LOCAL STRUCTURE PLAN

LOTS 670 AND 1338 BERTRAM ROAD AND RESERVE NO. 50672
WELLARD

OUR REF: 4904 20/06/2017

ROWEGROUP

DOCUMENT CONTROL

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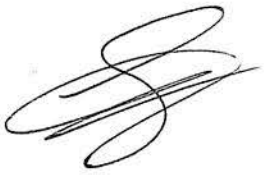
This report has been authorised by;



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RECORD OF ENDORSEMENT

This structure plan is prepared under the provisions of the City of Kwinana Town Planning Scheme No. 2.

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

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

4 August 2017

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

M. Wieclaw Witness

4 - Aug - 2017 Date

4 - Aug - 2027 Date of Expiry

TABLE OF AMENDMENTS

Amendment No.	Summary of the Amendment	Amendment Type	Date Approved by the WAPC

EXECUTIVE SUMMARY

This Local Structure Plan (LSP) addresses Lots 670 and 1338 Bertram Road and Reserve No. 50672 (Lot 1421 on Plan 156437), Wellard. The LSP area comprises 8.3 hectares of urban zoned land which is zoned 'Development' under the City of Kwinana's Town Planning Scheme No. 2.

The site is situated approximately 36 km south of Perth Central Area and approximately 2.5 km south-east of the Kwinana Town Centre. The LSP area is part of the eastern flank of the Bollard Bulrush Swamp which, together with the western flank, forms a residential enclave that is isolated from surrounding residential development by the roads that circulate around the Bollard Bulrush Swamp (being Bertram Road, Wellard Road and Johnson Road).

The Western Australian Planning Commission (WAPC) has approved structure plans for residential development on most of the (approximately 73%) urban zoned land in the Bollard Bulrush Swamp locality (not including the Kings College on Lot 680). The structure plans include the Providence LSP, the Lot 502 Tamblyn Place LSP, the Lot 661 Bertram Road LSP and the LWP (Oakabella) LSP.

This LSP seeks to facilitate the subdivision and development of the land for residential land use in a manner that interacts appropriately with both the developing urban environment in this locality and the adjoining Bollard Bulrush Swamp. Specifically, the LSP will provide for:

- Residential lots with an applicable density of R40; and
- Public Open Space (POS), including wetland buffer and drainage function, which integrates with the adjoining Bollard Bulrush Swamp and ensures the conservation and protection of the wetland.

This LSP is therefore prepared to satisfy the requirements of Town Planning Scheme No. 2 to facilitate subdivision and development of the site. In addition, the LSP acknowledges the City of Kwinana's *Bollard Bulrush East Landscape Master Plan* which provides an integrated plan for the POS at the face of the Bollard Bulrush Swamp in the different structure plan areas surrounding the wetland.

The preparation of this LSP has been undertaken in liaison with the City of Kwinana and government authorities.

Local Structure Plan Summary Table

Item	Data		Section number referenced in report
Total area covered by the Structure Plan	8.52 hectares		1.2.2
Area of each land use proposed:	Hectares	Lot Yield	
Residential	4.6 ha	106 lots	4.1
Public Open Space	1.7 ha	-	4.2
Road and Drainage	2.22 ha	-	4.4
Estimated lot and dwelling yield	101 lots / 108 dwellings		4.3
Estimated residential site density based on a total of 101 lots at a residential site density of R40			4.3
Dwellings Per Gross Urban Hectare (as per Directions 2031)	11.8 dwellings per gross urban hectare (includes the wetland buffer and the drainage basin).		
Dwellings Per Site Hectare (as per Liveable Neighbourhoods and Perth and Peel @ 3.5 million)	21.9 dwellings per site hectare (does not include the wetland buffer and the drainage basin)		
Estimated population	302 people @ 2.8 people per household		4.3
Number of high schools	nil		4.6
Number of primary schools	nil		4.6
Estimated area and % of public open space:			
Total Public Open Space	1.754 ha		4.2
Unrestricted Public Open Space	0.5865 ha		
Restricted Public Open Space	1.2974 ha		

CONTENTS

FIGURES

TABLES

TECHNICAL APPENDICES

Appendix Number	Document Title	Nature of Document	Referral/Approval Agency	Summary of Document Modifications
1.	Certificates of Title	Supporting document only	-	
2.	Fire Management Plan	Approval Required	Department of Fire and Emergency Services / City of Kwinana	
3.	Local Water Management Strategy	Approval Required	Department of Water	

Part One
IMPLEMENTATION

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1. Structure Plan Area

This Structure Plan applies to Lots 670 and 1338 Bertram Road and Reserve No. 50672 (Lot 1421 on Plan 156437), Wellard being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan map (refer Plan 1).

2. Operation

This Structure Plan comes into effect on the day it is approved by the Western Australian Planning Commission.

3. Staging

Development of the site will commence following issue of subdivision approval. Specific staging and timing for the development is unknown at this stage.

4. Subdivision and Development Requirements

a) Residential densities for the structure plan area are the residential densities shown on the Local Structure Plan Map.

b) Public open space is to be provided in accordance with the Local Structure Plan Map.

c) Land use permissibility within the structure plan area shall accord with the corresponding land use classification in the City of Kwinana Town Planning Scheme No. 2.

d) This Structure Plan is supported by a Bushfire Management Plan (BMP), Bush Fire Management Plan – Lots 670 and 1338 and Reserve 50672, Bertram Road, Wellard (FirePlan WA, February 2016), as amended. Any land falling within 100 metres of a bushfire hazard identified in the BMP is designated as a Bushfire Prone Area for the purpose of the Building Code of Australia.

e) Notification(s) on Title

The Council shall recommend to the Western Australian Planning Commission that a condition be imposed on the grant of subdivision approval for a notification to be placed on the Certificate of Title to suitably respond to the following:

- That a lot(s) with a bushfire attack level (BAL) rating of 12.5 or higher is within a designated bushfire prone area and subject to a *Bushfire Management Plan*.
- That the lots are in close proximity to known mosquito breeding areas and that the predominant mosquito species is known to carry viruses and other diseases.

f) Management Plans

The Council shall recommend to the Western Australian Planning Commission that a condition be imposed on the grant of subdivision approval to respond to the following as identified by the structure plan:

- The preparation, approval and implementation of a Wetland Management Plan providing for the conservation of the adjoining Bollard Bulrush Swamp; and
- The preparation and implementation of a mosquito and midge management plan.

5. Local Development Plan(s)

Local Development Plan(s) are to be prepared for lots with one or more of the following attributes:

a) Rear-loaded vehicle access;

b) Having the potential for grouped and/or multiple dwellings;

c) With frontages of less than 12 metres; and

d) With a bushfire attack level (BAL) rating of 12.5 or higher.

6. Other Requirements

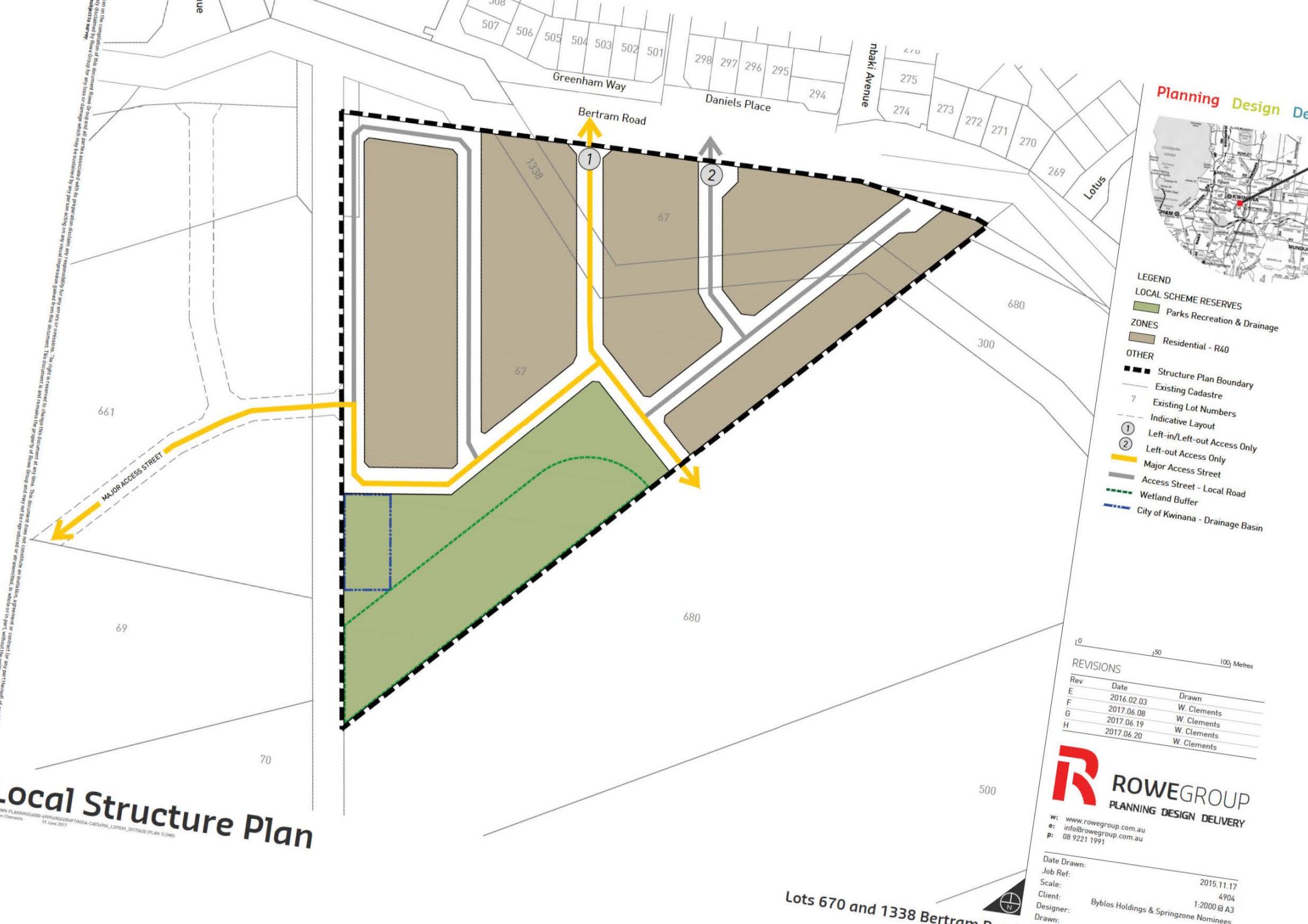
a) Development Contribution Arrangements

Under the City of Kwinana Town Planning Scheme No. 2, the following development contribution arrangements apply and/or are contemplated:

- Development Contribution Plan 1 for the funding of traditional infrastructure;
- Development Contribution Plan 7 for a district sporting ground; and
- Development Contribution Plan 12 for community infrastructure.

b) City of Kwinana Drainage Basin

An agreement between the City of Kwinana and the proponent is to be reached to address land and construction costs associated with the relocation of the City's drainage basin as shown on the Structure Plan Map (Plan 1).



Local Structure Plan

Lots 670 and 1338 Bertram R

Planning Design De

LEGEND

LOCAL SCHEME RESERVES
- Parks Recreation & Drainage

ZONES
- Residential - R40

OTHER
- Structure Plan Boundary
- Existing Cadastre
- 7 Existing Lot Numbers
- Indicative Layout
- 1 Left-in/Left-out Access Only
- 2 Left-out Access Only
- Major Access Street
- Access Street - Local Road
- Wetland Buffer
- City of Kwinana - Drainage Basin

0 50 100 Metres

REVISIONS

Rev	Date	Drawn
E	2016.02.03	W. Clements
F	2017.06.08	W. Clements
G	2017.06.19	W. Clements
H	2017.06.20	W. Clements

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Client:	Byblos Holdings & Springzone Nominees
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Part Two
EXPLANATORY SECTION

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01 Planning Background

1.1 Introduction and Purpose

The purpose of the Local Structure Plan (LSP) is to facilitate the development of the Urban zoned land within Lots 670 and 1338 Bertram Road and Reserve No. 50672 (Lot 1421 on Plan 156437), Wellard (the 'subject site'), for residential purposes.

The LSP will guide future land use and development over the subject site and provide a framework for more detailed planning at subdivision. This Part 2 of the Structure Plan provides explanation for the Part 1 provisions.

1.2 Land Description

1.2.1 Location

The LSP area is located within the metropolitan south-west corridor, within the municipality of the City of Kwinana. The site is situated approximately 36 km south of Perth Central Area, and is accessible via the Kwinana Freeway. The Kwinana Town Centre is located approximately 2.5 km south-east of the subject site.

The subject site is generally bound by Bertram Road to the north, the Peel Main Drain (a road reserve) to the west and other development lots to the south and east.

Refer to Figure 1 – Regional Location.

Refer to Figure 2 – Locality Plan.

1.2.2 Area and Land Use

The LSP area comprises approximately 8.52 hectares and is currently accessed via Bertram Road which connects to the Kwinana Freeway in the east.

The subject site has generally been previously been utilised for rural living purposes and is predominantly cleared with paddocks. There is an existing dwelling located within the northern portion of the site which is to be demolished as part of the redevelopment of the site. The City of Kwinana's drainage infiltration basin also exists within the northwest corner of the site.

1.2.3 Legal Description and Ownership

The LSP comprises three land parcels, being:

Lot Number	Address	Plan/ Diagram No.	Vol./Folio	Land Ownership
670	150 Bertram Road	P66358	2802-877	Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd
1338	No registered address	P184473	1636-857	Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd
1421 (Reserve No. 50672)	No Address	P156437	-	City of Kwinana

Table 1: Lot Details

Refer to Appendix 1 – Certificates of Title.

02 Planning Framework

2.1 Zoning and Reservations

2.1.1 Metropolitan Region Scheme

The subject site is zoned 'Urban' under the Metropolitan Region Scheme (MRS). The subject site was zoned 'Urban' following gazettal of MRS Amendment No. 1296/26.

The land was transferred to the 'Urban' zone under the MRS on 21 April 2015, by notice in the Government Gazette (notice reference PL403). Upon Gazettal of the Urban zone, the site was concurrently zoned 'Development' under the City of Kwinana Town Planning Scheme No. 2, by resolution of the WAPC and notice in the Government Gazette.

Refer to Figure 4 – Metropolitan Region Scheme Map.

2.1.2 City of Kwinana Town Planning Scheme No. 2

The subject site is zoned 'Development' under the City of Kwinana Town Planning Scheme No. 2 (TPS 2).

In accordance with the provisions of the 'Development' zone under the Scheme, a LSP is required as a precursor to subdivision and development. This LSP has therefore been prepared in accordance with provisions of Clause 6.17 of the Scheme.

Refer to Figure 5 – City of Kwinana Town Planning Scheme No. 2 Zoning.

2.2 Regional and Sub-Regional Structure Plan

2.2.1 Directions 2031 and Beyond

Directions 2031 and Beyond provides a broad strategic framework defining the overall visions for the Perth and Peel Regions for the next 20 years. It sets out the planning framework and objectives for the delivery of housing, infrastructure and services to accommodate future projected population growth within both regions. The document primarily seeks to control urban growth by maximising infill of existing urban zoned land. Directions 2031 also sets a density target of 15 dwellings per gross urban zoned hectare.

The subject site is situated within the south-west sub-region, as identified under Directions 2031.

Directions 2031 notes the south-west sub-region will require 41,000 additional dwellings and 41,000 new jobs. Growth will be accommodated by a combination of infill and Greenfields development. The subject site has since been transferred to the 'Urban' zone under the MRS and as such the development of the site will contribute to meeting these growth targets for the wider region.

2.2.2 Draft Perth and Peel @ 3.5 Million

The Draft *Perth and Peel @ 3.5 Million* was released for public comment in May 2015, and seeks to provide a framework for the development of the Perth and Peel regions as the population reaches an estimated 3.5 million by 2050. The document seeks to meet the targets identified under Directions 2031 and the State Planning Strategy 2050. The suite of documents include the over-arching Perth and Peel @ 3.5 million report and four draft planning frameworks for the Central, North-West, North-East and South Metropolitan sub-regions.

The subject site is situated within the South Metropolitan Sub-Region and is identified as 'Urban'. The development of the land for residential purposes is consistent with the draft Peel and Peel @ 3.5 Million framework.

2.2.3 Draft South Metropolitan Peel Sub-Regional Planning Framework

As noted above, the subject site is identified as 'Urban' under the draft South Metropolitan Sub-Regional Planning Framework (the 'Framework'). The development of the subject site will therefore contribute to reaching the urban infill targets specified under the Framework. Urban infill targets for the City of Kwinana are 1,365 dwellings, with an estimated population of 3,003 people. The Framework requires new urban development to meet a residential density target of 15 dwellings per gross hectare of which the LSP is capable of achieving.

2.2.4 Jandakot Structure Plan

The Jandakot Structure Plan (JSP) was adopted in August 2007 and operates as a Sub-regional Structure Plan. The JSP provides a guide to the future land use and development of the study area, the management of environmental influences and attributes in addition to natural resources.

The subject land is identified for urban development and is included within the Short Term Urban Area (0 – 5 years) under the JSP.

The land is located within Area 2: Bertram / Wellard under the JSP, which is expected to house 9,840 people. The proposed LSP will assist in the delivery of housing to the Bertram / Wellard area and is considered to be consistent with the intent and requirements of the JSP.

2.2.5 Eastern Residential Intensification Concept

The Eastern Residential Intensification Concept (ERIC) was prepared by the City of Kwinana as a district level Structure Plan. ERIC provides a framework within which Local Structure Planning can be undertaken. The ERIC was advertised for public comment in 2006, and while it remains in draft form, it has nevertheless as the basis for assessment of Local Structure Plans by both the City of Kwinana and the Department of Planning.

2.3 Planning Strategies

2.3.1 City of Kwinana Draft Local Planning Strategy

The City of Kwinana draft Local Planning Strategy (the 'Strategy') was released for public comment in April 2015 and provides the planning framework and strategic foundation for the future City of Kwinana Town Planning Scheme No. 4.

The subject site is identified under the Strategy as 'Future Residential'.

As the land is zoned 'Development' under TPS 2, the LSP will facilitate the development of the site for residential purposes. In this regard, the proposed LSP is consistent with the intent of the draft Strategy.

2.4 Policies

2.4.1 Liveable Neighbourhoods

Liveable Neighbourhoods (LN) represents the WAPC's primary policy to guide the design and assessment of structure plans and subdivision for new urban development of residential communities in Western Australia. The underlying objective is to create quality neighbourhoods with site responsive

identity supportive of local community that reduce dependency on private vehicles, and are more energy and land efficient. As such, LN focuses on an urban structure based on walkable mixed-use neighbourhoods with interconnected street patterns. It functions by drawing together key policy aspects into a single 'integrated planning and assessment policy' to provide for a performance based approach to planning assessment.

It does so according to a range of considerations including:

- Community;
- Movement;
- Lot Layout;
- Urban Water Management;
- Public Open Space; and
- Schools.

Liveable Neighbourhoods identifies a series of Objectives and Requirements for Local Structure Plans that, when met, demonstrate compliance with the overall outcomes sought by LN. These objectives and requirements relate to items such as road layout, relationship of housing to open space and schools, school location/distribution, POS layout and location and housing densities.

The LSP has been prepared to satisfy the various objectives and requirements of LN to ensure that more detailed proposals at subdivision stage are also capable of satisfying the relevant criteria.

2.4.2 Local Planning Policies

Development within the LSP area shall be in accordance with the following City of Kwinana Local Planning Policies, except where otherwise varied by this LSP, an approved Detailed Area Plan (DAP), or by the City of Kwinana.

- Design Guidelines for Medium Density Development;
- Conservation of Remnant Vegetation;
- Crossovers;
- Footpaths;
- Planning for Bushfire Protection Guidelines;
- Public Open Space;
- Residential Development;
- Residential Subdivision Development Guidelines;
- Residential Subdivision Road Standards;
- Retaining Wall Levels;
- Street Lighting;
- Street Naming; and
- Street Trees and Verge Treatments.

03 Site Conditions and Constraints

3.1 Biodiversity and Natural Area Assets

An Environmental Review (Report 11/079) was prepared over the Wellard Urban Precinct East to support the rezoning of the site from 'Rural' to 'Urban Deferred' (Amendment 118/57). The report identified all environmental factors and their management in relation to potential impacts, management objectives and proposed mitigation and management actions.

With regard to the LSP area, the Environmental Review identified potential threats to the adjacent Bollard Bulrush Swamp to include:

- Alteration to the water regime;
- Habitat modification;
- Inappropriate recreational use;
- Weed invasion; and
- Diminished water quality.

To ensure the protection of the Bollard Bulrush Swamp, a 50m wetland buffer has been identified with other measures such as a Wetland Management Plan and Construction Environmental Management Plan to be implemented as a result of subdivision.

The following provides a summary of the environmental site conditions and constraints. For further information, it is recommended the reader consult the Environmental Protection Authority's Report 1500 (January 2014) relating to Amendment 1188/57. A copy of the report can be accessed from the following link:
http://edit.epa.wa.gov.au/EPADocLib/Rep%201500%20Wellard%20MRS%20ER%20200114%20.pdf.

3.1.1 Flora and Vegetation

A Flora and Vegetation Assessment was prepared as part of the Environmental Review to support the lifting of deferment request.

The subject site was identified as being in 'Completely Degraded' condition as a result of onsite disturbances which includes invasive weeds, livestock grazing and trampling and historical clearing.

3.1.2 Wetlands

The Environmental Review undertaken for the consideration of the MRS rezoning of the land, approved a wetland boundary and wetland buffer in order to delineate the conservation and development areas of the site. Under the Environmental Review determination by the EPA, no portion of the subject site was found to contain any areas of wetland, however, from the southern boundary of the site there is an applicable 50m wetland buffer. It is recommended the reader refer to EPA Report 1500 (January 2014) for details of the wetland decision and the applicable wetland buffer boundaries.

The LSP proposes to retain the area identified as wetland buffer within an area of public open space along the southern boundary of Lot 680 which will be protected from residential development. The area mapped wetland buffer is consistent with the approved wetland boundary and approved 50m buffer as determined by the Environmental Review (refer EPA Report 1500 January 2014).

Refer to Figure 6 – EPA Wetland Management Categories.

3.1.3 Fauna

A Level One Fauna and Fauna Habitat Assessment was undertaken as part of the Environmental Review which included a field survey undertaken by a qualified Zoologist.

As noted above, the subject site is identified as being in 'Completely Degraded' condition and is considered to provide limited or no habitat value for fauna species. The Environmental Review and field survey confirmed that those areas of the site identified as being in 'Degraded' or 'Completely Degraded' condition are considered to provide limited or no habitat value for fauna species.

3.2 Landform and Soils

The subject site is generally flat which slopes gently towards the Peel Main Drain from Bertram Road. The elevation of the land across the site varies between approximately 4.5m AHD to 9.0m AHD.

The site is underlain by swamp deposits (MS_s). MS_s is described as a dark to grey black sandy clay with firm, variable quartz sand content, occasional silty of lacustrine origin.

A fringe of S8 sand encroaches the boundary of the site adjacent to Bertram Road and is described as a Bassendean sand that is very light at the surface and yellow at depth, fine to medium grained, sub-rounded quartz, moderately well sorted, of eolian origin.

3.2.1 Acid Sulphate Soils

The Department of Environmental Regulation (DER) Acid Sulphate Soil Risk Mapping identifies the majority of the site as having 'high to moderate risk of acid sulphate soils occurring within 3m of the natural surface' with a minor portion of the site in the north being identified as having 'moderate to low risk of acid sulphate soils occurring within 3m of the natural soil surface'.

The land is likely to be the subject of filling to facilitate development and therefore Acid Sulphate Soils 3m below the existing surface are unlikely to be disturbed through any excavation works.

3.2.2 Contamination

The Department of Environmental Regulation Contaminated Sites Database does not list the site as being a known or suspected contaminated site.

3.3 Groundwater and Surface Water

3.3.1 Groundwater

Groundwater on the site generally flows a south-westerly direction towards the Peel Main Drain. The maximum groundwater level is below natural surface across the majority of the Study Area, ranging from 0m clearance in the south west to 2m in the north east. These Maximum Groundwater Contours do not appear to include the drawdown influence of the Peel Main Drain. Regardless of the localised drawdown, the adopted MGL for design is considered a conservative approach.

Regional groundwater level seasonal variation on the Swan Coastal Plain is in the order of 1.5m, however due to the close proximity of the Bollard Bulrush Swamp, the groundwater level seasonal variation has been calculated by JDA to be 0.8m from nearby Department of Water Bore T240 (I).Surface Water

Pre-development surface water quality has not yet been undertaken within the site, however the Peel Main Drain which is adjacent to the Study Area has been monitored. The Jandakot DWMP indicates that Total Phosphorous and Total Nitrogen concentrations are low in comparison to the ANZECC (2000)

trigger values for streams in south-west Western Australia. These results are to be used to provide baseline water quality parameters for future development of the Study Area.

The long term targets for Total Phosphorous and Total Nitrogen for the Peel Main Drain as identified in the Jandakot DWMP are 0.1mg/L and 1.0mg/L respectively.

3.4 Bushfire Hazard

A Bushfire Management Plan has been prepared for the LSP in accordance with the WAPC's Planning for Bushfire Protection Guidelines 2010. The Bushfire Management Plan has considered the requirements of draft State Planning Policy 3.7: Planning for Bushfire Risk and Management. The Bushfire Management Plan is provided within Appendix 3, however the following provides an overview of the fire management assessment undertaken and applicable provisions to development of the site.

3.4.1 Hazard Assessment

The Bushfire Management Plan (BMP) identifies the site as comprising predominantly a low to moderate fire hazard threat with the area of extreme bushfire hazard being identified from the adjoining wetland. Specifically, the bushfire hazard assessment for the site is identified as follows:

- Grassland Class G: Low
- Scrub Class D: Moderate
- Open Forest Class A: Extreme located Wetland Open Forest to the south of the site.

The development of the LSP area as per the proposed layout will result in a reduced threat of bushfire due to urbanisation of the site and removal of bushfire prone vegetation.

3.4.2 Management Requirements

The FMP proposes a variety of measures to manage the fire hazard, including:

- A minimum 20 metre Building Protection Zones separating future development from fire hazard;
- Dwelling construction to a standard to align with the designated bush fire attack level (BAL) within the Building Protection Zone;
- A section 165 *Planning and Development Act 2005* notification on the title of lots with a bushfire attack level of 12.5 or higher to inform prospective purchasers that the lot is within a bushfire prone area as designated by the Fire and Emergency Services Commissioner, is subject to a Bushfire Management Plan and that, potentially, there are additional planning and building requirements.
- Compliance with the annual Fire Control Notice issued by the City of Kwinana under the Act.

The Fire Management Plan will be required to be implemented as a condition of subdivision approval.

3.5 Heritage

3.5.1 Indigenous Heritage

A search of the Department of Aboriginal Affairs Aboriginal Heritage Inquiry System identified no registered sites within the LSP area or immediate surrounds.

3.5.2 Non-Indigenous Heritage

No places were identified on the Heritage Council of Western Australia Heritage Places Database or the City of Kwinana Municipal Heritage List for the LSP area.

04 Land Use and Subdivision Requirements

4.1 Land Use

The LSP sets out land use, residential densities, public open space, vehicle and pedestrian access and servicing requirements.

The LSP is proposed to comprise residential development with densities ranging from R25 to R40. The LSP also comprises public open space in accordance with Liveable Neighbourhoods requirements.

The following describes the design response proposed under the LSP and addresses the relevant elements of Liveable Neighbourhoods. Please refer to the land use summary table provided within the Executive Summary on Page iii of this report.

Please also refer to Plan 1 – LSP.

4.2 Public Open Space

The LSP provides for approximately 1.754 ha of public open space (POS) within a single parcel within the southern portion of the site.

Refer Figure 7 – Public Open Space Plan.

The below Public Open Space Schedule provides a breakdown of the POS within the LSP area.

Lot 670 and Lot 1338 Bertram Road, Wellard – Public Open Space Schedule			
Site Area (Local Structure Plan boundary)			8.52 ha
Less			
City's Drainage Basin		0.185 ha	
Total		**0.185 ha**	
Net Site Area			**8.33 ha**
Deductions			
Drainage (1:1 yr)		0.08 ha	
Total		**0.08 ha**	
Gross Subdivisible Area			**8.26 ha**
POS @10%			0.83 ha
Public Open Space Contribution			
May comprise: - Min 80% unrestricted POS - Min 20% restricted use POS		 0.66 ha 0.17 ha	
Total Required POS			**0.83 ha**
POS Reference Number		**Unrestricted Urban POS sites (m^2)**	**Restricted Urban POS sites (m^2)**
POS 1	1.754	0.587 ha	1.089 ha
Total	**1.754 ha**	**0.587 ha**	**1.089 ha**
Restricted POS Surplus			**0.919 ha**
Revised Unrestricted POS Calculation (8%) 7.341 ha revised Gross Subdivisible Area		0.58 ha	
TOTAL POS PROVIDED:		**0.587 ha**	**1.089 ha**
		8.00%	**8.95%**

Table 2: POS Schedule

The area of POS is located adjacent to the Bollard Bulrush Swamp which is a Conservation Category Wetland to be protected as part of the urbanisation of the precinct. Areas of POS abutting the Bollard Bulrush Swamp will serve a range of functions, both active and passive recreation, in accordance with the City of Kwinana's *Bollard Bulrush East Landscape Master Plan* for the locality.

The *Bollard Bulrush East Landscape Master Plan* identifies a number of features within the LSP area, including:

- A future bridge link over the Peel Main Drain;
- A red asphalt dual use path which also provides secondary fire access;
- A 3m wide limestone firebreak;
- A stormwater detention basin;
- Playground equipment;

- Fitness equipment;
- Public open space area;
- Revegetation planting 'B' within the buffer zone with an average density of 1 plant per 2m² but clumped around existing vegetation interspersed with areas of thick woodchips to suppress weeds; and
- Revegetation planting 'A' to wetland side, density of 1 plant per m².

The City of Kwinana's drainage basin is currently located within Lot 1421 on Plan 156437 which abuts Bertram Road in the north of the site. At present, drainage from Lot 1421 is directly draining into the Peel Main Drain, which is not supported by the Water Corporation as a long term solution. To address this issue, the City proposes to relocate the existing drainage basin to a new location within Lot 670 which integrates with the proposed development drainage basin and POS of the development. In this regard, the City's future drainage requirements have been accommodated in the southern area of POS adjacent to the Peel Main Drain and will be integrated within the subject development. It is intended that the City will purchase from the owners of Lot 670, land for its share of the drainage basin. It is also intended that a proportional contribution to the construction of the basin will occur between the City and the owners of Lot 670.

In accordance with the Local Water Management Strategy prepared by JDA for the site, an indicative bioretention basin of 780m² has been provided for adjacent to the wetland buffer area. This basin will accommodate drainage from the internal road network up to the 15mm rainfall event with larger events ultimately flowing toward the wetland area and the Peel Main Drain.

As previously noted under Section 3.1.2, the subject site is located adjacent to the Bollard Bulrush Swamp which abuts the south-eastern boundary of the site. An area of 1.0885 hectares has been set aside to accommodate the required 50m buffer to the wetland as shown on the LSP Plan 1. The wetland buffer will need to be managed in accordance with an approved Wetland Management Plan in accordance with the EPA's requirements

In accordance with Liveable Neighbourhoods, POS is provided within 200 metres of all lots within the LSP area.

4.3 Residential

The LSP proposes an average residential density of 21.9 dwellings per residential site hectare and 11.8 dwellings per gross urban hectare, including the Bollard Bulrush Swamp buffer and City of Kwinana drainage basin. It is noted that the dwellings per gross hectare calculation would increase to 13.9 when the Bollard Bulrush Swamp buffer and City of Kwinana drainage basin are excluded from the gross urban area. This is generally consistent with the requirements of Liveable Neighbourhoods which stipulates a minimum average of 22 dwellings per site hectare for greenfield subdivision areas. This is also generally consistent with Directions 2031 and the Draft Sub-Regional Planning Framework which targets a minimum of 15 dwellings per gross urban hectare.

Based on these target densities, the subject site will need to achieve a minimum yield of 101 dwellings. Preliminary concept planning undertaken for the subject site indicates the proposed LSP layout is capable of achieving this.

The LSP proposes a blank residential density code of R40. This has been applied due to the small size of the LSP area and its irregular configuration with the area of POS adjacent to the Bollard Bulrush

Swamp. A blanket residential density of R40 will facilitate development flexibility and a diversity of lot products and dwelling types to the Wellard locality.

The preparation of Local Development Plans can also assist in facilitating the delivery of diversity in housing product, as well as seeking to achieve built form outcomes consistent with the development intent of the site.

4.4 Movement Networks

The following provides a brief summary of the proposed movement network.

4.4.1 Existing Road Network

Bertram Road

Access to the site is currently taken from Bertram Road which forms the northern boundary of the subject site. Bertram Road is constructed as a dual divided carriageway which connects to Mortimer Road in the east and Challenger Avenue in the west. Mortimer Road connects to the Kwinana Freeway which affords the land with high accessibility to the strategic regional road network.

Access to and from Bertram Road is restricted to left-in, left-out in its current form due to a central median which runs down the road reserve.

The proposed LSP maintains the existing access scenario, restricting access to Bertram Road to a single point of access in a left-in, left-out arrangement only.

Challenger Avenue

Challenger Avenue is located approximately 120 metre west of the subject site and is accessed via Bertram Road. Challenger Avenue is constructed as a single divided carriageway which provides a direct connection to the Kwinana Town Centre.

Johnson Road

Johnson Road is located approximately 800 metres south-east of the subject site which connects to Millar Road in the south. Access to Johnson Road from the subject site is via Bertram Road to the east.

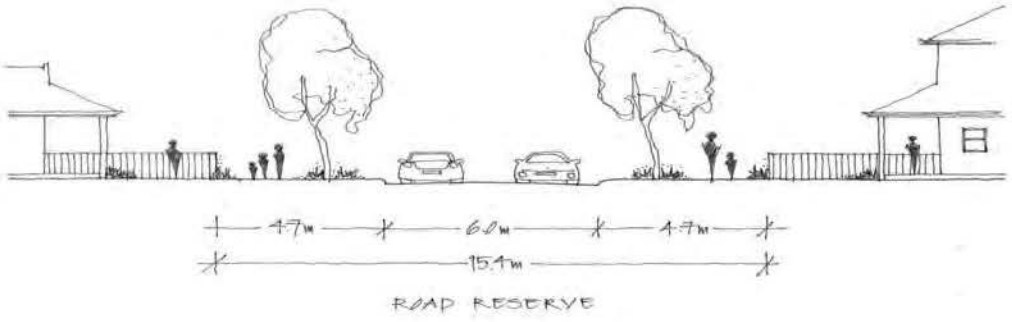
4.4.2 Proposed Road Network

The proposed road network is largely defined by access requirements to Bertram Road and future connection points to adjoining development areas. Direct lot access to Bertram Road shall not be permitted as part of the development of the site.

External road connections are provided in two locations within the LSP area, being north to Bertram Road and west over the Peel Main Drain as required by the relevant development contribution plan. An additional "left-out" only access point is provided to Bertram Road, primarily to facilitate compliant vehicle access in accordance with Acceptable Solutions A3.1 of the *Guidelines for Planning in Bushfire Prone Areas*.

The proposed road network predominantly consists of Access Street C roads, designed to a 15.4 metre cross-section. The LSP also proposes a 'major access street' running centrally through the site from Bertram Road and to the face of the Bollard Bulrush Swamp. The major access street is proposed with a road reserve width of 17m and is intended to provide a future connection to development to the west (across the Peel Main Drain) and to the south, beyond Lot 680 (currently occupied by the King's College).

TYPICAL ACCESS STREET C ROAD CROSS-SECTION



The LSP proposes two cul-de-sacs to Bertram Road to ensure access to and from Bertram Road is restricted to a single point of access and ensuring permeability for pedestrians to the overall road network

Estimated traffic volumes along the Access Street C road reserves are not expected to exceed 1,000 vehicle movements per day. This is consistent with Liveable Neighbourhoods requirements for Access Street C, which caters for traffic volumes less than 3,000 vehicle movements per day.

4.4.3 Public Transport

The LSP area is located within 3km to both the Kwinana and Wellard Railway Stations affording the land high accessibility to the public transport network. Transperth Bus Service 543 traverses Bertram Road west of Johnson Road and connects the site to both the Kwinana Railway Station and the Kwinana Town Centre, along with the broader public transport network.

Bus Stop No. 22987 is located along the northern boundary of the subject site on Bertram Road, approximately 30m west of entry to the site. Bus Stop 22988 is located on the adjacent side of Bertram Road, approximately 70m of the subject site.

4.4.4 Pedestrian and Cycle Networks

In accordance with Liveable Neighbourhoods requirements, footpaths will be provided on at least one side of every street.

4.5 Water Management

4.5.1 Regional Water Management Strategy

The Jandakot Drainage and Water Management Plan (JDWMP) was released by the Department of Water in December 2009. The JDWMP provides district scale flood modelling, a surface water management strategy and a groundwater management strategy, which specify post-development levels and flows to address the City of Kwinana's District Structure Plan (ERIC).

4.5.2 District Water Management Strategy

A District Water Management Strategy (DWMS) was prepared in 2015 and provides revised drainage management concepts based on the JDWMP for the area east of Bollard Bulrush Swamp. Specific discharge rates and conceptual estimated attenuation volumes are provided in the DWMS for sub-catchments of the Bollard Bulrush Swamp east catchment The DWMS also provides appropriate

district scale water design and management principles and objectives which are refined in the Local Water Management Strategy.

The DWMS has been approved by both the City of Kwinana and the Department of Water.

4.5.3 Local Water Management Strategy

A Local Water Management Strategy (LWMS) has been prepared in support of this LSP, and is provided as Appendix 4.

The LWMS addresses the LSP area, and provides a refinement of flood modelling, the surface water management strategy and the groundwater management strategy to a local scale. The LWMS has been prepared in accordance with the water sensitive urban design practices as described in the Stormwater Management Manual of WA and the WAPC's Better Urban Water Management (2008).

4.5.4 Proposed Drainage Network and Infrastructure Requirements

4.5.4.1 Regional / District Drainage

The subject site is located within the Peel Main Drain and Bollard Bulrush Swamp catchments which are significant in post-development regional flood management. The DWMS identified the required storage volumes within the East Precinct in the 10 and 100 year ARI as 12,146m³ and 15,790m³ respectively. This is based on a percentage ratio approach. As such, the required detention volumes in the Study Area are 1,020m³ in the 10yr ARI event and 1,326m³ in the 100yr ARI event.

As summarised in the LWMS, the above criterion was later superseded following advice from the Department of Water at an on-site meeting in 2014 with a neighbouring proponent. It was agreed that the development will retain, treat and infiltrate the first 15mm (small events), with the preferred management of this first 15mm being as close to source as possible. Additional stormwater for greater events is to be directed towards another biofiltration area located within the POS adjacent to the wetland and its buffer. Excess stormwater will discharge slowly as sheet flow overland into the wetland area as it does pre-development with scour and erosion protection. No infrastructure is to be included within the wetland or its buffer.

This approach has been accepted and applied to the subject site, therefore no attention of the 10yr and 100yr ARI peak volume is provided. The bioretention basin has been sized to hold the first 15mm of stormwater from the development. It is expected that the wetland and buffer itself will act as the detention storage areas, so pre and post development flows will inherently match.

4.5.4.2 Local Drainage

The local stormwater drainage system has been designed using a major/minor approach. The minor system consists of pipes, kerbs and gutters designed to convey the stormwater to the median swales, roadside swales and bioretention basins designed to infiltrate stormwater as close to the source as possible. The major system consists of the road, median and road-side swales, bioretention basins and POS areas to provide protection of the community from extreme flooding events (up to the 100 year ARI rainfall event) that exceed the capacity of the minor system.

The existing City of Kwinana Bertram Road infiltration basin will be relocated within the POS area and will be managed separately to stormwater runoff from the Study Area.

The major drainage system has been designed to accommodate rainfall events greater than 15mm. Stormwater run-off from the development will be directed along the roads towards the swale and basin system. When the capacity of the swale and bioretention basin is reached, overflow will be

directed towards the wetland buffer and storage area, which will be designed to minimise erosion and scouring during discharge events. The larger events will ultimately flow toward the wetland area and the Peel Main Drain.

The key elements of the stormwater management strategy area:

- To retain, treat and infiltrate the first 15mm of the rainfall event across the development area.
  - Retention of the first 15mm of rainfall on lots within soakwells or other infiltration structures.
  - To treat the first 15mm of rainfall event from roads through bioretention areas/swales or other techniques as close to source as feasible.
- Any additional stormwater run-off created during rainfall events greater than 15mm will be directed towards the wetland buffer.
- No stormwater infrastructure will be constructed within the CCW wetlands or its buffers.
- The discharge of these larger stormwater run-off events should occur as sheetflow across a vegetation surface towards the wetland buffer to replicate the pre-development environment (with scour and erosion protection at the initial discharge point).
- Bioretention areas should be located outside of the 10yr ARI Top Water Level (TWL) boundary.
- The City of Kwinana Bertram Road infiltration basin will be relocated within the POS within the subject site, with the concept design to be completed by the City. Stormwater discharged into this basin will be managed separately to stormwater runoff from the Study Area.
- Habitable floor levels are to be minimum 6.12m AHD above the adjacent Peel Main Drain 100yr ARI flood level.
- There is to be a minimum of 500mm clearance from the base of any bioretention basins or swales to the Maximum Groundwater Level (MGL) at that specific location.
- Use of subsoil drains to mitigate the rise of groundwater within fill and maintain a minimum separation of 1.5m between MGL and finished lot level.

The design strategy is generally consistent with the objectives provided within the DWMS and the drainage approach most recently adopted by the Department of Water for an adjacent development.

In accordance with the processes defined under *Better Urban Water Management*, an Urban Water Management Plan (UWMP) will be required to be prepared and implemented at the time of subdivision. The UWMP will refine and implement the proposed drainage network/system, as defined under the LWMS.

4.6 Education Facilities

The LSP does not propose any primary, secondary or tertiary education facilities consistent with both the ERIC and the JSP.

The site is well catered for with existing and planned educational facilities within the surrounding urban areas including the existing Bertram Primary School, King's College, St Vincent's Primary

School and Gilmore College. In addition, there are future Primary School sites identified at the southern end of the Emerald Park Structure Plan and the Wellard Village Structure Plan along with an additional High School.

4.7 Activity Centres and Employment

The LSP does not propose any retail or commercial uses, consistent with *SPP 4.2: Activity Centres for Perth and Peel*, and the City of Kwinana *Local Commercial and Activity Centres Strategy*. Further, it is noted the land is not remote from a developed urban front and an employment strategy is therefore not required.

The site is catered for existing and planning employment and activity centres in the surrounding urban areas including the Kwinana Industrial Area, Latitude 32, Rockingham Strategic Regional Centre, Kwinana Secondary Centre, Bertram Neighbourhood Centre and the future Activity Centre in the Emerald Park estate on Johnson Road to the south.

4.8 Infrastructure Coordination, Servicing and Staging

Wood and Grieve Consulting Engineers have confirmed there are no significant constraints to servicing the Structure Plan area with all required urban utilities.

The following provides a summary of the infrastructure and servicing for the LSP area:

4.8.1 Water Supply

The Water Corporation has advised that supply to the development can come from the existing DN300 water main within Johnson Road. Upgrades to the water distribution infrastructure may be required to service the ultimate development however, Water Corporation water planning is currently under review.

4.8.2 Sewerage

The Water Corporation's wastewater planning over the development area indicates that there is currently capacity within the existing Bertram Road wastewater pump station located to the north west of the site which can accommodate gravity flows from the subject site.

4.8.3 Natural Gas

ATCO Gas has advised that the development can be supplied from connection into existing gas mains at Tamblyn Place / Johnson Road intersection. The installation of gas mains will be undertaken by ATCO Gas.

4.8.4 Electricity

The proposed development will likely be serviced via connection to existing underground power cables within Bertram Road.

4.8.5 Telecommunications

In accordance with the National Broadband Network (NBN) legislation, developers are required to fund the design and installation of infrastructure suitable for handover to NBN Co. The developers will construct the pit and pipe telecommunications infrastructure across the site to enable the NBN Co. provision of services.

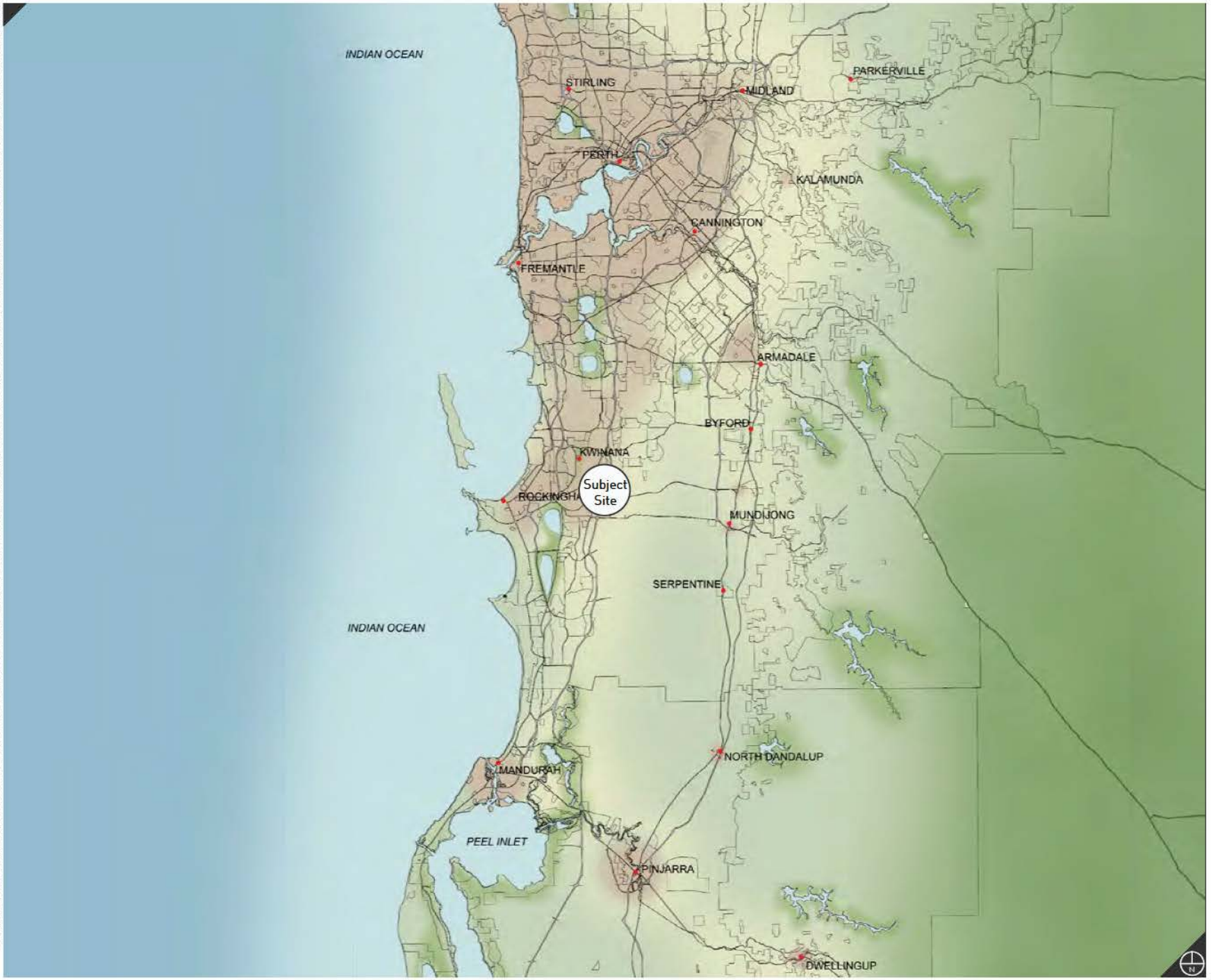
4.9 Developer Contribution Arrangements

The City of Kwinana recently advertised its Community Infrastructure Plan and associated Town Planning Scheme Amendments, Amendment 100A and Amendment 145. Amendment 100A addresses 'hard' infrastructure items and identifies the site under Development Contribution Area 7 – Wellard West / Bertram (DCA 7). In accordance with the advertised Amendment documentation, development contributions are to be collected from landowners to fund the District Sporting Ground. The costs for DCA 7 are estimated at $1,513,770 with contributions being made at a 'price per hectare' rate of $3,792.66. The advertised Amendment states a net contribution of $24,599.14 is required for Lot 670 Bertram Road.

Concurrent with Amendment 100A, the City is also advertising Amendment 145 to TPS 2 which identifies the site under Development Contribution Area 12 – Wellard West (DCA 12) which addresses 'soft' or 'community' infrastructure items. DCA 12 currently requires landowners to contribute funds towards '1 Local Sports Ground with Pavilion'. Under Amendment 145, development contributions are required from landowners to fund '1 Local Sports Ground with combined Local Community Centre / Pavilion'. The advertised cost per dwelling amount is $5,759.78 per lot, however it is noted this is subject to both Council and WAPC approval.

FIGURES

ROWEGROUP



Regional Location

N:\TOWN PLANNING\4000-4999\4904\DRAFTING\A-CAD\4904_FIG01A_20151008 [REGIONAL LOCATION].DWG
William Clements 8 December 2015

Planning Design Delivery

REVISIONS

Rev	Date	Drawn
A	2015.10.13	W. Clements

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w: www.rowegroup.com.au
e: info@rowegroup.com.au
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Date Drawn:	2015.10.09
Job Ref:	4904
Scale:	N/A @ A4
Client:	Byblos Holdings & Springzone Nominees
Designer:	R. Dial
Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-01-A

Map data supplied by WA Planning Commission

Lots 670 and 1338 Bertram Road
Wellard
Figure 1

Planning Design Delivery

LEGEND

Subject Site

REVISIONS

Rev	Date	Drawn
A	2015.10.13	W. Clements

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Client:	Byblos Holdings & Springzone Nominees
Designer:	R. Dial
Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-02-A

Map data supplied by Streetsmart

Local Location

N:\TOWN PLANNING\4000-4999\4904\DRAFTING\A-CAD\4904_FIG02A_20151008 [LOCAL LOCATION].DWG
William Clements 8 December 2015

Lots 670 and 1338 Bertram Road
Wellard
Figure 2

Planning Design Delivery

LEGEND

- Subject Site
- Contours
- 7 Existing Lot Numbers
- Existing Boundaries
- Water
- Sewer
- Power
- Power Pole

REVISIONS

Rev	Date	Drawn
A	2015.10.13	W. Clements

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Client:	Byblos Holdings & Springzone Nominees
Designer:	R. Dial
Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-03-A

Aerial photography capture and supplied by Nearmap

Site Plan

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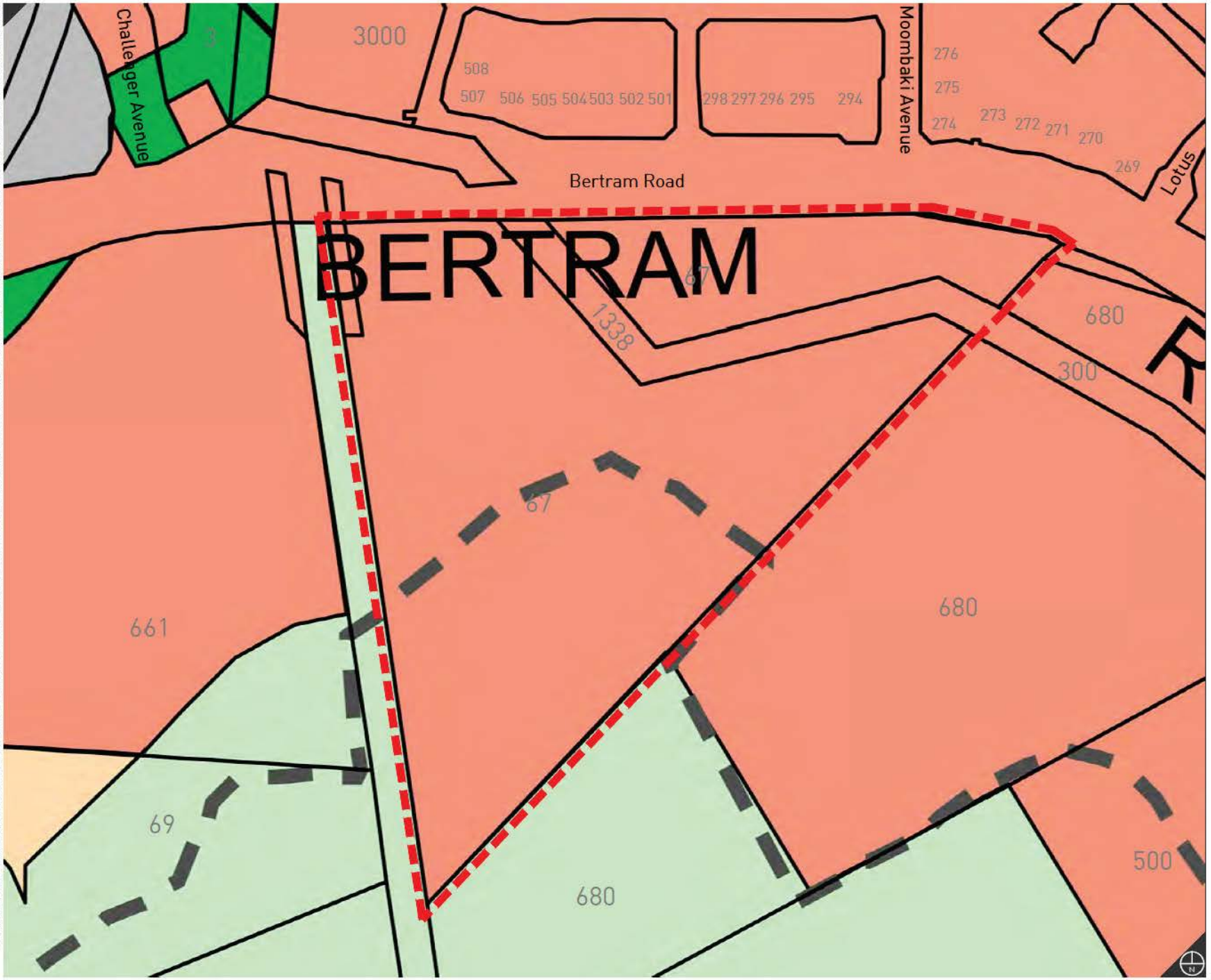
William Clements 8 December 2015

Lots 670 and 1338 Bertram Road
Wellard
Figure 3



Planning Design Delivery

LEGEND

- Subject Site
- 7 Existing Lot Numbers

RESERVED LANDS

- Parks and Recreation
- Railways

ZONES

- Urban
- Urban Deferred
- Rural

NOTICE OF DELAGATION

- Bush Forever Area

REVISIONS

Rev	Date	Drawn
A	2015.10.13	W. Clements

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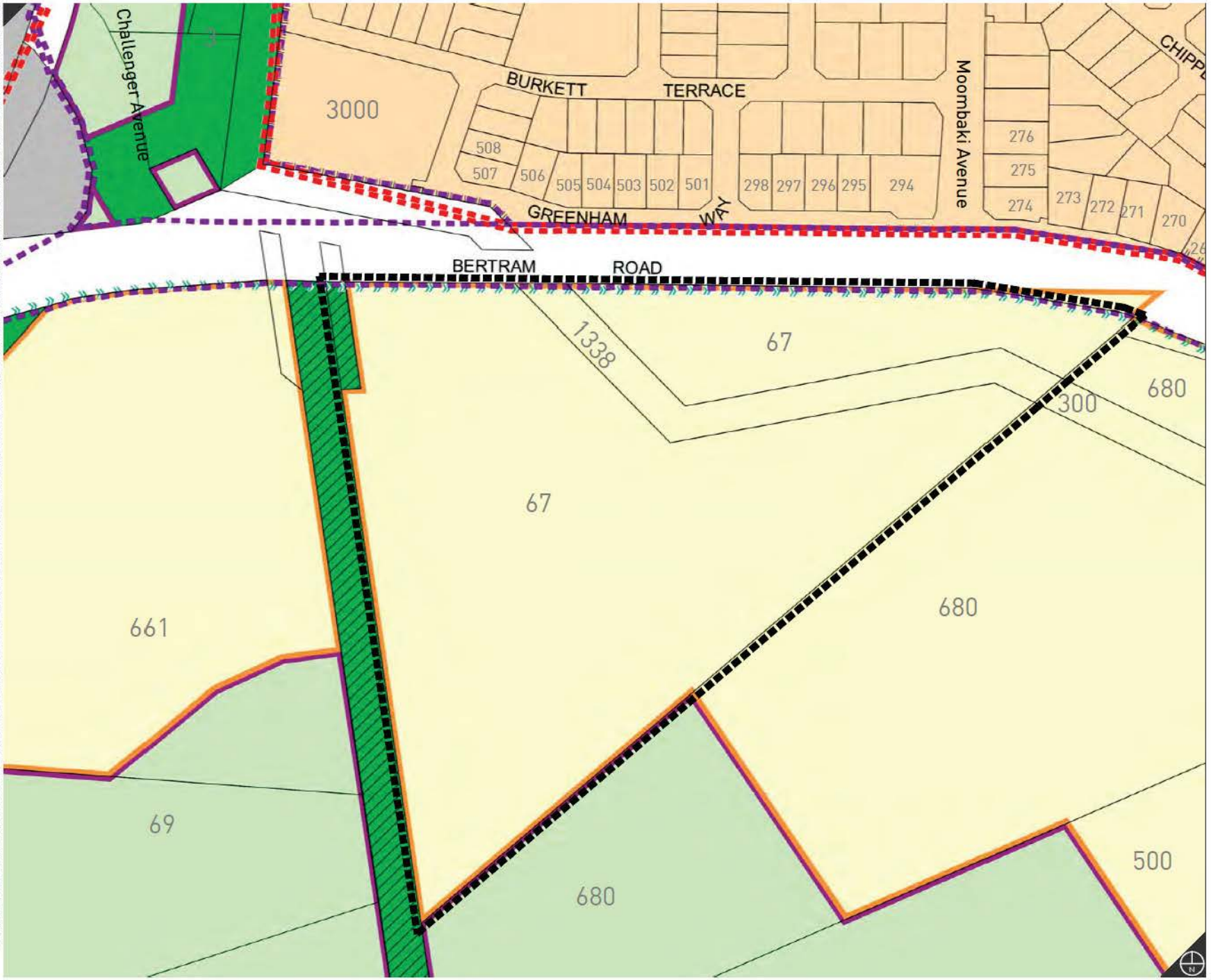
Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-04-A

Map data supplied by Western Australian Planning Commission

Metropolitan Region Scheme

N:\TOWN PLANNING\4000-4999\4904\DRAFTING\A-CAD\4904_FIG04A_20151008 [MRS].DWG
William Clements 8 December 2015

Lots 670 and 1338 Bertram Road
Wellard
Figure 4



Town Planning Scheme No. 2

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William Clements 8 December 2015

Lots 670 and 1338 Bertram Road
Wellard
Figure 5

Planning Design Delivery

LEGEND

- Subject Site
- 7 Existing Lot Numbers

METROPOLITAN REGION SCHEME RESERVES

- Parks/ Recreation/ Drainage
- Railways

LOCAL SCHEME RESERVES

- Local Road

ZONES

- Development
- Residential
- Rural A

OTHER

- Development Area
- Policy Areas
- Area of Landscape Protection
- R20 R Codes

REVISIONS

Rev	Date	Drawn
A	2015.10.13	W. Clements

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Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-05-A

Map data supplied by Western Australian Planning Commission

Planning Design Delivery

LEGEND

Subject Site

REVISIONS

Rev	Date	Drawn
A	2015.10.13	W. Clements
B	2015.10.14	W. Clements
C	2015.12.08	W. Clements

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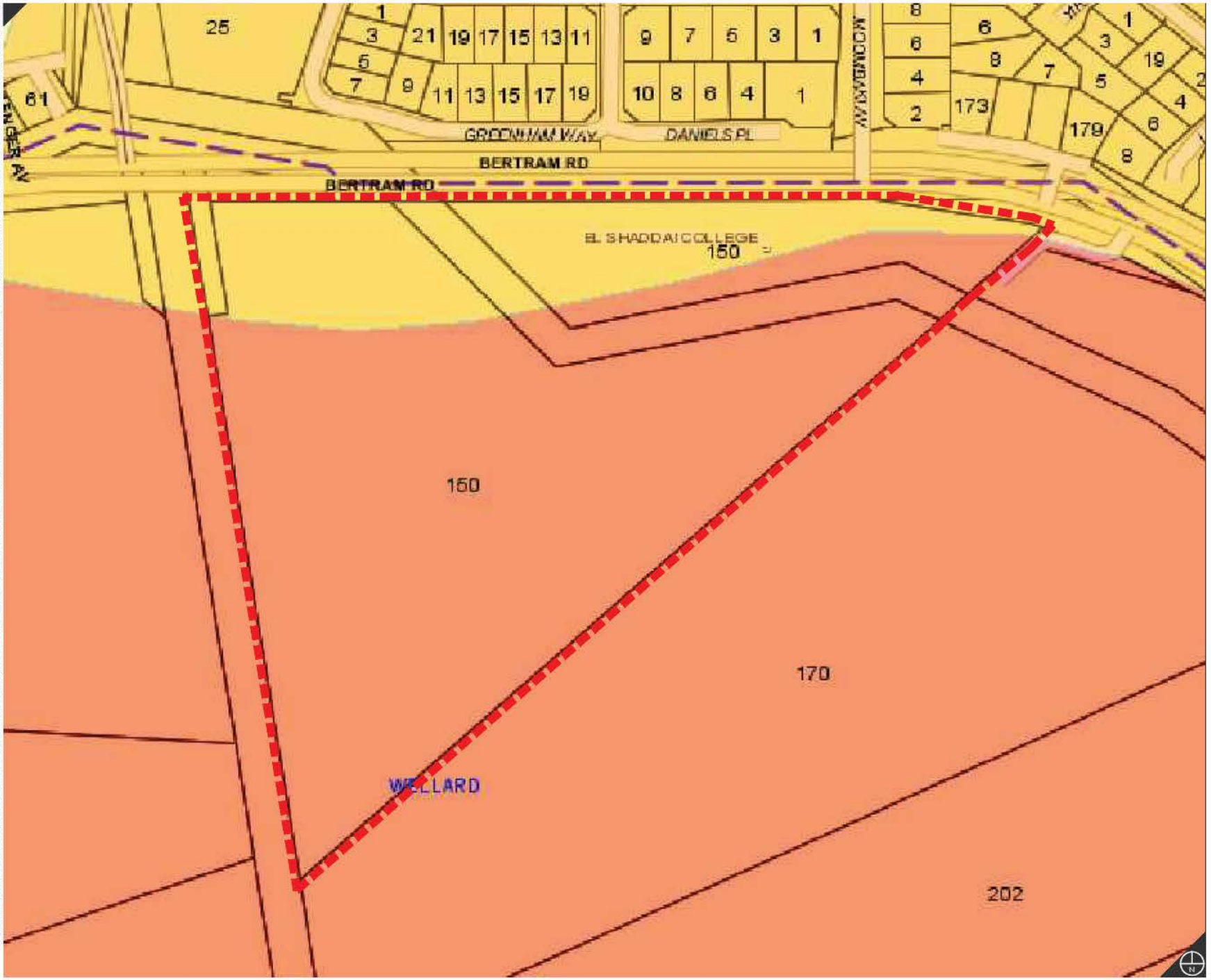
Scale:	N.T.S. @ A4
Client:	Byblos Holdings & Springzone Nominees
Designer:	R. Dial
Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-06-C

Cadastre supplied by Water Corporation of W.A.

EPA Wetland Management Categories

Lots 670 and 1338 Bertram Road
Wellard
Figure 6

N:\TOWN PLANNING\4000-4999\4904\DRAFTING\A-CAD\4904_FIG06C_20151208 [WETLAND LOCATION].DWG
Matt Sullivan 10 December 2015



Planning Design Delivery

LEGEND

- Subject Site
- Class 1
- Class 2

REVISIONS

Rev	Date	Drawn
A	2015.10.09	W. Clements

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Job Ref:	4904
Scale:	1:3000 @ A4
Client:	Byblos Holdings & Springzone Nominees
Designer:	R. Dial
Drawn:	W. Clements
Projection:	MGA50
Plan ID:	4904-FIG-07-A

Map data supplied by WA Atlas

Acid Sulphate Soils

N:\TOWN PLANNING\4000-4999\4904\DRAFTING\A-CAD\4904_FIG07A_20151008 [ACID SULPHATE].DWG
William Clements 8 December 2015

Lots 670 and 1338 Bertram Road
Wellard
Figure 7

Planning Design Delivery

LEGEND

- Subject Site
- Existing Cadastre
- 7 Existing Lot Numbers
- Indicative Layout
- Public Open Space
- Indicative Bioretention Area (subject to agreed final location)
- City of Kwinana - Drainage Basin
- Wetland Buffer
- 200m Walkable Catchment

REVISIONS

Rev	Date	Drawn
A	2015.11.17	W. Clements
B	2015.12.08	W. Clements
C	2016.01.29	W. Clements
D	2016.02.03	W. Clements

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w: www.rowegroup.com.au
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Date Drawn:	2015.11.17
Job Ref:	4904
Scale:	1:2000 @ A3
Client:	Byblos Holdings & Springzone Nominees
Designer:	R. Dial
Drawn:	W. Clements
Projection:	MGA50 GDA94
Plan ID:	4904-FIG-08-D

Cadastre supplied by Watercorp

Public Open Space Plan

N:\TOWN PLANNING\4000-4999\4904\DRAFTING\A-CAD\4904_FIG08_20160203 [PUBLIC OPEN SPACE].DWG
William Clements 4 February 2016

Lots 670 and 1338 Bertram Road
Wellard
Figure 8

Part Three
TECHNICAL APPENDICES

ROWEGROUP

APPENDIX 1

CERTIFICATES OF TITLE

ROWEGROUP

WESTERN AUSTRALIA

REGISTER NUMBER	
670/DP66358	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	5/12/2012

RECORD OF CERTIFICATE OF TITLE

VOLUME 2802 FOLIO 877

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 670 ON DEPOSITED PLAN 66358

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SPRINGZONE NOMINEES PTY LTD OF POST OFFICE BOX 369, CLOVERDALE
IN 1/2 SHARE
BYBLOS HOLDINGS PTY LTD OF UNIT 4, 190 ABERNETHY ROAD, BELMONT
IN 1/2 SHARE
AS TENANTS IN COMMON

(AF M085857) REGISTERED 26 OCTOBER 2012

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

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP66358.
PREVIOUS TITLE:	1617-788.
PROPERTY STREET ADDRESS:	150 BERTRAM RD, WELLARD.
LOCAL GOVERNMENT AREA:	CITY OF KWINANA.

WESTERN AUSTRALIA

REGISTER NUMBER	
1338/DP184473	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	28/2/2012

RECORD OF CERTIFICATE OF TITLE

VOLUME 1636 FOLIO 857

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 1338 ON DEPOSITED PLAN 184473

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SPRINGZONE NOMINEES PTY LTD OF POST OFFICE BOX 369, CLOVERDALE
IN 1/2 SHARE
BYBLOS HOLDINGS PTY LTD OF UNIT 4, 190 ABERNETHY ROAD, BELMONT
IN 1/2 SHARE
AS TENANTS IN COMMON

(T L808963) REGISTERED 14 DECEMBER 2011

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

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

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

STATEMENTS:

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

SKETCH OF LAND:	1636-857 (1338/DP184473).
PREVIOUS TITLE:	This Title.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	CITY OF KWINANA.

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF PEEL ESTATE LOT 1338 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 1338 ON DEPOSITED PLAN 184473 ON 23-JUL-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

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

WESTERN AUSTRALIA

REGISTER NUMBER	
1421/DP156437	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	**N/A**

VOLUME **LR3000** FOLIO **657**

RECORD OF QUALIFIED CERTIFICATE OF CROWN LAND TITLE

UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997

NO DUPLICATE CREATED

The undermentioned land is Crown land in the name of the STATE of WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 1421 ON DEPOSITED PLAN 156437

STATUS ORDER AND PRIMARY INTEREST HOLDER:
(FIRST SCHEDULE)

STATUS ORDER/INTEREST: RESERVE UNDER MANAGEMENT ORDER

PRIMARY INTEREST HOLDER: TOWN OF KWINANA OF PO BOX 21, KWINANA
(XE L412040) REGISTERED 26 AUGUST 2010

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

1. L412039 RESERVE 50672 FOR THE PURPOSE OF DRAINAGE REGISTERED 26.8.2010.
L412040 MANAGEMENT ORDER. CONTAINS CONDITIONS TO BE OBSERVED. REGISTERED 26.8.2010.

Warning: (1) A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.
(2) The land and interests etc. shown hereon may be affected by interests etc. that can be, but are not, shown on the register.
(3) The interests etc. shown hereon may have a different priority than shown.

----------END OF CERTIFICATE OF CROWN LAND 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:	DP156437.
PREVIOUS TITLE:	THIS TITLE.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	CITY OF KWINANA.
RESPONSIBLE AGENCY:	DEPARTMENT OF LANDS (SLSD).

NOTE 1: K661626 CORRESPONDENCE FILE 00924-1997-01RO

APPENDIX 2

BUSHFIRE MANAGEMENT PLAN

ROWEGROUP

2017

Bushfire Management Plan

Lots 670 and 1338 and Reserve 50672

Bertram Road

Wellard

City of Kwinana

BPAD
Bushfire
Planning & Design
Accredited Practitioner
Level 2

Original by
FirePlan WA

February 2016

Updated by

Smith Consulting

July 2017

Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address: Lots 670 and 1338 Bertram Road, Wellard

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 14 Month July Year 2016

Report author: Ralph Smith

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☑ Level 3 practitioner ☐

If accredited please provide the following.

BPAD accreditation number: 27541 Accreditation expiry: Month August Year 2017

Bushfire management plan version number: 4

Bushfire management plan date: Day 14 Month July Year 2017

Client/business name: Rowe Group, Proven Management

	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?		✓
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)?		✓

Is the proposal any of the following (see SPP 3.7 for definitions)?	Yes	No
Unavoidable development (in BAL-40 or BAL-FZ)		✓
Strategic planning proposal (including rezoning applications)		✓
Minor development (in BAL-40 or BAL-FZ)		✓
High risk land-use		✓
Vulnerable land-use		✓

None of the above ☐

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author  Date 14/07/2017

CONTENTS

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Document Status

Version	Comment	Reviewer	Review Date
Version 1		BWH	17.12.2015
Version 2	Comments Rowe Group		18.12.16
Version 3	Changes to LSP	Rowe Group	29.02.16
Version 4	Comments and feedback to version3		13.07.17

Disclaimer:

The measures contained in this fire management plan are considered to be minimum standards and they do not guarantee that a building will not be damaged in a bush fire. All surveys, forecasts, projections and recommendations made in this report associated with the project are made in good faith on the basis of information available to FirePlan WA at the time; and achievement of the level of implementation of fire precautions will depend among other things on the actions of the landowners or occupiers over which FirePlan WA has no control. Notwithstanding anything contained therein, FirePlan WA will not, except as the law may require, be liable for any loss or other consequences (whether or not due to the negligence of the consultants, their servants or agents) arising out of the services rendered by the consultants.

This Bushfire Management Plan has been prepared in good faith. It is derived from sources believed to be reliable and accurate at the time of publication. Nevertheless, this plan is distributed on the terms and understanding that the author is not responsible for results of any actions taken based on information in this publication or for any error or omission from this publication.

Smith Consulting has exercised due and customary care in the preparation of this Bushfire Management Plan and has not, unless specifically stated, independently verified information provided by others.

Any recommendations, opinions or findings stated in this report are based on circumstances and facts as they existed at the time Smith Consulting performed the work. Any changes in such circumstances and facts upon which this document is based may adversely affect any recommendations, opinions or findings contained in this plan.

1. Purpose of the management plan

The purpose of this Bushfire Management Plan (BMP) is to detail the fire management methods and requirements that will be implemented for Lots 670 & 1338 Bertram Rd. (Refer Figure 1: Location Plan).

This Bushfire Management Plan satisfies the requirements of the City of Kwinana and the Western Australian Planning Commission (WAPC) via the WAPC, DFES and Department of Planning document, *Guidelines for Planning in Bushfire Prone areas* (February 2017).

This Bushfire Management Plan will outline the responsibility and timing for implementing and maintaining the fire protection measures and strategies contained within this Bushfire Management Plan, allocating these responsibilities between individual land owners, the developers and the City of Kwinana. As fire management strategies may require altering to meet changing weather, environment and land use needs, it must be advised that the provisions of the *Bush Fires Act 1954* may still be enforced, in addition to this Bushfire Management Plan.

The City of Kwinana will be responsible for initiating a review of this Bushfire Management Plan as it may deem necessary to do so.

FirePlan WA prepared (August 2014) a Bushfire Hazard Assessment for the Wellard Landowners Group Concept Structure Plan that was used in the rezoning of the land to urban. The Western Australian Planning Commission and the City of Kwinana require the preparation of a "Bushfire Management Plan" to support a local structure plan. This document has been prepared to satisfy that requirement and becomes operational as a condition of subdivision.

This Bushfire Management Plan complies with the acceptable solutions detailed in the Appendices published in support of the Guidelines for Planning in Bushfire Prone Areas (Version1.1, February 2017).

In the Foreword of AS 3959- 2009 it states that "It should be borne in mind that the measures contained in this standard cannot guarantee that a building will survive a bushfire event on every occasion. This is substantially due to the degree of vegetation management, the unpredictable nature and behavior of fire and extreme weather conditions."

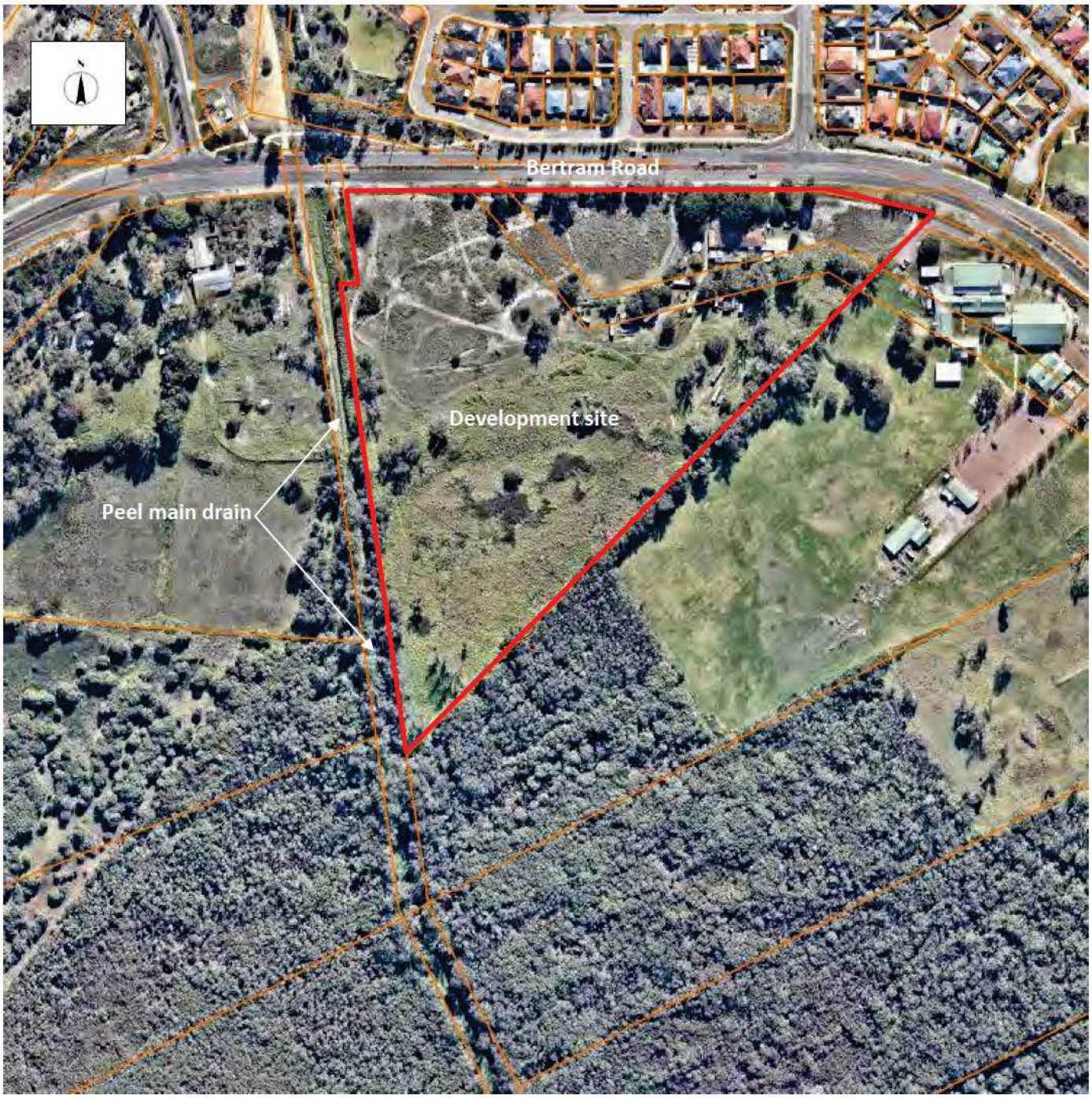

Figure 1. Development plan location with cadatral boundaries shown.
Source: Near maps

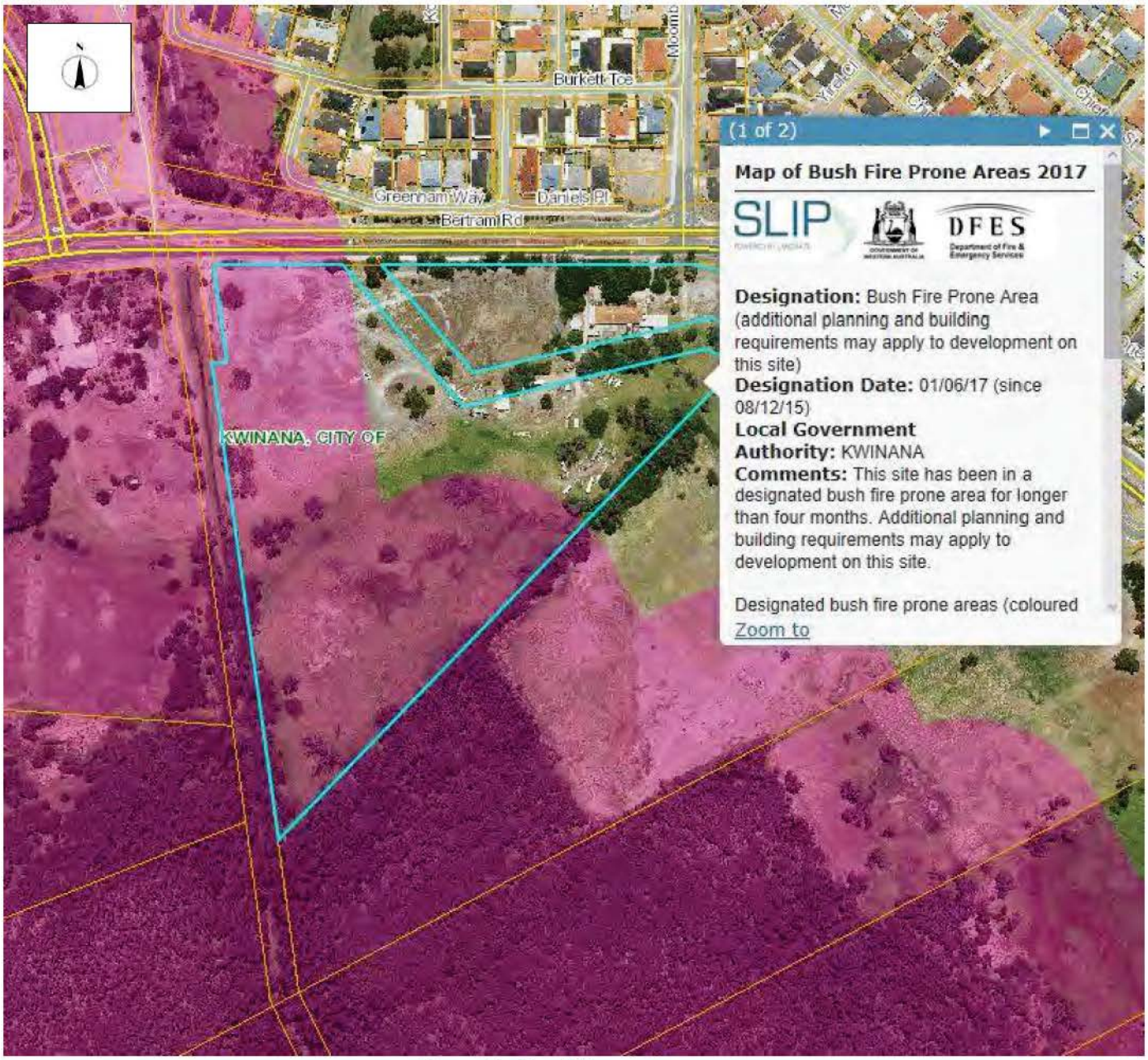

Figure 2. Bushfire prone map
Source: DFES web site

The State Government has only declared a portion of the development site as bushfire prone. Whilst this doesn't impact the bushfire management plan it will influence the construction standard of the dwellings not within the bushfire prone area after the lots have been determined and certificate of titles have been issued.

Figure 3. Development layout
Source: Rowe Group

2. Aim

It is generally recognised that bushfires are an inevitable threat in the spring, summer and autumn months in the south-west of Western Australia.

The aim of this Bushfire Management Plan when implemented is to reduce the occurrence of, and minimise the potential impact of bushfires onto buildings, vegetation and patrons located within the subject site, thereby reducing the threat to life, property and the environment.

This plan will document the minimum fire prevention requirements for the site.

3. Objectives

3.1 Purpose

The subject land comprising part Lots 670 and 1338 Bertram Rd, Wellard, is to be subdivided into urban residential with Public Open Space (POS) located on the outside of the Wetland Buffer. The lot adjoining to the east is occupied by the Kings College Education facility. To the west and south of the site is the Peel main drain Reserve 50672 and adjoining that is grassland that is proposed to be developed into urban residential.

Lots 670 and 1338 Bertram Rd are cleared grassland with several dwellings and sheds located on the site which will be removed as part of the site works when development commences. Bertram Road is located on the northern boundary of the site.

The Bollard Bulrush Swamp wetland consists of open forest vegetation with paper bark trees and scrub in the wetter areas of the wetland

The Bushfire Management Plan also seeks to ensure that the landowners, residents, patrons and relevant agencies are aware of their responsibilities.

3.2 Objectives

The objectives of this Bushfire Management Plan are achievable and measurable:

- Consider the land use proposal for the site and associated vehicular access
- Identify the site's vegetation, and surrounding vegetation, topography and proposed land use
- Assess potential bushfire issues, hazards and the proximity of the site to predominant vegetation classes
- Ensure water is available to enable property and life to be defended in event of a bushfire
- Ensure the proposed re-vegetation of any portions of the site or an adjacent site minimises the level of bushfire impact
- Outline the bushfire mitigation strategies for the site
- Identify the stakeholders responsible for undertaking and implementing the bushfire mitigation strategies defined in this Bushfire Management Plan.
- Define an assessment procedure which will evaluate the effectiveness and impact of proposed, as well as existing, bushfire risk management measures and strategies.

4. Legislation and Policy Consideration

The Western Australian Planning Commission and the City of Kwinana require the preparation of a Bushfire Management Plan for the proposed development as part of the Local Structure Plan application. This document has been prepared to satisfy that requirement.

All relevant provisions of applicable planning legislation and policies have been considered in the preparation of this Bushfire Management Plan. These include:

- Bush Fires Act (1954)
- State Planning Policy 3.7 (2015)
- Guidelines for Planning in Bushfire Prone Areas (2017)
- Visual guide for bushfire risk assessment in Western Australia (2016)
- Local planning scheme requirements (bushfire related)
- Local planning policy requirements (bushfire related)
- Fire Control Notice requirements
- Relevant approvals

5. Description of the subject area

5.1 General

The subject land comprises part Lot 670 and 1338 Bertram Rd Wellard is to be subdivided into urban residential with Public Open Space (POS) located on the outside of the wetland buffer which will be revegetated to scrub. The lot adjoining to the east is occupied by the Kings College Education facility. To the west of the development site is the Peel main drain Reserve 50672 and adjoining that is grassland that is proposed to be developed into urban residential. To the north is an established urban suburb.

Lots 670 and 1338 Bertram Rd are cleared grassland with several dwellings and sheds located on the site which will be removed as part of the Site Works when development commences. Bertram Road is located on the northern boundary of the Site.

The Bollard Bulrush Swamp wetland consists of open forest vegetation with paper bark trees and scrub in the wetter areas of the wetland.

The area is recognised within the City's planning for landscape protection and drainage catchment as a component of the KWIN2 local planning scheme.

5.2 Climate

The City of Kwinana has a Mediterranean climate with four seasons: cool, wet winters (June-August) followed by a mild spring (September-November), and hot, dry summers (December-February) leading into autumn (March-May). Rainfall usually occurs in autumn through to spring. This rainfall facilitates substantial vegetation growth during the winter and spring months, which dries in summer and continues through autumn. The rainfall predominantly occurs during winter, with very little rainfall in summer.

The maximum temperature occurs during summer when the bushfire fuels are at their driest. As the summer progresses the grass fuels cure and become available as bushfire fuel. Grass fuels are a diminishing bushfire risk as they start to break down, post being 100% cured. This is in stark contrast to the natural environment where forest, woodland or shrubland with a scrub multi-tiered understorey become a greater bushfire risk late in summer and early autumn, until the winter rains break. The bulk of the bushfire fuel in this location is open paddock grassland, with grassland associated with the riparian zone and *Melaleuca spp*. associated with the wetland and drain. The open paddock grassland areas are in the main going to be developed for housing and infrastructure, including the public open spaces.

One of the potential bushfire ignitions is lightning. While lightning can be an issue, it is highly improbable that it will be a significant issue for this development.

During the month of December, January and February the bushfire fuels are at their most dangerous, which corresponds to the summer period. During February the mean maximum temperature is 31.7°. The mean relative humidity is 38% at 3:00 pm. The wind at 9:00 am is predominantly an easterly for 42% of

the time and between 30 and 40 km/hr. At 3:00 pm the wind is a south-westerly for 45% of the time and with winds between 40 and 50 km/hr.

This means that the greatest fire threat will occur in the afternoon and with fire travelling through the swamp and buffer zone. The reduced bushfire fuels in the POS will assist in protecting the development.

5.3 Topography

The site slopes towards the Bollard Bulrush Swamp to the west at less than 1°. The slope of the "Flat land" AS 3959 classification will be used as a factor to determine the setbacks from vegetation and habitable building construction standards within the site as prescribed in AS 3959.

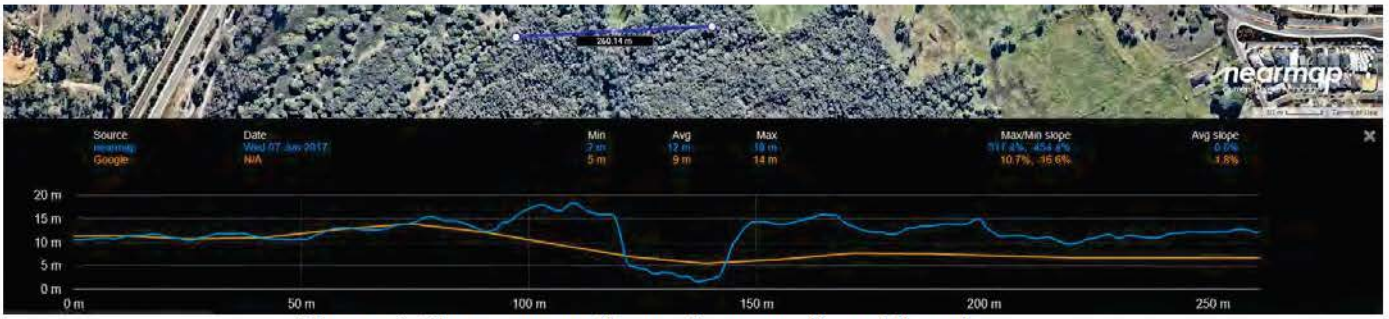

Figure 4: Slope across the northern portion of the site.

5.4 Bushfire Fuels

The development site is generally cleared grassland with scattered trees and scrub. The site other than Public Open Space and the wetland buffer will be cleared and developed for urban residential housing.

In wetland open forest, have a default fuel loads (as detailed in AS 3959-2009 Appendix B2) of 25-35 tonnes/ha and areas of grassland from 4.5 tonnes/ha. In the southern part of the site there are areas containing cotton bush which is a declared weed. In the swamp there are large areas of blackberries. It is proposed that the POS separating the residential lots from the wetland open forest vegetation will be landscaped and revegetated with scrub and contain a drainage basin. The south-west corner of the development site will be revegetated as a scrub vegetation in accordance with the Class D – Scrub vegetation classification.

5.5 Land use

The site will be used for residential R40 and parks, recreation and drainage. The adjoining cleared land and Bollard Bulrush Swamp area will be partly landscaped and used as public open space and managed by the City of Kwinana. The area adjoining the Bollard Bulrush Swamp and the west side is to remain as rural residential for development and rural A.

Figure 5: Concept landscape plan

5.6 Assets

The assets within the subject site include the dwellings, sheds, horse stables, cultivated garden and access roads.

The dwellings and other built assets currently on the site may be removed during the development of the site.

Within the local area, the assets include all the built structures on neighbouring properties, and the animals within the paddocks, holding areas or stables, and the grass (pasture) within those areas. To the north of the development site is urban development. The local assets are changing and becoming a more 'standard' urban development with a permanent swamp and buffer associated with the riparian zone.

Figure 6: Cadastral boundaries
Source: City of Kwinana online mapping

5.7 Access

Access to the existing Lots 670 and 1338 is off Bertram Rd. It is proposed that there will be two road linkages to Bertram Rd. The second access is proposed onto Bertram Road from the access location shown as number 2 on figure 2. This will provide roads constructed of bitumen and provide multiple alternative access roads to the east, west and north and provide safe and easy access for vehicle movements for the residents, public and emergency services.

5.8 Water supply

Reticulated mains water supply will be available to the urban development within the development site. Fire hydrants are to be installed by the developer in accordance with Water Corporations No 63 Water Reticulation Standard.

6. Bushfire

6.1 Bushfire hazard level

The bushfire hazard assessment for this site is currently rated as low for the grassland, moderate for the scrub and extreme for the forest areas that surround the development site. It is planned that the final development bushfire attack level will be between BAL-LOW and BAL-12.5 when considered against the requirements in *Guidelines for Planning in Bushfire Prone Areas* (2017). This determination is based on the observation of the predominant vegetation type on the development site and adjacent assessable lands and the development site at the completion of the development.

Table 1 Bushfire Risk Analysis

Risk Statement	Consequence	Likelihood	Risk Level	Prevention Controls (Planning Specific)
There is the potential that a bushfire will impact on the proposed development which in turn may cause injury: first aid may be required.	Insignificant	Possible	Low	• Required increased construction standard to BAL for new dwellings constructed with 100 metres of vegetation • Construction standard in accordance with AS 3959-2009 will provide bushfire resilient dwellings for people to seek shelter in. • The development provides access and egress routes from the development area. • Fire hydrants available within local streets to support firefighting operations.
There is the potential that a bushfire will impact on the proposed development which in turn may cause some damage to the proposed buildings.	Insignificant	Possible	Low	• Increased construction standard to all new dwellings. • Fire hydrants available within local streets to support firefighting operations. • The site is located within an urban area. • Wetland to south of development site. • Grassland to west and east of the Site to be developed into urban residential. Area to north of Bertram Rd is urban residential.
There is the potential that a bushfire will impact on the proposed development which in turn will cause damage to the environment.	Insignificant	Possible	Low	• Wetland Vegetation to south of development site to be separated from residential are by POS and road managed to APZ standard. • Compliance with Total Fire Bans • Fire Breaks to be maintained in accordance with Fire Break Notice. • POS to be maintained in Low Fuel Hazard state • POS separates development from adjoining vegetation

6.2 Vegetation Classification

All vegetation within 100 metres of the lots as indicated on the site BAL map was classified in accordance with the Western Australian Government criteria and Clause 2.2.3 of AS 3959 was applied. Each distinguishable vegetation plot with the potential to determine the Bushfire Attack Level is identified below. AS 3959 only requires consideration of 50 metres between vegetation and the building for grassland. AS 3959 requires certain overstorey vegetation classes (such as in this location) to be classified to the vegetation type on the basis of their understorey for application in determining bushfire attack levels.

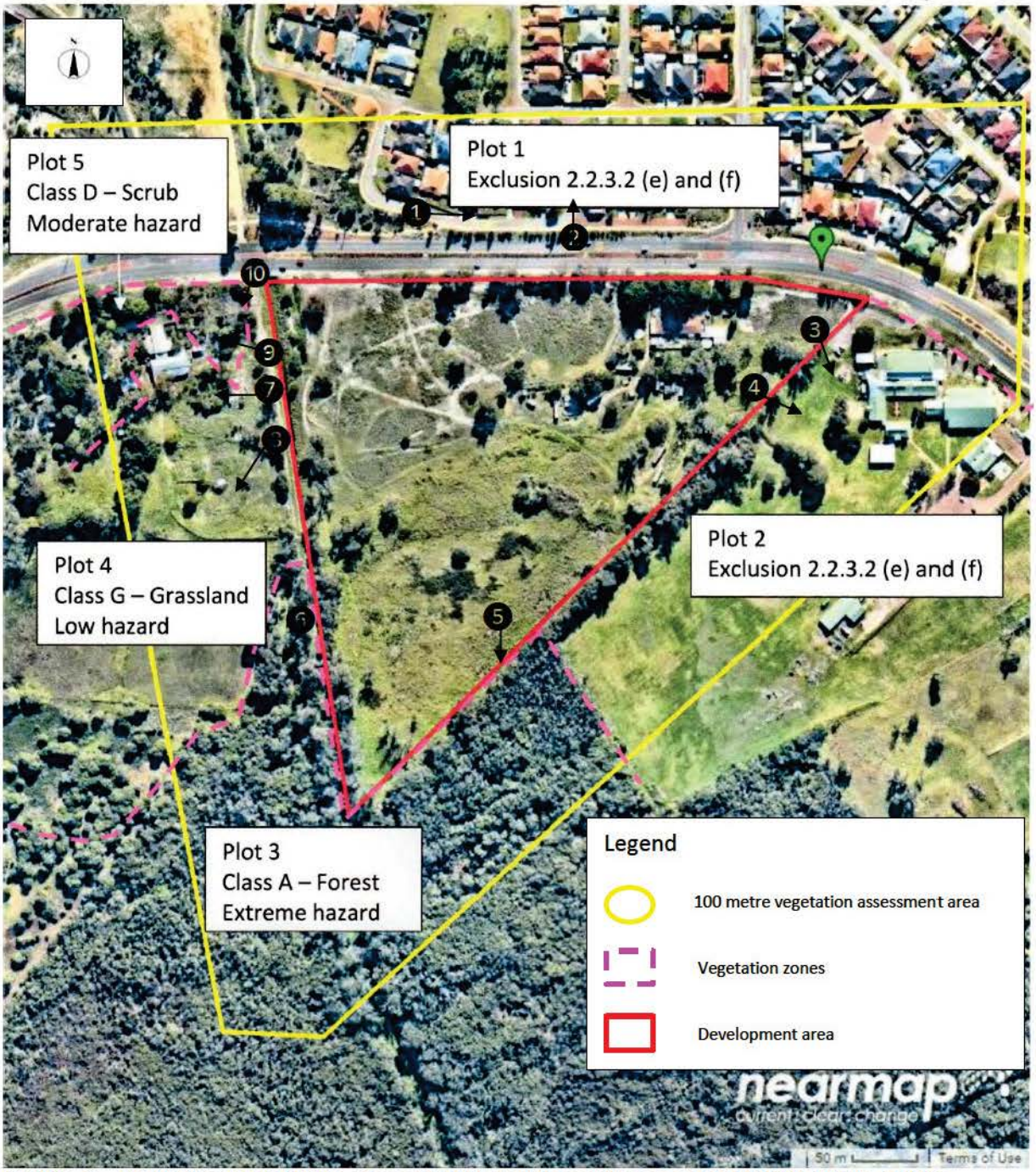

Figure 7. Indicative vegetation assessment and hazard assessment with photo points.

6.3 BAL contour map

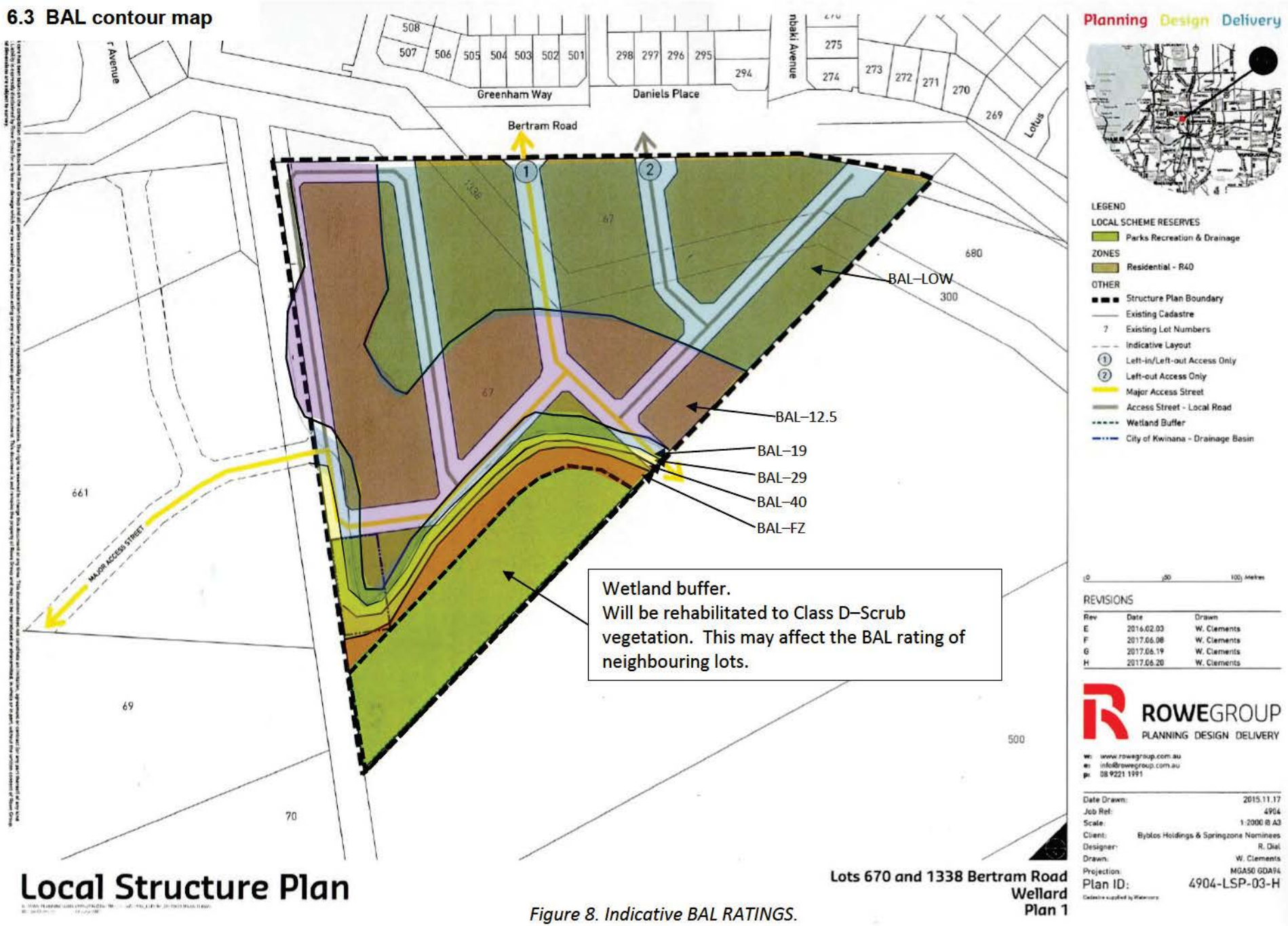

Figure 8. Indicative BAL RATINGS.

BAL determination

BAL (Bushfire Attack Level) determination using methodology from Section 2.2.1 of current adopted AS 3959- 2009 and Table 2.4.3 which applies to this development:

Table 2. Setback of Habitable Buildings from Classified Vegetation

Area	Class of Vegetation	Slope	Setback Distance	BAL Rating	AS 3959-2009	Width of APZ metres
Adjoining Peel Drain	Class G–Grassland	Flat	17–<50	12.5	S 3 & 5	20
Within Wetland	Class A –Forest (Open)	Flat	31–<42	19	S 3 & 6	31
Within Wetland (to be revegetated)	Class D–Scrub	Flat	27–<100	12.5	S 3 & 5	Whole of each Lot
Adjoining Wetland	Class A –Forest (Open)	Flat	100+	Low	Nil	Nil

All habitable buildings within 100 metres of classified vegetation will be constructed to the appropriate BAL rating in AS 3959. To achieve a BAL rating of BAL–19 and BAL–12.5 must be setback in accordance with Table 4 to achieve that BAL rating. The setback will consist of the front setback within a lot and the road reserve and must be managed to the Asset Protection Zone standards as detailed in the *Guidelines*.

The above BAL ratings are indicative only and the Developer is to provide the City of Kwinana with a map showing the BAL ratings for each Lot once the roads have been constructed and the lot boundaries identified in the field and prior to the issue of Land Titles.

The Kings College Education Facility grass areas are mown regularly throughout each year by the school management. The Lots that are adjoining the schools site along the eastern boundary of the Site will not be influenced by the BAL–Low grassland within the School Site.

Indicative BAL ratings are shown in Figure 8.

As part of the Building Permit Application a landowner may request a Fire Consultant to carry out a BAL assessment to confirm the indicative BAL or determine the BAL rating for a Lot with a specific habitable building design. This report is to be sent to the City of Kwinana as part of the Building Permit Application.

In AS 3959-2009 Section 3.5

"The construction requirements for the next lower BAL than that determined for the site may be applied to an elevation of the building where the elevation is not exposed to the source of bushfire attack. An elevation is deemed to be not exposed to the source of bushfire attack if all the straight lines between that elevation and the source of bushfire attack are obstructed by another part of the Building (See Figure 7 of BMP or Figure 3.1 of AS 3959)

6.4 Vegetation classification photos and description

Plot 1
Exclusion
Clause 2.2.3.2 (e) and (f)

Photo ID: Photo 1 Houses, roads and infrastructure to the north of the development site.

Photo ID: Photo 2 Infrastructure and houses north of Bertram Rd.

Plot 2
Exclusion
Clause 2.2.3.2 (e) and (f)

Photo ID: Photo 3 The school infrastructure east of the development site.

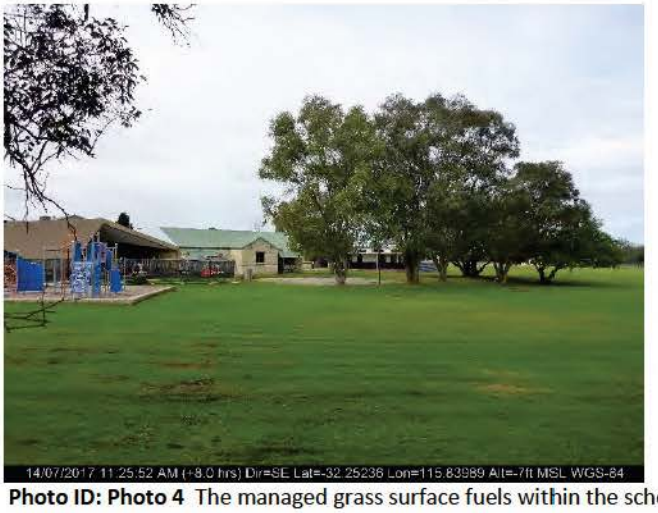

Photo ID: Photo 4 The managed grass surface fuels within the school.

Plot 3
Class A – Forest

Photo ID: Photo 5 The forest vegetation south-east of the development site.

Photo ID: Photo 6 The forest vegetation south-west of the development site.

Plot 4
Class G – Grassland

Photo ID: Photo 7 The grassland vegetation adjacent to the development site.

Photo ID: Photo 8 The grassland vegetation.

Plot 5
Class D – Scrub

Photo ID: Photo 9 The scrub vegetation west of the development site.

Photo ID: Photo 10 The scrub vegetation.

Notes to Accompany Vegetation Classification

1. Plot 1

Exclusion
Clause 2.2.3.2 (e) and (f)

The urban development north of the development site is an area that contains houses, managed gardens, driveways, roads and other infrastructure.

2. Plot 2

Exclusion
Clause 2.2.3.2 (e) and (f)

This plot comprises the developed neighbouring school, sheds, paths, managed grassland areas, cultivated gardens and bitumen driveway within the 100 metres assesment zone of the subject site and to the east of the development site. The area has been given an exclusion rating as a consequence of the areas of buildings, infrastructure and managed grassland within the area. .

3. Plot 3
Class A – Forest

The area is deemed a forest associated with the wetland vegetation structure The area is a mixture of dense and moderate density scrub understory and grass surface fuel and near surface fuels with an overstorey cover.

4. Plot 4
Class G – Grassland

This plot is the area to the west of the development site. There is grass surface vegetation (fuel) which is not managed in a 'low threat vegetation' status.

5. Plot 5
Class D – Scrub

This plot is the scrub area to the west of the development site and north of the unmanaged grassland. The scrub is limited in size, in that it is very small, within the vegetation assessment area.

7. Bushfire Mitigation Strategies

This Bushfire Management Plan is developed to provide guidance for the planning and management of the potential bushfire threat on the proposed development of Bertram East. The Bushfire Management Plan (BMP) is a supporting document for the proposed structure plan to the City of Kwinana. In accordance with the State Government's requirements, the BMP considers the bushfire threat after the BMP has been implemented.

This Bushfire Management Plan adopts an acceptable solution and performance-based system of control for each bushfire hazard management issue. The approach is consistent with Appendix 4 of *Guidelines for Planning in Bushfire Prone Areas* (2017).

7.1 Bushfire protection performance criteria and acceptable solutions

Element 1: Location
Intent: To ensure that strategic planning proposals, subdivision and development applications are located in areas with the least possible risk to bushfire to facilitate the protection of people, property and infrastructure.

Performance principle
The intent may be achieved where:

P1
The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is, or will, upon completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For minor or unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the Department of Fire and Emergency Services and the decision-maker.

The residential area will predominately be located in cleared grassland areas. The existing vegetation within the development to be included in Public Open Space is to be managed in accordance with the Asset Protection Zone (APZ) standards.

A suitable separation from the Bollard Bulrush Swamp vegetation and the urban residential area which included the road reserve (17 metres wide) and within the Bollard Bulrush Swamp Foreshore Reserve will be implemented.

Residential buildings within the 100 metres (and 50 metres of grassland vegetation) of classified vegetation will have an increased construction standard in accordance with AS 3959.

COMPLIANT
The proposed subdivision and development is located in an area where the bushfire hazard level is currently rated between low, moderate or extreme (adjacent to the forest area), and the bushfire attack level is assessed variously as BAL–LOW, BAL–12.5 and BAL–19 on the proposed lots. The area within the development site and surrounding the proposed dwellings will be cleared and there may be retention of a portion of the sparse tree overstorey.

Element 2: Siting and Design of Development

Intent: To ensure that the siting and design of development minimises the level of bushfire impact.

Performance principle

The intent may be achieved where:

P2

The siting and design of the proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of the bushfire threat that applies to the site. It minimises the bushfire risk to people, property and infrastructure, including compliance with *AS 3959* if appropriate.

A suitable setback from habitable buildings to classified vegetation or revegetation within the Bollard Bulrush Swamp Reserve is required to achieve a suitable BAL rating. The landscape zone will be required to be managed to the Asset Protection Zone or 'low threat vegetation' standard. This can be achieved by ensuring the appropriate species and separation distances between plants are chosen.

Dwellings on the newly created lots will be constructed to the appropriate standard as prescribed in AS 3959. The BAL ratings as shown in Figure 7 are indicative and can be reviewed after the development has been finalised. Individual Lots owners, as part of the building permit application process will (at their own expense) require a fire consultant to confirm or provide a new BAL rating for their lot. The report prepared by a fire consultant is to accompany the building permit application and be forwarded to the City of Kwinana.

COMPLIANT

The proposed development is located in an area that will become a more standard urban area. The Western Australian government has declared a portion of the site as bushfire prone and the dwellings will be constructed to the appropriate bushfire attack level as prescribed in AS 3959. When constructed all dwellings will be at a maximum BAL rating of BAL–19, with the bulk of the lots being BAL–LOW and those closer to the vegetation being rated as BAL–12.5 or BAL–19.

The access through the development will be all weather bitumen roads and will link to Bertram Road at two points.

The layout of the development has ensured that the roads, paths and infrastructure (such as water supply) is appropriate to the bushfire threat and minimises the potential bushfire risk to people, property and infrastructure.

The landscaping associated with the development has been designed to not increase the bushfire risk with the exception of the revegetation within the wetland buffer which will be revegetated to the Class D –Scrub. Homes within 100 metres will be constructed to an increased construction standard.

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
The intent may be achieved where:

P3
The internal layout, design and construction of public and private vehicular access and egress in the development allow emergency and other vehicles to move through it easily and safely at all times.

COMPLIANT
The proposed development is serviced by a major public bitumen road, being Bertram Road which runs east west and immediately north of the development. Access into the individual lots will be via independent driveways to each lot from public bitumen roads constructed as part of the development. These public bitumen roads, provide suitable all weather access for emergency, public and private vehicular access. There are number of alternative bitumen access roads which will facilitate movement onto or from Bertram Road, which provides a number alternative routes.

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
The intent may be achieved where:

P4
The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for fire-fighting purposes.

COMPLIANT
The subdivision will be linked to the reticulated scheme water system. Mains water will be available in accordance with the Water Corporation and Department of Fire and Emergency Services specifications. Hydrants will be located in accordance with the State's requirements.

8. Implementing the Bushfire Management Plan

8.1 Property owner's responsibilities

To maintain the reduced level of risk and threat of fire, the owners/occupiers of lots created by this proposal will be responsible for undertaking, complying and implementing measures protecting their own assets from the threat and risk of bushfire.

The owner/occupier shall be responsible for:

- Where specified, maintaining firebreaks on their property clear of flammable material by the dates shown on the City of Kwinana's *Fire Break Notice and Bushfire Information*. This is a statutory requirement. A copy is available from the City of Kwinana website.
- Where appropriate an APZ will be established prior to construction and maintained after dwelling construction to comply with the APZ requirements.
- Maintaining in good order and condition all fencing and gates.

- Ensuring that any new domestic dwellings to be built on the property are designed and constructed in full compliance with the requirements of the City of Kwinana and as detailed in *Australian Standard 3959 – Construction of buildings in bushfire-prone areas.*
- Implementing and maintaining bushfire fuels as specified in the Bushfire Management Plan and in accordance with the City of Kwinana requirements.
- Reviewing and implementing hazard reduction, when required, as required by the City of Kwinana.
- Installing and maintaining crossovers and driveways as required by the City of Kwinana
- Maintaining the property in good order to minimize potential bushfire fuels to mitigate the risk of fire on the property.
- Ensuring that the lot complies with the City of Kwinana Firebreak Notice. To be carried out annually.
- Ensuring that new dwellings are constructed to AS 3959 Table 4, Section 5.2 and Figure 7. There will be a Section 165 of the Planning Development Act 2005 notification on the Certificate of Title for each Lot requiring an increased construction standard in accordance with AS3959.
- Complying with the instructions of DFES Fire Services, the City of Kwinana and/or volunteer fire services in maintaining the property or during the event of a bushfire.

8.2 City of Kwinana responsibilities

The responsibility for compliance with the law rests with individual property owners and occupiers. The following conditions are not intended to transfer some of the responsibilities to the City of Kwinana. The City of Kwinana has statutory control and responsibility for ensuring that community fire safety is maintained.

The City of Kwinana shall be responsible for:

- Providing timely advice on standards and methods to achieve community fire protection to owners/occupiers of land.
- Administering development controls in accordance with the local planning scheme, with due regard for *State Planning Policy 3.7 – Planning in Bushfire Prone Areas* and other policies and publications outlined in these guidelines.
- Seeking compliance with Bushfire Management Plans, including issuing the annual issuing of Firebreak Notices under section 33 of the *Bush Fires Act 1954.*
- The City of Kwinana is to continue to provide the community with advice on bush fire prevention and preparedness through brochures, newspaper articles, the Firebreak Notice issued to rate payers and on their web site.
- The responsibility for compliance with the law rests with individual property owners and occupiers and the following conditions are not intended to unnecessarily transfer these responsibilities to the City of Kwinana.
- This Bushfire Management Plan will be implemented as a condition of subdivision and or development approval for the site.
- Likewise, it is the responsibility of the City of Kwinana to ensure that all standards required in this Bushfire Management Plan are met by the developer prior to clearing any conditions of subdivision relating to this Bushfire Management Plan.

8.3 Developer's responsibility

- The developer is to ensure that the development is compliant with the contents of the BMP.
- The developer is to provide a copy of the current City of Kwinana Firebreak Notice and this Bushfire Management Plan at the time of sale of a Lot. It is essential that the Real Estate agent handling the sale of Lots on behalf of the Developer advises potential landowners that a Fire Management Plan exists and the modification of vegetation and ongoing fuel reduction will be required within this development.
- As a condition of subdivision the Developer shall be required to carry out works described in this Bushfire Management Plan to the satisfaction of the City of Kwinana and the Western Australian Planning Commission.
- All driveway crossovers are to comply with the design requirements of the City of Kwinana.

- Each lot requiring an increased construction standard in accordance with AS 3959-2009 is to have a Section 165 of the Planning Development Act 2005 notification placed on the land title advising the landowner of the existence of this Bushfire Management Plan.
- Install road system and firebreaks as detailed in the BMP.
- Install fire hydrants as detailed in the BMP.
- Each lot is to comply with the City of Kwinana Firebreak Notice as published annually. This is to be maintained until lots are sold.
- Carry out landscaping as detailed in the Bollard Bulrush Swamp Reserve and Public Open Space and in accordance with the bushfire protection measures contained within the BMP.
- It will be the responsibility of the developer to implement the provisions of this Bushfire Management Plan in order to seek clearance of those conditions of subdivision.

9. Revising the Bushfire Management Plan

It is recommended that this Bushfire Management Plan be revised every five years to ensure that it is current and in-line with contemporary requirements to optimise protection. It is proposed that the property owners undertake the review.

10. References

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11. Appendices

11.1 Works program

Works Program Prior to issue of Titles and Ongoing Maintenance

Developer Responsibilities				
Activity	**Responsibility**	**Maintenance**	**Responsibility**	**Timing**
Installation & Maintain of Roads & cul de sac Standards Section 5.2.	Developer	Checking of quality of Roads	City of Kwinana	Developer clearance of Condition of subdivision
Implement fire protection measures as detailed in Sections 5.4	Developer	Annually maintenance required until Lots sold. Maintain POS to Building Protection Zone standard	City of Kwinana	Ongoing in perpetuity
Compliance with Firebreak Notice. Details Section 5.2.	Developer	Compliance with Firebreak Notice annually	Landowner	Developer clearance of Condition of subdivision
Installation of Fire Hydrants. Water Corporation Standards. Details Section 5.3	Developer	Water Corporation Standards	Water Corporation	Ongoing
Section 165 of the Planning Development Act 2005 notification on title of each lot advising BMP applies to each Lot	Developer	Maintain Lot in accordance with Landowners responsibilities	Landowner	Developer clearance of Condition of subdivision
Provide the City of Kwinana with BAL Ratings for prior to land release	Developer	Provide a copy to each prospective purchaser of a Lot	Developer	Developer clearance of Condition of subdivision
Landscape POS to BPZ standard	Developer	Maintain POS to BPZ standard	City of Kwinana	Ongoing in perpetuity
Provide a copy of following a sale of Lot:- *Bushfire Management Plan* *Home Owners Survival Manual* *Prepare Act Survive* *Fire Control Notice*	Developer	Landowners to familiarise themselves and annually update actions in the event of fire and annual maintenance.	Landowner	Developer clearance of Condition of subdivision
Landowner Responsibilities				
Landowner may request BAL reassessment to confirm or amend BAL rating. Copy of report to City of Kwinana	Landowner	Ensure Building design complies with relevant AS 3959 BAL rating	City of Kwinana to approve Building Permit	Re-assessment completed report sent to CoK as part of Building Permit Application
Compliance with Firebreak Notice. Details Section 5.3.	Developer until Lot is sold then landowner	Compliance with Firebreak Notice annually	Landowner	Completed by 1st November each year.
Section 165 of the Planning Development Act 2005 notification on Tile of each Lot advising BMP applies to each Lot	Developer	Maintain Lot in accordance with Landowners responsibilities in perpetuity.	Landowner	Completed by 1st November each year.

11.2 Glossary

Acceptable solution
A statement describing an acceptable means of complying with the requirements of corresponding performance criteria.

Appliance or fire appliance
A fire fighting appliance (vehicle) with structural, grass and bushfire fighting capabilities, with either a 2000 litres water capacity (2.4 appliance) or a 3000 litre water capacity (3.4 appliance) and four (4) wheel drive.

Asset protection zone (APZ)
Low fuel area immediately surrounding buildings. Minimum width 20 metres, increasing with slope. Maintained by the landowner.

BAL – (abb) Bushfire Attack Level.

Bushfire attack level
An assessed rating of a site's risk to a bushfire, based on vegetation type, slope of the land and its proximity to buildings.

Building construction standard buffer
An area 100 metres wide Including a Building Protection Zone in which an increase in building construction standard in accordance with AS3959 will apply.

Bush
Under the Bush Fires Act 1954 the term bush is defined to include trees, bushes, plants, stubble, scrub and undergrowth of a kind whatsoever whether dead or alive and whether standing or not standing.

Bushfire or Wildfire
A general term used to describe fire in vegetation that is not under control.

Bushfire hazard.
The flammability, arrangement and quantity of vegetation, dead or alive, that can be burnt in a bush fire. Development is to be avoided in extreme bush fire hazard designated areas.

Bushfire prone area - for the purposes of this fire management plan, a bush fire prone area is an area that has been declared as such by the relevant local government responsible for an area. Once an area is declared bush fire prone, then AS 3959 applies to new residential development in it.

Bushfire risk
The chance of a bush fire starting that will have harmful consequences on life and property. It is measured in terms of consequences and likelihood and arises from the interaction of hazards, communities and the environment.

Development application
An application for approval to carry out a development under either a local planning scheme or regional planning scheme.

Dwelling setback – the horizontal distance between a wall of the dwelling at any point, and an adjacent lot boundary, measured at right angles (90 degrees) to the boundary.

DFES
The Department of Fire and Emergency Services of Western Australia previously FESA.

Emergency access way
Road not normally open but available to the public (using two wheel drive vehicles) for evacuation during a bush fire emergency.

Firebreak
Any natural or constructed discontinuity in a fuel bed used to segregate, stop and control the spread of a bush fire or to provide a fire line from which to suppress a bush fire. This is an area cleared to reduce the risk of bush fire damage.

FDI- Fire Danger Index
The chance of a fire starting, its rate of spread, its intensity and the difficulty of its suppression, according to various combinations of air temperature, relative humidity, wind speed and both the long and short- term drought effects.

Fire protection
A generic term used to describe the range of services and systems used to mitigate the impact of fire on the community. It encompasses both fire prevention and emergency response.

Bushfire management plan
Ongoing, dynamic document that sets out the medium to long term mitigation strategies for fire hazards and risks in particular developments within local government areas.

Fire services access route
Accessible by heavy four wheel drive fire fighting vehicles.

Fuel reduction also hazard reduction
Removal and modification of bushfire fuel, or increase in building construction standards or a combination of the two.

Hazard separation zone (HSZ)
The fuel reduction area between an area bush fire hazard and the buildings (and associated building protection zones) of a development.

Low fuel area
An area 100 metres wide of reduced bush fire fuels that is required to surround a Stage of land release and negates the need to increase the standard of dwelling construction on the edge of the Stage of land release. It complies with the Building Protection Zone standards is temporary until the next stage of land is cleared for release.

Performance criteria.
Statement which specifies the outcomes required for the protection of life and property from bush fires.

SPP 3.7 (Abbreviation) State Planning Policy 3.7 Planning in Bushfire Prone Areas

Structural fire
A fire in a building.

APPENDIX 3

LOCAL WATER MANAGEMENT STRATEGY

ROWEGROUP

Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 and 1338 Bertram Rd and Reserve No. 50672, Wellard

Local Water Management Strategy

October 2016

JDA Consultant Hydrologists

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	Name	Signature	Date
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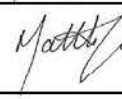
Checked by	Matthew Yan		31 October 2016
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EXECUTIVE SUMMARY

JDA has been engaged by Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd to complete a Local Water Management Strategy (LWMS) for Lots 670 and 1338 Bertram Rd and Reserve No. 50672, Wellard.

This LWMS has been prepared to guide water management for proposed residential development of approximately 8.35 ha, and to support the Local Structure Plan (LSP) for the Study Area. This document provides conceptual level drainage planning to assist in providing a coordinated approach to future subdivision.

This document addresses the principles and objectives of the overarching Wellard Urban Precinct East District Water Management Strategy (DWMS) (Emerge, 2015). Table 1 below provides a summary of the key elements of the LWMS in addressing the DWMS principles and objectives.

TABLE 1: SUMMARY OF PROPOSED 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; • Retain and treat 1year ARI event post development discharge relative to pre-development conditions;
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 – bioretention areas
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	• Retain and treat 1year ARI event post development discharge relative to pre-development conditions; and • Manage major event flows from the site.
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 100year 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.
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. • Post-development monitoring for a period 2 years

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1. INTRODUCTION

1.1 Background and Statutory Framework

This LWMS has been prepared by JDA Consultant Hydrologists on behalf of Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd for the development of Lots 670 and 1338 Bertram Rd and Reserve No. 50672, Wellard (herein referred to as the Study Area). The location of the Study Area is shown in Figure 1.

This LWMS document has been prepared to support the Local Structure Plan (LSP) for the Study Area and to provide conceptual level drainage planning to assist in providing a coordinated approach to future subdivision.

This document presents a recommended approach for total water cycle management within the Study Area consistent with sustainability principles. The document is consistent with State Planning Policy 2.9 Water Resources (WAPC, 2006) and guidelines presented in Better Urban Water Management (WAPC, 2008). The preparation of this document in relation to the requirements of Better Urban Water Management (BUWM) (WAPC, 2008) is shown in Table 2.

The compilation of this document has included a range of expertise and guidelines from leading government authorities including the Department of Environment and Conservation (DEC), Department of Water (DoW), and City of Kwinana (CoK), to assist in achieving the implementation of best practice in sustainable urban development and urban water management.

A copy of a completed LWMS Checklist for Developers (WAPC, 2008) and DoW LWMS Checklist have been included as Appendix A to assist the City and DoW in review of this document.

TABLE 2: INTEGRATED PLANNING AND URBAN WATER MANAGEMENT PROCESS

Planning Phase	Planning Document	Urban Water Management Document and Status
Regional	-	Jandakot Drainage and Water Management Plan (DoW, 2009b)
District	Amendment 1189/57	Wellard Urban Precinct East District Water Management Strategy (Emerge, 2015)
Local	Lots 670 & 1333 Bertram Rd, Wellard - Local Structure Plan	Lots 670 & 1333 Bertram Rd Wellard Local Water Management Strategy (LWMS) **THIS DOCUMENT**
Subdivision	Subdivision Application	Urban Water Management Plan (UWMP) (required for individual stages of development) **FUTURE PREPARATION**

1.2 Previous Studies

This LWMS uses the following key documents to define its principles, criteria, and objectives:

- Statement of Planning Policy 2.9: Water Resources (WAPC, 2006);
- Stormwater Management Manual for WA (Department of Water, 2007)
- Decision Process for Stormwater Management in WA (Department of Water, 2009a)
- Better Urban Water Management (WAPC, 2008)
- Peel-Harvey WSUD Local Planning Policy (PDC, 2006a);
- Peel-Harvey Water Sensitive Urban Design Technical Guidelines (PDC, 2006b)

- Peel-Harvey Water Quality Improvement Plan (PDC, 2008);
- Jandakot Drainage and Water Management Plan: Peel Main Drain catchment (DoW, 2009b)
- Wellard Urban Precinct East District Water Management Strategy (Emerge, 2015)

1.2.1 Planning Policy 2.9 and Liveable Neighbourhoods

The LWMS has been developed in accordance with regional and local principles and objectives of integrated urban water management (IUWM).

The Western Australian Planning Commission (WAPC) (2008) defines IUWM (also known as total water cycle management) as promoting '*management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality, waterways, estuaries and coastal waters is recognised*'.

IUWM should also promote water conservation measures, reuse and recycling of water and best practice in stormwater management (WAPC, 2008). These objectives are consistent with Liveable Neighbourhoods (WAPC, 2009).

1.2.2 Stormwater Management Manual for WA

DoW's current position on Urban Stormwater Management in Western Australia is outlined in Chapter 2: Understanding the Context of the Stormwater Management Manual for Western Australia (DoW, 2007), which details the management objectives, principles, and a stormwater delivery approach for WA. 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.

The DoW has also released a Decision Process for Stormwater Management in WA (DoW, 2009a) to provide a framework for the planning and design of stormwater management systems and assist in meeting the objectives specified above.

1.2.3 Better Urban Water Management

This LWMS has been developed to be consistent with the framework and process detailed in WAPC's urban water management planning guideline document Better Urban Water Management (WAPC, 2008).

This LWMS has been prepared to support local structure planning for the Study Area. Consistent with WAPC (2008) an Urban Water Management Plan (UWMP) will be required to support subdivision applications within the Study Area in due course. Further details specifying requirements of a UWMP are contained in Chapter 6 Implementation.

1.2.4 Regional Document Summary

Regional planning guidelines for the Study Area include the following three important documents:

- Peel-Harvey WSUD Local Planning Policy (PDC, 2006a);
- Peel-Harvey Water Sensitive Urban Design Technical Guidelines (PDC, 2006b);
- Peel-Harvey Water Quality Improvement Plan (PDC, 2008)

These documents provide guidance on the design, application, implementation and assessment of water sensitive urban design (WSUD) for the soil-hydrological conditions prominent throughout the Peel-Harvey region (PDC, 2006b).

The Local Planning Policy (PDC, 2006a) encourages the application of the WSUD principles discussed in the Technical Guidelines and provides advice for local government for the assessment of proposals. The Water Quality Improvement Plan provides specific environmental quality objectives for WSUD in the region.

1.2.5 District Document Summary

District drainage and water management guidance is provided by the Jandakot Drainage and Water Management Plan (DWMP) (DoW, 2009b) and the Wellard Urban Precinct East DWMS (Emerge, 2015). The DWMP provides conceptual drainage management for the Jandakot Structure Plan area including the Peel Main Drain. The Plan provides a catchment scale plan for drainage and water management on which smaller scale developments are based.

The DWMS (Emerge, 2015) provides revised drainage management concepts based on the DWMP for the area east of Bollard Bulrush Swamp. Specific discharge rates and conceptual estimated attenuation volumes are provided in the DWMS for sub-catchments of the Bollard Bulrush Swamp east catchment. The DWMS also provides appropriate district scale water design and management principles and objectives which are refined in this document.

1.3 Key Principles and Objectives

Summaries of key principles and objectives applicable to the LWMS for the Study Area based on these documents are provided in Table 3.

TABLE 3: SUMMARY OF LWMS PRINCIPLES AND OBJECTIVES

Key Guiding Principles		
• Facilitate implementation of sustainable best practice in urban water management • Encourage environmentally responsible development • Provide integration with planning processes and clarity for agencies involved with implementation • Facilitate adaptive management responses to the monitored outcomes of development • To minimise public risk • To maintain the total water cycle		
Category	**Principles**	**Objectives**
Water Use	• Consider all potential water sources in water supply planning • Integration of water and land use planning • Sustainable and equitable use of all water sources having consideration of the needs of all users, including community, industry and environment • No potable water should be used outside of homes and buildings	• Minimise the use of potable water where drinking water quality is not essential, particularly ex-house uses • POS area to remain as natural unirrigated vegetation • Consumption target for potable water of 40 – 60 kL/ person/ year
Groundwater Levels and Surface Water Flows	• To retain natural drainage systems and protect ecosystem health • To protect from flooding and waterlogging • To implement economically viable stormwater systems • Post development annual discharge volume and peak flow rates to remain at predevelopment levels or defined environmental water requirements • Minimise change in peak winter levels at groundwater dependent wetlands due to urbanisation	• The minimum habitable floor level will be 6.12 mAHD in order to provide a minimum 0.5 m clearance to the 100 year ARI flood level in the Peel Main Drain. • Maintain minimum 1.5m clearance between habitable floor level and MGL • 1 year ARI 1 hour event from lots will be infiltrated on lot via soakwells • 1 year ARI 1 hour event from the road network will retain in bioretention area • Where there are identified impacts on significant ecosystems, maintain or restore desirable environmental flows and/or hydrological cycles • Retain and restore existing elements of the natural drainage system.

Groundwater and Surface Water Quality	• To maintain or improve groundwater and surface water quality
	• Where waterways/open drains intersect the water table, minimise the discharge of pollutants from groundwater
	• Where development is associated with an ecosystem dependent upon a particular hydrologic regime, minimise discharge or pollutants to receiving waterways and maintain water quality in specified environment.
	• As compared to a development that does not actively manage stormwater quality:
	  • At least 80% reduction of TSS
	  • At least 60% reduction of TP
	  • At least 45% reduction of TN
	  • At least 70% reduction of gross pollutants
		• Implement current known best management practice as detailed in the DoW's Stormwater Management Manual for Western Australia (2007) and the Decision Process for Stormwater Management in Western Australia. (DoW 2009), with an emphasis on a treatment train approach including nutrient input source control, use of bioretention systems, rehabilitation of waterways as living streams, and maintaining 1 year ARI post development discharge volumes and peak flow rates at pre development levels.

Disease and Nuisance Insect Management	• To reduce health risks from mosquitoes, retention and detention treatments should be designed so that between November and May, detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours	• Permanent water bodies not proposed for the Study Area.

2. PRE-DEVELOPMENT ENVIRONMENT

2.1 Location and Topography

The Study Area is 8.35 ha and is located approximately 35km south of the Perth CBD within the City of Kwinana (Figure 1).

The topography is generally flat with a gentle grade north east to south west (Figure 2). Elevations range between approximately 4.5 mAHD and 9 mAHD.

Detailed feature survey of the Study Area has not been undertaken. LiDAR contours (1m) are shown in Figure 2.

2.2 Climate

The Study Area has a Mediterranean climate with warm dry summers and cool wet winters. The mean summer maximum temperature is 29.5 °C and the mean winter minimum temperature of 17.7 °C.

Annual rainfall recorded at the Bureau of Meteorology's Medina Research Centre station (009194) is shown in Figure 3. The 1983 – 2015 average annual rainfall for this site is 747 mm. The 2000 – 2015 average annual rainfall has declined to 675 mm, a 10% reduction.

2.3 Existing Land Use

An aerial photograph (Nearmap, 2015) showing existing land use within the Study Area is shown in Figure 2. The Study Area is predominately cleared with few, scattered remnant trees and vegetation. A house and sheds are present in the northeast corner of the Study Area.

In the northwest corner of the Study Area is the City of Kwinana Bertram Road infiltration basin. JDA understands that the City of Kwinana has proposed redesign of this basin, and to relocate it within the future POS area to the south within the Study Area. The design is being prepared by the other engineering consultants on behalf of the City of Kwinana and is separate to this report.

A search by JDA of the Aboriginal Heritage Site database indicates no known Aboriginal Heritage Sites within the Study Area. A search of the DEC Contaminated Sites database indicates no known contaminated sites within the Study Area.

2.4 Surface Geology

Surface geology mapping is shown in Figure 4. The 1:50,000 Rockingham Environmental Geology Map (GSWA 1985) indicates the geology of the Study Area is typically as follows:

- Ms5 SANDY SILT - dark brownish grey silt, with disseminated fine-grained quartz sand, firm, variable clay content, of lacustrine origin
- S8 SAND - pale yellowish brown, medium to coarse-grained, sub-angular to well-rounded quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin.

A geotechnical investigation has not been undertaken for the Study Area. A geotechnical investigation will be required prior to subdivision and the results of the investigation included in a future Urban Water Management Plan (UWMP).

Based on JDA's experience on the Swan Coastal Plain, sands within post-development Study Area (S8) have a low Phosphorus Retention Index (PRI).

Due to the high proportion of silty soils underlying a thin layer of sand over the Study Area, opportunities for infiltration of stormwater will be limited.

2.5 Acid Sulfate Soils

Acid Sulfate Soil mapping is shown in Figure 4. Regional ASS mapping indicates majority of the Study Area is classified High to Moderate Risk of ASS within 3m of the natural surface. A small northern portion of the Study Area is classified as Moderate to Low Risk of ASS within 3 m of natural surface.

A preliminary site ASS investigation has not been performed as the majority of the site is already classified at the highest level of High Risk. A detailed ASS Investigation will be undertaken prior to subdivision and relevant management, presented in an ASS Management Plan, referenced in the UWMP.

2.6 Wetlands

The Study Area is bounded by the Bollard Bulrush Swamp. The swamp is classified as a Conservation Category (CCW) Wetland (DEC, 2013). Majority of the Study Area is classified as Multiple Use Sumpland, with the south west portion classified as Conservation Sumpland. Wetlands and significant environmental features are shown in Figure 5.

A detailed Environmental Review (ENV, 2013) was assessed by the Environment Protection Authority (EPA). The Review highlighted the potential to amend the boundary of the CCW due to the poor condition of existing vegetation in certain areas (ENV Australia, 2013).

The EPA (2014) Report and Recommendations approved a wetland boundary and wetland buffer to delineate conservation and development areas.

A 50m buffer applies to the approved wetland boundary as shown in Figure 5.

In 2007 Ecoscape undertook an assessment of wetland ecological water requirements (EWRs) for the Bollard Bulrush Swamp. The EWRs were presented in the DWMP (DoW, 2009b) and are reproduced in Table 4.

TABLE 4: BOLLARD BULRUSH SWAMP ECOLOGICAL WATER REQUIREMENTS (ECOSCAPE, 2007 IN DOW, 2009B)

Most Vulnerable Species			Least vulnerable species	Most vulnerable species	Preferred maximum (mAHD)
Wetland	Upper max. groundwater level (mAHD)	Lower max. groundwater level (mAHD)	Lower max. groundwater level (mAHD)	Upper min. groundwater level (mAHD)	0.50 < Upper min.
Bollard Bulrush Swamp	4.11	1.99	0.67	5.99	5.49

DoW (2009b) recommends post-development monitoring of groundwater levels in locations with groundwater levels within and directly adjacent to the Swamp do not rise above the preferred maximum of 5.49 mAHD or fall below the lower maximum groundwater level of 1.99 mAHD.

2.7 Surface Water Hydrology

2.7.1 Existing Surface Drainage

The Study Area is located within the floodplain of the regionally significant Peel Main Drain (PMD) and the Bollard Bulrush Swamp within the Peel Main Drain Catchment. Surface water runoff generated in the Study Area flows towards the Bollard Bulrush Swamp in the south west via overland flow. Less surface water runoff is generated

in the northern portion of the Study Area due to higher infiltration rates corresponding to the surface geology comprised with sand. Remainder of the Study Area comprised of silty sands has less infiltration and higher runoff rates. Majority of surface water runoff is contained within the Study Area, and during extreme events areas along the eastern boundary may flow towards the localised depression along this boundary.

The Peel Main Drain is located along the western boundary and flows south through the Bollard Bulrush Swamp and discharges via a culvert under Millar Rd and ultimately into the Serpentine River. Surface water flow direction is shown in Figure 6.

2.7.2 Previous Drainage Planning

The Study Area is located within the Peel Main Drain (PMD) and Bollard Bulrush Swamp water catchments which are significant in determining regional flood management. Peak pre-development 10 and 100 year ARI flows and levels for the PMD and Bollard Bulrush Swamp have been modelled using Infoworks CS and are documented in the Jandakot DWMP (DoW, 2009b). A summary of the pre-development peak levels and flows at key locations along the PMD relative the Study Area are presented in Table 5 with locations shown in Figure 6. Further post development modelling options were performed by GHD (2010) and are discussed further in Section 5.

TABLE 5: PEEL MAIN DRAIN PRE-DEVELOPMENT FLOOD ESTIMATES (DOW, 2009B)

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 Year ARI	100 Year ARI	10 Year ARI	100 Year ARI
Peel Main Drain (PMD56) (Upstream of Bertram Rd Culvert)	7.90	8.20	3.25	3.82
Bollard Bulrush Swamp (BOLLCB)	4.82	5.61	3.38	4.00
Peel Main Drain (PMD55) (Downstream of Millar Rd Culvert)	4.70	5.59	4.38	5.06

2.7.3 Surface Water Quality

Pre-development surface water quality has not yet been undertaken within the site, however the Peel Main Drain which is adjacent to the Study Area has been monitored. The Jandakot DWMP indicates that Total Phosphorous and Total Nitrogen concentrations are low in comparison to the ANZECC (2000a) trigger values for streams in south-west Western Australia. These results are to be used to provide baseline water quality parameters for future development of the Study Area.

The long term targets for Total Phosphorous and Total Nitrogen for the Peel Main Drain as identified in the Jandakot DWMP and are 0.1mg/L and 1.0mg/L respectively.

2.8 Groundwater Hydrology

An 18 month pre-development groundwater investigation was undertaken by ENV (2011) from July 2010 to December 2011. Of the network of six groundwater monitoring bores installed by ENV, two of the bores, MW1E and MW2E, are located within the Study Area (see Figure 7) and described further below.

2.8.1 Maximum Groundwater Level (MGL)

Groundwater levels were measured by Emerge (2015) for bore MW1E in September and October 2014, however this data is limited due to access issues on site as well as the poor condition of the bores.

Maximum Groundwater Contours over the 18 month monitoring period were estimated for the wider DWMS area by ENV (2011) and presented in the DWMS (Emerge, 2015), see Figure 7. The maximum groundwater level is

within approximately 2m of the natural surface across the majority of the Study Area, ranging from 0m clearance in the south west to 2m in the north east. These MGL contours do not appear to include the drawdown influence of the Peel Main Drain. Consequently, the adopted MGL for design is considered a conservative approach.

Regional groundwater level seasonal variation on the Swan Coastal Plain is in the order of 1.5m, however due to the close proximity of the Bollard Bulrush Swamp, the groundwater level seasonal variation has been calculated by JDA to be 0.8m from nearby DoW Bore T240 (I) (WIN Site ID: 3038), see Appendix B.

Prior to December 2014, a seasonal open water body was evident in a localised depression next the eastern boundary of the Study Area in the adjacent Lot 680. The open water body appeared to be man made and had an open outlet channel that discharged towards the Bollard Bulrush Swamp. Recent aerial photography indicates that the open water body has since been filled in. It is unclear whether the open drainage channel along the boundary has also been filled or been replaced with pipe drainage as it is understood to have conveyed subsoil drainage from some of the buildings.

A small localised linear depression also exists under the tree line along the eastern boundary of the Study Area within Lot 680. During winter months, this may act as an open drainage channel that discharges towards the Bollard Bulrush Swamp.

2.8.2 Groundwater Quality

Groundwater quality was recorded by ENV on four occasions over the 18 month period. Results for bores MW1E and MW2E are presented in Table 6. ANZECC assessment levels (ANZECC, 2000a) are provided for *reference only* and do not indicate baseline trigger values. These water quality results are used as the basis for assessment of the post-development monitoring program, discussed further in Section 6.4.

TABLE 6: GROUNDWATER QUALITY RESULTS

Sample Date	pH	EC (uS/cm)	Total P (mg/L)	FRP (mg/L)	Total N (mg/L)	NH_3 (mg/L)	TKN (mg/L)	NOx (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)
$ANZECC_1$	6.5 – 8.0	-	0.065	0.04	1.2	-	-	0.15	-	
MW1E										
8/07/2010	7.3	810	1.30	0.25	3.8	0.02	3.0	-	0.72	0.039
28/10/2010	7.6	530	1.30	0.30	1.3	0.02	1.2	0.092	-	-
20/01/2011	7.7	510	0.79	0.17	3.7	0.047	1.4	2.80	-	-
1/12/2011	7.6	2100	0.67	0.12	4.0	0.10	5.6	0.09	0.04	0.04
Median	*7.6*	*670*	*1.04*	*0.21*	*3.7*	*0.034*	*2.2*	*0.092*	*0.38*	*0.0395*
MW2E										
8/07/2010	7.6	1200	0.58	<0.005	1.1	0.57	1.1	-	0.007	<0.005
28/10/2010	7.4	1000	0.12	0.005	1.3	0.64	1.2	0.008	-	-
20/01/2011	7.7	910	0.21	0.03	1.7	0.65	1.4	0.28	-	-
10/05/2011	7.5	1200	0.17	0.02	5.6	0.13	5.6	<0.05	-	-
14/06/2011	7.2	1100	0.86	0.05	1.9	0.41	1.9	<0.05	-	-
6/10/2011	7.7	1300	0.46	0.02	1.0	0.43	1.0	<0.05	<0.02	<0.02
1/12/2011	7.7	1300	0.43	0.04	1.9	0.05	1.4	0.52	0.41	0.12
Median	*7.6*	*1200*	*0.43*	*0.03*	*1.7*	*0.43*	*1.4*	*0.28*	*0.21*	*0.12*

1. Upper Limit for Slightly Disturbed Aquatic Ecosystems in South West Australia. Australian and New Zealand Environment and Conservation Council (ANZECC) (2000a) *Australian Water Quality Guidelines for Fresh and Marine Water Quality;*

2.9 Water Resources

The Study Area is located within the DoW's Serpentine River Catchment Surface Water Management Area and Lower Serpentine Surface Water Management Sub-area (SWMA). Use of surface water for water supply within the Study Area is not considered appropriate as surface water is required to maintain the Bollard Bulrush Swamp hydrological regime.

The Study Area is within the DoW's Serpentine Groundwater Management Area (GMA), and Jandakot Mound 2 Groundwater Management Sub-area. DoW Water Register indicates that the Jandakot Mound 2 Superficial Aquifer is already fully allocated and no water is available (26 October 2016). Limited information is available for the Perth-Leederville aquifer however as this water resource is currently used for potable water use, an alternate non-potable water supply is not considered appropriate.

Potable water supply to homes currently in the Study Area is via the Water Corporation managed Medina Water Scheme which is primarily fed by the Jandakot Mound (Perth-Leederville aquifer). Connection to the existing supply scheme will require the extension of existing infrastructure. Confirmation and details of Water Corporation supply will be provided in the UWMP. There are no existing DoW groundwater licences within the Study Area.

2.10 Hydrological Opportunities and Constraints

The above described characteristics of the pre-development environment in the Study Area provide a number of key constraints and opportunities for the application of water sensitive urban design with land use change:

- Silty clay soils are likely to limit post development infiltration opportunities in the Study Area, and this will impact the ability to meet DoW's preference to infiltrate frequently occurring storm events (typically less than 1 year ARI). Consequently, frequently occurring storm events (1 year ARI 1hr) will be infiltrated at source where possible via soakwells or swales in clean imported sand fill; subsoils will be required to manage rising of groundwater within fill.
- WAPC's Bulletin 64 (WAPC, 2003) ASS risk mapping for the Study Area indicates high risk of Actual ASS or Potential ASS within 3 m of the existing surface for the vast majority of the Study Area. An ASS Investigation and Management Plan will be required prior to development.
- There is a Conservation Category Wetland and EPP Lake within the Study Area which requires consideration in regard to drainage and water quality. Drainage infrastructure is to be placed outside of the 50m wetland buffer.
- Groundwater monitoring and mapping within the Study Area (ENV, 2011) has allowed for a local assessment of groundwater levels in relation to existing natural surface level. High groundwater levels will require management and control in the post-development environment to prevent rising groundwater table and inappropriate draining of groundwater.
- Habitable floor levels are to be minimum 6.12 mAHD, that is 0.5m above the adjacent Peel Main Drain 100 year ARI flood level of 5.62 mAHD.
- Historical rural land use within the Study Area has to varying degrees affected groundwater quality and there are currently no water quality controls. Change in land use provides an opportunity to improve groundwater quality through application of sustainability principles, water sensitive urban design, and establishment of water quality targets, monitoring and compliance reporting.
- No available groundwater allocation from the Jandakot Mound 2 GSWA Superficial Aquifer.

These constraints and opportunities are used in to assist development of a suitable Local Water Management Strategy (LWMS) for the Study Area.

3. PROPOSED DEVELOPMENT

The proposed Local Structure Plan for the Study Area is shown in Figure 8.

Key elements of the LSP related to urban water management include:

- Establishment of a buffer for the future protection of the Bollard Bulrush Swamp. This buffer area will include restricted POS but will not contain any active POS or drainage infrastructure;
- POS area proposed to be passive with mulching and use of native water-wise plantings for revegetation. No active turf areas are proposed. City of Kwinana has requested POS area to remain as existing natural condition with only minor revegetation around perimeter. Consequently, there is no requirement for installation of a groundwater bore or licence allocation. Detailed landscaping to be provided at UWMP stage.
- Use of ephemeral bioretention areas for management of local stormwater in POS;
- At-source infiltration of frequently occurring storm events, up to 1 year ARI 1hr duration, in road reserves and POS where practical;
- Maintenance of drainage/stormwater discharge points from the Study Area to the receiving environment;
- Control of post-development groundwater rise within imported fill via subsoil drainage;
- Minimisation of fill consistent with sustainability principles.
- Lot size and yield to be determined at subdivision stage.

4. WATER USE SUSTAINABILITY INITIATIVES

4.1 Water Conservation

Development of the Study Area will lead to an increased demand for water for new residents.

Water conservation measures will be implemented to reduce scheme water consumption within the development and will be consistent with Water Corporation's "Waterwise" land development criteria, and include:

- Use of medium density residential zoning and smaller lots to reduce garden (ex-house) use of water.
- Promotion of use of waterwise practices including water efficient fixtures and fitting (taps, showerheads, toilets and appliances, rainwater tanks, waterwise landscaping).
- Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water.
- All houses to be built to 5 star building standards.
- Utilise fit for purpose water sources throughout the development.
- Use of native plants in POS areas and buffer areas.
- Maximising on site retention of stormwater (where practicable).

Specific agreed measures and locations to achieve water conservation will be detailed in the UWMP.

4.2 Potable & Non-Potable Water Supplies

4.2.1 Household Scale

The water source planning strategy for the Study Area is for use of scheme water for domestic household use (both in and ex-house). The development will be connected to Water Corporation's Integrated Water Supply Scheme (IWSS). The Water Corporation has advised that supply to the development can come from the existing DN300 water main within Johnson Road. Upgrades to the water distribution infrastructure may be required to service the ultimate development however, Water Corporation water planning is currently under review. More detailed information and Water Corporation confirmation of supply will be provided at UWMP stage.

The use of rainwater tanks to supplement potable water use ex-house and in-house will be encouraged by the developer. The use of rainwater tanks will be assessed as part of the UWMP process at subdivision stage when more detailed planning is commenced. The integration of rainwater tanks for non-potable water with the domestic water supply scheme would assist in reducing excess stormwater generation and minimise scheme water importation.

Superficial groundwater abstraction via installation of domestic groundwater bores could also be used for ex-house uses such as irrigation of garden and lawn areas, where geology permits.

4.2.2 Public Open Space Areas

POS maintenance requirements will be managed by the developer for a period of two years before hand-over to the City of Kwinana. Detail landscaping design and planting will be presented in the UWMP.

City of Kwinana has requested POS area to remain as existing natural condition with only minor revegetation around perimeter. Consequently, POS will be passive with mulching and use of native water-wise plantings for revegetation, with no active turf areas.

Water for irrigation will only be required temporarily during establishment of the revegetation. This temporary demand can be satisfied by mobile water tanks as there is no water allocation available in the superficial aquifer. Thus there is no requirement for installation of a groundwater bore or application for a Licence to Take Water.

Based on the household and POS water strategies, a water balance for the site has not been provided in the LWMS, as it is typically required to support the identification of excess water generated by the development where use of this excess water as a non-potable water supply scheme is proposed. A water balance would not provide any further information on water use and potable/non-potable supply options. Furthermore, design and building of the proposed development to current industry standard should ensure water use is within current Water Corporation and Department of Water consumption targets.

4.3 Wastewater

Wastewater disposal from the development is proposed to be serviced via an extension of the Water Corporation's existing infrastructure. The Water Corporation's wastewater planning over the development area indicates that there is currently capacity within the existing Bertram Road wastewater pump station located to the north west of the site which can accommodate gravity flows from the Study Area. Further advice from Water Corporation on the completion of wastewater infrastructure planning for the Study Area will be provided at UWMP stage.

5. STORMWATER MANAGEMENT

5.1 District Flood Management

Pre-development flood modelling has previously been undertaken for the Peel Main Drain and Bollard Bulrush Swamp as documented in the Jandakot DWMP (DoW, 2009b) (See Section 2.7.2).

Post-development flood modelling has also been undertaken by GHD (2010) to identify storage volumes required by developments proposed within Bollard Bulrush Swamp to ensure pre-development peak flow rates and flood levels identified in the Jandakot DWMP are maintained. Modelling was based on the Infoworks CS model as used in the Jandakot DWMP and simulated full development around Bollard Bulrush Swamp with and without on-site detention storages.

Modelling concluded that with sufficient on-site detention storage, post development water level in Bollard Bulrush Swamp could be maintained at pre-development levels.

This was achieved by providing on-site detention throughout the Bollard Bulrush Swamp area; 30,000 m^3 in the 10 year ARI event and 39,000 m^3 in the 100 year ARI event. The DWMP identified the required storage volumes within the East Precinct in the 10 and 100 year ARI as 12,146 m^3 and 15,790 m^3 respectively. This is based on a percentage ratio approach. As such, the required detention volumes in the Study Area are 1,020 m^3 in the 10 year ARI event and 1,326 m^3 in the 100 year ARI event. Summary of these post-development peak levels and flows are shown in Table 7 and further detail in the GHD (2010) modelling memorandum in Appendix C.

Without any on-site detention, 100 year ARI top water level in Bollard Bulrush Swamp increased 40mm from 5.61m AHD to 5.65m AHD.

TABLE 7: PEEL MAIN DRAIN POST-DEVELOPMENT FLOOD ESTIMATES WITH ON-SITE DETENTION (GHD, 2010)

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 Year ARI	100 Year ARI	10 Year ARI	100 Year ARI
Peel Main Drain (PMD56) (Upstream of Bertram Rd Culvert)	7.90	8.20	3.25	3.82
Bollard Bulrush Swamp (BOLLCB)	4.82	5.61	3.38	4.00
Peel Main Drain (PMD55) (Downstream of Millar Rd Culvert)	4.70	5.59	4.39	5.14

The requirement for on-site detention was subsequently superseded following advice from Bill Till (Department of Water) at an on-site meeting in 2014 with consultants, a neighbouring proponent and the City of Kwinana (*pers. comm.* Jane Sturgess, 2015). At this meeting, it was agreed that the development will only retain, treat and infiltrate the first 15 mm of rainfall (small events).

The preferred management of this first 15 mm is as close to source as possible with stormwater directed towards a biofiltration area located within the POS adjacent to the wetland and its buffer. Excess stormwater is to discharge slowly as sheet flow overland into the wetland area as it does pre-development with scour and erosion protection. No drainage infrastructure is to be included within the wetland or its buffer.

This advice has been accepted and applied to the Study Area, therefore no attention of the 10 year or 100 year ARI peak volume is provided. The bioretention basin has been sized to hold the first 15 mm of stormwater from the development. It is expected that the wetland and buffer itself will act as the detention storage areas, so pre and post development flows will inherently match.

5.2 Stormwater Management Strategy

The stormwater management strategy has been prepared to meet the objectives and principles of urban water management outlined in Table 3. In addition, the proposed strategy is consistent with the design objectives from the Jandakot DWMP (DoW 2009a) and the Wellard Urban Precinct East DWMS (Emerge, 2015).

The key elements of the stormwater management strategy are:

- To retain, treat and infiltrate the first 15 mm of the rainfall event across the development area.
    - Retention of the first 15mm of rainfall on lots within soakwells or other infiltration structures.
    - To treat the first 15 mm rainfall event from roads through bioretention areas/swales or other techniques as close to source as feasible.
- Any additional stormwater run-off created during rainfall events greater than 15 mm will be directed towards the wetland buffer via pipe drainage and overland flow paths.
- No stormwater infrastructure will be constructed within the CCW wetlands or its buffers.
- Discharge of large stormwater runoff events that exceed the capacity of the bioretention area should occur as sheetflow across a vegetated surface towards the wetland buffer to replicate the pre-development environment (with scour and erosion protection at the initial discharge point).
- No discharge of any stormwater into adjacent Lot 680, except within the Bollard Bulrush Swamp area.
- Bioretention areas should be located outside of the Bollard Bulrush Swamp 10 year ARI Top Water Level (TWL).
- The City of Kwinana Bertram Road infiltration basin will be relocated within the Study Area POS, with the concept design to be completed by the City. Stormwater discharged into this basin will be managed separately to stormwater runoff from the Study Area.
- Habitable floor levels are to be minimum 6.12 mAHD, that is 0.5m above the adjacent Peel Main Drain 100 year ARI flood level of 5.62 mAHD.
- There is to be a minimum of 500 mm clearance from the base of any bioretention basins or swales to the Maximum Groundwater Level (MGL) at that specific location.
- Use of subsoil drains to mitigate the rise of groundwater within fill and maintain a minimum separation of 1.5m between MGL and finished lot level.

5.2.1 Catchment Runoff Parameters

For 1 year ARI 1 hour storm the runoff coefficients include 80% for Road Reserves and 10% for POS to calculate the equivalent impervious areas. It is assumed that individual Lots will have soakwells with sufficient storage capacity for 15 mm of rainfall from the impervious lot area.

A breakdown of the land use area is presented in Table 8 and land use is shown in Figure 8.

TABLE 8: LAND USE BREAKDOWN

Land Use	Total Area (ha)	1 year ARI Runoff Coefficient	Impervious Area (ha)
Lots	4.53	0.00	0.00
Road & Road Reserves	1.95	0.80	1.57
POS	0.57	0.00	0.00
Wetland Buffer	1.09	n/a	n/a
City of Kwinana Drainage Basin	0.21	n/a	n/a
Total	**8.02**	**-**	**1.57**

5.2.2 Conceptual Stormwater System Design

A major and minor approach to the design of the stormwater management system has been adopted for this site. The minor system consists of pipes, kerbs and gutters designed to convey the stormwater to the median swales, roadside swales, and bioretention basins designed to infiltrate stormwater as close to source as possible. The major system consists of the road, median and road-side swales, bioretention basins and POS areas to provide protection of the community from extreme flooding events (up to the 100 year ARI rainfall event) that exceed the capacity of the minor system.

All stormwater generated within the development will be managed within the Study Area. There will be no direct discharge into the adjacent PMD or Lot 680 (except within the Bollard Bulrush Swamp area).

The City of Kwinana Bertram Road infiltration basin will be relocated within the POS area and will be managed separately to stormwater runoff from the Study Area. The proposed location for this basin is shown on Figure 9. Note that this basin does not accept or discharge any stormwater into the Study Area.

Drainage practices and concepts intended for stormwater management are described below and they will be subject to further design and engineering specifications during the detailed design phase, with this information included in future UWMPs.

Minor System (15 mm Rainfall Event)

Management of the frequent event (15 mm rainfall event equivalent to the 1 year 1 hour ARI) is largely related to water quality protection of the receiving environments. Run-off from this event is the most likely to contain pollutants originating within the catchment, and therefore measures are required to retain and treat this storm event on site.

Lots

At the Lot scale, first 15 mm rainfall event will be retained within the lot boundary and infiltrated using soakwells. Impervious areas, such as roof area and driveways will be directly connected to soakwells. The system is achievable where there is adequate clearance to the groundwater level across the site (generally calculated to be greater than 1.5 metres) and favourable fill material suitable for sufficient infiltration rates. In high density areas (>R40), use of soakwells may be limited due to area and/or may require an overflow connection into the local pipe drainage system.

Road Drainage Network

It is proposed that flows from the roads and road reserve areas are to be conveyed to tree pits, median swales, road-side swales, bottomless manholes and to the bioretention basin for treatment and infiltration. The stormwater plan has been designed to maximise opportunities for infiltration throughout the site and as close to source as possible, helping to reduce the export of nutrients or pollutants in stormwater run-off from the site during the more frequent, minor storm events. The amount and location of any tree pits, bottomless manholes, median swales and/or road-side swales will be determined at UWMP stage.

Road drainage infrastructure will direct stormwater into the median or roadside swales via flush kerbing, or through a piped network to the bioretention basins. Stormwater will enter the street drainage system and discharge into these bioretention areas (swales or basin) where it will be infiltrated into an amended soil medium.

The total impervious road and road reserve area in the development is 1.56 ha. In a 15 mm rainfall event, a total of volume of 234 m^3 will require treatment. Assuming a basin/swale depth of 0.3 m, this suggests that 780 m^2 of area is required for drainage throughout the development. Indicative locations of stormwater treatment areas and basins are provided in Figure 9. It is suggested that the basins are located outside of the Bollard Bulrush Swamp 10 year ARI TWL boundary, as shown in Figure 9. Stormwater event plan for 1 year ARI is shown in Figure 10.

Major System (Rainfall Events Greater than 15 mm)

During rainfall events that exceed the capacity of the minor system, stormwater runoff from roads less than the 5 year ARI will be conveyed to swales and bioretention area by the underground pipe drainage system. For rainfall events that exceed the 5 year ARI, stormwater will be conveyed to the bioretention area via the road network as overland flow.

When the capacity of the swale and bioretention basin is reached (i.e. after the first 15 mm of rainfall), it is anticipated that the basin will overtop via an overflow spillway to mimic sheetflow and flow towards the wetland buffer and storage area, which will be designed to minimise erosion and scouring during discharge events. Larger events will ultimately flow into the Bollard Bulrush Swamp area and then into the PMD. Some overflow within the wetland buffer may also flow into the portion of the Bollard Bulrush Swamp area within Lot 680. However this will not adversely impact flood levels in this Lot due to the significantly large flood storage volume available in the wetland.

Stormwater event plan for major rainfall events are shown in Figure 10.

5.3 Groundwater Management

Minimum separation between building floor levels for development and the Maximum Groundwater Level (MGL) will be achieved by combination of subsoil drainage and the importation of clean sand fill. The design of the proposed development should incorporate a minimum habitable floor level 1.5m above the MGL to meet the recommended clearance, unless otherwise indicated in future geotechnical reports completed as part of the UWMP.

Use of subsoil drains will also be required to mitigate the rise of groundwater within fill. It will not be used to lower groundwater levels, but will be installed as a backup to ensure post development groundwater levels are maintained and minimum separation 1.5m is achieved in imported fill. A design groundwater level (DGL) will be implemented by setting subsoil drainage inverts as a minimum at the MGL. Subsoil drains will be located in road reserves and throughout the proposed lot area to achieve the DGL. Subsoil is to discharge into the bioretention area and be free draining. The existing localised linear depression under the tree line along the eastern boundary in Lot 680 will act as an open drain and also assist in controlling any groundwater rise on Lot 680.

Detailed cross sections including stormwater pits and pipes and detailed design of subsoil drainage including spacing to achieve the DGL is to be undertaken at subdivision stage and included in the UWMP.

Finished lot levels and fill requirements are a detailed design issue to be addressed during preparation of the UWMP and submitted for council approval at that stage. Note that other factors such as geotechnical, sewerage infrastructure or clearance to 100 year ARI flood level may be the determining factor for fill level, rather than groundwater clearance.

Groundwater mapping presented in Figure 7 should be considered indicative only for assisting in LWMS strategy development purposes and subject to further investigation/refinement during UWMP stage.

5.4 Water Quality Management

With respect to water quality management the LWMS proposes the use of a treatment train approach including source control techniques. The proposed water quality management approach for the Study Area will include:

- **Non Structural Controls**
  Planning practices (POS locations and configuration, watercourse buffers)
  Construction practices (construction management, use of plantings with City of Kwinana recommended Endemic Species (see Appendix D))
  Maintenance practices (street sweeping, stormwater system, POS areas)
  Educational and participatory practices (community education)

- **Structural Controls**
  - Infiltration of lot runoff at source via soakwells and gardens
  - Infiltration of road runoff via bioretention swale or basin (designed with soils with a PRI >10 and City of Kwinana recommended Endemic Species List (see Appendix D))
- **Monitoring**
  Establishment of post development monitoring network
  Annual reporting, including assessment of BMP's performance

With respect to criteria for water quality, the principle of improving water quality in comparison to existing water quality will be adopted via Water Sensitive Urban Design, and water quality targets developed on this basis as percentage reductions as per Best Management Practise water quality targets (see Section 5.4.1). Assessment of compliance with targets will be through post-development monitoring (refer section 6.4).

To achieve its water quality objectives, the LWMS focuses on implementing current known best management practice as detailed in the DoW's Stormwater Management Manual for Western Australia (2007) and the Decision Process for Stormwater Management in Western Australia (DoE & SRT, 2005), with an emphasis on nutrient input source control, rehabilitation of EPP Lake buffer, and establishing bioretention systems for treatment of frequently occurring storm events and subsoil drainage. Detailed design of these management items will be presented in the UWMP.

Opportunities for infiltration and treatment of frequent rainfall events (15mm) higher in the catchment with roadside swales, tree pits, flush kerbing adjacent to POS and soakwells within fill etc. are to be investigated further during detail design and presented in the UWMP.

5.4.1 Assessment of Proposed Structural BMP's to Design Criteria

Table 9 details a summary from DoW's Stormwater Management Manual for Western Australia (2007) of expected pollutant removal efficiencies for vegetated swales and detention/retention systems in relation to the water quality design criteria specified in Table 1.

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 5.4 will therefore clearly achieve the design objectives for water quality.

Specific details on the location scale of application, and management responsibilities for individual BMP's are to be assessed for individual stages during development of the UWMP.

TABLE 9: BMP WATER QUALITY PERFORMANCE IN RELATION TO DESIGN CRITERIA

Parameter	Design Criteria via DWMP (required removal as compared to a development with no WSUD)	Structural Controls Nutrient Output Reduction [1]	
		Vegetated Swales/ Bioretention Systems	Detention/ Retention Storages
Total Suspended Solids	80%	60-80%	65-99%
Total Phosphorus	60%	30-50%	40-80%
Total Nitrogen	45%	25-40%	50-70%
Gross Pollutants	70%	-	>90%

1. Typical Performance Efficiencies via DoW (2007)

5.5 Construction Management

5.5.1 Dewatering

Dewatering of the superficial aquifer may be required for some elements of development construction. As the volume of dewatering will be small compared to aquifer storage and this is to be infiltrated back into the superficial aquifer, the impact upon the aquifer will be minimal.

Drawdown will occur at the dewatering site, and mounding where the water is infiltrated. It should be noted that there will be zero net loss of groundwater, as all water abstracted will be infiltrated (except for minor losses to evaporation).

Prior to the commencement of any dewatering, construction contractors will be required to apply for and obtain from DoW a 'Licence to Take Water'. All dewatering will be carried out in accordance with the conditions of this licence.

Where possible, construction will be timed to minimise impact on groundwater and dewatering requirement.

5.5.2 Acid Sulphate Soils

All assessment and management of ASS will be conducted in accordance with the Acid Sulfate Soil Guideline Series Identification and Investigation of Acid Sulfate Soils (DoE, 2004), including the Preliminary Site Assessment (PSA) involving a targeted soil and groundwater sampling and analysis program, detailed site assessment (if required), and ultimately and an ASS Management Plan if ASS is to be impacted.

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 Sulphate 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 are appropriately tested and managed before reuse or disposal off-site.

6. IMPLEMENTATION

6.1 Roles and Responsibilities

Table 10 details the roles and responsibilities to undertake the implementation plan.

TABLE 10: IMPLEMENTATION RESPONSIBILITIES

IMPLEMENTATION	RESPONSIBILITY	
Action	**The Developer**	**City of Kwinana**
Preparation of an Urban Water Management Plan for individual development stages	✓	
Construction of stormwater system and 12 months maintenance post construction (defects period)	✓	
Long term stormwater system operation and maintenance		✓
Monitoring program – 2 years post development	✓	

6.2 Subdivision Application Process

Consistent with processes defined in WAPC (2007) an Urban Water Management Plan (UWMP) will be developed and submitted to support subdivision application.The UWMP will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of CoK and DoW.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Refine stormwater management design presented in the LWMS including the size, location and design of public open space areas, integrating major and minor flood management capability.
- Refine the management of groundwater levels (including proposed fill levels (if any) and subsoil drainage inverts) as presented in the LWMS.
- Specific structural and non-structural BMPs and treatment trains to be implemented including their function, location, maintenance requirements, expected performance and agreed ongoing management arrangements.
- Management of subdivisional works (including development of a strategy for sediment control during construction).
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Review and refinement of Monitoring Program, Performance Criteria and Contingency Planning to be undertaken for each UWMP area consistent with the monitoring program defined in the LWMS.
- A geotechnical investigation and Acid Sulfate Soil Investigation to be carried out for Lot 670 with results to be reported in a future UWMP for these lots.

6.3 Stormwater System Operation & Maintenance

Operation and maintenance of the drainage system will initially be the responsibility of the developer, ultimately reverting to the local authority, excluding proposed strata development areas. The surface drainage system will require regular maintenance to ensure its efficient operation. It is considered the following operating and maintenance practices will be implemented periodically:

- removal of debris to prevent blockages;
- street sweeping to reduce particulate build up on road surfaces and gutters;
- cleaning of sediment build up and litter layer on the bottom of basins;
- application of slow release/zero phosphorus fertilisers for maintenance of POS areas and any swales;
- undertake education campaigns regarding source control practices to minimise pollutant runoff into stormwater drainage system; and
- checks on any subsoil drainage function.

6.4 Monitoring Program

The monitoring program has been designed consistent with Joint Australian/ New Zealand Standards (2000) to allow quantitative assessment of hydrological impacts of proposed development within the Study Area.

In particular the program addresses the monitoring of groundwater quality within the development 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 program itself. Any modification to the program would require the agreement of all parties (DoW, CoK, and developer). The program is designed to operate over a two year post development period including construction to allow for time lag for full impacts of development on the receiving environment to occur.

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.

The timing of commencement of the monitoring program should be negotiated at UWMP stage with DoW and the CoK. Typically the monitoring program is commenced at practical completion of the subdivision.

Groundwater monitoring is described below and summarised in Table 11. Ongoing tracking of environmental performance will be undertaken as monitoring data becomes available.

TABLE 11: MONITORING SCHEDULE AND REPORTING

Monitoring Type	Parameter	Location	Method	Frequency and Timing	Reporting
Groundwater Level	Water Level (m AHD)	~3 locations	Electrical depth probe or similar	Monthly for 2 years	Annual assessment reports to be submitted to DoW & CoK for a 2 year period. Suitability of existing monitoring and reporting frequencies to be assessed annually with any modifications requiring agreement by all parties (DoW, CoK, & Developer)
Groundwater Quality	pH, EC Nitrogen Phosphorus	~3 locations	Pumped bore samples	Quarterly for 2 years (typically Jan, Apr, Jul & Oct)	

6.4.1 Groundwater

Monthly monitoring of groundwater levels at approximately 3 locations is proposed, with quarterly monitoring of groundwater quality for the following parameters:

- In situ - pH, EC and Temperature
- Nitrogen & Phosphorus (full suite)

The depth to water table will be measured by electrical depth probe or an alternative suitable device. Water samples are to be collected and transported to a NATA registered laboratory with procedures in accordance to AS/NZS Standards.

6.4.2 Performance Criteria and Contingency Planning

Assessment of performance compliance against water quality criteria will require careful consideration to account for inter seasonal and inter annual variability, as groundwater quality will be a function of historical land use practices not only within the development area, but over the entire upstream catchment.

Data collected from 18 months of monitoring of ENV bores within the Study Area (MW1E & MW2E) have been used to create interim water quality criteria based on the ANZECC (2000b) computation of the 80th percentile of recorded values as trigger guideline values, these are shown in Table 12. Note that these criteria are interim only and should be refined as more monitoring data becomes available.

TABLE 12: INTERIM POST DEVELOPMENT WATER QUALITY CRITERIA

Monitoring Parameter	Interim Water Quality Criteria
Physical Properties	
pH	7.32 - 7.70
EC (uS/cm)	1,300
Nutrients (mg/L)	
Total P	1.12
Total N	3.85

Should results from water quality monitoring indicate an exceedance of the interim water quality criteria (Table 12), the proposed process for contingency action in the assessment of performance compliance are summarised in Table 13 below.

TABLE 13: POST DEVELOPMENT CONTINGENCY PLANNING

Monitoring Type	Criteria for Assessment	Criteria Assessment Frequency	Contingency Action 1. Assess if an isolated, development area or regional occurrence. 2. Determine if due to the development or other external factors. 3. Perform appropriate contingency action as required (examples below). 4. Record and report in the annual report any breach and action taken. 5. If necessary, inform land owners of any required works and their purpose.
Groundwater Quality	Nutrient concentration in bores to be similar or better than interim targets established by pre-development monitoring.	Annual review of water quality targets	1. Resample the questionable samples. 2. Identify and remove any point sources. 3. Review operational and maintenance (eg. fertilising) practices. 4. Consider alterations to POS areas including landscape regimes and soil amendment. 5. Consider modifications to the stormwater system. 6. Consider initiation of community based projects.
Groundwater Level	Groundwater levels not to exceed MGL	After monitoring occasion	1. Resample the questionable bore. 2. Review design and operation of stormwater drainage system. 3. Perform maintenance as required.

6.4.3 Annual Reporting

Reporting is proposed to be annually, co-ordinated by the developer and submitted to CoK and DoW for review. The report will compare the monitoring results with the interim water quality 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 (Table 11).

Monitoring and reporting outcomes will be used in a continual improvement capacity to review proposed WSUD, and inform the planning and design approaches for subsequent stages of development.

7. REFERENCES

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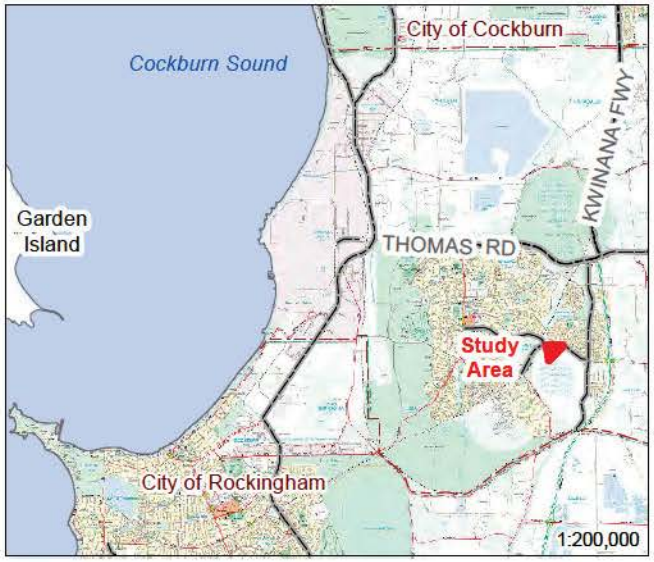

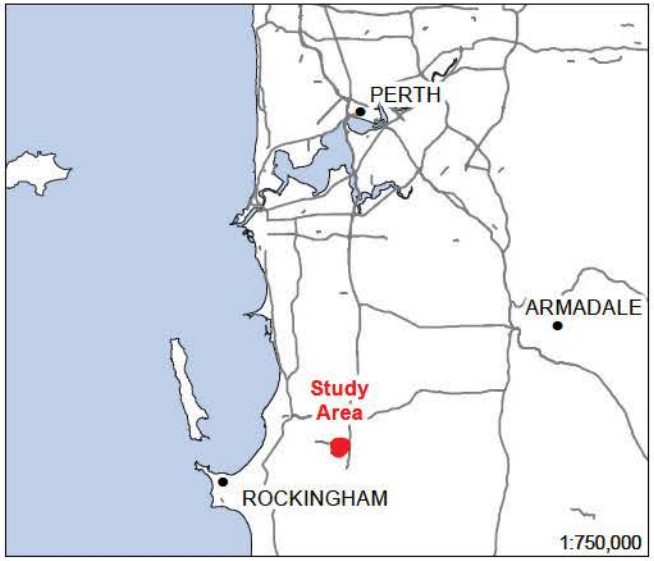

Data Source: Rowe Group (2015); Nearmap (2015)

JDA

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0 100 200 300 400 500 Metres

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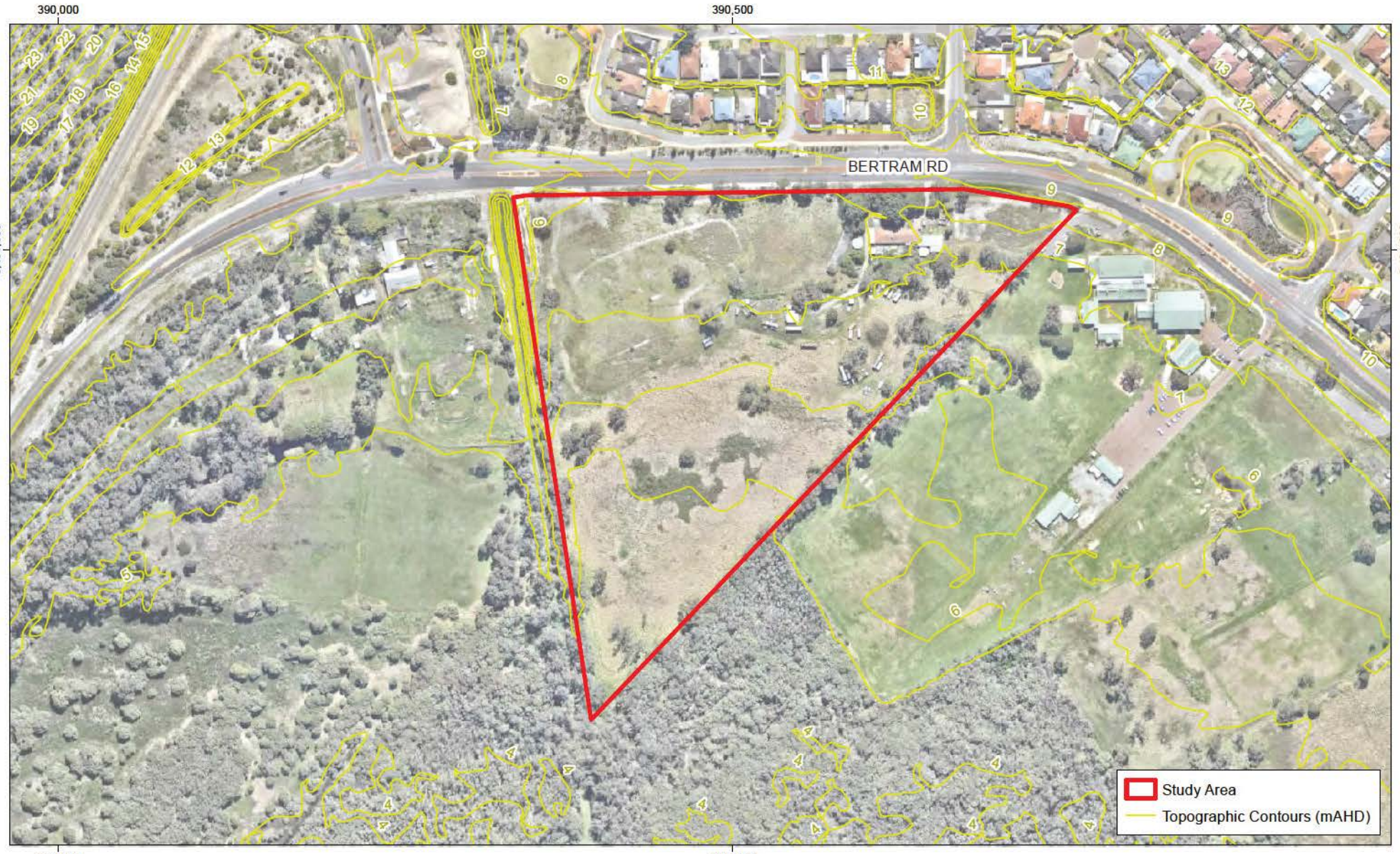
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 1: Location Plan



Data Source: DoP (2008); Nearmap (2015)

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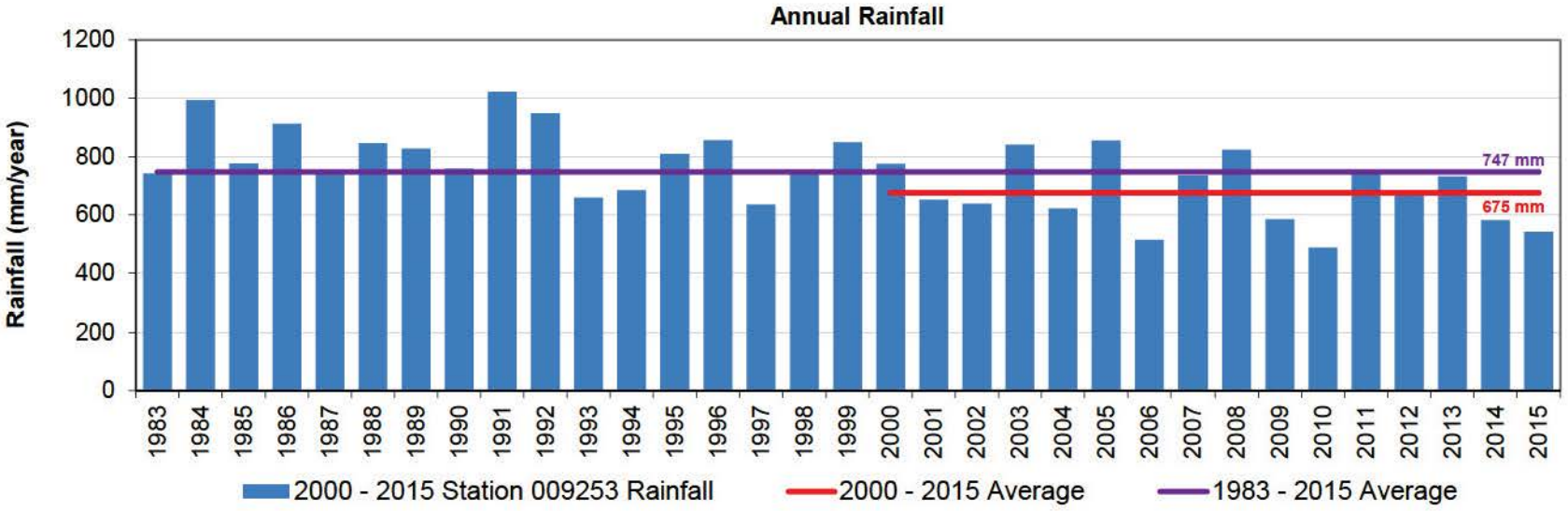
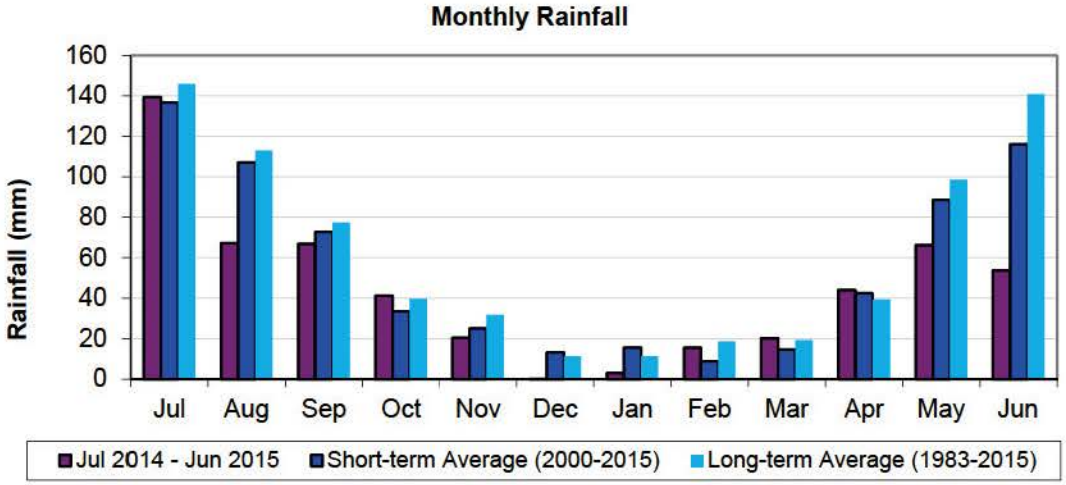
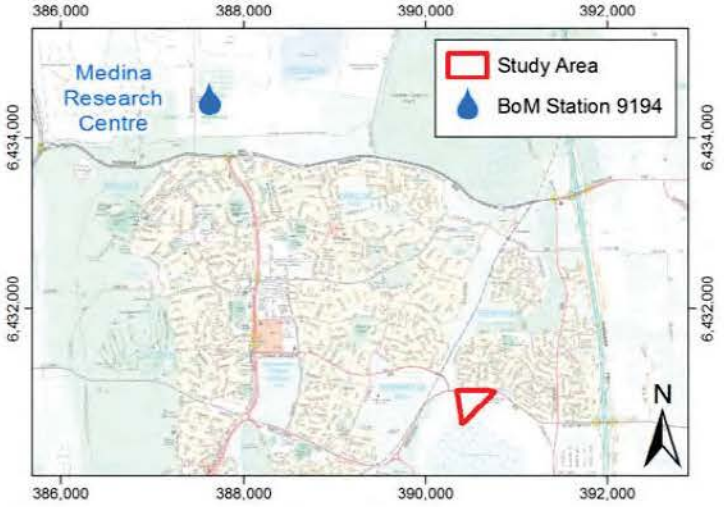
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 2: Existing Environment and Topography Plan





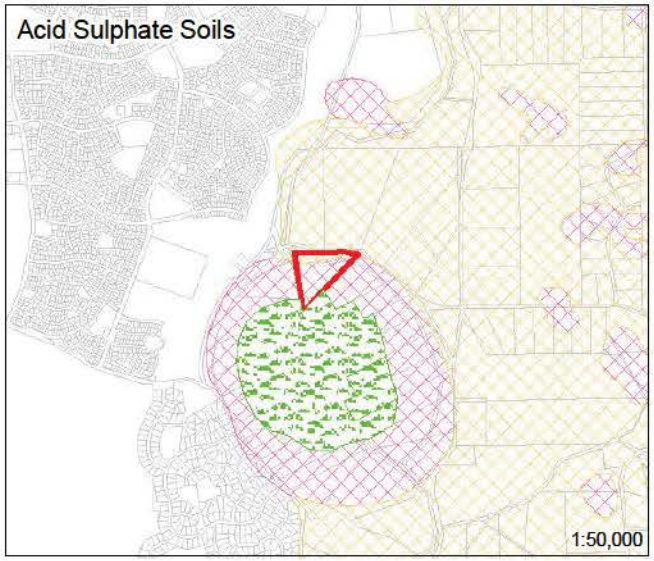


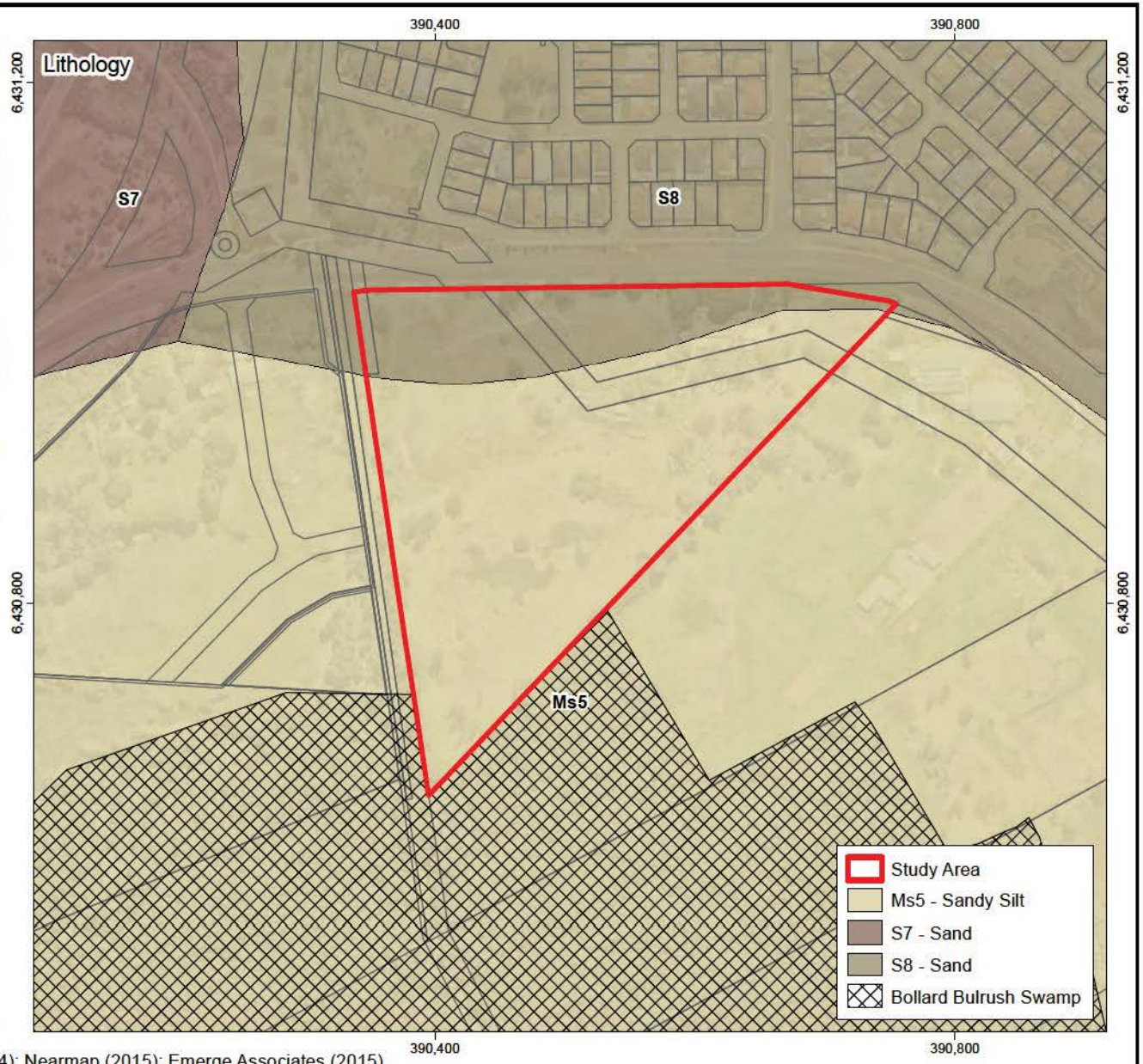
Data Source: http://www.bom.gov.au (accessed 10 December 2015)

Job No. J6040

Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd
Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 3: Annual and Monthly Rainfall





Lithological Classification

Ms5 - SANDY SILT - dark brownish grey silt, with disseminated fine -grained quartz sand, firm, variable clay content, of lacustrine origin.

S7 - SAND - pale yellowish brown, medium to coarse-grained, sub-angular to well-rounded quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin.

S8 - SAND - very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin as relatively thin veneer over clay, silt and clayey silt.

Bollard Bulrush Swamp

WAPC Acid Sulphate Soils Risk of ASS

High to moderate risk — occurring within 3 m from soil surface;

Moderate to low risk — occurring within 3 m from soil surface

Data Source: Department of Mines and Petroleum (2010); DER (2014); Nearmap (2015); Emerge Associates (2015)

JDA

Job No. J6040
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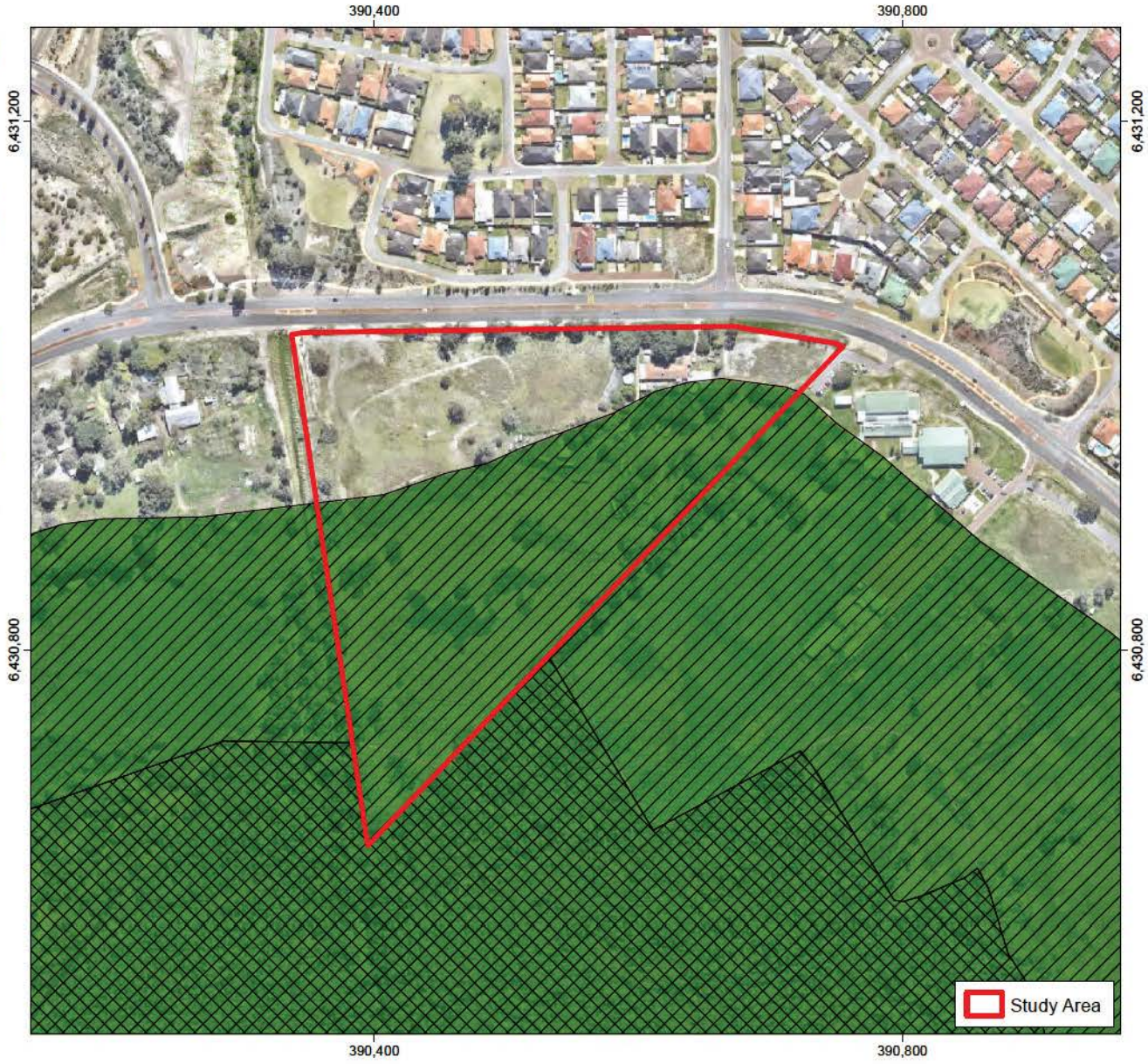
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 4: Environmental Geology and ASS Plan



Wetland Evaluation

- Multiple Use
- Bush Forever
- Bollard Bulrush Swamp

Wetland Classification

- Dampland
- Floodplain
- Palusplain
- Sumpland

Conservation:
Wetlands which support a high level of attributes and functions.

Multiple Use:
Wetlands with few attributes which still provide important wetland functions.

Resource Enhancement:
Wetlands which have been partly modified but still support substantial functions and attributes.

Data Source: DEC (2013); DoP (2013); Nearmap (2015)

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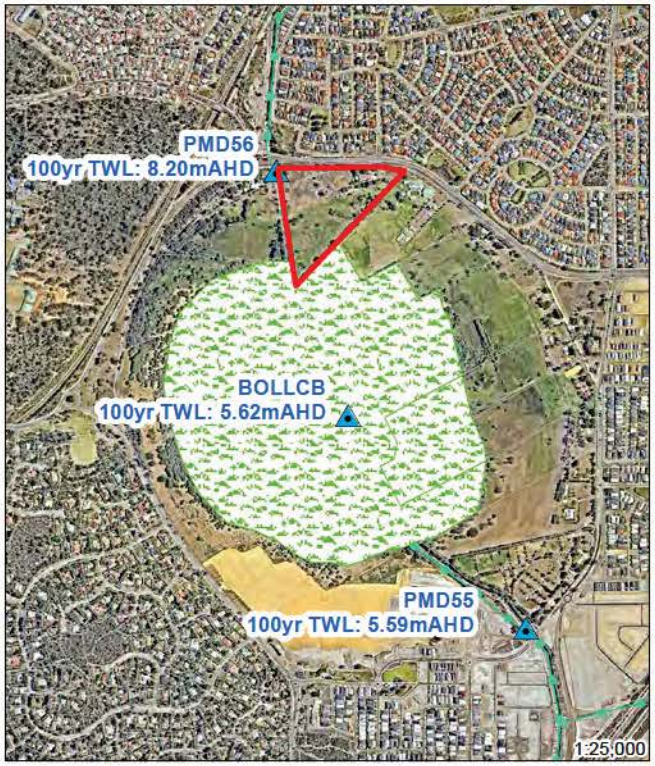
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 5: Wetland Plan



- Study Area
- Wetland Buffer
- Cadastre
- Estimated Bollard Bullrush Swamp 100yr TWL (5.62mAHD)
- Peel Main Drain
- Surface Water Flow Direction
- Topographic Contours (mAHD)
- Bollard Bulrush Swamp
- Surface Water Monitoring

Data Source: DEC (2013); DoP (2013); Nearmap (2015)

JDA

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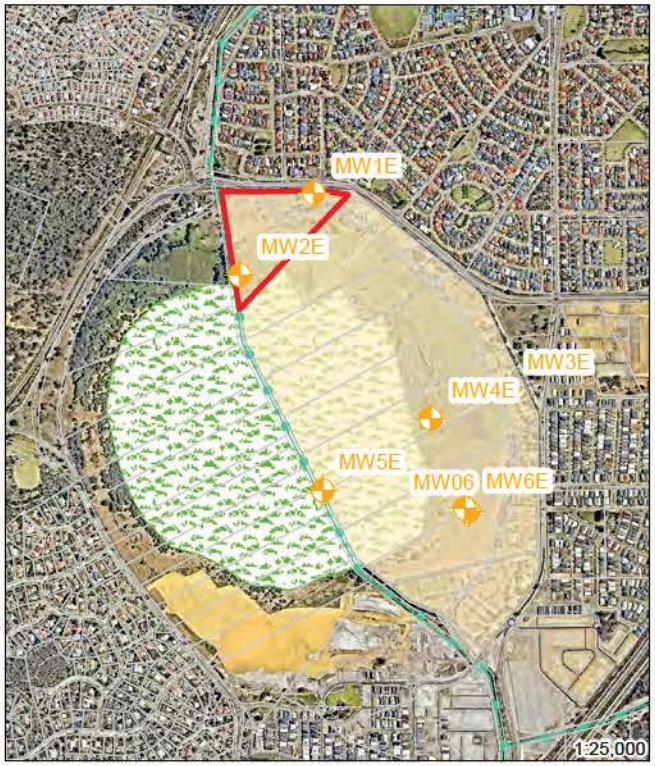
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 6: Surface Water Drainage Plan



- Study Area
- Bollard Bulrush Swamp
- Bollard Bullrush Swamp 50m Buffer
- DWMS Area
- Maximum Groundwater Level (mAHD) (Emerge, 2015)
- Peel Main Drain
- Topographic Contours (mAHD)
- ENV Groundwater Monitoring Bore

Data Source: DEC (2013); DoP (2013); Nearmap (2015)

JDA

Job No. J6040
Scale: 1:5,000 @A4

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Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd
Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 7: Pre-Development Groundwater Plan

Data Source: Rowe Group (2015); Nearmap (2015)

JDA

Job No. J6040
Scale:1:4,000 @A4

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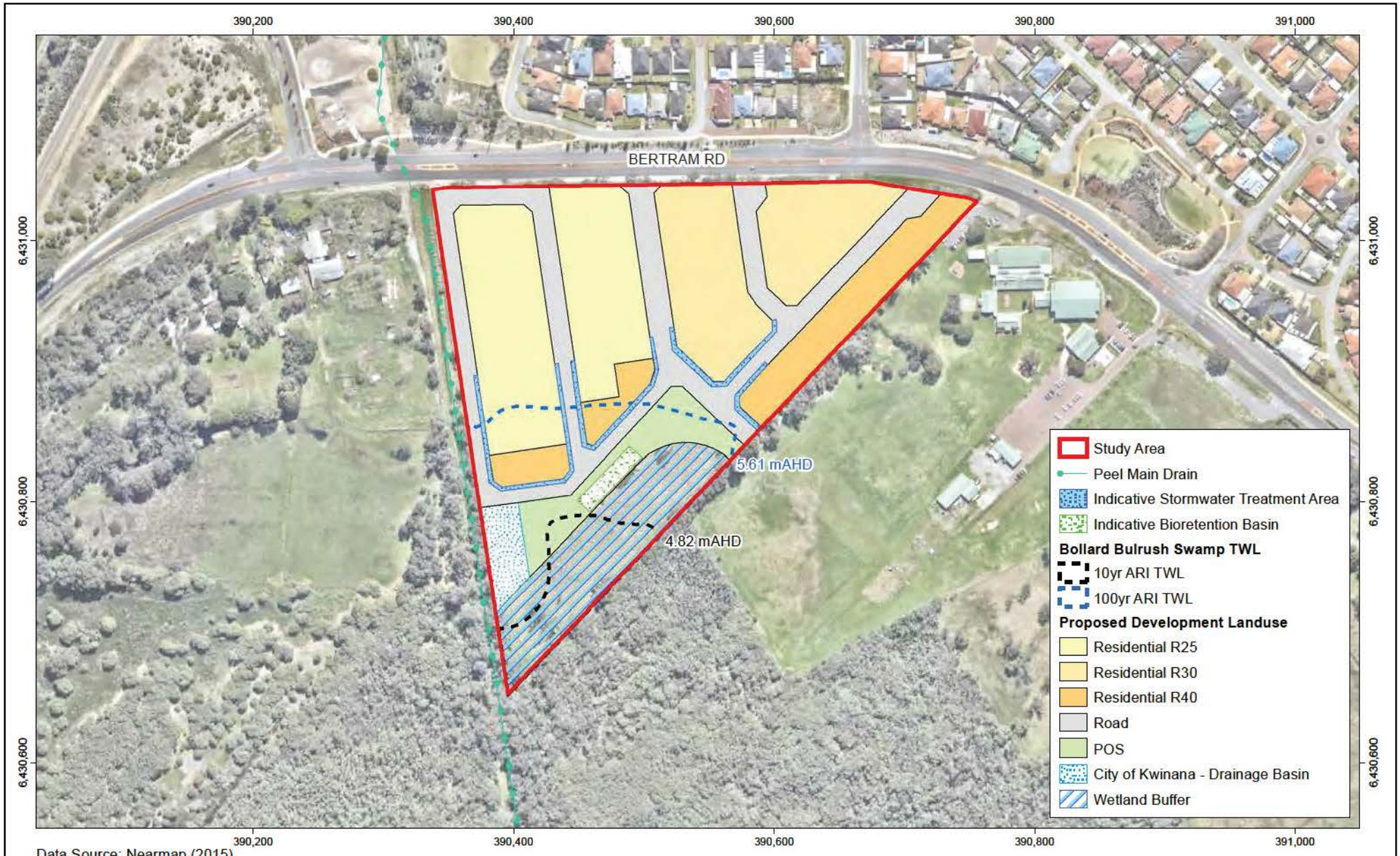
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 8: Proposed Structure Plan



Data Source: Nearmap (2015)

Job No. J6040

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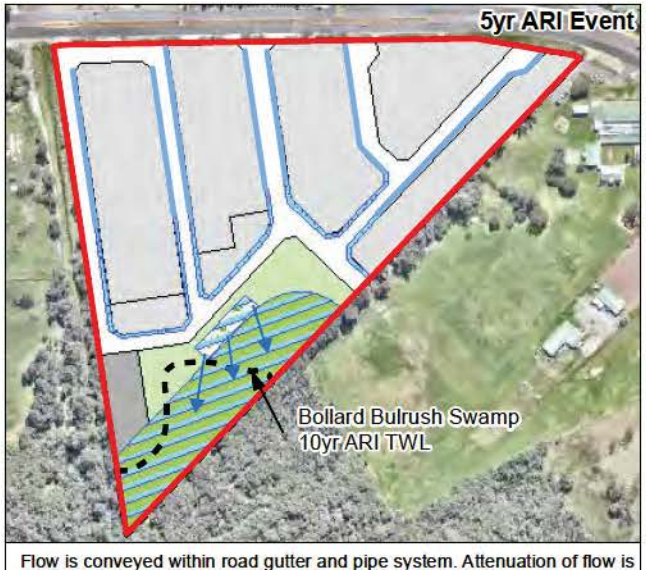
Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd

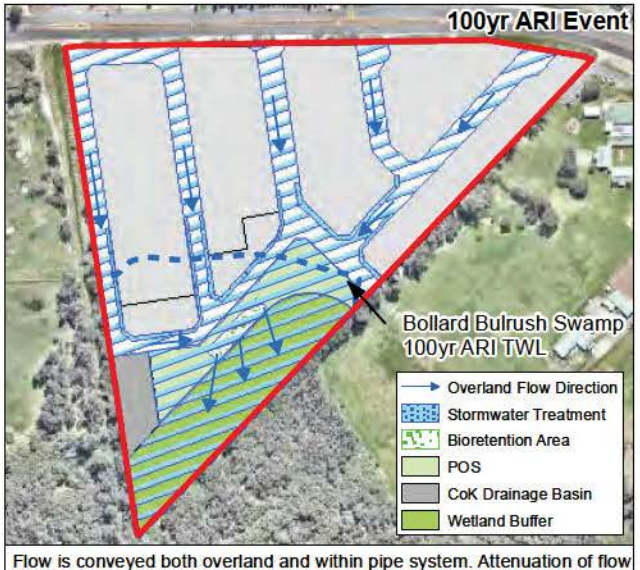
Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 9: Conceptual Stormwater Management Plan

Flow is contained within road pipe system. Attenuation of flow is limited to stormwater treatment areas and bioretention area.

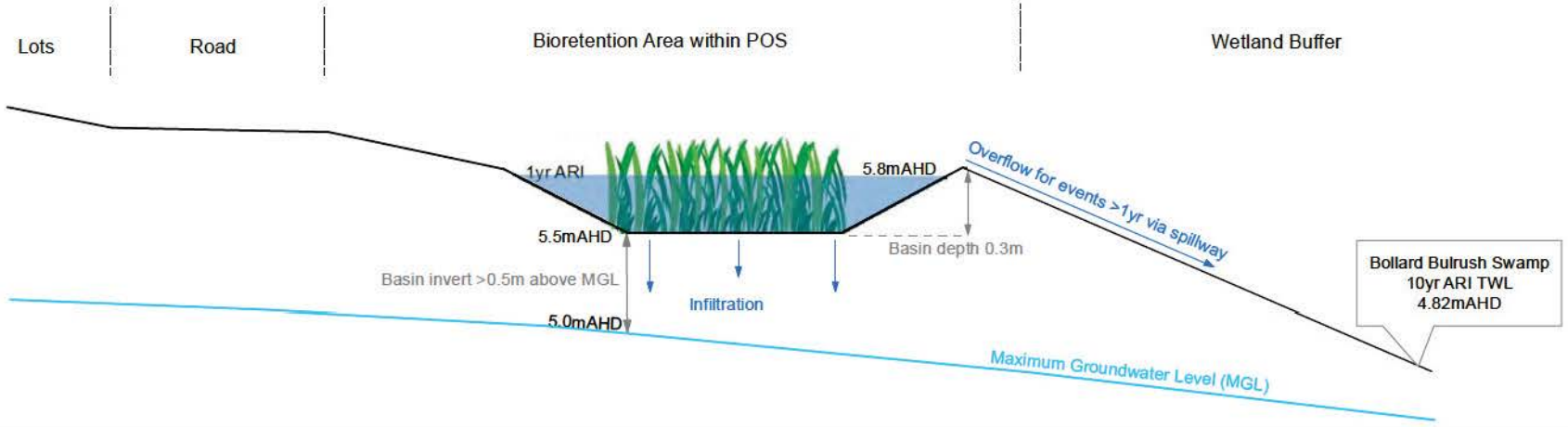


Flow is conveyed within road gutter and pipe system. Attenuation of flow is within stormwater treatment areas and bioretention area. Bioretention area will overtop via an overflow spillway towads the wetland buffer area.



Flow is conveyed both overland and within pipe system. Attenuation of flow in bioretention area, stormwater treatment areas, POS area and wetland buffer.

Bioretention Basin Cross Section A - A' (Not to Scale)



Note: Indicative bioretention area and stormwater treatment area design only. Detailed design to be presented in UWMP.

Job No. J6040

Byblos Holdings Pty Ltd and Springzone Nominees Pty Ltd
Lots 670 & 1338 Bertram Rd, Wellard and Reserve No. 50672 Wellard: LWMS

Figure 10: Stormwater Event Plan & Bioretention Area Cross Section

APPENDIX A

LWMS Checklist

LOCAL WATER MANAGEMENT STRATEGY: CHECKLIST (WAPC, 2008)

The following checklist provides a guide to items which should be addressed by developers in the preparation of Local Water Management Strategies for assessment by the local authority when an application for a structure plan is lodged.

1. Tick the status column for items for which information is provided
2. Enter N/A in the status column if the item is not appropriate and enter the reason in the comments column
3. Provide brief comments on any relevant issues
4. Provide brief descriptions of any proposed best management practices, e.g. multi-use corridors, community based-social marketing, water re-use proposals

Byblos Holdings Pty Ltd & Springzone Nominees Pty Ltd **Date:** February 2016

Name of Plan: Lots 670 and 1338 Bertram Rd and Reserve No. 50672, Wellard

Contact: Matthew Yan, JDA Consultant Hydrologists

Address: Suite 1, 27 York St Subiaco WA 6008

Telephone: 9388 2436 **Email:** matt@jdahydro.com.au

Local Water Management Strategy Item	Required Deliverable	Deliverable LWMS Reference	☐	Comment
Executive Summary				
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Design elements and requirements for BMPs and critical control points	Executive Summary		Not Provided
Introduction				
Total water cycle management – principles & objectives Planning background Previous studies		Section 1.2 Section 1.1	✓	
Proposed Development				
Structure plan, zoning and land use. Key landscape features Previous land use	Site context plan Structure plan	Sections 2, 3 Fig 1	✓	
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape Plan	Sections 3, 4 Figs 8, 9	✓	

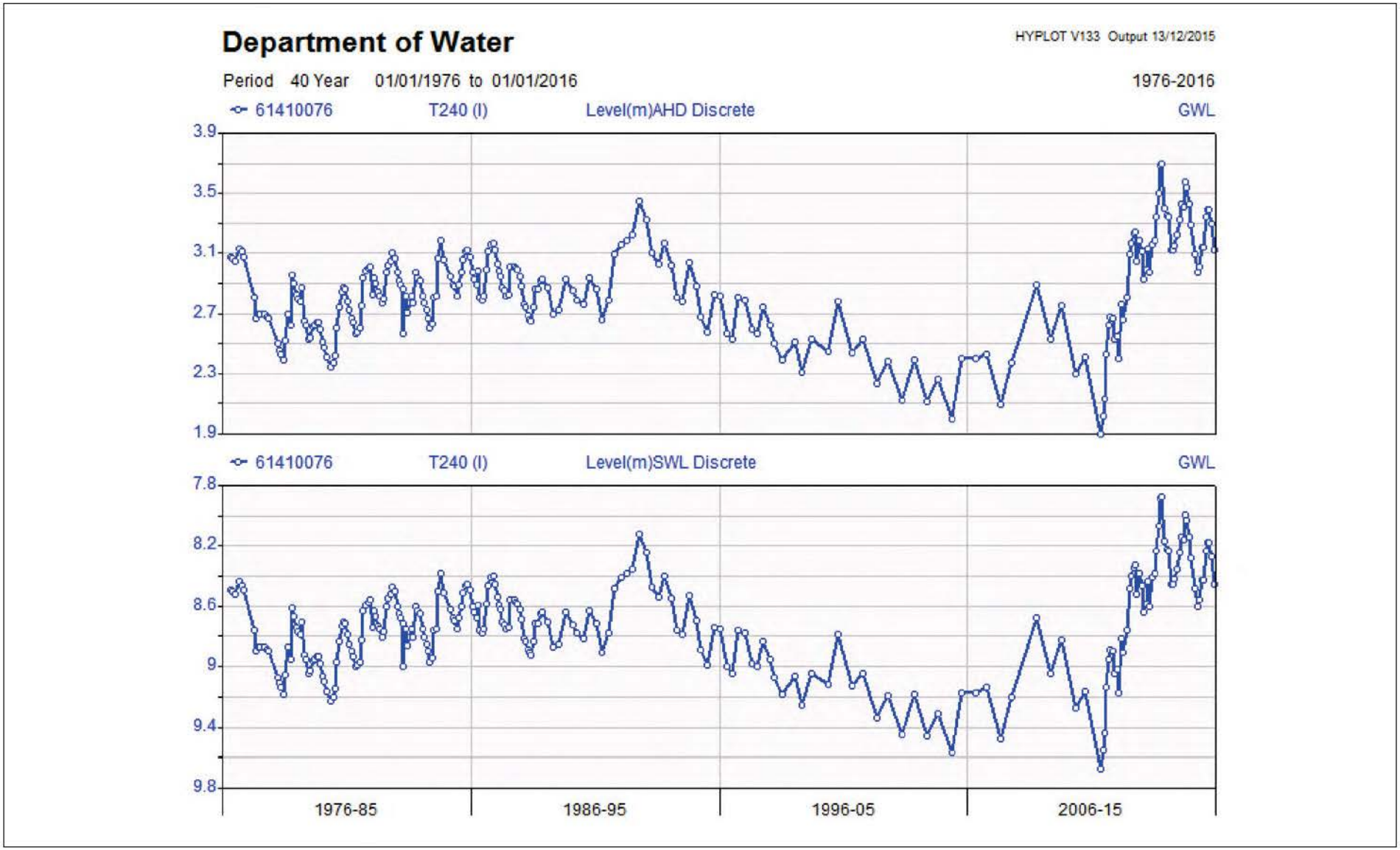
Local Water Management Strategy Item	Required Deliverable	Deliverable LWMS Reference	☐	Comment
Design Criteria				
Agreed design objectives and source of objective		Sections 1.2	✓	
Pre-development Environment				
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?	Existing Site Charicteristics	Section 2, Figs 1 - 7	✓	
Site Conditions - existing topography / contours, aerial photo underlay, major physical features	Site Condition Plan	Section 2.1, Figs 1, 2	✓	
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geology Description	Sections 2.4 & 2.5 Fig 4	✓	
Environmental - areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental Plan plus supporting datasets where appropriate	Sections 2.6, 2.7, Figs 2, 5	✓	
Surface Water – topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface Water Plan	Section 2.8, Fig 6	✓	
Groundwater – topography, pre development groundwater levels and water quality, test bore locations	Groundwater Plan	Section 2.9, Fig 7	✓	
Water Use Sustainability Initiatives				
Water efficiency measures – private and public open spaces including method of enforcement		Section 4, Fig 8	✓	
Water supply (fit-for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		Section 4.2	✓	
Wastewater management		Section 4.3	✓	
Stormwater Management Strategy				
Flood protection - peak flow rates, volumes and top water levels at control points,100 year flow paths and 100 year detentions storage areas		Section 5.2, Fig 9	✓	
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event		Section 5.2, Fig 9	✓	

Local Water Management Strategy Item	Required Deliverable	Deliverable LWMS Reference	☐	Comment
Protect ecology – detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages		Section 5.2, Fig 9	✓	
Groundwater Management Strategy				
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoils areas/exclusion zones	Groundwater Plan	Section 5.4	✓	
Actions to address acid sulfate soils or contamination		Section 5.5.2, Fig 4	✓	
The Next Stage - Subdivision and Urban Water Management Plans				
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design.		Section 6	✓	
Monitoring				
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		Sections 6.4	✓	
Implementation				
Developer commitments		Section 6.1	✓	
Roles, responsibilities, funding for implementation		Section 6.1	✓	
Review		Section 6.1	✓	

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

APPENDIX B

DoW Bore T240 Hydrograph



Data Source: DoW (2015)

Coordinate System: GDA 94, Zone 50

Job No. J6040

Wellard Landowners Group

Lot 670 & 1333 Bertram Rd, Wellard: Local Water Management Strategy

Appendix B: Dow Bore T240 (I) Hydrograph

APPENDIX C

GHD Modelling Memorandum

Memorandum

10 December 2010

To	Darren Evans, Greg Rowe & Associates		
Copy to			
From	Helen Brookes	Tel	61 8 6222 8702
Subject	Wellard Urban Precincts East and West	Job no.	61/25042/01

Introduction

It is proposed to develop land immediately surrounding the Bollard Bullrush Swamp environmental protection policy lake boundary. The development proposes to amend the environmental protection policy boundary in the Eastern Precinct and extend development into the floodway. In order that development may occur areas of the floodway will have to be filled and so it is necessary to determine the up and downstream impacts of this effective reduction in the flood capacity of the swamp.

GHD have been engaged to undertake preliminary investigations into the impact of the proposed fill for the purposes of rezoning and structure planning.

It is noted that the Water Corporation may have made some revisions to the Peel Main Drain InfoWorks model since the completion of the Jandakot Drainage and Water Management Plan that are not available at this time and that future assessments may need to be done with an updated version of the model. However since this is a comparative assessment of the impact from a specific development proposal it is not likely that any changes to other sections of the model will make substantial difference to the results.

Both the Department of Water and Water Corporation have been consulted during this study to gain approval to use the Peel Main Drain InfoWorks model for this purpose and correspondence with them is attached.

Methodology

The dimensions of the Bollard Bullrush Swamp as modelled for the Jandakot Drainage and Water Management Plan were amended to reflect the proposed filling of the proposed development areas to the south and north east of the swamp as seen in Figure 1. Modelling assumed that the environmental protection policy boundary and buffer are successfully moved in the Eastern Precinct so that the full extent of development can go ahead. In the Western Precinct the environmental protection policy boundary and buffer are maintained.

In addition, because of the proposed change in land use within the development areas, the percentage of impermeable area (and hence generated runoff) was increased according the local structure plan shown in Figure 1. This will give a worst case indication of the likely impact, since it does not take into consideration that the development will provide additional compensation and promote additional infiltration through the use of water sensitive urban design and therefore is likely to retain or reduce predevelopment runoff characteristics.

A second scenario has also been modelled which incorporates detention capacity within the development to maintain the pre-development discharge peak flow rates into the Main Drain.

The modelling parameters used adapted from those established within the Jandakot DWMP and are presented in Tables 1 and 2 below.

Table 1 Land use impervious areas

Land use	Area (m^2)	Percent impervious	Impervious area (m^2)
School	77797	72%	56014
Grouped Dwellings	7682	28%	2151
Aged Persons	10020	35%	3507
Low Density	481644	28%	134860
Existing Residential	223430	28%	62560
Roads	381155	80%	304924
Medium Density	209403	28%	58633
POS	144472	0%	0
Drainage	935238	0%	0
Total	**2,470,841**		**622,649**

Table 2 Runoff surface characteristics

Runoff surface ID	Description	Surface type	Surface roughness (Manning's n)	Initial loss (mm)	Fixed runoff coefficient
61	URBAN (Perv') 2yr	Pervious	0.025	0	0.1
62	URBAN (Perv') 10yr	Pervious	0.025	0	0.15
63	URBAN (Perv') 100yr	Pervious	0.025	0	0.2
7	URBAN (IMP)	Impervious	0.015	15	1

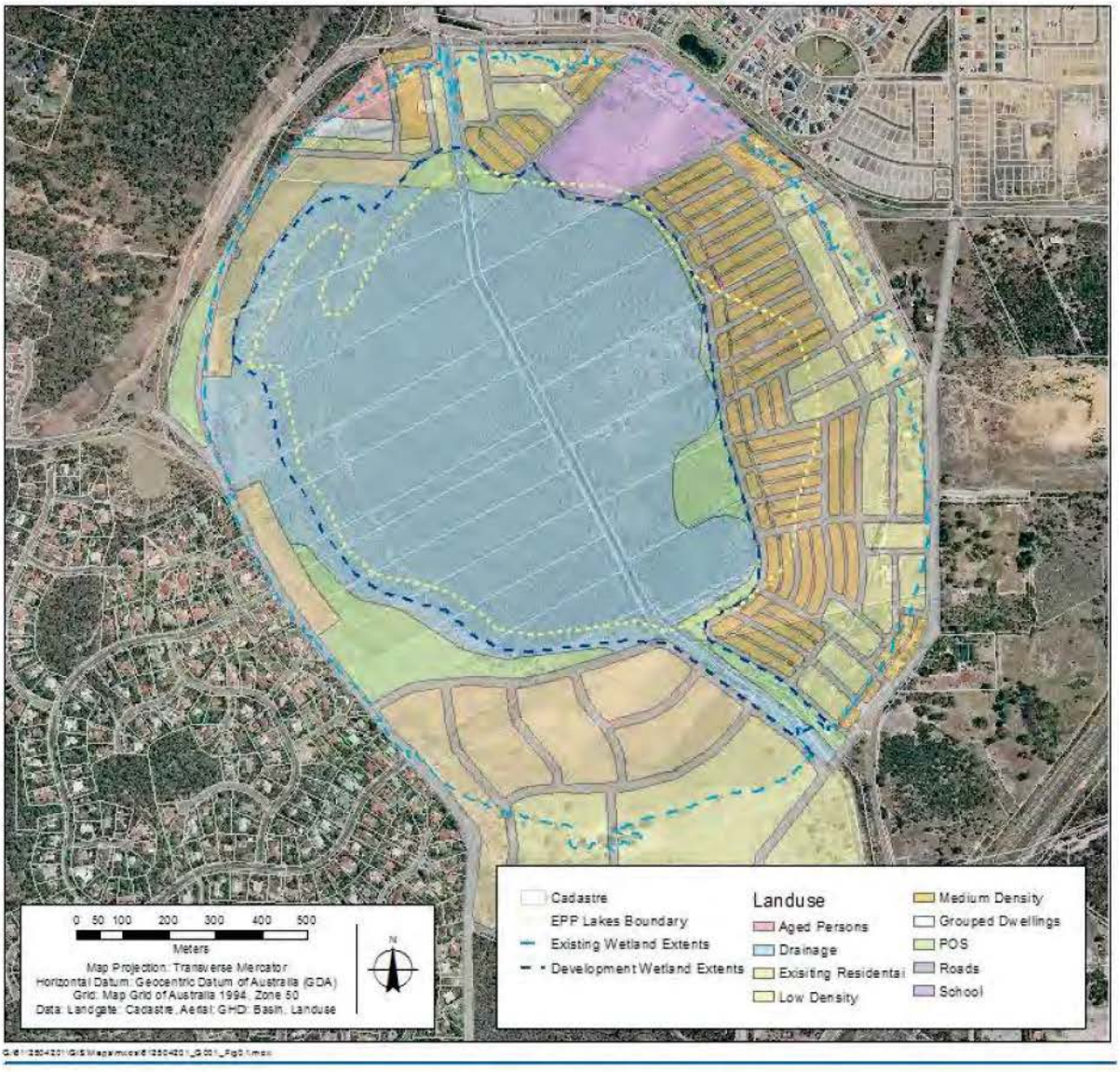


Figure 1 Exiting and Ultimate Wetland Extents with Proposed Landuse

Notes to figure 1:

1. Wetland extents indicated by the hatched lines are the areas available within the pre- and post-development models to accept overflow from the Peel Main Drain.
2. The land use type 'drainage' is used to define runoff parameters only and does not reflect the flooded area predicted by the model.

Results

Table 3 below presents top water levels and peak flow rates from modelling undertaken in support of the Jandakot Drainage and Water Management Plan at critical locations. Tables 4 and 5, also below, present a summary of the results of modelling for the two scenarios described above. Table 6 presents the discharge peak flow rates and required detention capacities within the development.

Table 3 Jandakot Drainage and Water Management Plan modelling results

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Road	7.90	8.20	3.25	3.82
Bollard Bullrush Swamp	4.82	5.61	3.38	4.00
Peel main Drain at Millar Road	4.70	5.59	4.38	5.06

Table 4 Modelling of full extent of proposed development without stormwater detention

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Rd	7.90 *(no change)*	8.20 *(no change)*	3.25 *(no change)*	3.82 *(no change)*
Bollard Bullrush Swamp	4.85 *(+ 30 mm)*	5.65 *(+ 40 mm)*	3.38 *(no change)*	4.00 *(no change)*
Peel main Drain at Millar Road	4.72 *(+20 mm)*	5.62 *(+ 30 mm)*	4.73 *(+ 350 L/s)*	5.77 *(+ 710 L/s)*

Table 5 Modelling of proposed development including provision of on-site detention

Location	Top Water Level (mAHD)		Peak Flow (m^3/s)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Rd	7.90 *(no change)*	8.20 *(no change)*	3.25 *(no change)*	3.82 *(no change)*
Bollard Bullrush Swamp	4.82 *(no change)*	5.62 *(no change)*	3.38 *(no change)*	4.00 *(no change)*
Peel main Drain at Millar Road	4.70 *(no change)*	5.59 *(no change)*	4.39 *(+ 10 L/s)*	5.14 *(+ 80 L/s)*

Table 6 Discharge peak flows and required detention volumes for the proposed development

ARI storm event	Basin outflow (m^3/s)	Storage volume required (m^3)
10 Year	0.2	30,000
100 Year	0.35	39,000

Notes to table 6:

1. Detention volumes are provided as a guide only for the entire development. Detention areas have not been determined at this time since this will be dependent on the depth and landscaping configuration of the designed basin.

Conclusions

The modelling summarised above indicates that in scenario 1, which is the worst case scenario given no detention capacity within the development area, the top water level within the Bollard Bullrush Swamp changes by less than 100 mm for the 100 year ARI event and that levels both up and downstream also remain relatively unchanged.

The scenario 2 results indicated that by providing a total detention capacity of approximately 39,000 m^3 for a 100 year ARI event (30,000 m^3 for a 10 year ARI event) within the development area the change in top water level will be zero.

Suitable fill levels for development must be determined by detailed site investigations in conjunction with drainage and earthworks design for the site. This modelling indicates that a minimum habitable floor level of 6.12 m AHD will be required to ensure that 500 mm of clearance is provided from the 100 year ARI event flood level in Bollard Bullrush Swamp.

In scenario 1, peak flows within the Peel Main Drain upstream of and within the swamp also remain unchanged, however there is an increase of up to 710 L/s on the downstream peak flow rate in the Peel Main Drain for the 100 year ARI event. This increase in flow rate is related to the increased impervious area and it will be a requirement of development that sufficient detention capacity is provided within the drainage system and public open space areas to ensure that this does not occur.

In scenario 2 the increase in downstream peak flow rate is managed through the provision of 39,000 m^3 total detention capacity within the development area. This results in a downstream peak flow rate in the Peel Main Drain for the 100 year ARI event of 5,140 L/s which is within 80 L/s of the predevelopment downstream peak flow rate.

The indicated detention capacity of 39,000 m^3 for the 100 year ARI event which is required in order to maintain the peak discharge peak flow rates for the development will need to reviewed during the development of drainage designs. It is likely that the drainage design process will be able to reduce this detention capacity through water sensitive urban design practices, providing capacity for minor events throughout the development on lots and in road reserves as well as provision of flood detention areas within the normal public open space provision.

Recommendations:

1. Rezoning submissions should indicate that the change in top water level is predicted to be zero in the 10 and 100 year ARI events as a result of the proposed development.
2. Rezoning submissions should also indicate that there is less than 100 L/s predicted increase in peak downstream flow rates in the 10 and 100 year ARI events as a result of the proposed development, and that this is not likely to cause any downstream impacts.
3. The design of the proposed development should provide sufficient detention capacity within lots, road reserves and/or public open space to ensure that predevelopment peak discharge flow rates are not exceeded (indicatively 30,000 m^3 and 39,000 m^3 respectively for the 10 and 100 year ARI events).
4. The design of the proposed development should incorporate a minimum habitable floor level of 6.12 m AHD.

Helen Brookes
Manager, Waterways

APPENDIX D

City of Kwinana Endemic Species

CENTRAL SOILS SPECIES LIST

Start of flowering time: Spring Summer Autumn Winter All Year

Common Name	Botanical Name	Height (m)	Flower Colour	Flower Time	Other Info
Trees (Up to 15m)					
Fraser's Sheoak	*Allocasuarina fraseriana*	15	brown	May-Oct	
Candle Banksia	*Banksia attenuata*	5-8	yellow	Sep-Oct	
Bull Banksia	*Banksia grandis*	10	yellow	Sep-Dec	
Holly-leaf Banksia	*Banksia ilicifolia*	10	pink & cream	Mar-Jan	
Firewood Banksia	*°Banksia menziesii*	10	pink & red	Feb-Aug	
Red Flowering Gum	*Eucalyptus ficifoli*	8	red	Dec-May	WA
Coastal Blackbutt	*Eucalyptus todtiana*	9-16	creamy white	Feb	
Coral Gum	*Eucalyptus torquata*	4-11	pink, red	Aug-Dec	WA
Sandplain Woody Pear	*Xylomelum angustifolium*	7	creamy white	Dec-Feb	WA
Shrubs (3 to 5m)					
Coojong	*Acacia saligna*	5	yellow	Aug-Oct	
Common Woollybush	*Adenanthos cygnorum*	2-4	red	Sep-Feb	
Tree Smokebush	*Conospermum triplinervium*	4.5	greyish white	Aug-Nov	
Red Pokers	*Hakea bucculenta*	4.5	red	Aug-Sep	WA
Royal Hakea	*Hakea victoria*	3	white, colourful foliage	Jun-Jul	WA
Zamia Palm	*Macrozamia riedlei*	3	red cones	Sep-Oct	
River Pea	*Oxylobium lineare*	3	red, yellow	Sep-Jan	
Shrubs (1 to 3m)					
	Acacia dentifera	3	golden	Aug-Nov	
Prickly Moses	*Acacia pulchella*	1.5	yellow	Jun-Oct	
Basket Flower	*Adenanthos obovatus*	2	scarlet, orange	May-Dec	
One-sided Bottlebrush	*°Calothamnus quadrifidu*	1-2	red	Aug-Dec	
Silky-leaved Blood Flower	*Calothamnus sanguineus*	1.5	blood red	Mar-Oct	
Plume Smokebush	*Conospermum incurvum*	0.4-1	white-grey	Jul-Nov	
Terete-leaved Dampiera	*Dampiera teres*	0.2-0.6	blue	Aug-Nov	
Prickly Dryandra	*Dryandra armata*	1.5	yellow	Jun-Nov	
Orange-flowered Eremae	*Eremaea pauciflor*	1.5-2	orange	Sep-Dec	
Purple-flowered Eremae	*Eremaea purpurea*	1.5	pink-purple	Oct-Feb	
Pink Pokers	*Grevillea petrophiloides*	3	pink	Jan-Nov	WA
Honey Bush	*Hakea lissocarpha*	3	white-yellow, pink	Jun-Sep	
Candle Hakea	*Hakea ruscifolia*	3	white	Dec-Mar	
Many-flowered Honeysuckl	*Lambertia multiflor*	2.5	yellow	Jun-Dec	
Coast Honey-myrtle	*Melaleuca acerosa*	1	cream	Sep-Dec	
	Melaleuca conothamnoides	0.3-1.5	pink-purple	Apr-Jun/ Sep-Nov	
Thread-leaf Snottygobble	*Persoonia saccata*	0.2-1.5	yellow	Jul-Jan	
Spiked Scholtzia	*Scholtzia involucrata*	1.5	white, pale pink	Dec-Mar	
Grass Tree	*Xanthorrhoea preissii*	3	white	Nov-Jan	
Shrubs (less than 1m)					
Narrow-winged Wattle	*Acacia stenoptera*	0.3-1	cream-yellow	May-Sep	
Grass Wattle	*Acacia willdenowiana*	0.5	yellow	Jun-Oct	
	Andersonia lehmanniana	0.5	white, pink-purple	May-Sep	
Camphor Myrtle	*Baeckea camphorosmae*	1	white-pink	May-Feb	
	Beaufortia elegans	1	purple, pink	Nov-Feb	
Aniseed Boronia	*Boronia crenulata*	1	pale red	Aug-Oct	
Common Brown Pea	*Bossiaea eriocarpa*	0.6	brown & yellow	Jul-Oct	
Summer Starflowe	*Calytrix flavescen*	0.8	yellow	Nov-Jan	
Pink Summer Calytrix	*Calytrix fraseri*	0.6-1	pink, purple	all year	
Common Dampiera	*Dampiera linearis*	0.5	indigo	Jul-Nov	
Couch Honeypot	*Dryandra lindleyana*	low	gold	May-Sep	
	Gompholobium confertum	1	blue-purple	Aug-Mar	
Hairy Yellow Pea	*Gompholobium tomentosum*	0.3-1	yellow	Aug-Dec	
Stalked Guinea-flowe	*Hibbertia racemosa*	0.3	yellow	Jul-Nov	
Orange Stars	*Hibbertia stellaris*	1	orange-yellow	Aug-Dec	
Devil's Pins	*Hovea pungens*	1	purple	Jun-Nov	
Common Hovea	*Hovea trisperma*	0.7	purple	Jun-Sep	
Swan River Myrtle	*Hypocalymma robustum*	1	pale-deep pink	Jul-Oct	
Granny's Bonnets	*Isotropis cuneifolia*	0.3	yellow & red	Aug-Oct	
Waldjumi	*Jacksonia sericea*	0.6	orange	Dec-Feb	
Lance-leaved Cassia	*Labichea punctata*	1	yellow	Jul-Oct	
Rough Honey-myrtle	*Melaleuca scabra*	1	pink-purple	Sep-Dec	
	Melaleuca trichophylla	0.7	pink-purple	Nov-Jan	
Pixie-mops	*Petrophile linearis*	0.7	pink, mauve	Sep-Nov	
	Petrophile macrostachya	1	yellow	Aug-Nov	
Pepper-and-salt	*Philotheca spicatus*	0.6	lilac	Jun-Oct	
Rose Banjine	*Pimelea rosea*	1	pale-deep pink	Aug-Nov	
Yellow Banjine	*Pimelea sulphurea*	0.5	yellow	Oct-Nov	
Bushy Featherflowe	*Verticordia densiflor*	1	pink, white	Nov-Jan	
Perennial Herbs					
Catspaw	*Anigozanthos humilis*	0.5	orange	Aug-Oct	
Kangaroo Paw	*Anigozanthos manglesii*	1	red & green	Sep-Nov	
Green Kangaroo Paw	*Anigozanthos viridis*	1	green	Sep-Nov	
Tall Speargrass	*Austrostipa flavescen*	0.5	silver	Sep-Oct	
Bearded Speargrass	*Austrostipa semibarbata*	0.6	white hairy	Aug-Nov	
Blue Squill	*Chamaescilla corymbosa*	0.3	blue	Aug-Oct	
Spiny Cottonheads	*Conostylis aculeata*	0.3	yellow	Sep-Nov	
Grey Cottonheads	*Conostylis candicans*	0.5	yellow	Aug-Sep	
Bristly Cottonheads	*Conostylis setigera*	0.3	yellow	Sep-Oct	
Blueberry Lily	*Dianella revoluta*	1	purple	Sep-Jan	
Foxtail Mulga-grass	*Neurachne alopecuroidea*	0.5	grey	Aug-Nov	
Morning Iris	*Orthrosanthus laxus*	0.4-0.6	blue	Aug-Oct	
Purple Flag	*Patersonia occidentalis*	0.5-0.8	purple	Sep-Oct	
Climbers & Groundcovers					
Native Wisteria	*°Hardenbergia comptoniana*	climber	purple	Jun-Sep	
Snakebush	*°Hemiandra pungens*	low	mauve	all year	
Running Postman	*Kennedia prostrata*	low	red	Aug-Nov	
Pronaya	*Pronaya fraseri*	climber	pale mauve	Dec-Feb	

° Comes in different forms (ie a shrub might have a groundcover form or different flower colours

✳ - Star Performer (hardy or long flowering - Butterfly attractin - Bird attracting

WA - Western Australian plant not a local plant

KEY

central

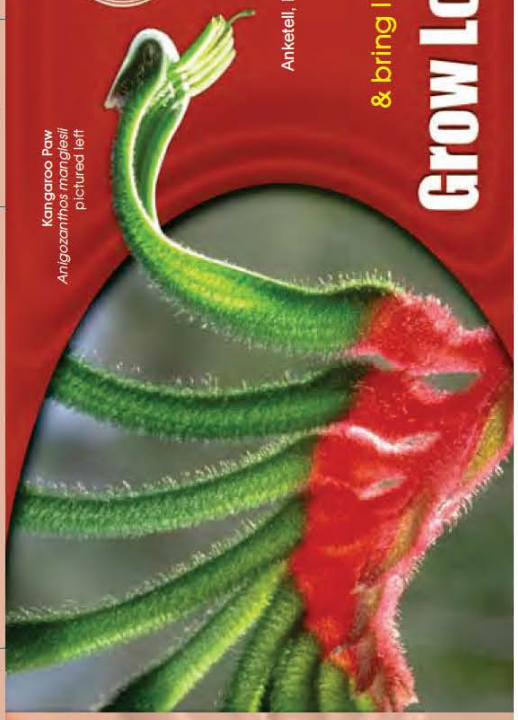
Grow Local Plants

& bring life back to your garden

save water, money

Central Coastal Plain
Anketell, Bertram, Casuarina, Wandi and Wellard*
*East of Wellard Road.

TOWN OF kwinana



Kangaroo Paw *Anigozanthos manglesii* pictured left

COASTCARE

TOWN OF kwinana

Central Coastal Plain
Anketell, Bertram, Casuarina, Wandi and Wellard*
*East of Wellard Road.

This brochure was prepared by Melinda Picton-King, North Metro Catchment Group Inc.

Sponsored by: State Water Strategy Department of the Premier and Cabinet

swan catchment council

Government of Western Australia

WHAT ARE LOCAL PLANTS?

Local plants are species that would naturally occur in your neighbourhood and are therefore adapted to the local climate and soil.

GROW LOCAL PLANTS

There are a huge range of local WA plants that can be used to create many contemporary garden styles such as cottage, formal, Mediterranean and bushland. Be creative with local plants and use them in hanging baskets and containers, as hedges and as topiary.

Garden Design Tips

- Plan your garden design on graph paper.
- Think about areas of usage (eg eating areas, play areas) and incorporate these into your garden design.
- Keep in mind views from the house (eg retain good views and use plants to hide eyesores).
- Plant trees at least 3m from fences and walls so their growth isn't hampered and they don't become a nuisance.
- Make sure you prepare the site and remove all weeds prior to mulching or planting.
- You can use local plants in your whole garden, in a garden bed or mixed in with exotics.
- Group plants with similar water and fertiliser requirements together, especially if mixing local plants with exotics.
- Keep in mind the growing requirements of plants (eg don't plant a sun loving plant in the shade of a larger shrub).
- Be aware that there are different forms of plants you can use in your garden (eg dwarf forms of trees and groundcover forms of many shrubs).
- Select plants that flower in each season to provide colour in y ur garden all year round.
- Use a diverse range of plants but repeat themes of plants and place them in groups of uneven numbers for greater impact.
- Vary the height layers in your garden to add interest and habitat. (eg tree canopy, shrubs, groundcovers).
- Think of your garden like a room in your house and plant in stages. Lay the carpet (groundcovers) in first, then place the furnitur (theme shrubs and trees) and then dress the room with the smaller flowering shrubs and feature plants.
- Continually review your design and keep complementing your garden with new plants. Think of your garden as progressive and ever changing to be built upon over time.

PLANT SELECTION & PLANTING OUT

- Buy plants local to your area or suited to your soil type (see list).
- Buy small plants in bigger pots as they aren't root bound and better establish in the garden. You can buy some larger feature plants for a more instant effect.
- Always read the labels to check the size of the plant when mature to be sure that you are getting the desired plant form.
- Coastal plants will grow inland, but inland plants don't grow well on the coast.
- Don't choose plants that are environmental weeds.
- Plant in late April or May after the first good autumn rains, as plants have more time to establish before summer.

WA PLANT NURSERIES

Different nurseries have varying ranges of WA plants so you might need to shop around. If you really want a particular selection of plants, then it is a good idea to order ahead in about September so the plants can be grown ready for planting in autumn. Some specialist local nurseries are:

APACE Nursery:	1 Johanna St, NORTH FREMANTLE
Boola Wongin:	619 Armadale Rd (near Nicholson Rd), FORRESTDALE
Carramar Coastal Nursery:	Lot 5 885 Mandurah Rd SECRET HARBOUR
Lullfitz Nursery:	1071 Thomas Road, OAKFORD
Men of the Trees:	Rockingham Golf Club, Elanora Dr, COOLOONGUP
Ngulla Community Nursery:	65 Born Road CASUARINA
Australian Native Nurseries Group:	141 King Rd, OAKFORD
Zanthorrea Nursery:	155 Watsonia Rd, MAIDA VALE

WATERING

WA plants are adapted to our dry climate and low rainfall - they are used to a bit of stress and in fact need this to perform their best. Overwatering leads to shorter lived plants with excessive growth and less prolific flowering. An excess of water leads to leaching of nutrients from sandy soils and encourages diseases that can lead to fatal root rot.

Remember the aim is to encourage plants to grow strong root systems, which makes them more water efficient and drought tolerant. To keep your garden looking its best, it may be desirable to give some plants a supplementary watering over summer.

When to water (always follow water restrictions)

For new plants water:
- Once or twice a week in the first few weeks after planting
- Once or twice a week in the summer period for the first 1-2 yea s until plants are established (generally from about November to May until the first good rain occurs)

For established plants water:
- When there is a heat wave
- When the soil under the surface is dry
- When signs of stress are apparent (eg wilting, dull foliage colour, leaf shrinkage)

In general the watering regime for mature plants varies with the soil type, origin of the plant, season and natural rainfall.

What irrigation to use

WA plants like the soil surface to remain dry and many are sensitive to overhead watering (eg sprinklers, misters). Thus the best irrigation to use is adjustable dripper/trickle systems or subsurface irrigation.

Watering tips

- Watering in the morning is preferable as moisture sitting on plant leaves and stems overnight can cause plant diseases.
- Avoid watering only the soil surface layer as this encourages shallow roots making plants more susceptible to drying out and blowing over. Longer deeper watering encourages the growth of deeper, more stable roots.
- If water repellence occurs, apply a wetting agent.
- Use a dripper with a high flow rate for water demanding plant eg *Boronia*, *Scaevola*.

Anigozanthos humilis

Hovea pungens

Hemiandra pungens

Conostylis aculeata

Hardenbergia comptoniana

PRUNING

To keep WA plants looking their best, it is necessary to do some pruning to help keep the plant in shape and promote flowering.

When to prune

In general prune after flowering has finished in late spring or early summer. Avoid pruning in winter or mid summer, as this may cause plants to die back extensively. It is better to prune young plants lightly and regularly. Older plants can be rejuvenated by more extensive pruning after flowering

How to prune

There are two main types of plant flowering habits each requiring different pruning methods:

1. Plants that flower on the end of each season s growth – trim off the flowering stems from behind the seed capsules after the plant has finished flowering. Regular pruning prevents these pl ts from becoming straggly. Eg *Callistemon* (Bottlebrush), *Pimelea*.
2. Plants that flower on old wood – remove the oldest wood from th centre of the plant, letting the younger wood remain. Eg some species of *Melaleuca*.

Tips for pruning

- Cut off the whole branch cleanly at the join leaving no protruding stump.
- Remove low branches to make weeding easier.
- Use chopped up prunings as mulch.
- Only prune the softer wooded plants (eg large wattles) lightly as they aren't as hardy as the woodier plants and tend to die back extensively.
- *Eucalypts*, *Callistemons* and *Melaleucas* respond well to pruning and can tolerate a hard prune.
- Cut back Kangaroo Paws to the ground after flowering each yea . It helps prevent black ink disease and promotes better growth.

MULCH

Good mulch consists of a mixture of different sized materials such as leaves, twigs and bark, lets water easily penetrate through to the soil and prevents evaporation. The mulch materials shouldn't absorb too much water, otherwise they make less available to the plants.

The best mulch

- Groundcovers and natural leaf litter formed by the plants in your garden.
- Street tree loppings – may contain some weeds but they are easily seen and removed.
- Inert materials (eg gravel, crushed brick) are particularly good in windy areas as they don't blow around.

When to mulch

Organic mulches need renewing seasonally as they break down over time, but are best applied at the start of warmer weather in spring and early summer.

How much mulch

Apply mulch about 5cm thick, creating a bowl shape around the plant to aid water retention.

What to avoid:

- Avoid layering mulch too thickly as this can impede water infilt ation and reduce plant survival.
- Avoid mulching too close to the stem of the plant as the constant humidity encourages plant diseases and WA plants prefer the surrounding soil surface to be dry.
- Avoid using sawdust and raw wood products (eg wood chips) as they can interfere with iron uptake, draw nitrogen out of the soil and cause the soil to become water repellent. Always compost woody mulches for at least 6 months before use.
- Avoid using mulch from soft leaved plants like many exotic species, as it decays too fast and releases too many nutrients for WA plants.
- Avoid some packaged mulches as they contain high levels of nitrogen and phosphorus which isn't suitable for WA plants.

FERTILISERS

As WA plants are adapted to soils that are low in nutrients they usually don't require fertiliser. In a garden situation you can apply a little fertiliser to keep plants looking perfect, but be cautious as some species are sensitive to fertilisers, particularly phosphorus. Sufficient phosphorus is naturally present in the soil.

When to apply

Apply fertiliser when planting by mixing into the soil at the bottom of the hole. Subsequent fertilising should be done on the surrounding root zone only when nutrient deficiency is apparent and only when plants are actively growing in spring.

What fertiliser to use

(Note: always follow the manufacturer instructions on dosage and application)

- Slow release fertilisers for native plants.
- Low phosphorus and low nitrogen fertilisers.
- Fish emulsion or seaweed fertiliser to boost plants immunity to disease.

What not to fertilise

- Some plants are highly sensitive to fertilisers, particularly fertilisers that contain phosphorus. Eg: *Banksias*, *Grevilleas*, *Dryandras*, *Hakeas* (Proteaceae family).
- Don't overfertilise Everlastings as they get too tall and weak and lie down when flowering

REFERENCES

For more information refer to

A New Image for WA Plants - George Lullfitz
Grow With Us - Wildflower Society of A,
Growing Locals - Robert Powell.

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