L	2100.00	13.22	Sandy soils – Runoff only (infiltration on lots)	0.90	0.04
Biofilter	Basin I	1100.00	4.67	Sandy soils – Runoff only (infiltration on lots)	1.09	0.05
Biofilter	Basin H	3200.00	77.76	Sandy soils – Runoff only (infiltration on lots)	3.81	0.18
Biofilter	Basin K	1700.00	14.77	Sandy soils – Runoff only (infiltration on lots)	0.83	0.04
Biofilter	Basin J	1800.00	10.88	Sandy soils – Runoff only (infiltration on lots)	0.89	0.05
Biofilter	Basin M	1440.00	8.55	Sandy soils – Runoff only (infiltration on lots)	0.92	0.04
Load removed					**0.68**	**0.02**
Net export					**1.82**	**0.05**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/ha/yr)	N export (kg/ha/yr)
Roads_H	7.00	0.15	1.77
Others_H	18.66	0.04	2.39
Roads_I	1.56	0.15	1.79
Others_I	3.11	0.05	3.55
Roads_J	3.11	0.15	1.78
Others_J	7.78	0.05	2.91
Roads_K	3.89	0.15	1.78
Others_K	10.89	0.05	2.81
Roads_L	3.89	0.15	1.78
Others_L	9.33	0.04	3.01
Roads_M	2.33	0.15	1.79
Others_M	6.22	0.04	3.06

PRE-TREATMENT LOAD (kg/ha/yr)		LOAD REMOVED (kg/ha/yr)		NET LOAD EXPORT (kg/ha/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
2.51	0.07	0.68	0.02	1.82	0.05

Treatment diagram



APPENDIX M

Footprint Lake Monitoring And Management Report (JDA, 2019)

Satterley Property Group

Provence:
Footprint Lake Monitoring & Management

December 2019

JDA Consultant Hydrologists

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1. INTRODUCTION

Footprint (Iluka) Lake is an unlined mining void used for storage of irrigation water abstracted from a production bore in the Yarragadee Formation Aquifer. The purpose of the storage is mainly to allow precipitation of dissolved iron from the groundwater, prior pumping out to Almond Parkway Lake (APL), a constructed lined lake located in the Provence Estate (Figure 1) to store water for irrigation.

Phosphorus and nitrogen in the groundwater obtained from the Yarragadee Formation Aquifer contribute to seasonal algal blooms in Footprint Lake, e.g. observed in May 2013 (JDA, 2013) and in March-April 2019 (this report).

The water quality of the lake and all components of the water-balance have been monitored over the period March to October 2019, to assess the nutrient balance of Footprint Lake, including inflows, outflows and ambient lake water quality. The various input components include groundwater from the Yarragadee Formation bore, groundwater inflow from the shallow (upgradient) Superficial Formations, rainfall and surface runoff. Output components are pumping transfer to APL, groundwater outflow (downgradient) into the Superficial Formations, and evaporation.

The report addresses comments by DWER on draft LWMS in the context of DoW Constructed Lakes Position Statement (DoW, 2007), namely: “The department does not generally support constructed lakes and therefore to enable a complete assessment of the proposal evidence should be provided as to how the criteria in the department’s *interim Position Statement: Constructed Lakes (2007)* are met. Of note being an unlined lake the water balance (including water supply) and nutrient management will be of particular relevance.”

This report presents the results of water quality sampling of lake inputs and outputs, and the water balance and nutrient balance of the lake over the monitoring period. It includes predictions of future water quality changes in the lake, and possible lake management options.

1.1 Objectives

The specific objectives of this report are to:

(1) Describe the Footprint Lake water quality 2019 status, compared with the ANZECC guideline for Southwest Australia slightly-disturbed ecosystem for freshwater lakes and guideline for recreational water quality and aesthetics (secondary contact) (ANZECC & ARMCANZ, 2000);

(2) Describe the visual observations of lake conditions and surrounding POS area, particularly midges, microphytes, and weed abundance, in addition to general conditions of the lake and surroundings;

(3) Describe the biodiversity of phytoplankton (microalgae) population 2019 to enable harmful species and any toxicity to be managed and mitigated (when necessary) in the Footprint Lake water;

(4) Evaluate the current water and nutrient balance of Footprint Lake including all inputs from groundwater, rainfall and surface flow, and all outputs from evaporation, groundwater outflow and abstraction;

(5) Assess potential future influences on water and nutrient balance of Footprint Lake, and methods to manage any such significant changes.

1.2 Relevant Documents

The following references and datasets were used in this report:

- Irrigation & Lake Water Management Strategy Provence (Emerge, 2017);
- ANZECC Guidelines for Fresh and Marine Water Quality (ANZECC & ARMCANZ, 2000a);
- ANZECC Guidelines for Water Quality Monitoring and Reporting (ANZECC & ARMCANZ, 2000b);
- An assessment guide for nuisance midge and mosquitoes (Midge Research Group of Western Australia, 2007);
- Interim Position Statement on Constructed Lakes (DoW, 2009): guidance on issues that should be considered when constructing lakes in urban areas as part of drainage, irrigation storage, recreation or aesthetic purposes, and in rural areas for recreation or aesthetic purposes.
- Water Information (WIN) database - discrete sample data. Department of Water and Environmental Regulation, Water Information section, Perth Western Australia.

2. FOOTPRINT LAKE AND ENVIRONMENT

2.1 Climate and Rainfall

Busselton has a Mediterranean climate with warm dry summers and cool wet winters. The long term (1877 to 2018) average annual rainfall at the Bureau of Meteorology's Busselton Shire Station (009515) is 801 mm; the station is located approximately 4km west of the Study Area (Figure 2). The average rainfall has decreased by about 9% since 1975 to 727 mm (Figure 2), consistent with the general decline in rainfall in southwest Western Australia (DoW, 2015).

The average annual pan evaporation is approximately 1100mm (Luke *et al*., 2003).

2.2 Footprint Lake: Operation and Environment

Footprint Lake has a surveyed area of 32,151 m^2 and calculated volume of 153,572 m^3, ranging up to 10m deep as shown in the lake bathymetry (Figure 3). The Lake was originally excavated for mining and processing of mineral sands and is unlined. It is now used for storage of groundwater abstracted from the Yarragadee Formation which is then, after precipitation of its iron content, pumped to Almond Parkway Lake to be used for irrigation on Provence Estate. The Yarragadee production bore is located approximately 30m from the south-western corner of the lake, shown in Figure 1.

Footprint Lake is excavated into sand derived from the Tamala Limestone, on or near the boundary with Guildford Formation sediments (sandy silt) on the southern (upgradient) side.

The Superficial Formations (residual sand from Tamala Limestone, and Guildford Formation) are about 10 m thick at the Lake site (Hirschberg, 1989). Four observation bores (FP01 – FP04) were constructed in February 2019 to the base of the Superficial Formations around the Lake:

- FP01 on the west side,
- FP02 at the north end,
- FP03 on the east side, and
- FP04 adjacent to the south end (Figure 1).

Bore FP01 encountered sand to 9.6 m with sandy clay 9.6 – 10.0 m, Bore FP02 encountered sand to 10 m depth, Bore FP03 encountered sand to 8.8 m with sandy clay 8.8 – 9.0 m, and Bore FP04 encountered mainly sandy clay and clayey sand to 10 m.

Bore FP 02 is interpreted as sand derived from Tamala Limestone, Bores FP01 and FP03 penetrating the same sand to Leederville Formation at the base, and Bore FP04 intersecting the Guildford Formation. Detailed bore logs are provided in Appendix A.

The Leederville Formation, which underlies the Superficial Formations at 9 to 10 m depth, consists generally of interbedded sandstone and shale, and is a major regional aquifer.

Table 1 lists the groundwater monitoring bores used in this report, and the locations are presented in Figures 1 and 4.

TABLE 1: GROUNDWATER MONITORING BORES

Bore ID	GDA (MGA 50)		Drill Date	Measurement Point/Top of Casing (mAHD)	Ground Level (mAHD)	Total Depth (m)
	Easting	Northing				
DWER Bores – Superficial						
BN18S (61030054)	348949	6273759	9 Feb 1984	4.907	4.302	6
BN19S (61030057)	352718	6274798	20 Dec 1983	6.308	5.577	8
DWER Bores – Leederville						
BN18I (61030055)	348949	6273760	8 Feb 1984	4.938	4.316	33.5
BN19I (61030058)	352718	6274796	9 Feb 1984	6.4	5.631	33.5
BN18D (61030056)	348949	6273762	8 Mar 2005	4.961	4.313	100
BN19D (61030059)	352717	6274799	20 Dec 1984	6.179	5.546	100
BN17D (61030053)	344675	6273944	2 Feb 1984	2.929	2.929	100
BN26D (61030079)	342007	6269318	3 Feb 1984	11.809	11.05	101.75
BN27D (61030082)	348513	6269137	7 Feb 1984	16.081	15.36	101.75
BN28D (61030086)	354837	6269604	15 Dec 1983	25.195	24.661	101.75
JDA Bores						
FP01	350733	6273607	19 Feb 2019	6.825	6.395	10
FP02	350839	6273749	19 Feb 2019	7.025	6.409	10
FP03	350921	6273568	19 Feb 2019	7.095	6.560	9.5
FP04	350819	6273423	19 Feb 2019	6.397	5.827	11

Source: [1)] DWER WIN database

2.3 Groundwater Levels

Groundwater levels in Bores FP01 to FP04 measured by JDA in 2019 are presented in Table 2 and shown in Figure 5.

Historical groundwater levels measured at DWER bores are summarized in Table 3 with detailed time-series graphs are presented in Appendix B. Consistent with the decrease in rainfall by about 9% since 1975, the groundwater water levels have also declined.

TABLE 2: GROUNDWATER LEVELS

Bore	19/02/19 (mAHD)	20/03/19 (mAHD)	13/08/19 (mAHD)	02/10/19 (mAHD)	Variation (m)
FP01	4.13	4.18	4.66	4.69	0.56
FP02	3.93	3.90	4.41	4.50	0.60
FP03	3.94	4.30	4.69	4.80	0.86
FP04	4.09	4.14	5.14	5.12	1.05

TABLE 3: GROUNDWATER LEVEL TREND AT DWER BORES.

Bore	Trend (Assessment Period)	Annual Minimum Water Level Trend	Annual Maxima Water Level Trend
Superficial Aquifer			
BN18S	No Trend (2008 – 2018)	-	-
BN19S	Decline (2008 - 2018)	3.7 m to 2.8 mAHD	5.3 m to 4.2 mAHD
Leederville Aquifer			
BN18I	Decline (2008 - 2018)	3.1 m to 1.5 mAHD	4.6 m to 3.8 mAHD
BN18D	Decline (2008 - 2018)	4.0 m to 1.5 mAHD	9.1 to 5.9 mAHD
BN19D	Decline (1998 - 2018)	6.9 m to 2.3 mAHD	9.8 m to 5.7 mAHD
BN19I	Decline (2000 - 2018)	4.3 m to 2.8 mAHD	5.6 m to 4.8 mAHD
BN17D	Decline (1990 - 2018)	4.0 m to 1.1 mAHD	6.7 m to 3.5 mAHD
BN26D	Decline (1990 - 2018)	8.9 m to 4.0 mAHD	10.2 m to 6.5 mAHD
BN27D	Decline (1988 - 2018)	13.0 m to 9.1 mAHD	15.0 m to 11.6 mAHD
BN28D	Decline (1992 – 2018)	17.3 m to 14.7 mAHD	18.5 m to 17.0 mAHD

3. LAKE WATER QUALITY MONITORING

3.1 Water Quality Monitoring Methodology

3.1.1 Monitoring Sites and Dates

JDA performed water quality monitoring of the Footprint Lake water quality on three occasions representing autumn (20 March 2019), winter (13 August 2019), and spring (2 October 2019). Monitoring was completed from a rowed canoe at two locations within the lake FPL1 and FPL2 (Figure 1), generally starting around 10am at every monitoring occasion. The two locations were selected to represent the deepest part of the lake.

Additional monitoring was conducted to measure nutrient input from the Yarragadee production bore and groundwater throughflow. A total of four groundwater monitoring bores were installed up-gradient and down-gradient of the lake, and groundwater samples were analysed for physicochemical, nutrient, and total iron concentrations at each monitoring occasion.

During the monitoring in March 2019, the lake water contained a significant population of potentially-toxic Cyanobacteria with the density and biovolume above the trigger guideline limits and are categorized as Alert mode in the (NHMRC, 2008), requiring increased phytoplankton sampling. Additional phytoplankton samplings were done on 16 April and 2 May 2019 at four locations identified in Figure 1.

All water quality data collected is stored in JDA ESdat database.

3.1.2 Monitoring Parameters

Monitoring procedure performed at each location was identical.

The vertical profiling of physico-chemical parameters of the lake water was performed from a rowed canoe using a HydroLab-Quanta and YSI ProDSS unit (with a turbidity sensor) with the readings conducted at 0.25 m intervals from beneath the water surface to the first 2.5 m depth and 0.5 m interval thereafter to about 10 mm above the lake bed. The readings just above the lake bed were conducted several times to ensure a consistent reading. The water quality profiling was started around 11 am allowing the sun to heat up the surface water following overnight convective cooling.

Lake water samples were collected from the surface and the lower layer. The lower layer depth was defined 3 m below the lake surface (i.e. the average thermocline depth of a shallow lake). The thermocline layer is the region in which temperature decreases rapidly with depth and was determined from temperature profiles from each monitoring occasion. This region may exist for a few hours during calm spring and summer periods and may create diurnal stratification. When a thermocline layer does not exist, water is in a mixing condition.

Water quality parameters monitored in Footprint Lake water include:

a. *In situ* profiling of physico-chemical parameters, i.e. temperature, salinity, dissolved oxygen (DO), pH, electrical conductivity (EC), oxidation-reduction potential (ORP), salinity, and turbidity;

b. Secchi depth as a measure of water transparency;

c. A NATA-accredited laboratory analysed samples for the following parameters:
   - Physico-chemical: EC, total dissolved solids (TDS), pH, dissolved organic carbon (DOC);
   - Nutrients (TP, PO_4-P, TN, TKN, NO_x-N, NH_3-N);
   - Metals: total iron (Fe) and dissolved ferrous iron (Fe^{+2})
   - Phytoplankton pigments: chlorophyll-*a* and phaeophytin-*a*;

- Phytoplankton identification and cells count.

Water quality parameters monitored in Yarragadee Bore and groundwater through-flow include:

- Physico-chemical: EC, total dissolved solids (TDS), pH, temperature;
- Nutrients (TP, PO_4-P, TN, TKN, NO_x-N, NH_3-N);
- Metals: total and dissolved Fe.

All sampling was undertaken according to the guidelines set out by Standards Australia (AS/NZS 5567.1:1998, AS/NZS 5567.4:1998, and AS/NZS 5567.11:1998). All samples from groundwater were field-filtered. All sample analyses were performed by NATA-registered laboratories.

3.1.3 Water Quality Guidelines

In this report, water quality results were compared with ANZECC guidelines for South-West Australia for (1) slightly disturbed freshwater lakes, and reservoirs, (2) irrigation water quality, and (3) recreational water quality and aesthetics (ANZECC & ARMCANZ, 2000a). The guideline values provide a range outside of which water quality problems and adverse biological impacts may occur.

These guidelines are useful as a starting point for comparison when local data does not exist. In the case of lakes these values allow the lake manager to set targets based on algal biomass and permissible nutrient concentrations. ANZECC and ARMCANZ (2000a) acknowledge that various local factors can affect the validity of applying the guidelines. Due to the variety of local determinants, conformity to guideline values may not be adequate to explain the presence of an alliance between certain types of organisms in particular water bodies.

Monitoring data collected was compared to the adopted guideline trigger values presented in Table 4, which are based on the following guidelines:

- ANZECC & ARMCANZ (2000a) provides guideline/trigger values for south-west Australia slightly disturbed freshwater lakes & reservoirs, and wetlands ecosystems;
- ANZECC & ARMCANZ (2000a)provides guideline/trigger values for toxicants applied to typical slightly to moderately disturbed ecosystems, which is also cited in DEC (2010) assessment levels for soil, sediment and water. For metals, most trigger values are for 95% level of protection (LoP) (except for Selenium 99% LoP);
- ANZECC & ARMCANZ (2000a) Guidelines for recreational water quality & aesthetics: secondary contact;
- ANZECC & ARMCANZ (2000a) Guidelines for long-term values (LTV) irrigation water quality;
- DoE (2004) Guidance for Groundwater Management in Urban Areas on Acid Sulphate Soils;
- Midge Research Group of Western Australia (2007) Assessment guide for nuisance midge and mosquitoes.

ANZECC and ARMCANZ (2000) guideline of optical properties also includes light attenuation coefficient which can be estimated using measured Secchi depth.

The Secchi depth (z_{Secchi}) reading equates to the depth at which light intensity is reduced to about 10% of the surface reading and the euphotic depth is the maximum light penetration depth (where light intensity is reduced to about 1% of surface reading). The euphotic depth is about twice the Secchi depth.

3.2 Visual Observation

A visual observation aims to identify any potential issues or improvements that could be made to reduce the likelihood of significant impacts on the Footprint Lake quality.

A visual observation was conducted at each monitoring occasion on:

a. Algal blooming appearance at Footprint Lake;
b. Evidence of ponding water or mosquito breeding locations at Footprint Lake and adjacent POS area;
c. Accumulation of debris, leaf litter and rubbish at Footprint Lake and adjacent POS area;
d. Presence of fish and other aquatic life at Footprint Lake;
e. Evidence of natural reproduction of wetland plant species;
f. Presence of trapped or dead animals at Footprint Lake and adjacent POS area.

TABLE 4: GUIDELINE VALUES ADOPTED FOR FOOTPRINT LAKE WATER QUALITY

Parameters	Relevant Guideline Values
A. Physico-chemical Property	
pH	6.5 to 8.0[1)]; 6.5 to 8.5[2)]
Temperature (°C)	15 to 35[1),2)]
DO Concentration (% saturation)	>90[1)]; >80[2)]
DO Concentration (mg/L)	>6.5[1), 2)]
Turbidity (NTU)	<10 to <100[1), 2)] depending on ecosystem
Electrical Conductivity (μS/cm)	<300 to <1500[1), 2)] depending on ecosystem
TDS (Total Dissolved Solids; mg/L)	<1000[3)]
B. Nutrients	
TN (Total Nitrogen) (mg/L)	<0.35[1)]
NO_x-N (Nitrogen in Nitrate and Nitrite) (mg/L)	<0.01[1)]; <0.1[2)]
NH_4-N (Nitrogen in Ammonium) (mg/L)	<0.01[1)]; <0.01[2)]
TP (Total Phosphorous) (mg/L)	<0.01[1)]
FRP (Filterable Reactive Phosphorus) (mg/L)	<0.005[1)]
C. Phytoplankton (MicroAlgae)	
Chlorophyll-*a* Concentration (μg/L)	<3 to <5[1)] depending on ecosystem
Total Phytoplankton Density (cells/mL)	<20,000[2)]
D. Optical Property	
Natural Visual Clarity (% reduction)	≤20%[1)]
Natural Colour Change (Munsell Scale)	≤10[2)]
Secchi Depth (m)	>1.6[2)]
Light Attenuation Coefficient (/m)	<0.13[1)]
D. Metal	
Total Iron (mg/L)	<0.3[2)]

[1)] Guideline for South-west Australia for slightly disturbed freshwater lakes and reservoirs; values are taken from Tables 3.3.6 and 3.3.7. Default trigger values for physical and chemical stressors for South-west Australia for slightly disturbed ecosystems, ecosystem type: freshwater lakes and reservoirs (ANZECC & ARMCANZ, 2000) Chapter 3.

[2)] Guideline for recreational water quality and aesthetics: secondary contact (ANZECC & ARMCANZ, 2000) Chapter 5.

3.3 Lake Monitoring Results

3.3.1 Lake Visual Observations

Visual observations for the appearance of algal blooms, rooted aquatic plant (macrophyte) domination, fish, bird population, insect population (midges in particular) and rubbish were made on each site visit.

Results from the visual observation are summarised in Table 5, illustrated with photographic evidence.

TABLE 5: LAKES VISUAL CONDITIONS

Description	A	B
Yarragadee Bore Inflow Pipe		
A. Withdrawal Outlet Pipe (to Almond Parkway Lake). B. Abstraction meter reading		
Cyanobacteria bloom observed in March – May 2019		
A. Lake Interior **B. Lake edge treatment**		

Table 5 cont.

Description	A	B
A. Culvert Outlet located at north end. B. microalgae patchiness observed during monitoring event on 2 October 2019.		
Algae bloom in Bioretention Swale at south end; observed during monitoring event on 13 August 2019		
Nutrient pathway from surrounding upstream catchment to the bioretention swale located on the south side of the lake.		

3.3.2 Lake Water Quality: Vertical Profiles

The vertical profiles of the lake water quality measured from 20 March, 13 August and 2 October 2019 are provided in Figure 9, enabling comparisons between seasonal values for temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), oxygen reduction potential (ORP) and turbidity.

Temperature Profiles

Figure 9 shows temperature profiles indicating that the lakes experienced a strong stratification in autumn (20 March 2019), well-mixed in winter (13 August 2019), and stratification (2 October 2019). Thermal stratification in March shows that the lake water column is divided into three layers: upper, middle and lower, suggesting a very strong stratification with the middle layer thickness of about 3m (extending from 3m to 6m depth). The two layers of water column due to thermal stratification in October 2019 shows that the stratification was weaker compared to March 2019.

Strong stratification causes the cold-heavy water in the lower layer (hypolimnion) to become anoxic as evident in DO profiles.

Water temperature (ranging from 14.2^{o}C to 24.5^{o}C; average 19^{o}C $\pm$ 3.7^{o}C), essentially remained within the adopted guideline values (15^{o}C to 35^{o}C; Table 4).

pH Profiles

The water pH is a measure of acidity and alkalinity. Figure 6 shows that the stratification observed from temperature profiles also closely matches the pH profiles. From this comparison, Footprint Lake experiences strong thermal and chemical (indicated by pH profile) stratification in autumn, creating three layers, and spring with two layers.

Measurements of pH ranged from 7.42 to 9.39 pH units (average 8.54 $\pm$ 0.61 pH units; median 8.75 pH units) and indicate that the lake is generally alkaline which also indicates high biological productivity. The Yarragadee bore water used to fill the Lake is neutral ranging from 6.3 to 7.5 pH units.

Electrical Conductivity (EC) and Salinity

Figure 6 shows that the electrical conductivity (EC) ranged from 1.59 mS/cm to 2.16 mS/cm (with average 1.87 $\pm$ 0.19 mS/cm and median 1.82 mS/cm), typically within the adopted guideline value of <2.0 mS/cm (Table 4). The Yarragadee bore yields fresh water with field EC ranging from 0.4 to 1.096 mS/cm, which equates to salinity of 250 to 820 mg/L TDS (see Table 8; Section 3.3).

Dissolved Oxygen (DO) Concentration Profiles

Dissolved oxygen (DO) is a measure of the amount of gaseous oxygen (O_2) dissolved in aqueous solution. Oxygen enters the water body by diffusion from the atmosphere via aeration and as a by-product of photosynthesis. This results in generally higher DO levels at the water surface than at depth. Consequently, in the bottom layer of a stratified water body (i.e. no atmospheric-surface water interface and relatively low photosynthesis when there are no submerged plants), the dissolved oxygen tends to be low. This may result in anaerobic conditions (i.e. low concentration of dissolved oxygen (DO<3 mg/L)). Because oxygen diffuses very slowly through water, its distribution in a water body is predominantly determined by wind-induced mixing.

Measurements of DO ranged from 0 to 13.95 mg/L (8.05 $\pm$ 5.03 mg/L). The lake has high DO levels at surface to about 2.5 m (Autumn and Spring) or 4.5 m (Winter), then anoxic at the bottom layer, as shown in Figure 6.

Oxidation Reduction Potential (ORP) Profiles

Oxidation Reduction Potential (ORP) is a measure of electron activity (pε) in the water at equilibrium. A positive value of pε indicates the water has the capacity to oxidize (i.e. accept electrons) organic material or contaminants which contain electrons (i.e. capable to donate electrons). Water quality improves when organic material is oxidised. For positive pε values, the higher the value the greater the oxidation potential.

Organic material will supply electrons to the lowest unoccupied electron level. Where there is inadequate oxygen in the water, other oxidisers will take its place in successive levels: NO_3^-, NO_2^-, Mn^{4+}, Fe^{3+}. When a sufficiently negative pε (i.e. too many electrons) has been reached (i.e. indicated with a negative ORP and DO concentration of 0 mg/L), fermentation reactions and reductions of SO_4^{2-} and CO_2 may occur almost simultaneously (Stumm and Morgan, 1996), which can create an odour problem.

Figure 6 shows values of negative ORP below 3m depth in summer (March 2019) and spring (September 2019). This condition suggests the lake water could potentially create an odour problem.

Turbidity Profiles

Figure 6 shows that most turbidity values were less than 10 NTU (i.e. the trigger guideline limit). During monitoring events, Sechi depths were observed generally 1.5 m, equating to an euphotic depth of about 3m. This means the light can only penetrate into the water column to about 3 m. The temperature, EC, pH, and DO profiles show consistent results.

3.3.3 Lake, Yarragadee Bore and Groundwater: Samples

Lake water quality monitoring consists of physicochemical, nutrients, dissolved organic carbon, TDS, metals, chlorophyll-*a* and algal density monitoring. The water quality results from samples collected on 20 March, 13 August and 2 October 2019 are presented in Tables 6 to 8 for lake, superficial groundwater and Yarragadee Bore respectively. Exceedances of the adopted guidelines presented in Table 4 are printed in blue in Table 6.

Lake Nutrient Concentration

Nitrogen

Four species of nitrogen were measured – Total Nitrogen (TN), Total Kjeldahl Nitrogen (TKN), Ammonia (NH_3-N) and Nitrate (NO_x-N). TN accounts for organic and inorganic nitrogen in all forms (dissolved and particulate). TKN is the insoluble organic-bound nitrogen which can result from detritus (inanimate cells) and ammonia. Ammonia and Nitrate are the soluble forms that are readily available for plant uptake. TKN is decomposed by aerobic and anaerobic bacteria and fungi in the lake sediment, into ammonia/ammonium (ammonification) which is then oxidised into Nitrites (NO_2–N) and Nitrates (NO_3–N) by nitrifying bacteria.

Table 6 shows that all TN concentrations exceeded the adopted trigger guideline presented in Table 4. All dissolved nitrogen (NH_3-N and NO_x-N) concentrations were less than detection levels, whilst TKN concentrations were as the same as TN, suggesting that most of the nitrogen is in organic form.

Phosphorus

Two Phosphorus (P) variables were measured: Total Phosphorus (TP) and Filterable Reactive Phosphorus (FRP or PO_4-P). TP accounts for all phosphorus species including FRP, Dissolved Organic Phosphorus, Particulate Organic and Inorganic Phosphorus. FRP is the soluble form of inorganic phosphorus which is directly linked to algal growth. Hence, the difference between the measured TP and FRP concentrations is the total amount of organic phosphorus (dissolved and particulate) and inorganic particulate phosphorus.

Internal sources of FRP in the water column include: (1) P-sediment release, (2) mineralisation of Dissolved Organic Phosphorus and (3) de-sorption of particulate inorganic particulate P from the water column.

Table 6 shows that most TP and PO_4-P concentrations exceeded the adopted guideline values. The high differences between the two phosphorus species suggests that phosphorus is in organic form.

Lake Dissolved Organic Carbon (DOC) Concentration

Dissolved organic carbon (DOC) is defined as the organic matter that is able to pass through a filter membrane of 0.22 µm diameter. Major forms of DOC in freshwater ecosystems are tannin and lignin from plant decomposition, which contributes to the brown lake water colour. High levels of DOC affect light penetration into the water column, which can create conditions suitable for stratification and poor water quality. DOC is also one of the main sources of energy for bacterial growth that play an important role in the sediment.

Lake DOC concentrations (generally 5 mg/L) suggest that carbon is not the main organic component in the lake water. This is consistent with the finding regarding N and P above.

TABLE 6: FOOTPRINT LAKE WATER QUALITY RESULT 2019

			Loc	FPL1-D	FPL1-D	FPL1-D	FPL1-S	FPL1-S	FPL1-S	FPL2-D	FPL2-D	FPL2-D	FPL2-S	FPL2-S	FPL2-S	FPL3	Statistical Summary					
			Date	20/03/19	13/08/19	2/10/19	20/03/19	13/08/19	2/10/19	20/03/19	13/08/19	2/10/19	20/03/19	13/08/19	2/10/19	2/10/19						
Chem. Group	**Chem. Name**	**unit**	**PQL**														**No. of Results**	**Min**	**Max**	**Average**	**Med**	**Std Dev**
Pigments	Phae-*a*	µg/L	0.2	18	2.8	4.9	7.2	7.1	1.4	14	8	8.1	1.3	5.7	7	12	13	1.3	18	7.5	7.1	4.8
	Chl-*a*	µg/L	0.1	230	100	140	31	150	31	14	140	3.2	30	100	87	230	13	3.2	230	99	100	77
Misc. Inorganics	EC	µS/cm	1	2000	2000	2000	2000	1900	2000	2000	2000	1900	1700	1900	2000	2000	13	1700	2000	1954	2000	88
	DOC	mg/L	1	5	5	8	4	6	5	5	5	5	4	5	6	9	13	4	9	5.5	5	1.5
	Fe+2	mg/L	0.05	-	<0.05	<0.05	-	<0.05	<0.05	-	0.06	<0.05	-	<0.05	<0.05	-	12	<0.05	0.06	0.051	0.05	0.0029
	pH	pH Units		8	8.4	8.6	8.8	8.8	9.2	7.8	8.7	8.2	8.8	8.8	9.2	9.2	13	7.8	9.2	8.7	8.8	0.45
	TDS	mg/L	5	1100	1100	1100	1100	1100	1200	1100	1100	1200	1100	1100	1200	1200	13	1100	1200	1131	1100	48
	TSS	mg/L	5	28	-	-	10	-	-	6	-	-	9	-	-	-	4	6	28	13	9.5	10
Nutrients	NH_3-N	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	13	<0.005	<0.005	0.005	0.005	0
	TKN	mg/L	0.1	1.8	0.8	1.5	0.9	1	0.6	1.4	0.9	0.5	0.8	0.8	1.1	2.4	13	0.5	2.4	1.1	0.9	0.53
	NO_x-N	mg/L	0.005	<0.005	<0.005	<0.005	0.026	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	13	<0.005	0.026	0.0066	0.005	0.0058
	TN	mg/L	0.1	1.8	0.8	1.5	0.9	1	0.6	1.4	0.9	0.5	0.8	0.8	1.1	2.4	13	0.5	2.4	1.1	0.9	0.53
	PO_4-P	mg/L	0.005	0.051	0.013	0.043	0.009	0.027	0.008	0.016	0.008	<0.005	0.006	0.011	0.038	0.077	13	<0.005	0.077	0.024	0.013	0.022
	TP	mg/L	0.05	0.16	0.12	0.24	0.09	0.12	0.06	0.1	0.14	<0.05	<0.05	0.06	0.15	0.39	13	<0.05	0.39	0.13	0.12	0.094
Tot.Metal	Fe	mg/L	0.01	0.07	0.14	0.08	0.38	0.13	0.05	0.08	0.14	0.07	0.07	0.13	0.06	0.06	13	0.05	0.38	0.11	0.08	0.087
Diss.Metal	Fe^{+2}	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	-	4	<0.05	<0.05	0.05	0.05	0

*) Blue-printed values are exceedance of guideline values presented in Table 4.

D refer to depth samples, S to surface samples.

TABLE 7: GROUNDWATER QUALITY AND WATER LEVEL RESULT 2019

			Location	FP01	FP01	FP01	FP02	FP02	FP02	FP03	FP03	FP03	FP04	FP04	FP04
			Date	20/03/19	13/08/19	2/10/19	20/03/19	13/08/19	2/10/19	20/03/19	13/08/19	2/10/19	20/03/19	13/08/19	2/10/19
Chem. Group	**Chem. Name**	**unit**	**PQL**												
Field	EC (Field)	µS/cm	1	1881	1606	1479	674	773	625	9330	8540	8990	8470	9290	8250
	Temp (Field)	°C		20.3	19.4	19.4	20.6	19.9	20.4	21.7	18.7	20	20.7	20.1	19.1
	pH (Field)	pH Units		6.9	6.77	7.09	7.39	6.84	7.21	6.27	6.09	6.69	6.5	6.61	6.51
Misc. Inorganics	EC (Lab)	µS/cm	1	1800	2000	1600	650	680	630	9300	9000	9400	8400	9700	8600
	pH (Lab)	pH Units		7	7.1	7.2	7.3	7.2	7.4	6.5	6.7	6.6	6.7	6.5	6.9
	TDS	mg/L	5	1000	1200	910	350	400	400	6000	5500	6000	5400	6000	5500
Nutrients (Field-filtered)	NH_3-N	mg/L	0.005	<0.005	0.011	0.007	0.015	0.11	0.03	0.041	0.017	0.048	0.044	0.024	0.045
	TKN	mg/L	0.1	0.3	0.1	0.1	0.2	0.2	<0.1	0.5	<0.1	0.2	0.4	0.1	0.2
	NOx-N	mg/L	0.005	<0.005	<0.005	0.014	0.094	0.032	0.33	<0.005	<0.05	<0.005	<0.005	<0.05	<0.005
	TN	mg/L	0.1	0.3	0.1	0.2	0.3	0.2	0.4	0.5	<0.1	0.2	0.4	0.1	0.2
	PO_4-P	mg/L	0.005	0.42	0.15	0.011	0.67	0.84	0.65	<0.05	0.19	0.28	<0.05	0.36	<0.005
	TP	mg/L	0.05	0.68	0.35	0.28	0.69	0.71	0.72	0.29	0.33	0.51	0.33	0.41	0.36
Diss. Metal	Diss. Fe	mg/L	0.01	4.5	2	1.7	0.11	0.78	0.68	24	18	24	21	25	17
Water Level		mAHD	-	4.18	4.66	4.69	3.90	4.41	4.9	4.30	4.69	4.80	4.14	5.14	5.12

TABLE 8: YARRAGADEE BORE WATER QUALITY RESULT 2019

			Location	Yarragadee PB	Yarragadee PB	Yarragadee PB						
			Date	20/03/19	13/08/19	2/10/19	Statistical Summary					
Chem. Group	**Chem. Name**	**unit**	**EQL**				**No. of Results**	**Min**	**Max**	**Average**	**Median**	**Std Dev**
Field	EC (field)	µS/cm	1	495	664	1096	3	495	1096	752	664	310
	Temp (Field)	°C		25	21.4	22.3	3	21.4	25	23	22.3	1.9
	pH (Field)	pH Units		6.11	6.59	6.78	3	6.11	6.78	6.5	6.59	0.35
Misc. Inorganics	EC (Lab)	µS/cm	1	480	580	1500	3	480	1500	1040	1040	650
	pH (Lab)	pH Units		6.5	6.5	7.3	3	6.5	7.3	6.8	6.5	0.46
	TDS	mg/L	5	250	320	820	3	250	820	463	320	311
Nutrients	NH3-N	mg/L	0.005	0.045	0.032	0.009	3	0.009	0.045	0.029	0.032	0.018
	TKN	mg/L	0.1	0.4	<0.1	0.3	3	<0.1	0.4	0.27	0.3	0.15
	NOx-N	mg/L	0.005	0.006	<0.005	<0.005	3	<0.005	0.006	0.0053	0.005	0.00058
	TN	mg/L	0.1	0.4	<0.1	0.3	3	<0.1	0.4	0.27	0.3	0.15
	PO4-P	mg/L	0.005	0.016	0.42	<0.005	3	<0.005	0.42	0.15	0.016	0.24
	TP	mg/L	0.05	0.59	0.49	0.29	3	0.29	0.59	0.46	0.49	0.15
Total Metals	Fe	mg/L	0.01	13	12	6.6	3	6.6	13	11	12	3.4

3.3.4 Lake Water Quality: Phytoplankton Population and Bloom Evidence

Phytoplankton (microalgae) Population Density and Chlorophyll-*a* Concentration

Figure 7 shows that the lake experienced high blooms of Cyanobacteria during summer monitoring in March 2019, as observed in FPL1 and FPL2 surface water samples, with total density exceeding the trigger guideline (20,000 cells/mL). Potentially-toxic Cyanobacteria species were observed during the bloom event: *Dolichospermum and Microcystis aeruginosa*. Not much of phytoplankton observed in the lower layer of the lake due to anoxic condition. Table 6 shows most chlorophyll-*a* concentration exceeded the trigger guideline value of 5 µg/L, with the maximum concentration is more than 40 times the guideline value.

Phytoplankton (microalgae) Biovolume

Figure 8 shows the biovolume for the Cyanobacteria species observed in March, showing that the biovolume of the potentially-toxic species triggered the Alert Mode: Amber Level.

When the total algae, especially the Cyanobacteria population trigger guideline value is breached (>20,000 cells/mL; Table 3), the Interim Blue-Green Algae Management Protocols (Water Directorate NSW, 2014) suggests three alert levels for recreational water in NSW (Table 9), which is based on the NHMRC (2008) Guideline for Managing Risks in Recreational Water. There is no similar guideline provided for WA; however WA Department of Water and Environmental Regulation (DWER) and Department of Biodiversity, Conservation and Attraction (DBCA) adopt the interpretation of alert levels presented in Table 9. The recommended actions for each three alert levels is also provided on Table 10.

The plans and actions outlined in Table 10 are ultimately for the prevention of health hazards arising from Cyanobacteria blooms if and when they occur, depending on the alert level. Planning for contingency is an important part of the overall strategy for managing blooms and the health hazards associated with toxic blooms.

TABLE 9: INTERPRETATION OF CYANOBACTERIA ALERT LEVELS FOR RECREATIONAL WATER (WATER DIRECTORATE NSW, 2014 AND NHMRC, 2008)

Surveillance Mode (Green Level)	Alert Mode (Amber Level)	Action Mode (Red Level)
>500 to < 5,000 cells/mL *Microcystis aeruginosa* or biovolume equivalent of <0.04 to <0.4 mm^3/L for the combined total of all Cyanobacteria.	≥5,000 to < 50,000 cells/mL *Microcystis aeruginosa* or biovolume equivalent of ≥0.4 to <4 mm^3/L for the combined total of all Cyanobacteria.	Level 1 guideline: ≥10 µg/L total microcystins or ≥ 50,000 cells/mL toxic *Microcystis aeruginosa* or biovolume equivalent of ≥4 mm^3/L for the combined total of all Cyanobacteria where a known toxin producer is dominant in the total biovolume,[a)] , or Level 2 guideline: The total biovolume of all Cyanobacterial material ≥10 mm^3/L or Cyanobacterial scums are consistently present.[b)]
Monitoring requirement: Routine sampling to measure Cyanobacterial levels.	Investigations into the causes of the elevated levels and increased sampling to enable the risks to recreational users to be more accurately assessed.	Local authority and health authorities to warn the public that the water body is considered to be unsuitable for primary contact recreation.

[a)] This applies where high cell densities or scums of 'non-toxic' Cyanobacteria are present, i.e. when the Cyanobacterial population has been tested and shown not to contain known toxins (microcystin, nodularia, cylindrospermopsin or saxitoxins).

[b)] This refers to the situation where scums occur at the recreation site each day, when conditions are calm, particularly in the morning. Note that it is not likely that scums are always present and visible when there is a high population, as the cells may mix down with the wind and turbulence and then reform later when conditions become stable.

TABLE 10: RECOMMENDED ACTIONS AT DIFFERENT ALERT LEVELS FOR CYANOBACTERIA BLOOMS

Level	Recommended actions
Surveillance Mode (Green Level)	Regular monitoring: ▪ Weekly sampling and cell counts at representative locations in the water body where known toxigenic species are present (i.e. *Microcystis*, *Anabaena*, *Nodularia, Cylindrospermopsis spp.* or ▪ Fortnightly sampling for other types including regular visual inspection of water surface for scums.
Alert Mode (Amber Level)	▪ Notify agencies as appropriate. ▪ Increase sampling frequency to twice weekly at representative locations in the water body where toxigenic species (above) are dominant within the alert level definition (i.e. total biovolume) to establish population growth and spatial variability in the water body. ▪ Monitor weekly or fortnightly where other types are dominant. ▪ Make regular visual inspections of water surface for scums ▪ Decide on requirement for toxicity assessment for toxin monitoring.
Action Mode (Red Level)	▪ Continue monitoring as for alert mode. ▪ Immediately notify health authorities for advice on health risk. ▪ Make toxicity assessment or toxin measurement of water, if this has not already been done. ▪ Health authorities warn of risk to public health (i.e. the authorities make a health risk assessment considering toxin monitoring data, sample type and variability.

Following the guideline, the phytoplankton sampling frequency was added to fortnightly: 16 April and 2 May 2019. The Cyanobacteria density and biovolume presented in Figures 10 and 11 show a significant reduced level. Samplings in August and October 2019 show that the total populations were less than the trigger guideline value of 20,000 cells/mL.

4. LAKE WATER AND NUTRIENT BALANCE

4.1 Water Balance Component

The current water balance for Footprint Lake includes the following potential inputs and outputs.

Inputs:

- Groundwater pumping from Yarragadee Bore - YB
- Groundwater inflow from Superficial Formations (upgradient) - GI
- Groundwater inflow from Leederville Formation - LF
- Rainfall - RF
- Surface runoff - SR

Outputs:

- Pumping to Almond Parkway Lake - AP
- Groundwater outflow from Superficial Formations (downgradient) - GO
- Evaporation - E

Assuming no change in the Lake water level the annual water balance is sum of Inputs = sum of Outputs.

YB + GI + LD + RF + SR = AP + GO + E

Estimation of Current Inputs

YB: The metered input from the Yarragadee Bore in the 2018/19 water year was 46,087 m^3, almost all during December to May, with peak input (22%) in January 2019.

GI: The groundwater flow direction in the Superficial Formations in the vicinity of Footprint Lake is northerly with a hydraulic gradient of about 3.4 x 10^{-3} on the upgradient side, in the Guildford Formation, and 1.7 x 10^{-3} on the downgradient side, reflecting the higher hydraulic conductivity of the sand derived from the Tamala Limestone (Hirschberg, 1989).

The cross-sectional width of the Lake, at right-angles to groundwater flow, is about 200 m. The flow will be emanating from the Guildford Formation, with a saturated thickness of about 9 m and hydraulic conductivity of about 0.5 m/day, giving a transmissivity of about 5 m^2/day.

Calculated throughflow into Footprint Lake, from the Superficial Formations, is therefore estimated as follows:

GI = Transmissivity x Gradient x Cross-Sectional Area

= 5 x 3.4 x 10^{-3} x 200 = 3.4 m^3/day or 1,240 m^3/year

LF: The hydraulic head in the Leederville Formation is now below the water level in Footprint Lake (see Table 3). Therefore there is now no groundwater inflow to Footprint Lake from the Leederville Formation. In addition, Observation Bores FP01 and FP03 indicate that the Leederville Formation in the vicinity of the Lake consists of sandy clay directly below the Superficial Formations, restricting any groundwater interchange.

RF: The annual rainfall in 2018/19 was 594 mm (BoM Busselton Shire Station), giving rainfall input to the Lake of about 19,100 m^3.

SR: The surface catchment of the Lake, estimated at 3 ha, is assumed to yield about 80 percent runoff from rainfall, giving a total of about 14,260 m^3.

Total input per year is therefore estimated to be:

46,087 m^3 (YB) + 1,240 m^3 (GI) + 19,100 m^3 (RF) + 14,260 m^3 (SR) ≈ 80,700 m^3.

Estimation of Current Outputs

AP: Pumped transfer to Almond Parkway Lake is reported to have been 42,790 m^3/yr (AP) in 2018/19.

GO: Groundwater outflow from the Lake will reflect the higher transmissivity of the Tamala Limestone sand, assumed from its lithology to be about 50 m^2/day. Outflow is therefore estimated at:

GO = Transmissivity x Gradient x Cross-Sectional Area

= 50 x 1.7 x 10^{-3} x 200 = 17 m^3/day or 6,200 m^3/year E: Evaporation is estimated to be about 85% of the average pan evaporation of 1,100 mm (Luke et al, 1987), giving a total of 30,100 m^3/yr over the Lake area of 32,151 m^2.

Total output per year is therefore estimated to be:

42,790 m^3 (AP) + 6,200 m^3 (GO) + 30,100 m^3 (E) ≈ 79,100 m^3/yr.

This is within two percent of the estimated total Inputs, indicating that any Lake inflow from surface drains was insignificant during the review period.

Note that in earlier years there was an upward head from the Leederville Formation into the Superficial Formations during which time there would have been upward flow into the Lake.

For example, in 1985 there was a significant upward hydraulic head from the Leederville Formation into the Superficial Formations of about 2.8 m as illustrated in Figure 9 (Hirschberg, 1989).

Since that time, however, regional abstraction from the Leederville Formation has lowered the hydraulic head in the vicinity of Footprint Lake by about 3.5 m, presented in Table 3, so that there is now a downward gradient from the Lake into the Leederville Formation.

4.2 Salt and Nutrient Mass Balance

The average concentrations of Total Dissolved Solids (TDS), Total Nitrogen (TN) and Total Phosphorus during the monitoring events in March, August and October 2019 are provided in Table 11, which are calculated from values presented in Tables 7 and 8.

Yarragadee Formation values are averaged from concentrations measured at the Yarragadee Bore. Values for groundwater inflow are taken from analyses of samples taken from upgradient Monitor Bores FP03 and FP04, and for groundwater outflow from downgradient Bores FP01 and FP02.

Figures 6 to 8 show shallow groundwater and Lake TDS, TD and TN on 20/3/19.

Referring to Figure 6 the groundwater has higher salinity upgradient (FP3 and FP4) than downgradient (FP1 and FP2) associated with dilution from the fresher water in the Lake discharging to the north.

TABLE 11: AVERAGE CONCENTRATION OF TDS, TN, TP

Component	TDS (mg/L)	TN (mg/L)	TP (mg/L)
INPUT			
Yarragadee Formation	285	0.23	0.46
Groundwater Inflow	5,735	0.23	0.37
Rainfall	30	0.30	0.01
Surface Water Runoff	30	0.30	0.01
OUTPUT			
Pumping to ALP	1,130	1.12	0.13
Groundwater Outflow	1,225	0.25	0.57

Rainfall values for Total Nitrogen and Total Phosphorus are averaged from analyses taken nearby at Vasse in July and August 2007. The TDS for rainfall is from Hingston & Gailitis (1976); surface runoff is assumed to be of the same chemical quality as rainfall.

Values for pumping to Almond Parkway Lake are taken from analyses of Footprint Lake.

Applying the above water quality values to the volumes estimated for the water balance gives the following 2019 totals:

TABLE 12: MASS BALANCE OF TDS, TN, TP

COMPONENT	TDS (kg/yr)	Total N (kg/yr)	Total P (kg/yr)
ANNUAL INPUT			
Yarragadee Formation	13,135	10.6	21.2
Groundwater Inflow	7,111	0.3	0.5
Rainfall	573	5.7	0.2
Surface Water Runoff	428	4.3	0.1
Totals	**21,247**	**20.9**	**22.0**
ANNUAL OUTPUT			
Pumpage Out	48,353	47.9	5.6
Groundwater Outflow	7,595	1.6	3.5
Totals	**55,948**	**49.5**	**9.1**
NETT	**-34,701**	**-29**	**13**

The current imbalance of input and output chemical totals reflects the previous history of Footprint Lake before pumping to Almond Parkway Lake began and before Footprint Lake received most of its input from the Yarragadee Formation.

There would have been many years of groundwater inflow from the Superficial Formations, with much higher salinity than that from the Yarragadee Formation (5,735 mg/L TDS compared with 285 mg/L). Thus the current TDS output is more than two and a half times the current input. All parameters, including TDS, would also be concentrated year by year by evaporation, which equates to about 20% of the Lake volume.

The current nitrogen output is more than twice the current input, reflecting reduced input from shallow groundwater which has higher Total Nitrogen content than that of the Yarragadee Formation.

The current phosphorus output, at less than half of the present input, reflects the lower phosphorus content of shallow groundwater, rainfall and surface runoff compared to the Yarragadee Formation. It may also reflect precipitation of phosphorus in the Lake sediment.

5. CONSTRUCTED LAKES GUIDELINE (DOW 2007)

The DoW (2007) *Interim Drainage and Water Management Position Statement: Constructed Lakes* is designed to guide developers, landowners, local government and State Government agencies on the Department's position on constructed lakes.

Table 13 presents the Constructed Lakes Checklist items provided in DoW (2007) with the left hand column list of requirements and the right hand column current evidence.

TABLE 13: CONSTRUCTED LAKES CHECKLIST

Checklist of requirements	Current Evidence
Land use planning for drainage and water management	
▪ Has the constructed lake been approved in regional or district planning? ▪ Is the constructed lake clearly indicated on the local structure plan, subdivision application and subdivision plan?	Footprint Lake has been used as part of the Irrigation and Lake Water Management Strategy (ILWMS) v.7, endorsed by the City of Busselton in February 2009. Given the extended life span of subdivision projects the ILWMS is revised in 2016 with more detailed description on Footprint Lake; awaiting approval.
General requirements	
▪ If the constructed lake is proposed solely for irrigation storage, has the developer or landowner demonstrated why alternatives, such as groundwater bores or tanks, are not viable options?	The lake functions to reduce the iron concentration contained in Yarragadee bore water which is used for irrigation.
▪ If the constructed lake is proposed as a component of the stormwater management system, is it consistent with the *Decision Process for Stormwater Management in WA* (DoE & SRT, 2005a).	Not Applicable. The lake is not part of stormwater management system, but receives minor stormwater from swale overflow.
▪ Has the developer or landowner demonstrated consideration of the local conditions when deciding whether the lake will be lined or unlined?	Existing lake
Water Use Efficiency	
▪ Does the design minimise surface area and use other design methods to reduce water loss through evaporation? ▪ Has a water balance calculation been provided, which demonstrates that the net loss of water will be acceptable?	Existing lake YES
▪ If the constructed lake is proposed for the purpose of irrigation storage, has the developer or landowner demonstrated that landscaping has been designed to minimise the amount of water required for irrigation. ▪ If the constructed lake is proposed for the purpose of irrigation storage, has the developer or landowner demonstrated that the volume of water in the constructed lake is consistent with the irrigation requirements? ▪ If required, has he developer or landowner applied for a Rights in Water and Irrigation (RIWI) Act 1914 licence.	YES YES YES – there is existing GW Licences in place: GWL157168(5) and GWL160990(4)

Table 13 cont.

Checklist of requirements	Current Evidence
Protection of natural wetlands, waterways and other water dependent ecosystems	
▪ Will the proposal impact on natural wetlands, waterways and other water dependent ecosystems located near to, or downstream of, the constructed lake? ▪ Have adequate wetland buffer areas and waterway foreshore areas been designated to protect any wetlands and waterways located adjacent to, or downstream of, the constructed lake? ▪ Has maintenance of the hydrologic regimes of nearby and downstream wetlands, waterways and other water dependent ecosystems been adequately considered?	Not Applicable Not Applicable Not Applicable
▪ Does the proposal avoid modifications to Conservation and Resource Enhancement management category wetlands? ▪ If it is proposed to modify a Multiple Use Management category wetland, has the Department of Environment and Conservation granted approval (i.e. based on the merits of the proposal)?	Not Applicable Not Applicable
If required, has the developer or landowner applied for a RIWI Act permit?	Existing lake
Does the proposal avoid directly connecting the constructed lake to natural wetlands and waterways (e.g. via pipes, constructed channels or drains)?	YES
Algal and aquatic weed blooms	
Has the developer or landowner demonstrated (e.g. by modelling) that the turnover (i.e. rate of water exchange) and circulation of the constructed lake will be adequate to significantly minimise the risk of algal and aquatic weed blooms?	Based on 2019 monitoring the lake water column stratifies generally all year around, posing a significant risk of algal and aquatic weed blooms.
Has the developer or landowner demonstrated that the water quality will not contribute to algal and aquatic weed blooms?	TBA
Has the developer or landowner used appropriate non-structural and structural methods to maintain or treat water quality?	TBA

Table 13 cont.

Checklist of requirements	Current Evidence
Acid sulfate soils and iron monosulfides	
▪ Has the developer or landowner identified whether there is a risk of acid sulfate soils (ASS) being present? If ASS have been identified, are the proposed management practices	ASS is unidentified
▪ Is appropriate management proposed to minimise the risk of iron monosulfides forming in the sediments of drainage systems? ▪ Has the developer or landowner demonstrated that inflow water quality (i.e. sulfate and ferrous iron) will not contribute to the formation of iron monosulfides	TBA TBA
Other issues considered	
▪ Has the developer or landowner adequately considered the requirements for on-going maintenance? ▪ Has the developer or landowner adequately considered the life-cycle cost of maintenance and retrofitting or replacement, including all associated infrastructure?	See ILWMS
Has the developer or landowner proposed to avoid using algicides and algistats or using them only where appropriate, for the management of algal and aquatic weed blooms?	See ILWMS
Has the local government provided support for the proposal?	See ILWMS
Has the developer or landowner demonstrated that the design and management of the proposed constructed lake will minimise the risk of mosquitoes and midges?	See ILWMS

1. TBA: To Be Advised

The Checklist entries under *Algal and aquatic weed blooms,* which were one of the drivers for this report, highlight the need for further research on appropriate management options for the Lake.

6. FUTURE LAKE MANAGEMENT

Based on the monitoring results presented in Chapters 3 and 4 during 2019, options for future lake management are summarised in Table 14.

TABLE 14: FOOTPRINT LAKE: SUMMARY OF OPTIONS FOR LAKE ALGAE MANAGEMENT

Option	Name	Brief Description	Intermittent or Permanent	Previous Application	JDA Ranking	Pros / Cons
1	Oxygenation	Adding oxygen to lake from bed diffusers from oxygen cylinder to reduce stratification.	Permanent	Vasse Estuary by DWER 2018	High	Con: nutrient input not reduced.
2	Filtration of Yarragadee Bore	Reduce N, P input to lake by inline filter from bore to lake to reduce N & P particulates entering lake.	Permanent	Usually applied to prevent irrigation sprinkler / dipper blockage, not for water quality improvement	High	Pro: reduces nutrient input.
3	Aeration by Fountain	Pump to create fountain for natural aeration.	Permanent	Vale Lake, City of Swan	Medium	Con: nutrient input not reduced.
4	Lowering of Offtake	Lower offtake to Almond Parkway Lake to reduce stratification.	Permanent	N/A	Medium	Pro: increased mixing of lake. Con: nutrient input not reduced. Con: may adversely affect APL WQ.
5	Ultrasonic Algae Control	Killing all algae species by ultrasonic pulses.	Intermittent	Water Corp at Rosalea Lake, Karrinyup.	Low	Con: nutrient input not reduced. Con: toxins associated with algae will remain in lake.
6	Chemical Algae Control	Killing all algae by liquid chemical treatment in lake.	Intermittent	Swan River Trust (2005)	Low	Con: nutrient input not reduced. Con: toxins associated with algae will remain in lake.

7. CONCLUSIONS

Based on the three monitoring events (March, August, and October 2019) and additional monitoring due to phytoplankton (Cyanobacteria) bloom in March and April 2019, JDA concludes as follows with respect to the specific objectives in Section 1.1:

Objective 1: Describe the Footprint Lake water quality 2019 status, compared with the ANZECC guideline for Southwest Australia slightly-disturbed ecosystem for freshwater lakes and guideline for recreational water quality and aesthetics (secondary contact) (ANZECC & ARMCANZ, 2000).

- *Footprint Lake water quality is poor with nutrients (TN and TP) exceeding the trigger guideline values and most of the nutrient is in organic form. The lake water column experiences very strong stratifications in summer and spring, and weaker in winter. Due to this, the lake lower layer (from 3 m depth) is anoxic (indicated with DO concentration of 0 mg/L) and have no capacity to oxidize (negative values of ORP), which could potentially create an odour problem. This condition suggests the lake water could potentially create an odour problem.*

Objective 2: Describe the visual observations of lake conditions and surrounding POS area, particularly midges, microphytes, and weed abundance, in addition to general conditions of the lake and surroundings.

- *Visual observations of the surrounding POS area do not indicate any significant population of midges and microphytes.*

Objective 3: Describe the biodiversity of phytoplankton (microalgae) population 2019 to enable harmful species to be managed and mitigated (when necessary) in the Footprint Lake water.

- *The lake experienced high blooms of Cyanobacteria in March 2019 with total density exceeding the trigger guideline (20,000 cells/mL) and chlorophyll-a concentration exceeding guideline (5 µg/L), as shown in Table 6 and Figure 10. Potentially-toxic Cyanobacteria species observed during the bloom event were: Dolichospermum and Microcystis aeruginosa with biovolume which triggered the Alert Mode Amber Level as shown in Figure 11. The Cyanobacteria bloom reduced significantly in winter and spring 2019.*

Objective 4: Evaluate the current water and nutrient balance of Footprint Lake including all inputs from groundwater, rainfall and surface flow, and all outputs from evaporation, groundwater outflow and abstraction.

- *The mass balance for salt (TDS) and nutrients calculation result is presented in Table 12.*

Objective 5: Asses potential future influences on water and nutrient balance of Footprint Lake, and methods to manage any such significant changes

- *The mass balance for salt (TDS) and nutrients in the review period indicates that the water in Footprint Lake will become fresher in time, as more salt is being exported than imported. Similarly, the Total Nitrogen concentration in the lake is expected to decrease. Total Phosphorus may increase depending on rate of precipitation onto bed sediment. Methods to manage the lake nutrient balance and algae are summarised in Table 14.*

8. REFERENCES

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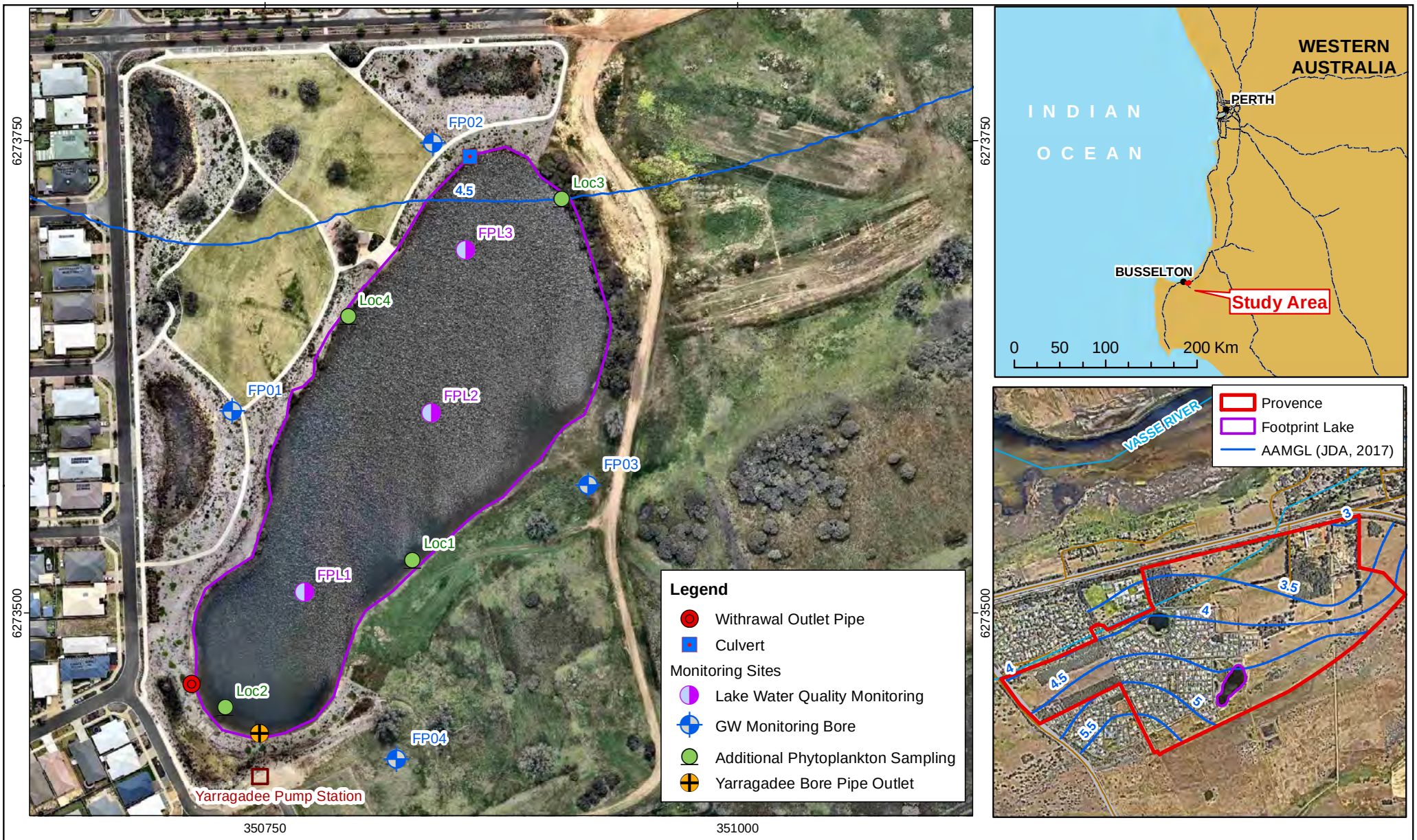
FIGURES



Data Source: NearMap Aerial Photo (9 October 2019)

Coordinate System: GDA 94, Zone 50

Job No. J6712
Scale: 1:2,750 @A4

0 50 100 150 200 Meters

N

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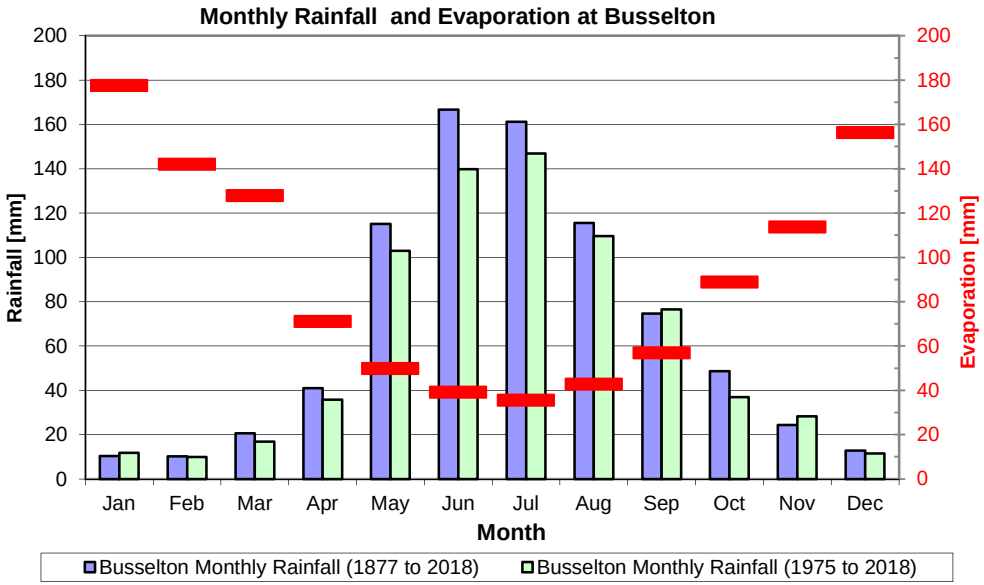
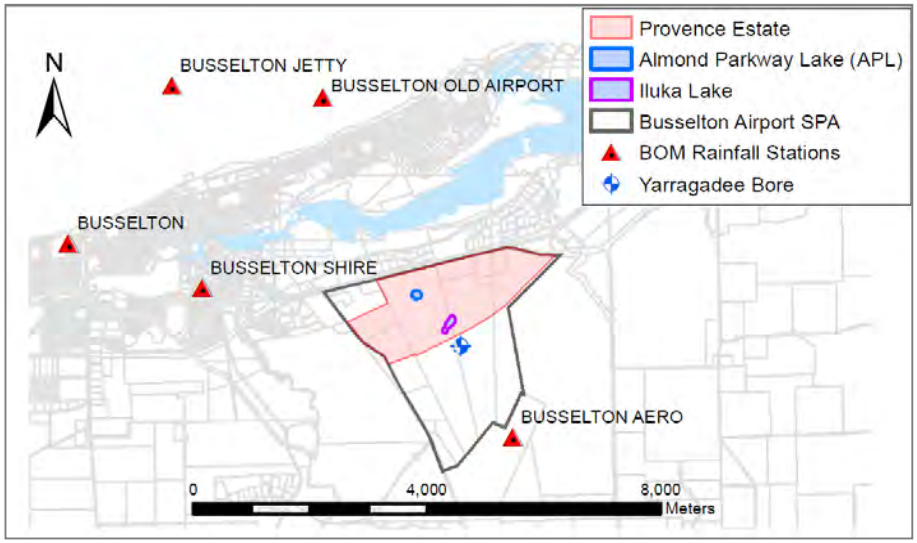
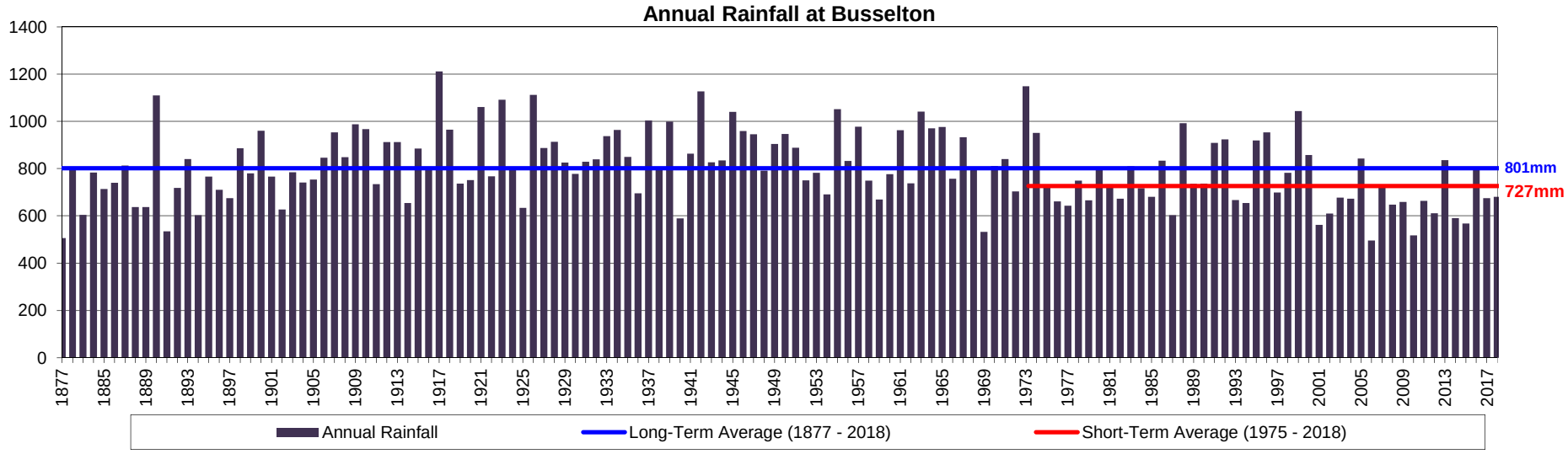
Satterley Property Group
Provence: Footprint Lake Monitoring and Management

Figure 1: Lake Monitoring Sites







Data Source: BoM (2019)

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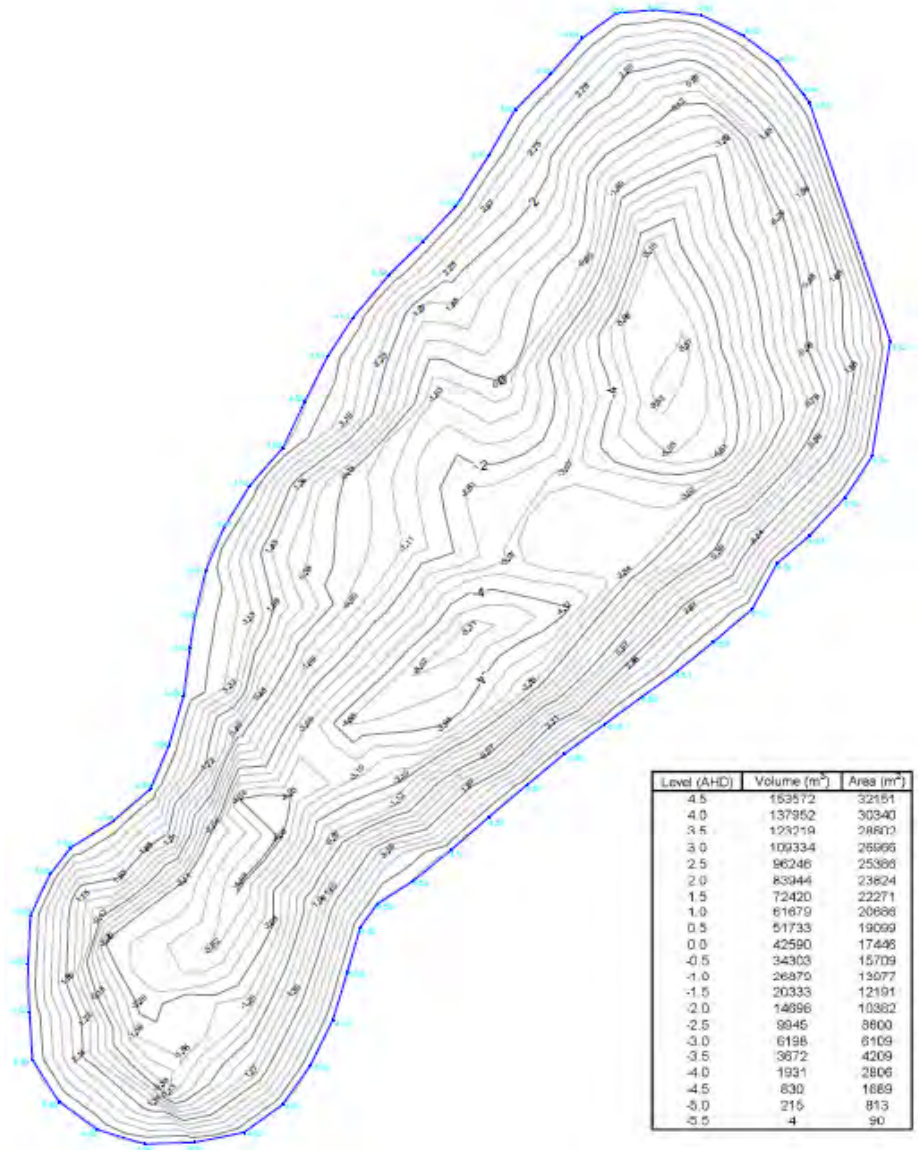
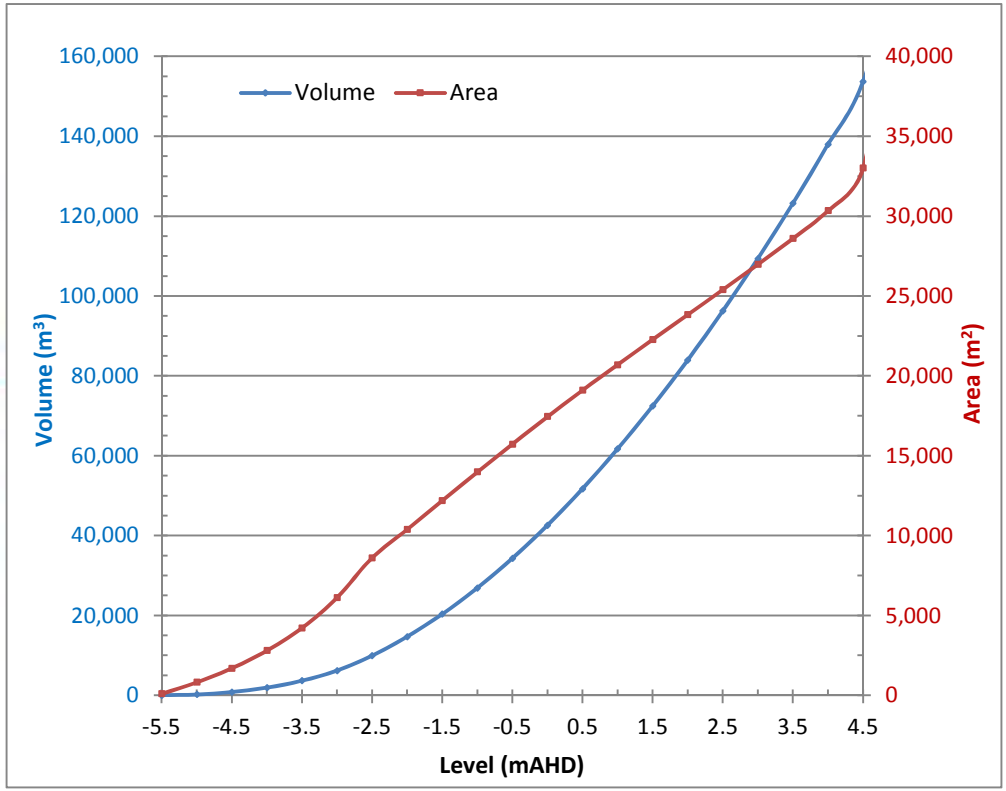
Figure 2: Annual and Monthly Rainfall Measured at Busselton Shire Station



Level (AHD)	Volume (m^3)	Area (m^2)
4.5	153572	32151
4.0	137952	30340
3.5	123019	28602
3.0	109334	26966
2.5	96246	25386
2.0	83944	23824
1.5	72420	22271
1.0	61679	20686
0.5	51733	19099
0.0	42590	17446
-0.5	34303	15709
-1.0	26879	13977
-1.5	20333	12191
-2.0	14696	10382
-2.5	9945	8600
-3.0	6196	6109
-3.5	3672	4209
-4.0	1931	2806
-4.5	830	1689
-5.0	215	813
-5.5	4	90



Data Source: McMullen Nolan (2007)

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Figure 3: Footprint Lake Bathymetry

Data Source: NearMap Aerial Photo (27 Nov 2018), WIN Database [10 Sep 2019]. DWER Water Information section, Perth Western Australia.

Coordinate System: GDA 94, Zone 50

JDA

Job No. J6712
Scale:1:60,000 @A4

0 1 2 3 4 Km

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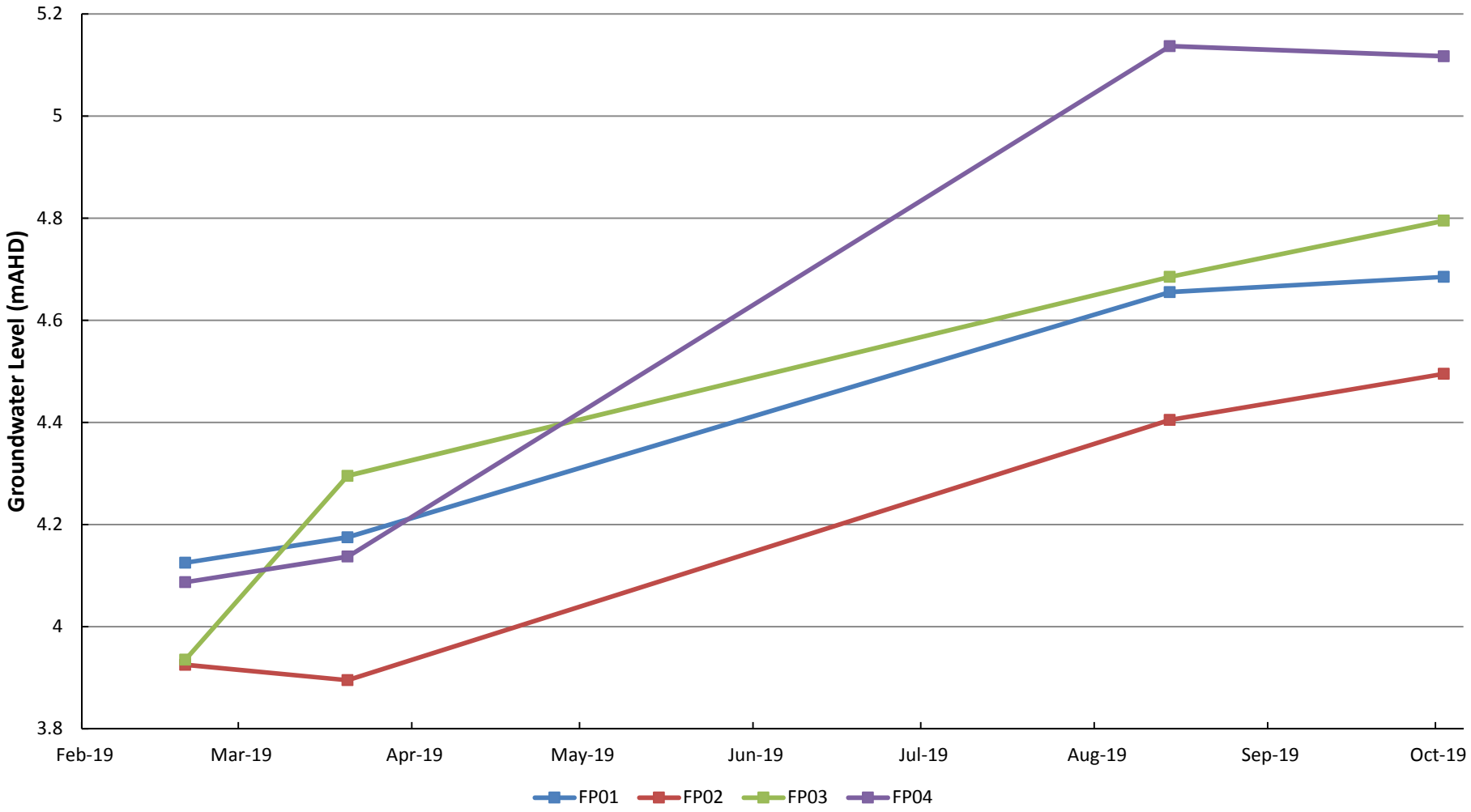
Figure 4: DWER Monitoring Bores Utilized



Data Source:

Job No. J6712

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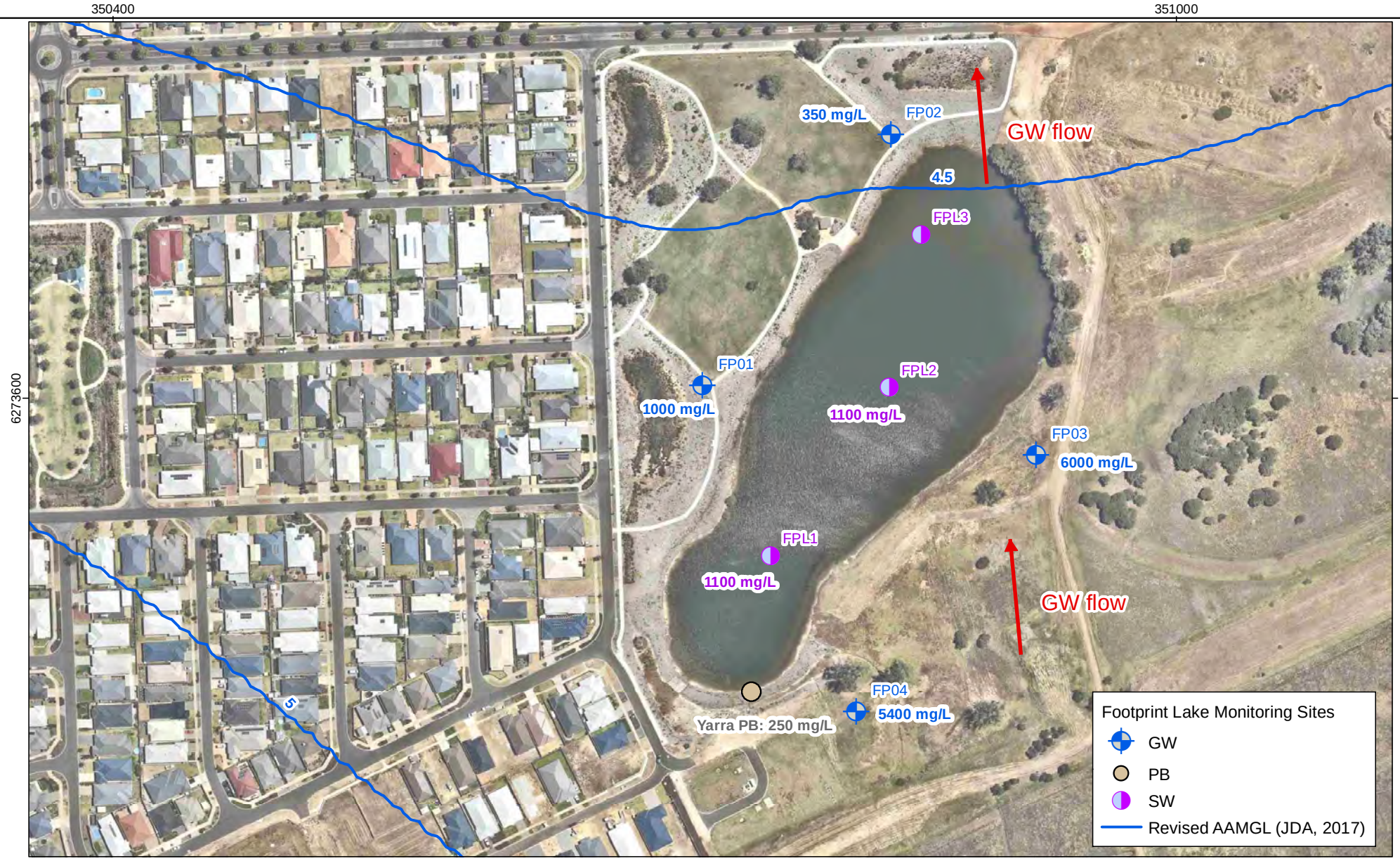
Figure 5: Groundwater Levels, 2019



Data Source: NearMap Aerial Photo (27 Nov 2018)

Coordinate System: GDA 94, Zone 50

Job No. J6712
Scale: 1:3,000 @A4

0 50 100 150 200 Meters

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Figure 6: Groundwater and Lake TDS, 20/3/19

Data Source: NearMap Aerial Photo (27 Nov 2018)

Coordinate System: GDA 94, Zone 50

Job No. J6712
Scale: 1:3,000 @A4

0 50 100 150 200 Meters

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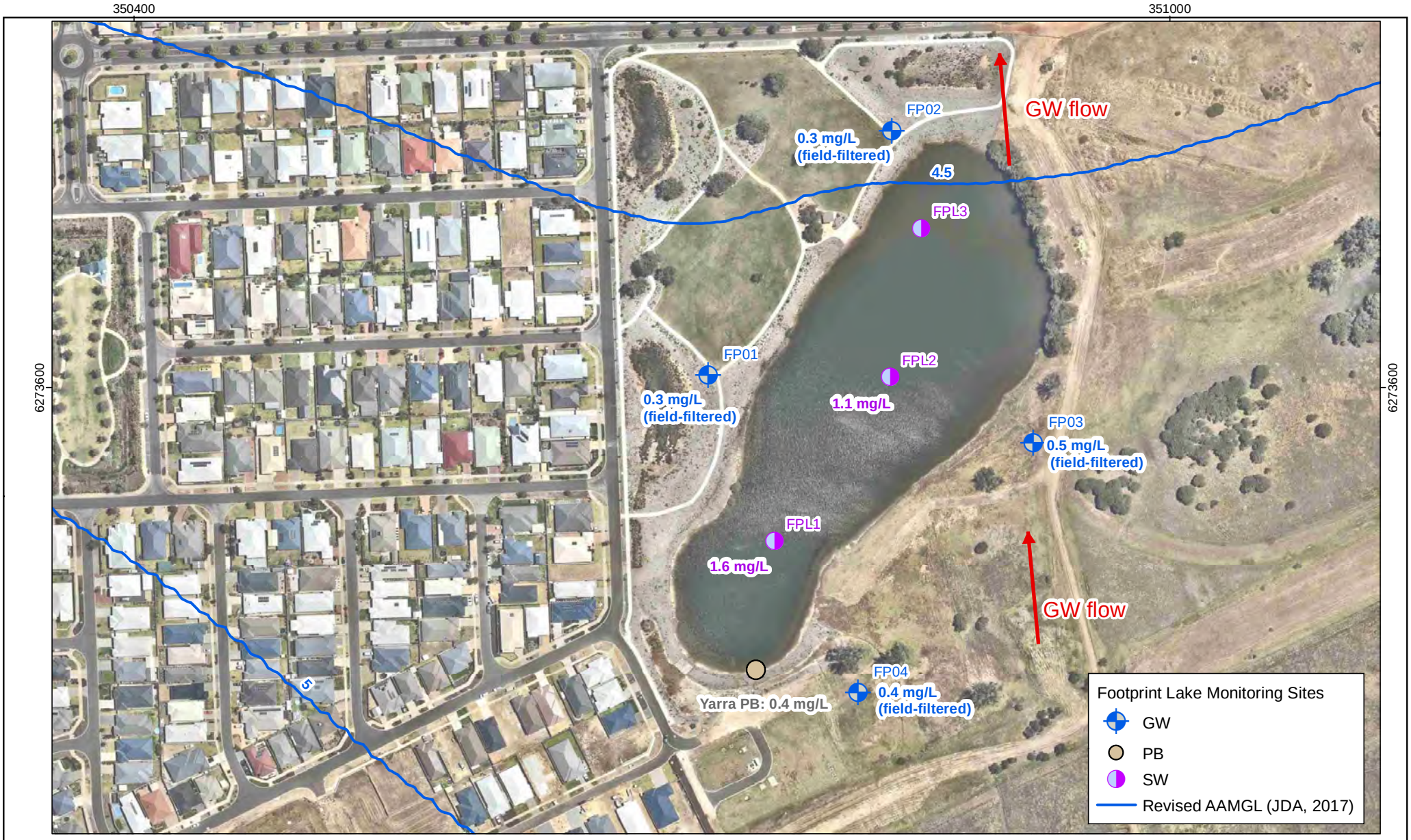
Figure 7: Groundwater and Lake TP, 20/3/19



Data Source: NearMap Aerial Photo (27 Nov 2018)

Coordinate System: GDA 94, Zone 50

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Scale: 1:3,000 @A4

0 50 100 150 200 Meters

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Figure 8: Groundwater and Lake TN, 20/3/19

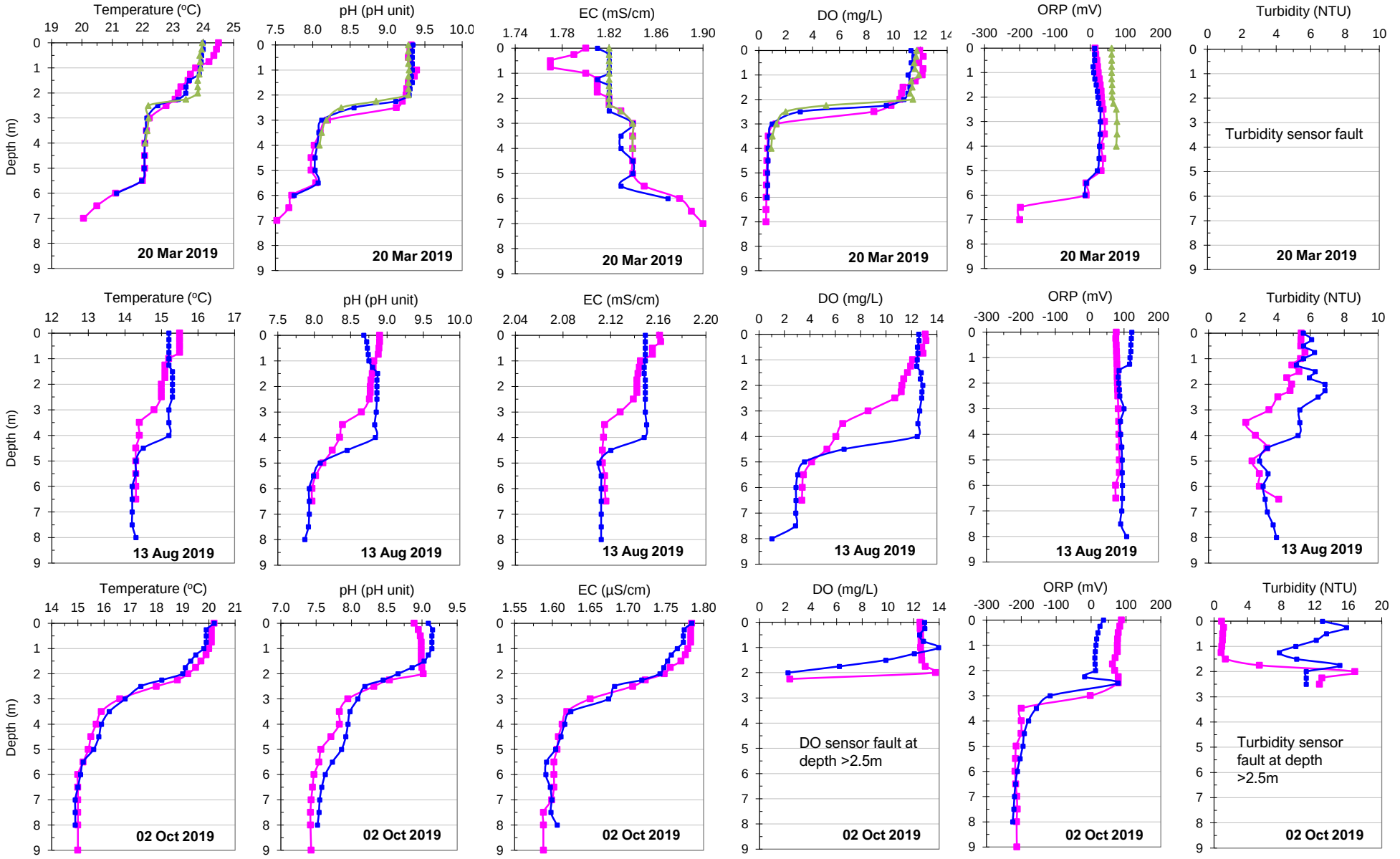

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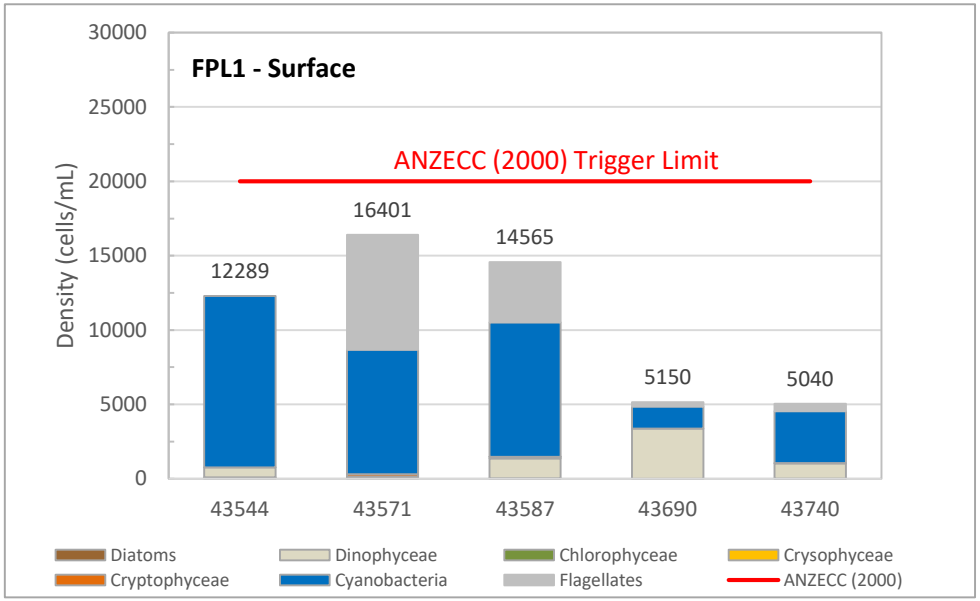
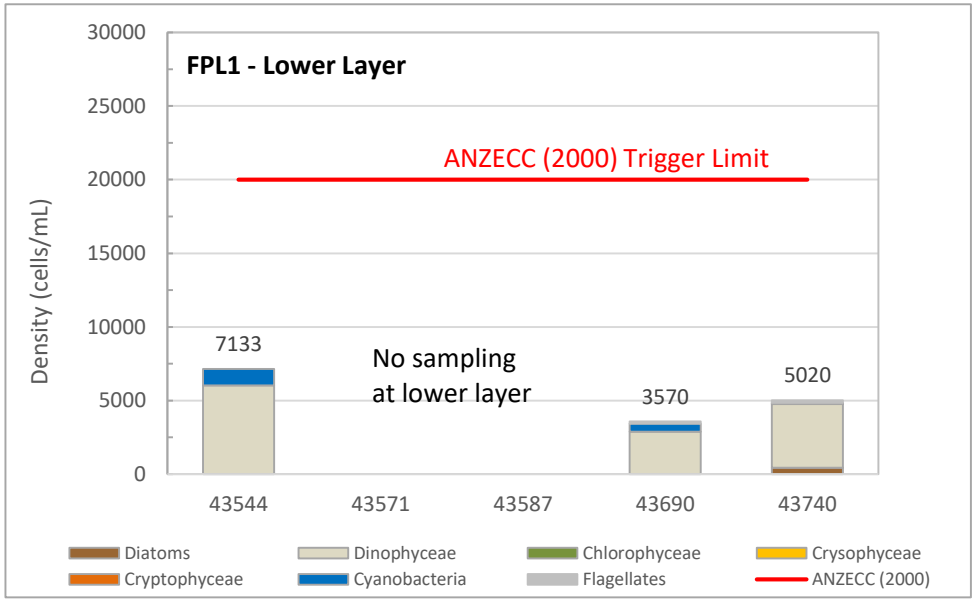
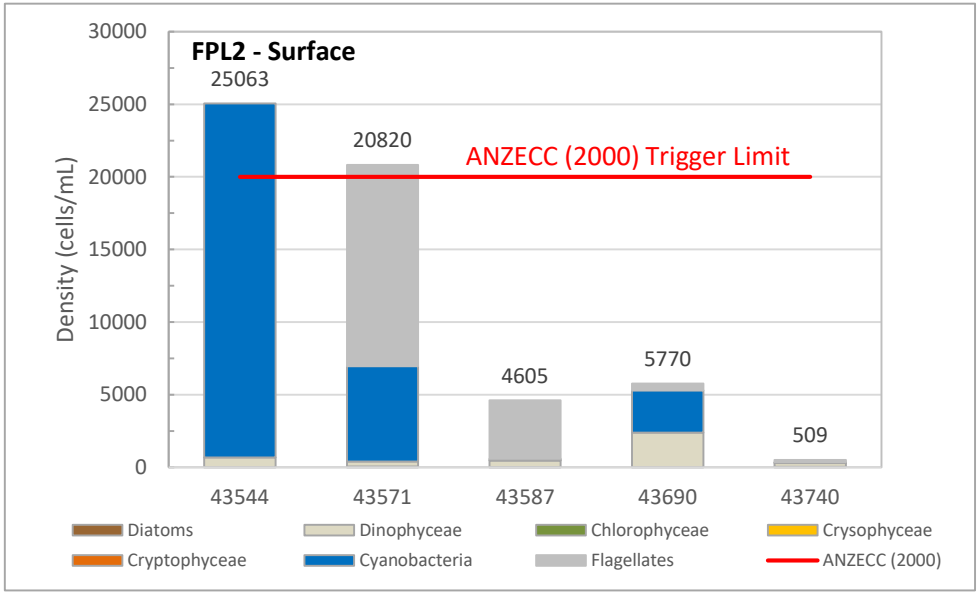
Figure 9: Physicochemical WQ Parameters Profiling







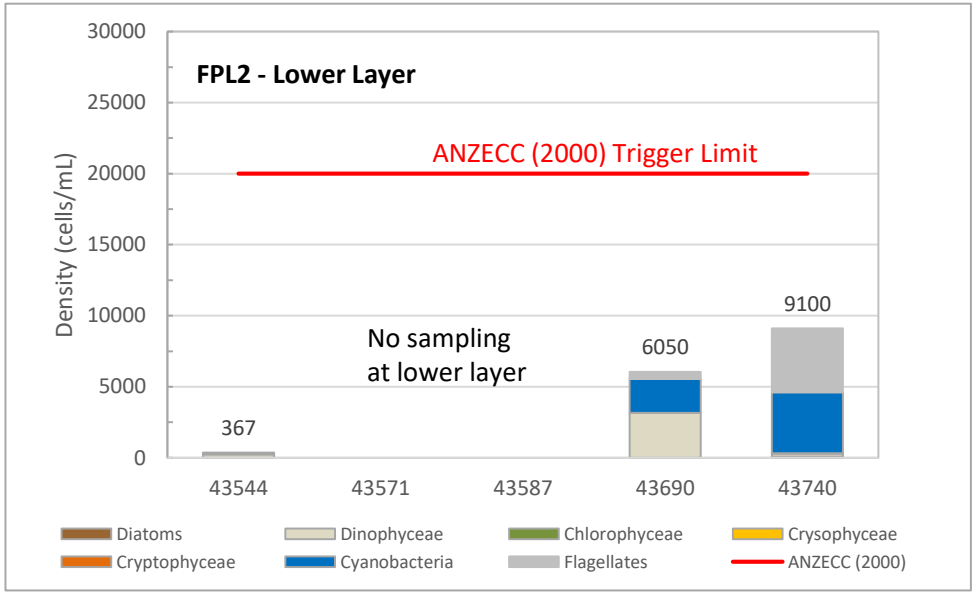


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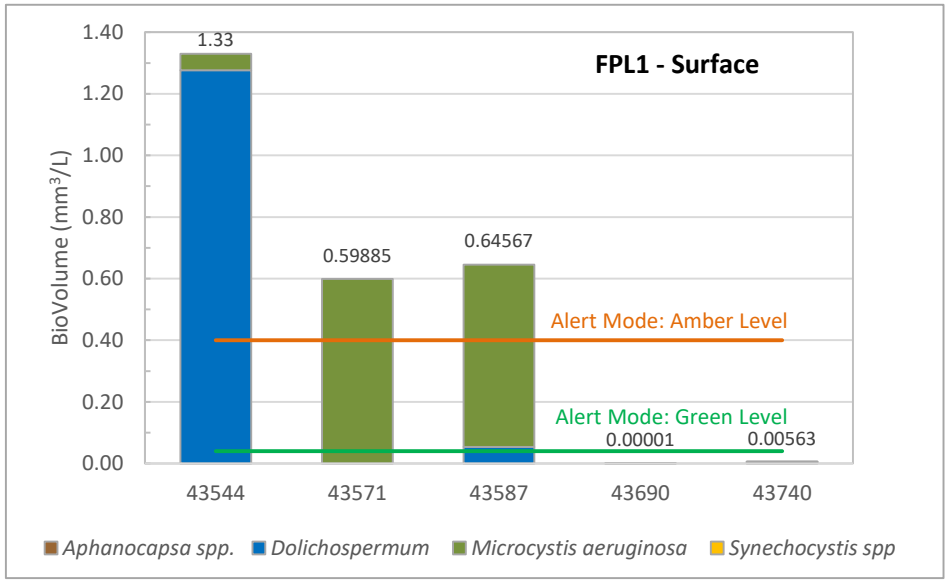
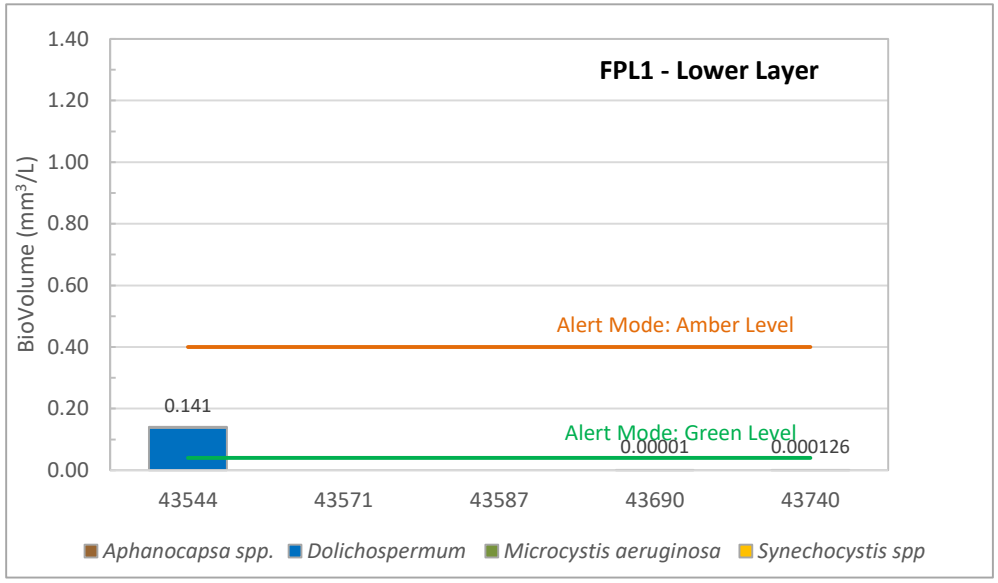
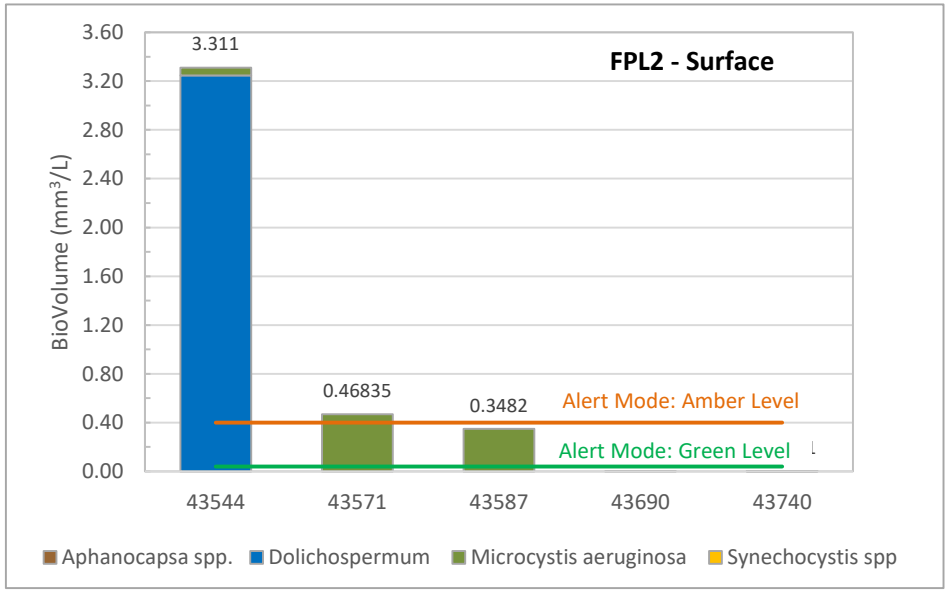
Figure 10: Phytoplankton Density







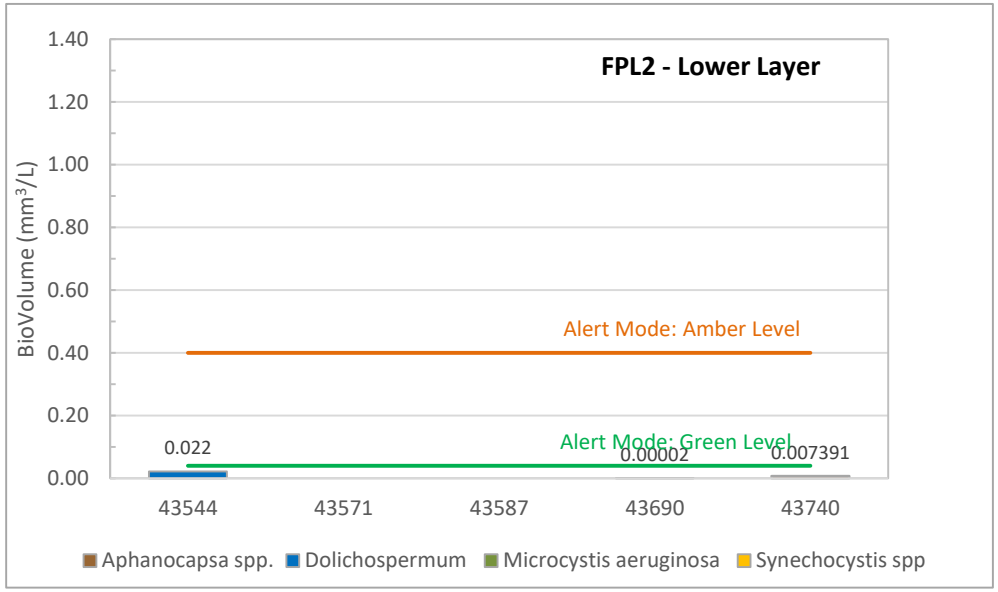


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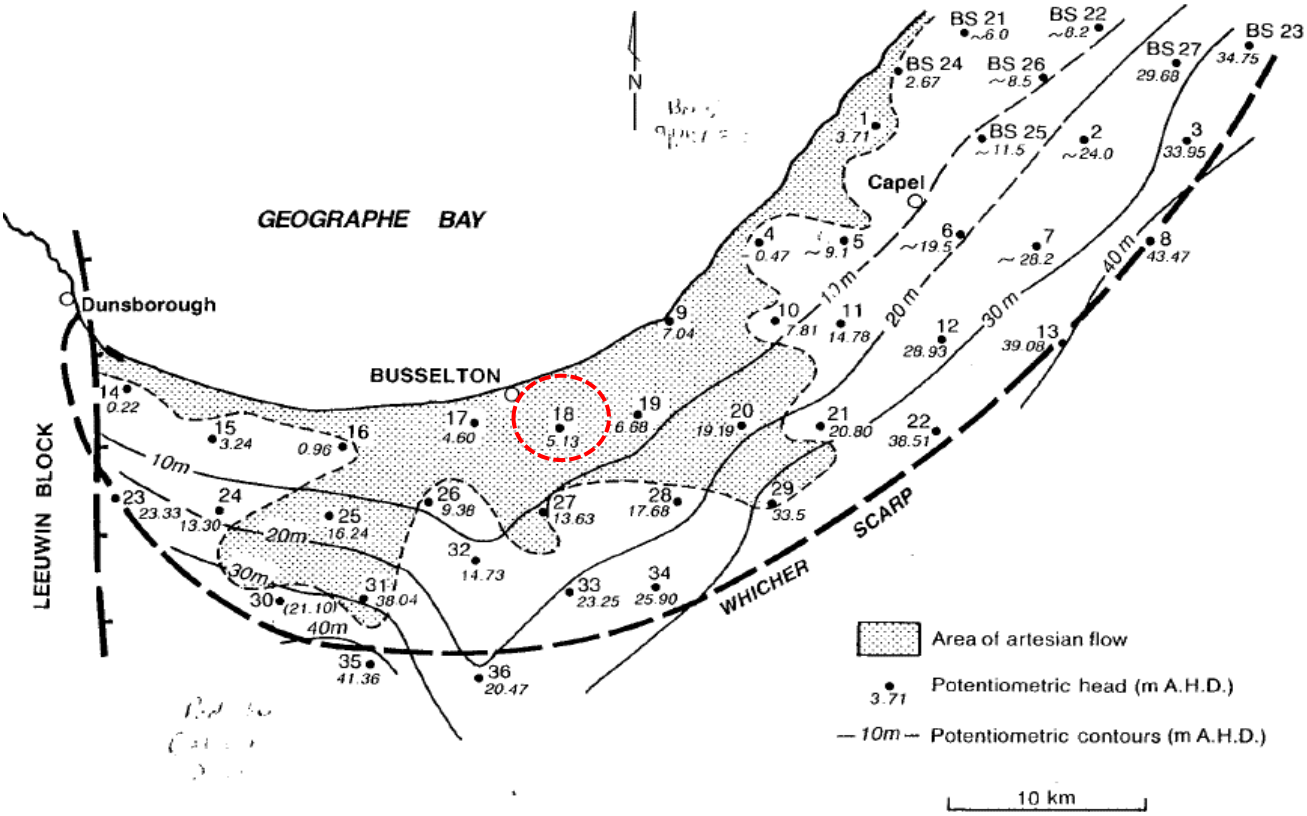
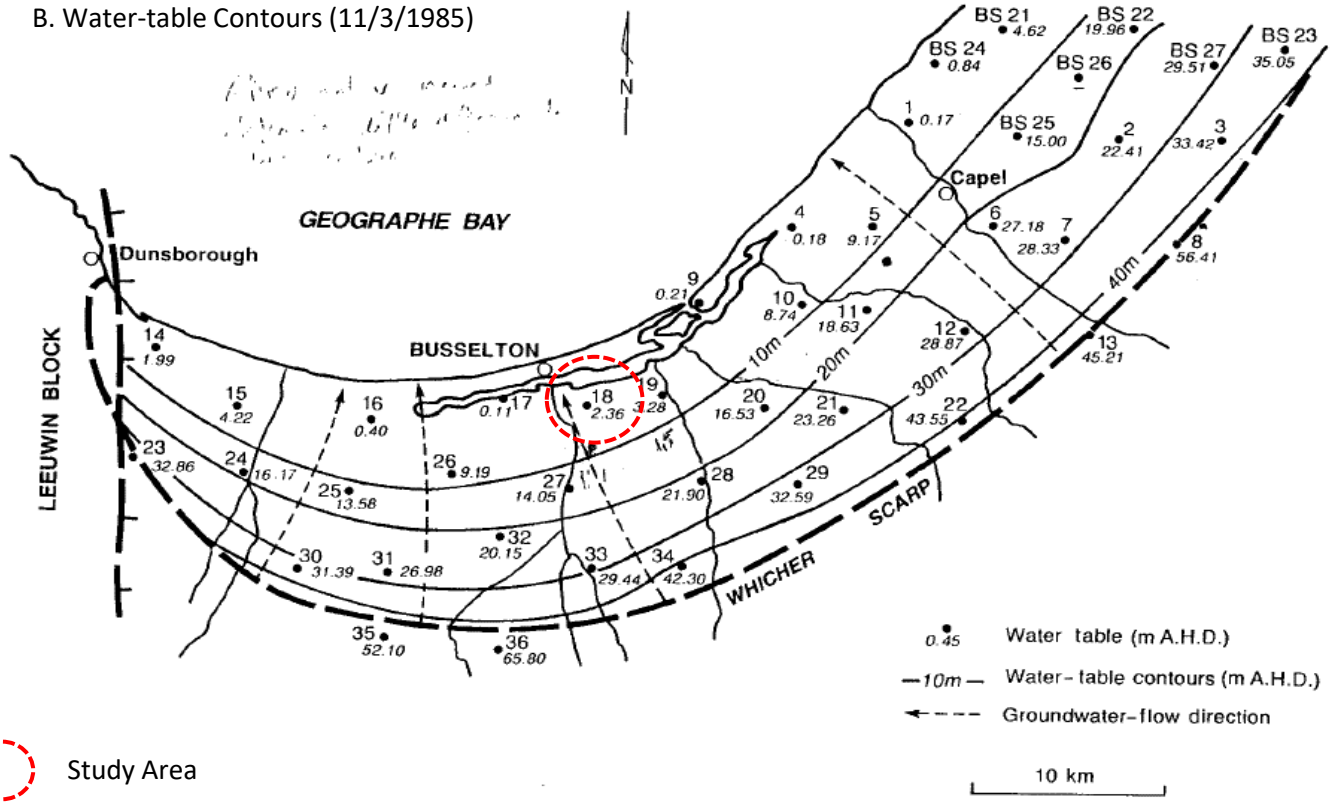
Figure 11: Cyanobacteria Biovolume

A. Potentiometric head in the Leederville Formation



B. Water-table Contours (11/3/1985)



Study Area

Data Source: Hirschberg, K-J.B (1989) GSWA 23594, 23599

JDA	Job No. J6712	Satterley Property Group Provence: Footprint Lake Monitoring and Management **Figure 12: Water-table Contours and Potentiometric Head in the Leederville Formation**

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APPENDIX A

JDA Bore Logs

JDA Consultant Hydrologists
Suite 1, 27 York Street
Subiaco WA 6008
Tel: 9388 2436
Fax: 9381 9279

LITHOLOGICAL LOG

Client: Satterley
Project: Provence
Bore location: Footprint Lake, Provence
Datum: GDA '94 MGA Zone 50 E: 350733 N: 6273607

Job No: J6712
Hole commenced: 19/02/2019
Hole completed: 19/02/2019
Logged by: GW

Bore Name: FP01
Driller and drill type: Edrill - Hollow auger
Hole diameter: 0.150 m Casing Diam: 0.050 m

Total Depth: 10.00 m
R.L. TOC: 6.825 mAHD
Natural Surface: 6.4 mAHD

Depth (m)	BORE CONSTRUCTION	GRAPHICAL LOG	LITHOLOGICAL LOG						
			LITHOLOGY	COLOUR	GRAIN SIZE	SORTING	GRAIN SHAPE	MOISTURE	COMMENTS
0.5m									
1.0m					F/M			Dry	
1.5m				Cream					
2.0m									
2.5m								Moist	
3.0m									
3.5m			Sand		M	M	Sub R		Mulch garden
4.0m									
5.0m									
6.0m				Brown				Saturated	
7.0m					F/M				
8.0m									
9.0m									
									Some interface with Sand and Sandy Clay.
10.0m	EOH		Sandy Clay	Dk Grey Green	F/M	M	Sub R	Moist	Sampled

Gravel
Sand
Clayey Sand
Sandy Clay
Clay
Coffee Rock
Bentonite

Grain Size	Sorting	Grain Shape	Moisture
Very Fine	Poor	Angular	Dry
Fine	Moderate	Subangular	Moist
Medium	Well	Subrounded	Saturated
Coarse	Very well	Rounded	
Very coarse		Well rounded	
Gravel			

NOTES:
6m of slotted pipe with 0.005 slots, gravel 2.50-10.0m, Cuttings 2.50-1.0, Bentonite seal 1.0-0.50m and backfilled with cuttings to the surface.

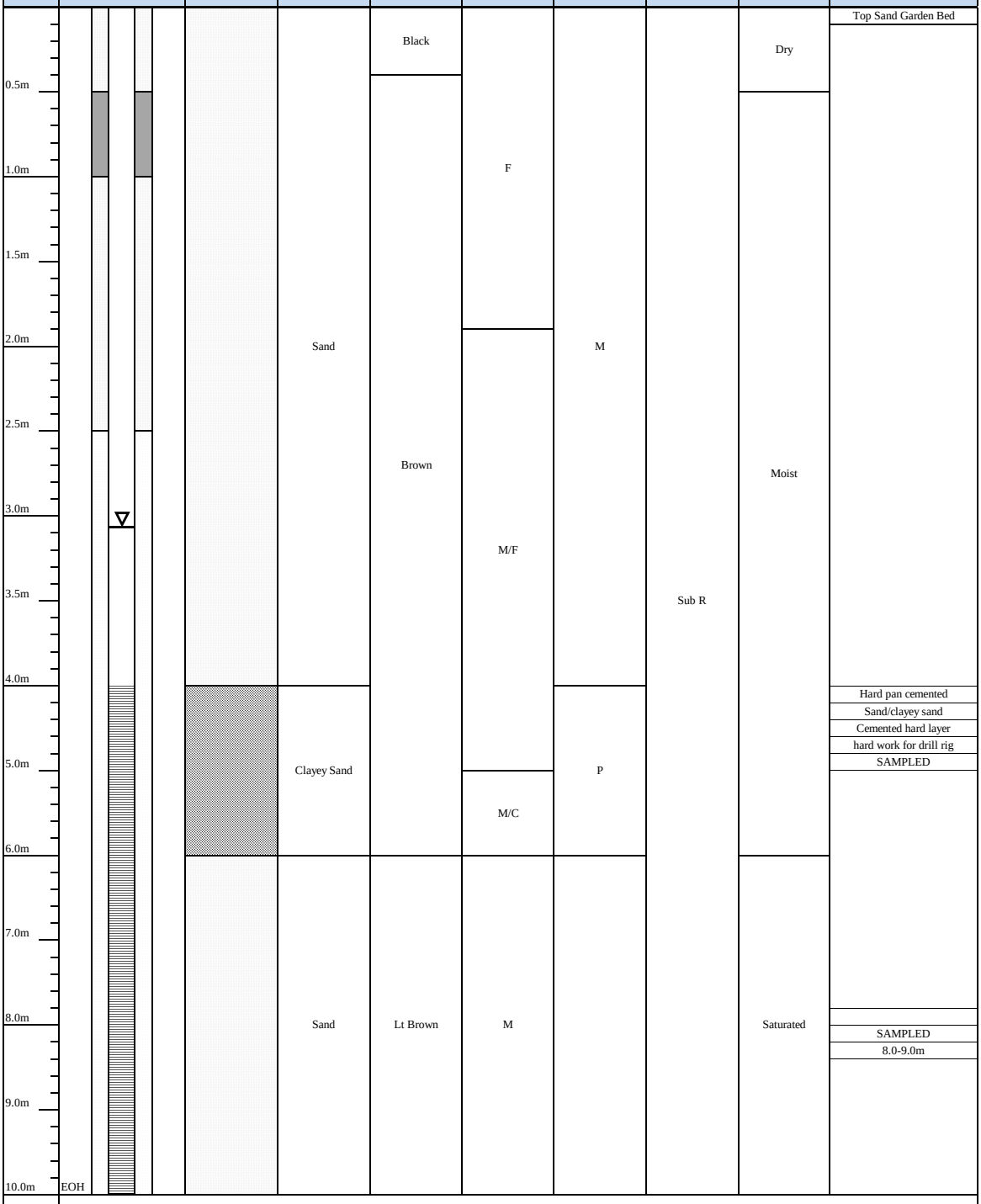
Date	19/02/2019
Stick Up	0.425 m
Total Depth	11 mBTOC
Water Level	2.7 mBTOC

time - 16.50

JDA Consultant Hydrologists
Suite 1, 27 York Street
Subiaco WA 6008
Tel: 9388 2436
Fax: 9381 9279

LITHOLOGICAL LOG

Client: Satterley		Job No:	J6712
Project: Provence		Hole commenced:	19/02/2019
Bore location: Footprint Lake, Provence		Hole completed:	19/02/2019
Datum: GDA '94 MGA Zone 50	E: 3508839 N: 6273749	Logged by:	GW
Bore Name:	FP02	Total Depth:	10.00 m
Driller and drill type:	Edrill - Hollow auger	R.L. TOC:	7.025 mAHD
Hole diameter:	0.150 m Casing Diam: 0.050 m	Natural Surface:	6.41 mAHD



Gravel
Sand
Clayey Sand
Sandy Clay
Clay
Coffee Rock
Bentonite

Grain Size	Sorting	Grain Shape	Moisture
Very Fine	Poor	Angular	Dry
Fine	Moderate	Subangular	Moist
Medium	Well	Subrounded	Saturated
Coarse	Very well	Rounded	
Very coarse		Well rounded	
Gravel			

NOTES:
6m of slotted pipe with 0.005 slots, gravel 2.50-10.0m, Cuttings 2.50-1.0, Bentonite seal 1.0-0.50m and backfilled with cuttings to the surface.

Date	19/02/2019
Stick Up	0.62 m
Total Depth	11.04 mBTOC
Water Level	3.1 mBTOC

JDA Consultant Hydrologists
Suite 1, 27 York Street
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Tel: 9388 2436
Fax: 9381 9279

LITHOLOGICAL LOG

Client: Satterley		Job No:	J6712
Project: Provence		Hole commenced:	19/02/2019
Bore location: Footprint Lake, Provence		Hole completed:	19/02/2019
Datum: GDA '94 MGA Zone 50 E: 350921 N: 6273568		Logged by:	GW
Bore Name: FP03		Total Depth:	9.00 m
Driller and drill type: Edrill - Hollow auger		R.L. TOC:	7.1 mAHD
Hole diameter: 0.150 m Casing Diam: 0.050 m		Natural Surface:	6.56 mAHD

Depth (m)	BORE CONSTRUCTION	GRAPHICAL LOG	LITHOLOGICAL LOG						
			LITHOLOGY	COLOUR	GRAIN SIZE	SORTING	GRAIN SHAPE	MOISTURE	COMMENTS
0.5m			Sand	Red Brown	M	M	Sub R	Dry	
1.0m				Brown	M/F				
1.5m			Clayey Sand	Dk Brown					
2.0m									
2.5m				Brown				Moist	
3.0m									
3.5m				Lt Brown				Saturated	Sloppy
4.0m			Sand		M				
5.0m									
6.0m									
7.0m									Greenish Tinge
8.0m									
9.0m	EOH		Sandy Clay	Greenish Brown					

Gravel
Sand
Clayey Sand
Sandy Clay
Clay
Coffee Rock
Bentonite

Grain Size	Sorting	Grain Shape	Moisture
Very Fine	Poor	Angular	Dry
Fine	Moderate	Subangular	Moist
Medium	Well	Subrounded	Saturated
Coarse	Very well	Rounded	
Very coarse		Well rounded	
Gravel			

NOTES:
6m of slotted pipe with 0.005 slots, gravel 2.5-9.0m, Cuttings 2.5-2.0m
Bentonite seal 2.0-1.0m and backfilled with cuttings to the surface.

Date	19/02/2019
Stick Up	0.54 m
Total Depth	9.57 mBTOC
Water Level	3.16 mBTOC

JDA Consultant Hydrologists
Suite 1, 27 York Street
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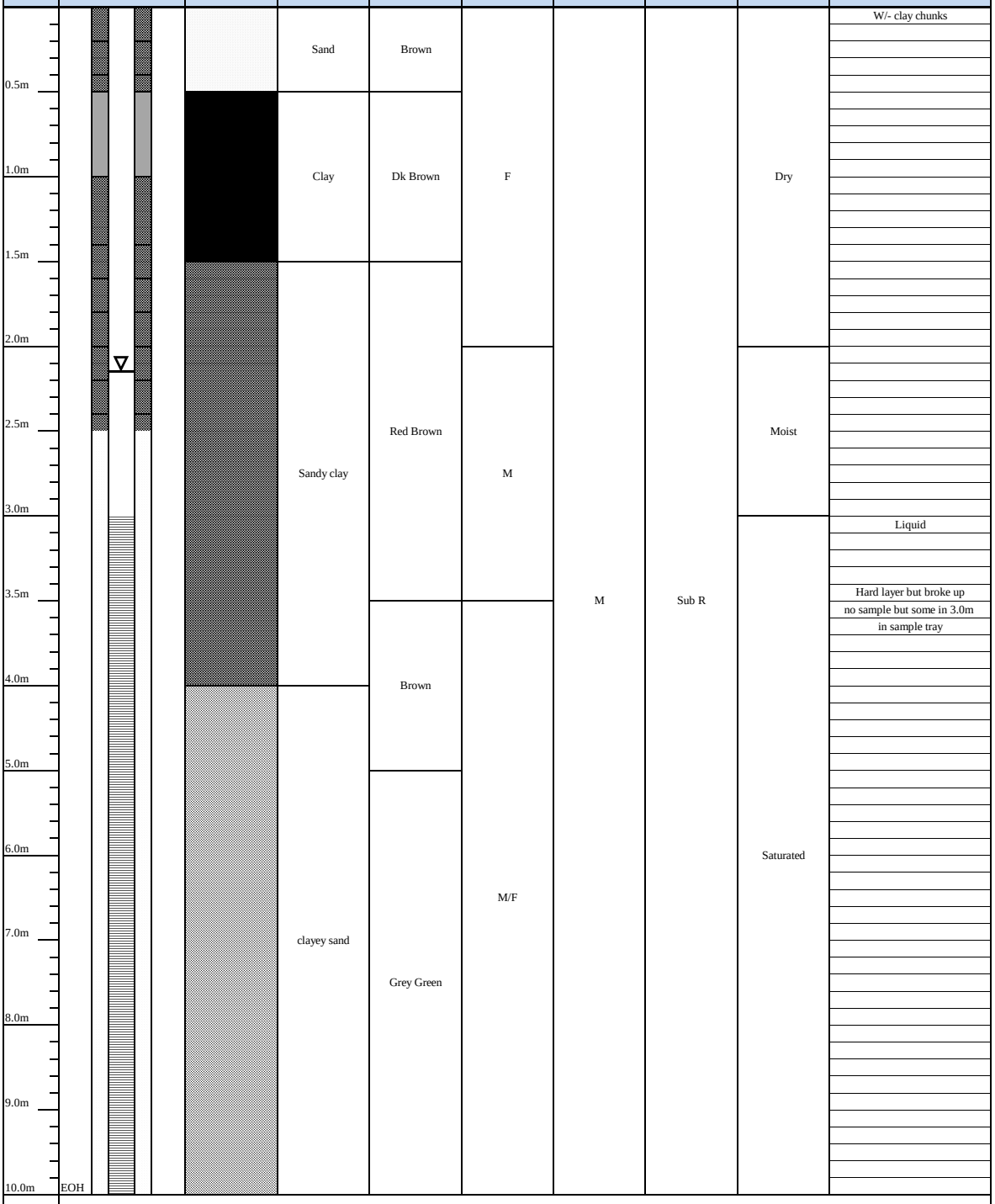
Tel: 9388 2436
Fax: 9381 9279

LITHOLOGICAL LOG

Client: Satterley		Job No: J6712	
Project: Provence		Hole commenced:	19/02/2019
Bore location: Footprint Lake, Provence		Hole completed:	19/02/2019
Datum: GDA '94 MGA Zone 50	E 35082_ N 62734__	Logged by:	GW
Bore Name:	FP04	Total Depth:	10.00 m
Driller and drill type:	Edrill - Hollow auger	R.L. TOC:	6.4 mAHD
Hole diameter:	0.150 m Casing Diam: 0.050 m	Natural Surface:	5.83 mAHD



Depth (m)	BORE CONSTRUCTION	GRAPHICAL LOG	LITHOLOGICAL LOG: LITHOLOGY	COLOUR	GRAIN SIZE	SORTING	GRAIN SHAPE	MOISTURE	COMMENTS
0.0m			Sand	Brown					W/- clay chunks
1.0m			Clay	Dk Brown	F			Dry	
2.0m			Sandy clay	Red Brown	M			Moist	
3.0m									Liquid
3.5m						M	Sub R		Hard layer but broke up
4.0m				Brown					no sample but some in 3.0m in sample tray
5.0m			clayey sand		M/F			Saturated	
6.0m				Grey Green					
7.0m									
8.0m									
9.0m									
10.0m	EOH								

Gravel
Sand
Clayey Sand
Sandy Clay
Clay
Coffee Rock
Bentonite

Grain Size	Sorting	Grain Shape	Moisture
Very Fine	Poor	Angular	Dry
Fine	Moderate	Subangular	Moist
Medium	Well	Subrounded	Saturated
Coarse	Very well	Rounded	
Very coarse		Well rounded	
Gravel			

NOTES: _____

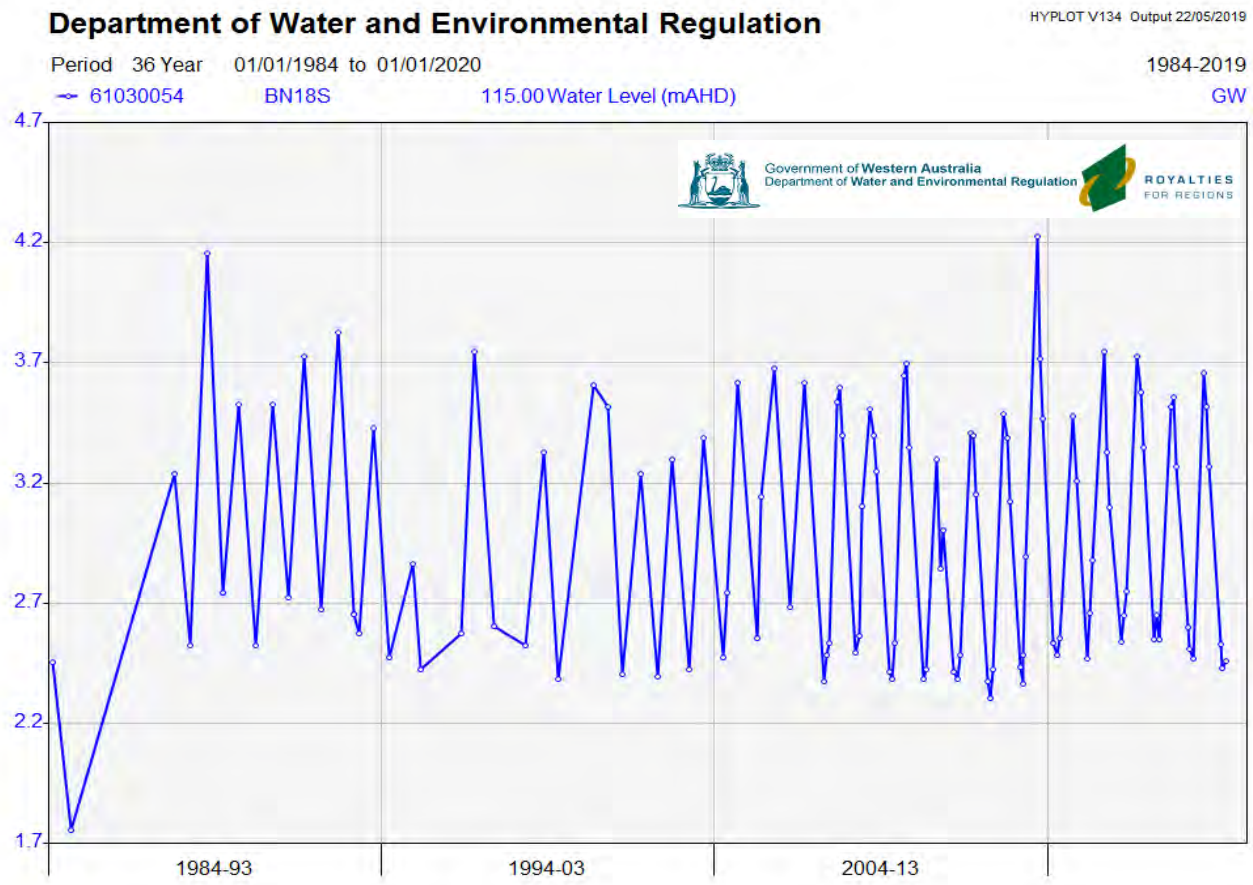
6m of slotted pipe with 0.005 slots, gravel 2.50-10.0m, Cuttings 2.50-1.0, Bentonite seal 1.0-0.50m and backfilled with cuttings to the surface.

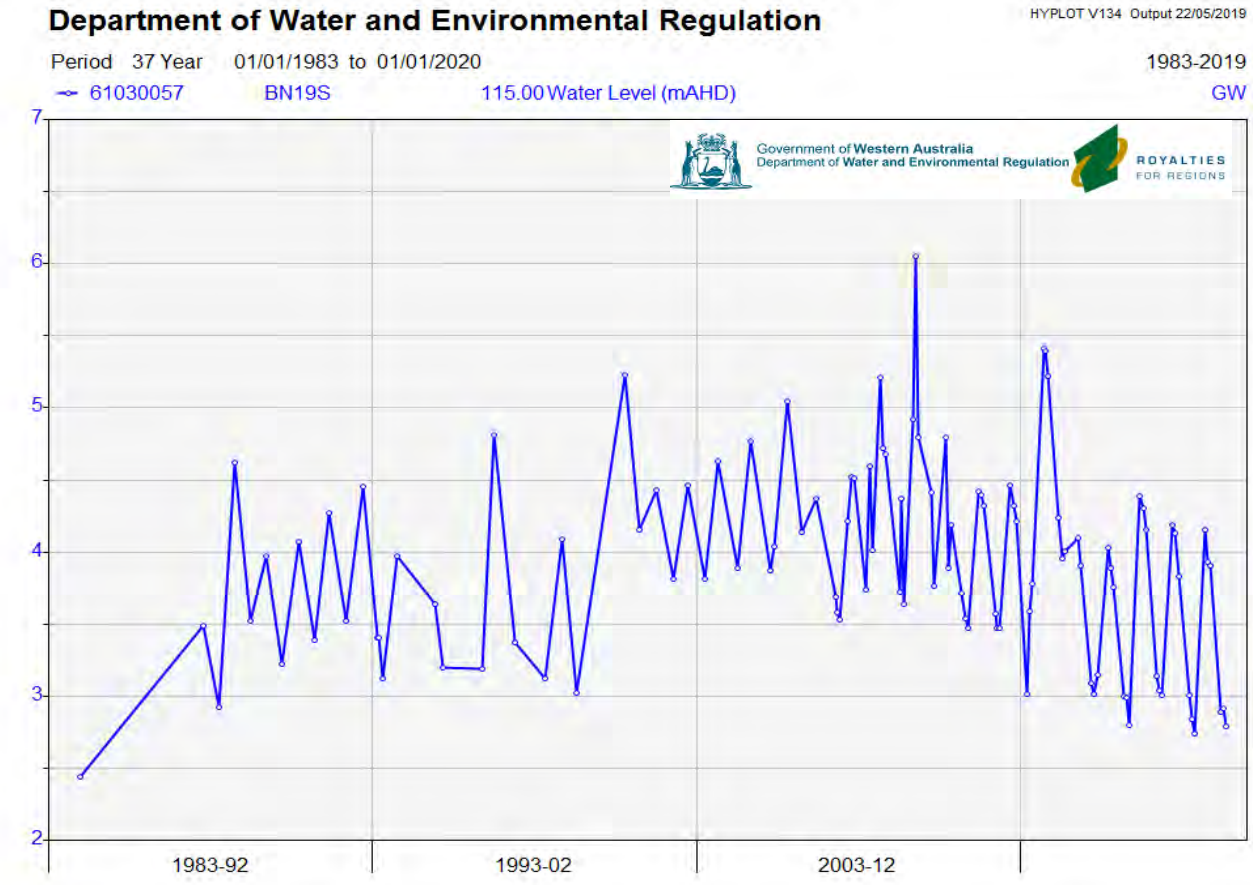
Date	19/02/2019
Stick Up	0.57 m
Total Depth	11.14 mBTOC
Water Level	2.31 mBTOC

Still rising only 40 mins since purging completed.

APPENDIX B

Groundwater Levels in DWER Bores





Data Source: DWER Water Information Reporting (WIR) (accessed 10 September 2019)

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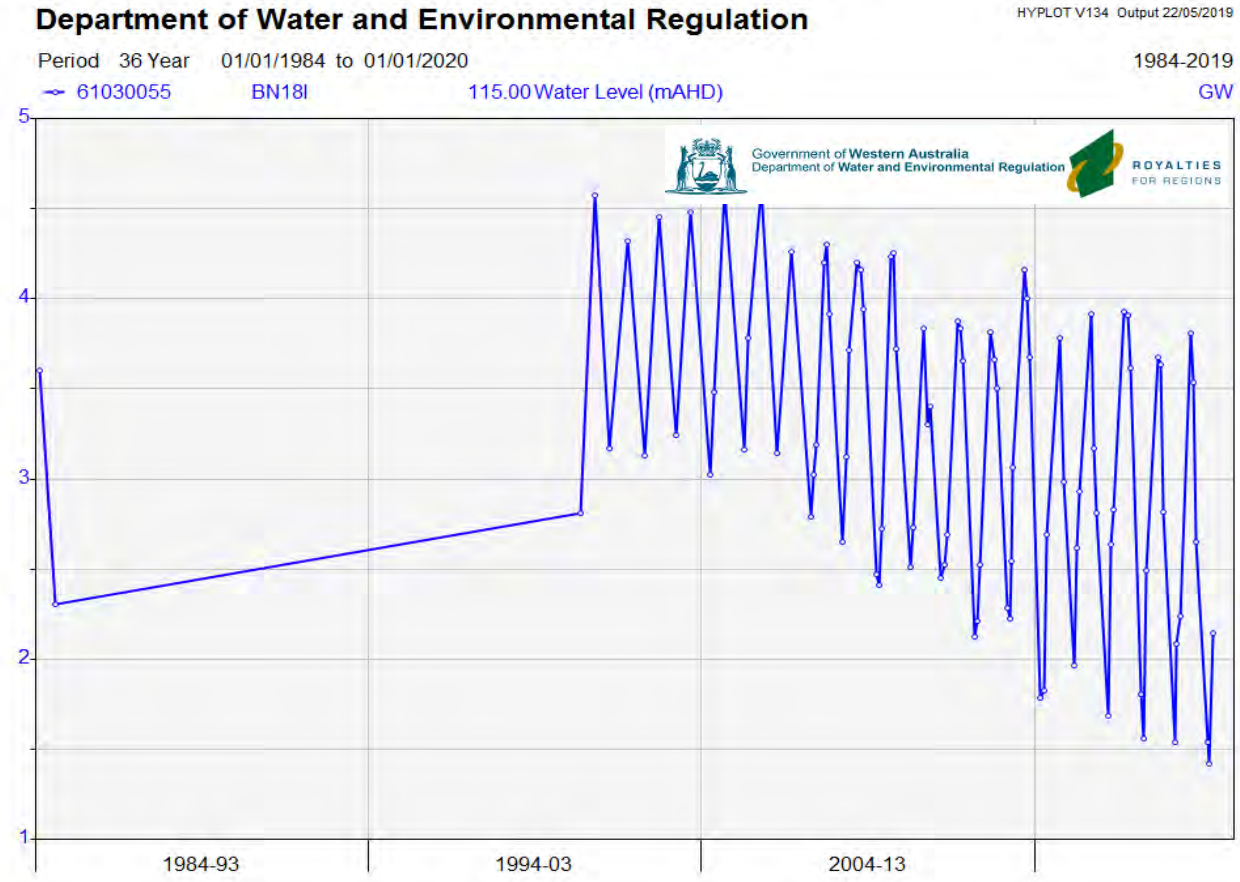

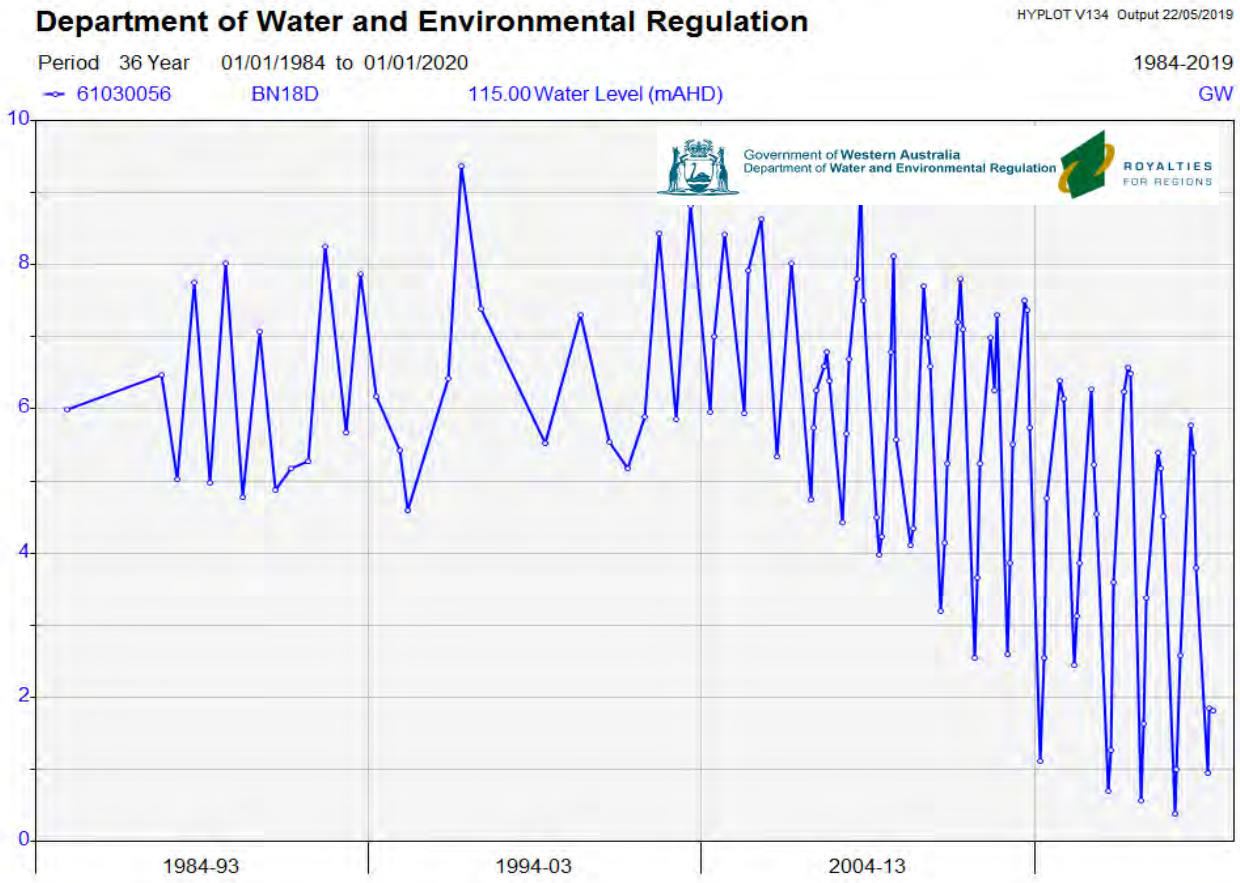

Data Source: DWER Water Information Reporting (WIR) (accessed 10 September 2019)

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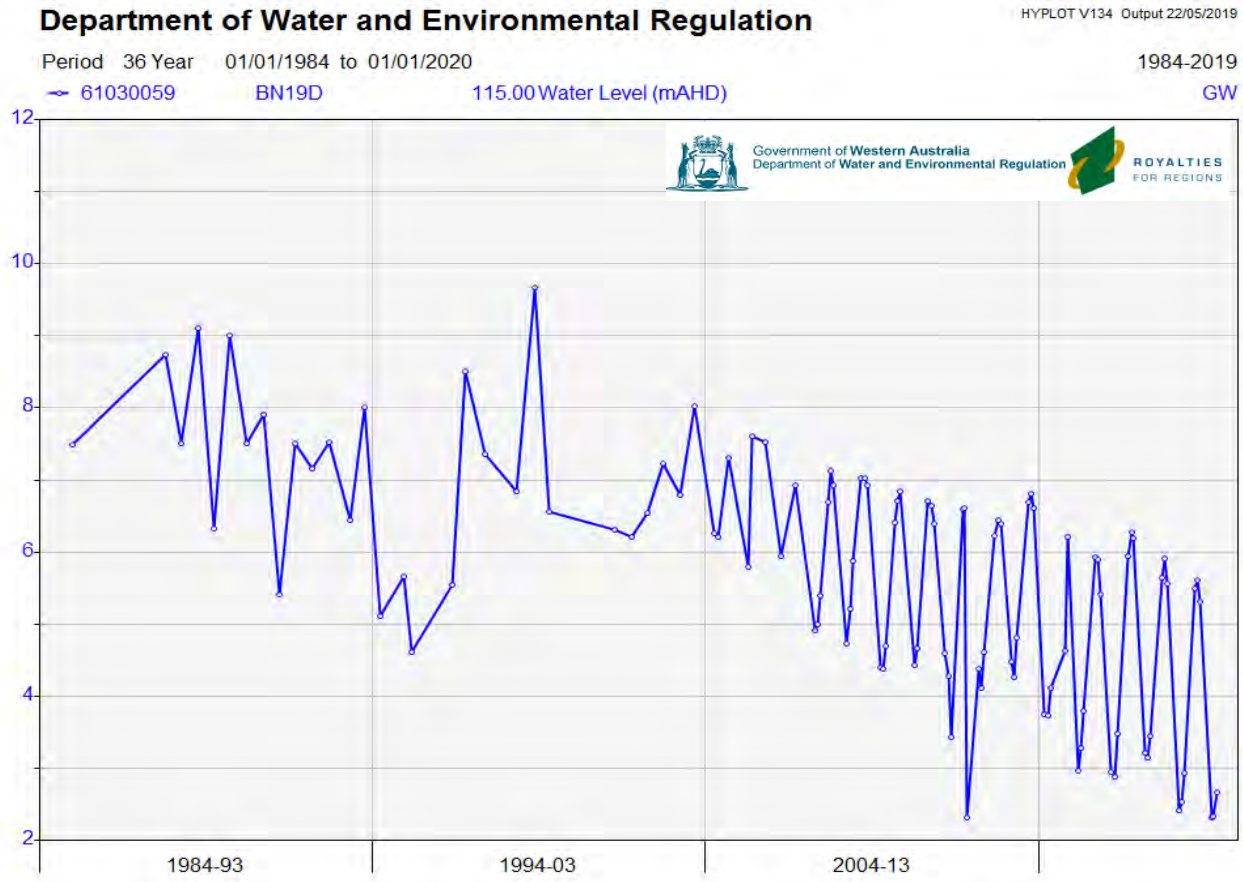

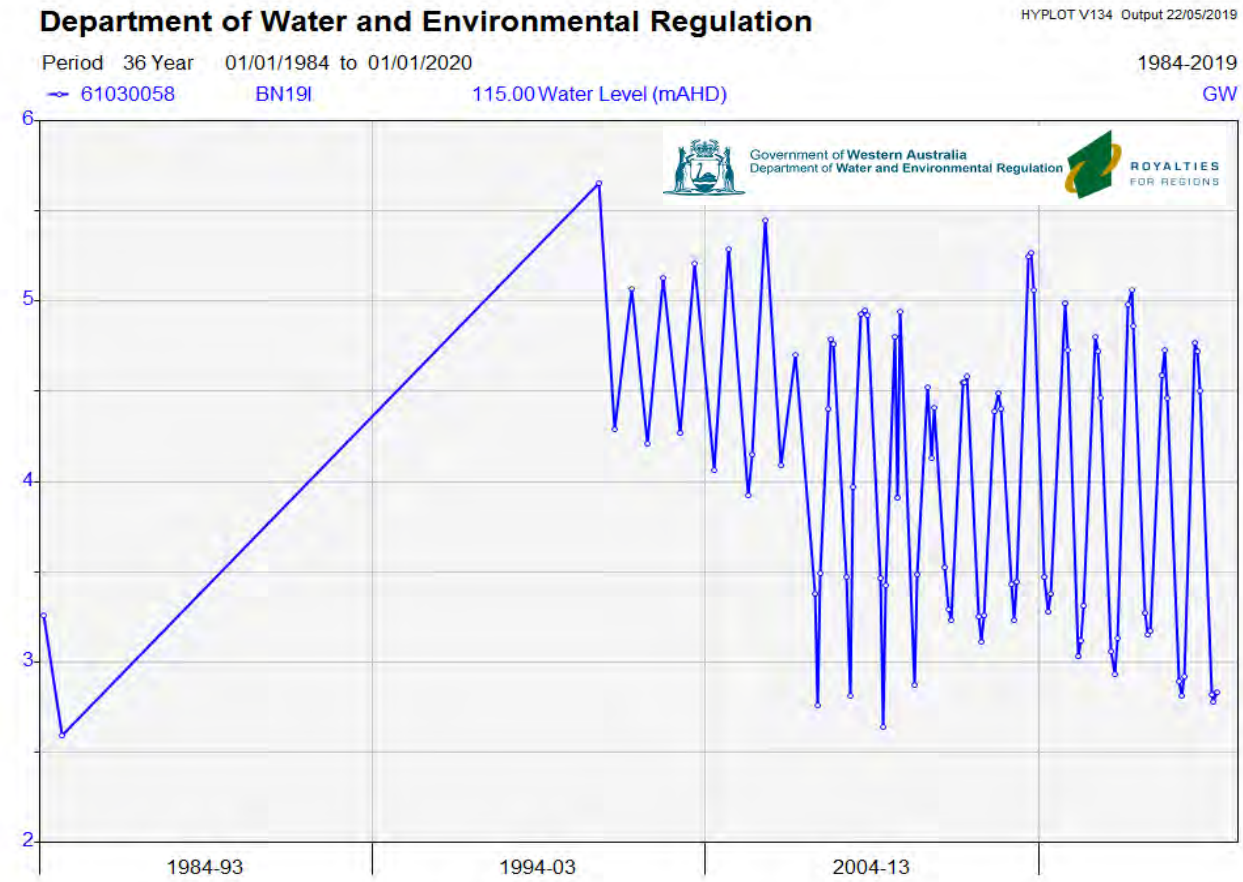

Data Source: DWER Water Information Reporting (WIR) (accessed 10 September 2019)

Job No. J6712

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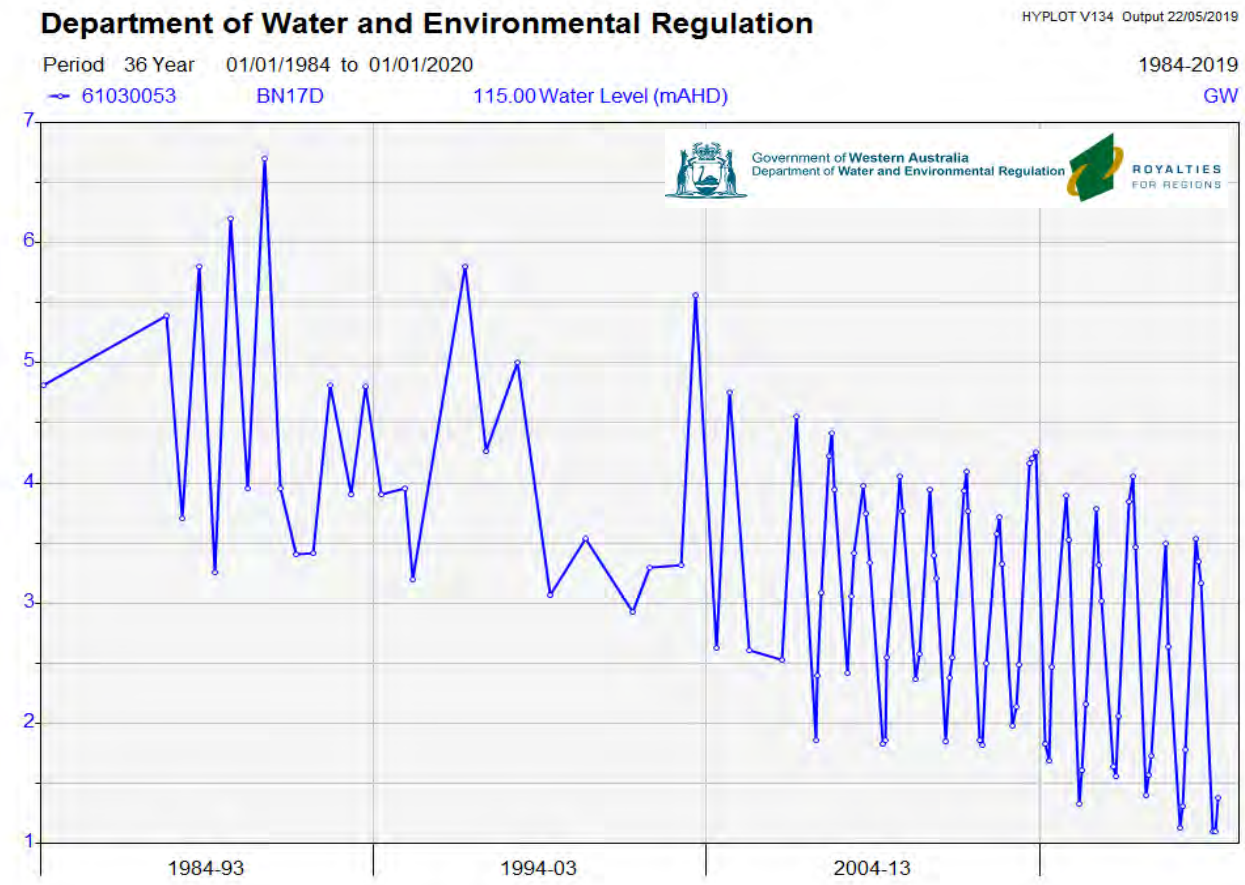
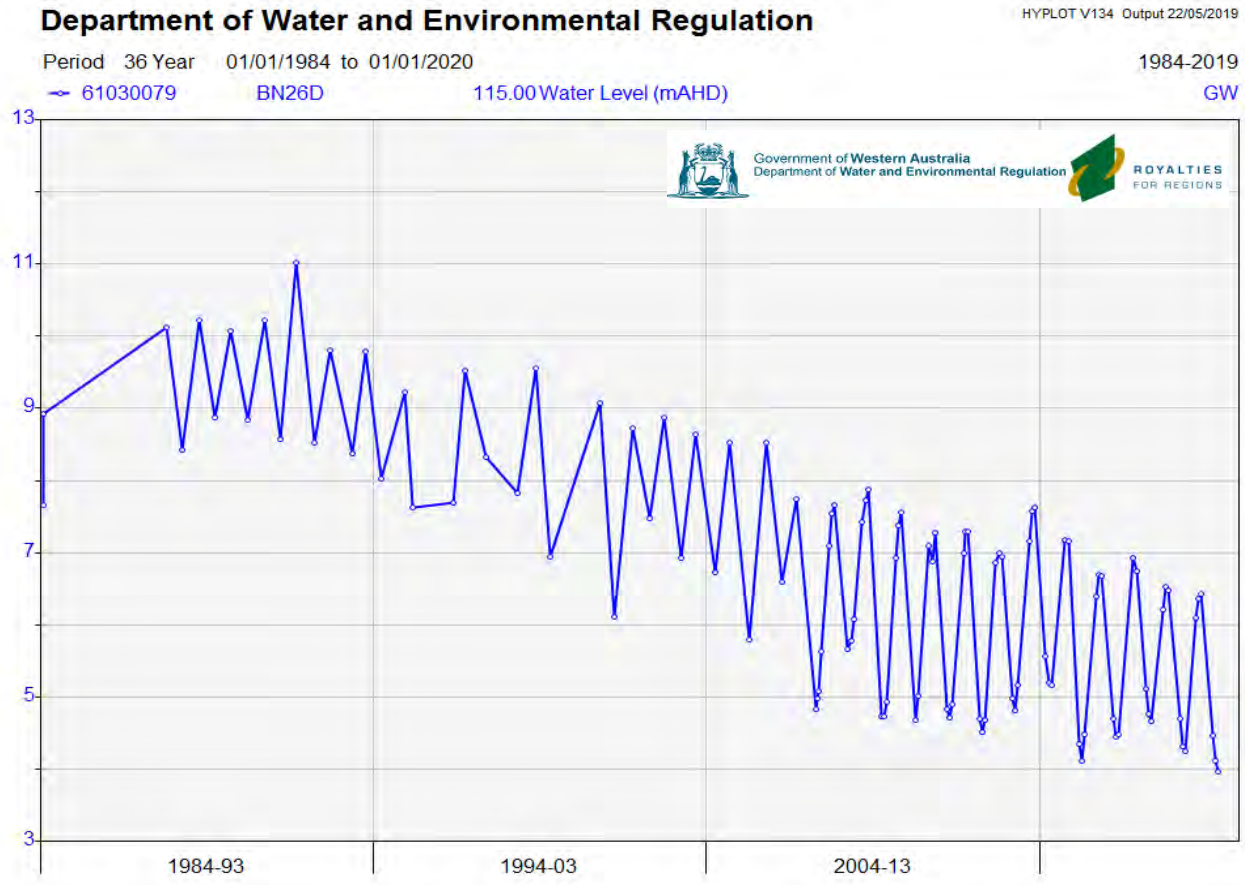
Satterley Property Group

Provence: Footprint (Iluka) Lake Monitoring 2019

Appendix B3: Groundwater Levels: Leederville Aquifer (BN19I and BN19D)





Data Source: DWER Water Information Reporting (WIR) (accessed 10 September 2019)

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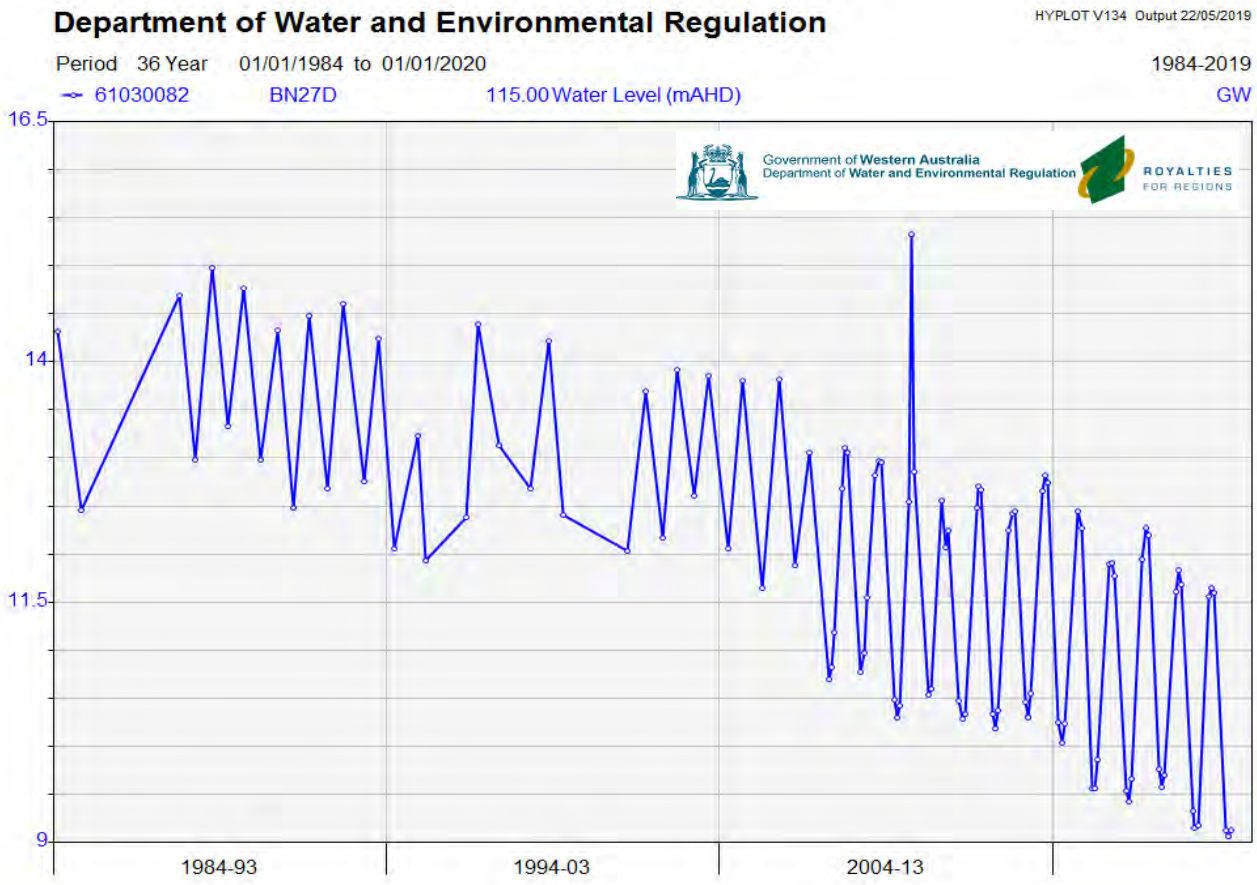

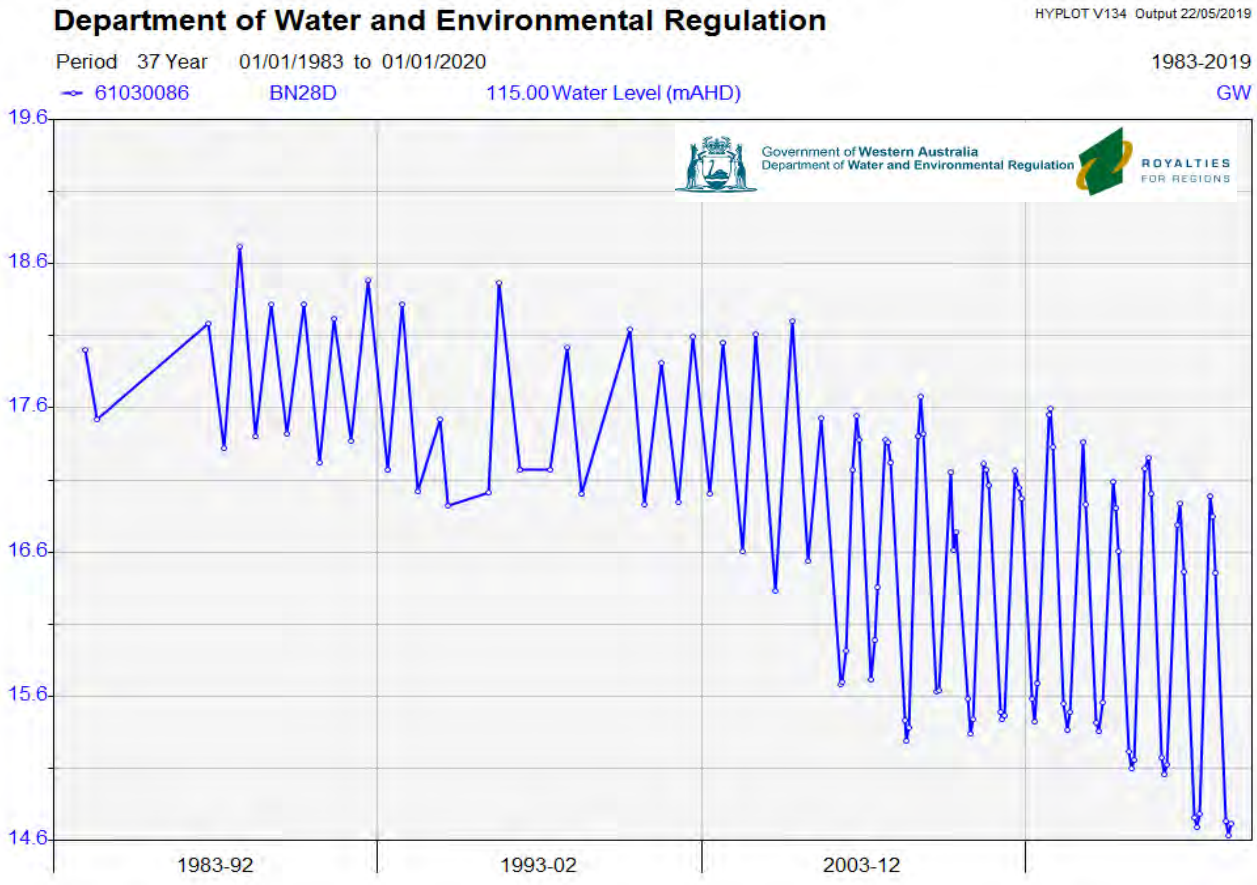

Data Source: DWER Water Information Reporting (WIR) (accessed 10 September 2019)

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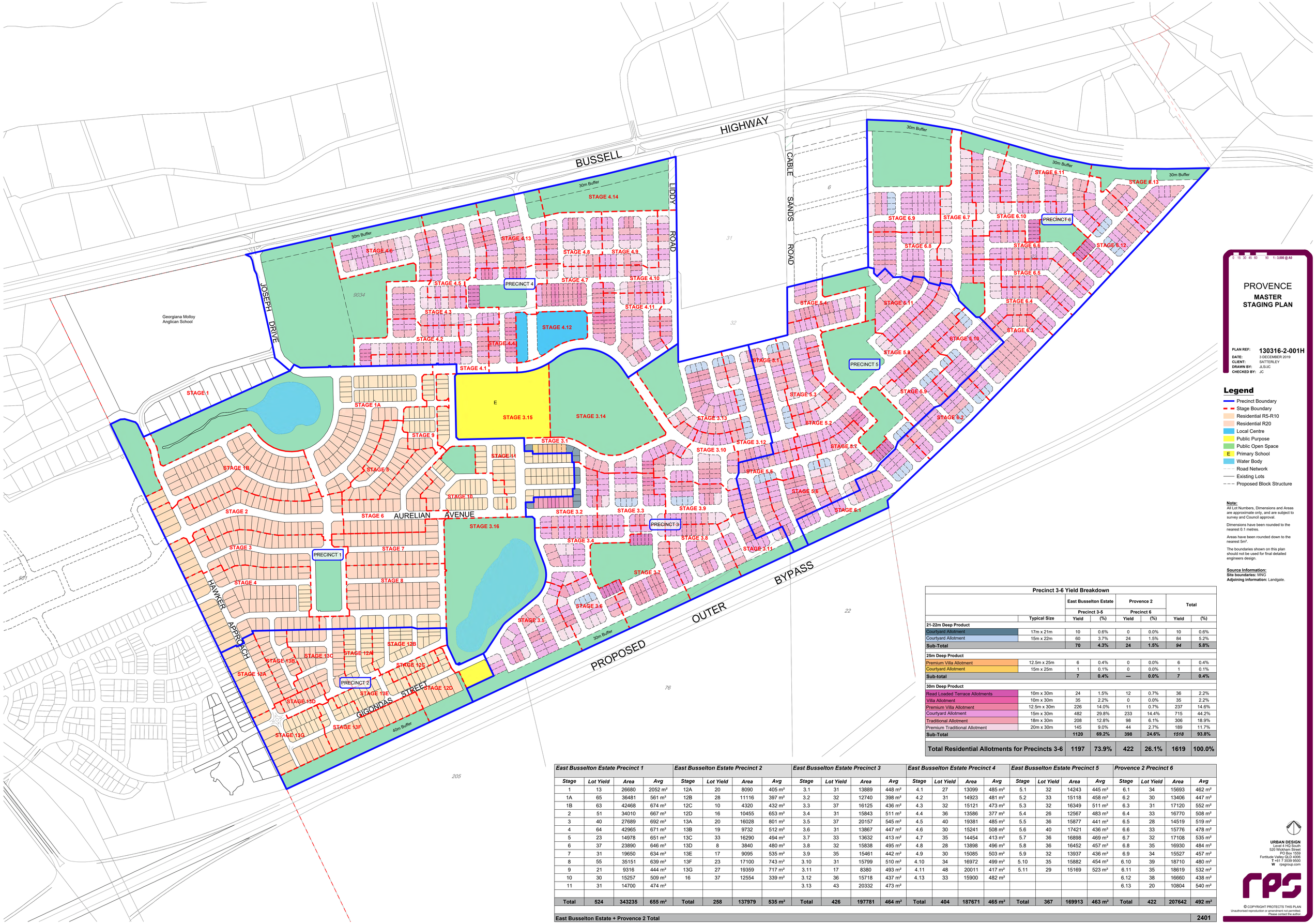
APPENDIX N

Master Staging Plan



PROVENCE
MASTER STAGING PLAN

0 15 30 45 60 90 1:3,000 @ A0

PLAN REF: 130316-2-001H
DATE: 3 DECEMBER 2019
CLIENT: SATTERLEY
DRAWN BY: JLS/JC
CHECKED BY: JC

Legend
- Precinct Boundary
- Stage Boundary
- Residential R5-R10
- Residential R20
- Local Centre
- Public Purpose
- Public Open Space
- E Primary School
- Water Body
- Road Network
- Existing Lots
- Proposed Block Structure

Note:
All Lot Numbers, Dimensions and Areas are approximate only, and are subject to survey and Council approval.

Dimensions have been rounded to the nearest 0.1 metres.

Areas have been rounded down to the nearest 5m².

The boundaries shown on this plan should not be used for final detailed engineers design.

Source Information:
Site boundaries: MNG
Adjoining information: Landgate.

Precinct 3-6 Yield Breakdown

		East Busselton Estate		Provence 2		Total	
		Precinct 3-5		Precinct 6			
	Typical Size	Yield	(%)	Yield	(%)	Yield	(%)
21-22m Deep Product							
Courtyard Allotment	17m x 21m	10	0.6%	0	0.0%	10	0.6%
Courtyard Allotment	15m x 22m	60	3.7%	24	1.5%	84	5.2%
Sub-Total		**70**	**4.3%**	**24**	**1.5%**	***94***	**5.8%**
25m Deep Product							
Premium Villa Allotment	12.5m x 25m	6	0.4%	0	0.0%	6	0.4%
Courtyard Allotment	15m x 25m	1	0.1%	0	0.0%	1	0.1%
Sub-total		**7**	**0.4%**	**—**	**0.0%**	***7***	**0.4%**
30m Deep Product							
Read Loaded Terrace Allotments	10m x 30m	24	1.5%	12	0.7%	36	2.2%
Villa Allotment	10m x 30m	35	2.2%	0	0.0%	35	2.2%
Premium Villa Allotment	12.5m x 30m	226	14.0%	11	0.7%	237	14.6%
Courtyard Allotment	15m x 30m	482	29.8%	233	14.4%	715	44.2%
Traditional Allotment	18m x 30m	208	12.8%	98	6.1%	306	18.9%
Premium Traditional Allotment	20m x 30m	145	9.0%	44	2.7%	189	11.7%
Sub-Total		**1120**	**69.2%**	**398**	**24.6%**	***1518***	**93.8%**
Total Residential Allotments for Precincts 3-6		**1197**	**73.9%**	**422**	**26.1%**	**1619**	**100.0%**

East Busselton Estate Precinct 1				*East Busselton Estate Precinct 2*				*East Busselton Estate Precinct 3*				*East Busselton Estate Precinct 4*				*East Busselton Estate Precinct 5*				*Provence 2 Precinct 6*			
Stage	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*
1	13	26680	2052 m²	12A	20	8090	405 m²	3.1	31	13889	448 m²	4.1	27	13099	485 m²	5.1	32	14243	445 m²	6.1	34	15693	462 m²
1A	65	36481	561 m²	12B	28	11116	397 m²	3.2	32	12740	398 m²	4.2	31	14923	481 m²	5.2	33	15118	458 m²	6.2	30	13406	447 m²
1B	63	42468	674 m²	12C	10	4320	432 m²	3.3	37	16125	436 m²	4.3	32	15121	473 m²	5.3	32	16349	511 m²	6.3	31	17120	552 m²
2	51	34010	667 m²	12D	16	10455	653 m²	3.4	31	15843	511 m²	4.4	36	13586	377 m²	5.4	26	12567	483 m²	6.4	33	16770	508 m²
3	40	27689	692 m²	13A	20	16028	801 m²	3.5	37	20157	545 m²	4.5	40	19381	485 m²	5.5	36	15877	441 m²	6.5	28	14519	519 m²
4	64	42965	671 m²	13B	19	9732	512 m²	3.6	31	13867	447 m²	4.6	30	15241	508 m²	5.6	40	17421	436 m²	6.6	33	15776	478 m²
5	23	14978	651 m²	13C	33	16290	494 m²	3.7	33	13632	413 m²	4.7	35	14454	413 m²	5.7	36	16898	469 m²	6.7	32	17108	535 m²
6	37	23890	646 m²	13D	8	3840	480 m²	3.8	32	15838	495 m²	4.8	28	13898	496 m²	5.8	36	16452	457 m²	6.8	35	16930	484 m²
7	31	19650	634 m²	13E	17	9095	535 m²	3.9	35	15461	442 m²	4.9	30	15085	503 m²	5.9	32	13937	436 m²	6.9	34	15527	457 m²
8	55	35151	639 m²	13F	23	17100	743 m²	3.10	31	15799	510 m²	4.10	34	16972	499 m²	5.10	35	15882	454 m²	6.10	39	18710	480 m²
9	21	9316	444 m²	13G	27	19359	717 m²	3.11	17	8380	493 m²	4.11	48	20011	417 m²	5.11	29	15169	523 m²	6.11	35	18619	532 m²
10	30	15257	509 m²	16	37	12554	339 m²	3.12	36	15718	437 m²	4.13	33	15900	482 m²					6.12	38	16660	438 m²
11	31	14700	474 m²					3.13	43	20332	473 m²									6.13	20	10804	540 m²
Total	**524**	**343235**	**655 m²**	**Total**	**258**	**137979**	**535 m²**	**Total**	**426**	**197781**	**464 m²**	**Total**	**404**	**187671**	**465 m²**	**Total**	**367**	**169913**	**463 m²**	**Total**	**422**	**207642**	**492 m²**
East Busselton Estate + Provence 2 Total																							**2401**

URBAN DESIGN
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W rpsgroup.com

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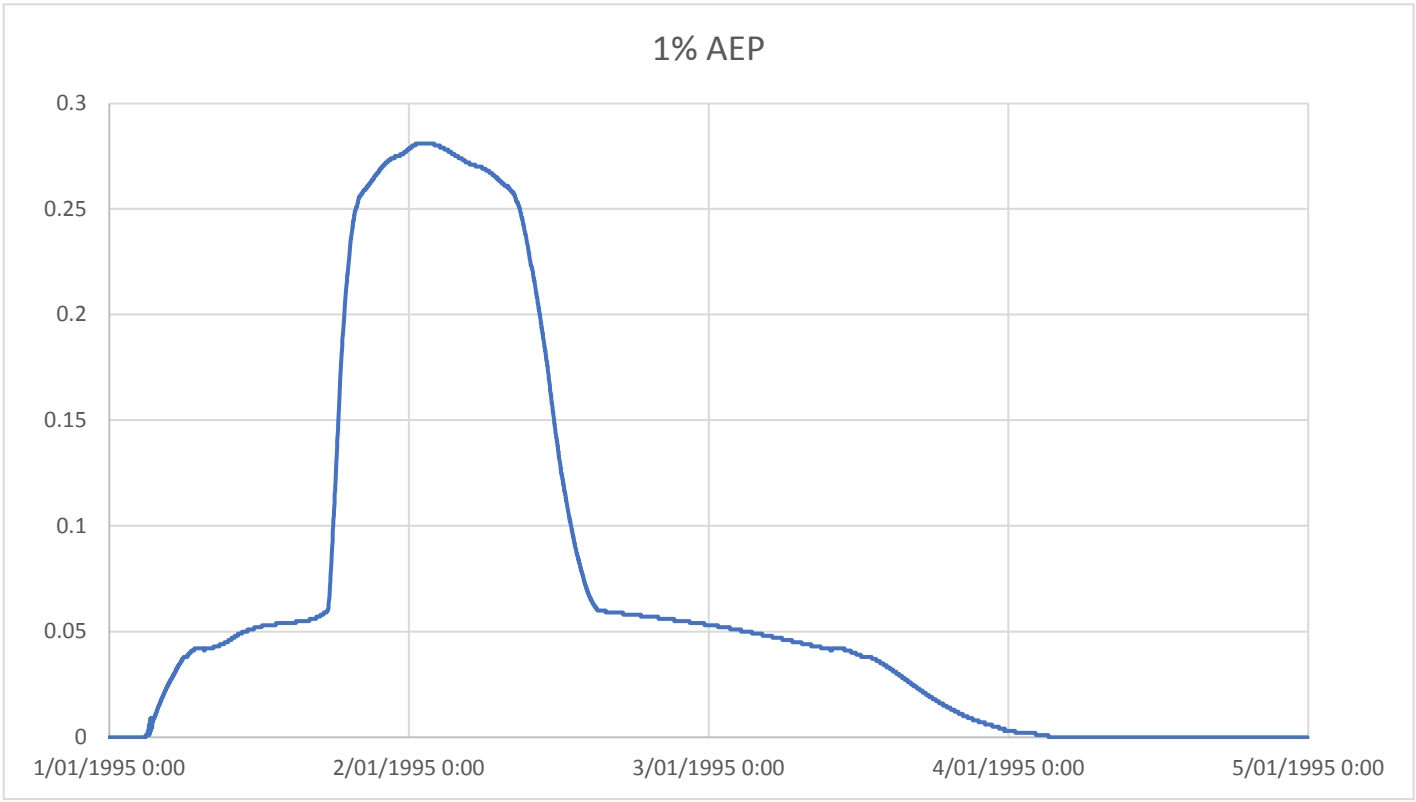
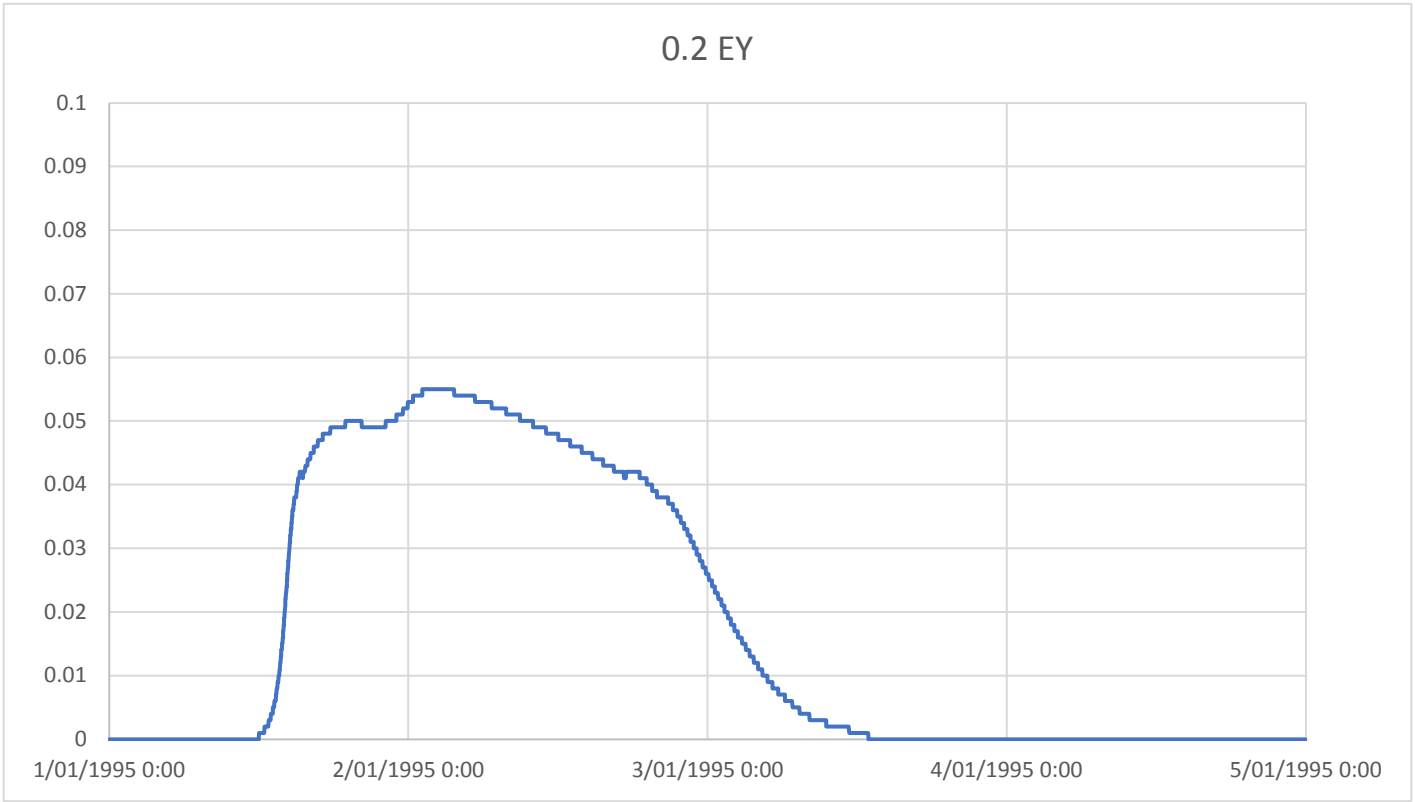
APPENDIX O

Basin Outflow Hydrographs





Job No. J6049

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Provence: LWMS
Figure O1: Basin A Outflow Hydrographs

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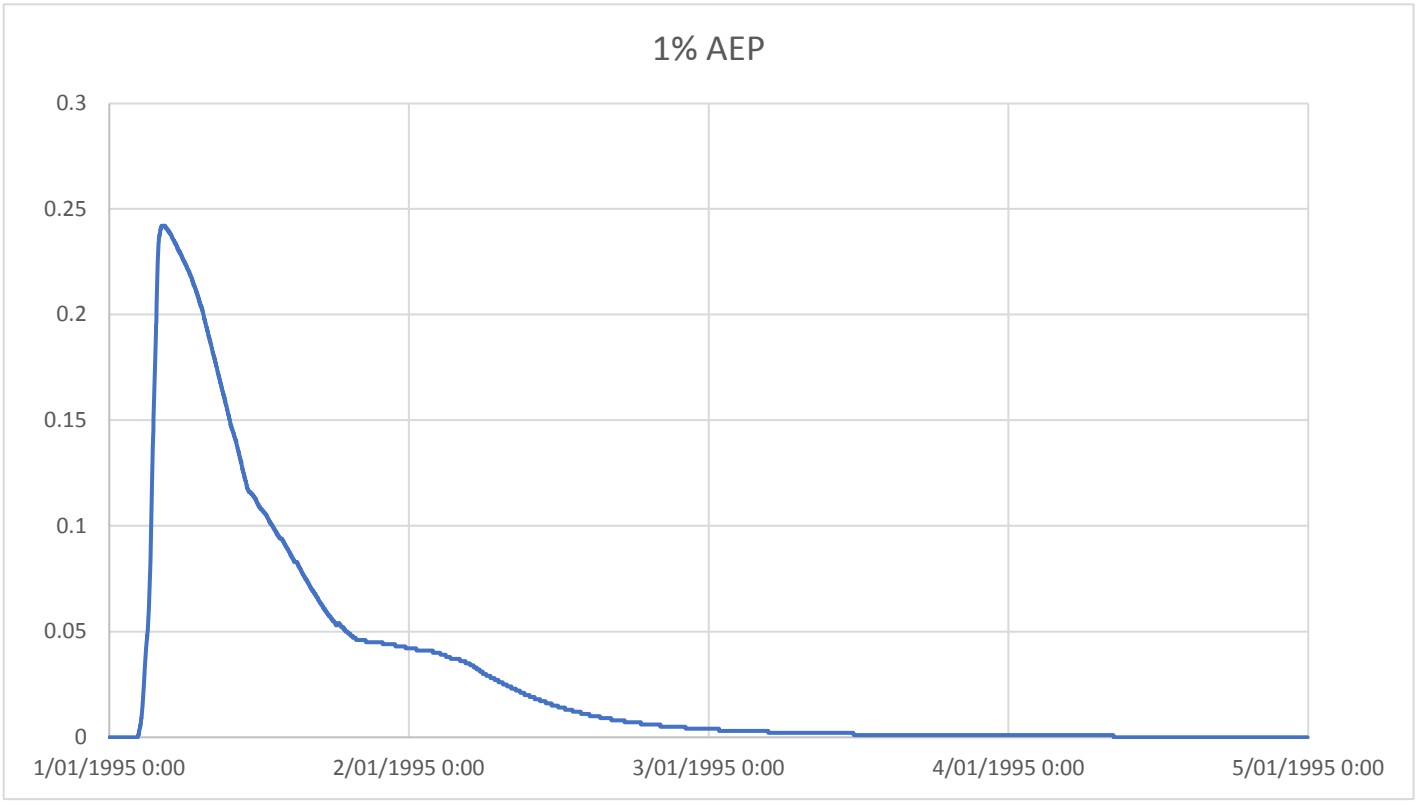

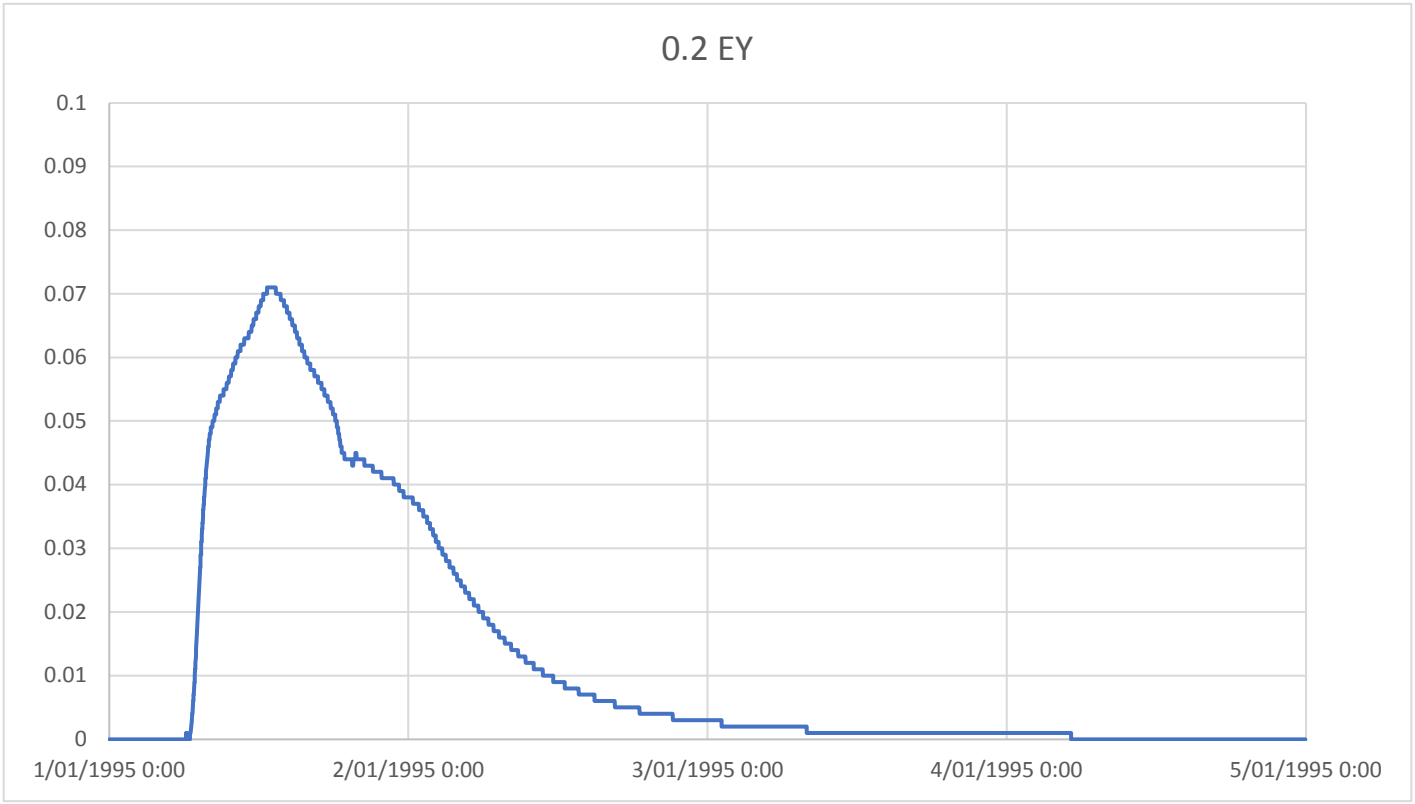

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Provence: LWMS
Figure O2: Basin B Outflow Hydrographs

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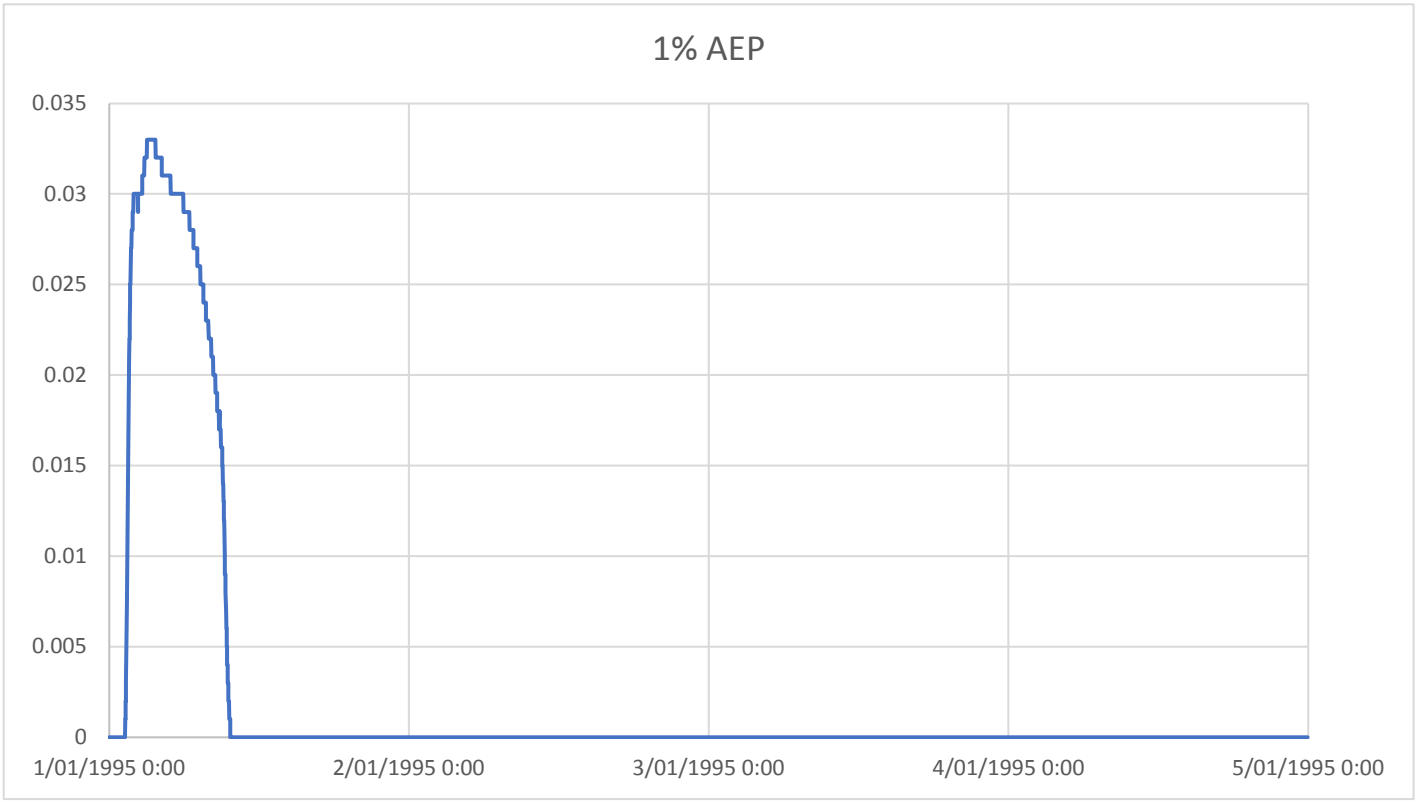

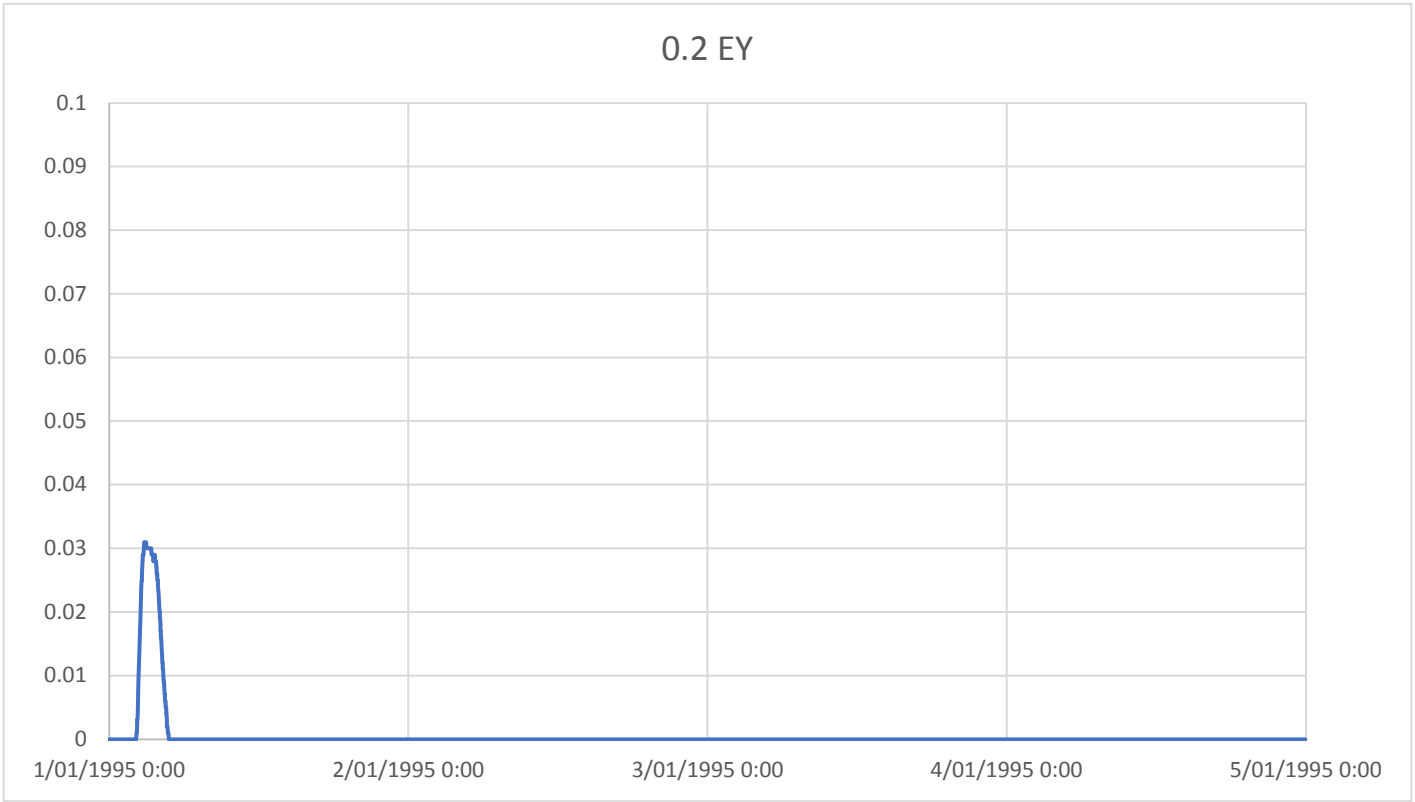

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Figure O3: Basin C Outflow Hydrographs

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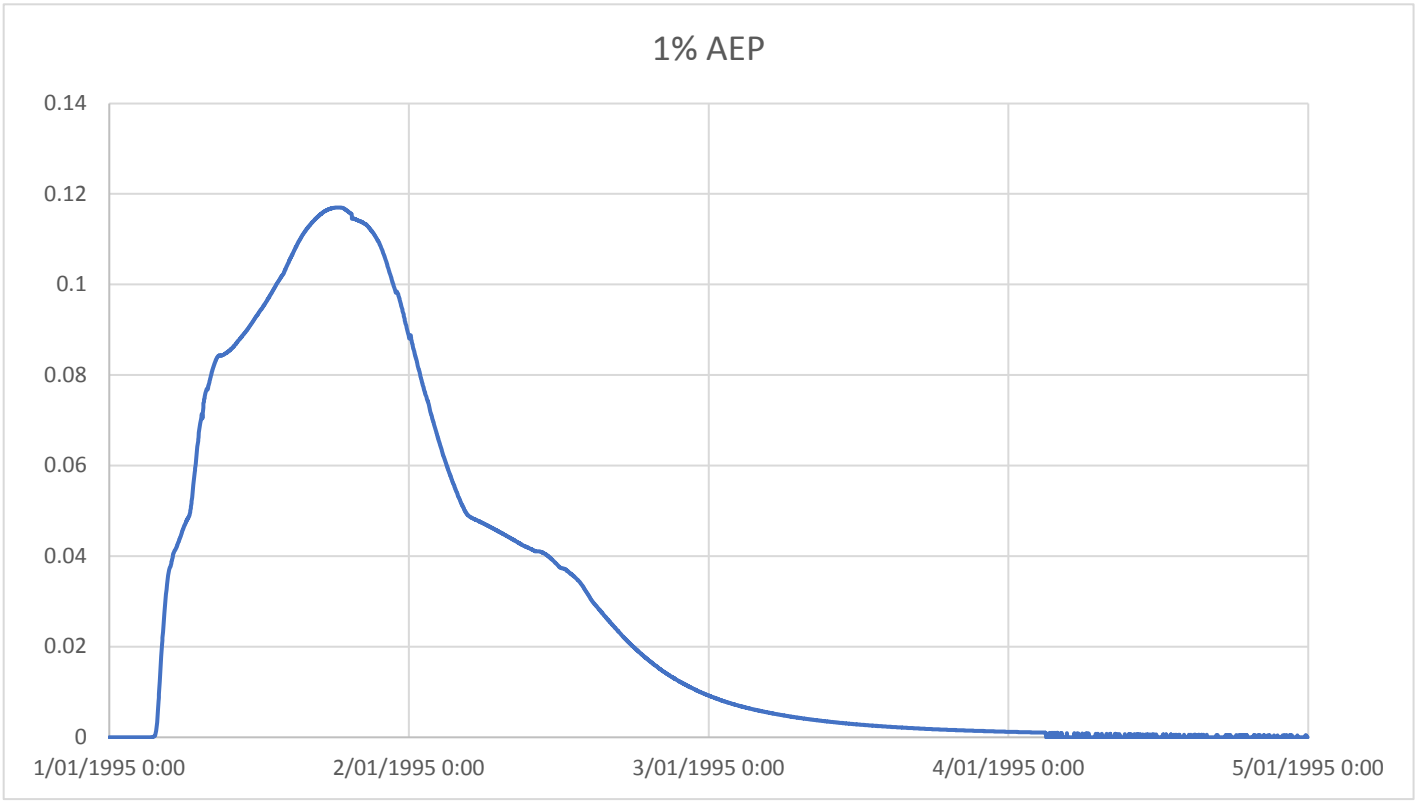

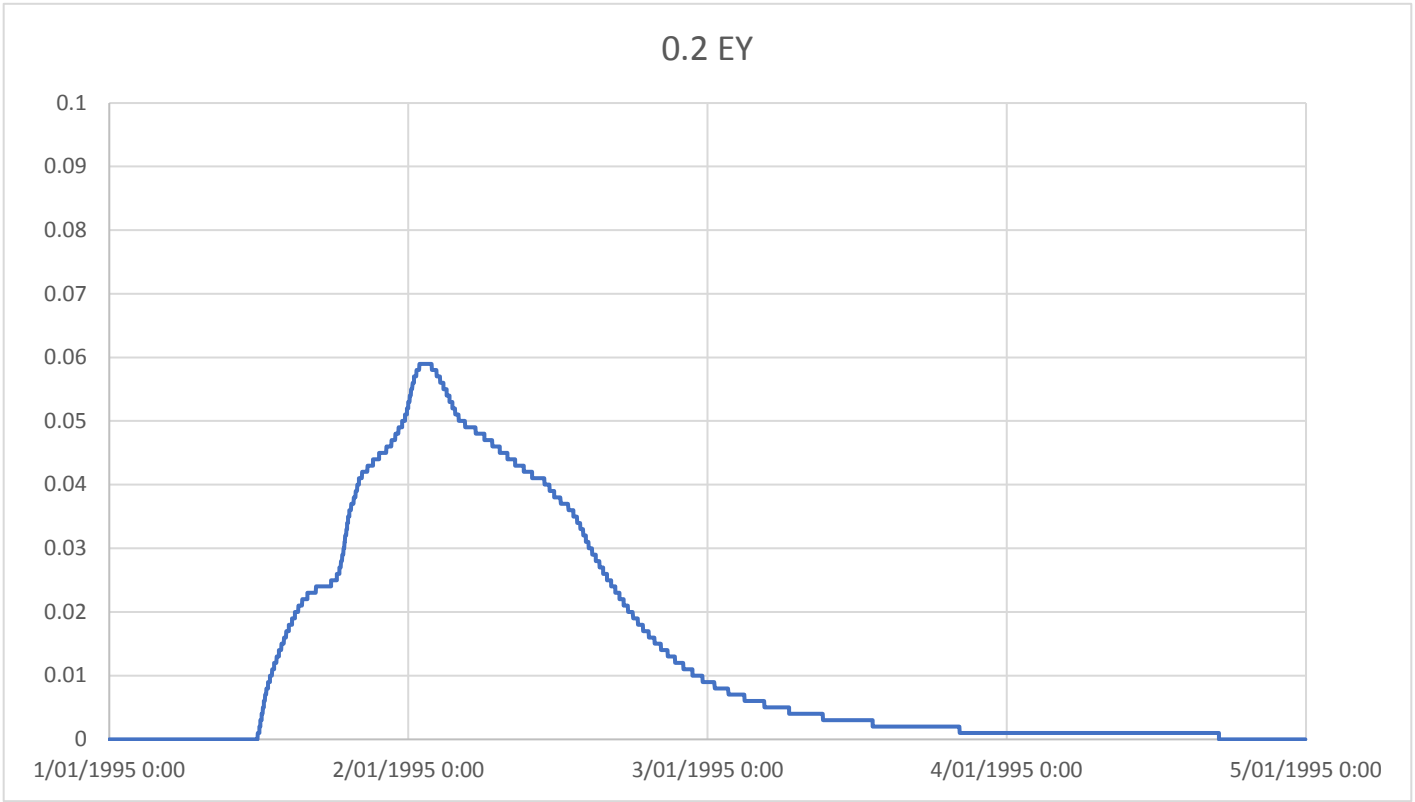

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Figure O4: Basin D Outflow Hydrographs

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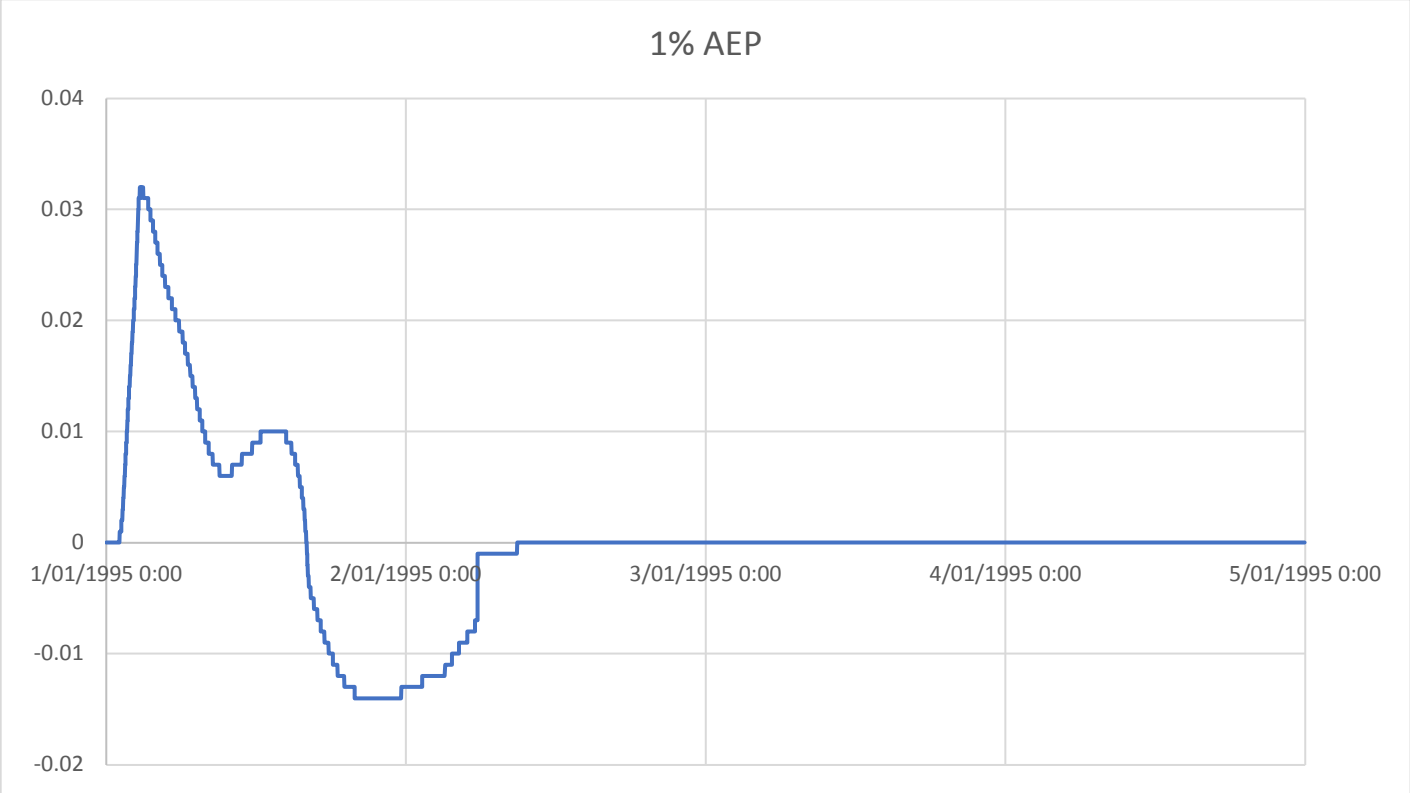

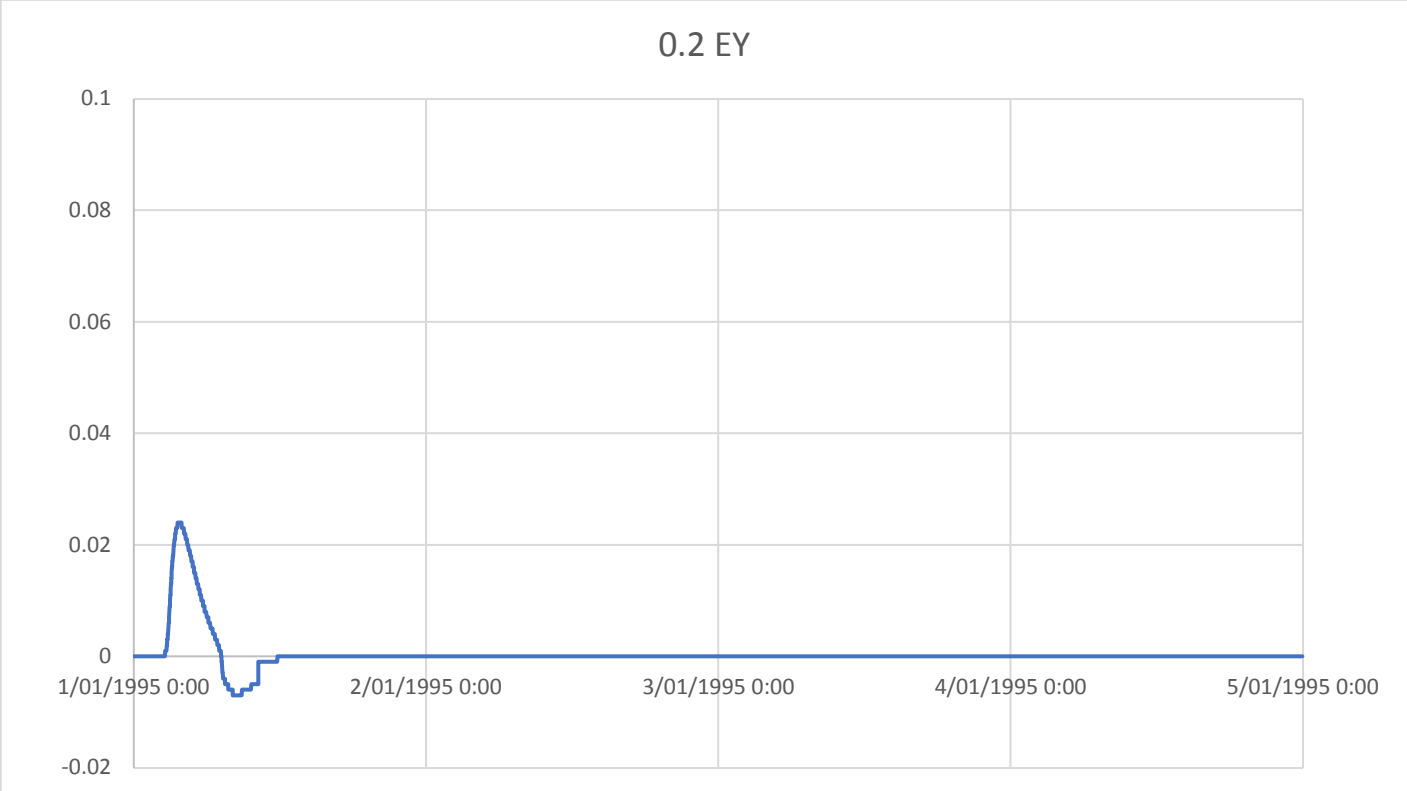

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Figure O5: Basin E Outflow Hydrographs

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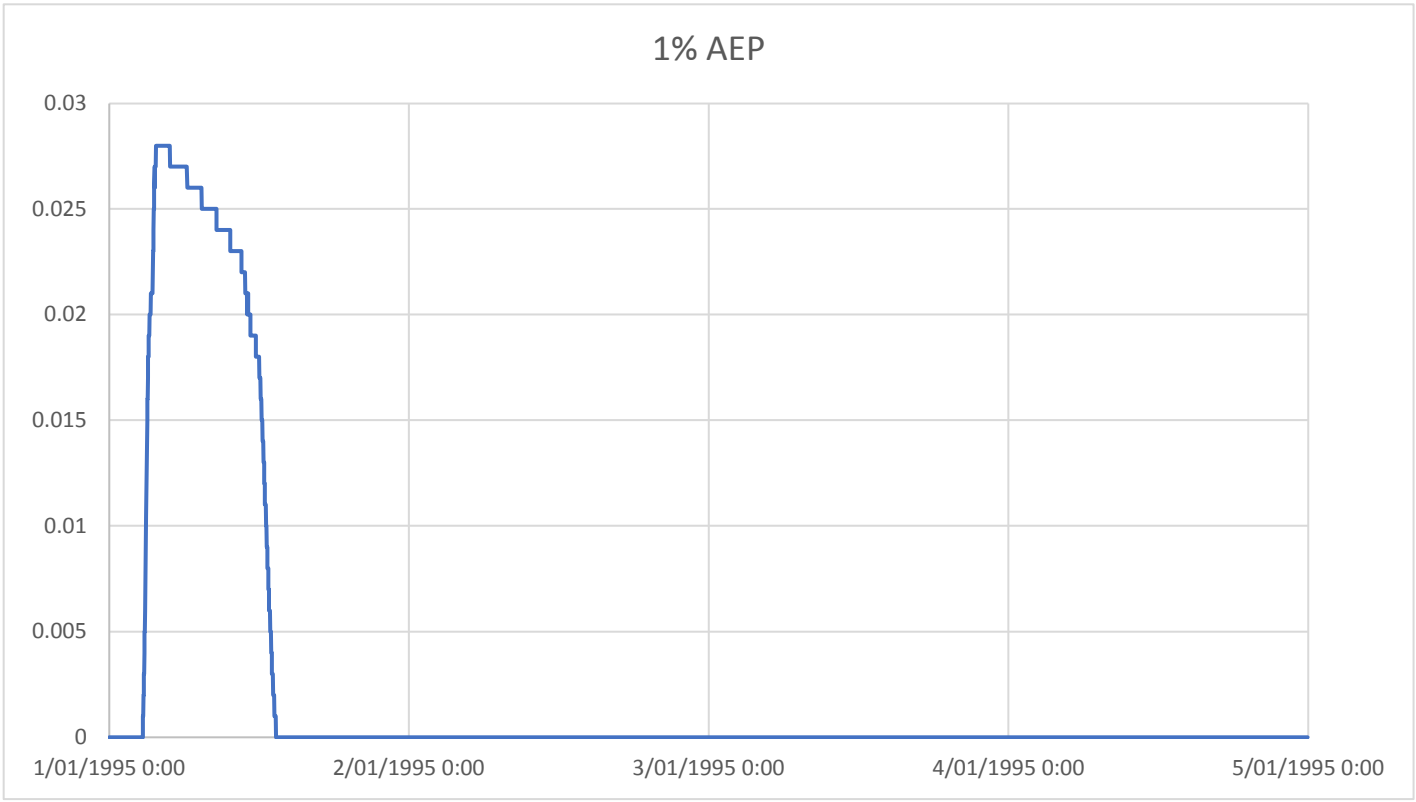

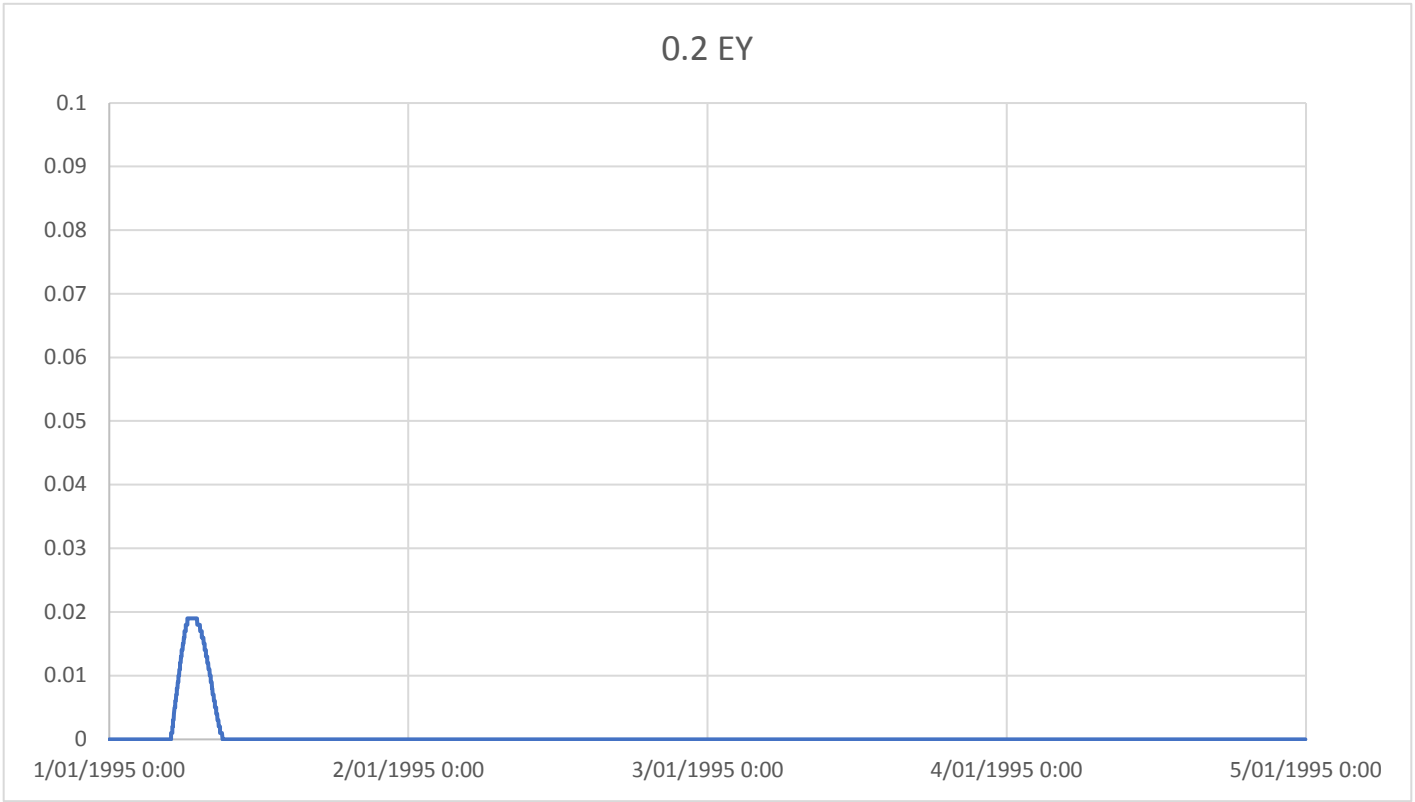

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Figure O6: Basin F Outflow Hydrographs

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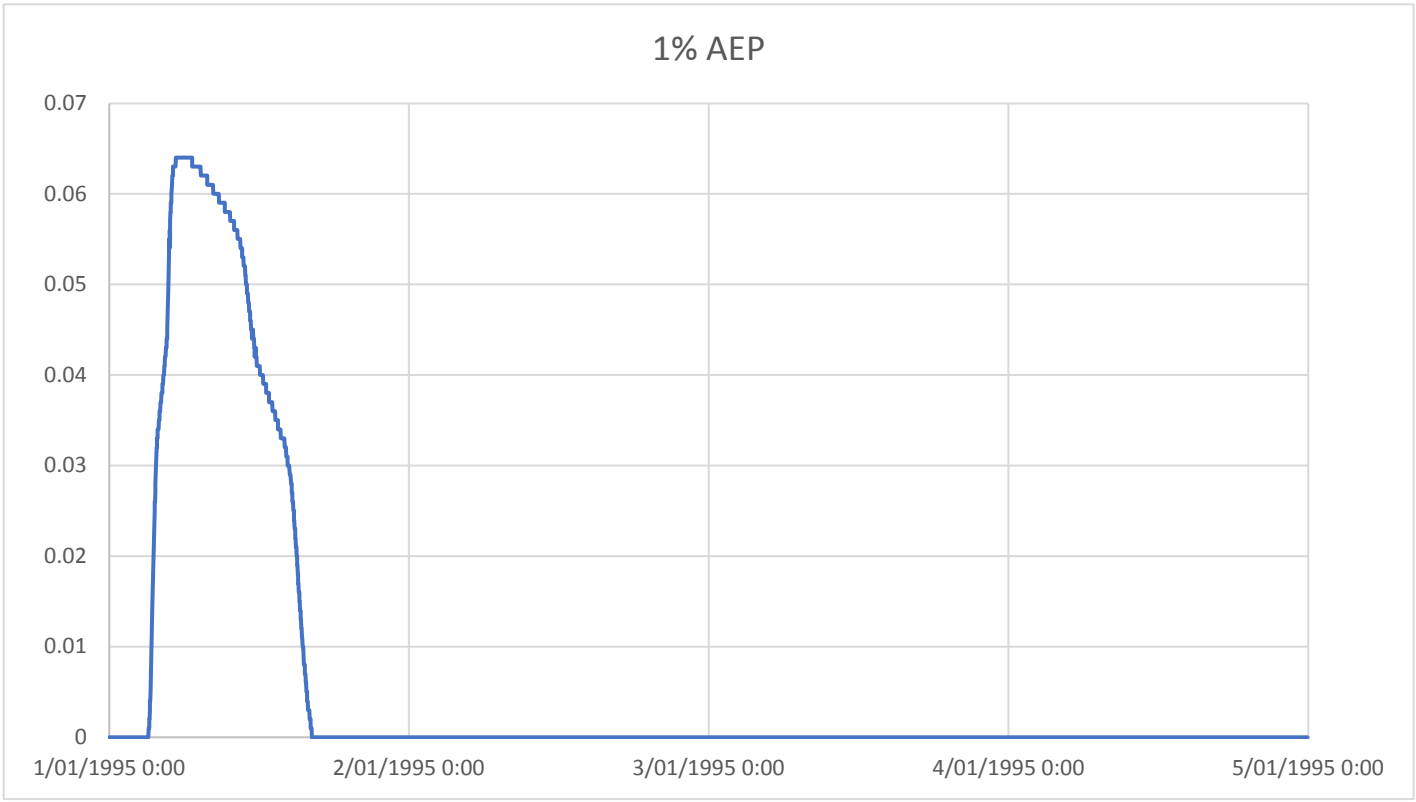

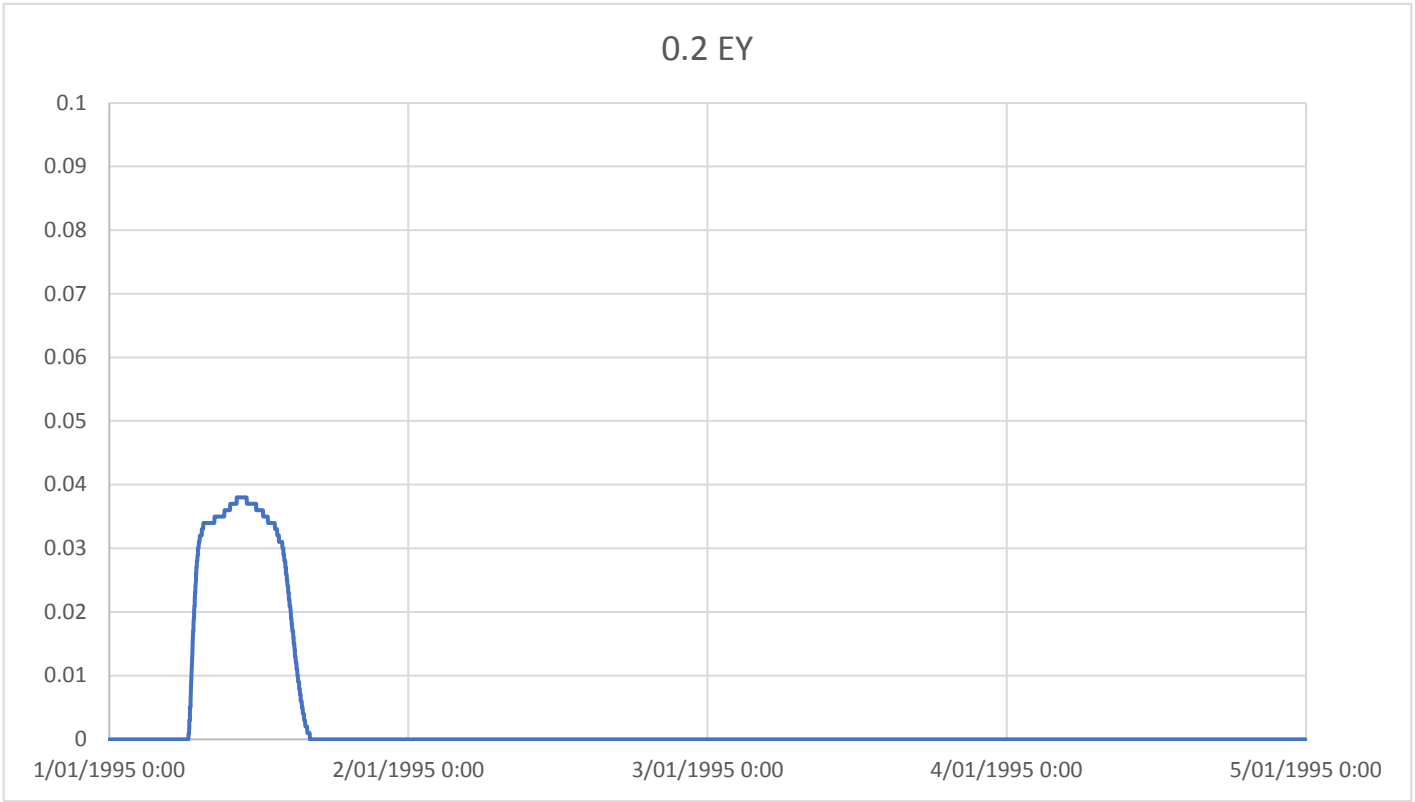

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Figure O7: Basin G Outflow Hydrographs

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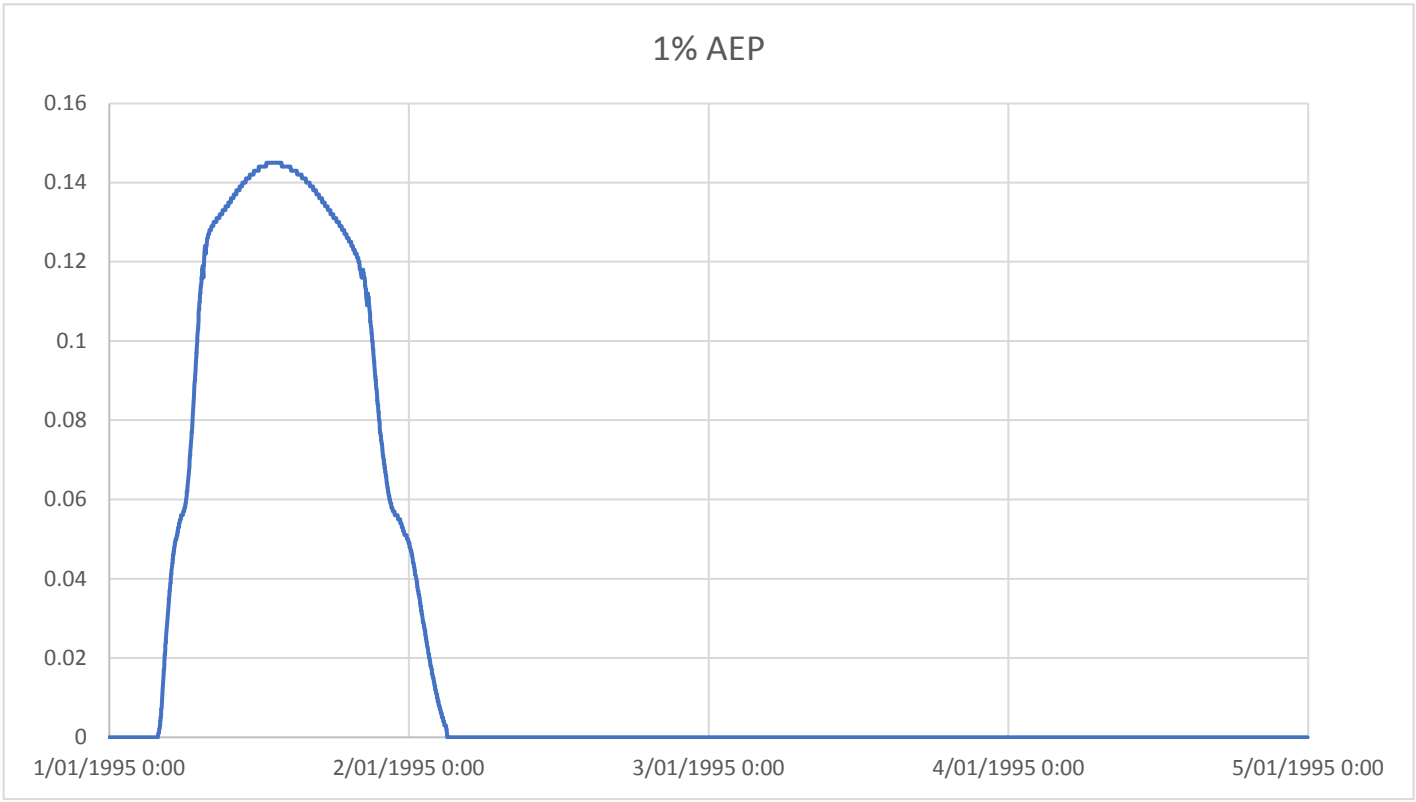

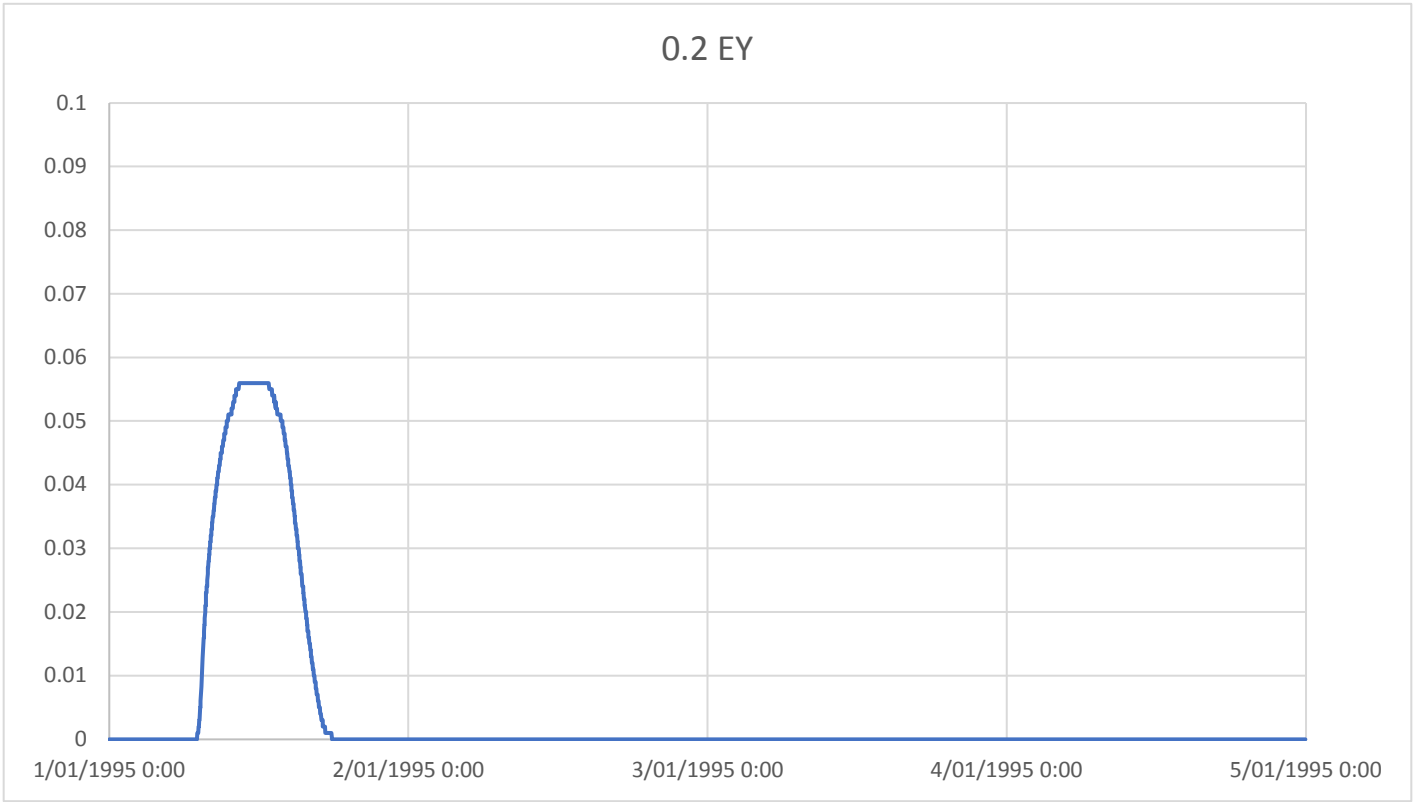

Job No. J6049

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Figure O8: Basin H Outflow Hydrographs

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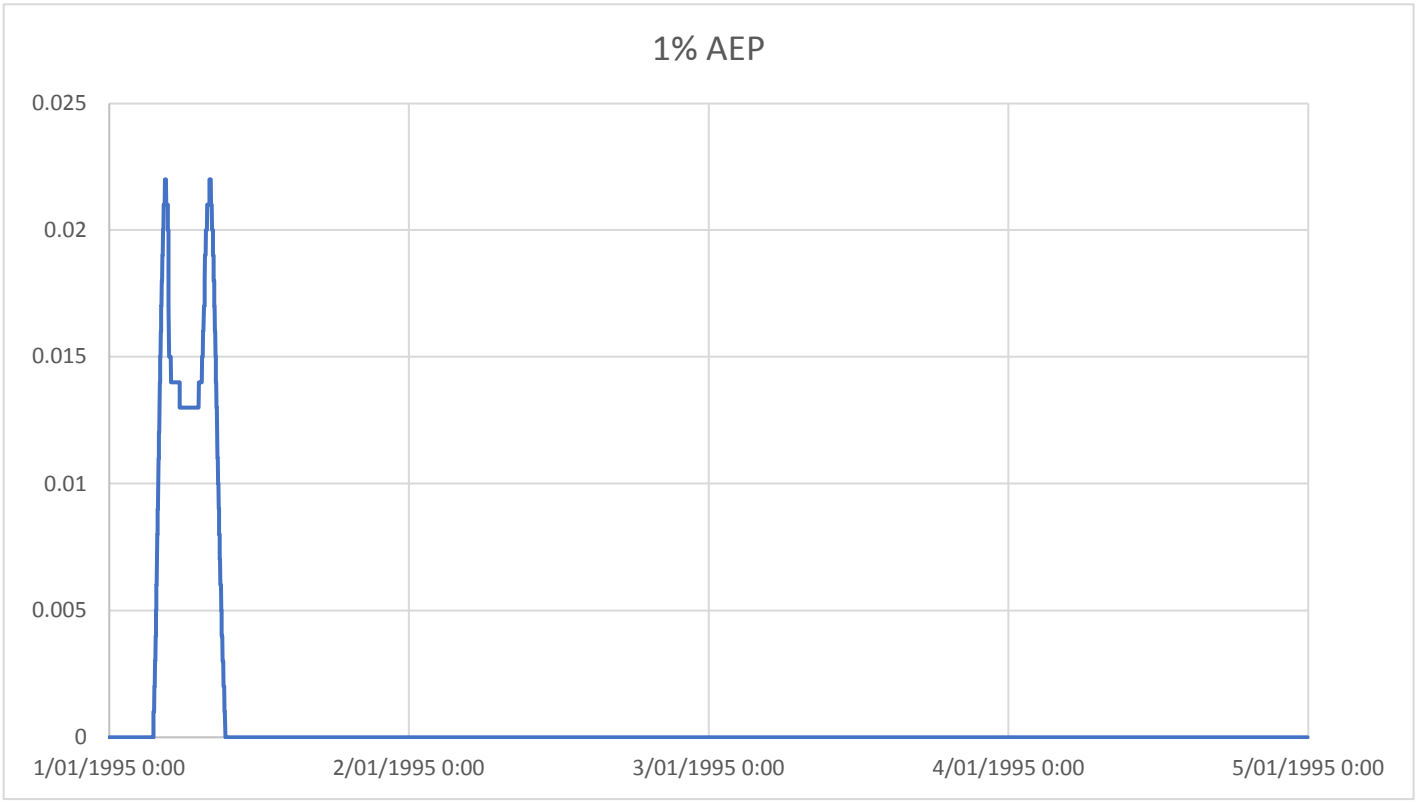

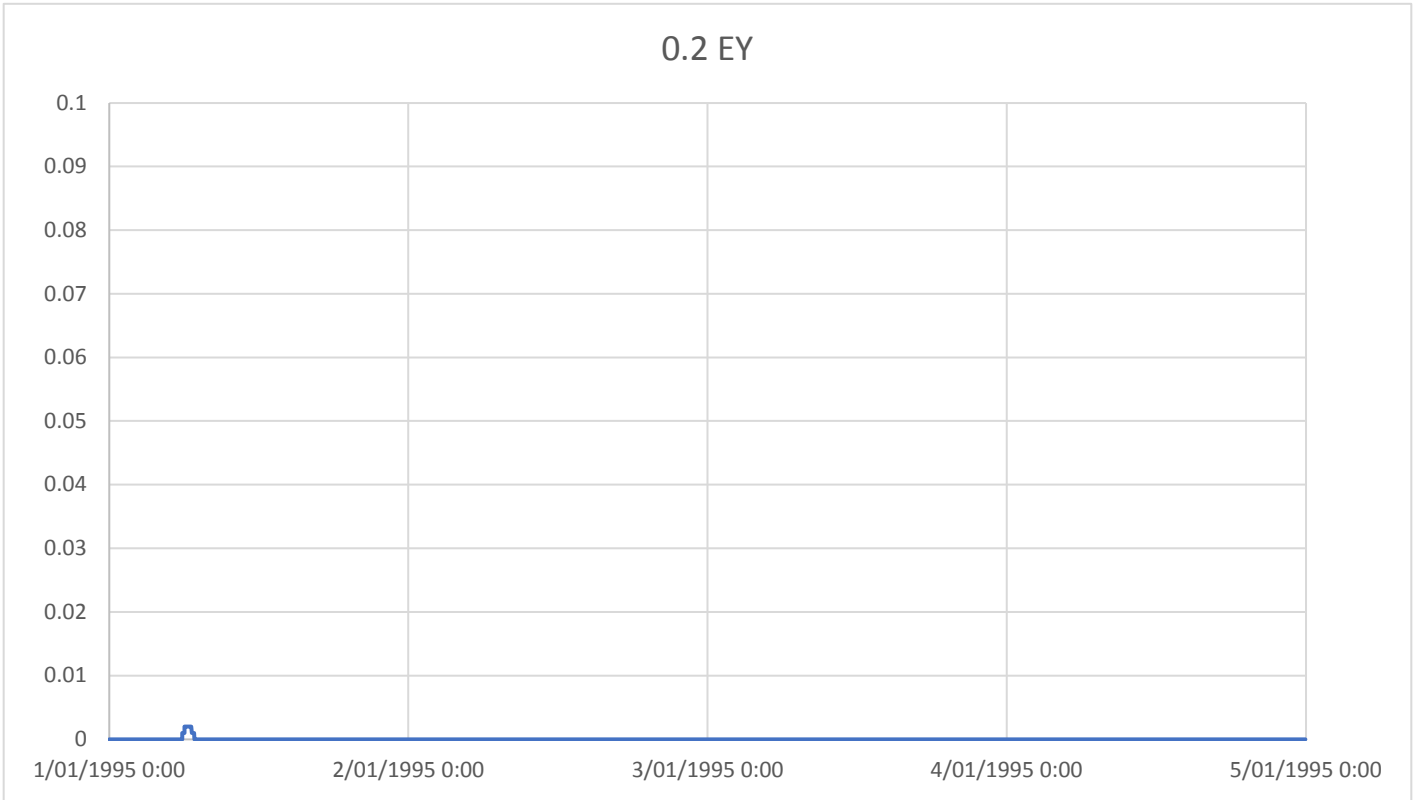

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Figure O9: Basin I Outflow Hydrographs

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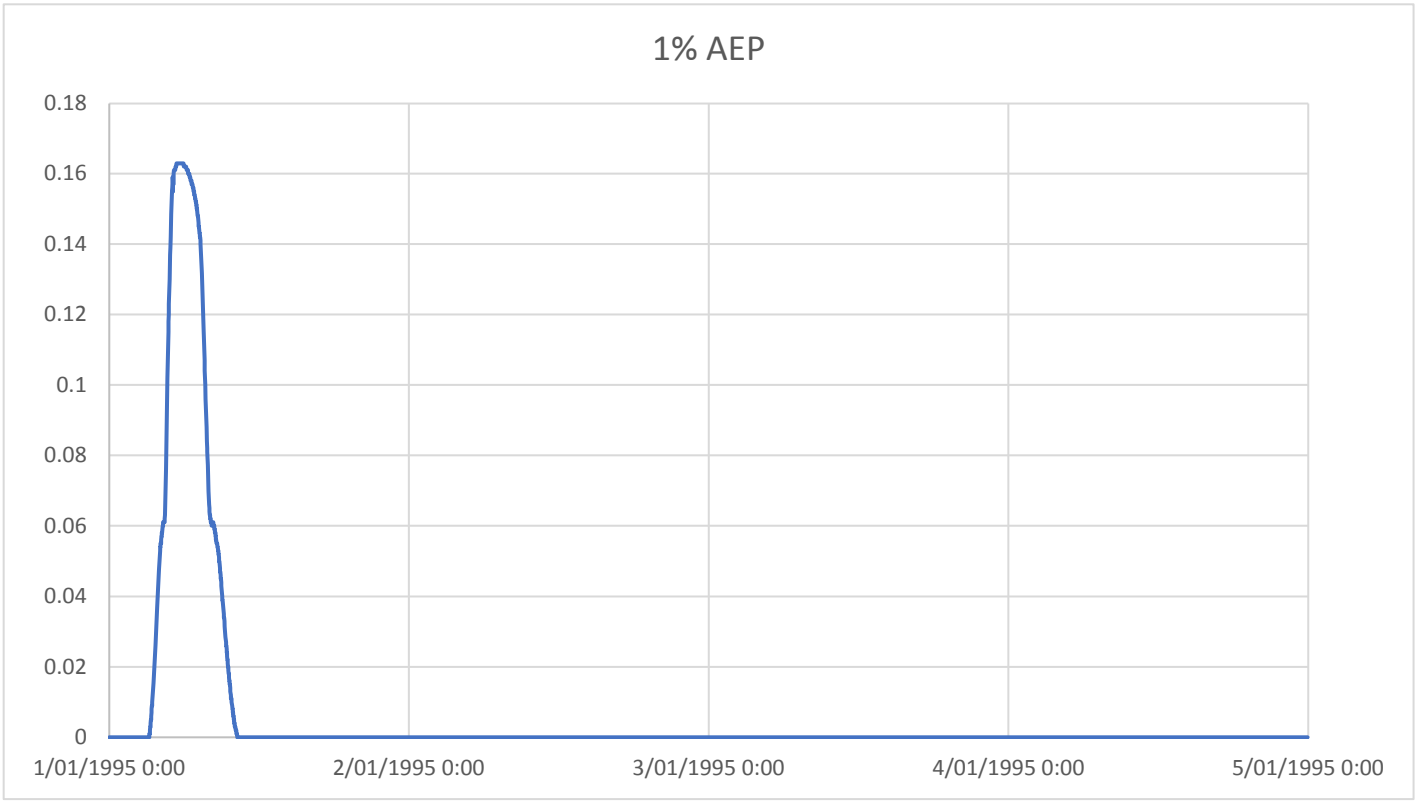

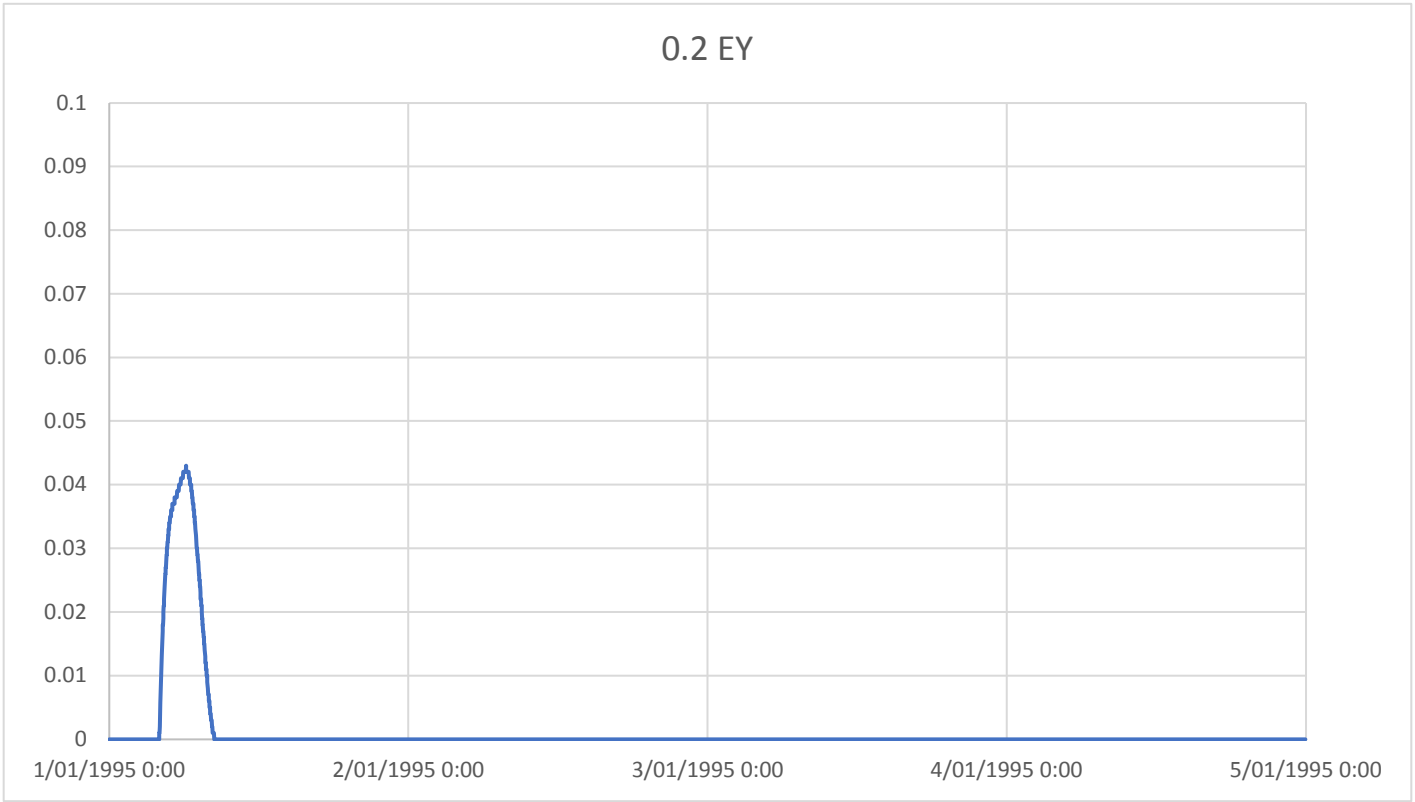

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Provence: LWMS
Figure O10: Basin J Outflow Hydrographs

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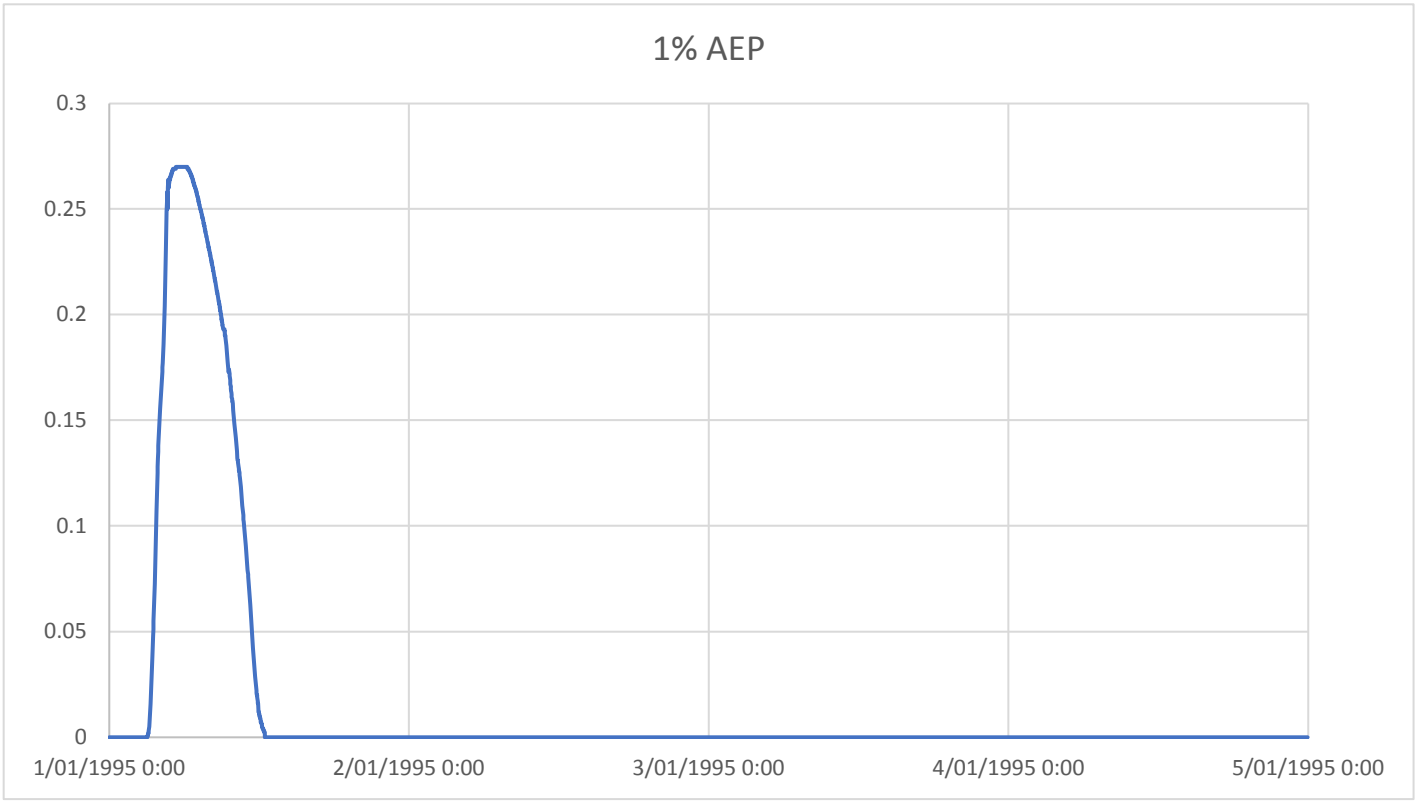

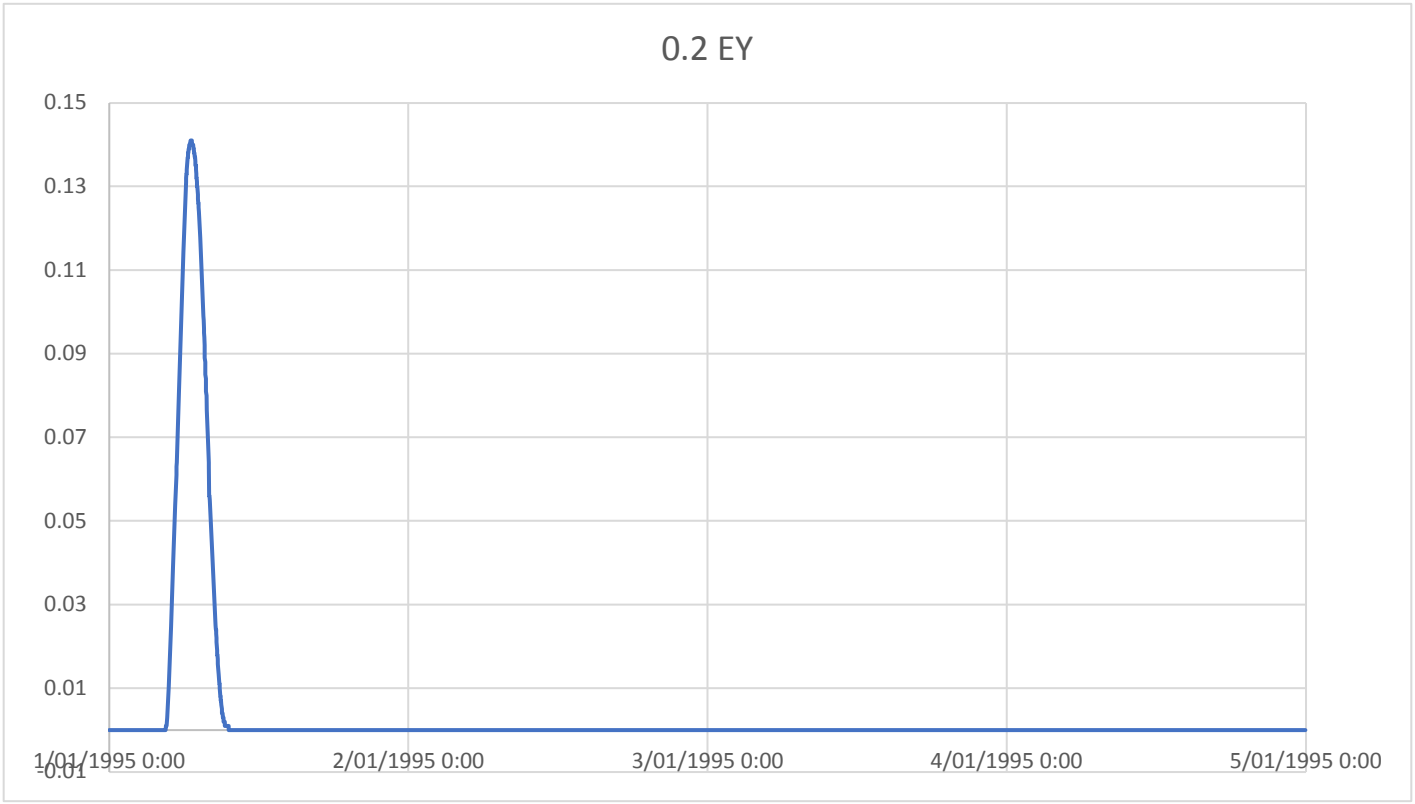

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Figure O11: Basin K Outflow Hydrographs

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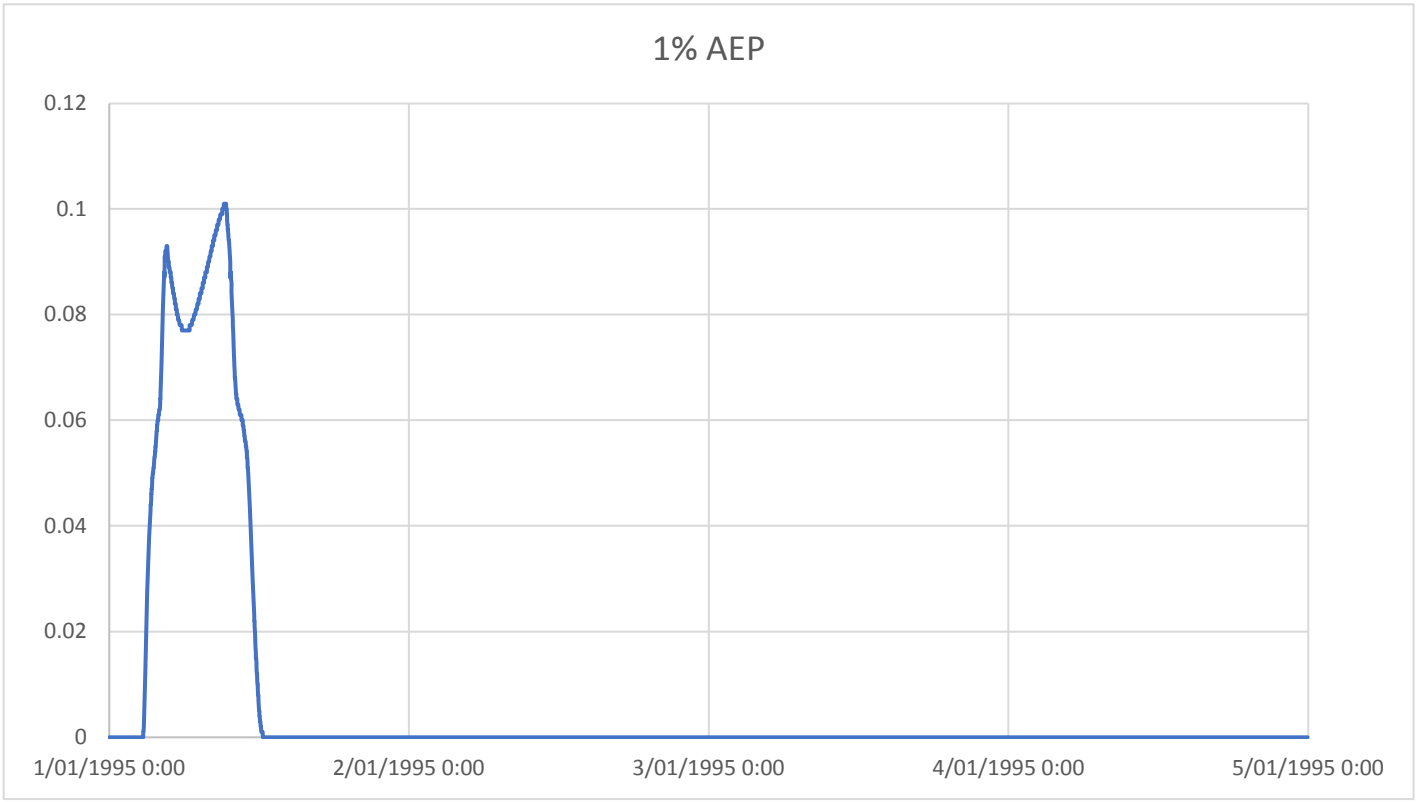

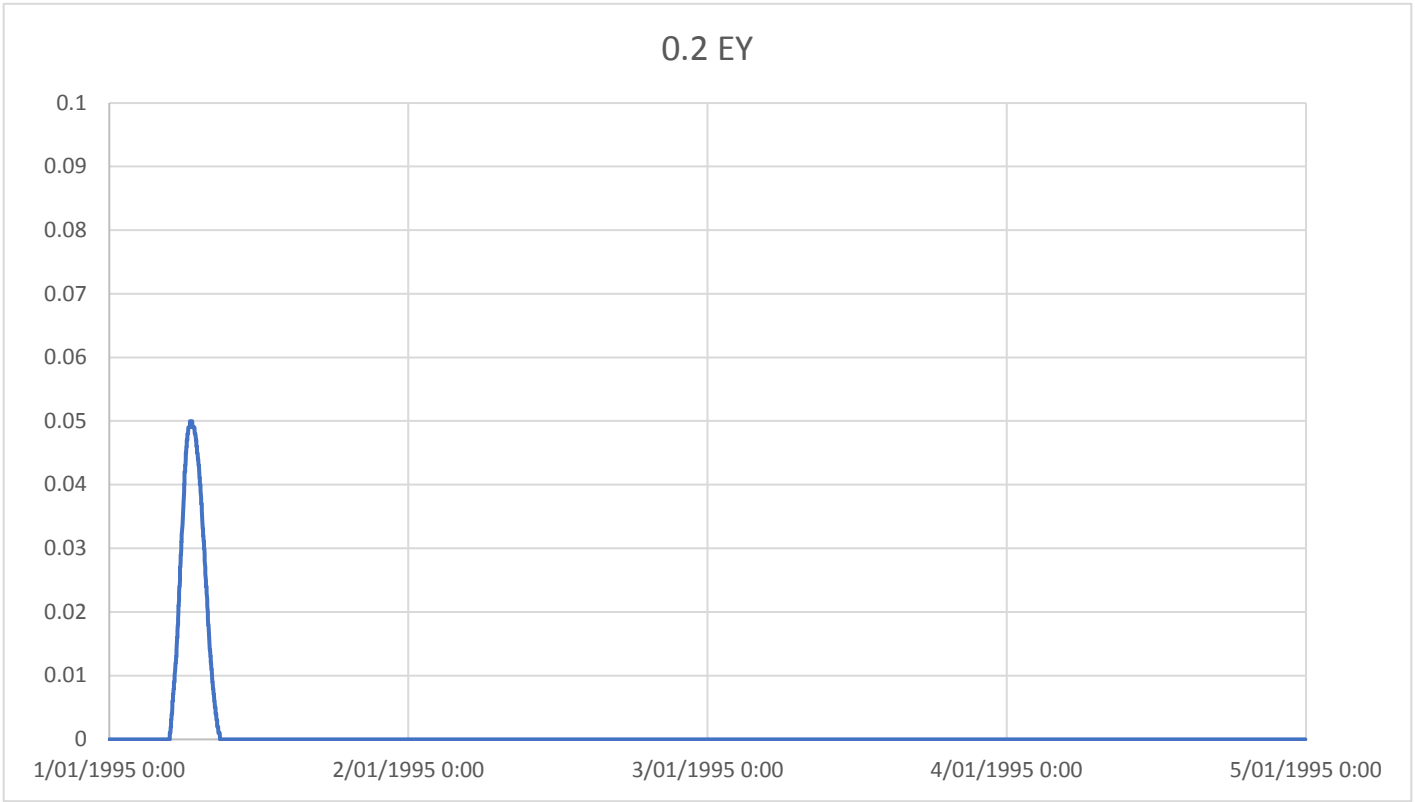

Job No. J6049

East Busselton Estate Pty Ltd
Provence: LWMS
Figure O12: Basin L Outflow Hydrographs

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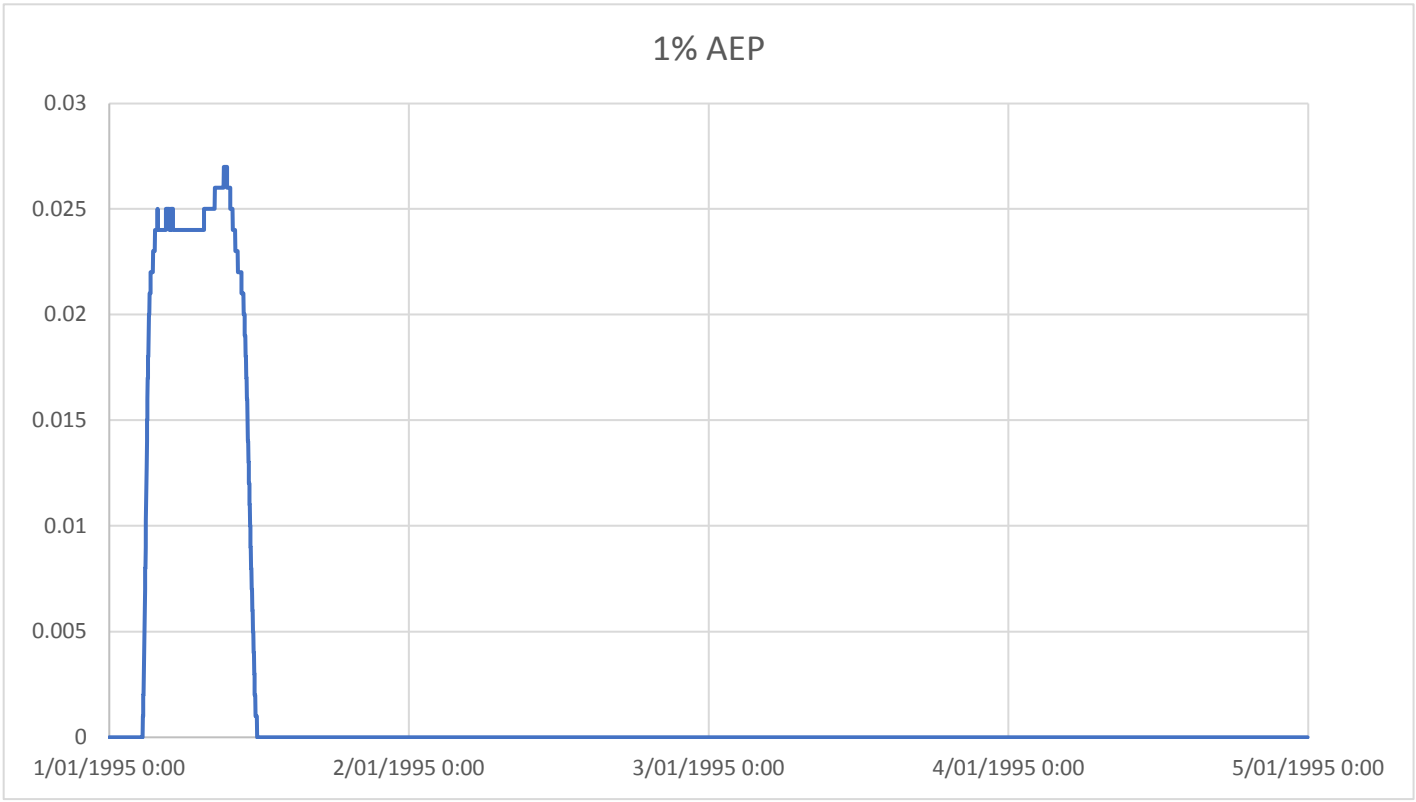

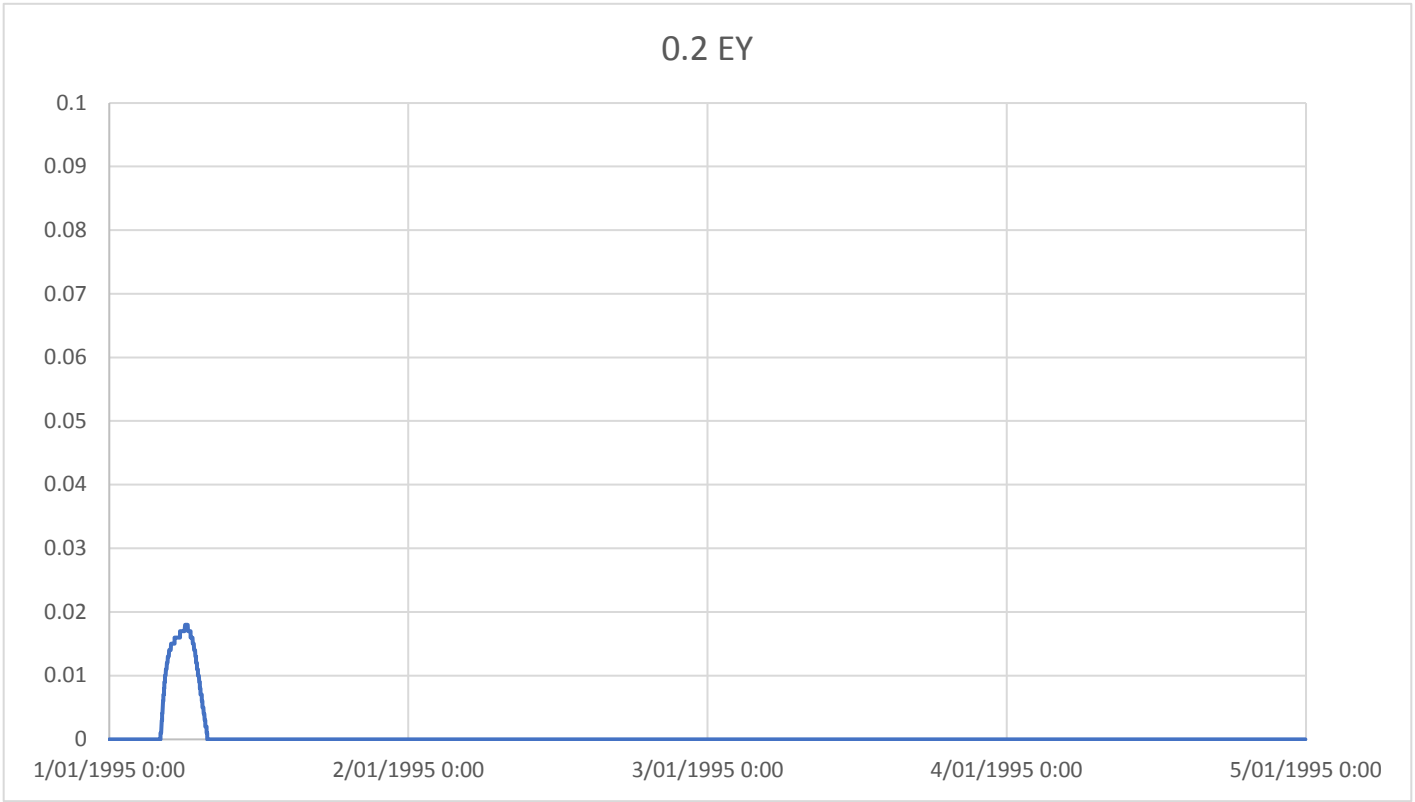

Job No. J6049

East Busselton Estate Pty Ltd

Provence: LWMS

Figure O13: Basin M Outflow Hydrographs

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10 August 2022

Your Ref:
Our Ref: H22018Fv2

Department of Water and Environmental Regulation
South West Region
PO Box 261,
BUNBURY, WA 6231
ATTENTION: Krish Seewraj, Planning Advice Program Manager

Dear Krish,

LOTS 9032 AND 9034 JOSEPH DRIVE YALYALUP, WAPC SUBDIVISION 162371
JDA (2019) LOCAL WATER MANAGEMENT STRATEGY ADDENDUM REPORT

Please find below Hyd2o's Addendum report to supplement the existing Local Water Management Strategy prepared by JDA Consultant Hydrologists for Lots 9032 and 9034 Joseph Drive Yalyalup at East Busselton (herein referred to as the site).

This Addendum is provided to support Yolk Property's Stage 1 development at the site for 72 residential lots (Attachment 1) in advance of the Local Structure Plan (LSP) revision and its supporting technical documents which are currently in progress. The relationship of Stage 1 (WAPC 162371) to the site is shown in Figure 1.

This Addendum is intended to provide a bridging document for the JDA (2019) LWMS which is understood not to have received 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.

This LWMS Addendum therefore aims to:

- Provide responses to outstanding agency matters from the JDA (2019) LWMS, and specifically address any issues which may affect Stage 1 works.
- Demonstrate that Stage 1 is able to be developed consistent with the existing LWMS (JDA, 2019) prior to the finalisation of the revised LWMS currently being prepared by Hyd2o for the updated LSP.
- Demonstrate that any outstanding matters for the JDA(2019) LWMS not related to Stage 1 can be readily addressed via the revised LWMS.

This approach has been developed in consultation with DWER and City of Busselton as a practical and sensible way to process and manage risks associated with the subdivision, without needing to undertake work that will effectively become redundant once the revised LSP is complete and a new LWMS prepared in the near future.

It is important to therefore note this LWMS Addendum has been developed solely to satisfy the progression of the Stage 1 subdivision application only, and is not intended and will not be used to support any further subdivision stages. Future subdivision stages will not occur until the structure plan has been revised, along with supporting studies and reports including a new LWMS.

1. REVIEW OF PREVIOUS LWMS (JDA, 2019) AGENCY RESPONSES

A copy of the remaining issues from DWER and City of Busselton on the JDA (LWMS) as provided by DWER are detailed in Attachment 2. These issues are reviewed and summarised in Table 1 in the context of how each issue relates to the Stage 1 area, and when and how the issue will be addressed in the planning process.

In summary, Table 1 demonstrates the Stage 1 area can be developed based on the existing LWMS, with the remaining issues addressed and documented via the Stage 1 Urban Water Management Plan (UWMP) and revised LSP LWMS.

Note that with respect to Footprint (Iluka) Lake, Hyd2o have recently prepared a report detailing an assessment of water quality management options. The report summarises the periodic occurrence of algae blooms in the lake including prior to urban development, and seeks to provide methods to reduce the severity and frequency of these occurrences by using a range of best management practice techniques.

Table 1: Summary of JDA (2019) Outstanding Issues

Issue	Required to Inform Stage 1	Comment/Response
DWER Comments		
It is stated that management of Iluka Lake will be required. There is however no mention of this work in Sect 7.1 and agreement needs to be reached with the City in relation to timeframes for this work.	No	The Stage 1 area is separate to Footprint Lake and no stormwater from the area flows to the lake. The groundwater flow from the Stage 1 area is also in a northern direction away from Footprint Lake. Hyd2o have recently prepared an assessment of water quality management options for the lake (Hyd2o, 2022d) which has been forwarded to agencies for review. It is anticipated the report, its findings, and any review amendments will be included as part of the revised LSP LWMS.
It is unclear where the Design GWL in the long sections is referring to the controlled groundwater level, mounding between sub-soil pipes or uncontrolled post-development groundwater level? In all situations the design GWL is lower than the invert of the piped stormwater system, for areas where is it proposed that groundwater will be controlled via a sub-soil system (as per Fig 41) will these systems be completely separate to the stormwater system? For all long sections the Design GWL is lower than the downstream control of the road crossing culvert invert? Specifically for Figure 37: The design GWL at Basin A is 2.9 which is lower than the outfall control of the culvert of 3.1? Design GWL at Basin E is higher than the basin invert?	No	Hyd2o understand the design GWL on the JDA long sections represents a variety of different groundwater levels and/or controls depending on location. For example at a storage which requires subsoil, the design GWL will be the level of subsoil under the storage. In other areas, it may represent an uncontrolled AAMGL. Regarding subsoil control, Hyd2o understand these will flow into a storage and be treated in biofilters before discharge. Subsoil control pipes under storages are not shown on the long sections hence design GWLs appear below pipes. Text and information in the revised LWMS will be updated to avoid confusion. Re the design GWL this is 0.1m lower that the downstream control of the road crossing culvert invert on the JDA sections. This should only occur if the AAMGL at these locations is below the crossing level. Hyd2o will revise this

Issue	Required to Inform Stage 1	Comment/Response
		as part of the LWMS review based on updated groundwater mapping for the site. In Figure 37, Hyd2o understand the design GWL shown at Basin A is the subsoil outlet level under the basin rather than the surface water downstream control level. This will be clarified in the revised LWMS. For Basin E1, the 4.5 mAHD design GWL appears to be an error and this should be controlled by the outlet at 4.3 mAHD. These amendments will not modify the design outlet levels to which the Stage 1 area will drain. Key levels as detailed in JDA (2019b) to demonstrate the Stage 1 outlet levels will not be constrained by groundwater control levels in Reinscourt are as follows : • Existing culvert under Bussell Hwy : 2.9 mAHD • 63% AEP level at this location : 3.10 mAHD (based on downstream Reinscourt survey and modelling) • Stage 1 Basin(Storage C) invert : 4.33 mAHD • Stage 1 Basin(Storage C) outlet : 4.53 mAHD • Groundwater level at Stage 1 Basin 3.50 mAHD This will be further demonstrated and detailed in the Stage 1 UWMP.
Section 6.6.5. The net load export for nitrogen (4.25kg/ha/yr) exceeds the target (2.7kg/ha/yr) from the Vasse River and Estuary Catchment. There is however no discussion to interrogate options to manage this. Table 12: The units are in kg/ha/yr and therefore the values for each catchment cannot be added to provide a total.	No	For the revised LSP and LWMS, UNDO modelling will be completely updated. This will include a pre-development model, not previously performed by JDA. Modelling results will be compared against previous DWER load estimates, and published targets. These results will be tabulated and used to discuss the WSUD measures implemented and management approach to minimise nutrient export from the site. Re Table 12, noted and agreed. This will be corrected in the revised LWMS. Note that water sensitive urban design measures to be applied to the Stage 1 area will represent best management practice.
Hydrographs in Appendix O would benefit from having the total volume stated, as included in Figure 29.	No	Modelling will be redone to reflect the revised LSP. Volumes will be reported on the updated hydrographs in the revised LWMS as requested. Based on discussions with DWER, Hyd2o understand that maintaining post development volumes as well as flow rate is a key consideration for future water management planning to avoid downstream flood risk.

Issue	Required to Inform Stage 1	Comment/Response
City of Busselton Comments		
The City would prefer that the management strategy for the Iluka Lake is fully developed and costed before the LWMS is approved. This will need to include capital cost and ongoing maintenance and management cost that the City can expect to incur. The City would also like the option of lining the lake to be considered. Although it is understood that this will not eliminate the existing main source of TP inflow it may assist with other sources of TP should they become prevalent in the future.	No	The Stage 1 area is separate to Footprint Lake and no stormwater from the area flows to the lake. Hyd2o have recently prepared an assessment of water quality management options for the lake (Hyd2o, 2022d) which has been sent to agencies for review. It is anticipated the report, its findings, and any review amendments will be included as part of the revised LSP LWMS. Based on JDA (2019) water balance findings, lining of the lake to limit shallow groundwater inflow (which represents only 2% of annual flow to the lake) is not considered a cost effective or viable option for water quality improvement.
There are a few queries in relation to the Footprint Lake Monitoring and Management Plan. The monitoring results suggest the primary source of TP in the lake is from inflow from the Yarragadee Aquifer through pumping from the bore feeding the lake. Can you please confirm why the inflow from the Yarragadee Aquifer has such a high concentration of TP. Can you also please confirm if there is a risk that TP will increase in the future, either through increases in the TP concentration in the Yarragadee Aquifer inflow and/or in increase TP from other inflows to the lake. Figure 7 Can you please confirm why FP01 and FP02 appear to have higher TP concentration that Yarra PB? Table 13, all items marked as TBA need to be addressed. In addition, the items marked as "See ILWMS" Please refer to sections of ILWMS where these have been addressed. It is felt that a number of these items are not sufficiently addressed in the ILWMS, which is why additional information and analysis was required in the LWMS.	No	Testing of the original Yarragadee bore by JDA in 2004 recorded a TP level of only 0.08 mg/L and testing of the original Almond Park Lake water quality in 2009 reported a TP concentration of less than 0.05 mg/L. These results were considerably lower than other monitoring results since and following the Yarragadee Bore relocation and redrill. This increase is not fully understood, however it is considered possible this may be due to the new screen depth being against a narrower aquifer zone of grey sands with areas of black shale. Phosphorus mobilisation into soils and groundwater is a function of rock weathering. Black shales can have high phosphorus concentration and are susceptible to chemical weathering. This is discussed in Hyd2o(2022d), and considered for further investigation to improve lake water quality. This opportunity will be further discussed as a separate process with DWER and the City of Busselton in due course as part of the Hyd2o (2020d) Footprint Lake Management Options Report review negotiations. Regarding TP concentrations, it is not uncommon for superficial aquifer water quality to contain higher nutrient levels that deeper aquifers due to land use activity. Predevelopment monitoring of superficial bores on the site recorded TP levels up to 1.1 mg/L. Text will be added into the revised LWMS to provide context. With respect to Table 13 of the Footprint Lake Monitoring and Management Plan, Hyd2o (2022d) will effectively replace this document in the revised LWMS as the proposed lake management strategy. We will continue to liaise with DWER and the City of Busselton to ensure the report is complaint with agency requirements. A Constructed Lakes Checklist as per the JDA Footprint Lake Monitoring and Management Plan can be added to Hyd2o's document if required.

2. STAGE 1 SUBDIVISION STORMWATER MANAGEMENT

Figure 2 shows the Stage 1 location relative to the site's overall stormwater management planning detailed in JDA (2019).

The site is part of the catchment proposed to flows under Bussell Hwy and through Reinscourt to the Sabina River. The size of the predevelopment catchment flowing to this location was estimated by JDA (2019) to be 189.6 ha, which discharges under Bussell Highway via 2 x 600mm diameter culverts near Osprey Drive

Stage 1 comprises a total area of 9.50 ha with 72 lots (4.35 ha), roads, two public open space areas (2.87 ha) and balance lots. The site is proposed to contain a single stormwater management area in compliance with the JDA (2019) LWMS.

Refined stormwater modelling of this area will be conducted as part of the UWMP which will be prepared to cover the whole of the Stage 1 Area. The key consideration for this modelling will be to ensure that the subdivision does not discharge more flow (rate and volume) than predevelopment towards Reinscourt. Modelling will therefore be required to identify if any additional temporary flood detention measures are required to manage this risk during staged development.

JDA (2019) provided detailed modelling outcomes to demonstrate post development flows and volumes into Reinscourt were maintained at predevelopment levels, and similar outputs in the UWMP are proposed for the Stage 1 UWMP.

Refined stormwater modelling for the Stage 1 area and other existing development areas will then be used to inform the revised LWMS.

3. REVISED LOCAL STRUCTURE PLAN & LWMS

Taylor Burrell Barnett (TBB) on behalf of Yolk Property are currently in the process of revising the LSP for the site. A copy of the draft concept plan and staging schedule are contained as Attachments 4 and 5 respectively. Hyd2o have been commissioned to undertake the new LWMS addressing the revised LSP, and have been involved in undertaking constraints and opportunities analysis to assist in inform the development of the plan.

The updated LWMS will address changes to the LSP, detail updated stormwater modelling including implemented works for the Stage 1 UWMP area, revised groundwater mapping based on recent investigation, updated Footprint lake management investigations, and provide consideration of alternative approaches to minimise fill requirements. A key criteria for the LWMS will be to demonstrate post development flows and volumes to Reinscourt downstream of Bussell Hwy continue to be maintained at pre-development levels., A further key consideration will be to demonstrate any Controlled Groundwater Levels (CGL's) are mapped clearly and reflect any controls downstream of the site in Reinscourt.

The LWMS is currently being prepared by Hyd2o consistent with DWER requirements as described in Better Urban Water Management (Western Australian Planning Commission, 2008), and will be submitted for agency consideration with the updated LSP in due course. As part of this process, ongoing discussions with both the City of Busselton and DWER will be undertaken to ensure the document is prepared consistent with agency requirements.

4. IMPLEMENTATION PROCESS

Table 2 details key actions and responsibilities for implementation of this LWMS Addendum in sequential order, consistent with the processes of Better Urban Water Management. It is important to recognise this Addendum report supports Stage 1 only, and future subdivision stages will not occur until the LSP has been revised, along with supporting studies and reports including a revised LWMS.

Table 2: Implementation Responsibilities for Water Management

Implementation Action	Responsibility		
	Developer	DWER	City of Busselton
1. Preparation of JDA(2019) LWMS Addendum Report (this document)	✓		
2. Review and approval of LWMS Addendum Report		✓	✓
3. Preparation of UWMP for Stage 1	✓		
4. Review and approval of Stage 1 UWMP		✓	✓
5. Preparation of LWMS to support revised local structure planning and future stages UWMP's	✓		
6. Review and approval of revised LWMS		✓	✓
7. Preparation of future stage UWMP's	✓		
8. Review and approval of future UWMP's		✓	✓

5. REFERENCES

JDA, 2019a. Provence: Footprint Lake Monitoring & Management

JDA, 2019b. Provence Local Water Management Strategy

JDA, 2021. Provence, Footprint (lluka) Lake: Harmful Algal Blooms Microcystis Aeruginosa Observations 25-26 May, 16 Jun, 14 Jul, 7 & 23 Sep, 1 Nov 2021 Summary Report.

JDA, 2022a. Provence, Footprint (lluka) Lake: Harmful Algal Blooms (Habs) Microcystis Aeruginosa Observations 25-26 May, 16 Jun, 14 Jul, 7 & 23 Sep, 1 & 30 Nov 2021, 10 Jan 2022 Summary Report.

JDA, 2022b. Provence, Footprint (lluka) Lake: Harmful Algal Blooms (Habs) Microcystis Aeruginosa Observations 25-26 May, 16 Jun, 14 Jul, 7 & 23 Sep, 1 & 30 Nov 2021, 10 Jan 2022, 22 Feb 2022 Summary Report.

Hyd2o, 2022a. Footprint (lluka) Lake Monitoring Report April 2022

Hyd2o, 2022b. Footprint (lluka) Lake Monitoring Report May 2022

Hyd2o, 2022c. Footprint (Iluka) Lake Monitoring Report June 2022

Hyd2o, 2022d. Footprint Lake: Assessment of Water Quality Management Options

WAPC, 2008. Better Urban Water Management

Should you have any queries, please do not hesitate to contact Sasha Martens of this office.

Yours sincerely,

Sasha Martens, Principal Engineering Hydrologist

Attached

Figure 1: Site Context Plan
Figure 2: Stormwater Management Context Plan

Attachment 1: Stage 1 Subdivision Plan
Attachment 2: Agency Responses to JDA (2019) LWMS
Attachment 3: Footprint Lake Management Options Report (Hyd2o, 2022d)
Attachment 4: Structure Plan Concept
Attachment 5: Indicative Staging Plan

This document is published in accordance with and subject to an agreement between Hyd2o and the Client for whom it has been prepared, and is restricted to those issues that have been raised by the Client in its engagement of Hyd2o. It has been prepared using the skill and care ordinarily exercised by hydrologists in the preparation of such documents.

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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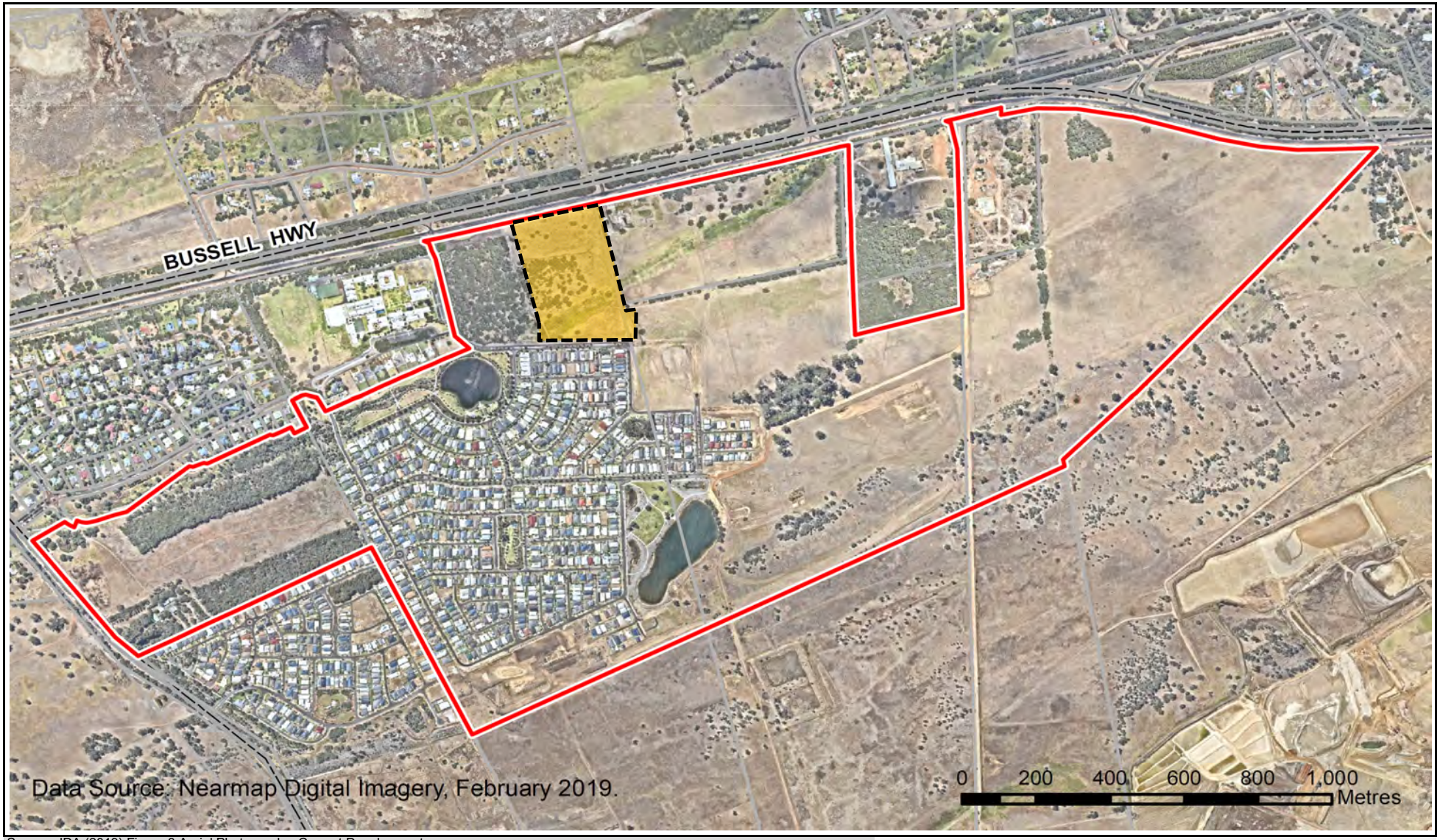
Figures

Date: 19/07/2022 Job No H22018



Source: JDA (2019) Figure 3 Aerial Photography, Current Development

Stage 1 Development Area

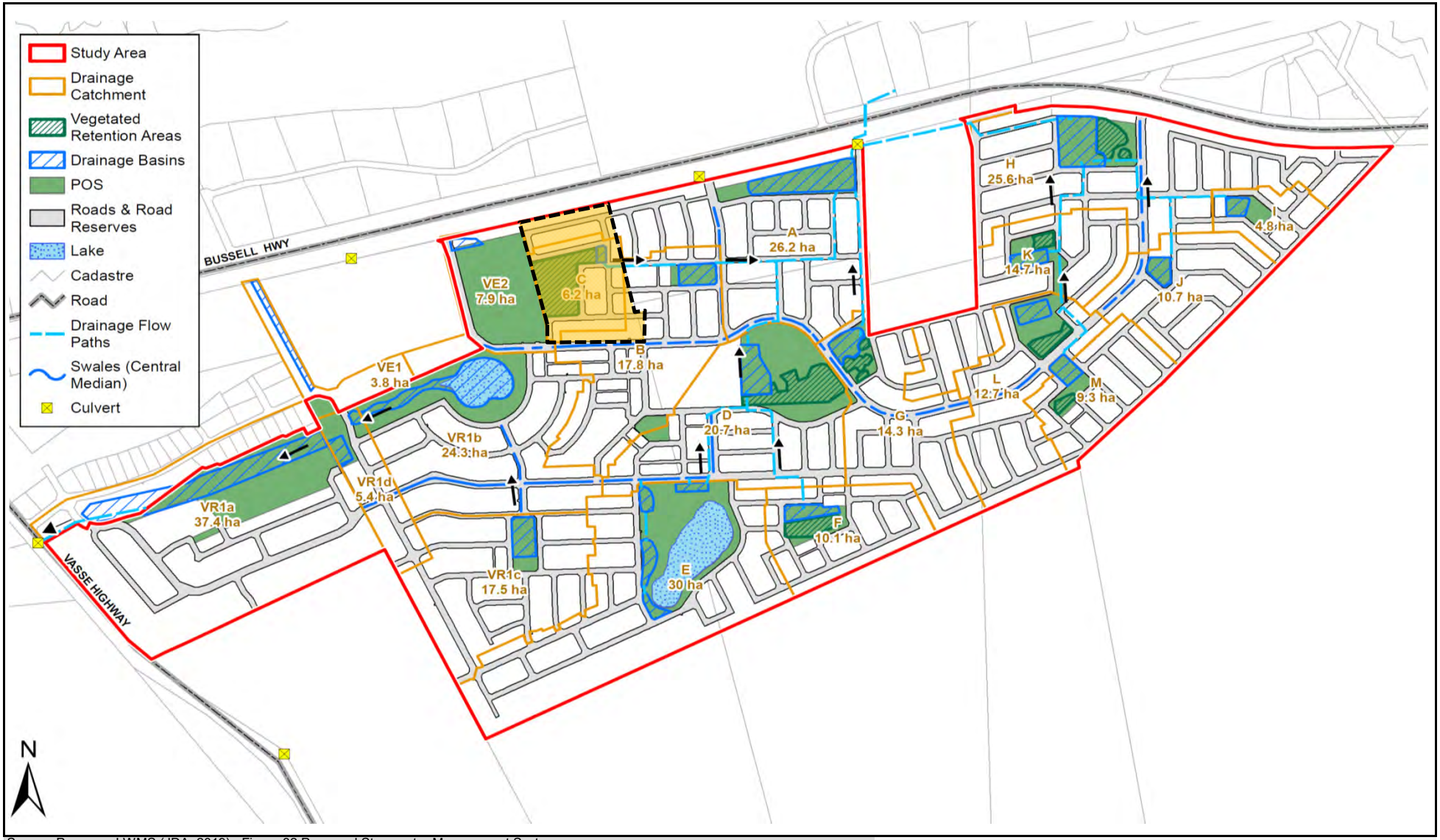
hyd$_2$o

Lot 9032 and 9034 Joseph Drive Yalyalup LWMS Addendum

Site Context Plan

Figure 1

Date: 19/07/2022 Job No H22018



Source: Provence LWMS (JDA, 2019) , Figure 32 Proposed Stormwater Management System

Stage 1 Development Area

hyd$_2$o

Lot 9032 and 9034 Joseph Drive Yalyalup LWMS Addendum

Stormwater Management Context Plan

Figure 2

Attachment 1
Stage 1 Subdivision Plan

LEGEND

TOTAL SITE AREA (9.5007ha)

TREES TO BE RETAINED WHERE POSSIBLE

TREES TO BE REMOVED

SERVICES

WATER

PIPE

SEWER

CONNECTION

GRAVITY PIPE

ELECTRICAL

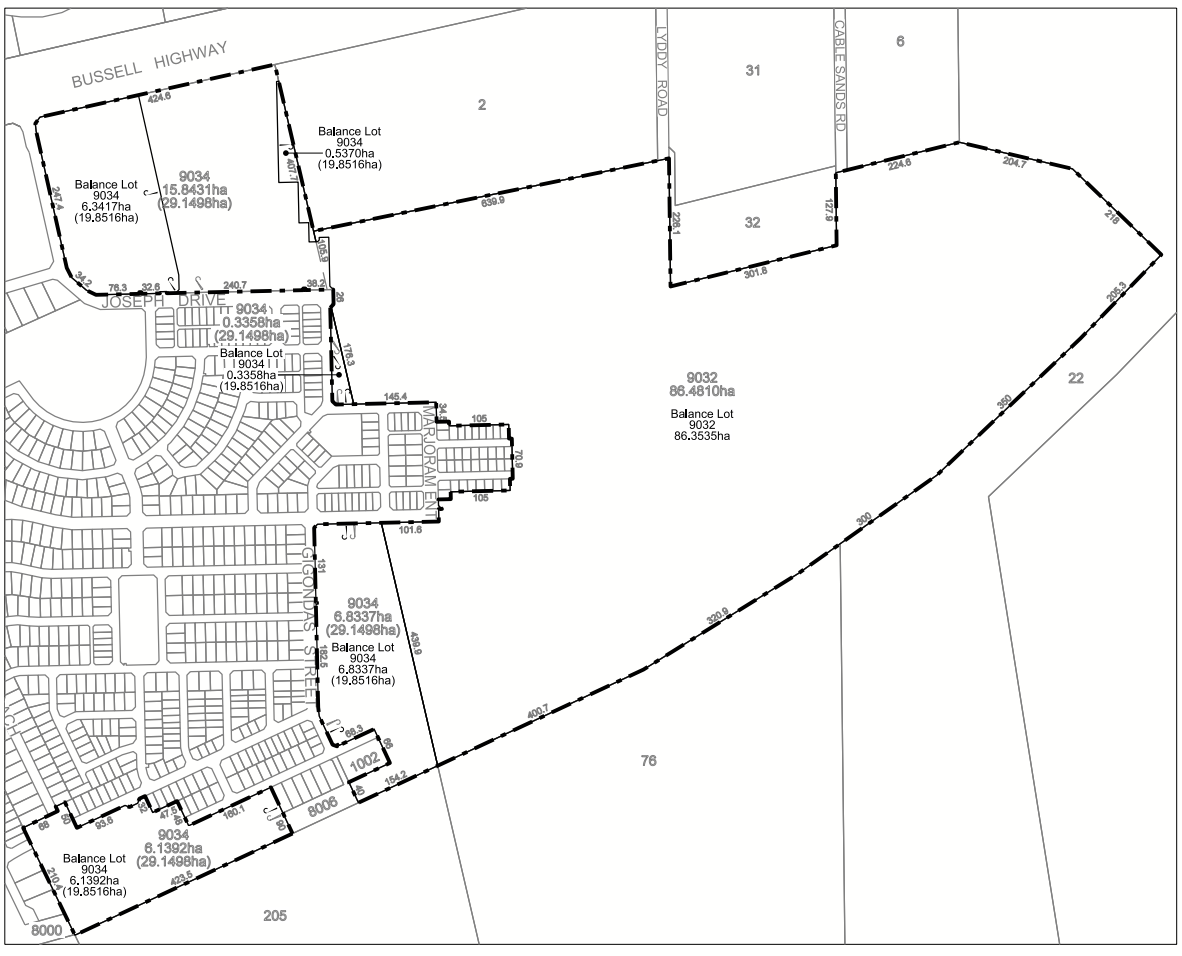
UNDERGROUND DISTRIBUTION LINE

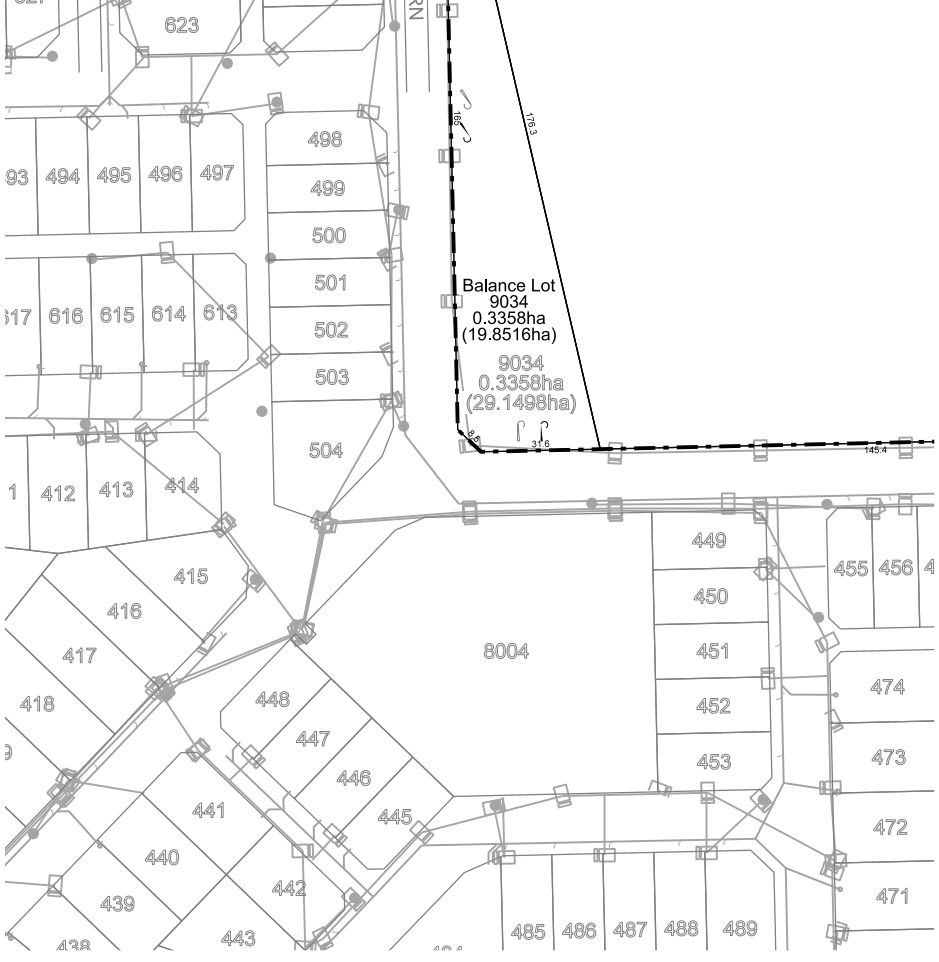
DISTRIBUTION POLE/LIGHT POLE/PILLAR

LOT SUMMARY

LOT YIELD			LOT AREA	
Size	No. Lots	% Total Lots	Average Size	% of Total Area
320m² - 449m²	10	13.89%	433m²	10.20%
450m² - 499m²	1	1.39%	459m²	1.08%
500m² - 549m²	19	26.39%	519m²	23.20%
550m² - 599m²	10	13.89%	581m²	13.68%
600m² - 699m²	17	23.61%	629m²	25.15%
700m² - 799m²	13	18.06%	746m²	22.81%
800m² - 899m²	2	2.78%	825m²	3.88%
Total Number of Lots	72			
Minimum Lot Size 424m² Maximum Lot Size 837m²			Average Lot Size 590m² Total Lot Area 42524m²	
Balance Lots	2			
Total Number of Lots	74			
Public Open Space	2			
Road & Lane Reserves	5			

OVERALL SUBDIVISION





Plan of Subdivision - Freehold

Lot 9032 & 9034 Joseph Drive, YALYALUP

A Yolk Property Group Project

DRAFT

plan: 22/010/008C
date: 9/06/2022
designed: ME
scale: 1:2000@A3
grid: BCG 94
checked: ME
0 20 40m
aerial: n/a
drawn: MH

Taylor Burrell Barnett Town Planning & Design
Level 7, 160 St Georges Terrace, Perth WA 6000
e: admin@tbbplanning.com.au
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Taylor Burrell Barnett

Attachment 2
Agency Responses to JDA(2019) LWMS

Government of Western Australia
Department of Water

Lot 9031 Joseph Drive Yalyalup LWMS Dec19 DWER & CoB comments

Approval Comments Tracking Spreadsheet

Departmwent of Water
SW Region
Bunbury WA 6231
Ph: 9726 4111

Location:	Lot 9031 Joseph Drive Yalyalup
LGA:	City of Busselton
Type:	LWMS (ref J6049g, 9/3/17)
Consultant:	JDA

	Date received (by DWER)	Comments Sent (by DWER)
Version 1	16/08/18	04/10/18
Version 2	14/01/20	17/02/20
Version 3		
Version 4		

No.	Page	Section	Version 1 - DWER Comments	Version 1 - JDA Response	Version 2 - DWER Comments
1	11	3.2	Discussion were held between the department, City and JDA in 2015 related to the constraints of the downstream system through Reinscourt (email attached). This area experiences yearly flooding and there is a need to ensure that the flood risk is not exacerbated. While the LWMS indicates that the off-site pre-development peak flood level will be maintained there is no discussion of the volume. Pre and post development flood hydrographs should be provided for each off-site discharge location with an analysis of the change in discharge (both flow rate and volume) to ascertain the risk of detrimentally impacting the flood regime of the downstream system.	Section 3.2 second paragraph (p11) has been revised to include flow volumes as well as rates. Reference has also been made to Reinscourt and previous discussions. Clarification regarding 'level' and 'rate' has also been made. LWMS has been revised to include pre and post hydrographs at each outlet from the study area, with a comparison of discharge volumes also provided to allow assessment of any potential impact on downstream systems.	OK
2	13	Table 3	While the statement that "Finished lot levels to be 0.3 m above the 1% AEP (100 year ARI) flood level" is technically correct it should be noted that this separation is for local stormwater TWLs and is not related to catchment flooding.	Text in Table 3 has been updated to refer to the local stormwater system for the 0.3m separation and catchment flooding for the 0.5m separation.	OK
3	23	5.8.2	Fifth para - there is no discussion of sea level rise and the impact this will have on flood levels. While the Vasse Wonnerup system is managed with a surge barrier the sea level rise as outlined in SPP 2.6 will impact on these inland water levels.	A discussion regarding sea level rise and possible impacts on flooding in the Vasse Wonnerup Estuary and Sabina River has been added as Section 5.8.5.	OK
4	23	5.8.2	Sixth para - reference should be made to discussion between the department, City and JDA in 2015 as detailed in comment 1.	Text will be added in Section 5.8.2 para 5.	OK
5	25	5.9	The EPP (Swan Coastal Plain Lakes) Policy was revoked in 2016.	Text was updated to remove reference to EPP Policy.	OK
6	27	6.1	The department does not generally support constructed lakes and therefore to enable a complete assessment of the proposal evidence should be provided as to how the criteria in the department's *Interim Position Statement: Constructed Lakes (2007)* are met. Of note being an unlined lake the water balance (including water supply) and nutrient management will be of particular relevance.	Section 6.7 Iluka Lake Management has been added as well as an assessment of the lake and inflows and outflows (Appendix M)	It is stated that management of Iluka Lake will be required. There is however no mention of this work in Sect 7.1 and agreement needs to be reached with the City in relation to timeframes for this work. See City of Busselton Comment 1 below.
7	28	6.2	Some of the assumptions provided in the whole of site water balance are not deemed appropriate. This includes: using long term rainfall (account should be taken of the recognised step down periods in the SW to determine an appropriate duration of historical data); the irrigation rate applied the department is 6,750kL/ha; for 500m2 lots it is highly unlikely that there will be many garden bores and the 10% is considered an overestimation; there is no reference to evaporation from the unlined lake. It is also unclear what the outputs of the water balance are intended to inform.	Water balance has been updated with recent rainfall averages, 6750kL/ha DWER irrigation rate and removal of garden bores. Lake evaporation has also been added. Additional text has also been added to Section 6.2.	OK
8	33	6.4.2	The runoff coefficients indicate that runoff from schools, Rural/Special Residential, Active and Passive POS are all substantially less that pre-development runoff for rural land (Sect 5.8.3). In addition the department does not support a continuing loss of 10mm/hr from residential lots. This is based on a single test of one house during periods of low groundwater. These parameters need to be justified and agreed to.	The runoff coefficients have been revised in consultation with DWER and CoB (emails 14/12/18 and 14/2/19). Table 8 in Section 6.4.2 contains the revised coefficients.	OK
9	36	6.5.2	In view that subdivision will start at the upstream end of the natural flow paths the control points in the downstream system must be defined to ensure that placing sub-soil at the indicated AAMGL will be effective. This is of particular interest for Sabina River subcatchment in view of the culverts under the Bussell Hwy and the braided and constrained flow path through Reinscourt, but should equally be considered for the Vasse Estuary and Vasse River subcatchments.	Longsections to the outlet have been prepared to address the issue of control levels and relative inverts of basins and subsoil drainage (Figures 36 to 40). Minimum pipe gradients present a significant control on basin invert levels.	It is unclear where the Design GWL in the long sections is referring to the controlled groundwater level, mounding between sub-soil pipes or uncontrolled post-development groundwater level? In all situations the design GWL is lower than the invert of the piped stormwater system, for areas where is it proposed that groundwater will be controlled via a sub-soil system (as per Fig 41) will these systems be completely seperate to the stormwater system? For all long sections the Design GWL is lower than the downstream control of the the road crossing culvert invert? Specifically for Figure 37: The design GWL at Basin A is 2.9 which is lower than the outfall control of the culvert of 3.1? Design GWL at Basin E is higher than the basin invert?

Government of Western Australia
Department of Water

Approval Comments Tracking Spreadsheet

Departmwent of Water
SW Region
Bunbury WA 6231
Ph: 9726 4111

Location:	Lot 9031 Joseph Drive Yalyalup
LGA:	City of Busselton
Type:	LWMS (ref J6049g, 9/3/17)
Consultant:	JDA

	Date received (by DWER)	Comments Sent (by DWER)
Version 1	16/08/18	04/10/18
Version 2	14/01/20	17/02/20
Version 3		
Version 4		

No.	Page	Section	Version 1 - DWER Comments	Version 1 - JDA Response	Version 2 - DWER Comments
10	36	6.6.1	While the methodology used in the current LWMS was previously adopted in the 2008 study, the methodology for assessing nutrient discharge from urban developments has since been improved. The department promotes the use of UNDO, and it is requested that UNDO is applied for this development. The water quality targets that have been set for other developments that discharge (both directly and indirectly but in close proximity) to the Vasse Wonnerup system are 0.3 kg/ha/yr for P and 2.7 kg/ha/yr for N.	Water quality modelling has been revised using UNDO, with updated results discussed in Section 6.6.5 and Appendix L.	Sect 6.6.5: The net load export for nitrogen (4.25kg/ha/yr) exceeds the target (2.7kg/ha/yr) from the Vasse River and Estuary Catchment. There is however no discussion to interrogate options to manage this. Table 12: The units are in kg/ha/yr and therefore the values for each catchment cannot be added to provide a total.
11	42	7.0	Due to the scale of the development and in view of comment 1 it is deemed appropriate to provide a staging plan and consideration of how temporary drainage will be provided to enable stormwater and groundwater drainage to operate, prior to downstream systems being fully developed. Post-development flood hydrographs at each stage boundary are required to set next the criteria for subsequent planning stages to ensure that there are no unintended cumulative impacts resulting from differing approaches being used for each subsequent stage.	An addition section (7.3) has been included to discuss staging, with Master Staging Plan included as Appendix N, and simplified version as Figure 43. Outflow hydrographs have been included in Appendix O.	Hydrograph's in Appendix O would benefit from having the total volume stated, as included in Figure 29.
12	42	Table 12	Other aspects that are worth including in the implementation table include construction of irrigation system, and the agreement to hand over of irrigation allocation when the responsibility for management is handed to the City. In addition it is assumed that the term Stormwater drainage includes groundwater drainage.	Text has been added to Table 14 (previously 12) to including irrigation. Section 7.4 has also been added.	OK
13	General		The document refers to pre-merger agency names and should be updated.	Agency names have been updated through the LWMS.	OK
14	General		The above comments need to be reviewed at the same time as reviewing LGA comments, if there are any conflicts in LGA and DWER comments it is expected that the consultant will mediate an agreed position.		n/a
No.	**Page**	**Section**	**Version 1 - CoB Comments**	**Version 1 - JDA Response**	**Version 2 - CoB Comments**
1	27	6.1	It is assumed that the Iluka lake is unlined. As outlined in the DoW comments above, management of nutrients entering the lake through groundwater exchange and stormwater will need to be considered to limit eutrophication	Section 6.7 Iluka Lake Management has been added as well as an assessment of the lake and inflows and outflows (Appendix M)	The City would prefer that the management strategy for the Iluka Lake is fully developed and costed before the LWMS is approved. This will need to include capital cost and ongoing maintenance and management cost that the City can expect to incur. The City would also like the option of lining the lake to be considered. Although it is understood that this will not eliminate the existing main source of TP inflow it may assist with other sources of TP should they become prevalent in the future.
2	31	6.4.1	It is understood that the testing on soakwells shows infiltration is not significantly influenced by a groundwater level at the base of the soakwell for sandy soils. Is this still applicable for the site and for groundwater levels above the base of the soakwell? The City requires a 300mm seperation between the base of soakwells and AAMGL/CGL to allow for uncertainty in estimates of the groundwater levels and the potential loss of storage volume within the soakwell due to higher groundwater levels should be considered.	The soakwell testing is considered to be applicable at the site based on shallow groundwater depth, soil types and shallow effective aquifer thinkness. It is noted that soakwell capacity should be based on the capacity above the groundwater table.	noted
3	32	6.5.2	It is understood that the stormwater basins identified in section 6.4.1 will be underlain by subsoil to aid infiltration and limit the potential for waterlogging and standing water. The control level on the groundwater system will then influence the ability of these basins to drain and the potential for standing water. As outlined in the DoW comments above, this control level needs to be considered in detail to ensure groundwater and stormwater systems can funtion as required.	Longsections to the outlet have been prepared to address the issue of control levels and relative inverts of basins and subsoil drainage (Figures 36 to 40). Minimum pipe gradients present a significant control on basin invert levels. The downstream constraints have been considered, to provide a downstream control level for the system. This level has then been used to set the subsoil invert and basin invert of Basin A, and from there the upstream system.	noted
4	Figure 7	Figures	Where is monitoring bore BA22 located?	BA22 has been added to Figure 7.	noted
5	Figure 23 & Figure 26	Figures	Comparison of Figure 23 and Figure 26 appears to show a change in the split of stormwater discharge to the different catchment post development. It would seem that pre-development the south and west of the site flows to the Vasse River with the the north and east flowing to the Sabina River. Post-development drainage catchments A-M (majority of the development area) appear to flow to the Sabina River with only a small portion in the west flowing to Vasse River. Further clarification on this is required as post development hydraulic regime will need to mimic pre-development	While this is correct, the LWMS is a revision to the existing Provence Water Management Plan (JDA, 2008). The western section of the Study Area is complete in the majority, and changing the flow directions at this stage is not possible using gravity drainage.	noted

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No.	Page	Section	Version 1 - DWER Comments	Version 1 - JDA Response	Version 2 - DWER Comments
6	Figure 30	Figures	Subsoil is shown under some but not all stormwater basins, please clarify why and how these basins are to drain if subsoil not included	The stormwater (and subsoil) system has been revised to ensure the system will have sufficient grade (minimum pipe grade) combined with setting a downstream level constraint. This redesign has resulted in most basins having increased separation to groundwater, such that subsoil to control waterlogging is no longer required. Figures 36 to 40 show longsections with separation to groundwater and Section 6.5 discusses groundwater management.	noted
6					There are a few queries in relation to the Footprint Lake Monitoring and Management Plan. The monitoring results suggest the primary source of TP in the lake is from inflow from the Yarragadee Aquifer through pumping from the bore feeding the lake. Can you please confirm why the inflow from the Yarragadee Aquifer has such a high concentration of TP. Can you also please confirm if there is a risk that TP will increase in the future, either through increases in the TP concentration in the Yarragadee Aquifer inflow and/or in increase TP from other inflows to the lake. Figure 7 Can you please confirm why FP01 and FP02 appear to have higher TP concentration that Yarra PB? Table 13, all items marked as TBA need to be addressed. In addition, the items marked as "See ILWMS" Please refer to sections of ILWMS where these have been addressed. It is felt that a number of these items are not sufficiently addressed in the ILWMS, which is why additional information and analysis was required in the LWMS.

Attachment 3
Footprint Lake Management Options Report
(Hyd2o,2020d)

07 July 2022

Your Ref:
Our Ref: H22018Bv2

Yolk Property Group
Level 2 Atwell Arcade
3 Cantonment St
Fremantle WA 6160
ATTENTION: Tao Bourton

Dear Tao,

FOOTPRINT LAKE: ASSESSMENT OF WATER QUALITY MANAGEMENT OPTIONS

As requested, please find below Hyd2o assessment of water quality management options for Footprint Lake located in Provence estate at East Busselton.

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. Blooms appear to predominately occur in the late summer/autumn period.

This report addresses the occurrence of these blooms and seeks to provide methods and recommendations to reduce the severity and frequency of these occurrences by using a range of best management practice techniques.

1. DESCRIPTION OF LAKE

Footprint Lake is an existing unlined lake repurposed from a mining void. The lake is currently used as part of the irrigation system for Provence estate, 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 (APL) 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.

Initially water from the Yarragadee was sourced for the lake from an old mining bore located approximately 350 m south of the lake. This bore was 200 m deep and screened for its lower 100 m. This bore was replaced in 2016 adjacent to the southern boundary of the lake. The bore was constructed to similar depth, but screened for the lower 40 m only.

2. WATER QUALITY IMPACTS ON ALGAL GROWTH

Algal blooms are the result of nutrients in a water body 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.

The JDA (2019) monitoring and nutrient balance results are summarised below with mean results presented in Table 1.

- 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.
- 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.

Hyd2o is aware that previous testing of the original Yarragadee bore prior to its redrill reported significantly lower Phosphorous concentrations than those for the new bore and those of the superficial aquifer and lake water quality.

Reasons for this increase are not fully understood, however it is considered possible this is due to the new screen depth being slotted in a narrower aquifer zone of grey sands amongst areas of black shale.

Phosphorus mobilisation into soils and groundwater is a function of rock weathering (Griffith, 1977) and the drainage of groundwater through rock can facilitate chemical weathering releasing phosphorus into the groundwater (Rempe and Dietrich, 2014). Black shales have a high phosphorus concentration (Porder & Ramachandran, 2012) and are considered susceptible to chemical weathering (Parviainen & Loukola-Ruskeeniemi, 2019).

Table 1: Mean Nutrient Water Quality Summary (JDA, 2019)

Param	ANZECC (2000)	Shallow Lake Water Quality			Deep Lake Water Quality		Superficial Bores Around Lake				Bore
		FPL1	FPL2	FPL3	FPL1	FPL2	FP01	FP02	FP03	FP04	YPB
TN (mg/L)	1.20	0.83	0.90	-	1.34	0.93	0.20	0.30	0.27	0.23	0.27
TP (mg/L)	0.065	0.090	0.087	0.390	0.173	0.097	0.437	0.707	0.377	0.367	0.457
PO_4-P (mg/L)	0.040	0.015	0.018	0.077	0.036	0.010	0.194	0.720	0.173	0.138	0.147

3. OPTIONS FOR IMPROVED LAKE WATER QUALITY MANAGEMENT

Based on information summarised in previous section of this report and further algae monitoring of the lake undertaken between 2021 and 2022, a range of potential options for lake management and water quality improvement are summarised in Table 2.

Based on the JDA (2019) water balance findings, lining of the lake to limit shallow groundwater inflow (2% of annual flow to the lake) is not considered a cost effective or viable option for water quality improvement.

Table 2: Algae Lake Management 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 the 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.

Approach	Description	Key Outcomes and Considerations
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
Yarragadee bore water quality performance review	Extract water from a different lower nutrient area of the aquifer.	• Adjustment of pump height and/or bore screen (if possible) to improve water quality outcomes from the aquifer. • Possible decrease in nutrient discharge into the lake.
Implementation of Stormwater Lot Connections	Apply lot connections to new development areas in proximity to the lake to transfer low nutrient roof runoff into the lake	• Modify the existing water balance of the lake by introducing better quality runoff. • Likely to be a secondary effect on overall nutrient balance of lake given volumes from other inflow sources. • Need to confirm availability of lake to received additional stormwater via modelling for future stages.

4. RECOMMENDED APPROACH

Algal blooms have occurred historically in Footprint Lake in the late summer/autumn period, including prior to urban development before water from the Yarragadee Aquifer was transferred into the lake. Based on the above assessment Hyd2o recommends a

combined approach of various measures be implemented to improve water quality management at the lake targeting the key drivers for algae growth.

Measures are proposed to be implemented in a staged approach with monitoring outcomes to be used to assess the performance of individual measures and the need for further stages and additional measures as development proceeds.

STAGE 1

- Use of a bed diffuser type aerator to reduce stratification and improve mixing. A fountain is also recommended in addition given the size of the lake and its visible presence as a water quality control measure. A proposal prepared by LD Total for the supply and instalment of aerators at Footprint Lake is contained as Attachment A. This proposal allows for two floating and one submersible unit, with the proposed models understood to have been used within the City of Busselton at other locations. With respect to installation timing it is acknowledged these devices cannot be installed during an active bloom, and installation will be required to be timed accordingly.
- Future stages to implement (where possible) lot connections for development in proximity to the lake to direct discharge low nutrient roof runoff into the lake.

STAGE 2

- Implement increased vegetation along the banks of the lake where shallow, stagnant exposed water areas currently exist. This will reduce temperature and light exposure in these areas, and increase nutrient uptake.

STAGE 3

- Further investigate the water quality performance of the current Yarragadee bore and seek opportunities to improve the quality of water abstracted via pumping from an alternative area/strata of the aquifer.

STAGE 4

- Consider implementation of a recirculating biofiltration swale system with high PRI media materials to treat and manage both nutrient levels within the existing lake and the nutrient levels of future inflow. This would be implemented in areas of POS adjacent to the lake not yet landscaped.

Monitoring is currently being undertaken monthly to monitor and manage algal blooms within the lake with continuation until lake water quality is classified as a green level surveillance as per NHMRC (2008). The measures detailed above are considered a best practice management approach to achieve this outcome.

5. REFERENCES

Australia and New Zealand Environmental and Conservation Council (ANZECC), 2000. National Water Quality Management Strategy: Australia and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Department of Water, 2009. Busselton–Capel Groundwater Area Subarea Reference Sheets, Plan companion for the South West groundwater areas allocation plan

Griffith, 1977. Phosphorus, A Key to Life on the Primitive Earth

JDA, 2019. Provence: Footprint Lake Monitoring & Management

JDA, 2021. Provence, Footprint (Iluka) Lake: Harmful Algal Blooms Microcystis Aeruginosa Observations 25-26 May, 16 Jun, 14 Jul, 7 & 23 Sep, 1 Nov 2021 Summary Report.

JDA, 2022a. Provence, Footprint (Iluka) Lake: Harmful Algal Blooms (Habs) Microcystis Aeruginosa Observations 25-26 May, 16 Jun, 14 Jul, 7 & 23 Sep, 1 & 30 Nov 2021, 10 Jan 2022 Summary Report.

JDA, 2022b. Provence, Footprint (Iluka) Lake: Harmful Algal Blooms (Habs) Microcystis Aeruginosa Observations 25-26 May, 16 Jun, 14 Jul, 7 & 23 Sep, 1 & 30 Nov 2021, 10 Jan 2022, 22 Feb 2022 Summary Report.

Landgate, 2022. Landgate Map Viewer Plus (Online)

National Health and Medical Research Council (NHMRC), 2008. Guidelines for Managing Risks in Recreational Water.

Porder & Ramachandran, 2012. The phosphorus concentration of common rocks—a potential driver of ecosystem P status

Parviainen & Loukola-Ruskeeniemi, 2019. Environmental impact of mineralised black shales

Rempe and Dietrich, 2014. A bottom-up control on fresh-bedrock topography under landscapes.

Should you have any queries, please do not hesitate to contact Sasha Martens or Georgia Ross of this office.

Yours sincerely,

Sasha Martens

Principal Engineering Hydrologist

This document is published in accordance with and subject to an agreement between Hyd2o and the Client for whom it has been prepared, and is restricted to those issues that have been raised by the Client in its engagement of Hyd2o. It has been prepared using the skill and care ordinarily exercised by hydrologists in the preparation of such documents. 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. Any person or organisation that relies on or uses the document for purposes or reasons other than those agreed by Hyd2o and the Client does so entirely at their own risk. Hyd2o denies all liability in tort, contract or otherwise for any loss, damage or injury of any kind whatsoever (whether in negligence or otherwise) that may be suffered as a consequence of relying on this document for any purpose other than that agreed with the Client.

ATTACHMENT A
LD Total Aerator Proposal

SANPOINT PTY LTD ACN 052 314 682

ABN 62 052 314 682

SOUTH WEST OFFICE

7 Mason Street Bunbury WA 6230

Phone (08) 9725 6555

TO:	Yolk Property	**EMAIL**	tao@yolkpropertygroup.com.au
ATTENTION:	Tao Burton	**DATE:**	16/5/22
FROM:	Pauline Dillon	**OUR REF:**	
SUBJECT	FOOTPRINT LAKE AERTORS (PROVENCE)		

Please see below options and estimated costs for Aeration of the Footprint Lake in Provence. The lake should also be treated with a biological agent to help. The recommendations have been to install two surface Aerators one at each end and a sub-surface aerator in the middle at the deepest point.

Please note that the above surface aerators cannot be used while there is a toxic algal outbreak as it will disperse it into the air

The southern electrical connection is straight forward as the power is close to the bank of the dam.
It is hoped with the northern connection we can run cable from the roadside power to the dam bank using an existing conduit. If this is not possible a new conduit will need to be installed and will be priced accordingly

Qty	Description	Rate	Total
2	5hp 3ph Airolator Carnival surface aerator. Incl 316SS motor, control box w/motor protection, cable and float.	$12,285.00	$24,570.00
2	Install Aerators	$ 1,440.00	$ 2,880.00
1	Southern electrical works	$ 1,950.00	$ 1,950.00
1	Northern Electrical works (using existing conduit)	$ 3,550.00	$ 3,550.00
1	Submersible Compressor Aerator	$16,750.00	$16,750.00
1	Install Aerator	$ 1,440.00	$ 1,440.00
1	Electrical works	$ 1,250.00	$ 1,250.00
1	Biostim Powder (20kg) ea	$ 1,350.00	$ 1,350.00
	Preliminaries/Insurances/Supervision/Mobilisation/ Administration	$ 2,000.00	$ 2,000.00
		TOTAL	**$55,740.00**
		GST	**$ 5,574.00**
		TOTAL	**$61,314.00**

SANPOINT PTY LTD ACN 052 314 682

ABN 62 052 314 682

SOUTH WEST OFFICE

7 Mason Street Bunbury WA 6230

Phone (08) 9725 6555

If you have any further queries, please don't hesitate to call.

Regards

Pauline Dillon
South West Manager
LD TOTAL

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.

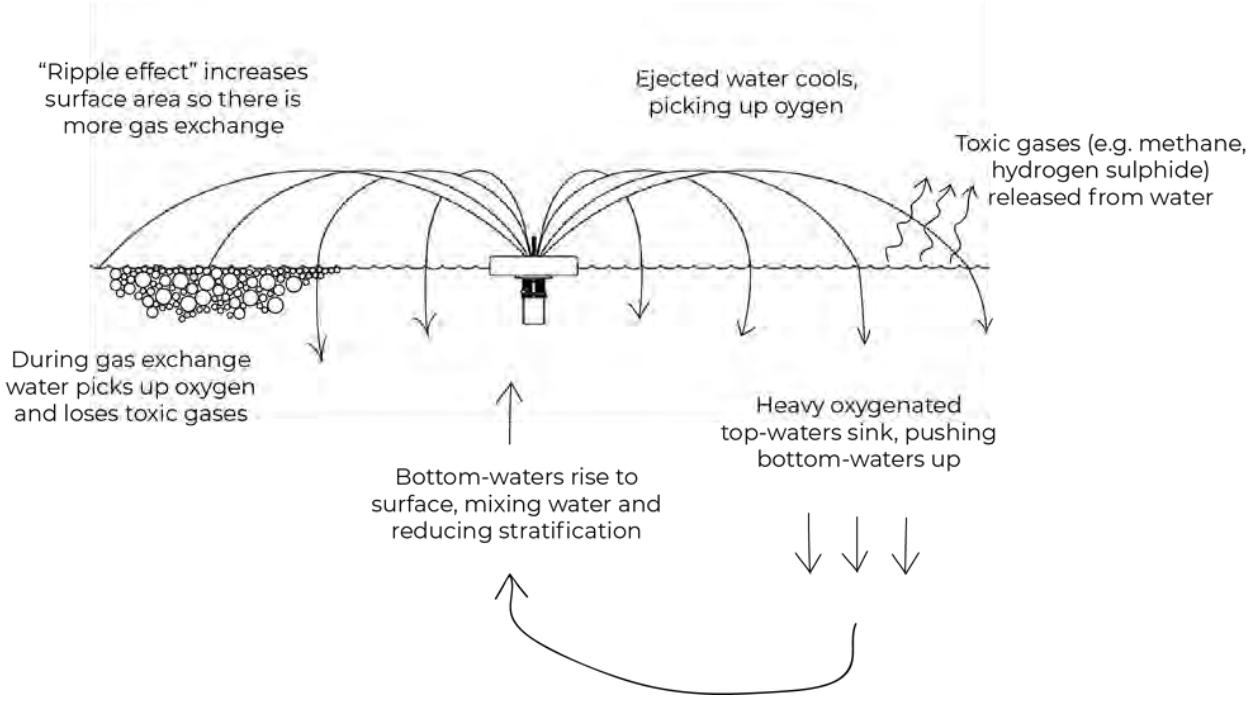
HIGHLIGHTS

- 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

WATCH IT IN ACTION

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

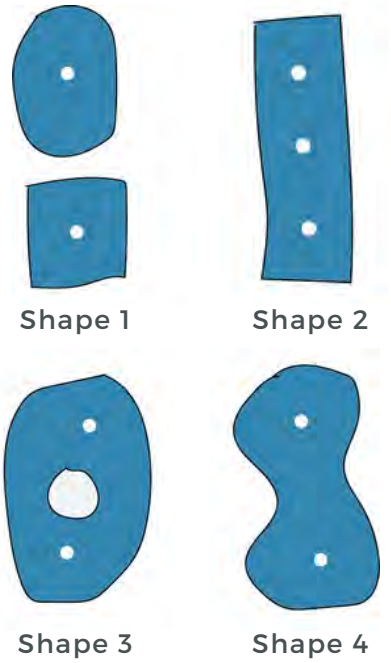
† Based on ideal dam shape and water conditions, results may differ

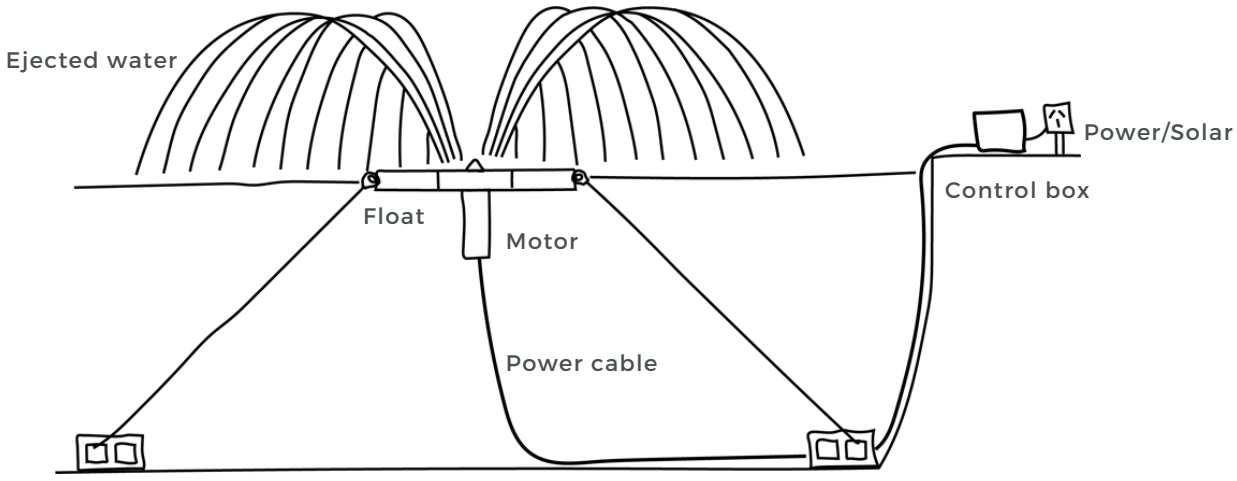
* Approximations based on conversions from US 60Hz equipment

‡ 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.



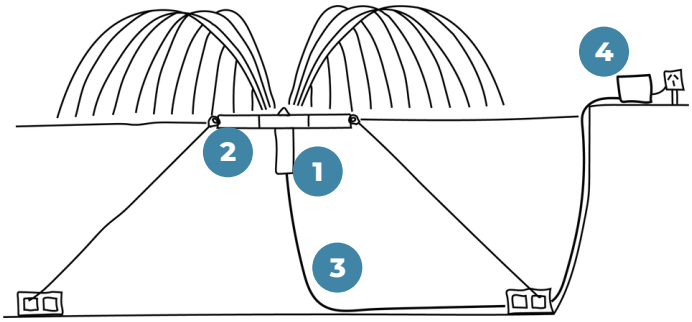


Concrete anchors (not included).
You can also anchor to the shore.

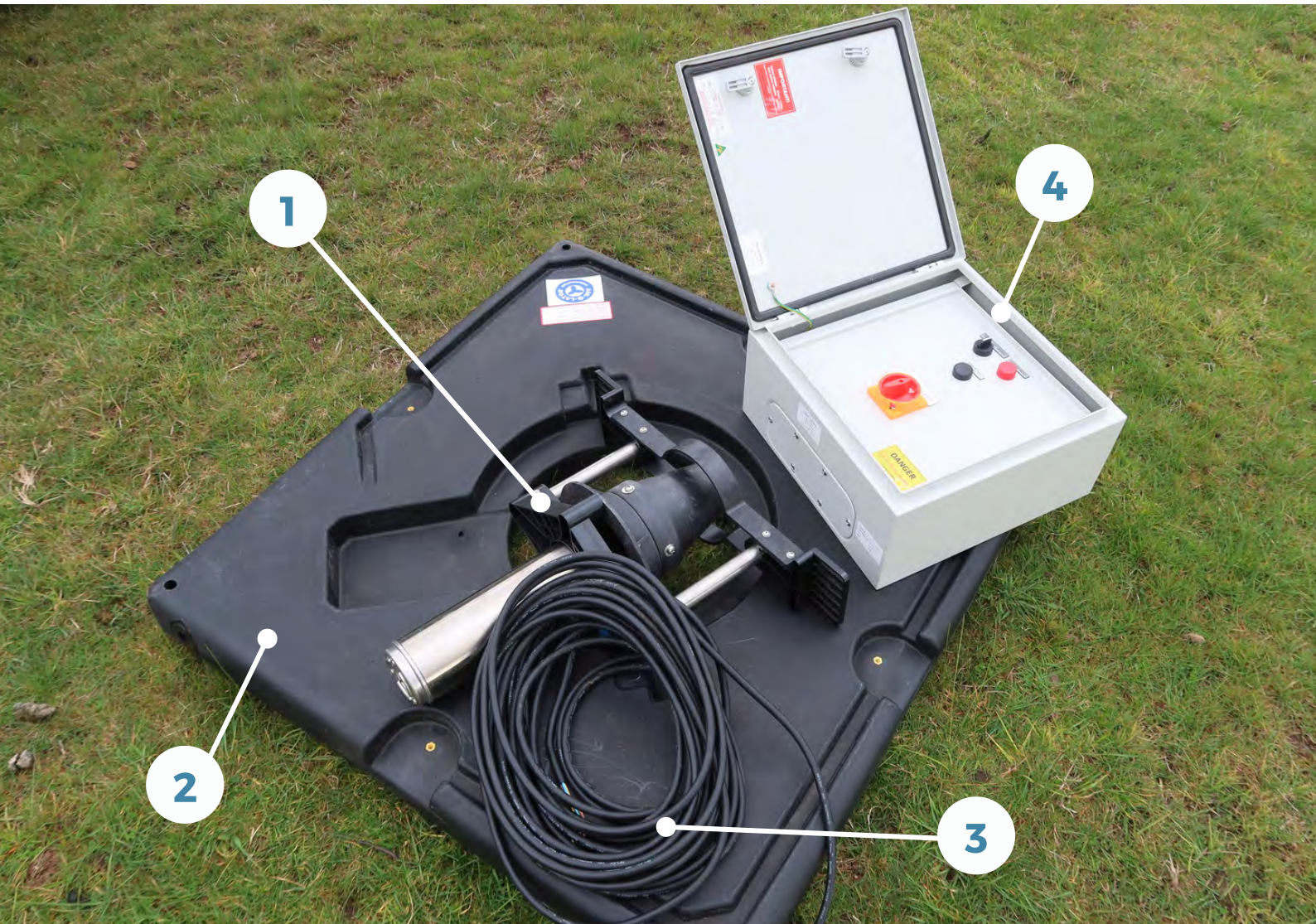
KIT 1

MAINS-POWERED

¾hp / 1hp / 2hp / 3hp / 5hp



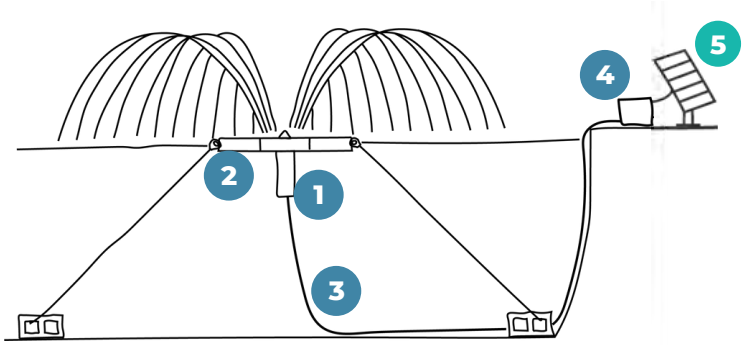
1. 1-phase / 3-phase 316 grade stainless steel motor and fountain nozzle
2. 40 inch square float
3. 40m cable (custom lengths available)
4. Lockable control box with under/over voltage & current protection and surge & overload protection, plus timer and automatic/manual selector switch



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

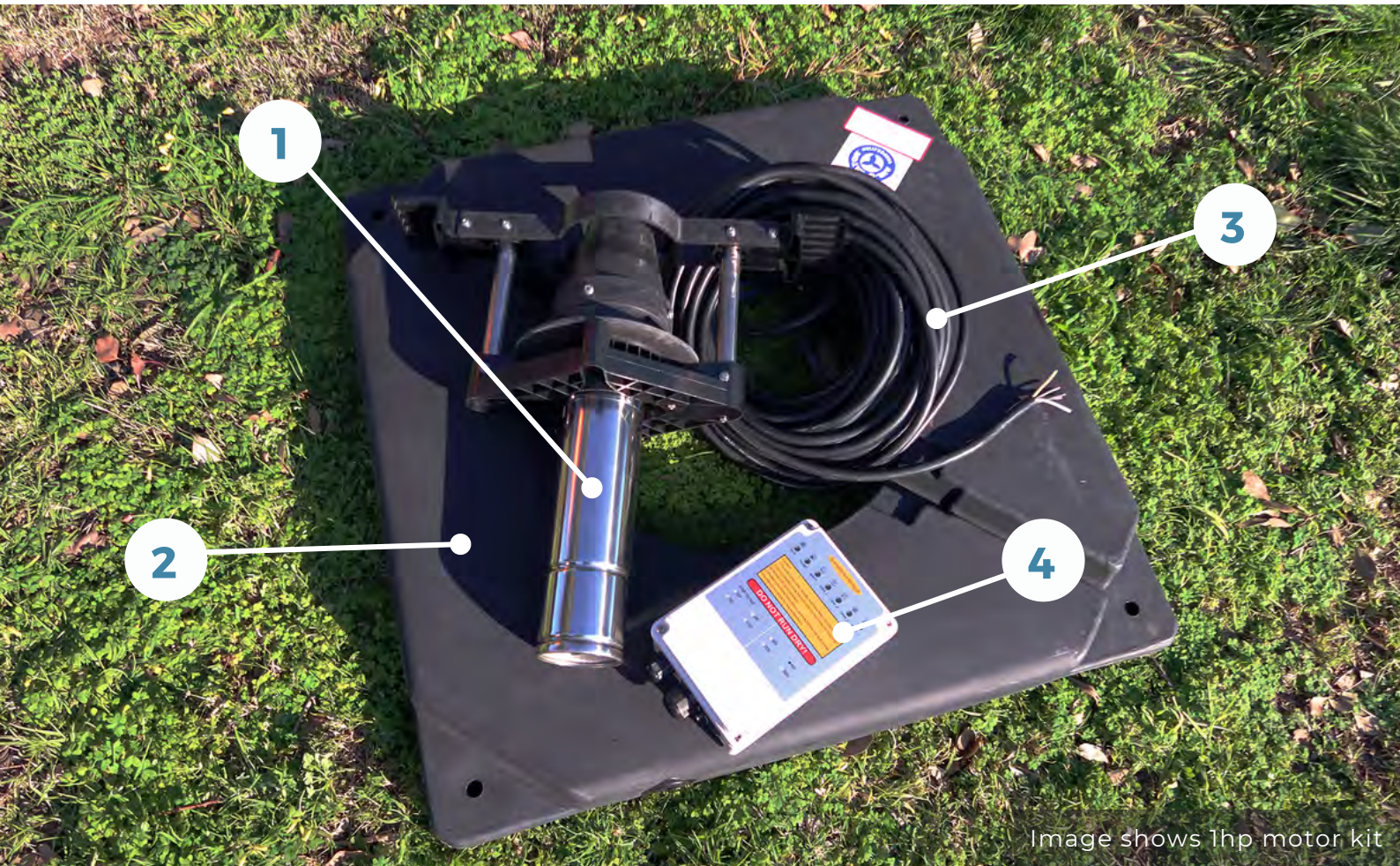


Image shows 1hp motor kit

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

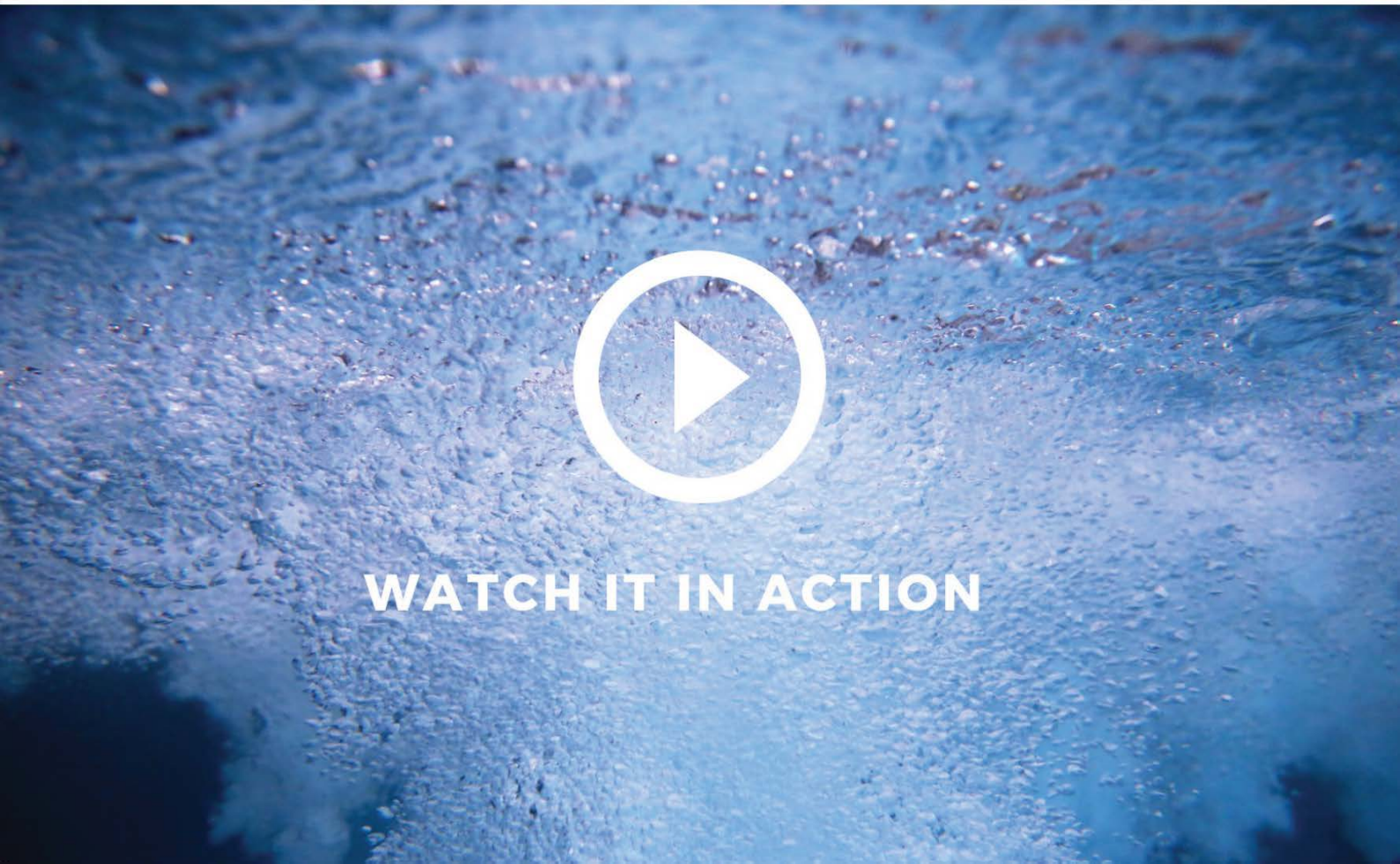
MATALA

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
Depth 2.5-3.5m		½ acre	1½ acres	2 acres
Depth 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

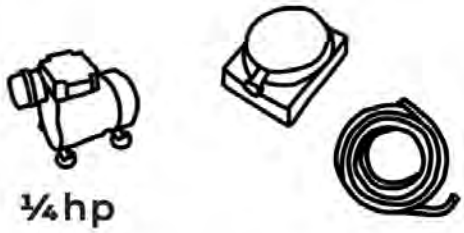
TWIN-DISC AIR-STATION

WEIGHTED HOSE (30M)

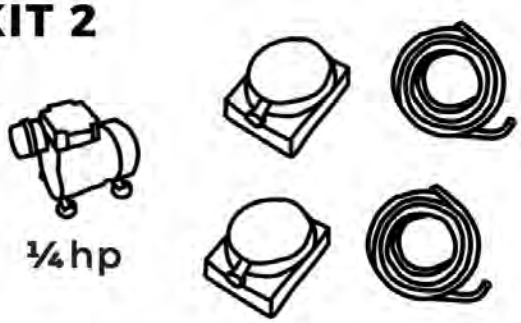
KITS

Below is an overview of our Matala Rocking Piston kits.
See next pages for a detailed list of items in each kit.

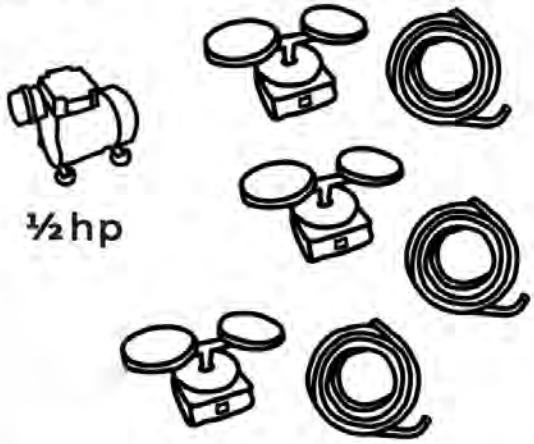
KIT 1



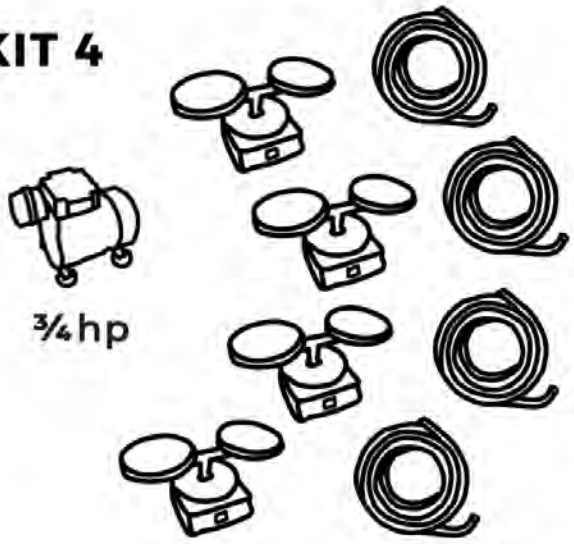
KIT 2



KIT 3

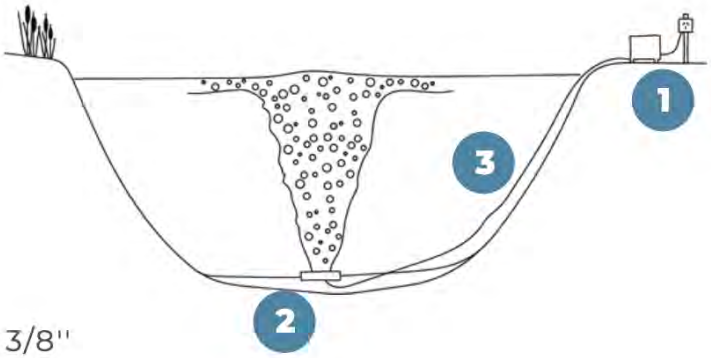


KIT 4



KIT 1

¼hp

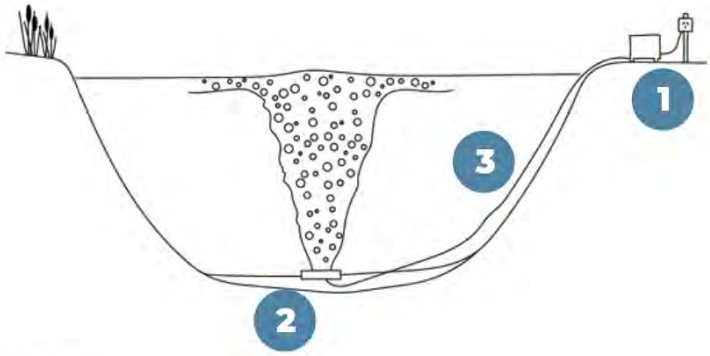


1. ¼hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 1 x single-disc Matala air-station
3. 1 x 30m roll Matala weighted air hose 3/8'' (custom lengths available)

Plus clamps and fittings

KIT 2

¼hp

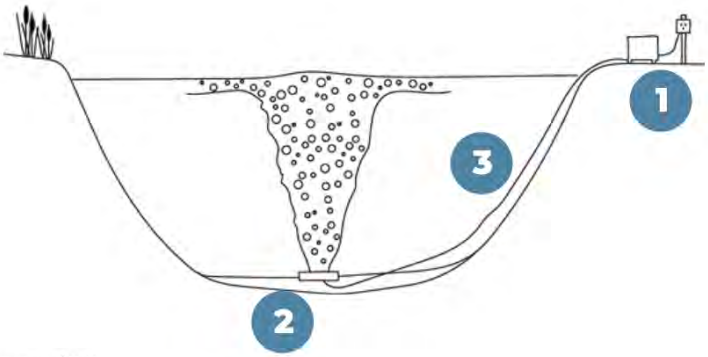


1. ¼hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 2 x single-disc Matala air-stations
3. 2 x 30m rolls Matala weighted air hose 3/8" (custom lengths available)

Plus clamps and fittings

KIT 3

½hp

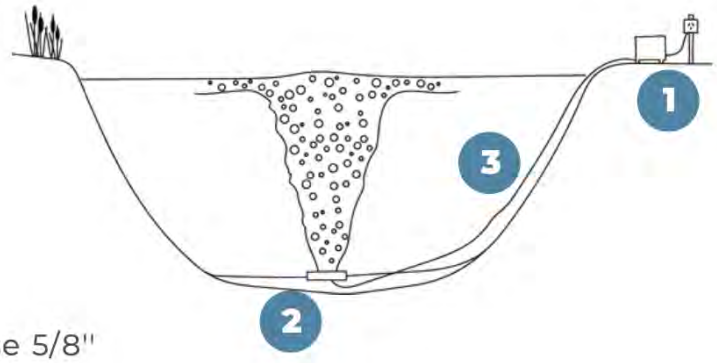


1. ½hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 3 x twin-disc Matala air-stations
3. 3 x 30m rolls Matala weighted air hose 1/2" (custom lengths available)

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

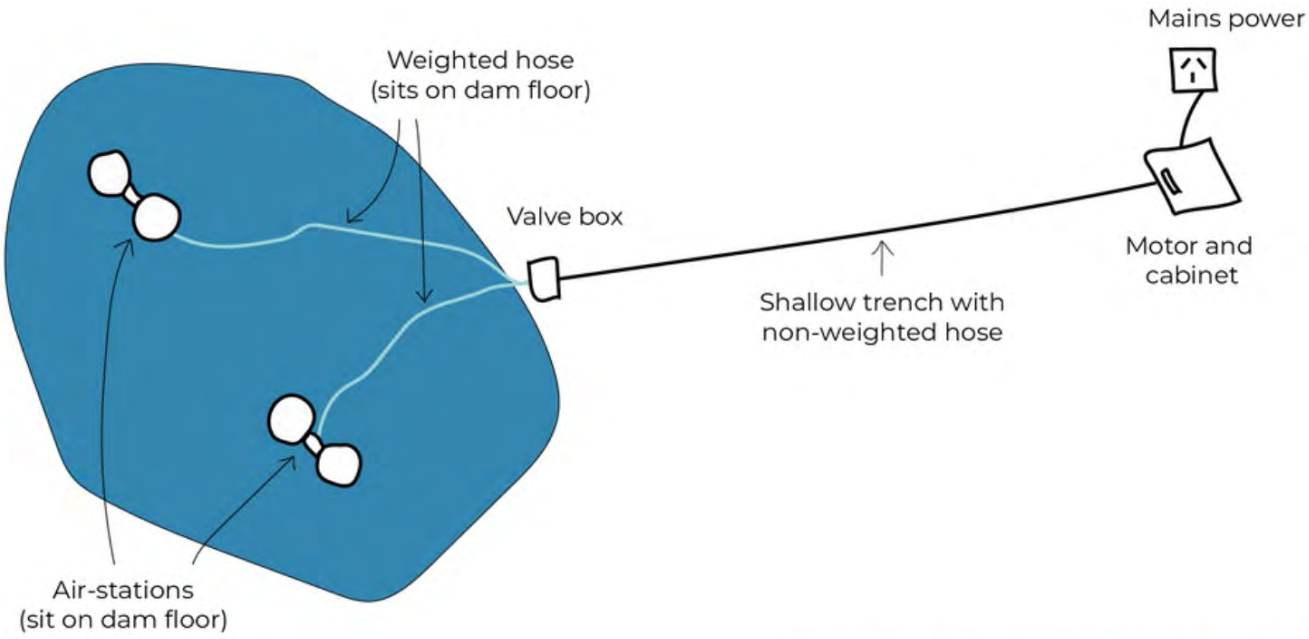
- Heavy-duty rocking piston motor
- Built from lightweight aluminium
- Oil-free, non-lube piston and cylinder
- Permanently lubricated bearings
- Cylinder hard-coated for wear resistance
- Smooth, low vibration operation

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.

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

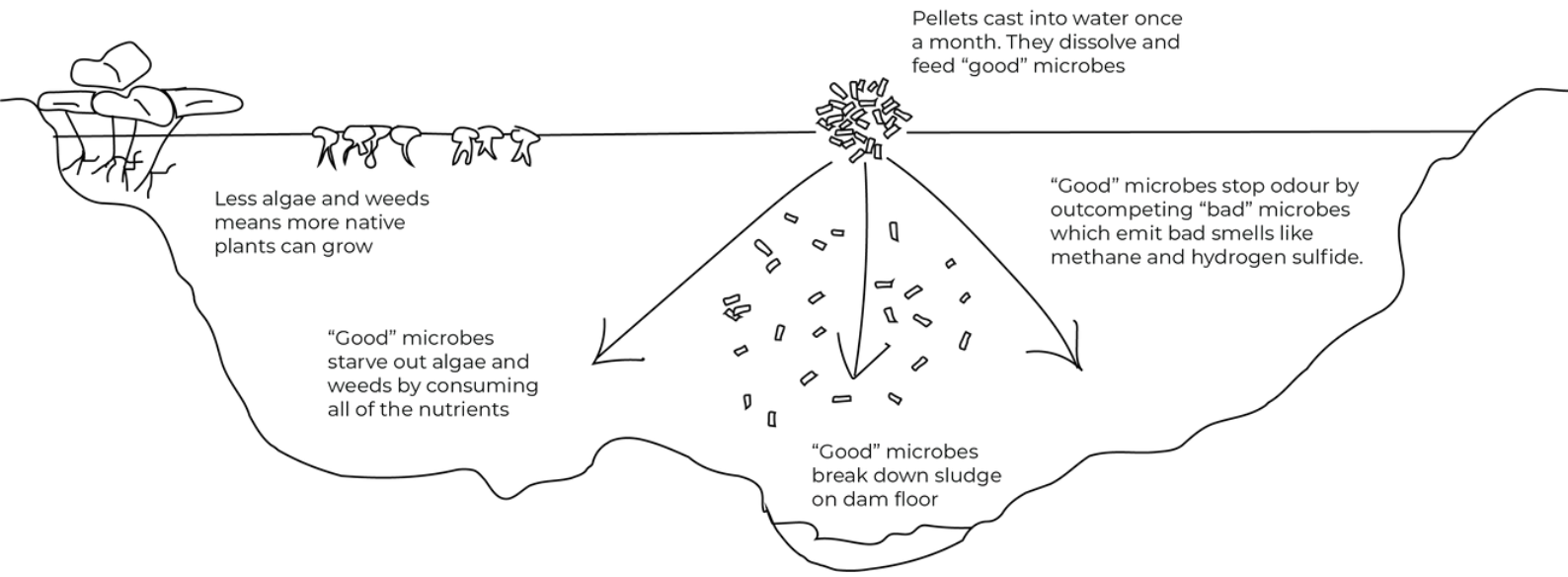
BIOLOGICAL STIMULANT
100% NATURAL

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.

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

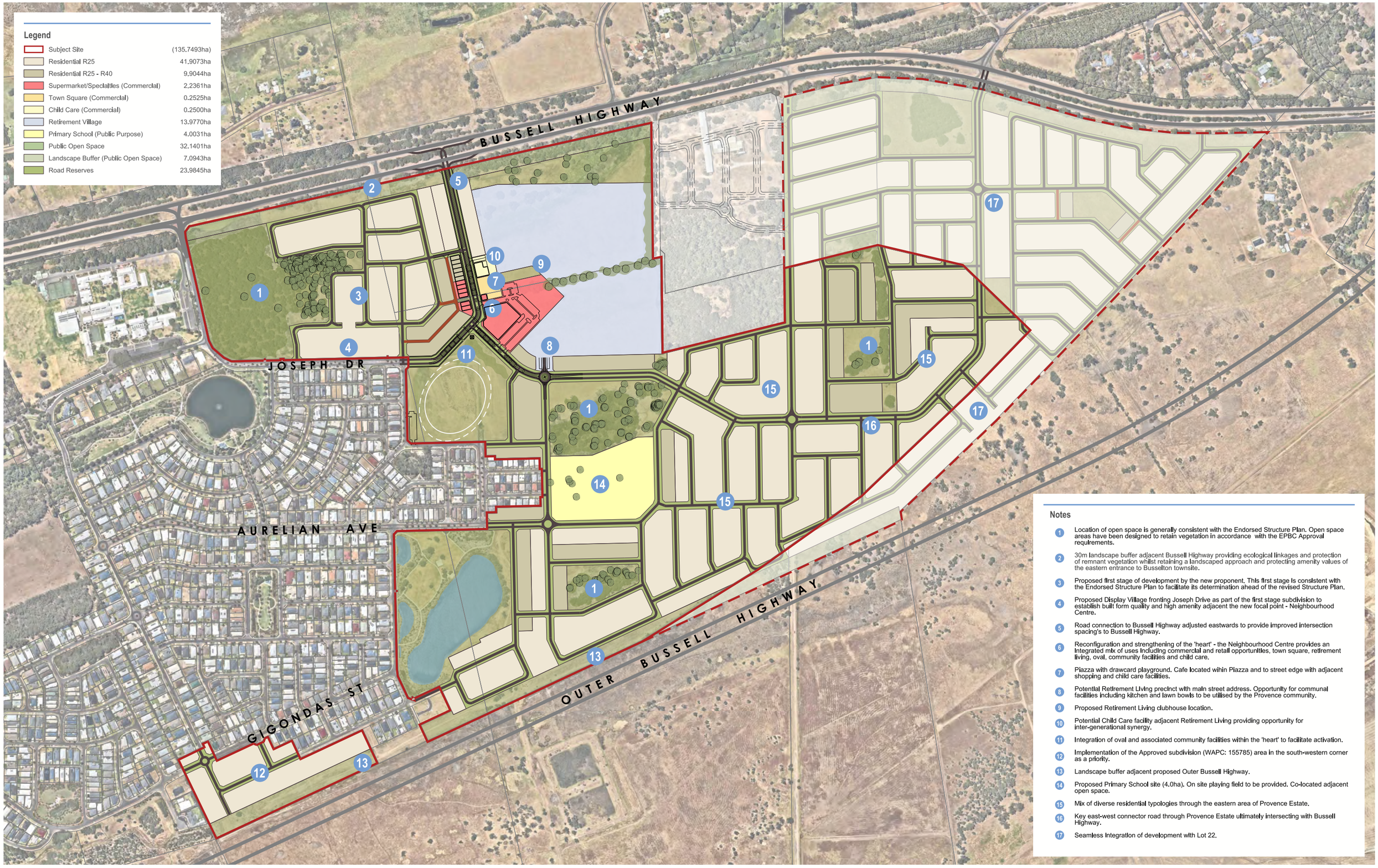
"We had an urgent problem—our old irrigation system had blockages from weeds. Our dam was also riddled with black sludge. Scott recommended both aeration and Biostim and within six weeks the dam became so clear I could see to the bottom of it! I was chuffed we could fix the issue without the use of chemicals."

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

Attachment 4
Structure Plan Concept



Legend

Subject Site	(135.7493ha)
Residential R25	41.9073ha
Residential R25 - R40	9.9044ha
Supermarket/Specialties (Commercial)	2.2361ha
Town Square (Commercial)	0.2525ha
Child Care (Commercial)	0.2500ha
Retirement Village	13.9770ha
Primary School (Public Purpose)	4.0031ha
Public Open Space	32.1401ha
Landscape Buffer (Public Open Space)	7.0943ha
Road Reserves	23.9845ha

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

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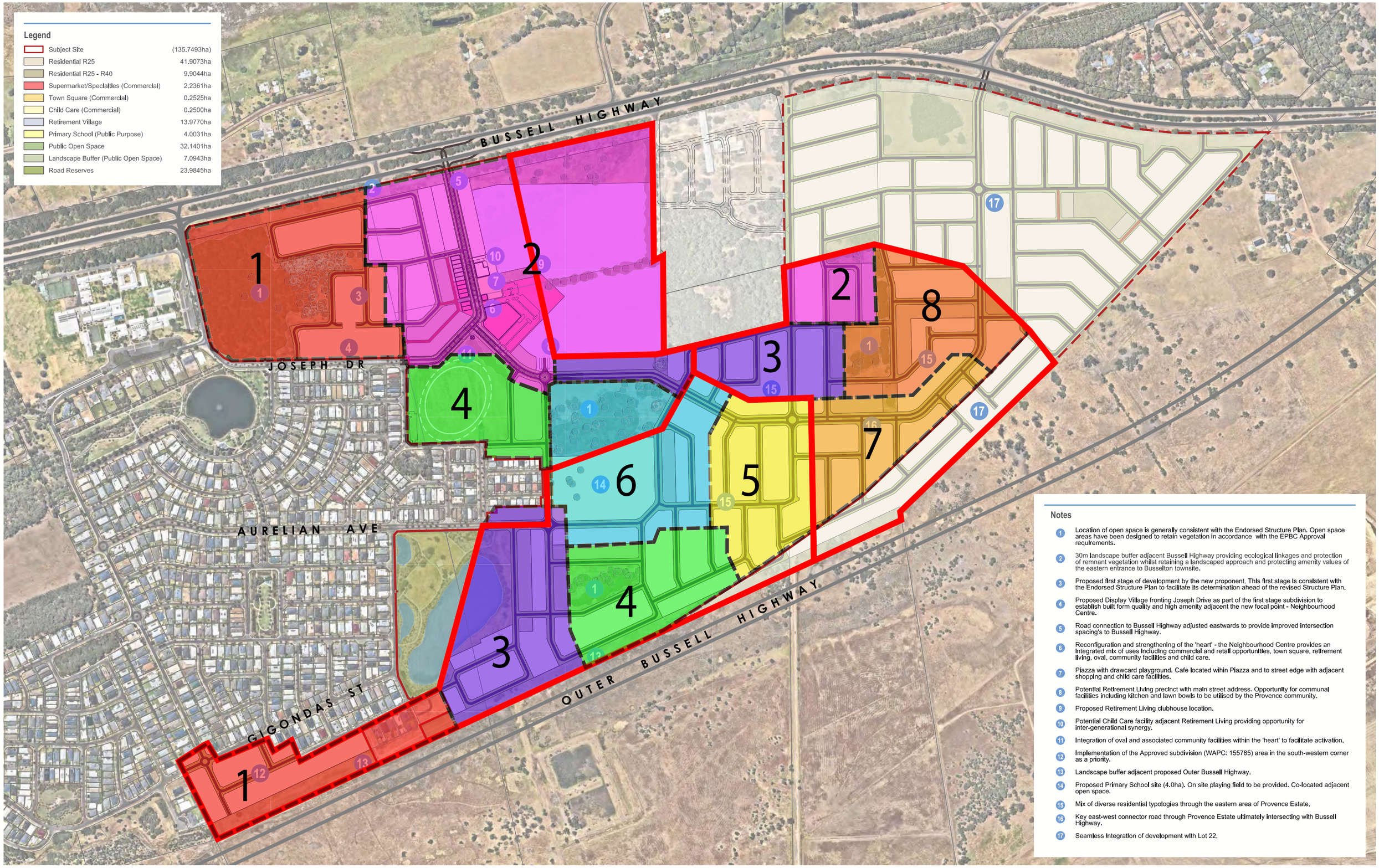
Attachment 5
Indicative Staging Plan



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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

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1. REVIEW OF PREVIOUS LWMS (JDA, 2019) AGENCY RESPONSES

A copy of the remaining issues from DWER and City of Busselton on the JDA (LWMS) as provided by DWER are detailed in Attachment 2. These issues are reviewed and summarised in Table 1 in the context of how each issue relates to the Stage 1 area, and when and how the issue will be addressed in the planning process.

In summary, Table 1 demonstrates the Stage 1 area can be developed based on the existing LWMS, with the remaining issues addressed and documented via the Stage 1 Urban Water Management Plan (UWMP) and revised LSP LWMS.

Note that with respect to Footprint (Iluka) Lake, Hyd2o have recently prepared a report detailing an assessment of water quality management options. The report summarises the periodic occurrence of algae blooms in the lake including prior to urban development, and seeks to provide methods to reduce the severity and frequency of these occurrences by using a range of best management practice techniques.

Table 1: Summary of JDA (2019) Outstanding Issues

Issue	Required to Inform Stage 1	Comment/Response
DWER Comments		
It is stated that management of Iluka Lake will be required. There is however no mention of this work in Sect 7.1 and agreement needs to be reached with the City in relation to timeframes for this work.	No	The Stage 1 area is separate to Footprint Lake and no stormwater from the area flows to the lake. The groundwater flow from the Stage 1 area is also in a northern direction away from Footprint Lake. Hyd2o have recently prepared an assessment of water quality management options for the lake (Hyd2o, 2022d) which has been forwarded to agencies for review. It is anticipated the report, its findings, and any review amendments will be included as part of the revised LSP LWMS.
It is unclear where the Design GWL in the long sections is referring to the controlled groundwater level, mounding between sub-soil pipes or uncontrolled post-development groundwater level? In all situations the design GWL is lower than the invert of the piped stormwater system, for areas where is it proposed that groundwater will be controlled via a sub-soil system (as per Fig 41) will these systems be completely separate to the stormwater system? For all long sections the Design GWL is lower than the downstream control of the road crossing culvert invert? Specifically for Figure 37: The design GWL at Basin A is 2.9 which is lower than the outfall control of the culvert of 3.1? Design GWL at Basin E is higher than the basin invert?	No	Hyd2o understand the design GWL on the JDA long sections represents a variety of different groundwater levels and/or controls depending on location. For example at a storage which requires subsoil, the design GWL will be the level of subsoil under the storage. In other areas, it may represent an uncontrolled AAMGL. Regarding subsoil control, Hyd2o understand these will flow into a storage and be treated in biofilters before discharge. Subsoil control pipes under storages are not shown on the long sections hence design GWLs appear below pipes. Text and information in the revised LWMS will be updated to avoid confusion. Re the design GWL this is 0.1m lower that the downstream control of the road crossing culvert invert on the JDA sections. This should only occur if the AAMGL at these locations is below the crossing level. Hyd2o will revise this

Issue	Required to Inform Stage 1	Comment/Response
		as part of the LWMS review based on updated groundwater mapping for the site. In Figure 37, Hyd2o understand the design GWL shown at Basin A is the subsoil outlet level under the basin rather than the surface water downstream control level. This will be clarified in the revised LWMS. For Basin E1, the 4.5 mAHD design GWL appears to be an error and this should be controlled by the outlet at 4.3 mAHD. These amendments will not modify the design outlet levels to which the Stage 1 area will drain. Key levels as detailed in JDA (2019b) to demonstrate the Stage 1 outlet levels will not be constrained by groundwater control levels in Reinscourt are as follows : • Existing culvert under Bussell Hwy : 2.9 mAHD • 63% AEP level at this location : 3.10 mAHD (based on downstream Reinscourt survey and modelling) • Stage 1 Basin(Storage C) invert : 4.33 mAHD • Stage 1 Basin(Storage C) outlet : 4.53 mAHD • Groundwater level at Stage 1 Basin 3.50 mAHD This will be further demonstrated and detailed in the Stage 1 UWMP.
Section 6.6.5. The net load export for nitrogen (4.25kg/ha/yr) exceeds the target (2.7kg/ha/yr) from the Vasse River and Estuary Catchment. There is however no discussion to interrogate options to manage this. Table 12: The units are in kg/ha/yr and therefore the values for each catchment cannot be added to provide a total.	No	For the revised LSP and LWMS, UNDO modelling will be completely updated. This will include a pre-development model, not previously performed by JDA. Modelling results will be compared against previous DWER load estimates, and published targets. These results will be tabulated and used to discuss the WSUD measures implemented and management approach to minimise nutrient export from the site. Re Table 12, noted and agreed. This will be corrected in the revised LWMS. Note that water sensitive urban design measures to be applied to the Stage 1 area will represent best management practice.
Hydrographs in Appendix O would benefit from having the total volume stated, as included in Figure 29.	No	Modelling will be redone to reflect the revised LSP. Volumes will be reported on the updated hydrographs in the revised LWMS as requested. Based on discussions with DWER, Hyd2o understand that maintaining post development volumes as well as flow rate is a key consideration for future water management planning to avoid downstream flood risk.

Issue	Required to Inform Stage 1	Comment/Response
City of Busselton Comments		
The City would prefer that the management strategy for the Iluka Lake is fully developed and costed before the LWMS is approved. This will need to include capital cost and ongoing maintenance and management cost that the City can expect to incur. The City would also like the option of lining the lake to be considered. Although it is understood that this will not eliminate the existing main source of TP inflow it may assist with other sources of TP should they become prevalent in the future.	No	The Stage 1 area is separate to Footprint Lake and no stormwater from the area flows to the lake. Hyd2o have recently prepared an assessment of water quality management options for the lake (Hyd2o, 2022d) which has been sent to agencies for review. It is anticipated the report, its findings, and any review amendments will be included as part of the revised LSP LWMS. Based on JDA (2019) water balance findings, lining of the lake to limit shallow groundwater inflow (which represents only 2% of annual flow to the lake) is not considered a cost effective or viable option for water quality improvement.
There are a few queries in relation to the Footprint Lake Monitoring and Management Plan. The monitoring results suggest the primary source of TP in the lake is from inflow from the Yarragadee Aquifer through pumping from the bore feeding the lake. Can you please confirm why the inflow from the Yarragadee Aquifer has such a high concentration of TP. Can you also please confirm if there is a risk that TP will increase in the future, either through increases in the TP concentration in the Yarragadee Aquifer inflow and/or in increase TP from other inflows to the lake. Figure 7 Can you please confirm why FP01 and FP02 appear to have higher TP concentration that Yarra PB? Table 13, all items marked as TBA need to be addressed. In addition, the items marked as "See ILWMS" Please refer to sections of ILWMS where these have been addressed. It is felt that a number of these items are not sufficiently addressed in the ILWMS, which is why additional information and analysis was required in the LWMS.	No	Testing of the original Yarragadee bore by JDA in 2004 recorded a TP level of only 0.08 mg/L and testing of the original Almond Park Lake water quality in 2009 reported a TP concentration of less than 0.05 mg/L. These results were considerably lower than other monitoring results since and following the Yarragadee Bore relocation and redrill. This increase is not fully understood, however it is considered possible this may be due to the new screen depth being against a narrower aquifer zone of grey sands with areas of black shale. Phosphorus mobilisation into soils and groundwater is a function of rock weathering. Black shales can have high phosphorus concentration and are susceptible to chemical weathering. This is discussed in Hyd2o(2022d), and considered for further investigation to improve lake water quality. This opportunity will be further discussed as a separate process with DWER and the City of Busselton in due course as part of the Hyd2o (2020d) Footprint Lake Management Options Report review negotiations. Regarding TP concentrations, it is not uncommon for superficial aquifer water quality to contain higher nutrient levels that deeper aquifers due to land use activity. Predevelopment monitoring of superficial bores on the site recorded TP levels up to 1.1 mg/L. Text will be added into the revised LWMS to provide context. With respect to Table 13 of the Footprint Lake Monitoring and Management Plan, Hyd2o (2022d) will effectively replace this document in the revised LWMS as the proposed lake management strategy. We will continue to liaise with DWER and the City of Busselton to ensure the report is complaint with agency requirements. A Constructed Lakes Checklist as per the JDA Footprint Lake Monitoring and Management Plan can be added to Hyd2o's document if required.

2. STAGE 1 SUBDIVISION STORMWATER MANAGEMENT

Figure 2 shows the Stage 1 location relative to the site's overall stormwater management planning detailed in JDA (2019).

The site is part of the catchment proposed to flows under Bussell Hwy and through Reinscourt to the Sabina River. The size of the predevelopment catchment flowing to this location was estimated by JDA (2019) to be 189.6 ha, which discharges under Bussell Highway via 2 x 600mm diameter culverts near Osprey Drive

Stage 1 comprises a total area of 9.50 ha with 72 lots (4.35 ha), roads, two public open space areas (2.87 ha) and balance lots. The site is proposed to contain a single stormwater management area in compliance with the JDA (2019) LWMS.

Refined stormwater modelling of this area will be conducted as part of the UWMP which will be prepared to cover the whole of the Stage 1 Area. The key consideration for this modelling will be to ensure that the subdivision does not discharge more flow (rate and volume) than predevelopment towards Reinscourt. Modelling will therefore be required to identify if any additional temporary flood detention measures are required to manage this risk during staged development.

JDA (2019) provided detailed modelling outcomes to demonstrate post development flows and volumes into Reinscourt were maintained at predevelopment levels, and similar outputs in the UWMP are proposed for the Stage 1 UWMP.

Refined stormwater modelling for the Stage 1 area and other existing development areas will then be used to inform the revised LWMS.

3. REVISED LOCAL STRUCTURE PLAN & LWMS

Taylor Burrell Barnett (TBB) on behalf of Yolk Property are currently in the process of revising the LSP for the site. A copy of the draft concept plan and staging schedule are contained as Attachments 4 and 5 respectively. Hyd2o have been commissioned to undertake the new LWMS addressing the revised LSP, and have been involved in undertaking constraints and opportunities analysis to assist in inform the development of the plan.

The updated LWMS will address changes to the LSP, detail updated stormwater modelling including implemented works for the Stage 1 UWMP area, revised groundwater mapping based on recent investigation, updated Footprint lake management investigations, and provide consideration of alternative approaches to minimise fill requirements. A key criteria for the LWMS will be to demonstrate post development flows and volumes to Reinscourt downstream of Bussell Hwy continue to be maintained at pre-development levels., A further key consideration will be to demonstrate any Controlled Groundwater Levels (CGL's) are mapped clearly and reflect any controls downstream of the site in Reinscourt.

The LWMS is currently being prepared by Hyd2o consistent with DWER requirements as described in Better Urban Water Management (Western Australian Planning Commission, 2008), and will be submitted for agency consideration with the updated LSP in due course. As part of this process, ongoing discussions with both the City of Busselton and DWER will be undertaken to ensure the document is prepared consistent with agency requirements.

APPENDIX E

Bushfire Assessment Report

prepared by Ecosystem Solutions

Addendum prepared by Strategen JBS&G to address resolution of the Statutory Planning Committee (SPC)

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: Provence Estate		
Suburb: Yalyalyup	**State:** WA	**P/code:** 6280
Local government area: City of Busselton		
Description of the planning proposal: Multi lot subdivision		
BMP Plan / Reference Number: 17357	**Version:** Rev D	**Date of Issue:** 28/02/2020
Client / Business Name: Satterley Property Group C/- RPS Australia Asia Pacific Att: Joanne Cousins		

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.)?

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
Gary McMahon	Level 3	35078	Nov 2020
Company Ecosystem Solutions		**Contact No.** 08 9759 1960	

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

Signature of Practitioner **Date** 28/02/2020

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Bushfire Management Plan

Provence Estate, Yalyalup

28 February 2020

Prepared for:
Satterley Property Group
C/- RPS Australia Asia Pacific
Att: Joanne Cousins

Limitations Statement

This report has been prepared for Satterley Property Group, C/- RPS Australia Asia Pacific Att: Joanne Cousins and remains the property of Ecosystem Solutions. 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.

STATEMENT OF CONFORMITY – *PLANNING AND DEVELOPMENT ACT 2005*

BPAD Bushfire Planning & Design Accredited Practitioner Level 3

Gary McMahon
B.Sc. M. Env Mgmt. PG Dip Bushfire Protection. C.EnvP, BPAD Level 3 (35078)

The signatory declares that this Bushfire Management Plan meets the requirements of State Planning Policy 3.7 and the Guidelines for Planning in Bushfire Prone Areas V1.3.

Document Control

Client - Satterley Property Group

Site - Provence Estate, Yalyalup

Version	Revision	Purpose	Author	Reviewer	Submitted	
					Form	Date
Report	Rev A	Initial Report	KP	GM	Electronic (email)	3/04/2017
Report	Rev B	Comments from City of Busselton	KP	GM	Electronic (email)	5/03/2019
Report	Rev C	Update Site Plan	KP	GM	Electronic (email)	25/02/2020
Report	Rev D	Update Landscape Plan	KP	GM	Electronic (email)	28/02/2020

Filename: Z:\PROJECTS\17357 Provence Structre Plan BMP\Reports\Provence Structure Plan BMP Rev C.docx

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1 Proposal

This Bushfire Management Plan (BMP) has been prepared by Ecosystem Solutions Pty Ltd, as part of the process of the owners of Provence Estate, Yalyalup (Figure 1) to proceed with the latest stage of the development (Lot 9033, Lot 2, Lot 9032, Lot 32 and Part Lot 75, shown in Figure 2, hereafter called the "Site"). This report has been prepared by Kelly Lamp (B.Sc Hons. Nat Rs Mgmt, BPAD Level 2 - 38253), with review provided by Gary McMahon (B.Sc M. Env Mgmt. PG Dip Bushfire Protection. C.EnvP. BPAD Level 3 – 35078).

The Site is located within the City of Busselton and is situated approximately 4 km to the south-east of the Busselton town Site, Western Australia (Map 1). Main access to Proposed Lots will be via Joseph Drive and the roading to be constructed during the development (Figure 1).

The Site 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 2).

The structure plan area consists of approximately 293.5 hectares, currently comprised of existing residential development, extensive cleared areas of pasture and smaller patches of bushland areas.

Portions of the Site are located within a bushfire prone area, as declared by State Planning Policy 3.7: Planning in Bushfire Prone Areas (Figure 3).

The purpose of this BMP is to detail the fire management methods and requirements that will be implemented within the Site as part of the structure plan. The aim of the BMP is to reduce the threat to residents and fire fighters in the event of a fire within or near the Site.

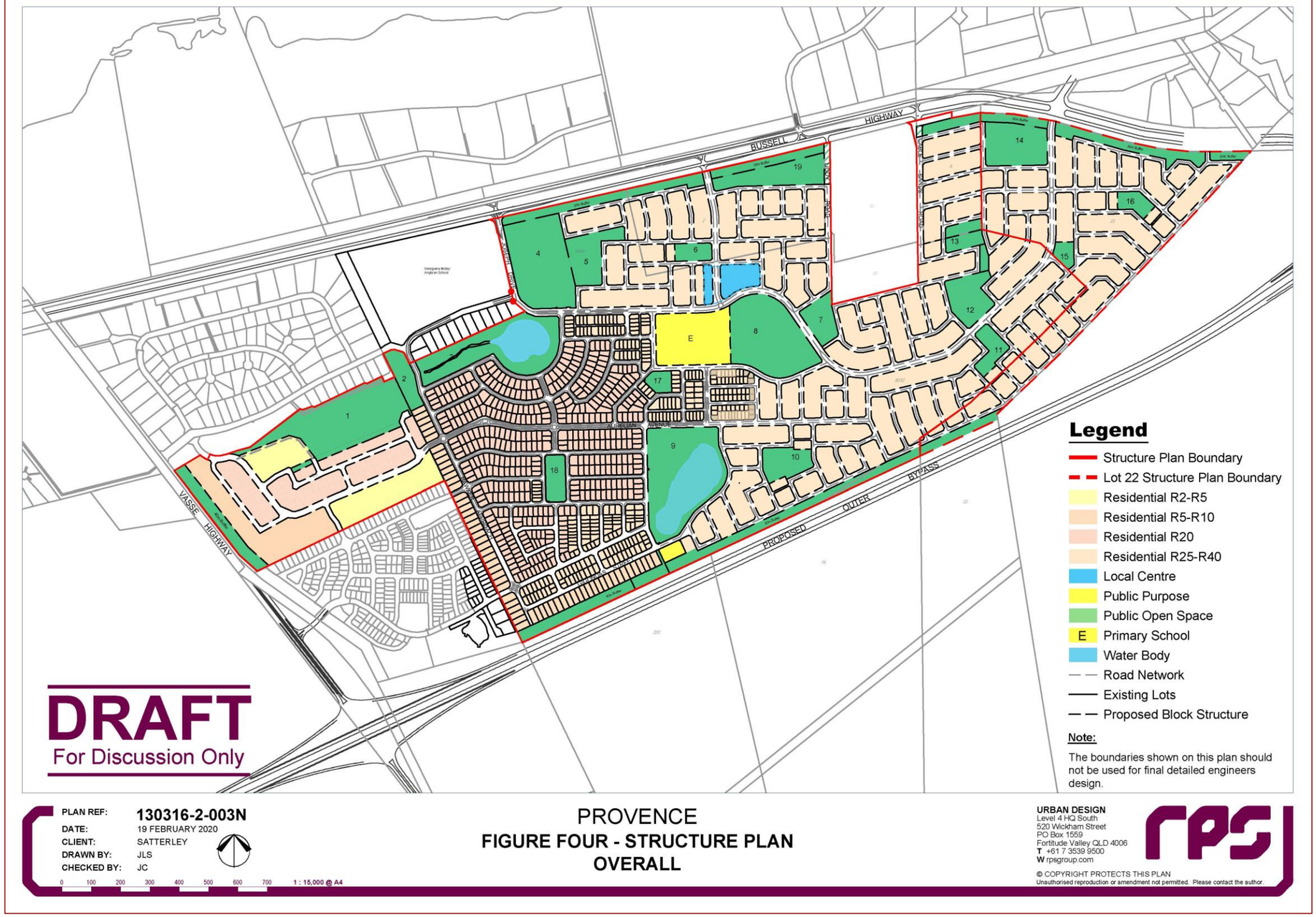


Figure 1 Structure Plan for Provence Estate

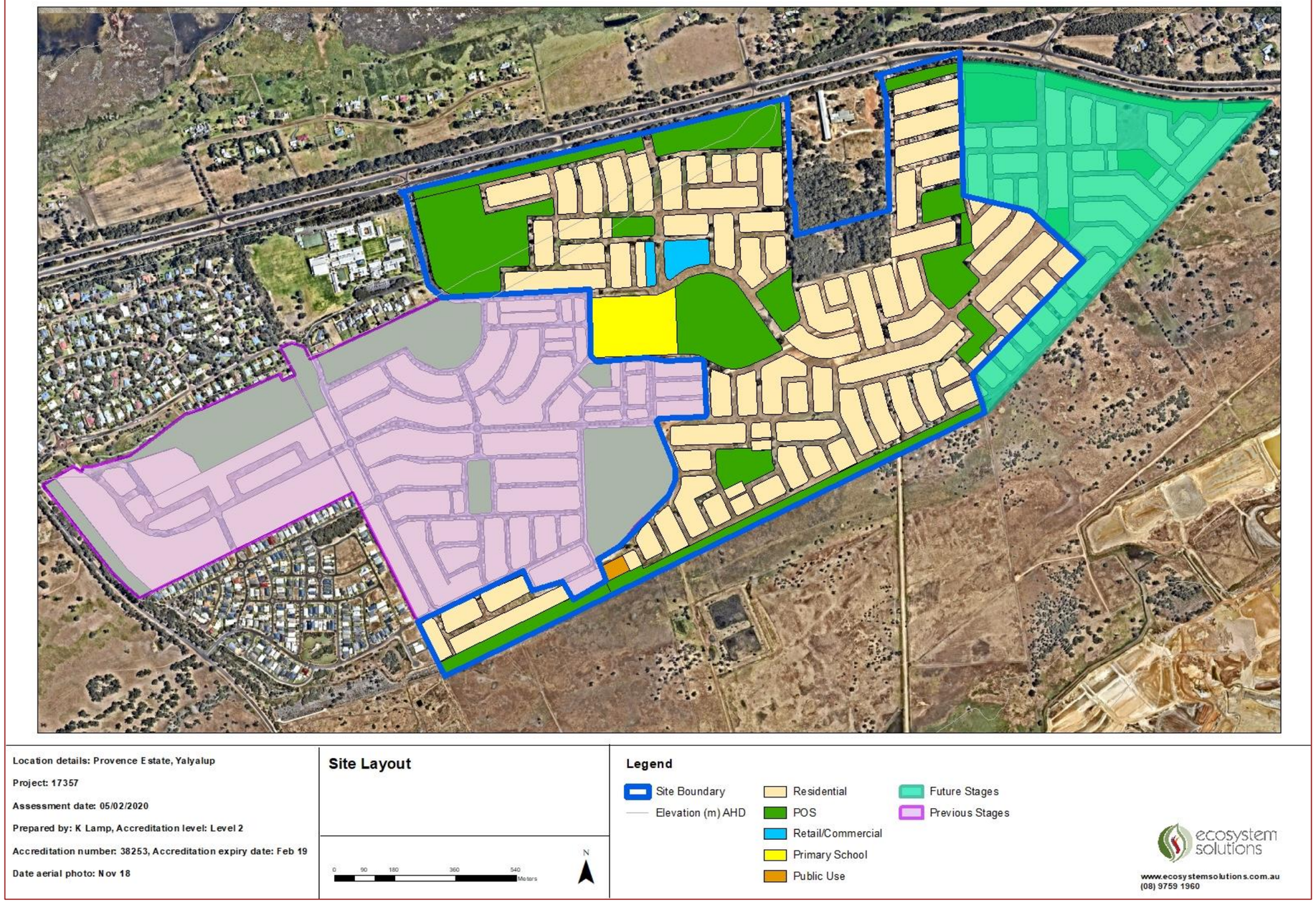


Figure 2 Site Layout for Provence Estate, highlighting previous and future stages.

Figure 3 Map of Bushfire Prone Areas for Provence Estate, Yalyalup

2 Bushfire Assessment Results

2.1 Assessment Inputs

A Site inspection was conducted on 2nd February 2017 by Gary McMahon (B.Sc. M. Env Mgmt, CEnvP. BPAD Level 3) from Ecosystem Solutions, with follow up assessments conducted on 11 January 2019 by Kelly Lamp (B.Sc Hons, Nat Rs Mgmt., BPAD Level 2), Danae Plowman (B.Sc. Env Sc. PG Dip Energy Env., BPAD Level 1) and Dani Cuthbert (Dip Bus & Dip TM, BPAD Level 1) and by Kelly Lamp and Dani Cuthbert on 5 February 2020, for the purpose of determining the Bushfire Attack Level in accordance with AS 3959-2018.

All vegetation within 150m of the Site was classified and the slope under the vegetation determined in accordance with Clause 2.2.3 & 2.2.5 of AS 3959-2018, shown in the photos below with map provided in Figure 4. For the purpose of consistency, vegetation within 150m of the previous stage has also been included in the mapping.

There are two methods to conduct BAL assessments under AS 3959-2018:

- Method 1 – a simplified procedure that involves five procedural steps to determine BAL and is subject to limitations on the circumstance in which it can be used.
- Method 2 – a detailed procedure using calculations to determine BALs where a more specific result is sought or where the Site conditions are outside the scope of the simplified procedure.

A Method 2 approach was conducted for Plot 9 – Class A Forest Upslope / Flat. A Method 2 approach provides a more detailed and accurate assessment of the BAL rating to account for variations in fire runs, intermittent fuel profiles and flame widths which would result in moderated bushfire behaviour compared to the standard Method 1 approach. The default elements used in a Method 1 calculation were used in this situation, apart from the flame width, which was calculated using the DFES short fire run calculator based on Transect 1 of 10 m. This is discussed in more detail below.

Plot	1	Vegetation Classification or Exclusion Clause	Class A Forest Upslope / Flat

Photo ID: 1

Photo ID: 2

Description / Justification for Classification:	Canopy of *Agonis flexuosa,* subject to revegetation works as part of a conservation covenant to protect Western Ringtail Possums. The canopy cover of this vegetation is currently under 30%, supporting a classification of Class B – Woodland, however the revegetation works may eventuate in a tiered understorey structure and canopy cover in excess of 30%, so a 'worst case scenario' classification of Class A – Forest has been used. This vegetation plot includes POS 4 & 5.

Plot	2	**Vegetation Classification or Exclusion Clause**	Class A Forest – Upslope / Flat

Photo ID: 3

Photo ID: 4

Description / Justification for Classification:	*Agonis flexuosa, Eucalyptus gomphocephala, Eucalyptus marginata* and *Corymbia calophylla* canopy of 30 – 70% with tiered understorey including *Lepidosperma gladiatum.* A portion of this vegetation plot will be removed prior to the sale of any lots.

Plot	3	Vegetation Classification or Exclusion Clause	Class A Forest – Upslope / Flat

Photo ID: 5

Photo ID: 6

Description / Justification for Classification:	*Eucalyptus gomphocephala* and *Eucalyptus* sp. canopy of 30 – 70% with understorey of **Zantedeschia aethiopica.* This vegetation plot includes POS 7 and POS 8. A portion of this vegetation is to be removed as part of the development process, this must occur prior to the sale of any lots to ensure no dwellings are constructed in areas above a BAL-29 rating. Remaining areas of vegetation will include some revegetation including the planting of shrubs, therefore the Class A – Forest classification has been used.

Plot	4	**Vegetation Classification or Exclusion Clause**	Excluded S 2.2.3.2 (b)

Photo ID: 7

Photo ID: 8

Description / Justification for Classification:	Areas of mature trees to remain within POS 10. Vegetated area of POS10 is <8000m^2, with any other classified vegetation more than 100m away. Revegetation is to occur under the existing trees. This allows exclusion under S 2.2.3.2 (b).

Plot	5	**Vegetation Classification or Exclusion Clause**	Class A Forest – Upslope / Flat

Photo ID: 9

Photo ID: 10

Description / Justification for Classification:	*Agonis flexuosa*, *Corymbia calophylla* and *Eucalyptus rudis* woodland with canopy currently <30% and annual and perennial grass weed understorey. This plot includes the Outer Bypass Landscape Buffer, Bussell Highway Landscape Buffer and POS 19 and is subject to significant revegetation works, with future plantings possibly increasing the canopy cover above 30%, hence the Class A – Forest classification. Any areas of the Outer Bypass Landscape Buffer, Bussell Highway Landscape Buffer or POS 19 within 21 metres of a lot must be established as a low fuel zone and maintained to these standards in perpetuity, as per the landscape plan (Appendix C). This plot also includes roadside vegetation along Bussell Highway and remnant vegetation in adjacent lots.

Plot	6	Vegetation Classification or Exclusion Clause	Class G – Grassland Upslope / Flat

Photo ID: 11

Photo ID: 12

Description / Justification for Classification:	Neighbouring lot to the south of the Site, with unmanaged paddocks including introduced grasses and other pasture species with scattered trees.

Plot	7	Vegetation Classification or Exclusion Clause	Class A - Forest Upslope / Flat

Photo ID: 13

Photo ID: 14

Description / Justification for Classification:	*Agonis flexuosa* and *Corymbia calophylla* trees, canopy >30%, with minimal understorey.

Plot	8	Vegetation Classification or Exclusion Clause	Excluded S 2.2.3.2 (a), S2.2.3.2 (b), S 2.2.3.2 (e) or S 2.2.3.2 (f).

Photo ID: 15

Photo ID: 16

Photo ID: 17

Photo ID: 18

Description / Justification for Classification:	The remainder of the Site has been excluded from classification under AS 3959-2018 Section 2.2.3.2. Areas more than 100m from the Site have been excluded under S 2.2.3.2 (a). Areas less than 1 ha in area and more than 100m from any other classified vegetation are excluded under S 2.2.3.2 (b). Non-vegetated areas including roads and buildings have been excluded under Section 2.2.3.2 (e). Low threat vegetation including reticulated lawns and gardens,

windbreaks and nature strips have been excluded under Section 2.2.3.2 (f), with urban lots required to be managed to the standard in the City of Busselton's Firebreak and Fuel Hazard Reduction Notice. Areas of Public Open Space maintained to a high level, with irrigation to nearly all landscape areas have been excluded under S 2.2.3.2 (f), as they have insufficient fuel to significantly increase the severity of a bushfire attack, with ongoing maintenance required in accordance with the Landscape Plan (Appendix C). The Asset Protection Zones of some lots extend into neighbouring areas of Public Open Space, these areas must be maintained in a low fuel state in perpetuity, as detailed in the Landscape Plans (Appendix C) and have therefore been excluded from classification under S 2.2.3.2 (f).

Plot	9	Vegetation Classification or Exclusion Clause	Class A Forest Upslope / Flat

Photo ID: 19

Photo ID: 20

Description / Justification for Classification:	Canopy including *Eucalyptus gomphocephala, Agonis flexuosa* and **Eucalyptus robusta* of 30 – 70%. As part of the landscape plan, this area will have any under plantings removed, tidied and replaced with plantings of low groundcover species known for their low flammability. A short fire run has been used for this plot, using a transect of 10 metres which was the maximum distance measured across this vegetation plot.

1.1.1 Method 2 Calculation

The following data was used for the Method 2 calculations.

Climate data

- The default Fire Danger Index for Western Australia (Table 2.1 – AS 3959-2018) of 80 was used in this calculation.
- 45 km/h wind speed default was used in this calculation.

Fuel Loadings

- The Class A Forest classification has been used for the Method 2 calculation. This determines which bushfire model is more appropriate to the landscape and vegetation.
- The slope under the classified vegetation was calculated as flat/upslope. This was measured in the field for this vegetation plot using the Nikon Forestry Pro.

Flame Length Calculation

The intensity, rate of spread and flame length calculations using AS 3959-2018 are deemed overly conservative for the Site due the narrowing of the planted vegetation with Plot 9 (Figure 6), limiting the potential head fire width the adjacent areas will be exposed to. AS3959-2018 uses a default 100 m fire run in its modelling. Using an ellipse-shaped fire model as proposed by Alexander (2005) is more appropriate to this situation.

The simplest fire pattern from a single ignition point on flat terrain and under calm conditions, will spread out at an equal rate in all directions from the starting point, in a circular fashion, with the origin at the approximate centre. As time increases and with the influences of wind and slope or both, the fire shape assumes a roughly elliptical shape provided wind is constant. In this model, the flanks of the fire make up an increasing greater proportion of the total perimeter, hence the standard “panel” fire models of AS 3959-2018 can be significantly overstated.

The Department of Fire and Emergency Services (DFES) has prepared a draft Short Run Fire Model for these situations. These calculate a potential Head Fire Width based on the total fire length. The calculation of the Site is shown in Table 1.

Table 1 Short Fire Run & Head Fire Width Calculations – Forest Corridor (DFES 2016)

Transect	Fire Run (m)	FDI	Surface Fuel (t/ha)	Slope (˚)	Total Fire Length (m)	Head fire Width (m)
1	10	80	25	0	10.33	3.66

The flame length for the vegetation is calculated by inputting these data into the Method 2 model:

- An appropriate fire behaviour equation to determine the forward rate of spread of a fire;
- A correction for the forward rate of spread based on the effective slope;

The fire behaviour model is McArthur (1973) and Noble *et al* (1980), as shown in Table B1: As 3959 is:

R = 0.0012*FDi*w

Where R is the rate of spread in Km/h;

FDI is the McArthur Fire Danger Index; and

w is the surface fuel load (t/ha)

Radiant Heat Flux

Other elements included in the calculations are:

- Flame width (Table 1);
- Elevation of the receiver (this is the level at which the site will receive the incident radiant heat flux); and
- The radiation heat flux is determined from the flame emissive power, the view factor and the atmospheric transmissivity.

Based on the above parameters, Table 2 shows parameters used and resulting Radiant Heat Flux (RHF). Appendix F shows the full details of the calculations for the transect.

Table 2 Method 2 Calculation Inputs and Results

***M*ethod 2 Calculation**	**Plot 6**
Transect	1
RoS (km/h)	2.4
Flame length (m)	19.8
Flame Angle (degrees)	16, 19, 23, 28, 31 & 51
Flame Temp (K)	1,090
Intensity (kW/m)	43,400
Min distance to <40 kW/m^2	11.5999997 m
Min distance to <29 kW/m^2	**12.3999997 m**
Min distance to <19 kW/m^2	13.6999997 m
Min distance to <12.5 kW/m^2	15.2999997 m
Min distance to <10 kW/m^2	16.2999997 m

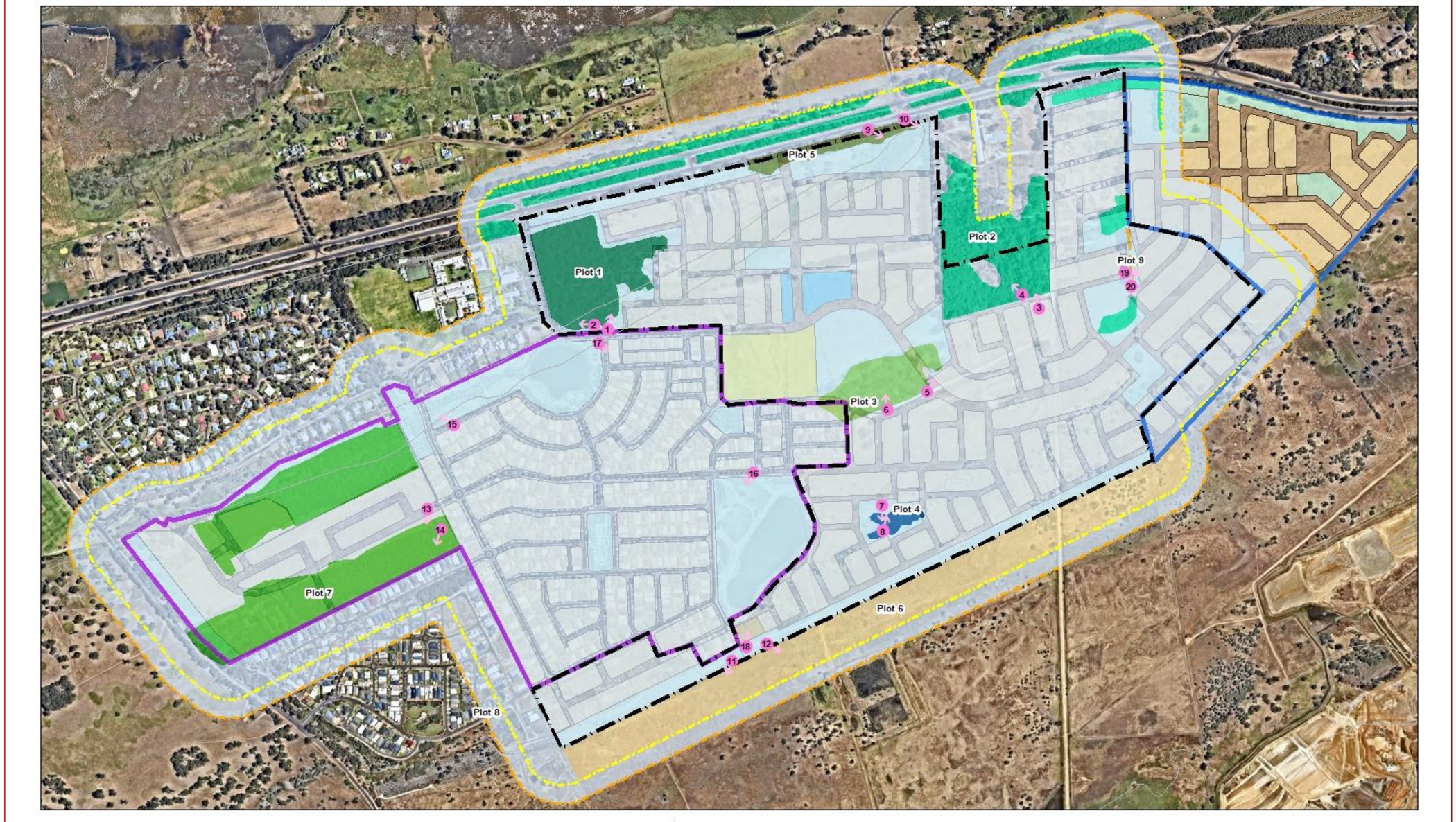
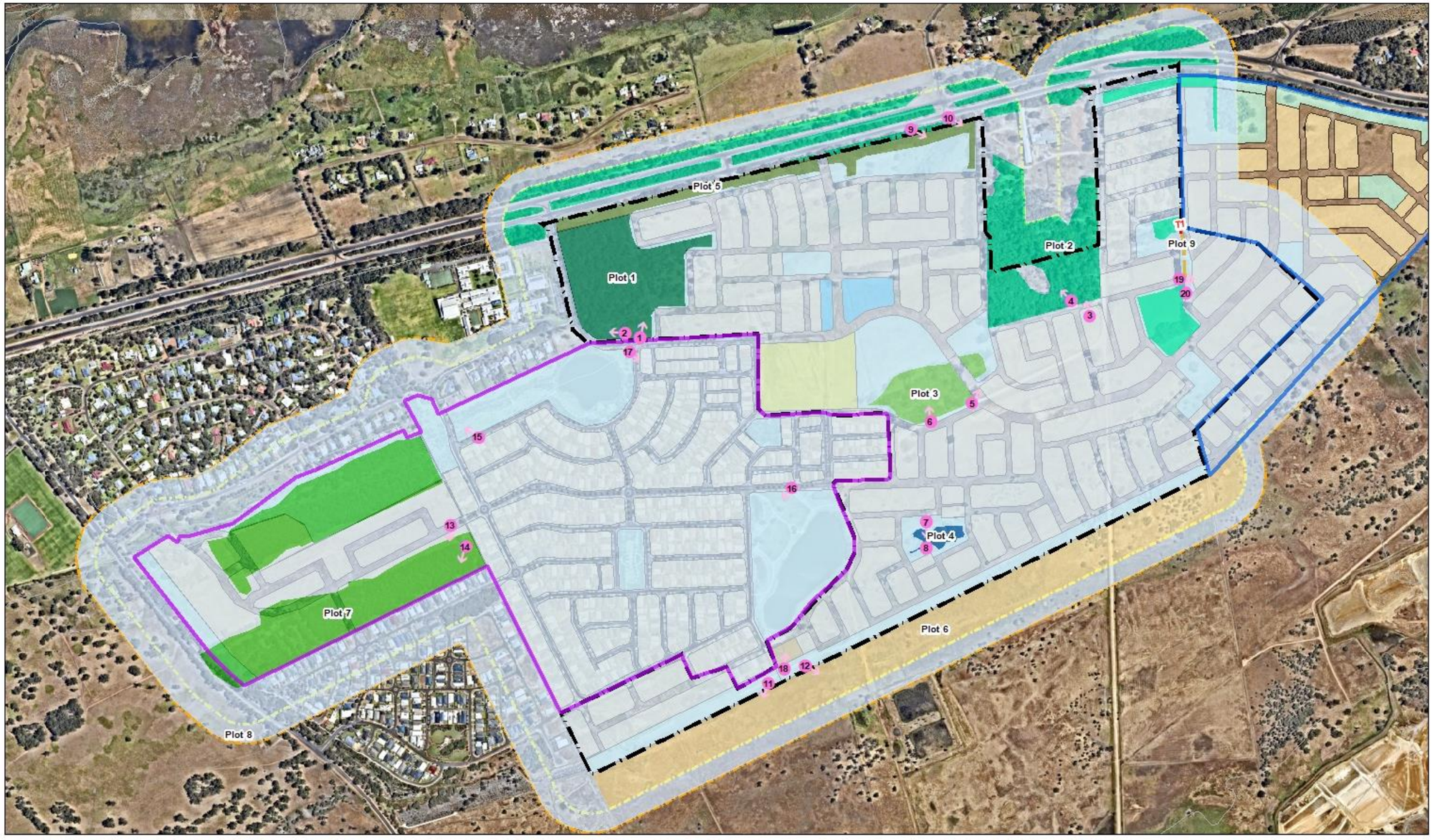


Figure 4 Vegetation Classification – Current Extent



Location details: Provence Estate, Yalyalup

Project: 17357

Assessment date: 05/02/2020

Prepared by: K Lamp, Accreditation level: Level 2

Accreditation number: 38253, Accreditation expiry date: Feb 21

Date aerial photo: Nov 18

Vegetation Classification
Post Development

0 90 180 360 540 Meters

N

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- 150m assessment area
- 100m buffer
- Current Stages
- Future Stages
- Previous Stages
- Residential
- POS
- Retail/Commercial
- Primary School
- Public Use
- Photo Points
- Plot 1, Class A Forest Upslope / Flat
- Plot 2, Class A Forest Upslope / Flat
- Plot 3, Class A Forest Upslope / Flat
- Plot 4, Excluded S 2.2.3.2 (b)
- Plot 5, Class A Forest Upslope / Flat
- Plot 6, Class G Grassland Upslope Flat
- Plot 7, Class A Forest Upslope / Flat
- Plot 8, Excluded S 2.2.3.2 (a), (e) or (f)
- Plot 9, Class A Forest Upslope / Flat
- Transect 1

Figure 5 Vegetation Classification – Post Development

Figure 6 Vegetation Classification – Post Development – Short Fire Run Transect

2.2 Assessment Outputs

The results from the Site assessment are provided in Table 3. The Determined Bushfire Attack Level (highest BAL) for the Site has been determined in accordance with clause 2.2.6 of AS 3959-2018 with map provided in Figure 7. Detailed BAL Contour Maps are provided in Figures 8 to 13.

Table 3 Site Assessment Results

Method 1 BAL Determination				
Fire Danger Index - 80 (AS3959-2018 Table 2.1)				
Plot	**Vegetation Classification**	**Effective Slope Under the Classified Vegetation (degrees)**	**Separation Distance to the Classified Vegetation (metres)**	**Bushfire Attack Level**
1	Class A - Forest	Upslope/Flat	Min 21 m	BAL-29
2	Class A - Forest	Upslope/Flat	Min 21 m	BAL-29
3	Class A - Forest	Upslope/Flat	Min 21 m	BAL-29
4	Excluded S 2.2.3.2 (b)	N/A	N/A	BAL-LOW
5	Class A - Forest	Upslope/Flat	Min 21 m	BAL-29
6	Class G Grassland	Upslope/Flat	Min 32 m	BAL-12.5
7	Class A Forest	Upslope/Flat	Min 420 m	BAL-LOW
8	Excluded S 2.2.3.2 (a), (e) & (f)	N/A	N/A	BAL-LOW
9	Class A – Forest **(Short Fire Run)**	Upslope/Flat	Min 12.4 m	BAL-29
			Determined Bushfire Attack Level	**BAL-29***

* A lower BAL rating can be achieved based on an increased separation distance from the classified vegetation, depending on the location of the Lot. A detailed BAL assessment may be required prior to the construction of any dwelling. Some lots include a restrictive covenant excluding building within BAL-FZ or BAL-40 areas to ensure no dwelling is constructed in an area over BAL-29.

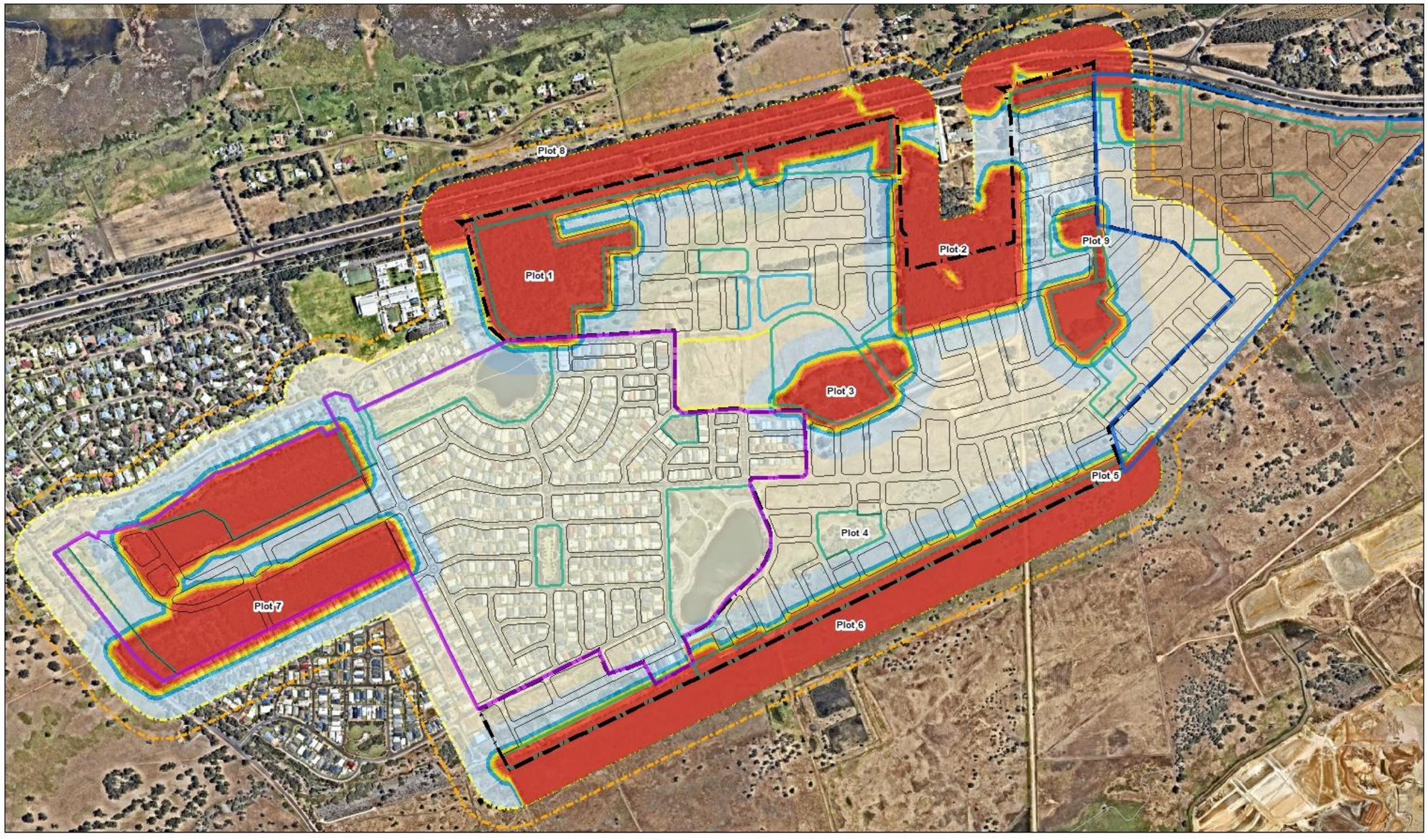


Figure 7 BAL Contour for Provence Estate

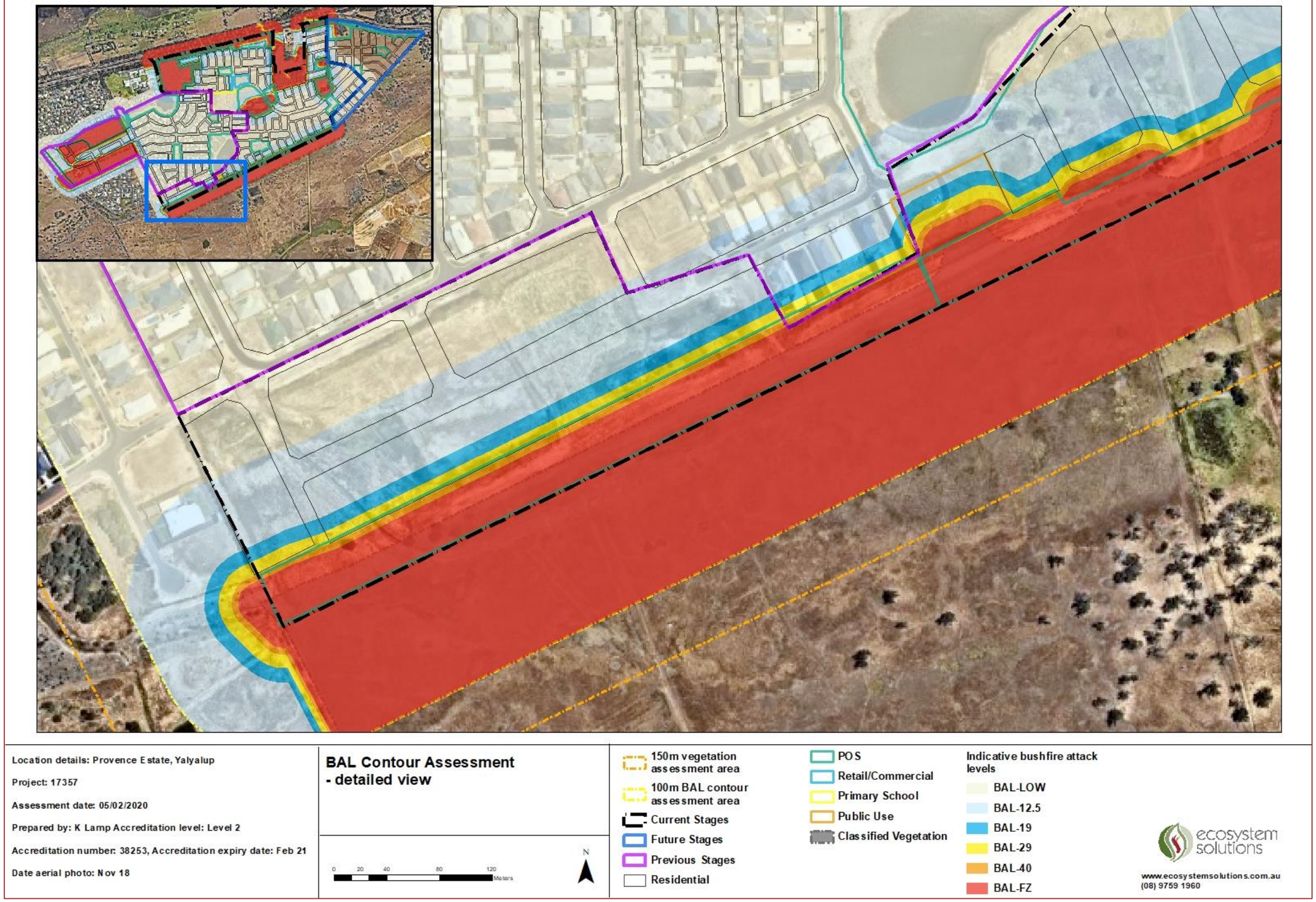


Figure 8 BAL Contour – detailed view, south west corner

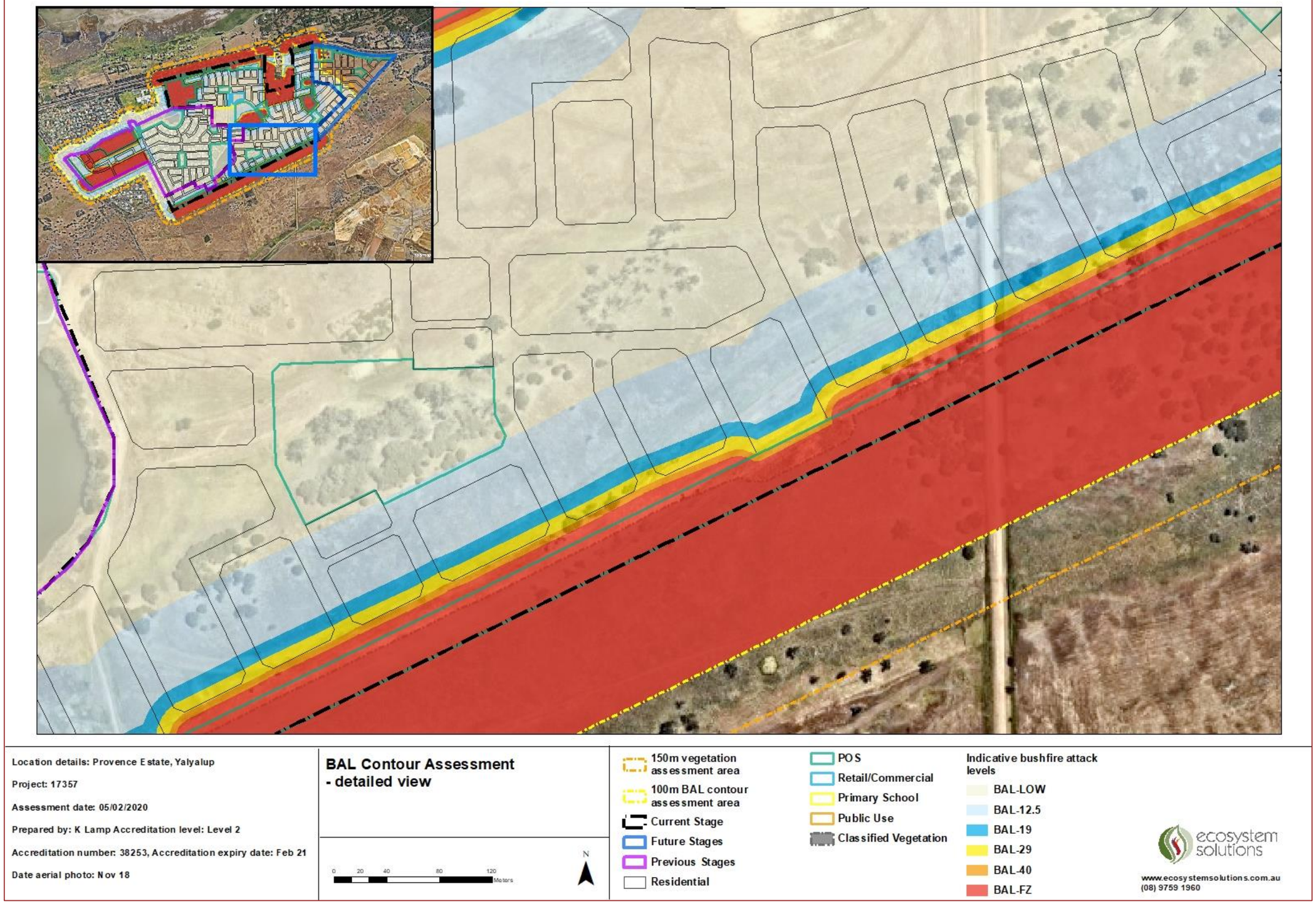


Figure 9 BAL Contour – detailed view, south

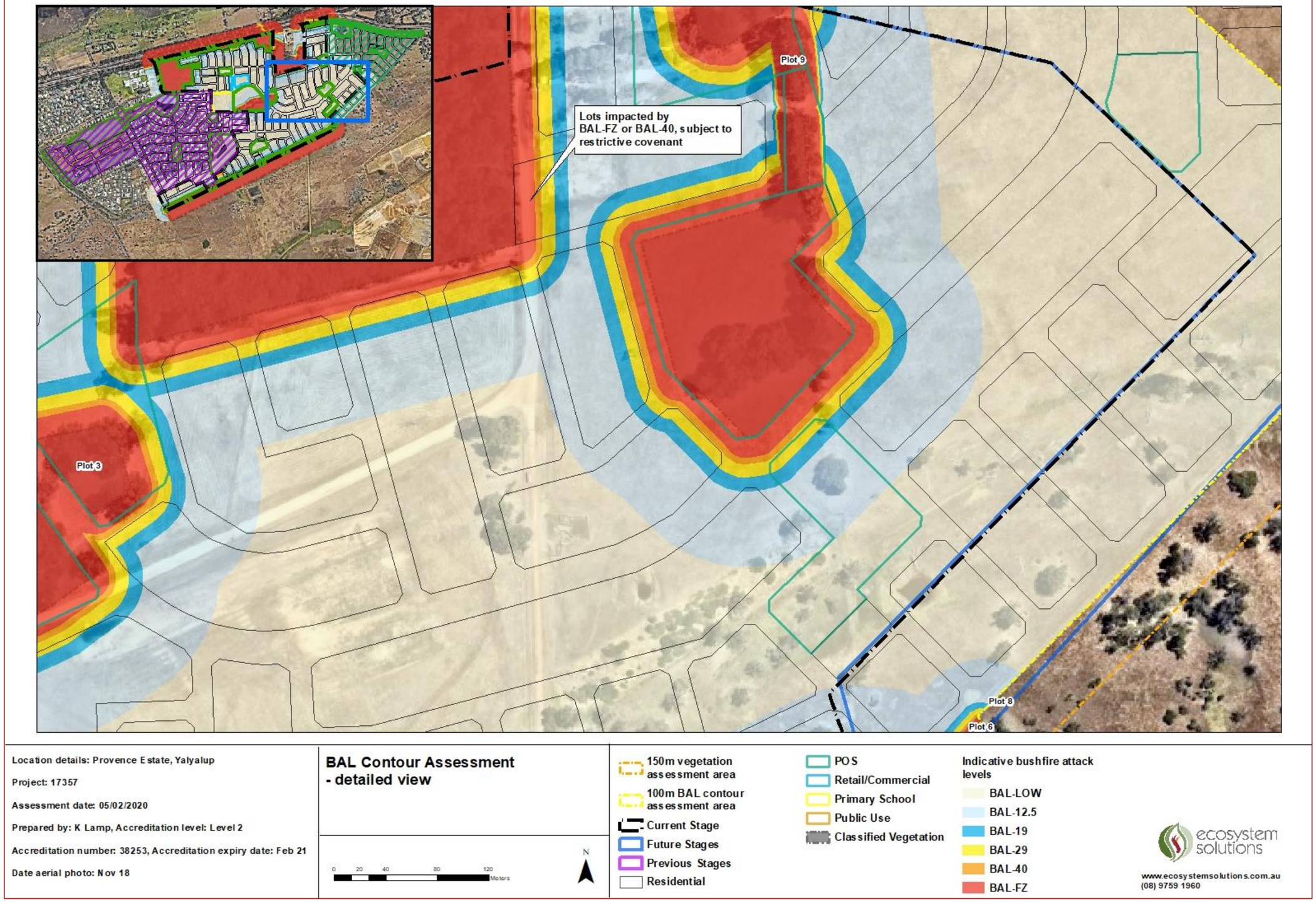


Figure 10 BAL Contour – detailed view, east

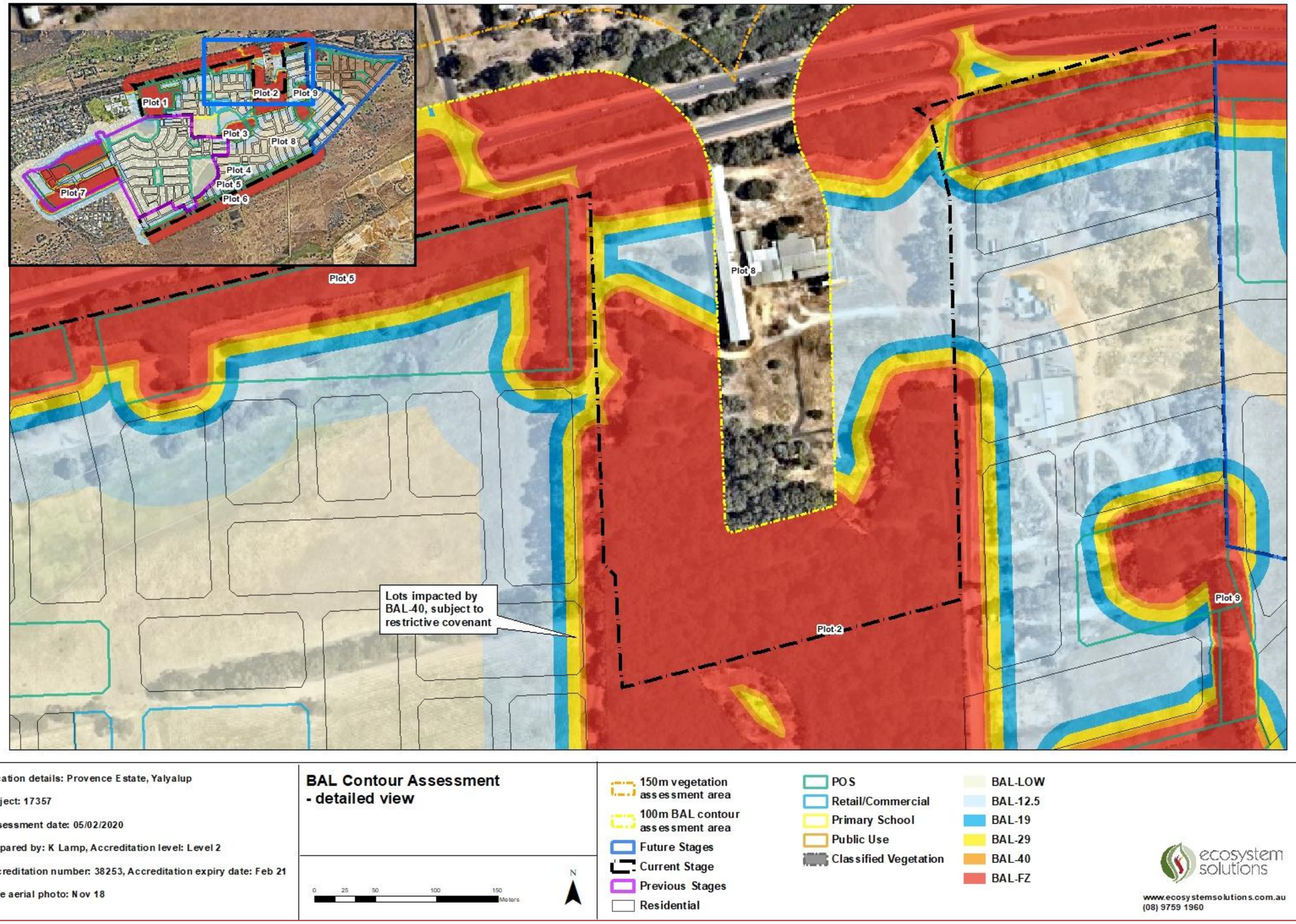


Figure 11 BAL Contour – detailed view, north east

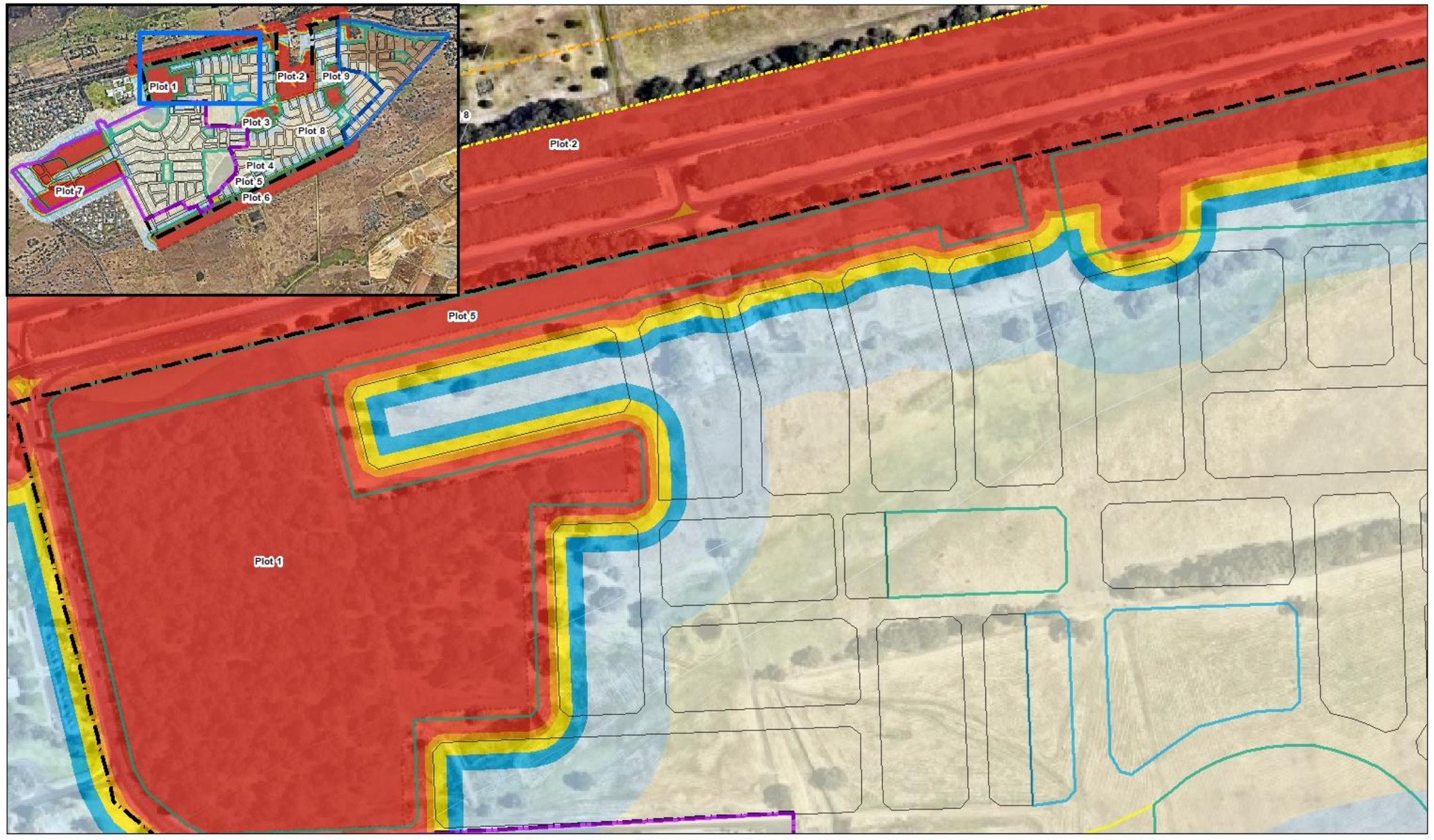


Figure 12 BAL Contour – detailed view, north west

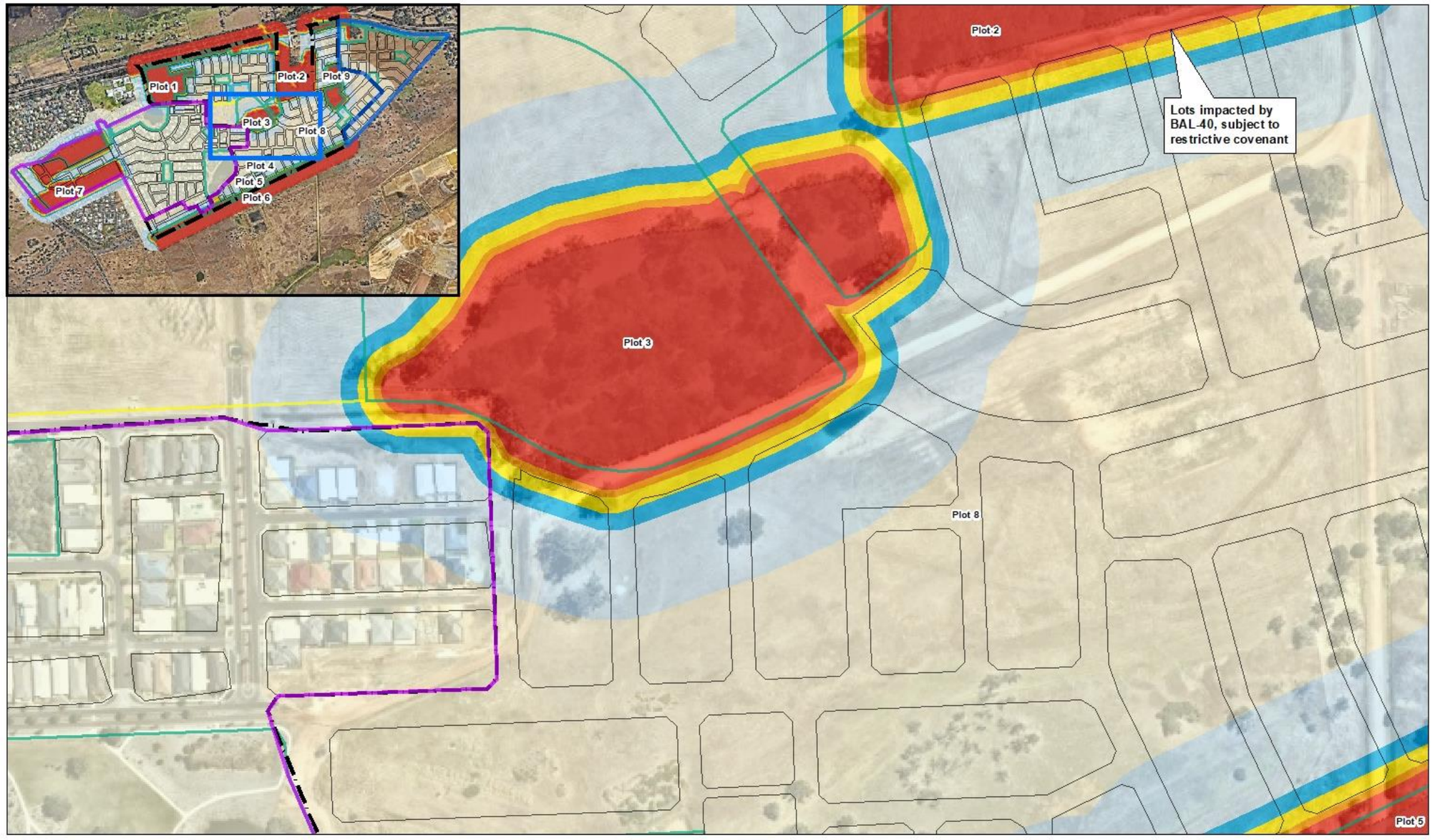


Figure 13 BAL Contour – detailed view, central

3 Environmental Considerations

3.1 Native Vegetation – modification and clearing

Provence Estate, Yalyalup contains grassland previously cleared for agriculture, with small pockets of vegetation and windbreaks. Extensive environmental surveys have been conducted across the Site in relation to the areas of vegetation that require removal as part of the development process.

The Site and the surrounding 150m buffer have been assessed for environmental values using a simple desktop review (Table 4). A Protected Matters Search identified 18 threatened flora species are likely to occur in the area and two threated ecological communities. No vegetation representative of either of the TECs was observed during the site assessments. A review of the SLIP data identifies a geomorphic wetland through the Site.

Table 4 Significant environmental values identified within the Site

Environmental Value	Yes or No	If Yes - describe
Conservation Covenants	No	Not applicable
Bushfire Forever Sites	No	Not applicable
Conservation Category Wetlands and Buffer	Yes	A geomorphic wetland runs through the Site (SLIP 17/01/19).
Threatened Ecological Communities (TECs)	Yes	Banksia Woodlands of the Swan Coastal Plain ecological community and Subtropical and Temperate Coastal Saltmarsh communities are likely to occur within the area (PMST Report, 17/01/19).
Declared Rare Flora (DRF)	Yes	18 DRF species or species habitat are likely to occur within the area (PMST Report, 17/01/19).
Significant through Local Planning or Biodiversity Strategy	No	Not applicable

3.2 Re-vegetation / Landscape Plans

The approved landscape plan for Provence Estate is provided in Appendix C, with excerpt provided in Figure 14 below. Detailed concept plans for the Bussell Highway and Outer Bypass Buffers, POS 4, 5, 6, 7, 8, 10, 11,

12, 13 and 19 are also included in Appendix C. These clearly describe the 21 metre setback provided between all lot boundaries and these areas of Public Open Space, to ensure no adjacent lots are subjected to radiant heat >29 kW/m^2 (BAL-29). The landscape plan has informed the vegetation classification within this BMP, with the mature state of any plantings used to determine the appropriate classification. The areas of Public Open Space will be established by the developers and maintained according to the landscape plan for a minimum of two years, when management will become the responsibility of the City of Busselton in perpetuity. Public Open Space Areas 2, 3, 9, 17 and 18 are all maintained to a high level, with irrigation to nearly all landscape areas (pers comm Chad Elton, Senior Landscape Architect, Emerge Associates, 22 January 2019). These areas have been excluded from classification under AS3959-2018 S 2.2.3.2 (f) as low threat vegetation, with insufficient fuel to significantly increase the severity of a bushfire attack. Public Open Space Area 6, 10 and 17 have standing vegetation of less than a hectare in size with a setback of more than 100m from any other areas of classified vegetation and can therefore be excluded under AS3959-2018 S 2.2.3.2 (b). Any existing or proposed standing vegetation within Public Open Space areas 15 and 16 is more than 100m from the Site and is excluded under S 2.2.3.2 (a). Low fuel zones will ensure the Asset Protection Zones of adjacent lots will be maintained in a low fuel state in perpetuity as detailed in the landscape plan (Appendix C). These low fuel zones must be established prior to the sale of any adjacent lots. Table 5 below further details and justifies the vegetation classification of each area of Public Open Space.

Table 5 Classification of areas of Public Open Space within the development

Public Open Space Name	Exclusion / Classification Clause	Justification
POS 1	Class A - Forest	Part of an existing stage
POS 2	Excluded S 2.2.3.2 (f)	Maintained to a high level, with irrigation to the majority of the area
POS 3	Excluded S 2.2.3.2 (f)	Maintained to a high level, with irrigation to the majority of the area
POS 4	Class A – Forest & Excluded S 2.2.3.2 (f)	Conservation Public Open Space, revegetation plantings may result in canopy of >30%. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.

Public Open Space Name	Exclusion / Classification Clause	Justification
POS 5	Class A – Forest & Excluded S 2.2.3.2 (f)	Conservation Public Open Space, revegetation plantings may result in canopy of >30%. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
POS 6	Excluded S 2.2.3.2 (b)	Less than 1 ha in size (~0.64 ha) and more than 100m from any other classified vegetation
POS 7	Class A - Forest & Excluded S 2.2.3.2 (f)	Area will include turf recreation area (16%), with 36% revegetation to occur under the existing mature trees. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
POS 8	Class A Forest & Excluded S 2.2.3.2 (f)	Area will be 60% sporting fields, with 17% revegetation to occur under the existing mature trees. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
POS 9	Excluded S 2.2.3.2 (f)	Maintained to a high level, with irrigation to the majority of the area
POS 10	Excluded S 2.2.3.2 (b), (e) and (f)	Existing vegetation to be retained, with understorey planting to occur. Revegetation across this area at 45%, intersected by footpaths and seating nodes. The total area of classifiable vegetation will be less than 1 ha and this area is more than 100m from any other classified vegetation, allowing exclusion under S 2.2.3.2 (b). Remaining low threat vegetation and non vegetated areas within this POS are excluded under S 2.2.3.2 (f) and (e) respectively. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.

Public Open Space Name	Exclusion / Classification Clause	Justification
POS 11	Excluded S 2.2.3.2 (e) and (f)	Area will include turf recreation area (35%), with 20% revegetation to occur, with areas intersected by footpaths. 94% of this POS will be irrigated. Given the lack of existing vegetation, sparse revegetation and irrigation to nearly the entire POS, this area is excluded under S 2.2.3.2 (f), with non vegetated areas excluded under S 2.2.3.2 (e). Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
POS 12	Class A Forest & Excluded (e) and (f)	Area will include turf recreation area (35%), with 20% revegetation to occur, with areas intersected by footpaths. 92% of this POS will be irrigated. Existing vegetation is to be retained and is Class A Forest. Remaining low threat vegetation and non vegetated areas within this POS are excluded under S 2.2.3.2 (f) and (e) respectively. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
POS 13	Class A Forest & Excluded (e) and (f)	Existing vegetation is Class A Forest. Remaining low threat vegetation and non vegetated areas within this POS are excluded under S 2.2.3.2 (f) and (e) respectively. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
POS 14	Class A Forest & Excluded S 2.2.3.2 (a)	Part of a future stage of the development, the majority of the standing vegetation is more than 100m from the current development. A small strip of Class A Forest is within 100m and has been mapped along the western boundary.

Public Open Space Name	Exclusion / Classification Clause	Justification
POS 15	Excluded S 2.2.3.2 (a) & (f)	Part of a future stage of the development, more than 100m from the current development. POS will be mostly irrigated (96%), with no existing trees allowing for predominately turf and active uses, therefore also excluded under S 2.2.3.2 (f).
POS 16	Excluded S 2.2.3.2 (a) & (f)	Part of a future stage of the development, more than 100m from the current development. POS will be mostly irrigated (95%), with no existing trees allowing for predominately turf and active uses, therefore also excluded under S 2.2.3.2 (f).
POS 17	Excluded S 2.2.3.2 (b) and (f)	Less than 1 ha in size (~0.57 ha) and more than 100m from any other classified vegetation. Also maintained to a high level, with irrigation to the majority of the area.
POS 18	Excluded S 2.2.3.2 (f)	Maintained to a high level, with irrigation to the majority of the area.
Bussell Highway Landscape Buffer	Class A – Forest and Excluded S 2.2.3.2 (f)	Buffer to be planted with indigenous trees and shrubs. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.
Outer Bypass Landscape Buffer	Class A - Forest and Excluded S 2.2.3.2 (f)	Buffer to be planted with indigenous trees and shrubs. Low fuel zone provided to ensure 21m setback between classified vegetation and any residential lot.

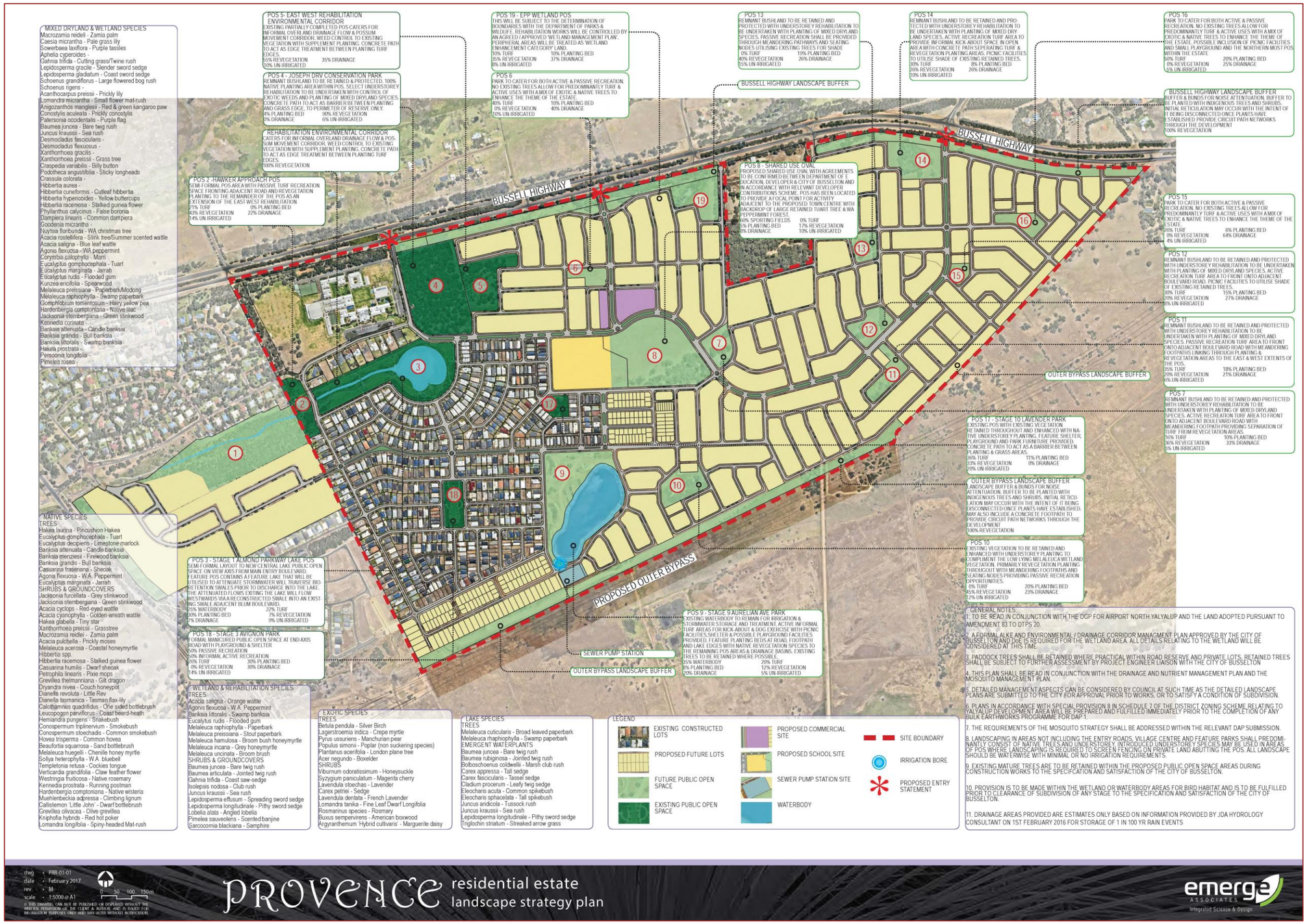


Figure 14 Landscape Strategy Plan for Provence Estate

4 Assessment Against the Bushfire Protection Criteria

4.1 Compliance with the Acceptable Solutions for each Element

Bushfire Protection Criteria – Element 1 - Location		
Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk of bushfire to facilitate the protection of people, property and infrastructure.		
Performance Principle P1: The intent may be achieved where the strategic planning proposal, subdivision or 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 applies 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 DFES and the decision-maker.		
Acceptable Solution	**Compliance**	**Assessment Statements**
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.	Compliance with this element is achieved.	A number of lots will include an area of BAL-40 or BAL-FZ along their boundaries, as they are impacted by vegetation within neighbouring Lot 31 Lyddy Road (Figures 10, 11 & 13). All lots that have BAL-40 or BAL-FZ along their boundary will have a restrictive covenant excluding the construction of dwellings within any BAL-40 or BAL-FZ area. This ensures that no dwelling will be constructed in an area over BAL-29. In the future, this adjacent lot is likely to be developed, allowing lot owners to have a separate BAL assessment completed to show an

updated BAL rating for their lot, which may allow a greater area of the lot to be utilized for the construction of a dwelling in the future.

The BAL Contours across the Site show that the remainder of the residential lots are within areas of BAL-29 or lower.

The entire Site will be maintained by the developer with grassland under 10 cm as per the City of Busselton Firebreak Notice for Category 2 Lots until they are sold, when this maintenance will become the responsibility of the individual landowner. The areas of vegetation that are to be removed during the development process must be removed prior to the release of any lots, to ensure no future dwelling is subjected to a BAL rating over BAL-29.

Low fuel areas within public open space must also be established in a low fuel state prior to the sale of any lots and maintained in this state in perpetuity, as detailed in the Landscape Plan (Appendix C).

Bushfire Protection Criteria – Element 2 – Siting and Design		
Intent: To ensure that the siting and design of development minimises the level of bushfire impact.		
Performance Principle 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. That it 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.		
Acceptable Solution	**Compliance**	**Assessment Statements**
A2.1 Asset Protection Zone (APZ) Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the following requirements: • Width: Measured from any external wall or supporting post or column of the proposed building, and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m² (BAL-29) in all circumstances. • Location: the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in instances where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, in perpetuity (see explanatory notes). • Management: the APZ is managed in accordance with the requirements of 'Standards for Asset Protection Zones'. (see Schedule 1).	Compliance with this element is achieved.	As illustrated in the BAL Contour, all dwellings will have a sufficient setback from the classified vegetation to achieve a BAL-29 or lower rating. Asset Protection Zones will be achieved with all proposed lots being established and maintained in perpetuity as a low fuel zone as part of the development process, ensuring that any areas of an APZ that extend into a neighbouring lot will also be maintained in a low fuel state in perpetuity. The Asset Protection Zones of some lots extend into areas of Public Open Space, these areas will be established and maintained in a low fuel state in perpetuity to ensure compliance with the requirements for an Asset Protection Zone, as detailed in the Landscape Plans (Appendix C).

Bushfire Protection Criteria – Element 2 – Siting and Design		
		In addition to the requirements of the Guidelines, the City of Busselton's Firebreak and Fuel Hazard Reduction Notice for Category 2 lots must be complied with, including maintaining grasses at under 10cm in height.

Bushfire Protection Criteria – Element 3 – Vehicular Access		
Intent: To ensure that the vehicular access serving a subdivision/development is available and safe during a bushfire event.		
Performance Principle P3: The internal layout, design and construction of public and private vehicular access and egress in the subdivision/ development allow emergency and other vehicles to move through it easily and safely at all times.		
Acceptable Solution	**Compliance**	**Assessment Statements**
A3.1 Two Access Routes Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.	Compliance with this element is achieved.	All proposed lots will have two access/egress routes on a public road network. Joseph Drive and the roads to be constructed during the development process allow for three access/egress options for the lots onto Bussell Highway (Figure 1). Bussell Highway can then be taken to the west towards Busselton or to the east towards Capel. During the development process both Lyddy Road and Cabel Sands Road will be decommissioned, however there will be a minimum of two exit

Bushfire Protection Criteria – Element 3 – Vehicular Access		
		points out to Bussell Highway at all stages of the development process (see Appendix E – Technical Note regarding Access Points)
A3.2 Public Road A public road is to meet the requirements in Table 6, Column 1 (Figure 15)	Compliance with this element is achieved.	Public roads will be constructed to meet the requirements within the Guidelines (Figure 15).
A3.3 Cul-de-sac (including a dead-end road) Where no alternative exists (i.e. the lot layout already exists, demonstration required): • Requirements in Table 6, Column 2 (Figure 15); • Maximum length: 200 m (if public emergency access is provided between cul-de-sac heads maximum length can be increased to 600 m provided no more than eight lots are serviced and the emergency access way is no more than 600 m); and • Turn-around area requirements, including a minimum 17.5 metre diameter head.	Compliance with this element is achieved.	To ensure that each stage of the development process meets the Guidelines, temporary compliant cul-de-sacs will be installed as shown in Figure 15. Once future stages of the development proceed, the temporary cul-de-sacs will no longer be necessary.
A3.4 Battle-axe Where no alternative exists: • Requirements in Table 6, Column 3 (Figure 15); • Maximum length: 600 m; and • Minimum width: 6 m.	Not applicable to this Site.	There are no proposed battle-axe lots within this development.

Bushfire Protection Criteria – Element 3 – Vehicular Access		
A3.5 Private driveway >50m • Requirements in Table 6, Column 3 (Figure 15); • Required where a house site is more than 50 m from a public road; • Passing bays: every 200 m with a minimum length of 20 m and a minimum width of 2 m; • Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 m (i.e. kerb to kerb 17.5 m) and within 50 m of a house; • Any bridges or culverts are able to support a minimum weight capacity of 15 t; and • All-weather surface (i.e. compacted gravel, limestone or sealed).	Compliance with this element is achieved.	Given the size of the lots within this development, it is unlikely that the location of the dwelling within any of the lots will result in a private driveway greater than 50 m. Any driveway over 50 m will comply with the requirements in the Guidelines.
A3.6 Emergency Access Way	Not applicable to this Site.	
A3.7 Fire Service Access Routes (perimeter roads)	Not applicable to this Site.	
A3.8 Firebreak Width Lots greater than 0.5 ha must have an internal perimeter firebreak of a minimum width of 3 m or to the level as prescribed in the local firebreak notice issued by the local government.	Compliance with this element is achieved.	According to the City of Busselton Firebreak and Fuel Hazard Reduction Notice: • Lots under 2,024 m^2, firebreaks are not required, • Lots 2,042 m^2 and over, a minimum 3 m wide trafficable firebreak within 6 metres of all lot boundaries is required.

TECHNICAL REQUIREMENTS	1 Public road	2 Cul-de-sac	3 Private driveway	4 Emergency access way	5 Fire service access routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 metres	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5
*Refer to E3.2 Public roads: Trafficable surface					

Figure 15 Vehicular access technical requirements (Guidelines for Planning in Bushfire Prone Areas Table 6)

Bushfire Protection Criteria – Element 4 - Water		
Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.		
Performance Principle P4: The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for fire fighting purposes.		
Acceptable Solution	**Compliance**	**Assessment Statements**
A4.1 Reticulated Areas The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.	Compliance with this element is achieved.	The Site will be reticulated. Reticulated water will be supplied in accordance with the Water Corporation's No. 63 Water Reticulation Standard. Fire hydrants will be supplied in accordance with Water Corporation requirements.
A4.2 Non-reticulated Areas	Not applicable to this Site.	
A4.3 Individual lots within non-reticulated areas (only for 1 additional lot)	Not applicable to this Site.	

4.2 Performance Based Solutions

The Site assessment was conducted in accordance with AS 3959-2018 Simplified Procedure (Method 1), with a Method 2 calculation required for the Plot 9 vegetation. The Proposal meets all the compliance requirements for the four Bushfire Protection Criteria Elements. There are no performance-based solutions proposed.

4.3 Summary of the Assessment Outcomes

This plan provides acceptable solutions and responses to the performance criteria outlined in the Guidelines for Planning in Bushfire Prone Areas (WAPC, Dec 2017).

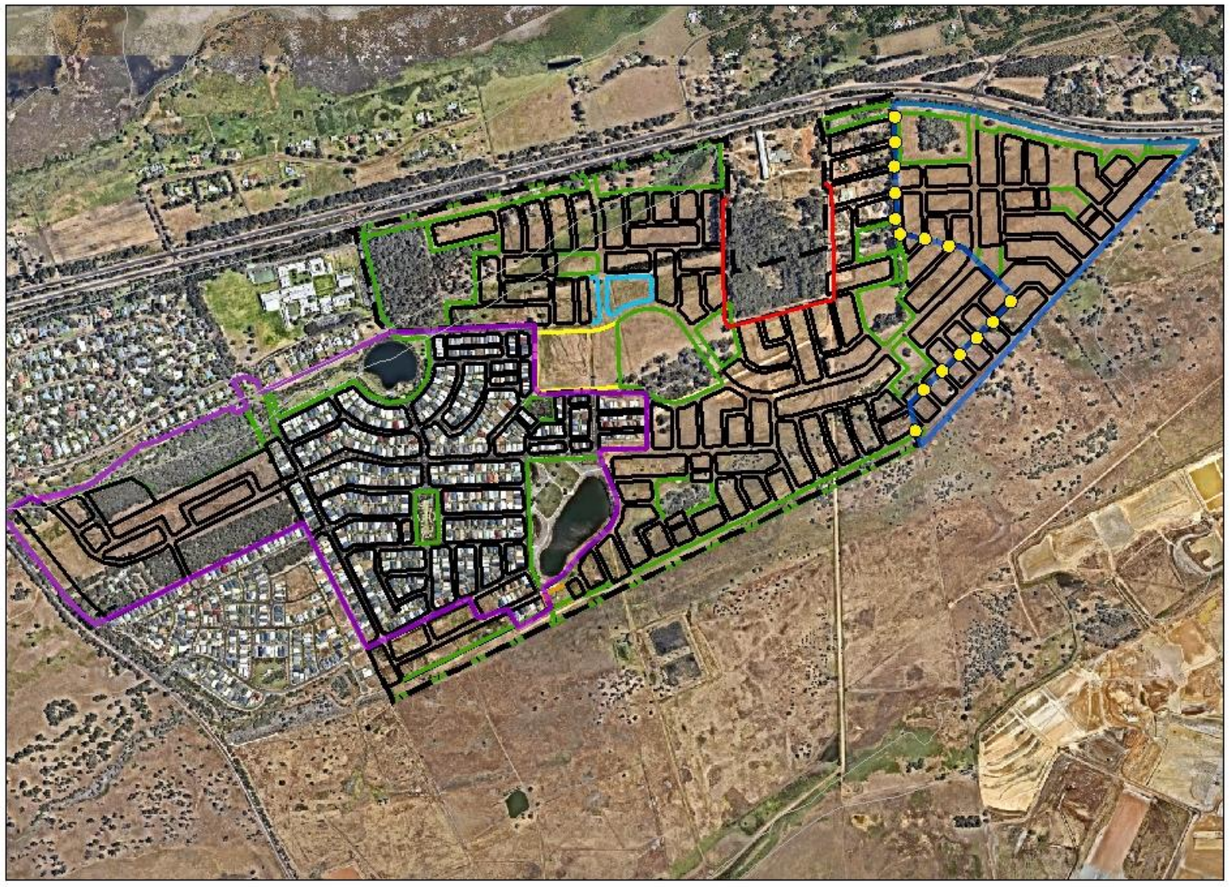
The layout and design of the development is such that no dwelling will be required to be exposed to a radiant heat flux in excess of 29kW/m^2 (BAL-29) provided the management as outlined in the plan is adopted.

Any class 1,2, 3 or associated 10a structure that are to be constructed, or additions planned to existing dwellings shall be designed and built to conform with Australian Standards AS3959-2018:

- BAL-29: sections 3 & 7;
- BAL-19 sections 3 & 6; and
- BAL 12.5 sections 3 & 5.

A summary of the Bushfire Management Strategies to be implemented is provided in Figure 15. An individual BAL assessment may achieve a lower BAL rating, based on the exact location of a dwelling within a lot, or the development of areas adjacent to the Site that are currently vegetated.

Spatial representation of the proposed risk management measures



PROPERTY / ASSESSMENT DETAILS

Owner: Satterley
Property Address: Provence Estate, Yalyalup
Project No: 17357
Prepared by: K Lamp
Accreditation Level: Level 2
Accreditation Number: 38253
Accreditation Expiry Date: 02/21

N
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Meters

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LEGEND

- Current Stages
- Future Stages
- Previous Stages
- Residential
- POS
- Retail/Commercial
- Primary School
- Public Use
- Temporary turn arounds
- Maximum BAL-40 extent

NOTES

The minimum width for the Asset Protection Zone (APZ) for this Site is the distance required to meet the BAL-29 setback.

Vegetation within the APZ is to comply with Schedule 1 Element 2 of the Guidelines noting that:

- Trees >5m in height are to be setback a minimum distance of 6m from the building with no branches overhanging the roof.
- Shrubs < 5m in height are to be setback a minimum distance of 3m from the building, and not planted in clumps greater than 5 sqm
- Grass is to be maintained at less than 100mm in height.

No dwelling is to be constructed in an area with a BAL-40 or BAL-FZ rating. Lots within this development with boundaries currently subjected to a BAL-40 or BAL-FZ rating include a restrictive covenant prohibiting the construction of a dwelling within areas >BAL-29.

The Developer will maintain all public open space in accordance with the approved Landscape Plan for a minimum of two years, when ownership and management responsibility is handed over to the City of Busselton. The Asset Protection Zones of some lots extend into the public open space. These areas must be maintained in a low fuel state in perpetuity, as detailed in the landscape plans for the development.

Reticulated water and fire hydrants will be provided in accordance with the Water Corporation No.63 Water Reticulation Standard.

Public Roads will be constructed to the requirements in the Guidelines, A3.2, with temporary cul-de-sacs constructed to the requirements in Table 6 of the Guidelines by the Developer.

Any driveway 50 m or longer will comply with the requirements of the Guidelines A3.5.

For any lots 2,024sqm and above, firebreaks will be installed and maintained according to the City of Busselton's Firebreak and Fuel Hazard Reduction Notice.

Installation and upkeep of the APZ, compliance with the City of Busselton's Firebreak Notice, driveways and construction to BAL standards are the responsibility of the landowner. The measures listed above shall be implemented prior to the occupation of any dwelling within the Site and shall continue to be maintained in perpetuity.

Figure 16 Map of Bushfire Management Strategies

5 Responsibilities for Implementation and Management of the Required Bushfire Measures

The responsibilities for the Developer, Builder, Landowner/Occupier and Local Government are outlined in Table 6, Table 7, Table 8 and Table 9 respectively.

Table 6 Developer Responsibilities

Number	Action	Due	Completed
1	Establish lots to the dimensions and standard stated in the Bushfire Management Plan.	Post planning approval and prior to lot sale	☐
2	Construct public roads (A3.2) and temporary cul-de-sacs (A3.3) to the dimensions and standard stated in the Bushfire Management Plan.	Post planning approval and prior to lot sale	☐
3	Install reticulated water supply in accordance with Water Corporation's No. 63 Water Reticulation Standards.	Post planning approval and prior to lot sale	☐
4	Install fire hydrants in accordance Water Corporation requirements.	Post planning approval and prior to lot sale	☐
5	Provide a copy and obtain endorsement of this Bushfire Management Plan by those with responsibility under this plan including Builders, Landowners/Occupiers and City of Busselton.	Post planning approval and prior to lot sale	☐
6	Establish and maintain all public open space to the standard detailed in the Landscape Plans (Appendix C) until the lots are sold and the responsibility for the public open space is handed over to the City of Busselton.	Post planning approval and prior to lot sale / handover to City of Busselton	☐
7	Establish Restrictive Covenants over all lots with areas >BAL-29, prohibiting the construction of dwellings within any BAL-40 or BAL-FZ area, to ensure any dwelling constructed within the Site is BAL-29 or less.	Creation of titles and deposited plan	☐

Number	Action	Due	Completed
8	Where WAPC condition a subdivision application approval with a requirement to place a notification onto the certificate(s) of title and a notice of the notification onto the diagram or plan of survey (deposited plan). This will be done pursuant to Section 165 of the *Planning and Development Act 2005* ('Hazard etc. affecting land, notating titles as to:') and applies to lots with a determined BAL rating of BAL-12.5 or above. The notification will be required to state: 'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land'.	Creation of titles and deposited plan	☐
9	Provide a copy and obtain endorsement of this Bushfire Management Plan by those with responsibility under this plan including Builders, Landowners/Occupiers and Shire of Augusta-Margaret River.	Post planning approval and prior to lot sale	☐

Table 7 Builder Responsibilities

Action	Action	Due	Completed
1	Be aware of the existence of any BMP that refers to the Site	Prior to any building work.	☐
2	Ensure the building or incidental structure to which a building permit applies is compliant on completion with the bushfire provisions of the Building Code of Australia (BCA) as it applies in WA.	Prior to any building work.	☐

Table 8 Landowner / Occupier Responsibilities

Number	Action	Due
1	Install and maintain driveways longer than 50 m in compliance with the Guidelines (A3.5).	Prior to occupancy & ongoing
2	Maintain an Asset Protection Zone (APZ) according to the standard in the Guidelines or according to a detailed BAL assessment.	Ongoing
3	For lots 2,024 m^2 and above, install and maintain firebreaks according to the City of Busselton's Firebreak and Fuel Hazard Reduction Notice.	Prior to occupancy & ongoing

Number	Action	Due
4	Comply with the relevant local government annual firebreak notice issued under s33 of the *Bush Fires Act 1954*.	Ongoing
5	Ensure that any builders (of future structures on the Lot) are aware of the existence of this Bushfire Management Plan and the responsibilities it contains regarding the application of construction standards corresponding to the determined BAL rating.	Ongoing
6	Ensure all future buildings the landowner has responsibility for, are designed and constructed in full compliance with: (a) the requirements of the WA Building Act 2011 and the bushfire provisions of the Building Code of Australia (BCA) as applicable to WA; and (b) with any identified additional requirements established by this BMP or the relevant local government.	Ongoing
7	Ensure no habitable buildings are constructed in areas above a BAL-29 rating.	Ongoing
8	Updating the Bushfire Management Plan may be required to ensure that the bushfire risk management measures remain effective. Bushfire plans do not expire and are a 'living document'. Updating is required in certain circumstances, including (but not limited to) if site conditions change, if further details are required at subsequent development stages or to reflect new technologies or methodologies in best practice bushfire risk management ('Guidelines' s4.6.4).	Ongoing

Table 9 City of Busselton Responsibilities

Number	Action	Due
1	Monitor landowner compliance with the annual firebreak notice.	Ongoing
2	Develop and maintain district bushfire fighting services and facilities.	Ongoing
3	Promote education and awareness of bushfire prevention and preparation measures though the community.	Ongoing
4	Administer the requirements of the *Bush Fire Act 1954*, *Planning and Development Act 2005* and the *Building Act 2011*.	Ongoing
5	Maintain areas of Public Open Space to the level prescribed in the Landscape Plans (Appendix C), including low fuel zones, in perpetuity.	Ongoing

6 References

DFES (2015). Map of Bush Fire Prone Areas. Department of Fire and Emergency Services. [available at www.dfes.wa.gov.au/bushfireproneareas].

FESA, WAPC & Dept of Planning (2010). Planning for Bushfire Protection. Edition 2. May, Government of Western Australia, Perth. WA.

WAPC (V1.3, Dec 2017). Guidelines for Planning in Bushfire Prone Areas. Western Australian Planning Commission, Perth. WA.

WAPC (2015a). State Planning Policy 3.7: Planning in Bushfire Prone Areas (SPP 3.7). Western Australian Planning Commission, Perth. WA.

Appendix A City of Busselton Firebreak & Fuel Hazard Reduction Notice

Document Set ID: 4164081
Version: 1, Version Date: 08/08/2019

BUSH FIRES ACT 1954

PROPERTY COMPLIANCE REQUIREMENTS

Compliance inspections of land will be carried out from 16 November 2019, to assess landowner(s) or occupier(s) of land compliance with the City of Busselton Firebreak and Fuel Hazard Reduction Notice.

- **Rural Residential, Urban and Industrial Land requirements must be compliant by 16 November 2019**
- **Rural Land requirements must be compliant by 15 December 2019**

Local Government may serve a notice pursuant to Section 33 of the *Bush Fires Act 1954*, requiring the property owner to undertake any extra work to reduce the impact of a fire

- **Rural Residential, Urban and Rural Land requirements must be maintained in accordance with the table overleaf until 12 May 2020** or a later date if the compliance period is extended, in which case a notice will be placed in the local newspaper

FIRE PERMITS

- Permits to burn are required for the whole of the restricted periods and can only be obtained from the Fire Control Officer for your area
- Permits are to be obtained before burning commences (the permit holder must be in possession of the permit during the burn)

FIRE PERMIT APPLICATION

Before you call a Fire Control Officer ensure you have the following information

- Who will be the three able bodied persons in attendance at all times whilst the fire is alight including contact phone number?
- What is the address of the property for which the permit applies?
- What fire fighting equipment and resources will you have at the fire front and is it in good working order?
- What is the size of burn to take place?
- Are there firebreaks installed and can a fire unit get access to the area?
- What material are you burning? Is it dry? Are there any plastics, tyres, treated posts or woods in the piles or area to be burnt? If so, remove them to a safe place.
- Ensure you give 72 hours notice to the Fire Control Officer first; and
- Ensure you notify neighbours 72 hours prior to commencing your burn

For further advice, contact your local Fire Control Officer, as advertised in the City of Busselton's Community Directory or on the City of Busselton website www.busselton.wa.gov.au

GENERAL REQUIREMENTS

- **Garden Refuse Urban Areas (Town sites):** No garden refuse is permitted to be burnt on the ground, in the open air or in an outdoor incinerator within the urban areas of Busselton and Dunsborough town sites at any time of the year
- **Garden Refuse Rural Residential Areas (non-Town sites):** The burning of garden refuse is prohibited from 14 December to 28 February. **During the restricted burning period**, 2 November to 14 December and 1 March to 12 May each year, permits are required to be obtained from the Fire Control Officer in your area for the burning of any garden refuse
- **Burning of toxic materials** and **rubbish** is prohibited at all times
- **Camp fires** are prohibited within the City during the restricted and prohibited burning period
- **Wood** and **coal fuelled barbecues,** including wood fired pizza ovens and chimineas are banned during a total fire ban or in any period when the fire danger forecast is 'Very High' or above
- **Wood fired pizza ovens** must have a spark arrestor fitted
- **Warning:** The use of electric fences during periods of 'Very High' or above may cause fire
- **Owners of tractors** with down swept exhaust systems are encouraged to have an approved spark arrestor fitted as provided in the *Bush Fires Act 1954*
- **Welding, Cutting** and **Grinding Equipment:** A person shall not operate this equipment during the restricted/prohibited burning times on land which is under crop, pasture, stubble and bush unless one working fire extinguisher is provided, work area is clear of flammable materials and there is compliance with any other controls required by a Fire Control Officer.
- **Welding, cutting** and **grinding equipment** is **not permitted** to be used anywhere within the City of Busselton when the fire index is **'extreme'** or above

FIRE DANGER RATING

For the current fire danger rating visit Department of Fire & Emergency Services (DFES) website www.dfes.wa.gov.au or Bureau of Meteorology (BOM) website www.bom.gov.au

CONTRACTORS

Please be advised, if you engage a contractor to gain compliance with this notice it is the property owner, **not the contractor**, who is responsible for the standard and quality of the fire prevention work undertaken and required to be compliant by 16 November (or 15 December if Rural Land) each year and maintained as per this notice throughout whole the fire season.

CONTACT US

For further fire safety information visit the City of Busselton website www.busselton.wa.gov.au or Department of Fire & Emergency Services (DFES) website www.dfes.wa.gov.au

IMPORTANT DATES

The below dates may change due to seasonal fire conditions in which case details will be published in the local newspaper.

RESTRICTED

BURNING PERMITS ARE REQUIRED FROM
2 November 2019 to 14 December 2019 inclusive
and
1 March 2020 to 12 May 2020 inclusive

BURNING PROHIBITED

ALL FIRES PROHIBITED
15 December 2019 to 28 February 2020 inclusive

COMPLIANCE DATE

- **Completion of firebreaks/fuel hazard reduction on all rural residential, urban and industrial land is required to be completed by 16 November 2019 and must be maintained until 12 May 2020**
- **Completion of firebreaks/fuel hazard reduction on all rural land is required to be completed by 15 December 2019 and must be maintained until 12 May 2020**
- **Burning on public holidays during the restricted fire season is prohibited**

Applications for a variation of this the Firebreak and Fuel Hazard Reduction Notice, where ground considerations or environmental concerns prevent compliance with the requirements of this Notice, must be lodged in writing together with a Firebreak and Fuel Hazard Reduction Notice Variation form, prior to 31 October 2019

The hardest aspect of fire prevention is explaining to your family why you didn't undertake any!

Actions speak louder than words and actions save lives

Should you require further clarification of the information contained in this notice please do not hesitate to contact the City's Ranger and Emergency Services Department on (08) 9781 0444.

City of Busselton
Geographe Bay

FIREBREAK AND FUEL HAZARD REDUCTION NOTICE

ARE YOU BUSHFIRE READY?

2019/2020 BUSH FIRE SEASON

FIRST AND FINAL NOTICE

Bush Fires Act 1954

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 the City of Busselton Firebreak and Fuel Hazard Reduction Notice.

Failure to comply with this notice may result in a

$5,000 FINE

Fire Prevention Starts with You!

RING 000 FOR ALL FIRES

Document Set ID: 4164091
Version: 1, Version Date: 08/08/2019

FIREBREAK CATEGORY CODE AND SUMMARY OF REQUIREMENTS

ALL REQUIREMENTS IN THIS NOTICE ARE TO BE MAINTAINED THROUGHOUT THE ENTIRE DURATION OF THE FIRE SEASON (1 DECEMBER TO 12 MAY EACH YEAR).

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 *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.*	A	B	C	D
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

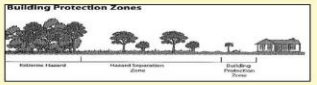
1) **Category 2 - Urban Residential and Industrial-Commercial:** Where the area of land is 2024m² (½ acre) or less, **ALL HAZARDOUS MATERIAL** must be removed from the whole of the land except living trees. In the area remaining, vegetation is to be maintained to a height of no greater than **10 centimetres**; 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 B APZ Requirements

Any habitable building eventuating within the Site will be surrounded by an APZ which meets the following requirements:

a. Width: measured from any external wall or supporting post or column of the proposed building, (developable area/building envelope for a subdivision) and of sufficient size to ensure the potential radiant heat impact of a bushfire does not exceed 29kW/m^2 (BAL-29) in all circumstances;

b. Location: the APZ should be contained solely within the boundaries of the lot on which the building is situated, except in situations where the neighbouring lot or lots will be managed in a low-fuel state on an ongoing basis, into perpetuity;

c. Fences: within the APZ are constructed from non-combustible materials (eg. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.

d. Objects: within 10 metres of a building combustible object must not be located close to vulnerable parts of the building i.e. windows and doors.

e. Fine Fuel load: combustible dead vegetation matter less then 6mm in thickness reduced to and maintained at an average of two tonnes per hectare.

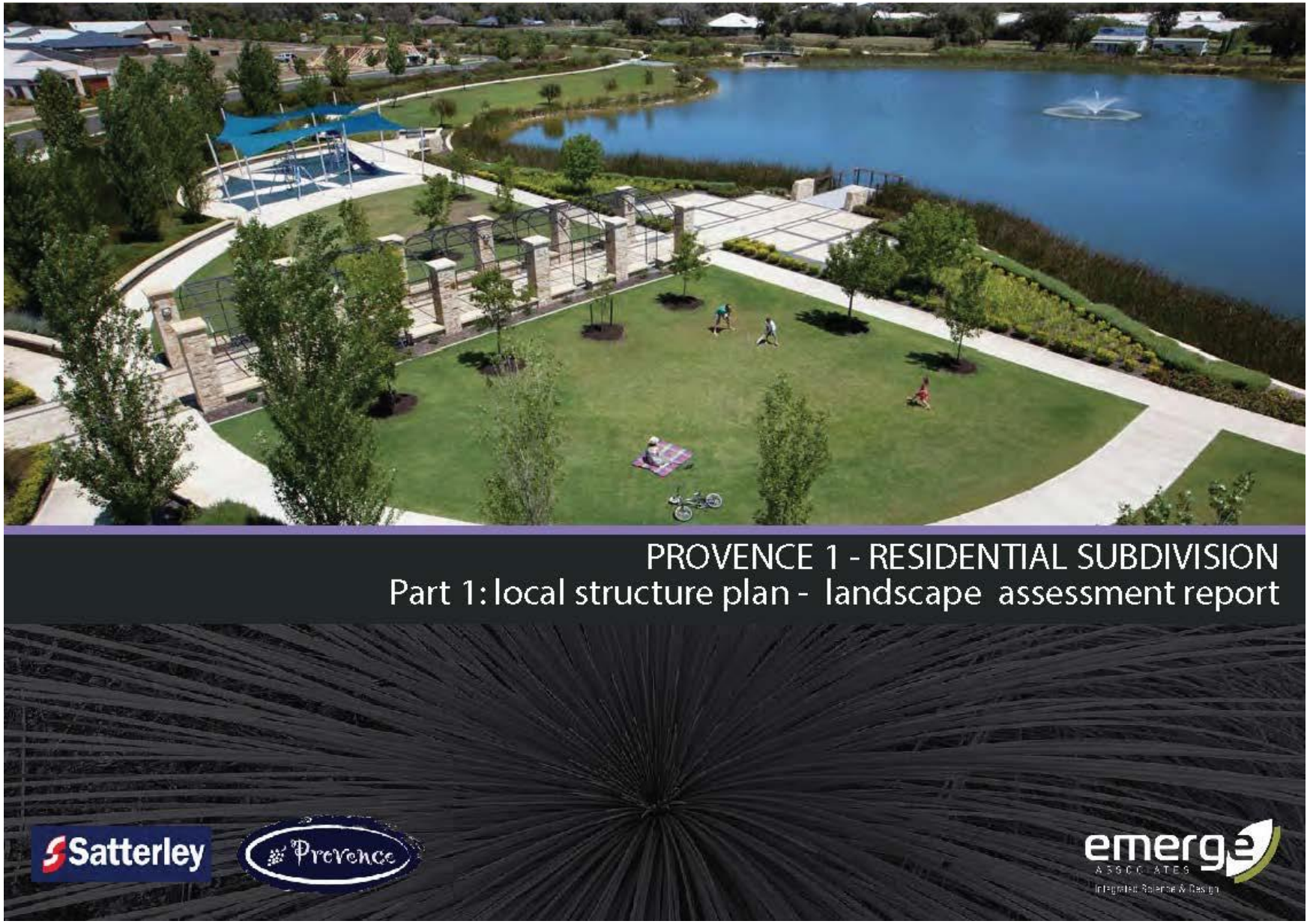
f. Trees (>5m in height): trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and/or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy.

g. Shrubs (0.5m – 5m in height): should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m^2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated at trees.

h. Ground covers (<0.5m in height): can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 meters of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs.

i. Grass: should be managed to maintain a height of 100 millimetres or less.

Appendix C Landscape Plan – including updated concept plans detailing low fuel zones


PROVENCE 1 - RESIDENTIAL SUBDIVISION
Part 1: local structure plan - landscape assessment report
Satterley
Provence
emerge
ASSOCIATES

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1.0 The Project Summary

GENERALLY

1.1 PROJECT LOCATION

The project site is located approximately 4 km south east of the Busselton townsite in southwest Western Australia within the Shire of Busselton off the Bussell Highway and approximately 230km south of Perth. The site is on the main eastern approaches to Busselton town and is visible to the majority of traffic heading into the southwest. The project is in a major urban growth corridor which will see the conversion of surplus rural land to residential and support uses.

1.2 PROJECT SCOPE

The proposed development is anticipated to consist of residential lots and commercial development to be distributed along the southern side of the Busselton Bypass. The project proposes to contain the following elements.

- Commercial precinct / Town Centre
- Between 2100 residential lots total of various densities
- Private High School
- Primary School
- New public open space areas
- Streetscapes of various hierarchies
- Pockets of retained vegetation
- Open water bodies (existing and proposed)
- Creek lines and seasonal flow corridors

The project commenced construction of its first Stages in 2004 with completion of approximately 600 lots up to December 2015. These proposed changes to the existing Structure Plan propose a further 1,500 lots approximately of various sizes.

1.3 ADJACENT LAND USES & INFLUENCES

The development is affected by various adjacent land uses and influences which may require particular design responses in order to relate to or screen off various effects. Adjacent land uses and influences include the Business Park, the Busselton Aiport and declining rrual uses each with possible landscape and project responses to be considered as part of the site design process.

1.4 BUSSELTON BYPASS & FUTURE OUTER BYPASS

The effects of highway noise and movement may have detrimental affects on adjacent residential areas adversely effecting price and lifestyle.

1.5 PROTECTED WETLANDS

Adjacent protected wetland are locally significant and may not be adversely affected by the development including water levels, pollutants, unauthorised access and the like.

1.6 RURAL USES

Adjacent rural uses, while declining, can have a longer term affect on the development through the leaching of high nutrient loads through groundwater across the development. Potential historic contamination of small areas with pesticides, fertilisers and the like may be possible. Immediate issues relating to adjacent rural uses such as odour may also periodically affect parts of the site.

1.7 TYPICAL LOCAL CLIMATE AND RAINFALL

The local area climate is characterised as a mild Mediterranean climate with cool wet winter and generally hot summer with cooling afternoon sea breezes. The key data is as follows:

Summer	-Mean Daily Maximum Temperature	29.5 oC
	-Mean Daily Minimum Temperature	13.8 oC
	-Maximum Temperature	41.0 oC
Winter	-Mean Daily Maximum Temperature	17.4 oC
	-Mean Daily Minimum Temperature	7.2 oC
	-Minimum Temperature	-1.0 oC

Monthy Rainfall (millimetres)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10.8	3.1	16.0	35.4	104.7	128.8	131.2	104.1	79.0	29.8	24.6	9.0

1.8 SITE TOPOGRAPHY

The site is relatively flat and low lying. Natural surface elevation ranges from 3.5mAHD in the north increasing to approximately 8mAHD in the south of the site.

1.9 SITE WATER RESOURCES

Existing groundwater is generally high compared to the existing ground level. This may impact on footings, structural location, vegetation types and species success. High variation in existing groundwater must be considered in detail (while allowing for development pressures) during design to ensure an optimum outcome.

The existence of the groundwater and stream flows provide an opportunity to reinforce the presence of the natural system within the design of the estate. The journey along the water corridor becomes one of the key design elements for the development.

There are six dampland areas within the site that are classified as Multiple Use Wetlands. A portion of one of the damplands has also been identified as an EPP Wetland.

The existence of the groundwater and stream flows provide an opportunity to reinforce the presence of the natural system within the design of the estate. The journey along the water corridor becomes one of the key design elements for the development.

1.10 Existing Site Vegetation

There are only two significant remnants of native vegetation that remain within the site since a significant portion of the area has been cleared for past grazing and mineral sand mining. Retention of this resource is highly desirable and work should allow opportunities to enhance the existing vegetation. These remnants of native vegetation include:

- an area approximately 4.5ha remnant Peppermint (Agonis flexuosa) Low Closed Forest with scattered Marri (Corymbia calophylla) located on the north-eastern boundary of Lot 9003.
- An area approximately 2ha remnant Tuart (Eucaptus gomphocephala) and Peppermint (A.flexuosa)Tall Woodland located in the centre of Lot 202.

Although the majority of the remaining project area has been cleared scattered Marri, Peppermint and Tuart trees exist on site. The EPP wetland, located in the north-eastern corner of Lot 2, is associated with scattered Paperbark (Melaleuca rhaphiophylla).

1.11 EXISTING SITE FAUNA

Surveys of the remnant vegetation areas have identified habitats for the Western Ringtail Possum, along with the existence of the Western Grey Kangaroo. Measures are in place to accommodate for the native fauna, with all site work needing to comply with the Western Ringtail Possum Management Plan and Western Grey Kangaroo Management Plan.

1.12 KEY SITE ASSET SUMMARY LIST

The following key assets and elements are evident upon examination of the existing site. These elements should be considered, promoted and integrated into the design process to best ensure success of the project, meshing new design in with existing retained site elements and minimised cost in recreation of existing assets. Key site assets include;

- Ease of main access off the Busselton Bypass
- Retained in tact bushland and habitat areas
- Retained significant individual trees
- Retained site dams from past rural uses
- Retained and protected creek lines and drainage corridors
- Western Ringtail Possum habitat / access corridor
- Seasonally high groundwater levels may require use and or mitigation

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1.13 KEY POINTS & OPPORTUNITIES

The following key points summarise inherent site opportunities and the projects intent. These points form the basis of the projects design brief and are to be referenced and considered when embarking on future design processes.

1. Retain and protect existing stands of intact vegetation
2. Retain and protect existing significant trees in desirable locations
3. Maximise exposure to the site entry off the Busselton Bypass
4. Maximise pedestrian linkages throughout the development, particularly to significant attractants including shops, town centre, schools and similar.
5. Maximise legibility of planning layout and access through the road hierarchy
6. Provide shade, shelter and respite from the effects of the south west seasons
7. Provide a wide range of recreational options and locations for residents
8. Provide areas of informal open space
9. Define and highlight existing open water bodies
10. Utilise open space to accommodate drainage and water quality improvements
11. Maximise opportunities for safe ringtail possum movement through natural areas
12. Provide interpretive material reflective of the local environment and ecology
13. Maximise integrated planting approach between historic, cultural and native plantings
14. Ensure the agreed design approach extends through many elements and materials
15. Ensure all works proposed are compliant and consistent with the required Bush fire Mangement Plan

2.0 GUIDING LANDSCAPE PRINCIPLES

2.1 LANDSCAPE AIM

To create a sustainable community and a place that is derived from the local areas history, culture, commerce and ecology which resonates with residents and visitors as local, desirable, legible and true.

2.2 LANDSCAPE OBJECTIVES

The following objectives have been determined to support the above aim at various levels.

- To support the existing and nuture the creation of a new community through provision of facilities, places, spaces, character and elements appropriate to the communities views and needs.
- To engende a community with an aspirational and self reliant outlook and a sense of ownership based on quality planning and design,
- To balance or improve upon existing site environmental qualities following development,
- The creation of this place is to be demonstrated and supported through all facets of the landscape across all effected disciplines to best ensure design harmony across responsibilities.
- To ensure the ongoing delivery of quality design and construction outcomes based on rigorous thought, process, selection and detailing.
- To maximise the use of sustainability principles and measurable outcomes

3.0 LANDSCAPE CHARACTER

3.1 GUIDING CHARACTER

The guiding character of the projects landscape elements and overall theme is based on a fusion of French provincial character and the existing south west rural character.

It is proposed that both of these background themes are similar in many respects pertaining to detail, materials, scale, form and both convey a relaxed and informal character. This is in part reflective of the local southwest semi-rural outdoor and vineyard culture and also draws on historic themes via French explorers and remnant French influences and naming that exists across southwest Western Australia. Vestiges of former rural uses and materials are evident in both the provincial and southwest landscapes and built form.

It is therefore proposed that the base French provincial character is not in conflict with the broad aims of the local authority and is not alien to the local southwest area or its residents. It is also proposed that this provincial theme will build upon reinforcing the local areas existing relaxed rural appeal to current and new residents. The proposed preferred theme is conveyed here forward by this document and its contents.

3.2 LANDSCAPE CHARACTER

The character of public open space is proposed to be expressed through the following elements;

- Landform and contouring to reflect a rolling rural landscape,
- Planting to reflect past cultural and rural uses,
- Planting to embrace the local environment,
- Recreational uses in communal and human scaled spaces,
- Domestic elements eg; pots and urns which convey a pedestrian scale and resemble a private garden in content and character,
- Informal elements with a clear functional design basis,
- Finishes that are indicative of continued and historic use,
- Rammed earth in rich colour tones,
- Limestone coloured rough textured render,
- Natural limestone cladding in random pattern,
- Precast concrete block set in a stone look,
- Precast concrete cobbles in various sizes and earthy colours,
- Wrought Iron look detailing and highlights,
- Galvanised permeable metal fencing with detail highlights in neutral colours,
- Thick local timber framing in feature locations,

3.3 FORM & ELEMENTS

The form and scale of various landscape elements is influenced by and builds upon the guiding character as outlined above. Various forms and elements are to be characterised by;

- Thick set posts or ornate light structures,
- Heavy set and grounded elements,
- Landmark elements,
- Informal edges or trimmed edges with informal infill,
- Small openings,
- Earthy tones with highlight colours,
- Robust and Solid Materials,
- Weathered, rumbled and rustic finishes,
- Oversized wall and plinth widths

3.4 GUIDING MATERIALS

The following material selection recommendations are made reflecting the inspiration of the guiding character as outlined previously.

Recommended material design selections may include;

- Limestone coloured rough textured render
- Natural limestone and Donnybrook stone cladding in random mosaic pattern
- Rough sawn and recycled oversize hardwood timbers
- Precast concrete block set in a stone look
- Precast concrete cobbles in various sizes and earthy colours
- Precast concrete sleepers in various sizes and earthy colours
- Wrought Iron look detailing and highlights
- Galvanised permeable metal fencing with detail highlights in neutral colours
- Natural stone in highlight locations
- Galvanised metal shutters with neutral coloured finish
- Brushwood screen fencing in long runs or feature locations
- Corrugated Steel in agreed locations
- Granite cobble sets - subject to budget

Refer attached 'Provence 1: Residential Subdivision Part 2 - Landscape Character & Material Palette' for detail information on material and landscape palette selections.

4.0 PUBLIC OPEN SPACE

4.1 INTENT

Public open space is the focal point for the developments creation of character, community gathering and activities, informal recreation, habitat, public facilities, visual relief and urban softening. Refer Appendix A 'Provence - Landscape Strategy Plan' Revision N dated February 2020.

4.2 LOCATION & DISTRIBUTION

The location of public open space can demonstrate and highlight the lifestyle and character of the development on offer. Distribution and sizing of public open space is determined by broad town planning principles and various approvals as evident in the current attached master plan.

4.3 POS FOCAL POINTS & AXIS VIEWS

Open space should aim to locate and display popular various facilities, feature elements at focal points easily visible from vehicles and by pedestrians and cyclists. This maximises marketing return for budgets spent, provides passive surveillance, clearly conveys the facilities available.

4.4 LIFESTYLE & FACILITIES

Various facilities proposed for creation within the public realm may include;

- Adventure level playgrounds
- Discovery and learning playgrounds
- Shelters and Arbors
- Viewing platforms
- BBQs and gathering spaces
- Boardwalks
- Integrated path systems
- Feature lighting
- Security and safety lighting
- Informal open recreation spaces
- Fitness trails
- Smaller contemplative spaces
- Interpretive signage
- Public art

4.5 PUBLIC OPEN SPACE CATEGORIES

The West Australian Planning Commission document 'Liveable Neighbourhoods: A Western Australian Government Sustainable City Initiative' published in January 2009 provides a basic definition for the categorisation of public open space areas broadly based on size, proximity to dwellings and servicable population. These include:

- Local Parks
- Neighbourhood Parks
- District Open Space
- Community Facilities Sites
- Natural Areas and Cultural Features
- Foreshore Reserves and Regional Open Space

The layout and planning for public open space within the Provence residential development has been undertaken in accordance with the Liveable Neighbrouhood Guidelines and subsequently proposes to deliver a series of public open spaces incorporating the above landscape categories.

Further to this, the local government authority City of Busselton uses these POS categories to guide the delivery of public facilities such as turf areas, park furniture, playgrounds, and picnic facilities as well as the subseqent on-going maintenance requirements associated with the upkeep of the public open space areas. The following public open space area descriptions have therefore been organised into the Liveable Neighbourhood public open space categories.

4.6 PUBLIC OPEN SPACE MAINTENANCE

It is a standard process for the local government authority to require a Developer Maintenance Period to establish the various landscape works and elements constructed within the public open space areas prior to the ceding of land to the Crown and all responsibility to be transferred to the local government authority. The City of Busselton have previously required that the developer undertake a 5 year developer maintenance of public open space and streetscapes for completed public open space at Provence. This has also required a Landscape Maintenance Agreement to be developed to guide the maintenance and subsequent handover to the City.

The policy of the City has recently been revised and the developer maintenance period has been reduced to 2 years and provided all conditions and requirements of the Landscape Maintenance Agreement are acheived.

FIGURE 1 - LANDSCAPE MASTER PLAN

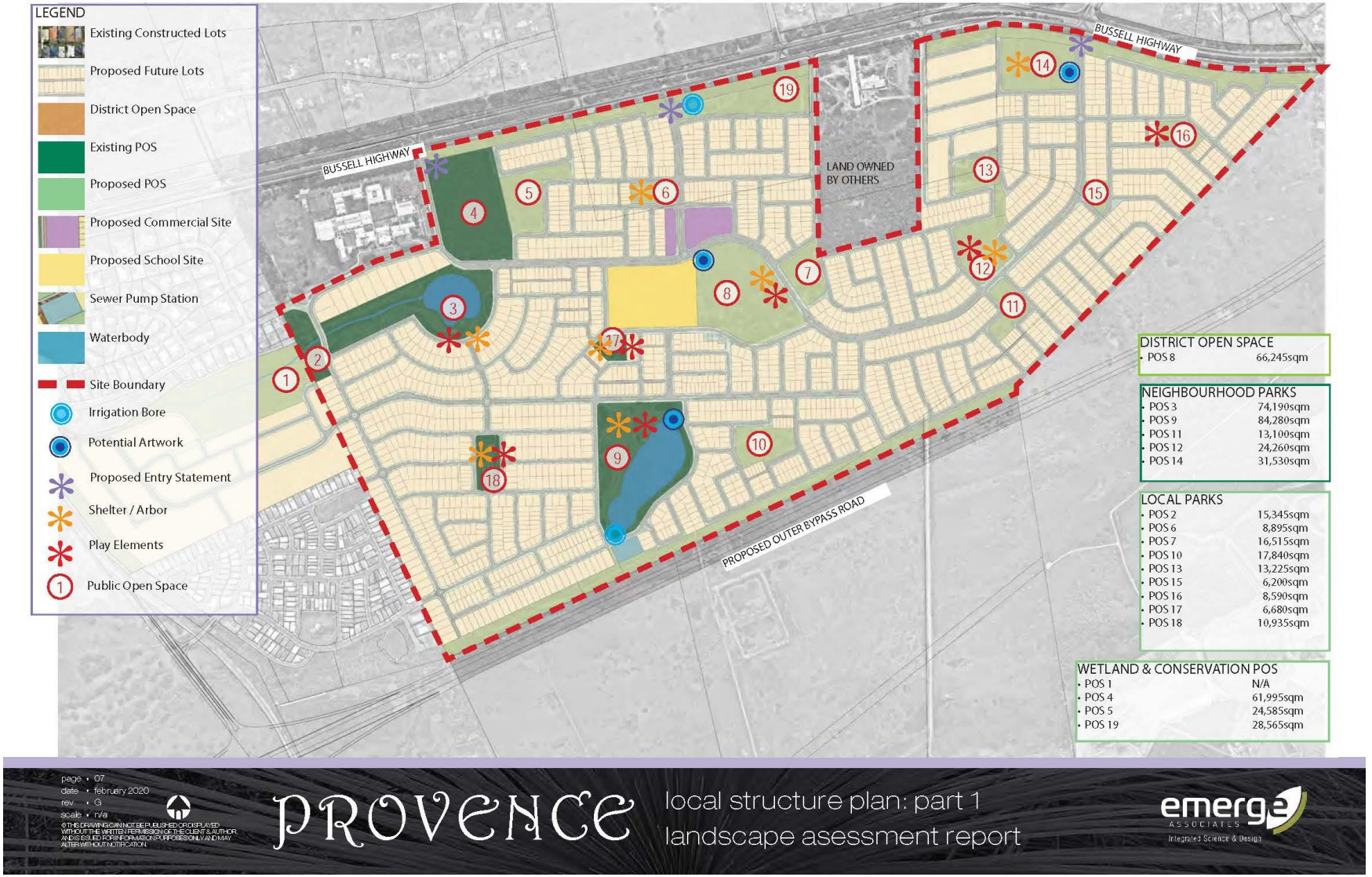
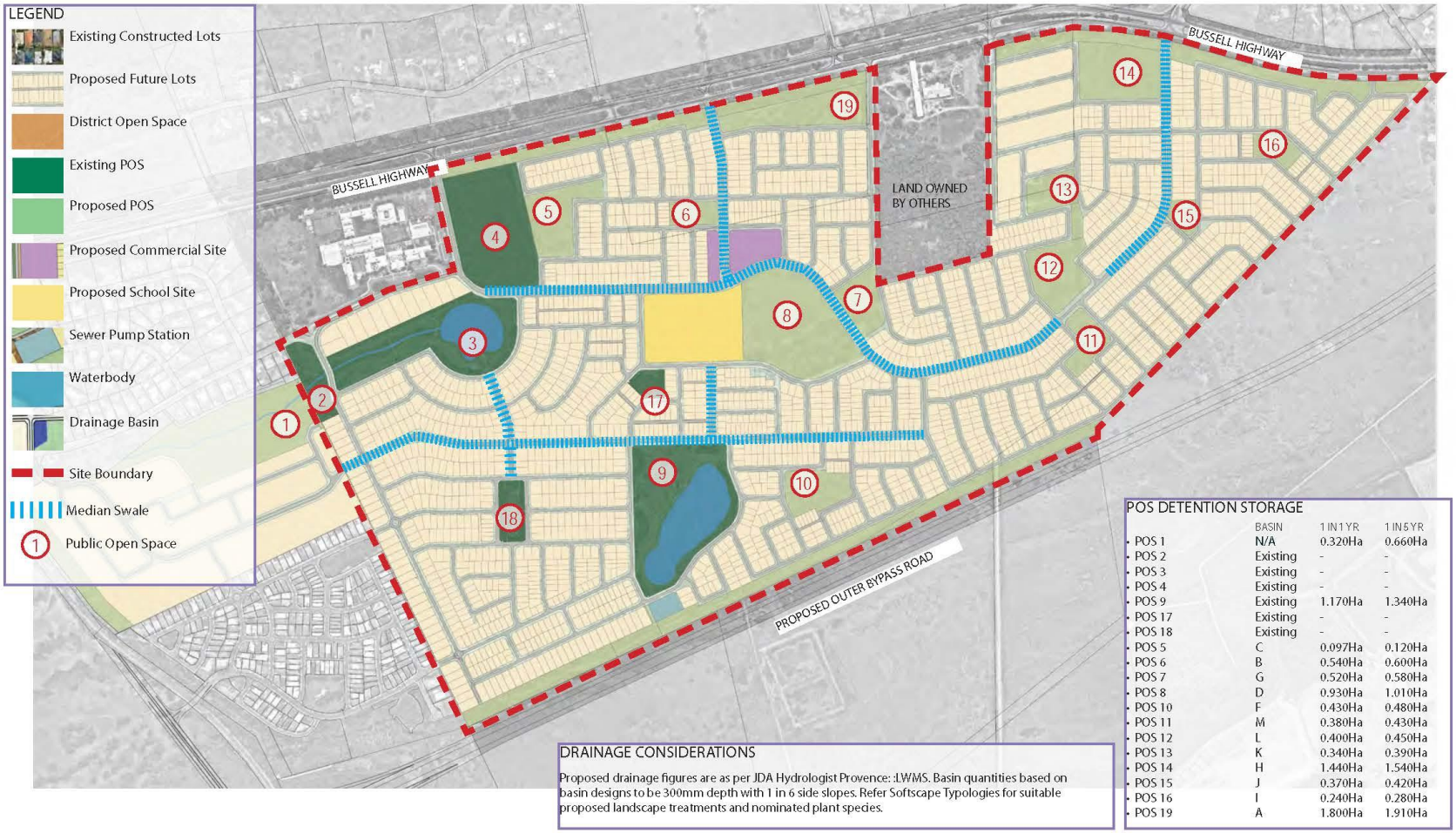


FIGURE 2 - STORMWATER TREATMENT



POS DETENTION STORAGE

	BASIN	1 IN 1 YR	1 IN 5 YR
POS 1	N/A	0.320Ha	0.660Ha
POS 2	Existing	-	-
POS 3	Existing	-	-
POS 4	Existing	-	-
POS 9	Existing	1.170Ha	1.340Ha
POS 17	Existing	-	-
POS 18	Existing	-	-
POS 5	C	0.097Ha	0.120Ha
POS 6	B	0.540Ha	0.600Ha
POS 7	G	0.520Ha	0.580Ha
POS 8	D	0.930Ha	1.010Ha
POS 10	F	0.430Ha	0.480Ha
POS 11	M	0.380Ha	0.430Ha
POS 12	L	0.400Ha	0.450Ha
POS 13	K	0.340Ha	0.390Ha
POS 14	H	1.440Ha	1.540Ha
POS 15	J	0.370Ha	0.420Ha
POS 16	I	0.240Ha	0.280Ha
POS 19	A	1.800Ha	1.910Ha

DRAINAGE CONSIDERATIONS

Proposed drainage figures are as per JDA Hydrologist Provence: :LWMS. Basin quantities based on basin designs to be 300mm depth with 1 in 6 side slopes. Refer Softscape Typologies for suitable proposed landscape treatments and nominated plant species.

page. • 08
date • February 2020
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PROVENCE

local structure plan: part 1
landscape asesssment report

emerge ASSOCIATES
Integrated Science & Design

4.7 POS STRATEGY- DISTRICT OPEN SPACE

4.7.1 Brief Description

POS 8 is the largest and most signficant POS area for the Provence development and has therefore been centrally located between the proposed Village Centre commerical / retail precinct and the proposed Department of Education public Primary School site. Negotiations are required between the Developer, Department of Education and City of Busselton to confrim the various steps for the delivery of this space and its uses and facilities to be provided.

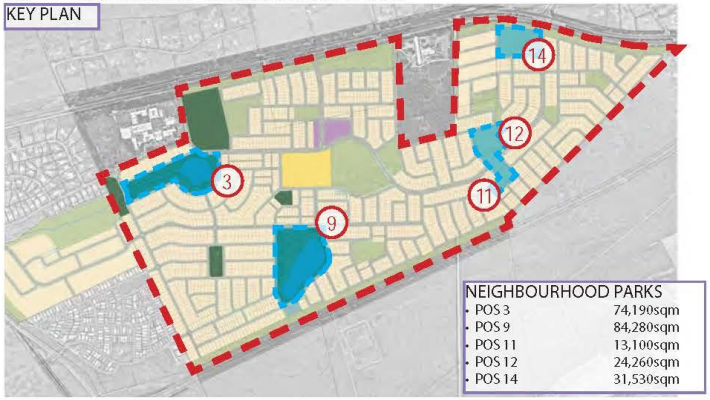
4.7.2 Functions

- Large formalised turf playing fields for organised sports and community events
- Possible clubhouse, changeroom, toilet & kiosk facilities
- Possible inclusion of pump track and/or other sporting uses e.g. hard courts
- Off-street carparking
- Picnic facilities such as BBQ's, picnic settings, shelters and drink fountains
- Play elements for all ages including possible exercise stations
- Maximise shade trees
- Path network connecting to the broader path network
- High level finishes and inclusion of feature planting areas

4.7.3 Environmental Considerations

- Limit planting of feature and exotic species to key nodes and high finish areas
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the sportsfields and playing surfaces.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.8 POS STRATEGY - NEIGHBOURHOOD PARKS



4.8.1 Brief Description

Located centrally to the development and at a max. 400m walking distance from most dwellings, the Neighbourhood Parks provide residents with more active recreational opportunities as well as picnic, BBQ and play space facilites. The parks have connections internally and a broader network to the surrounding POS areas.

4.8.2 Functions

- Large turf informal kick-about areas and connecting expanses of turf
- POS 3 & POS 9 contain irrigation lakes for storage and treatment of irrigation water source (bore)
- Picnic facilities for family / friend gatherings
- Play elements for all ages including possible exercise stations
- Maximise shade trees
- Mixture of exotic and native waterise planting to reinforce project character & landscape themes
- Path network connecting to the broader path network
- High level finishes limited to feature node and picnic areas
- Drainage basin areas incorporated into POS spaces

4.8.3 Environmental Considerations

- Limit planting of feature and exotic species to key nodes and high finish areas
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to informal turf kick-about areas.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.9 POS STRATEGY- LOCAL PARKS

4.9.1 Brief Description

The Local Parks provide residents with open space in close proximity to their dwellings. The parks have areas of turf for passive play and informal kick-about area with nodes of seating and shelter either provided by trees or built structure. A path network through and around the POS allows footpath connection to surrounding streets and POS areas.

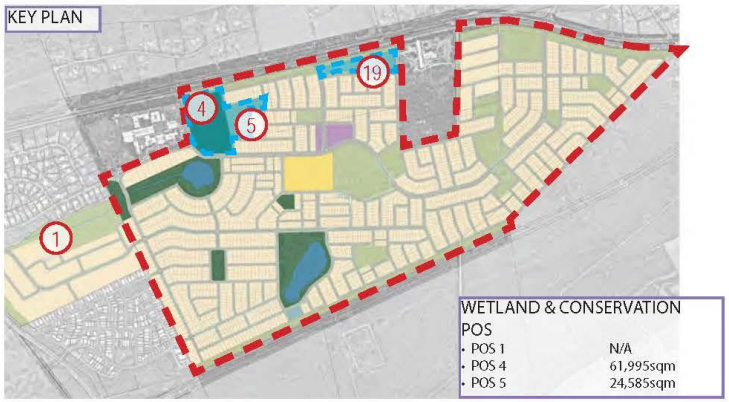
4.9.2 Functions

- Consolidated areas of turf for informal active play
- Internal footpath network
- Path network connecting to broader path networks
- Limited picnic facilities
- Seating nodes and bench seating
- Water wise planting
- Drainage

4.9.3 Environmental Considerations

- Water wise planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to turf areas but garden beds and revegetation areas able to be disconnected once panting is established.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.10 POS STRATEGY - WETLAND & CONSERVATION POS



4.10.1 Brief Description

The Wetland and Conservation POS are located along the northern boundary of the site and contain largely retained existing vegetation identified as being regionally significant or containing protected fauna. They form a larger East-West Rehabilitation Environmental Corridor providing for fauna movement across the project site. Each individual POS must comply with specific management plans relating to vegetation and fauna protection and management.

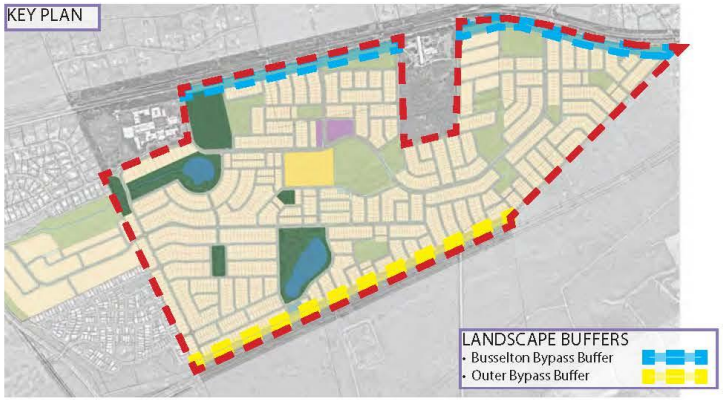
4.10.2 Functions

- Path networks connecting to the broader path network
- Conservation fencing and gates to control access
- Interpretive signange for education
- Shaded seating nodes
- Maximise shade trees
- Local endemic plant species for revegetation and rehabilitation
- Drainage

4.10.3 Environmental Considerations

- Local endemic waterwise plant species only
- Temporary irrigation considered to assist with establishment of revegetation works and removed after first two summers
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

4.11 POS STRATEGY- LANDSCAPE BUFFERS



4.11.1 Brief Description

The Lanscape Buffers are located along the northern and southern boundaries of the site directly adjacent to Busselton Bypass and proposed Busselton Outer Bypass Roads. Varying in width from min. 30m the buffers are located to provide visual screening of the development as well as noise mitigation where required by traffic noise assessments

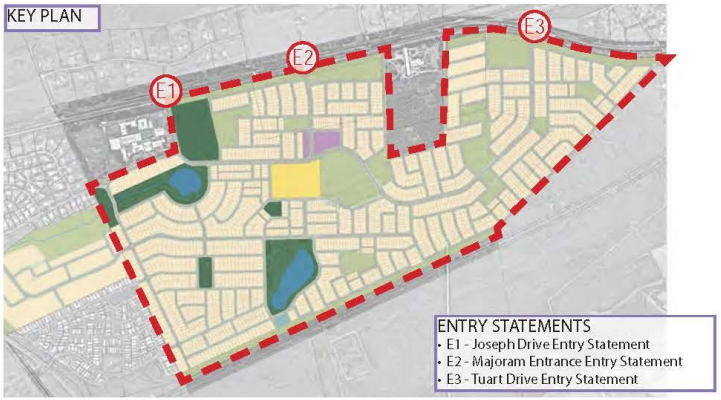
4.11.2 Functions

- Dense layered native vegetation planting for visual screening
- Noise bunds and walls for noise mitigation as may be required
- Fitness path network connecting to the broader path network
- Retain vegetation linkages and connections off-site

4.11.3 Environmental Considerations

- Local endemic waterwise plant species only
- Temporary irrigation considered to assist with establishment of revegetation works and removed after first two summers
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

4.12 POS STRATEGY - ENTRY STATEMENTS



4.12.1 Brief Description

Entry locations to the estate are located along the Busselton Bypass. Existing intersections are proposed to be upgraded to cater for increased traffic volumes & to provide safe access. Feature signage, artwork and landscape treatments are proposed at these key entry locations for way finding, visual queues for residents and visitors. They will also introduce the landscape character and themes being the developments first point of contact.

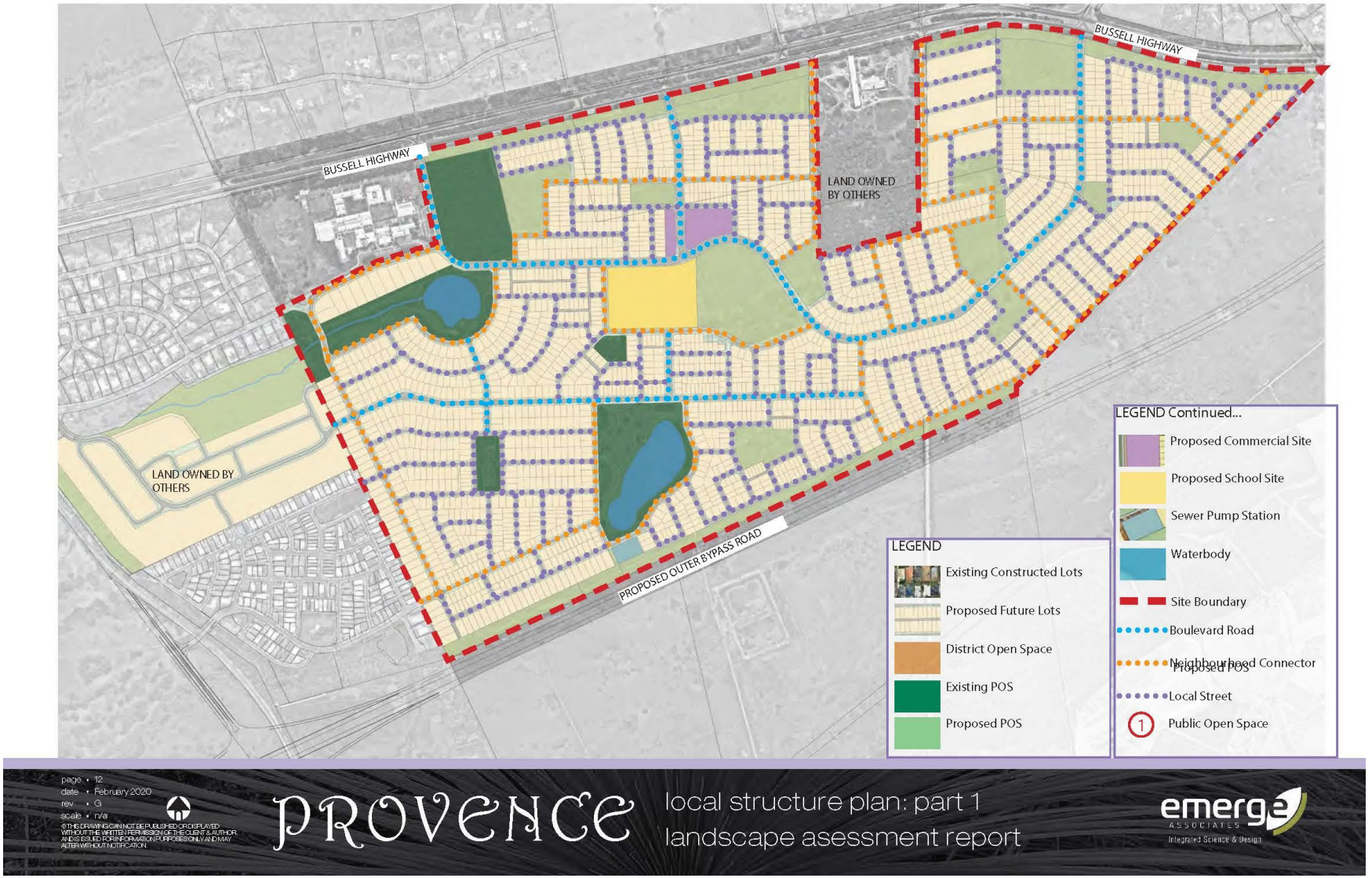
4.12.2 Functions

- Feature signage, flags and vertical elements
- Artwork and scupltural elements for way finding and visual queues
- Feature walls and retaining walls for signage and elevation
- Mixture of exotic and native planting species to introduce landscape character and themes
- Consolidated turf areas for clear sightlines to signage and traffic clear zones

4.12.3 Environmental Considerations

- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to turf areas but garden beds and revegetation areas able to be disconnected once panting is established.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

FIGURE 3 - STREET TREE MASTER PLAN



5.0 STREETSCAPES

5.1 BOULEVARD ROADS

5.1.1 Brief Description

The Boulevard Roads proposed within the development are the major roads connecting through the estate and projected to carry the highest volumes of traffic. They link the major entry statements off the Busselton Bypass to the Village Centre, District Open Space, School Site and most Neighbourhood Parks. These are to be a key feature of the development with exotic deciduous tree planting to create avenues and materials to reinforce the landscape character and theming where appropriate. A central median is proposed to assist with stormwater management.

5.1.2 Functions

- Typical road reserve widths 24.0m
- Dual use footpaths to verges and formalised crossing points
- Exotic, deciduous avenue tree planting
- Central median with flush kerbing and swale
- Feature planting at intersections and nodes with native rush and sedge planting to central median swale

Refer attached Appendix B - 'Street Tree Masterplan' Revision E dated February 2020 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

5.2 NEIGHBOURHOOD CONNECTORS

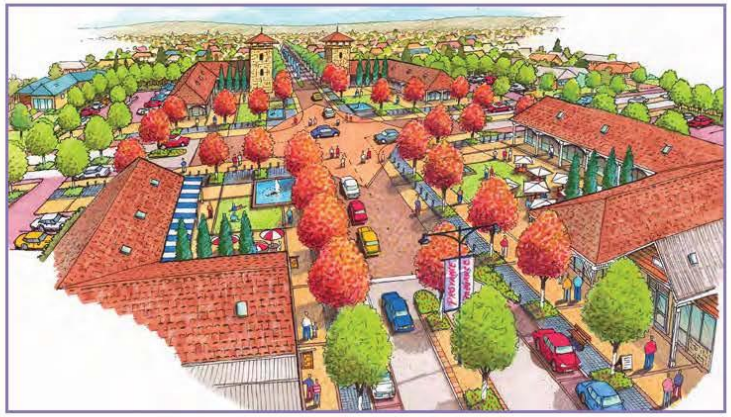
5.2.1 Brief Description

The Neighbourhood Connector roads are proposed to link from the Boulevard Roads to carry residents and visitors to the local parks and their homes. Some opportunities for feature planting within verges and key intersections will occur with the tree planting to continue avenues where possible. It is anticpated that the majority of tree planting shall occur within the private lot verges.

5.2.2 Functions

- Typical road reserve width of 18.0m
- Footpaths to verges providing connection to the broader footpath networks
- Mixture of native and exotic tree planting to create avenues or at spacing of one tree per lot
- Feature planting at intersections and nodes

Refer attached Appendix B - 'Street Tree Masterplan' Revision E dated February 2020 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.



5.3 LOCAL STREETS

5.3.1 Brief Description

The local streets provide access to private residents and carry the lowest traffic volumes. The majority of tree planting shall occur adjacent to private lots and form part of the residents private lot landscaping.

5.3.2 Functions

- Typical road reserve width of between 15.0m and 16.0m
- Footpaths to verges providing connection to the broader footpath networks
- Native tree planting to create avenues or at spacing of one tree per lot
- Verge landscaping to be undertaken by private lot owners as part of private lot landscaping packages.

Refer attached Appendix B - 'Street Tree Masterplan' Revision E dated February 2020 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

6.0 IRRIGATION

An irrigation and water supply to the development has been established with the initial stages of construction works that have been completed since 2004. It is proposed to continue to be extended and upgraded as the development progresses and in accordance with the approved 'Irrigation and Lake Water Management Strategy' Revision 7 dated October 2009 and prepared by Emerge Associates (formerly MNLA). This document can be briefly summarised as follows:

6.1 WATER SOURCE & STORAGE

The development has an existing water source being a Yarragadee Bore. This is currently located to the south of the development land and is required to be relocated into a future public open space area to allow handover and on-going maintenance by the City of Busselton. The bore is currently proposed to be relocated to POS 9 Aurelian Ave Park where it will run through a rip rap system to filter any iron particles from the bore water. It is then transferred to the POS 2 Almond Parkway Lake to be pumped by the existing irrigation pump station to the required POS and streetscape areas.

6.2 WATER LICENCE

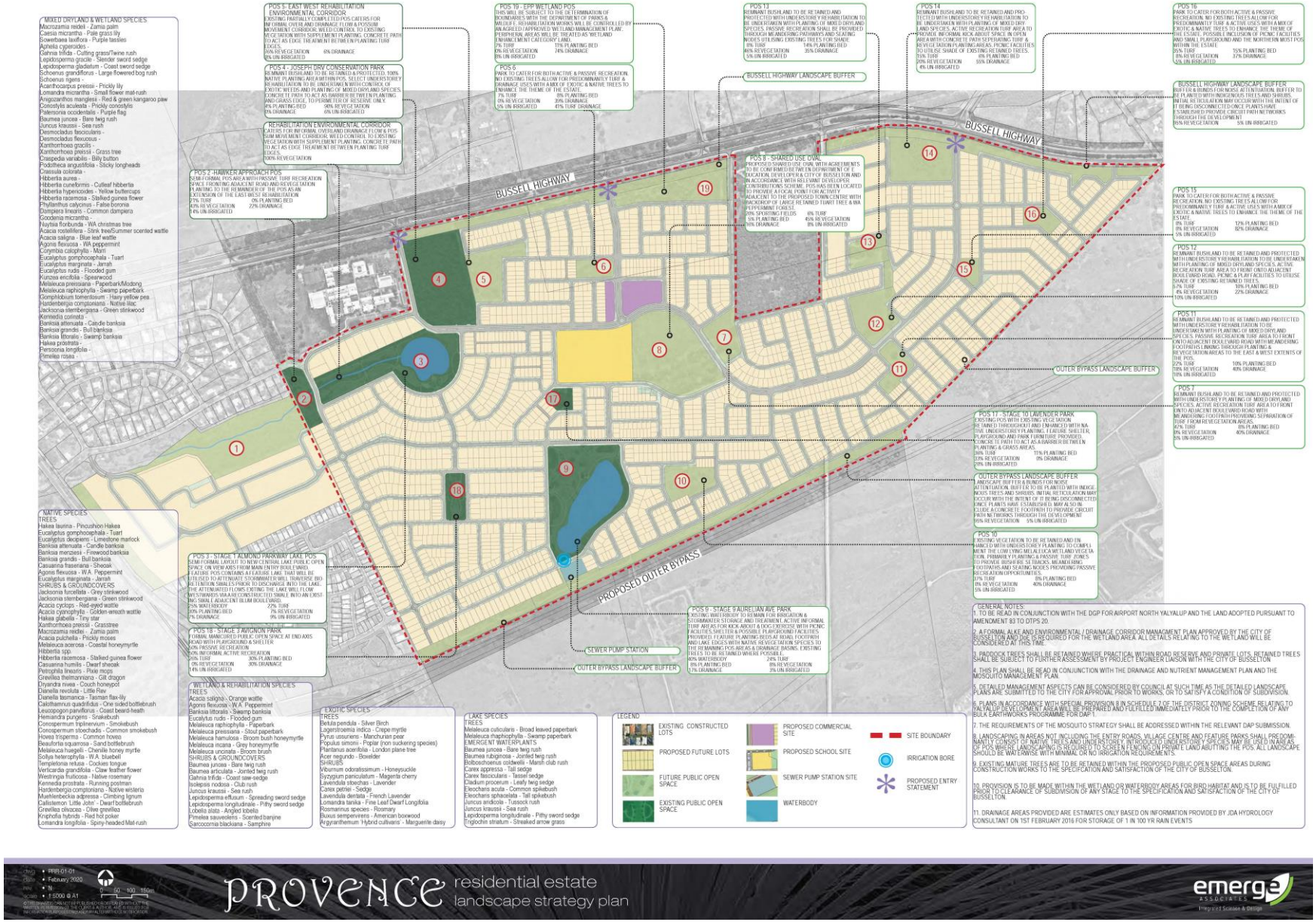
The developer has secured a Licence to Take Water from the Department of Water to draw water from the Yarragadee aquifer. This allows 168,300kL per annum to drawn from the aquifer and used for irrigation of up to 23Ha of public open space. The licence is valid until 30 August 2020. Refer attached Appendix D 'Irrigation Strategy Plan' Revision i dated February 2020 and Appendix F 'Provence Irrigation, Water Use and Allocation Schedule' dated February 2020 for a detailed summary of the proposed irrigation requirements of this revised structure plan design.

7.0 APPENDICES

7.1	Appendix A	Provence - Landscape Strategy Plan, Revision N, dated February 2020
7.2	Appendix B	Provence - Street Tree Masterplan, Revision E, dated February 2020
7.3	Appendix C	Provence - Typical Road Cross-sections, Revision A, dated January 2016
7.3	Appendix D	Provence - Irrigation Strategy Plan, Revision i, dated February 2020
7.3	Appendix E	Provence - Irrigation, Water Use and Allocation Schedule, Revision L, dated February 2020

7.1 APPENDIX A

Provence - Landscape Strategy Plan, Revision N, dated February 2020


PROVENCE
residential estate
landscape strategy plan
emerge ASSOCIATES
BUSSELL HIGHWAY
PROPOSED OUTER BYPASS
SEWER PUMP STATION
OUTER BYPASS LANDSCAPE BUFFER
BUSSELL HIGHWAY LANDSCAPE BUFFER
POS 1
POS 2 - HAWKER APPROACH POS
POS 3 - STAGE 1 ALMOND PARKWAY LAKE POS
POS 4 - JOSEPH DRY CONSERVATION PARK
POS 5 - EAST WEST REHABILITATION ENVIRONMENTAL CORRIDOR
POS 6
POS 8 - SHARED USE OVAL
POS 9 - STAGE 9 AURELIAN AVE PARK
POS 10
POS 11
POS 12
POS 13
POS 14
POS 15
POS 16
POS 17 - STAGE 10 LAVENDER PARK
POS 18 - STAGE 2 AVOCADO PARK
POS 19 - EPP WETLAND POS
NATIVE SPECIES
WETLAND & REHABILITATION SPECIES
EXOTIC SPECIES
LAKE SPECIES
LEGEND
GENERAL NOTES:

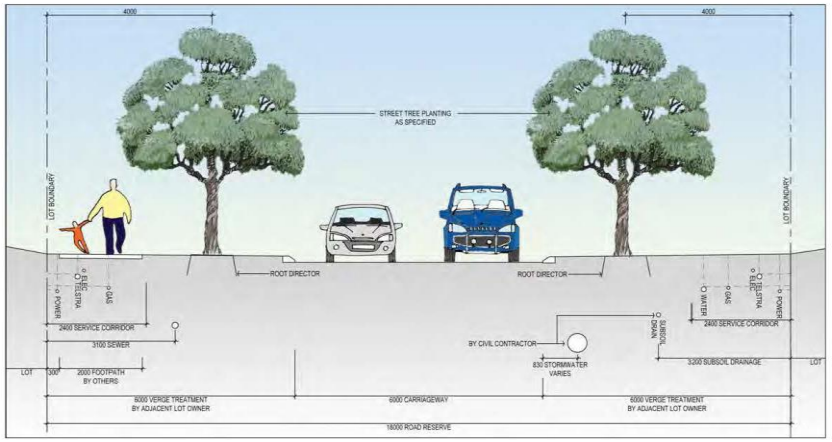
7.2 APPENDIX B

Provence - Street Tree Masterplan, Revision E, dated February 2020

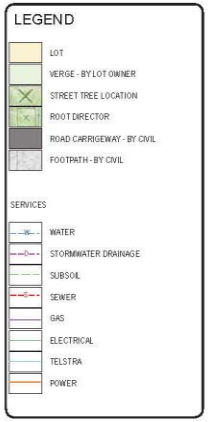
BUSSELL HIGHWAY
BUSSELTON OUTER BYPASS
NEIGHBOURHOOD CONNECTOR TREE SPECIES
Betula pendula
SILVER BIRCH
Hakea laurina
PINCUSHION HAKEA
Agonis flexuosa
WA PEPPERMINT
Pyrus usseriensis
MANCHURIAN PEAR
Melaleuca quinquenerva
BROAD-LEAFED PAPERBARK
Melaleuca rhaphiophylla
SWAMP PAPERBARK
EXISTING
PROPOSED
LEGEND
EXISTING CONSTRUCTED LOTS
PROPOSED FUTURE LOTS
EXISTING PUBLIC OPEN SPACE
PROPOSED PUBLIC OPEN SPACE
WATERBODY
PROPOSED COMMERCIAL SITE
PROPOSED SCHOOL SITE
SITE BOUNDARY
BOULEVARD ROAD TREE SPECIES
Pyrus usseriensis
MANCHURIAN PEAR
Platanus acerifolia
LONDON PLANE TREE
Populus simonii fastigata
SIMON'S POPLAR
Betula pendula
SILVER BIRCH
LOCAL STREET TREE SPECIES
Melaleuca quinquenerva
BROAD-LEAFED PAPERBARK
Hakea laurina
PINCUSHION HAKEA
Agonis flexuosa
WA PEPPERMINT
Melaleuca rhaphiophylla
SWAMP PAPERBARK
PROVENCE residential estate
street tree masterplan
emerge ASSOCIATES

7.3 APPENDIX C

Provence - Typical Road Cross-sections, Revision A, dated January 2016



SECTION - TYPICAL 18.0m WIDE ROAD RESERVE



PLAN - TYPICAL 18.0m WIDE ROAD RESERVE

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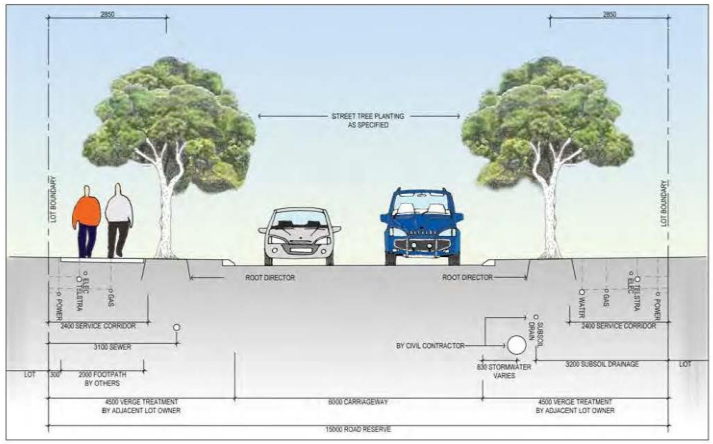
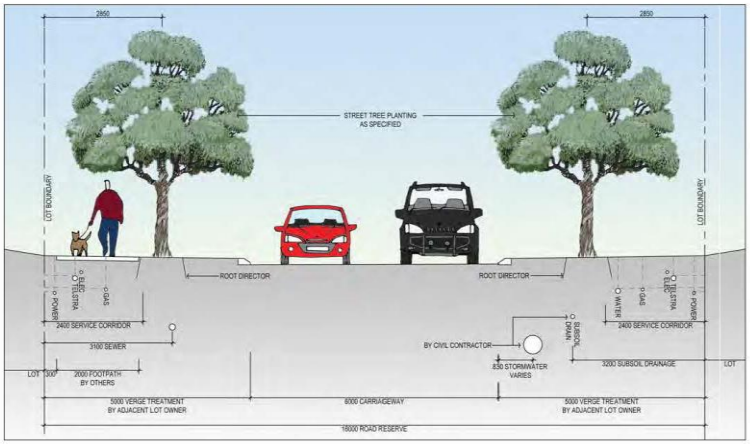
PROVENCE residential estate
typical road cross-sections

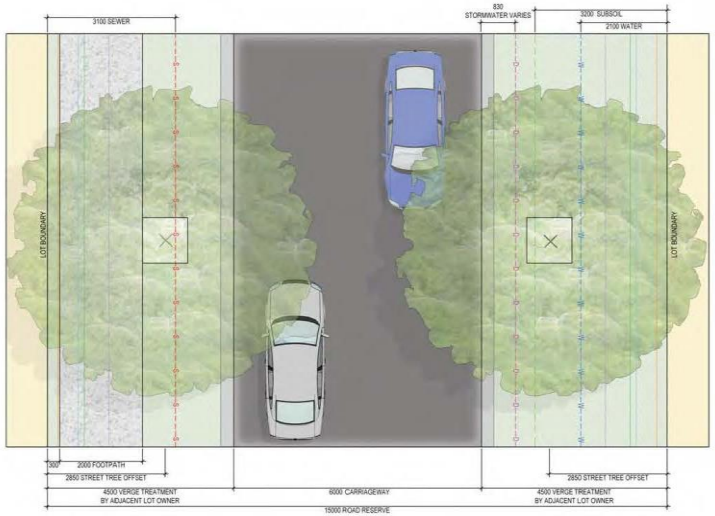
emerge ASSOCIATES Integrated Science & Design



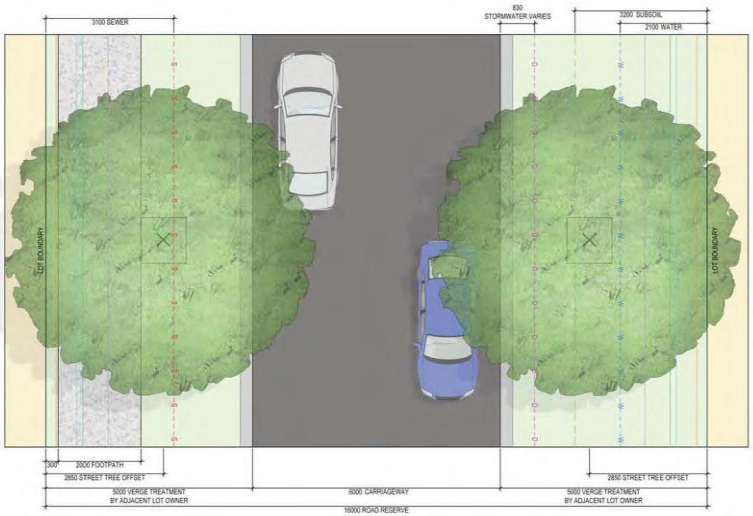
SECTION - TYPICAL 15.0m WIDE ROAD RESERVE



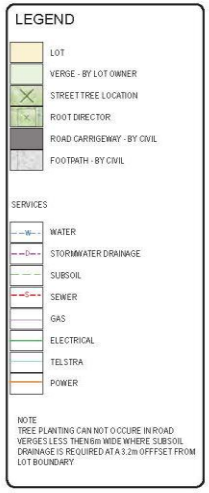
SECTION - TYPICAL 16.0m WIDE ROAD RESERVE



PLAN - TYPICAL 15.0m WIDE ROAD RESERVE



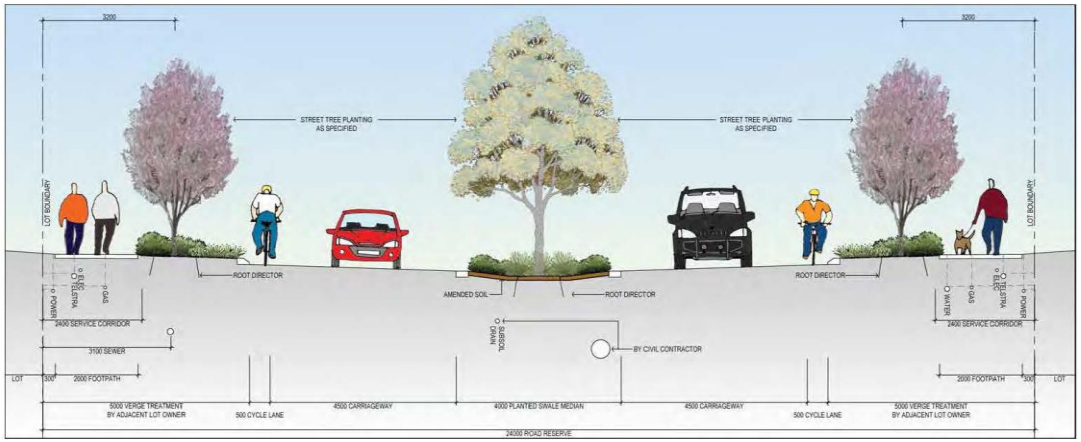
PLAN - TYPICAL 16.0m WIDE ROAD RESERVE



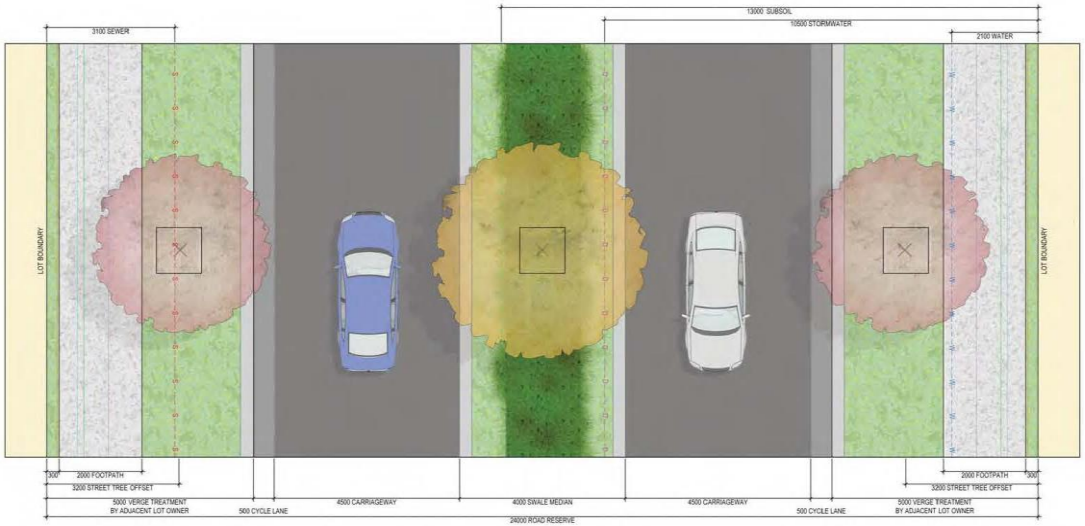
dwg • PRP-01-08
date • January 2016
rev • B
scale • 1:500@A1

PROVENCE residential estate
typical road cross-sections

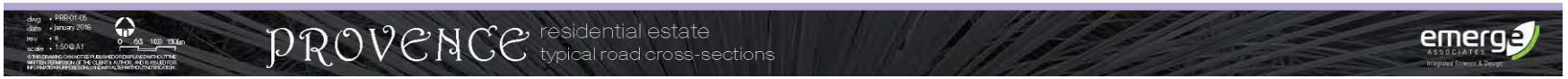
emerge ASSOCIATES Integrated Science & Design

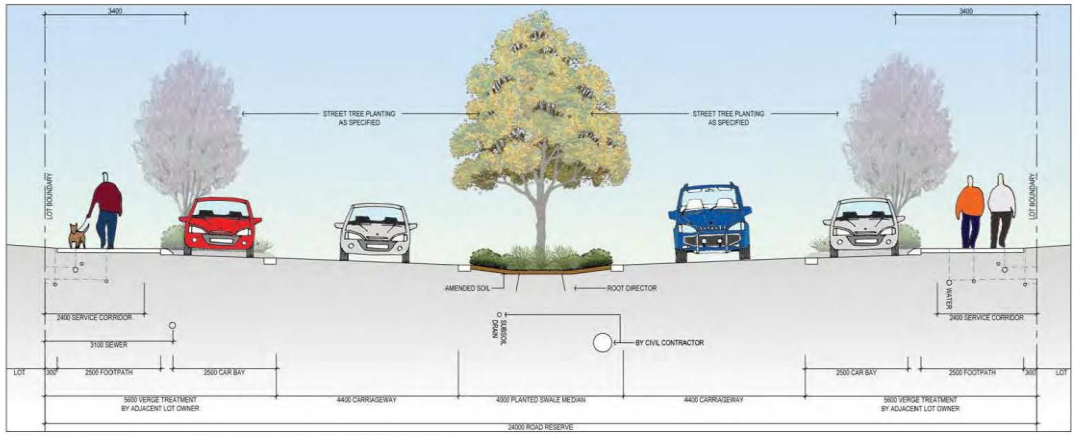


SECTION - TYPICAL 24.0m WIDE ROAD RESERVE

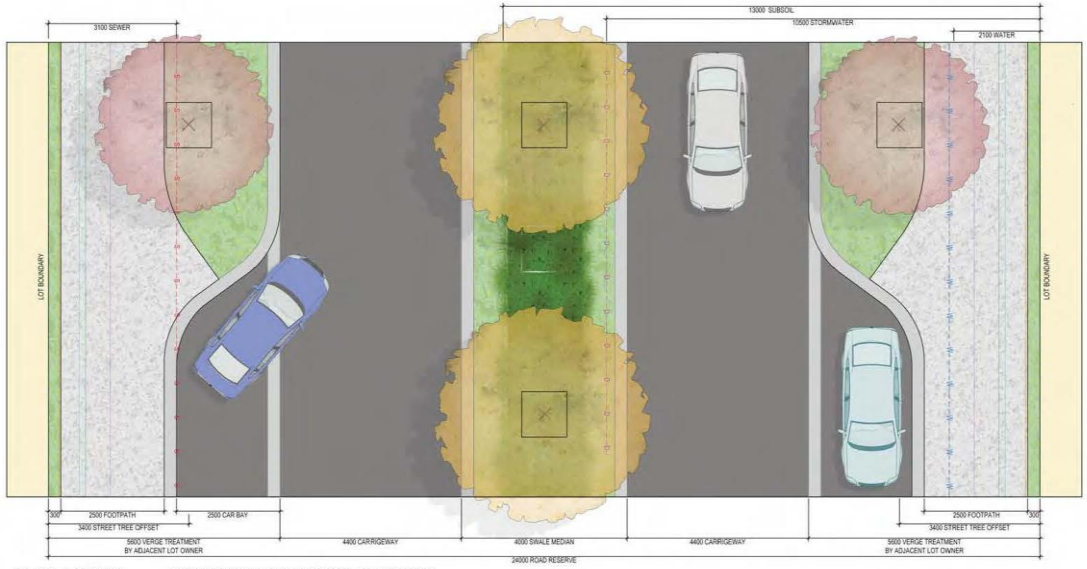


PLAN - TYPICAL 24.0m WIDE ROAD RESERVE

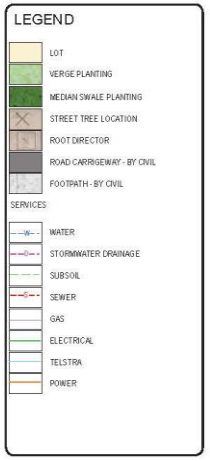




SECTION - TYPICAL 24.0m WIDE ROAD RESERVE WITH PARKING



PLAN - TYPICAL 24.0m WIDE ROAD RESERVE WITH PARKING



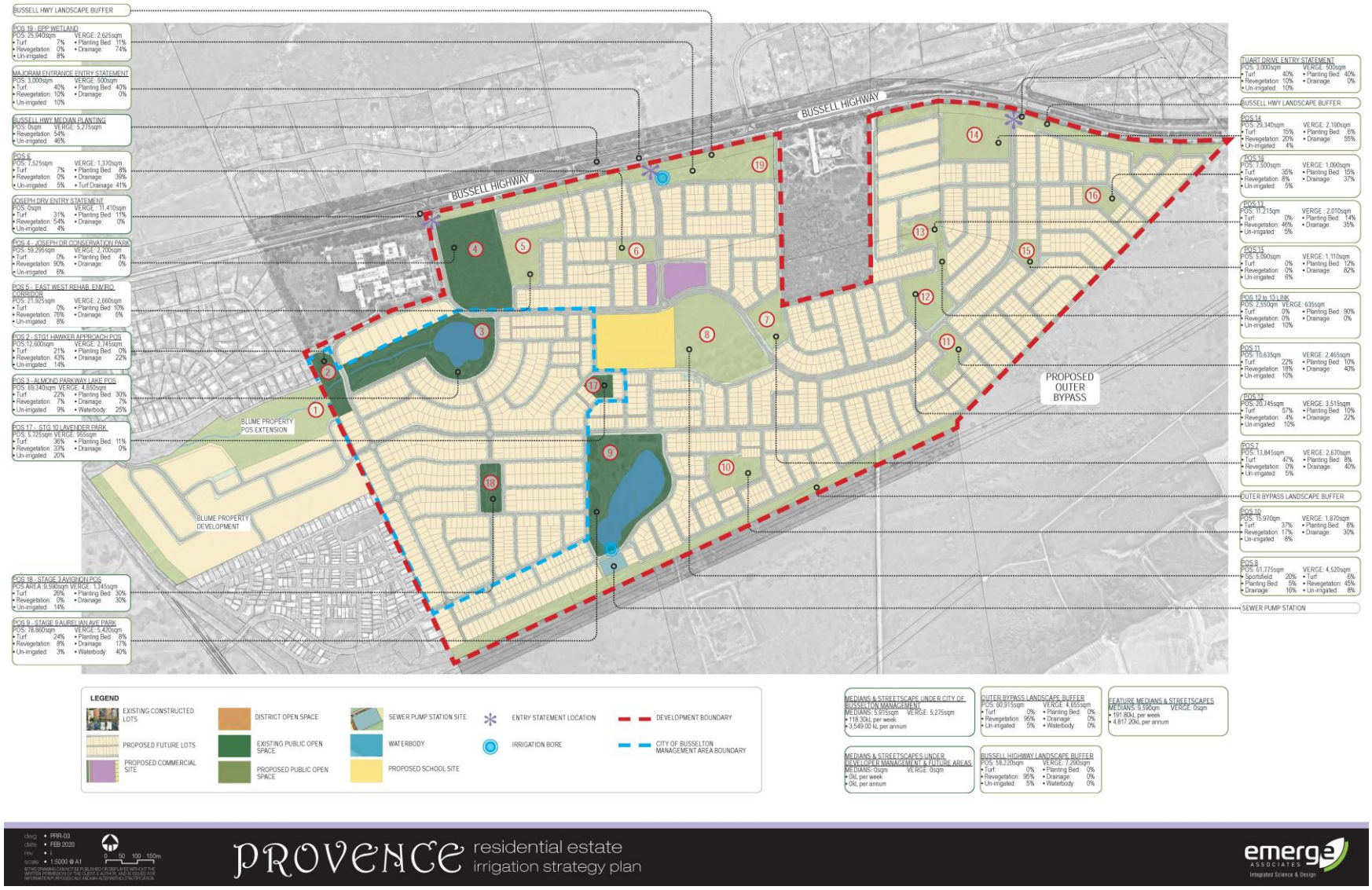
dwg • P99-01-08
date • January 2016
rev • a
scale • 1:50 @ A1

PROVENCE residential estate
typical road cross-sections

emerge ASSOCIATES Integrated Science & Design

7.4 APPENDIX D

Irrigation Strategy Plan, Revision i, dated February 2020


BUSSELL HWY LANDSCAPE BUFFER
POS 19 - EPP WETLAND
POS: 25,940sqm VERGE: 2,625sqm
• Turf: 7% • Planting Bed: 11%
• Revegetation: 0% • Drainage: 74%
• Un-irrigated: 8%
MAJORAM ENTRANCE ENTRY STATEMENT
POS: 3,000sqm VERGE: 500sqm
• Turf: 40% • Planting Bed: 40%
• Revegetation: 10% • Drainage: 0%
• Un-irrigated: 10%
BUSSELL HWY MEDIAN PLANTING
POS: 0sqm VERGE: 5,275sqm
• Revegetation: 54%
• Un-irrigated: 46%
POS 6
POS: 7,525sqm VERGE: 1,370sqm
• Turf: 7% • Planting Bed: 8%
• Revegetation: 0% • Drainage: 39%
• Un-irrigated: 5% • Turf Drainage: 41%
JOSEPH DRV ENTRY STATEMENT
POS: 0sqm VERGE: 11,410sqm
• Turf: 31% • Planting Bed: 11%
• Revegetation: 54% • Drainage: 0%
• Un-irrigated: 4%
POS 4 - JOSEPH DR CONSERVATION PARK
POS: 59,295sqm VERGE: 2,700sqm
• Turf: 0% • Planting Bed: 4%
• Revegetation: 92% • Drainage: 0%
• Un-irrigated: 8%
POS 5 - EAST WEST REHAB. ENVIRO. CORRIDOR
POS: 21,925sqm VERGE: 2,660sqm
• Turf: 0% • Planting Bed: 10%
• Revegetation: 76% • Drainage: 6%
• Un-irrigated: 8%
POS 2 - STG1 HAWKER APPROACH POS
POS:12,600sqm VERGE: 2,745sqm
• Turf: 21% • Planting Bed: 0%
• Revegetation: 43% • Drainage: 22%
• Un-irrigated: 14%
POS 3 - ALMOND PARKWAY LAKE POS
POS: 69,340sqm VERGE: 4,850sqm
• Turf: 22% • Planting Bed: 30%
• Revegetation: 7% • Drainage: 7%
• Un-irrigated: 9% • Waterbody: 25%
POS 17 - STG 10 LAVENDER PARK
POS: 5,725sqm VERGE: 955sqm
• Turf: 36% • Planting Bed: 11%
• Revegetation: 33% • Drainage: 0%
• Un-irrigated: 20%
POS 18 - STAGE 3 AVIGNON POS
POS AREA :9,590sqm VERGE: 1,345sqm
• Turf: 26% • Planting Bed: 30%
• Revegetation: 0% • Drainage: 30%
• Un-irrigated: 14%
POS 9 - STAGE 9 AURELIAN AVE PARK
POS: 78,860sqm VERGE: 5,420sqm
• Turf: 24% • Planting Bed: 8%
• Revegetation: 8% • Drainage: 17%
• Un-irrigated: 3% • Waterbody: 40%
BUSSELL HIGHWAY
BUSSELL HIGHWAY
BLUME PROPERTY POS EXTENSION
BLUME PROPERTY DEVELOPMENT
PROPOSED OUTER BYPASS
TUART DRIVE ENTRY STATEMENT
POS: 3,000sqm VERGE: 500sqm
• Turf: 40% • Planting Bed: 40%
• Revegetation: 10% • Drainage: 0%
• Un-irrigated: 10%
BUSSELL HWY LANDSCAPE BUFFER
POS 14
POS: 29,340sqm VERGE: 2,100sqm
• Turf: 15% • Planting Bed: 6%
• Revegetation: 20% • Drainage: 55%
• Un-irrigated: 4%
POS 16
POS: 7,500sqm VERGE: 1,060sqm
• Turf: 35% • Planting Bed: 15%
• Revegetation: 8% • Drainage: 37%
• Un-irrigated: 5%
POS 13
POS: 11,215sqm VERGE: 2,010sqm
• Turf: 0% • Planting Bed: 14%
• Revegetation: 46% • Drainage: 35%
• Un-irrigated: 5%
POS 15
POS: 5,090sqm VERGE: 1,110sqm
• Turf: 0% • Planting Bed: 12%
• Revegetation: 0% • Drainage: 82%
• Un-irrigated: 6%
POS 12 to 13 LINK
POS: 2,350sqm VERGE: 635sqm
• Turf: 0% • Planting Bed: 90%
• Revegetation: 0% • Drainage: 0%
• Un-irrigated: 10%
POS 11
POS: 10,635sqm VERGE: 2,465sqm
• Turf: 22% • Planting Bed: 10%
• Revegetation: 18% • Drainage: 40%
• Un-irrigated: 10%
POS 12
POS: 20,745sqm VERGE: 3,515sqm
• Turf: 57% • Planting Bed: 10%
• Revegetation: 4% • Drainage: 22%
• Un-irrigated: 10%
POS 7
POS: 13,845sqm VERGE: 2,670sqm
• Turf: 47% • Planting Bed: 8%
• Revegetation: 0% • Drainage: 40%
• Un-irrigated: 5%
OUTER BYPASS LANDSCAPE BUFFER
POS 10
POS: 15,970sqm VERGE: 1,870sqm
• Turf: 37% • Planting Bed: 8%
• Revegetation: 17% • Drainage: 30%
• Un-irrigated: 8%
POS 8
POS: 61,775sqm VERGE: 4,520sqm
• Sportsfield: 20% • Turf: 6%
• Planting Bed: 5% • Revegetation: 45%
• Drainage: 16% • Un-irrigated: 8%
SEWER PUMP STATION
LEGEND
EXISTING CONSTRUCTED LOTS
PROPOSED FUTURE LOTS
PROPOSED COMMERCIAL SITE
DISTRICT OPEN SPACE
EXISTING PUBLIC OPEN SPACE
PROPOSED PUBLIC OPEN SPACE
SEWER PUMP STATION SITE
WATERBODY
PROPOSED SCHOOL SITE
ENTRY STATEMENT LOCATION
IRRIGATION BORE
DEVELOPMENT BOUNDARY
CITY OF BUSSELTON MANAGEMENT AREA BOUNDARY
MEDIANS & STREETSCAPE UNDER CITY OF BUSSELTON MANAGEMENT
MEDIANS: 5,975sqm VERGE: 5,275sqm
• 118.30kL per week
• 3,549.00 kL per annum
OUTER BYPASS LANDSCAPE BUFFER
POS: 60,915sqm VERGE: 4,655sqm
• Turf: 0% • Planting Bed: 0%
• Revegetation: 95% • Drainage: 0%
• Un-irrigated: 5% • Waterbody: 0%
FEATURE MEDIANS & STREETSCAPES
MEDIANS: 9,590sqm VERGE: 0sqm
• 191.80kL per week
• 4,817.20kL per annum
MEDIANS & STREETSCAPES UNDER DEVELOPER MANAGEMENT & FUTURE AREAS
MEDIANS: 0sqm VERGE: 0sqm
• 0kL per week
• 0kL per annum
BUSSELL HIGHWAY LANDSCAPE BUFFER
POS: 58,220sqm VERGE: 1,290sqm
• Turf: 0% • Planting Bed: 0%
• Revegetation: 95% • Drainage: 0%
• Un-irrigated: 5% • Waterbody: 0%
dwg • PRP-03
date • FEB 2020
rev • 1
scale • 1:5000 @ A1
0 50 100 150m
PROVENCE residential estate irrigation strategy plan
emerge ASSOCIATES Integrated Science & Design

7.5 APPENDIX E

Provence - Irrigation, Water Use and Allocation Schedule, Revision L, dated February 2020

Project: **PROVENCE - IRRIGATION STRATEGY PEAK WATER USE SUMMARY**
Client: East Busselton Pty Ltd
Plan Ref: Irrigation Strategy Plan DWG No. PRR-03 Revision i
Prepared by Emerge Associates
Prepared by: Mel Holland
Date: 26-Feb-20
Revision: M

emerge ASSOCIATES Integrated Science & Design

No	IRRIGATION PEAK WATER USE SUMMARY	FINISH						POS	Verge	TOTAL	Unit	% of	Estimate	Estimate	Estimate	Estimate	Est. Weekly	Unit	Est. Annual	Total
		Turf	Garden	Reveg	Drainage	Hardworks	Waterbody	lot	area	area		Irrigation	Lawn Irrigation	Lawn Irrigation	Garden Irrigation	Garden Irrigation	water		water use	Irrigation
		%	%	%	%	%	%	area					Area sqm	Water kl.	Area sqm	Water kl.	use			Area sqm
	Public Open Space							469,265	46,745	516,010	sqm		107,286	3,304.77	60,232	1,205	4,509.42	KL	114,689.10	167,518
	Landscape Buffers							119,135	11,945	131,080	sqm		0	0	0	0	0	KL	0	0
	Streetscapes							5,915	9,590	5,915	sqm		0	0.00	5,915	118.30	118.30	KL	8,825.70	5,915
	Entry Statements							6,000	12,410	18,410	sqm		6,337	190.11	4,055	81.10	271.22	KL	6,811.60	10,392
	Lake Evaporation																2,612.80		40,829.80	
	GRAND TOTAL							**600,315**	**80,690**	**671,415**	**sqm**		**113,623**	**3,495**	**70,202**	**1,404**	**7,512**	**KL**	**171,156**	**183,826**

POS / Landscape Works Complete - Managed by Developer
POS / Landscape Works Complete - Managed by City of Busselton
POS Construction commenced or on hold

	LANDSCAPE AREAS	FINISH						POS	Verge	TOTAL	Unit	% of	Estimate	Estimate	Estimate	Estimate	Est. Weekly	Unit	Est. Annual	Total
		Turf	Garden	Reveg	Drainage	Hardworks	Waterbody	lot	area	area		Irrigation	Lawn Irrigation	Lawn Irrigation	Garden Irrigation	Garden Irrigation	water		water use	Irrigation
	POS	%	%	%	%	%	%	area					Area sqm	Water kl.	Area sqm	Water kl.	use			Area sqm
	POS 2 Hawker Approach POS	21	0	43	22	14	0	12,600	2,745	15,345	sqm	21%	3222	96.67	0	0.00	96.67	KL	2,427.70	3222
	POS 3 Almond Parkway Lake POS	22	30	7	7	9	25	69,340	4,850	74,190	sqm	52%	16322	489.65	22257	445.14	934.79	KL	23,478.20	38579
	POS 4 Joseph Drive Conservation Park	0	4	90	0	6	0	59,295	2,700	61,995	sqm	4%	0	0.00	2480	49.60	49.60	KL	955.40	2480
	POS 5 - East West Rehabilitation Corridor	0	10	76	6	8	0	21,925	2,660	24,585	sqm	10%	0	0.00	2459	49.17	49.17	KL	1,475.10	2459
	POS 17 Lavender Park	36	11	33	0	20	0	5,725	955	6,680	sqm	47%	2405	72.14	735	14.70	86.84	KL	2,181.30	3140
	POS 18 Avignon POS	26	30	0	30	14	0	9,590	1,345	10,935	sqm	56%	2843	85.29	3281	65.61	150.90	KL	3,790.20	6124
	POS 9 - Aurelian Ave Lake POS (neighbourhood park)	24	8	8	17	3	40	78,660	5,420	84,080	sqm	32%	20179	605.38	6726	134.53	739.90	KL	19,262.20	26906
	POS 6 - (local park with playground)	48	8	0	41	5	0	7,525	1,370	8,895	sqm	56%	4270	128.09	712	14.23	142.32	KL	2,298.10	4981
	POS 7 - (local park)	47	8	0	40	5	0	13,845	2,670	16,515	sqm	55%	7762	232.86	1321	26.42	259.29	KL	2,158.40	9083
	POS 8 - District Open Space	26	5	45	16	8	0	61,775	4,520	66,295	sqm	31%	17237	603.28	3315	66.30	669.58	KL	36,603.30	20551
	POS 10 - (local park)	37	8	17	30	8	0	15,970	1,870	17,840	sqm	45%	6681	198.02	1427	28.54	226.57	KL	1,387.90	8028
	POS 11 - (neighbourhood park with shelter)	22	10	18	40	10	0	10,635	2,465	13,100	sqm	32%	2882	86.46	1310	26.20	112.66	KL	3,575.70	4192
	POS 12 - (neighbourhood park with playground)	57	10	4	22	10	0	20,745	3,515	24,260	sqm	67%	13828	414.85	2426	48.52	463.37	KL	2,364.40	16254
	POS 12 - 13 Link	0	90	1	0	10	0	2,550	635	3,185	sqm	90%	0	0.00	2867	57.33	57.33	KL	2,364.40	2867
	POS 13 - (local park)	0	14	46	35	5	0	11,215	2,010	13,225	sqm	14%	0	0.00	1852	37.03	37.03	KL	278.30	1852
	POS 14 - Neighbourhood Park	15	6	20	55	4	0	29,340	2,190	31,530	sqm	21%	4730	141.89	1892	37.84	179.72	KL	3,074.40	6621
	POS 15 - Local Park	0	12	0	82	6	0	5,090	1,110	6,200	sqm	12%	0	0.00	744	14.88	14.88	KL	1,076.50	744
	POS 16 - Local Park	35	15	8	37	5	0	7,590	1,090	8,590	sqm	50%	3007	90.20	1289	25.77	115.97	KL	3,585.50	4295
	POS 19 - EPP Wetland Conservation Park (conservation)	7	11	0	74	7	0	25,940	2,625	28,565	sqm	18%	2000	59.99	3142	62.84	122.83	KL	2,352.10	5142
	SUB TOTAL							469,265	46,745	516,010			107,286	3,304.77	60,232	1,204.64	4,509.42	KL	114,689.10	167518
	LANDSCAPE BUFFERS																			
	Bussell Highway Landscape Buffer	0	0	95	0	5	0	58,220	7,290	65,510	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Outer Bypass Landscape Buffer	0	0	95	0	5	0	60,915	4,655	65,570	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	SUB TOTAL							119,135	11,945	131,080	sqm	0	0	0	0	0	0	KL	0	0

	STREETSCAPES																			
	DAP1 Streetscapes																			
	Bussell Highway Medians	0	0	54	0	46	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 1	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 1A	0	100	0	0	0	0	1,805	0	1,805	sqm	100%	0	0.00	1805	36.10	36.10	KL	905.70	1805
	Stage 1B	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2	0	100	0	0	0	0	1375	0	1,375	sqm	100%	0	0.00	1375	27.50	27.50	KL	690.70	1375
	Stage 3	0	100	0	0	0	0	210	0	210	sqm	100%	0	0.00	210	4.20	4.20	KL	105.50	210
	Stage 4	0	100	0	0	0	0	40	0	40	sqm	100%	0	0.00	40	0.80	0.80	KL	20.10	40
	Stage 5	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 6	0	100	0	0	0	0	795	0	795	sqm	100%	0	0.00	795	15.90	15.90	KL	399.30	795
	Stage 7	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 8	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 9	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 10	0	100	0	0	0	0	820	0	820	sqm	100%	0	0.00	820	16.40	16.40	KL	411.90	820
	Stage 11	0	100	0	0	0	0	870	0	870	sqm	100%	0	0.00	870	17.40	17.40	KL	437.00	870
	Stage 16A	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	SUB TOTAL							5,915	0	5,915	sqm		0	0.00	5,915	118.30	118.30	KL	2,971.20	5915
	DAP2 Streetscapes																			
	Stage 12A	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 12B	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13A	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13B	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13C	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13D	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.7 (12C)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.8 (12D)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.9 (13E)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.10 (13F)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.11 (13G)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	SUB TOTAL							0	0	0	sqm		0	0.00	0	0.00	0.00	KL	0.00	0
	Future Stages																			
	Feature Streetscape Medians	0	100	0	0	0	0	0	9,590	0	sqm	100%	0	0.00	0	0.00	0.00	KL	5,854.50	0
	SUB TOTAL							0	9,590	0	sqm		0	0.00	0	0.00	0.00	KL	5,854.50	0

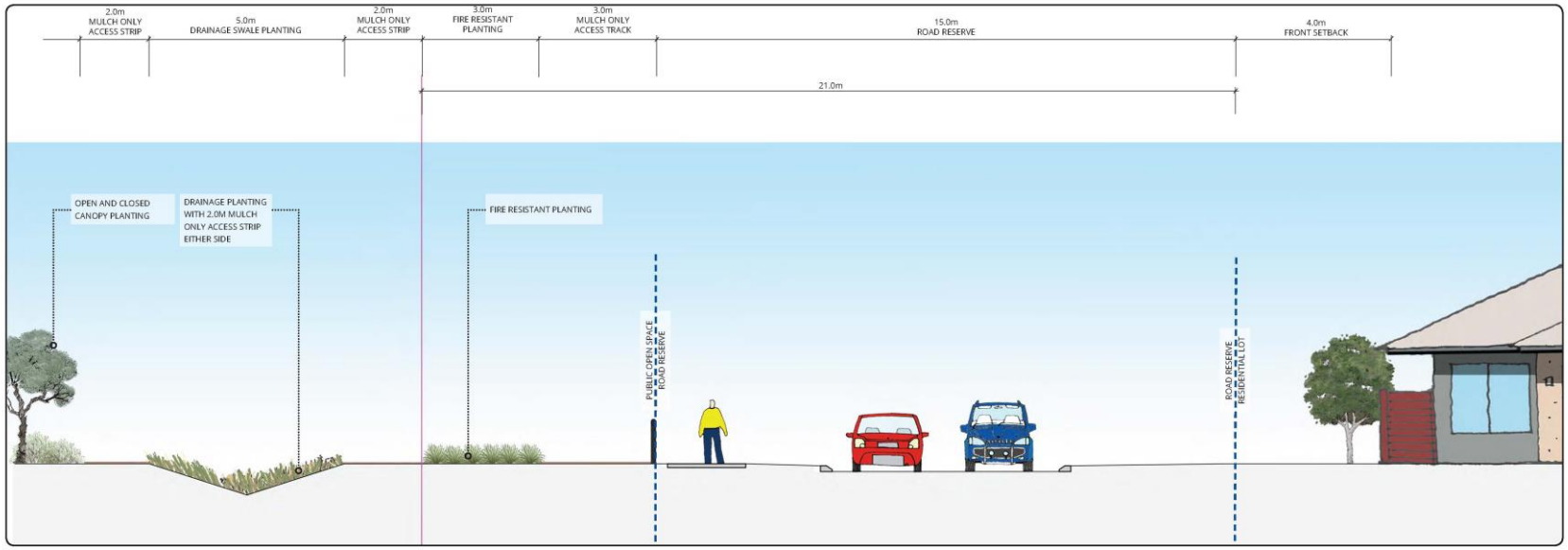
	ENTRY STATEMENTS																			
	Joseph Drive Entry Statement (original works)	31	11	54	0	4	0	0	11,410	11,410	sqm	42%	3637	105.11	1255	25.10	131.22	KL	3,295.40	4752
	Joseph Drive Entry Statement										sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Majoram Entrance Entry Statement	40	40	10	0	10	0	3,000	500	3,500	sqm	60%	1400	42.00	1400	28.00	70.00	KL	1,758.10	2800
	Tuart Drive Entry Statement	40	40	10	0	10	0	3,000	500	3,500	sqm	60%	1400	42.00	1400	28.00	70.00	KL	1,758.10	2800
	SUB TOTAL							6,000	12,410	18,410	sqm		6,337	190.11	4,055	81.10	271.22	KL	6,811.60	10352

	LAKE EVAPORATION																			
	Allowance for Evaporation from Both Lakes																2,612.60	KL	40,829.60	0
	refer Total Eden Irrigation Strategic Overview Report																			
	SUB TOTAL																2,612.60	KL	40,829.60	0

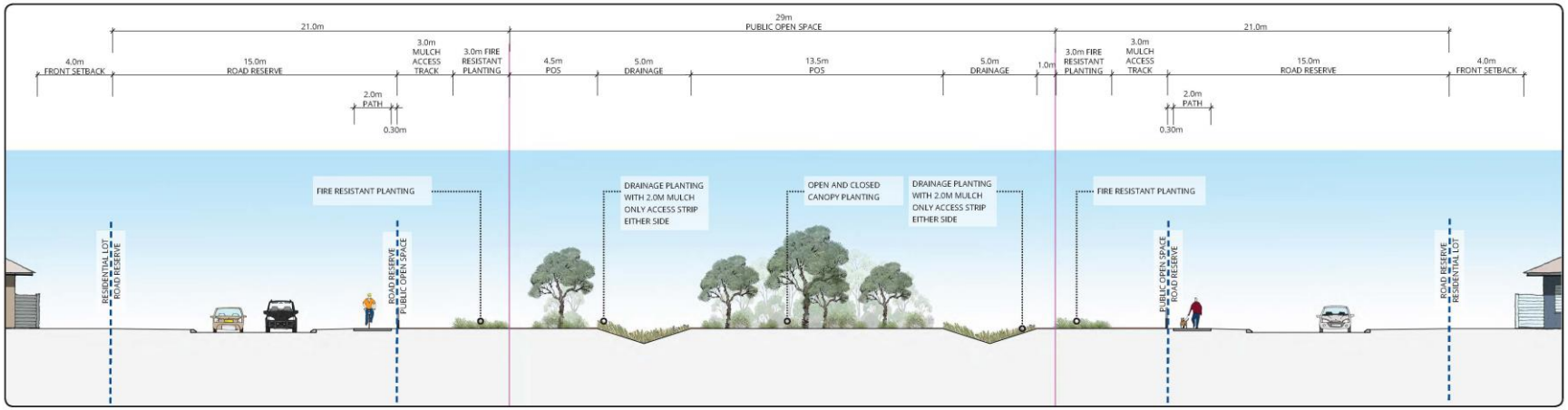
dwg • PR-02-01
date • february 2019
rev • a
scale • 1:750 @ A1

PROVENCE residential structure plan redesign
pos 4 & 5: jospeh drive public open space - landscape concept plan

emerge ASSOCIATES Integrated Science & Design



LANDSCAPE SECTION - A
SCALE 1:50 @ A1

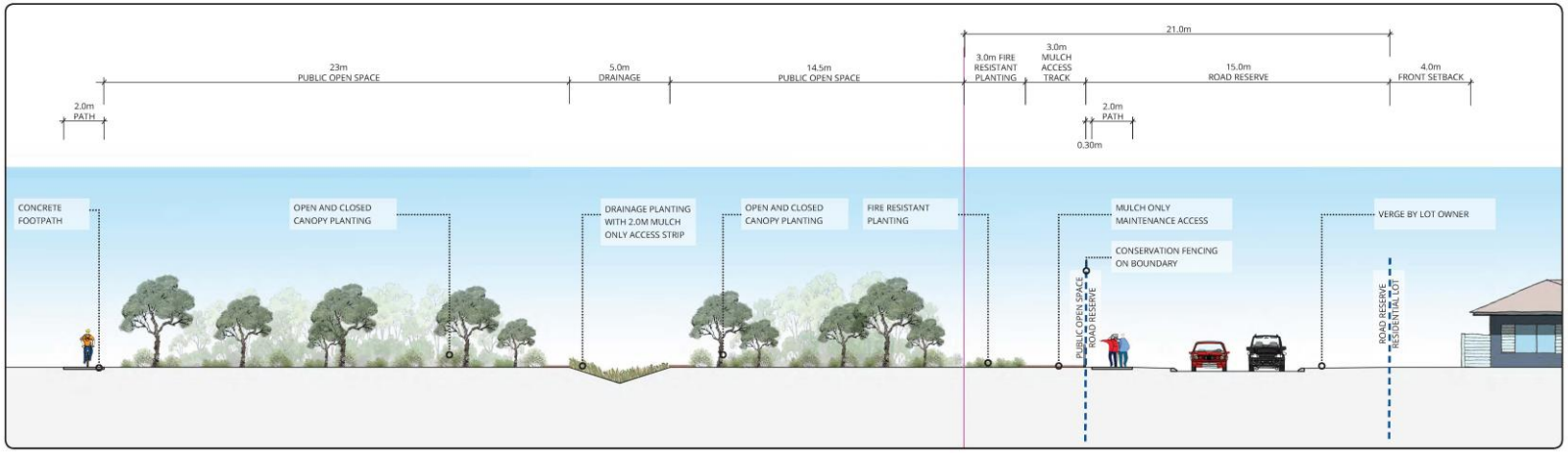


LANDSCAPE SECTION - B
SCALE 1:100 @ A1

dwg • PR-02-02
date • february 2019
rev • a
scale • as shown

PROVENCE residential structure plan redesign
pos 4 & 5: jospeh drive public open space - typical landscape cross sections

emerge ASSOCIATES Integrated Science & Design



LANDSCAPE SECTION - C
SCALE 1:100 @ A1

RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA

dwg • PR-02-03
date • february 2019
rev • a
scale • as shown

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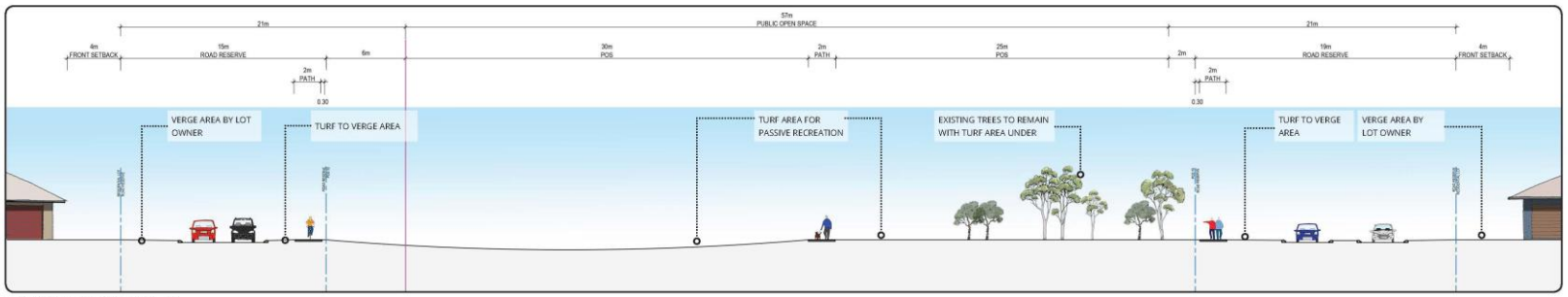
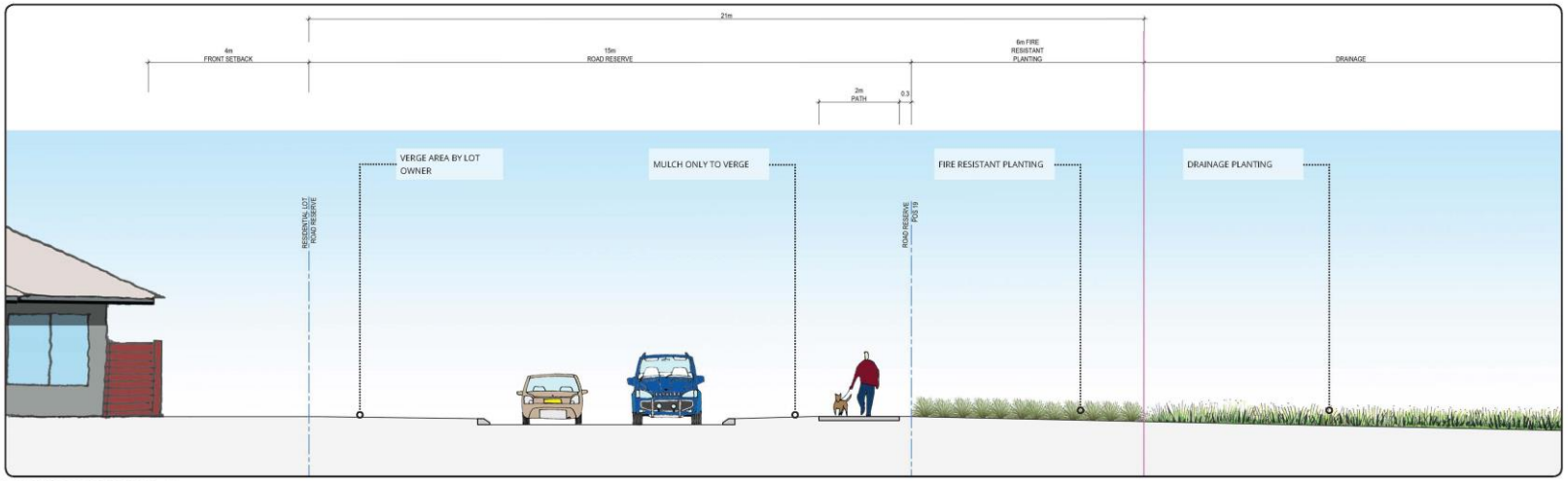
PROVENCE residential structure plan redesign
pos 4 & 5: jospeh drive public open space - typical landscape cross sections & plant species

emerge ASSOCIATES Integrated Science & Design

BUSSELL HIGHWAY
EXISTING VEGETATION TO REMAIN
EXISTING BUSSELL HIGHWAY VERGE VEGETATION TO REMAIN
FIRE RESISTANT PLANTING
DRAINAGE PLANTING
VERGE BY LOT OWNER
21M OFFSET LINE SHOWN IN PINK
MULCH ONLY TO VERGE
CONCRETE FOOTPATH
BUSSELL HWY BUFFER PLANTING. REFER LANDSCAPE BUFFER CONCEPT PLAN
VERGE BY LOT OWNER
MULCH ONLY TO VERGE
OPEN CANOPY PLANTING
CLOSED CANOPY PLANTING
CONCRETE FOOTPATH
FIRE RESISTANT PLANTING
21M OFFSET LINE SHOWN IN PINK
TURF AREA FOR PASSIVE RECREATION
LEGEND
OPEN CANOPY PLANTING
CLOSED CANOPY PLANTING
LANDSCAPE BUFFER PLANTING
DRAINAGE PLANTING
FIRE RESISTANT LANDSCAPE PLANTING - REFER PREFERRED SPECIES LIST
EXISTING BUSSELL HIGHWAY VERGE VEGETATION TO REMAIN
MULCH ONLY AREA
FOOTPATH
VERGE AREA BY LOT OWNER
FUTURE LOTS
21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION
TURF AREA
POS 19
SCALE 1:500 @ A1
PROVENCE residential structure plan redesign
bussell highway buffer landscape concept plan
emerge ASSOCIATES Integrated Science & Design



LANDSCAPE SECTION - A
SCALE 1:150 @ A1



LANDSCAPE SECTION - B
SCALE 1:50 @ A1

RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA

dwg • PR-02-sx
date • february 2019
rev • a
scale • as shown

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PROVENCE residential structure plan redesign
typical landscape cross sections

emerge ASSOCIATES Integrated Science & Design

PHOTO A
Bussell Hwy Median - 32m total width from edge of bitumen to edge of bitumen

A mix of upper tree canopy species, middle storey shrub layer species and lower ground cover species planted across approximately 20m of the 32m median area. The middle storey shrub layer is more dominant and this provides 90% to 100% visual screening across to the Busselton Bypass south bound lanes.

PHOTO B
Bussell Hwy Median - 32m total width from edge of bitumen to edge of bitumen

A mix of upper tree canopy species, middle storey shrub layer species planted across approximately 15m of the 32m median area. The lower groundcover layer is very sparse primarily due to the more dominant upper tree canopy layer. This provides 80% - 90% screening to Busselton Bypass south bound lanes.

PHOTO C
Bussell Hwy Median - 32m total width from edge of bitumen to edge of bitumen

A mix of upper tree canopy species, midle storey shrub layer species and lower groundcover layer species planted across aproximatly 15m of the 32m median area. The middle storey shrub layer is very dense but there the upper tree canopy and groundcover layers still have presence. This provides 100% screening to Busselton Bypass south bound lanes.

PHOTO F
Main Roads W.A Verge - 17m

Primarily middle storey shrub layer species and lower groundcover layer species planted across approximately 10m of the 17m verge area with some upper storey tree planting. This provides 70% to 80% screening to the abutting future development land behind.

PHOTO E
Main Roads W.A Verge - 17m total width

A relatively even mix of upper tree canopy species, middle stirey shrub layer species and lower ground layer species planted across approximatly 10m of the 17m verge area. Density of planting is quite low and could be increased. This currently provides 90% screening to the abutting future development land.

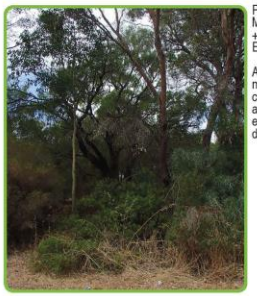

PHOTO D
Main Roads W.A Verge - 17m
+
Existing Landscape Buffer - 20m

An even mix of upper tree canopy species, middle storey shrub layer species and lower ground-cover layer species planted across approximatly 30m of the combined 37m verge and buffer area provides 100% screening to the abutting future development land.

dwg • PR-02-06
date • february 2019
rev • b
scale • not to scale

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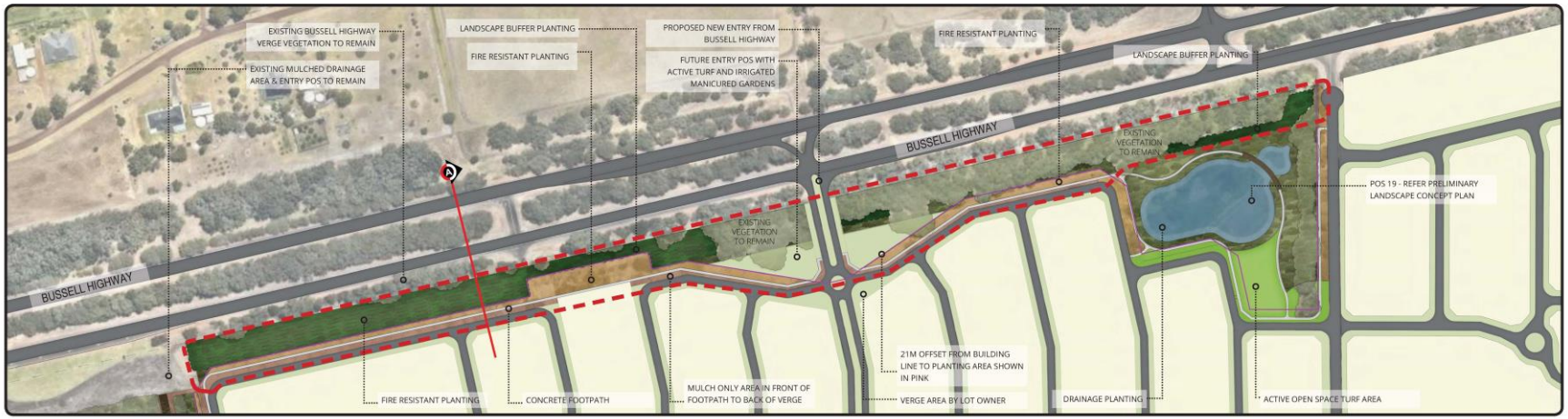
PROVENCE residential structure plan redesign
bussell highway existing verge photos

emerge ASSOCIATES
Integrated Science & Design

RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA



LEGEND

- EXISTING TREE PLANTING TO BE RETAINED WITHIN LANDSCAPE BUFFER WITH INFILL PLANTING MANAGED TO CITY OF BUSSELTON STANDARDS
- EXISTING TREES AND VERGE VEGETATION TO BE RETAINED AND MANAGED TO CITY OF BUSSELTON STANDARDS
- LANDSCAPE BUFFER AND INFILL PLANTING TO ACHIEVE VISUAL SCREEN. TO BE MANAGED AND MAINTAINED TO CITY OF BUSSELTON STANDARDS
- DRAINAGE PLANTING
- FIRE RESISTANT LANDSCAPE PLANTING - REFER PREFERRED SPECIES LIST
- PROPOSED TURF AREA
- EXISTING BUSSELL HIGHWAY VERGE VEGETATION TO REMAIN
- MULCH ONLY AREA
- FOOTPATH
- VERGE AREA BY LOT OWNER
- FUTURE LOTS
- 21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION

dwg • PR-02-07
date • february 2019
rev • b
scale • 1:2000 @ A1

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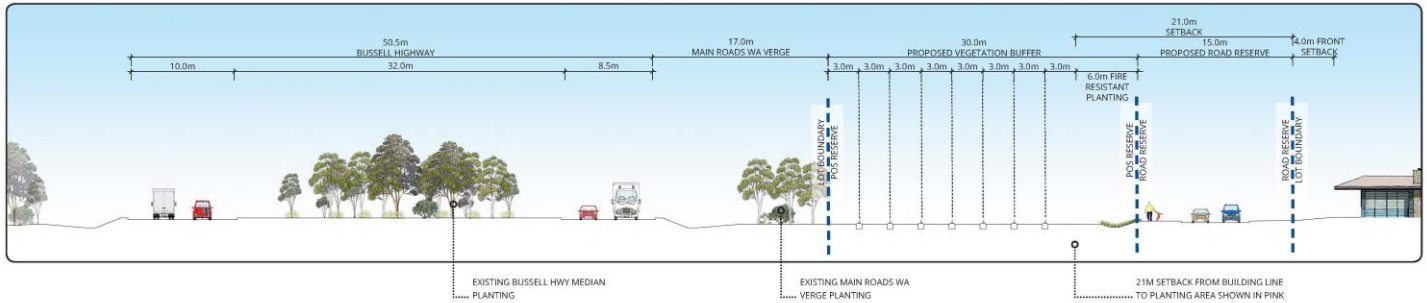
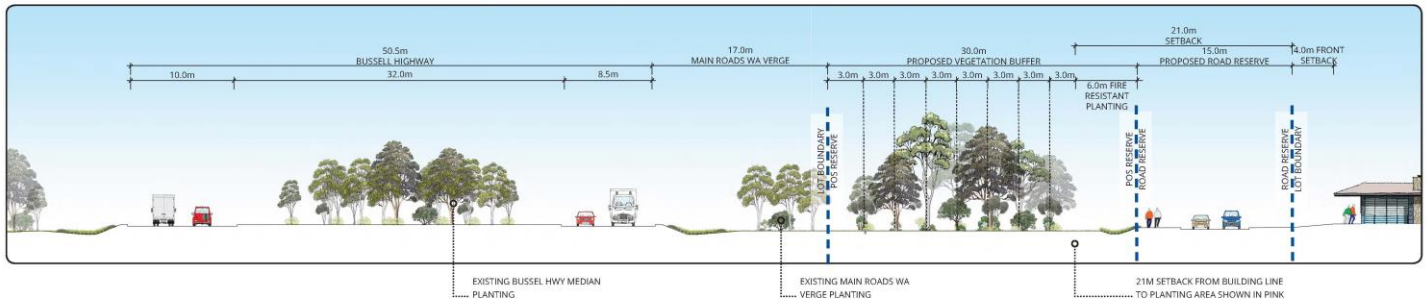
PROVENCE residential structure plan redesign
bussell highway buffer - landscape concept plan

emerge ASSOCIATES Integrated Science & Design



LANDSCAPE SECTION - INITIAL INSTALLATION
SCALE 1:200 @ A1



LANDSCAPE SECTION - MATURITY
SCALE 1:200 @ A1

dwg • PR-02-08
date • february 2019
rev • b
scale • 1:200 @ A1

PROVENCE residential structure plan redesign
bussell highway buffer - typical cross sections

emerge ASSOCIATES Integrated Science & Design

BUSSELTON OUTER BYPASS LANDSCAPE BUFFER AND NOISE BUND
SCALE 1:2500 @ A1

RECOMMENDED FIRE RESISTANT PLANT SPECIES:

CONOSTYLIS ACULEATA | DAMPIERA LINEARIS | HEMIANDRA PUNGENS | KENNEDIA COCCINEA | KENNEDIA PROSTRATA | SCAEVOLA CALLIPTERA

dwg • PR-30-01
date • MARCH 2019
rev • D
scale • 1:2500 @ A1

PROVENCE outer bypass landscape buffer and noise bund
overall landscape concept plan

emerge ASSOCIATES Integrated Science & Design

NOISE BUND DETAIL PLAN
SCALE 1:200 @ A1

dwg • PR 33102
date • MARCH 2018
rev • D
scale • 1:200 @ A1

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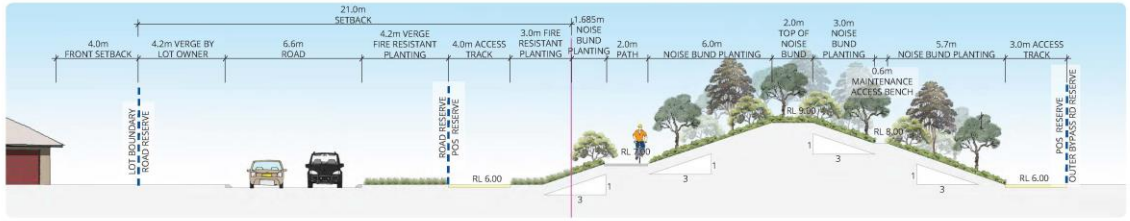
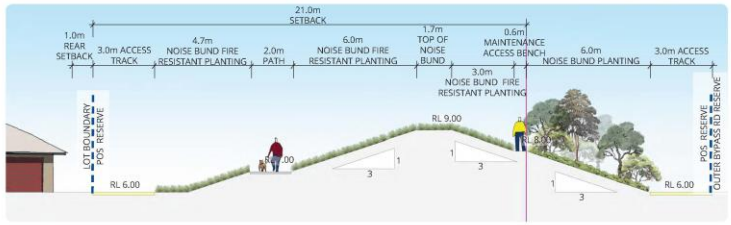
PROVENCE outer bypass landscape buffer and noise bund detail concept plan

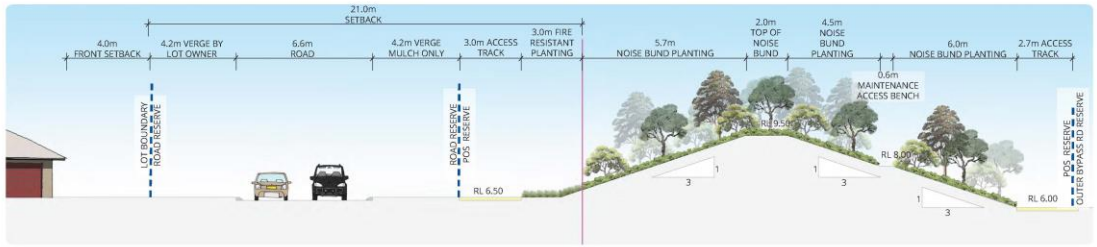
emerge ASSOCIATES Integrated Science & Design



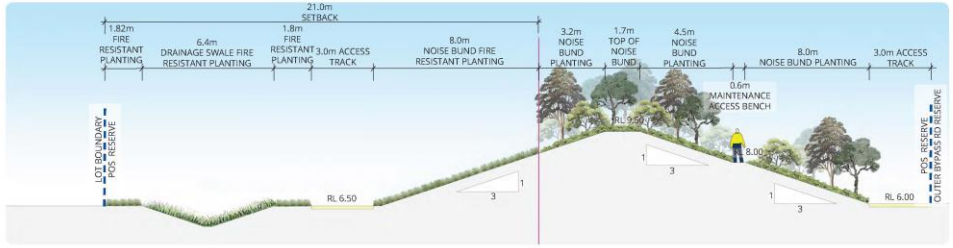
NOISE BUND SECTION A
SCALE 1:100 @ A1



NOISE BUND SECTION B
SCALE 1:100 @ A1



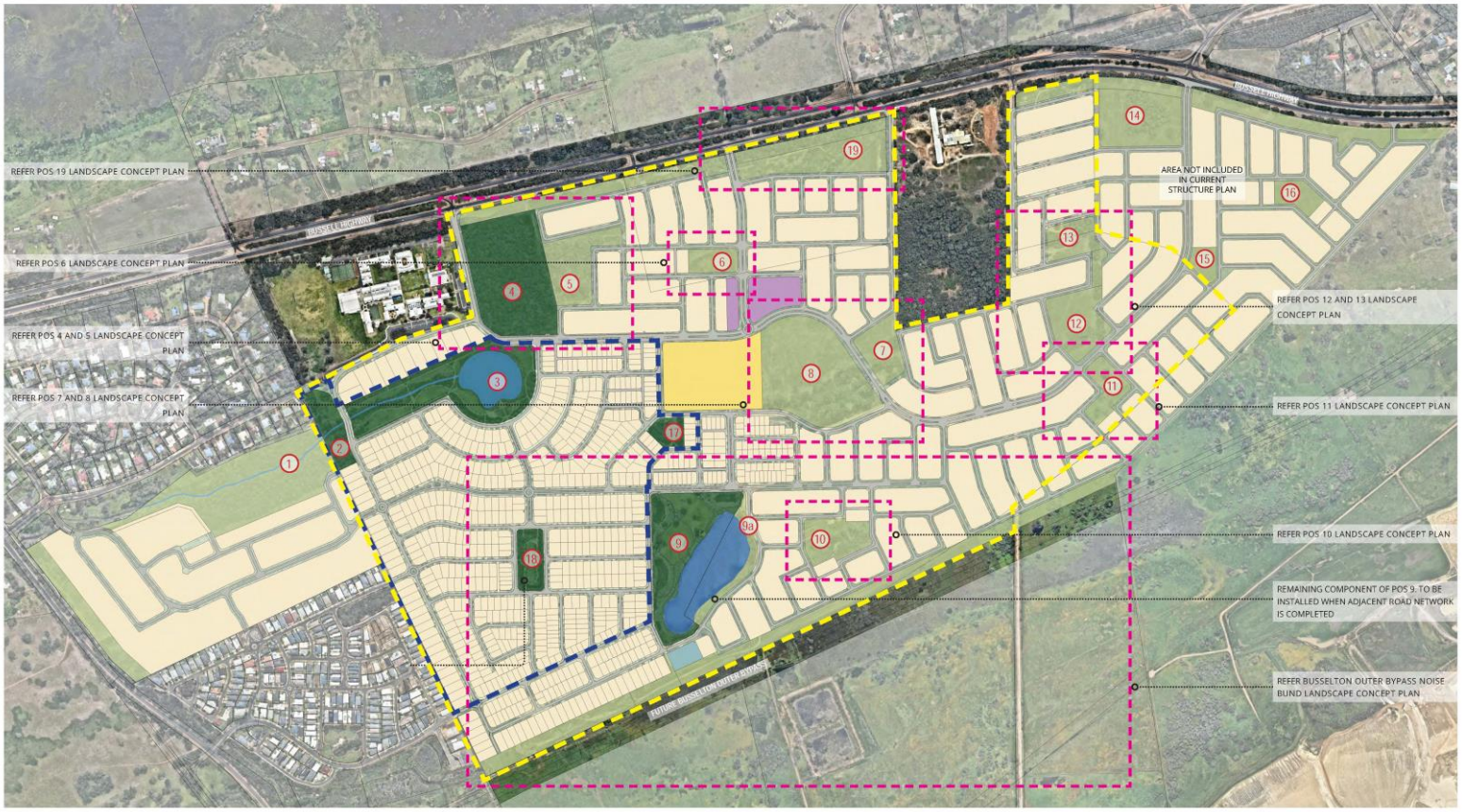
NOISE BUND SECTION C
SCALE 1:100 @ A1



NOISE BUND SECTION D
SCALE 1:100 @ A1

PROVENCE outer bypass landscape buffer and noise bund
typical landscape cross-sections

emerge ASSOCIATES Integrated Science & Design



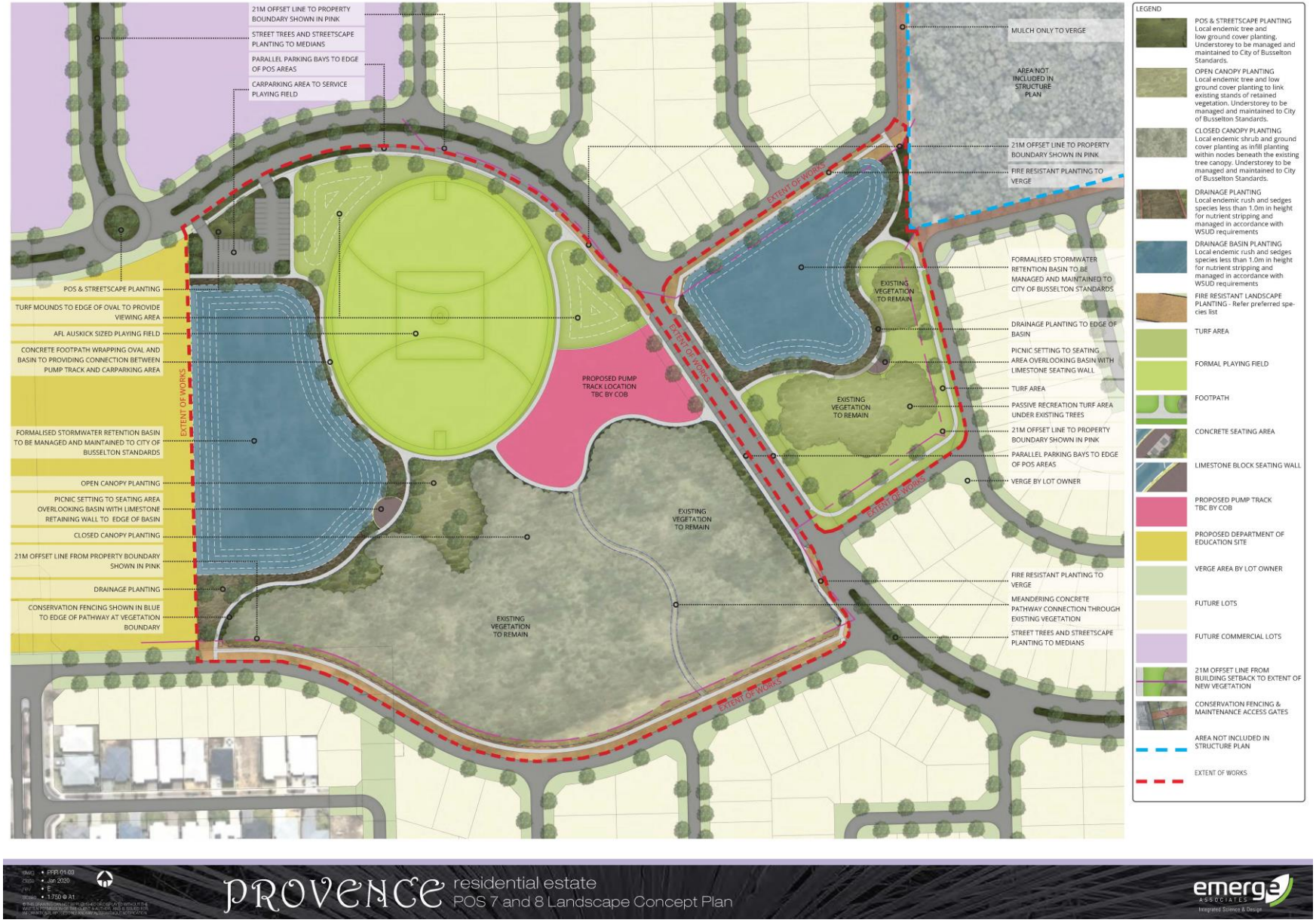
PROVENCE residential estate
Landscape Location Plan

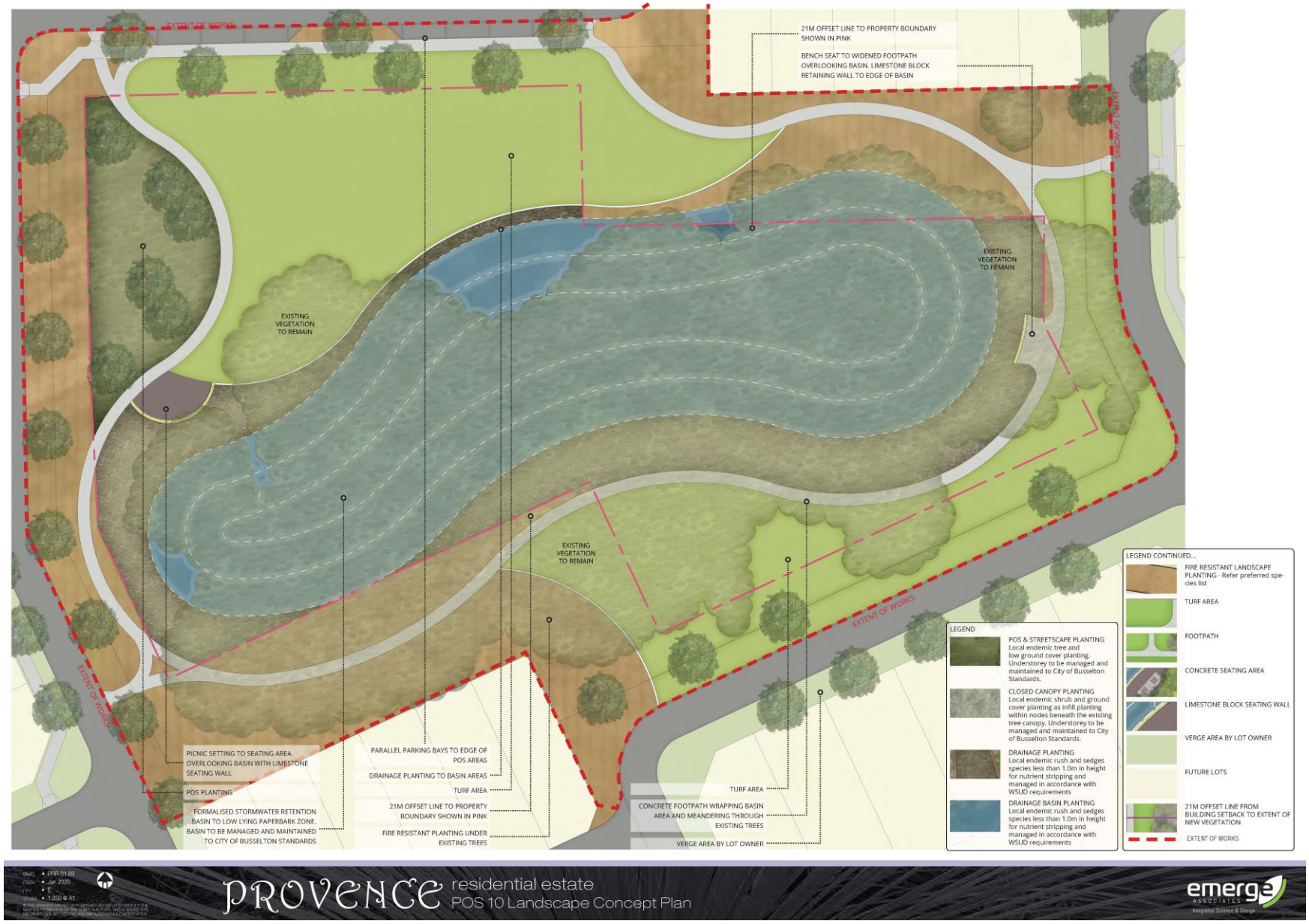
emerge ASSOCIATES
Integrated Science & Design

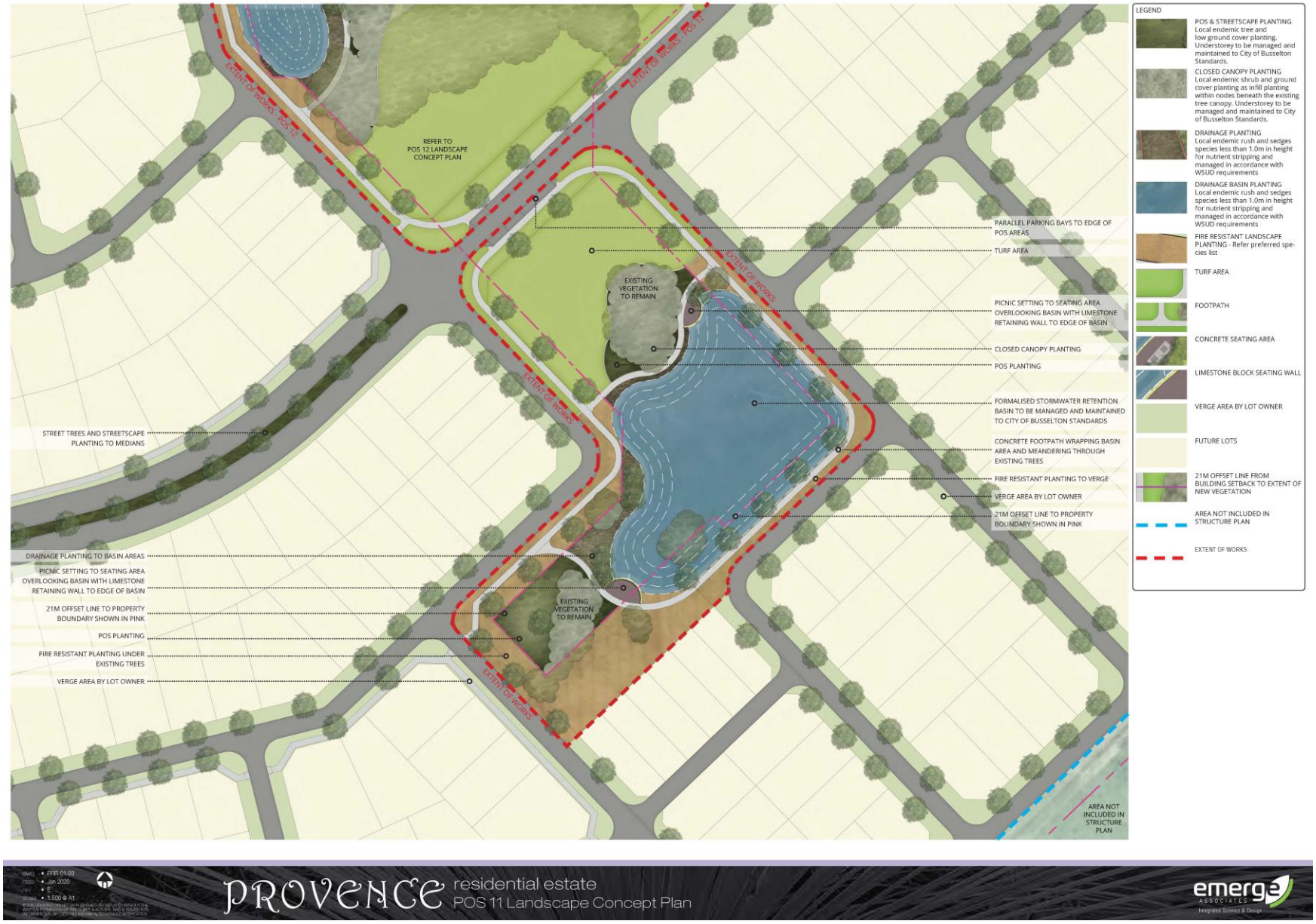
PROVENCE residential estate
POS 4 and 5 Landscape Concept Plan

PROVENCE residential estate
POS 6 Landscape Concept Plan

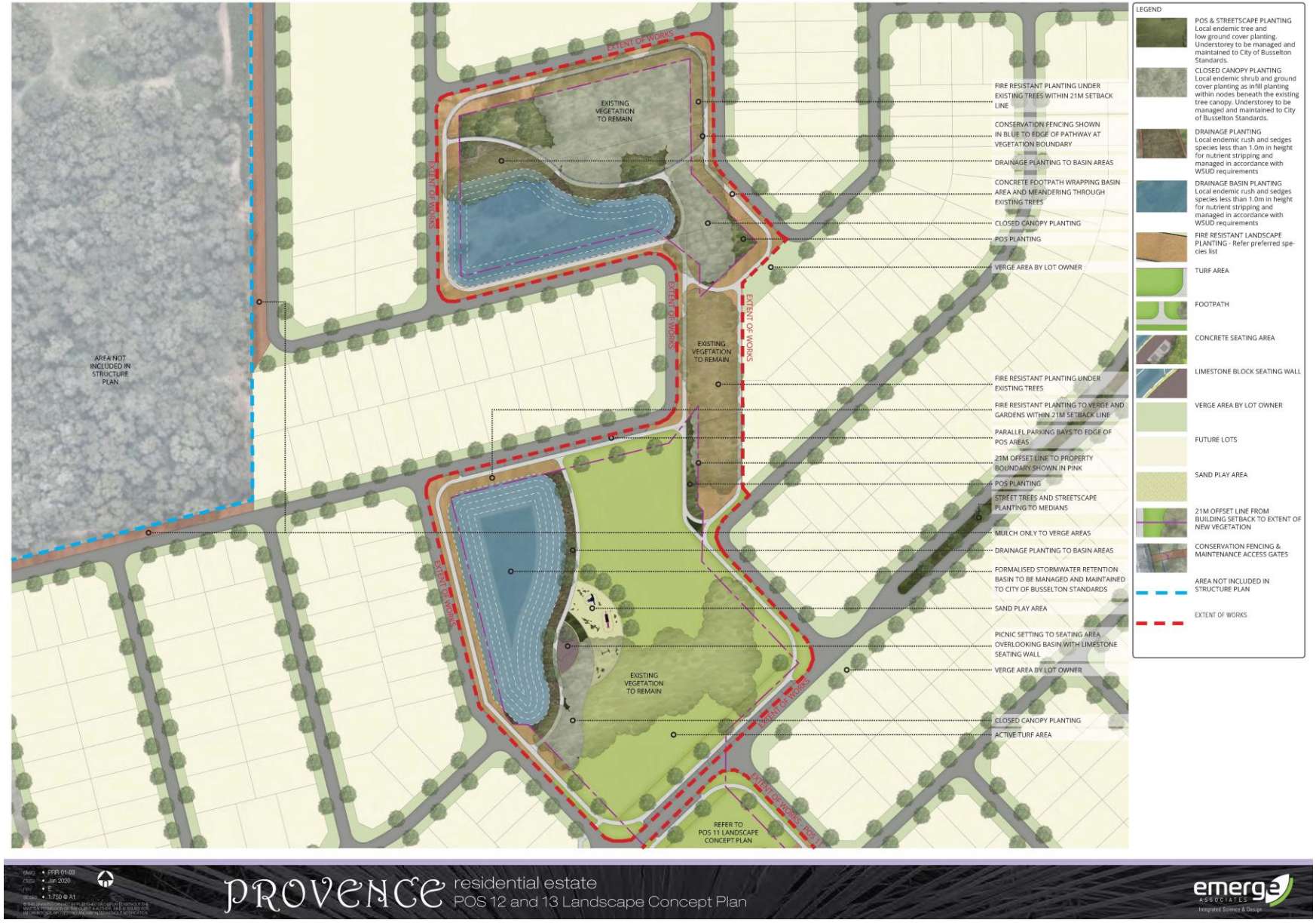
emerge ASSOCIATES


21M OFFSET LINE TO PROPERTY BOUNDARY SHOWN IN PINK
STREET TREES AND STREETSCAPE PLANTING TO MEDIANS
PARALLEL PARKING BAYS TO EDGE OF POS AREAS
CARPARKING AREA TO SERVICE PLAYING FIELD
POS & STREETSCAPE PLANTING
TURF MOUNDS TO EDGE OF OVAL TO PROVIDE VIEWING AREA
AFL AUSKICK SIZED PLAYING FIELD
CONCRETE FOOTPATH WRAPPING OVAL AND BASIN TO PROVIDING CONNECTION BETWEEN PUMP TRACK AND CARPARKING AREA
EXTENT OF WORKS
FORMALISED STORMWATER RETENTION BASIN TO BE MANAGED AND MAINTAINED TO CITY OF BUSSELTON STANDARDS
OPEN CANOPY PLANTING
PICNIC SETTING TO SEATING AREA OVERLOOKING BASIN WITH LIMESTONE RETAINING WALL TO EDGE OF BASIN
CLOSED CANOPY PLANTING
21M OFFSET LINE FROM PROPERTY BOUNDARY SHOWN IN PINK
DRAINAGE PLANTING
CONSERVATION FENCING SHOWN IN BLUE TO EDGE OF PATHWAY AT VEGETATION BOUNDARY
PROPOSED PUMP TRACK LOCATION TBC BY COB
EXISTING VEGETATION TO REMAIN
MULCH ONLY TO VERGE
AREA NOT INCLUDED IN STRUCTURE PLAN
21M OFFSET LINE TO PROPERTY BOUNDARY SHOWN IN PINK
FIRE RESISTANT PLANTING TO VERGE
FORMALISED STORMWATER RETENTION BASIN TO BE MANAGED AND MAINTAINED TO CITY OF BUSSELTON STANDARDS
DRAINAGE PLANTING TO EDGE OF BASIN
PICNIC SETTING TO SEATING AREA OVERLOOKING BASIN WITH LIMESTONE SEATING WALL
TURF AREA
PASSIVE RECREATION TURF AREA UNDER EXISTING TREES
21M OFFSET LINE TO PROPERTY BOUNDARY SHOWN IN PINK
PARALLEL PARKING BAYS TO EDGE OF POS AREAS
VERGE BY LOT OWNER
FIRE RESISTANT PLANTING TO VERGE
MEANDERING CONCRETE PATHWAY CONNECTION THROUGH EXISTING VEGETATION
STREET TREES AND STREETSCAPE PLANTING TO MEDIANS
LEGEND
POS & STREETSCAPE PLANTING
Local endemic tree and low ground cover planting. Understorey to be managed and maintained to City of Busselton Standards.
OPEN CANOPY PLANTING
Local endemic tree and low ground cover planting to link existing stands of retained vegetation. Understorey to be managed and maintained to City of Busselton Standards.
CLOSED CANOPY PLANTING
Local endemic shrub and ground cover planting as infill planting within nodes beneath the existing tree canopy. Understorey to be managed and maintained to City of Busselton Standards.
DRAINAGE PLANTING
Local endemic rush and sedges species less than 1.0m in height for nutrient stripping and managed in accordance with WSUD requirements
DRAINAGE BASIN PLANTING
Local endemic rush and sedges species less than 1.0m in height for nutrient stripping and managed in accordance with WSUD requirements
FIRE RESISTANT LANDSCAPE PLANTING - Refer preferred species list
TURF AREA
FORMAL PLAYING FIELD
FOOTPATH
CONCRETE SEATING AREA
LIMESTONE BLOCK SEATING WALL
PROPOSED PUMP TRACK TBC BY COB
PROPOSED DEPARTMENT OF EDUCATION SITE
VERGE AREA BY LOT OWNER
FUTURE LOTS
FUTURE COMMERCIAL LOTS
21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION
CONSERVATION FENCING & MAINTENANCE ACCESS GATES
AREA NOT INCLUDED IN STRUCTURE PLAN
EXTENT OF WORKS
PROVENCE residential estate
POS 7 and 8 Landscape Concept Plan
emerge ASSOCIATES

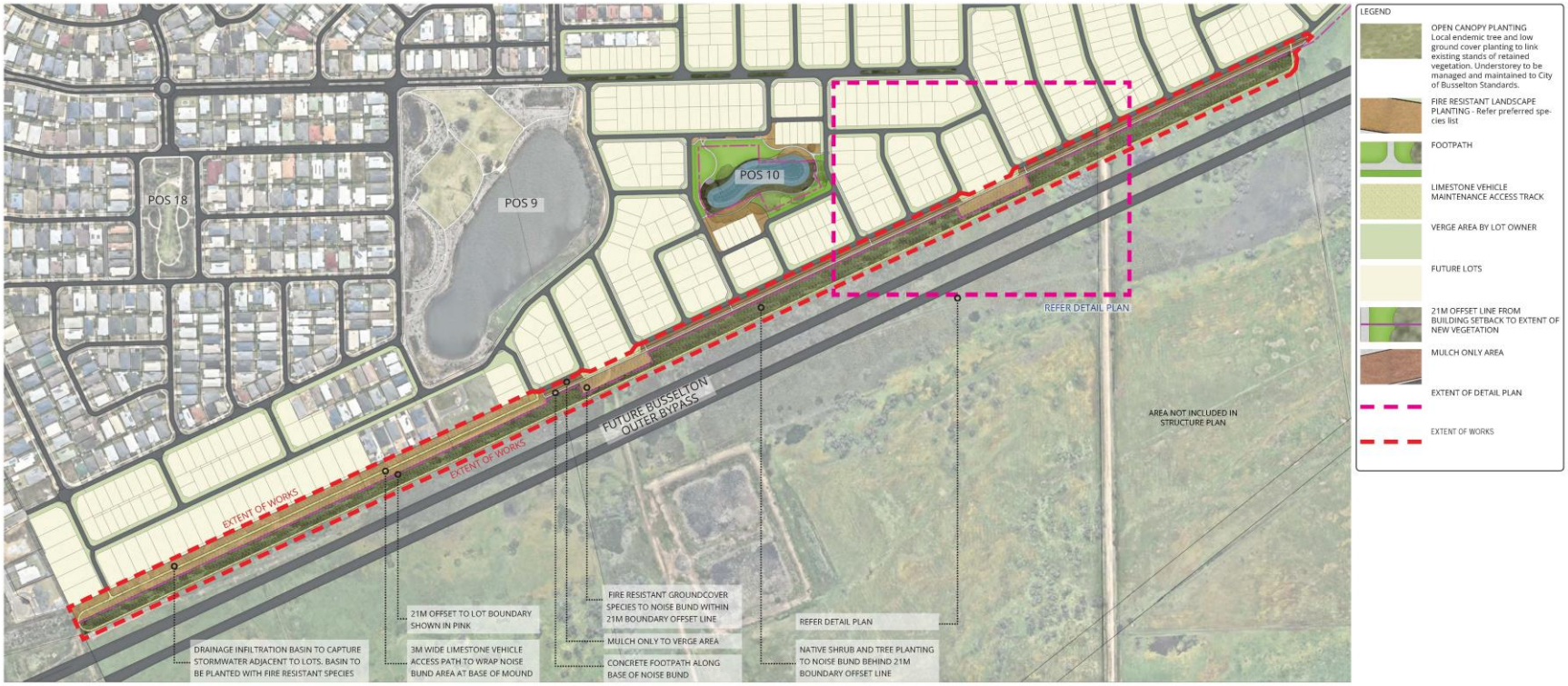

EXTENT OF WORKS
21M OFFSET LINE TO PROPERTY BOUNDARY SHOWN IN PINK
BENCH SEAT TO WIDENED FOOTPATH OVERLOOKING BASIN. LIMESTONE BLOCK RETAINING WALL TO EDGE OF BASIN
EXISTING VEGETATION TO REMAIN
EXISTING VEGETATION TO REMAIN
EXISTING VEGETATION TO REMAIN
EXTENT OF WORKS
EXTENT OF WORKS
EXTENT OF WORKS
PICNIC SETTING TO SEATING AREA OVERLOOKING BASIN WITH LIMESTONE SEATING WALL
POS PLANTING
FORMALISED STORMWATER RETENTION BASIN TO LOW LYING PAPERBARK ZONE. BASIN TO BE MANAGED AND MAINTAINED TO CITY OF BUSSELTON STANDARDS
PARALLEL PARKING BAYS TO EDGE OF POS AREAS
DRAINAGE PLANTING TO BASIN AREAS
TURF AREA
21M OFFSET LINE TO PROPERTY BOUNDARY SHOWN IN PINK
FIRE RESISTANT PLANTING UNDER EXISTING TREES
TURF AREA
CONCRETE FOOTPATH WRAPPING BASIN AREA AND MEANDERING THROUGH EXISTING TREES
VERGE AREA BY LOT OWNER
LEGEND
POS & STREETSCAPE PLANTING Local endemic tree and low ground cover planting. Understorey to be managed and maintained to City of Busselton Standards.
CLOSED CANOPY PLANTING Local endemic shrub and ground cover planting as infill planting within nodes beneath the existing tree canopy. Understorey to be managed and maintained to City of Busselton Standards.
DRAINAGE PLANTING Local endemic rush and sedges species less than 1.0m in height for nutrient stripping and managed in accordance with WSUD requirements
DRAINAGE BASIN PLANTING Local endemic rush and sedges species less than 1.0m in height for nutrient stripping and managed in accordance with WSUD requirements
LEGEND CONTINUED...
FIRE RESISTANT LANDSCAPE PLANTING - Refer preferred species list
TURF AREA
FOOTPATH
CONCRETE SEATING AREA
LIMESTONE BLOCK SEATING WALL
VERGE AREA BY LOT OWNER
FUTURE LOTS
21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION
EXTENT OF WORKS
PROVENCE residential estate
POS 10 Landscape Concept Plan
emerge ASSOCIATES



PROVENCE residential estate
POS 11 Landscape Concept Plan


EXTENT OF WORKS
EXISTING VEGETATION TO REMAIN
AREA NOT INCLUDED IN STRUCTURE PLAN
FIRE RESISTANT PLANTING UNDER EXISTING TREES WITHIN 21M SETBACK LINE
CONSERVATION FENCING SHOWN IN BLUE TO EDGE OF PATHWAY AT VEGETATION BOUNDARY
DRAINAGE PLANTING TO BASIN AREAS
CONCRETE FOOTPATH WRAPPING BASIN AREA AND MEANDERING THROUGH EXISTING TREES
CLOSED CANOPY PLANTING
POS PLANTING
VERGE AREA BY LOT OWNER
FIRE RESISTANT PLANTING UNDER EXISTING TREES
FIRE RESISTANT PLANTING TO VERGE AND GARDENS WITHIN 21M SETBACK LINE
PARALLEL PARKING BAYS TO EDGE OF POS AREAS
21M OFFSET LINE TO PROPERTY BOUNDARY SHOWN IN PINK
POS PLANTING
STREET TREES AND STREETSCAPE PLANTING TO MEDIANS
MULCH ONLY TO VERGE AREAS
DRAINAGE PLANTING TO BASIN AREAS
FORMALISED STORMWATER RETENTION BASIN TO BE MANAGED AND MAINTAINED TO CITY OF BUSSELTON STANDARDS
SAND PLAY AREA
PICNIC SETTING TO SEATING AREA OVERLOOKING BASIN WITH LIMESTONE SEATING WALL
VERGE AREA BY LOT OWNER
CLOSED CANOPY PLANTING
ACTIVE TURF AREA
REFER TO POS 11 LANDSCAPE CONCEPT PLAN
LEGEND
POS & STREETSCAPE PLANTING Local endemic tree and low ground cover planting. Understorey to be managed and maintained to City of Busselton Standards.
CLOSED CANOPY PLANTING Local endemic shrub and ground cover planting as infill planting within nodes beneath the existing tree canopy. Understorey to be managed and maintained to City of Busselton Standards.
DRAINAGE PLANTING Local endemic rush and sedges species less than 1.0m in height for nutrient stripping and managed in accordance with WSUD requirements
DRAINAGE BASIN PLANTING Local endemic rush and sedges species less than 1.0m in height for nutrient stripping and managed in accordance with WSUD requirements
FIRE RESISTANT LANDSCAPE PLANTING - Refer preferred species list
TURF AREA
FOOTPATH
CONCRETE SEATING AREA
LIMESTONE BLOCK SEATING WALL
VERGE AREA BY LOT OWNER
FUTURE LOTS
SAND PLAY AREA
21M OFFSET LINE FROM BUILDING SETBACK TO EXTENT OF NEW VEGETATION
CONSERVATION FENCING & MAINTENANCE ACCESS GATES
AREA NOT INCLUDED IN STRUCTURE PLAN
EXTENT OF WORKS
PROVENCE residential estate
POS 12 and 13 Landscape Concept Plan
emerge ASSOCIATES

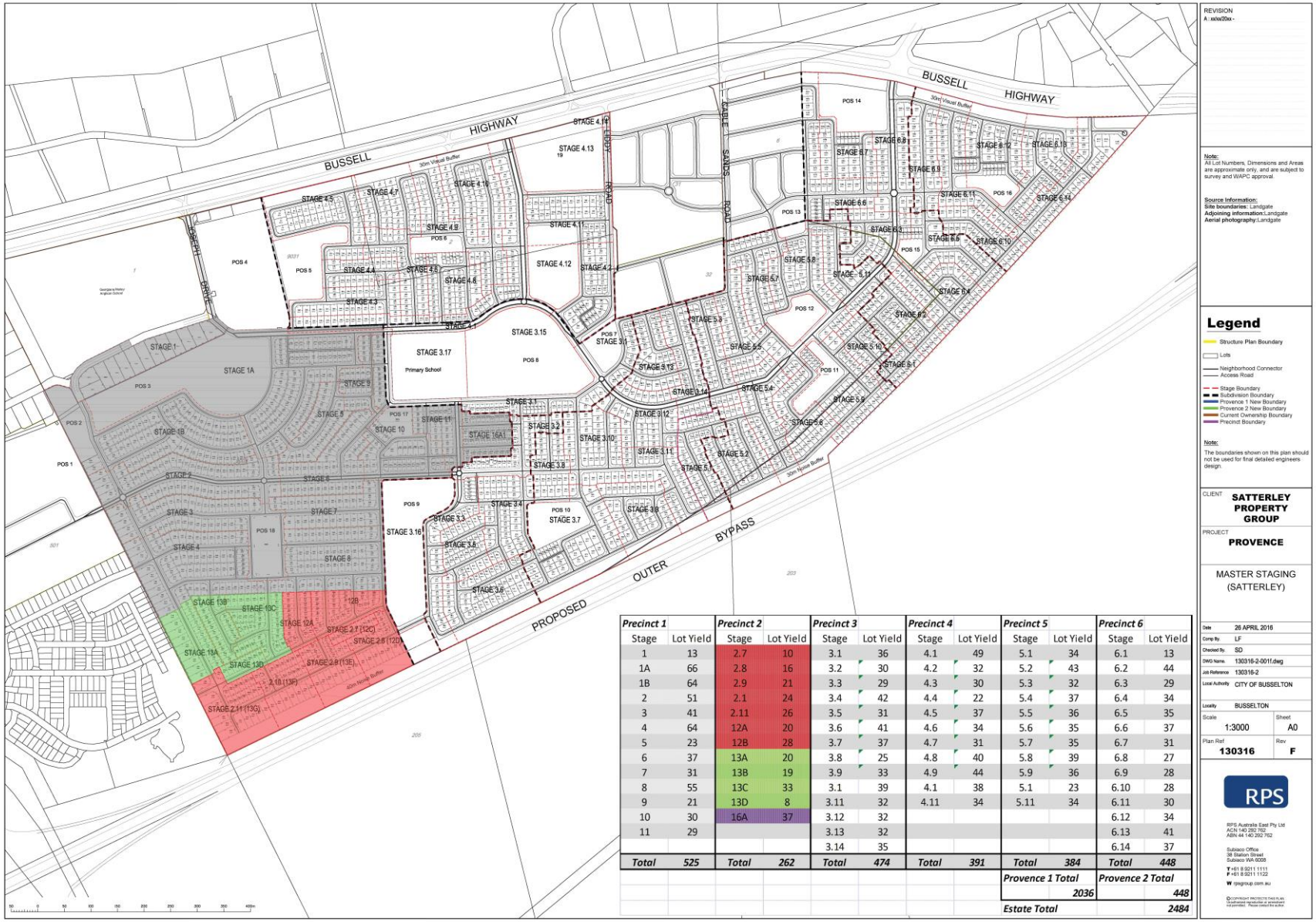
PROVENCE residential estate
POS 19 Landscape Concept Plan



PROVENCE residential estate
Busselton Outer Bypass Noise Bund Landscape Concept Plan

PROVENCE residential estate
Busselton Outer Bypass Buffer Landscape Concept Plan - Detail Plan

Appendix D Staging Plan



Precinct 1		Precinct 2		Precinct 3		Precinct 4		Precinct 5		Precinct 6	
Stage	Lot Yield	Stage	Lot Yield	Stage	Lot Yield	Stage	Lot Yield	Stage	Lot Yield	Stage	Lot Yield
1	13	2.7	10	3.1	36	4.1	49	5.1	34	6.1	13
1A	66	2.8	16	3.2	30	4.2	32	5.2	43	6.2	44
1B	64	2.9	21	3.3	29	4.3	30	5.3	32	6.3	29
2	51	2.1	24	3.4	42	4.4	22	5.4	37	6.4	34
3	41	2.11	26	3.5	31	4.5	37	5.5	36	6.5	35
4	64	12A	20	3.6	41	4.6	34	5.6	35	6.6	37
5	23	12B	28	3.7	37	4.7	31	5.7	35	6.7	31
6	37	13A	20	3.8	25	4.8	40	5.8	39	6.8	27
7	31	13B	19	3.9	33	4.9	44	5.9	36	6.9	28
8	55	13C	33	3.1	39	4.1	38	5.1	23	6.10	28
9	21	13D	8	3.11	32	4.11	34	5.11	34	6.11	30
10	30	16A	37	3.12	32					6.12	34
11	29			3.13	32					6.13	41
				3.14	35					6.14	37
Total	*525*	*Total*	*262*	*Total*	*474*	*Total*	*391*	*Total*	*384*	*Total*	*448*
								Provence 1 Total		*Provence 2 Total*	
									2036		*448*
								Estate Total			*2484*

REVISION
A - xx/xx/20xx -

Note:
All Lot Numbers, Dimensions and Areas are approximate only, and are subject to survey and WAPC approval.

Source Information:
Site boundaries: Landgate
Adjoining information: Landgate
Aerial photography: Landgate

Legend

- Structure Plan Boundary
- Lots
- Neighborhood Connector
- Access Road
- Stage Boundary
- Subdivision Boundary
- Provence 1 New Boundary
- Provence 2 New Boundary
- Current Ownership Boundary
- Precinct Boundary

Note:
The boundaries shown on this plan should not be used for final detailed engineers design.

CLIENT: **SATTERLEY PROPERTY GROUP**

PROJECT: **PROVENCE**

MASTER STAGING (SATTERLEY)

Date	26 APRIL 2016
Comp By	LF
Checked By	SD
DWG Name	130316-2-001f.dwg
Job Reference	130316-2
Local Authority	CITY OF BUSSELTON
Locality	BUSSELTON
Scale	1:3000
Sheet	A0
Plan Ref	130316
Rev	F

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Appendix E Technical Note – Traffic Access Points

JACOBS

11th Floor, Durack Centre
263 Adelaide Terrace
PO Box H615

Subject	Mapping for Traffic Volume Distribution & Access Staging	**Project Name**	Provence Local Structure Plan – Transport Impact Assessment
Attention	Satterley Property Group c/o Joanne Cousins, RPS Group	**Project No.**	IW098900
From	Richard Isted, Section Lead Transport Planning & Advisory		
Date	February 7, 2019		
Copies to	Daniel Naude, Road Corridor Planning Manager, Main Roads WA South West		

This technical note provides the most current information regarding the indicative timeframes for subdivision development and associated staging recommendations for the operation of new access points and decommissioning of old access points. It should be noted that staging of access points has been based on the current subdivision development schedule and therefore should the schedule change this may have an associated impact on the recommended approach to the staging of access points.

Access Staging Plan

As per the related Transport Impact Assessment (revision 7, 09 July 2018), Jacobs has recommended typical street types for the internal street network and access points to the Busselton Bypass. These recommendations are based on the expected function of the road and existing road reservations within the Local Structure Plan. The locations of each existing or future access point is shown below in **Figure 1**.

The roads connecting Access Points 'A', 'B' and 'C' have been classified as 'Neighbourhood Connector A' roads, whereas the existing Access Point 'D' has been classified as 'Neighbourhood Connector B' in accordance with the criteria outlined in Liveable Neighbourhoods (WAPC 2015, draft). The desirable maximum volume of a Neighbourhood Connector A is 7,000 vehicles per day, whereas a 'Neighbourhood Connector B' road has a desirable maximum volume of 3,000 vehicles per day.

In addition to the new access points both the existing accesses at Liddy Road and Cable Sands Road have been classed as 'Access Street Type A' with a maximum desirable volume of 3,000 vehicles per day.

The expected traffic volumes on the internal road network have been estimated by applying the residential trip generation rate to the lot yield detailed in the current subdivision plan provided by Satterley and the use of trip generation rates from Transport Impact Assessment Guidelines for Developments, (WAPC 2016). Table 1 below indicates the traffic volumes for each of the six precincts.

Table 1: Precinct Traffic Generation

Precinct	Lot Yield	Traffic Generated	Cumulative Traffic Count
Precinct 1	525	4,200	4,200
Precinct 2	262	2,096	6,296
Precinct 4	391	3128	10,496
Precinct 3	474	3,792	13,216
Precinct 5	384	3,072	16,288
Precinct 6	448	3,584	19,872
Total	2,484	19,872	

As mentioned above, the assumed threshold for Neighbourhood and Access Point Connectors is 7,000 and 3,000 respectively. Based upon this, the following recommendations regarding the operation of new access points and the decommissioning of old access points are provided:

- The commencement of works for Precinct 1 and 2 is to be serviced by the existing Access A and Access D;
- The commencement of work for Precinct 4 can be serviced by the existing Access A and Access D, as well as the existing access of Liddy Road (due to not exceeding 13,000 vehicles per day);
- When works commences in Precinct 3, this will require the operational instatement of Access B (due to exceeding 13,000 vehicles per day). Once Access B has been operationally instated, the existing Liddy Road Access can be decommissioned;
- The commencement of works for Precinct 5 can be serviced by the existing Access A and D, as well as the newly instated Access B and the existing Cable Sands Road (due to the cumulative vehicle count not exceeding 20,000 per day); and
- The commencement of works for Precinct 6 will require the operational instatement of Access C as although the cumulative vehicles per day does not exceed 20,000, the vehicle count does not take into consideration construction vehicles which will increase the vehicle count. Furthermore, from a construction point of view, it would be logical that given the through road in Precinct 5 being instated that Access C be operationally instated and therefore Cable Sands Road be decommissioned.

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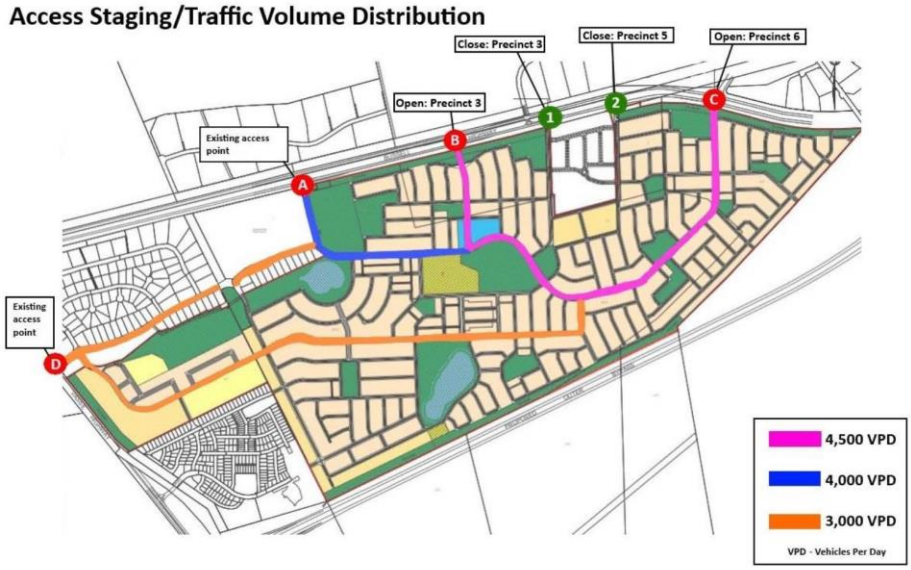
Traffic Volume Network Diagram

Figure 1: Access Staging/Traffic Volume Distribution



Appendix F Method 2 calculations

Calculated February 24, 2020, 2:37 pm (MDc v.4.8)

Provence Plot 9

Minimum Distance Calculator - AS3959-2009 (Method 2)			
Inputs		Outputs	
Fire Danger Index	80	Rate of spread	2.4 km/h
Vegetation classification	Forest	Flame length	19.8 m
Surface fuel load	25 t/ha	Flame angle	16 °, 19 °, 23 °, 28 °, 31 ° & 51 °
Overall fuel load	35 t/ha	Elevation of receiver	2.72 m, 3.22 m, 3.86 m, 4.64 m, 5.09 m & 7.69 m
Vegetation height	n/a	Fire intensity	43,400 kW/m
Effective slope	0 °	Transmissivity	0.895, 0.891, 0.885, 0.877, 0.872 & 0.829
Site slope	0 °	Viewfactor	0.5743, 0.4236, 0.2782, 0.1848, 0.1495 & 0.0393
Flame width	3.66 m	Minimum distance to < 40 kW/m²	11.59999999999997 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	12.39999999999997 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	13.69999999999997 m
Flame temperature	1,090 K	Minimum distance to < 12.5 kW/m²	15.29999999999996 m
		Minimum distance to < 10 kW/m²	16.29999999999996 m

Rate of Spread - Mcarthur, 1973 & Noble et al., 1980

Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980

Elevation of receiver - Douglas & Tan, 2005

Flame angle - Douglas & Tan, 2005

Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

FPA AUSTRALIA | Fire Protection Association Australia | Life. Property. Environment.

BPAD Bushfire Planning & Design

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: Provence Estate 2020 Structure Plan - BMP Addendum

Suburb: Yalyalup **State:** WA **P/code:** 6280

Local government area: City of Busselton

Description of the planning proposal: Structure Plan

BMP Plan / Reference Number: 62888 **Version:** M02 Rev 0 **Date of Issue:** 09/08/2022

Client / Business Name: Yolk Property Group on behalf of 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.)?

The original BMP prepared by Ecosystem Solutions used Method 2 and has been previously assessed by the decision-making authorities and DFES. This addendum does not propose any further Method 2 BAL calculations.

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	28/02/2023
Company		**Contact No.**	
Strategen-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** 09/08/2022

Name:	Sheldon Day / David Sands	Date:	9 August 2022
Company:	Yolk Property Group / City of Busselton	Job/Doc. No.:	62888/146,456
Email:	sheldon@yolkpropertygroup.com.au / david.sands@busselton.wa.gov.au	Inquiries:	Louisa Robertson

Provence Estate 2020 Structure Plan – Bushfire Management Plan addendum

1. Background and purpose

This Bushfire Management Plan (BMP) addendum has been prepared in respect of the BMP prepared for the 2020 Structure Plan over Provence Estate, Yalyalup, by Ecosystem Solutions. The BMP that this addendum is to be appended to is referenced as Revision D, dated 28 February 2020.

This addendum has been prepared to assist the final determination of the 2020 Structure Plan application for Provence Estate to enable the current proponents (Yolk Property Group on behalf of Almond Lake Pty Ltd) to progress a subdivision application of over Part Lot 9034 Joseph Drive, as well as an upcoming Structure Plan Amendment.

This addendum addresses modifications to the BMP required by the City of Busselton (the City) and the Western Australian Planning Commission (WAPC) made on in the Schedule of Modifications. It should be noted that the Schedule of Modifications was prepared in response to a previous version of the BMP (Revision B, dated 5 March 2019), however, the modifications were largely not incorporated into the final BMP (Revision D).

This addendum does not address compliance with the current version of *Guidelines for Planning in Bushfire Prone Areas* (Version 1.4) given the Structure Plan application was submitted prior to the Version 1.4 being adopted in March 2022. However, all future planning applications, including the abovementioned subdivision application and Structure Plan Amendment will address the relevant requirements of Version 1.4.

Since Strategen-JBS& does not have access to the digital versions of the figures within the BMP (which were prepared by Ecosystem Solutions and RPS), modifications to the figures consist of strikethrough of text that has been deleted, and insertion of text boxes where text has been added. No modifications have been made to the figure dates and revision numbers etc.

This addendum has been prepared by Louisa Robertson, a Level 3 accredited Bushfire Planning and Design Practitioner and addresses the modifications required by the City and the WAPC. This addendum does not provide an evaluation of the BMP, nor does it provide Strategen-JBS&G's endorsement of the BMP.

The modifications to the BMP are set out in Sections 2 and 3 below.

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2. Modifications required by the City

2.1 City modification 1

2.1.1 Required modification

Remove all references to restrictive covenants between developer and individual landowners.

2.1.2 Reason

The BMP identifies two residential cells that may partially be affected by BAL-40 along their boundaries and proposes restricted covenants between the developer and individual landowners to ensure that no dwelling is constructed within BAL-40 areas. The City does not support this proposal as it is unworkable and unnecessary. A detailed BAL assessment would be required at building licence stage to ensure that no dwelling is constructed within BAL-40.

2.1.3 BMP amendments

This addendum makes the following amendments to the BMP:

1. Section 2.2, Table 3 (Page 26)

   Replace text below the table: "*Some lots include a restrictive covenant excluding building within BAL-FZ or BAL-40 areas to ensure no dwelling is constructed in an area over BAL-29*."

   with: "*Some lots include provision for an Asset Protection Zone setback to ensure future habitable buildings are not constructed within areas of BAL-40 or BAL-FZ. The setbacks will be enforced through preparation of a Local Development Plan at subdivision stage to ensure that future habitable development is located in BAL-29 or below*."

2. Figure 10, BAL Contour Assessment – detailed view, east (Page 30)

   Figure 10 is replaced with Figure 10 at Attachment A, which removes reference to restrictive covenants.

3. Figure 11, BAL Contour Assessment – detailed view, north east (Page 31)

   Figure 11 is replaced with Figure 11 at Attachment B, which removes reference to restrictive covenants.

4. Figure 13, BAL Contour Assessment – detailed view, central (Page 33)

   Figure 13 is replaced with Figure 13 at Attachment C, which removes reference to restrictive covenants.

5. Section 4.1, Acceptable Solution A1.1 (Page 40)

   Replace text: *"All lots that have BAL-40 or BAL-FZ along their boundary will have a restrictive covenant excluding the construction of dwellings within any BAL-40 or BAL-FZ area."*

   with: "*All lots that have BAL-40 or BAL-FZ along their boundary will have habitable development excluded from these areas through nomination of Asset Protection Zone setbacks, which will be enforced through preparation of a Local Development Plan at subdivision stage to ensure all future habitable development is located in BAL-29 or below."*

2.2 City modification 2

2.2.1 Required modification

Section 5 Table 4 'Developer Responsibilities' – remove actions 1, 2, 3 & 4 as these would be standard subdivision requirements. Remove action 7 requiring restrictive covenants.

2.2.2 Reason

Table 4 – actions 1 to 4 are standard requirements of subdivision. Restrictive covenants between the developer and individual landowners are either unworkable (given this is a condition of subdivision) or may fall away based upon further detailed assessments at the subdivision stage.

2.2.3 BMP amendments

1. Section 5, Table 6 (as referenced in Revision D; Page 50) is amended, as per below Table 6 below.
2. The following additional modifications have been made to Table 6:
    a. No. 1 (previously No. 5) has been modified to clarify what planning stages this action is due for completion.
    b. No. 2 (previously No. 6) has been modified to remove reference to the Landscape Plan prepared to support the Structure Plan as this is only conceptual in nature and has not been endorsed by the City. Future Landscape Plans prepared to support future subdivision applications have been referenced instead.
    c. No. 3 (previously No. 7) has been modified (instead of being deleted outright as suggested), to clarify that APZ setbacks will be enforced by a means deemed suitable by the City at subdivision stage.

Table 6: Developer Responsibilities

Number	Action	Due	Completed
1	Provide a copy and obtain endorsement of this Bushfire Management Plan by those with responsibility under this plan including Builders, Landowners/Occupiers.	Post Structure Plan/subdivision approval (as appropriate) and prior to lot sale.	
2	Establish and maintain all public open space to the standard detailed in BMPs prepared to support future subdivision applications, and supported by Landscaping Plans, until the lots are sold and the responsibility for the public open space is handed over to the City of Busselton.	Post subdivision approval and prior to lot sale / handover to City of Busselton.	
3	Provide for enforcement of Asset Protection Zone setbacks to ensure no habitable development is constructed within areas of BAL-40/FZ via preparation of Local Development.	Post subdivision approval, on preparation of a Local Development Plan, or as advised by the City.	
4	Where WAPC condition a subdivision application approval with a requirement to place a notification onto the certificate(s) of title and a notice of the notification onto the diagram or plan of survey (deposited plan). This will be done pursuant to Section 165 of the *Planning and Development Act 2005* ('Hazard etc. affecting land, notating titles as to:') and applies to lots with a determined BAL rating of BAL-12.5 or above. The notification will be required to state: *'This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and may be subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land*'.	Creation of titles and deposited plan.	

2.3 City modification 3

2.3.1 Required modification

Section 5 Table 5 'Builder Responsibilities' – remove action 2.

2.3.2 Reason

Table 5 – it is not necessary for a bushfire management plan to include these actions. Building licence approvals would be processed by the City and the requirements of the Building Code of Australia and the relevant bushfire management plan would be considered as part of those approval processes.

2.3.3 BMP amendments

Section 5, Table 7 (as referenced in Revision D; Page 51) is amended, as per Table 7 below.

Table 7: Builder Responsibilities

Number	Action	Due	Completed
1	Be aware of the existence of any BMP that refers to the Site.	Prior to any building work.	

2.4 City modification 4

2.4.1 Required modification

Section 5 Table 6 'Landowner Responsibilities' – remove actions 6 and 7.

2.4.2 Reason

Table 6 – as per comment in response to iii above.

2.4.3 BMP amendments

Section 5, Table 8 (as referenced in Revision D; (Page 51) is amended, as per Table 8 below.

Table 8: Landowner/Occupier Responsibilities

Number	Action	Due	Completed
1	Install and maintain driveways longer than 50 m in compliance with the Guidelines (A3.5).	Install and maintain driveways longer than 50 m in compliance with the Guidelines (A3.5).	
2	Maintain an Asset Protection Zone (APZ) according to the standard in the Guidelines or according to a detailed BAL assessment.	Maintain an Asset Protection Zone (APZ) according to the standard in the Guidelines or according to a detailed BAL assessment.	
3	For lots 2,024 m^2 and above, install and maintain firebreaks according to the City of Busselton's Firebreak and Fuel Hazard Reduction Notice.	Prior to occupancy & ongoing.	
4	Comply with the relevant local government annual firebreak notice issued under s33 of the Bush Fires Act 1954.	Ongoing.	
5	Ensure that any builders (of future structures on the Lot) are aware of the existence of this Bushfire Management Plan and the responsibilities it contains regarding the application of construction standards corresponding to the determined BAL rating.	Ongoing.	
6	Updating the Bushfire Management Plan may be required to ensure that the bushfire risk management measures remain effective. Bushfire plans do not expire and are a 'living document'. Updating is required in certain circumstances, including (but not limited to) if site conditions change, if further details are required at subsequent development stages or to reflect new technologies or methodologies in best practice bushfire risk management ('Guidelines' s4.6.4).	Ongoing.	

2.5 City modification 5

2.5.1 Required modification

Section 5 remove Table 7 'City of Busselton Responsibilities' and Figure 13 'Landscape Strategy Plan for Provence'.

2.5.2 Reason

Table 7 – it is not appropriate for a bushfire management plan to direct a local government to administer an Act or carry out municipal services pursuant to an Act. The BMP requires outcomes relating to a Landscape Strategy Plan for Provence that has not been approved by the City and that would normally be addressed at subdivision stage as it concerns numerous matters that are not relevant to consideration of a Structure Plan (i.e. amount of grassed areas, proposals for POS infrastructure and materials). The Landscape Strategy Plan referred to by the BMP requires revision in accordance with any relevant modification to the draft Structure Plan (i.e. redesign of POS areas).

2.5.3 BMP amendments

1. Table 9 – City of Busselton Responsibilities (Page 52), is deleted from the BMP.
2. Figure 14 – 'Landscape Strategy Plan for Provence Estate' (Page 39), is deleted from the BMP.
3. The following additional modifications have been made to ensure the BMP text maintains consistency with the comments made by the City above.

    a. Section 3.2, Revegetation/Landscape Plans (Page 34)

    Replace entire section with below text:

    "Landscaping of the Bussell Highway and Outer Bypass Buffers, POS 4, 5, 6, 7, 8, 10, 11,12, 13 and 19 is indicated on the concept landscape plan. These clearly describe the 21 metre setback provided between all lot boundaries and these areas of Public Open Space, to ensure no adjacent lots are subjected to radiant heat >29 kW/m^2 (>BAL-29). The strategic landscaping design presented on the concept landscape plan has informed the vegetation classification within this BMP, with the mature state of any plantings used to determine the appropriate classification.

    The areas of Public Open Space will be established by the developers and maintained according to future detailed landscape plans prepared at subdivision stage for a minimum of two years, when management will become the responsibility of the City of Busselton in perpetuity.

    Public Open Space Areas 2, 3, 9, 17 and 18 are anticipated to be maintained to a high level, with irrigation to nearly all landscape areas (pers comm Chad Elton, Senior Landscape Architect, Emerge Associates, 22 January 2019). These areas have been excluded from classification under AS 3959-2018 S 2.2.3.2 (f) as low threat vegetation, with insufficient fuel to significantly increase the severity of a bushfire attack.

    Public Open Space Area 6, 10 and 17 have standing vegetation of less than a hectare in size with a setback of more than 100 m from any other areas of classified vegetation and are therefore anticipated to be excluded under AS 3959-2018 S 2.2.3.2 (b).

    Any existing or proposed standing vegetation within Public Open Space areas 15 and 16 is more than 100 m from the Site and is excluded under S 2.2.3.2 (a).

Low fuel zones will ensure the Asset Protection Zones of adjacent lots will be maintained in a low fuel state in perpetuity. These low fuel zones must be established prior to the sale of any adjacent lots.

Table 5 below further details and justifies the vegetation classification of each area of Public Open Space."

2.6 City modification 6

2.6.1 Required modification

Figure 15 is to be replaced with a version consistent with modifications to the draft Structure Plan and modifications to the revised BMP (i.e. references to restrictive covenants).

2.6.2 Reason

Figure 15 proposes removal of vegetation that is to be retained and protected within POS area 8 as per EPBC 2004/1878 approval conditions.

2.6.3 BMP amendments

1. Figure 16 (as referenced in Revision D), Map of Bushfire Management Strategies (Page 49), is replaced with the figure included in Attachment D, which removes reference to restrictive covenants.
2. Revision D of the BMP has previously modified Figure 16 to remove reference to 'vegetation to be removed' within POS 8.

3. Modifications required by the WAPC

3.1 WAPC modification 1

3.1.1 Required modification

Supported subject to adding a statement to the structure plan as follows:

'At the time of subdivision, where shown and/or required by the Bushfire Management Plan, Public Open Space is to be designed and landscaped such that it does not generate higher than a Low bushfire hazard level to ensure Asset Protection Zone and BAL standards on neighbouring lots can be met.'

3.1.2 Reason

The BMP incudes APZ's that extend into 'managed' public open space areas where private BAL rated lots adjoin bushland in public open space reserves and therefore requires POS to be delivered in a low fuel state at the time of subdivision. In accordance with Element 2.1 Asset Protection Zone (page 37 of the BMP date 5 March 2019) the POS will need to be maintained in a low fuel state. This will need to be demonstrated at the time of subdivision noting that patches of bushland are required to be protected under Commonwealth EPBC Legislation.

3.1.3 BMP amendments

The Structure Plan (Figure 1; Page 7), is replaced by the Structure Plan at Attachment E, which includes a note to state:

'At the time of subdivision, where shown and/or required by the Bushfire Management Plan, Public Open Space is to be designed and landscaped such that it does not generate higher than a Low bushfire hazard level to ensure Asset Protection Zone and BAL standards on neighbouring lots can be met.'

Attachment A Figure 10, BAL Contour assessment

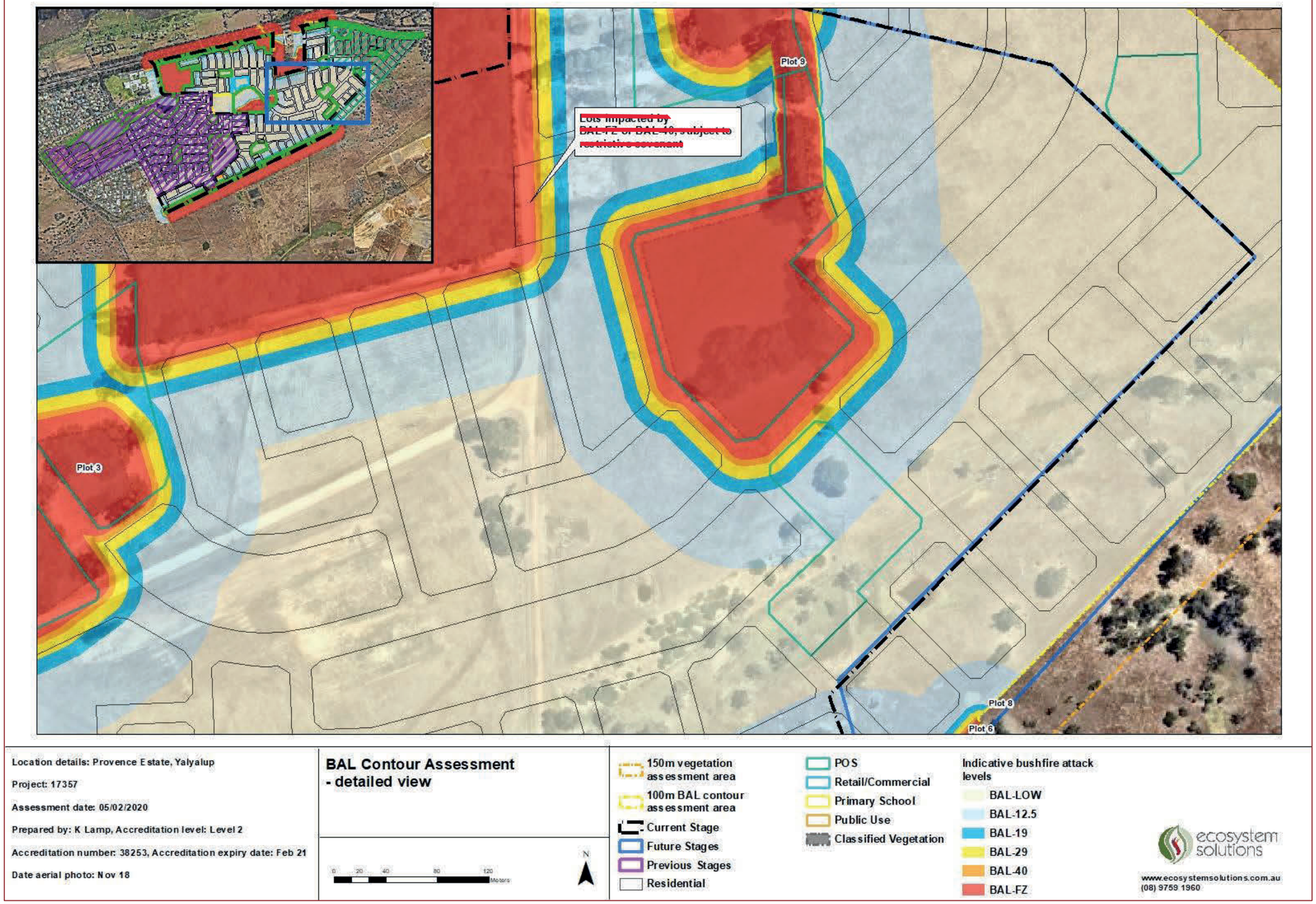


Figure 10 BAL Contour – detailed view, east

Attachment B Figure 11, BAL Contour Assessment – detailed view, north east

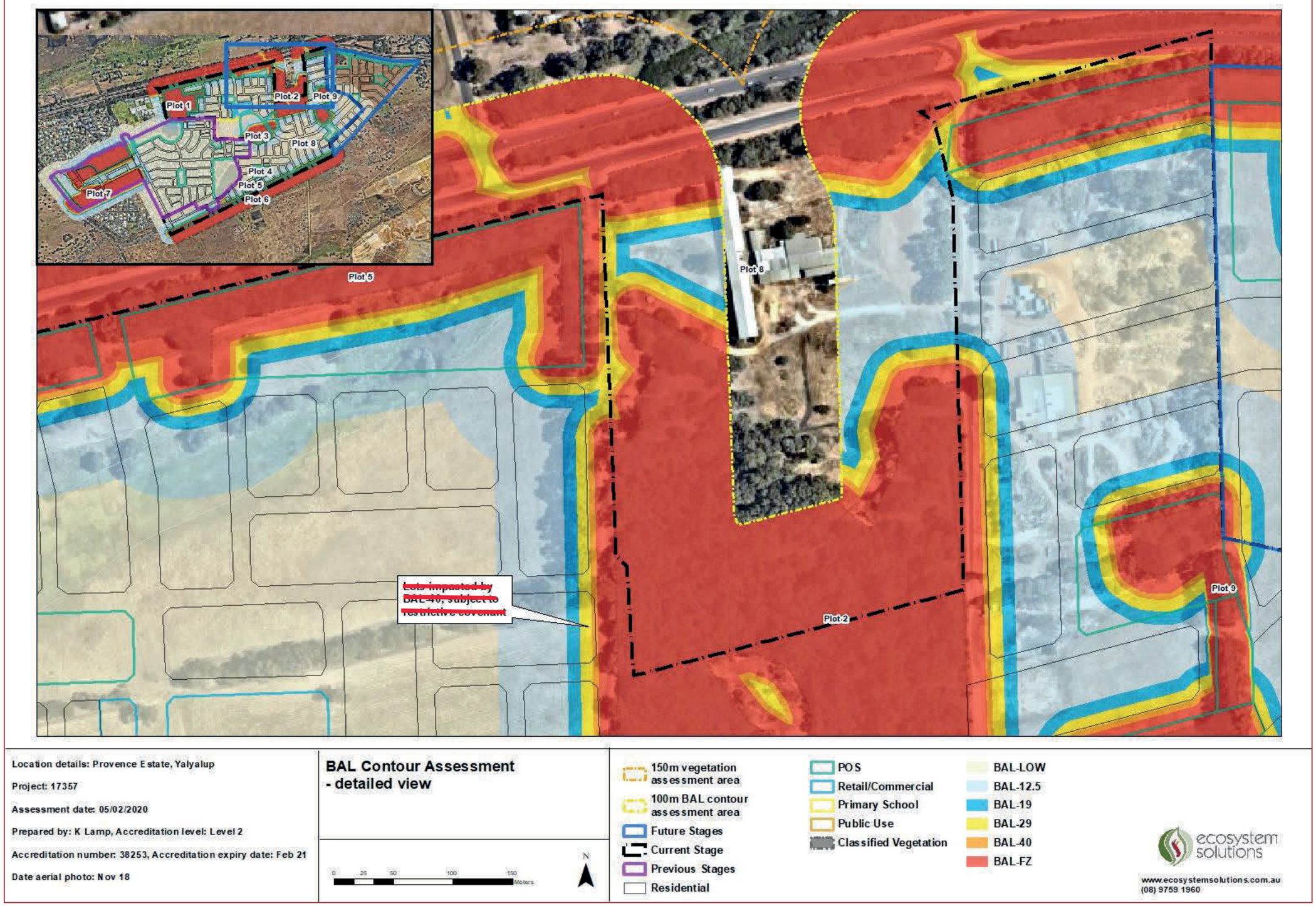


Figure 11 BAL Contour – detailed view, north east

Attachment C Figure 13, BAL Contour Assessment – detailed view, central

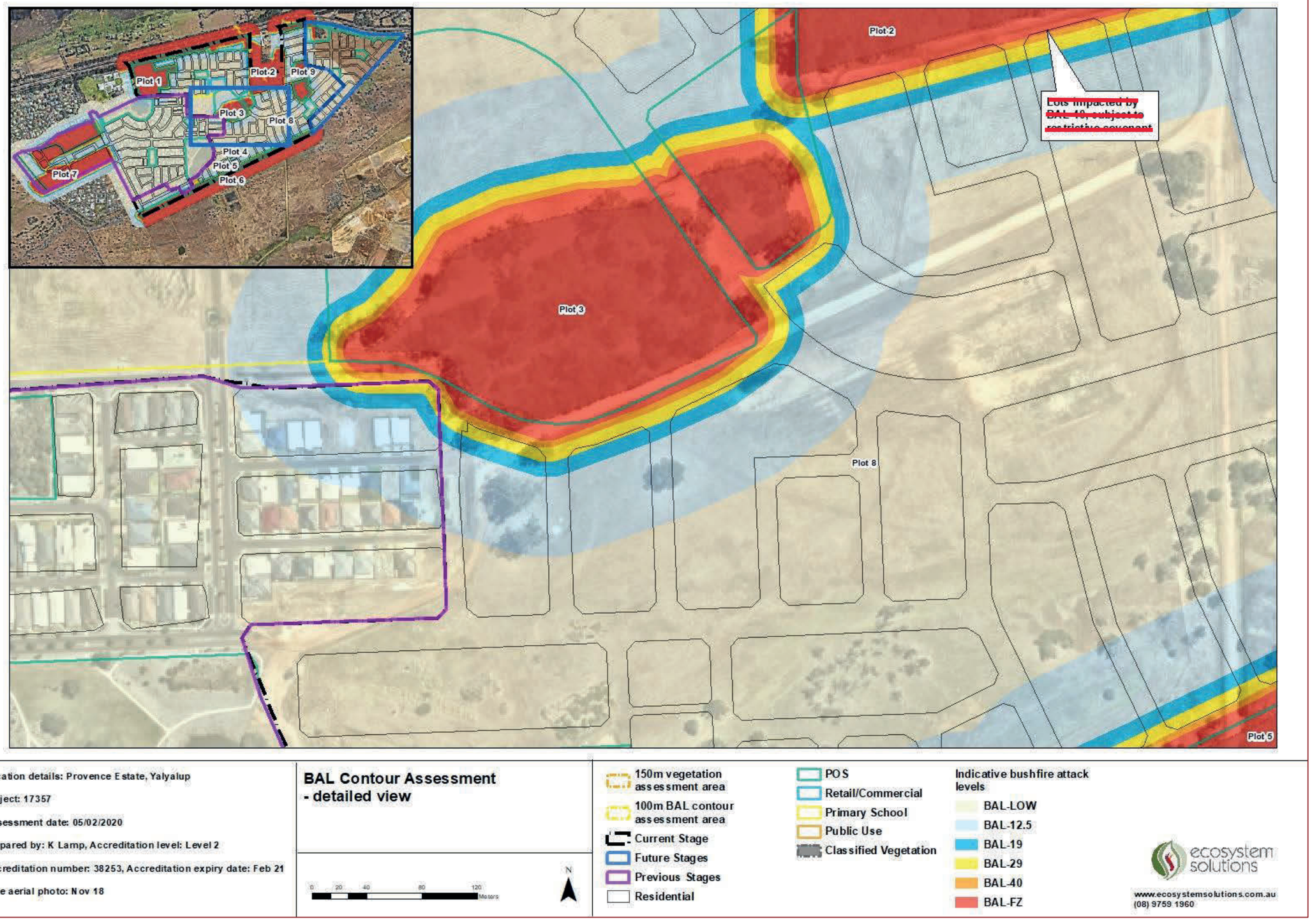
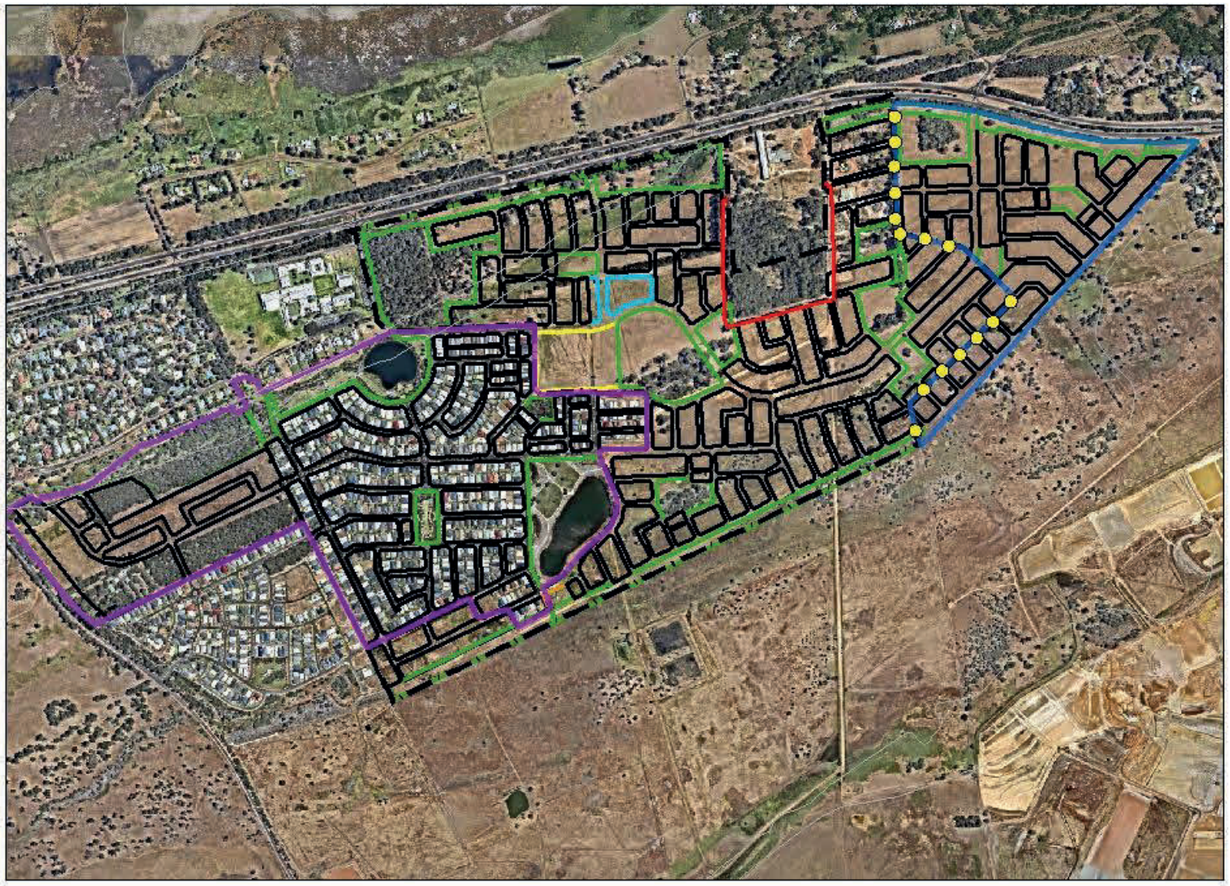


Figure 13 BAL Contour – detailed view, central

Attachment D Figure 16, Map of Bushfire Management Strategies

Spatial representation of the proposed risk management measures



PROPERTY / ASSESSMENT DETAILS

Owner: Satterley
Property Address: Provence Estate, Yalyalup
Project No: 17357
Prepared by: K Lamp
Accreditation Level: Level 2
Accreditation Number: 38253
Accreditation Expiry Date: 02/21

N

0 75150 300 450 600
Meters

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LEGEND

- Current Stages
- Future Stages
- Previous Stages
- Residential
- POS
- Retail/Commercial
- Primary School
- Public Use
- Temporary turn arounds
- Maximum BAL-40 extent

NOTES

The minimum width for the Asset Protection Zone (APZ) for this Site is the distance required to meet the BAL-29 setback.

Vegetation within the APZ is to comply with Schedule 1 Element 2 of the Guidelines noting that:

- Trees >5m in height are to be setback a minimum distance of 6m from the building with no branches overhanging the roof.
- Shrubs < 5m in height are to be setback a minimum distance of 3m from the building, and not planted in clumps greater than 5 sqm
- Grass is to be maintained at less than 100mm in height.

No dwelling is to be constructed in an area with a BAL-40 or BAL-FZ rating. ~~Lots within this development with boundaries currently subjected to a BAL-40 or BAL-FZ rating include a restrictive covenant prohibiting the construction of a dwelling within areas >BAL-29.~~

The Developer will maintain all public open space in accordance with the approved Landscape Plan for a minimum of two years, when ownership and management responsibility is handed over to the City of Busselton. The Asset Protection Zones of some lots extend into the public open space. These areas must be maintained in a low fuel state in perpetuity, as detailed in the landscape plans for the development.

Reticulated water and fire hydrants will be provided in accordance with the Water Corporation No.63 Water Reticulation Standard.

Public Roads will be constructed to the requirements in the Guidelines, A3.2, with temporary cul-de-sacs constructed to the requirements in Table 6 of the Guidelines by the Developer.

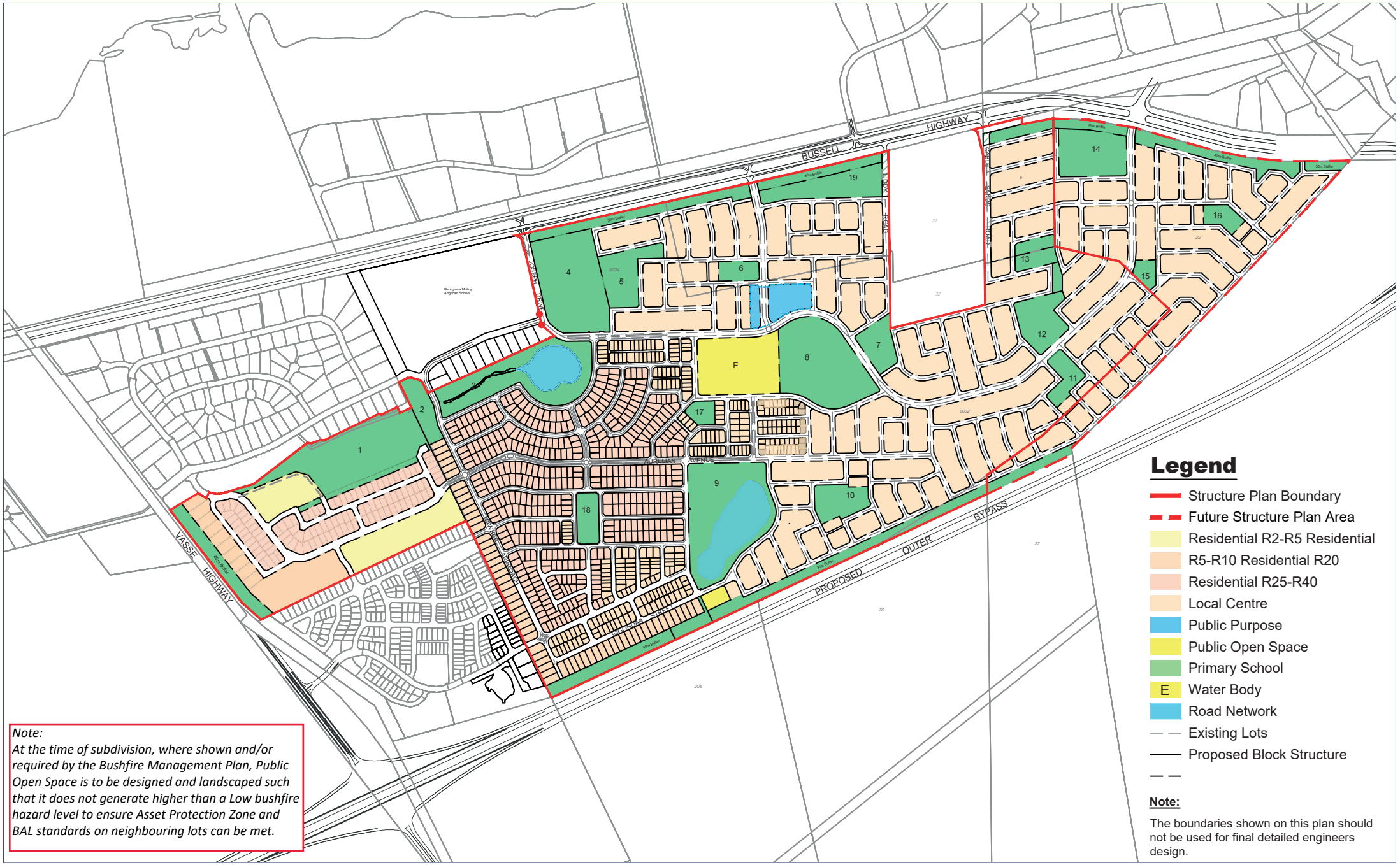
Any driveway 50 m or longer will comply with the requirements of the Guidelines A3.5.

For any lots 2,024sqm and above, firebreaks will be installed and maintained according to the City of Busselton's Firebreak and Fuel Hazard Reduction Notice.

Installation and upkeep of the APZ, compliance with the City of Busselton's Firebreak Notice, driveways and construction to BAL standards are the responsibility of the landowner. The measures listed above shall be implemented prior to the occupation of any dwelling within the Site and shall continue to be maintained in perpetuity.

Figure 16 Map of Bushfire Management Strategies

Attachment E Figure 1, Structure Plan



Legend

- Structure Plan Boundary
- Future Structure Plan Area
- Residential R2-R5 Residential
- R5-R10 Residential R20
- Residential R25-R40
- Local Centre
- Public Purpose
- Public Open Space
- Primary School
- E Water Body
- Road Network
- Existing Lots
- Proposed Block Structure

Note:

The boundaries shown on this plan should not be used for final detailed engineers design.

Note:
At the time of subdivision, where shown and/or required by the Bushfire Management Plan, Public Open Space is to be designed and landscaped such that it does not generate higher than a Low bushfire hazard level to ensure Asset Protection Zone and BAL standards on neighbouring lots can be met.

PLAN REF: 130316-2-003N
DATE: 19 FEBRUARY 2020
CLIENT: SATTERLEY
DRAWN BY: JLS
CHECKED BY: JC

0 100 200 300 400 500 600 700 **1 : 15,000 @ A4**

PROVENCE
STRUCTURE PLAN
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APPENDIX F

Retail Demand Analysis

prepared by MacroPlan Dimasi

Provence, Busselton, WA

Retail Demand Assessment

September 2016

MacroPlanDimasi

MacroPlan Dimasi

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Prepared for: Satterley Property Group

MacroPlan Dimasi staff responsible for this report:

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Executive summary

The analysis of the timing, likely sales and retail mix for the proposed Provence Neighbourhood Centre at Provence has revealed the following key findings:

- The proposed centre is expected to become the main community hub for food and grocery shopping and other convenience orientated purposes for residents within the primary sector.
- By 2021, the main trade area population is forecast to grow to 5,570 residents, from 3,170 at 2015. This population is forecast to continue to grow and reach its capacity of around 8,500 residents after 2031.
- At 2021, main trade area residents will be spending an estimated $79 million on retail goods and services, including around $37 million on take-home food and groceries plus packaged liquor. Primary sector residents will generate the majority of the retail expenditure, estimated at around $72 million at 2021.
- Based on the retail floorspace analysis, the Provence Neighbourhood Centre could support approximately 3,450 sq.m of retail floorspace at 2021, including a 2,500 sq.m supermarket and around 9-10 specialty tenants focused around food and convenience.
- Total retail sales for the Provence Neighbourhood Centre are projected at around $22-23 million in 2020/21, including supermarket sales of $16.3 million and retail specialty sales of around $6 million (in constant 2014/15 dollars).

Introduction

This report presents an independent retail demand assessment for the proposed neighbourhood centre located within the Provence estate, in the City of Busselton, approximately 220 km south of Perth. The purpose of this report is to assess the demand for such a centre, in order to meet the existing and future residents' needs.

The report has been prepared in accordance with instructions received from Satterley Property Group, and is presented as follows:

- **Section 1** examines the regional and locational context of the proposed Provence neighbourhood centre, and its future role in the locality.
- **Section 2** examines the potential trade area for the proposed centre, including the outlook for population and retail spending growth, and the socio-demographic profile of trade area residents.
- **Section 3** details the competitive environment within which the proposed centre will operate.
- **Section 4** presents our assessment of supportable retail floorspace at the proposed Provence Neighbourhood Centre, including staging and timing for the development.

Section 1: Regional and local context

This section considers the locational context of the proposed neighbourhood centre at Provence, as well as providing an overview of the proposed development.

1.1 Regional and local context

The City of Busselton is located approximately 220 km south of Perth and 50 km south-west of Bunbury (refer Map 1.1) and is one of Western Australia's top tourist destinations. Considered the capital of the popular Margaret River wine region, the town of Busselton acts as the gateway for the tourist attractions within the region, due to its proximity to Dunsborough (25 km), Yallingup (35 km) and the town of Margaret River (50 km). Tourism Research Australia indicates that the region averages 1.14 million visitors contributing $364 million annually for the four-year period ending December 2013. To facilitate further tourism growth in the region, a $60 million expansion of the Busselton Regional Airport has been green-lit, with construction to start in early 2017 and a completion date expected by mid-2018. This expansion will see the regional airport accommodate direct interstate flights from the eastern seaboard.

Provence is situated within the suburb of Yalyalup, approximately 4.4 km south-east of the Busselton Town Centre. The estate is being developed by Satterley, and is the largest residential estate in the region (refer Map 1.2). There are currently over 600 dwellings already built at Provence, as well as public open space, a number of landscape features, and the Georgiana Molloy Anglican School, which caters for early learners to Year 12's with around 600 students.

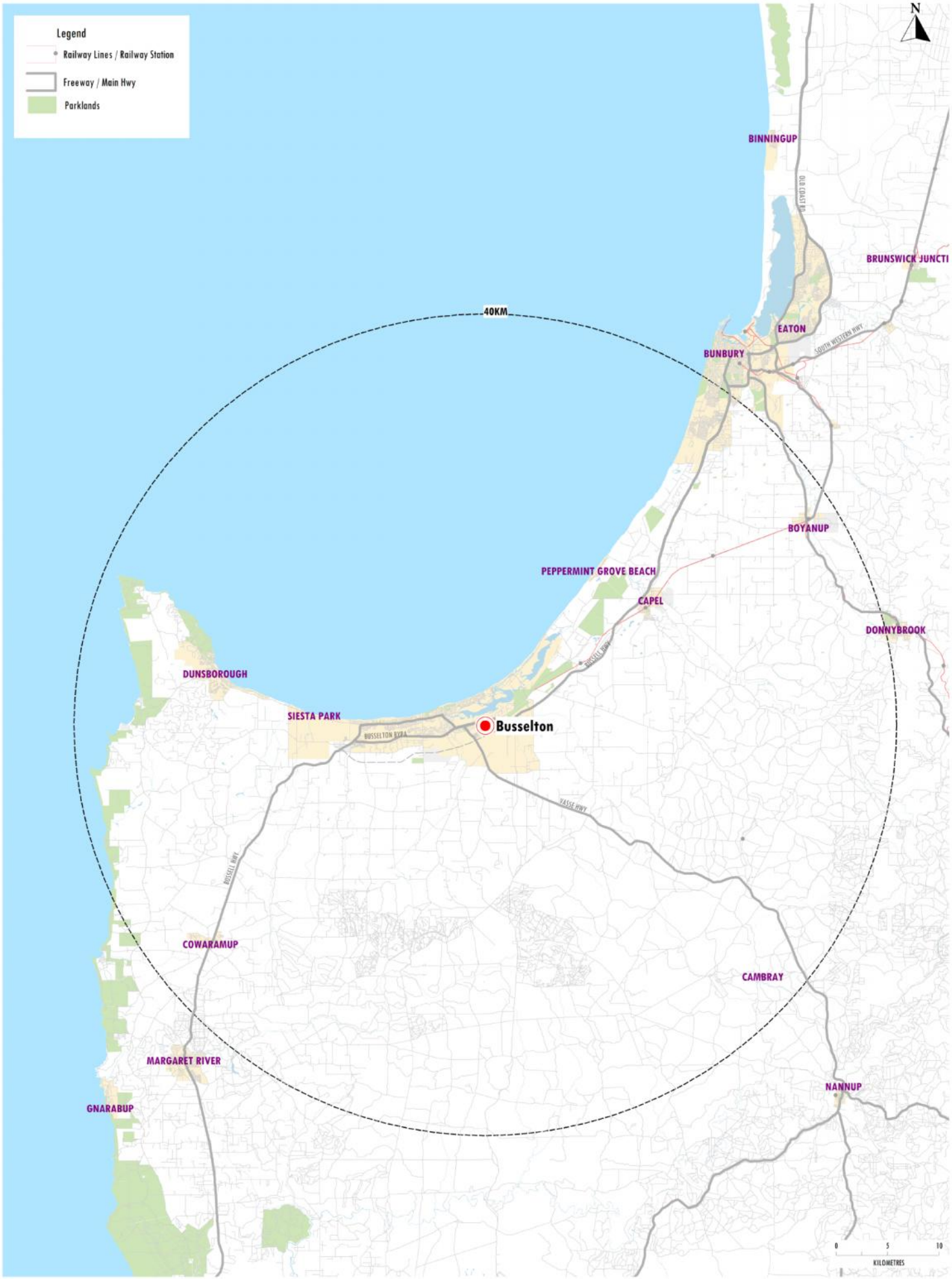
As part of the Provence residential estate, a neighbourhood shopping centre is proposed to serve the local residents, which is discussed in more detail in Section 1.2 following. The major retail facilities currently serving these residents are provided at the Busselton Town Centre, which contains as anchors two Woolworths supermarkets, a Coles store, and a Supa IGA store, together with a broad range of street-based specialty stores and services.

1.2 Proposed development

Figure 1.1 illustrates the endorsed Provence Structure Plan, which was released in 2011 and has a lot yield capacity of 1,787 lots. More detailed master planning of the estate has occurred in the meantime, in order to better reflect and account for current market demand. Within the revised masterplan (refer Figure 1.2), the expected lot capacity for Provence is estimated now at around 2,750.

The Structure Plan shows the approximate location of the proposed Neighbourhood Centre in the heart of the estate, as well as the existing and proposed school, future road network, public open space, and water features.

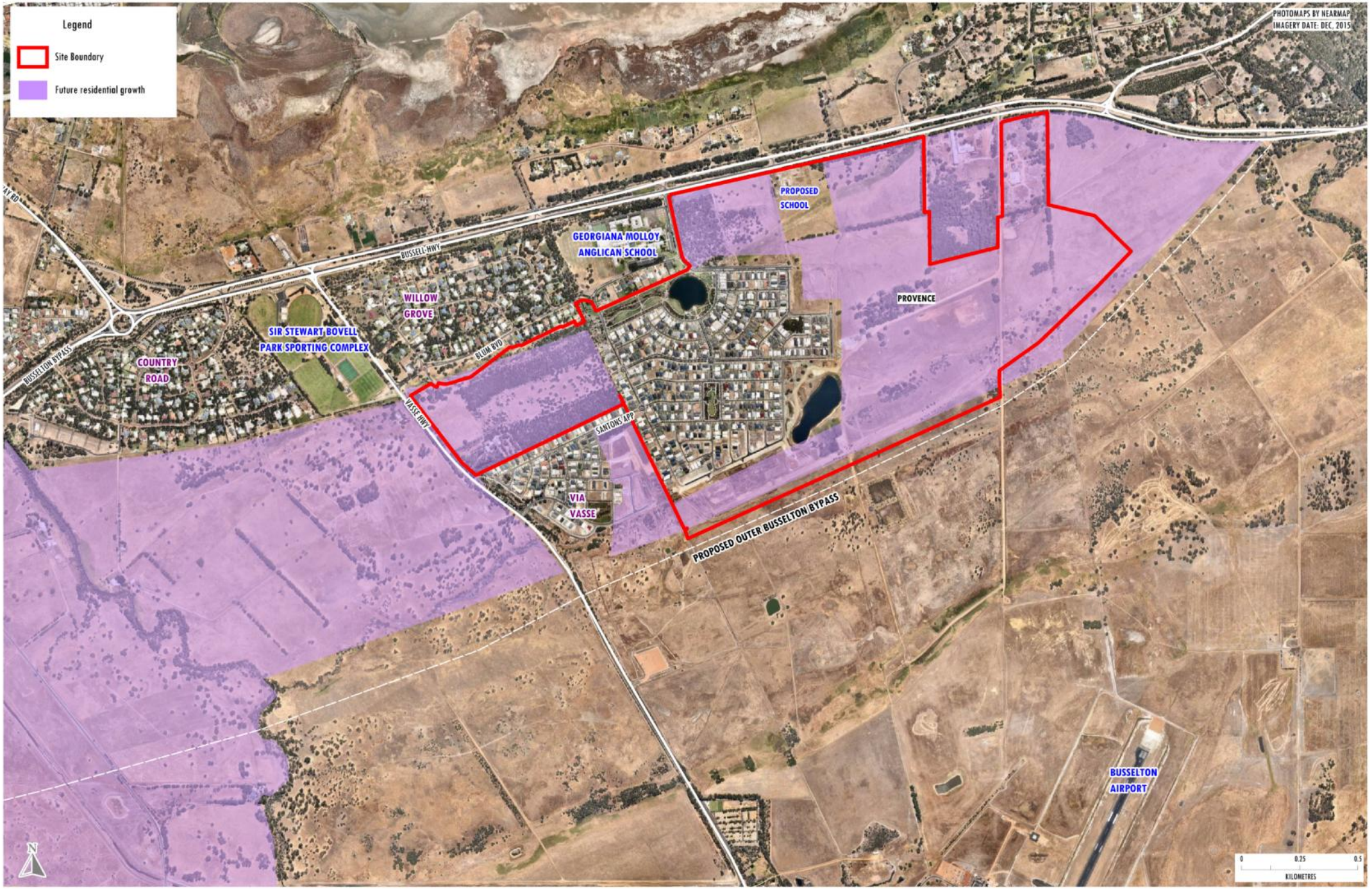
The Provence Neighbourhood Centre will be able to serve a range of daily and weekly (retail and convenience) needs of the surrounding Provence residents, with the appropriate scale for the centre considered in more detail in Section 4.



Map 1.1: Busselton

Regional context

MacroPlanDimasi

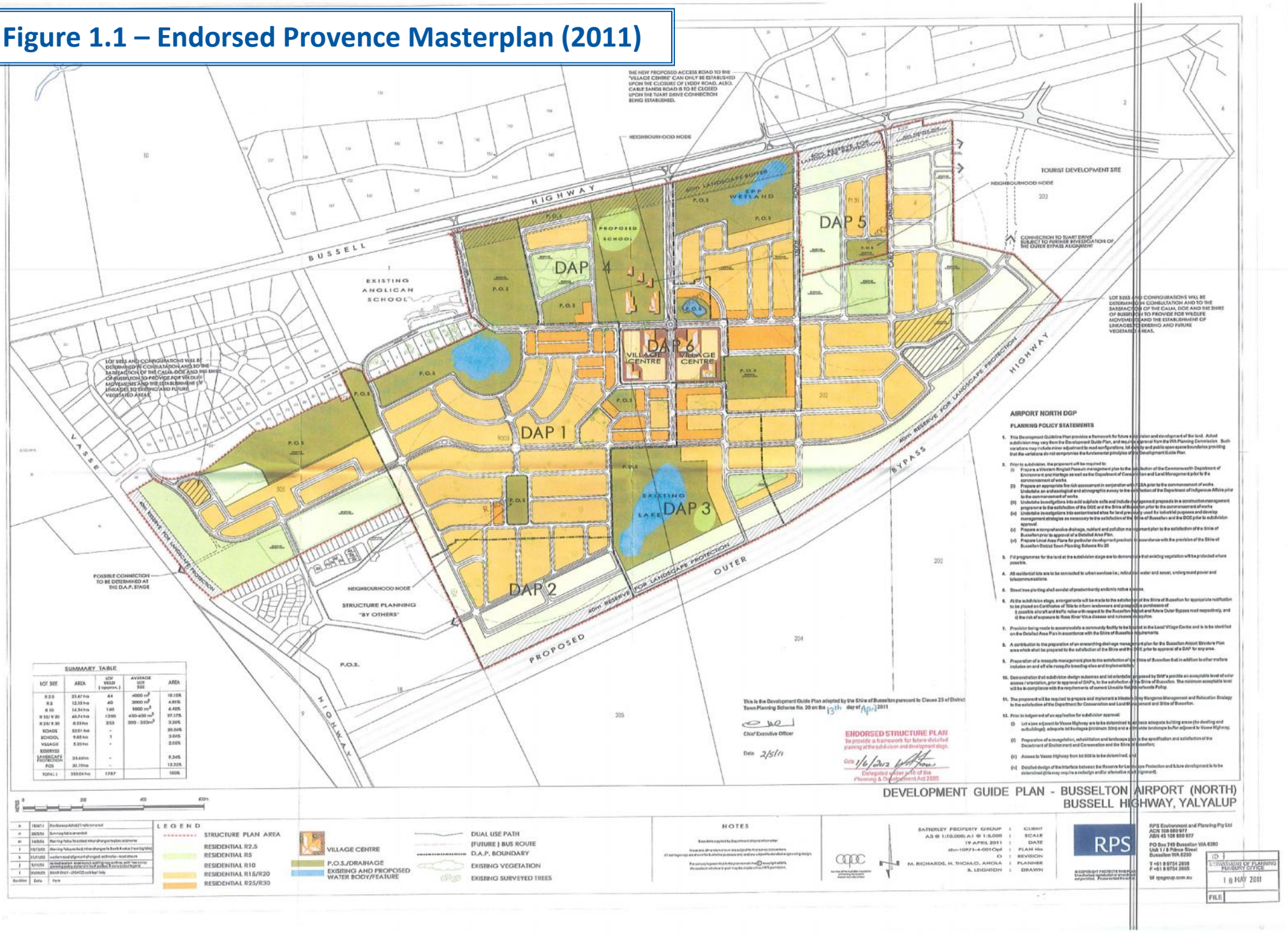


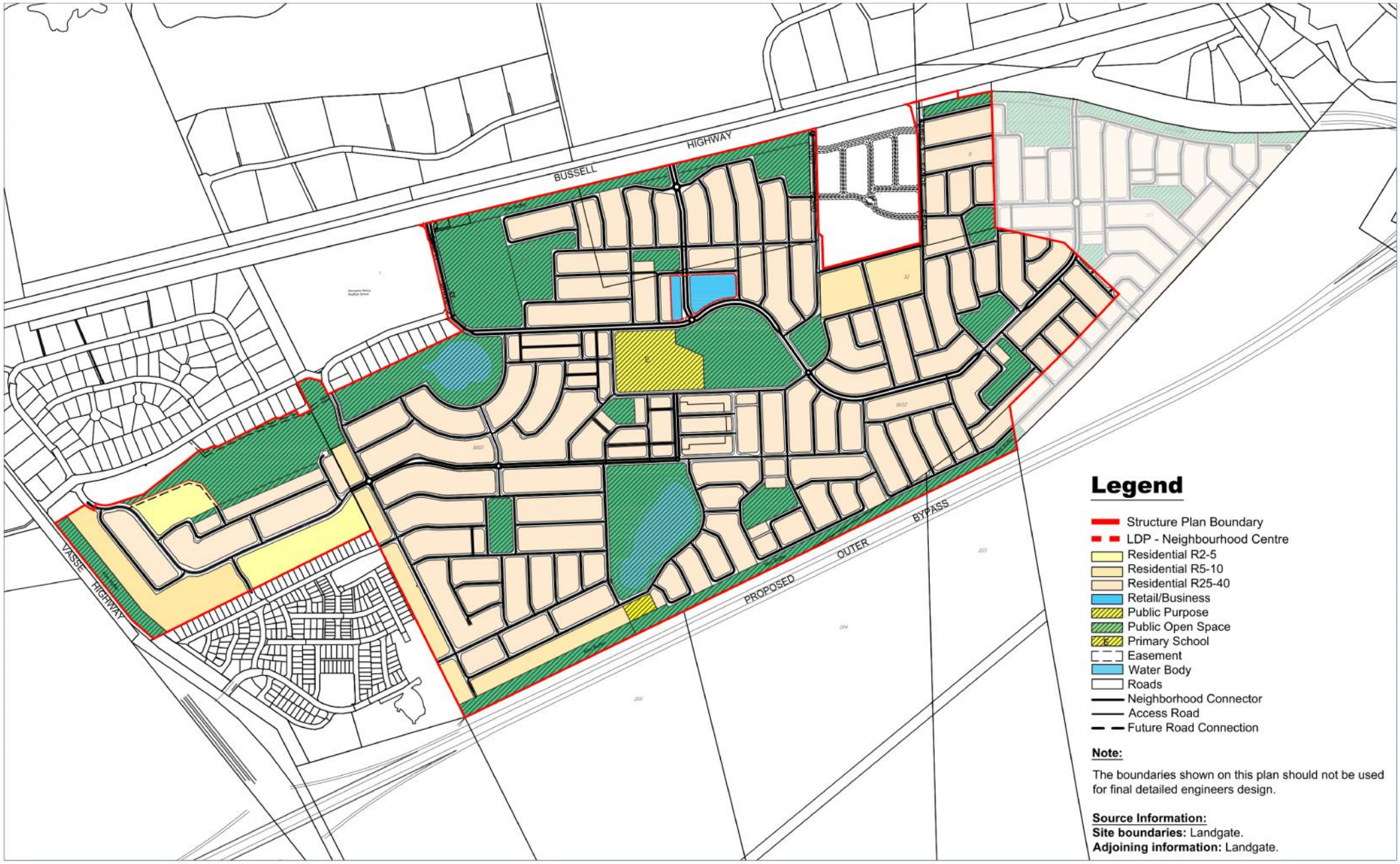
Map 1.2: Provence

Site location

MacroPlanDimasi

Figure 1.1 – Endorsed Provence Masterplan (2011)





PLAN 1 - STRUCTURE PLAN
Provence

0 300 600 900 1300

Figure 1.2 – Proposed Provence Structure Plan

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Scale 1:10000@A3 | **Date** 21 August 2017 | **Project No** 130316-2-003C

Section 2: Trade area analysis

This section of the report details the trade area which is likely to be served by the Provence Neighbourhood Centre (PNC), including an analysis of the current and forecast population levels, socio-demographic profile, and retail spending capacity of trade area residents.

2.1 Trade area definition

The extent of the trade area (or catchment) that is served by any retail facility is shaped by the interplay of a number of critical factors, with the most important being the following:

- The scale and composition of the centre, in particular the major trader that is included within it, the layout and ambience, and the quality of carparking.
- The proximity and relative attraction of competitive retail facilities, including the location, composition, quality, and scale of competitive centres.
- The available road network and public transport service, which affects the ease of use and access to the centre.
- Significant physical barriers which are difficult to negotiate or which take considerable time to cross.

Taking the above into account, the proposed PNC trade area is expected to be influenced by the following:

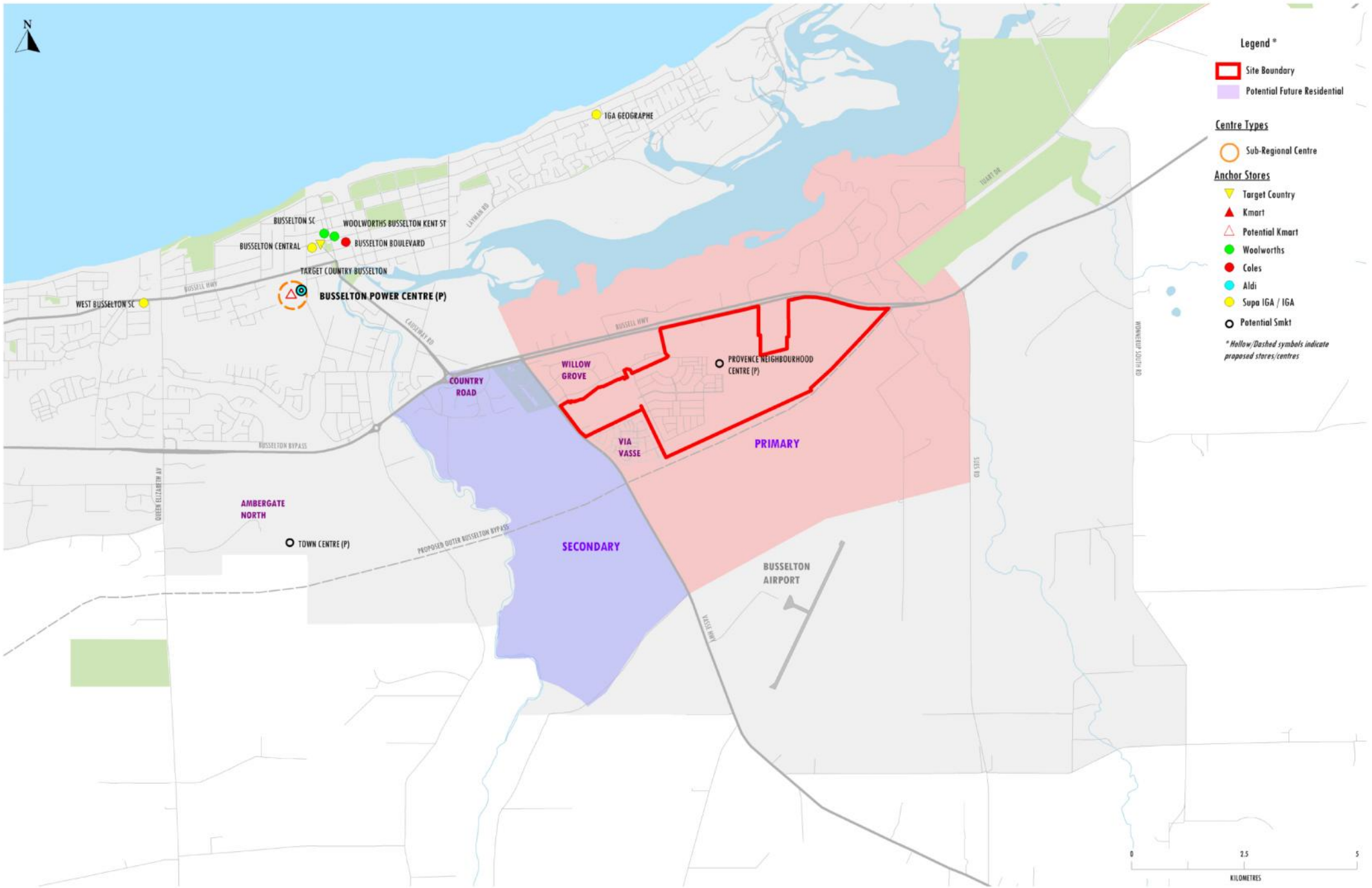
- The role of the centre, which will be to predominantly serve the food and convenience needs of the surrounding residents in Provence and adjoining estates.
- The locations of both existing and proposed competitive retail facilities, which are primarily concentrated in the Busselton Town Centre.

- The pattern of residential development within the surrounding area, in particular having regard to the future growth expected throughout the Provence estate.
- The location of the Bussell Highway, which is a significant asset in enabling access to the Provence locality, though at the same time, is a physical barrier separating the extensive existing residential catchment to the north (i.e. the Busselton area) from Provence and the other established and growing estates to the south of the highway.

Based on the above, the **main trade area** for the PNC has been defined to include a primary and a secondary sector, as shown on Map 2.1 and described as follows:

- The **primary sector** encompasses the estates of Provence, Via Vasse, and Willow Grove. It is bound by the Vasse Estuary to the north, Sues Road to the east, the airport to the south, and Vasse Highway to the west.
- The **secondary sector** extends between the Vasse Highway and the Vasse River, encompassing the established Country Road estate.

The proposed PNC is expected to serve residents within the primary trade area sector particularly well, being easily accessible within that sector. It will also be able to conveniently serve residents within the secondary sector as it will be the first centre to be developed south of the Bussell Highway. It will however be constrained in attracting residents located to the north of the Bussell Highway, given the limited crossovers to the south and the extensive retail provision available within the Busselton Town Centre, particularly supermarkets.



Map 2.1: Provence Neighbourhood Centre

Trade area and competition

MacroPlanDimasi

2.2 Trade area population

In addition to the Provence estate, the primary sector comprises two other residential developments - Willow Grove and Via Vasse (refer Map 2.1) - detailed as follows:

- **Willow Grove** is an established residential area located to the south-east of the intersection of the Bussell Highway and the Vasse Highway, with 112 large, low-density style lots.
- **Via Vasse** is situated to the south of Willow Grove with access from the Vasse Highway. At capacity the development will accommodate 280 lots, 168 of which are already constructed. For the purposes of this analysis it is assumed Via Vasse will reach capacity by 2021.

The secondary sector contains the existing residential development around Country Road. The large area of land to the south is currently zoned agriculture but is planned to accommodate urban uses in the longer term. For the purposes of this analysis, it is assumed that this development occurs post 2031.

Trade area population forecasts have been calculated for a base case scenario which assumes that the Provence estate will sell 110 lots per annum until it reaches its capacity of 2,750 households (approx. 8,500 residents). Alternative forecasts have been calculated for a higher rate of development (150 lots per annum) and a low development scenario (70 lots per annum). The supporting tables for these additional scenarios are included in the appendix to the report.

Under the base case scenario, the main trade area population is forecast to grow from around 3,170 residents in 2015 to over 9,000 residents by 2031, growing at an average rate of 6.8% per annum (refer Table 2.1). The majority of growth is planned to occur within the primary sector, largely within the Provence estate but with some growth also in the Via Vasse estate.

Table 2.1
Provence trade area population, 2006-2031*
Base case scenario

	Estimated population			Forecast population			
Trade area sector	2006	2011	2015	2018	2021	2026	2031
Primary	240	1,350	2,790	3,960	5,130	6,830	8,530
Secondary	340	340	380	410	440	490	540
Main trade area	**580**	**1,690**	**3,170**	**4,370**	**5,570**	**7,320**	**9,070**

	Average annual growth (no.)					
Trade area sector	2006-11	2011-15	2015-18	2018-21	2021-26	2026-31
Primary	222	360	390	390	340	340
Secondary	0	10	10	10	10	10
Main trade area	**222**	**370**	**400**	**400**	**350**	**350**

	Average annual growth (%)					
Trade area sector	2006-11	2011-15	2015-18	2018-21	2021-26	2026-31
Primary	41.3%	19.9%	12.4%	9.0%	5.9%	4.5%
Secondary	0.0%	2.8%	2.6%	2.4%	2.2%	2.0%
Main trade area	**23.8%**	**17.0%**	**11.3%**	**8.4%**	**5.6%**	**4.4%**

**As at June*
Source: ABS Census 2011; WA Tomorrow, 2015; MacroPlan Dimasi

Under the base case scenario, the Provence estate is expected to reach capacity post 2031. Under the high and low scenarios, capacity is expected by around 2026 and post-2031 respectively.

In the main, the different development scenarios would not affect the **ultimate potential** of the PNC, rather the timing of supportable development. The eventual rate of development will obviously be dependent on market demand, with the base case scenario considered the most 'likely' outcome based on all available information, and given Satterley's intention to kick-start development at Provence.

2.3 Socio-demographic profile

The socio-demographic profile of the defined Provence main trade area is based on those living within the trade area at the time of the 2011 census, which comprises Willow Grove and the residential area around Country Road. Table 2.2 and Chart 2.1 summarise the socio-demographic profile, with the key points to note as follows:

- The average household income in the main trade area is higher than both the non-metro WA benchmark and the Australian average.
- The average household size, at 3.1 people per household, is larger than the Australian and non-metro WA benchmarks.
- The average age of the main trade area (33.4 years) is younger than the non-metro WA benchmark of 36.7 years, due to a significantly higher representation of children and fewer people aged over 50 years.
- Home ownership levels are much higher than the benchmarks, at 85.4% for the main trade area compared to 62.6% for non-metro WA.
- Traditional families (i.e. couples with dependent children) are the most prevalent household type (60%) in the main trade area, followed by couples without children (23.4%), and a noticeably lower provision of lone person households.

In summary, the socio-demographic profile of the main trade area residents is reflective of a new growth area in a regional city, comprised of young traditional families attracted by the lifestyle on offer. Such families associate strongly with their local shopping facilities.

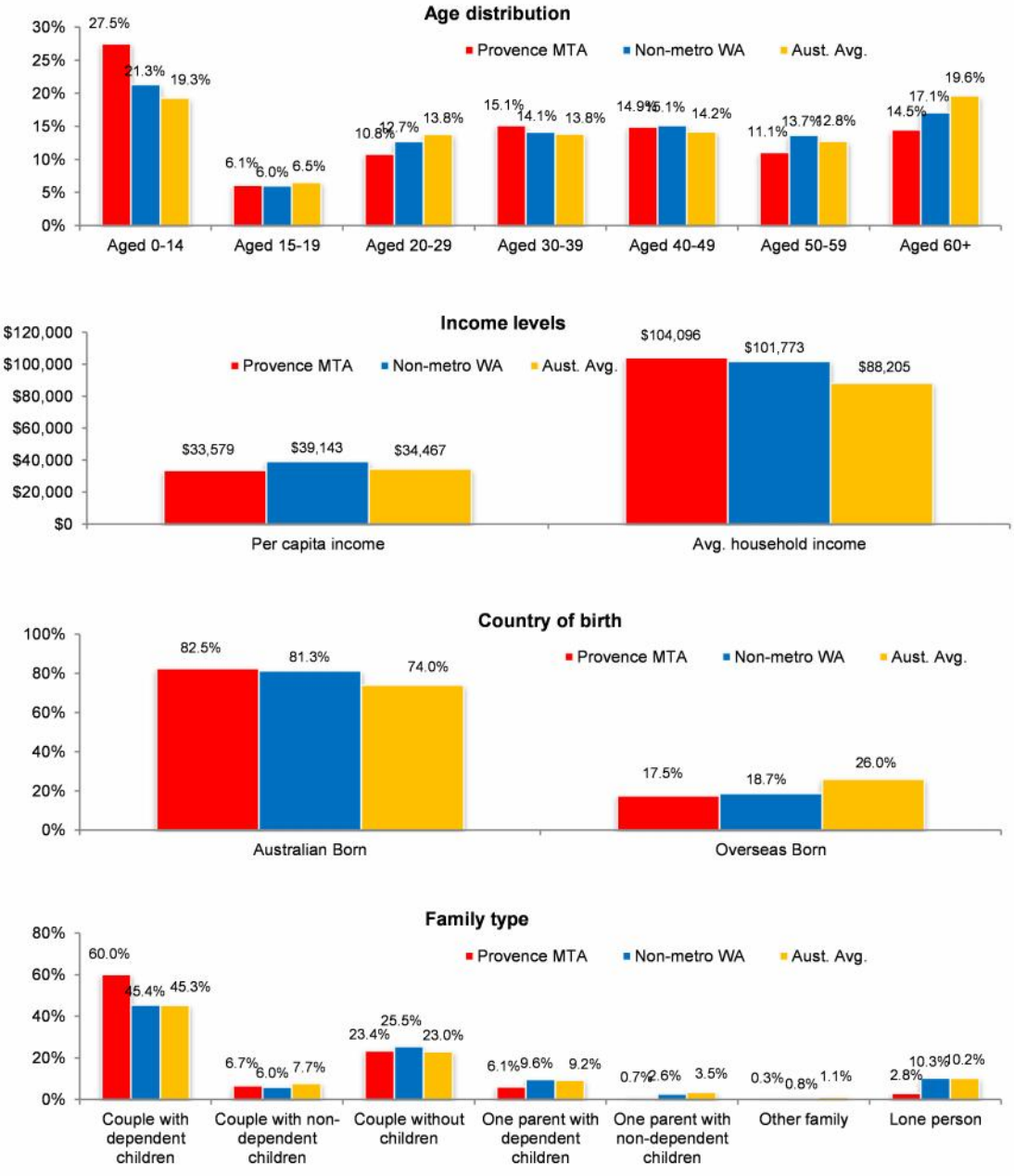
Table 2.2
Provence main trade area - socio-demographic profile, 2011

Census item	Primary sector	Secondary sector	Main TA	Non-metro WA avg.	Aust. avg.
Per capita income	$32,333	$37,983	$33,579	$39,143	$34,467
Var. from Non-metro WA benchmark	*-17.4%*	*-3.0%*	*-14.2%*		
Avg. household income	$100,232	$117,749	$104,096	$101,773	$88,205
Var. from Non-metro WA benchmark	*-1.5%*	*15.7%*	*2.3%*		
Avg. household size	3.1	3.1	3.1	2.6	2.6
Age distribution (% of population)					
Aged 0-14	29.7%	19.7%	27.5%	21.3%	19.3%
Aged 15-19	6.1%	6.1%	6.1%	6.0%	6.5%
Aged 20-29	12.2%	5.9%	10.8%	12.7%	13.8%
Aged 30-39	16.2%	11.5%	15.1%	14.1%	13.8%
Aged 40-49	14.9%	14.8%	14.9%	15.1%	14.2%
Aged 50-59	9.2%	17.9%	11.1%	13.7%	12.8%
Aged 60+	11.8%	24.0%	14.5%	17.1%	19.6%
Average age	31.2	41.0	33.4	36.7	37.9
Housing status (% of households)					
Owner (total)	83.3%	92.5%	85.4%	62.6%	68.7%
• Owner (outright)	19.6%	52.5%	26.8%	31.3%	32.9%
• Owner (with mortgage)	63.8%	40.0%	58.5%	31.3%	35.8%
Renter	16.7%	5.0%	14.1%	36.4%	30.4%
Other	0.0%	2.5%	0.6%	1.1%	0.9%
Birthplace (% of population)					
Australian born	81.4%	86.6%	82.5%	81.3%	74.0%
Overseas born	18.6%	13.4%	17.5%	18.7%	26.0%
• Asia	1.3%	0.0%	1.0%	2.9%	8.6%
• Europe	11.6%	12.4%	11.8%	9.4%	10.5%
• Other	5.7%	1.1%	4.7%	6.5%	7.0%
Family type (% of households)					
Couple with dep't children	63.2%	48.7%	60.0%	45.4%	45.3%
Couple with non-dep't child.	4.5%	14.2%	6.7%	6.0%	7.7%
Couple without children	21.8%	29.2%	23.4%	25.5%	23.0%
One parent with dep't child.	6.4%	5.0%	6.1%	9.6%	9.2%
One parent w non-dep't child.	0.9%	0.0%	0.7%	2.6%	3.5%
Other family	0.4%	0.0%	0.3%	0.8%	1.1%
Lone person	2.8%	2.9%	2.8%	10.3%	10.2%

Source: ABS Census of Population & Housing, 2011; MacroPlan Dimasi

Chart 2.1

Provence trade area - socio-demographic profile, 2011

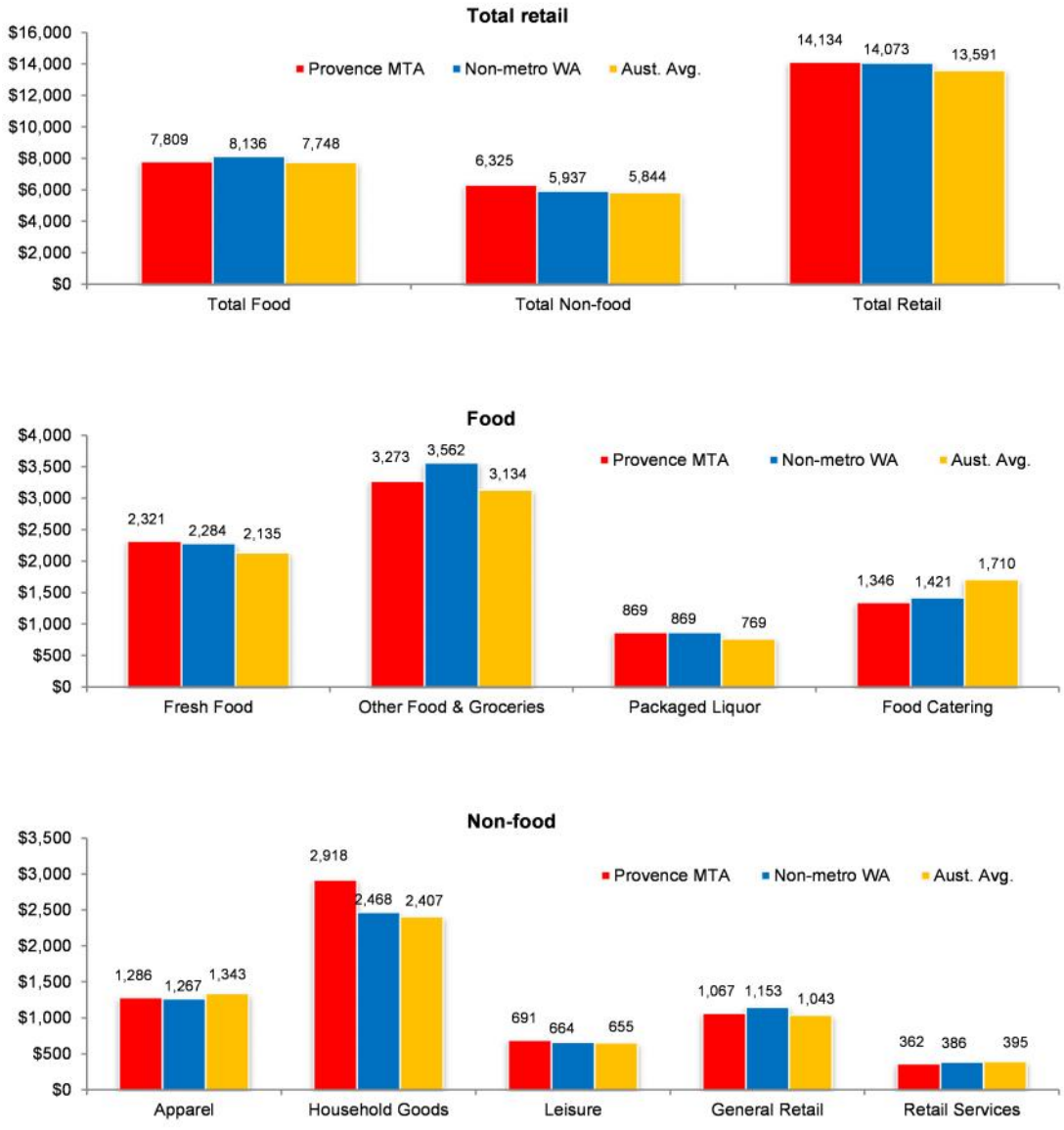


Source: ABS Census of Population & Housing, 2011; MacroPlan Dimasi

2.4 Retail expenditure

Chart 2.2 compares the retail spending levels of the Provence trade area population with benchmarks for non-metro WA and Australia. In general, the per capita spending levels of Provence trade area residents are estimated to be slightly higher than the non-metro WA benchmarks, with the exception of other food & groceries, food catering, general retail, and retail services.

Chart 2.2
Provence trade area - retail spending per person, 2014/15*



*Including GST
Source: MarketInfo; MacroPlan Dimasi

Table 2.3 presents projections of retail expenditure growth in the trade area over the forecast period to 2031. All retail figures are expressed in 2014/15 dollars, i.e. excluding retail inflation, but include GST.

The retail market generated by the main trade area population is expected to increase from $41.3 million currently to $146.4 million by 2031. The bulk of the retail expenditure capacity is generated by primary sector residents, increasing from $35.5 million in 2015 to $136.6 million by 2031, reflecting a real annual growth rate of 8.8%.

The average annual real growth rate in retail expenditure by the main trade area population to 2031 is estimated at 8.2%. The components which make up this growth rate are:

- Population growth across the main trade area from 2015-2031 of 7.2%; and
- Real growth in per capita retail expenditure by the main trade area population, which in our estimation, will average 1.0% annually over the forecast period.

Table 2.4 provides a breakdown of retail expenditure by category. Take-home food, groceries and packaged liquor is by far the largest category, representing around 46% of total retail expenditure, followed by household goods and food catering.

Table 2.3
Provence main trade area - retail expenditure ($M), 2015-2031*
Base case scenario

Year ending June	Primary sector	Secondary sector	Main TA
2015	35.5	5.8	41.3
2016	41.5	6.0	47.5
2017	47.0	6.2	53.2
2018	53.3	6.5	59.7
2019	59.5	6.7	66.2
2020	65.5	6.9	72.4
2021	72.2	7.1	79.3
2022	78.4	7.4	85.8
2023	83.9	7.6	91.5
2024	89.8	7.9	97.7
2025	96.1	8.1	104.3
2026	102.9	8.4	111.3
2027	109.5	8.7	118.2
2028	115.7	8.9	124.7
2029	122.3	9.2	131.5
2030	129.3	9.5	138.8
2031	136.6	9.8	146.4
Average annual growth ($M)			
2015-2021	6.1	0.2	6.3
2021-2031	6.4	0.3	6.7
2015-2031	**6.3**	**0.2**	**6.6**
Average annual growth (%)			
2015-2021	12.6%	3.4%	11.5%
2021-2031	5.7%	2.9%	5.5%
2015-2031	8.8%	3.3%	8.2%

**Constant 2014/15 dollars & including GST*
Source: MarketInfo; MacroPlan Dimasi

Table 2.4
Provence main trade area - retail expenditure by category ($M), 2015-2031*
Base case scenario

Year ending June	FLG	Food catering	Apparel	Household goods	Leisure	General retail	Retail services	**Total retail**
2015	18.9	3.9	3.8	8.5	2.0	3.1	1.1	41.3
2016	21.8	4.5	4.3	9.8	2.3	3.6	1.2	47.5
2017	24.4	5.1	4.8	11.0	2.6	4.0	1.4	53.2
2018	27.4	5.8	5.4	12.3	2.9	4.5	1.5	59.7
2019	30.4	6.4	5.9	13.6	3.2	4.9	1.7	66.2
2020	33.4	7.1	6.5	14.8	3.5	5.4	1.8	72.4
2021	36.6	7.8	7.0	16.2	3.8	5.8	2.0	79.3
2022	39.6	8.5	7.6	17.5	4.1	6.3	2.2	85.8
2023	42.3	9.1	8.1	18.7	4.4	6.7	2.3	91.5
2024	45.2	9.8	8.6	19.9	4.6	7.1	2.5	97.7
2025	48.3	10.5	9.1	21.2	4.9	7.6	2.7	104.3
2026	51.7	11.3	9.7	22.6	5.2	8.0	2.8	111.3
2027	54.9	12.0	10.2	24.0	5.5	8.5	3.0	118.2
2028	58.0	12.8	10.7	25.2	5.8	8.9	3.2	124.7
2029	61.2	13.6	11.3	26.6	6.1	9.4	3.4	131.5
2030	64.7	14.4	11.9	28.0	6.4	9.9	3.6	138.8
2031	68.3	15.3	12.5	29.5	6.7	10.4	3.8	146.4
Average annual growth ($M)								
2015-2031	3.1	0.7	0.5	1.3	0.3	0.5	0.2	6.6
Average annual growth (%)								
2015-2031	8.4%	8.8%	7.8%	8.1%	7.8%	7.8%	8.2%	8.2%

**Constant 2014/15 dollars & including GST*
Source: MarketInfo; MacroPlan Dimasi

Retail expenditure category definitions:

- FLG: take-home food and groceries, as well as packaged liquor.
- Food catering: expenditure at cafes, take-away food outlets and restaurants.
- Apparel: clothing, footwear, fashion accessories and jewellery.
- Household goods: giftware, electrical, computers, furniture, homewares and hardware goods.
- Leisure: sporting goods, music, DVDs, computer games, books, newspapers & magazines, stationery and photography equipment.
- General retail: pharmaceutical goods, cosmetics, toys, florists, mobile phones and pets.
- Retail services: hair & beauty, optical goods, dry cleaning, key cutting and shoe repairs.

Section 3: Competition

This section of the report reviews the retail environment within which the Provence Neighbourhood Centre (PNC) will operate. Table 3.1 details the existing and proposed retail facilities in the surrounding area, while the previous Map 2.1 illustrates the location of these facilities.

Table 3.1
Provence N'd Centre - schedule of competing retail facilities

Centre	Retail GLA (sq.m)	Major traders	Dist. by road from Provence N'd Centre (km)
Busselton Town Centre	35,800		4.4
• Busselton Central	8,700	Supa IGA, Best & Less	
• Busselton Boulevard	4,500	Coles	
• Busselton SC	4,000	Woolworths (west of Queen St)	
• balance	18,600	Woolworths (east of Queen St), Target Country, Rivers	
West Busselton SC	1,450	IGA	7.5
IGA Geographe	850	IGA	9.5
Future retail facilities			
Power Centre (p)		Kmart, Aldi	5.6
Ambergate North TC (p)		Supermarket	7.0

Source: Property Council of Australia; MacroPlan Dimasi

3.1 Existing facilities

Busselton Town Centre is the main retail and commercial hub within the City of Busselton and is situated approximately 4.4 km north-west of the Provence estate. The main competitive facilities situated within the Busselton Town Centre are summarised as follows:

- **Busselton Central** is one of three small enclosed shopping centres situated within the town centre and is anchored by a Progressive Supa IGA supermarket and a Best & Less store. The centre also contains a small provision of apparel/fashion specialties, which

include national retailers such as Jeans West, Just Jeans, Noni B, Rockmans, Factorie, and Prouds the Jewellers.

- **Busselton Boulevard** is a supermarket centre, anchored by a Coles supermarket and supported by a limited provision of convenience oriented, specialty retailers.

- **Busselton SC** is located to the west of Queen Street and is anchored by the smaller of the two Woolworths supermarkets in Busselton. The centre also contains a small range of retail specialty stores.

- The second **Woolworths** supermarket, a recently built store, is located on the eastern side of Queen Street with access from Duchess and Kent Streets. This is now the leading supermarket in Busselton.

- Both Rivers superstore and Target Country are free-standing stores in the town centre, located immediately east of Busselton Central.

- **Queen Street** is the main retail strip within the Busselton Town Centre providing an extensive range of food catering (restaurants and bars) as well as non-retail (banks and real estate agents) specialties. A **bulky goods strip** centre is provided on Bussell Highway (bound by West Street to the east and Court Street to the west) and includes national retailers Retravision, Forty Winks and Harvey Norman.

- Two small IGA supermarkets are located outside the Busselton Town Centre, one to the west of the town centre and IGA Geographe to the east. These small stores cater to the convenience and top-up needs of residents in their respective catchments.

3.2 Future facilities

There are no future retail facilities proposed within the defined main trade area. Beyond the trade area, the proposed facilities are:

- The **Power Centre** is a proposed development situated on West Street at the southern end of the Busselton Town Centre. A Kmart discount department store and potentially an Aldi supermarket will anchor the site. While a planning application has not been lodged with the City of Busselton, Council is understood to be supportive of a full-line discount department store within the town centre, and is anticipating an application to be lodged in the near future.

- *Future Busselton 2050* (a broad document with four long term strategic growth scenarios for Busselton) includes a potential future Town Centre within the **Ambergate North** residential development, located to the west of the secondary sector. This proposal would not have any competitive bearing on the Provence retail facilities, and in any case would not eventuate for many years.

- The **Vasse Village Centre** will be a new neighbourhood centre anchored by Coles, located at the intersection of the Bussell Highway and the Busselton Bypass, and more than 13 km west of Provence. This development will not have any competitive influence on the Provence centre, given the large distance between the two centres which will therefore serve separate trade areas.

Section 4: Centre potential

This section of the report considers the appropriate scale and composition of the proposed Provence Neighbourhood Centre (PNC), as well as examining the centre's sales potential. Sales potential is determined by a combination of factors including:

- The location of the centre and the regional context of that location, including the locations of other relevant competitive centres.
- The extent of the trade area or catchment which the centre is designed to serve or can effectively serve, and the population levels within that trade area.
- The socio-demographic profile of the trade area population, and the resultant retail expenditure potential.
- The pattern of urban development, including physical breaks/barriers to accessibility.
- The available transport routes and ease of access to the site relative to its competitors.

4.1 Provence Neighbourhood Centre sales potential

The amount of floorspace which can be supported at the PNC and which will be appropriate to meet the needs of the trade area population, will be driven primarily by the level of retail sales which the centre can reasonably expect to retain from the pool of expenditure generated by the existing and future trade area population.

Table 4.1 provides an indicative assessment of the volume of sales, by retail category, which the centre could reasonably expect to retain from the trade area population, taking into account the planned nature and scale of the centre in the foreseeable future, as well as the nature and extent of the trade area.

Table 4.1
Provence MTA - potential retained retail expenditure by category ($M), 2015-2031*
Base case scenario

Year ending June	FLG	Food catering	**Total food**	Apparel	HH goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2015	11.0	0.5	**11.5**	0.1	0.2	0.4	0.6	0.2	**1.3**	**12.9**
2016	12.8	0.6	**13.5**	0.1	0.2	0.4	0.6	0.2	**1.5**	**15.0**
2017	14.5	0.7	**15.2**	0.1	0.2	0.5	0.7	0.2	**1.7**	**16.9**
2018	16.4	0.8	**17.2**	0.1	0.2	0.5	0.8	0.3	**1.9**	**19.2**
2019	18.3	0.9	**19.2**	0.1	0.3	0.6	0.9	0.3	**2.1**	**21.4**
2020	20.2	1.0	**21.2**	0.1	0.3	0.6	1.0	0.3	**2.4**	**23.5**
2021	22.2	1.1	**23.3**	0.1	0.3	0.7	1.1	0.4	**2.6**	**25.9**
2022	24.1	1.2	**25.3**	0.1	0.3	0.8	1.2	0.4	**2.8**	**28.1**
2023	25.8	1.3	**27.1**	0.1	0.4	0.8	1.3	0.4	**3.0**	**30.1**
2024	27.7	1.4	**29.1**	0.1	0.4	0.9	1.3	0.5	**3.2**	**32.2**
2025	29.6	1.5	**31.1**	0.1	0.4	0.9	1.4	0.5	**3.4**	**34.5**
2026	31.7	1.6	**33.3**	0.1	0.4	1.0	1.5	0.5	**3.6**	**36.9**
2027	33.8	1.7	**35.5**	0.1	0.5	1.0	1.6	0.6	**3.8**	**39.3**
2028	35.7	1.8	**37.5**	0.2	0.5	1.1	1.7	0.6	**4.0**	**41.6**
2029	37.7	2.0	**39.7**	0.2	0.5	1.2	1.8	0.6	**4.2**	**43.9**
2030	39.9	2.1	**42.0**	0.2	0.5	1.2	1.9	0.7	**4.5**	**46.5**
2031	42.2	2.2	**44.4**	0.2	0.6	1.3	2.0	0.7	**4.7**	**49.1**
% retail expenditure retained										
Primary	65.0%	15.0%	**56.5%**	1.5%	2.0%	20.0%	20.0%	20.0%	**7.9%**	**34.9%**
Secondary	15.0%	7.5%	**13.6%**	0.5%	1.0%	5.0%	5.0%	5.0%	**2.2%**	**8.3%**
MTA	**58.2%**	**13.9%**	**50.6%**	**1.3%**	**1.9%**	**17.9%**	**17.8%**	**17.5%**	**7.1%**	**31.1%**

**Constant 2014/15 dollars & including GST*
Source: MacroPlan Dimasi

The indicative estimates also take into account the competitive framework in which the proposed centre will operate, having regard to the surrounding alternative offers in Busselton Town Centre to the north of the Bussell Highway, as discussed in Section 3 earlier.

The PNC will play an important role in the surrounding neighbourhood, particularly for food, grocery and convenience shopping. It will therefore be able to retain much of the food and grocery spending of primary trade area residents, and some food catering and general retail spend. The respective retention rates which are considered able to be achieved by the

proposed PNC from the secondary sector are expected to be significantly lower, given that those residents have more straight-forward access to the Busselton Town Centre.

Table 4.1 takes all of these factors into account in providing indicative estimates of the sales potential for the Provence Neighbourhood Centre by retail category for the defined trade area, based on the estimated market shares of available retail expenditure, by category and by trade area sectors, which the centre can attract.

The majority of the retail expenditure that the centre can expect to retain from trade area residents will be in the Food & Liquor category (FLG), which includes expenditure on food and groceries purchased for consumption at home, as well as packaged liquor. It does not include take-away food, café/restaurant expenditure, or liquor consumed on the premises, all of which fall within the food catering category. Across the total retail spectrum, the proportion of available retail expenditure which the centre is forecast to retain from the defined trade area is in the order of 31%, including 35% from the primary trade area.

4.2 Supportable retail floorspace

Having addressed the market capture which the PNC is considered able to achieve, Table 4.2 provides indicative estimates of the amounts of supportable retail floorspace for the centre on a year on year basis, taking into account the estimated levels of expenditure which the centre is likely to retain.

Table 4.2
Provence MTA - indicative supportable retained floorspace by category (sq.m), 2015-2031
Base case scenario

Year ending June	FLG	Food catering	**Total food**	Apparel	Household goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2015	1,294	91	**1,385**	11	40	72	74	37	**234**	**1,620**
2016	1,493	105	**1,598**	13	45	83	85	43	**269**	**1,867**
2017	1,672	118	**1,789**	14	50	93	95	48	**300**	**2,090**
2018	1,874	132	**2,006**	16	56	103	106	54	**335**	**2,341**
2019	2,071	146	**2,218**	18	62	114	116	59	**369**	**2,586**
2020	2,257	160	**2,417**	19	67	123	126	64	**400**	**2,817**
2021	2,460	175	**2,636**	21	73	134	137	70	**434**	**3,070**
2022	2,646	189	**2,835**	22	78	143	146	75	**465**	**3,300**
2023	2,805	201	**3,007**	23	83	151	154	80	**491**	**3,498**
2024	2,975	214	**3,189**	25	87	159	163	85	**519**	**3,707**
2025	3,154	228	**3,382**	26	92	168	172	90	**548**	**3,930**
2026	3,344	243	**3,587**	27	97	177	181	95	**578**	**4,165**
2027	3,524	257	**3,781**	29	102	186	190	100	**607**	**4,388**
2028	3,690	270	**3,960**	30	107	194	198	105	**633**	**4,593**
2029	3,863	284	**4,148**	31	111	202	206	110	**660**	**4,808**
2030	4,045	299	**4,344**	32	116	210	215	115	**689**	**5,033**
2031	4,236	314	**4,550**	34	121	219	224	121	**719**	**5,269**
RTD*	8,500	6,000	**8,335**	4,500	4,000	5,000	7,500	5,000	**5,598**	**7,939**

** Retail Turnover Density - Turnover ($) per sq.m in 2014/15, increasing at 1.0% real growth p.a.*
Source: MarcoPlan Dimasi

Floorspace figures in Table 4.2 are calculated by applying average Retail Turnover Density (RTD) to the estimated available retail sales volume. The RTD is simply the level of sales per sq.m which it is considered new retailers at the proposed centre would need to achieve in order to create a successful centre. Adopted RTD levels range from $8,500 per sq.m for retailers in FLG (including any supermarket provided) to $4,000 per sq.m for homewares

retailers. The resultant figures show the estimated supportable level of floorspace, including any major (e.g. supermarket) stores floorspace.

The main points to note from the above analysis are as follows:

- A medium sized supermarket (say 2,500 sq.m) is likely to become supportable by around 2021, when the trade area population is expected to reach 5,570 residents.
- As the surrounding area undergoes further development, the estimated amount of supportable retail specialty floorspace to support the supermarket anchor at the centre would be in the order of 800-1,000 sq.m, with the bulk of that floorspace being allocated to food retail and food catering, as well as other convenience retailers. Some additional non-retail shopfront space, providing some limited services such as real estate agents, small gym, possibly small medical centre, etc., could also form part of the centre.
- The indicative timing suggested above (base case) will of course depend on the rate at which residential development within the area proceeds. Should a higher rate of residential take-up be able to be achieved (high scenario), the supermarket would be expected to become supportable at an earlier date, possibly by around 2019, i.e. two years earlier than under the base case. Conversely, if only the low scenario can be achieved due to softening market demand, the supportability of the supermarket would be pushed by around 2-3 years into the future, i.e. by around 2023-24.
- The timing of the PNC should be flexible around this critical factor; however as a general guide, the centre should be developed sooner rather than later, which would stimulate the take up of the residential development, as well as provide appropriate facilities and a community focus for the growing population.

4.3 Scope for anchor tenants

The analysis outlined in the previous Sections 4.1 and 4.2 details the approximate sales volume which the PNC could expect to retain given the available trade area retail expenditure and the consequent levels of retail floorspace across each of the seven categories which such sales volumes could then support.

The development of retail centres in practice though is not quite as straightforward. There are many other real world factors which serve to make the planning and development of effective retail centres rather more complex. The three most important of these other factors are the site features, the commerce of construction cost, income and value, and most importantly the availability of major tenants to successfully anchor the new retail development.

In this regard, Table 4.3 shows the indicative potential sales volumes that would be available to a supermarket (of 2,500 sq.m) within the PNC, taking into account the total volume of food and grocery retail expenditure generated by the trade area population; the proportion of that expenditure which the centre can expect to retain; the provision of that expenditure which in turn a supermarket anchoring the centre would be likely to attract; and passing traffic (modest in this case given the assumed location of the centre internally within the estate).

The information in Table 4.3 shows that at 2021, the potential sales volume for a supermarket would be in the order of $16-17 million, in constant 2014/15 dollars, or $18-19 million in inflated dollars, indicating that a medium scale supermarket could successfully locate at the site by that date, given the strong growth outlook in subsequent years. This estimated sales volume assumes that a rate of residential development within Provence can be achieved as specified under the base case scenario in Section 2.

Table 4.3 represents a base case scenario for the supermarket, assuming that population growth occurs steadily at around 110 lots per annum on average, and that there will be no additional competitive facilities built within or near the trade area. Under those assumptions, the supermarket sales potential at the PNC would increase strongly over the forecast period.

Table 4.3
Provence N'd Centre supermarket sales potential, 2021-2031
Base case scenario

Year ending June	**Estimated** sales ($M)*	**Est. sales ($M)** inflated dollars
2021	16.3	18.3
2022	17.7	20.3
2023	18.9	22.2
2024	20.3	24.2
2025	21.7	26.4
2026	23.2	28.9
2027	24.7	31.3
2028	26.1	33.8
2029	27.6	36.5
2030	29.2	39.3
2031	30.9	42.4
Avg. ann. growth, 2021-2031	6.6%	8.8%

**Constant 2014/15 dollars & including GST*
Source: MacroPlan Dimasi

Given the available trade area population base as well as the role of the centre as a neighbourhood centre, no non-food majors can be expected to locate at the PNC. Higher-order non-food shopping of Provence residents will continue to be directed to the Busselton Town Centre.

4.4 Centre sales potential

Based on the analysis presented in this report, we consider that the proposed PNC should be anchored by a medium sized supermarket, together with a range of convenience orientated stores at 2021.

In terms of the retail specialty mix which could be included at the PNC, the key components of that mix are considered to be the following:

- Food retail – A limited range (2-3) of food retail operators would be able to be accommodated at the centre to meet the daily needs of the surrounding residents and to complement the supermarket offer, including a bakery, potentially a butcher and a liquor store.

- Food catering – The centre could incorporate 3-4 food catering outlets, comprising take-away food stores and casual cafés/restaurants. Such a provision would help to provide activation and a community focus to the centre.

- Leisure/general/retail services – Convenience orientated retailers, in particular a pharmacy and possibly a newsagency/post office, would be helpful additions for the successful trading of the centre. A hairdresser and a florist have also been included in our recommended mix.

In summary, around 9-10 retail specialty stores across 900-1,000 sq.m of floorspace could be included at the PNC, to support the supermarket anchor. As previously noted, some non-retail shopfront uses could add further to the mix, potentially another 200-300 sq.m.

Table 4.4 details the broad indicative mix and the estimated sales potential for the retail components of the PNC at 2020/21. Potential centre sales are estimated at some $22.2 million (in constant 2014/15 dollars) in 2020/21, including $6 million in specialty sales, reflecting an average trading level of $6,440 per sq.m for the total retail floorspace.

The sales estimates for the new centre are based on an assessment of the sales potential for the supermarket, with the estimated specialty sales potential taking into account the projected supermarket performance. The key principle of any shopping centre is that the majors are the main attractors and generators of customer traffic, with the specialty shops then feeding off the major tenants. The sales projections also take into account the trade area analysis and competition detailed in earlier sections of this report; sales by similar retailers in comparable centres; and also average sales levels achieved by each category of tenant in single supermarket based centres throughout Australia and Western Australia.

Table 4.5 details the market share performance which the PNC would have to achieve in order to record the projected sales volumes outlined in Table 4.4. The centre's share of total retail spending throughout the main trade area is forecast at 27%. Within the primary trade area, the centre's market share of available spending is estimated at 43% for food and 10% for non-food, averaging 29% of the total available spending in that sector. Although the food market share performance for the PNC is relatively high in the primary sector, it is considered to be achievable given an appropriate attractive supermarket offer at the centre.

Table 4.4
Provence N'd Centre - Centre sales potential by retail category, 2020/21*
Base case scenario

Category	Provence N'd Centre GLA (sq.m)	Est. sales ($'000)	($/sq.m)
Major tenants			
Supermarket	2,500	16,269	6,508
Total majors	2,500	16,269	6,508
Retail specialties			
Food & liquor	300	2,200	7,333
Food catering	260	1,460	5,615
Apparel	0	0	0
Household	0	0	0
Leisure	100	500	5,000
General	210	1,440	6,857
Retail services	80	360	4,500
Total retail spec.	950	5,960	6,274
Total centre - retail	**3,450**	**22,229**	**6,443**
Non-retail**	250		
Total centre	**3,700**		

Constant 2014/15 dollars & including GST
***Non-retail shopfronts such as real estate agents, small gymnasium, small medical centre*
Source: MacroPlan Dimasi

Table 4.5
Provence N'd Centre - Estimated market shares, 2020/21*
Base case scenario

Trade area	Retail spend ($M) Food	Non-food	Total	Centre sales ($M) Food	Non-food	Total	Market share Food	Non-food	Total
Primary	40.5	31.7	72.2	17.5	3.0	20.6	43.3%	9.6%	28.5%
Secondary	3.9	3.3	7.1	0.5	0.1	0.5	11.9%	2.4%	7.6%
Main TA	**44.4**	**34.9**	**79.3**	**18.0**	**3.1**	**21.1**	**40.6%**	**8.9%**	**26.6%**
Sales from beyond TA				0.9	0.2	1.1			
Total centre sales				**19.0**	**3.3**	**22.2**			

Constant 2014/15 dollars & including GST
Source: MacroPlan Dimasi

Appendix

Appendix Table L.1
Provence trade area population, 2006-2031*
Low scenario

	Estimated population			Forecast population			
Trade area sector	2006	2011	2015	2018	2021	2026	2031
Primary	240	1,350	2,790	3,600	4,410	5,510	6,610
Secondary	340	340	380	410	440	490	540
Main trade area	**580**	**1,690**	**3,170**	**4,010**	**4,850**	**6,000**	**7,150**

	Average annual growth (no.)					
Trade area sector	2006-11	2011-15	2015-18	2018-21	2021-26	2026-31
Primary	222	360	270	270	220	220
Secondary	0	10	10	10	10	10
Main trade area	**222**	**370**	**280**	**280**	**230**	**230**

	Average annual growth (%)					
Trade area sector	2006-11	2011-15	2015-18	2018-21	2021-26	2026-31
Primary	41.3%	19.9%	8.9%	7.0%	4.6%	3.7%
Secondary	0.0%	2.8%	2.6%	2.4%	2.2%	2.0%
Main trade area	**23.8%**	**17.0%**	**8.2%**	**6.5%**	**4.3%**	**3.6%**

**As at June*
Source: ABS Census 2011; WA Tomorrow, 2015; MacroPlan Dimasi

Appendix Table L.2
Provence main trade area - retail expenditure ($M), 2015-2031*
Low scenario

Year ending June	Primary sector	Secondary sector	Main TA
2015	35.5	5.8	41.3
2016	40.8	6.0	46.9
2017	44.8	6.2	51.0
2018	49.2	6.5	55.7
2019	53.6	6.7	60.3
2020	57.9	6.9	64.8
2021	62.6	7.1	69.8
2022	66.9	7.4	74.3
2023	70.8	7.6	78.4
2024	74.8	7.9	82.7
2025	79.1	8.1	87.2
2026	83.6	8.4	92.0
2027	88.0	8.7	96.7
2028	92.2	8.9	101.2
2029	96.7	9.2	105.9
2030	101.4	9.5	110.9
2031	106.3	9.8	116.1
Average annual growth ($M)			
2015-2021	4.5	0.2	4.7
2021-2031	4.4	0.3	4.6
2015-2031	**4.4**	**0.2**	**4.7**
Average annual growth (%)			
2015-2021	9.9%	3.4%	9.1%
2021-2031	4.7%	2.9%	4.6%
2015-2031	7.1%	3.3%	6.7%

**Constant 2014/15 dollars & including GST*
Source: MarketInfo; MacroPlan Dimasi

Appendix Table L.3
Provence main trade area - retail expenditure by category ($M), 2015-2031*
Low scenario

Year ending June	FLG	Food catering	Apparel	Household goods	Leisure	General retail	Retail services	**Total retail**
2015	18.9	3.9	3.8	8.5	2.0	3.1	1.1	41.3
2016	21.5	4.5	4.2	9.7	2.3	3.5	1.2	46.9
2017	23.4	4.9	4.6	10.5	2.5	3.8	1.3	51.0
2018	25.6	5.4	5.0	11.4	2.7	4.2	1.4	55.7
2019	27.7	5.9	5.4	12.4	2.9	4.5	1.5	60.3
2020	29.8	6.3	5.8	13.3	3.1	4.8	1.7	64.8
2021	32.2	6.9	6.2	14.3	3.3	5.1	1.8	69.8
2022	34.3	7.4	6.6	15.2	3.5	5.5	1.9	74.3
2023	36.2	7.8	6.9	16.0	3.7	5.7	2.0	78.4
2024	38.2	8.3	7.3	16.8	3.9	6.0	2.1	82.7
2025	40.4	8.8	7.6	17.7	4.1	6.3	2.2	87.2
2026	42.6	9.3	8.0	18.7	4.3	6.7	2.4	92.0
2027	44.9	9.9	8.4	19.6	4.5	7.0	2.5	96.7
2028	47.0	10.4	8.7	20.5	4.7	7.3	2.6	101.2
2029	49.3	10.9	9.1	21.4	4.9	7.6	2.7	105.9
2030	51.6	11.5	9.5	22.4	5.1	7.9	2.9	110.9
2031	54.1	12.1	9.9	23.4	5.3	8.2	3.0	116.1
Average annual growth ($M)								
2015-2031	2.2	0.5	0.4	0.9	0.2	0.3	0.1	4.7
Average annual growth (%)								
2015-2031	6.8%	7.3%	6.2%	6.5%	6.3%	6.3%	6.7%	6.7%

Constant 2014/15 dollars & including GST
Source: MarketInfo; MacroPlan Dimasi

Appendix Table L.4
Provence MTA - potential retained retail expenditure by category ($M), 2015-2031*
Low scenario

Year ending June	FLG	Food catering	**Total food**	Apparel	HH goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2015	11.0	0.5	**11.5**	0.1	0.2	0.4	0.6	0.2	**1.3**	**12.9**
2016	12.6	0.6	**13.2**	0.1	0.2	0.4	0.6	0.2	**1.5**	**14.7**
2017	13.8	0.7	**14.5**	0.1	0.2	0.5	0.7	0.2	**1.6**	**16.2**
2018	15.2	0.8	**15.9**	0.1	0.2	0.5	0.8	0.3	**1.8**	**17.7**
2019	16.5	0.8	**17.4**	0.1	0.2	0.5	0.8	0.3	**1.9**	**19.3**
2020	17.9	0.9	**18.8**	0.1	0.3	0.6	0.9	0.3	**2.1**	**20.9**
2021	19.3	1.0	**20.3**	0.1	0.3	0.6	0.9	0.3	**2.2**	**22.5**
2022	20.7	1.0	**21.7**	0.1	0.3	0.7	1.0	0.3	**2.4**	**24.1**
2023	21.9	1.1	**23.0**	0.1	0.3	0.7	1.1	0.4	**2.5**	**25.5**
2024	23.1	1.2	**24.3**	0.1	0.3	0.7	1.1	0.4	**2.7**	**27.0**
2025	24.4	1.3	**25.7**	0.1	0.3	0.8	1.2	0.4	**2.8**	**28.5**
2026	25.9	1.3	**27.2**	0.1	0.4	0.8	1.2	0.4	**2.9**	**30.1**
2027	27.2	1.4	**28.6**	0.1	0.4	0.8	1.3	0.5	**3.1**	**31.7**
2028	28.6	1.5	**30.1**	0.1	0.4	0.9	1.4	0.5	**3.2**	**33.3**
2029	30.0	1.6	**31.5**	0.1	0.4	0.9	1.4	0.5	**3.4**	**34.9**
2030	31.4	1.6	**33.1**	0.1	0.4	1.0	1.5	0.5	**3.5**	**36.6**
2031	33.0	1.7	**34.7**	0.1	0.4	1.0	1.5	0.6	**3.7**	**38.4**
% retail expenditure retained										
Primary	65.0%	15.0%	**56.5%**	1.5%	2.0%	20.0%	20.0%	20.0%	**7.9%**	**34.9%**
Secondary	15.0%	7.5%	**13.6%**	0.5%	1.0%	5.0%	5.0%	5.0%	**2.2%**	**8.3%**
MTA	**58.2%**	**13.9%**	**50.6%**	**1.3%**	**1.9%**	**17.9%**	**17.8%**	**17.5%**	**7.1%**	**31.1%**

**Constant 2014/15 dollars & including GST*
Source: MacroPlan Dimasi

Appendix Table L.5
Provence MTA - indicative supportable retained floorspace by category (sq.m), 2015-2031
Low scenario

Year ending June	FLG	Food catering	**Total food**	Apparel	Household goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2015	1,294	91	**1,385**	11	40	72	74	37	**234**	**1,620**
2016	1,470	104	**1,574**	13	45	82	84	42	**265**	**1,839**
2017	1,596	113	**1,709**	14	48	89	91	46	**287**	**1,995**
2018	1,735	123	**1,857**	15	52	96	98	50	**310**	**2,168**
2019	1,870	133	**2,003**	16	56	103	105	53	**333**	**2,336**
2020	2,001	142	**2,143**	17	60	109	112	57	**355**	**2,498**
2021	2,142	153	**2,295**	18	64	116	119	61	**378**	**2,673**
2022	2,268	163	**2,431**	19	67	123	125	65	**399**	**2,830**
2023	2,375	171	**2,546**	20	70	128	131	68	**416**	**2,962**
2024	2,487	180	**2,666**	21	73	133	136	71	**434**	**3,101**
2025	2,604	189	**2,793**	21	76	139	142	74	**453**	**3,246**
2026	2,726	199	**2,925**	22	80	145	148	78	**472**	**3,397**
2027	2,843	208	**3,052**	23	83	150	153	81	**491**	**3,542**
2028	2,953	217	**3,171**	24	86	155	159	84	**508**	**3,678**
2029	3,068	227	**3,295**	25	89	160	164	87	**525**	**3,820**
2030	3,187	237	**3,424**	26	92	166	169	91	**544**	**3,967**
2031	3,310	247	**3,557**	26	95	171	175	94	**562**	**4,120**
RTD*	8,500	6,000	**8,335**	4,500	4,000	5,000	7,500	5,000	**5,598**	**7,939**

** Retail Turnover Density - Turnover ($) per sq.m in 2014/15, increasing at 1.0% real growth p.a.*
Source: MarcoPlan Dimasi

Appendix Table H.1
Provence trade area population, 2006-2031*
High scenario

	Estimated population			Forecast population			
Trade area sector	2006	2011	2015	2018	2021	2026	2031
Primary	240	1,350	2,790	4,350	5,910	8,260	9,610
Secondary	340	340	380	410	440	490	540
Main trade area	**580**	**1,690**	**3,170**	**4,760**	**6,350**	**8,750**	**10,150**

	Average annual growth (no.)					
Trade area sector	2006-11	2011-15	2015-18	2018-21	2021-26	2026-31
Primary	222	360	520	520	470	270
Secondary	0	10	10	10	10	10
Main trade area	**222**	**370**	**530**	**530**	**480**	**280**

	Average annual growth (%)					
Trade area sector	2006-11	2011-15	2015-18	2018-21	2021-26	2026-31
Primary	41.3%	19.9%	16.0%	10.8%	6.9%	3.1%
Secondary	0.0%	2.8%	2.6%	2.4%	2.2%	2.0%
Main trade area	**23.8%**	**17.0%**	**14.5%**	**10.1%**	**6.6%**	**3.0%**

**As at June*
Source: ABS Census 2011; WA Tomorrow, 2015; MacroPlan Dimasi

Appendix Table H.2
Provence main trade area - retail expenditure ($M), 2015-2031*
High scenario

Year ending June	Primary sector	Secondary sector	Main TA
2015	35.5	5.8	41.3
2016	42.1	6.0	48.2
2017	49.2	6.2	55.5
2018	57.6	6.5	64.1
2019	65.9	6.7	72.6
2020	73.7	6.9	80.6
2021	82.5	7.1	89.6
2022	90.7	7.4	98.1
2023	98.1	7.6	105.7
2024	106.0	7.9	113.9
2025	114.6	8.1	122.7
2026	123.9	8.4	132.3
2027	131.5	8.7	140.2
2028	137.0	8.9	146.0
2029	142.8	9.2	152.0
2030	148.8	9.5	158.3
2031	155.0	9.8	164.8
Average annual growth ($M)			
2015-2021	7.8	0.2	8.1
2021-2031	7.3	0.3	7.5
2015-2031	**7.5**	**0.2**	**7.7**
Average annual growth (%)			
2015-2021	15.1%	3.4%	13.8%
2021-2031	5.5%	2.9%	5.3%
2015-2031	9.7%	3.3%	9.0%

**Constant 2014/15 dollars & including GST*
Source: MarketInfo; MacroPlan Dimasi

Appendix Table H.3
Provence main trade area - retail expenditure by category ($M), 2015-2031*
High scenario

Year ending June	FLG	Food catering	Apparel	Household goods	Leisure	General retail	Retail services	**Total retail**
2015	18.9	3.9	3.8	8.5	2.0	3.1	1.1	41.3
2016	22.1	4.6	4.4	9.9	2.3	3.6	1.2	48.2
2017	25.5	5.3	5.0	11.4	2.7	4.2	1.4	55.5
2018	29.4	6.2	5.8	13.2	3.1	4.8	1.6	64.1
2019	33.4	7.1	6.5	14.9	3.5	5.4	1.8	72.6
2020	37.1	7.9	7.2	16.5	3.9	6.0	2.1	80.6
2021	41.4	8.8	7.9	18.3	4.3	6.6	2.3	89.6
2022	45.3	9.7	8.7	20.0	4.7	7.2	2.5	98.1
2023	48.9	10.5	9.3	21.6	5.0	7.7	2.7	105.7
2024	52.8	11.4	10.0	23.2	5.4	8.3	2.9	113.9
2025	56.9	12.4	10.7	24.9	5.8	8.9	3.1	122.7
2026	61.4	13.4	11.5	26.8	6.2	9.6	3.4	132.3
2027	65.1	14.3	12.1	28.4	6.6	10.1	3.6	140.2
2028	67.9	14.9	12.6	29.5	6.8	10.5	3.7	146.0
2029	70.8	15.7	13.0	30.7	7.1	10.9	3.9	152.0
2030	73.8	16.4	13.5	31.9	7.3	11.3	4.1	158.3
2031	76.9	17.2	14.0	33.2	7.6	11.7	4.2	164.8
Average annual growth ($M)								
2015-2031	3.6	0.8	0.6	1.5	0.3	0.5	0.2	7.7
Average annual growth (%)								
2015-2031	9.2%	9.7%	8.6%	8.9%	8.6%	8.6%	9.0%	9.0%

**Constant 2014/15 dollars & including GST*
Source: MarketInfo; MacroPlan Dimasi

Appendix Table H.4
Provence MTA - potential retained retail expenditure by category ($M), 2015-2031*
High scenario

Year ending June	FLG	Food catering	**Total food**	Apparel	HH goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2015	11.0	0.5	**11.5**	0.1	0.2	0.4	0.6	0.2	**1.3**	**12.9**
2016	13.0	0.6	**13.7**	0.1	0.2	0.4	0.7	0.2	**1.5**	**15.2**
2017	15.2	0.8	**15.9**	0.1	0.2	0.5	0.8	0.3	**1.8**	**17.7**
2018	17.7	0.9	**18.6**	0.1	0.2	0.6	0.9	0.3	**2.1**	**20.7**
2019	20.2	1.0	**21.2**	0.1	0.3	0.7	1.0	0.3	**2.4**	**23.6**
2020	22.6	1.1	**23.8**	0.1	0.3	0.7	1.1	0.4	**2.6**	**26.4**
2021	25.3	1.3	**26.6**	0.1	0.4	0.8	1.2	0.4	**2.9**	**29.5**
2022	27.8	1.4	**29.2**	0.1	0.4	0.9	1.4	0.5	**3.2**	**32.5**
2023	30.1	1.5	**31.6**	0.1	0.4	1.0	1.5	0.5	**3.5**	**35.1**
2024	32.5	1.6	**34.2**	0.1	0.4	1.0	1.6	0.5	**3.7**	**37.9**
2025	35.2	1.8	**37.0**	0.2	0.5	1.1	1.7	0.6	**4.0**	**41.0**
2026	38.1	1.9	**40.0**	0.2	0.5	1.2	1.8	0.6	**4.3**	**44.3**
2027	40.4	2.1	**42.5**	0.2	0.5	1.3	1.9	0.7	**4.6**	**47.1**
2028	42.1	2.2	**44.3**	0.2	0.6	1.3	2.0	0.7	**4.8**	**49.1**
2029	44.0	2.3	**46.2**	0.2	0.6	1.3	2.1	0.7	**4.9**	**51.2**
2030	45.8	2.4	**48.2**	0.2	0.6	1.4	2.1	0.8	**5.1**	**53.4**
2031	47.8	2.5	**50.3**	0.2	0.6	1.5	2.2	0.8	**5.3**	**55.6**
% retail expenditure retained										
Primary	65.0%	15.0%	**56.5%**	1.5%	2.0%	20.0%	20.0%	20.0%	**7.9%**	**34.9%**
Secondary	15.0%	7.5%	**13.6%**	0.5%	1.0%	5.0%	5.0%	5.0%	**2.2%**	**8.3%**
MTA	**58.2%**	**13.9%**	**50.6%**	**1.3%**	**1.9%**	**17.9%**	**17.8%**	**17.5%**	**7.1%**	**31.1%**

**Constant 2014/15 dollars & including GST*
Source: MacroPlan Dimasi

Appendix Table H.5
Provence MTA - indicative supportable retained floorspace by category (sq.m), 2015-2031
High scenario

Year ending June	FLG	Food catering	**Total food**	Apparel	Household goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2015	1,294	91	**1,385**	11	40	72	74	37	**234**	**1,620**
2016	1,516	107	**1,622**	13	46	84	86	43	**273**	**1,896**
2017	1,750	123	**1,873**	15	53	97	99	50	**314**	**2,187**
2018	2,023	142	**2,165**	17	61	112	114	58	**361**	**2,526**
2019	2,288	161	**2,449**	19	68	126	128	65	**407**	**2,856**
2020	2,532	179	**2,711**	21	75	138	141	72	**448**	**3,160**
2021	2,805	199	**3,004**	24	83	152	156	80	**494**	**3,498**
2022	3,055	217	**3,272**	25	90	165	169	87	**536**	**3,808**
2023	3,270	234	**3,504**	27	96	176	180	93	**572**	**4,075**
2024	3,501	251	**3,752**	29	102	187	192	100	**610**	**4,362**
2025	3,748	270	**4,018**	31	109	200	204	107	**650**	**4,668**
2026	4,013	290	**4,303**	33	116	213	217	114	**693**	**4,996**
2027	4,219	306	**4,526**	34	122	222	227	120	**726**	**5,252**
2028	4,357	318	**4,675**	35	126	229	234	124	**747**	**5,422**
2029	4,499	330	**4,829**	36	129	235	240	128	**768**	**5,597**
2030	4,646	342	**4,988**	37	133	241	247	132	**790**	**5,779**
2031	4,797	355	**5,153**	38	137	248	253	136	**813**	**5,966**
RTD*	8,500	6,000	**8,335**	4,500	4,000	5,000	7,500	5,000	**5,598**	**7,939**

** Retail Turnover Density - Turnover ($) per sq.m in 2014/15, increasing at 1.0% real growth p.a.*
Source: MarcoPlan Dimasi

APPENDIX G

Addendum to address resolution of the Statutory Planning Committee (SPC)

Technical Note:	No 1c	**Date:** 26/06/2023
Project:	Provence Structure Plan	
Subject:	**Implementation of Internal and External Road Connections**	

Introduction and Background

The Provence Estate Structure Plan (SP) 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 A.** This SP shows the location of the external intersections along Bussell Highway and Vasse Highway.

Yolk Property Group has recently acquired a substantial landholding within the Estate and has worked to finalise the Structure Plan amendment following the consideration of the WAPC. Transcore have been engaged to prepare thistechnical note which is an addendum to the TIA to address the WAPC requirements, noting that the TIA prepared as part of the structure plan was considered deficient in a number of areas.

It should be noted that Yolk Property Group are also proposing a further amendment to the Structure Plan which will be accompanied by a new TIA, and this will be lodged with the City of Busselton for consideration and progression tothe WAPC in late 2022.

The timing, funding and staging of the Vasse Highway and Bussell Highway intersections/upgrades will be set out in an Intersection Upgrade andImplementation Strategy to be prepared prior to further subdivision, in consultation with Main Roads WA and to the satisfaction of the WAPC. Implementation of the Intersection Upgrade and Implementation Strategy shall be undertaken as a condition of each progressive stage of subdivision.

Appendix B shows the staging plan for the construction of the proposed Provence Estate Structure Plan. Stage 1 entails the proposed residential subdivision (for about 73 lots) at Lot 9032 and 9034 Joseph Drive, Yalyalup, in addition to the approved subdivision (WAPC Ref 155785) in the south-west of the Estate for the creation of residential lots.

In order to proceed with the subdivision, an implementation strategy will need to be prepared and agreed to ensure satisfactory progressive development of the Provence SP with a suitably functioning internal and external road network that will operate effectively during each progressive stage of subdivision and development of land within the SP area.

Implementation Strategy

Prior to approval of future stages of subdivision, the applicant/proponent is required to model traffic for the forecast year of 2040 in accordance with the WAPC's Transport Impact Assessment Guidelines Volume 2, with all assumptions and inputs to be verified to the specifications of Main Rods WA and to the satisfaction of the WAPC.

The following Implementation Strategy for the SP internal and external road connections, as identified in Appendix A, was the outcome of extensive discussions with MRWA and the Department of Planning, Lands and Heritage and is intended to commit all landowners forming part of the Provence Structure Plan Area to deliver the necessary State road infrastructure requirements for the Provence SP development area via deeds of agreement required as a condition of future subdivision approvals.

- **Access A** – (Joseph Drive/Bussell Highway), to be upgraded by Main Roads WA, subject to satisfactory arrangements being made for Accesses B and D (Vasse Highway / Blum Boulevard intersection). Access B is to be delivered by Yolk Property Group in the short term (by December 2024) unless otherwise agreed by Main Roads. In relation to Access D, an acceptable solution/developer-lead funding agreement being reached regarding the upgrading of the Vasse Highway / Blum Boulevard / Golding Ramble intersection (Access D) prior to further subdivision approvals for Blum Estate.
- **Access B** – (new access to Bussell Highway), to be built by the Developer (Yolk Property Group) to MRWA specification/satisfaction prior Stage 2 subdivision clearances (refer Appendix B) or December 2024, whichever event occurs first (refer Appendix B). Yolk Property Group is required to liaise with the landowner(s) of properties along Lyddy Road regarding the timing of closure of Lyddy Road and to provide written agreement of support from the City of Busselton to Main Roads to this effect prior to construction of Access B.
- **Access D** – - (upgrade of Blum Blvd/Vasse Highway), a proportional contribution to be made by Yolk Property Group and others (adjoining land holding to the west) to upgrade this road junction to the specifications of Main Roads. The contribution by Yolk Property Group is an off-set developer contribution against its obligation to upgrade Access A and shall not exceed the development construction costs for which it would have otherwise be responsible for to upgrade Access A.
- **Access E** – (Paterson Drive/Vasse Highway) no intersection upgrades/ contributions required at the intersection. However, connection of Gigondas Street to Paterson Drive is required to be implemented by Yolk Property Group at the next available

subdivision stage/development.

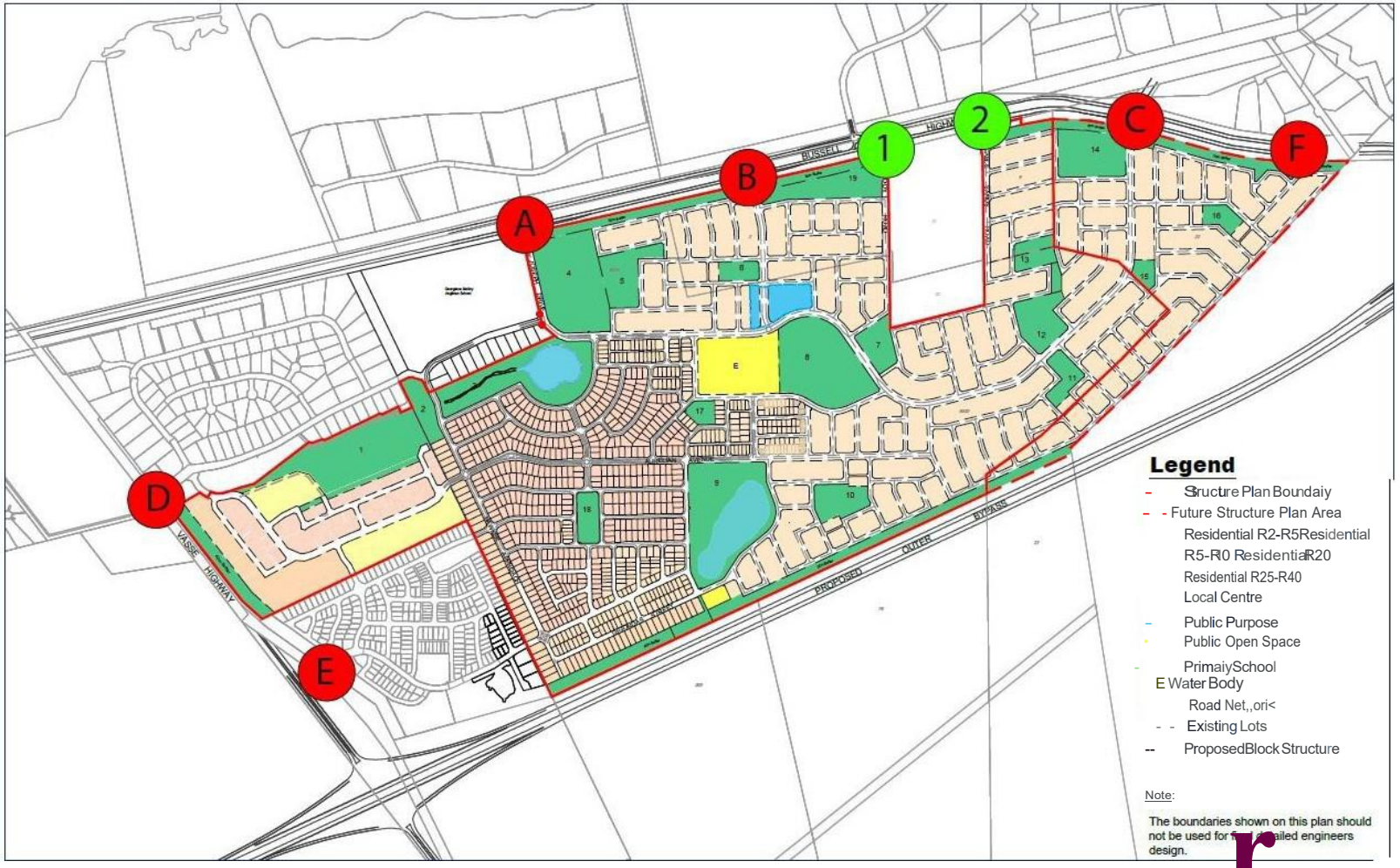
Accesses C and F – (eastern side of SP area and under separate ownership), the timing and staging to deliver Access C to be confirmed prior to any subdivision application being lodged with the WAPC. Requirement for the landowner to enter into a Deed of Agreement with the Commissioner of Main Roads as a condition of the first stage of subdivision of Lot 22. The landowner is also required to liaise with the landowner(s) of properties along Cable Sands Road regarding the closure of Cable Sands Road and to provide written agreement of support from the City of Busselton to Main Roads to this effect. Main Roads advises that it does not support provision of additional Access F to the State road network Busselton and Main Roads to this effect. Main Roads advises that it does not support provision of additional Access F to the State road network.

- **Closure of Lyddy Road** (1) to be exercised when internal road frontage/ access is provided via the primary Stage 2 development in consultation with Main Roads. Yolk Property Group is to accommodate internal subdivisional development road access and infrastructure access to the lots fronting Lyddy Road to the satisfaction of the WAPC.
- **Closure of Cable Sands Road** (2) Subject to potential Deed of Agreement with the Commissioner of Main Roads; anticipated to be exercised when Access C is constructed and internal road frontage/access is provided by Yolk Property Group or development of Lot 22. Yolk Property Group and/or Lot 22 is to accommodate internal subdivisional development road access and infrastructure access to Lot 6 Cable Sands Road to the satisfaction of the WAPC.
- **Bussell Highway / Vasse Highway junction** – Main Roads to address/undertake the necessary future intersection improvements to the Bussell Highway / Vasse Highway junction, subject to the conditions above outlined for Accesses B and D
- In relation to **Access A**, Main Roads advises that the scope of works includes the following scope of works –
    - Setting back the left and right turn lanes to further improve current masking issue for vehicles attempting to make the right-out movement from Joseph Drive.
    - Extension of the left-turn acceleration lane by 250 metres to 500 metres to meet the current Austroads/Main Roads design standard."

Footnote: *Main Roads expectation is that Access B is a full movement intersection built as either a four way signalised control intersection or a round-a-bout and Access D is a full movement 'T' intersection with right turn and left turn pockets/passing lane(s) on Vasse Highway.*

Appendix A

Original Provence Structure Plan with ExternalIntersections



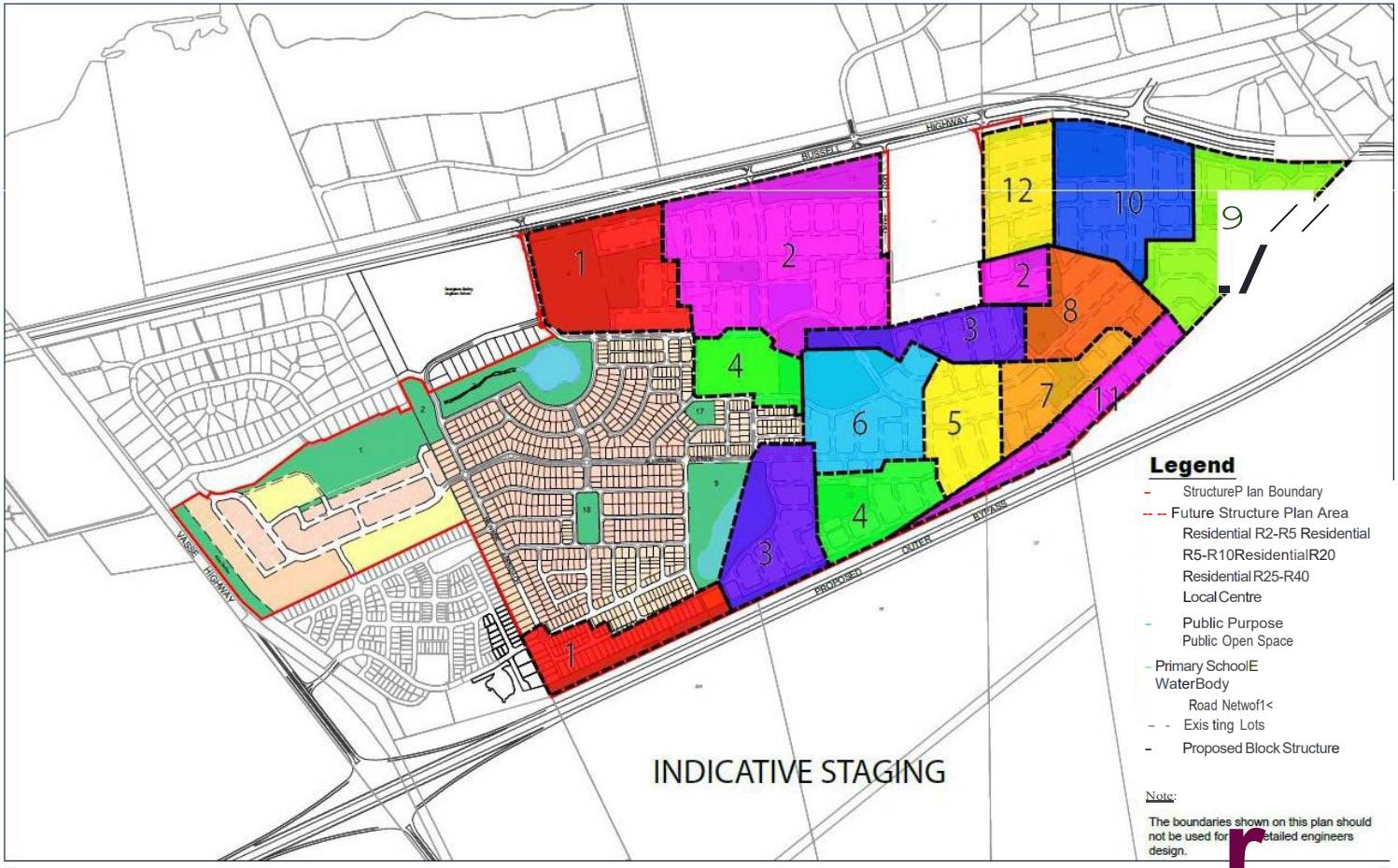
PIANREfc 130316-2-00JN
DATE: IQ FEBRUARY 20:20
CUENT: SATTERLEY
DRAV.WBY: JLS
CI-ECKEOBY: JC

PRO VENCE
STRUCTURE PLAN
Bussell Highway & Vasse Higway, Yalyalup

URBAN DESIGN

Appendix B

Structure Plan Concept and Indicative Staging



PLANREF: 130316-2-003N
DATE: 19FEBRUARY 2020
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PRO VENCE
STRUCTURE PLAN
Bussell Highway & Vasse Higway, Yalyalup

APPENDIX H

Landscape Assessment Report

prepared by Emerge Associates

PROVENCE 1 - RESIDENTIAL SUBDIVISION
Part 1: local structure plan - landscape assessment report

Satterley

Provence

emerge ASSOCIATES
Integrated Science & Design

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1.0 The Project Summary

GENERALLY

1.1 PROJECT LOCATION

The project site is located approximately 4 km south east of the Busselton townsite in southwest Western Australia within the Shire of Busselton off the Bussell Highway and approximately 230km south of Perth. The site is on the main eastern approaches to Busselton town and is visible to the majority of traffic heading into the southwest. The project is in a major urban growth corridor which will see the conversion of surplus rural land to residential and support uses.

1.2 PROJECT SCOPE

The proposed development is anticipated to consist of residential lots and commercial development to be distributed along the southern side of the Busselton Bypass. The project proposes to contain the following elements.

- Commercial precinct / Town Centre
- Between 2100 residential lots total of various densities
- Private High School
- Primary School
- New public open space areas
- Streetscapes of various hierarchies
- Pockets of retained vegetation
- Open water bodies (existing and proposed)
- Creek lines and seasonal flow corridors

The project commenced construction of its first Stages in 2004 with completion of approximately 600 lots up to December 2015. These proposed changes to the existing Structure Plan propose a further 1,500 lots approximately of various sizes.

1.3 ADJACENT LAND USES & INFLUENCES

The development is affected by various adjacent land uses and influences which may require particular design responses in order to relate to or screen off various effects. Adjacent land uses and influences include the Business Park, the Busselton Aiport and declining rrual uses each with possible landscape and project responses to be considered as part of the site design process.

1.4 BUSSELTON BYPASS & FUTURE OUTER BYPASS

The effects of highway noise and movement may have detrimental affects on adjacent residential areas adversely effecting price and lifestyle.

1.5 PROTECTED WETLANDS

Adjacent protected wetland are locally significant and may not be adversely affected by the development including water levels, pollutants, unauthorised access and the like.

1.6 RURAL USES

Adjacent rural uses, while declining, can have a longer term affect on the development through the leaching of high nutrient loads through groundwater across the development. Potential historic contamination of small areas with pesticides, fertilisers and the like may be possible. Immediate issues relating to adjacent rural uses such as odour may also periodically affect parts of the site.

1.7 TYPICAL LOCAL CLIMATE AND RAINFALL

The local area climate is characterised as a mild Mediterranean climate with cool wet winter and generally hot summer with cooling afternoon sea breezes. The key data is as follows:

Summer	-Mean Daily Maximum Temperature	29.5 oC
	-Mean Daily Minimum Temperature	13.8 oC
	-Maximum Temperature	41.0 oC
Winter	-Mean Daily Maximum Temperature	17.4 oC
	-Mean Daily Minimum Temperature	7.2 oC
	-Minimum Temperature	-1.0 oC

Monthy Rainfall (millimetres)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10.8	3.1	16.0	35.4	104.7	128.8	131.2	104.1	79.0	29.8	24.6	9.0

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1.8 SITE TOPOGRAPHY

The site is relatively flat and low lying. Natural surface elevation ranges from 3.5mAHD in the north increasing to approximately 8mAHD in the south of the site.

1.9 SITE WATER RESOURCES

Existing groundwater is generally high compared to the existing ground level. This may impact on footings, structural location, vegetation types and species success. High variation in existing groundwater must be considered in detail (while allowing for development pressures) during design to ensure an optimum outcome.

The existence of the groundwater and stream flows provide an opportunity to reinforce the presence of the natural system within the design of the estate. The journey along the water corridor becomes one of the key design elements for the development.

There are six dampland areas within the site that are classified as Multiple Use Wetlands. A portion of one of the damplands has also been identified as an EPP Wetland.

The existence of the groundwater and stream flows provide an opportunity to reinforce the presence of the natural system within the design of the estate. The journey along the water corridor becomes one of the key design elements for the development.

1.10 Existing Site Vegetation

There are only two significant remnants of native vegetation that remain within the site since a significant portion of the area has been cleared for past grazing and mineral sand mining. Retention of this resource is highly desirable and work should allow opportunities to enhance the existing vegetation. These remnants of native vegetation include:

- an area approximately 4.5ha remnant Peppermint (Agonis flexuosa) Low Closed Forest with scattered Marri (Corymbia calophylla) located on the north-eastern boundary of Lot 9003.
- An area approximately 2ha remnant Tuart (Eucaptus gomphocephala) and Peppermint (A.flexuosa)Tall Woodland located in the centre of Lot 202.

Although the majority of the remaining project area has been cleared scattered Marri, Peppermint and Tuart trees exist on site. The EPP wetland, located in the north-eastern corner of Lot 2, is associated with scattered Paperbark (Melaleuca rhaphiophylla).

1.11 EXISTING SITE FAUNA

Surveys of the remnant vegetation areas have identified habitats for the Western Ringtail Possum, along with the existence of the Western Grey Kangaroo. Measures are in place to accommodate for the native fauna, with all site work needing to comply with the Western Ringtail Possum Management Plan and Western Grey Kangaroo Management Plan.

1.12 KEY SITE ASSET SUMMARY LIST

The following key assets and elements are evident upon examination of the existing site. These elements should be considered, promoted and integrated into the design process to best ensure success of the project, meshing new design in with existing retained site elements and minimised cost in recreation of existing assets. Key site assets include;

- Ease of main access off the Busselton Bypass
- Retained in tact bushland and habitat areas
- Retained significant individual trees
- Retained site dams from past rural uses
- Retained and protected creek lines and drainage corridors
- Western Ringtail Possum habitat / access corridor
- Seasonally high groundwater levels may require use and or mitigation

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1.13 KEY POINTS & OPPORTUNITIES

The following key points summarise inherent site opportunities and the projects intent. These points form the basis of the projects design brief and are to be referenced and considered when embarking on future design processes.

1. Retain and protect existing stands of intact vegetation
2. Retain and protect existing significant trees in desirable locations
3. Maximise exposure to the site entry off the Busselton Bypass
4. Maximise pedestrian linkages throughout the development, particularly to significant attractants including shops, town centre, schools and similar.
5. Maximise legibility of planning layout and access through the road hierarchy
6. Provide shade, shelter and respite from the effects of the south west seasons
7. Provide a wide range of recreational options and locations for residents
8. Provide areas of informal open space
9. Define and highlight existing open water bodies
10. Utilise open space to accommodate drainage and water quality improvements
11. Maximise opportunities for safe ringtail possum movement through natural areas
12. Provide interpretive material reflective of the local environment and ecology
13. Maximise integrated planting approach between historic, cultural and native plantings
14. Ensure the agreed design approach extends through many elements and materials
15. Ensure all works proposed are compliant and consistent with the required Bush fire Mangement Plan

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2.0 GUIDING LANDSCAPE PRINCIPLES

2.1 LANDSCAPE AIM

To create a sustainable community and a place that is derived from the local areas history, culture, commerce and ecology which resonates with residents and visitors as local, desirable, legible and true.

2.2 LANDSCAPE OBJECTIVES

The following objectives have been determined to support the above aim at various levels.

- To support the existing and nuture the creation of a new community through provision of facilities, places, spaces, character and elements appropriate to the communities views and needs.
- To engende a community with an aspirational and self reliant outlook and a sense of ownership based on quality planning and design,
- To balance or improve upon existing site environmental qualities following development,
- The creation of this place is to be demonstrated and supported through all facets of the landscape across all effected disciplines to best ensure design harmony across responsibilities.
- To ensure the ongoing delivery of quality design and construction outcomes based on rigorous thought, process, selection and detailing.
- To maximise the use of sustainability principles and measurable outcomes

3.0 LANDSCAPE CHARACTER

3.1 GUIDING CHARACTER

The guiding character of the projects landscape elements and overall theme is based on a fusion of French provincial character and the existing south west rural character.

It is proposed that both of these background themes are similar in many respects pertaining to detail, materials, scale, form and both convey a relaxed and informal character. This is in part reflective of the local southwest semi-rural outdoor and vineyard culture and also draws on historic themes via French explorers and remnant French influences and naming that exists across southwest Western Australia. Vestiges of former rural uses and materials are evident in both the provincial and southwest landscapes and built form.

It is therefore proposed that the base French provincial character is not in conflict with the broad aims of the local authority and is not alien to the local southwest area or its residents. It is also proposed that this provincial theme will build upon reinforcing the local areas existing relaxed rural appeal to current and new residents. The proposed preferred theme is conveyed here forward by this document and its contents.

3.2 LANDSCAPE CHARACTER

The character of public open space is proposed to be expressed through the following elements;

- Landform and contouring to reflect a rolling rural landscape,
- Planting to reflect past cultural and rural uses,
- Planting to embrace the local environment,
- Recreational uses in communal and human scaled spaces,
- Domestic elements eg; pots and urns which convey a pedestrian scale and resemble a private garden in content and character,
- Informal elements with a clear functional design basis,
- Finishes that are indicative of continued and historic use,
- Rammed earth in rich colour tones,
- Limestone coloured rough textured render,
- Natural limestone cladding in random pattern,
- Precast concrete block set in a stone look,
- Precast concrete cobbles in various sizes and earthy colours,
- Wrought Iron look detailing and highlights,
- Galvanised permeable metal fencing with detail highlights in neutral colours,
- Thick local timber framing in feature locations,

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3.3 FORM & ELEMENTS

The form and scale of various landscape elements is influenced by and builds upon the guiding character as outlined above. Various forms and elements are to be characterised by;

- Thick set posts or ornate light structures,
- Heavy set and grounded elements,
- Landmark elements,
- Informal edges or trimmed edges with informal infill,
- Small openings,
- Earthy tones with highlight colours,
- Robust and Solid Materials,
- Weathered, rumbled and rustic finishes,
- Oversized wall and plinth widths

3.4 GUIDING MATERIALS

The following material selection recommendations are made reflecting the inspiration of the guiding character as outlined previously.

Recommended material design selections may include;

- Limestone coloured rough textured render
- Natural limestone and Donnybrook stone cladding in random mosaic pattern
- Rough sawn and recycled oversize hardwood timbers
- Precast concrete block set in a stone look
- Precast concrete cobbles in various sizes and earthy colours
- Precast concrete sleepers in various sizes and earthy colours
- Wrought Iron look detailing and highlights
- Galvanised permeable metal fencing with detail highlights in neutral colours
- Natural stone in highlight locations
- Galvanised metal shutters with neutral coloured finish
- Brushwood screen fencing in long runs or feature locations
- Corrugated Steel in agreed locations
- Granite cobble sets - subject to budget

Refer attached 'Provence 1: Residential Subdivision Part 2 - Landscape Character & Material Palette' for detail information on material and landscape palette selections.

4.0 PUBLIC OPEN SPACE

4.1 INTENT

Public open space is the focal point for the developments creation of character, community gathering and activities, informal recreation, habitat, public facilities, visual relief and urban softening. Refer Appendix A 'Provence - Landscape Strategy Plan' Revision N dated February 2020.

4.2 LOCATION & DISTRIBUTION

The location of public open space can demonstrate and highlight the lifestyle and character of the development on offer. Distribution and sizing of public open space is determined by broad town planning principles and various approvals as evident in the current attached master plan.

4.3 POS FOCAL POINTS & AXIS VIEWS

Open space should aim to locate and display popular various facilities, feature elements at focal points easily visible from vehicles and by pedestrians and cyclists. This maximises marketing return for budgets spent, provides passive surveillance, clearly conveys the facilities available.

4.4 LIFESTYLE & FACILITIES

Various facilities proposed for creation within the public realm may include;

- Adventure level playgrounds
- Discovery and learning playgrounds
- Shelters and Arbors
- Viewing platforms
- BBQs and gathering spaces
- Boardwalks
- Integrated path systems
- Feature lighting
- Security and safety lighting
- Informal open recreation spaces
- Fitness trails
- Smaller contemplative spaces
- Interpretive signage
- Public art

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4.5 PUBLIC OPEN SPACE CATEGORIES

The West Australian Planning Commission document 'Liveable Neighbourhoods: A Western Australian Government Sustainable City Initiative' published in January 2009 provides a basic definition for the categorisation of public open space areas broadly based on size, proximity to dwellings and servicable population. These include:

- Local Parks
- Neighbourhood Parks
- District Open Space
- Community Facilities Sites
- Natural Areas and Cultural Features
- Foreshore Reserves and Regional Open Space

The layout and planning for public open space within the Provence residential development has been undertaken in accordance with the Liveable Neighbrouhood Guidelines and subsequently proposes to deliver a series of public open spaces incorporating the above landscape categories.

Further to this, the local government authority City of Busselton uses these POS categories to guide the delivery of public facilities such as turf areas, park furniture, playgrounds, and picnic facilities as well as the subseqent on-going maintenance requirements associated with the upkeep of the public open space areas. The following public open space area descriptions have therefore been organised into the Liveable Neighbourhood public open space categories.

4.6 PUBLIC OPEN SPACE MAINTENANCE

It is a standard process for the local government authority to require a Developer Maintenance Period to establish the various landscape works and elements constructed within the public open space areas prior to the ceding of land to the Crown and all responsibility to be transferred to the local government authority. The City of Busselton have previously required that the developer undertake a 5 year developer maintenance of public open space and streetscapes for completed public open space at Provence. This has also required a Landscape Maintenance Agreement to be developed to guide the maintenance and subsequent handover to the City.

The policy of the City has recently been revised and the developer maintenance period has been reduced to 2 years and provided all conditions and requirements of the Landscape Maintenance Agreement are acheived.

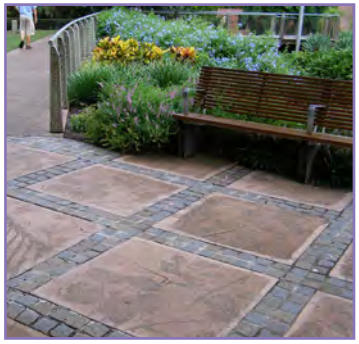

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FIGURE 1 - LANDSCAPE MASTER PLAN

DISTRICT OPEN SPACE

• POS 8	66,245sqm

NEIGHBOURHOOD PARKS

• POS 3	74,190sqm
• POS 9	84,280sqm
• POS 11	13,100sqm
• POS 12	24,260sqm
• POS 14	31,530sqm

LOCAL PARKS

• POS 2	15,345sqm
• POS 6	8,895sqm
• POS 7	16,515sqm
• POS 10	17,840sqm
• POS 13	13,225sqm
• POS 15	6,200sqm
• POS 16	8,590sqm
• POS 17	6,680sqm
• POS 18	10,935sqm

WETLAND & CONSERVATION POS

• POS 1	N/A
• POS 4	61,995sqm
• POS 5	24,585sqm
• POS 19	28,565sqm

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FIGURE 2 - STORMWATER TREATMENT

POS DETENTION STORAGE

	BASIN	1 IN 1 YR	1 IN 5 YR
• POS 1	N/A	0.320Ha	0.660Ha
• POS 2	Existing	-	-
• POS 3	Existing	-	-
• POS 4	Existing	-	-
• POS 9	Existing	1.170Ha	1.340Ha
• POS 17	Existing	-	-
• POS 18	Existing	-	-
• POS 5	C	0.097Ha	0.120Ha
• POS 6	B	0.540Ha	0.600Ha
• POS 7	G	0.520Ha	0.580Ha
• POS 8	D	0.930Ha	1.010Ha
• POS 10	F	0.430Ha	0.480Ha
• POS 11	M	0.380Ha	0.430Ha
• POS 12	L	0.400Ha	0.450Ha
• POS 13	K	0.340Ha	0.390Ha
• POS 14	H	1.440Ha	1.540Ha
• POS 15	J	0.370Ha	0.420Ha
• POS 16	I	0.240Ha	0.280Ha
• POS 19	A	1.800Ha	1.910Ha

DRAINAGE CONSIDERATIONS

Proposed drainage figures are as per JDA Hydrologist Provence: :LWMS. Basin quantities based on basin designs to be 300mm depth with 1 in 6 side slopes. Refer Softscape Typologies for suitable proposed landscape treatments and nominated plant species.

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4.7 POS STRATEGY- DISTRICT OPEN SPACE

4.7.1 Brief Description

POS 8 is the largest and most signficant POS area for the Provence development and has therefore been centrally located between the proposed Village Centre commerical / retail precinct and the proposed Department of Education public Primary School site. Negotiations are required between the Developer, Department of Education and City of Busselton to confrim the various steps for the delivery of this space and its uses and facilities to be provided.

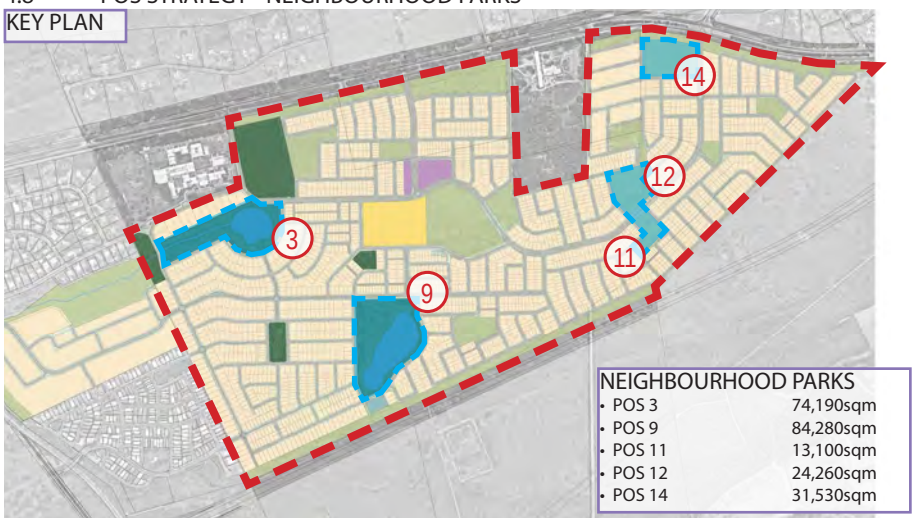
4.7.2 Functions

- Large formalised turf playing fields for organised sports and community events
- Possible clubhouse, changeroom, toilet & kiosk facilities
- Possible inclusion of pump track and/or other sporting uses e.g. hard courts
- Off-street carparking
- Picnic facilities such as BBQ's, picnic settings, shelters and drink fountains
- Play elements for all ages including possible exercise stations
- Maximise shade trees
- Path network connecting to the broader path network
- High level finishes and inclusion of feature planting areas

4.7.3 Environmental Considerations

- Limit planting of feature and exotic species to key nodes and high finish areas
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to the sportsfields and playing surfaces.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.8 POS STRATEGY - NEIGHBOURHOOD PARKS



4.8.1 Brief Description

Located centrally to the development and at a max. 400m walking distance from most dwellings, the Neighbourhood Parks provide residents with more active recreational opportunities as well as picnic, BBQ and play space facilites. The parks have connections internally and a broader network to the surrounding POS areas.

4.8.2 Functions

- Large turf informal kick-about areas and connecting expanses of turf
- POS 3 & POS 9 contain irrigation lakes for storage and treatment of irrigation water source (bore)
- Picnic facilities for family / friend gatherings
- Play elements for all ages including possible exercise stations
- Maximise shade trees
- Mixture of exotic and native waterise planting to reinforce project character & landscape themes
- Path network connecting to the broader path network
- High level finishes limited to feature node and picnic areas
- Drainage basin areas incorporated into POS spaces

4.8.3 Environmental Considerations

- Limit planting of feature and exotic species to key nodes and high finish areas
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to informal turf kick-about areas.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

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4.9 POS STRATEGY- LOCAL PARKS

4.9.1 Brief Description

The Local Parks provide residents with open space in close proximity to their dwellings. The parks have areas of turf for passive play and informal kick-about area with nodes of seating and shelter either provided by trees or built structure. A path network through and around the POS allows footpath connection to surrounding streets and POS areas.

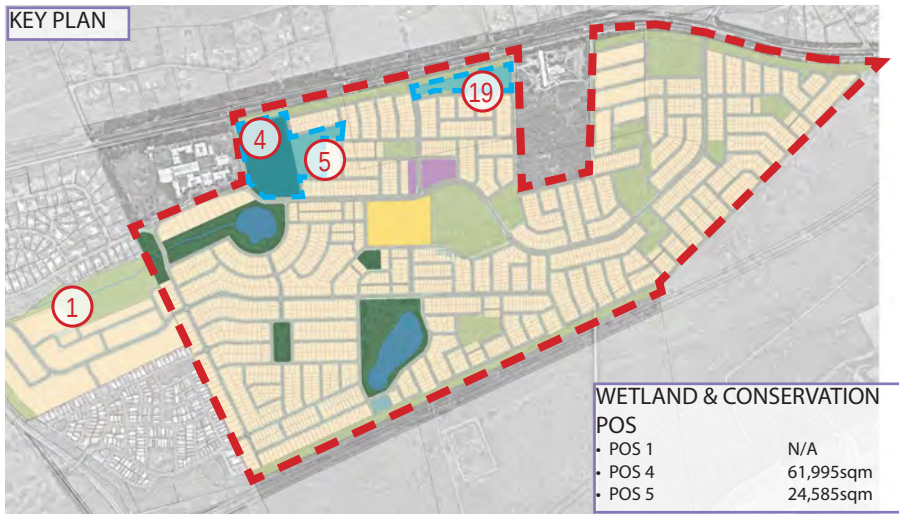
4.9.2 Functions

- Consolidated areas of turf for informal active play
- Internal footpath network
- Path network connecting to broader path networks
- Limited picnic facilities
- Seating nodes and bench seating
- Water wise planting
- Drainage

4.9.3 Environmental Considerations

- Water wise planting
- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to turf areas but garden beds and revegetation areas able to be disconnected once panting is established.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials where possible
- Consider long term maintenance requirements of all materials

4.10 POS STRATEGY - WETLAND & CONSERVATION POS



4.10.1 Brief Description

The Wetland and Conservation POS are located along the northern boundary of the site and contain largely retained existing vegetation identified as being regionally significant or containing protected fauna. They form a larger East-West Rehabilitation Environmental Corridor providing for fauna movement across the project site. Each individual POS must comply with specific management plans relating to vegetation and fauna protection and management.

4.10.2 Functions

- Path networks connecting to the broader path network
- Conservation fencing and gates to control access
- Interpretive signange for education
- Shaded seating nodes
- Maximise shade trees
- Local endemic plant species for revegetation and rehabilitation
- Drainage

4.10.3 Environmental Considerations

- Local endemic waterwise plant species only
- Temporary irrigation considered to assist with establishment of revegetation works and removed after first two summers
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

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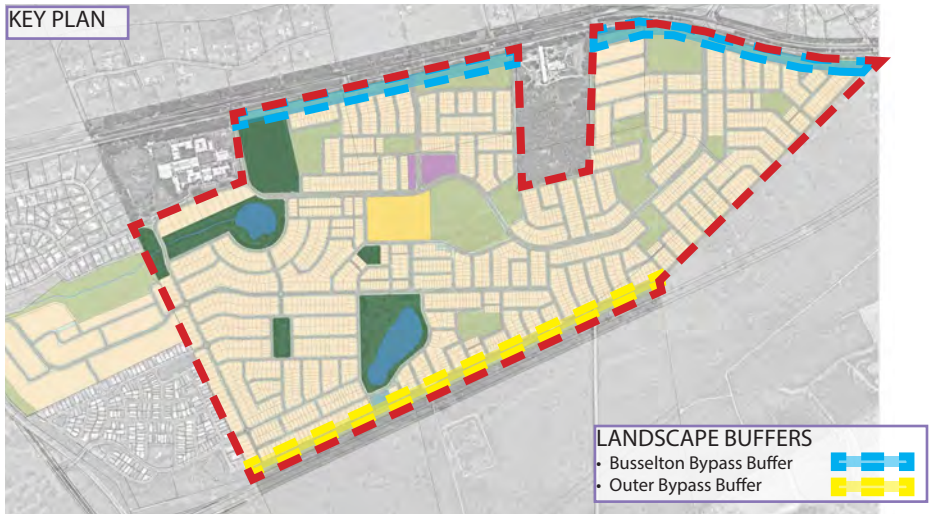
4.11 POS STRATEGY- LANDSCAPE BUFFERS



4.11.1 Brief Description

The Lanscape Buffers are located along the northern and southern boundaries of the site directly adjacent to Busselton Bypass and proposed Busselton Outer Bypass Roads. Varying in width from min. 30m the buffers are located to provide visual screening of the development as well as noise mitigation where required by traffic noise assessments

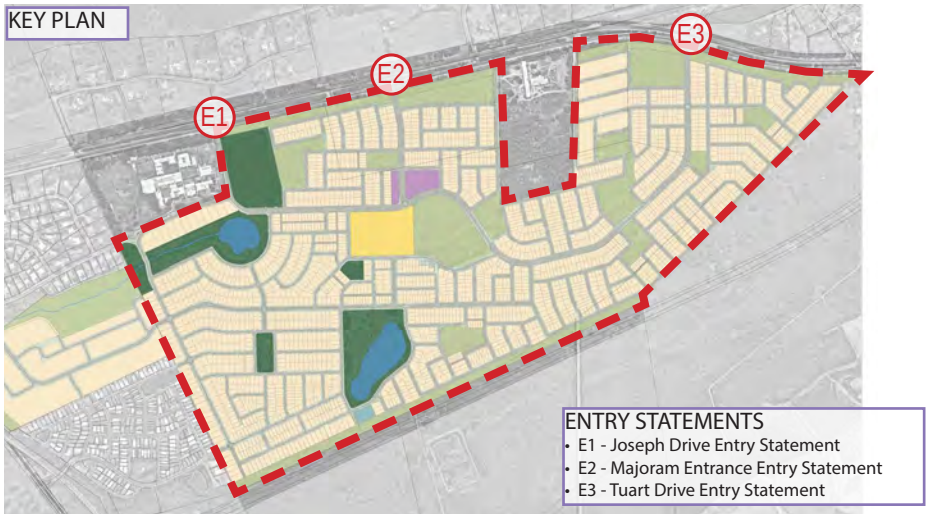
4.11.2 Functions

- Dense layered native vegetation planting for visual screening
- Noise bunds and walls for noise mitigation as may be required
- Fitness path network connecting to the broader path network
- Retain vegetation linkages and connections off-site

4.11.3 Environmental Considerations

- Local endemic waterwise plant species only
- Temporary irrigation considered to assist with establishment of revegetation works and removed after first two summers
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

4.12 POS STRATEGY - ENTRY STATEMENTS



4.12.1 Brief Description

Entry locations to the estate are located along the Busselton Bypass. Existing intersections are proposed to be upgraded to cater for increased traffic volumes & to provide safe access. Feature signage, artwork and landscape treatments are proposed at these key entry locations for way finding, visual queues for residents and visitors. They will also introduce the landscape character and themes being the developments first point of contact.

4.12.2 Functions

- Feature signage, flags and vertical elements
- Artwork and scupltural elements for way finding and visual queues
- Feature walls and retaining walls for signage and elevation
- Mixture of exotic and native planting species to introduce landscape character and themes
- Consolidated turf areas for clear sightlines to signage and traffic clear zones

4.12.3 Environmental Considerations

- Planting design to be zoned according to irrigation requirement, with full irrigation requirements to turf areas but garden beds and revegetation areas able to be disconnected once panting is established.
- All POS landscape works shall be managed as a low threat environment in accordance with bushfire management plan requirements.
- Retain, protect and enhance existing vegetation for fauna habitat
- Source local materials and site mulch where possible
- Consider long term maintenance requirements of all materials

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FIGURE 3 - STREET TREE MASTER PLAN

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5.0 STREETSCAPES

5.1 BOULEVARD ROADS

5.1.1 Brief Description

The Boulevard Roads proposed within the development are the major roads connecting through the estate and projected to carry the highest volumes of traffic. They link the major entry statements off the Busselton Bypass to the Village Centre, District Open Space, School Site and most Neighbourhood Parks. These are to be a key feature of the development with exotic deciduous tree planting to create avenues and materials to reinforce the landscape character and theming where appropriate. A central median is proposed to assist with stormwater management.

5.1.2 Functions

- Typical road reserve widths 24.0m
- Dual use footpaths to verges and formalised crossing points
- Exotic, deciduous avenue tree planting
- Central median with flush kerbing and swale
- Feature planting at intersections and nodes with native rush and sedge planting to central median swale

Refer attached Appendix B - 'Street Tree Masterplan' Revision E dated February 2020 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

5.2 NEIGHBOURHOOD CONNECTORS

5.2.1 Brief Description

The Neighbourhood Connector roads are proposed to link from the Boulevard Roads to carry residents and visitors to the local parks and their homes. Some opportunities for feature planting within verges and key intersections will occur with the tree planting to continue avenues where possible. It is anticpated that the majority of tree planting shall occur within the private lot verges.

5.2.2 Functions

- Typical road reserve width of 18.0m
- Footpaths to verges providing connection to the broader footpath networks
- Mixture of native and exotic tree planting to create avenues or at spacing of one tree per lot
- Feature planting at intersections and nodes

Refer attached Appendix B - 'Street Tree Masterplan' Revision E dated February 2020 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

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5.3 LOCAL STREETS

5.3.1 Brief Description

The local streets provide access to private residents and carry the lowest traffic volumes. The majority of tree planting shall occur adjacent to private lots and form part of the residents private lot landscaping.

5.3.2 Functions

- Typical road reserve width of between 15.0m and 16.0m
- Footpaths to verges providing connection to the broader footpath networks
- Native tree planting to create avenues or at spacing of one tree per lot
- Verge landscaping to be undertaken by private lot owners as part of private lot landscaping packages.

Refer attached Appendix B - 'Street Tree Masterplan' Revision E dated February 2020 for all proposed boulevard tree planting species and Appendix C - 'Typical Road Cross-sections' Revision A dated January 2016 for typical road design options.

6.0 IRRIGATION

An irrigation and water supply to the development has been established with the initial stages of construction works that have been completed since 2004. It is proposed to continue to be extended and upgraded as the development progresses and in accordance with the approved 'Irrigation and Lake Water Management Strategy' Revision 7 dated October 2009 and prepared by Emerge Associates (formerly MNLA). This document can be briefly summarised as follows:

6.1 WATER SOURCE & STORAGE

The development has an existing water source being a Yarragadee Bore. This is currently located to the south of the development land and is required to be relocated into a future public open space area to allow handover and on-going maintenance by the City of Busselton. The bore is currently proposed to be relocated to POS 9 Aurelian Ave Park where it will run through a rip rap system to filter any iron particles from the bore water. It is then transferred to the POS 2 Almond Parkway Lake to be pumped by the existing irrigation pump station to the required POS and streetscape areas.

6.2 WATER LICENCE

The developer has secured a Licence to Take Water from the Department of Water to draw water from the Yarragadee aquifer. This allows 168,300kL per annum to drawn from the aquifer and used for irrigation of up to 23Ha of public open space. The licence is valid until 30 August 2020. Refer attached Appendix D 'Irrigation Strategy Plan' Revision i dated February 2020 and Appendix F 'Provence Irrigation, Water Use and Allocation Schedule' dated February 2020 for a detailed summary of the proposed irrigation requirements of this revised structure plan design.

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7.0 APPENDICES

7.1	Appendix A	Provence - Landscape Strategy Plan, Revision N, dated February 2020
7.2	Appendix B	Provence - Street Tree Masterplan, Revision E, dated February 2020
7.3	Appendix C	Provence - Typical Road Cross-sections, Revision A, dated January 2016
7.3	Appendix D	Provence - Irrigation Strategy Plan, Revision i, dated February 2020
7.3	Appendix E	Provence - Irrigation, Water Use and Allocation Schedule, Revision L, dated February 2020

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7.1 APPENDIX A

Provence - Landscape Strategy Plan, Revision N, dated February 2020

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MIXED DRYLAND & WETLAND SPECIES
Macrozamia reideli - Zamia palm
Caesia micrantha - Pale grass lily
Sowerbaea laxiflora - Purple tassles
Aphelia cyperoides -
Gahnia trifida - Cutting grass/Twine rush
Lepidosperma gracile - Slender sword sedge
Lepidosperma gladiatum - Coast sword sedge
Schoenus grandiflorus - Large flowered bog rush
Schoenus rigens -
Acanthocarpus preissii - Prickly lily
Lomandra micrantha - Small flower mat-rush
Anigozanthos manglesii - Red & green kangaroo paw
Conostylis aculeata - Prickly conostylis
Patersonia occidentalis - Purple flag
Baumea juncea - Bare twig rush
Juncus kraussii - Sea rush
Desmocladus fascicularis -
Desmocladus flexuosus -
Xanthorrhoea gracilis -
Xanthorrhoea preissii - Grass tree
Craspedia variabilis - Billy button
Podotheca angustifolia - Sticky longheads
Crassula colorata -
Hibbertia aurea -
Hibbertia cuneformis - Cutleaf hibbertia
Hibbertia hypericoides - Yellow buttercups
Hibbertia racemosa - Stalked guinea flower
Phyllanthus calycinus - False boronia
Dampiera linearis - Common dampiera
Goodenia micrantha -
Nuytsia floribunda - WA christmas tree
Acacia rostellifera - Stink tree/Summer scented wattle
Acacia saligna - Blue leaf wattle
Agonis flexuosa - WA peppermint
Corymbia calophylla - Marri
Eucalyptus gomphocephala - Tuart
Eucalyptus marginata - Jarrah
Eucalyptus rudis - Flooded gum
Kunzea ericifolia - Spearwood
Melaleuca preissiana - Paperbark/Modong
Melaleuca raphiophylla - Swamp paperbark
Gomphlobium tomentosum - Hairy yellow pea
Hardenbergia comptoniana - Native lilac
Jacksonia sternbergiana - Green stinkwood
Kennedia corinata -
Banksia attenuata - Candle banksia
Banksia grandis - Bull banksia
Banksia littoralis - Swamp banksia
Hakea prostrata -
Persoonia longifolia -
Pimelea rosea -

POS 5- EAST WEST REHABILITATION ENVIRONMENTAL CORRIDOR
EXISTING PARTIALLY COMPLETED POS CATERS FOR INFORMAL OVERLAND DRAINAGE FLOW & POSSUM MOVEMENT CORRIDOR. WEED CONTROL TO EXISTING VEGETATION WITH SUPPLEMENT PLANTING. CONCRETE PATH TO ACT AS EDGE TREATMENT BETWEEN PLANTING TURF EDGES.
76% REVEGETATION 6% DRAINAGE
8% UN-IRRIGATED

POS 4 - JOSEPH DRV CONSERVATION PARK
REMNANT BUSHLAND TO BE RETAINED & PROTECTED. 100% NATIVE PLANTING AREA WITHIN POS. SELECT UNDERSTOREY REHABILITATION TO BE UNDERTAKEN WITH CONTROL OF EXOTIC WEEDS AND PLANTING OF MIXED DRYLAND SPECIES. CONCRETE PATH TO ACT AS BARRIER BETWEEN PLANTING AND GRASS EDGE, TO PERIMETER OF RESERVE ONLY.
4% PLANTING BED 90% REVEGETATION
0% DRAINAGE 6% UN-IRRIGATED

REHABILITATION ENVIRONMENTAL CORRIDOR
CATERS FOR INFORMAL OVERLAND DRAINAGE FLOW & POSSUM MOVEMENT CORRIDOR. WEED CONTROL TO EXISTING VEGETATION WITH SUPPLEMENT PLANTING. CONCRETE PATH TO ACT AS EDGE TREATMENT BETWEEN PLANTING TURF EDGES.
100% REVEGETATION

POS 2 -HAWKER APPROACH POS
SEMI-FORMAL POS AREA WITH PASSIVE TURF RECREATION SPACE FRONTING ADJACENT ROAD AND REVEGETATION PLANTING TO THE REMAINDER OF THE POS AS AN EXTENSION OF THE EAST-WEST REHABILITATION
21% TURF 0% PLANTING BED
43% REVEGETATION 22% DRAINAGE
14% UN-IRRIGATED

POS 19 - EPP WETLAND POS
THIS WILL BE SUBJECT TO THE DETERMINATION OF BOUNDARIES WITH THE DEPARTMENT OF PARKS & WILDLIFE. REHABILITATION WORKS WILL BE CONTROLLED BY AN AGREED / APPROVED 'WETLAND MANAGEMENT PLAN'. PERIPHERAL AREAS WILL BE TREATED AS 'WETLAND ENHANCEMENT CATEGORY' LAND.
7% TURF 11% PLANTING BED
0% REVEGETATION 74% DRAINAGE
8% UN-IRRIGATED

POS 6
PARK TO CATER FOR BOTH ACTIVE & PASSIVE RECREATION. NO EXISTING TREES ALLOW FOR PREDOMINANTLY TURF & DRAINAGE USES WITH A MIX OF EXOTIC & NATIVE TREES TO ENHANCE THE THEME OF THE ESTATE.
7% TURF 8% PLANTING BED
0% REVEGETATION 39% DRAINAGE
5% UN-IRRIGATED 41% TURF DRAINAGE

POS 13
REMNANT BUSHLAND TO BE RETAINED AND PROTECTED WITH UNDERSTOREY REHABILITATION TO BE UNDERTAKEN WITH PLANTING OF MIXED DRYLAND SPECIES. PASSIVE RECREATION SHALL BE PROVIDED THROUGH MEANDERING PATHWAYS AND SEATING NODES UTILISING EXISTING TREES FOR SHADE
0% TURF 14% PLANTING BED
46% REVEGETATION 35% DRAINAGE
5% UN-IRRIGATED

BUSSELL HIGHWAY LANDSCAPE BUFFER

POS 14
REMNANT BUSHLAND TO BE RETAINED AND PROTECTED WITH UNDERSTOREY REHABILITATION TO BE UNDERTAKEN WITH PLANTING OF MIXED DRYLAND SPECIES. ACTIVE RECREATION TURF AREA TO PROVIDE INFORMAL KICK-ABOUT SPACE IN OPEN AREA WITH CONCRETE PATH SEPERATING TURF & REVEGETATION PLANTING AREAS. PICNIC FACILITIES TO UTILISE SHADE OF EXISTING RETAINED TREES.
15% TURF 6% PLANTING BED
20% REVEGETATION 55% DRAINAGE
4% UN-IRRIGATED

POS 8 - SHARED USE OVAL
PROPOSED SHARED USE OVAL WITH AGREEMENTS TO BE CONFIRMED BETWEEN DEPARTMENT OF EDUCATION, DEVELOPER & CITY OF BUSSELTON AND IN ACCORDANCE WITH RELEVANT DEVELOPER CONTRIBUTIONS SCHEME. POS HAS BEEN LOCATED TO PROVIDE A FOCAL POINT FOR ACTIVITY ADJACENT TO THE PROPOSED TOWN CENTRE WITH BACKDROP OF LARGE RETAINED TUART TREE & WA PEPPERMINT FOREST.
20% SPORTING FIELDS 6% TURF
5% PLANTING BED 45% REVEGETATION
16% DRAINAGE 8% UN-IRRIGATED

POS 16
PARK TO CATER FOR BOTH ACTIVE & PASSIVE RECREATION. NO EXISTING TREES ALLOW FOR PREDOMINANTLY TURF & ACTIVE USES WITH A MIX OF EXOTIC & NATIVE TREES TO ENHANCE THE THEME OF THE ESTATE. POSSIBLE INCLUSION OF PICNIC FACILITIES AND SMALL PLAYGROUND AND THE NORTHERN MOST POS WITHIN THE ESTATE
35% TURF 15% PLANTING BED
8% REVEGETATION 37% DRAINAGE
5% UN-IRRIGATED

BUSSELL HIGHWAY LANDSCAPE BUFFER
BUFFER & BUNDS FOR NOISE ATTENTUATION. BUFFER TO BE PLANTED WITH INDIGENOUS TREES AND SHRUBS. INITIAL RETICULATION MAY OCCUR WITH THE INTENT OF IT BEING DISCONNECTED ONCE PLANTS HAVE ESTABLISHED. PROVIDE CIRCUIT PATH NETWORKS THROUGH THE DEVELOPMENT
95% REVEGETATION 5% UN-IRRIGATED

POS 15
PARK TO CATER FOR BOTH ACTIVE & PASSIVE RECREATION. NO EXISTING TREES ALLOW FOR PREDOMINANTLY TURF & ACTIVE USES WITH A MIX OF EXOTIC & NATIVE TREES TO ENHANCE THE THEME OF THE ESTATE.
0% TURF 12% PLANTING BED
0% REVEGETATION 82% DRAINAGE
5% UN-IRRIGATED

POS 12
REMNANT BUSHLAND TO BE RETAINED AND PROTECTED WITH UNDERSTOREY REHABILITATION TO BE UNDERTAKEN WITH PLANTING OF MIXED DRYLAND SPECIES. ACTIVE RECREATION TURF AREA TO FRONT ONTO ADJACENT BOULEVARD ROAD. PICNIC & PLAY FACILITIES TO UTILISE SHADE OF EXISTING RETAINED TREES.
57% TURF 10% PLANTING BED
4% REVEGETATION 22% DRAINAGE
10% UN-IRRIGATED

POS 11
REMNANT BUSHLAND TO BE RETAINED AND PROTECTED WITH UNDERSTOREY REHABILITATION TO BE UNDERTAKEN WITH PLANTING OF MIXED DRYLAND SPECIES. PASSIVE RECREATION TURF AREA TO FRONT ONTO ADJACENT BOULEVARD ROAD WITH MEANDERING FOOTPATHS LINKING THROUGH PLANTING & REVEGETATION AREAS TO THE EAST & WEST EXTENTS OF THE POS.
22% TURF 10% PLANTING BED
18% REVEGETATION 40% DRAINAGE
10% UN-IRRIGATED

OUTER BYPASS LANDSCAPE BUFFER

POS 7
REMNANT BUSHLAND TO BE RETAINED AND PROTECTED WITH UNDERSTOREY PLANTING OF MIXED DRYLAND SPECIES. ACTIVE RECREATION TURF AREA TO FRONT ONTO ADJACENT BOULEVARD ROAD WITH MEANDERING FOOTPATH PROVIDING SEPARATION OF TURF FROM REVEGETATION AREAS.
47% TURF 8% PLANTING BED
0% REVEGETATION 40% DRAINAGE
5% UN-IRRIGATED

POS 17 - STAGE 10 LAVENDER PARK
EXISTING POS WITH EXISTING VEGETATION RETAINED THROUGHOUT AND ENHANCED WITH NATIVE UNDERSTOREY PLANTING. FEATURE SHELTER, PLAYGROUND AND PARK FURNITURE PROVIDED. CONCRETE PATH TO ACT AS A BARRIER BETWEEN PLANTING & GRASS AREAS.
36% TURF 11% PLANTING BED
33% REVEGETATION 0% DRAINAGE
20% UN-IRRIGATED

OUTER BYPASS LANDSCAPE BUFFER
LANDSCAPE BUFFER & BUNDS FOR NOISE ATTENTUATION. BUFFER TO BE PLANTED WITH INDIGENOUS TREES AND SHRUBS. INITIAL RETICULATION MAY OCCUR WITH THE INTENT OF IT BEING DISCONNECTED ONCE PLANTS HAVE ESTABLISHED. MAY ALSO INCLUDE A CONCRETE FOOTPATH TO PROVIDE CIRCUIT PATH NETWORKS THROUGH THE DEVELOPMENT
95% REVEGETATION 5% UN-IRRIGATED

POS 10
EXISTING VEGETATION TO BE RETAINED AND ENHANCED WITH UNDERSTOREY PLANTING TO COMPLIMENT THE LOW LYING MELALEUCA WETLAND VEGETATION. PRIMARILY PLANTING & PASSIVE TURF ZONES TO PROVIDE BUSHFIRE SETBACKS. MEANDERING FOOTPATHS AND SEATING NODES PROVIDING PASSIVE RECREATION OPPORTUNITIES.
37% TURF 8% PLANTING BED
0% REVEGETATION 40% DRAINAGE
5% UN-IRRIGATED

NATIVE SPECIES
TREES
Hakea laurina - Pincushion Hakea
Eucalyptus gomphocephala - Tuart
Eucalyptus decipiens - Limestone marlock
Banksia attenuata - Candle banksia
Banksia menziesii - Firewood banksia
Banksia grandis - Bull banksia
Casuarina fraseriana - Sheoak
Agonis flexuosa - W.A. Peppermint
Eucalyptus marginata - Jarrah
SHRUBS & GROUNDCOVERS
Jacksonia furcellata - Grey stinkwood
Jacksonia sternbergiana - Green stinkwood
Acacia cyclops - Red-eyed wattle
Acacia cyanophylla - Golden-wreath wattle
Hakea glabella - Tiny star
Xanthorrhoea preissii - Grasstree
Macrozamia reidlei - Zamia palm
Acacia pulchella - Prickly moses
Melaleuca acerosa - Coastal honeymyrtle
Hibbertia spp.
Hibbertia racemosa - Stalked guinea flower
Casuarina humilis - Dwarf sheoak
Petrophila linearis - Pixie mops
Grevillea thelmanniana - Gilt dragon
Dryandra nivea - Couch honeypot
Dianella revoluta - Little Rev
Dianella tasmanica - Tasman flax-lily
Calothamnus quadrifidus - One sided bottlebrush
Leucopogon parviflorus - Coast beard-heath
Hemiandra pungens - Snakebush
Conospermum triplinervium - Smokebush
Conospermum stoechadis - Common smokebush
Hovea trisperma - Common hovea
Beaufortia squarrosa - Sand bottlebrush
Melaleuca huegelli - Chenille honey myrtle
Sollya heterophylla - W.A. bluebell
Templetonia retusa - Cockies tongue
Verticardia grandifolia - Claw feather flower
Westringia fruticosa - Native rosemary
Kennedia prostrata - Running postman
Hardenbergia comptoniana - Native wisteria
Muehlenbeckia adpressa - Climbing lignum
Callistemon 'Little John' - Dwarf bottlebrush
Grevillea olivacea - Olive grevillea
Kniphofia hybrids - Red hot poker
Lomandra longifolia - Spiny-headed Mat-rush

POS 3 - STAGE 1 ALMOND PARKWAY LAKE POS
SEMI-FORMAL LAYOUT TO NEW CENTRAL LAKE PUBLIC OPEN SPACE ON VIEW AXIS FROM MAIN ENTRY BOULEVARD. FEATURE POS CONTAINS A FEATURE LAKE THAT WILL BE UTILISED TO ATTENUATE STORMWATER WILL TRAVERSE BIO-RETENTION SWALES PRIOR TO DISCHARGE INTO THE LAKE. THE ATTENUATED FLOWS EXITING THE LAKE WILL FLOW WESTWARDS VIA A RECONSTRUCTED SWALE INTO AN EXISTING SWALE ADAJCENT BLUM BOULEVARD.
25% WATERBODY 22% TURF
30% PLANTING BED 7% REVEGETATION
7% DRAINAGE 9% UN-IRRIGATED

POS 18 - STAGE 3 AVIGNON PARK
FORMAL MANICURED PUBLIC OPEN SPACE AT END AXIS ROAD WITH PLAYGROUND & SHELTER
50% PASSIVE RECREATION
50% INFORMAL ACTIVE RECREATION
26% TURF 30% PLANTING BED
0% REVEGETATION 30% DRAINAGE
14% UN-IRRIGATED

WETLAND & REHABILITATION SPECIES
TREES
Acacia saligna - Orange wattle
Agonis flexuosa - W.A. Peppermint
Banksia littoralis - Swamp banksia
Eucalytus rudis - Flooded gum
Melaleuca raphiophylla - Paperbark
Melaleuca preissiana - Stout paperbark
Melaleuca hamulosa - Broom bush honeymyrtle
Melaleuca incana - Grey honeymyrtle
Melaleuca uncinata - Broom brush
SHRUBS & GROUNDCOVERS
Baumea juncea - Bare twig rush
Baumea articulata - Jointed twig rush
Gahnia trifida - Coast saw-sedge
Isolepsis nodosa - Club rush
Juncus kraussii - Sea rush
Lepidosperma effusum - Spreading sword sedge
Lepidosperma longitudinale - Pithy sword sedge
Lobelia alata - Angled lobelia
Pimelea sauveolens - Scented banjine
Sarcocornia blackiana - Samphire

EXOTIC SPECIES
TREES
Betula pendula - Silver Birch
Lagerstroemia indica - Crepe myrtle
Pyrus ussuriens - Manchurian pear
Populus simonii - Poplar (non suckering species)
Plantanus acerifolia - London plane tree
Acer negundo - Boxelder
SHRUBS
Viburnum odoratissimum - Honeysuckle
Syzygium paniculatum - Magenta cherry
Lavendula stoechas - Lavender
Carex petriei - Sedge
Lavendula dentata - French Lavender
Lomandra tanika - Fine Leaf Dwarf Longifolia
Rosmarinus species - Rosmary
Buxus sempervirens - American boxwood
Argyranthemum 'Hybrid cultivars' - Marguerite daisy

LAKE SPECIES
TREES
Melaleuca cuticularis - Broad leaved paperbark
Melaleuca rhaphiophylla - Swamp paperbark
EMERGENT WATERPLANTS
Baumea juncea - Bare twig rush
Baumea rubiginosa - Jointed twig rush
Bolboschoenus coldwellii - Marsh club rush
Carex appressa - Tall sedge
Carex fascicularis - Tassel sedge
Cladium procerum - Leafy twig sedge
Eleocharis acuta - Common spikebush
Eleocharis sphacelata - Tall spikebush
Juncus aridicola - Tussock rush
Juncus kraussii - Sea rush
Lepidosperma longitudinale - Pithy sword sedge
Triglochin striatum - Streaked arrow grass

SEWER PUMP STATION

OUTER BYPASS LANDSCAPE BUFFER

POS 9 - STAGE 9 AURELIAN AVE PARK
EXISTING WATERBODY TO REMAIN FOR IRRIGATION & STORMWATER STORAGE AND TREATMENT. ACTIVE INFORMAL TURF AREAS FOR KICK-ABOUT & DOG EXERCISE WITH PICNIC FACILITIES,SHELTER & POSSIBLE PLAYGROUND FACILITIES PROVIDED. FEATURE PLANTING BEDS AT ROAD, FOOTPATH AND LAKE EDGES WITH NATIVE REVEGETATION SPECIES TO THE REMAINING POS AREAS & DRAINAGE BASINS. EXISTING TREES TO BE RETAINED WHERE POSSIBLE.
40% WATERBODY 24% TURF
8% PLANTING BED 8% REVEGETATION
17% DRAINAGE 3% UN-IRRIGATED

LEGEND
EXISTING CONSTRUCTED LOTS
PROPOSED FUTURE LOTS
FUTURE PUBLIC OPEN SPACE
EXISTING PUBLIC OPEN SPACE
PROPOSED COMMERCIAL SITE
PROPOSED SCHOOL SITE
SEWER PUMP STATION SITE
WATERBODY
SITE BOUNDARY
IRRIGATION BORE
PROPOSED ENTRY STATEMENT

GENERAL NOTES:
1. TO BE READ IN CONJUNCTION WITH THE DGP FOR AIRPORT NORTH YALYALUP AND THE LAND ADOPTED PURSUANT TO AMENDMENT 83 TO DTPS 20.

2. A FORMAL ALKE AND ENVIRONMENTAL / DRAINAGE CORRIDOR MANAGMENT PLAN APPROVED BY THE CITY OF BUSSELTON AND DoE IS REQUIRED FOR THE WETLAND AREA. ALL DETAILS RELATING TO THE WETLAND WILL BE CONSIDERED AT THIS TIME.

3. PADDOCK TREES SHALL BE RETAINED WHERE PRACTICAL WITHIN ROAD RESERVE AND PRIVATE LOTS. RETAINED TREES SHALL BE SUBJECT TO FURTHER ASSESSMENT BY PROJECT ENGINEER LIAISON WITH THE CITY OF BUSSELTON

4. THIS PLAN SHALL BE READ IN CONJUNCTION WITH THE DRAINAGE AND NUTRIENT MANAGEMENT PLAN AND THE MOSQUITO MANAGEMENT PLAN.

5. DETAILED MANAGEMENT ASPECTS CAN BE CONSIDERED BY COUNCIL AT SUCH TIME AS THE DETAILED LANDSCAPE PLANS ARE SUBMITTED TO THE CITY FOR APPROVAL PRIOR TO WORKS, OR TO SATISFY A CONDITION OF SUBDIVISION.

6. PLANS IN ACCORDANCE WITH SPECIAL PROVISION 8 IN SCHEDULE 7 OF THE DISTRICT ZONING SCHEME RELATING TO YALYALUP DEVELOPMENT AREA WILL BE PREPARED AND FULFILLED IMMEDIATELY PRIOR TO THE COMPLETION OF ANY BULK EARTHWORKS PROGRAMME FOR DAP 1.

7. THE REQUIREMENTS OF THE MOSQUITO STRATEGY SHALL BE ADDRESSED WITHIN THE RELEVANT DAP SUBMISSION.

8. LANDSCAPING IN AREAS NOT INCLUDING THE ENTRY ROADS, VILLAGE CENTRE AND FEATURE PARKS SHALL PREDOMINANTLY CONSIST OF NATIVE TREES AND UNDERSTOREY. INTRODUCED UNDERSTOREY SPECIES MAY BE USED IN AREAS OF POS WHERE LANDSCAPING IS REQUIRED TO SCREEN FENCING ON PRIVATE LAND ABUTTING THE POS. ALL LANDSCAPE SHOULD BE WATERWISE WITH MINIMAL OR NO IRRIGATION REQUIREMENTS.

9. EXISTING MATURE TREES ARE TO BE RETAINED WITHIN THE PROPOSED PUBLIC OPEN SPACE AREAS DURING CONSTRUCTION WORKS TO THE SPECIFCATION AND SATISFACTION OF THE CITY OF BUSSELTON.

10. PROVISION IS TO BE MADE WITHIN THE WETLAND OR WATERBODY AREAS FOR BIRD HABITAT AND IS TO BE FULFILLED PRIOR TO CLEARANCE OF SUBDIVISION OF ANY STAGE TO THE SPECIFICATION AND SATISFACTION OF THE CITY OF BUSSELTON.

11. DRAINAGE AREAS PROVIDED ARE ESTIMATES ONLY BASED ON INFORMATION PROVIDED BY JDA HYDROLOGY CONSULTANT ON 1ST FEBRUARY 2016 FOR STORAGE OF 1 IN 100 YR RAIN EVENTS

dwg • PRR-01-01
date • February 2020
rev • N
scale • 1:5000 @ A1

0 50 100 150m

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PROVENCE residential estate landscape strategy plan

emerge ASSOCIATES
Integrated Science & Design

7.2 APPENDIX B

Provence - Street Tree Masterplan, Revision E, dated February 2020

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BUSSELL HIGHWAY

BUSSELL HIGHWAY

BUSSELTON OUTER BYPASS

BUSSELTON OUTER BYPASS

NEIGHBOURHOOD CONNECTOR TREE SPECIES

Betula pendula
SILVER BIRCH

PROPOSED -

Hakea laurina
PINCUSHION HAKEA

EXISTING -

PROPOSED -

Agonis flexuosa
WA PEPPERMINT

EXISTING -

PROPOSED -

Pyrus usseriensis
MANCHURIAN PEAR

EXISTING -

PROPOSED -

Melaleuca quinquenerva
BROAD-LEAFED PAPERBARK

EXISTING -

Melaleuca rhaphiophylla
SWAMP PAPERBARK

PROPOSED -

LEGEND

- EXISTING CONSTRUCTED LOTS
- PROPOSED FUTURE LOTS
- EXISTING PUBLIC OPEN SPACE
- PROPOSED PUBLIC OPEN SPACE
- WATERBODY
- PROPOSED COMMERCIAL SITE
- PROPOSED SCHOOL SITE
- SITE BOUNDARY

BOULEVARD ROAD TREE SPECIES

Pyrus usseriensis
MANCHURIAN PEAR

EXISTING -

PROPOSED -

Platanus acerifolia
LONDON PLANE TREE

EXISTING -

Populus simonii fastigata
SIMON'S POPLAR

EXISTING -

PROPOSED -

Betula pendula
SILVER BIRCH

PROPOSED -

LOCAL STREET TREE SPECIES

Melaleuca quinquenerva
BROAD-LEAFED PAPERBARK

EXISTING -

Hakea laurina
PINCUSHION HAKEA

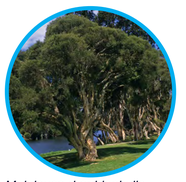
EXISTING -

PROPOSED -

Agonis flexuosa
WA PEPPERMINT

EXISTING -

PROPOSED -



Melaleuca rhaphiophylla
SWAMP PAPERBARK

PROPOSED -

dwg • PRR-03
date • FEB 2020
rev • E
scale • 1:5000 @ A1

0 50 100 150m

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PROVENCE residential estate
street tree masterplan

emerge ASSOCIATES
Integrated Science & Design

7.3 APPENDIX C

Provence - Typical Road Cross-sections, Revision A, dated January 2016

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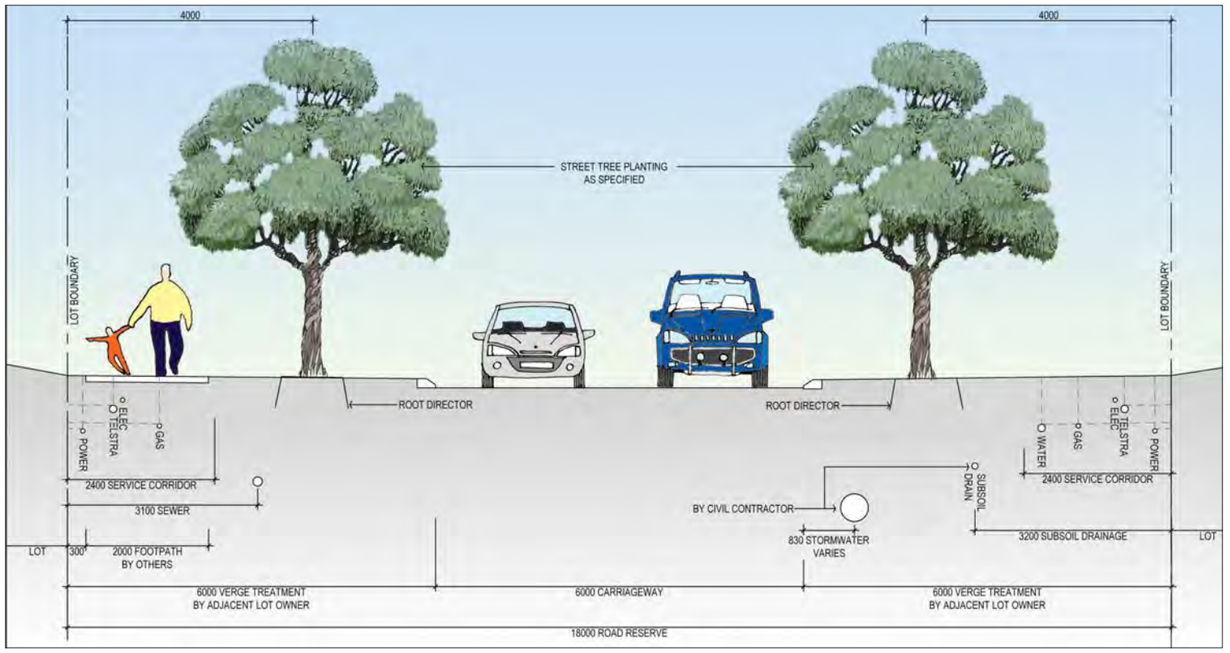

SECTION - TYPICAL 18.0m WIDE ROAD RESERVE

PLAN - TYPICAL 18.0m WIDE ROAD RESERVE

LEGEND

- LOT
- VERGE - BY LOT OWNER
- STREET TREE LOCATION
- ROOT DIRECTOR
- ROAD CARRIGEWAY - BY CIVIL
- FOOTPATH - BY CIVIL

SERVICES

- WATER
- STORMWATER DRAINAGE
- SUBSOIL
- SEWER
- GAS
- ELECTRICAL
- TELSTRA
- POWER

dwg • PRR-01-04
date • january 2016
rev • a
scale • 1:50 @ A1

0 5 10 15 20m

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PROVENCE residential estate
typical road cross-sections

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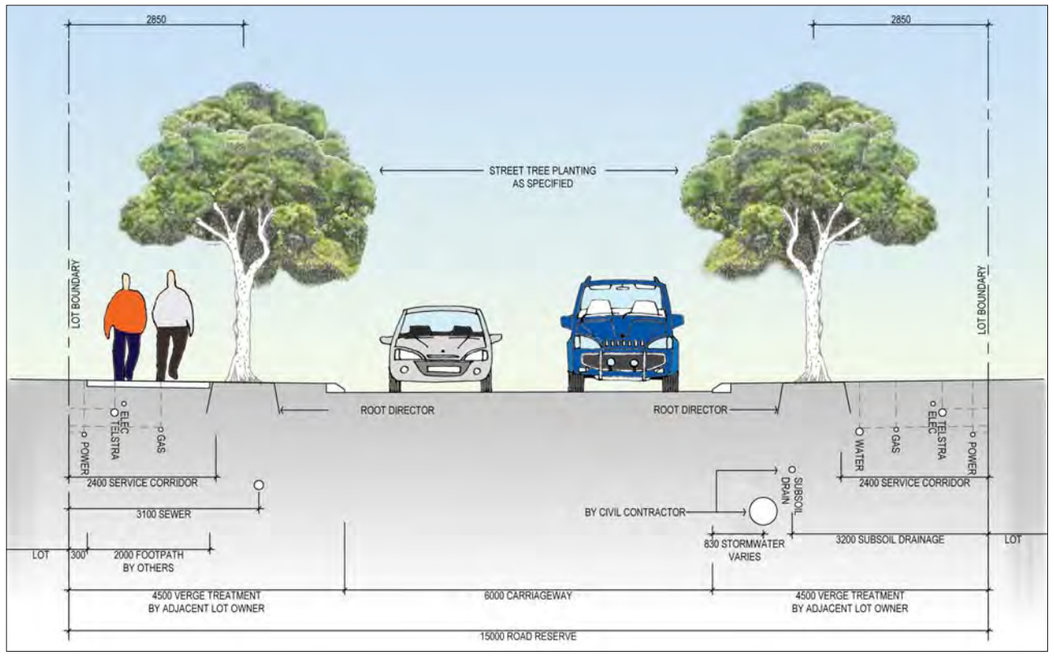
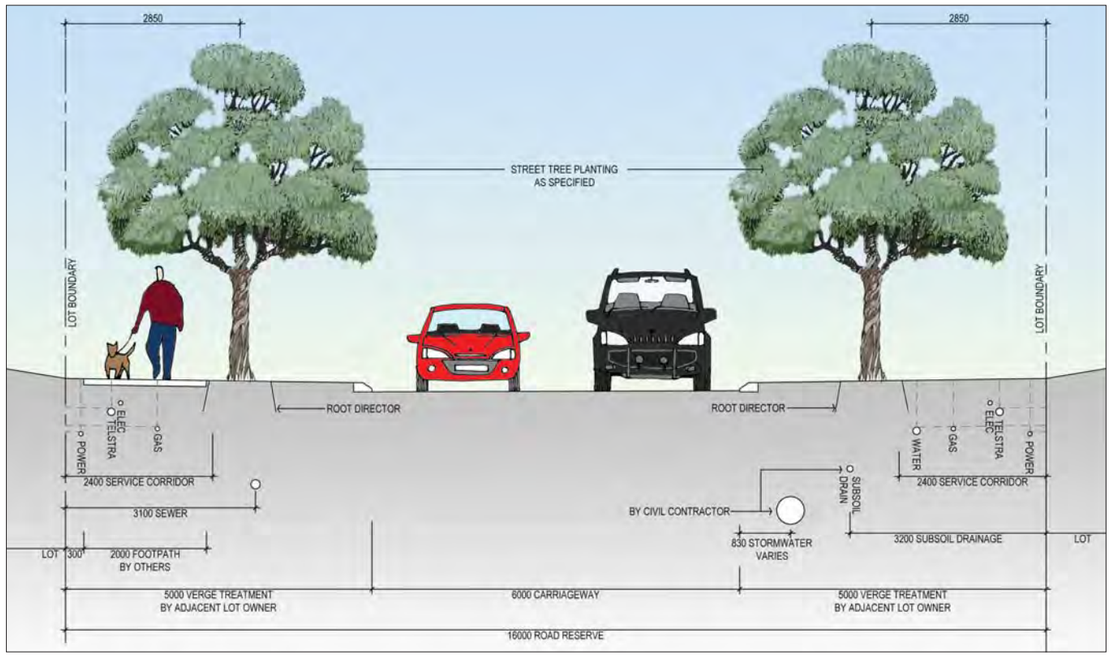
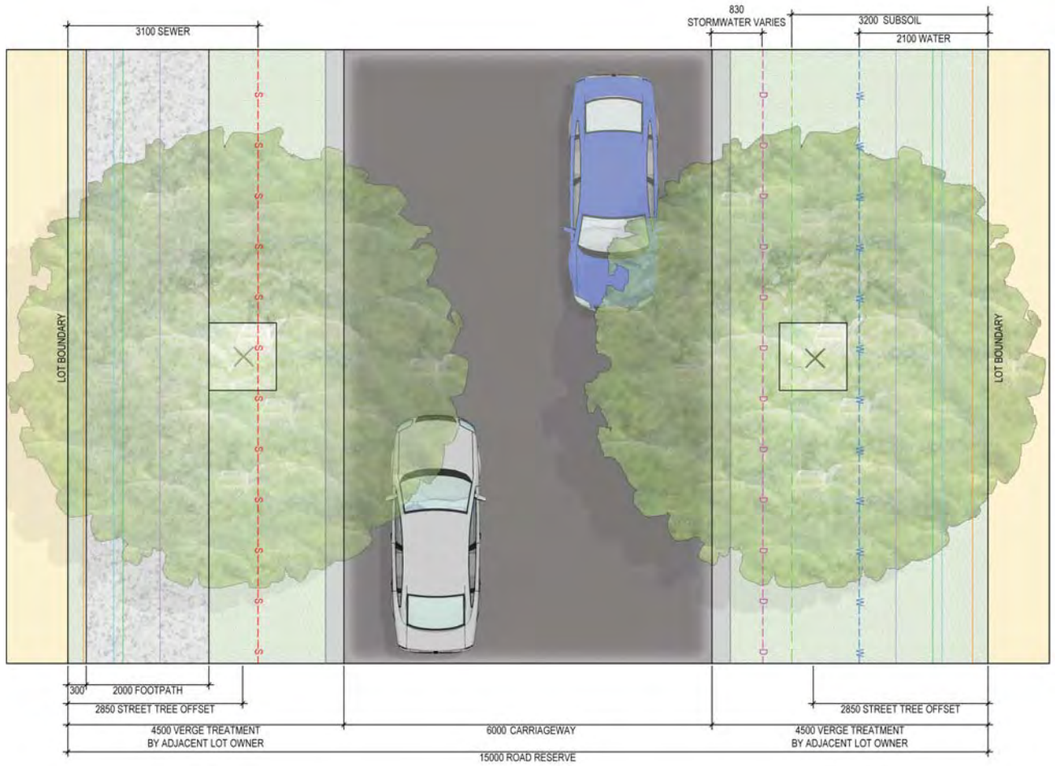


SECTION - TYPICAL 15.0m WIDE ROAD RESERVE



SECTION - TYPICAL 16.0m WIDE ROAD RESERVE



PLAN - TYPICAL 15.0m WIDE ROAD RESERVE

PLAN - TYPICAL 16.0m WIDE ROAD RESERVE

LEGEND

- LOT
- VERGE - BY LOT OWNER
- STREET TREE LOCATION
- ROOT DIRECTOR
- ROAD CARRIGEWAY - BY CIVIL
- FOOTPATH - BY CIVIL

SERVICES

- WATER
- STORMWATER DRAINAGE
- SUBSOIL
- SEWER
- GAS
- ELECTRICAL
- TELSTRA
- POWER

NOTE
TREE PLANTING CAN NOT OCCURE IN ROAD VERGES LESS THEN 6m WIDE WHERE SUBSOIL DRAINAGE IS REQUIRED AT A 3.2m OFFFSET FROM LOT BOUNDARY

dwg • PRR-01-03
date • january 2016
rev • a
scale • 1:50 @ A1

0 0.5 1.00 1.50m

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PROVENCE residential estate
typical road cross-sections

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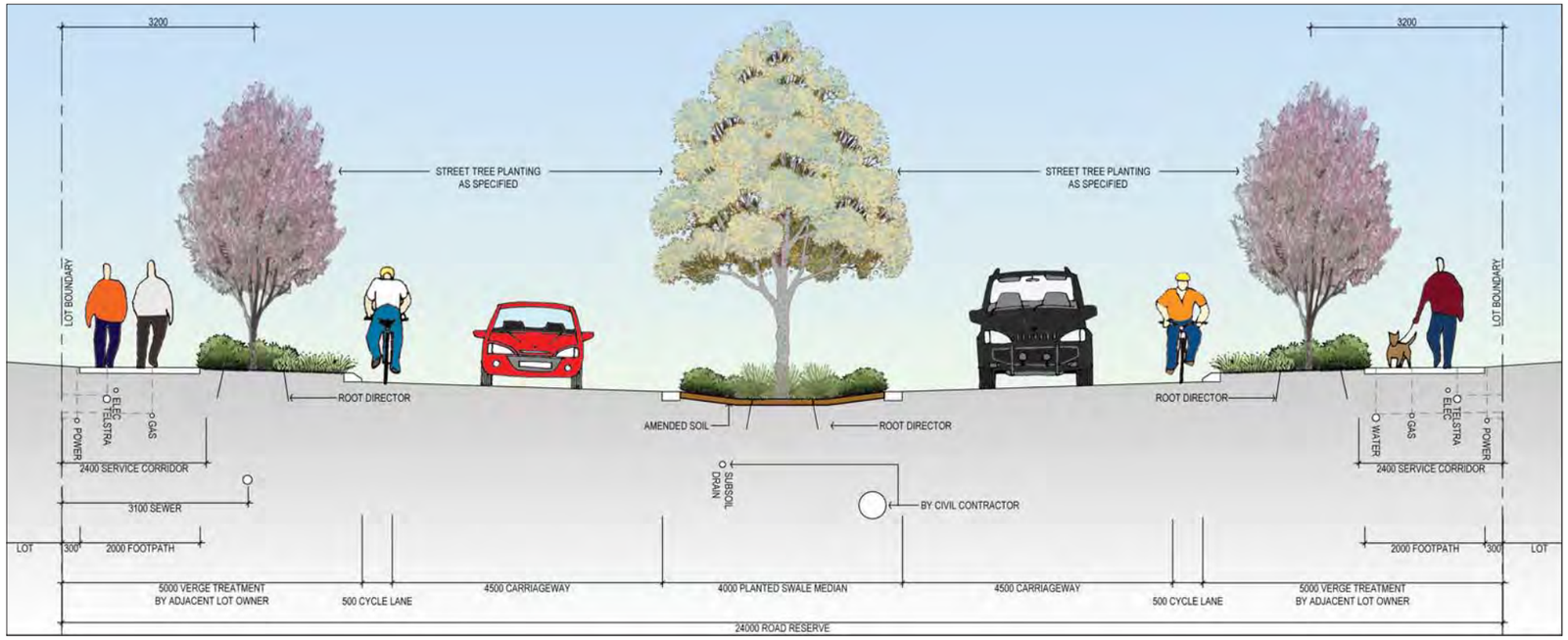
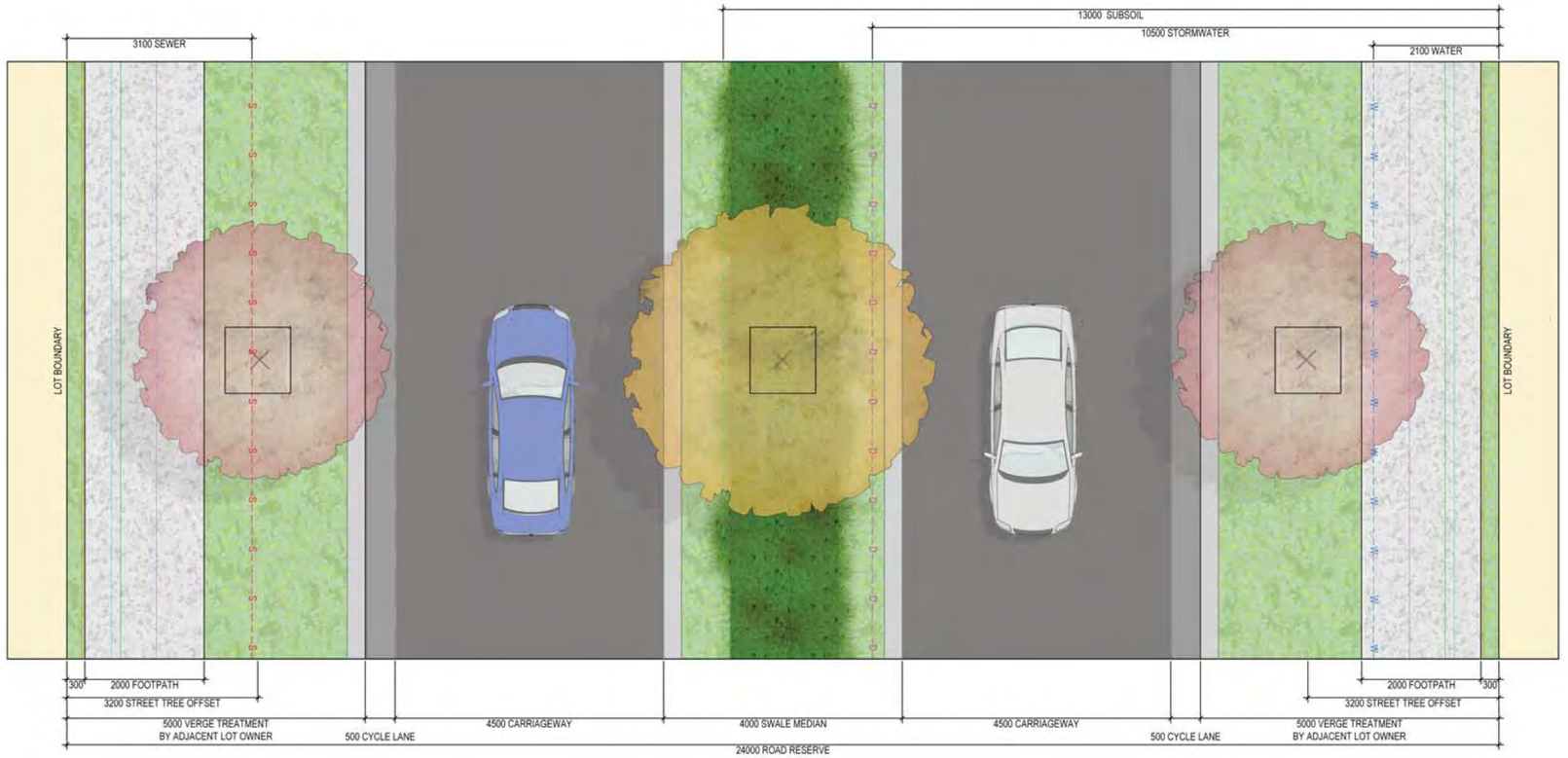


SECTION - TYPICAL 24.0m WIDE ROAD RESERVE



PLAN - TYPICAL 24.0m WIDE ROAD RESERVE

LEGEND

- LOT
- VERGE PLANTING
- MEDIAN SWALE PLANTING
- STREET TREE LOCATION
- ROOT DIRECTOR
- ROAD CARRIGEWAY - BY CIVIL
- FOOTPATH - BY CIVIL

SERVICES

- WATER
- STORMWATER DRAINAGE
- SUBSOIL
- SEWER
- GAS
- ELECTRICAL
- TELSTRA
- POWER

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date • january 2016
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scale • 1:50 @ A1

0 0.5 1.0 1.5m

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PROVENCE residential estate
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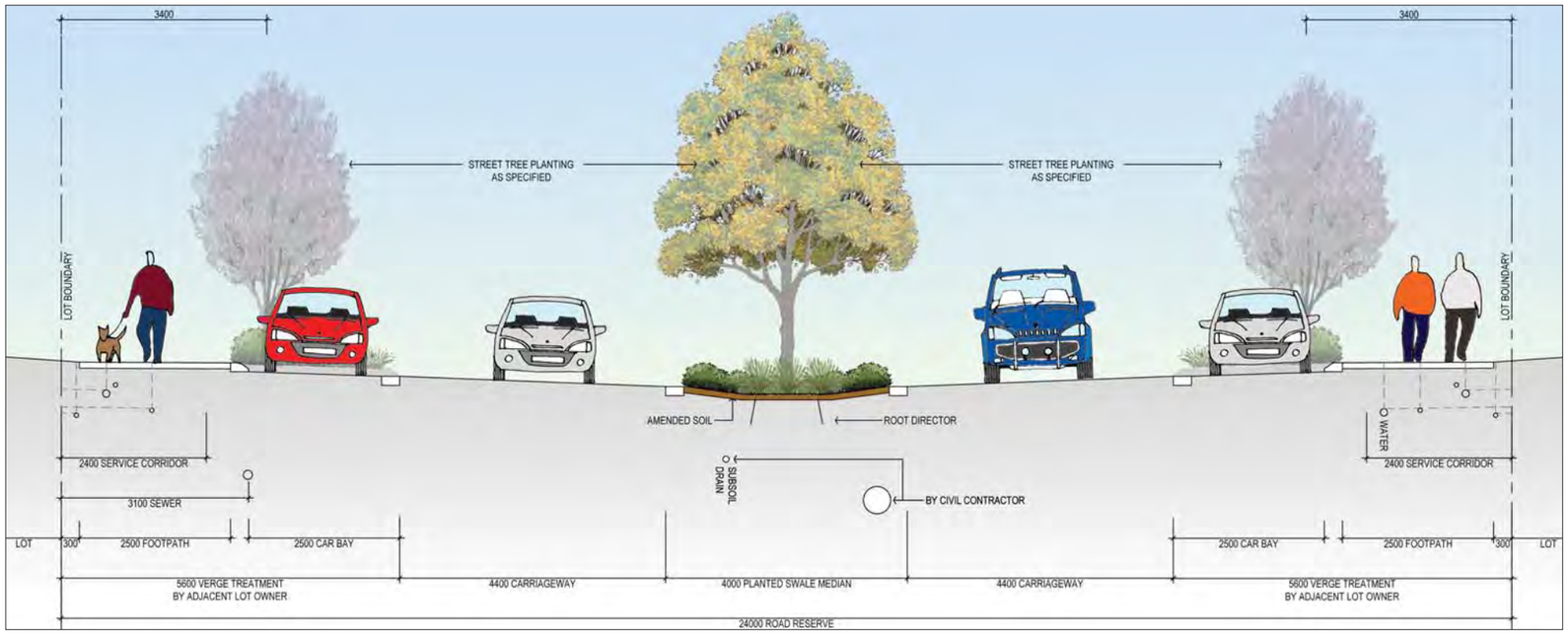

SECTION - TYPICAL 24.0m WIDE ROAD RESERVE WITH PARKING

PLAN - TYPICAL 24.0m WIDE ROAD RESERVE WITH PARKING

LEGEND

- LOT
- VERGE PLANTING
- MEDIAN SWALE PLANTING
- STREET TREE LOCATION
- ROOT DIRECTOR
- ROAD CARRIGEWAY - BY CIVIL
- FOOTPATH - BY CIVIL

SERVICES

- WATER
- STORMWATER DRAINAGE
- SUBSOIL
- SEWER
- GAS
- ELECTRICAL
- TELSTRA
- POWER

dwg • PRR-01-06
date • january 2016
rev • a
scale • 1:50 @ A1

0 0.5 1.00 1.50m

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PROVENCE residential estate
typical road cross-sections

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7.4 APPENDIX D

Irrigation Strategy Plan, Revision i, dated February 2020

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BUSSELL HWY LANDSCAPE BUFFER

POS 19 - EPP WETLAND
POS: 25,940sqm VERGE: 2,625sqm
- Turf: 7% • Planting Bed: 11%
- Revegetation: 0% • Drainage: 74%
- Un-irrigated: 8%

MAJORAM ENTRANCE ENTRY STATEMENT
POS: 3,000sqm VERGE: 500sqm
- Turf: 40% • Planting Bed: 40%
- Revegetation: 10% • Drainage: 0%
- Un-irrigated: 10%

BUSSELL HWY MEDIAN PLANTING
POS: 0sqm VERGE: 5,275sqm
- Revegetation: 54%
- Un-irrigated: 46%

POS 6
POS: 7,525sqm VERGE: 1,370sqm
- Turf: 7% • Planting Bed: 8%
- Revegetation: 0% • Drainage: 39%
- Un-irrigated: 5% • Turf Drainage: 41%

JOSEPH DRV ENTRY STATEMENT
POS: 0sqm VERGE : 11,410sqm
- Turf: 31% • Planting Bed: 11%
- Revegetation: 54% • Drainage: 0%
- Un-irrigated: 4%

POS 4 - JOSEPH DR CONSERVATION PARK
POS: 59,295sqm VERGE: 2,700sqm
- Turf: 0% • Planting Bed: 4%
- Revegetation: 90% • Drainage: 0%
- Un-irrigated: 6%

POS 5 - EAST WEST REHAB. ENVIRO CORRIDOR
POS: 21,925sqm VERGE: 2,660sqm
- Turf: 0% • Planting Bed: 10%
- Revegetation: 76% • Drainage: 6%
- Un-irrigated: 8%

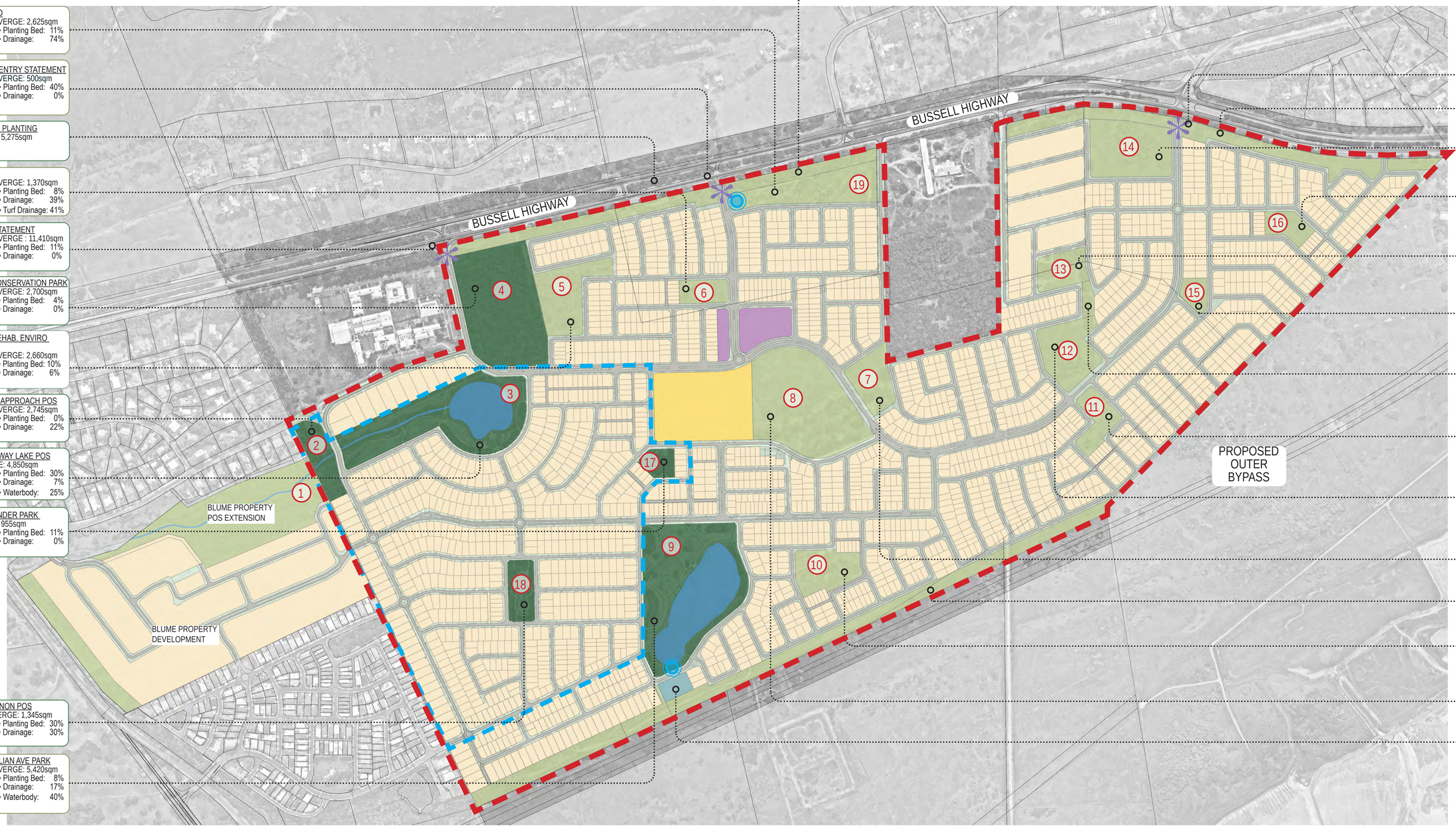
POS 2 - STG1 HAWKER APPROACH POS
POS:12,600sqm VERGE: 2,745sqm
- Turf: 21% • Planting Bed: 0%
- Revegetation: 43% • Drainage: 22%
- Un-irrigated: 14%

POS 3 - ALMOND PARKWAY LAKE POS
POS: 69,340sqm VERGE: 4,850sqm
- Turf: 22% • Planting Bed: 30%
- Revegetation: 7% • Drainage: 7%
- Un-irrigated: 9% • Waterbody: 25%

POS 17 - STG 10 LAVENDER PARK
POS: 5,725sqm VERGE: 955sqm
- Turf: 36% • Planting Bed: 11%
- Revegetation: 33% • Drainage: 0%
- Un-irrigated: 20%

POS 18 - STAGE 3 AVIGNON POS
POS AREA :9,590sqm VERGE: 1,345sqm
- Turf: 26% • Planting Bed: 30%
- Revegetation: 0% • Drainage: 30%
- Un-irrigated: 14%

POS 9 - STAGE 9 AURELIAN AVE PARK
POS: 78,860sqm VERGE: 5,420sqm
- Turf: 24% • Planting Bed: 8%
- Revegetation: 8% • Drainage: 17%
- Un-irrigated: 3% • Waterbody: 40%



TUART DRIVE ENTRY STATEMENT
POS: 3,000sqm VERGE: 500sqm
- Turf: 40% • Planting Bed: 40%
- Revegetation: 10% • Drainage: 0%
- Un-irrigated: 10%

BUSSELL HWY LANDSCAPE BUFFER

POS 14
POS: 29,340sqm VERGE: 2,190sqm
- Turf: 15% • Planting Bed: 6%
- Revegetation: 20% • Drainage: 55%
- Un-irrigated: 4%

POS 16
POS: 7,500sqm VERGE: 1,090sqm
- Turf: 35% • Planting Bed: 15%
- Revegetation: 8% • Drainage: 37%
- Un-irrigated: 5%

POS 13
POS: 11,215sqm VERGE : 2,010sqm
- Turf: 0% • Planting Bed: 14%
- Revegetation: 46% • Drainage: 35%
- Un-irrigated: 5%

POS 15
POS: 5,090sqm VERGE: 1,110sqm
- Turf: 0% • Planting Bed: 12%
- Revegetation: 0% • Drainage: 82%
- Un-irrigated: 6%

POS 12 to 13 LINK
POS: 2,550qm VERGE: 635sqm
- Turf: 0% • Planting Bed: 90%
- Revegetation: 0% • Drainage: 0%
- Un-irrigated: 10%

POS 11
POS: 10,635qm VERGE: 2,465sqm
- Turf: 22% • Planting Bed: 10%
- Revegetation: 18% • Drainage: 40%
- Un-irrigated: 10%

POS 12
POS: 20,745sqm VERGE: 3,515sqm
- Turf: 57% • Planting Bed: 10%
- Revegetation: 4% • Drainage: 22%
- Un-irrigated: 10%

POS 7
POS: 13,845sqm VERGE: 2,670sqm
- Turf: 47% • Planting Bed: 8%
- Revegetation: 0% • Drainage: 40%
- Un-irrigated: 5%

OUTER BYPASS LANDSCAPE BUFFER

POS 10
POS: 15,970qm VERGE: 1,870sqm
- Turf: 37% • Planting Bed: 8%
- Revegetation: 17% • Drainage: 30%
- Un-irrigated: 8%

POS 8
POS: 61,775sqm VERGE: 4,520sqm
- Sportsfield: 20% • Turf: 6%
- Planting Bed: 5% • Revegetation: 45%
- Drainage: 16% • Un-irrigated: 8%

SEWER PUMP STATION

LEGEND

- EXISTING CONSTRUCTED LOTS
- PROPOSED FUTURE LOTS
- PROPOSED COMMERCIAL SITE
- DISTRICT OPEN SPACE
- EXISTING PUBLIC OPEN SPACE
- PROPOSED PUBLIC OPEN SPACE
- SEWER PUMP STATION SITE
- WATERBODY
- PROPOSED SCHOOL SITE
- ENTRY STATEMENT LOCATION
- IRRIGATION BORE
- DEVELOPMENT BOUNDARY
- CITY OF BUSSELTON MANAGEMENT AREA BOUNDARY

MEDIANS & STREETSCAPE UNDER CITY OF BUSSELTON MANAGEMENT
MEDIANS: 5,915sqm VERGE: 5,275sqm
- 118.30kL per week
- 3,549.00 kL per annum

MEDIANS & STREETSCAPES UNDER DEVELOPER MANAGEMENT & FUTURE AREAS
MEDIANS: 0sqm VERGE: 0sqm
- 0kL per week
- 0kL per annum

OUTER BYPASS LANDSCAPE BUFFER
POS: 60,915sqm VERGE: 4,655sqm
- Turf: 0% • Planting Bed: 0%
- Revegetation: 95% • Drainage: 0%
- Un-irrigated: 5% • Waterbody: 0%

BUSSELL HIGHWAY LANDSCAPE BUFFER
POS: 58,220sqm VERGE: 7,290sqm
- Turf: 0% • Planting Bed: 0%
- Revegetation: 95% • Drainage: 0%
- Un-irrigated: 5% • Waterbody: 0%

FEATURE MEDIANS & STREETSCAPES
MEDIANS: 9,590qm VERGE: 0sqm
- 191.80kL per week
- 4,817.20kL per annum

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scale • 1:5000 @ A1

0 50 100 150m

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PROVENCE
residential estate irrigation strategy plan

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7.5 APPENDIX E

Provence - Irrigation, Water Use and Allocation Schedule, Revision L, dated February 2020

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Project: **PROVENCE - IRRIGATION STRATEGY PEAK WATER USE SUMMARY**
Client: East Busselton Pty Ltd
Plan Ref: Irrigation Strategy Plan DWG No. PRR-03 Revision i
Prepared by Emerge Associates
Prepared by: Mel Holland
Date: 26-Feb-20
Revision: **M**

emerge ASSOCIATES
Integrated Science & Design

No	IRRIGATION PEAK WATER USE SUMMARY	FINISH						POS	Verge	TOTAL	Unit	% of	Estimate	Estimate	Estimate	Estimate	Est. Weekly	Unit	Est. Annual	Total
		Turf	Garden	Reveg	Drainage	Hardworks	Waterbody	lot	area	area		Irrigation	Lawn Irrigation	Lawn Irrigation	Garden Irrigation	Garden Irrigation	water		water use	Irrigation
		%	%	%	%	%	%	area					Area sqm	Water kL	Area sqm	Water kL	use			Area sqm
	Public Open Space							469,265	46,745	516,010	sqm		107,286	3,304.77	60,232	1,205	4,509.42	KL	114,689.10	167,518
	Landscape Buffers							119,135	11,945	131,080	sqm		0	0	0	0	0	KL	0	0
	Streetscapes							5,915	9,590	5,915	sqm		0	0.00	5,915	118.30	118.30	KL	8,825.70	5,915
	Entry Statements							6,000	12,410	18,410	sqm		6,337	190.11	4,055	81.10	271.22	KL	6,811.60	10,392
	Lake Evaporation																2,612.80		40,829.80	
	GRAND TOTAL							**600,315**	**80,690**	**671,415**	**sqm**		**113,623**	**3,495**	**70,202**	**1,404**	**7,512**	**KL**	**171,156**	**183,826**

POS / Landscape Works Complete - Managed by Developer
POS / Landscape Works Complete - Managed by City of Busselton
POS Construction commenced or on hold

	LANDSCAPE AREAS	FINISH						POS	Verge	TOTAL	Unit	% of	Estimate	Estimate	Estimate	Estimate	Est. Weekly	Unit	Est. Annual	Total
		Turf	Garden	Reveg	Drainage	Hardworks	Waterbody	lot	area	area		Irrigation	Lawn Irrigation	Lawn Irrigation	Garden Irrigation	Garden Irrigation	water		water use	Irrigation
	POS	%	%	%	%	%	%	area					Area sqm	Water kL	Area sqm	Water kL	use			Area sqm
	POS 2 Hawker Approach POS	21	0	43	22	14	0	12,600	2,745	15,345	sqm	21%	3222	96.67	0	0.00	96.67	KL	2,427.70	3222
	POS 3 Almond Parkway Lake POS	22	30	7	7	9	25	69,340	4,850	74,190	sqm	52%	16322	489.65	22257	445.14	934.79	KL	23,478.20	38579
	POS 4 Joseph Drive Conservation Park	0	4	90	0	6	0	59,295	2,700	61,995	sqm	4%	0	0.00	2480	49.60	49.60	KL	955.40	2480
	POS 5 - East West Rehabilitation Corridor	0	10	76	6	8	0	21,925	2,660	24,585	sqm	10%	0	0.00	2459	49.17	49.17	KL	1,475.10	2459
	POS 17 Lavender Park	36	11	33	0	20	0	5,725	955	6,680	sqm	47%	2405	72.14	735	14.70	86.84	KL	2,181.30	3140
	POS 18 Avignon POS	26	30	0	30	14	0	9,590	1,345	10,935	sqm	56%	2843	85.29	3281	65.61	150.90	KL	3,790.20	6124
	POS 9 - Aurelian Ave Lake POS (neighbourhood park)	24	8	8	17	3	40	78,660	5,420	84,080	sqm	32%	20179	605.38	6726	134.53	739.90	KL	19,262.20	26906
	POS 6 - (local park with playground)	48	8	0	41	5	0	7,525	1,370	8,895	sqm	56%	4270	128.09	712	14.23	142.32	KL	2,298.10	4981
	POS 7 - (local park)	47	8	0	40	5	0	13,845	2,670	16,515	sqm	55%	7762	232.86	1321	26.42	259.29	KL	2,158.40	9083
	POS 8 - District Open Space	26	5	45	16	8	0	61,775	4,520	66,295	sqm	31%	17237	603.28	3315	66.30	669.58	KL	36,603.30	20551
	POS 10 - (local park)	37	8	17	30	8	0	15,970	1,870	17,840	sqm	45%	6601	198.02	1427	28.54	226.57	KL	1,387.90	8028
	POS 11 - (neighbourhood park with shelter)	22	10	18	40	10	0	10,635	2,465	13,100	sqm	32%	2882	86.46	1310	26.20	112.66	KL	3,575.70	4192
	POS 12 - (neighbourhood park with playground)	57	10	4	22	10	0	20,745	3,515	24,260	sqm	67%	13828	414.85	2426	48.52	463.37	KL	2,364.40	16254
	POS 12 - 13 Link	0	90	1	0	10	0	2,550	635	3,185	sqm	90%	0	0.00	2867	57.33	57.33	KL	2,364.40	2867
	POS 13 - (local park)	0	14	46	35	5	0	11,215	2,010	13,225	sqm	14%	0	0.00	1852	37.03	37.03	KL	278.30	1852
	POS 14 - Neighbourhood Park	15	6	20	55	4	0	29,340	2,190	31,530	sqm	21%	4730	141.89	1892	37.84	179.72	KL	3,074.40	6621
	POS 15 - Local Park	0	12	0	82	6	0	5,090	1,110	6,200	sqm	12%	0	0.00	744	14.88	14.88	KL	1,076.50	744
	POS 16 - Local Park	35	15	8	37	5	0	7,500	1,090	8,590	sqm	50%	3007	90.20	1289	25.77	115.97	KL	3,585.50	4295
	POS 19 - EPP Wetland Conservation Park (conservation)	7	11	0	74	7	0	25,940	2,625	28,565	sqm	18%	2000	59.99	3142	62.84	122.83	KL	2,352.10	5142
	SUB TOTAL							469,265	46,745	516,010			107,286	3,304.77	60,232	1,204.64	4,509.42	KL	114,689.10	167518
	LANDSCAPE BUFFERS																			
	Bussell Highway Landscape Buffer	0	0	95	0	5	0	58,220	7,290	65,510	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Outer Bypass Landscape Buffer	0	0	95	0	5	0	60,915	4,655	65,570	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	SUB TOTAL							119,135	11,945	131,080	sqm	0	0	0	0	0	0	KL	0	0

	STREETSCAPES																			
	DAP1 Streetscapes																			
	Bussell Highway Medians	0	0	54	0	46	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 1	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 1A	0	100	0	0	0	0	1,805	0	1,805	sqm	100%	0	0.00	1805	36.10	36.10	KL	906.70	1805
	Stage 1B	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2	0	100	0	0	0	0	1375	0	1,375	sqm	100%	0	0.00	1375	27.50	27.50	KL	690.70	1375
	Stage 3	0	100	0	0	0	0	210	0	210	sqm	100%	0	0.00	210	4.20	4.20	KL	105.50	210
	Stage 4	0	100	0	0	0	0	40	0	40	sqm	100%	0	0.00	40	0.80	0.80	KL	20.10	40
	Stage 5	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 6	0	100	0	0	0	0	795	0	795	sqm	100%	0	0.00	795	15.90	15.90	KL	399.30	795
	Stage 7	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 8	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 9	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 10	0	100	0	0	0	0	820	0	820	sqm	100%	0	0.00	820	16.40	16.40	KL	411.90	820
	Stage 11	0	100	0	0	0	0	870	0	870	sqm	100%	0	0.00	870	17.40	17.40	KL	437.00	870
	Stage 16A	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	SUB TOTAL							5,915	0	5,915	sqm		0	0.00	5,915	118.30	118.30	KL	2,971.20	5915
	DAP2 Streetscapes																			
	Stage 12A	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 12B	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13A	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13B	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13C	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 13D	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.7 (12C)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.8 (12D)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.9 (13E)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.10 (13F)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Stage 2.11 (13G)	0	0	0	0	0	0	0	0	0	sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	SUB TOTAL							0	0	0	sqm		0	0.00	0	0.00	0.00	KL	0.00	0
	Future Stages																			
	Feature Streetscape Medians	0	100	0	0	0	0	0	9,590	0	sqm	100%	0	0.00	0	0.00	0.00	KL	5,854.50	0
	SUB TOTAL							0	9,590	0	sqm		0	0.00	0	0.00	0.00	KL	5,854.50	0

	ENTRY STATEMENTS																			
	Joseph Drive Entry Statement (original works)	31	11	54	0	4	0	0	11,410	11,410	sqm	42%	3537	106.11	1255	25.10	131.22	KL	3,295.40	4792
	Joseph Drive Entry Statement										sqm	0%	0	0.00	0	0.00	0.00	KL	0.00	0
	Majoram Entrance Entry Statement	40	40	10	0	10	0	3,000	500	3,500	sqm	80%	1400	42.00	1400	28.00	70.00	KL	1,758.10	2800
	Tuart Drive Entry Statement	40	40	10	0	10	0	3,000	500	3,500	sqm	80%	1400	42.00	1400	28.00	70.00	KL	1,758.10	2800
	SUB TOTAL							6,000	12,410	18,410	sqm		6,337	190.11	4,055	81.10	271.22	KL	6,811.60	10392

	LAKE EVAPORATION																			
	Allowance for Evaporation from Both Lakes																2,612.80	KL	40,829.80	0
	refer Total Eden Irrigation Strategic Overview Report																			
	SUB TOTAL																2,612.80	KL	40,829.80	0

APPENDIX I

Noise Assessment

prepared by Herring Storer Acoustics

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SATTERLEY PROPERTY GROUP

PROVENCE – EAST BUSSELTON ESTATE LOCAL STRUCTURE PLAN

BUSSELL HIGHWAY, YALYALUP

NOISE ASSESSMENT

MARCH 2016

OUR REFERENCE: 20303-6-15300

DOCUMENT CONTROL PAGE

NOISE ASSESSENT

PROVENCE EAST BUSSELTON ESTATE
BUSSELL HIGHWAY, YALYALUP

Job No: 15300

Document Reference: 20303-6-15300

FOR

SATTERLEY PROPERTY GROUP

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1	Aircraft Noise Reference	17/03/2016	PLD	
2	Updated Structure Plan Layout	07/04/2016	PLD	
3	Revision of BMRA Noise Contours	15/07/2016	PLD	
4	Reference to buffer diststance	25/08/2016	PLD	
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APPENDICES

A Proposed Layout Plan

B Noise Contours

1. INTRODUCTION

RPS Group, on behalf of Satterley Property Group commissioned Herring Storer Acoustics to carry out a noise assessment for the proposed residential development, Provence – East Busselton Estate, Bussell Highway, Yalyalup.

Traffic noise received at this estate has previously been assessed *(HSA Reference 9004-1-08056)* with individual assessments conducted for various Detailed Area Plans (DAP) within the proposed subdivision. The purpose of this report is to re-assess noise received within the entire Local Structure Plan (LSP) which has undergone an upgrade to allow for the inclusion of additional land areas. Noise emissions from vehicles travelling along the proposed outer bypass road and the Bussell Highway have been assessed in accordance with State Planning Police 5.4.

Additionally, consideration of aircraft noise from the future Busselton Margaret River Regional Airport onto the future residence within the estate has been made.

As the previous noise studies for this area have identified the general requirements for noise control and buffers, the LSP has been designed with these noise options in mind. Therefore, the buffers and bunding previously recommended are contained within the updated LSP.

For information, a locality plan is attached in Appendix A.

2. SUMMARY

2.1 ROAD TRAFFIC ASSESSMENT

In accordance with the WAPC Planning Policy 5.4 an assessment of the noise that would be received within the development of the DAP 2 and DAP 3 sub-division, from vehicles travelling on the proposed outer bypass 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.

The acoustic analysis indicates that for future residential Lots effected by noise from the proposed outer bypass, noise levels will be a L_{Aeqday} of 55 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.

For residential Lots adjoining the Bussell Highway, buffer zones previously determined have been included in the design of the LSP. With the inclusion of the buffers, noise levels at these façade Lots would be a L_{Aeqday} of 59 dB(A) or less. At this noise level, in strict accordance with SPP 5.4, "Quiet House" design in the form of Package A, is normally required. However, based on experience of similar projects, an external noise level of 59 dB(A), generally achieves the internal noise level criteria with standard construction. Additionally, as the night noise level is 14 dB(A) less than the day noise level, night internal noise levels would be more than achievable with standard construction. At this noise level standard residential construction would be deemed to satisfy the internal noise levels, therefore no noise amelioration in the form of quiet house design has been recommended. It should be noted that the calculated noise level of 59 dB(A) has a 2.5 dB(A) inclusion for façade reflection, which would be removed when calculating internal noise levels.

We note that under the Planning Policy, as noise received within the proposed development would exceed the "Noise Target", notification on Titles are required for the residences exposed to the Bussell Highway. Assessment has been conducted on the extent of the requirements for notification with only the first row of housing being affected. Houses behind the first row are suitably protected, therefore require no notifications.

Additionally, as the houses are all positioned with setbacks from the road system, the outdoor areas are towards the rear of the property, therefore, are protected by the rear fencing or the main residential building. This ensures compliance with the requirement for outdoor areas to achieve L_{Aeq} 50 dB(A) or less.

2.2 AIRCRAFT ASSESSMENT

For aircraft noise associated with the Busselton Margaret River Regional Airport (in the future) the ANEF20 noise contour is the appropriate criteria. As all parts of the Provence residential LSP are not within the stipulate criteria, there are no acoustic requirements for future residential development.

3. ACOUSTIC CRITERIA

3.1 WAPC PLANNING POLICY

The Western Australian Planning Commission (WAPC) released on 22 September 2009 State Planning Policy 5.4 *"Road and Rail Transport Noise and Freight Considerations In Land Use Planning"*. Section 5.3 – Noise Criteria, which outlines the acoustic criteria, states:

"5.3 - NOISE CRITERIA

Table 1 sets out the outdoor noise criteria that apply to proposals for new noise-sensitive development or new major roads and railways assessed under this policy.

These criteria do not apply to –

- *proposals for redevelopment of existing major roads or railways, which are dealt with by a separate approach as described in section 5.4.1; and*
- *proposals for new freight handling facilities, for which a separate approach is described in section 5.4.2.*

The outdoor noise criteria set out in Table 1 apply to the emission of road and rail transport noise as received at a noise-sensitive land use. These noise levels apply at the following locations—

- *for new road or rail infrastructure proposals, at 1 m from the most exposed, habitable façade of the building receiving the noise, at ground floor level only; and*
- *for new noise-sensitive development proposals, at 1 m from the most exposed, habitable façade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.*

Further information is provided in the guidelines.

Table 1: Outdoor Noise Criteria

Time of day	*Noise Target*	*Noise Limit*
Day (6 am–10 pm)	$L_{Aeq(Day)}$ *= 55 dB(A)*	$L_{Aeq(Day)}$ *= 60 dB(A)*
Night (10 pm–6 am)	$L_{Aeq(Night)}$ *= 50 dB(A)*	$L_{Aeq(Night)}$ *= 55 dB(A)*

The 5 dB difference between the outdoor noise target and the outdoor noise limit, as prescribed in Table 1, represents an acceptable margin for compliance. In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin. In relation to greenfield sites, however, there is an expectation that the design of the proposal will be consistent with the target ultimately being achieved.

Because the range of noise amelioration measures available for implementation is dependent upon the type of proposal being considered, the application of the noise criteria will vary slightly for each different type. Policy interpretation of the criteria for each type of proposal is outlined in sections 5.3.1 and 5.3.2.

The noise criteria were developed after consideration of road and rail transport noise criteria in Australia and overseas, and after a series of case studies to assess whether the levels were practicable. The noise criteria take into account the considerable body of research into the effects of noise on humans, particularly community annoyance, sleep disturbance, long-term effects on cardiovascular health, effects on children's learning performance, and impacts on vulnerable groups such as children and the elderly. Reference is made to the World Health Organization (WHO) recommendations for noise policies in their publications on community noise and the Night Noise Guidelines for Europe. See the policy guidelines for suggested further reading.

5.3.1 Interpretation and application for noise-sensitive development proposals

In the application of these outdoor noise criteria to new noise-sensitive developments, the objective of this policy is to achieve –

- *acceptable indoor noise levels in noise-sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and*
- *a reasonable degree of acoustic amenity in at least one outdoor living area on each residential lot[1].*

If a noise-sensitive development takes place in an area where outdoor noise levels will meet the noise target, no further measures are required under this policy.

1 For non residential noise-sensitive developments, (e.g. schools and child care centres) consideration should be given to providing a suitable outdoor area that achieves the noise target, where this is appropriate to the type of use.

In areas where the noise target is likely to be exceeded, but noise levels are likely to be within the 5dB margin, mitigation measures should be implemented by the developer with a view to achieving the target levels in a least one outdoor living area on each residential lot[1]. Where indoor spaces are planned to be facing any outdoor area in the margin, noise mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply measures detailed in the guidelines.

In areas where the outdoor noise limit is likely to be exceeded (i.e. above $L_{Aeq(Day)}$ of 60 dB(A) or $L_{Aeq(Night)}$ of 55 dB(A)), a detailed noise assessment in accordance with the guidelines should be undertaken by the developer. Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin. Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces, as specified in the following paragraphs.

For residential buildings, acceptable indoor noise levels are $L_{Aeq(Day)}$ of 40 dB(A) in living and work areas and $L_{Aeq(Night)}$ of 35 dB(A) in bedrooms[2]. For all other noise-sensitive buildings, acceptable indoor noise levels under this policy comprise noise levels that meet the recommended design sound levels in Table 1 of Australian Standard AS 2107:2000 Acoustics—Recommended design sound levels and reverberation times for building interiors.

These requirements also apply in the case of new noise-sensitive developments in the vicinity of a major transport corridor where there is no existing railway or major road (bearing in mind the policy's 15-20 year planning horizon). In these instances, the developer should engage in dialogue with the relevant infrastructure provider to develop a noise management plan to ascertain individual responsibilities, cost sharing arrangements and construction time frame.

If the policy objectives for noise-sensitive developments are not achievable, best practicable measures should be implemented, having regard to section 5.8 and the guidelines."

The Policy, under Section 5.7, also provides the following information regarding "Notifications on Titles".

3.2 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 For residential buildings, indoor noise levels are not set for utility spaces such as bathrooms. This policy encourages effective "quiet house" design, which positions these non-sensitive spaces to shield the more sensitive spaces from transport noise (see guidelines for further information).

3.2.1 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.

3.2.2 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 is refererced.

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.

3.3 APPROPRIATE CRITERIA

Based on the above, the following criteria are proposed for this development:

Road Traffic Noise

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.

Aircraft Noise

Less than ANEF 20 is acceptable;

And reference to Less than the N65/20 noise contour

4. MEASUREMENTS AND OBSERVATIONS

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 is approximately 10m from the nearest running edge of Bussell Highway.

Test instrumentation comprised an ARL Noise Logger and Rion Calibrator.

The test results are summarised in Table 3.1.

TABLE 3.1: SUMMARY OF MEASURED NOISE LEVELS

Parameter	Measured Level dB(A)*	Difference between $L_{10(18hour)}$ and $L_{Aeq(parameter)}$ dB(A)
$L_{A10\ (18\ hour)}$	63.4	N/A
$L_{Aeq,\ day\ (6am\ to\ 10pm)}$	60.8	= $L_{A10\ (18\ hour)}$ – 2.6
$L_{Aeq,\ night\ (10pm\ to\ 6am)}$	47.0	= $L_{A10(18\ hour)}$ – 16.4

* It is normal practice to quote decibels to the nearest whole number. Fractions are retained here to minimise any cumulative rounding error.

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.

5. METHODOLOGY

5.1 ROAD TRAFFIC NOISE

To determine the noise level received within the subdivision from the Busselton Highway and the proposed future Outer Bypass Road, acoustic modelling was carried out by SoundPlan using the Calculation of Road Traffic Noise (CoRTN) algorithms.

The input data for the model included:

- Updated LSP – Detailed in Appendix A;
- Topographical data, with the ground level within the subdivision from information supplied by client;
- Traffic volumes supplied by MRWA, as listed in Table 5.1;
- Other traffic data as listed in Table 5.1;'
- Conversion from $L_{A10\ (18\ hour)}$ to $L_{Aeq\ (16\ hour)}$ (Day) – 2.6*
- Conversion from $L_{A10\ (18\ hour)}$ to $L_{Aeq\ (8\ hour)}$ (Night) – 16.4*
- A +2.5 dB adjustment to allow for façade reflection.

*Based on monitoring from Bussell Highway (Assumed same relationship for proposed road)

TABLE 5.1 - NOISE MODELLING INPUT DATA

Parameter	Bussell Highway	Proposed Future Busselton Outer Bypass
Existing Traffic (2007)	9,800 vpd	N/A
Forecast Volumes (2031) (growth rate of 5.2%pa used to represent worst case scenario)	22,000 vpd	14,500 vpd
Percentage traffic 0600 – 2400 hours (Assumed)	94%	94%
Heavy Vehicles (%) (Assumed)	5%	5%
Speed (km/hr)	90	90
Façade Correction	+ 2.5 dB(A)	+ 2.5 dB(A)
Road Surface	14mm Chip Seal	14mm Chip Seal

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.

6. PREDICTED FUTURE NOISE LEVELS

6.1 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 1) from vehicles travelling along the Bussell Highway and the proposed future Outer Bypass Road has been predicted, with Table 6.1 summarising the results and Appendix B showing the noise contour plot.

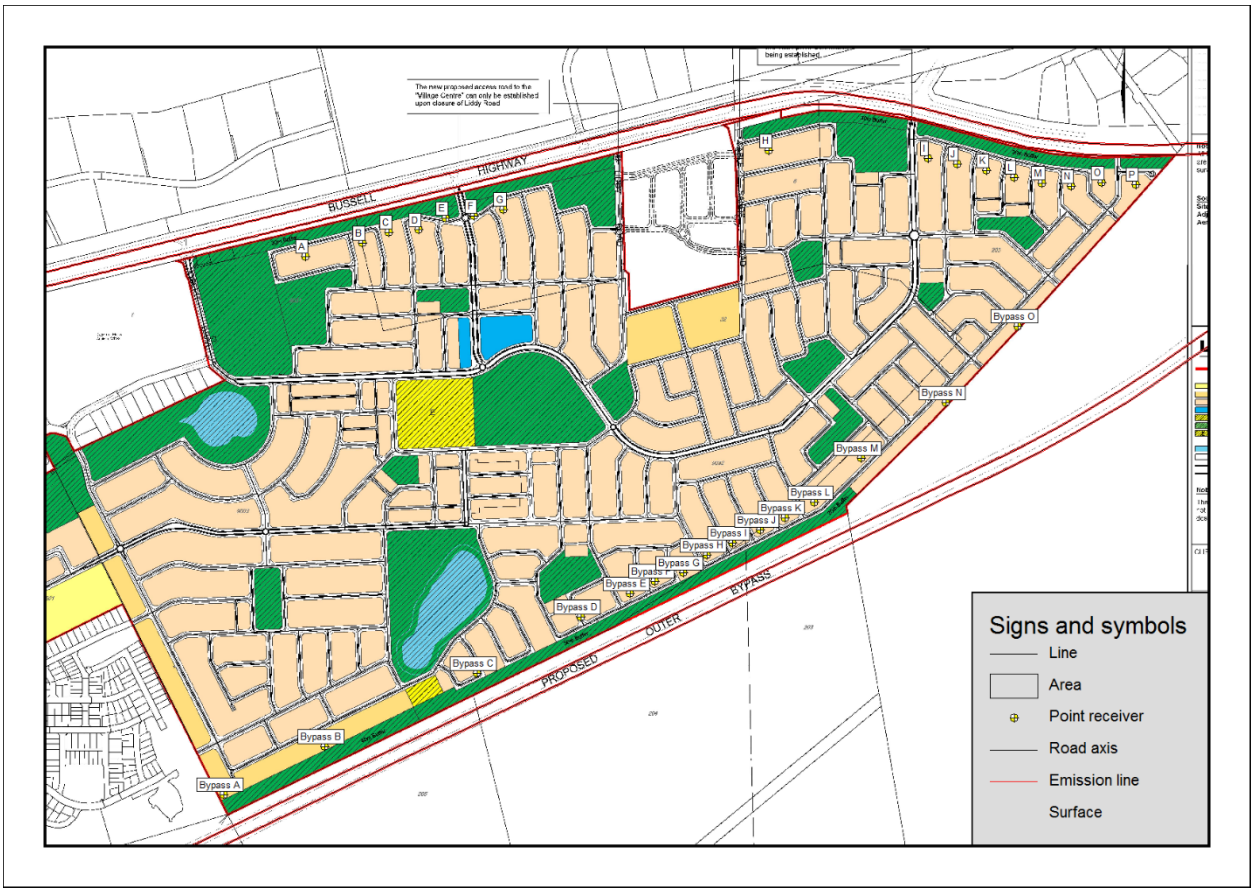


FIGURE 1 – LOT RECEIVER LOCATIONS

TABLE 6.1: FUTURE NOISE LEVELS PROVENCE LSP

Receiver Reference	Calculated Level dB(A) $L_{Aeq, day (6am to 10pm)}$
Bussell A	58
Bussell B	58
Bussell C	59
Bussell D	58
Bussell E	59
Bussell F	58
Bussell G	58
Bussell H	57
Bussell I	58
Bussell J	58
Bussell K	58
Bussell L	58
Bussell M	58
Bussell N	58
Bussell O	59
Bussell P	59
Bypass A	55
Bypass B	54
Bypass C	54
Bypass D	54
Bypass E	53
Bypass F	53
Bypass G	53
Bypass H	53
Bypass I	53
Bypass J	53
Bypass K	53
Bypass L	54
Bypass M	53
Bypass N	53
Bypass O	52

6.2 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 Provence residential estate. For the purpose of this study only the ANEF 20 and N65/20 contours has been referenced.

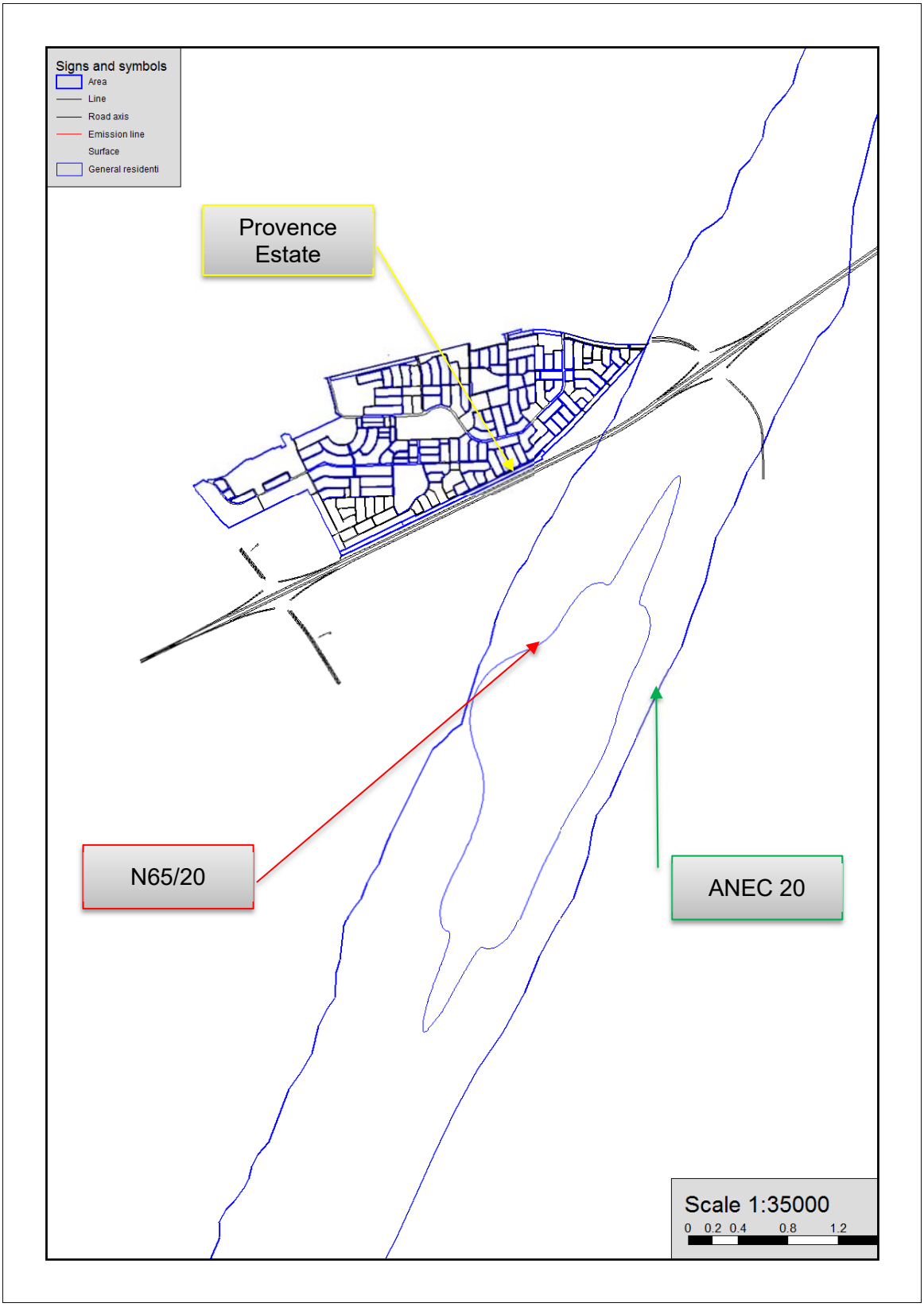


FIGURE 2 – FUTURE BUSSELTON MARGARET RIVER REGIONAL AIRPORT – NOISE CONTOURS

7. DISCUSSION

7.1 FUTURE OUTER BYPASS

For future residential Lots effected by noise from the proposed outer bypass, noise levels will be an L_{Aeqday} of 55 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.

7.2 FUTURE BUSSELL HIGHWAY

Previous noise studies identified that a buffer of approximately 30 metres would be required for Lots adjoin the Bussell Highway. As this has been included in the LSP, noise levels at future residence along Bussell Highway will be a L_{Aeqday} of 59 dB(A) or less.

For residential Lots adjoining the Bussell Highway, buffer zones previously determined have been included in the design of the LSP. With the inclusion of the buffers, noise levels at these façade Lots would be a L_{Aeqday} of 59 dB(A) or less. At this noise level, in strict accordance with SPP 5.4, "Quiet House" design in the form of Package A, is normally required. However, based on experience of similar projects, an external noise level of 59 dB(A), generally achieves the internal noise level criteria with standard construction. Additionally, as the night noise level is 14 dB(A) less than the day noise level, night internal noise levels would be more than achievable with standard construction. At this noise level standard residential construction would be deemed to satisfy the internal noise levels, therefore no noise amelioration in the form of quiet house design has been recommended. It should be noted that the calculated noise level of 59 dB(A) has a 2.5 dB(A) inclusion for façade reflection, which would be removed when calculating internal noise levels.

We note that under the Planning Policy, as noise received within the proposed development would exceed the "Noise Target", notification on Titles are required for the residences exposed to the Bussell Highway. Assessment has been conducted on the extent of the requirements for notification with only the first row of housing being affected. Houses behind the first row are suitably protected, therefore require no notifications.

Additionally, as the majority of Lots will have houses that are facing onto the road system, the outdoor areas are towards the rear of the property, therefore, are protected by the building. This ensures compliance with the requirement for outdoor areas to achieve L_{Aeq} 50 dB(A) or less.

For the few Lots which will have housing backing onto the roadway, expectations are that rear fences will be provided which will protect the outdoor living areas hence compliance with the requirement for outdoor areas to achieve L_{Aeq} 50 dB(A) or less will be achieved.

7.3 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 Provence residential LSP are not within the stipulate criteria, there are no acoustic requirements for future residential development.

8. CONCLUSION

In accordance with the WAPC Planning Policy 5.4 an assessment of the noise that would be received within the Provence 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.

The acoustic analysis indicates that for future residential Lots effected by noise from the proposed outer bypass, noise levels will be a L_{Aeqday} of 55 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.

For residential Lots adjoining the Bussell Highway, buffer zones previously determined have been included in the design of the LSP. With the inclusion of the buffers, noise levels at these façade Lots would be a L_{Aeqday} of 59 dB(A) or less. At this noise level, in strict accordance with SPP 5.4, "Quiet House" design in the form of Package A, is normally required. However, based on experience of similar projects, an external noise level of 59 dB(A), generally achieves the internal noise level criteria with standard construction. Additionally, as the night noise level is 14 dB(A) less than the day noise level, night internal noise levels would be more than achievable with standard construction. At this noise level standard residential construction would be deemed to satisfy the internal noise levels, therefore no noise amelioration in the form of quiet house design has been recommended. It should be noted that the calculated noise level of 59 dB(A) has a 2.5 dB(A) inclusion for façade reflection, which would be removed when calculating internal noise levels.

We note that under the Planning Policy, as noise received within the proposed development would exceed the "Noise Target", notification on Titles are required for the residences exposed to the Bussell Highway. Assessment has been conducted on the extent of the requirements for notification with only the first row of housing being affected. Houses behind the first row are suitably protected, therefore require no notifications.

Additionally, as the houses are all positioned with setbacks from the road system, the outdoor areas are towards the rear of the property, therefore, are protected by the rear fencing or the main residential building. This ensures compliance with the requirement for outdoor areas to achieve L_{Aeq} 50 dB(A) or less.

For aircraft noise associated with the Busselton Margaret River Regional Airport (in the future) the ANEF20 noise contour is the appropriate criteria. As all parts of the Provence residential LSP are not within the stipulate criteria, there are no acoustic requirements for future residential development.

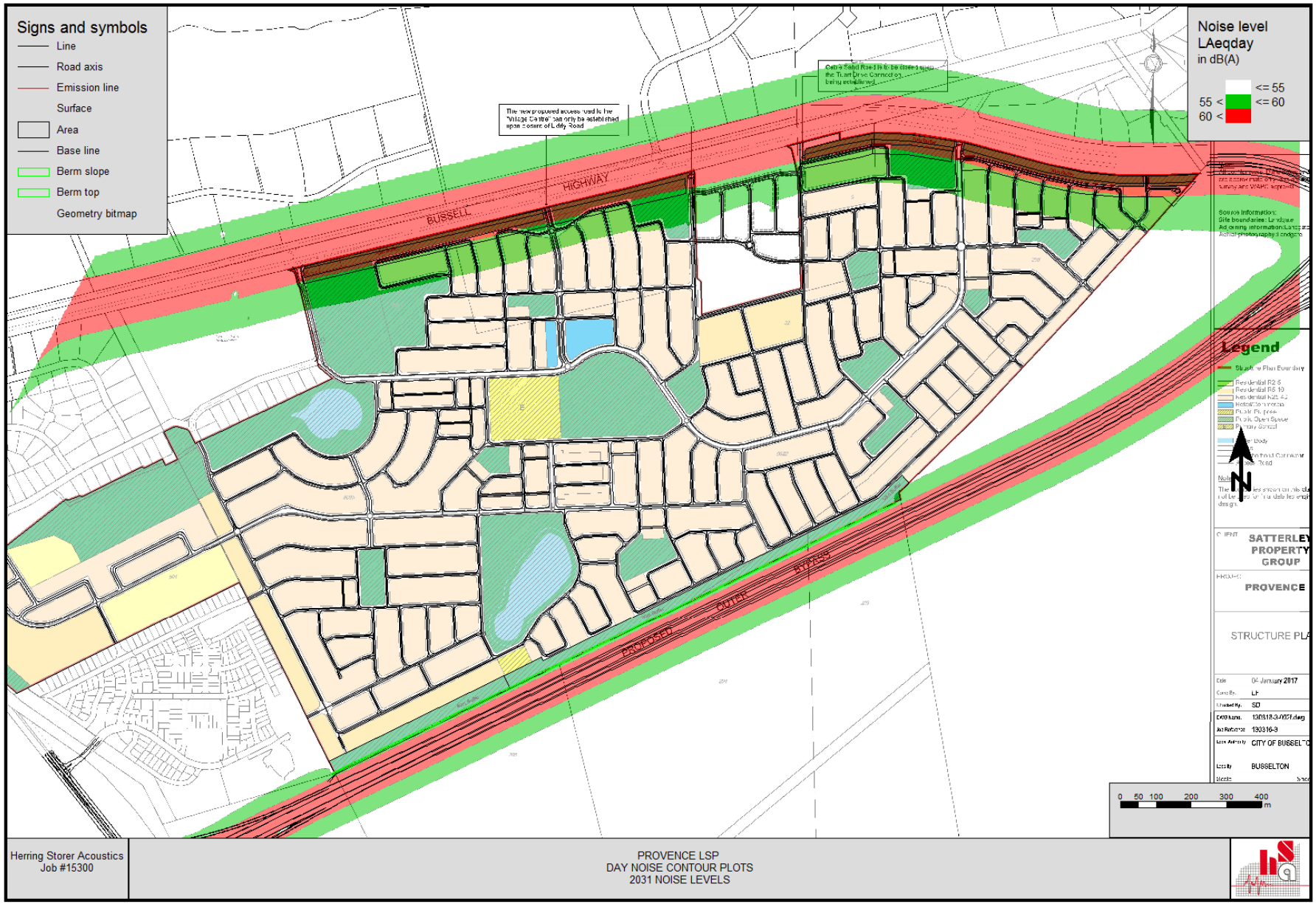
APPENDIX A

Proposed Local Structure Plan

The new proposed access road to the "Village Centre" can only be established upon closure of Liddy Road
Cable Sand Road is to be closed upon the Tuart Drive Connection being established
BUSSELL HIGHWAY
VASSE HIGHWAY
PROPOSED OUTER BYPASS
REVISION
Note:
All Lot Numbers, Dimensions and Areas are approximate only, and are subject to survey and WAPC approval.
Source Information:
Site boundaries: Landgate
Adjoining information: Landgate
Aerial photography: Landgate
Legend
Structure Plan Boundary
Residential R2.5
Residential R5-10
Residential R25-40
Retail/Commercial
Public Purpose
Public Open Space
Primary School
Water Body
Roads
Neighborhood Connector
Access Road
Note:
The boundaries shown on this plan should not be used for final detailed engineers design.
CLIENT SATTERLEY PROPERTY GROUP
PROJECT PROVENCE
STRUCTURE PLAN
Date 04 January 2017
Comp By LF
Checked By SD
DWG Name 130316-3-002f.dwg
Job Reference 130316-3
Local Authority CITY OF BUSSELTON
Locality BUSSELTON
Scale 1:3500
Sheet A0
Plan Ref 130316
Rev F
RPS
RPS Australia East Pty Ltd
ACN 140 292 782
ABN 44 140 292 782
Level 2, 27-31 Troode Street
West Perth, WA, Australia, 6005
PO Box 700, West Perth WA 6872
T +61 8 9211 1111
F +61 8 9211 1122
W rpsgroup.com.au

APPENDIX B

NOISE CONTOURS


Signs and symbols
Line
Road axis
Emission line
Surface
Area
Base line
Berm slope
Berm top
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LAeqday
in dB(A)
<= 55
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BUSSELL
HIGHWAY
BYPASS
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PROVENCE
Legend
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PROPERTY
GROUP
PROVENCE
STRUCTURE PLA
04 January 2017
LH
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130316-3
CITY OF BUSSELTON
BUSSELTON
0 50 100 200 300 400
m
Herring Storer Acoustics
Job #15300
PROVENCE LSP
DAY NOISE CONTOUR PLOTS
2031 NOISE LEVELS

APPENDIX J

Servicing and Infrastructure Report

prepared by Wood and Grieve Engineers

Provence - Planning

Servicing and Infrastructure Report

Prepared for: Satterley Property Group Pty Ltd

Attention: Brenton Downing

Date: 28 Jan 2020

Prepared by: Richard Martin

Ref: 17098-PLANNING

Wood & Grieve Engineers now part of Stantec
PO Box 1276, 10 / 44 - 48 Queen Street, Busselton WA 6280
Tel: +61 8 9754 4244 Email: busselton@wge.com.au www.wge.com.au

P:\27496\MARKETING_MATERIAL\MASTER DOCUMENTS-BRAND-SEPT2019\MDCR - TEMPLATES AND TRACKING\SP1\SP1-MASTER-SPECIFICATION-STANDARD.DOCX

WOOD & GRIEVE ENGINEERS

NOW PART OF

Stantec

Revision

Revision	Date	Comment	Prepared By	Approved By
A	24-02-2016	Review	R. Martin	R. Martin
B	1-04-2016	Structure Plan amended	R. Martin	R. Martin
C	15-09-2016	Structure Plan amended	R. Martin	R. Martin
D	17-02-2017	Structure Plan amended	R. Martin	R. Martin
E	28-01-2020	Structure Plan amended	L. Sutherland	R. Martin

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Appendix A RPS Structure Plan (3 December 2019)

Appendix B Water Corporation Sewer Planning Scheme SD090 – October 2012

Appendix C Geotechnical Report Extract – Golder Associates 2007

1. Introduction

This report has been prepared by Wood & Grieve Engineers now part of Stantec (WGENPOS) to assist with the redesign and development of a Local Structure Plan for the balance of land at Provence Estate.

It is proposed to subdivide the balance of land into approximately 1619 residential lots with strategically placed Retail/Commercial and Public Open Space areas that will enhance the appeal of the Estate.

This servicing report makes comment on the existing services present within the Estate, and the requirements of any future services for the balance of the proposed development.

Within this report we have addressed the major civil, electrical and communications engineering components, consisting of:

- Sewerage Reticulation and Pump Station infrastructure
- Stormwater
- Potable Water reticulation
- Gas
- Roads
- Underground Power
- Communications

This report has been based on the draft structure plan prepared by RPS dated 3 December 2019 (attached as Appendix 1) and is to be relied on only by the Satterley Property Group.

The information and investigations in this report are based on preliminary advice previously received from service authorities, and their strategic planning information.

2. Site Description

2.1 Location

The proposed development is generally bounded by Bussell Highway to the north, Vasse Highway to the west, and the future Busselton Outer Bypass to the south.

The majority of the western area of the Provence Estate has been developed, with the revised structure plan covering the eastern undeveloped portion of the landholding.

The site is low lying and generally flat, with elevations ranging from RL 7m AHD in the south, to RL 3m AHD in the northern areas.

The undeveloped areas of the site are predominantly cleared, with small pockets of vegetation remaining. The revised structure plan has identified areas of important vegetation and incorporated POS areas to allow retention where possible.

2.2 History

The subject area's geological history was predominantly affected by mining operations undertaken by Cable Sands Pty Ltd from 1990 to approximately 1996. Advice on the operations of the mining was provided by Ken Bell, Allan Turner & Peter Harrison of, or formally of, Cable Sands.

Heavy minerals were extracted during the mining process such as ilmenite and zircon which are used in the manufacture of paint and tile facing. The sand was typically excavated to a depth of 2 to 3m with some locations being as deep as 15m. The existing basin adjacent and central to the southern boundary of the site was created as part of the mining operations.

The mined sand underwent a process of wet gravity separation to extract the heavy minerals. This process was carried out in a large shed. Following processing the sand, the slurry was hydraulically pumped into dams where it remained for several weeks to dry. The coarser sand was initially extracted from the mining process. The medium-coarse sands and fines were separated later in the typical process and were mixed together using dozers in layers of approximately 1m in thickness. Approximately 5-6% by weight of heavy metal was extracted from the sand and approximately four million tonnes of sand was processed per year.

The remediation of the site incorporated the slurry spreading and track rolling of the sand followed by revegetation. There was no chemical treatment of the sand and Cable Sands have advised that the sand does not contain harmful chemicals as a result of the mining operation.

Figure 5 within the Geotechnical Report indicates the approximate mined areas where fine residue is expected to be encountered.

3. Geotechnical Information

The Busselton Sheet of the 1:50,000 Environmental Geology Series maps indicate that the northern portion of the site is underlain by Tamala Limestone and sand derived from Tamala Limestone with a thin seam of Clayey Peaty Sand along a drainage path near the Bussell Highway. The southern portion of the site is underlain by Guildford Formation soils comprising a mix of clay, silt and sand.

Golder Associates were originally engaged to undertake a preliminary geotechnical investigation of the site to broadly assess subsurface soil and groundwater conditions across the proposed development area and identify geotechnical factors that may affect development of the site. Golders preliminary findings are summarised below.

The investigation included a walkover survey of the site, excavation of test pits, collection and testing of samples, Perth penetrometer and infiltration testing.

Based on the results of the testing to date, the majority of the site contains sandy soil and housing lots can be generally classified as having a Class S in accordance with AS2870 “Residential Slabs and Footings”.

A small portion of land typically 200m wide and located along the southern boundary of the site has a thin surface layer of sand soil and overlaying sandy clay. Results indicate that the clayey material generally has a moderate to high potential for volume change with change in moisture content. This zone containing clayey material should be generally classified as having Class M in accordance with AS2870 “Residential Slabs and Footings”. The housing lots in this area may be engineered to have a Class S classification where approximately 1m of compacted sandy soil is placed beneath the shallow footings and above the clayey material.

Ground surface inundation of the site is known to occur during the wetter months of the year, particularly over the central portion of the site where relatively low permeability clayey soils inhibit drainage. To ensure that water does not pond beneath structures and affect their performance, Golder Associates recommends that a suitable drainage layer occur beneath the buildings. The insitu soils will generally provide a suitable drainage layer for the majority of the soil. In areas where clayey material exists, a drainage layer approximately 1m thick may need to be constructed in residential areas which can be incorporated in a sand pad to engineer the site classification or, alternatively subsoil drainage may be required.

Further and more detailed investigations will be conducted for each stage of development to assess soils at depth within the mined areas and to assess the potentially expansive soils to the south of the site.

3.1 Site Geology

The site can be typically divided into three areas consisting of the northern (Zone 1), central (Zone 2) and the southern (Zone 3) area. The Busselton Sheet of the 1:50,000 Environmental Geology Series maps shows that these areas are underlain by the following geology types:

- Zone 1 – Comprises primarily sandy soil overlying variably cemented limestone
- Zone 2 – Primarily sandy soil with interbedded zones of fines residue overlying loose to dense limestone in the northern areas
- Zone 3 – Comprises loose sand over clayey soil

3.2 Methodology and Site Classification

The proposed methodology for developing in the 3 identified Zones are as follows:

Zone 1

- Remove topsoil
- Carry our proof compaction
- Place and compact sand fill to achieve adequate clearance to groundwater

A site classification of “S” should be achieved in Zone 1 areas after the above works have been completed.

Zone 2

- Remove topsoil and any unsuitable founding material
- Remove any layers of clayey soil (fine residue) within 1m of finished design levels
- Carry our proof compaction
- Place and compact sand fill to achieve adequate clearance to groundwater

A site classification of “S” should be achieved in Zone 2 areas after the above works have been completed.

Zone 3

This zone may be developed in a number of ways. The 2 recommended methodologies by Golder Associates are:

1 Excavate and Replace

- Remove topsoil
- Remove surficial sand (if present) and stockpile for re-use
- Remove loose clayey material and either stockpile for drying and blending before re-use or remove from site
- Carry our proof compaction of the exposed clayey soil
- Place and compact sand fill to achieve adequate clearance to groundwater

A site classification of “S” should be achieved in Zone 3 areas after the above works have been completed.

2 Fill and Surcharge

- Remove topsoil
- Carry out heavy proof compaction of the exposed surface

- Place and compact sand fill up to the design level
- Place a surcharge load of fill over the sand fill
- Remove surcharge fill back down to design levels

A site classification of “S” or “M” should be achieved in Zone 3 areas after the above works have been completed.

4. Flood Levels and Hydrological Investigations

This site displays areas where high groundwater and adjacent flood levels may dictate the earthworks methodology.

From the Busselton Flood Study carried out by the Department of Environment and its subsequent recent revisions to this study, the 100-year flood level within the Wonnerup Estuary to the north of the subject land is 1.45m AHD.

Jim Davies and Associates are the Hydrological Consultants for this project and have been involved with installing monitoring bores and documenting management plans for the Estate in conjunction with Department of Water and Department of Environment. These bores will be monitored over the coming years to refine the AAMGL contours and the earthworks designs will be reflective of the latest data received.

5. Traffic Investigations

Jacobs Group (Jacobs) was commissioned by Satterley Property Group to undertake and report on a transport assessment for the proposed structure plan.

The results of this report include recommendations on intersections, road hierarchy and advice on public transport and pedestrian facilities.

6. Sewerage Reticulation and Pump Stations

The proposed development area is contained within the Water Corporation’s strategic sewer planning. Therefore, planning of existing and future sewerage infrastructure has been allowed to accommodate the proposed development. The Provence Estate falls within the Water Corporation’s Busselton SD090 long term scheme planning area.

The Water Corporation’s SD090 (October 2012) (included as Appendix 2) indicates that the development will be serviced by gravity sewer reticulation in accordance with Water Corporation Design Standard 50.

This sewer reticulation will gravitate to a number of wastewater pump station (WWPS) sites throughout the development. Ultimately, three WWPS’s will be required to service the development. At the time of writing this report, two of the WWPS’s have been constructed; being Busselton Pump Station No. 18 (PS18) (located adjacent the north-west area of the development), and Busselton Pump Station No. 20 (PS20) (located in the south of the development adjacent Stage 12D). A third WWPS will be required to service the eastern areas of the development, and is currently referred to as Busselton PS “U” (PSU). The Water Corporation’s planning indicates that ultimately, PSU and PS18 will both pump wastewater back up to the gravity sewer network that flows to PS20.

At the time of writing this report, construction of PS20 had recently been completed and commissioned. PS20 is currently a Type 90 pump station, and as such will only be able to service its catchment to an interim level. As development within the catchment continues, and before the Type 90 capacity is exceeded, PS20 will ultimately need to be upgraded to a Type 180 pump station.

The Water Corporation's SD090 also indicates that a future DN250 pressure main is planned to be constructed from an offsite pump station north of Bussell Highway, through the Provence estate and up to the gravity sewer network that flows to PS20.

In order for the north-eastern area of the development to be serviced, the future Pump Station (PSU) must be constructed. This station will receive gravity flows from within the catchment and pump out via a pressure main to the existing Pump StationPS20. This future Station will be pre-funded if it is constructed within the Water Corporations Capital Works Program. WGENPOS has advised Satterley that discussions with the Water Corporation must commence as soon as the structure plan has been lodged to ensure it is placed on the Capital Works Program as prefunded infrastructure.

7. Stormwater

7.1 Management

In 2008 JDA Consulting Hydrologists (JDA) prepared a Water Management Strategy (WMS) for the Provence Estate. This document was a precursor to a District Water Management Strategy (DWMS) and:

- Aimed to ensure that the Vasse-Wonnerup wetland is not negatively impacted by the Provence development.
- Provided an understanding of the existing surface water and shallow groundwater
- Provided advice on:
  - seasonal groundwater variation
  - flow regime of wetlands
  - water quality considerations, and
  - stormwater drainage issues

A DWMS was prepared by JDA in 2009 for the Busselton Airport Structure Plan Area. The Provence Estate residential development falls within the study area of this DWMS. This document outlines the following:

- The overarching urban water management strategy for the development
- A framework for the application of total water cycle management

The DWMS is intended to provide key principles and a framework from which Local Water Management Strategies (LWMS's) can be prepared for individual developments. Some of the key principles and objectives identified in the DWMS include:

- Maintain groundwater levels within their current natural ranges.
- Provide sufficient clearance above groundwater levels in developed areas.
- Provide improved water quality management compared to the existing land use.
- Provide improved management of existing wetlands

7.2 Collection and Conveyance

The generally adopted design criteria for new development areas is that post development flows are attenuated to pre-development levels. Flood management for the Study Area has therefore been based on maintaining the peak flow at the downstream boundary of the Study Area with existing design peak flows, to protect downstream areas from flooding and erosion.

The detention basins toward the downstream of catchments will be designed as wet basins and, subject to detailed design, the approximate area required for the detention areas is shown on the structure plan.

Due to the relatively large distance from the upper areas of the catchments to the downstream detention basins, intermediate compensating basins will be incorporated. The compensating basins will reduce the size of the required stormwater pipes and will encourage on-site infiltration. A low flow relief below the floor level of the basin will be provided to ensure the basins fully empty after each storm event which will increase the useability of the Public Open Space. The low flow relief will be above the AAMGL level to limit any effect on the natural ground water levels. Compensating basin sizes will be sized to adequately reduce peak flows to a manageable rate and are to be constructed within the vicinity of the areas indicated on the structure plan. Exact sizes and locations of compensation basins will be determined during development of the drainage concept plan.

As outlined in the original Drainage and Nutrient Management Plan prepared by JDA Consulting Hydrologists, the groundwater will be managed as follows:

- Any existing drains which are located below the AAMGL are permitted to remain to allow existing hydrological regimes to continue
- New drainage routes, if existing natural drainage systems are not available, be located to minimise impacts on wetlands and their buffers

For water quality management, the following criteria are proposed by JDA Consulting Hydrologists:

- Water quality targets based on ANZECC (2000a) and EPA Bulletin 711
- Retain and restore natural drainage lines and valuable ecosystems such as natural channels, wetlands and riparian vegetation
- Minimise pollutant input to surface water and groundwater by use of non-structural and structural source control techniques and WSUD BMP's, particularly in higher-than-average nutrient loss areas. Typically, on-site infiltration at source will be promoted by adopting open pit bases and compensating basins
- Contribute toward meeting phosphorus and nitrogen targets for the Vasse Wonnerup Estuary system

It is envisaged that stormwater from major and minor storm events will be collected and conveyed through a network of drainage systems.

In areas of relatively high groundwater the use of sub-soil drains will be considered to limit the volume of imported fill required for separation distances.

8. Water

8.1 Water Supply

The existing Provence residential area is serviced via a 300mm diameter main along Bussell Highway. It is anticipated that this main will be extended to service a portion of the proposed residential areas however does not have capacity to service the entire development.

Previous advice from Busselton Water has indicated that system reinforcement would be required in order to ultimately support the entire residential development. This system reinforcement is also required to service the entirety of the proposed Yalyalup Industrial Park development. Busselton Water owns an area of land to the south of the proposed residential development, which is the site identified to house the system reinforcement.

The Busselton Water site and the 375mm diameter main along Vasse Hwy will ultimately assist in servicing the proposed residential development.

8.2 Water Reticulation

It is anticipated that the proposed residential area will be serviced via internal water reticulation, as is the case with the existing residential areas.

This water reticulation will be developed in accordance with Busselton Water standards for residential areas.

9. Gas Supply

ATCO Gas previously confirmed that the high pressure gas network within the existing stages of the Provence Estate has capacity to supply the proposed development. As development continues east, the internal gas mains will be extended to supply future stages.

This advice is on the basis that development continues in an easterly direction, with future stages being developed adjacent to existing stages and the existing gas network. If development did not occur adjacent existing infrastructure, extension of high pressure gas mains would be required, along with installation of high pressure reducers.

10. Roads

The road network within the proposed development will connect to and extend from the road network within the existing stages of the Provence Estate.

Three intersections are proposed onto Bussell Highway and these are discussed within the traffic report prepared by Jacobs. The future Busselton Outer Bypass (BOB) will be constructed to the south of the proposed development, however no intersections or access points into the proposed development are planned at this point in time.

Jacobs' traffic report provides a recommendation on the hierarchy of the internal road network which consists of five road categories, namely:

- Neighbourhood Connector A
- Access Street Type A
- Access Street Type B
- Access Street Type C
- Access Street Type D

These categories as are identified in the WAPC's Liveable Neighbourhoods policy. Each category relates to different traffic volume capacities, road reserve widths, kerb-to-kerb widths, and target vehicle speeds.

All internal intersections are anticipated to be either priority controlled intersections or roundabouts, with no need for signalised intersections within the development. Jacob's' traffic report indicates that the proposed intersections are anticipated to operate effectively with the estimated traffic flows.

The engineering design of the internal road network will generally be in accordance with City of Busselton requirements, and the recommendations of Liveable Neighbourhoods. The design of road cross-sections will accommodate utility services on standard alignments, stormwater drainage, parking bays, and pedestrian facilities as required.

11. Underground Power

The proposed development will be reticulated with underground power using standard Western Power equipment and street lighting to match previous stages.

A high voltage masterplan has been developed and will be updated in accordance with the project staging and lot configuration. The masterplan ensures that HV cabling and equipment use are optimised and that there is sufficient capacity for future stages. It also ensures that there are sufficient isolation/interconnection points which enhance the security of supply during network fault conditions.

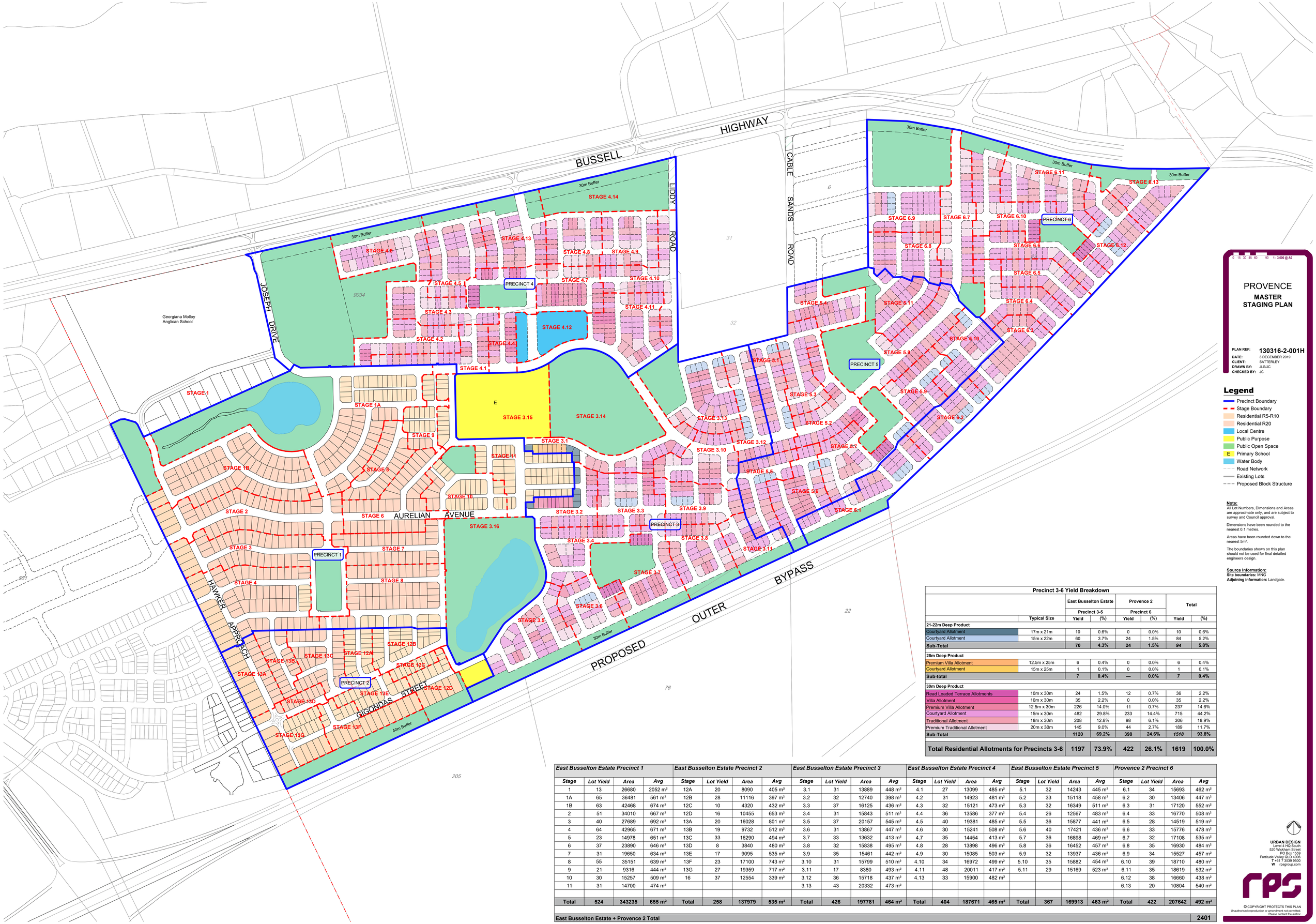
12. Communications

It is likely that the future development will be serviced by NBNCo, who will require fibre ready pit and conduit to be installed by the developer. NBNCo will undertake the fibre optic cabling installation as well as any off site headworks that may be required.

NBNCo's service model aims for all customers to have access to a service provides 25Mbps, but ultimately that 90% of fixed line customers have access to download speeds of 50Mbps.

In addition to the above, there may be off site headworks to which the developer may be required to contribute. These costs are expected to be of a minor nature and can only be determined prior to commencement of the development.

Appendix A RPS Structure Plan (3 December 2019)



PROVENCE
MASTER STAGING PLAN

0 15 30 45 60 90 1:3,000 @ A0

PLAN REF: 130316-2-001H
DATE: 3 DECEMBER 2019
CLIENT: SATTERLEY
DRAWN BY: JLS/JC
CHECKED BY: JC

Legend
- Precinct Boundary
- Stage Boundary
- Residential R5-R10
- Residential R20
- Local Centre
- Public Purpose
- Public Open Space
- E Primary School
- Water Body
- Road Network
- Existing Lots
- Proposed Block Structure

Note:
All Lot Numbers, Dimensions and Areas are approximate only, and are subject to survey and Council approval.

Dimensions have been rounded to the nearest 0.1 metres.

Areas have been rounded down to the nearest 5m².

The boundaries shown on this plan should not be used for final detailed engineers design.

Source Information:
Site boundaries: MNG
Adjoining information: Landgate.

Precinct 3-6 Yield Breakdown

		East Busselton Estate		Provence 2		Total	
		Precinct 3-5		Precinct 6			
	Typical Size	Yield	(%)	Yield	(%)	Yield	(%)
21-22m Deep Product							
Courtyard Allotment	17m x 21m	10	0.6%	0	0.0%	10	0.6%
Courtyard Allotment	15m x 22m	60	3.7%	24	1.5%	84	5.2%
Sub-Total		**70**	**4.3%**	**24**	**1.5%**	***94***	**5.8%**
25m Deep Product							
Premium Villa Allotment	12.5m x 25m	6	0.4%	0	0.0%	6	0.4%
Courtyard Allotment	15m x 25m	1	0.1%	0	0.0%	1	0.1%
Sub-total		**7**	**0.4%**	**—**	**0.0%**	***7***	**0.4%**
30m Deep Product							
Read Loaded Terrace Allotments	10m x 30m	24	1.5%	12	0.7%	36	2.2%
Villa Allotment	10m x 30m	35	2.2%	0	0.0%	35	2.2%
Premium Villa Allotment	12.5m x 30m	226	14.0%	11	0.7%	237	14.6%
Courtyard Allotment	15m x 30m	482	29.8%	233	14.4%	715	44.2%
Traditional Allotment	18m x 30m	208	12.8%	98	6.1%	306	18.9%
Premium Traditional Allotment	20m x 30m	145	9.0%	44	2.7%	189	11.7%
Sub-Total		**1120**	**69.2%**	**398**	**24.6%**	***1518***	**93.8%**
Total Residential Allotments for Precincts 3-6		**1197**	**73.9%**	**422**	**26.1%**	**1619**	**100.0%**

East Busselton Estate Precinct 1				*East Busselton Estate Precinct 2*				*East Busselton Estate Precinct 3*				*East Busselton Estate Precinct 4*				*East Busselton Estate Precinct 5*				*Provence 2 Precinct 6*			
Stage	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*	*Stage*	*Lot Yield*	*Area*	*Avg*
1	13	26680	2052 m²	12A	20	8090	405 m²	3.1	31	13889	448 m²	4.1	27	13099	485 m²	5.1	32	14243	445 m²	6.1	34	15693	462 m²
1A	65	36481	561 m²	12B	28	11116	397 m²	3.2	32	12740	398 m²	4.2	31	14923	481 m²	5.2	33	15118	458 m²	6.2	30	13406	447 m²
1B	63	42468	674 m²	12C	10	4320	432 m²	3.3	37	16125	436 m²	4.3	32	15121	473 m²	5.3	32	16349	511 m²	6.3	31	17120	552 m²
2	51	34010	667 m²	12D	16	10455	653 m²	3.4	31	15843	511 m²	4.4	36	13586	377 m²	5.4	26	12567	483 m²	6.4	33	16770	508 m²
3	40	27689	692 m²	13A	20	16028	801 m²	3.5	37	20157	545 m²	4.5	40	19381	485 m²	5.5	36	15877	441 m²	6.5	28	14519	519 m²
4	64	42965	671 m²	13B	19	9732	512 m²	3.6	31	13867	447 m²	4.6	30	15241	508 m²	5.6	40	17421	436 m²	6.6	33	15776	478 m²
5	23	14978	651 m²	13C	33	16290	494 m²	3.7	33	13632	413 m²	4.7	35	14454	413 m²	5.7	36	16898	469 m²	6.7	32	17108	535 m²
6	37	23890	646 m²	13D	8	3840	480 m²	3.8	32	15838	495 m²	4.8	28	13898	496 m²	5.8	36	16452	457 m²	6.8	35	16930	484 m²
7	31	19650	634 m²	13E	17	9095	535 m²	3.9	35	15461	442 m²	4.9	30	15085	503 m²	5.9	32	13937	436 m²	6.9	34	15527	457 m²
8	55	35151	639 m²	13F	23	17100	743 m²	3.10	31	15799	510 m²	4.10	34	16972	499 m²	5.10	35	15882	454 m²	6.10	39	18710	480 m²
9	21	9316	444 m²	13G	27	19359	717 m²	3.11	17	8380	493 m²	4.11	48	20011	417 m²	5.11	29	15169	523 m²	6.11	35	18619	532 m²
10	30	15257	509 m²	16	37	12554	339 m²	3.12	36	15718	437 m²	4.13	33	15900	482 m²					6.12	38	16660	438 m²
11	31	14700	474 m²					3.13	43	20332	473 m²									6.13	20	10804	540 m²
Total	**524**	**343235**	**655 m²**	**Total**	**258**	**137979**	**535 m²**	**Total**	**426**	**197781**	**464 m²**	**Total**	**404**	**187671**	**465 m²**	**Total**	**367**	**169913**	**463 m²**	**Total**	**422**	**207642**	**492 m²**
East Busselton Estate + Provence 2 Total																							**2401**

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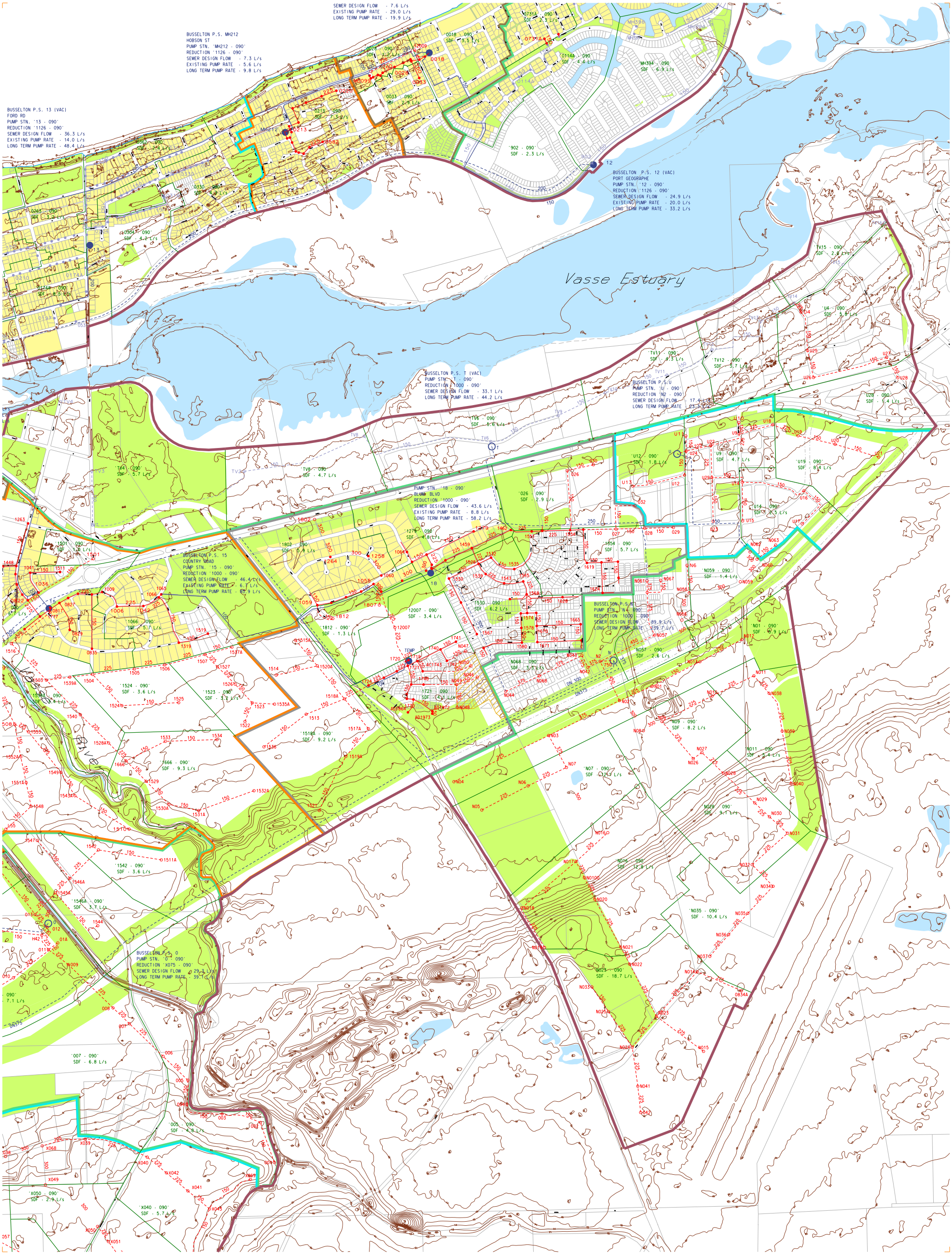
Appendix B Water Corporation Sewer Planning Scheme SD090 – October 2012



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APPENDIX 3.4

LEGEND

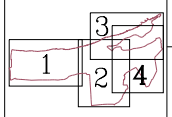
- EXISTING PUMPING STATION
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- PARKS AND PUBLIC OPEN SPACE
- EXISTING SEWERED AREAS
- SEWERED BY PRIVATE PS
- RIVERS, LAKES AND DRAINS
- NODE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT

NOTATION

SEWER DESIGN FLOW - 1.5 x AVERAGE DAILY FLOW RATE
PUMP RATE - LONG TERM PUMP RATE OR EXISTING PUMP RATE IF LARGER

100 0 500
METRES

SHEET INDEX



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WASTEWATER SCHEME PLANNING SERIES

BUSSELTON - SD090
CONCEPTUAL PLANNING
LONG TERM SCHEME: SHEET 4 OF 4

PLANNING BY	COMPILED BY	ACCEPTED BY
C. DELPORT	W. CALLANAN	A. FORMATO
SCALE	VERSION	FILE NO.
1: 10 000	OCTOBER 2012	JT1 2008 06326 V01 A1

Appendix C Geotechnical Report Extract – Golder Associates 2007

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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

DISTRIBUTION:

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August 2007 06642457-R01

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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.

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