FURNISSDALE WEST STRUCTURE PLAN

LOTS 181 - 185,197-198, 1186, 1187 RONLYN ROAD AND LOTS 179 & 180 RIVERSIDE DRIVE, LOTS 149, 150 &156 PINJARRA ROAD
FURNISSDALE

OUR REF: 5227 18/07/2016

ROWEGROUP

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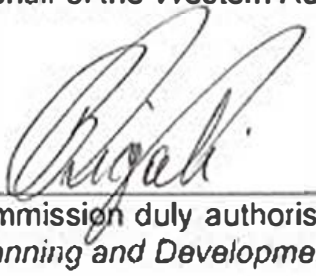
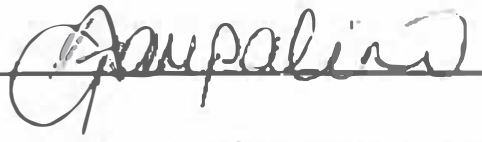
This structure plan is prepared under the provisions of the Shire of Murray Town Planning Scheme No.4

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: 19 October 2016

Signed for and on behalf of the Western Australian Planning Commission



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



Witness

19 October 2016

Date

Date of Expiry: 15 October 2036

TABLE OF AMENDMENTS

Amendment No.	Summary of Amendment	Amendment Type	Date approved by WAPC

EXECUTIVE SUMMARY

The Structure Plan covers an area of 50.15 hectares of Residential Development zoned land in Furnissdale approximately 14 kilometres north west of the Pinjarra Town Centre and approximately 5 kilometres east of the Mandurah Town Centre.

The site is bordered by Riverside Drive to the northwest, Ronlyn Drive to the southeast and Pinjarra Road to the northeast. The locality is predominantly semi rural in nature, with some areas of remnant bushland, Commercial (to the northeast along Pinjarra Road) and low density residential land in the Furnissdale townsite, which abuts the subject land to the south.

The purpose of this Structure Plan is to facilitate the development of the subject site for residential purposes. This Structure Plan is therefore prepared to satisfy the requirements of Town Planning Scheme No. 4 to facilitate subdivision and development of the site. The design of the Structure Plan proposes for an open space design which provides green linkages to other reserves as well as preserving approximately 6.8 hectares of bushland.

The Structure Plan is based on contemporary planning principles with density yields appropriate to the area in line with current strategic planning principles.

The preparation of this Structure Plan has been undertaken in liaison with the Shire of Murray and government authorities.

Structure Plan Summary Table

Item	Data	Section number referenced in Part 2 report
Total area covered by the Structure Plan	50.15 hectares	1.2.2
Area of each land use proposed: Residential Industrial Commercial	 26.4 hectares 0 hectares 0 hectares	4.1
Estimated lot yield	750 lots	4.3
Estimated number of dwellings	750 dwellings	4.3
Estimated residential site density	28 dwellings per site hectare 15 dwellings per gross hectare	4.3
Estimated population	1950 people	4.3
Number of high schools	0 high schools	4.6
Number of primary schools	0 primary schools	4.6
Estimated commercial floor space (for activity centres if appropriate)	0 net lettable area	4.7
Estimated area and % of public open space: Regional open space District open space	 0 hectares, 0% 0 hectares, 0%	4.2
Estimated area and number neighbourhood parks local parks	 1.1 hectares, 3 parks 3.9 hectares, 5 parks	4.2
Estimated number and area of natural area and biodiversity assets	6.8 hectares 1 park	4.2

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TECHNICAL APPENDICES

Appendix Number	Document Title	Nature of Document	Referral/Approval Agency	Summary of Document Modifications
1.	Certificates of Title	Information only	-	
2.	Flora and Vegetation Survey	Supporting document only	DPaW / Shire of Murray	
3.	Environmental Assessment	Supporting document only	DPaW	
4.	Local Water Management Strategy	Approval Required	Department of Water	
5.	Fire Management Plan	Approval Required	Department of Fire and Emergency Services / Shire of Murray	
6.	Transport Report	Supporting document only	Main Roads / Shire of Murray	
7.	Acoustic Report	Supporting document only	-	
8.	Engineering Report	Supporting document only	Shire of Murray	
9.	Landscape Master Plan	Supporting document only	-	

Part One
IMPLEMENTATION

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1. Structure Plan Area

This Structure Plan (hereafter referred to as the Structure Plan) applies to the urban zoned portion of Lots 181 - 185, 197, 198, 1186 and 1187 Ronlyn Road, Lots 179 and 180 Riverside Drive and Lots 149, 150 and 156 Pinjarra Road, this being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan map (Plan 1).

2. Operation

The date this Structure Plan comes into effect is the date of the Structure Plan being approved by the Western Australian Planning Commission.

3. Staging

Subdivision and development should proceed in stages, generally in accordance with Figure 14.

The poultry farm located on Lot 1186 Ronlyn Road, Furnissdale is to be permanently closed prior to any residential subdivision or development occurring within 500 metres of that lot.

4. Subdivision and Development Requirements

The Structure Plan outlines land use zones and reserves applicable within the Structure Plan area in accordance with the zones and reserves listed in the Local Planning Scheme.

4.1 Protection of Environmental Features

4.1.1 Conservation Area

The conservation area located on Lots 181 and 182 Ronlyn Road and Lot 180 Riverside Drive, Furnissdale should be set aside as public open space so it can be protect as a conservation area.

This area should be protected by:

a) Controlling access to the area by people, pets, livestock and vehicles; and

b) Appropriate management, through the preparation and implementation of a Public Open Space Management Plan.

4.1.2 Conservation Category Wetland

The Conservation Category Wetland within Lot 185 Ronlyn Road, Furnissdale, contains vegetation representative of Threatened Ecological Community FCT07, and should be protected by:

a) Restricting access to this area by people, pets, livestock and vehicles;

b) Providing a 20 metre wide buffer around the wetland, except where the wetland abuts Riverside Drive;

c) Re-vegetating the buffer area with endemic plant species and in a manner which discourages access to the conservation area;

d) Establishing a hydrological regime (through the preparation and implementation of a Wetland Management Plan) which maintains the wetland's environmental values and characteristics by managing water levels, the period of annual inundation and the quality of storm-water entering the wetland;

e) Appropriately managing (through the preparation and implementation of a Wetland Management Plan) weed control, revegetation, fencing, educational signage and any other relevant management issues; and

f) Ensuring that the wetland, its buffer and any abutting public open space are separated from residential development by a public road.

Mature Marri trees, located to the north of the abovementioned conservation category wetland contribute to the environmental and aesthetic values of the Structure Plan area and should be protected in accordance with the Shire of Murray's Tree Retention Local Planning Policy.

4.2 Response to Hazards and Separation Requirements

Bushfire Attack Level Contour Maps or Assessments and, if required, Bushfire Management Plans are to be prepared and submitted with all subdivision applications within the Structure Plan area, demonstrating compliance with the requirements of *State Planning Policy 3.7: Planning in Bushfire Prone Areas*. Bushfire attack level assessments should consider the impact of surrounding bushfire prone areas on the subdivision and development of land within the Structure Plan area and account for the staging of development.

No subdivision or development, excepting any proposed road or public open space, should be approved in Asset Protection Zone 1 unless it can be demonstrated that the 20 metre wide asset protection zone is not required on Lot 156 Pinjarra Road, Furnissdale.

No subdivision or development, excepting any proposed road, should be approved in Asset Protection Zone 2 unless it can be demonstrated that the 20 metre wide Asset Protection Zone is not required on Lot 150 Pinjarra Road and Lots 1186 and 1187 Ronlyn Road, Furnissdale.

Dwellings located in areas identified as requiring increased building protection measures are to be constructed in accordance with the requirements of *Australian Standard 3959: Construction of Buildings in Bushfire-Prone Areas under the Building Code of Australia*.

4.3 Public Open Space

Public open space should be provided in accordance with this Structure Plan, when approved.

4.4 Residential Densities and Development Standards

Dwelling Targets

It is intended that the Structure Plan area accommodate a minimum of 710 dwellings, with an average of at least:

a) 26 dwellings per site hectare across the Structure Plan area; and

b) 30 dwellings per site hectare within 400 metres of the Barragup – Furnissdale Activity Centre.

Residential Density

Plan 1 sets out the residential density codes that apply to the Structure Plan area.

Subdivision applications should demonstrate how the proposed subdivision meets (as a minimum) the density targets set out above. In doing so, the landowner/applicant should include a summary of the proposed dwelling yield of the subdivision.

5. Local Development Plans

Local Development Plans may need to be prepared for lots:

a) immediately adjoining public open space;

b) zoned Residential R20 fronting Ronlyn Road and Riverside Drive where additional development provisions are required to ensure a gradual transition from the existing rural and rural residential area;

c) abutting a rear laneway;

d) abutting Pinjarra Road or which are adversely affect by traffic noise from Pinjarra Road;

e) where it is important to control vehicle access and egress;

f) of an irregular shape or with an area of less than 350m^2;

g) narrow lots that require special conditions to be set;

h) are subject to fire management requirements; and

i) where otherwise deemed appropriate to the satisfaction of the Shire of Murray.

Where necessary, Local Development Plans should address the following matters:

a) Building envelope(s) – ground and upper floor setbacks, building envelopes, north boundary setback for solar access, nil setbacks.

b) Parking – location (mandatory or desired), potential additional parking for duplex-sized lots.

c) Vehicle access – location of vehicle access points, particularly where laneway access is available.

d) Fencing – heights, detailing, retaining walls, developer-provided fencing.

e) Services – easements.

f) Private Open Space – location of strategically important outdoor living areas.

g) Landscaping – location of existing trees to be retained in the street or in lots (as agreed with the Local Government).

h) Noise-buffering – location and type of noise-buffering and/or attenuation measures.

i) Ancillary dwellings and/or studio dwellings, home business or home workspace – potential location and size, parking provision and location.

j) Encroachments – reciprocal rights of way, party walls.

k) Variations from *State Planning Policy 3.1: Residential Design Codes*.

l) Mechanisms for expiry or variations of Local Development Plans.

Local Development Plans should be consistent with the Framework for Local Development Plans.

6. Other Requirements

6.1 Notifications

Notifications may be placed on the Certificate of Title for each affected lot to advise of:

a) The construction standards required to achieve higher noise standards in accordance with *State Planning Policy No. 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning*.

b) Building setbacks and construction standards to achieve a Bushfire Attack Level between BAL 12.5 and BAL 29, in accordance with *Australian Standard 3959-2009: Construction of Buildings in Bushfire Prone Areas*, and any subsequent amendments thereto.

6.2 Infrastructure Requirements

With regard to the Structure Plan area, it may be necessary to require developers to contribute to:

a) Ceding and developing land for public open space in accordance with the Structure Plan and Liveable Neighbourhoods;

b) Upgrading and widening those parts of Riverside Drive and Ronlyn Road which abut the Structure Plan area – upgrading these roads may involve the provision of dual use pathways, the installation of underground power lines, drainage facilities and street trees;

c) Upgrading the Riverside Drive and Pinjarra Road intersection and the Ronlyn Road and Pinjarra Road intersection;

d) Acquiring land required for the construction of drainage infrastructure necessary to drain the Structure Plan area; and

e) The cost of preparing and administering developer contributions.

6.3 Funding Arrangements

Due to the fragmented nature of land ownership within the Structure Plan area, it will be necessary to coordinate contributions (made by landowners and/or developers) towards infrastructure and the ceding of land required to support the subdivision and development of land within the Structure Plan area. There are several mechanisms which can be used to coordinate the provision of contributions, including:

a) A Development Contribution Plan, incorporated into the Local Planning Scheme;

b) A voluntary agreement between the landowners and the Council; or

c) Conditions of subdivision approval, where doing so would be consistent with the requirements set out in Appendix 1 of *State Planning Policy No. 3.6: Development Contributions for Infrastructure*.

The mechanism(s) used to coordinate infrastructure contributions should be finalised and given effect prior to the granting of conditional subdivision approval.

7. Additional Information

Additional Information	Approval Stage	Consultation Required
Transport Assessment	Submit with subdivision application	Shire of Murray / Main Roads WA
Transport Noise Assessment	Submit with subdivision application	Shire of Murray / Main Roads WA
Tree Survey / Retention Plan	Condition of subdivision approval	Shire of Murray
Urban Water Management Plan	Condition of subdivision approval	Shire of Murray / Department of Water
Bushfire Attack Level Assessment / Bushfire Management Plan	Submit with subdivision application	Shire of Murray / Department of Fire and Emergency Services
Public Open Space Development and Management Plan	Condition of subdivision approval	Shire of Murray
Mosquito Management Plan	Condition of subdivision approval	Shire of Murray / Department of Health
Contaminated Site Assessment	Condition of subdivision approval	Department of Environmental Regulation
Local Development Plan(s)	Condition of subdivision approval	Shire of Murray

Table 1: Additional Information

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All areas and dimensions are subject to survey.



Structure Plan

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William Clements 7 July 2016

Furnissdale West Plan 1

Planning Design Delivery



RESIDENTIAL
- Residential - R20
- Residential - R30
- Residential - R40
- Residential - R60

PARKS,RECREATION & CONSERVATION
- Public Open Space
- Conservation Area

WATER
- Wetland Buffer
- Wetland

TRANSPORT
- Neighbourhood Connector
- Access Street - Local Road

OTHER
- Structure Plan Boundary
- Asset Protection Zone 1
- Asset Protection Zone 2

0 125 250 Metres

REVISIONS

Rev	Date	Drawn
B	2015.07.08	M. Sullivan
C	2015.12.11	M. Sullivan
D	2016.05.12	W. Clements
E	2016.07.07	W. Clements

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Date Drawn:	2015-05-13
Job Ref:	5527
Scale:	1:5,000 @ A3
Client:	Coode Pty Ltd
Designer:	R. Dial
Drawn:	M. Sullivan
Projection:	MGA50 GDA94
Plan ID:	5227-LSP-04-E

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Part Two
EXPLANATORY SECTION

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01 Planning Background

1.1 Introduction and Purpose

This Structure Plan has been prepared by Rowe Group on behalf of Coode Pty Ltd as a precursor to subdivision for land zoned 'Residential Development' under the provisions of the Shire of Murray TPS 4.

The purpose of the Structure Plan is to refine the provisions under the district framework and ensure a comprehensive approach to planning and development is undertaken, with input from the local community, landowners, government agencies and other key stakeholders.

The Structure Plan will guide future land use and development within the Furnissdale West area and provide a framework for more detailed planning at subdivision. The purpose of Part 2 of the Structure Plan provides explanation for the Statutory Part 1 provisions.

1.2 Land Description

1.2.1 Location

The subject land is located within the municipality of the Shire of Murray, in the locality of Furnissdale. The subject site is approximately 65 kilometres south of the Perth CBD, approximately 14 kilometres north-west of the Pinjarra Town Centre and approximately 5 kilometres east of the Mandurah Town Centre. The Serpentine River is situated approximately 350 metres west of the site.

The existing locality is predominantly semi-rural in nature, with some remnant bushland. Surrounding land uses include 'Highway Commercial' to the northeast (along Pinjarra Road) and low density residential within the Furnissdale townsite, which immediately abuts the Structure Plan area to the southwest.

Refer to Figure 1 – Regional Location.

Refer to Figure 2 – Locality Plan.

1.2.2 Area and Land Use

The Structure Plan area comprises approximately 50.15 hectares currently accessed by Riverside Drive and Ronlyn Road, which connect to Pinjarra Road in the north.

The Structure Plan area comprises rural properties ranging in size from approximately 1.9 hectares through to 5.8 hectares, which are currently being utilised for rural and rural-residential activities. A number of existing dwellings are also located within the Structure Plan area, with associated outbuildings, fences and other structures. These are intended to be demolished and removed as part of the development of the site.

It is noted there is an existing poultry farm currently operating on Lot 1186 Ronlyn Road, Furnissdale. It is intended that the poultry operator/owner will cease operation and relocate the business as subdivision works are progressed within the Furnissdale West Structure Plan area.

Refer to Figure 3 – Aerial Photography / Site Plan

1.2.3 Legal Description and Ownership

The Structure Plan comprises fourteen (14) freehold titles, being:

Address	Diagram	Volume / Folio	Area (Hectares)	Legal Proprietor
Lot 179 on Plan 8254	D8254	81/38A	4.0204	John Peter Davies
Lot 180 (No. 182) Riverside Drive, Furnissdale	D8254	81/37A	3.9471	Coode Pty Ltd
Lot 181 on Plan 8254	D8254	1301/944	3.9353	John Peter Davies
Lot 182 (No. 107) Ronlyn Road, Furnissdale	D8254	58/1A	3.9352	Leon Paul Boderacki
Lot 183 (No. 123) Ronlyn Road, Furnissdale	D8254	1766/316	3.9277	Clifford James Harper
Lot 184 (No. 135) Ronlyn Road, Furnissdale	D8254	39/ 203A	3.9301	Mervyn James Stewart Felicia Rosina Stewart
Lot 185 (No. 137) Ronlyn Road, Furnissdale	D8254	1737/ 911	3.9331	Murray John Gray Jill Ann Gray
Lot 197 (No. 75) Ronlyn Road, Furnissdale	D8254	278/131A	3.9351	Murray Thomas Poultney
Lot 198 (No. 61) Ronlyn Road, Furnissdale	D8254	17/102A	3.8539	Dennis Albert Wells Carolyn Betty Wells
Lot 1187 (No. 167) Ronlyn Road, Furnissdale	D26315	2503/76	1.9987	Loxleigh Pty Ltd
Lot 1186 (No. 155) Ronlyn Road, Furnissdale	D26315	2503/75	5.8803	Michael Edwin Twine Gregory Shayne Kendall
Lot 149 (No. 304) Pinjarra Road, Furnissdale	D20014	1579/299	2.0253	Serafina Vergone
Lot 150 Pinjarra Road, Furnissdale	D20014	1579/300	2.0257	Serafina Vergone
Lot 156 (No. 607) Pinjarra Road, Furnissdale	D20124	1837/106	2.7981	H and R Bostelman, S and K Draper, G Marshall and Lotus Bay Investments Pty Ltd

Table 2: Lot Details

Refer to Appendix 1 – Certifications of Title.

02 Planning Framework

2.1 Zoning and Reservations

2.1.1 Peel Region Scheme

The subject land is predominantly zoned 'Urban' under the Peel Region Scheme (PRS) with portions of Lot 149 Riverside Drive and Lots 150 and 156 Pinjarra Road, Furnissdale falling under the 'Primary Regional Road' zone. Those portions of Lot 149 Riverside Drive and Lots 150 and 156 Pinjarra Road which are zoned 'Primary Regional Road' under the PRS are not subject to this Structure Plan.

Pinjarra Road which abuts the northern portion of the site is reserved as a 'Primary Regional Road'. Portions of the nearby Serpentine River foreshore located on the opposite side of Riverside Drive are reserved as 'Regional Open Space' under the PRS.

Refer to Figure 4 – Peel Region Scheme Map.

2.1.2 Shire of Murray Town Planning Scheme No. 4

The subject land is zoned 'Residential Development' under the Shire of Murray Town Planning Scheme No. 4. Portions of Lot 149 Riverside Drive and Lots 150 and 156 Pinjarra Road are identified as 'Primary Regional Road' under the Scheme. The portions of land which are zoned 'Primary Regional Road' under the Scheme are not subject to this Structure Plan.

In accordance with the provisions of the zone under the Scheme, a Structure Plan is required as a precursor to subdivision and development. The Structure Plan has been prepared in accordance with the provisions of Clause 6.5 of the Scheme.

Refer to Figure 5 – Shire of Murray Town Planning Scheme No. 4 Zoning.

2.2 Planning Strategies

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 for delivery of housing, infrastructure and services to accommodate future projected population growth within both regions. A key element of the overall visions identified by Directions 2031 is the consolidation of existing urbanised areas to ensure the efficient use of land and infrastructure.

Directions 2031 identify potential urban expansion and investigation areas. The subject land is within the 'Peel Sub-Region' and has been identified as 'Urban Deferred' land.

In accordance with the findings of the report, the population of the Peel Region is expected to increase by 45,000 people from 2008 to 2031 and therefore requires an additional 26,000 dwellings by this time.

The mapped Urban Deferred status of the land has been superseded by the respective 'Urban' and 'Residential Development' zonings of the land as previously noted. The Structure Plan is consistent with the broad strategic framework of the Strategy by facilitating the development of the land for approximately 710 additional dwellings.

2.2.2 Inner Peel Region Final Structure Plan (1997)

Within the Inner Peel Region Final Structure Plan (IPRSP) the subject site is identified as 'Future Urban Category B'.

The findings of the Structure Plan have been carried forward to zonings contained in the PRS and the Scheme. The subsequent rezoning of the land to 'Urban' under the PRS and 'Residential Development' under TPS 4 confirms the suitability and availability of the land for urban purposes. The Structure Plan accommodates the fragmented landownership by providing for an integrated but staged implementation of the Structure Plan as residential development progresses across the site.

Refer Figure 6 – Inner Peel Region Structure Plan.

2.2.3 Furnissdale Structure Plan

The subject land is located within the parameters of the Furnissdale Structure Plan which was completed in November 2003 by GHD Consultants Pty Ltd on behalf of the Shire of Murray. The Structure Plan has been approved by the Shire of Murray and endorsed by the WAPC.

The study was commissioned by the Shire in 2000 to explore opportunities for future residential development in the Furnissdale area, which had been identified in regional planning documents as having the potential for future urban development.

Since the Structure Plan was prepared, the strategic planning for the area has evolved and elements of the Plan are already redundant in regard to the future zoning of the land. The 'Urban' and 'Residential Development' zoning of the land supersede the need to retain Special Rural and lower density development on the subject land.

Refer to Figure 7 - Furnissdale Structure Plan.

2.3 Policies

2.3.1 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 Structure Plan's 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 Structure Plan 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.

2.3.2 State Planning Policy 2.1 – Peel Harvey Coastal Catchment

The subject land is located 350 metres east of the Serpentine River which discharges directly into the Peel-Harvey estuary to the south.

The general policy objectives as outlined under the Peel Harvey Coastal Plain Catchment Policy are focused on improving and balancing the social, economic, ecological, aesthetic and recreational management and potential of the Peel–Harvey Coastal Plain Catchment.

State Planning Policy 2.1 (SPP2.1) seeks to minimise the export of nutrient (primarily phosphorous) from land use and development within the catchment, to the district drainage network. It deals in particular with phosphorous discharge arising from subdivision and development of land, and requires that this should not exceed pre-development levels.

The following strategies have been included within the Local Water Management Strategy (LWMS) prepared by Hyd2o for the Structure Plan area to satisfy the requirements of SPP2.1:

- 1 in 5 year ARI event detained in POS to provide additional water quality treatment;
- Potential use of soakwells at lot scale;
- 1 year ARI storm events to be infiltrated where possible;
- 1 year ARI infiltration areas designed as ephemeral wetland/bioretention areas with refined modelling to be undertaken at UWMP stage; and
- Infiltration areas located outside of wetland buffers.

The recommendations of the LWMS will be carried forward to subdivision and development stages by way of an Urban Water Management Plan which may be required as a condition of subdivision or development.

2.3.3 State Planning Policy 3 – Urban Growth and Settlement

The intention of State Planning Policy 3 (SPP 3) is to set out principles and considerations which apply to the planning and management of urban development.

Key objectives of SPP3 relate to the development of sustainable communities based on a number of considerations including environmental capability, employment opportunity, provision of adequately serviced land and accessibility to community services.

The Structure Plan area can be serviced with all essential infrastructures through extension of existing infrastructure available on adjacent land.

The subject land is located within 5 km of the Mandurah CBD and is well serviced by existing regional and local road networks and employment centres. Being situated within the locality of Furnissdale the land is within close proximity to a range of existing community infrastructure and services.

The Structure Plan therefore considered consistent with the intent and objectives of SPP 3.

2.3.4 State Planning Policy 3.6 – Development Contributions for Infrastructure

The objective of State Planning Policy 3.6 (SPP 3.6) is to clarify requirements for the provision of public infrastructure and facilities, ensure development contributions are equitably charged among those that benefit from the infrastructure and facilities, and to ensure consistency and transparency of the development contribution process.

Whilst there is presently no Development Contribution Plan in place for the Structure Plan area, provision has been built into Part 1 of the Structure Plan to require a Development Control Area to be introduced under the Scheme with the requirement for a Developer Contribution Plan to be prepared. The Developer Contribution Plan shall detail the cost sharing arrangement for common infrastructure items.

The provisions provided under Part 1 of the Structure Plan are considered to be consistent with the objective and intent of SPP 3.6.

2.3.5 State Planning Policy 4.3 – Poultry Farms Policy

The planning intent behind State Planning Policy 4.3 (SPP4.3) is to provide development criteria for the assessment of land which is the subject of an application for rezoning, subdivision or development for the purpose of poultry farms, and to further set out the planning process in relation to other land uses (including residential) which are proposed to be situated within the vicinity of poultry farms.

Clause 5.4 of SPP4.3 specifically outlines assessment criteria in relation to proposals to rezone, subdivide and develop land for residential and rural-residential purposes which are situated within 300 to 500 metres of existing poultry farms. Such assessment criteria include consideration of projected odours, dust and noise and vehicle movement issues (including time of day and frequency).

The subject land contains an existing poultry farm within Lot 1186 Ronlyn Road. The poultry operator/owner will cease operation and relocate the business post approval of this Structure Plan thereby freeing Lot 1186 and land located within the current buffer for subdivision and development.

Two further mapped poultry farms are located within 500 and 750 metres of the subject land. The nearest farm is located approximately 500 metres north-west of the subject land, on the northern side of Pinjarra Road and abutting the Serpentine River. The other poultry farm is situated approximately 750 metres south-east of the subject land, on the eastern side of Furnissdale Road. Both poultry farms are located sufficient distance from the subject land so as not to create any potential land use conflict, particularly as the northern poultry farm has not operated for more than 5 years.

2.3.6 Planning Bulletin No. 79 – Designing Out Crime Guidelines

The Structure Plan exhibits a strong focus on 'crime prevention' principles through, for example, the following:

- Where laneways are proposed they are straight and designed to maximise visibility;
- In general roads form a simple grid pattern, which promotes a high level of legibility and visual connectivity;
- The Structure Plan accommodates uniform lots that will support houses oriented to the street and to public open space;

- Lots with direct frontage to POS shall be subject to LDP's which will further reinforce an effective relationship to that POS, including with respect to surveillance;
- Small lot precincts supporting narrow frontages can potentially include laneways so that (particularly opposite POS) the street is not dominated by garages and can, instead, be devoted to outdoor living space and habitable rooms thereby maximising public realm interaction and surveillance; and
- The legible and efficient road network as well as regularly spaced POS fosters a high level of walkability, which is consistent with a safe public realm.

2.3.7 Barragup Furnissdale Activity Centre Policy

The Barragup Furnissdale Activity Centre Policy was adopted by the Shire of Murray on 18 December 2014 which is intended to guide to development of the centre to create a high quality main street along Pinjarra Road which serves as the primary gate way to the Shire.

Whilst the subject land is not subject to the provisions of the policy, a portion of the Structure Plan area in the north east abuts the south western most edge of the Barragup Furnissdale Activity Centre. Specifically, Lot 150 directly abuts the portion of the activity centre zoned for 'Residential' purposes, whilst Lot 1187 abuts a portion of the activity centre zoned 'Neighbourhood Centre'. Consultation with both the Shire of Murray and the adjoining landowner has been undertaken during the development stages of the policy to ensure the Structure Plan appropriately integrates with the centre.

The following design measures have been undertaken to ensure an appropriate integration with the future activity centre is provided:

- The Structure Plan proposes residential densities code of R60 and R-AC to those lots adjacent to the future 'Residential' precinct of the Barragup Furnissdale Activity Centre. The 'Residential R-AC' coding proposed over Lots 149 and 150 Pinjarra Road provides for the opportunity to create higher density development which has the potential to accommodate a range of housing types to complement the activity centre such as detached terraces, townhouses and small scale multiple dwellings. The proposed R60 and R-AC zonings provide an appropriate transition of built form between the activity centre and the Structure Plan area.
- A road interface has been provided for between the 'Spud Shed' site and Lot 150. The road interface provides for the opportunity to maximise the outlook of the future residential lots within the centre site over the area of public open space located within Lot 150.
- Residential lots have been provided for backing on to the southern boundary of the 'Spud Shed' site on Lots 151 and 152 Pinjarra Road. The lots are proposed to be serviced by a rear right-of-way (as shown on Figure 10 – Detailed Layout Plan) located within Lots 151 and 152 Pinjarra road. The rear right-of-way is to be developed and provided as part of the future redevelopment of the site and is to be a gazetted road to ensure the future lots will have vehicular access at all times.

2.4 Other Approvals and Decisions

At the time of writing, we are unaware of any other approvals or decisions that might impact o the consideration of the Structure Plan.

03 Site Conditions and Constraints

3.1 Biodiversity and Natural Area Assets

The following provides a summary of the environmental site conditions and constraints. For further information the Environmental Assessment Report is provided in Appendix 3.

3.1.1 Flora and Vegetation

A comprehensive Flora and Vegetation survey was undertaken by ENV across the Structure Plan area in 2010. The vegetation surveyed on site consisted of one main vegetation unit being:

> ***AfBaCc*** *- Woodland of Allocasuarina fraseriana, Banksia attenuate, Corymbia calophylla, Kunzea glabrescens, Macrozamia riedlei, Hibbertia hypericoides, Iridasceae sp. And Briza maxima.*

A total of 46 families, 97 genera and 144 taxa were recorded within the survey area (113 native flora taxa and 31 introduced) with the survey concluding that none of the taxa found were of significance.

It is noted that no Endangered or Vulnerable species pursuant to the EPBC Act were located during the survey. Further, no Priority Flora or Declared Rare Flora were located within the Structure Plan area during the survey.

The condition of the vegetations across the sites ranges in quality from being predominantly Very Good condition to Good condition with only some areas towards the edges of the site being described as Degraded to Completely Degraded condition.

3.1.2 Remnant Vegetation

An area of approximately 6.83 hectares of remnant bushland within Lots 180 – 182 Ronlyn Road has been identified by the Office of the Environmental Protection Authority (OEPA) to be of regional significance. The area of remnant vegetation to be retained, as shown on the Structure Plan, is consistent with that provided to the proponent by the OEPA.

The rationale for the boundary recommended by the OEPA is to 'maximise the size of the bushland in a shape that will improve the long term viability and potential linkage to Southern River' (OEPA, 2011).

3.1.3 Threatened Ecological Communities

A search of DPaW's Threatened Ecological Community (TEC) database (2015) indicates there are no TEC's known to exist on site.

Notwithstanding, during a site visit DPaW determined the vegetation associated with the Conservation Category Wetland located within Lot 185 Ronlyn Road to be consistent with that of TEC FCT 7 which is broadly defined as a claypan on the Swan Coastal Plain.

Based on the advice received from DPaW, the TEC vegetation is to be wholly retained within the area of CCW with a buffer distance of 20m being required in this instance. The buffer to the TEC / CCW is to be revegetated with native species and may be used for passive recreational activities such as walk trails.

3.1.4 Wetlands

The DPaW's Geomorphic Database Wetlands of the Swan Coastal Plain depicts the following wetlands within the Structure Plan area:

UFI 3548 Multiple Use Wetland, located generally across the north western boundaries of Lots 184, 185 and Lot 1186 Ronlyn Road.

UFI 3549 Multiple Use Wetland, extending across the north western corner of Lot 183 Ronlyn Road and a small portion of the north western corner of Lot 182 Ronlyn Road.

UFI 3650 Conservation Category Wetland, located centrally within Lot 185 Ronlyn Road.

The portions of wetland classified as 'Multiple Use' which extend into the Structure Plan area will be subject to development. The area of 'Conservation Category' wetland however, will be managed and retained in accordance with the written agreement with DPaW as detailed within Part 1 of the Structure Plan report.

A Wetland Management Plan will be required as a condition of subdivision approval.

3.1.5 Fauna

A Fauna Survey was carried out as part of the Environmental Report prepared by ENV in 2007 for the Structure Plan area. The survey generally concluded that no Declared Rare, Endangered, Vulnerable or Priority Fauna species were located on the site.

The results of the survey however, suggest that a number of species of fauna which have conservation significance may utilise the site for feeding purposes or part of a larger home range. These species include:

- Numbat;
- Brush-tailed Phascogale;
- Western False Pipistrelle;
- Greater Long-eared Bat;
- Muir's Corella;
- Forest Red-tailed Black Cockatoo;
- Baudin's Cockatoo; and
- Carnaby's Cockatoo.

The report stated however, that the species listed above are only likely to utilise the area for feeding purposes and more suitable habitat for these species to utilise exists in abundance in the Pinjarra area. As such, the taxa are not expected to be specifically dependant on the habitats found within the site.

A Fauna Management Plan will be prepared as a condition of subdivision approval that details the protection measures applicable to the site.

3.2 Landform and Soils

The subject land is relatively flat. There is a slight gradation from 3.9 metres Australian Height Datum (AHD) within the north eastern portion through to 2.0 metres AHD in the south western portion of the subject land.

The subject site is situated within the Pinjarra Plain with soil types of predominantly Bassendean Sands, overlaying the Guildford Formation. Given the sites proximity to the Serpentine River, small portions of the site are underlain by estuarine and lagoonal deposits.

3.2.1 Acid Sulphate Soils

The Department of Environmental Regulation (DER) Acid Sulphate Soil Risk Mapping identifies the entire site as having high to moderate risk of acid sulphate soils (ASS) occurring within 3m of the natural soil surface.

Whilst testing undertaken by ENV in 2007 indicated that there was no actual ASS present, the potential for ASS below the watertable was identified. As soils will be disturbed for the installation of services such as sewerage, more detailed ASS assessment and management plans will be required as development progresses.

In this regard, an ASS Management Plan will likely be required to be prepared and implemented as a condition of subdivision approval.

3.2.2 Contamination

A search of the Department of Environmental Regulation's (DER) Contaminated Sites Database does not indicate the presence of contamination within the land.

Whilst no properties within the Structure Plan area are listed as contaminated on the Contaminated Sites Database, it is recognised that further investigation and remediation will need to be undertaken over Lot 1186 Ronlyn Road which is presently used for poultry farming, prior to subdivision or development occurring. The operating poultry farm will ultimately cease operation as subdivision and development progresses within 500m of the site.

All remedial works required will be undertaken in accordance with the *Contaminated Sites Act 2003* and verified by an independent auditor prior to approval by the DER.

3.3 Groundwater and Surface Water

3.3.1 Surface Water

There are no surface water streams or surface flows within the site, however it is noted that the site is located to the west of the Serpentine River. Floodplain mapping available from the Department of Water indicates that a small portion of the site adjacent to Riverside Drive is located within the flood fringe of the Serpentine River, however it is noted that this sits well outside of the floodway.

The site is divided into two catchments both of which discharge into the Serpentine River. Within the northern catchment, a naturally low depression exists along Riverside Drive which coincides with part of the Multiple Use wetland area. During winter, water is present within the depressions. It is noted there are three existing culverts present under Riverside Drive near the depression to convey flow under the road and to the Serpentine River. The culverts and flow path are to be reinstated to enable flow to the Serpentine River from this area.

3.3.2 Groundwater

Results of ground water monitoring undertaken by the Department of Water indicated the base average annual maximum groundwater levels (AAMGL) ranged from 1m AHD to 1.5m AHD within the Furnissdale West area, with the depth to groundwater ranging from at surface to 2.0m below ground level.

The modelling also concluded that in the event of 0.9m sea level rise, AAMGL would rise to 1.75m AHD to 2.0m AHD across the site.

To facilitate local scale planning for subject area, ENV undertook 2 years of groundwater monitoring from October 2007 to October 2009. Details of the monitoring undertaken and results are provided in the LWMS at Appendix 4.

3.4 Bushfire Hazard

A Fire Management Plan has been prepared for the Structure Plan in accordance with the WAPC's *Planning for Bushfire Protection Guidelines 2010*. The Fire Management Plan has considered the requirements of draft State Planning Policy 3.7: Planning for Bushfire Risk and Management. The Fire Management Plan is provided as Appendix 5 to this report. The following provides an overview of bushfire management assessment undertaken and the applicable development provisions which apply to the site.

3.4.1 Hazard Assessment

The Fire Management Plan (FMP) identifies the site as comprising predominantly a low to moderate fire hazard threat.

The development of the Structure Plan 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.

The FMP identifies the dwellings located adjacent to the areas of OEPA vegetation and CCW / TEC vegetation as those areas requiring increased construction standards to satisfy the WAPC's guidelines.

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; and
- Compliance with and annual Fire Control Notice issued by the Shire of Murray under the Act.

The Fire Management Plan will be required to be implemented as a condition of subdivision approval. It is noted the FMP does not propose to modify the area of remnant bushland required to be protected by the OEPA.

3.5 Heritage

3.5.1 Indigenous Heritage

There are no known registered aboriginal sites within the Structure Plan area.

A search of Department of Aboriginal Affairs Aboriginal Heritage Inquiry System identified two sites of significance within close proximity to the site being:

- ID: 3367 "Barragup Crossing", located on the north side of Pinjarra Road, on the Serpentine River.
- ID: 3582 "Serpentine River", located approximately 350m from the Structure Plan area.

In accordance with the requirements of the Shire of Murray's Furnissdale Structure Plan and Traffic Impact Study of 2008, the Department of Aboriginal Affairs were consulted during the advertising period of the Structure Plan and raised no objection to the development the subject site.

3.5.2 Non-Indigenous Heritage

No places were identified on the Heritage Council of Western Australia Heritage Places Database or the Shire of Murray Municipal Heritage List for the Structure Plan area.

3.6 Context and Other Land Use Constraints

A Context Plan is provided at Figure 8 illustrating the various facilities located within proximity to the Structure Plan area. In addition an Opportunities and Constraints Plan has been provided at Figure 9 to illustrate factors located within and immediately around the subject site.

Refer to Figure 8 – Context Plan and Figure 9 – Opportunities and Constraints.

04 Land Use and Subdivision Requirements

4.1 Land Use

The Structure Plan sets out land use, residential densities, public open space, public and private transport provision, environmental considerations and servicing requirements.

The Structure Plan is proposed to comprise residential development ranging from R25 to R60 densities with a small portion of R-AC density provided for adjacent to the Barragup Furnissdale Activity Centre. Areas of higher density have generally been located in areas of high amenity such as adjacent to areas of public open space and the future activity centre along Pinjarra Road. The Structure Plan also comprises a range of local and neighbourhood public open space areas in accordance with Liveable Neighbourhoods requirements.

The following describes the design response proposed under the Structure Plan and addresses the relevant elements of Liveable Neighbourhoods.

Please also refer to the Structure Plan (Plan 1) and Figure 10 – Detailed Layout Plan.

4.2 Public Open Space

Under the provisions of Liveable Neighbourhoods a range of site responsive urban parkland is required, which appropriately addresses district, neighbourhood and local needs of residents, comprising a mixture of unrestricted and restricted open space.

The Structure Plan therefore provides a framework for the hierarchy and location of public open space areas across the site, considering the requirements for drainage and vegetation retention, and defining key areas of open space as identified on Plan 1.

The Structure Plan provides for approximately 5.1 hectares of public open space (POS) across the Structure Plan area by way of three neighbourhood parks and five local parks. This comprises 3.8 hectares of unrestricted (9.2% of gross subdivisible area) and 0.9 hectares of restricted open space (2.1% of gross subdivisible area).

As noted above, the hierarchy and location of POS areas have been designed to ensure residents are generally within:

- 150m of a local park;
- 400m of a neighbourhood park; and

A Landscape Master Plan (LMP) has been prepared for the Structure Plan area and included as Appendix 9 to this report. The LMP depicts the anticipated use and intent of each of the public open space areas.

The following provides a detailed overview of the public open space design response proposed under the Structure Plan.

Refer to Figure 11 - Public Open Space Plan and Figure 12 - Public Open Space Schedule.

4.2.1 OEPA Vegetation

It is recognised that the area of OEPA vegetation is not included in the overall provision of POS throughout the Structure Plan area. Notwithstanding, areas of POS have been provided around the

OEPA vegetation to accommodate bushfire protection requirements and to ensure an area of active open space is provided within the southern portion of the Structure Plan to satisfy the requirements of Liveable Neighbourhoods.

4.2.2 Conservation Category Wetland / Threatened Ecological Community

The area of POS containing the CCW and TEC has been designed in a manner to allow for the retention of areas of environmental significance whilst also accommodating stormwater drainage requirements and active open space opportunities.

The proposed design response therefore aims to deliver:

- The provision of a 20m buffer to the area mapped as CCW / TEC;
- Public and vehicular access to those areas of environmental significance being controlled to protect the environmental value of the wetland;
- The retention of the mature River Red Gums within the northern portion of the POS area; and
- The provision of an area of active open space to the south of the CCW / TEC area.

The resultant design outcome has been produced in consultation with the Shire, Department of Water and the Department of Parks and Wildlife.

4.3 Residential

Residential Densities have been established for the Structure Plan area in accordance with the requirements of Liveable Neighbourhoods and Directions 2031 to achieve densities of 22 dwellings per site hectare and 15 dwellings per gross site hectare respectively.

The Structure Plan generally provides for a transitional density of R20 to those lots which interface with the existing rural and rural residential areas, with a base density of R30 being provided throughout the Structure Plan area. Medium to higher densities of R40 to R60 have generally been located around areas of POS and within proximity to Pinjarra Road and the Barragup Furnissdale Activity Centre. A small area of R-AC density has been provided adjacent to the Barragup Furnissdale Activity Centre at the request of the landowners of Lots 149 and 150 Pinjarra Road.

Based on preliminary designs, the Structure Plan provides for a yield of approximately 700 dwellings. On this basis, the Structure Plan achieves a density of approximately 26 dwellings per site hectare, and 14 dwellings per gross hectare.

The Structure Plan therefore exceeds the average residential density of 22 dwellings per site hectare, however falls short of the 15 dwellings per gross hectare stipulated under Liveable Neighbourhoods and Directions 2031. This is largely due to the retention of the OEPA Vegetation which comprises 6.83 hectares of the total gross urban area.

Due to the proximity of the Barragup Furnissdale Activity Centre relative to the subject site, subdivision must meet the standard 30 dwellings per site hectare within 400m of the Activity Centre. Densities varying from R30 to R60 are proposed to ensure the density targets under Liveable Neighbourhoods are achieved.

4.3.1 Residential R20

Residential R20 lots are proposed to provide a transitional interface from the existing rural and rural-residential properties and the existing Residential R10 lots which form part of the Furnissdale townsite to the proposed residential area to minimise visual and amenity impacts to existing residents.

This is to be further reinforced through Local Development Plans which will be required for all transitional R20 lots with interface to the existing rural and rural residential areas and Residential R10 lots. The Local Development Plans are to provide further guidance for development in regard to:

- Lot frontage requirements;
- Setbacks and building envelope;
- Vehicular access requirements; and
- Landscape/ Vegetation Areas.

The Residential R20 lots are to be developed with wider lot frontages to complement the existing rural-residential and Residential R10 setting.

4.3.2 Residential R60

Areas of 'Residential R60' have been provided within the northern portion of the Structure Plan, generally to the west of Riverside Drive and a portion of land adjacent to Ronlyn Road and the future Spud Shed redevelopment site which forms part of the Barragup Furnissdale Activity Centre.

The proposed R60 area to the west of Riverside Drive has been proposed to facilitate a potential future 'Lifestyle Village'. The area of R60 density proposed adjacent to the Spud Shed site will facilitate a mix of housing options including detached terraces, townhouses and small scale multiple dwellings, consistent with the adjacent 'Residential Precinct' of the Barragup Furnissdale Activity Centre. The R60 zoning is consistent with *State Planning Policy 4.2 – Activity Centres for Perth and Peel* with higher densities being supported around activity centre notes.

4.4 Movement Networks

The following provides a summary of the proposed movement network. For further information it is recommended the reader consult the Transport Assessment included at Appendix 6.

Refer to Figure 13 - Movement Network.

4.4.1 Existing Road Network

4.4.1.1 Pinjarra Road

Pinjarra Road is classified as a Primary Distributor under the Main Roads Functional Road Hierarchy and is constructed as a median-divided dual carriageway. Pinjarra Road is the major transport route between Mandurah and Pinjarra. An Intersection and Access Strategy for Pinjarra Road undertaken by Main Roads suggests that the road reserve will be widened from 40m to 60m and increased from 4 to 6 traffic lanes. The Structure Plan has reflected the required 10m widening as shown on the Structure Plan 1.

4.4.1.2 Riverside Drive

Riverside Drive is classified as a Local Distributor under the Main Roads Functional Road Hierarchy and is constructed as a un-kerbed, sealed road adjacent to the Structure Plan area.

Riverside Drive has a sealed width of approximately 6.1m with unsealed shoulder varying in width from 2.5m to 3.0m. It is noted there are no existing pedestrian or cycle paths along Riverside Drive.

4.4.1.3 Ronlyn Road

Ronlyn Road is classified as a Local Distributor under the Main Roads Functional Road Hierarchy and is constructed as an unkerbed, sealed road adjacent to the Structure Plan area. Ronlyn Road has a sealed width of approximately 6.1m with unsealed shoulder varying in width from 2.5m to 3.0m. There is an existing pedestrian path along the northern verge of the road reserve.

4.4.2 Proposed Road Network

The proposed road hierarchy for the Structure Plan has been determined from modelling based on the indicative Structure Plan layout, and provides for simple and efficient vehicle movements through the site.

The road hierarchy primarily consists of internal Access Streets, with two Neighbourhood Connectors providing north-south links from Pinjarra Road.

The movement network reflects a strong north-south and east-west modified grid configuration, with direct connections to Pinjarra Road, albeit with restricted right-turn access from Riverside Drive. The street block lengths are generally consistent with the requirements of LN, providing for connectivity and permeability through the site, for both pedestrians and vehicles.

4.4.2.1 Neighbourhood Connectors

Ronlyn Road and Riverside Drive are proposed as a combination of Neighbourhood Connector A and Neighbourhood Connector B road reserves and are expected to carry traffic volumes between 3,000 to 7,000 vehicles per day. The location of the transition from a Neighbourhood Connector A to a Neighbourhood Connector B occurs at the 'link road', which provides direct access to both Ronlyn Road and Riverside Drive.

It is expected that both Ronlyn Road and Riverside Drive will be upgraded to an urban standard along those portions of road abutting the Structure Plan area. The road reserve width is proposed to be a total of 24.4m for the portion of road classified as Neighbourhood Connector A, with a 20m road reserve being required for the portion of road classified as Neighbourhood Connector B. Both road reserves will incorporate a central median and on-street bicycle lanes.

4.4.2.2 Access Streets

The remainder of the streets within the Structure Plan are proposed to primarily consist of Access Street C road reserves, designed to a 16m cross-section in accordance with the Shire of Murray's infrastructure requirements. Where services are only required to one side of the road, such as adjacent to areas of public open space or the Pinjarra Road reserve, a reduced Access Street D cross-section of 13.5m is proposed.

An Access Street B of 20m in width is proposed within the central portion of the Structure Plan, located south of the area of public open space containing the CCW / TEC and running east–west from Ronlyn Road to Riverside Drive. The additional road reserve width is required to accommodate a central swale which is required to service the external drainage catchment, carrying stormwater to the existing culverts under Riverside Drive.

4.4.3 Public Transport

The existing Furnissdale area is currently adequately serviced by public transport. Transperth Bus Route 598 operates between Furnissdale and the Mandurah Bus Station which commences from the

western end of Smith Street and travels eastward on to York Road, Riverside Drive, Ronlyn Road before turning westward on to Pinjarra Road in to Mandurah.

It is noted however, that the existing bus route will need to be reviewed by the Public Transport Authority as subdivision and development progresses throughout the Structure Plan area to encompass the new residential areas. The revised bus route will depend on the staging of development and in particular the staging of new roads dwellings as they are constructed and inhabited respectively.

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. It is noted there is an existing shared path along Ronlyn Road however currently no shared path exists along Riverside Drive. A shared path is proposed to be constructed as part of the required upgrades to Riverside Drive along those areas which abut the Structure Plan area.

The Access Streets within the Structure Plan area have low daily traffic volumes and are therefore suitable for on-road cycling. It is recognised however, that informal on-street parking will create some interference for on-road cycling however this will typically occur on very low traffic volume roads where the opportunity for conflict is considered to be low.

4.5 Urban Water Management

This section addresses the proposed urban water management network.

4.5.1 Water Management Strategies and Planning

4.5.1.1 Regional Water Management Strategy

An overarching Drainage Water Management Plan (DWMP) for the Murray region was released by the Department of Water in June 2011. The DWMP provides the framework for future planning and development proposals and their subsequent site-specific water management strategies and plans.

4.5.1.2 District Water Management Strategy

The West Furnissdale District Water Management Strategy (DWMS) was prepared in 2012 and provides guidance on water re-use options, stormwater detention basins, monitoring requirements, and structural and non-structural controls for stormwater treatment. The DWMS has been approved by both the Shire of Murray and the Department of Water (2012).

4.5.1.3 Local Water Management Strategy

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

The LWMS addresses the Structure Plan 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 principles, objectives and key criteria of the WAPC's Better Urban Water Management 2008.

4.5.2 Proposed Drainage Network and Infrastructure Requirements

Surface water flows are to be managed at the lot level and development scale to maintain predevelopment hydrology by retaining or detaining surface water and to infiltrate runoff close to source. The proposed drainage system will consist of a series of lot soakwells, a road drainage system comprising pipes and bioretention areas and ephemeral storage areas within POS to provide water quantity and quality treatment for stormwater generated from the proposed development.

In accordance with the LWMS prepared for the site, the key elements for managing stormwater within the Structure Plan area are as follows:

- Rehabilitation of the conservation category wetland buffer; and
- Use of distributed public open space areas for ephemeral stormwater retention/detention.

4.5.2.1 Local Drainage

The LWMS proposes three areas for stormwater retention. Storage Area A is located in the southwest corner of the site and is proposed to discharge via a piped outlet into the Serpentine River. A culvert is required to be installed under Riverside Drive which continues within the road reserve easement towards a regional open space reserve to the south which will ultimately discharge into the Serpentine River.

Storage Area B is located adjacent to Riverside Drive and accesses the existing culvert under the road. As per the LWMS, Storage Area B has been designed to detain the 1 in 5 year ARI via the existing 300mm diameter culvert under Riverside Drive, with a spillway being created for the greater events to discharge via the 600mm culvert which exists under Riverside Drive and is ultimately discharged towards the Serpentine River.

Storage Area C is located in the northwest corner of the site and has been designed to detain the 1 in 5 year ARI with greater events being released via a spillway towards the conservation category wetland. The greater events will flow back toward Riverside Drive and utilise an existing drainage easement from Riverside Drive to the wetland.

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.

4.5.2.2 Groundwater Management

In accordance with the preliminary bulk earthworks plan which have been prepared as part of the servicing report, the proposed post development levels are to range from between 3.25m AHD to 3.5m AHD. This is to be achieved predominantly through the importation of fill.

It is likely that subsoil drainage will be used across the site to establish a controlled groundwater level to ensure adequate separate between groundwater and the natural surface.

4.5.2.3 Ongoing Management and Responsibilities

The ongoing water management and responsibilities are summarised in the table below.

Organisation	Role/Responsibility
Shire of Murray	Reinstates the piped drainage outlet to the Serpentine River. Assumes future long term responsibility for roads and storm water infrastructure including the ongoing operation and maintenance thereof subsequent to agreed handover by the developer.
Water Corporation	Assumes future responsibility for the potable water supply and sewerage infrastructure including the ongoing operations and maintenance thereof.
Developer	Obtain approval of the UWMP. Implement approved Acid Sulphate Soils Management Plans (where required), and Taking Water and Disposal Licenses during construction of subdivision works.

Organisation	Role/Responsibility
	Demonstrate that the proposed subdivision designs supportive of the UWMP can achieve the water quantity and quality objectives and criteria set by this document. Undertake post development monitoring, including the provision of appropriate monitoring locations, for a period of 2 years following sale of the last lot within the development. Utilise monitoring data to amend or provide BMPs to ensure that water quality objectives are achieved. Construct and subsequently maintain stormwater control measures until handover to the Shire of Murray.

Table 3: Water Management Responsibilities

4.6 Education Facilities

The Structure Plan does not propose the creation of any new school sites.

The existing education facilities within the Furnissdale and nearby Pinjarra locality will adequately cater for the needs of the future residents. Pinjarra presently accommodates both a public and private primary school and a senior high school.

It is noted that a new Primary School is planned for on the eastern side of Ronlyn Road to serve the wider Furnissdale urban catchment area.

4.7 Activity Centres and Employment

4.7.1 Activity Centres

In accordance with *State Planning Policy 4.2: Activity Centres for Perth and Peel* (SPP 4.2), the closest Strategic Metropolitan Centre to the Structure Plan area is the Mandurah City Centre, located approximately 4.2 to the west. It is also noted the Pinjarra townsite, which is recognised as a Secondary Centre, is located approximately 13.4 kilometres from the Structure Plan area.

The Mandurah City Centre comprises the main regional activity centre within close proximity to the Furnissdale West area. The Centre is well positioned to provide for a diversity of uses, including a range of economic and community services required to service the future population.

At a local level, the Barragup Furnissdale Activity Centre abuts the north eastern portion of the site. The Barragup Furnissdale Activity Centre provides a diverse, main street based neighbourhood centre to serve the daily and weekly needs of the Barragup and Furnissdale communities.

4.7.2 Employment

Given the location of the site relative to the Mandurah City Centre, there are a number of regional employment opportunities available to the community in close proximity to the Structure Plan area. The Pinjarra townsite is also located within close proximity to the site and provides for local employment opportunities.

A number of industrial employment opportunities may be available to the local community at nearby Industrial Centres such as Nambeelup, Greenfield, Pinjarra and Oakley which is identified as a Strategic Industrial Centre.

Local employment opportunities will also be generated from the Barragup Furnissdale Activity Centre along with the existing commercial uses along Pinjarra Road. The centre seeks to create both a 'Neighbourhood Centre' and a 'Business' precinct which will create a variety of job opportunities for local residents.

The proposed Primary School site on the eastern side of Ronlyn Road will also provide for employment opportunities for the local community.

4.8 Infrastructure Coordination, Servicing and Staging

The following provides a summary of the infrastructure and servicing for the Structure Plan area, however for further information it is recommended the reader consult the Engineering Services Report provided as Appendix 8.

4.8.1 Water Supply

The site is situated with the Water Corporation's Yunderup Pressure Reduction Valve (PRV) water Supply zone. Current water supply to the Furnissdale area is via a system of PRV's off the large distribution mains along Pinjarra Road (DN700 and DN460).

Water supply to the Structure Plan area will need to be via reticulation-sized mains DN200, DN250 with smaller reticulation as needed. The reticulation layout will be further reviewed at detailed design stage in consultation with the Water Corporation's Land Servicing Branch.

It is noted that the Water Corporation's long term planning for the Pinjarra and Mandurah area is currently under review. The review is set to define whether the Yunderup PRV zone continues to be served from the Stirling Trunk main, from a future Pinjarra scarp tank to the east or from the north-west via the Mandurah tanks and distribution system. It is expected this will be further defined as detailed design work is undertaken at subdivision stage.

4.8.2 Sewer

The Water Corporation has advised that the subject site falls under the Barragup planning area where it is proposed to install gravity sewers feeding to a new pump station on Ronlyn Road. The required future pump station will be located within the proponent's land, subject to approval from the Water Corporation at detailed design stage.

The southern portion of the Structure Plan area overlaps with the catchment of the existing permanent Vacuum Pump Station on Ronlyn Road. It is noted preliminary investigations indicated there was limited capacity within the existing Vacuum Sewer Pump Station however this would ultimately be subject to further discussions at detailed design stage.

Any extensions/upgrades that are necessary for development shall be the responsibility of the developer as part of the normal subdivision process.

4.8.3 Natural Gas

AtcoGas propose to install a 225mm PE high pressure gas main along Pinjarra Road. AtcoGas advised they would review the Structure Plan and advise if any further upgrades are required. To date, no further correspondence has been received.

It is expected that gas could be reticulated from the high pressure main into the Structure Plan area however will be further investigated at subdivision stage.

4.8.4 Electricity

Western Power has indicated that it has made arrangements to cater for the future load growth in the Furnissdale Area. This includes an updated to the Meadow Springs Sub-station distribution feeder which will increase supply capacity to the South Metro 22kV area, which include the Furnissdale area.

Western Power's network mapping facility indicates there is currently 5MVA capacity in the network with this increasing to 15MVA capacity of five years with the capacity reducing back to 5MVA in 20 years after development.

The current demand for residential development is typically around 4.7kVa per lot. It is anticipated based on these per lot calculations that the Structure Plan area would create a total load of 12.2MVA. This increase will typically be catered for by Western Power in accordance with the planning predictions for the area.

Street lighting will be installed in accordance with the relevant Australian Standards and in accordance with approved Western Power and Shire of Murray designs.

Any extensions/upgrades that are necessary for development shall be the responsibility of the developer as part of the normal subdivision process.

4.8.5 Telecommunications

The National Broadband Network Company (NBN Co.) will provide optic fibre cabling for the new development which will replace the local Telstra copper network. NBN Co. has reviewed the Structure Plan and to date, has not advised of any land requirements for hub facilities.

4.8.6 Development Staging

An Indicative Staging Plan has been included at Figure 14.

The Staging Plan indicates that development is likely to commence in the area immediately to the south of the OEPA vegetation, with the exception of Lot 197. This represents the most logical first stage of development given the location of existing services and the existing Furnissdale townsite to the south of the Structure Plan area.

The second stage of development is expected to commence from the north and progressively move in a southerly direction. The timing of the second stage of development will be largely dependent on the closure of the existing poultry farm on Lot 1186.

It is also noted that the development timeframe for Lots 149 and 150 Pinjarra Road is uncertain as these lots are under separate ownership to the proponent and may have differing development timeframes.

Refer to Figure 14 – Indicative Staging Plan.

4.9 Developer Contribution Arrangements

The Structure Plan does not form a Development Contribution Area under the Scheme. As such, prior to subdivision and/or development proceeding on the subject land a Scheme Amendment will be required to introduce a Development Contribution Area into the Scheme to cover 'hard' infrastructure items. The Development Contribution Plan is to be approved and incorporated in the Council's Local Planning Scheme as per the requirements of State Planning Policy 3.6 – Development Contributions for Infrastructure.

It is understood that the list of items to be included within the Development Contribution Area generally includes the following:

- Pinjarra Road;
- Riverside Drive;
- Ronlyn Road;
- Public Open Space;
- Conservation Area;
- Drainage; and
- Community Infrastructure.

Should the Development Contribution Area not be finalised prior to subdivision within the Structure Plan, it is likely that an interim development contribution arrangement between the proponent and the Shire will be established to cover the payment of interim costs.

4.10 Other Requirements

4.10.1 Traffic Noise

Traffic noise has been identified as a potential issue for those lots with frontage to Pinjarra Road. An Acoustic Assessment was undertaken by Herring Storer Acoustics which has been included as Appendix 7 to this report.

The Acoustic Assessment notes that the current traffic noise generated from Pinjarra Road is in excess of the requirements as per the WAPC's State Planning Policy 5.4 – Road and Rail Transport Noise (SPP 5.4) and Freight Considerations in Land Use Planning. The Acoustic Assessment notes that should a noise wall of 2.4m in height be installed along Pinjarra Road, it is likely that noise levels would not exceed that permitted under SPP 5.4. Notwithstanding however, the Shire of Murray has expressed that a noise wall is not suitable in this location for aesthetic streetscapes reasons given the portion of Pinjarra Road which would be subject to a noise wall is one of the main entry roads into the Shire.

Local Access Roads have been provided for abutting Pinjarra Road to create additional separation distance between lots with frontage to Pinjarra Road to minimise impacts of traffic noise whilst promoting an aesthetically pleasing streetscape outcome.

Further detailed noise amelioration methods shall be investigated at the time of subdivision which is likely to be enforced by way of a condition of subdivision approval.

FIGURES

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Planning Design Delivery





Regional Location

Furnissdale West

Figure 1

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG02B_20140516 FURNISSDALE (REGIONAL - FIGURE 1).DWG
William Clements 7 July 2016

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B	2014.05.16	K. Trenberth

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Regional Mapping supplied by WA Planning Commission

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Cadastral Data supplied by STREETSMART

Locality Plan

Furnissdale West
Figure 2

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG03C_20160512 FURNISSDALE (LOCALITY - FIGURE 2).DWG
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- Subject Site
- 7 Existing Lot Numbers
- Existing Boundaries

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Plan ID:	5227-FIG-04-C

Aerial Photography captured and supplied by NEARMAP

Aerial Photography / Site Plan

Furnissdale West

Figure 3

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG04C_20160512 FURNISSDALE (AERIAL AND SITE - FIGURE 3).DWG
William Clements 5 July 2016

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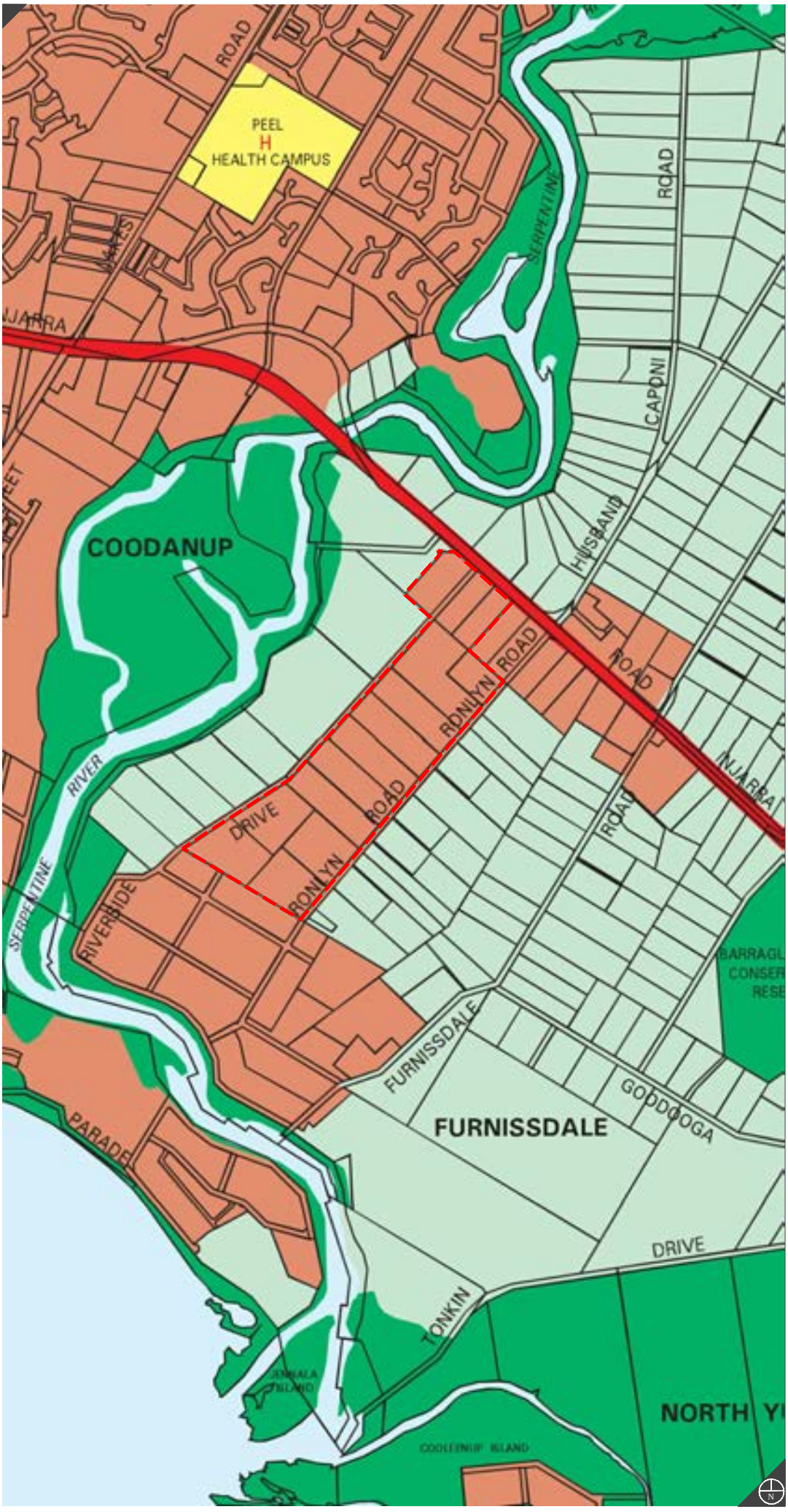

Planning Design Delivery



Legend

Subject Site

Reserved Lands

- Regional Open Space
- Waterways
- Public Purposes
  Denoted as follows:
  H Hospital
- Primary Regional Roads

Zones

- Urban
- Rural

0 500 Metres

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Zoning supplied by WA Planning Commission

Peel Region Scheme Zoning

Furnissdale West
Figure 4

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG05C_20160512 FURNISSDALE (PRS - FIGURE 4).DWG
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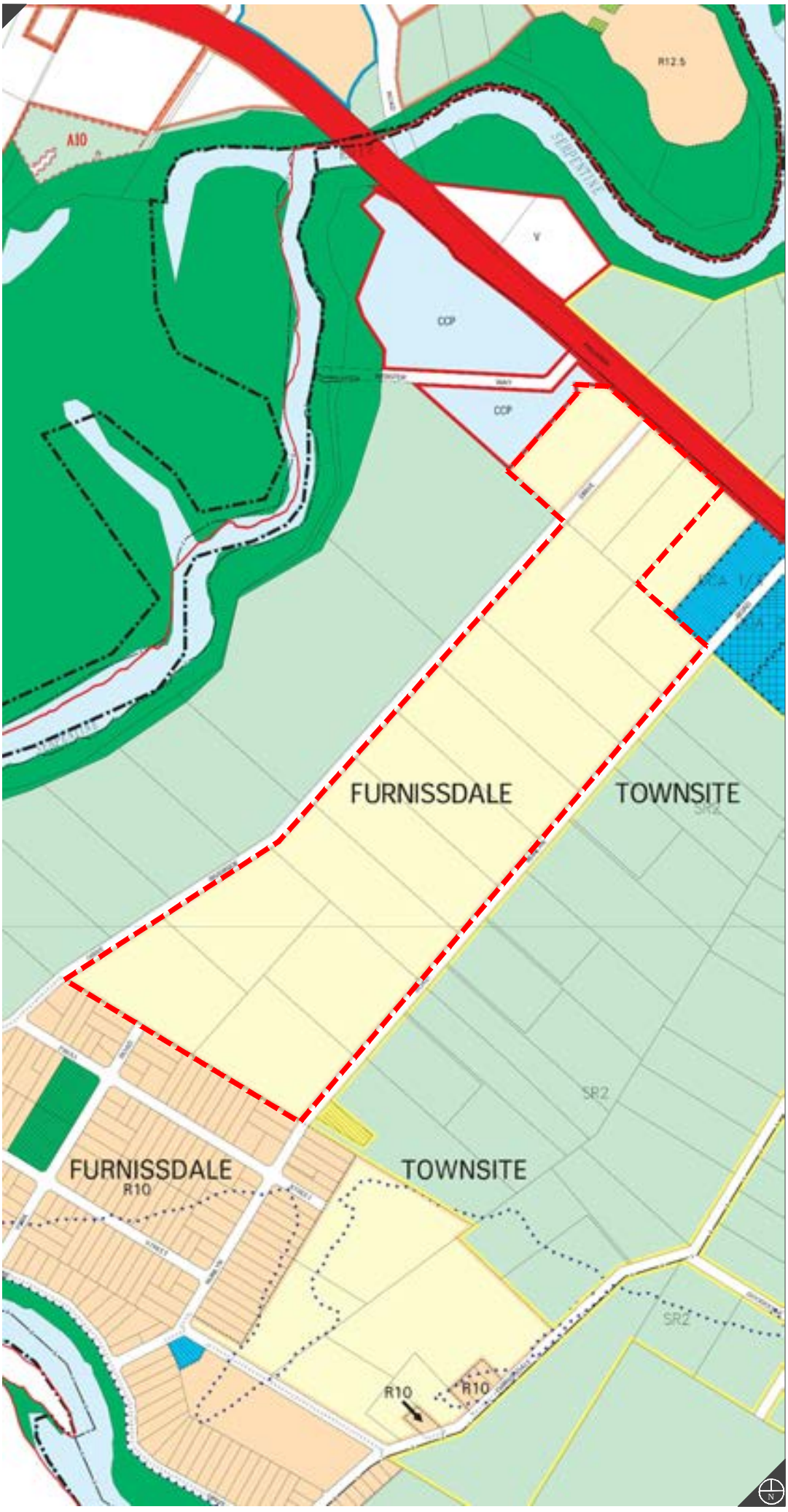

Planning Design Delivery



LEGEND

- Subject Site

PEEL REGION SCHEME RESERVES

- Parks And Recreation
- Waterways
- Primary Regional Roads

ZONES

- Residential Development
- Residential
- Commercial
- City Centre - Commercial Deferred
- Caravan / Chalet Park
- General Rural
- Special Rural

OTHER

- R20 — R Codes
- A1 — Additional Uses
- Scheme Boundary
- Local Government Boundary
- Flood Prone Areas (100 Year Flood)
- SR3 — Special Rural Area
- 1 — Peel-Harvey Coastal Plain Catchment Area
- DCA1 — SCA-Development Contribution Area
- No Zone

0 250 Metres

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Zoning supplied by WA Planning Commission

Town Planning Scheme No. 4

Furnissdale West

Figure 5

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG06C_20160512 FURNISSDALE (TPS - FIGURE 5).DWG
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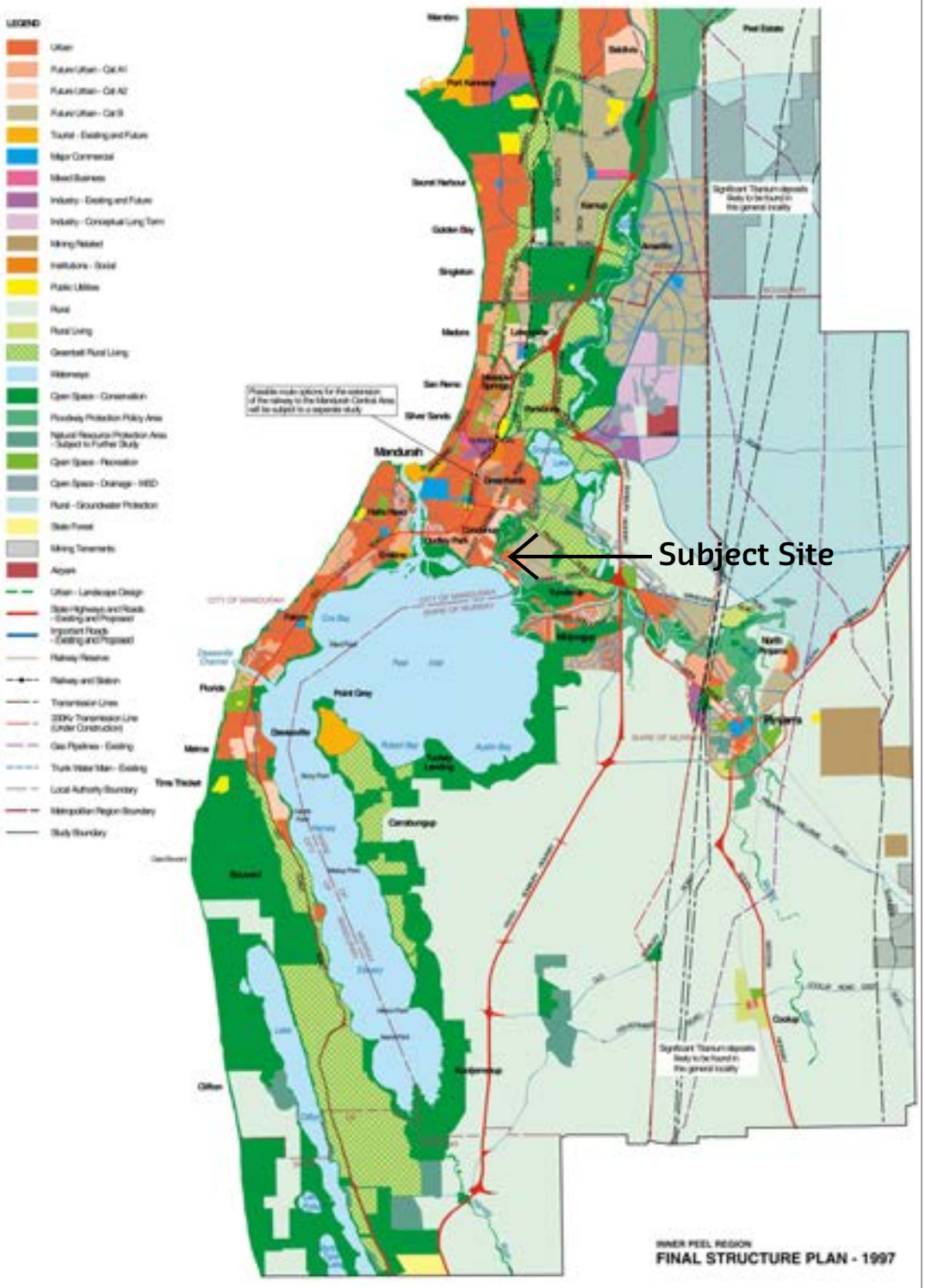

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Plan ID:	5227-FIG-16-B

Inner Peel Region Structure Plan

Furnissdale West
Figure 6

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG16C_20160706 FURNISSDALE (INNER PEEL REGION STRUCTURE PLAN - FIGURE 6).DWG
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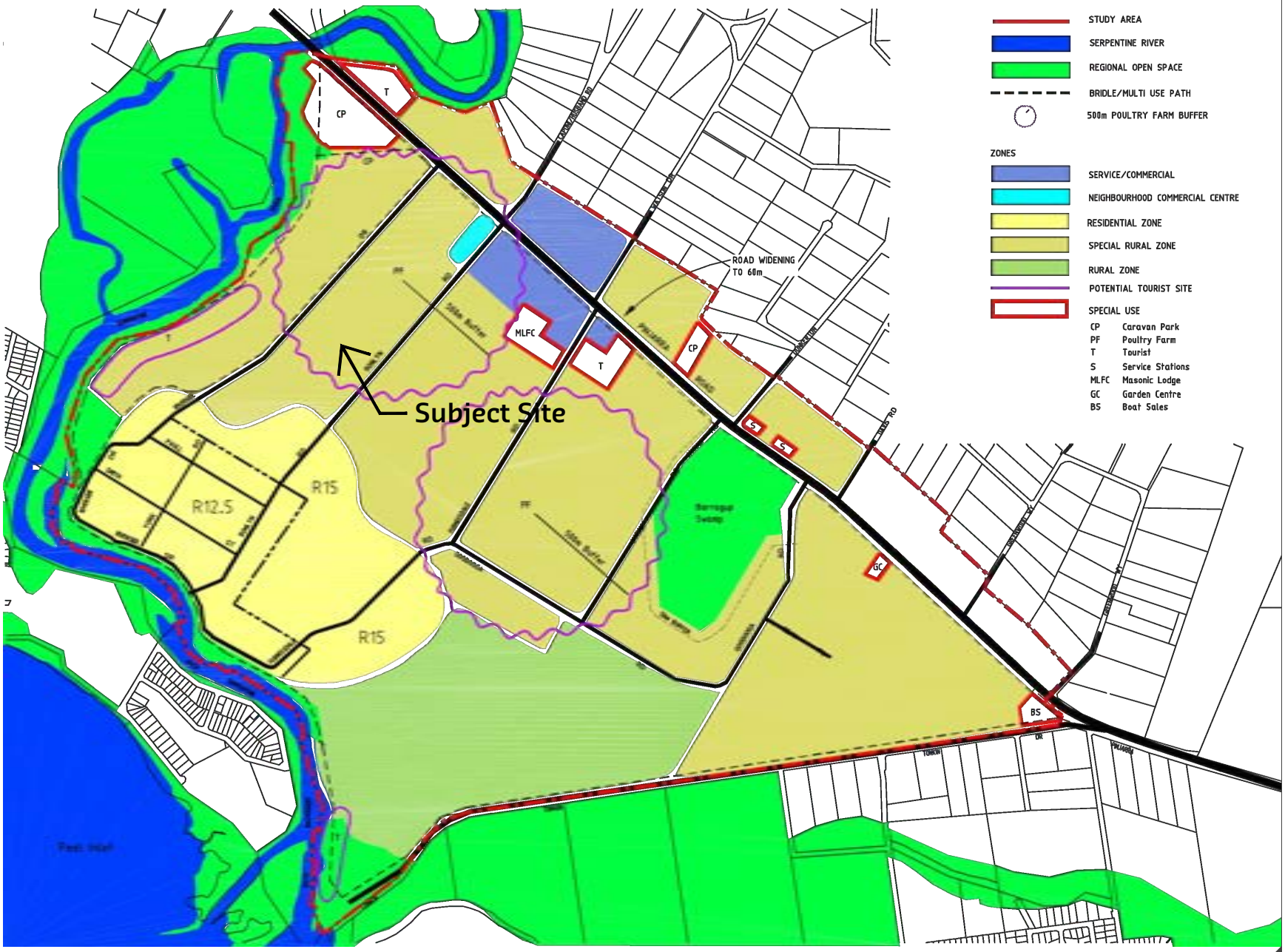

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Cadastral Data supplied by LANDGATE

Furnissdale Structure Plan

Furnissdale West
Figure 7

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG15A_20140522 FURNISSDALE (FURNISSDALE STRUCTURE PLAN - FIGURE 7).DWG
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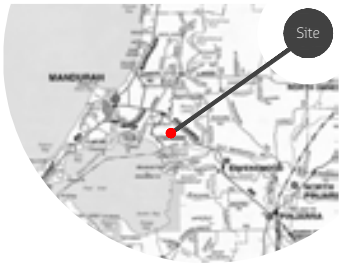

LEGEND

Subject Site

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Drawn:	M. Sullivan
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Plan ID:	5227-FIG-01-B

Aerial Photography captured and supplied by NEARMAP

Context Plan

Furnissdale West

Figure 8

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG01B_20140516 FURNISSDALE (CONTEXT - FIGURE 8).DWG
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Planning Design Delivery



LEGEND

- Subject Site
- Existing Boundaries
- Contours
- 1187 Existing Lot Numbers
- Existing Building
- Traffic Lights
- Viewscapes
- OEPA Vegetation
- Bushfire Protection Zone
- Poultry Farm
- 500m Buffer to Poultry Farms
- 300m Buffer EPA
- Tourist
- Commercial Precinct (Local Centre)
- Wetland - Conservation
- Wetland - Conservation 50m Buffer
- Wetland - Multiple Use
- Flood Fringe (2011)
- Flood Fringe (2011) - 90m Buffer

0 125 250 Metres

REVISIONS

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A	2014.05.19	K. Trenberth
B	2015.03.13	K. Trenberth
C	2016.05.12	W. Clements

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Drawn:	K. Trenberth
Projection:	MGA50 GDA94
Plan ID:	5227-OPS-02-C

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Opportunities and Constraints

Furnissdale West
Figure 9

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Detailed Layout Plan

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William Clements 7 July 2016

Furnissdale West
Figure 10

Planning Design Delivery



LEGEND

- Subject Site
- Existing Boundaries
- 150 Existing Lot Numbers
- Proposed Boundaries
- OEPA POS Boundary
- Bush Fire Development Buffer
- OEPA Vegetation
- POS
- CCW

Densities

- R20
- R30
- R40
- R60

0 125 250 Metres

REVISIONS

Rev	Date	Drawn
G	2015.08.31	W. Clements
H	2015.12.11	M. Sullivan
I	2016.01.19	W. Clements
J	2016.07.07	W. Clements

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LEGEND

- Subject Site
- Existing Boundaries
- 150 Existing Lot Numbers
- Proposed Boundaries
- 400m Walkable Catchment
- 150m Walkable Catchment
- Drainage
- POS
- CCW
- River Red Gums to be Retained

0 200 Metres

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Date Drawn:	2015-03-13
Job Ref:	5227
Scale:	1:7500 @ A4
Client:	Coode Pty Ltd
Designer:	S. Jeleric
Drawn:	M. Sullivan
Projection:	MGA50 GDA94
Plan ID:	5227-FIG-08-H

Cadastre supplied by Landgate

Public Open Space

Furnissdale West
Figure 11

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG08H_20160512_FURNISSDALE (POS - FIGURE 11).DWG
William Clements 7 July 2016

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Planning Design Delivery



Furnissdale West Local Structure Plan – Public Open Space Schedule				
10.05.2016				
Site Area (Structure Plan boundary)				50.15
Less				
Protected Bushland Site (POS H - OEPA Vegetation)		6.80		
CCW Core		8.49%		
Net Site Area				42.80
Deductions				
Pinjarra Road widening		0.237%		
Drainage (1:1yr) * See below		0.599%		
Total			0.8	
Gross Subdivisible Area				**42.0**
POS @10%				4.2
Public Open Space Contribution				
May comprise:				
Min 80% unrestricted POS			3.4	
Min 20% restricted use POS			0.8	
Total Required POS				**4.2**

POS Reference Number (area within urban zone/LSP boundary only)		1:1yr Drainage (m²) Deduction from Net Area	Unrestricted Urban POS sites (m²)	1:5yr Restricted POS (m²) / CCW buffer
A	2111	580	811	715
B	4006	0	4006	0
C	14801	3150	5207	6444
D	9198	0	9198	0
E	14497	0	14497	0
F	6423	2260	2565	1598
Total	**51036**	**5990**	**36281**	**8757**
	5.1	**0.6**	**3.6**	**0.9**
Percentage of gross subdivisible area	**12.2%**	**1.4%**	**8.6%**	**2.1%**

REVISIONS

Rev	Date	Drawn
A	2015.08.31	W. Clements
B	2015.10.13	W. Clements
C	2016.07.07	W. Clements

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PLANNING DESIGN DELIVERY

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e: info@rowegroup.com.au
p: 08 9221 1991

Date Drawn:	2015.08.31
Job Ref:	5227
Scale:	N.A. @ A4
Client:	Various
Designer:	R. Dial
Drawn:	W. Clements
Projection:	N.A.
Plan ID:	5227-FIG-23-C

Public Open Space Schedule

Furnissdale West
Figure 12

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG23C_20160707 FURNISSDALE (POS SCHEDULE - FIGURE 11).DWG
William Clements 7 July 2016

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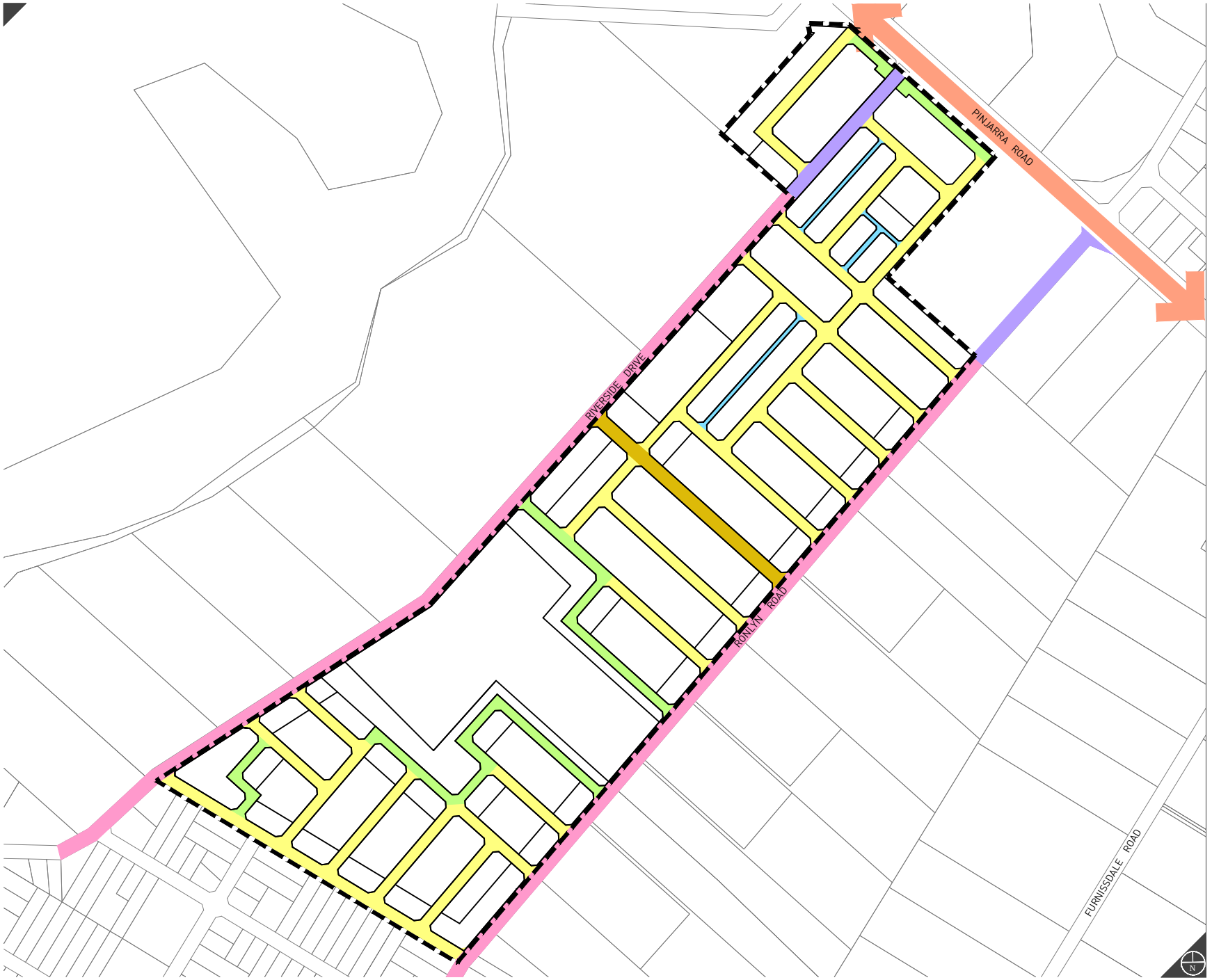

Planning Design Delivery



LEGEND

- Subject Site
- Primary Distributor
- Neighbourhood Connector A
- Neighbourhood Connector B
- Access Street B
- Access Street C
- Access Street D
- Laneway

0 187.5 Metres

REVISIONS

Rev	Date	Drawn
B	2014.05.19	K. Trenberth
C	2014.10.27	K. Trenberth
D	2015.08.31	W. Clements
E	2016.05.12	W. Clements

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PLANNING DESIGN DELIVERY

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p: 08 9221 1991

Date Drawn:	2014-03-24
Job Ref:	5227
Scale:	1:7500 @ A4
Client:	Various
Designer:	S. Jeleric
Drawn:	M. Sullivan
Projection:	MGA50 GDA94
Plan ID:	5227-FIG-10-E

Cadastral Data supplied by LANDGATE

Movement Network

Furnissdale West

Figure 13

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_FIG10E_20160707 FURNISSDALE (MOVEMENT NETWORK - FIGURE 13).DWG
William Clement 7 July 2016

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Planning Design Delivery



LEGEND

- Subject Site
- Existing Boundaries
- 150 Existing Lot Numbers
- Proposed Boundaries
- Stage 1
- Stage 2
- Stage 3
- Stage 4
- Stage 5
- Residual Stages

0 125 250 Metres

REVISIONS

Rev	Date	Drawn
A	2014.05.19	K. Trenberth
B	2014.10.27	K. Trenberth
C	2015.08.27	W. Clements
D	2015.10.13	W. Clements

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p: 08 9221 1991

Date Drawn:	2014.05.19
Job Ref:	5227
Scale:	1:5000 @ A3
Client:	Coode Pty Ltd
Designer:	P. Fitzgerald
Drawn:	K. Trenberth
Projection:	MGA50 GDA94
Plan ID:	5227-STG-01-D

Cadastre supplied by LANDGATE

Indicative Staging Plan

Furnissdale West
Figure 14

N:\TOWN PLANNING\5000-5999\5227\DRAFTING\A-CAD\5227_STG01D_20151013 FURNISSDALE (STAGING - FIGURE 14).DWG
William Clements 7 July 2016

Part Three
TECHNICAL APPENDICES

ROWEGROUP

APPENDIX 1

CERTIFICATES OF TITLE

ROWEGROUP

WESTERN AUSTRALIA

REGISTER NUMBER	
179/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 81 FOLIO 38A

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

LAND DESCRIPTION:

LOT 179 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

JOHN PETER DAVIES OF 13 ROCKFORD STREET, MANDURAH
(T D609083) REGISTERED 20 NOVEMBER 1987

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: 81-38A (179/P8254).
PREVIOUS TITLE: 81-35A.
PROPERTY STREET ADDRESS: NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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354L.

REGISTER NUMBER	
198/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	7/4/2014

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 17 FOLIO 102A

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

LAND DESCRIPTION:

LOT 198 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COODE PTY LTD OF 51 STONEHAM ROAD, ATTADALE
(T M597206) REGISTERED 3 APRIL 2014

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:	17-102A (198/P8254).
PREVIOUS TITLE:	1228-765.
PROPERTY STREET ADDRESS:	61 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA:	SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
197/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	26/9/2007

RECORD OF CERTIFICATE OF TITLE

VOLUME 278 FOLIO 131A

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

LAND DESCRIPTION:

LOT 197 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MURRAY THOMAS POULTNEY OF 197 RONLYN ROAD, BARRAGUP
(T B842578) REGISTERED 7 JANUARY 1980

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

1. G271512 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 3.9.1996.
2. *H624032 CAVEAT BY SHIRE OF MURRAY LODGED 15.12.2000.

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: 278-131A (197/P8254).
PREVIOUS TITLE: 1228-765.
PROPERTY STREET ADDRESS: 75 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
180/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	28/2/2001

RECORD OF CERTIFICATE OF TITLE

VOLUME 81 FOLIO 37A

UNDER THE TRANSFER OF LAND ACT 1893

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 180 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

COODE PTY LTD OF LEVEL 1, 58 KISHORN ROAD, MOUNT PLEASANT
(T K453988) REGISTERED 20 DECEMBER 2007

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

1. *K453989 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 20.12.2007.

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

----------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: 81-37A (180/P8254).
PREVIOUS TITLE: 81-35A.
PROPERTY STREET ADDRESS: 182 RIVERSIDE DR, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING K453989

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WESTERN AUSTRALIA

REGISTER NUMBER	
181/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1301 FOLIO 944

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 181 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

JOHN PETER DAVIES OF 13 ROCKFORD STREET, MANDURAH
(T B248520) REGISTERED 19 NOVEMBER 1976

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:	1301-944 (181/P8254).
PREVIOUS TITLE:	1228-765.
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AREA:	SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
182/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 58 FOLIO 1A

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

LAND DESCRIPTION:

LOT 182 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LEON PAUL BODERACKI OF LOT 182 RONLYN ROAD, FURNISSDALE
(T C309749) REGISTERED 23 FEBRUARY 1982

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:	58-1A (182/P8254).
PREVIOUS TITLE:	1228-765.
PROPERTY STREET ADDRESS:	107 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA:	SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
183/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	18/1/2005

RECORD OF CERTIFICATE OF TITLE

VOLUME 1766 FOLIO 316

UNDER THE TRANSFER OF LAND ACT 1893

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 183 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CLIFFORD JAMES HARPER OF 183 RONLYN ROAD, FURNISSDALE
(T H246577) REGISTERED 11 OCTOBER 1999

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

1. J120980 MORTGAGE TO PEPPER FINANCE CORPORATION LTD REGISTERED 15.12.2004.

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

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

STATEMENTS:
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SKETCH OF LAND: 1766-316 (183/P8254).
PREVIOUS TITLE: 16-258A.
PROPERTY STREET ADDRESS: 123 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
184/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

VOLUME 39 FOLIO 203A

UNDER THE TRANSFER OF LAND ACT 1893

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 184 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MERVYN JAMES STEWART
FELICIA ROSINA STEWART
BOTH OF LOT 184 RONLYN ROAD, FURNISSDALE
AS JOINT TENANTS

(T B198418) REGISTERED 11 AUGUST 1976

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

1. E829696 MORTGAGE TO WESTPAC BANKING CORPORATION REGISTERED 12.3.1992.

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: 39-203A (184/P8254).
PREVIOUS TITLE: 1228-765.
PROPERTY STREET ADDRESS: 135 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
185/P8254	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	12/5/2008

RECORD OF CERTIFICATE OF TITLE

VOLUME 1737 FOLIO 911

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

LAND DESCRIPTION:

LOT 185 ON PLAN 8254

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MURRAY JOHN GRAY
JILL ANN GRAY
BOTH OF LOT 185 RONLYN ROAD, FURNISSDALE
AS JOINT TENANTS

(T I274329) REGISTERED 24 OCTOBER 2002

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:	1737-911 (185/P8254).
PREVIOUS TITLE:	49-69A.
PROPERTY STREET ADDRESS:	137 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA:	SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
1186/DP26315	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	15/6/2001

RECORD OF CERTIFICATE OF TITLE

VOLUME 2503 FOLIO 75

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

LAND DESCRIPTION:

LOT 1186 ON DEPOSITED PLAN 26315

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MICHAEL EDWIN TWINE
GREGORY SHAYNE KENDALL
BOTH OF LOT 186 RONLYN ROAD, FURNISSDALE
AS JOINT TENANTS

(AF H759534) REGISTERED 28 MAY 2001

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

1. H759535 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD REGISTERED 28.5.2001.
2. *L849743 MEMORIAL. CONTAMINATED SITES ACT 2003 REGISTERED 3.2.2012.

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: DP26315.
PREVIOUS TITLE: 49-68A, 1297-2.
PROPERTY STREET ADDRESS: 155 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
1187/DP26315	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	15/6/2001

RECORD OF CERTIFICATE OF TITLE

VOLUME 2503 FOLIO 76

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

LAND DESCRIPTION:

LOT 1187 ON DEPOSITED PLAN 26315

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LOXLEIGH PTY LTD OF LOT 186 RONLYN ROAD, FURNISSDALE
(T J642968) REGISTERED 2 MARCH 2006

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

1. *J642969 MORTGAGE TO BANK OF WESTERN AUSTRALIA LTD REGISTERED 2.3.2006.

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
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STATEMENTS:

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SKETCH OF LAND: DP26315.
PREVIOUS TITLE: 1297-2.
PROPERTY STREET ADDRESS: 167 RONLYN RD, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
156/D20124	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	10/12/2003

RECORD OF CERTIFICATE OF TITLE

VOLUME 1837 FOLIO 106

UNDER THE TRANSFER OF LAND ACT 1893

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 156 ON DIAGRAM 20124

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

GEOFFREY KENNETH MARSHALL OF 7 HERA COURT, SAN REMO
IN 3/10 SHARE
STEPHEN ROBERT DRAPER
KAREN ANNE DRAPER
BOTH OF 30 PANAMUNA DRIVE, FALCON
AS JOINT TENANTS IN 2/10 SHARE
RAYMOND BARRY BOSTELMAN
HELEN LOUISE BOSTELMAN
BOTH OF 2C CLYDESDALE STREET, ALFRED COVE
AS JOINT TENANTS IN 1/10 SHARE
KEMOC PTY LTD OF 4 SUTTON STREET, MANDURAH
IN 4/10 SHARE
AS TENANTS IN COMMON

(T L302648) REGISTERED 3 MAY 2010

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

1. *L302649 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 3.5.2010.

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SKETCH OF LAND: 1837-106 (156/D20124).
PREVIOUS TITLE: 1289-718.
PROPERTY STREET ADDRESS: 607 PINJARRA RD, FURNISSDALE.

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REGISTER NUMBER: 156/D20124 VOLUME/FOLIO: 1837-106 PAGE 2

LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
149/D20014	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	9/9/2008

RECORD OF CERTIFICATE OF TITLE

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 149 ON DIAGRAM 20014

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SERAFINA VERGONE OF 304 RIVERSIDE DRIVE, FURNISSDALE
(ND K688666) REGISTERED 19 AUGUST 2008

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

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STATEMENTS:

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SKETCH OF LAND: 1579-299 (149/D20014).
PREVIOUS TITLE: 1184-107.
PROPERTY STREET ADDRESS: 304 RIVERSIDE DR, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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WESTERN AUSTRALIA

REGISTER NUMBER	
150/D20014	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	9/9/2008

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

VOLUME 1579 FOLIO 300

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REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 150 ON DIAGRAM 20014

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SERAFINA VERGONE OF 304 RIVERSIDE DRIVE, FURNISSDALE
(ND K688666) REGISTERED 19 AUGUST 2008

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.
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STATEMENTS:

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SKETCH OF LAND: 1579-300 (150/D20014).
PREVIOUS TITLE: 1184-107.
PROPERTY STREET ADDRESS: LOT 150 PINJARRA RD, FURNISSDALE.
LOCAL GOVERNMENT AREA: SHIRE OF MURRAY.

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APPENDIX 2

FLORA AND VEGETATION SURVEY

ROWEGROUP

FLORA AND VEGETATION OF LOT 180 RIVERSIDE DRIVE NORTH FURNISSDALE

Prepared for

GREG ROWE AND ASSOCIATES



Job No: 08.297

Report No: RP001

env Australia

FLORA AND VEGETATION OF LOT 180 RIVERSIDE DRIVE NORTH FURNISSDALE

Prepared for

GREG ROWE AND ASSOCIATES

Prepared by

ENV Australia Pty Ltd
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PERTH WA 6000
Phone: (08) 9289 8360
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Prepared by:	*Natalie Pawley*
Status:	*Final*
QA Review:	*Peter Jobson*
Technical Review:	*Rachael Pratt / Narelle Whittington*
Content Review:	*Teresa Gepp*
Date:	*10 September 2010*

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ('the report') has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ('scope of services'). In some circumstances the scope of services may have been limited by factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

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

Environmental Conclusions

In accordance with the scope of services, ENV has relied on the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

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

Report for Benefit of Client

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

Other Limitations

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

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report, nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV.Australia Pty Ltd was commissioned by Greg Rowe and Associates to undertake a comprehensive flora and vegetation assessment of Lot 180 Riverside Drive, North Furnissdale. The site is approximately 4 ha in size and contains remnant native vegetation with a house, tracks and firebreaks representing the only cleared areas. The purpose of this study is to support an application for rezoning from rural to urban in the Peel Region Scheme, and from special rural to urban in the Shire of Murray Town Planning Scheme. The survey will complement that done by ENV for the adjacent land in 2007.

The area is mapped as containing one Swan Coastal Plain vegetation complex, Bassendean Complex, which is related to the underlying soil profile. Currently on the Swan Coastal Plain, 27% of the Bassendean Complex is estimated to remain. The EPA guidance recommends a standard level of native vegetation retention of at least 10% of each ecological community in constrained areas (i.e. areas of urban development in cities and major towns), based on its pre-European extent in the State. Below this threshold level, species loss is known to accelerate exponentially at an ecosystem level.

The Bassendean Complex has more than 10% of the retention rate recommended for Western Australia by the Environmental Protection Authority's *Position Statement No. 2* and therefore will not pose a constraint to development.

Forty-three taxa (two of which were introduced) were found during the survey. This level of species diversity is considered low, compared to vegetation surveys previously undertaken in the area.

A database search of the area resulted in four Declared Rare and 11 Priority Flora being identified as potentially occurring in the area. This survey was conducted during spring when all but one potentially occurring DRF and Priority species listed by the DEC were identifiable and none were located.

Two dominant weed species were identified during the survey, **Iridaceae* sp. and **Briza maxima*. Neither is listed as Declared Plant species by the Agriculture Protection Board. As such, specific weed management plan for the site is not considered necessary.

One vegetation community was observed during the study, found to be possibly associated with Gibson *et al*.'s (1994) Floristic Community Type SCP21a. This FCT is well reserved and not at risk in terms of conservation.

However, the FCT SCP3b "*Corymbia calophylla – Eucalyptus marginata* woodlands on sandy-clay soils", was statistically similar to the survey area. SCP3b is listed as a "vulnerable" TEC under state legislation, and therefore is protected under the *Environmental Protection* (Clearing of Native Vegetation) *Regulation 2004* and under the *Environmental Protection Act 1986* as an Environmentally Sensitive Area.

With a high percentage of species in common between the survey area and SCP3b, it is recommended that the survey area data be provided to the DEC to determine if the site is representational of Community Type 3b. If this is confirmed, the site will be protected as an ESA and the proposal may be required to undergo formal assessment by the EPA. This process will also determine whether the site is regionally significant.

According to the Bush Forever Vegetation Condition scale, the project area was in Very Good condition with some areas in Good condition. Weeds were generally associated with firebreaks and cleared areas with a few weed species occasionally occurring within the core areas of the site. Some localised areas of disturbance were noted included rubbish dumping and the remains of tree stumps.

1 INTRODUCTION

ENV.Australia Pty Ltd was commissioned by Greg Rowe and Associates to undertake a comprehensive flora and vegetation assessment of Lot 180 Riverside Drive, North Furnissdale. The site is approximately 4 ha in size and contains remnant native vegetation with a house, tracks and firebreaks representing the only cleared areas.

The purpose of this study is to support an application for rezoning from rural to urban in the Peel Region Scheme (PRS), and from special rural to urban in the Shire of Murray Town Planning Scheme (TPS). The survey will complement work completed by ENV for the adjacent land in 2007 (ENV 2007).

1.1 LOCATION

The site is located approximately 65 kilometres south west of Perth and 5 kilometres south east of Mandurah in the suburb of North Furnissdale, within the Shire of Murray (Figure 1). The site is bound by Riverside Drive to the north-west, land zoned as Rural under the Peel Region Scheme (PRS) to the north-east and south-east, and land zoned as Urban under the PRS to the south-west (Western Australian Planning Commission 2007).

The site is in the South-west province and the Darling Botanical District (Beard 1990). This region typically consists of forest country with related woodlands, in the south-west part of the province. The survey area is located within the Swan Coastal Plain Subregion and the Drummond Botanical Subdistrict, which consists mainly of the following vegetation communities:

- *Banksia* low woodlands;
- Tuart (*Eucalyptus gomphocephala)*; and
- Jarrah (*Eucalyptus marginata)* (Beard 1990).

The climate of this region is warm Mediterranean with winter precipitation of 600-1000 mm and five to six dry months per year (Beard 1990; Bureau of Meteorology 2008).

1.2 REGIONAL SOILS, LANDFORMS AND VEGETATION

For a development proposal to be assessed in terms of the flora and vegetation values that may be impacted upon, an understanding of the vegetation communities at the site in question is required. In Western Australia, there are various floristic reports that detail a region's botanical values.

A widely-used vegetation classification system that maps and describes vegetation communities in south-west Western Australia is *Vegetation of the Darling System* in the *Atlas of Natural Resources, Darling System, Western Australia* (Heddle *et al.* 1980). This document describes vegetation communities as vegetation complexes, and maps the distribution of each complex.

Vegetation complexes are defined as a combination of distinct site vegetation types usually associated with a particular geomorphic, climatic, floristic and vegetation structural association. Vegetation complexes are based on the pattern of vegetation at a regional scale, as it reflects the underlying key determining factors of landforms, climate and soils.

1.2.1 Soils and Landforms

The site occurs on the Swan Coastal Plain portion of the Darling System. The Swan Coastal plain consists of aeolian and fluviatile deposits. The soils of the area are described as primarily Bassendean Sand unit overlays the Guildford Formation on much of the Pinjarra Plain ranging from 0.5 to 2m thick. In this locality, given the proximity of the Serpentine River, the sand is underlain by estuarine and lagoonal deposits in places (Churchward & McArthur 1978).

Bassendean Sand - sand plains with low dunes and occasional swamps iron or humus podzols; areas of complex steep dunes.

1.2.2 Vegetation Complex Mapping

Heddle *et al.* (1978) mapped the area as containing one Swan Coastal Plain vegetation complex which is related to the underlying soil profile:

- Bassendean Complex – Central and South: Vegetation ranges from woodland of *Eucalyptus marginata, Allocasuarina fraseriana* and *Banksia* spp. to low woodland of *Melaleuca* spp. and sedgeland on moister sites. This area includes the transition of *E. marginata* to *E. todtiana* in the vicinity of Perth.

The Environmental Protection Authority (EPA) recognises that native vegetation complexes which have less than 10% of pre-European clearing extent remaining in constrained areas (i.e. areas of urban development in cities and major towns) on the Swan Coastal Plain may be considered regionally significant (EPA 2006). Currently it is estimated that on the Swan Coastal Plain, 27 % of the Bassendean Complex – Central and South remains (EPA 2006).

1.2.3 Floristic Community Types

The Bassendean Complex – Central and South is recognised as containing the following Floristic Community Types (FCTs) as described by Gibson *et al.* (1994):

- SCP4 - *Melaleuca preissiana* damplands;
- SCP5 – Mixed shrub damplands;
- SCP11 – Wet forests and woodlands;
- SCP12 – *Melaleuca teretifolia* and/or *Astartea* aff. *fasicularis* Shrublands;
- SCP13 – Deeper wetlands on heavy soils;

- SCP14 – Deeper wetlands on sandy soils;
- SCP21a – Central *Banksia attenuata – Eucalyptus marginata* woodlands;
- SCP21c – Low lying *Banksia attenuata* woodlands or Shrublands (PEC);
- SCP22 – *Banksia ilicifolia* woodlands (PEC);
- SCP23a – Central *Banksia attenuata – B. menziesii* woodlands; and
- SCP23b – Northern *Banksia attenuata – B. menziesii* woodlands (PEC).

On the Bassendean Complex, three FCTs are listed as a PEC under State legislation.

1.3 PROTECTION OF FLORA AND VEGETATION

Flora is protected formally and informally by various legislative and non-legislative measures, which are as follows:-

Legislative Protection

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth): a Federal Act;
- *Wildlife Conservation Act 1950* (WA): a State Act; and
- *Environmental Protection Act 1986* (WA): a State Act.

Non-Legislative Protection

- Western Australian Department of Environment and Conservation (DEC) Priority lists for flora and vegetation; and
- informal recognition of locally significant populations.

A short description of these measures is given below, and definitions of the species conservation codes and ecological community categories they use, and those used by the DEC, are provided in Appendix A.

Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) aims to protect matters of national environmental significance, which are detailed in Appendix A.

Under the EPBC Act, the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) lists threatened species and Threatened Ecological Communities (TECs) in certain categories determined by criteria set out in the Act (*www.environment.gov.au/epbc/index.html*).

The Act provides for substantial penalties for any unauthorised actions likely to adversely affect matters of national environmental significance. It also provides for a national environmental assessment and approvals process for proposed actions likely to affect the prescribed matters of national environmental significance. If a proposed action is approved subject to certain conditions, the proponent of the action does not contravene the Act if the action is carried out in accordance with the conditions imposed.

Projects likely to cause impacts on matters of national environmental significance (as defined in the EPBC Act – see Appendix A) should be referred to DEWHA for assessment under the EPBC Act. Although the time taken for a proposal to be assessed may be considerable, there is considerable risk in not referring a project likely to affect matters of national environmental significance, as the Act provides for substantial penalties for unauthorised actions.

Wildlife Conservation Act 1950 (WA*)*

Flora is listed under the provisions of the *Wildlife Conservation Act 1950* (WA*)* (WC Act) as protected according to its need for protection (see Appendix A).

Flora is given Declared Rare status when populations are geographically restricted or are threatened by local processes. In addition, under the WC Act, by Notice in the Western Australian Government Gazette of 9 October 1987, all native flora (spermatophytes, pteridophytes, bryophytes and thallophytes) is protected throughout the State.

The Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the Act.

Environmental Protection Act 1986 (WA)

Declared Rare Flora (DRF) and TECs are given special consideration in environmental impact assessment, and areas covered by TECs have special are Environmentally Sensitive Areas (ESAs) under the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection* (Clearing of Native Vegetation) *Regulations 2004*.

The protection of DRF and TECs are 'clearing principles' for assessing applications for permits to clear native vegetation, where exemptions for a clearing permit under the *Environmental Protection* (Clearing of Native Vegetation) *Regulations 2004* do not apply. There are substantial penalties (financial and/or imprisonment) for unlawfully damaging ESAs.

DEC Priority lists

The DEC lists 'Priority' flora that have not been assigned statutory protection under the WC Act, but which are under consideration for declaration as 'Rare Flora' under the Act. Species assessed as Priorities 1-3 (see Appendix A) are in urgent need of further survey, whilst Priority 4 species require monitoring every 5-10 years (see Appendix A for definitions).

In addition, the DEC maintains a list of Priority Ecological Communities (PECs) which identifies those communities that need further investigation before possible nomination for TECs status (see below).

Although DEC Priority species and communities have no formal legal protection, they are under consideration for legislative protection. Sensitivities to harm can therefore be expected to be heightened.

Informal Recognition of Flora and Vegetation

Certain populations or communities may be of local significance or interest because of their patterns of distribution and abundance. For example, flora may be locally significant because they are range extensions to the previously-known distribution or are newly-discovered taxa (and therefore have the potential to be of more than local significance). In addition, many species are in decline as a result of threatening processes (primarily land clearing), and relict populations of such species assume local importance.

Despite the lack of any formal protection for species in this category, project proponents are strongly advised to be aware of and to be sensitive to community concerns as to locally significant species or communities.

1.4 INTRODUCED SPECIES

The Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity (Appendix B). The Strategy defines environmental weeds as 'plants that establish themselves in natural ecosystems and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.'

Plants may also be 'Declared' by the Agriculture Protection Board under the *Agriculture and Related Resources Protection Act 1979* (WA) (ARRP Act). Declared Plants are gazetted under five categories (P1 - P5), which define the action required. Details of the definitions of these categories are provided in Appendix B. A declaration may apply to the whole State, to districts, individual properties or even to single paddocks. If a plant is Declared, landholders are obliged to control that plant on their properties (Department of Agriculture and Food 2008).

2 SCOPE OF WORK

The flora and vegetation assessment focussed on determining vegetation communities present, locating Declared Rare and Priority Flora and Threatened/ Priority Ecological Communities, as well as conducting a condition assessment of the existing vegetation. Specifically, this comprised:

- a flora and vegetation field survey;
- a search for rare and endangered flora records within the defined area;
- identification of any TECs or PECs;
- the review of data collected against criteria established in State and Federal processes for species conservation;
- the production of aerial photography with vegetation mapping and condition overlaid; and
- a final report that describes the results from the above, the potential constraints that may be posed by the vegetation given the available information and recommendations for further work.

3 METHODS

All flora surveys undertaken by ENV are designed to be compliant with the EPA requirements for the environmental surveying and reporting of flora surveys in Western Australia, as set out in the following documents:

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002); and
- *Guidance for the Assessment of Environmental Factors – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA 2004).

ENV then assesses and reports the results of its surveys with particular regard to the provisions of the following EPBC Act, WC Act and EP Act.

The methodology for the work involved the following key steps:

Desktop Survey

On 27 August 2007 a database search was submitted to the DEC to obtain a list of Declared Rare and Priority Flora and TECs/PECs within the site and the surrounding area (ENV 2007). The search was within co-ordinates from 380968mE, 6399508mN to 387890mE to 6394408mN (GDA94, zone 50).

Field Survey

On 23 September 2008 an ENV botanist visited the site and conducted a vegetation survey by traversing the entire property on foot along 50 m spaced transects. Data were collected from quadrats in the survey area, and geographic coordinates noted for changes in vegetation type. The sampling intensity was selected in consideration of the landforms, habitat, vegetation structure, diversity and seasonality. At least two 10 m x 10 m quadrats were assessed in each vegetation unit. At each site a photograph was taken, the vegetation unit was described and a condition statement made. During the field survey, potential Declared Rare and Priority Flora populations not identified by past surveys or database searches were described and their geographic coordinates noted.

Taxonomic Identification

Where field identification of plant taxa was not possible, specimens were collected systematically for later identification at the Western Australian Herbarium by comparison with the reference collection and use of identification keys. Species were also checked against *Florabase* (Western Australian Herbarium 2008) for correct distribution.

Checking Currency of Flora

Once the field survey was completed, the taxa in the area were compiled into a list and each species was checked against *Florabase* to determine whether they were listed as Rare or Priority species. Species were also checked against the EPBC Act listing of Threatened species to determine whether any were federally listed.

Threatened/ Priority Ecological Communities

Vegetation unit descriptions were then tabulated, and these communities were mapped. The vegetation descriptions for all communities across the site were referenced against Gibson *et al*. (1994) to determine the FCTs present and the consequent potential for the site to support TECs or PECs. FCTs were inferred from those available in Gibson *et al.* (1994) on the basis of species presence/ absence, landform, topography, regional locality and soil type using a statistical analysis program (Primer).

3.1 FLORA SURVEY LIMITATIONS AND CONSTRAINTS

It is important to note the specific constraints imposed on individual surveys. Constraints are often difficult to predict, as is the extent to which they influence survey effort. Survey constraints of the site's flora and vegetation survey are detailed in Table 1.

3.2 PERMITS

Specimens collected during the survey were taken by permit of and subject to the conditions of the licences SL008006 and 116-0708 issued to Ms Natalie Pawley under sections 23C and 23F of the *Wildlife Conservation Act 1950*.

Table 1: Limitations and Constraints Associated with Flora and Vegetation Survey

Variable	Impact on Survey Outcomes
Access Problems	No access problems were encountered during the site survey
Experience levels	The botanists who executed these surveys were practitioners suitably qualified in their respective fields. • Coordinating Botanist: Ms Natalie Pawley (Environmental Scientist/ Botanist); • Field Staff: Ms Natalie Pawley; • Taxonomy: Ms Rachael Pratt (Senior Environmental Scientist); and • Data Intepretation: Ms Natalie Pawley.
Timing[1], weather, season.	The survey was undertaken in Spring on 23 September 2008. The area had received 660.4 millimetres of rain in the year to date (1 January to 23 September inclusive) (Bureau of Meteorology 2008). Flora composition changes over time, with flora having specific growing periods, especially annuals and ephemerals (some plants lasting for a markedly brief time, some only a day or two). Therefore the results of future botanical surveys in this location may differ from the results of this survey.
Completeness	Species that were insufficiently mature or dead were identified in the field to genus or family level only (where possible). A comprehensive species list has not been prepared for areas that do not constitute a natural vegetation area, such as gardens or areas that have been totally cleared.
Determination	This survey makes inferences about vegetation types that have the potential to be TECs. However, a decision as to the presence or absence of TECs at the site remains the responsibility of the DEC's Species & Communities Branch. The taxonomy and conservation status of the Western Australian flora are dynamic. This report was prepared in reliance on taxonomy and conservation current at the time, but it should be noted this may change.

[1] EPA Guidance Statement No. 51 (2004) stipulates that flora and vegetation surveys should be undertaken following the season that contributes the greatest rainfall in the region. In the South-west Province the main rain is in winter, requiring surveys to be undertaken in spring. Short-term variations in normal weather patterns (e.g. drought) may necessitate supplementary survey work at other times of year or in later years to take into account temporal changes in diversity.

4 RESULTS

4.1 DATABASE SEARCH

A database search of the area results identified four Declared Rare Flora and 11 Priority Flora as potentially occurring in the area. For a comprehensive list of species found during the database search is in Appendix C.

Seven TECs are known to occur within the vicinity of the study area (Appendix C).

4.2 FIELD SURVEY

4.2.1 Flora

Twenty-three families, 34 genera and 43 taxa were recorded in the survey area (41 native flora taxa and two introduced). Refer to Appendix D for the flora list.

The plant families most frequently recorded from the survey were as follows:

- Proteaceae five species;
- Anthericaceae four species; and
- Cyperaceae four species.

4.2.2 Protected Flora

No Endangered or Vulnerable species pursuant to the EPBC Act were located during the survey.

No plant taxa gazetted as Declared Rare Flora pursuant to the WC Act were located in the survey area.

No Priority Flora was located in the survey area.

4.2.3 Locally Significant Flora

No locally significant flora was identified during the field survey.

4.2.4 Vegetation

The site consisted of one main vegetation unit[2] (Figure 2):

AfBaCc Woodland of *Allocasuarina fraseriana*, *Banksia attenuata, Corymbia calophylla, Kunzea glabrescens, Macrozamia riedlei, Hibbertia hypericoides,* Iridaceae sp. and **Briza maxima.*

Refer to Appendix E for site photographs.

4.2.5 Floristic Community Types

On the Swan Coastal Plain (SCP), the Bassendean Complex is recognised as containing 11 FCTs. Of these, those relating to wetland and shrubland communities were not statistically compared to the vegetation of the site due to the physical and vegetative characteristics of the site. The following FCTs, as described by Gibson *et al.* (1994) of the Bassendean Complex relevant to the site are:

- SCP21a – Central *Banksia attenuata – Eucalyptus marginata* woodlands;
- SCP21c – Low lying *Banksia attenuata* woodlands or Shrublands (PEC);
- SCP22 – *Banksia ilicifolia* woodlands (PEC);
- SCP23a – Central *Banksia attenuata – B. menziesii* woodlands; and
- SCP23b – Northern *Banksia attenuata – B. menziesii* woodlands (PEC).

Although the vegetation across the study area resulted in a higher percentage of species in common with SCP21b and SCP3b, these FCTs do not occur on the Bassendean Complex. Based on the presence/absence of species, landform, topography, regional locality and soil type, the site was considered to best fit – SCP21a – Central *Banksia attenuata – Eucalyptus marginata* woodlands (16.85 % species in common) (Table 2).

[2] A "vegetation unit" is defined as a grouping of plants distinct from other such units in floristic structure and composition. The term has a local meaning as compared to the terms "vegetation type", "vegetation complex" and "Floristic Community Types", which are used in a larger scale and are more specific.

Table 2: Floristic Community Type Analysis

Floristic Community Type	% Species in common
SCP1b – Southern Corymbia calophylla woodlands on heavy soils	13.25
SCP3b – Corymbia calophylla – Eucalyptus marginata woodlands on sandy-clay soils	19.67
SCP20a – Banksia attenuata woodlands over species rich dense shrublands	15.81
SCP21a – Central Banksia attenuata - Eucalyptus marginata woodlands	16.85
SCP21b – Southern *Banksia attenuata* woodlands	20.17

4.2.6 Priority Ecological Communities and Threatened Ecological Communities

The conservation status of SCP21a is not considered to be Threatened or Priority Ecological Community.

4.2.7 Vegetation Condition

Vegetation within the site is categorised as ranging from being in predominately Very Good condition to Good condition with only some edge areas in Degraded to Completely Degraded condition (Government of Western Australia 2000). Refer to Appendix F for Bush Forever condition scale. Degrading factors at the site include rubbish, logging, weeds, informal tracks and fire breaks (Figure 3).

4.2.8 Introduced Flora

The table below contains the dominant weed species identified during the field survey, with their ratings and criteria according to the Environmental Weed Strategy for Western Australia (refer to Appendix B for the criteria used for ranking). No Declared Plant species were found in the study area.

Table 3: Dominant Weed Species Identified

Taxon	Common Name	Criteria			
		Rating	Invasiveness	Distribution	Impacts
**Briza maxima*	Blow Fly Grass	Moderate	-	Yes	Yes
*Iridaceae sp.	-	Not listed	-	-	-

5 DISCUSSION

Vegetation Complexes

The area is mapped as containing one Swan Coastal Plain vegetation complex, the Bassendean Complex, which is related to the underlying soil profile. Currently on the Swan Coastal Plain, 27% of the Bassendean Complex is estimated to remain. The EPA guidance recommends a standard level of native vegetation retention of at least 10% of each ecological community in constrained areas (i.e. areas of urban development in cities and major towns), based on its pre-European extent in the State. Below this threshold level, species loss is known to accelerate exponentially at an ecosystem level.

The Bassendean Complex has more than 10% of the retention rate recommended for Western Australia by the Environmental Protection Authority's *Position Statement No. 2* and therefore will not pose a constraint to development.

Flora

Forty-three taxa (two of which were introduced) from 33 families and 34 genera were found during the survey. This level of species diversity is considered typically low, compared to vegetation surveys previously undertaken in the area.

Declared Rare or Priority Flora

No DRF or Priority species were found during the survey.

Four DRF were identified in the database search, including *Caladenia huegelii.* The DEC maintains records of known *C. huegelii* populations and based on the most current information obtainable, approximately 1400 individual plants are known to exist in 34 populations, restricted to *Banksia* woodlands on the Bassendean Sand System along the Swan Coastal Plain. The closest record of *C. huegelii* individuals were recorded 6 km south east of the site in the suburb of Ravenswood, growing in similar vegetation to that present on the site.

C. huegelii survives for most of its life underground and is only visible above the soil when flowering (about four weeks in September/October) each year, and not all plants flower every year.

The survey was conducted during the appropriate time of year for the flowering parts of *C. huegelii* to be visible and based on not finding this species within the two sequential surveys on the site in September 2008 and on the properties adjacent to the site in September 2007 (ENV 2007), ENV concludes that the likelihood of the site containing *C. huegelii* is low. There has been, however, a general decline in orchid emergence over the past few years, possibly attributable to unfavorable climatic conditions.

The database search also indicated *Drakaea elastica* which occurs in the surrounding area of the site with the closest being 4 km to the east in the suburb of Barragup, on the banks of Nambeelup Pool.

Prior to the field work, a desktop survey recognised that the site is not suitable for *Drakaea elastica.* It's preferred habitat is low-lying situations adjoining winter-wet swamps, which is lacking within the site. As such ENV did not time the survey within the orchid's flowering period and therefore *D. elastica* was not identified during either of the 2007 or 2008 field surveys.

This survey was conducted during spring when all of the remaining potentially occurring DRF and Priority species listed by the DEC were identifiable and none were located.

Introduced Flora

Two weed species were identified during the survey, **Iridaceae* sp. and **Briza maxima*. Neither of the weed species identified are listed as a Declared Plant by the Agriculture Protection Board. As such, a specific weed management plan for the site is not required as the weed species identified are typical weed species of fragmented bushland remnants.

Floristic Community Types

One vegetation community was recorded during the study; this appears to be associated with Gibson *et al*.'s (1994) Floristic Community Type SCP21a – Central *Banksia attenuata – Eucalyptus marginata* woodlands (Table 2). Species recorded for this vegetation community are listed in Appendix D.

The reservation status of SCP21a is listed as a "well reserved" and the conservation status is considered at low risk.

Correlation to this FCT was based on a statistical analysis using species presence/ absence. Comparative analysis with SCP21b resulted in a higher percentage of species in common. However, SCP21b is restricted to sand sheets at the base of the Whicher Scarp, the sand sheets on elevated ridges or the sand plain south of Bunbury (Gibson *et al.* 1994) makes it an unlikely candidate.

Even though according to landform (Churchward and McArthur 1978) and vegetation maps (Heddle et al 1978) the survey area appears to be in the Bassendean Complex and not the Vasse Complex, we need to further examine the high statistical association of the survey with SCP3b.

Most of Gibson *et al.*'s plots within Community Type 3b are dominated by *C. calophylla* and *E. marginata* and species such as *Bossiaea eriocarpa* and *Conostylis juncea*, all of which occur within the site, differentiate this group. Type 3b has been recorded from alluvial soils near the Peel – Harvey estuary as well as the better drained sites on the eastern side of the plain (Gibson *et al.* 1994), similar to that of the site's soils, and therefore it was concluded that the site is potentially representational of Gibson *et al.*'s Community Type 3b.

With 19.67% of species in common between the site and SCP3b, however, it is recommended that the site's data be provided to the DEC to determine if the site is representational of Community Type 3b. If confirmed, the site is protected as an ESA and the proposal may be required to undergo formal assessment by the EPA.

Vegetation Condition

According to the Bush Forever Vegetation Condition scale, the project area was in Very Good condition with some areas in Good condition. Weeds were generally associated with firebreaks and cleared areas with a few weed species occasionally occurring within the core areas of the site. Some localised areas of disturbance were noted included rubbish dumping and the remains of tree stumps.

Regional Significance

To investigate the impact of clearing the site's vegetation, the site's natural values were measured against the six criteria stipulated in Guidance Statement No. 10 to determine regional significance (EPA 2006):

1. REPRESENTATION OF ECOLOGICAL COMMUNITIES – ***A number of areas selected to represent the range of ecological communities and the places in which these communities merge.***	Even though the remnant vegetation within the site is small in size (less than 4 ha), it is in predominately Very Good condition. The FCT of the site is to be determined.
2. DIVERSITY – ***Areas with a high diversity of landforms, flora and/ or fauna species or communities in close relation.***	The site contains one vegetation unit with a total of 43 taxa. This does not represent high species diversity. From this study, the area also does not contain a diversity of landforms. ENV is not in a position to comment on the diversity of fauna as fauna was not a component of this study.
3. RARITY – ***Does the area contain rare or threatened communities or species, or species of restricted distribution.***	No Threatened, Declared Rare, Priority Flora or any species of local significance were found during the survey. The FCT of the site is to be determined.
4. MAINTAINING ECOLOGICAL PROCESSES OR NATURAL SYSTEMS – ***Maintenance of ecological processes or natural systems at a regional or national scale.***	The site forms part of a large remnant on adjacent properties, connected along the site's north, east and south boundaries.
5. SCIENTIFIC OR EVOLUTIONARY IMPORTANCE – ***Areas containing evidence or evolutionary processes and areas containing unusual or important geomorphologic or geological sites.***	The criterion was not investigated as part of the scope of works for this project. As such ENV is not in a position to determine whether the site contains evidence or evolutionary processes and contains unusual or important geomorphologic or geological sites.

6. GENERAL CRITERIA FOR PROTECTION OF WETLAND, STREAMLINE, AND ESTUARINE FRINGING VEGETATION AND COASTAL VEGETATION – ***Conservation Category Wetland areas including fringing and associated upland vegetation; coastal vegetation within the accepted coastal management zone.***	The site does not contain any wetlands and as such this criterion does not apply to the site.

If the DEC confirms that the site is a likely to be a representation of the FCT SCP3b then it may be considered an area of regional significance and will be a constraint to development.

6 CONCLUSIONS AND RECOMMENDATIONS

The flora and vegetation survey undertaken by ENV determined that of the 43 taxa found during the survey, none were of significance. The vegetation community indicates that the site may represent a protected ESA and therefore it is recommended the data be provided to the DEC for consideration. Confirmation of whether the site is representational of SCP21a or SCP3b may make the site an area of regional significance and will determine whether the proposal will require referral to the EPA for consideration.

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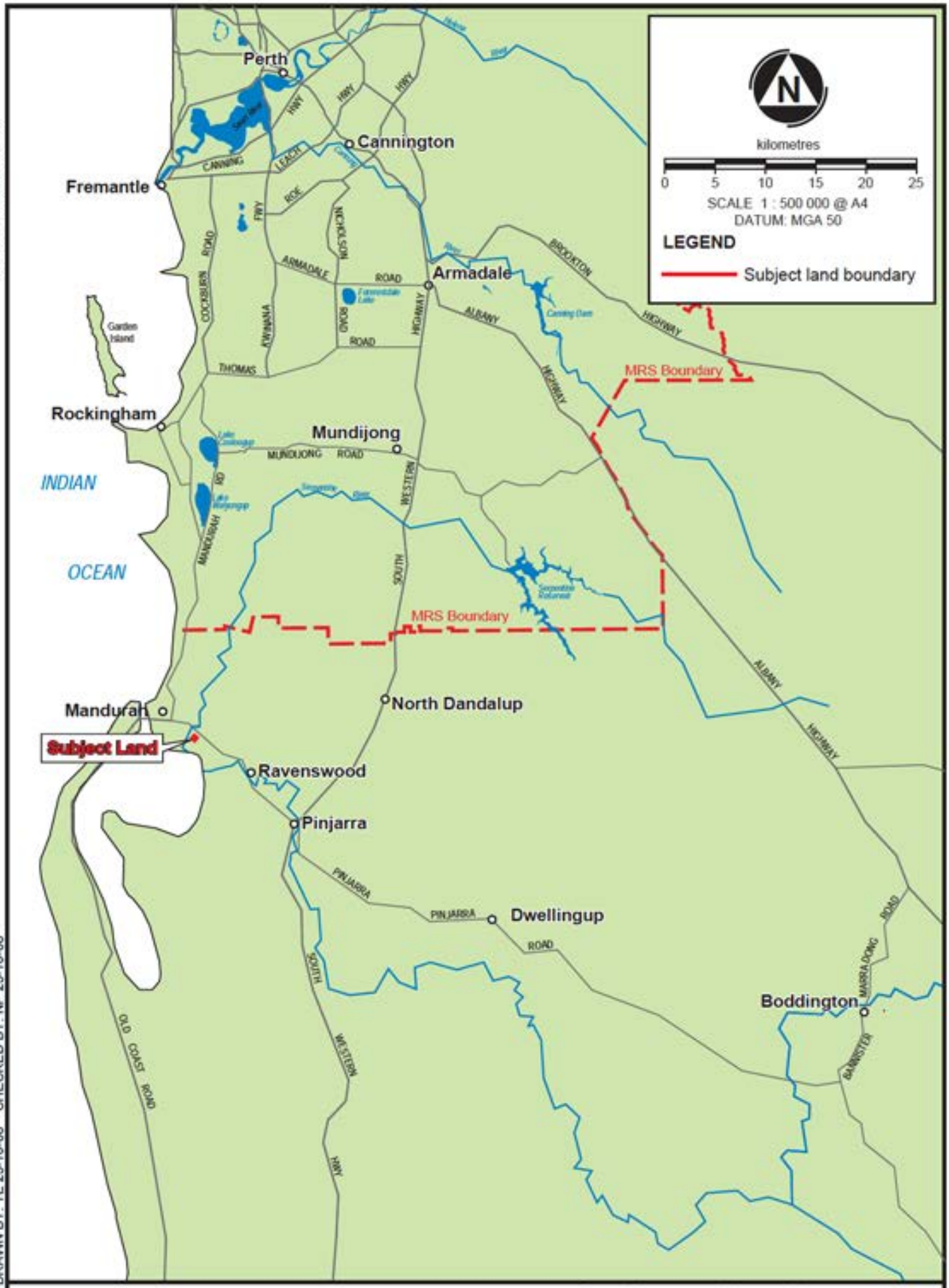
FIGURES



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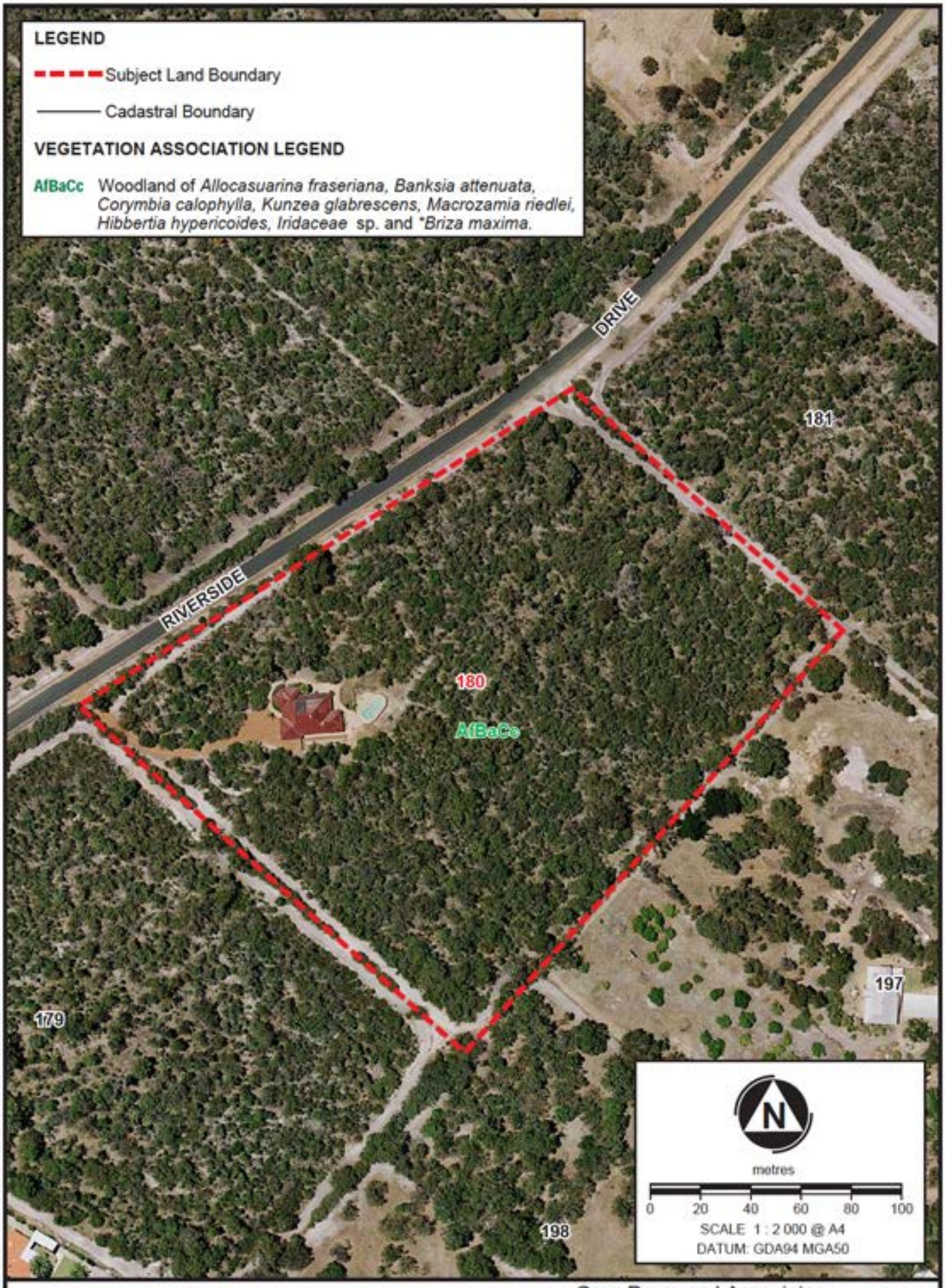
Greg Rowe and Associates
FLORA AND VEGETATION
LOT 180 RIVERSIDE DRIVE, NTH FURNISDALE

REGIONAL LOCATION

FIGURE 1

env Australia



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FLORA AND VEGETATION
LOT 180 RIVERSIDE DRIVE, NORTH FURNISSDALE

VEGETATION UNITS

AERIAL PHOTOGRAPH SOURCE: Landgate, SkyView, 2007.

FIGURE 2

env Australia



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FLORA AND VEGETATION
LOT 180 RONLYN RD, NORTH FURNISSDALE

VEGETATION CONDITION

FIGURE 3

AERIAL PHOTOGRAPH SOURCE: Landgate, SkyView, 2007.

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APPENDIX A

DEFINITIONS OF DECLARED RARE AND PRIORITY FLORA AND THREATENED/ PRIORITY ECOLOGICAL COMMUNITIES

APPENDIX A
Definition of Declared Rare/ Priority Flora and Threatened Ecological Communities

Categories of Threatened and Priority Flora (Department of Environment and Conservation, 2007)

Conservation Code	Category
R	Declared Rare Flora- Extant Taxa "Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such"
X	Declared Rare Flora – Presumed Extinct Taxa Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
P1	Priority One- Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P2	Priority Two- Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P3	Priority three- Poorly Known Taxa "Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey."
P4	Priority Four- Rare Taxa "Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years."

Categories of Threatened Flora Species
(Environmental Protection and Biodiversity Conservation Act, 1999)

Category Code	Category
Ex	Extinct Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died**.**
ExW	Extinct in the wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Definitions of Threatened Ecological Communities

Presumed Totally Destroyed (PD)

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B);

A) Records within the last 50 years have not been confirmed despite thorough searches or known or likely habitats **or**

B) All occurrences recorded within the last 50 years have since been destroyed.

Critically Endangered (CR)

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and **either or both** of the following apply (i or ii)

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years)

   ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii):

   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years)

   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes

   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years)

Endangered (EN)

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and **either or both** of the following apply (i or ii)

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term (within approximately 10 years)
   ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii):

   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years)
   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes
   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the short term future (within approximately 10 years).

Vulnerable (VU)

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction in the medium to long term future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated.
B) The ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.
C) The ecological community may still be widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

APPENDIX B

ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES

APPENDIX B

DEFINITIONS OF ENVIRONMENTAL WEEDS AND DECLARED PLANTS

Standard Meanings of Declared Plant Categories

P1

Prohibits movement.

The movement of plants or their seeds is prohibited within the State.

This prohibits the movement of contaminated machinery and produce including livestock and fodder.

P2

Aim is to eradicate infestation.

Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.

P3

Aims to control infestation by reducing area and/or density of infestation.

The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.

Treat to destroy and prevent seed set all plants:

* Within 50m inside of the boundaries of the infestation;
* within 50m of roads and high water mark on waterways;
* within 50m of sheds, stock yards and houses.

Treatment must be done prior to seed set each year.

Properties with less than 20ha of infestation must treat the entire infestation.

Additional areas may be ordered to be treated.

P4

Aims to prevent infestation spreading beyond existing boundaries of infestation

The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.

Treat to destroy and prevent seed set all plants:

* within 50m inside of the boundaries of the infested property for one-leaf and 20m for two-leaf;

* within 50m of roads and high water mark on waterways;

* within 50m of sheds, stock yards and houses.

Treatment must be done prior to seed set each year. Properties with less than 20ha of infestation must treat the entire infestation.

Additional areas may be ordered to be treated.

Special considerations.

In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.

P5

Aims to control infestations on public lands.

Criteria used for Ranking Environmental Weeds

The Environmental Weed Strategy for Western Australia (CALM 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity. These criteria are as follows:

- **Invasiveness –** ability to invade bushland in good to excellent condition or ability to invade waterways. (Score as yes or no).
- **Distribution** – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world. (Score as yes or no).
- **Environmental Impacts** – ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community. (Score as yes or no).

The rating of each weed is determined by the following scoring system:

- **High** - a weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritising this weed for control and/or research i.e. prioritising funding to it.
- **Moderate** -a weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** – a weed species scoring one of the criteria. A mild rating would indicate monitoring of the week and control where appropriate.
- **Low** – a weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

APPENDIX C
DEC DATABASE SEARCH RESULTS

APPENDIX C

DEC Flora Database Search Results

FAMILY	TAXA	Conservation Status Code	
		STATE	FEDERAL
CYPERACEAE	*Schoenus* sp. Waroona	3	Not Listed
ORCHIDACEAE	*Caladenia huegelii*	R	Endangered
ORCHIDACEAE	*Diuris drummondii*	R	Vulnerable
ORCHIDACEAE	*Diuris micrantha*	R	Vulnerable
ORCHIDACEAE	*Drakaea elastica*	R	Endangered
PROTEACEAE	*Grevillea manglesii* subsp. *ornithopoda*	2	Not Listed
PAPILIONACEAE	*Dillwynia dillwynioides*	3	Not Listed
PAPILIONACEAE	*Jacksonia sericea*	4	Not Listed
MYRTACEAE	*Eucalyptus rudis* subsp. *cratyantha*	4	Not Listed
HALORAGACEAE	*Myriophyllum echinatum*	3	Not Listed
APIACEAE	*Eryngium pinnatifidum* subsp. *palustre*	3	Not Listed
APIACEAE	*Eryngium pinnatifidum* subsp. *umbraphilim*	3	Not Listed
MENYANTHACEAE	*Villarsia submersa*	4	Not Listed
LAMIACEAE	*Hemigenia microphylla*	3	Not Listed
ASTERACEAE	*Blennospora doliiformis*	3	Not Listed

APPENDIX D
FLORA LIST

APPENDIX D
FLORA SPECIES LIST

* denotes introduced species

? indicates that this taxa is likely, however, insufficient taxonomic features were present for full and definitive identification. The question mark is placed before the item which is uncertain.

Abbreviations:

sp.: species (singular)
spp.: species (plural)
subsp.: subspecies
var.: variety
ms: manuscript name (unpublished)

FAMILY		*TAXA*	CONS. CODE
ZAMIACEAE		*Macrozamia reidlei*	
POACEAE	*	*Briza maxima*	
CYPERACEAE		*Lepidosperma* sp. A	
		Lepidosperma sp. B	
		Lepidosperma sp. C	
		Lepidosperma sp. D	
DASYPOGONACEAE		*Dasypogon bromeliifolius*	
		Lomandra sonderi	
PHORMIACEAE		*Dianella revoluta*	
ANTHERICACEAE		*Caesia micrantha*	
		Chamaescilla corymbosa	
		Thysanotus manglesianus	
		Sowerbaea laxiflora	
COLCHICACEAE		*Burchardia congesta*	
HAEMODORACEAE		*Conostylis aculeata*	
		Conostylis juncea	
IRIDACEAE	*	Iridaceae sp.	
ORCHIDACEAE		*Caladenia flava*	
		Pyrorchis nigricans	
CASUARINACEAE		*Allocasuarina fraseriana*	
PROTEACEAE		*Banksia attenuata*	
		Banksia grandis	
		Banksia ilicifolia	
		Phlebocarya ciliata	
		Xylomelum occidentale	
DROSERACEAE		*Drosera erythrorhiza*	
		Drosera sp.	

APPENDIX D
FLORA SPECIES LIST

* denotes introduced species

? indicates that this taxa is likely, however, insufficient taxonomic features were present for full and definitive identification. The question mark is placed before the item which is uncertain.

Abbreviations:

sp.: species (singular)
spp.: species (plural)
subsp.: subspecies
var.: variety
ms: manuscript name (unpublished)

FAMILY	*TAXA*	CONS. CODE
MIMOSACEAE	*Acacia pulchella*	
	Acacia saligna	
	Acacia stenoptera	
PAPILIONACEAE	*Bossiaea eriocarpa*	
	Hardenbergia comptoniana	
	Hovea trisperma	
RUTACEAE	*Philotheca spicata*	
EUPHORBIACEAE	*Phyllanthus calycinus*	
DILLENIACEAE	*Hibbertia hypercoides*	
VIOLACEAE	*Hybanthus calycinus*	
THYMELAEACEAE	*Pimelea suaveolens*	
MYRTACEAE	*Corymbia calophylla*	
	Eucalyptus marginata	
	Kunzea glabrescens	
STYLIDIACEAE	*Stylidium piliferum*	
ASTERACEAE	*Lagenophora huegelii*	

APPENDIX E
SITE PHOTOGRAPHS

APPENDIX E
Site Photographs



Photo 1: Quadrat One (Community Unit AfBaCc.*)*



Photo 2: Quadrat Two (Community Unit AfBaCc.*)*



Photo 3: Logging



Photo 4: Rubbish dumping

APPENDIX F
BUSH FOREVER CONDITION SCALES

APPENDIX F

BUSH FOREVER CONDITION SCALE

Condition Scale Code	Condition Scale
P	**Pristine (1)** Pristine or nearly so, no obvious signs of disturbance
E	**Excellent (2)** Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
VG	**Very Good (3)** Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
G	**Good (4)** Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
D	**Degraded (5)** Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
CD	**Completely Degraded (6)** The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

Source: Government of Western Australia (2000). *Bush Forever Volume 2: Directory of Bush Forever Sites*. Department of Environmental Protection, Perth, Western Australia.

APPENDIX 3
ENVIRONMENTAL ASSESSMENT

ROWEGROUP

LOTS 181–185, 197, 198, 1186, 1187 RONLYN ROAD, AND LOTS 179 & 180 RIVERSIDE DRIVE, NORTH FURNISSDALE

ENVIRONMENTAL ASSESSMENT

Prepared for:

GREG ROWE AND ASSOCIATES

Job No: 07.266

Report No: RP001

Australia

LOTS 181–185, 197, 198, 1186,1187 RONLYN ROAD, AND LOTS 179 & 180 RIVERSIDE DRIVE, NORTH FURNISSDALE

ENVIRONMENTAL ASSESSMENT

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Content Review:	*Teresa Gepp*
Date:	*13 May 2008*

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

Reliance on Data

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

Environmental Conclusions

In accordance with the scope of services, ENV has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Also it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

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

Report for Benefit of Client

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

Other Limitations

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

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

ENV.Australia (ENV) was commissioned to undertake an environmental assessment of Lots 181–185, 197, 198, 1186 and 1187 Ronlyn Road, Lot 179 and Lot 180 River Road, North Furnissdale (the site). The assessment is to support an application for rezoning of the land from rural to urban in the Peel Region Scheme (PRS), and from special rural to urban the Shire of Murray Town Planning Scheme (TPS).

The site is approximately 65 km south west of Perth and 5 km south east of Mandurah. The 43 ha site has a mixture of land uses; including rural residential (bush blocks), pasture and a poultry farm to the north. The majority consists of cleared, semi-cleared rural land with some large areas of remnant native vegetation. It is bound by Ronlyn Road to the south-east, Riverside Drive to the north-west, Pinjarra Road to the north-east and residential properties of Furnissdale to the south-west.

The site is relatively flat, between 4–5 m AHD, with a slight northeast to southwest slope. The soils are Bassendean Sand over estuarine deposits. The soils have a very low capacity to retain nutrients, particularly phosphorous. The sand is underlain by a confining clay layer at 3–4 m below ground level.

Acid Sulfate Soils (ASS) risk mapping indicates that the entire site has a “high to moderate risk of ASS occurring within 3 m of the natural soil surface. The results of field testing indicate that while there is no Actual ASS present there is Potential Acid Sulfate Soils (PASS) below the watertable. Disturbance of soils below the water table for the installation of services such as sewerage for example would trigger the need for more detailed ASS assessment and management plans.

Groundwater perches on the impermeable clay and flows within the sand layer. It is anticipated that groundwater levels within the site could fluctuate due to the influence of tidal variation from the nearby Serpentine River and Peel Inlet.

Monitoring of groundwater indicates evidence of nutrient loading in groundwater near the chicken farm in the north of the property. These are above drinking water threshold limits. The actual extent of nutrient loading in groundwater would require delineation through the installation of additional monitoring wells. The site may need to be formally reported to the Department of Environment and Conservation (DEC), as required under the *Contaminated Sites Act 2003*. The rest of the site shows water quality typical for the region.

Drainage at the site is reasonably unconstrained by the sandy soil profile which allows for rapid infiltration of stormwater complying with Water Sensitive Urban Design principles. A Local Water Management Strategy (LWMS) based on 18 to 24 months monitoring will be required to accompany a TPS amendment and an Urban Water Management Plan (UWMP) required to accompany a subdivision application.

A small area of Conservation (C) category and multiple use category wetland is mapped by the Department of Environment and Conservation (DEC) as occurring on the western boundary of the site. This wetland mapping aligns approximately with the flood fringe of the Serpentine River. This C category wetland is largely cleared and does not warrant the C management category. An opportunity exists for a formal request to the DEC for a re-evaluation to a less restrictive management category.

No Declared Rare, Endangered, Vulnerable or Priority Flora species were located on the site. There are some relatively large areas of remnant vegetation in Very Good to Good condition. These should be considered for retention in Public Open Space and as regional ecological linkages.

The majority of the site is of limited habitat value for fauna and is surrounded by roads which may impede fauna movement into and out of the site. Sections of relatively undisturbed vegetation considered to be of moderate to high habitat value comprise part of a potential fauna movement corridor with vegetation west of Riverside Road and east of Ronlyn Road (Lot 181). The site may therefore support significant fauna such as the Chuditch which may require further investigation. Proposed development of the site would not be expected to have a significant impact on the regionally widespread fauna.

1 INTRODUCTION

ENV.Australia (ENV) was commissioned by Lexington Pty Ltd and Coode Pty Ltd to undertake an environmental assessment of Lots 181–185, 197, 198, 1186 and 1187 Ronlyn Road, Lot 197 and 180 River Road, North Furnissdale (the site). The assessment is to support an application for rezoning from rural to urban in the Peel Region Scheme (PRS), and from special rural to urban in the Shire of Murray Town Planning Scheme (TPS).

The site is approximately 65 km south west of Perth and 5 km south east of Mandurah (Figure 1). The subject land is 43 ha in area and has a mixture of land uses; including rural residential (bush blocks) and a poultry farm to the north. The majority of the site consists of cleared, semi cleared rural land with some large areas of remnant native vegetation (Figure 2). The development site is bound by Ronlyn Road to the south-east, Riverside Drive to the north-west, Pinjarra Road to the north-east and residential properties of Furnissdale to the south-west.

The key issues examined by ENV include:

- Flora and vegetation;
- Fauna assessment;
- Groundwater and surface water monitoring; and
- Preliminary Acid Sulphate Soils (ASS) assessment.

Flora and vegetation was assessed by a spring survey and a Fauna Assessment, including a field reconnaissance survey was undertaken.

A groundwater and surface water monitoring program was established and the Average Annual Maximum Groundwater Level (AAMGL) for the site calculated. Groundwater and surface water quality was tested. A preliminary Acid Sulphate Soils (ASS) assessment was undertaken. The site is mapped as having a high risk of ASS and this investigation is designed to inform management of any future proposed development.

The report covers the hydrological aspects of the site and provides a constraints and opportunities analysis with respect to water management and the potential for urban development. This report also deals with the requirements of the *Peel-Harvey Water Sensitive Design (WSUD) Local Planning Policy*.

2 SOILS AND GEOLOGY

The soils of the area are described by Geological Survey Western Australia (1978) as primarily Bassendean Sand which overlays the Guildford Formation on much of the Pinjarra Plain:

> *Pub - Sand very light grey at surface, yellow at depth, fine to medium grained sub-rounded quartz, moderately well sorted of eolian origin (Bassendean Sand).*

In this locality, given the proximity of the Serpentine River, Bassendean Sand is underlain by estuarine and lagoonal deposits in places (see Figure 3). The sites soils were assessed by way of soil bores (refer to Soil Bore Logs Appendix A. The bore logs confirmed the Geological Survey mapping indicated Bassendean Sand 0.25 m–2.75 m deep underlain by silty brown orange sands (at bores MW1, MW2, MW3, MW5 (See Figure 5). The soil profile of MW 4 was much the same with the addition of layer of coffee rock at 1.25–1.75m below ground level. Generally, sand was underlain by silty clay/clay across the site and a depth of 3m –4 m below ground level.

Drainage in Bassendean sands can be a problem in areas of shallow water table. This is discussed in more detail in section 3.

2.1.1 PRI and Nutrient Export

During the installation of groundwater monitoring wells samples were collected to allow assessment of the soil's phosphorous retention index (PRI). PRI quantifies the ability of a soil to bind and retain phosphate and hence the capacity for purification of nutrients. This is important in terms of nutrient export given the proximity of receiving water bodies of the Serpentine River and the Peel-Harvey Estuary. The higher the PRI value, the greater the capacity of the soil to retain phosphate and nutrients. The PRI values recorded for the site are very low which is typical of Bassendean Sand (Table 1) (source unknown).

TABLE 1: PRI Results for Soil Samples Collected During the Drilling Program

Sample ID (bore name)	PRI	Ranking
MW1	1.2	Very weak
MW2	0.0	Very weak
MW3	0.0	Very weak
MW4	1.2	Very weak
MW5	1.8	Very weak
MW6	1.1	Very weak
MW7	1.0	Very weak
MW8	1.2	Very weak

The site's natural soils have a very low capacity to retain nutrients, particularly phosphorous. This is not necessarily a problem as the proposed development would be sewered. It does mean that nutrient management will be a consideration in an Local Water Management Strategy for the site to prevent offsite water quality impacts.

2.2 TOPOGRAPHY

There is generally poor regional topographic mapping for the Peel Region; the height of the site is 4–5m AHD, and the only available topographic mapping includes 5m contours. The site is relatively flat; with a slight northeast to southwest slope (Figure 3).

3 ACID SULPHATE SOILS

3.1 GENERAL

ENV Australia Pty Ltd (ENV) was commissioned to conduct a preliminary Acid Sulphate Soils (ASS) investigation of the site. This involved testing soil samples collected during the drilling of groundwater monitoring bores at the site.

3.2 ASS INVESTIGATION

The scope of the works for the preliminary ASS investigation included:

- Desktop assessment for the potential for ASS on site;
- Collection of soil samples from bores drilled as part of a groundwater investigation;
- Field pH tests on collected soil samples on 0.25m intervals.
- Interpretation of field test results and reporting

3.3 TERMINOLOGY

Following DEC (2006), the term 'Acid Sulphate Soils' (ASS) includes both Potential Acid Sulphate Soils (PASS) and Actual Acid Sulphate Soils (AASS). The definitions for each of these are reproduced from DEC (2006) as follows:

- *Potential acid sulphate soils (PASS) are soils or sediments which contain iron sulphides and/or other sulphidic minerals that have not been oxidised by exposure to air. The field pH of these soils in their undisturbed state is more than pH 4 and is commonly neutral to alkaline (pH 7 to pH 9). These soils or sediments are invariably saturated with water in their natural state. The waterlogged layer may be peat, clay, loam, silt, or sand and is usually dark grey and soft but may also be dark brown, or medium to pale grey to white.*
- *Actual acid sulphate soils (AASS) are soils or sediments which contain iron sulphides and/or other sulphidic minerals that have previously undergone some oxidation to produce sulphuric acid. This results in existing acidity (pH <4) and often a yellow and/or red mottling (jarosite/iron oxide) in the soil profile. AASS commonly also contain residual un-oxidised iron sulphides or potential acidity as well as existing acidity.*

3.4 ASS RISK MAPPING

ASS risk mapping in relation to the site is shown in Figure 4 (taken from Western Australian Planning Commission (WAPC) Bulletin 64, (WAPC, 2004, Amended 2006). The mapping indicates that the entire site has a "high to moderate risk of ASS occurring within 3m of the natural soil surface."

The ASS risk mapping was largely a desktop exercise based on reinterpretation of existing geological, topographic and other data sets. The produced maps are generally accepted as being indicative only, with incomplete "ground truthing" of the mapping. However, where high ASS risk is indicated, this flags the likely requirement for further detailed ASS investigations and possibly the preparation of an ASS management plan in the future.

DEC (2006) notes that sites in high ASS risk areas should be investigated for acid sulphate soils if any of the following works are proposed:

- soil or sediment disturbance greater than 100m^3 in the ASS high risk areas (e.g. construction of roads, foundations, drainage works, land forming works, dams and aquaculture ponds or sand or gravel extraction); or

- lowering of the watertable, whether temporary or permanent (e.g. for groundwater abstraction, dewatering, installation of new drainage, modification to existing drainage) in areas depicted in the ASS risk map as "high risk of AASS or PASS occurrence."

The investigation referred to in the points above typically would involve drilling, sampling and laboratory analysis of soil samples at a rate and density determined by DEC ASS guidelines and the extent of the proposed development works. As has been noted, such investigation is beyond the limited scope of that reported herein.

3.5 FIELD OBSERVATIONS

Geological logs of the groundwater bores are included in Appendix A and the geology is discussed in Section 2.

3.6 ASS RESULTS

3.6.1 ASS Field Testing

As described in DEC (2006), ASS field testing provides indicative field data on ASS, which is intended to guide the selection of samples for more definitive laboratory analysis. Field testing results also assist in the logging and

interpretation of the soil profile. Field testing was carried out by ALS Laboratory (Malaga, Perth) with analytical certificates included as Appendix B.

Table 2 summarises the results of field testing and includes descriptive statistics. A total of 129 soil samples were collected from the eight groundwater bores drilled on site (MW 1 to MW 8). All soil samples were pH-tested following mixing with deionised water (pH_F) and hydrogen peroxide (pH_{FOX}) and this was carried out by ALS Laboratory (Malaga, Perth) except for bores MW5 and MW8 which were tested by ENV.

The results of field testing are summarised in Table 2 which indicates that there is no AASS (ie pH_F <4) at the site, and with pH_F results overall ranging between pH_F 5 and 6.

TABLE 2: Interpretative Summary of ASS Field Test Results

pHF	%	Interpretation	pHFOX	%	Interpretation
<4	0	Actual ASS (AASS) present	<3	14	PASS present
4 - 4.9	1	Acidic soil, possible AASS	3 - 4.9	74	Possible PASS
5 - 5.9	45	Acidic soil, unlikely AASS	>5	12	PASS unlikely
>6	54	Unlikely AASS			

The pH_{FOX} values indicate 14% in the pH_{FOX} <3 category which nominally indicates the presence of PASS according to DEC ASS guidelines (DEC, 2006). The pH_{FOX} <3 zones are typically associated with poorly sorted, coarse-grained, gravelly quartz sand and gravel and sometimes includes orange-brown iron oxide material. These zones are located at between 1.0m and 1.5m below the watertable, however as indicated in Table 2, it is possible that PASS may be present between these deeper zones and the watertable. PASS is typically located at or below the watertable.

The strength of reaction with hydrogen peroxide indicated strong or extreme reactions associated with some but not all of the low pH_{FOX} zones. This further suggests the likely presence of ASS.

3.7 SUMMARY

ASS Field testing and geological logging supports there being PASS beneath the site, which is mapped as high ASS risk. It is likely that laboratory analysis would confirm PASS at concentrations above the DEC guideline criteria, however it is not possible to indicate the level of these concentrations, or the extent of PASS within the soil profile.

PASS is controlled by the watertable which is recorded at between 1.6 m and 4.45 m below ground level across the site. Future development plans, including the depth of excavation and any dewatering for sewer installation, would determine whether further investigation is required. The presence of PASS does not pose a major constraint and is considered manageable within the development process.

4 HYDROLOGY

4.1 BACKGROUND

This report provides the outcomes of the preliminary hydrological investigation for the site with respect to the potential opportunities and constraints in complying with the Shire of Murray's Water Sensitive Urban Design principles and strategies outlined in the draft Local Planning Policy No 50.

4.2 HYDROGEOLOGY

As described above, the superficial formation consists of Bassendean sand at the surface overlying a course beach sand deposit underlain by a confining clay sequence at 3–4m below ground level. Groundwater appears to perch on the impermeable clay layer and flow within the sandy sequence.

Hydraulic conductivity refers to the ease at which water can flow through a water bearing formation or soil profile; the higher the hydraulic conductivity the greater the capacity for water to flow through the profile. Bassendean sand has an approximate hydraulic conductivity of 16.5 m/day – 50 m/day (Davidson, 1995); this considered a high hydraulic conductivity.

Because the site is close to the Serpentine River and the Peel-Harvey estuary, groundwater level within the site could fluctuate due to the influence of tidal fluctuation. For example, as the water level within the estuary and river fluctuates it causes groundwater level nearby to fluctuate. The extent of tidal fluctuation of groundwater within the site is not known; further monitoring will be required to determine if such a tidal effect occurs.

4.3 GROUNDWATER

A series of 8 monitoring wells were installed across the site to characterise the Average Annual Maximum Groundwater Level (AAMGL), groundwater flow direction and groundwater quality (Figure 5). The monitoring wells will serve as long term monitoring points to establish pre-development baseline groundwater quality for the site. Groundwater contours have been compiled based on the AAMGL calculation. Groundwater flow direction is generally in a south westerly direction towards the Peel-Harvey estuary.

4.3.1 Average Annual Maximum Groundwater Level

AAMGL is a technique used to estimate the maximum groundwater level to determine whether an area is constrained by shallow groundwater. Long term monitoring data, from the Department of Water (DoW) monitoring wells, is used to calibrate recorded water level within a site. The AAMGL calculations are

presented in Appendix C. Groundwater was sampled at the site on the 3rd of October 2007, this sample date coincides with the approximate annual peak groundwater level. Depth to maximum groundwater from the natural ground surface varied across the site from 0.78m to 2.57m (Figure 5). Depth to groundwater was greatest in the north east of the site (MW1) and the shallowest in the west near the mapped wetland (MW5).

It should be noted that this is a preliminary AAMGL calculation; further water level monitoring will provide more accurate information on annual groundwater fluctuation and potential tidal influence.

4.4 SURFACE WATER

The site is dominated by sandy soils and has a low topographic gradient; infiltration of rainfall would be possible across the site. There are no surface water streams or surface flows. The only surface water feature is a wetland located on the western edge of the site along Riverside Drive (Figure 6). The wetland is largely classified as Multiple Use Wetland with a small portion classified as Conservation Category Wetland by the Department of Environmental and Conservation (DEC). Wetlands are discussed further in Section 5.

4.4.1 Proximity to Serpentine River and Floodplain Mapping

The major surface water feature in close proximity to the site is the Serpentine River, located approximately 350 m to the west, which discharges directly into the Peel-Harvey estuary.

Floodplain mapping has been carried out for the Serpentine River. Figure 7 shows the extent of the floodway and the flood fringe that comprises the 1 in 100 year floodplain. The extent of the floodplain can constrain the developable area due to the risk of inundation during a major flood event. As shown in Figure 7, the extent of the 1 in 100 year flood plain only includes the area mapped as wetland in the western edge of the site. The hydraulic connection between the wetland and the Serpentine River has possibly been altered due to works (fill) observed on the lot to the west of Riverside Drive. The true floodplain extent in reality is likely to be different than that indicated by the mapping.

The Shire of Murray requires that the finished floor level of any new building be 0.5 m above the 1 in 100 year floodplain level to prevent inundation during major storm events. Floodplain mapping for site shows the majority of the site is outside the 1 in 100 year floodplain boundary (Figure 7). The only area within the floodplain is the wetland in the west. Areas within the floodplain can be filled to achieve a 0.5 m clearance to the 1 in 100 year level for the siting of building

envelopes. The floodplain extent will not effect the development of the rest of the site.

4.5 GROUNDWATER

4.5.1 Average Annual Maximum Groundwater level

A minimum of 1.2 m from the base of building foundations to the highest known groundwater is required by local government authorities, the majority of the site currently meets this requirement. The preliminary AAMGL indicates that the site has sufficient clearance to the water table (>1.2m) except for MW 2 and MW 5 on the north-western side of the site (Figure 5) (Appendix C), this will be verified with further monitoring. Based on the preliminary AAMGL, shallow groundwater should not constrain development for the majority of the site.

Development is still possible in areas where the clearance to the water table is less than 1.2 m, using fill to increase the ground surface level, sub-surface drainage and controlled groundwater levels. The area in close proximity to the wetland boundary in the west has shallow groundwater and fill may be required for siting building envelopes in this area.

4.6 WATER QUALITY

Groundwater was sampled at the site on the 3rd of October 2007, this sample date coincides with the approximate annual peak groundwater level. Groundwater will continue to be monitored over a 12 month period to capture annual fluctuation in water quality and water level. The outcome from the initial groundwater sampling event is presented below.

A suite of water quality parameters including pH, Electrical Conductivity and Nutrients were tested for and compared with regional water quality guideline targets.

4.6.1 Groundwater pH

Groundwater pH values ranged from 5.12 (MW5) to 6.24 (MW1), the natural pH is slightly acidic being just below the freshwater guideline range of 6.5 to 8.5 (Department of Environment, 2005).

4.6.2 Groundwater Electrical Conductivity

Electrical Conductivity (EC) is a measure of salinity of a water sample, the higher the EC the higher the salinity. The EC was variable across the site ranging from 0.24mS (MW7) to 14.66mS (MW8). Freshwater is considered to be <0.83mS, MW1, MW2, MW4 and MW7 all had salinities less than 0.83mS. MW3 and MW5

had marginal salinities. MW6 showed brackish water quality and MW8 had saline water quality (see Table 3). The salinity gradient on the south western area of the site shows the influence of the estuary to the south-west of the site. In general, the groundwater salinity within the site ranges from fresh to marginal.

4.6.3 Nutrients

Preliminary groundwater nutrient quality results are presented in Table 3. A surface water sample (SW) was also collected from the wetland located on the western edge of the site (Figure 5. The results are compared with Swan-Canning Cleanup nutrient targets as an indication of compliance with regional water quality objectives.

TABLE 3: Water Quality Data for the Groundwater and Surface Water On-Site

Sample ID	pH	EC mS	NOX mg/L	NH3-N mg/L	TKN mg/L	Total N mg/L	PO4 mg/L	Total P mg/L
SCCP Long Term Target[1]						**1**		**0.1**
SCCP Short Term Target[2]						**2**		**0.2**
ANZECC Drinking Water[3]			**11.4/22.7***					
MW1	6.24	0.61	0.20	0.232	0.80	**1.00**	<0.010	<0.01
MW2	5.27	0.57	1.34	<0.010	0.40	**1.70**	<0.010	0.01
MW3	6.33	1.53	**24.0**	0.023	2.10	**26.1**	0.42	**0.44**
MW4	5.92	0.64	0.084	0.095	1.60	**1.70**	0.012	0.02
MW5	5.12	1.22	0.165	0.132	6.00	**6.10**	0.056	0.07
MW6	5.7	5.46	0.066	0.512	1.50	**1.60**	<0.010	0.01
MW7	6.08	0.24	0.096	0.289	1.20	**1.30**	0.016	0.03
MW8	6.11	14.66	0.064	0.18	4.10	**4.20**	<0.010	0.03
SW	7.31	1.73	<0.010	0.351	3.60	**3.60**	0.996	**0.98**

[1]*Swan-Canning Cleanup Program long term target 20 years*

[2]*Swan-Canning Cleanup Program short term target 5 years*

[3]*Australian Drinking Water Guidelines ANZECC (2004) 11.4mg/L for bottle fed infants and 22.7mg/L for adults*.

4.6.4 Nitrogen

Total nitrogen values exceed long-term Swan-Canning Cleanup Program (SCCP) guideline values for all groundwater monitoring wells and short-term target values for MW3, MW5, MW8 and SW. The total nitrogen is broken down into the different nitrogen species including NOx (both nitrate and nitrite which have public health concerns), ammoniacal nitrogen (NH3-N) and Kjeldahl nitrogen (TKN). TKN is a measure of the nitrogen bound up in organic compounds like proteins and biological compounds. TKN makes up the majority of the total nitrogen for all monitoring points apart from MW3, where NOx is the dominant

nitrogen source. The NOx concentration recorded in MW3 exceeds Australian Drinking Water Guideline values.

4.6.5 Phosphorous

Phosphorous is a key nutrient in the Peel-Harvey catchment area with excessive phosphorus loadings being responsible for the eutrophication within the estuary. The total phosphorous values are below SCCP guideline values except for MW3 and SW. The phosphate values are also low for all monitoring wells except MW3 and SW. The initial phosphorous data shows the site is generally well within any catchment targets except for MW3.

The influence of the chicken farm in the north of the property on nutrient loading is evident in MW3 particularly in terms of NOx (nitrate and nitrite) which have public health implications for use of groundwater; the other monitoring wells generally show typical water quality for the region for nutrients. It is noted that the chicken farm is scaling back operations and the source of this contamination will be removed.

4.6.6 Water Quality Discussion

The quality of groundwater for the majority of the site is typical of regional groundwater quality. Continued monitoring over the next 12 months will form baseline groundwater quality for the site.

Table 3 shows the Australian Drinking Water Guideline values (ANZECC, 2000) for nitrate were exceeded for MW3. This is a public health concern and maybe considered “potentially contaminated”, even though the risk of exposure is low in this case (i.e. groundwater is not used for drinking water). As stipulated in Section 11 of the Contaminated Sites Act 2003, the DEC requires notification of any potential or actual contaminated sites. This is the responsibility of the land owner and is required within 21 days from the notification of the existence of contamination. Initial monitoring shows the contamination to be limited to MW3, the other monitoring points are below drinking water guideline values. The actual extent of the contaminated groundwater would require delineation through the installation of additional monitoring wells.

4.7 THE URBAN WATER MANAGEMENT PLANNING PROCESS

The Department of Water (DoW) currently has no regional drainage plans for the Furnissdale area, so detailed assessment of where drainage water will discharge from any proposed subdivision area cannot be made at this point. Advice from the DoW is for development of the site to comply with broader stormwater management principles, as previously discussed. Further analysis can be made

once subdivision and engineering designs as well as regional drainage plans have been formulated.

The Shire of Murray and (DoW) are currently in the process of changing their requirements for water management in relation to land use changes in the Peel-Harvey area through the adoption of the *Peel Harvey Water Sensitive Urban Design (WSUD) Local Planning Policy* (LPP). The LPP requires that water management issues are addressed at the Town Planning Scheme (TPS) Amendment stage, as well as at Subdivision Stage. A Local Water Management Strategy (LWMS) based on 18 to 24 months monitoring will be required to accompany a TPS amendment. An Urban Water Management Plan (UWMP) is required to accompany a subdivision application.

A LWMS will need to address the requirements for drainage, water quality management including groundwater and surface water acidity, management and/or remediation of acid sulphate soil issues, groundwater management and potable water conservation in detail. Areas within Public Open Space (POS) and road reserve required for stormwater quantity and quality management must be identified and reserved for this purpose. The interaction of the site with the hydrology of the adjacent Conservation Category wetland will also need to be assessed.

4.8 OPPORTUNITIES AND CONSTRAINTS

One of the key strategies for the draft WSUD LPP is to maintain predevelopment nutrient export or to reduce nutrient export for the site, if predevelopment nutrient export exceeds regional criteria as is the case at several locations within this site. Nutrients can be exported through surface run-off in drainage infrastructure or through contamination of groundwater that subsequently discharges downstream. The low PRI values for the soils on site, indicates that nutrients are not retained within the soil profile and readily discharge into groundwater and surface water environments. However, low PRI soils are wide spread across the Swan Coastal Plain (SCP) and can be managed to improve nutrient retention.

Soil amendment can be used to improve the PRI and hence the nutrient retention capacity of the soil, thus reducing the risk of contamination of groundwater or surface water environments. Soil amendment materials include sands high in iron like yellow Spearwood sands or lime rich sand like Karrakatta soils. Soil amendment can be blended with the existing soil profile or added as a layer on the natural soil profile. To maximise efficacy of soil amendment, it should be used in areas where infiltration volumes and nutrient concentration will be greatest, such as beneath grassed areas and drainage swales to treat stormwater before it moves offsite.

Other management options to reduce nutrient export within the site; include, community education programs that promote low nutrient and waterwise gardens.

4.9 CONCLUSIONS AND RECOMMENDATIONS

ENV believes that the site's soils and hydrology is such that development is feasible in compliance with the Shire of Murray WSUD LPP requirements. A Local Water Management Strategy will be required to address the constraints listed above and other sustainable water management objectives required for the statutory planning approvals process.

4.9.1 Confirmation of Tidal Fluctuation

The extent and magnitude of tidal fluctuation on groundwater is required to be determined as this will affect the AAMGL for the site. An accurate AAMGL is required for drainage design for the site and determining whether fill is required to provide the separation distance between max groundwater and floor levels.

To determine tidal fluctuation at the site, ENV recommends the use of groundwater level loggers to automatically monitor groundwater level on a frequent basis. Water level loggers record groundwater level automatically at frequent intervals (i.e. every 15 minutes), which provides comprehensive data that will show tidal fluctuation.

4.9.2 Contaminated Groundwater

ENV recommends that the potentially contaminated groundwater identified in the north of the site be formally reported to the DEC, as required under the *Contaminated Sites Act 2003*. Reporting of the site involves lodging a Form 1 "Report of a known or suspected contaminated site". This form can be submitted by the land owner or another party such as an environmental consultant can fill out and submit the Form 1 on behalf of the land owner. The DEC will subsequently require the site to be investigated to characterise the extent, nature and risk of exposure of the groundwater plume to classify it appropriately. This would be carried out through a Preliminary Site Investigation (PSI) and then a Detailed Site Investigation (DSI) in accordance with DEC guidelines.

5 WETLANDS

The Geomorphic Wetlands Swan Coastal Plain Database maps wetlands and classifies them as to geomorphic type and period of inundation (e.g. lake, sumpland, dampland, palusplain) and provides a management category with related objectives. There are three wetland management categories, Conservation Category (CCWs), Resource Enhancement (REWs) and Multiple Use (MUWs). The category and management objectives are explained in Table 4 below.

TABLE 4: Wetland Management Categories

Management Category	General Description	Management Objectives
Conservation	Wetlands which support a high level of ecological attributes and functions.	Highest priority wetlands. Objective is to preserve and enhance the existing conservation values of the wetlands, through various mechanisms including: reservation in national parks, crown reserves and State owned land, protection under Environmental Protection Policies, and wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate. The EPA urges that all CCWs and their buffers are fully protected
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. The ultimate objective is to manage restore and protect towards improving their conservation value. These wetlands have the potential to be restored to conservation category. This can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms. The EPA urges that all reasonable measures are taken to minimise the potential impacts on REWs and their buffers.

Management Category	General Description	Management Objectives
Multiple Use	Wetlands with few remaining important attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare. The EPA urges that all reasonable measures are taken to retain the wetland's hydrological functions (including on-site water infiltration and flood detention) and where possible, other wetland functions.

(After: EPA 2005)

A standard minimum buffer of 50m from the edge of wetland dependant vegetation is typically allocated to CCWs. The policy context is that the buffer be determined on a case-by-case basis.

The DEC position on buffers is that they should be maintained as is and/or rehabilitated to native vegetation and that no development (e.g. drainage basins, lawn area, active recreation space) occurring within the buffer.

Wetlands are often retained within Public Open Space and there are no purchase or compensation mechanisms associated with being unable to develop due to the presence of a wetland.

Two wetlands are mapped on the western boundary of the site along Riverside Drive extending to the Serpentine River These are identified as UFI 3548 and UFI 3549 Multiple Use Floodplain and UFI 3650 Conservation Category Floodplain by the DEC 2007. The wetland mapping currently overlaps Lots 183, 184 185 and Lot 1186 (see Figure 7). The wetland shape approximates the Flood Fringe of the Serpentine River (see Figure 7).

The wetland on lots 184, 185 and Lot 1186 is Multiple Use Category floodplain and on Lots 183 and 184 is Conservation Category. The Conservation Category portion is largely degraded and cleared of vegetation on Lot 184. The current Conservation management category wetland poses a constraint to the potential development of this area of the site and may attract a minimum 50 m buffer from development.

In order to remove/reduce the constraint of the wetland mapping and related buffers, a formal request would be need would need to be made to the DEC for modification to the geomorphic wetland dataset for the conservation category area prior to development. The multiple use categorisation of the rest of the wetland on the site is not considered to pose a constraint to development.

5.1 RECOMMENDATIONS

A formal request be made to revaluate the area of Conservation Category Wetland UFI 3650 to the less restrictive Multiple Use category.

6 FLORA AND VEGETATION

6.1 INTRODUCTION

The site is located in Southwest province and the Darling Botanical District. This region typically consists of forest country with related woodlands, in the southwest part of the province. It is divided into four subregions or botanical subdistricts.

The site is located within the Swan Coastal Plain Subregion and the Drummond Botanical Subdistrict, which consists mainly of the following vegetation communities:

- *Banksia* low woodlands;
- *Melaleuca*;
- Tuart (*Eucalyptus gomphocephala)*; and
- Jarrah (*Eucalyptus marginata)* (Beard 1990).

The climate of this region is warm Mediterranean with winter precipitation of 600-1000 mm and five to six dry months per year (Beard 1990).

6.1.1 Regional Representation

A vegetation complex is a combination of distinct site vegetation types, usually associated with a particular geomorphic, climactic, floristic and vegetation structural association. Vegetation complexes are based on the pattern of vegetation at a regional scale as it reflects the underlying key determining factors of landforms, forest climate and soils.

The Environmental Protection Authority (EPA) recognises vegetation complexes that are poorly reserved as being significant. Proposals that would impact upon a vegetation complex with 10% or less remaining are likely to be formally assessed by the EPA and are therefore considered to be important.

The site supports vegetation that belongs to the Vasse Complex, of which there is 29.4% remaining (EPA 2006).

6.1.2 Declared Rare, Priority and Significant Flora

Flora species acquire Declared Rare or Priority conservation status where populations are geographically restricted or threatened by local processes. The DEC (previously CALM) enforces regulations under the *Wildlife Conservation Act*

1950 (WC Act) to conserve Declared Rare Flora and protect significant populations.

Declared Rare Flora species are gazetted under subsection 2 of section 23F of the WC Act and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the WC Act defines "to take" as to: 'gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means'.

Priority Flora are under consideration for declaration as 'rare flora', but are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four) (see Appendix D for definitions).

Flora is also classified according to its conservation status at a federal level, under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). These categories of classification are summarised in Appendix D.

6.1.3 Threatened Ecological Communities

An ecological community is a naturally occurring biological assemblage that occurs in a particular type of habitat. A vegetation community is considered a Threatened Ecological Community ("TEC") if it is classified in one of the following categories:

- Presumed Totally Destroyed;
- Critically Endangered;
- Endangered; or
- Vulnerable.

The definitions of these categories are described in Appendix E.

Coordination of threatened species and ecological community conservation is carried out by DEC's Nature Conservation Division, primarily through the Species and Communities Branch.

6.1.4 Listing of Threatened Flora and Vegetation

The WC Act provides for taxa of plants and animals to be listed as 'threatened'. Threatened flora and vegetation lists are reviewed and changes recommended by DEC's Threatened Species Scientific Committee. Ministerial approval is necessary before changes are given legal status in a notice in the Government Gazette.

There is currently no equivalent legislation or formal policy for the protection of TECs. However, an informal non-statutory process, including advice from a scientific advisory committee, the establishment of a TEC database, and steps for assigning ecological communities to categories of threat, is now in place.

The DEC has been identifying and informally listing TECs for 13 years. As of May 2003, 106 ecological communities had been entered into the Department's TEC Database. Of these, 21 had been endorsed by the Minister for the Environment as Critically Endangered, 17 as Endangered, 28 as Vulnerable and three as presumed totally destroyed. The remainder were either awaiting endorsement as threatened or are allocated to one of five priority lists. Sixteen of these TECs are now listed under the Commonwealth EPBC Act.

6.1.5 Introduced Species

The Environmental Weed Strategy for Western Australia (CALM, 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity. These criteria are contained within Appendix F.

Plants may also be “declared” by the Agriculture Protection Board under the Agriculture and Related Resources Protection Act 1979 (ARRP Act). Declared Plants are gazetted under 5 categories (P1-P5) which define the action required. Details on the standard meaning of these are provided in Appendix G. The category may apply to the whole State, districts, individual properties, or even paddocks. If a plant is Declared, all landholders are obliged to control that plant on their properties in accordance with the declaration (Department of Agriculture and Food, 2007).

6.2 SCOPE OF WORK

Work focussed on determining vegetation communities present, locating Declared Rare and Priority flora and Threatened Ecological Communities, as well as conducting a condition assessment of the existing vegetation. Specifically, work completed included:

- a database search for Rare and Endangered species and Threatened Ecological Communities (TEC’s) that may occur in the area, by reference to DEC and Department of Environment, Water, Heritage and the Arts databases;
- a flora and vegetation field survey;
- a search for Declared Rare and Priority Flora;
- identification of any Threatened Ecological Communities (TEC’s);

- the review of data collected against criteria established in state and federal processes for species conservation;
- the production of an aerial photograph with vegetation mapping overlaid; and

6.3 METHODS

The methodology for the flora and vegetation survey work involved the following steps:

PHASE 1

On 27 August 2007 a database search was submitted to the DEC to obtain a list of Declared Rare and Priority Flora species that occur within the site and the surrounding area. The search was within co-ordinates from 380968 mE, 6399508 mN to 387890 mE to 6394408 mN (GDA94, zone 50).

PHASE 2

On 26 September 2007 an ENV botanist visited the site and conducted a vegetation survey by traversing the property on foot. The sampling intensity was selected in consideration of the landforms, habitat, vegetation structure, diversity and seasonality, therefore data was collected from *relévés*[1] within the survey area and 10 x 10m quadrats were assessed in remnant native vegetation units where appropriate also. Geographic coordinates were also noted for changes in vegetation type[2].

At each site species present were recorded, average height and percent foliage cover noted, the vegetation unit was described, a condition statement made and a photograph was taken. During the field survey, potential Declared Rare and Priority Flora populations were described and their geographic coordinates noted.

PHASE 3

Where field identification of plant taxa was not possible, specimens were collected in a systematic manner so that they could be later identified at the West Australian Herbarium by comparison with the reference collection and use of identification keys.

[1] For the purposes of this flora and vegetation assessment, a *relévé* is defined as an unconfined survey area in which a general statement about the floristic composition of the location can be made.

[2] For the purposes of this flora and vegetation assessment, vegetation units are described on a fine scale (intra-locality)

Vegetation unit descriptions were then tabulated and these communities were mapped. The vegetation descriptions for all communities across the site were then referenced against Gibson *et. al.* (1994) to determine the potential for the site to support TECs. Floristic communities were inferred from those available in Gibson *et. al.* (1994) on the basis of species composition, soils, topography and where known, hydrology.

6.3.1 Flora Survey Limitations and Constraints

It is important to note the specific constraints imposed upon individual surveys. Constraints are often difficult to predict, as is the extent to which they will ultimately influence survey effort. Survey constraints of the flora and vegetation survey are detailed in Table 5.

TABLE 5: Limitations and Constraints Associated with the Flora and Vegetation Survey

Variable	Impact on Survey Outcomes
Access Problems	No access problems were encountered
Experience levels	The botanists that executed the survey included practitioners that are regarded as suitably qualified in their respective fields. • Coordinating Botanist: Olivia Davies (Senior Environmental Botanist); • Field Staff: Olivia Davies • Taxonomy: Bev Koch (Independent Botanical Taxonomist), and; • Data Interpretation: Olivia Davies and Natalie Pawley (Environmental Scientist/ Botanist).
Timing, weather, season.	The survey was undertaken during spring (26 September 2007). The area had received 630.8mm of rainfall this year to date (January 2007 to September 2007 inclusive) (Bureau of Meteorology 2007). Flora composition changes over time with flora species having specific growing periods, especially annuals and ephemerals (some plants lasting for a markedly brief time, some only a day or two). For this reason the results of future botanical surveys undertaken in this location have the potential to differ from the results of this survey.
Sources of information	The area of each vegetation unit to be impacted upon by any proposals associated with this survey area has not been presented as a percentage of local and regional vegetation owing to the lack of information available about the total area of different types of vegetation, variation in vegetation mapping at different scales and the

Variable	Impact on Survey Outcomes
	tentative nature of proposals when these surveys are commissioned.
Completeness	Species that were insufficiently mature or dead were not collected. In these cases such taxa were identified in the field to Genus or Family level only if possible. A comprehensive species list has not been prepared for areas that do not constitute a natural vegetation area, such as gardens or areas that have been totally cleared. Flora composition changes over time with flora species having specific growing periods, especially annuals and ephemerals (some plants lasting for a markedly brief time, some only a day or two). For this reason the results of future botanical surveys undertaken in this location have the potential to differ from the results of this survey.
Determination	This survey makes inferences about vegetation types that have the potential to be TECs, however, a definitive decision as to the presence or absence of TECs at the site remains the responsibility of the DEC's Species and Communities Branch. The taxonomy and conservation status of the Western Australian flora are dynamic and though current at the time this report was prepared, may not be correct in the future.

6.3.2 Permits

Specimens collected during the survey were taken by permit of and subject to the conditions of the following licences issued under section 23C and section 23F of the *Wildlife Conservation Act 1950*:

- SL007811 Ms Olivia Davies.

6.4 RESULTS

6.4.1 Database Search

A database search of the area resulted in 15 Declared Rare and Priority (four Declared Rare and 11 Priority) Flora species being identified as potentially occurring in the area (Appendix H).

A database search resulted in no known occurrences of Threatened Ecological Communities within the survey area.

6.4.2 Field Survey

6.4.3 Flora

A total of 46 families, 97 genera and 144 taxa were recorded within the survey area (113 native flora taxa and 31 introduced). Refer to Appendix I for the flora species list.

The dominant plant families recorded from the survey were as follows:

- Myrtaceae 13 species;
- Asteraceae 6 species; and
- Stylidiaceae 6 species.

6.4.4 Declared Rare, Threatened and Priority Flora

No plant taxa gazetted as Declared Rare pursuant to subsection 2 of section 23F of the WC Act (Atkins 2006) were located within the survey area.

No Endangered or Vulnerable species, pursuant to section 178 of the EPBC Act were located during the survey, or Priority Flora species were located within the survey area either.

6.4.5 Significant Flora

Taxa recorded during the time of survey are within known population ranges

6.4.6 Vegetation

The site consisted of seven vegetation associations (Figure 8). These were:

- **BaEm -** Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia, Hibbertia hypericoides* and *Phlebocarya cilliata* (see Appendix J photograph 1 - 3);
- **BaEmR -** regenerating Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata.* This vegetation unit has been disturbed, however, is assumed to have historically represented BaEm as described above (see Appendix J photograph 6);
- **ErMcMv –** Woodland of *Eucalyptus rudis*, *Melaleuca cuticularis* and *M. viminea* over open water (see Appendix J photographs 7 – 9);
- **E.spAf –** Very Open Woodland of **Eucalyptus* sp. (planted) and *Agonis flexuosa* over weeds

- **RGR –** residential garden, with regenerating native taxa (see Appendix J photographs 10 - 15);
- **Cc –** *Corymbia calophylla* over pasture (see Appendix J photographs 16 and 17); and
- **CP –** cleared paddock/ Plantation (see Appendix J photograph 18).

TABLE 6: Floristic Communities

Vegetation unit	Quadrat	Total Area (ha)	Inferred Floristic Community	Species in common	Condition
Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia, Hibbertia hypericoides* and *Phlebocarya cilliata* (BaEm and BaEmR)	1 - 3	approx 10.2ha	SCP21a Central *Banksia attenuata – Eucalyptus marginata* woodlands	55	Very Good - Good
Woodland of *Eucalyptus rudis*, *Melaleuca cuticularis* and *M. viminea* over open water (ErMcMv)	n/a	approx 0.5ha	SCP07 herb rich shrublands in saline clay pans	15	Good

For further discussion and interpretation of the site floristics, please refer to Section 5.5.

6.4.7 Vegetation Condition

Vegetation within the site is categorised as ranging from being in Very Good condition to Completely Degraded condition (Figure 9). Refer to Appendix K for Bush Forever condition scales.

- **BaEm -** is categorised a ranging from Very Good to Good condition. Generally, this vegetation unit is intact, with minimal signs of disturbance. Some areas, however small and fragmented, and are adjacent to grassed lawn contributing to weed invasion (see Appendix J photograph 3 - 5);
- **BaEmR -** this vegetation unit is in degraded condition, as vegetation clearing (overstorey) has occurred. Signs of rehabilitation are evident, and some overstorey had been replanted, forming "*Banksia* plantation";
- **ErMcMv –** is categorised a being in Good condition. This remnant has historically been open to grazing, therefore a lower than expected number of understorey species were recorded;

- **E.spAf –** this vegetation unit is considered to be Degraded. Very few flora taxa were noted in the mid and understorey, and the dominant trees present were introduced species;
- **RGR –** ranges from Degraded to Completely Degraded. This unit no longer represents remnant native vegetation;
- **Cc –** is considered to be Completely Degraded. Very few other native flora taxa were recorded, other than isolated stands of *Corymbia calophylla*; and
- **CP –** is Completely Degraded. No native flora taxa were present within this unit.

6.4.8 Introduced Flora

The table below contains the dominant weed species identified during the field survey with their ratings and criteria according to the Environmental Weed Strategy for Western Australia (refer to Appendix F for the criteria used for ranking).

TABLE 7: Dominant Weed Species Identified

Taxon	Common Name	Criteria			
		Rating	Invasiveness	Distribution	Impacts
**Avena barbata*	Perennial veldt grass	High	√	√	√
**Avena fatua*	African love grass	High	√	√	√
**Brassica tournefortii*	Mediterranian Turnip	High	√	√	√
**Bromus diandrus*	Great Brome	High	√	√	√
**Ehrharta calycina*	Veldt Grass or Perennial Veldt Grass	High	√	√	√
**Euphorbia terracina*	Geldton Carnation Weed	High	√	√	√
**Lagurus ovatus*	Hares Tail Grass	High	√	√	√
**Lupinus cosentinii*	Sandplain Lupin	High	√	√	√
**Morraea flaccida*	One-leaf Cape Tulip	High	√	√	√
**Pinus pinaster*	Great brome	High	√	√	√
**Romulea rosea*	Guildford Grass	High	√	√	√
**Anagallis arvensis*	-	Moderate	√	√	-

Taxon	Common Name	Criteria			
		Rating	Invasiveness	Distribution	Impacts
**Arctotheca calendula*	Cape Weed	Moderate	√	√	-
**Briza minor*	Shivery Grass	Moderate	√	√	-
**Briza maxima*	Blowfly Grass	Moderate	√	√	-
**Ehrharta longiflora*	Annual Veldt grass	Moderate	√	√	-
**Hordeum leporinum*	Barley Grass	Moderate	√	√	-
**Hypochaeris glabra*	Smooth Cat's Ear Flat Weed	Moderate	√	√	-
**Lolium rigidum*	Annual Rye Grass	Moderate	√	√	-
**Orobanche minor*	Lesser Broomrape	Moderate	√	√	-
**Pennisetum clandestinum*	Kikuyu	Moderate	√	√	-
**Ursinia anthemoides*	Ursinia	Moderate	√	√	-
**Acacia dealbata*	Silver Wattle	Mild	-	-	√
**Oxalis pes-caprae*	Soursob	Mild	-	√	-
**Petrorhagia dubia*	-	Mild	√	-	-
**Oxalis purpuraea*	Four O'clock	Low	-	-	-
**Schinus terebinthifolius*	-	TBA	-	-	-
**Disa bractea*	n/a	n/a	-	-	-

There was one Declared Plant species found within the study area. This was:

- **Moraea flaccida* (P1[3] for the whole of the state).

6.5 DISCUSSION

A total of 46 families, 97 genera and 144 taxa (113 native flora taxa and 31 introduced) were identified during the survey. Quadrats surveyed during this spring 2007 assessment returned 54 species (Q1) and 47 species (Q2). By comparing this level of diversity against vegetation units from this area, as surveyed by Gibson *et al* (1994) it became apparent that the site contained a

[3] Category P1 prohibits movement. The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder. Please refer to Appendix G for the standard meanings of Declared Plant categories.

typical level of species richness, based on an average of 52.0 taxa for the Floristic Community Type SCP21a, which best represents quadrats 1 and 2 (vegetation unit BaEm).

No Declared Rare or Priority Flora species were found within the survey area and based on the results of this search, ENV concludes that the potential for this site to support populations of any additional DRF or Priority species is unlikely. This is because a thorough search was conducted at the appropriate time of year and no individuals were located.

The site contains a high number of weed species (31 taxa). This is a result of land clearing for agriculture and the site's history of livestock grazing. Condition of vegetation across the site was therefore considered to range from Very Good where remnant native vegetation has been excluded from grazing, to Completely Degraded across paddock areas.

Thirty one weed species were identified during the survey. Pursuant to Section 37 of the *Agriculture and Related Resources Protection Act 1976* (WA), the Agriculture Protection Board lists the classes of plants that are currently subject to a declaration made under Section 35 of the Act. One species located during the field survey is listed as Declared Plant species by the Agriculture Protection Board.

During the 2007 survey, seven vegetation units were described. Of these seven vegetation units, two vegetation types were considered to represent intact remnants: BaEm and ErMcMv. By comparison to Gibson *et al* (1994) BaEm was considered to best represent SCP21a Central *Banksia attenuata – Eucalyptus marginata* woodlands (55 species in common). ErMcMv was considered to best represent SCP07 - Herb rich shrublands in saline clay pans, however, this vegetation unit contained a low number of understorey taxa, owing to this wetland area being exposed to grazing. As such, only 15 species were recorded from ErMcMv in common with SCP07.

None of the above discussed FCTs are listed on the DEC, or Department of Environment, Water, Heritage and the Arts TEC databases.

The site supports vegetation that belongs to the Vasse Complex, of which there is 29.4% remaining (EPA 2006).

ENV considers that areas of remnant vegetation in Very Good condition are worthy of retention wherever possible in the development design.

6.6 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the Flora and Vegetation survey undertaken by ENV determined that:

- a total of 46 families, 97 genera and 144 taxa were recorded within the survey area (113 native flora taxa and 31 introduced);
- no Declared Rare, Threatened, Priority or otherwise significant flora taxa were located during the site survey;
- remnant native vegetation of the site ranges from Very Good to Completely Degraded Condition;
- One Declared Weed species was recorded; **Moraea flaccida* (P1[4] for the whole of the state).
- two of the seven described vegetation units were able to be correlated against Florist Community Types (Gibson *et al*, 1994). The remaining five described vegetation units represent degraded paddock areas or residential gardens;
- vegetation unit BaEm was inferred as SCP21a Central *Banksia attenuata – Eucalyptus marginata* woodlands;
- ErMcMv vegetation unit best represented SCP07 herb rich shrublands in clay pans; and
- neither of the FCTs are Threatened or Priority Ecological Communities.

Approximately two thirds of the site is cleared paddock land or degraded residential garden and does pose a constraint to development. The two vegetation units considered intact native remnants; Banksia Woodland (BaEm) and Flooded Gum Woodland (ErMcMv) are regarded as being in Very Good to Good condition, and therefore wherever possible, ENV retention of areas of these in Public Open Space within the development.

[4] Category P1 prohibits movement. The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder. Please refer to Appendix G for the standard meanings of Declared Plant categories.

7 FAUNA

7.1 BACKGROUND AND OBJECTIVES

A fauna survey is required to support a rezoning application. This survey has been undertaken in accordance with the Environmental Protection Authority's (EPA) Guidance Statement No. 56. This report will describe the fauna habitats present at the site together with fauna that may potentially occur. Furthermore, this report will provide recommendations for the management of impacts on fauna species that may occur on site prior to, during and post development.

The objectives of the fauna survey were to:

- document the general habitat types of the project area as they relate to faunal assemblages;
- compile a list of terrestrial vertebrate fauna likely to occur within the project area based on database searches;
- identify terrestrial vertebrate fauna of conservation significance that may occur within the project area based on database searches; and
- report on the likely occurrence of terrestrial vertebrate fauna, including that of conservation significance, being found in the project area based on habitats present and their condition.

7.2 BIOGEOGRAPHY

7.2.1 Biographic Regionalisation for Australia

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 85 bioregions based on major biological and geographical/geological attributes (Thackway & Cresswell 1995). These bioregions are further subdivided into 404 subregions, as part of a refinement of the IBRA framework (Department of Environment, Water, Heritage and the Arts 2007). The site is located within the Swan Coastal Plain Bioregion as per IBRA. This is defined as:

'Low lying coastal plain, mainly covered with woodlands. It is dominated by Banksia or Tuart on sandy soils, *Allocasuarina obesa* on outwash plains, and paperbark in swampy areas. In the east, the plain rises to duricrusted Mesozoic sediments dominated by Jarrah woodland. Three phases of marine sand dune development provide relief. The outwash plains, once dominated by *A. obesa*-marri woodlands and *Melaleuca* shrublands, are extensive only in the south.'

7.2.2 Fauna of Conservation Significance

Fauna species can be classified as of conservation significance on an international, commonwealth, state, or local level, in accordance with the EPA *Guidance Statement No. 56* (EPA 2004). Under each level, the conservation status of fauna is determined by a number of different Acts and Agreements. A short description of these Acts and Agreements are outlined below, with definitions of the conservation codes detailed in Appendix L.

International Level:

- International Union for the Conservation of Nature and Natural Resources (IUCN): The World Conservation Union publishes an international listing of species of conservation importance, known as the IUCN Red List (IUCN 2007). This list identifies those species most in need of conservation attention if global extinction rates are to be reduced.

- Japan-Australia Migratory Bird Agreement (JAMBA): Australia has an agreement with the Government of Japan relating to the conservation and protection of migratory birds. This agreement is known as the Japan-Australia Migratory Bird Agreement (JAMBA) and lists terrestrial, water, and shorebird species which migrate between Australia and Japan.

- China-Australia Migratory Bird Agreement (CAMBA): Australia has an agreement with the Government of the People's Republic of China, relating to the conservation and protection of migratory birds. This agreement is known as the China-Australia Migratory Bird Agreement (CAMBA) and lists terrestrial, water, and shorebird species which migrate between Australia and China.

- Bonn Convention: The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) aims to improve the status of all threatened migratory species through national action and international Agreements. The convention lists migratory species that would benefit from conservation measures undertaken by the countries that have agreed to the Convention.

Commonwealth Level:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999): The Department of Environment, Water, Heritage and the Arts (DEWHA) release a list of threatened species determined by the Threatened Species Scientific Committee according to the set of criteria stated under the Act (DEWHA 2007).

State Level:

- *Wildlife Conservation Act 1950* (WC Act 1950): The Minster for the Environment produces a notice where fauna taxa are listed as protected and are classified as Schedule 1 through to Schedule 4 according to their relative need for protection.

- Department of Environment and Conservation (DEC) Priority species: The DEC produces a list of Priority species that have not been assigned statutory protection under the WC Act 1950. Priority Fauna are under consideration as 'Scheduled' fauna, but are in urgent need of further survey or require regular monitoring, and although not currently threatened may become so in the future.

Local Level:

Species may be considered of local conservation significance due to their patterns of distribution and abundance. Although not formally recognised under legislation, many species are in decline because of threatening processes; primarily the loss and/or restriction of breeding grounds, foraging areas or resident habitat due to historical or current land use.

7.3 METHODOLOGY

7.3.1 Legislation and Guidance Statements

All surveys undertaken by ENV are performed to meet the requirements of the following State and Federal legislation:

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999).

- *Environmental Protection Act 1986* (WA) (EP Act 1986).

- *Wildlife Conservation Act 1950* (WA) (WC Act 1950).

The assessment was carried out in a manner compliant with the EPA requirements for environmental surveying and reporting in WA:

- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas. Position Statement No. 2* (EPA 2000).

- *Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3* (EPA 2002).

- *EPA Guidance for the Assessment of Environmental Factors: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia Guidance Statement No. 56* (EPA 2004).

7.3.2 EPA Guidance Statements No. 56

A baseline fauna survey for Environmental Impact Assessment should at the very least provide a comprehensive list of species within a given area. There are two formal levels of flora and fauna survey as delineated by the EPA:

- ***Level One:*** a 'desktop' study to collate historical knowledge conducted in conjunction with a reconnaissance survey (site inspection).

- ***Level Two:*** an intensive survey that incorporates a detailed and comprehensive survey to characterise the flora or fauna present combined with a Level One survey.

The methodology of the current fauna survey, a Level One survey, has been developed in consideration of the EPA *Guidance Statement No. 56.* This level of survey work is considered suitable as the fauna of the south west is previously well surveyed and documented and limited impact on fauna habitats is anticipated.

7.3.3 Assignment of Conservation Codes

A relative level of conservation importance has been assigned to the fauna within this report based on the background information detailed in Sections 6.2.1.

Conservation codes for fauna are outlined below:

- ***Conservation Importance 1 (CI 1):*** Refers to species that are listed as Threatened Fauna as per International publications, Commonwealth and State Acts. These species are those with a rating of Vulnerable, Endangered or Critically Endangered under the IUCN Red List (International Level) or under the EPBC Act 1999 (Commonwealth Level), or those with a Schedule rating under the WC Act 1950 (State Level).

- ***Conservation Importance 2 (CI 2):*** Refers to those species that are listed as Priority Fauna by the DEC and, species listed in peer reviewed publications of threatened fauna. These species are not officially protected under any legislation, however, are considered of conservation importance on a State Level.

- ***Conservation Importance 3 (CI 3):*** Species not formally identified (CI 1, CI 2 or CI 4), yet considered of conservation importance on a Local Level due to

their known patterns of distribution and abundance. This status includes regionally endemic species and species with habitats that are in decline.

- ***Conservation Importance 4 (CI 4):*** Species that are recognised on a International Level under treaties such as CAMBA and JAMBA, the Bonn Convention, and also under the EPBC Act 1999 list of marine species. Due to the high mobility of many of these species, impacts upon them are generally less direct, therefore offering a lower status of conservation importance.

- ***Conservation Importance 5 (CI 5):*** Refers to species that are identified by the IUCN as Near Threatened, Least Concern or Data Deficient. Although these species are recognised on an International Level, they are considered to be of lower conservation importance as these species may be widespread and abundant, and not specifically dependant upon habitats within the project area.

7.4 FAUNA SURVEY METHODOLOGY

7.4.1 Desktop Assessment

The purpose of a desktop survey is to gather background information on the project area and the fauna that it may support. This involves a search of literature, data, aerial photographs and maps for information pertaining to possible habitats that are likely to be found in the area.

A search of the Western Australian Museum's (WAM) FaunaBase (WAM 2003) was undertaken to generate a list of fauna species previously recorded in the area. In addition, a review of literature was conducted along with a review of historical and current records of fauna species for the project area. Information on threatened species was obtained from the Threatened Fauna Database (maintained by the DEC). Collectively, these sources are used to compile a list of potentially occurring species that could utilise the habitat/s within the project area. Habitat knowledge gained from the above initial research, and that gained during the flora field survey, was used to determine which of the potentially occurring species were likely or unlikely to occur at the site.

7.4.2 Field Survey

Habitat Assessment

The flora field survey took place on the 26th of September, 2007. The information collated during the flora field survey about landforms and vegetation associations present was used to characterise the habitats found at the site. This habitat information was used to determine which of the fauna potentially occurring at the

site were realistically likely to occur through consideration of fauna habitat requirements.

Habitats present within the site were assessed in terms of their faunal attributes, i.e. vegetation structure, microhabitats present and potential to support fauna of conservation significance. From these attributes, the fauna habitats were then ranked (high to low) according to the quality and diversity of refuge that they provide for a wider suite of fauna species.

7.5 FAUNA SURVEY CONSTRAINTS

It is important to note the specific constraints imposed upon individual surveys. Constraints are often difficult to predict, as is the extent to which they will ultimately influence survey outcomes. Survey constraints of the fauna survey are detailed in Table 9.

TABLE 9: Constraints Associated with the Fauna Survey

Variable	Impact on Survey Outcomes
Access problems	No access problems to the site were encountered.
Experience levels	The biologists that executed this survey included practitioners that are regarded as suitably qualified in their respective field. • Dr Ayesha Whitehead– Zoologist/biologist • Ms. Olivia Davies- Senor Botanist
Timing, weather, season.	The ENV flora field survey that was used to compile information for the Level One fauna survey was undertaken on the 26th of September 2007. In the three months preceding the survey the Mandurah area had received 360mm of rainfall (Bureau of Meteorology 2007).
Scope: sampling methods/ Intensity	The survey carried out was a Level One survey, comprising a desktop survey and a habitat assessment derived from information collected during the ENV flora survey that was conducted at the site. Opportunistic records are not included.
Sources of information	At the bioregion level the south-west region has been relatively well studied.
Completeness	The flora field survey was completed adequately, with all areas accessible and sufficient time spent to detail the site. The Level one fauna survey was completed adequately.

7.6 FAUNA RESULTS

7.6.1 Habitat assessment

The habitats present and their associated vegetation are listed below and shown in Figure 10.

1. Wetland: Vegetation comprises Woodland of *Eucalyptus rudis*, *Melaleuca cuticularis* and *M. viminea* over open water (see Appendix J photographs 7 – 9);

2. Alluvial plain: Vegetation comprises Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia, Hibbertia hypericoides* and *Phlebocarya cilliata* (see Appendix J photograph 1 - 3)

3. Cleared alluvial plain: Vegetation consists of scattered Eucalypts over paddock weeds.

7.6.2 Ecological Linkages

1. The majority of the site is surrounded by urbanisation in the form of housing and roads and lacks connectivity with other bushland areas. The exception to this is Lot 181 which forms part of an ecological linkage with native vegetation to the west of Riverside Road and to the east of Ronlyn Road (see Figure 10).

7.6.3 Habitat Value

The wetland habitat type is considered to be of medium habitat value. A number of microhabitats exist within this habitat for fauna to exploit. The low shrubbery present is conducive to supporting ground-dwelling mammals and reptiles which rely on such vegetation for refuge from predators. The wetland itself may potentially support a number of amphibian species and waterbird species. However, despite the potential of this habitat to support a diverse assemblage of fauna, the small size of this habitat in conjunction with its proximity to a main road and lack of ecological connectivity, limit the diversity of fauna expected to occur to mainly amphibian and waterbird species.

The alluvial plain habitat is considered to be of high habitat value. The alluvial plain habitat has the potential to support a large number of fauna species because of the relatively undisturbed native vegetation that is present, its large size and connectivity with other bushland areas. Bird species and arboreal mammals are likely to utilise the trees and shrubbery present for feeding and or nesting purposes. The well developed shrub layer that is present within this

habitat is likely to offer ground-dwelling mammals and reptiles a source of refuge from predators and food.

The cleared alluvial plain habitat is considered to be of low habitat value. Because of the lack of native vegetation that remains, this habitat lacks microhabitats for fauna to exploit for refuge and or feeding and subsequently, the diversity of fauna that may be supported by this habitat is severely limited. The scattered Eucalypts present within this habitat suggest it is most likely to be of value to bird species for foraging and or nesting purposes. The lack of tree hollows present within this habitat type suggests that arboreal mammals are unlikely to reside or nest within this habitat type. Ground-dwelling mammals and reptiles are not expected to utilise this habitat owing to the high rates of predation that are likely to exist because of the lack of shrubbery present, and therefore refuge.

No tree hollows suitable for nesting by birds or mammals were observed at the site.

7.7 EXPECTED FAUNA

The species that may occur near the project area are listed within their respective taxonomic groups in Appendix M through to Appendix P. These lists include species that have been recorded in the area and those likely to be present based on habitat type observations. Threatened, Priority or locally significant species are indicated and are discussed in detail below.

7.7.1 Mammals

There are 21 mammal species (four introduced) that may occur in the project area (see Appendix M). Eighteen of these species are of conservation importance. However, seven of these species are listed under the category CI 5. These species have an IUCN rating of Near Threatened, Least Concern or Data Deficient, and do not classify for the rating of Vulnerable. These species will not be discussed as many of the taxa are considered to be widespread and abundant, and not specifically dependant on the site at the local level.

Species listed under category CI 1 include:

- Chuditch (*Dasyurus geoffroii*)
- Numbat (*Myrmecobius fasciatus*)
- Brush-tailed Phascogale (*Phascogale tapoatafa* ssp. [WAM M434])
- Western False Pipistrelle (*Falsistrellus mackenziei*)

- Greater Long-eared Bat (*Nyctophilus timoriensis timoriensis*)

The Chuditch is listed as Schedule 1 by DEC and Vulnerable by EPBC and IUCN. This species once occurred over 70% of Australia, however, it has been reduced to a patchy distribution throughout the Jarrah and mixed forests of the southwest. The Chuditch is found in a wide range of habitats including woodlands, dry sclerophyll forests and riparian vegetation that contain hollow-bearing trees and logs. Numbers have decreased due to habitat alteration, removal of suitable den logs and dens and competition for food and predation by foxes and cats. A search of the DEC threatened fauna database revealed the Chuditch was recorded in 1999 in the neighbouring suburb of South Yunderup. The Chuditch is known to be highly mobile and capable of utilising bush remnants and may be found in semi-rural areas. This species may utilise the alluvial plain habitat at the site. Future development at the site may impact this species through a loss of den sites such as hollowed out logs or a reduction of a home range.

The Numbat is listed as Schedule 1 by DEC and as Vulnerable by the EPBC Act and IUCN. Populations of the Numbat currently occur in habitat types including upland Jarrah forests, open Eucalypt woodlands, Banksia woodlands and tall closed shrublands. This species is found in areas with an abundance of termites (its exclusive food source), hollow logs and branches for shelter. The severe decline in the population numbers of Numbats is due to predation by foxes, loss of habitat due to clearing for agriculture and changes in fire regimes. A search of the DEC's Threatened Fauna Database revealed that the Numbat was sighted at Barragup in 2002. Given the increasing level of urban development in the North Furnissdale area, ENV considers it unlikely that this species would be present within the site. Although suitable habitat, i.e. woodland and shrubland, exists for this species within the site, the food source this species exclusively utilises, namely termite mounds, were not present within the site suggesting it is unlikely this species would occur. Therefore, the Numbat is unlikely to rely specifically on habitat found within the site although this species may occasionally pass through the area as a transient. Future development at the site is considered unlikely to impact local populations of the Numbat.

The Brush-tailed Phascogale known as *Phascogale tapoatafa* ssp. (WAM M434) is listed as Schedule 1 by DEC. This subspecies has been observed in dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover. This mammal is unlikely to reside within the site owing to the lack of tree hollows present that may provide a source of refuge for this mammal. The Brush-tailed Phascogale may utilise the site as part of a larger home range. Future development at the site may result in a loss of foraging habitat for this species, however, given that suitable habitat exists in the immediate vicinity, minimal impact is anticipated.

The Western False Pipistrelle is listed as Priority 4 by DEC and Vulnerable by IUCN. This species prefers Karri forest, wetter stands of Jarrah and Tuart and woodlands. The Western False Pipistrelle roosts in tree hollows and forages mainly at canopy level. The major threat to this species is the loss of feeding grounds and suitable habitat to forestry and clearing for agriculture. The absence of suitable tree hollows at the site suggests this mammal is unlikely to roost on site. This mammal may utilise the site as part of a larger home range for foraging purposes. Future development at the site may result in a loss of foraging habitat for this species, however, given that suitable habitat exists in the immediate vicinity, minimal impact is anticipated.

The Greater Long-eared Bat (listed as Priority 4 by DEC and Vulnerable by IUCN) is found within wet sclerophyll forests, dry woodlands and shrubland communities. This species also roosts in tree hollows in old trees and forages in the canopy and shrub layers. The absence of suitable tree hollows at the site suggests this mammal is unlikely to roost on site. This mammal may utilise the site as part of a larger home range for foraging purposes. Future development at the site may result in a loss of foraging habitat for this species, however, given that suitable habitat exists in the immediate vicinity, minimal impact is anticipated.

Species listed under category CI 2 include:

- Western Brush Wallaby (*Macropus irma*)
- Quenda (*Isoodon obesulus fusciventer*)
- Water Rat (*Hydromys chrysogaster*)

The Western Brush Wallaby is listed as Priority 4 by DEC. This mammal is also listed by Bush Forever as a species that is in decline on the Swan Coastal Plain (Government of Western Australia 2000). Optimum habitat for this species is open forest or woodland supporting a dense shrub layer and seasonally wet flats with low grasses and open scrubby thickets. Although suitable habitat is present within the site, it is considered too small for a sustainable population of this species to occur. Transient individuals are also unlikely to occur given the surrounding area is highly urbanised. As a result, any impact on this species brought about by future development at the site is anticipated to be minimal.

The Quenda (Southern Brown Bandicoot) is classified as Priority 5 by the DEC. This mammal typically seeks daytime refuge from predators in very thick ground-storey vegetation usually associated with swamps or damplands. Major threats to the Quenda include habitat loss and fragmentation and predation by feral fauna. The DEC Threatened Fauna database search revealed that this mammal was recorded at Greenfields in 2006. Therefore, the Quenda is likely to occur in the North Furnissdale area. The Quenda may reside on site or utilise it as part of a larger home range. Specifically, the Quenda may occur within the wetland habitat

or the alluvial plain habitat. Future development at the site may impact this species through a loss of habitat in the clearing process and possible displacement of individual Quendas.

The Water Rat (*Hydromys chrysogaster*) (CI 2) is classified Priority 4 (DEC) and occupies a wide variety of freshwater habitats, from streams and other inland waterways to lakes, drainage lines, swamps, and farm dams. The DEC Threatened Fauna Database search revealed this species was recently recorded in South Yunderup. This species is unlikely to reside within the wetland area present on site owing to its small size and isolation. However, this species may potentially use the site as part of a larger home range. Future development at the site may impact this species through a loss of habitat in the clearing process and possible displacement of individuals.

Species listed under category CI 3 include:

- Western Pygmy Possum (*Cercartetus concinnus*)

One species of local conservation importance is the Western Pygmy Possum. This species is not listed under State or Federal Acts, but is known to have restricted distributions on the Swan Coastal Plain and is vulnerable to the impacts of further habitat fragmentation. This species is also listed as a *decreaser* species in Bush Forever (Government of Western Australia 2000). Given that only historical records for this species exist in the North Furnissdale area, it is unlikely that it would occur within habitats present on the site or use them as part of a large home range. As a result, future development on site is not expected to impact this species.

7.7.2 Reptiles

There are 30 species of reptile that may occur within the project area (see Appendix N). Five species of conservation importance may be expected within the vicinity of the project area.

Species listed under category CI 1 include:

- Carpet Python (Southwest population) (*Morelia spilota imbricata*)

The south western population of the Carpet Python is classified as Schedule 4 under the WC Act (1950) and is also listed as Priority 4 by DEC. This sub species has a wide distribution within the south west but is generally uncommon, having been recorded from semi-arid, coastal and inland habitats, Banksia woodland, Eucalypt woodlands, and grasslands. It commonly utilises hollow logs for shelter (Wilson and Swan 2003). Local populations in the south west have suffered due to extensive clearing and the removal of habitat for this species and as a result this species is only found on large bushland remnants. Given that only historical

records exist for this reptile in the Pinjarra area and the surrounding habitat destruction that has occurred, it is unlikely to occur or utilise the site as part of a larger home range. As a result, future development at the site is not anticipated to affect this species.

Species listed under category CI 3 include:

- Gould's Snake (*Parasuta gouldii*)
- Crowned Snake (*Elapognathus corontaus*)

These two species are of local conservation importance, as they are not listed under State or Federal Acts, but are known to have restricted distributions and are vulnerable to the impacts of further habitat fragmentation. These species are also listed as *decreaser* species in Bush Forever (Government of Western Australia 2000). Given these reptiles lack mobility, it is possible that individuals may be present within the alluvial habitat, although sustainable populations would be lacking due to the surrounding habitat destruction that has occurred. Future development at the site and clearing may impact these species through loss of habitat. However, given that larger expanses of suitable habitat exist near the site, the broader representation of these species is not anticipated to be affected.

7.7.3 Amphibians

Eight amphibian species may potentially occur within the site (Appendix O). These taxa are listed under the category CI 5 and will not be discussed as they are considered widespread and abundant, and not specifically dependant on the patches of vegetation found within the site.

7.7.4 Birds

Over 200 species of bird potentially occur within the project area (Appendix P). Most of these species are widespread in the south west, but some species have more restricted habitat requirements. Ninety species are listed under the category CI 5. These species have an IUCN rating of Near Threatened, Least Concern or Data Deficient, and do not classify for the rating of Vulnerable. These species will not be discussed as many of the taxa are considered widespread and abundant, and not specifically dependant on habitats present within the site.

Species listed under category CI 1 include:

- Peregrine Falcon (*Falco peregrinus*)
- Muir's Corella (*Cacatua pastinator pastinator*)
- Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)

- Baudin's Cockatoo *(Calyptorhynchus baudinii)*
- Carnaby's (Short-billed) Black Cockatoo *(Calyptorhynchus latirostris*)

The Peregrine Falcon is listed as Schedule 4 under the WC Act (1950). Individuals of this species are uncommon but wide ranging across Australia. This bird was recorded at Lake McLarty in 1995. The Peregrine Falcon nests in tall trees and on cliff faces and ledges. The site lacks suitable nesting areas and as a result it is unlikely that this species will occur although it is possible that it may use the site as part of a larger home range. Future development at the site is anticipated to have minimal if any impact on this species.

Muir's Corella is listed as Schedule 1 under the WC Act and as Vulnerable under the EPBC Act. The Muir's Corella occurs only in the south west region of Western Australia. Muir's Corella depends on mature Eucalypts with hollows for nesting. The absence of suitable tree hollows at the site suggests this mammal is unlikely to nest within the site. This bird may utilise the site as part of a larger home range for foraging purposes. Future development at the site may result in a loss of foraging habitat for this species, however, given that suitable habitat exists in the immediate vicinity, minimal impact is anticipated.

The Forest Red-tailed Black Cockatoo is listed as Schedule 1 under the WC Act and is found in the south west of Western Australia. This Cockatoo was sighted in the Goegrup Lake Nature Reserve in 2002 (DEC Threatened Fauna database search). This species has a distinct distribution that is closely related to the abundance of Marri due to the bird's preference for feeding on the seeds. The Forest Red-tailed Black Cockatoo is a seasonal breeder, and individuals roost in loose groups and nest in large tree hollows typical of most cockatoo species. The absence of suitable tree hollows at the site suggests this bird is unlikely to nest on site. This bird may utilise the site as part of a larger home range for foraging purposes. Future development at the site may result in a loss of foraging habitat for this species, however, given that suitable habitat exists in the immediate vicinity, minimal impact is anticipated. The above discussed impacts also apply to Baudin's Cockatoo and Carnaby's Cockatoo which are discussed below.

Baudin's Cockatoo is listed as Schedule 1 under the WC Act and as Vulnerable under the EPBC Act. This species is known to occur in Eucalypt forests where it feeds primarily on the Marri seeds, Banksia and Hakeas. Baudin's Cockatoo nests in tree hollows. As with the Forest Red-tailed Cockatoo, this bird may be impacted by future development at the site through the clearing of feeding habitat.

Carnaby's Black Cockatoo is listed as Schedule 1 under the WC Act and as Endangered under the EPBC Act. This species of cockatoo has declined due to loss of breeding habitat in the wheatbelt and of non-breeding habitat along the

west coast. Tree and shrub species known to be used as food resources for Carnaby's Black-Cockatoo, namely Marri and Banksia, and Dryandra, are present within the project area. As with the Forest Red-tailed Cockatoo, this bird may be impacted by future development at the site through the clearing of feeding habitat.

Species listed under category CI 2 include:

- Australian Bustard (*Ardeotis australis*)

The Australian Bustard is listed as Priority 4 by the DEC. This bird occurs within open or lightly wooded grasslands. This bird typically does not occur in south-west Australia (Barrett et al. 2003). However, the Australian Bustard was observed in 2002 in Pinjarra (DEC Threatened Fauna Database Search). Given the rarity of sightings in the South-west region, this bird is unlikely to be impacted by the proposed development.

Species listed under category CI 3:

Forty one species are of local conservation importance. These species are not listed under State or Federal Acts, but most are listed in Bush Forever (Government of Western Australia 2000). These species are known to have restricted distributions on the Swan Coastal Plain, either naturally or as the result of European settlement. The alluvial plain habitat may support such species, either those that reside on site or those that use the site as part of a larger home range.

Species listed under category CI 4:

Sixty four species are classified under the category CI 4. These species are recognised under international treaties such as CAMBA and JAMBA, as well as the Bonn Convention for migratory species and the EPBC list of marine species. Many of these species are largely aerial species and have an extensive home range. These species may utilise the site as part of a larger home range or periodically visit the site although larger areas of more pristine habitat occur near the site. As a result, impact upon these species is anticipated to be minimal.

7.8 DISCUSSION AND CONCLUSIONS

7.8.1 Fauna Habitat

The majority of the site exhibits disturbance with no native understorey existing due to clearing. As a result, the majority of the site is of limited value from a habitat perspective. The site does contain sections of relatively undisturbed

remnant native vegetation that are considered to be of conservation value in terms of habitat.

Areas on site with native vegetation comprise three fauna habitats: wetland, alluvial plain and cleared alluvial plain. Furthermore, the alluvial plain and wetland habitats present at the site are considered to be of high and medium value in terms of habitat value as they are relatively undisturbed and may support a diverse assemblage of fauna. The cleared alluvial plain habitat is degraded in condition and lacks microhabitats for fauna to exploit, and as a result is considered to be of low habitat value.

The native vegetation present on Lot 181 is considered part of a potential ecological corridor with vegetation existing west of Riverside Road and east of Ronlyn Road. It should be emphasized that there may be an exchange of fauna with the site via this connection. However, the presence of roads which interrupt this corridor may result in a large number of road deaths of terrestrial fauna attempting to cross Riverside and Ronlyn Road, so movement into and out of the site is most likely to be limited to highly mobile species.

No tree hollows suitable as nesting sites for birds or arboreal mammals were observed during the survey.

7.8.2 Fauna Potentially Occurring

The project site can be expected to support an assemblage of fauna typical of the habitats within the vicinity of Pinjarra surrounding area. The condition of the majority of the site is degraded (cleared alluvial plain habitat), due to human impacts. This has resulted in much of the site being of low habitat value. As a result, a limited number of species would actually be expected to occur at this site, in consideration of those identified within the desktop study, with few expected to be of conservation importance. The latter would likely consist of aerial species or highly mobile species that can access the site on a temporary basis.

Up to 200 fauna of conservation significance may potentially utilise and be found within habitats at the site based on database searches and knowledge of broad habitat types in the area. The majority of these species are either unlikely to specifically rely on habitat types found within the site or unlikely to still occur owing to the isolated nature of the site and destruction of habitat in the surrounding areas.

Fauna of conservation significance that are of noteworthy mention that may potentially occur within the project area may be divided into those that may reside within the project area, those that may utilise the site for feeding purposes or part of a larger home range, and those that are unlikely to occur.

Fauna of conservation significance of noteworthy importance that that may reside within the site, specifically within the alluvial habitat or wetland habitat, include the Southern Brown Bandicoot (*Isoodon obesulus fusciventer*), the Chuditch (Dasyurus *geoffroii*) and birds and reptiles of local conservation importance on the Swan Coastal Plain (of the CI 3 category). Given that suitable habitat exists in the nearby vicinity of the site, future development at the site is likely to only have minimal impact on these species providing that potential den or nesting sites are inspected prior to clearing within the wetland or alluvial plain habitats. In the case of the Chuditch, it is recommended that further work be carried out in the form of a targeted search for this species at the site to determine if it is present prior to development.

Fauna of conservation significance that may utilise the site for feeding purposes or part of a larger home range are list in Table 10.

Table 10: Fauna Potentially Occurring

Common Name	***Species Name***
Numbat	*(Myrmecobius fasciatus)*
Brush-tailed Phascogale	(*Phascogale tapoatafa* ssp. (WAM M434))
Western False Pipistrelle	*(Falsistrellus makenziei)*
Greater Long-eared Bat	*(Nyctophilus timoriensis timoriensis)*
Muir's Corella	*(Cacatua pastinator pastinator)*
Forest Red-tailed Black Cockatoo	*(Calyptorhynchus banksii naso)*
Baudin's Cockatoo	*(Calyptorhynchus baudinii)*
Carnaby's Cockatoo	*(Calyptorhynchus latirostris)*

Given that these taxa are only likely to utilise the area for feeding purposes and more suitable habitat for these species to utilise exists in abundance in the Pinjarra area, these taxa are not expected to be specifically be dependant on habitats within the site.

Fauna of conservation significance that are of noteworthy importance that are unlikely to occur within habitats recorded at the site include the Carpet Python (*Morelia spilota imbricata*), the Numbat (*Myrmecobius fasciatus*), the Western Brush Wallaby (*Macropus irma*) and the Australian Bustard (*Ardeotis australis*). These species are unlikely to occur at the site as either only historical records

exist for these species in the Pinjarra area or, as the case with the Australian Bustard, they are very rare in the Pinjarra area.

7.8.3 Potential impacts

Future development at the site which involves clearing of habitat considered to be of low habitat value, i.e. the cleared alluvial plain habitat, is considered to have minimal impact on potentially occurring fauna. Potential impacts will include the loss of feeding or nesting trees used by bird species. Given that such trees are located in abundance in areas surrounding the site, this is considered a minor impact. No tree hollows suitable for nesting by birds or mammals were observed on site, and as a result, minimal impact is anticipated for such fauna.

Future development at the site which involves clearing of habitat considered of high or medium value, i.e. the alluvial plain habitat and wetland habitat, is considered to have a moderate impact on the fauna potentially occurring. Potential impacts on fauna species may include:

- fauna deaths during clearing;
- displacement of fauna;
- loss of potential den sites;
- loss of fauna habitat required for feeding or nesting purposes; and
- loss of or further fragmentation of an ecological linkage.

The above impacts may be minimised through the implementation of management procedures as recommended in Section 6.11.

Marri and Banksia trees, which are known food sources to Black Cockatoos, are present within the site. As a result, the site is likely to provide feeding habitat for white-tailed Black Cockatoos which are protected species under State and Federal legislation. It is ENV's experience that there is an increasing focus by the regulatory authorities on proposals that impact on these species. There are, however, no guidelines on determining the significance of remnant native vegetation for supporting white-tailed Black Cockatoos.

While larger expanses of suitable feeding habitat exist near the site, due to a lack of regulatory guidelines concerning the preservation of feeding habitat for these species, ENV can not accurately advise whether clearing within this habitat would constitute a significant impact and require referral under the EPBC Act. Consideration should therefore be given to excluding sufficient area of the alluvial plain habitat from development, as it provides feeding habitat to white-tailed Black Cockatoos.

Whilst there are no published guidelines to assess whether an area is significant for white-tailed Black Cockatoos, the DEC and DEW are preparing guidelines based on the size of the remnant native vegetation providing habitat. Proposals impacting breeding habitat are likely to be considered a significant impact. A similar area guideline is not specified for feeding habitat but would be larger than for breeding habitat, with the significance likely to depend on whether the site provides a seasonal or year round food source.

ENV therefore recommends that should a subsequent development proposal include clearing within the alluvial plain habitat, an additional assessment to ascertain the significance of the remnant as a food source to Black Cockatoos, be conducted.

7.9 CONCLUSIONS AND RECOMMENDATIONS

The proposed development would not be expected to have a significant impact on the regionally widespread fauna within the vicinity of the project area. The proposed development may have an impact on an ecological linkage that exists through Lot 181 and as a result, vegetation on this property should be retained where possible.

The following recommendations have been developed for the management of impacts on fauna associated with the proposed development of the site.

- Clearing of the alluvial habitat and wetland habitat should be minimised where possible.
- Clearing of Lot 181 be minimised to maintain the ecological linkage to the west that exists.
- Development focus on the cleared alluvial habitat which is already heavily disturbed.
- Further work be carried out in the form of a fauna search targeting the Chuditch to determine if it is present.
- Should a subsequent development proposal include clearing within the alluvial plain habitat, an additional assessment to ascertain the significance of the remnant as a food source to Black Cockatoos, be conducted.
- A fauna management plan be prepared prior to any commencement of clearing.

8 SUMMARY AND CONCLUSIONS

In summary, no major environmental constraints have been identified by this study. The constraints and opportunities are shown on Figure 11. The following issues requiring management are summarised below:

- The sandy soils have a low capacity to absorb nutrients and there in evidence of elevated nitrates in groundwater near the egg farm, which are above drinking water threshold limits. The actual extent of nutrient loading in groundwater requires delineation through the installation of additional monitoring wells. The site may need to be formally reported to the Department of Environment and Conservation (DEC), as required under the Contaminated Sites Act 2003. The rest of the site shows water quality typical for the region.

- The area is mapped has having a high risk of Acid Sulphate Soils (ASS). This risk was confirmed by field and laboratory testing of soil samples. Field testing and geological logging supports there being PASS beneath the site and it is likely that laboratory analysis would confirm PASS at concentrations above the DEC guideline criteria. Future development plans, including the depth of excavation and any dewatering for sewer installation, would determine whether further investigation and management is required.

- Most of the site has sufficient clearance to the watertable to facilitate development without the need for extensive areas of fill. The sandy soil profile within the site allows Water Sensitive Urban Design principles to be utilised, such as infiltration of drainage and stormwater generated within the site. For example, residential properties could use soak wells to infiltrate domestic drainage water (from roofs and runoff from hardstand areas). This will reduce runoff volumes by maximising infiltration at the lot level. The sandy soil will also allow the runoff generated from road surfaces to infiltrate using compensation basins and drainage swales, minimising off-site runoff. The site would appear to be suitable to manage stormwater in compliance with the draft WSUD LPP.

- The extent and magnitude of tidal fluctuation on groundwater is required to be determined as this will affect the AAMGL for the site. An accurate AAMGL based on a winter of groundwater monitoring is required for drainage design for the site and determining whether fill is required to provide the separation distance between max groundwater and floor levels

- A conservation category wetland is mapped by the DEC as occurring on the western boundary of the site. This area is largely cleared and ENV considers that it does not warrant the current conservation management category. A formal request could be made to the DEC for modification to the geomorphic

wetland dataset, prior to development approval being sought. The Flood way of the Serpentine River overlaps the wetland . The hydraulic connection between the wetland and the Serpentine River has possibly been altered due to works (fill) observed on the lot to the west of Riverside Drive. The true floodplain extent is likely to be different and would need to be verified.

- No Declared Rare, Endangered, Vulnerable or Priority Flora species were located on the site. There are some relatively large areas of remnant vegetation in Very Good to Good condition. These should be considered for retention in Public Open Space and as regional ecological linkages.

- Sections of relatively undisturbed vegetation considered to be of high habitat value comprise part of a potential fauna movement corridor with vegetation west of Riverside Road and east of Ronlyn Road (Lot 181).

- The site may therefore support significant fauna such as the Black Cockatoo and the Chuditch which may require further investigation.

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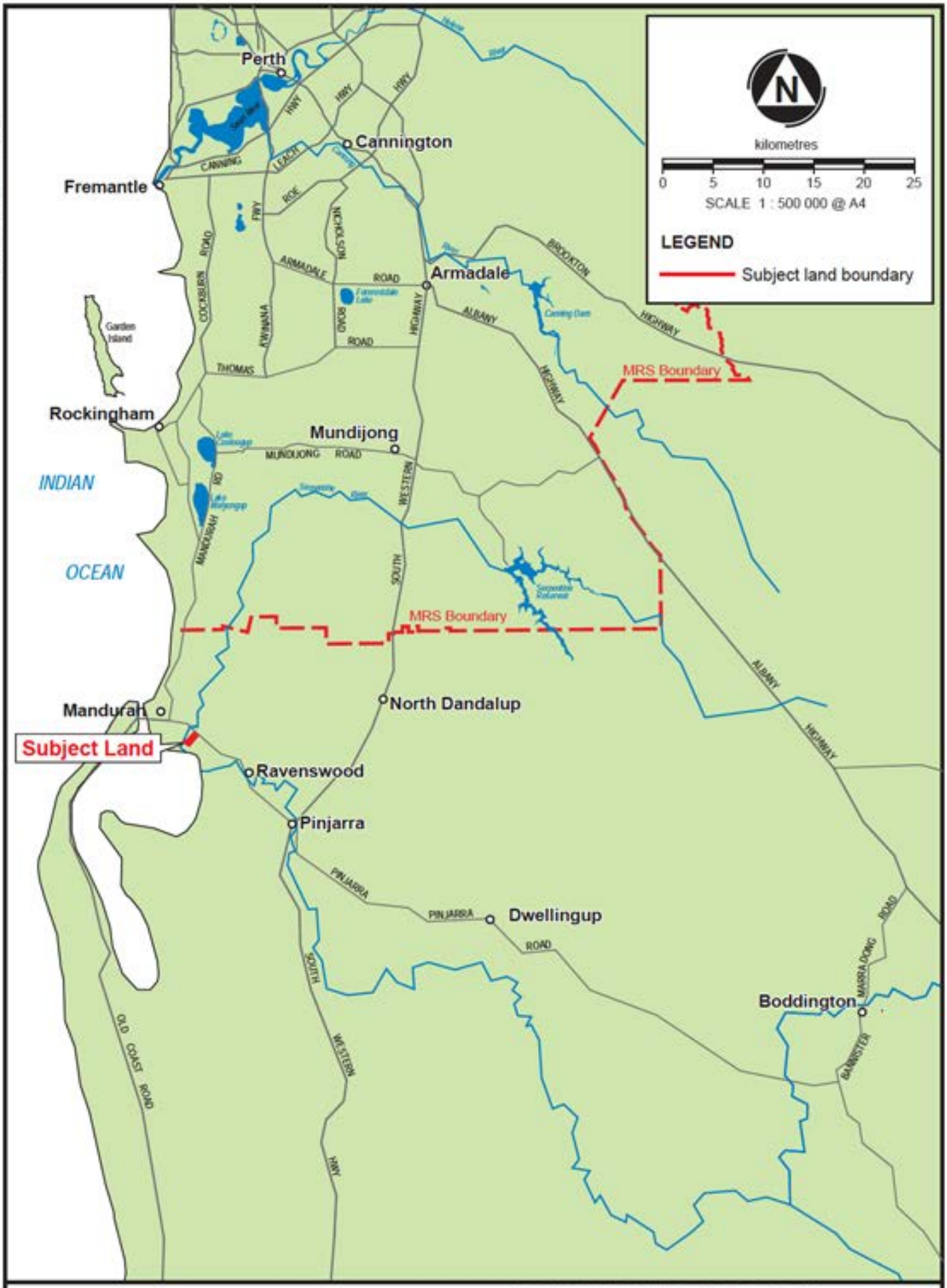
FIGURES



GREG ROWE AND ASSOCIATES
ENVIRONMENTAL ASSESSMENT - LOTS 181-185, 197, 198, 1186 & 1187 RONLYN RD, 179 & 180 RIVERSIDE DVE, NTH FURNISDALE

REGIONAL LOCATION

FIGURE 1

07-266_1F1.dgn
DATUM: MGA50
DRAWN BY: TE 25-09-07
CHECKED BY: MD 25-09-07

env Australia

PRINTED: Wed 07 May 08



LEGEND

Subject Land Boundary

197 Cadastral Boundary and Lot Number

4 Spot Height

N

metres

0 50 100 150 200 250

SCALE 1 : 7 000 @ A4

07-266-1F2.dgn
DATUM: MGA50
DRAWN: TE 13-02-08
AUTHOR: MD 13-02-08

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ENVIRONMENTAL ASSESSMENT - LOTS 181-185, 197, 198, 1186 & 1187 RONLYN RD, 179 & 180 RIVERSIDE DVE, NTH FURNISDALE

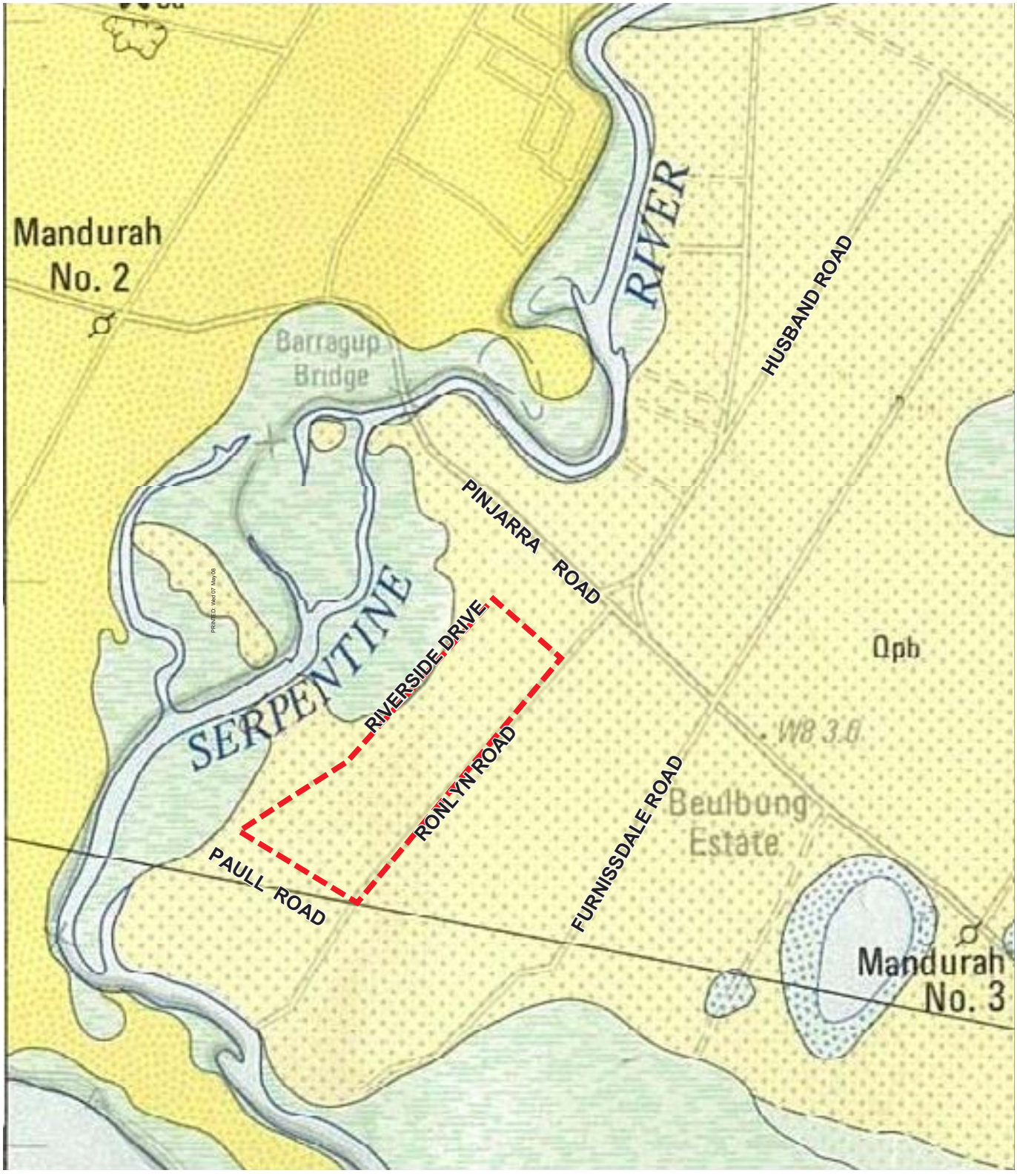
AERIAL AND SPOT HEIGHTS

FIGURE 2

Aerial Photography Source: Greg Rowe and Associates, 2007

env Australia

PRINTED: Wed 07 May 08



LEGEND

Subject Land Boundary

ENVIRONMENTAL GEOLOGY

Qhg — Estuarine and lagoonal deposits

Qts — Tamala (Coastal) Limestone -predominantly sand

Qpb — Bassendean Sand

N

metres

0 20 40 60 80 100

SCALE 1 : 20 000 @ A4

07-266-1F3.dgn
DATUM: MGA50
DRAWN: TE 5-12-07
AUTHOR: JH 5-12-07

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SOILS AND GEOLOGY

FIGURE 3

SOURCE: Environmental Geology Series, Pinjarra, 1978

env Australia

PRINTED: Wed 07 May 08



ACID SULFATE SOILS

HIGH ASS — High risk of actual acid sulfate soil (AASS) & potential acid sulfate soil (PASS) <3m from surface

MOD. ASS — Moderate to low risk of AASS and PASS occuring generally at depths of >3m (Not applicable to this figure)

LOW ASS — Low to no risk of AASS and PASS occuring generally at depths of >3m (Not Applicable to this figure)

Source: DPI, 10-2-2005
Mapped Scale 1:200 000, Accurate up to 1:25 000
Indicative at 1 : 7 000

N

metres

0 50 100 150 200 250

SCALE 1 : 7 000 @ A4

07-266-1F4.dgn
DATUM: MGA50
DRAWN: TE 13-02-08
AUTHOR: MD 13-02-08

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ENVIRONMENTAL ASSESSMENT - LOTS 181-185, 197, 198, 1186 & 1187 RONLYN RD, 179 & 180 RIVERSIDE DVE, NTH FURNISDALE

ACID SULFATE SOILS

FIGURE 4

Aerial Photography Source: Greg Rowe and Associates, 2007

env Australia

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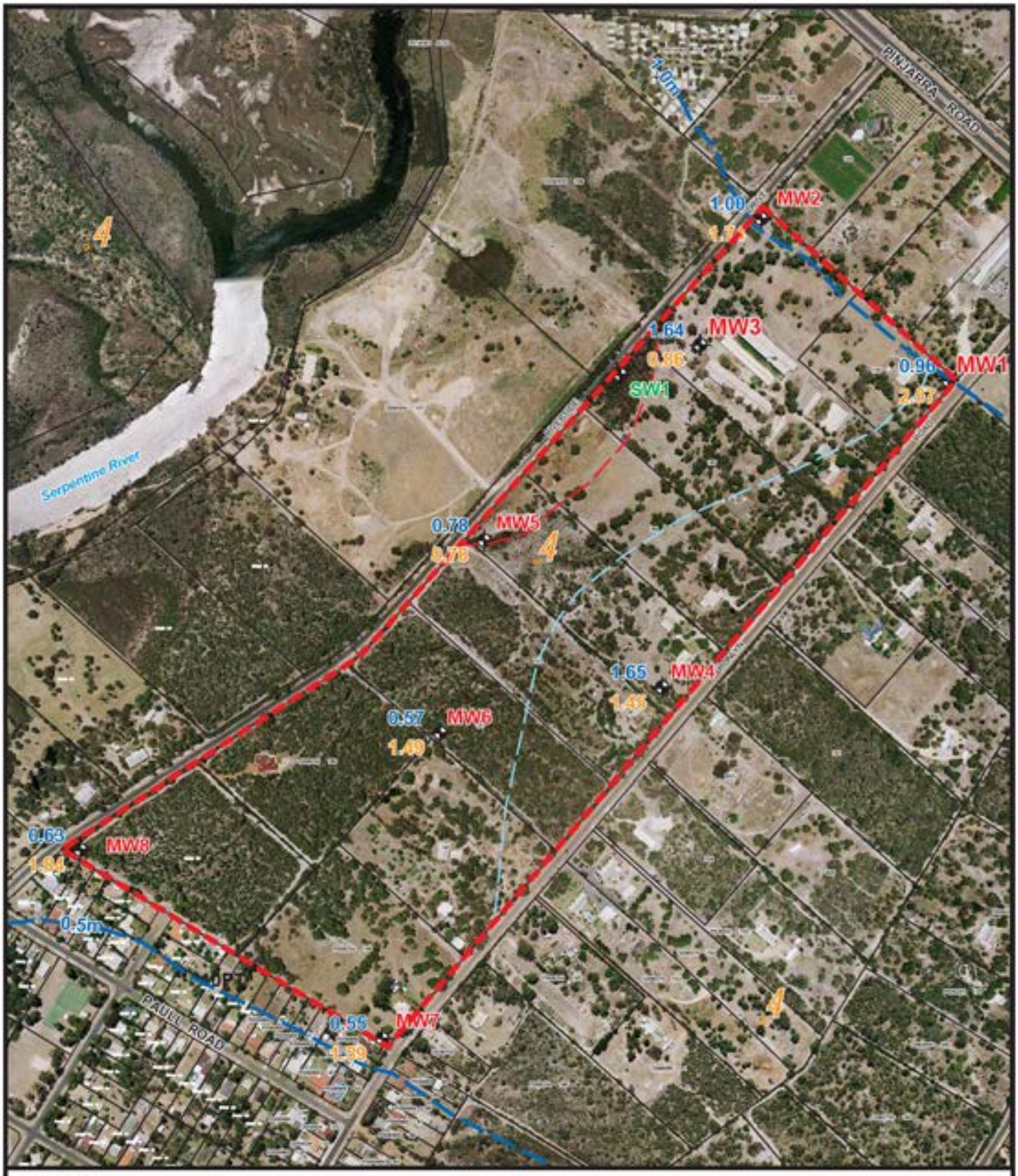

LEGEND

- Subject Land Boundary
- 197 Cadastral Boundary and Lot Number
- 1.00 AAMGL (mAHD)
- MW7 Monitoring Well Location
- 1.74 Depth to AAMGL from Ground Surface (m)
- SW1 Surface Water Monitoring Location

N

metres

0 50 100 150 200 250

SCALE 1 : 7 000 @ A4

07-269-1F5.dgn
DATUM: MGA50
DRAWN: TE 14-02-08
AUTHOR: JH 14-02-08

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GROUNDWATER & SURFACE WATER MONITORING POINTS & AAMGL

Aerial Photography Source: Greg Rowe and Associates, 2007

FIGURE 5

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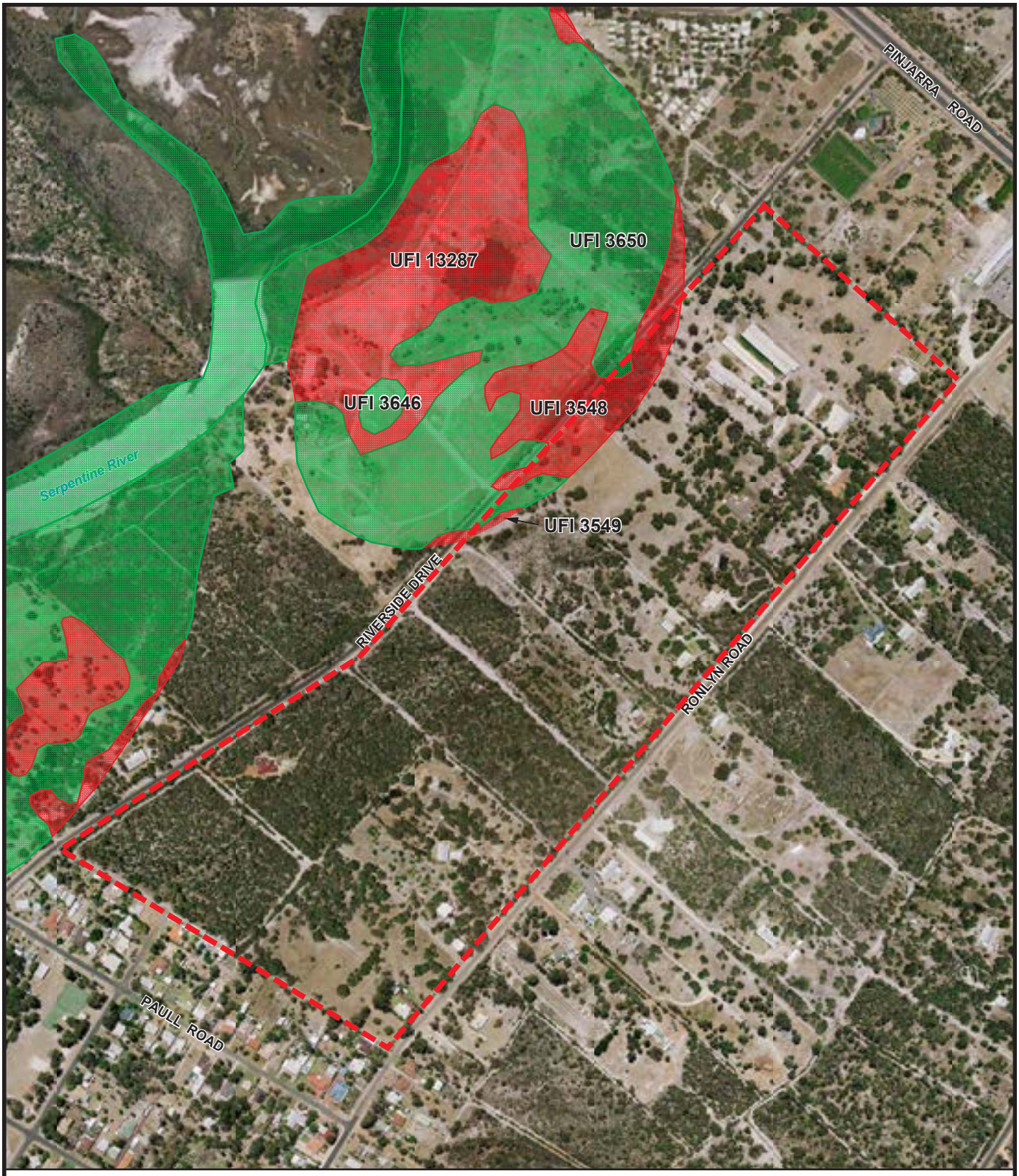

LEGEND

- Subject Land Boundary
- Geomorphic Wetland Boundary
- Conservation Category Wetland
- Multiple Use Wetland
- Resource Enhancement Wetland

N

metres

0 50 100 150 200 250

SCALE 1 : 7 000 @ A4

07-266-1F6.dgn
DATUM: MGA50
DRAWN: TE 13-02-08
AUTHOR: MD 13-02-08

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GEOMORPHIC WETLANDS

FIGURE 6

Aerial Photography Source: Greg Rowe and Associates, 2007

env Australia

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LEGEND

- Subject Land Boundary
- Extent of 1in 100 year Floodplains
- Serpentine River Floodway
- Serpentine River Flood Fringe
- **1.92** Flood levels (mAHD)

N

metres

0 50 100 150 200 250

SCALE 1 : 7 000 @ A4

07-266-1F7.dgn
DATUM: MGA50
DRAWN: TE 13-02-08
AUTHOR: JH 13-02-08

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FLOOD MAPPING

FIGURE 7

Aerial Photography Source: Greg Rowe and Associates, 2007

env Australia

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LEGEND

- Subject Land Boundary
- Cadastral Boundary
- Vegetation Association Boundary

VEGETATION ASSOCIATION LEGEND

BaEm	Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia*, *Hibbertia hypericoides* and *Phlebocarya ciliata*
BaEmR	regenerating Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata*. This vegetation unit has been disturbed, however, this vegetation unit is assumed to have historically represented BaEm as described above
ErMcMv	Woodland of *Eucalyptus rudis*, *Melaleuca cuticularis* and *M. viminea* over open water
E.spAf	Very Open Woodland of **Eucalyptus* sp. (planted) and *Agonis flexuosa* over weeds
RGR	residential garden, with regenerating native taxa
Cc	*Corymbia calophylla* over pasture
CP	cleared paddock

07-266-F8.dgn
DATUM: MGA50
DRAWN: CR 08-01-08
AUTHOR: OD 08-01-08

AERIAL PHOTOGRAPH SOURCE: Landgate, SkyView, 2007.

GREG ROWE AND ASSOCIATES
ENVIRONMENTAL ASSESSMENT - LOTS 181-185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE, NORTH FURNISSDALE

VEGETATION ASSOCIATIONS

FIGURE 8

env Australia

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07-266-1F9.dgn
DATUM: MGA50
DRAWN: CR 08-01-08
AUTHOR: OD 08-02-08

AERIAL PHOTOGRAPH SOURCE: Landgate, SkyView, 2007.

GREG ROWE AND ASSOCIATES
ENVIRONMENTAL ASSESSMENT - LOTS 181-185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE, NORTH FURNISSDALE

VEGETATION CONDITION

FIGURE 9

env Australia

PRINTED: Wed 07 May 08



LEGEND

- Subject Land Boundary
- 197 Cadastral Boundary and Lot Number
- 4 Spot Height

HABITAT TYPES

- W Wetland
- AP Alluvial Plain
- CAP Cleared Alluvial Plain

- Ecological Linkage

N

metres

0 50 100 150 200 250

SCALE 1 : 7 000 @ A4

07-271-1F10.dgn
DATUM: MGA50
DRAWN: TE 13-02-08
AUTHOR: AW 13-02-08

GREG ROWE AND ASSOCIATES
ENVIRONMENTAL ASSESSMENT - LOTS 181-185, 197, 198, 1186 & 1187 RONLYN RD, 179 & 180 RIVERSIDE DVE, NTH FURNISDALE

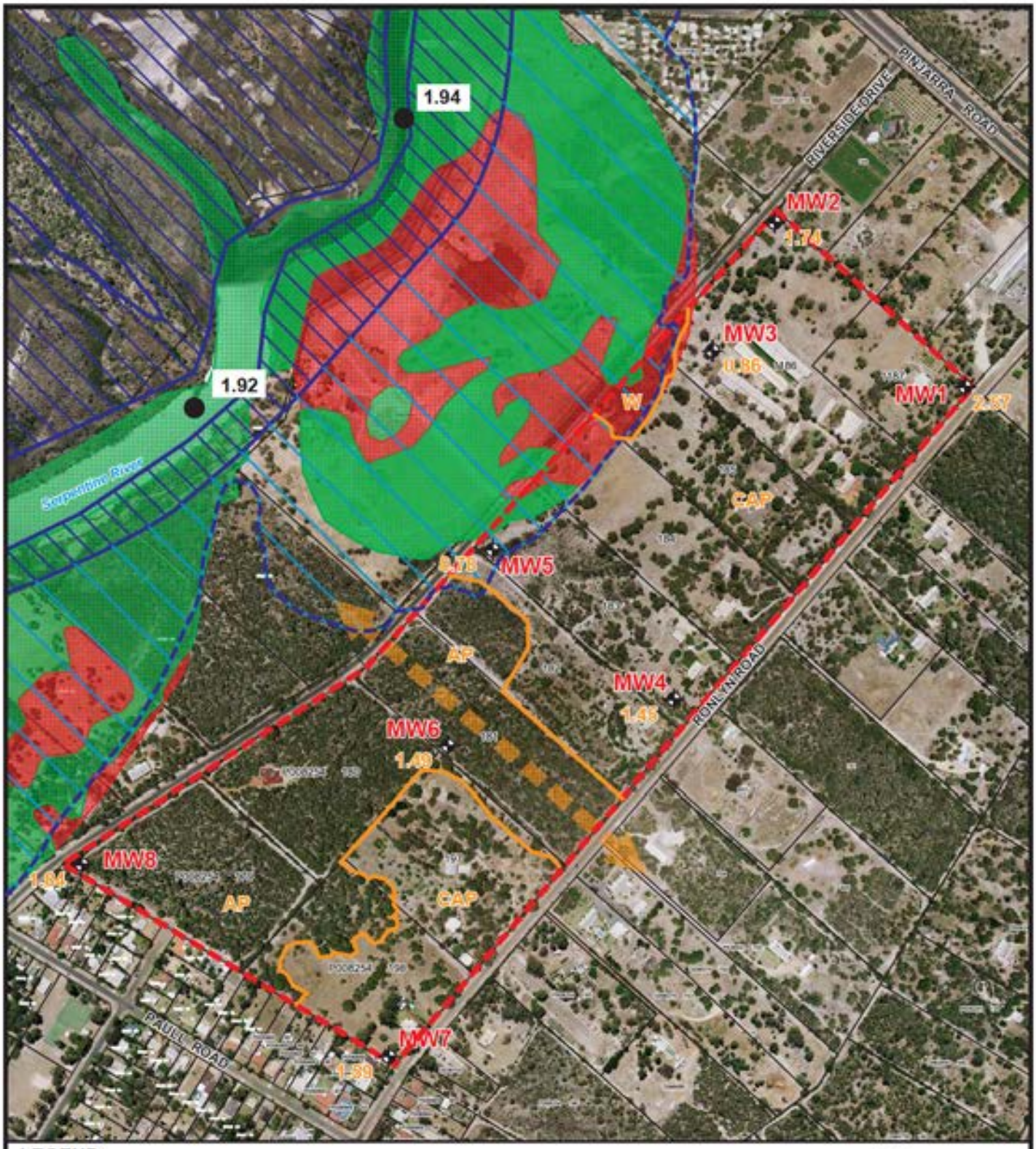
HABITAT TYPES

FIGURE 10

Aerial Photography Source: Greg Rowe and Associates, 2007

env Australia

PRINTED: Wed 07 May 08



LEGEND

- Subject Land Boundary
- 197 Cadastral Boundary and Lot Number
- Spot Height
- MW1 Monitoring Location
- 1.59 Depth to AAMGL from Ground Surface (m)
- Extent of 1in 100 year Floodplains
- Serpentine River Floodway
- Serpentine River Flood Fringe
- 1.92 Flood levels (mAHD)

HABITAT TYPES
- W Wetland
- AP Alluvial Plain
- CAP Cleared Alluvial Plain
- Ecological Linkage

GEOMORPHIC WETLAND
- Conservation Category Wetland
- Multiple Use Wetland
- Resource Enhancement Wetland

N

metres
0 50 100 150 200 250

SCALE 1 : 7 000 @ A4
DATUM: MGA 50

07-266-1F11.dgn
DRAWN: TE 6-05-08
AUTHOR: GR 6-05-08

GREG ROWE AND ASSOCIATES
ENVIRONMENTAL ASSESSMENT - LOTS 181- 185, 197, 198, 1186 & 1187 RONLYN RD, 179 & 180 RIVERSIDE DVE, NTH FURNISDALE

OPPORTUNITIES & CONSTRAINTS

FIGURE 11

Aerial Photography Source: Greg Rowe and Associates, 2007
Geomorphic Wetlands Source: DOE, 2004

env Australia

APPENDIX A
BORE LOGS

Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW1

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Rig

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
		0.00 - 0.25	Sand, dark grey, coarse to medium grained, Ao horizon		Vegetation, grass understorey.
		0.25 - 2.75	Sand, yellow/light brown, coarse grained, poorly sorted, large (72mm) angular quartz grains present,orange grains throught 1mm in diamter, no organics		Coarser with depth
					Layers of coarse and medium
					large quartz grains >3mm
					Lighter in colour with depth
1.0					
2.0					
		2.75 - 4.25	Sand, cream, coarse grained, poorly sorted, large angular quartz grains, orange mineral grains 2mm diameter, come dark mottling		Water table @ 2.7 m gbl
3.0					Coaser and lighter in colour with
4.0					
		4.25 - 4.6	Silty-Sand, grey, coarse, large quartz grains present very coarse, large orange mineral		Very coarse > 4mm subangular shape
			End of Hole @ 4.6 m bgl		0.6 m stick
5.0					

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW2

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Drilling

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)
		0.00 - 0.5	Sand, dark grey/black, medium grained, organic and root matter, quartz grains < 2mm diameter		Vegetation, grass cover open understory
		0.5 - 1.0	Sand, light grey, medium grained, no organic debris, quartz grains < 2mm diameter		
1.0		1.0 - 1.9	Sand, orange/grey medium to coarse grained, large quartz grains ~4mm, subangular, orange mineral grains		More orange and coarser with depth
		1.9 - 3.0	Sand, grey, very coarse large grains ~4mm diameter subangular, large quartz grains, silty fraction with depth		Water table @ 1.9 m
2.0					
3.0		3.0 - 3.9	Silty, clay, sand, grey, high silt and clay component with large quartz grains throughout (> 3mm) quite cohesive and sticky.		Coaser and lighter in colour with
4.0			End of Hole @ 3.9 m bgl		0.45 m stick up
5.0					

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW3

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Drilling

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
		0.0 - 0.25	Sand, dark brown medium grained, roots and organic matter, quartz grains present		Color lightening with depth
		0.25 - 2.25	Sand, brown-grey, coarse grained, large quartz grains throughout 3mm diameter		Becomes coarser with depth
1.0					
					Water table @ 1.668 m
2.0					
		2.25 - 3.0	Silty sand, brown/orange, coarse grained, large aubangular quartz with a silty fraction		
3.0		3.0 - 3.8	Clay/Silty/Sand, brown/orange, poorly sorted, large subangular quartz, higher clay content cohesive		Coaser and lighter in colour with
		3.8 - 3.87	Clay, orange, with large quartz grains throughout, water perching on clay		Would be what wetlands are perching on
4.0			End of Hole @ 3.87 m bgl		0.45 m stick up
					TOC 0.72m
5.0					

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW4

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Drilling

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)
		0.0 - 0.25	Sand, dark brown, coarse to medium grained, poorly sorted, quartz grains present < 2mm		Leaf litter, layer of 5cm eucalyptus
		0.25 - 1.25	Sand, white/grey, poorly sorted, medium to coarse grained, no organics		
1.0					
		1.25 - 1.75	Sand/rock, coffee, soft unconsolidated dark brown, poorly sorted		
		1.75 - 4.0	Sand, orange/brown, coarse grained, poorly sorted, quartz 3mm diameter, silty component, sub angular quartz grains.		Getting coarser and more orange with depth
					Silty content increasing with depth
2.0					
					Water table @ 4.45m
3.0					Coaser and lighter in colour with depth
4.0		4.0 - 4.45	Clay, blue/grey, stiff, some coarse fragments throughout orange mottly within clay		
			End of Hole @ 4.45 m bgl		TOC 0.82 m
					It should be noted that there is a high level of GW use in the area
					every lot has bore, chook farm
					use it forchook water, high users
5.0					ironstaining

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

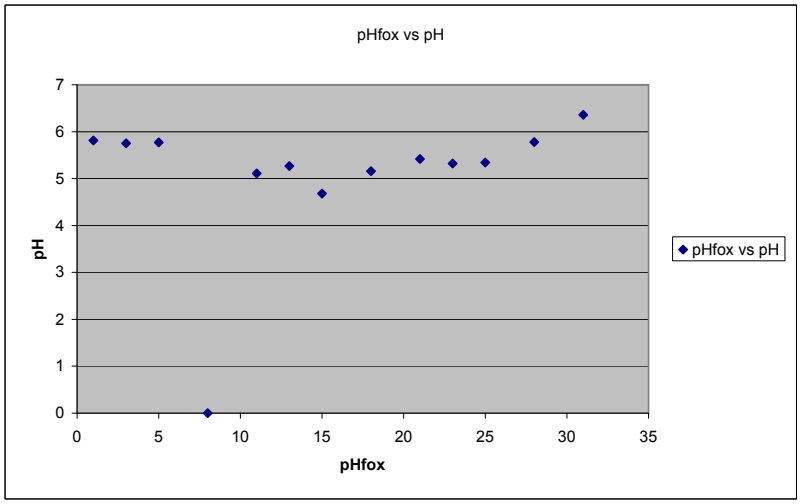
Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW5

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Drilling

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)	pH	pHfox	Reaction
		0.0 - 0.5	Sand, dark brown, coarse to medium graine, high organics, root matter. Ao- Artesian		Natural bush, reeds (shallow GW)			
					Melaluca, leaf litter, eucalyptus			
	0.25					5.81	4.72	
	0.5	0.5 - 1.5	Sand, grey/white, coarse grained, poorly sorted, quartz fragments subangular < 2mm diameter			5.75	5.02	
	0.75					5.77	5.49	
1.0	1.0					-	-	
	1.25					5.11	4.82	
	1.5	1.5 - 2.0	Sand, orange, coarse grained, poorly sorted, large quartz ~ 3mm subangular			5.27	4.40	
					Water table @ 1.58 m			
	1.75					4.68	3.35	x
2.0	2.0	2.0 - 3.4	Silty/sand, brown grey, poorly sorted, quartz fragments (~4mm diameter), orange minerals present			5.16	2.57	x
	2.25					5.42	1.32	x
	2.5					5.32	1.48	x
	2.75					5.34	1.70	x
3.0	3.0				Coaser and lighter in colour with depth	5.78	2.39	x
	3.25					6.36	4.48	
		3.4 - 3.93	Clay, blue grey, coarser fragments throughout, quartz, sulphidic odour, plastic-stiff clay					
4.0			End of Hole @ 3.93 m bgl		Stick 0.8 m			
5.0								

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.



Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW6

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Drilling

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
		0.0 - 0.25	Sand, dark grey/black, medium grained, poorly sorted, quartz grains roots and organics		Natural vegetation, Melalucas. Sparse understorey, thin litter layer
		0.25 - 3.0	Sand, light brown-brown, medium grained, poorly sorted, quartz fragments getting larger		Becoming coarser and lighter in colour with depth
1.0					
					Water table @ 1.6 m
2.0					
3.0		3.0 - 3.8	Sand.gravel, very coarse grained, poorly sorted, large quartz grains sub-angluar		Coaser and lighter in colour with
			End of Hole @ 3.8 m bgl		Casing 0.3 m
4.0					
5.0					

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW7

Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Drilling solid auger

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)
		0.0 - 0.25	Sand, dark/brown, medium grained, high organic content, root debris		Field with grass, grey cleared of native vegetation
		0.25 - 1.75	Sand, white/grey, medium grained, poorly sorted, quartz fragments present (~2mm)		Lightening with depth
1.0					
		1.75 - 3.5	Brown, poorly sorted, large (~3mm) quartz grains, large orange minerals, getting more orange with depth		
2.0					
					Water table @ 2.25m
3.0					Coaser and lighter in colour with depth
		3.5 - 4.32	Gravel Sand/gravel, brown, very coarse grained (~3mm-4mm), poorly sorted, large quartz grain, semi-rounded quite rounded to smooth		
4.0					
			End of Hole @ 4.32 m bgl		Riser 0.545 m
5.0					

NOTE:

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client:
Logged By: JH
Drilled By: Strataprobe
Soil Bore No: MW8

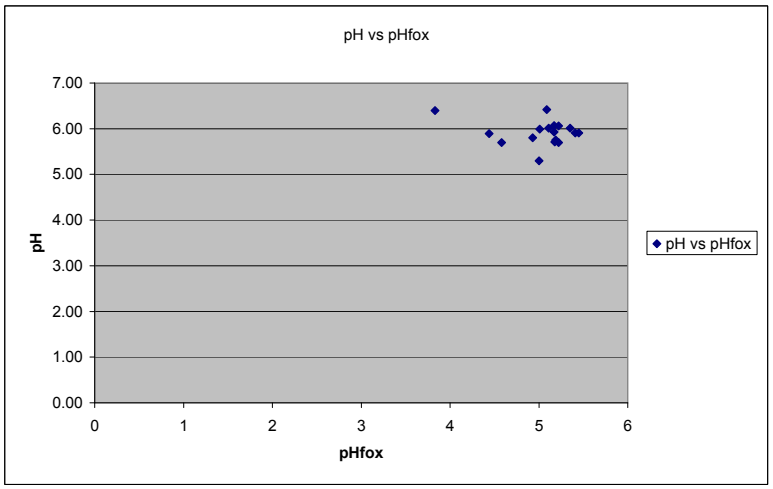
Project: Northfurnissdale
Job No: 07.269
Date Logged: 21-Sep-07
Installation Method: Solid auger

Depth BGL (m)	Sample Taken	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	pH	pHfox	Reaction
		0.0 - 0.25	Sand, dark brown, medium grained, poorly sorted, quartz fragments		Vegetation native covers understorey, no real leaf litter, just green creeper			
	0.25	0.25 - 1.75	Sand, white/grey, medium grained, pooly sorted, orange mineral fragments, quartz sub-angular < 2mm diameter		Becoming lighter with depth	5.70	4.58	
	0.5					5.93	5.17	
	0.75					5.91	5.41	
1.0	1.0					5.91	5.45	
	1.25					6.01	5.35	
	1.50					6.01	5.11	
	1.75	1.75 - 2.75	Sand, coffee, unconsolidated coffee sand, poorly sorted, quartz grains present, dark brown in column		Coffee rock/sand	6.07	5.17	
2.0	2.00					6.06	5.22	
	2.25					5.80	4.93	
	2.50					5.3	5	
					Water table @ 2.6m			
	2.75	2.75 - 3.75	Sand, orange/brown, coarse grained, poorly sorted, very large (> 4mm diameter), quartz grains		More orange with depth and coarser with depth	5.7	5.22	
3.0	3.00				Coaser and lighter in colour with depth	5.71	5.18	
	3.25					5.99	5.01	
	3.50					5.75	5.19	
	3.75	3.75 - 4.5	Gravelly sand, brown grey, very coarse grained, poorly sorted, large quartz grains			5.89	4.44	
4.0	4.00					6.42	5.09	
	4.30					6.40	3.83	x
		4.5	Clay layer, blue/grey, orange and green mottly, coarse fragments present, sulphidic odour					
			End of Hole @ 4.42 m bgl		Stickup 0.6 m			
5.0								

NOTE:
x - Small
xx - Medium
xxx - Large
xxxx - Extreme

pH DI - 6.12
pH OH - 5.66

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.



APPENDIX B
ASS FIELD TESTING

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923001	EP0704923002	EP0704923003	EP0704923004	EP0704923005	EP0704923006	EP0704923007	EP0704923008	EP0704923009	EP0704923010	EP0704923011	EP0704923012	EP0704923013
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1	MW1
			Client sample ID (2nd):	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**6.9**	**6.7**	**6.3**	**6.4**	**6.3**	**6.5**	**6.5**	**6.2**	**6.4**	**6.3**	**6.2**	**6.4**	**6.6**
pH (Fox)		pH Unit	0.1	**4.5**	**4.7**	**4.6**	**4.7**	**4.7**	**4.8**	**4.6**	**4.6**	**4.2**	**4.4**	**3.4**	**4.4**	**4.9**
Reaction Rate			1	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923014	EP0704923015	EP0704923016	EP0704923017	EP0704923018	EP0704923019	EP0704923020	EP0704923021	EP0704923022	EP0704923023	EP0704923024	EP0704923025	EP0704923026
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW1	MW1	MW1	MW1	MW1	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2
			Client sample ID (2nd):	3.75	4	4.25	4.5	4.75	0.25	0.5	0.75	1	1.25	1.5	1.75	2
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**6.6**	**6.4**	**6.5**	**6.3**	**6.2**	**6.3**	**5.8**	**6.0**	**6.2**	**6.3**	**6.2**	**6.1**	**5.9**
pH (Fox)		pH Unit	0.1	**4.9**	**4.0**	**2.3**	**1.8**	**2.0**	**3.6**	**3.4**	**3.8**	**4.2**	**4.4**	**4.4**	**4.5**	**4.4**
Reaction Rate			1	**Slight**	**Slight**	**Slight**	**Slight**	**Extreme**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923027	EP0704923028	EP0704923029	EP0704923030	EP0704923031	EP0704923032	EP0704923033	EP0704923034	EP0704923035	EP0704923036	EP0704923037	EP0704923038	EP0704923039
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW2	MW3	MW3
			Client sample ID (2nd):	2.25	2.5	2.75	3	3.25	3.5	3.75	4	4.25	4.5	4.75	0.25	0.5
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**5.8**	**5.8**	**5.9**	**5.8**	**5.7**	**5.7**	**5.8**	**5.5**	**5.2**	**5.2**	**5.1**	**5.3**	**5.3**
pH (Fox)		pH Unit	0.1	**4.5**	**4.2**	**4.3**	**4.3**	**3.4**	**2.9**	**2.8**	**2.9**	**3.1**	**3.0**	**3.1**	**4.2**	**4.4**
Reaction Rate			1	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923040	EP0704923041	EP0704923042	EP0704923043	EP0704923044	EP0704923045	EP0704923046	EP0704923047	EP0704923048	EP0704923049	EP0704923050	EP0704923051	EP0704923052
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3	MW3
			Client sample ID (2nd):	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3	3.25	3.5	3.75
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**5.7**	**6.3**	**6.1**	**6.2**	**6.3**	**6.2**	**6.5**	**6.5**	**6.5**	**6.5**	**6.5**	**6.4**	**6.6**
pH (Fox)		pH Unit	0.1	**4.5**	**4.8**	**4.6**	**4.5**	**4.6**	**4.7**	**4.9**	**4.9**	**4.8**	**4.9**	**4.9**	**4.8**	**2.9**
Reaction Rate			1	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Strong**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923053	EP0704923054	EP0704923055	EP0704923056	EP0704923057	EP0704923058	EP0704923059	EP0704923060	EP0704923061	EP0704923062	EP0704923063	EP0704923064	EP0704923065
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW3	MW3	MW4	MW4	MW4	MW4	MW4	MW4	MW4	MW4	MW4	MW4	MW4
			Client sample ID (2nd):	4	4.5	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**6.6**	**6.8**	**5.4**	**5.7**	**6.5**	**6.2**	**6.2**	**5.8**	**6.1**	**6.4**	**6.0**	**6.1**	**6.1**
pH (Fox)		pH Unit	0.1	**3.4**	**3.0**	**3.9**	**4.2**	**4.7**	**4.7**	**4.7**	**4.6**	**4.8**	**4.2**	**4.6**	**4.5**	**4.6**
Reaction Rate			1	**Strong**	**Strong**	**Strong**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Moderate**	**Slight**	**Slight**	**Slight**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923066	EP0704923067	EP0704923068	EP0704923069	EP0704923070	EP0704923071	EP0704923072	EP0704923073	EP0704923074	EP0704923075	EP0704923076	EP0704923077	EP0704923078
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW4	MW4	MW4	MW4	MW4	MW4	MW6	MW6	MW6	MW6	MW6	MW6	MW6
			Client sample ID (2nd):	3	3.25	3.5	3.75	4	WETLAND SAMPL	0.25	0.5	0.75	1	1.25	1.5	1.75
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**5.7**	**5.6**	**5.6**	**5.7**	**5.9**	**5.9**	**5.9**	**5.4**	**5.0**	**5.4**	**5.5**	**5.6**	**5.3**
pH (Fox)		pH Unit	0.1	**4.0**	**4.2**	**4.2**	**4.2**	**4.3**	**3.8**	**4.0**	**3.9**	**4.1**	**4.1**	**4.4**	**4.1**	**4.0**
Reaction Rate			1	**Slight**	**Slight**	**Slight**	**Slight**	**Strong**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923079	EP0704923080	EP0704923081	EP0704923082	EP0704923083	EP0704923084	EP0704923085	EP0704923086	EP0704923087	EP0704923088	EP0704923089	EP0704923090	EP0704923091
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW6	MW6	MW6	MW6	MW6	MW6	MW7	MW7	MW7	MW7	MW7	MW7	MW7
			Client sample ID (2nd):	2	2.25	2.5	2.75	3	3.25	0.25	0.5	0.75	1	1.25	1.5	1.75
			Site:													
			Purchase Order:													
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**													
EA037: Ass Field Screening Analysis																
pH (F)		pH Unit	0.1	**5.7**	**5.5**	**5.4**	**5.3**	**5.4**	**5.6**	**6.0**	**6.0**	**5.8**	**6.1**	**6.2**	**6.1**	**6.1**
pH (Fox)		pH Unit	0.1	**3.9**	**3.6**	**3.6**	**3.5**	**3.4**	**2.1**	**4.0**	**4.4**	**4.4**	**4.6**	**4.4**	**4.4**	**4.5**
Reaction Rate			1	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

APPENDIX B
LABORATORY FIELD TEST RESULTS

Matrix:	SOIL		**Sample Type:**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**	**REG**
Workgroup:	EP0704923		**ALS Sample number:**	EP0704923092	EP0704923093	EP0704923094	EP0704923095	EP0704923096	EP0704923097	EP0704923098	EP0704923099	EP0704923100
Project name/number:	07.269		**Sample date:**	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007	23/10/2007
			Client sample ID (1st):	MW7	MW7	MW7	MW7	MW7	MW7	MW7	MW7	MW7
			Client sample ID (2nd):	2	2.25	2.5	2.75	3	3.25	3.5	3.75	4
			Site:									
			Purchase Order:									
Analyte grouping/Analyte	**CAS Number**	**Units**	**LOR**									
EA037: Ass Field Screening Analysis												
pH (F)		pH Unit	0.1	**6.1**	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**	**5.9**	**6.0**	**5.8**
pH (Fox)		pH Unit	0.1	**4.3**	**3.8**	**4.3**	**4.4**	**4.3**	**3.2**	**2.3**	**2.2**	**2.4**
Reaction Rate			1	**Slight**	**Moderate**	**Moderate**	**Slight**	**Slight**	**Slight**	**Extreme**	**Extreme**	**Extreme**

CHAIN OF CUSTODY

env Australia **ENV. Australia** **ABN 72 091 839 520**	PO Box 7480 Cloisters Square Perth WA 6850 Ph: 9289 8360 Fax: 9322 4251 **Invoice To:** Jon Hanna	**REPORT TO:** Jon Hanna **EMAIL:** jon.hanna@env.net.au	**JOB #:** 07.269 **PROJECT:**	**CoC # :** 2392 **PAGE:** 1 OF 7
		REPORT TYPE: ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)		**OTHER SPECIFIC INSTRUCTIONS** For extended storage once tested.
SAMPLED BY: JH	**LAB DETAILS:** ALS	**QUOTE #:**	**DETECTION LIMIT:**	

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	HOLD	ASS Field Testing	ASS Lab Testing	ANALYSIS
1 ✓	MW1-0.5	S	23/10/2007		X		
2 ✓	MW1-0.75	S	23/10/2007		X		
3 ✓	MW1-1.0	S	23/10/2007		X		
4 ✓	MW1-1.25	S	23/10/2007		X		
5 ✓	MW1-1.5	S	23/10/2007		X		
6 ✓	MW1-1.75	S	23/10/2007		X		
7 ✓	MW1-2.0	S	23/10/2007		X		
8 ✓	MW1-2.25	S	23/10/2007		X		
9 ✓	MW1-2.5	S	23/10/2007		X		
10 ✓	MW1-2.75	S	23/10/2007		X		
11 ✓	MW1-3.0	S	23/10/2007		X		
12 ✓	MW1-3.25	S	23/10/2007		X		
13 ✓	MW1-3.5	S	23/10/2007		X		
14 ✓	MW1-3.75	S	23/10/2007		X		
15 ✓	MW1-4.0	S	23/10/2007		X		

COMMENTS **All Field Testing, Hold in Extended Storage for Lab Testing.**

ASS Field Test - pHf and pHfox

Environmental Division
Perth
Work Order
EP0704923

Telephone : +61-8-9209 7655

ENV. Australia Relinquished by: Ashton Betti Signature: Betti 23/10/2007	**Lab** Received by: Signature:	**Date:**	**Time:**	**Custody Seal Intact:** Y N

23/10 2007 11:57 FAX 93224251 ENV.AUSTRALIA 010

CHAIN OF CUSTODY

env Australia **ENV. Australia** **ABN 72 091 839 520**	PO Box 7480 Cloisters Square Perth WA 6850 Ph: 9289 8360 Fax: 9322 4251	**REPORT TO:** Jon Hanna	**JOB #:** 07.269	**CoC # :** 2392
		EMAIL: jon.hanna@env.net.au	**PROJECT:**	**PAGE:** 2 OF 7
	Invoice To: Jon Hanna	**REPORT TYPE:** ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)		**OTHER SPECIFIC INSTRUCTIONS** For extended storage once tested.

SAMPLED BY: JH	**LAB DETAILS:** ALS	**QUOTE #:**	**DETECTION LIMIT:**

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	ANALYSIS: HOLD	ASS Field Testing	ASS Lab Testing										COMMENTS
16 ✓	MW1-4.25	S	23/10/2007		x											**All Field Testing, Hold in Extended Storage for Lab Testing.** **ASS Field Test - pHf and pHfox**
17 ✓	MW1-4.5	S	23/10/2007		x											
18 ✓	MW1-4.75	S	23/10/2007		x											
19 ✓	MW2-0.25	S	23/10/2007		x											
20 ✓	MW2-0.5	S	23/10/2007		x											
21 ✓	MW2-0.75	S	23/10/2007		x											
22 ✓	MW2-1.0	S	23/10/2007		x											
23 ✓	MW2-1.25	S	23/10/2007		x											
24 ✓	MW2-1.5	S	23/10/2007		x											
25 ✓	MW2-1.75	S	23/10/2007		x											
26 ✓	MW2-2.0	S	23/10/2007		x											
27 ✓	MW2-2.25	S	23/10/2007		x											
28 ✓	MW2-2.5	S	23/10/2007		x											
29 ✓	MW2-2.75	S	23/10/2007		x											
30 ✓	MW2-3.0	S	23/10/2007		x											

ENV. Australia Relinquished by: Ashton Betti Signature: Betti 23/10/2007	**Lab** Received by: Signature:	**Date:**	**Time:**	**Custody Seal Intact:** Y N

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CHAIN OF CUSTODY

env Australia **ENV. Australia** ABN 72 091 839 520	PO Box 7480 Cloisters Square Perth WA 6850 Ph: 9289 8360 Fax: 9322 4251 **Invoice To:** Jon Hanna	**REPORT TO:** Jon Hanna **EMAIL:** jon.hanna@env.net.au	**JOB #:** 07.269 **PROJECT:**	**CoC # :** 2392 **PAGE:** 3 OF 7
		REPORT TYPE: ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)		**OTHER SPECIFIC INSTRUCTIONS** For extended storage once tested.
SAMPLED BY: JH		**LAB DETAILS:** ALS	**QUOTE #:**	**DETECTION LIMIT:**

ANALYSIS

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	HOLD	ASS Field Testing	ASS Lab Testing	COMMENTS
31 ✓	MW2-3.25	S	23/10/2007		X		**All Field Testing, Hold in Extended Storage for Lab Testing.** **ASS Field Test - pHf and pHfox**
32 ✓	MW2-3.5	S	23/10/2007		X		
33 ✓	MW2-3.75	S	23/10/2007		X		
35 ✓	MW2-4.25	S	23/10/2007		X		
36 ✓	MW2-4.5	S	23/10/2007		X		
38 ✓	MW3-0.25	S	23/10/2007		X		
39 ✓	MW3-0.5	S	23/10/2007		X		
40 ✓	MW3-0.75	S	23/10/2007		X		
41 ✓	MW3-1.0	S	23/10/2007		X		
42 ✓	MW3-1.25	S	23/10/2007		X		
43 ✓	MW3-1.5	S	23/10/2007		X		
44 ✓	MW3-1.75	S	23/10/2007		X		
45 ✓	MW3-2.0	S	23/10/2007		X		
46 ✓	MW3-2.25	S	23/10/2007		X		
47 ✓	MW3-2.5	S	23/10/2007		X		

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Add extras to P= Jon Hanna 23/10/07 4.30p.m.

extras -
*MW2 - 4.0
*MW2 - 4.75

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CHAIN OF CUSTODY

env Australia ENV. Australia ABN 72 091 839 520	PO Box 7480 Cloisters Square Perth WA 6850 Ph: 9289 8360 Fax: 9322 4251	REPORT TO: Jon Hanna	JOB #: 07.269	CoC # : 2392
		EMAIL: jon.hanna@env.net.au	PROJECT:	PAGE: 4 OF 7
	Invoice To: Jon Hanna	REPORT TYPE: ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)		OTHER SPECIFIC INSTRUCTIONS For extended storage once tested.

SAMPLED BY: JH	LAB DETAILS: ALS	QUOTE #:	DETECTION LIMIT:

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	ANALYSIS: HOLD	ASS Field Testing	ASS Lab Testing	COMMENTS
48 ✓	MW3-2.75	S	23/10/2007		X		All Field Testing, Hold in Extended Storage for Lab Testing. ASS Field Test - pHf and pHfox
49 ✓	MW3-3.0	S	23/10/2007		X		
50 ✓	MW3-3.25	S	23/10/2007		X		
51 ✓	MW3-3.5	S	23/10/2007		X		
52 ✓	MW3-3.75	S	23/10/2007		X		
53 ✓	MW3-4.0	S	23/10/2007		X		
54 ✓	MW3-4.5	S	23/10/2007		X		
55 ✓	MW4-0.25	S	23/10/2007		X		
56 ✓	MW4-0.5	S	23/10/2007		X		
57 ✓	MW4-0.75	S	23/10/2007		X		
58 ✓	MW4-1.0	S	23/10/2007		X		
59 ✓	MW4-1.25	S	23/10/2007		X		
60 ✓	MW4-1.5	S	23/10/2007		X		
61 ✓	MW4-1.75	S	23/10/2007		X		
62 ✓	MW4-2.0	S	23/10/2007		X		

ENV. Australia Relinquished by: Ashton Bettl Signature: Bettl 23/10/2007	Lab Received by: Signature:	Date:	Time:	Custody Seal Intact: Y N

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CHAIN OF CUSTODY

env Australia ENV. Australia ABN 72 091 839 520	PO Box 7480 Cloisters Square Perth WA 6850 Ph: 9289 8360 Fax: 9322 4251 **Invoice To:** Jon Hanna	**REPORT TO:** Jon Hanna **EMAIL:** jon.hanna@env.net.au **REPORT TYPE:** ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)	**JOB #:** 07.269 **PROJECT:**	**CoC # :** 2392 **PAGE:** 5 OF 7 **OTHER SPECIFIC INSTRUCTIONS** For extended storage once tested.

SAMPLED BY: JH	**LAB DETAILS:** ALS	**QUOTE #:**

DETECTION LIMIT:

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	ANALYSIS: HOLD	ASS Field Testing	ASS Lab Testing
63 ✓	MW4-2.25	S	23/10/2007		x	
64 ✓	MW4-2.5	S	23/10/2007		x	
65 ✓	MW4-2.75	S	23/10/2007		x	
66 ✓	MW4-3.0	S	23/10/2007		x	
67 ✓	MW4-3.25	S	23/10/2007		x	
68 ✓	MW4-3.5	S	23/10/2007		x	
69 ✓	MW4-3.75	S	23/10/2007		x	
70 ✓	MW4-4.0	S	23/10/2007		x	
71 ✓	MW4-wetland sample	S	23/10/2007		x	
72 ✓	MW6-0.25	S	23/10/2007		x	
73 ✓	MW6-0.5	S	23/10/2007		x	
74 ✓	MW6-0.75	S	23/10/2007		x	
75 ✓	MW6-1.0	S	23/10/2007		x	
76 ✓	MW6-1.25	S	23/10/2007		x	
77 ✓	MW6-1.5	S	23/10/2007		x	

COMMENTS **All Field Testing, Hold in Extended Storage for Lab Testing.**

ASS Field Test - pHf and pHfox

ENV. Australia Relinquished by: Ashton Betti Signature: Betti 23/10/2007	**Lab** Received by: Signature:	**Date:**	**Time:**	**Custody Seal Intact:** Y N

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		EMAIL: jon.hanna@env.net.au	PROJECT:	PAGE: 6 OF 7
	Invoice To: Jon Hanna	REPORT TYPE: ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)		OTHER SPECIFIC INSTRUCTIONS For extended storage once tested.

SAMPLED BY: JH	LAB DETAILS: ALS	QUOTE #:	DETECTION LIMIT:

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	ANALYSIS: HOLD	ASS Field Testing	ASS Lab Testing	COMMENTS
78 ✓	MW6-1.75	S	23/10/2007		x		All Field Testing, Hold in Extended Storage for Lab Testing. ASS Field Test - pHf and pHfox
79 ✓	MW6-2.0	S	23/10/2007		x		
80 ✓	MW6-2.25	S	23/10/2007		x		
81 ✓	MW6-2.5	S	23/10/2007		x		
82 ✓	MW6-2.75	S	23/10/2007		x		
83 ✓	MW6-3.0	S	23/10/2007		x		
84 ✓	MW6-3.25	S	23/10/2007		x		
85 ✓	MW7-0.25	S	23/10/2007		x		
86 ✓	MW7-0.5	S	23/10/2007		x		
87 ✓	MW7-0.75	S	23/10/2007		x		
88 ✓	MW7-1.0	S	23/10/2007		x		
89 ✓	MW7-1.25	S	23/10/2007		x		
90 ✓	MW7-1.5	S	23/10/2007		x		
91 ✓	MW7-1.75	S	23/10/2007		x		
92 ✓	MW7-2.0	S	23/10/2007		x		

ENV. Australia Relinquished by: Ashton Betti Signature: Betti 23/10/2007	Lab Received by: Signature:	Date:	Time:	Custody Seal Intact: Y N

23/10 2007 11:58 FAX 93224251 ENV.AUSTRALIA ☑015

CHAIN OF CUSTODY

ENV. Australia ABN 72 091 839 520	PO Box 7480 Cloisters Square Perth WA 6850 Ph: 9289 8360 Fax: 9322 4251	REPORT TO: Jon Hanna	JOB #: 07.269
		EMAIL: jon.hanna@env.net.au	PROJECT:
	Invoice To: Jon Hanna	REPORT TYPE: ☑ Hardcop ☐ Fax ☑ Email (excel / pdf)	OTHER SPECIFIC INSTRUCTIONS For extended storage once tested.

SAMPLED BY: JH	LAB DETAILS: ALS	QUOTE #:	DETECTION LIMIT:

LAB No.	SAMPLE ID.	SOIL/WATER (S/W)	DATE	HOLD	ASS Field Testing	ASS Lab Testing	COMMENTS
93 ✓	MW7-2.25	S	23/10/2007		x		All Field Testing, Hold in Extended Storage for Lab Testing. ASS Field Test - pHf and pHfox
94 ✓	MW7-2.5	S	23/10/2007		x		
95 ✓	MW7-2.75	S	23/10/2007		x		
96 ✓	MW7-3.0	S	23/10/2007		x		
97 ✓	MW7-3.25	S	23/10/2007		x		
98 ✓	MW7-3.5	S	23/10/2007		x		
99 ✓	MW7-3.75	S	23/10/2007		x		
100 ✓	MW7-4.0	S	23/10/2007		x		

ENV. Australia Relinquished by: Ashton Betti Signature: Betti 23/10/2007	Lab Received by: Signature:	Date:	Time:	Custody Seal Intact: Y N

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APPENDIX C
AVERAGE ANNUAL MAXIMUM GROUNDWATER LEVEL

Appendix C: AAMGL Calculation

Job Name: North Furnissdale **Job Number:** **07.269**

AAMGL for DoW bores

Monitoring Bore ID	Top of Casing AHD or RL(m)	Total Bore Depth (m) from TOC	Depth to SWL (m) from TOC	SWL AHD (m)	AAMGL (m AHD)	Difference (m)	Depth to AAMGL from TOC (m)
HS55A	3.542	3.000	2.455	1.087	1.338	0.251	2.204
HS55B	3.603	30.000	2.260	1.343	1.592	0.249	2.011
					Averaged Difference	0.250	

AAMGL for Site

Monitoring Bore ID	Top of Casing AHD or RL(m)	Total Bore Depth (m) from TOC	Depth to SWL (m) from TOC	SWL AHD (m)	AAMGL (m AHD)	Ground level (m AHD)	Depth to AAMGL from Surface (m)
MW 1	4.150	4.97	3.445	0.71	0.96	3.520	2.57
MW 2	3.115	4.21	2.368	0.75	1.00	2.735	1.74
MW 3	3.227	3.85	1.834	1.39	1.64	2.507	0.86
MW 4	3.965	4.48	2.568	1.40	1.65	3.095	1.45
MW 5	2.385	3.92	1.855	0.53	0.78	1.555	0.78
MW 6	2.379	4.06	2.055	0.32	0.57	2.059	1.49
MW 7	2.708	4.27	2.405	0.30	0.55	2.138	1.59
MW 8	3.094	4.43	2.715	0.38	0.63	2.464	1.84

Notes:

DoW refers to department of water bores

AAMGL for site boes = SWL on 22/1+Averaged Difference

AAMGL is limited to the surface because it is a groundwater level rather than a surface water level.

AAMGL for bore HS55A

7/11/2007 1.087 m AHD
0.251 Difference (= AAMGL - Measured 23/1)

		AAMGL	1.338	m AHD
WIN SITE ID	**COLLECTED DATE**	**CONVERTED LEVEL**		
HS55A	12:40:00 21/07/1988	=	1.427	m
HS55A	13:45:00 01/12/1988	=	0.942	m
HS55A	11:55:00 07/03/1989	=	0.542	m
HS55A	13:45:00 29/06/1989	=	1.442	m
HS55A	13:15:00 17/10/1989	=	1.342	m
HS55A	10:46:00 18/01/1990	=	0.692	m
HS55A	12:00:00 04/04/1990	=	0.342	m
HS55A	12:40:00 19/07/1990	=	1.482	m
HS55A	13:30:00 23/10/1990	=	1.042	m
HS55A	08:55:00 22/01/1991	=	0.542	m
HS55A	13:00:00 11/04/1991	=	0.242	m
HS55A	13:00:00 16/07/1991	=	1.292	m
HS55A	10:40:00 19/09/1991	=	1.542	m
HS55A	12:00:00 10/04/1992	=	0.592	m
HS55A	11:54:00 01/10/1992	=	1.412	m
HS55A	14:07:00 02/04/1993	=	0.492	m
HS55A	11:44:00 20/09/1993	=	1.452	m
HS55A	13:20:00 14/04/1994	=	0.422	m
HS55A	13:23:00 30/11/1994	=	0.772	m
HS55A	14:32:00 12/04/1995	=	0.212	m
HS55A	10:45:00 08/11/1995	=	1.162	m
HS55A	08:51:00 16/05/1996	=	0.417	m
HS55A	07:46:00 24/10/1996	=	1.292	m
HS55A	15:26:00 02/06/1997	=	0.722	m
HS55A	11:51:00 27/05/1998	=	0.462	m
HS55A	14:10:00 09/12/1998	=	0.822	m
HS55A	13:47:00 18/05/1999	=	0.492	m
HS55A	14:30:00 26/05/2000	=	0.612	m
HS55A	14:24:00 12/10/2000	=	1.142	m
HS55A	14:20:00 16/03/2001	=	0.342	m
HS55A	08:00:00 24/09/2001	=	1.302	m
HS55A	12:00:00 02/04/2002	=	0.342	m
HS55A	09:40:00 16/09/2002	=	1.442	m
HS55A	10:18:00 08/04/2003	=	0.312	m
HS55A	10:42:00 08/04/2003	=	0.312	m
HS55A	09:07:00 01/09/2003	=	1.412	m
HS55A	11:16:00 05/04/2004	=	0.302	m
HS55A	09:19:00 06/09/2004	=	1.532	m
HS55A	09:10:00 04/04/2005	=	0.432	m
HS55A	09:20:00 17/10/2005	=	1.362	m
HS55A	09:27:00 03/04/2006	=	0.932	m
HS55A	09:02:00 04/09/2006	=	1.752	m
HS55A	09:00:00 10/04/2007	=	0.232	m
HS55A	08:59:00 07/05/2007	=	0.462	m
HS55A	08:51:00 05/06/2007	=	0.612	m

AAMGL for bore HS55B

7/11/2007 1.343 m AHD
0.249 Difference (= AAMGL - Measured 23/1)

		AAMGL	1.592	m AHD
WIN SITE ID	COLLECTED DATE	CONVERTED LEVEL (mAHD)		
HS55B	12:51:00 21/07/1988	=	1.428	m
HS55B	13:50:00 01/12/1988	=	1.353	m
HS55B	12:00:00 07/03/1989	=	0.603	m
HS55B	13:50:00 29/06/1989	=	1.203	m
HS55B	13:35:00 17/10/1989	=	1.803	m
HS55B	10:47:00 18/01/1990	=	1.053	m
HS55B	12:05:00 04/04/1990	=	0.453	m
HS55B	12:45:00 19/07/1990	=	1.353	m
HS55B	13:55:00 23/10/1990	=	1.403	m
HS55B	09:00:00 22/01/1991	=	0.933	m
HS55B	13:15:00 11/04/1991	=	0.403	m
HS55B	13:05:00 16/07/1991	=	1.303	m
HS55B	10:55:00 19/09/1991	=	1.603	m
HS55B	12:05:00 10/04/1992	=	1.053	m
HS55B	11:57:00 01/10/1992	=	1.863	m
HS55B	14:17:00 02/04/1993	=	0.653	m
HS55B	11:46:00 20/09/1993	=	1.543	m
HS55B	13:40:00 14/04/1994	=	0.553	m
HS55B	13:22:00 30/11/1994	=	1.223	m
HS55B	14:30:00 12/04/1995	=	0.333	m
HS55B	10:42:00 08/11/1995	=	1.473	m
HS55B	08:53:00 16/05/1996	=	0.283	m
HS55B	07:51:00 24/10/1996	=	1.543	m
HS55B	15:24:00 02/06/1997	=	0.553	m
HS55B	11:53:00 27/05/1998	=	0.183	m
HS55B	14:08:00 09/12/1998	=	1.143	m
HS55B	13:50:00 18/05/1999	=	0.153	m
HS55B	14:35:00 26/05/2000	=	0.473	m
HS55B	14:24:00 12/10/2000	=	1.603	m
HS55B	14:20:00 16/03/2001	=	0.363	m
HS55B	08:00:00 24/09/2001	=	1.458	m
HS55B	12:00:00 02/04/2002	=	0.421	m
HS55B	09:40:00 16/09/2002	=	1.573	m
HS55B	10:18:00 08/04/2003	=	0.453	m
HS55B	10:49:00 08/04/2003	=	0.453	m
HS55B	09:10:00 01/09/2003	=	1.623	m
HS55B	11:19:00 05/04/2004	=	0.583	m
HS55B	09:19:00 06/09/2004	=	1.823	m
HS55B	09:10:00 04/04/2005	=	0.723	m
HS55B	09:22:00 17/10/2005	=	1.823	m
HS55B	09:28:00 03/04/2006	=	1.603	m
HS55B	09:02:00 04/09/2006	=	2.133	m
HS55B	09:00:00 10/04/2007	=	0.313	m
HS55B	08:59:00 07/05/2007	=	0.373	m
HS55B	08:52:00 05/06/2007	=	0.503	m

APPENDIX D
DEFINITIONS OF CATEGORIES OF FLORA SPECIES

APPENDIX D

Definitions of Declared Rare and Priority Flora Species (Department of Conservation and Land Management 2003)

Conservation Code	Category
R	Declared Rare Flora - Extant Taxa "Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such."
X	Declared Rare Flora - Presumed Extinct Taxa "Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such."
P1	Priority One - Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P2	Priority Two - Poorly Known Taxa "Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey."
P3	Priority Three - Poorly Known Taxa "Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but need further survey."
P4	Priority Four - Rare Taxa "Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require

	monitoring every 5-10 years.”

Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act 1999)

Category Code	Category
Ex	Extinct Taxa which at a particular time if, at the time, there is no reasonable doubt that the last member of the species has died**.**
ExW	Extinct in the wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at a particular time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

APPENDIX E
DEFINITIONS OF THREATENED ECOLOGICAL COMMUNITIES

APPENDIX E

Definitions of Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) (Department of Conservation and Land Management 2001)

Threatened Ecological Communities

Presumed Totally Destroyed (PD)

An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant **and either** of the following applies (A or B);

A) Records within the last 50 years have not been confirmed despite thorough searches or known or likely habitats **or,**

B) All occurrences recorded within the last 50 years have since been destroyed.

Critically Endangered (CR)

An ecological community will be listed as **Critically Endangered** when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and **either or both** of the following apply (i or ii);

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 5 years),

   ii) modification throughout its range is continuing such that in the immediate future (within approximately 5 years) the community is unlikely to be capable of being substantially rehabilitated.

B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii);

   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 5 years),

   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes,

   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the immediate future (within approximately 5 years).

APPENDIX E (cont)

Endangered (EN)

An ecological community will be listed as **Endangered** when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 70% and **either or both** of the following apply (i or ii);

   i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term (within approximately 10 years),

   ii) modification throughout its range is continuing such that in the short term future (within approximately 10 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

B) Current distribution is limited, and **one or more** of the following apply (i, ii or iii);

   i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 10 years),

   ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes,

   iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes.

C) The ecological community exists only as highly modified occurrences which may be capable of being rehabilitated if such work begins in the short term future (within approximately 10 years).

Vulnerable (VU)

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction in the medium to long term future. This will be determined on the basis of the best available information, by it meeting **any one or more** of the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences which are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community can be modified or destroyed and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may still be widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

APPENDIX E (cont)

Priority Ecological Community List

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community Lists under Priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as threatened ecological communities. Ecological Communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly known ecological communities Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly known ecological communities. Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation.

Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:

(ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or;

(iii) Communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable.

(c) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

APPENDIX F
WESTERN AUSTRALIAN WEEDS STRATEGY

APPENDIX F

WESTERN AUSTRALIAN ENVIRONMENTAL WEEDS STRATEGY

The Environmental Weed Strategy for Western Australia (CALM 1999) contains criteria for the assessment and ranking of weeds in terms of their environmental impact on biodiversity. These criteria are as follows:

- **Invasiveness –** ability to invade bushland in good to excellent condition or ability to invade waterways. (Score as yes or no).
- **Distribution** – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world. (Score as yes or no).
- **Environmental Impacts** – ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community. (Score as yes or no).

The rating of each weed is determined by the following scoring system:

- **High** - a weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritising this weed for control and/or research i.e. prioritising funding to it.
- **Moderate** -a weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).
- **Mild** – a weed species scoring one of the criteria. A mild rating would indicate monitoring of the week and control where appropriate.
- **Low** – a weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

APPENDIX G
DECLARED WEED CATEGORIES

APPENDIX G

Standard Meanings of Declared Plant Categories

P1

Prohibits movement

The movement of plants or their seeds is prohibited within the State.

This prohibits the movement of contaminated machinery and produce including livestock and fodder.

P2

Aim is to eradicate infestation

Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.

P3

Aims to control infestation by reducing area and/or density of infestation

The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.

Treat to destroy and prevent seed set all plants:-

* Within 50 metres inside of the boundaries of the infestation

* within 50 metres of roads and high water mark on waterways

* within 50 metres of sheds, stock yards and houses.

Treatment must be done prior to seed set each year.

Properties with less than 20 hectares of infestation must treat the entire infestation.

Additional areas may be ordered to be treated.

P4

Aims to prevent infestation spreading beyond existing boundaries of infestation

The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery.

Treat to destroy and prevent seed set all plants:-

* within 50 metres inside of the boundaries of the infested property for one-leaf and 20 metres for two-leaf

* within 50 metres of roads and high water mark on waterways

* within 50 metres of sheds, stock yards and houses.

Treatment must be done prior to seed set each year. Properties with less than 20 hectares of infestation must treat the entire infestation.

Additional areas may be ordered to be treated.

Special considerations

In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.

P5

Aims to control infestations on public lands

APPENDIX H
DEC FLORA AND TEC DATABASE SEARCH RESULTS

APPENDIX H

DEC Flora Database Search Results

FAMILY	TAXA	Conservation Status Code	
		STATE	FEDERAL
CYPERACEAE	*Schoenus* sp. Waroona	3	Not Listed
ORCHIDACEAE	*Caladenia huegelii*	R	Endangered
ORCHIDACEAE	*Diuris drummondii*	R	Vulnerable
ORCHIDACEAE	*Diuris micrantha*	R	Vulnerable
ORCHIDACEAE	*Drakaea elastica*	R	Endangered
PROTEACEAE	*Grevillea manglesii* subsp. *ornithopoda*	2	Not Listed
PAPILIONACEAE	*Dillwynia dillwynioides*	3	Not Listed
PAPILIONACEAE	*Jacksonia sericea*	4	Not Listed
MYRTACEAE	*Eucalyptus rudis* subsp. *cratyantha*	4	Not Listed
HALORAGACEAE	*Myriophyllum echinatum*	3	Not Listed
APIACEAE	*Eryngium pinnatifidum* subsp. *palustre*	3	Not Listed
APIACEAE	*Eryngium pinnatifidum* subsp. *umbraphilim*	3	Not Listed
MENYANTHACEAE	*Villarsia submersa*	4	Not Listed
LAMIACEAE	*Hemigenia microphylla*	3	Not Listed
ASTERACEAE	*Blennospora doliiformis*	3	Not Listed

APPENDIX I
FLORA SPECIES LIST

APPENDIX I

FLORA SPECIES LIST

*: denotes introduced species

FAMILY	TAXA		PRESENCE/ABSENCE BaEm (SCP21a)	BaEmR (SCP21a)	ErMcMv	E.spAf	RGR
ZAMIACEAE	*Macrozamia*	*riedlei*	+			+	+
PINACEAE	* *Pinus*	*pinaster*					+
DASYPOGONACEAE	*Dasypogon*	*bromeliifolius*	+	+			
	Lomandra	*caespitosa*	+				
	Lomandra	*purpurea*	+				
	Lomandra	*sonderi*	+				
XANTHORRHOEACEAE	*Xanthorrhoea*	*gracilis*	+				
	Xanthorrhoea	*preissii*	+				
PHORMIACEAE	*Dianella*	*revoluta*	+				
ANTHERICACEAE	*Anthericaceae*	sp.	+				
	Caesia	*micrantha*					+
	Chamaescilla	*corymbosa*	+				
	Dichopogon	*capillipes*	+				
	Laxmannia	*ramosa*	+				
	Laxmannia	*squarrosa*	+	+			
	Sowerbaea	*laxiflora*	+		+	+	
	Thysanotus	*dichotomus*	+		+		
	Thysanotus	*manglesianus*	+				
	Thysanotus	*thyrsoideus*	+				
	Tricoryne	*elatior*					
COLCHICACEAE	*Burchardia*	*congesta*	+	+	+	+	
POACEAE	* *Avena*	*barbata*	+		+	+	
	* *Avena*	*fatua*	+				+
	* *Briza*	*maxima*	+	+		+	+
	* *Briza*	*minor*	+				+
	* *Bromus*	*diandrus*	+			+	
	* *Ehrharta*	*calycina*	+	+		+	+
	* *Ehrharta*	*longiflora*			+	+	+
	* *Hordeum*	*leporinum*					+
	* *Lagurus*	*ovatus*				+	+
	* *Lolium*	*rigidum*			+		+
	* *Pennisetum*	*clandestinum*			+	+	+
	Austrostipa	*campylachne*					
	Austrostipa	*elegantissima*	+				
CYPERACEAE	*Cyperaceae*	sp.	+				
	Lepidosperma	*longitudinale*			+		
	Lepidosperma	*squamatum*	+				+
	Schoenus	*nigens*			+		
	Tetraria	*capillaris*	+				
LEMNACEAE	*Lemna*	*disperma*			+		
RESTIONACEAE	*Desmocladus*	*fasciculatus*	+				
	Desmocladus	*flexuosus*	+	+			+
	Hypolaena	*exsulca*	+		+		
	Lyginia	*imberbis*	+				
	Mesomelaena	*tetragona*	+	+			
JUNCACEAE	*Juncus*	*kraussii*			+		
HAEMODORACEAE	*Conostylis*	*aculeata subsp. aculeata*	+				
	Conostylis	*juncea*	+				
	Conostylis	*setigera*	+				
	Haemodoraceae	sp.	+				
	Phlebocarya	*ciliata*	+	+			+
IRIDACEAE	* *Moraea*	*flaccida*	+				
	* *Romulea*	*rosea*			+		
	Patersonia	*occidentalis*	+				+
ORCHIDACEAE	* *Disa*	*bracteata*	+				
	Caladenia	*flava*	+				
	Pyrorchis	*nigricans*	+	+			
CASUARINACEAE	*Allocasuarina*	*fraseriana*	+		+	+	+
PROTEACEAE	*Hakea*	*?varia*			+		
	Adenanthos	*cygnorum*	+	+			
	Banksia	*attenuata*	+			+	+
	Banksia	*grandis*	+				
	Banksia	*ilicifolia*	+			+	+
	Dryandra	*sessilis var. sessilis*					
	Petrophile	*linearis*	+				
	Synaphea	*spinulosa subsp. spinulosa*					
	Xylomelum	*occidentale*	+				
LORANTHACEAE	*Nuytsia*	*floribunda*					
CHENOPODIACEAE	*Halosarcia*	*?indica*			+		
CARYOPHYLLACEAE	* *Petrorhagia*	*dubia*	+			+	
LAURACEAEA	*Cassytha*	*racemosa*	+				
	Cassytha	sp.			+		
BRASSICACEAE	* *Brassica*	*tournefortii*					+
DROSERACEAE	*Drosera*	sp.A	+				
	Drosera	sp.B	+				
	Drosera	*stolonifera*	+				+
CRASSULACEAE	*Crassula*	*colorata var. colorata*	+				
MIMOSACEAE	* *Acacia*	*dealbata*					+
	Acacia	*huegelii*	+				
	Acacia	*?huegelii*	+				
	Acacia	*pulchella*	+			+	+
	Acacia	*saligna*	+	+	+		+
	Acacia	*?stenoptera*	+				
PAPILIONACEAE	* *Lotus*	sp.	+				
	* *Lupinus*	*cosentinii*					+
	Acitus	*procumbens*	+	+			
	Bossiaea	*eriocarpa*	+				
	Gastrolobium	*obtectelatum*	+				
	Gompholobium	*tomentosum*	+				
	Hardenbergia	*comptoniana*					+
	Hovea	*trisperma*	+				
	Isotropis	*cuneifolia*	+				
	Jacksonia	*furcellata*					+
	Jacksonia	*stembergiana*					
	Kennedia	*prostrata*	+	+			
GERANIACEAE	* *Pelargonium*	*littorale*					+
OXALIDACEAE	* *Oxalis*	*pes-caprae*				+	+
	* *Oxalis*	*purpurea*	+				
RUTACEAE	*Phebalium*	*spicata*	+				
POLYGALACEAE	*Comesperma*	*calymega*					
EUPHORBIACEAE	* *Euphorbia*	*terracina*			+		+
	Monotaxis	*occidentalis*		+			
ANACARDIACEAE	* *Schinus*	*terebinthifolius*			+		
DILLENIACEAE	*Hibbertia*	*hypericoides*	+				
	Hibbertia	*racemosa*					
VIOLACEAE	*Hybanthus*	*calycinus*					
THYMELAEACEAE	*Pimelea*	*rosea*	+				
MYRTACEAE	*Agonis*	*flexuosa*	+			+	
	Calothamnus	*quadrifidus*	+				
	Chamelaucium	*uncinatum*					+
	Corymbia	*calophylla*					+
	Eucalyptus	*marginata subsp. marginata*	+		+	+	+
	Eucalyptus	*rudis*			+		
	Eucalyptus	*sp.(planted)*	+			+	
	Eucalyptus	*gomphocephala*					+
	Kunzea	*ericifolia subsp. ericifolia*	+		+	+	+
	Melaleuca	*cuticularis*			+		
	Melaleuca	*viminea*			+		
	Melaleuca	*teretifolia*			+		
	Pericalymma	*ellipticum*	+				
APIACEAE	*Daucus*	*glochidiatus*	+				
	Trachymene	*pilosa*	+				
	Xanthosia	*huegelii*	+				
EPACRIDACEAE	*Astroloma*	*pallidum*	+				
	Epacridaceae	sp.	+				
PRIMULACEAE	* *Anagallis*	*arvensis*	+	+		+	+
LAMIACEAE	*Hemiandra*	*pungens*	+				
OROBANCHACEAE	* *Orobanche*	*minor*	+				
RUBIACEAE	*Opercularia*	*vaginata*	+	+			
LOBELIACEAE	*Lobelia*	*rhytidosperma*	+	+			
GOODENIACEAE	*Dampiera*	*linearis*	+				
STYLIDIACEAE	*Stylidium*	*araeophyllum*	+				
	Stylidium	*brunonianum*	+	+			
	Stylidium	*calcaratum*	+				
	Stylidium	*carnosum*	+				
	Stylidium	*piliferum*	+	+			
	Stylidium	*schoenoides*	+				
ASTERACEAE	* *Arctotheca*	*calendula*	+		+	+	+
	* *Hypochaeris*	*glabra*	+	+	+	+	
	* *Ursinia*	*anthemoides*	+	+			
	Asteridea	*pulverulenta*	+				
	Hyalosperma	*cotula*	+				
	Podotheca	*chrysantha*	+	+			
	* non-endemic Palm tree					+	+

APPENDIX J
SITE PHOTOS

APPENDIX J

Site Photos



Photo 1: Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* over *Kunzea ericifolia* subsp. *ericifolia, Hibbertia hypericoides* and *Phlebocarya cilliata* (BaEm)



Photo 2: second quadrat within BaEm



Photo 3: BaEm (Good condition)



Photo 4: BaEm surrounded by grassed lawn



Photo 5: grassed lawn within BaEm



Photo 6: regenerating Woodland of *Banksia attenuata* and *Eucalyptus marginata* subsp. *marginata* (BaEmR)



Photo 7: Woodland of *Eucalyptus rudis, Melaleuca cuticularis* and *M. vimenea* over open water (ErMcMv)



Photo 8: ErMcMv



Photo 9: large *Melaleuca cuticularis* within ErMcMv



Photo 10: open water extending passed remnant native vegetation of ErMcMv



Photo 11: RGR



Photo 12: RGR



Photo 13: RGR



Photo 14: high weed densities within RGR



Photo 15: ****Pinus pinaster* **tree within RGR



Photo 16: ***Corymbia calophylla*** **over pasture (Cc)**



Photo 17: Cc



Photo 18: cleared paddock (CP)

APPENDIX K
BUSH FOREVER CONDITION SCALE

APPENDIX K
BUSH FOREVER CONDITION SCALES

Condition scale used in BUSH FOREVER VOL 2, from Keighery BJ (1994)	Condition scale used to derive Keighery BJ (1994) and Connell (1995) after Trudgen (1991)	Condition scale used in PEP MAPPING after Connell (1995)
Pristine (1) Pristine or nearly so, no obvious signs of disturbance	**Excellent (E)** Pristine or nearly so, no obvious signs of damage caused by the activities of European man.	No equivalent unit.
Excellent (2) Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	**Very Good (VG)** Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fires and the presence of some relatively non-aggressive weeds such as *Ursinia anthemoides* or *Briza* species, or occasional vehicle tracks.	**Very Good (VG)** Evidence of localised low level damage to otherwise healthy bush. Seedling recruitment and generally healthy population size (age/stage) structure apparent. Weed and grazing damage is confined (<20% of area). Some modification to vegetation structure due to changes in fire regimes may be apparent. Evidence of logging or firewood collection may be found. High likelihood that vegetation structure and species richness can be maintained.
Very Good (3) Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	**Good (G)** More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.	**Good (g)** Evidence of localised high level damage to otherwise low level damaged bush. Recruitment is localised and the populations of some species may be senescent. Weed and grazing damage is apparent in 20-50% of the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Localised gall and parasitic plant damage may be apparent. Evidence of logging or firewood collection. Moderate likelihood that vegetation structure and species richness can be maintained.
Good (4) Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.	**Poor (P)** Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining) or very frequent fires. Weeds as above, probably plus some more aggressive ones such as *Ehrharto* species.	**Poor (p)** Widespread high level damage. Recruitment is disrupted and most woody species appear senescent. Weed and grazing damage may be apparent throughout >50% of the area. Modification to vegetation structure due to changes in fire regimes may be apparent. Locally some vertical strata are absent. Gall and mistletoe damage apparent. Evidence of logging or firewood collection. Low likelihood that vegetation structure and species richness can be maintained or re-established.
Degraded (5) Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	**Very Poor (VP)** Severely impacted by grazing, fire, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.	**Very Poor (p)** Widespread high level damage. Recruitment is disrupted and most species appear senescent. Weed and grazing damage apparent throughout the area. Modification to vegetation structure due to changes in fire regimes apparent. Widespread loss of vertical strata. Gall and mistletoe damage apparent. Evidence of logging or firewood collection. Little to no likelihood that vegetation structure and species richness can be re-established.
Completely Degraded (6) The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.	**Completely Degraded (D)** Area that are completely or almost completely without native species in the structure of their vegetation, i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.	Not used – does not apply to bushland.

APPENDIX L
FAUNA CONSERVATION CODES

LOTS 181, 183, 184, 185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE - FAUNA SURVEY

APPENDIX P

Definition of Conservation Codes for Fauna of Conservation Significance

Western Australian Threatened Fauna Categories

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct.
Schedule 2	S2	Fauna which is presumed extinct.
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Fauna that is otherwise in need of special protection.

Department of Environment and Conservation (DEC) Fauna Priority Codes

Category	Code	Description
Priority 1	P1	Taxa with few, poorly known populations on threatened lands.
Priority 2	P2	Taxa with few, poorly known populations on conservation lands.
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands.
Priority 4	P4	Taxa in need of monitoring which are considered not currently threatened or in need of special protection, but could be if present circumstances change. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Environment Protection and Biodiversity Conservation Act 1999 (EPBC) Threatened Species Codes

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	EW	Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically endangered	CR	Taxa which is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	EN	Taxa which is not critically endangered but is facing a high risk of extinction in the wild in the near future.
Vulnerable	VU	Taxa which is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term

Category	Code	Description
		future.
Conservation dependent	CO	Taxa which are the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

IUCN Red List of Threatened Species Codes

Category	Code	Description
Extinct	EX	Taxa for which there is no reasonable doubt that the last individual has died.
Extinct in the Wild	EW	Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range and it has not been recorded in known or expected habitat despite exhaustive survey over a time frame appropriate to its life cycle and form.
Critically endangered	CR	Taxa facing an extremely high risk of extinction in the wild.
Endangered	EN	Taxa facing a very high risk of extinction in the wild.
Vulnerable	VU	Taxa facing high risk of extinction in the wild
Near threatened	NT	Taxa which has been evaluated but does not qualify for CR, EN, or VU now but is close to qualifying or likely to qualify in the near future.
Least Concern	LC	Taxa which has been evaluated but does not qualify for CR, EN, VU, or NT but is likely to qualify for NT in the near future.
Data deficient	DD	Taxa for which there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status.

International conventions and agreements

Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)

This is an intergovernmental treaty under the United Nations Environmental Program which lists migratory species that would significantly benefit from international cooperation on their conservation and management.

Japan-Australia Migratory Bird Agreement (JAMBA)

This is an agreement between the Government of Australia and the Government of Japan for the protection of migratory, threatened and birds in danger of extinction. It requires both parties to conserve and protect the birds and their habitats as well as exchange information and build a cooperative relationship.

China-Australia Migratory Bird Agreement (CAMBA)

This is an agreement between the Government of Australia and the Government of the People's Republic of China for the protection of migratory birds and their environment. It requires both parties to conserve and protect the birds and their habitats as well as exchange information and build a cooperative relationship.

APPENDIX M
POTENTIALLY OCCURING MAMMALS

LOTS 181, 183, 184, 185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE - FAUNA SURVEY

APPENDIX M

Potentially Occurring Mammals

Species Name	Common Name	*Status
Burramyidae		
Western Pygmy-possum, Mundarda	*Cercartetus concinnus*	**CI: 3**
Dasyuridae		
Western Quoll / Chuditch	*Dasyurus geoffroii*	**CI: 1**
Brush-tailed Phascogale	*Phascogale tapoatafa ssp. (WAM M434)*	**CI: 1**
Peramelidae		
Quenda (Southern Brown Bandicoot)	*Isoodon obesulus fusciventer*	**CI: 2**
Myrmecobiidae		
Numbat, Walpurti	*Myrmecobius fasciatus*	**CI: 1**
Phalangeridae		
Common Brushtail Possum	*Trichosurus vulpecula vulpecula*	CI: 5
Macropodidae		
Western Brush Wallaby	*Macropus irma*	**CI: 2**
Quokka	*Setonix brachyurus*	
Vespertilionidae		
Gould's Wattled Bat	*Chalinolobus gouldii*	CI: 5
Chocolate Wattled Bat	*Chalinolobus morio*	CI: 5
Western False Pipistrelle	*Falsistrellus mackenziei*	**CI: 1**
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	CI: 5
Goulds Long-eared Bat	*Nyctophilus gouldi*	CI: 5
Greater Long-eared Bat	*Nyctophilus timoriensis timoriensis*	**CI: 1**
Southern Forest Bat	*Vespadelus regulus*	CI: 5
Muridae		
Water Rat	*Hydromys chrysogaster*	**CI: 2**
House Mouse	*Mus Musculus*	Feral
Bush Rat	*Rattus fuscipes*	CI: 5
Black Rat	*Rattus rattus*	Feral
Leporidae		
European Rabbit	*Oryctolagus cuniculus*	Feral
Felidae		
Feral/House Cat	*Felis catus*	Feral

The conservation importance of species is noted as its status, introduced species also noted [Feral].

* When species falls under more than one 'conservation importance' category, the highest status is noted.

APPENDIX N
POTENTIALLY OCURRING REPTILES

LOTS 181, 183, 184, 185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE - FAUNA SURVEY

APPENDIX N

Potentially Occurring Reptiles

Species Name	Common Name	*Status
Cheluidae		
Oblong Turtle	*Chelodina oblonga*	CI: 5
Agamidae		
Western Bearded Dragon	*Pogona minor minor*	-
Gekkonidae		
Marbled Gecko	*Christinus marmoratus*	-
Barking Gecko	*Underwoodisaurus milii*	-
Pygopodidae		
Sandplain Worm Lizard	*Aprasia repens*	-
Burton's Legless Lizard	*Lialis burtonis*	-
Scincidae		
Southwestern Cool Skink	*Acritoscincus trilineatum*	-
Fence, Wall Skink	*Cryptoblepharus plagiocephalus*	-
	Ctenotus australis	-
	Ctenotus fallens	-
Odd-striped Skink	*Ctenotus impar*	-
Red-legged Skink	*Ctenotus labillardieri*	-
King's Skink	*Egernia kingii*	-
Southwestern Crevice Skink	*Egernia napoleonsis*	-
Two-toed Earless Skink	*Hemiergis quadrilineata*	-
	Lerista elegans	-
	Lerista lineata	**CI: 2**
Common Dwarf Skink	*Menetia greyii*	-
Western Pale-flecked Skink	*Morethia lineoocellata*	-
Southwestern Bobtail	*Tiliqua rugosa rugosa*	-
Typhlopidae		
Blind Snake	*Ramphotyphlops australis*	-
Rotund Blind Snake	*Ramphotyphlops pinguis*	-
Boidae		
Carpet Python (Southwest population)	*Morelia spilota imbricata*	**CI: 1**
Elapidae		
	Demansia psammophis reticulata	-
Crowned Snake	*Elapognathus coronatus*	**CI: 3**
Black-naped Snake	*Neelaps bimaculatus*	-
Tiger Snake	*Notechis scutatus*	-
Gould's Snake	*Parasuta gouldii*	**CI: 3**
Dugite	*Pseudonaja affinis affinis*	-

Species Name	Common Name	*Status
Jan's banded Snake	*Simoselaps bertholdi*	-

The conservation importance of species is noted as its status, introduced species also noted [Feral].

* When species falls under more than one 'conservation importance' category, the highest status is noted.

APPENDIX O
POTENTIALLY OCURRING AMPHIBIANS

LOTS 181, 183, 184, 185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE - FAUNA SURVEY

APPENDIX O

Amphibians Expected to Occur Within the Project Area

Species Name	Common Name	Recorded	Status
Hylidae			
Slender Tree Frog	*Litoria adelaidensis*		CI: 5
Motorbike Frog or Bell Frog	*Litoria moorei*		CI: 5
Myobatrachidae			
Quacking Frog	*Crinia georgiana*		CI: 5
Glauert's Froglet	*Crinia glauerti*		CI: 5
Squelching Froglet	*Crinia insignifera*		CI: 5
Moaning Frog	*Heleioporus eyrei*		CI: 5
Bullfrog or Banjo Frog	*Limnodynastes dorsalis*		CI: 5
Crawling Frog or Gunther's Toadlet	*Pseudophryne guentheri*		CI: 5

An [X] indicates that the fauna was recorded during the site visit. The conservation importance of species is noted as its status, introduced species also noted [Feral].

* When species falls under more than one 'conservation importance' category, the highest status is noted.

APPENDIX P
POTENTIALLY OCCURING BIRDS

LOTS 181, 183, 184, 185, 197, 198, 1186 AND 1187 RONLYN ROAD AND LOT 179 RIVERSIDE DRIVE - FAUNA SURVEY
APPENDIX P

Birds Expected to Occur Within the Vicinity of the Project Area

Species Name	Common Name	Recorded	Status
Phasianidae			
Stubble Quail	*Coturnix pectoralis*		CI: 5
Brown Quail (southern form)	*Coturnix ypsilophora australis*		CI: 5
Anatidae			
Chestnut Teal	*Anas castanea*		**CI: 4**
Grey Teal	*Anas gracilis*		**CI: 4**
Australian Shoveler	*Anas rhynchotis*		**CI: 3, CI: 4**
Pacific Black Duck	*Anas superciliosa*		**CI: 4**
Hardhead	*Aythya australis*		**CI: 3, CI: 4**
Musk Duck	*Biziura lobata*		**CI: 3, CI: 4**
Australian Wood Duck	*Chenonetta jubata*		**CI: 4**
Black Swan	*Cygnus atratus*		**CI: 4**
Pink-eared Duck	*Malacorhynchus membranaceus*		**CI: 3, CI: 4**
Blue-billed Duck	*Oxyura australis*		**CI: 3, CI: 4**
Freckled Duck	*Stictonetta naevosa*		**CI: 3, CI: 4**
Australian Shelduck (Mountain Duck)	*Tadorna tadornoides*		**CI: 4**
Podicipedidae			
Great Crested Grebe	*Podiceps cristatus australis*		CI: 5
Hoary-headed Grebe	*Poliocephalus poliocephalus*		CI: 5
Australasian Grebe	*Tachybaptus novaehollandiae*		CI: 5
Anhingidae			
Darter	*Anhinga melanogaster novaehollandiae*		CI: 5
Phalacrocoracidae			
Great Cormorant	*Phalacrocorax carbonovaehollandiae*		CI: 5
Little Pied Cormorant	*Phalacrocorax melanoleucos*		CI: 5
Little Black Cormorant	*Phalacrocorax sulcirostris*		CI: 5
Pied Cormorant	*Phalacrocorax varius*		CI: 5
Pelecanidae			
Australian Pelican	*Pelecanus conspicillatus*		**CI: 4**
Ardeidae			
Great Egret, White Egret	*Ardea albus*		**CI: 4**
Cattle Egret	*Ardea ibis*		**CI: 4**
White-faced Heron	*Ardea novaehollandiae*		CI: 5
White-necked Heron	*Ardea pacifica*		CI: 5

Australasian Bittern	*Botaurus poiciloptilus*		**CI: 1, CI:3**
Little Egret	*Egretta garzetta*		CI: 5
Little Bittern	*Ixobrychus minutus dubius*		**CI: 2, CI: 3**
Black Bittern (SW population)	*Ixobrychus flavicollis*		**CI: 2**
Nankeen, Rufous Night Heron	*Nycticorax caledonicus hilli*		**CI: 3,** CI: 5
Threskiornithidae			
Yellow-billed Spoonbill	*Platalea flavipes*		CI: 5
Glossy Ibis	*Plegadis falcinellus*		**CI: 4**
Australian White Ibis	*Threskiornis molucca*		**CI: 4**
Straw-necked Ibis	*Threskiornis spinicollis*		**CI: 4**
Accipitridae			
Collared Sparrowhawk	*Accipiter cirrocephalus cirrocephalus*		**CI:3, CI: 4**
Brown Goshawk	*Accipiter fasciatus fasciatus*		**CI:3, CI: 4**
Wedge-tailed Eagle	*Aquila audax audax*		**CI:3, CI: 4**
Swamp Harrier	*Circus approximans*		**CI: 4**
Black-shouldered Kite	*Elanus axillaris*		**CI: 4**
Whistling Kite	*Haliastur sphenurus*		**CI:3, CI: 4**
Square-tailed Kite	*Hamirostra isura*		**CI:3, CI: 4**
Little Eagle	*Hieraaetus morphnoides morphnoides*		**CI:3, CI: 4**
Falconidae			
Brown Falcon	*Falco berigora berigora*		**CI:3, CI: 4**
Nankeen Kestrel	*Falco cenchroides*		**CI: 4**
Australian Hobby	*Falco longipennis*		**CI: 4**
Peregrine Falcon	*Falco peregrinus*		**CI: 1, CI:3, CI: 4**
Rallidae			
Eurasian Coot	*Fulica atra australis*		CI: 5
Dusky Moorhen	*Gallinula tenebrosa tenebrosa*		**CI: 3**, CI: 5
Black-tailed Native-hen	*Gallinula ventralis*		CI: 5
Buff-banded Rail	*Gallirallus philippensis*		CI: 5
Purple Swamphen	*Porphyrio porphyrio bellus*		CI: 5
Australian Spotted Crake	*Porzana fluminea*		CI: 5
Baillon's Crake	*Porzana pusilla*		**CI: 4**
Spotless Crake	*Porzana tabuensis*		**CI: 4**
Turnicidae			
Painted Button-Quail	*Turnix varia varia*		CI: 5
Otididae			
Australian Bustard	*Ardeotis australis*		**CI: 2, CI:3**

Scolopacidae			
Common Sandpiper	*Actitis hypoleucos*		**CI: 4**
Sharp-tailed Sandpiper	*Calidris acuminata*		**CI: 4**
Curlew Sandpiper	*Calidris ferruginea*		**CI: 4**
Red-necked Stint	*Calidris ruficollis*		**CI: 4**
Wood Sandpiper	*Tringa glareola*		**CI: 4**
Common Greenshank	*Tringa nebularia*		**CI: 4**
Marsh Sandpiper	*Tringa stagnatilis*		**CI: 4**
Burhinidae			
Bush Stone-Curlew	*Burhinus grallarius*		**CI: 2**
Recurvirostridae			
Banded Stilt	*Cladorhynchus leucocephalus*		**CI: 4**
Black-winged Stilt	*Himantopus himantopus*		**CI: 4**
Red-necked Avocet	*Recurvirostra novaehollandiae*		**CI: 4**
Charadriidae			
Hooded Plover (Western ssp)	*Charadrius rubricollis rubricollis*		**CI: 2**
Red-capped Plover	*Charadrius ruficapillus*		**CI: 4**
Black-fronted Dotterel	*Elseyornis melanops*		**CI: 4**
Red-kneed Dotterel	*Erythrogonys cinctus*		**CI: 4**
Banded Plover	*Vanellus tricolor*		**CI: 4**
Laridae			
Silver Gull	*Larus novaehollandiae novaehollandiae*		**CI: 4**
Whiskered Tern	*Sterna hybrida*		CI: 5
Columbidae			
Domestic Pigeon	*Columba livia*		Feral
Crested Pigeon	*Ocyphaps lophotes*		CI: 5
Common Bronzewing	*Phaps chalcoptera*		CI: 5
Spotted Turtle Dove	*Streptopelia chinensis*		**CI: 3,** CI: 5
Laughing Turtle Dove	*Streptopelia senegalensis*		Feral
Cacatuidae			
Sulphur-crested Cockatoo	*Cacatua galerita*		CI: 5
Muir's Corella	*Cacatua pastinator pastinator*		**CI: 1**
Galah	*Cacatua roseicapilla*		CI: 5
Little Corella	*Cacatua sanguinea*		Feral
Long Billed Corella	*Cacatua tenuirostris*		Feral
Forest Red-tailed Black Cockatoo	*Calyptorhynchus banksii naso*		**CI: 1**
Baudin`s Cockatoo, Long-billed Black Cockatoo	*Calyptorhynchus baudinii*		**CI: 1, CI: 3**
Carnaby`s Black Cockatoo, Short-billed Black Cockatoo	*Calyptorhynchus latirostris*		**CI: 1, CI: 3**
White-tailed Black Cockatoo	*Calyptorhynchus* sp.		-
Psittacidae			
Australian Ringneck	*Barnardius zonarius*		CI: 5
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*		CI: 5
Rainbow Lorikeet	*Trichoglossus haematodus*		CI: 5

Elegant Parrot	*Neophema elegans*		CI: 5
Western Rosella	*Platycercus icterotis icterotis*		CI: 5
Western Rosella (inland subsp)	*Platycercus icterotis xanthogenys*		**CI: 1**
Red-capped Parrot	*Platycercus spurius*		CI: 5
Regent Parrot	*Polytelis anthopeplus anthopeplus*		**CI: 3**
Rock Parrot	*Neopthema petrophila*		**CI: 3,** CI: 5
Cuculidae			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		**CI: 4**
Horsfields Bronze-cuckoo	*Chrysococcyx basalis*		**CI: 4**
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		**CI: 4**
Pallid Cuckoo	*Cuculus pallidus*		**CI: 4**
Strigidae			
Southern Boobook	*Ninox novaeseelandiae*		**CI: 4**
Tytonidae			
Barn Owl	*Tyto alba*		CI: 5
Masked Owl (Southern ssp)	*Tyto novaehollandiae novaehollandiae*		**CI: 2, CI:3**
Podargidae			
Tawny Frogmouth	*Podargus strigoides*		CI: 5
Aegothelidae			
Australian Owlet Nightjar	*Aegotheles cristatus cristatus*		CI: 5
Apodidae			
Fork-tailed Swift	*Apus pacificus*		**CI: 4**
Halcyonidae			
Laughing Kookaburra	*Dacelo novaeguineae*		Feral
Sacred Kingfisher	*Todiramphus sanctus sanctus*		**CI: 4**
Meropidae			
Rainbow Bee-eater	*Merops ornatus*		**CI: 4**
Climacteridae			
Rufous Treecreeper	*Climacteris rufa*		**CI: 3,** CI: 5
Maluridae			
Red-winged Fairy-wren	*Malurus elegans*		**CI: 3,** CI: 5
Splendid Fairywren	*Malurus splendens*		**CI: 3,** CI: 5
Southern Emu-wren	*Stipiturus malachurus westernensis*		**CI: 3,** CI: 5
Pardalotidae			
Spotted Pardalote	*Pardalotus punctatus*		CI: 5
Striated Pardalote	*Pardalotus striatus*		CI: 5
Broad-tailed Thornbill (Inland Thornbill)	*Acanthiza apicalis*		**CI: 3,** CI: 5
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*		**CI: 3,** CI: 5
Western Thornbill	*Acanthiza inornata*		**CI: 3,** CI: 5

Western Warbler	*Gerygone fusca fusca*		CI: 5
White-browed Scrubwren	*Sericornis frontalis*		CI: 5
	Sericornis frontalis maculatus		CI: 5
Weebill	*Smicrornis brevirostris*		CI: 5
Meliphagidae			
Western Spinebill	*Acanthorhynchus superciliosus*		CI: 5
Red Wattlebird	*Anthochaera carunculata*		CI: 5
Western Little Wattlebird	*Anthochaera lunulata*		**CI: 3,** CI: 5
White-fronted Chat	*Epthianura albifrons*		CI: 5
Yellow-plumed Honeyeater	*Lichenostomus ornatus*		**CI: 3,** CI: 5
Singing Honeyeater	*Lichenostomus virescens*		CI: 5
Brown Honeyeater	*Lichmera indistincta indistincta*		CI: 5
Yellow-throated Miner	*Manorina flavigula*		**CI: 3,** CI: 5
Brown-headed Honeyeater	*Melithreptus brevirostris*		CI: 5
Western White-naped Honeyeater	*Melithreptus chloropsis*		**CI: 3,** CI: 5
Tawny-crowned Honeyeater	*Phylidonyris melanops*		**CI: 3,** CI: 5
White-cheeked Honeyeater	*Phylidonyris nigra*		**CI: 3,** CI: 5
New Holland Honeyeater	*Phylidonyris novaehollandiae*		**CI: 3,** CI: 5
Petroicidae			
Western Yellow Robin	*Eopsaltria australis griseogularis*		**CI: 3,** CI: 5
White-breasted Robin	*Eopsaltria georgiana*		**CI: 3,** CI: 5
Jacky Winter	*Microeca fascinans*		CI: 5
Hooded Robin	*Petroica cucullata*		**CI: 3,** CI: 5
Red-capped Robin	*Petroica goodenovii*		CI: 5
Scarlet Robin (SW Population)	*Petroica multicolor campbelli*		**CI: 3**
Cinclosomatidae			
Western Whipbird (western mallee ssp)	*Psophodes nigrogularis oberon*		**CI: 1, CI: 3**
Neosittidae			
Varied Sittella	*Daphoenositta chrysoptera*		**CI: 3,** CI: 5
Pachycephalidae			
Grey Shrike-Thrush	*Colluricincla harmonica harmonica*		**CI: 3,** CI: 5
Crested Bellbird	*Oreoica gutturalis*		**CI: 2**
Golden Whistler	*Pachycephala pectoralis*		**CI: 3,** CI: 5
Rufous Whistler	*Pachycephala rufiventris rufiventris*		CI: 5
Dicruridae			
Magpie-lark	*Grallina cyanoleuca*		**CI: 4**
Restless Flycatcher	*Myiagra inquieta*		**CI: 3,** CI:

			5
Grey Fantail	*Rhipidura fuliginosa*		CI: 5
Willie Wagtail	*Rhipidura leucophrys*		CI: 5
Campephagidae			
Black-faced Cuckoo-Shrike	*Coracina novaehollandiae*		**CI: 4**
White-winged Triller	*Lalage tricolor*		CI: 5
Artamidae			
Black-faced Woodswallow	*Artamus cinereus*		**CI: 3,** CI: 5
Dusky Woodswallow	*Artamus cyanopterus*		**CI: 3,** CI: 5
Pied Butcherbird	*Cracticus nigrogularis*		CI: 5
Grey Butcherbird	*Cracticus torquatus*		CI: 5
Australian Magpie	*Gymnorhina tibicen*		CI: 5
Grey Currawong	*Strepera versicolor*		**CI: 3,** CI: 5
Corvidae			
Australian Raven	*Corvus coronoides*		CI: 5
Hirundinidae			
White-backed Swallow	*Cheramoeca leucosternus*		CI: 5
Fairy Martin	*Hirundo ariel*		CI: 5
Welcome Swallow	*Hirundo neoxena*		**CI: 4**
Tree Martin	*Hirundo nigricans nigricans*		**CI: 4**
Zosteropidae			
Silvereye	*Zosterops lateralis*		**CI: 4**
Sylviidae			
Clamorous Reed-Warbler	*Acrocephalus stentoreus*		**CI: 4**
Brown Songlark	*Cincloramphus cruralis*		**CI: 4**
Rufous Songlark	*Cincloramphus mathewsi*		**CI: 4**
Little Grassbird	*Megalurus gramineus gramineus*		**CI: 4**
Dicaeidae			
Mistletoebird	*Dicaeum hirundinaceum*		CI: 5
Passeridae			
Chestnut-breasted Mannikin	*Lonchura castaneothorax*		CI: 5
Red-eared Firetail	*Stagonopleura oculata*		CI: 5
Motacillidae			
Australian Pipit (Richard's Pipit)	*Anthus novaeseelandiae*		**CI: 4**
Fringillidae			
European Goldfinch	*Carduelis carduelis*		CI: 5

An [X] indicates that the fauna was recorded during the site visit. The conservation importance of species is noted as its status, introduced species also noted [Feral].

APPENDIX 4

LOCAL WATER MANAGEMENT STRATEGY

ROWEGROUP

Various Landholdings Furnissdale

Local Water Management Strategy

October 2015



Client: Coode Pty Ltd

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Executive Summary

Hyd2o was commissioned by Rowe Group to prepare this Local Water Management Strategy (LWMS) to support the proposed outline development plan (ODP) for Coode Pty Ltd's proposed residential development (the site).

The site has an approximate area of 50 ha and is located within the suburb of Furnissdale within the Shire of Murray. The site is bound to the south by the existing townsite, Riverside Drive to the west, Ronlyn Road to the east and Pinjarra Rd to the north (Figure 1).

The proposed development consists of a mix of medium density residential lots and public open space (POS) areas.

The site has generally been cleared and used for small scale rural residential type landholdings with small scale agriculture/cattle grazing and a poultry farm.

The site is generally flat with topography between 1 and 4 mAHD. The lithology of the site is predominantly characterised by Bassendean Sands with seasonal groundwater ranging from at surface in wetland areas to greater than 1.5 m below surface.

This LWMS has used 18 months predevelopment monitoring (2001-2010), an overarching District Water Management Strategy (Hyd2o, 2012) and a groundwater modelling report undertaken by Department of Water to inform its development. This LWMS has been prepared in accordance with the principles, objectives, and key criteria of *Better Urban Water Management* (Western Australian Planning Commission, 2008) and the *Murray Drainage and Water Management Plan* (Department of Water, 2010).

Implementation of the strategy will be undertaken in accordance with *Better Urban Water Management* through the development and implementation of Urban Water Management Plans for individual stages of development within the site.

Local Water Management Strategy Summary

Strategy Elements	LWMS Method & Approach
Water Use Sustainability	
Water Efficiency	• 5 Star Building Standards (water efficient fixtures and fittings). • Use of native plantings in POS and wetland rehabilitation areas. • Maximising infiltration of stormwater and use of superficial groundwater for POS irrigation.
Water Supply	• Rainwater Tanks and Water Corporation IWSS for lots. • Irrigation bore for Public Open Space
Wastewater	• Water Corporation reticulated sewerage
Stormwater	
Flood Protection	• Safe conveyance of the 1 in 100 year ARI flood event to the Serpentine River. • Stormwater storage areas located and integrated within POS areas. An area of 0.97 ha allocated for 100 year ARI storage across the site. • Habitable building levels set a minimum of 0.5m above 100 year ARI flood level in stormwater storage areas. • Habitable building levels set a minimum of 0.3m above 100 year ARI flood level in street drainage system. • Habitable building levels set 0.5m above 1 in 100 year flood heights of the nearby Serpentine River. • Local stormwater storage areas above 1 in 100 year flood heights of the nearby Serpentine River. • Overland flows paths within road reserves identified for safe conveyance of flows exceeding pipe drainage system capacity.
Serviceability	• Piped drainage system sized to convey 5 year event. • 1 in 5 year ARI event detained in 0.91 ha of POS.
Ecological Protection	• Use of soakwells at lot scale for R20 and R30 lots. • 1 year 1 hour ARI storm events to be treated and infiltrated where possible. • 1 year 1 hour ARI areas designed as ephemeral wetland/bioretention areas with detailed modelling to be undertaken at UWMP stage. • Bioretention area required calculated as 0.47 ha (2% of EIA). • Existing degraded wetland buffers rehabilitated. • Infiltration areas located outside of wetland buffers. • Non-structural control commitment, details at UWMP stage.
Groundwater	
Fill & Subsoil Drainage	• Clearance to groundwater to be achieved using imported fill. • No subsoil drainage to be used.
ASS & Contamination	• ASS and contaminated sites to be investigated as a separate process and reported in UWMP.

1. Introduction

Hyd2o was commissioned by Rowe Group to prepare this Local Water Management Strategy (LWMS) to support the proposed outline development plan (ODP) for Coode Pty Ltd's proposed residential development (the site).

The proposed ODP is for Lots 181-185, 197,198, 1186 & 1187 Ronlyn Road and Lots 179 & 180 Riverside Drive, Lots 149, 150 & 156 Pinjarra Road.

The site has an approximate area of 50 ha and is located within the suburb of Furnissdale in the Shire of Murray approximately 8 km east of Mandurah city centre. The site is bound to the south by the existing townsite, Riverside Drive to the west, Ronlyn Road to the east and Pinjarra Rd to the north (Figure 1).

The proposed development consists of medium density development and public open space (POS) (Figure 2). It should be noted that 7 ha of land in the south central area of the site has been allocated as OEPA Vegetation which will not be impeded by development. Figure 2 indicates the OEPA Vegetation boundary which has been surrounded by POS on the outer fringe.

The site is within the area covered by the overarching *Murray Drainage and Water Management Plan (DWMP)* (Department of Water (DoW), 2010) and the *West Furnissdale District Water Management Strategy* (Hyd2o, 2012).

This LWMS provides a total water cycle management approach to development and has been prepared consistent with *Better Urban Water Management* (Western Australian Planning Commission (WAPC), 2008). This document provides the outcomes of site specific analysis relating to groundwater, surface water and wetland hydrology and provides a clear vision in terms of adopting best management practices to achieve water sensitive design.

1.1 Planning Background

Peel Region Scheme amendment 034/57 was approved by the Minister for Planning and was took effect on Tuesday 21 May 2013 as published in the Government Gazette. The amendment transferred the site from Rural Zone to Urban Zone.

The Shire of Murray Town Planning Scheme No. 4 has also been amended to include the site within the Residential Development Zone.

Table 1 provides the relationship between various stages of planning, the required urban water management documentation and the status of each document.

Table 1: Integrated Planning and Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Document and Status
Scheme Amendment	Peel Region Scheme Amendment	West Furnissdale District Water Management Strategy (Hyd2o, 2012) **APPROVED**
Local	Furnissdale Outline Development Plan	Various Landholdings Furnissdale Local Water Management Strategy **THIS DOCUMENT**
Subdivision	Subdivision Application	Urban Water Management Plan (for individual subdivision applications) **FUTURE PREPARATION**

1.2 Principles and Objectives

This document has been prepared consistent with the principles and objectives for water sensitive urban design that are presented in the DWMS (Hyd2o, 2012), the DWMP (DoW, 2010), and *Better Urban Water Management* (WAPC, 2008).

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

- *West Furnissdale District Water Management Strategy* (Hyd2o, 2012)
- *Murray Drainage and Water Management Plan* (DoW, 2010)
- *Better Urban Water Management* (WAPC, 2008)
- *Stormwater Management Manual for WA* (Department of Water, 2007)
- *Decision Process for Stormwater Management in WA* (Department of Water, 2009)
- *Peel Harvey WSUD Local Planning Policy* (Peel Development Commission 2006)

1.3 Previous Studies

The following previous studies have been undertaken for the site:

- *Furnissdale groundwater modelling report* (Department of Water, 2012)
- *Lots 181-185, 197, 198, 1186, 1187 Ronlyn Rd and Lots 179 & 180 Riverside Drive North Furnissdale: Environmental Assessment* (ENV Australia, 2008)
- Groundwater monitoring undertaken by ENV Australia
- *Furnissdale Outline Development Plan Infrastructure* (Porter Consulting Engineers, 2013)

2 Pre-Development Environment

2.1 Site Conditions

An aerial photo of the site is provided as Figure 3. The majority of the site is currently used as rural residential property with some small scale agriculture and a poultry farm.

Generally, the site has been previously cleared for small scale agricultural purposes with some existing bushland.

Topography of the site is generally flat and low-lying with topography between 1 mAHD and 4 mAHD. The Lidar topographic data obtained from Department of Water is shown in Figure 3.

The Perth and Peel regions is characterised by a Mediterranean climate with warm dry summers and cool wet winters.

2.2 Geotechnical

According to environmental geology mapping in the 1:250 000 series of Perth mapping (sheets Sh50-14 & part SG50-13) the entire site is identified as being Bassendean Sand (Figure 4).

Groundwater monitoring bores installed by ENV Australia also provide site specific data regarding the soil profile. Eight monitoring bores were installed across the site on 21 September 2007 to approximately 4 m depth below surface (until intersection with the groundwater table). Predominantly the subsurface profile was characterised by a variable size grain sand ranging in colour from dark brown to orange. In MW2-MW5 and MW8 some sandy clay or clay soils were encountered at approximate depth of 3.5 m below ground surface.

2.2.1 Acid Sulphate Soils

According to *Planning Bulletin 64 Acid Sulphate Soils* (WAPC, 2009) the site is classified as having a high to moderate risk of acid sulphate soils occurring within the upper 3 m.

2.3 Wetlands

There is one wetland on the western boundary of the site adjacent to Riverside Drive. The wetland is classified as a Floodplain type wetland and is an extension of the floodplain area adjacent to the Serpentine River (Figure 5). In the Department of Parks and Wildlife's (DPaW) *Geographic wetlands of the Swan coastal* plain dataset, a small portion of the wetland is listed as a conservation category wetland (CCW) with the majority shown as multiple use (MU).

The Department of Water (DoW) and DPaW have confirmed that the parts of the floodplain wetland in Lot 185 Ronlyn Road have good condition remnant native vegetation, and that the wetland is of conservation management category status. This will be maintained post development with a buffer area within the public open space (POS).

Parts of the floodplain area on the western side of Riverside Drive are mapped as conservation category wetland (CCW), however upon site inspection the areas within 50 m of the site boundary have been cleared of native vegetation and filled (Figure 5). Based on a review of historical aerial photographs it appears that the clearing and filling occurred sometime in 2000/2001. It is assumed that there is no buffer relevant to this wetland.

Lower-lying central parts of Lots 117 and 118 Riverside Drive are vegetated and may retain conservation category status.

2.3.1 CCW and TEC Management

Strategen met with DPaW on-site at Lot 185 Ronlyn Road on 16 December 2014 to confirm whether the wetland was representative of Threatened Ecological Community FCT 07 and to discuss DPaW's position on the values, protection and management of the above wetland. The site inspection confirmed that the wetland vegetation is in good condition and that the vegetation community is consistent with TEC FCT 07.

It was verbally confirmed by DPaW (Lyndon Mutter and Jill Pryde) that the 4960sq m area (shown in Figure 5a) as 'Conservation value wetland' is worthy of protection and management, inclusive of a 20m buffer (excluding the western side which is immediately adjacent to Riverside Road). This is consistent with the position provided by the Department of Water. Further to this, DPaW have requested that a commitment be provided in writing, confirming that the requirements stipulated by the Department of Water will be met by the proponents.

Strategen submitted the following documentation to satisfy DPaW's request for a written commitment to the protection and management of the wetland. This has since been endorsed by DPaW and the Shire:

> The following commitments are made with regard to the conservation and management of the area identified as wetland and Threatened Ecological Community:
>
> 1. Protection of the area indicated as 'conservation value wetland' (in Figure 5a). Access to this area by people, pets, livestock and vehicles will be restricted (e.g. by fencing).
>
> 2. Provision of a buffer of 20 m width on all sides of the wetland area, except where Riverside Drive adjoins the wetland.
>
> 3. The buffer will be revegetated with appropriate local native plants species, but may be used for passive recreation such as walk trails. Revegetation will be designed to discourage access to the conservation area.
>
> 4. Recognising that the wetland forms part of the current and future stormwater management system for the site and that the management of downstream flows are under the control of other parties such as the Shire of Murray, a hydrological regime will be established by the consultant team through the development of Wetland Management Plan that maintains the wetland values as best as is possible. The hydrological regime will consider and seek to manage water levels and periods of annual inundation, and stormwater quality entering the wetland.

5. Preparation of a Wetland Management Plan by an appropriately qualified consultant. The plan will address weed control, revegetation, fencing to restrict access to the core conservation area but maintain aesthetic values (e.g. split rail fence with dense shrubs in the buffer), educational signage and any other management issues identified.

6. The wetland, buffer and any additional POS area will be separated from adjacent development by a road. The road reserve will be designed to provide appropriate setbacks in accordance with the WAPC's Planning for Bushfire Management Guidelines.

7. Every effort will be made to retain the mature river red gums to the north of the 'conservation value wetland' (shown in blue in attached figure) and incorporated into a larger and manageable area of POS.

The commitment made by the proponent (as outlined within this correspondence) relates to the land under the control or ownership of the proponent only. It must be acknowledged that the proponent is unable to guarantee the commitment of the adjoining landowner of Lot 184 with regard to the future development of their landholding. Notwithstanding, following approval of the ODP all future development and/or subdivision of the land is to be undertaken in accordance with the provisions of the ODP unless otherwise approved by the Shire of Murray and other relevant State authorities.

The proponent's commitment as detailed within this correspondence is provided on the basis that the ODP and subsequent subdivision plans are approved to the proponent's satisfaction and development proceeds across the subject site.

2.3.2 Wetland Management Plan

Preparation of the Wetland Management Plan (WMP) will be undertaken at the UWMP stage as a condition of subdivision approval and would be prepared prior to development occurring on site.

As part of the preparation of the WMP, a hydrological investigation is required to assess the hydrological regime of the CCW/TEC. This will be used to assess the function of the wetland with the existing culverts unblocked to allow discharge from the wetland. Particular consideration is required to identify the following aspects:

- A functioning water level within the wetland, taking into account the TEC requirements.
- Design features to assist in retaining water in the wetland once the culverts have been unblocked. This should include modelling the culverts with infrastructure to partially block the culverts or potentially raise the invert of the outlet.
- Long term maintenance of the wetland to ensure the vegetation health improves.

Monitoring of the wetland water levels will be necessary for this investigation. Further scoping of this work will be required at the UWMP stage.

2.4 Surface Water Hydrology

2.4.1 Surface Water Features

There are no rivers, creeks, drains, or waterways within the site. The site is located to the west of Serpentine River. DoW floodplain mapping indicates that a small portion of the site adjacent to Riverside Drive is located within the flood fringe of the Serpentine River but is well outside the floodway (Figure 6). Flood levels in the Serpentine River during the 1 in 100 year event are approximately 2.10 mAHD at the northern end of the site and falling to 1.83 mAHD at the southern part of the site (pers comm, Simon Rodgers, DoW).

The site is divided into two catchments both of which discharge into the Serpentine River. However it should be noted that there are no well-defined pre development flow paths within either of these catchments and overland flow, based on the topography, is assumed. These overland flow paths are shown in Figure 6.

In the northern catchment there is a naturally low depression located along Riverside Drive coincident with part of the Multiple Use wetland area. During winter water is present within the depression. There are three culverts present under Riverside Drive near the depression, one 600 mm diameter culvert and two 300 mm diameter culverts to convey flow under the road and to the Serpentine River.

Hyd2o undertook an inspection of the site on 24/4/2012 and the three culverts mentioned above were located and found to be blocked on their downstream end. This has occurred due to the filling of the neighbouring land.

A plan provided by the Shire of Murray indicates that the culverts are to be reinstated with inverts between 0.39 mAHD and 0.46 mAHD with a flow path reinstated within an easement downstream to enable flow to the Serpentine River from this area. This plan, produced by Development Engineering Consultants (2010) is included in Appendix A.

There are currently no external catchments feeding into the site. The DWMS indicated flows onto the site from lots in the east however no current flow path is apparent across Ronlyn Road and it has been assumed that the road forms the pre development catchment boundary. Similarly, Pinjarra Road forms the northern boundary of the site's pre development catchment (Figure 6).

Although no current pre development flows exist from the lots on the eastern side of Ronlyn Rd, it is anticipated that the development of these lots will require stormwater conveyance through the site in order to discharge to the Serpentine River. Therefore a pre development flow rate, based on all lots located within the external catchment, was estimated to inform the post development stormwater strategy within this LWMS.

2.4.2 Pre and Post Development Flow Rates

An XP Storm model was used to estimate flow rates from the two pre development catchments within the site and the external catchment upstream of the site.

The northern catchment had 5 and 100 year ARI flows of 0.38 m^3/s and 0.62 m^3/s, respectively. The southern catchment had 5 and 100 year ARI flows of 0.18 m^3/s and 0.28 m^3/s, respectively.

The external catchment 5 and 100 year ARI flow rates were estimated to be 0.4 m^3/s and 0.66 m^3/s, respectively. This was based on applying 12 l/s/ha and 20 L/s/ha, respectively, over the 33 ha area.

2.4.3 Surface Water Quality

ENV monitored the water quality in the wetland on 3/10/2007 (location shown on Figure 6), results are summarised below:

- Neutral with a pH of 7.31.
- Electrical conductivity of 1.73 mS/day.
- Both total nitrogen and total phosphorus were recorded above ANZECC guideline values as 3.60 mg/L and 0.98 mg/L respectively.

2.5 Groundwater Hydrology

ENV Australia Pty Ltd (ENV) undertook a hydrological monitoring programme across the site between October 2007 and October 2009. ENV installed eight groundwater well via drill rig in October 2007; all bores were constructed suitable for groundwater quality sampling (Figure 7). Monitoring results are provided in Appendix B.

2.5.1 Groundwater Levels

The Department of Water utilised the groundwater monitoring results along with a number of other sources to calibrate and run a groundwater model for the site consistent with the recommendations of the Murray DWMP.

The study established a calibrated groundwater/surface water model in the MIKE SHE framework at a suitable resolution to inform future residential development. The following scenarios were developed:

- A base case scenario of average annual maximum groundwater levels (AAMGL).
- The AAMGL including sea level rise of 0.9 m consistent with State Policy 2.6 State Coastal Planning
- A post development scenarios with subsoil drainage inverts set at base case AAMGLs both with and without sea level rise.
- A post development scenario with subsoil drainage inverts set at AAMGL including sea level rise and run with and without sea level rise.

Results of the modelling found the following:

- The AAMGL base case scenario ranged from 1 mAHD to 1.5 mAHD within the West Furnissdale area with the depth to groundwater ranging from at surface to 2.0m below ground surface.
- In the event of 0.9 m sea level rise AAMGL would rise to 1.75 mAHD to 2.0 mAHD across the site.
- Figure 7 provides a comparison of the two sets of groundwater levels.

Groundwater levels used for design are discussed in Section 7: Groundwater Management Strategy.

2.5.2 Groundwater Quality

Groundwater quality was measured on an approximately quarterly basis for the 2 year monitoring period. Samples were tested for physical parameters, nutrients, and heavy metals.

Groundwater quality can be summarised as follows:

- Total nitrogen concentrations ranged between 0.58 mg/L and 5.4 mg/L with the average concentration being 2.3 mg/L which is above ANZECC guideline value of 1.2 mg/L.
- Total phosphorus concentrations ranged between 0.01 mg/L and 0.89 mg/L with the average concentration being 0.15 mg/L which is above the ANZECC guideline value of 0.065 mg/L.
- Average concentrations for arsenic, cadmium, chromium, copper, and zinc were all found to be above ANZECC guideline values whilst lead and nickel were found to be below
- Mercury concentrations were generally recorded below the laboratory limit of detection.

3 Design Criteria

Key design criteria for the site are shown in Table 2 and have been established consistent with criteria specified in the key reference documents previously detailed in Section 1.3

These design criteria are used in Sections 5, 6 and 7 together with the identified constraints and opportunities of the predevelopment environment (Section 3) to establish the water management strategy for the site.

Table 2: Design Criteria

Strategy Elements	Criteria
Water Use Sustainability	
Water Efficiency	• Reduce consumptive use through adoption of waterwise practices.
Water Supply	• Develop "fit for purpose" water supply strategy, and minimise potable water use where drinking quality water is not essential.
Wastewater	• Provide a wastewater system which meets agency requirements.
Stormwater	
Flood Protection	• Provide safe passage of the 1 in 100 year ARI event to the Serpentine River. • Establish minimum habitable floor levels at 0.5m above the 100 year ARI flood levels. • Provide flood paths for overland flows which exceed the capacity of piped drainage.
Serviceability	• Provision of 1 in 5 year storage areas for retention of local stormwater. • Road drainage system to be designed so that roads will be passable in the 1 in 5 year event.
Ecological Protection	• 1 in 1 year 1 hour storm event to be retained on site. • Bioretention areas established at 2% of connected impervious areas. • Rehabilitate existing degraded wetland buffers. • Implement non-structural controls.
Groundwater	
Fill Requirement & Subsoil Drainage	• Establish development levels with acceptable clearance above post development groundwater levels. • No subsoil drainage to be used post development.
Acid Sulphate Soils & Contamination	• Management of Acid Sulphate Soils to be handled as a separate process to LWMS consistent with DoE(2004) requirements.

4 Water Use Sustainability Initiatives

4.1 Water Efficiency Measures

Development of the site will lead to an increased demand of potable water for residential use as irrigation of gardens and POS areas. Water conservation measures will be implemented to reduce scheme water consumption within the development will be consistent with Water Corporation's "Waterwise" land development criteria including:

- Use of high 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 fittings (taps, showerheads, toilets, rainwater tanks, waterwise landscaping).
- All houses to be built to 5 star building standards.
- Use of native plants in POS areas and wetland rehabilitation.
- Use of groundwater bores for irrigation of POS and common areas.
- Maximising on site retention of stormwater (where practicable).

4.2 Water Supply

Potable water supply to future homes in the site will be via the Water Corporation Integrated Water Supply System (IWSS). The Infrastructure report for the site was prepared by Porter Consulting Engineers (2013) and is provided in Appendix C which outlines the strategy for water supply management in greater detail.

With respect to Public Open Space irrigation, the site is located within the Murray groundwater management area (GMA), Nambeelup groundwater sub area. The DoW water register indicates that is allocation available in the superficial aquifer.

Rainwater tanks have been identified as a non-potable source to be integrated as part of the domestic water supply scheme to assist in reducing stormwater generation and minimise scheme water importation.

A number of small private licenses are currently being used in the site which may be potentially transferred to the proposed development. The licence details are as follows:

- GWL 172565 (4800 kL)
- GWL 63685 (43,000 kL)
- GWL 63876 (9000 kL)

These licenses provide a total of 33,000 kL allocation. The outline development plan shows approximately 4.4 ha of public open space. Assuming a normal irrigation rate of 7500 kl/ha this would require an allocation of 33,000 kL which can be accommodated with the existing groundwater licences.

An application for a groundwater licence to take water will be submitted to DoW as a separate process to this LWMS in due course.

4.3 Wastewater Management

Wastewater will be deep sewerage (reticulated) with long term management by the Water Corporation. The servicing report for the site is provided in Appendix C which outlines the strategy for wastewater management in greater detail.

5 Stormwater Management Strategy

Stormwater management is proposed to be undertaken consistent with DoW water sensitive design practices. The system will consist of a series of lot soakwells, road drainage system comprising pipes and bioretention areas, and ephemeral storage areas within POS to provide water quantity and quality treatment for stormwater generated from the proposed development.

Key elements of the system which are reflected in the structure plan include:

- Rehabilitation of wetland buffer.
- Use of distributed POS areas for ephemeral stormwater retention/detention.

5.1 Stormwater Modelling

Stormwater modelling for the site was performed using XP-Storm to determine flood storage requirements and provide an assessment of local structure plan areas required for drainage purposes. There are three post development catchment areas and three contributing storage areas proposed as part of the development which are shown in Figure 8.

An upstream catchment identified in the DWMS (Hyd2o, 2012) which will ultimately discharge through the site is also detailed in Figure 8. A 20 m road reserve within the site has been proposed to allow conveyance of this external flow to discharge to the Serpentine River via the CCW within the site. This flow path will need to be accommodated in engineering design at UWMP stage. It should be noted that this external flow has not been included in modelling for this LWMS.

Storage A is located in the southwest corner of the site and is proposed to discharge via a piped outlet into the Serpentine River. A culvert is proposed to be installed under Riverside Drive and continue within the road easement towards a regional open space reserve discharging into the Serpentine River. Modelling has assumed piped discharge into the Serpentine River however opportunities may exist for other suitable conveyance method. Engineering detail regarding the type discharge of structure (table drain/pipe) is to be provided in a subsequent Urban Water Management Plan. The option of discharging Storage A through the Furnissdale townsite was investigated however there is currently no existing drainage pipework close to the site available to provide a suitable connection. The Shire of Murray has also indicated that the soakwells within the townsite have some root intrusion and may not have adequate capacity.

Storage B is located in the central POS area along Riverside Drive and accesses the natural low depression within the conservation category wetland (CCW) and existing culverts under the road as an outlet. The storage area is situated in POS outside the adjacent CCW area that lies within the site's boundary as shown in Figure 9. Storage B is designed to detain the 5 year ARI event to improve water quality prior to discharging into the adjacent CCW and exiting the site via the 300 mm culverts under Riverside Drive. During greater events (100 year ARI) this storage area will overflow into the CCW via a spillway created to direct flow towards the 600 mm culvert under Riverside Drive. In all events, discharge from the CCW via the existing culverts will be directed into a table drain along the road which will convey the flow to the northeast, into the open channel which has been reinstated to

discharge the flow to the Serpentine River. This flow path is shown in Figures 9 and 9B. Engineering designs for the Riverside Drive table drain and the open channel have been undertaken by Development Engineering Consultants and are included in Appendix A. It has been assumed that the 100 year ARI event from the development will have a shorter time of concentration than the flooding from the Serpentine River catchment.

Storage C is located in the northeast corner of the site within POS area. Similar to Storage B, Storage C is designed to detain the 5 year ARI and release greater events via a spillway to the larger CCW on the northwest side of Riverside Drive (outside the site). During greater events, discharge from the storage area will be directed to a table drain along Riverside Drive, then flow southwest and utilising the existing drainage easement which has been reinstated to discharge the flow to Serpentine River. The flow path is shown in Figure 9.

Design criteria for the 5 year ARI storage is to correspond with the pre-development run-off rates in the 5 year ARI event and to suit the proposed downstream infrastructure.

It should be noted that Storage A has been currently designed with a single piped outlet to also provide attenuation of flows greater than 5 year ARI, unlike Storages B and C which discharge via a spillway for events greater than 5 year. Opportunities for use of a similar outlet structure for Storage A as for Storages B and C will be considered at UWMP stage in consultation with the Shire of Murray subject to impacts on the downstream receiving environment. This may ultimately result in a smaller land take for drainage for Storage A than currently detailed in this report.

Key stormwater modelling parameters including runoff coefficients are shown in Table 3 for each of the identified proposed land uses. The proposed runoff rates have assumed the use of soakwells within the lots.

Modelled detention storage volumes, areas and depths are detailed in Table 3.

All storage area inverts for this modelling were established above the 100 year ARI flood levels for the Serpentine River (shown in Figure 6). It should be noted that the 100 year ARI flood levels in the Serpentine River are greater than the AAMGL (sea level rise scenario).

The design storms modelled by XP-Storm were calculated internally by the model with reference to the methodology in Australian Rainfall & Runoff (AR&R) (Institution of Engineers, Australia 2000) and the Bureau of Meteorology Computerised Design IFD Rainfall System. The rainfall temporal pattern was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 30 minutes to 72 hours.

Table 3: Stormwater Storage Sizing

		Catchment		
		A	**B**	**C**
Catchment Details	**Runoff Coefficient**			
Residential Lots R20 & R30 (ha)	25%	6.92	10.63	-
R40 & R60 (lot connections) (ha)	65%	0.88	4.46	1.95
R-AC (ha)	70%	-	1.54	-
Road & Road Reserve (ha)	90%	3.78	6.75	0.56
POS (ha)	10%	2.09	2.80	0.21
CC Wetland (ha)	0%	-	0.50	-
OEPA + buffer (ha)	0%	5.76	1.24	0.08
Total Contributing Area (ha)	-	19.43	27.91	2.80
Equivalent Impervious Area (ha)	-	5.91	12.91	1.79
Pre Dev 5 year Discharge (m^3/s)	-	0.18	0.78 (0.38)	0.03
Pre Dev 100 year Discharge (m^3/s)	-	0.28	1.28 (0.62)	0.06
			Allowable discharge rates from Catchment B are the combined flow from B and the external upstream catchment	
Storage Design Parameters				
Base Area (m^2)		2000	2000	900
Side Slopes (v:h)		6	6	6
Base Invert		2.00	2.10	2.10
Depth to AAMGL (m)		1.6	0.6	1.5
Outlet Pipe Dia (mm)		300	300	125
1 Year 1 Hour - Bioretention area				
Required Area (m^2) (calculated as 2% EIA)		1200	2580	360
TWL Area (m^2)		2140	2265	980
Flood Rise (m)		0.13	0.24	0.10
Volume (m^3)		272	510	100
5 Year ARI				
Flood Rise (m)		0.47	0.54	0.44
Volume (m^3)		1070	1233	470
TWL Surface Area (m^2)		2540	2620	1243
TWL (mAHD)		2.47	2.64	2.54
Peak Discharge (m^3/s)		0.10	0.27	0.02
Critical Storm		**48hr**	**48hr**	**48hr**
100 Year ARI				
Flood Rise (m)		0.92	0.55	0.52
Volume (m^3)		2350	1275	580
TWL Surface Area (m^2)		3090	2640	1320
TWL (mAHD)		2.92	2.65	2.62
Peak Discharge (m^3/s)		0.11	0.50	0.06
Critical Storm		**48hr**	**48hr**	**48hr**

5.2 Flood Protection (100 Year)

Modelled flood protection storage volumes, areas, and flood rises are detailed in Table 3 and Figure 9 for the 100 year ARI flood event showing the extent of inundation of POS area for major event flood management.

Figure 9 also shows the flow paths along roads for overland conveyance of the 100 year ARI short duration storm events which exceed the capacity of the piped drainage system.

Figure 9B provides more detail for the flow paths of Storages B and C along Riverside Drive and discharge into the CCW and Serpentine River.

The total area within the site required for flood storage up to the 100 year ARI event is approximately 0.71 ha with a total detention storage volume of approximately 4205 m^3 . The proportion of 100 year ARI storage will be downstream of the site within the conservation category wetland near Serpentine River.

Note that storage shapes shown in Figure 9 are indicative only for determination of area requirements and representation of storage areas required in relation to POS areas allocated in the structure plan.

The final flood attenuation area configuration (side slopes etc), locations, and elevations will be documented in UWMPs and will be dependent on final earthworks, drainage, and road design levels for the development. Minor changes (refinements) in catchment areas shown in this report are considered likely to occur as detailed design proceeds, and stormwater modelling will be updated accordingly during the UWMP process.

The minimum building floor levels will comply with DoW and Shire of Murray requirements for a 0.5m clearance above estimated 100 year ARI flood levels.

5.3 Serviceability (5 Year)

Modelled storage volumes, areas, flood rise and inverts are detailed in Table 3 and Figure 9 for the 5 year flood event, showing the extent of inundation of POS area for serviceability requirements.

The total area required for the 5 year ARI event is approximately 0.64 ha or 1.3% of the total site area with a total detention storage volume of approximately 2773 m^3.

5.4 Ecological Protection (1 Year)

5.4.1 Structural Controls

Bioretention areas are typically calculated as 2% of the effective impervious area to provide a guide for storage requirements and areas for water quality treatment consistent with DoW requirements (DoW, 2009). Based on this, the total area required for bioretention is approximately 0.47 ha.

Table 3 provides the modelling results of the 1 year 1 hour ARI event indicating the volume required to be treated within the bioretention areas.

Specific details of 1 year ARI areas such as their locations and design will be contained in the UWMP. Opportunities for distributed storages within streetscapes will be examined at

UWMP stage to reduce these sizes. This will include examining opportunities for use of street scale infiltration devices and shallow open swale networks.

Soil amendment will be required in the bioretention areas. It is recommended that soils with a PRI of greater than 10 should be used at a minimum depth of 300 mm across the area. Identification of appropriate soil amendment will be detailed at UWMP stage.

Table 4 details a summary from DoW's Stormwater Management Manual for Western Australia (2007) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria.

Table 4: BMP Water Quality Performance In Relation to Design Criteria

Parameter	Design Criteria via BUWM (WAPC,2008) (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)

While DoW (2007) does not provide expected pollutant removal efficiencies for all BMP's, application of a treatment train approach using a combination of the non-structural and structural measures will therefore clearly achieve the design objectives for water quality as detailed in *Better Urban Water Management* (WAPC, 2008).

5.4.2 Non-Structural Controls

This LWMS proposes a treatment train approach to water quality management which includes non- structural as well as structural controls:

- **Non-Structural Controls**
  Planning: POS locations, and configurations
  Landscape: Vegetation (native plantings) and soil selection, WSUD integration
  Education: Point of sale WSUD education package
  Maintenance: POS Areas, Street sweeping, Manhole eduction
  Monitoring : Post development program and review
- **Structural Controls**
  Bioretention storage: 1 year treatment areas
  Wetland : Vegetated buffer areas and native plantings

Measures adopted represent known best management practice as detailed in the DoW's *Stormwater Management Manual for Western Australia* (2007).

5.5 Landscaping

The Landscape Strategy Plan, provided by Emerge Associates (2015), has been included as Appendix C. The detailed plan includes the overall master plan as well as POS concept layouts, wetland rehabilitation areas and recommended tree species.

Cross sections of the wetland buffers and the entry boulevard have also been included in the landscape plans.

5.6 OEPA Vegetation

The 6.8 ha of OEPA Vegetation located within the site has not been included in the modelling or stormwater management strategy of this LWMS. This area will be ceded to the Shire at subdivision stage and maintained by the developer for two years by way of condition of subdivision approval.

6 Groundwater Management Strategy

6.1 Fill and Subsoil Drainage

Detailed bulk earthworks plans have been prepared by Porter Consulting Engineers and are included in Appendix D. Plans indicate the proposed development levels between 3.25 – 3.5 mAHD. This is to be achieved predominantly through the importation of fill. Porter Consulting Engineers also prepared a services and infrastructure report for the site which has been included as Appendix E.

Due to the significant levels of fill being applied across the site, subsoil drainage will not be necessary to ensure separation between groundwater and finished surface levels across the site. Furthermore, inverts for all stormwater storage areas are in exceedance of the minimum requirement of 300mm above the AAMGL (Table 3).

Finished lot levels and fill requirements are a detailed design issue to be addressed during preparation of the UWMP and will be submitted for Shire approval at that stage.

6.2 Acid Sulphate Soils

Management of Acid Sulphate Soils (ASS) will be addressed as a separate study to this LWMS.

Details regarding the outcomes of this study will be included as part of the Urban Water Management Plan (UWMP).

All assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series Identification and Investigation of Acid Sulphate Soils (DoE, 2004).

7 Urban Water Management Plans

Consistent with processes defined in WAPC (2008), Urban Water Management Plans (UWMP's) will be developed and submitted to support subdivision applications for various stages of development within the site.

UWMP's will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of the Shire and DoW.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Preparation of a Wetland Management Plan which will address weed control, revegetation, fencing to restrict access to core conservation area, educational signage and any other management issues identified.
- Investigation into the hydrological regime of the CCW/TEC to assess maintaining an appropriate water level for the wetland vegetation. Modelling should include looking at partially blocking the existing culverts and/or raising the invert outlet using engineering design. Monitoring of the wetland may also be necessary for this investigation.
- Detailed stormwater management design including the size, location and design of public open space areas, integrating major and minor flood management capability.
- Management of groundwater levels including proposed cut/fill levels.
- 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.
- Opportunities for use of a similar outlet structure for Storage A as for Storage B and C will be considered at UWMP stage.
- Management of subdivisional works including development of a strategy for sediment control during construction.
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Specific monitoring and reporting to be undertaken for each UWMP area consistent with the monitoring program defined in the LWMS.
- Contingency plans (where necessary).

More detail of the POS and wetland buffer areas will be provided during the development of the UWMP, including refinement of stormwater modelling, preparation of landscape plans (species selection and treatments), and detailed design drawings.

Preparation of the UWMP will be the developers' responsibility.

8 Monitoring

8.1 Pre Development

It is not envisaged any further additional predevelopment groundwater monitoring will be required to inform the UWMP and subdivision process.

The project has undertaken 18 months of predevelopment monitoring included 2 winter periods.

8.2 Post Development

Post development groundwater monitoring locations are detailed in Figure 11 consisting of five bores that exist on site. Locations of these bores will assess groundwater flow in and out of the site as well as groundwater levels close the wetland area on site. No surface water locations are included in the monitoring program.

Parameters included in the monitoring program, as well as method and frequency of monitoring, are detailed in table 5.

DoW (2011) indicates a minimum of 3 years post development monitoring is required, and defines post development as "*from completion of first subdivision to five years after 80 per cent of the development (by land area) has been completed*".

The program is therefore designed to operate over the minimum three year post development period, with the timing for commencement of the program to be negotiated at UWMP stage with DoW and Shire of Murray.

It is noted that DoW (2011) states extensive monitoring is not required to continue between pre and post development periods. Any ongoing requirements during the construction phase for individual subdivisions will be negotiated with DoW and Shire of Murray at UWMP stage.

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 be identified through review of the collected data and would require the agreement of all parties (DoW, Shire of Murray, and developer).

A brief annual report, summarising the monitoring data will be submitted to DoW and is the responsibility of the developer.

All water quality testing will be conducted by a NATA approved laboratory.

Based on monitoring outcomes, a contingency action plan is shown in Table 6.

Table 5: Post Development Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Groundwater	Water Level (m AHD)	4 bores within development area and 1 DoW bore (Figure 10)	Electrical depth probe or similar	Quarterly
	pH, EC, Nitrogen Phosphorus		Pumped bore sample	Quarterly (Jan, Apr, Jul & Oct)

Table 6: Contingency Planning

Type	Criteria for Assessment	Frequency	Process & Possible Actions
Water Quality	Groundwater quality from the site significantly greater than: a) predevelopment water quality TN: 2.0 mg/L TP: 0.15 mg/L or b) SCCP[2] Short Term Targets TN : 2.0 mg/l TP : 0.20 mg/l with reference to ANZECC guidelines [1]	Annual Review	**Process** 1. Assess spatial extent of occurrence. 2. Determine if due to development or other factors. 3. Perform appropriate action as required (refer below) 4. Record and report any breach and action taken. 5. If necessary, inform residents of any required works. 6. Inform and provide monitoring data to DoW/Shire. **Possible Actions** 1. Identify and remove point sources of pollution. 2. Review operational and maintenance practices. 3. Consider alterations to POS areas including landscape regimes and soil amendment. 4. Consider modifications to the stormwater system. 5. Consider initiation of community based projects.

1. ANZECC guidelines to be used as a reference point only. ANZECC guidelines state that guidelines values are not intended to be directly applied to stormwater quality, however are applicable where the stormwater system are regarded as having conservation value. ANZECC guideline values are derived for unmodified or slightly modified ecosystems. ANZECC recommends the values only be applied where site specific values do not exist, or site specific targets cannot be derived.

2. Swan-Canning Cleanup Program short term target 5 years.

9 Implementation

Table 7 details the roles, responsibilities and funding to implement the LWMS.

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

Any modification required to the LWMS would be identified through the review process of monitoring data and would require the agreement of all parties (DoW, Shire of Murray, and developer).

Details of construction and maintenance responsibilities will be appropriately detailed at UWMP stage.

Table 7: Implementation Responsibilities

LWMS Section	Implementation Action	Responsibility & Funding		
		The Developer	Shire of Murray	DoW
6	Reinstatement of Outlet to Serpentine River		☑	
8	Preparation of a UWMP for individual development stages	☑		
8	Review & Approval of UWMPs		☑	☑
9	Post Development Monitoring Program	☑		

10 References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000), National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Department of Water (2007), Stormwater Management Manual for Western Australia.

Department of Water (2009) *Decision Process for Stormwater Management in WA*

Department of Water (2010) *Murray Drainage and Water Management Plan.*

ENV Australia (2008) *Lots 181-185, 197, 198, 1186, 1187 Ronlyn Rd and Lots 179 & 180 Riverside Drive North Furnissdale: Environmental Assessment* prepared for Greg Rowe and Associates.

Gozzard, J. R. (1983) Rockingham Sheet 2033 II and 2033 II, Environmental Geology Series. Geological Survey of Western Australia, Department of Minerals and Energy, Perth.

Hyd2o (2012) *West Furnissdale District Water Management Strategy*

Institution of Engineers Australia (2006), Australian Rainfall Quality

Institution of Engineers Australia (2000), Australian Rainfall & Runoff

Porter Consulting Engineers (2013) *Furnissdale Outline Development Plan Infrastructure*.

Western Australian Planning Commission (2003) *State Coastal Planning Policy 2.6: State Coastal Planning.* Government of Western Australia

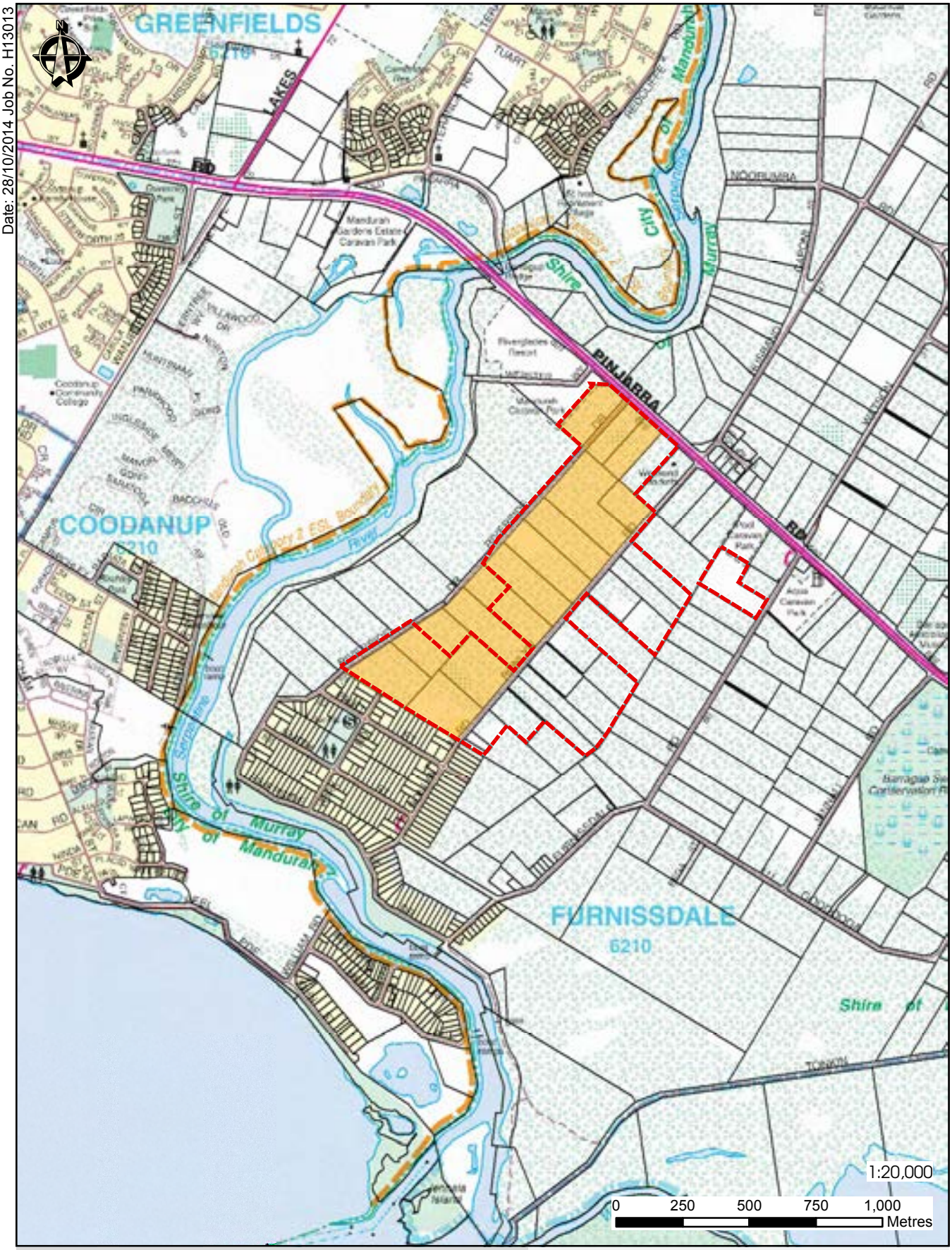
Western Australian Planning Commission, (2003). Planning Bulleting No. 64: Acid Sulphate Soils. Western Australian Planning Commission, November 2003.

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

Western Australian Planning Commission (2011) Peel Region Scheme. Government of Western Australia

FIGURES

Date: 28/10/2014 Job No. H13013



DWMS Area

Site

hyd2o

Furnissdale LWMS

Location Plan

Figure 1

Date : 23/7/2015 Job No H13013



Source: Rowe Group, 2015

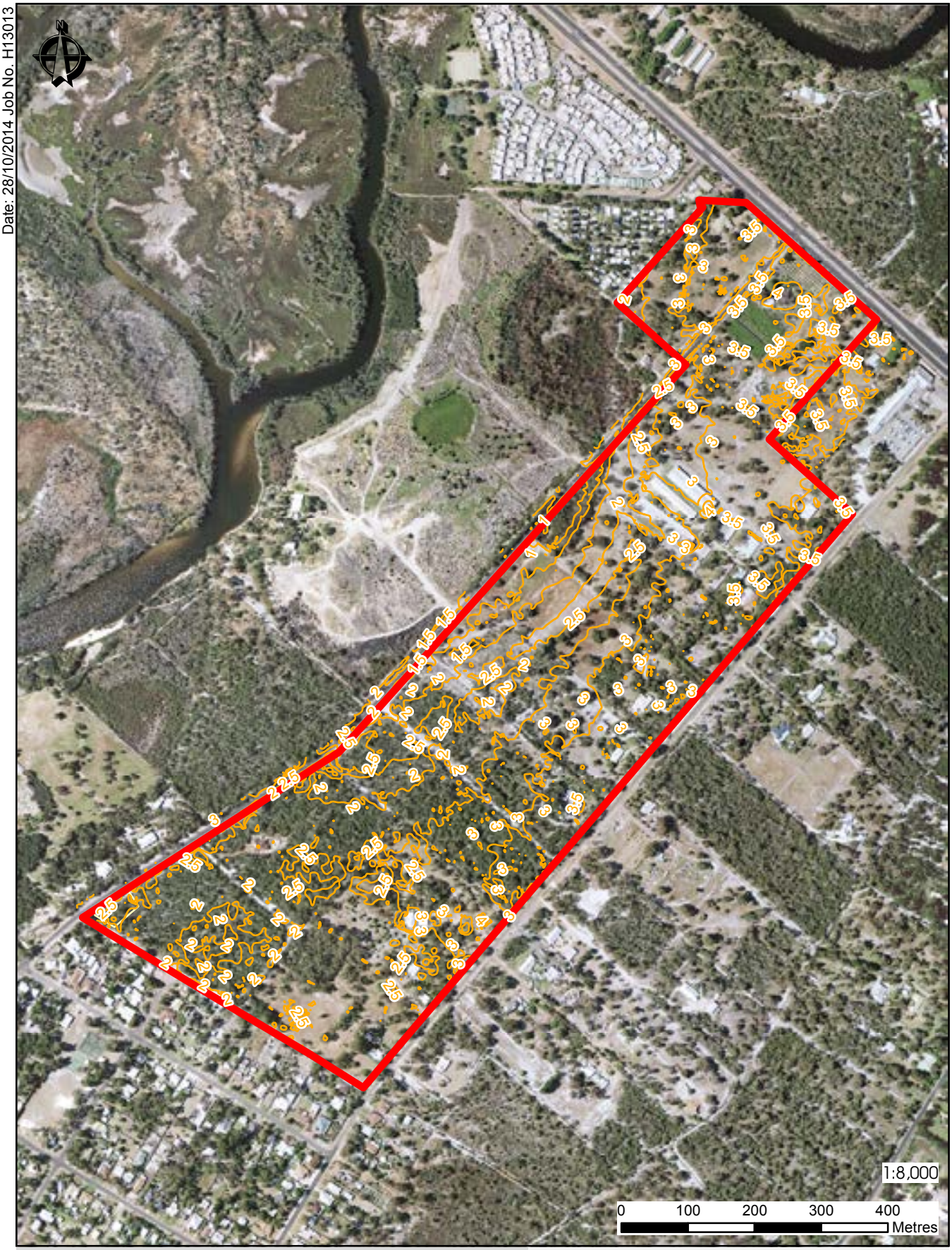
hyd2o

Furnissdale LWMS

Outline Development Plan

Figure 2

Date: 28/10/2014 Job No. H13013



Site

Topography (mAHD)

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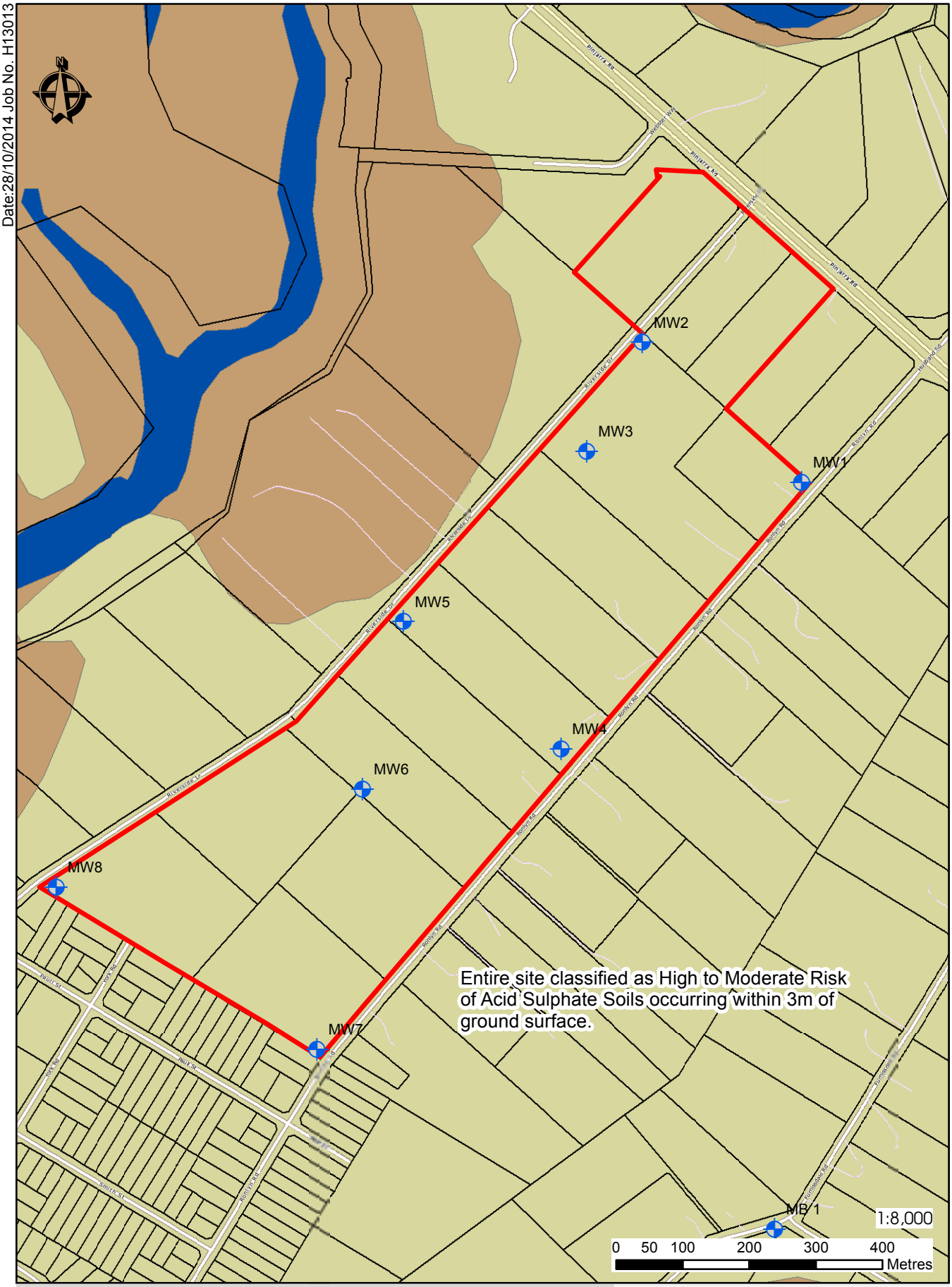
Furnissdale LWMS

Site Conditions

Figure 3

Date:28/10/2014 Job No. H13013



Site

ENV Bore

Environmental Geology

Guildford Formation: clay, sand, loam, and gravel

Bassendean Sand

Water

hyd2o

Furnissdale LWMS

Geotechnical Plan

Figure 4



Site

Conservation Category Wetland

Multiple Use Wetland

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Furnissdale LWMS

Wetlands

Figure 5

Date : 08/09/2015 Job No H13013



Source: Department of Water, 2015

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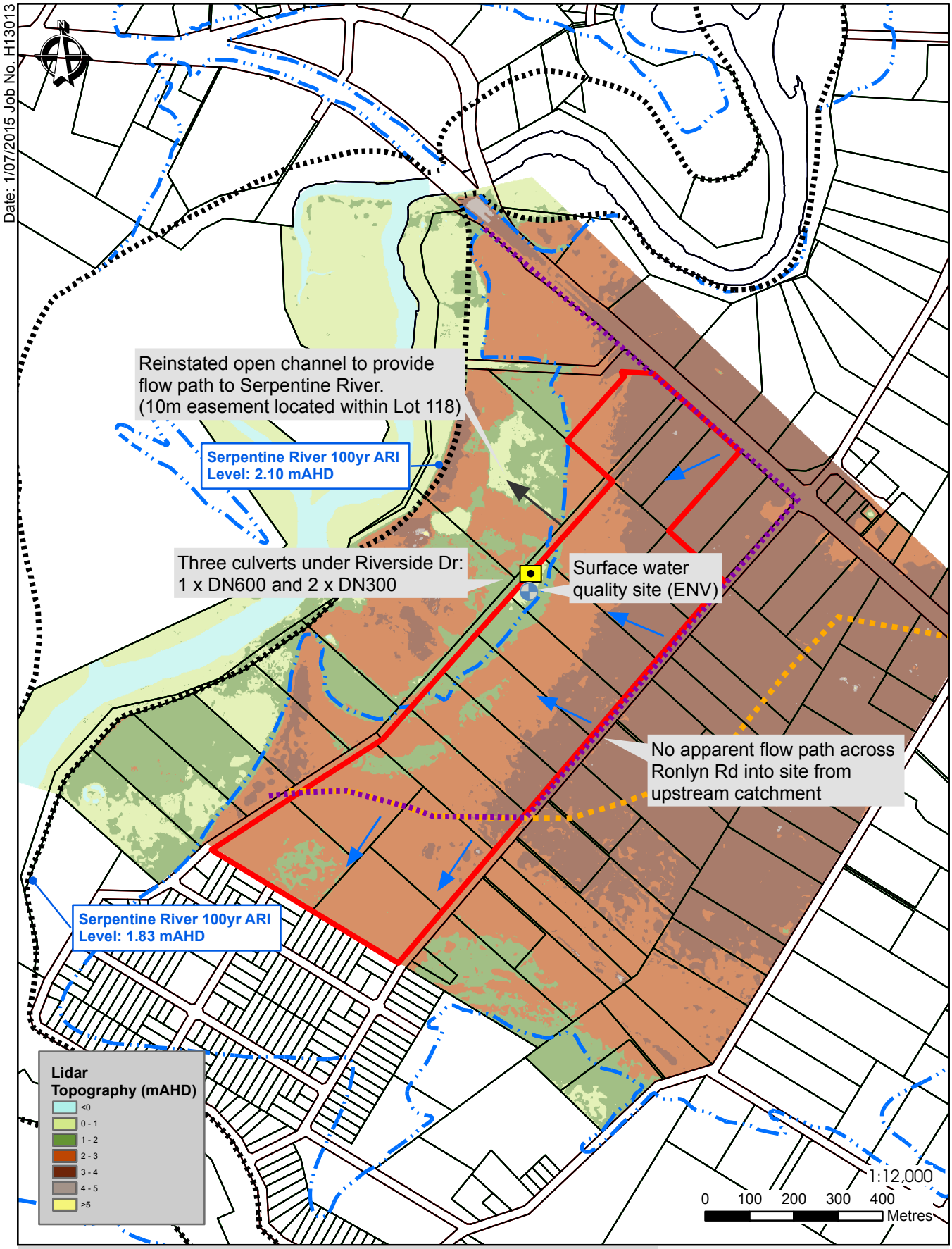
Furnissdale LWMS

Conservation Category Wetland Buffer

Figure 5b

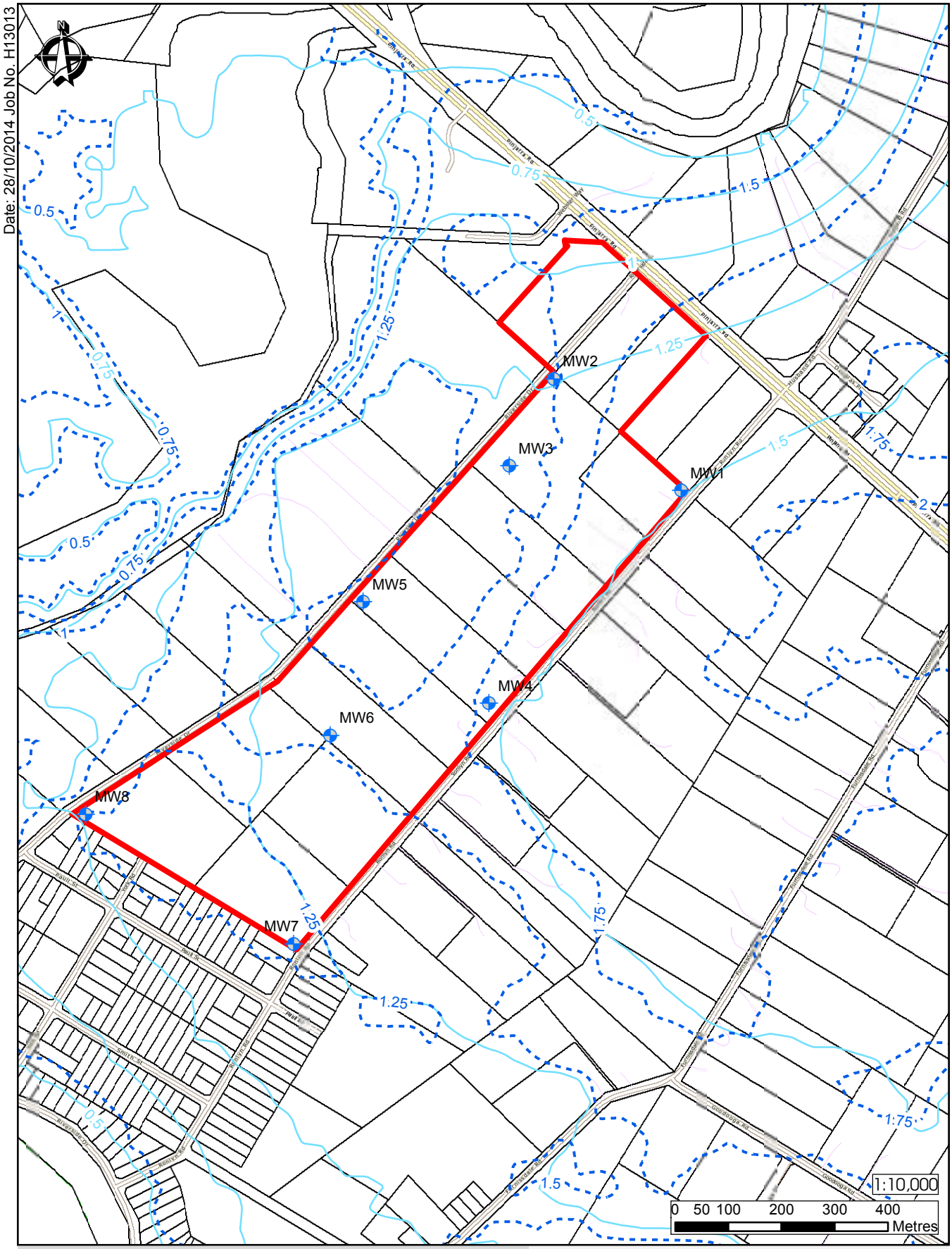


Site
Overland Flow Path
Reinstated Flow Path
Existing Culverts

Predevelopment Catchment
Topographic Boundary
Actual Adopted Boundary

Serpentine River 100yr ARI
Flood Fringe
Floodway

hyd2o
Furnissdale LWMS
Surface Water Plan
Figure 6



Site

ENV Monitoring Bore

Post-Development AAMGL with Sea Level Rise

Current climate AAMGL (mAHD)

Source: Department of Water (2012)

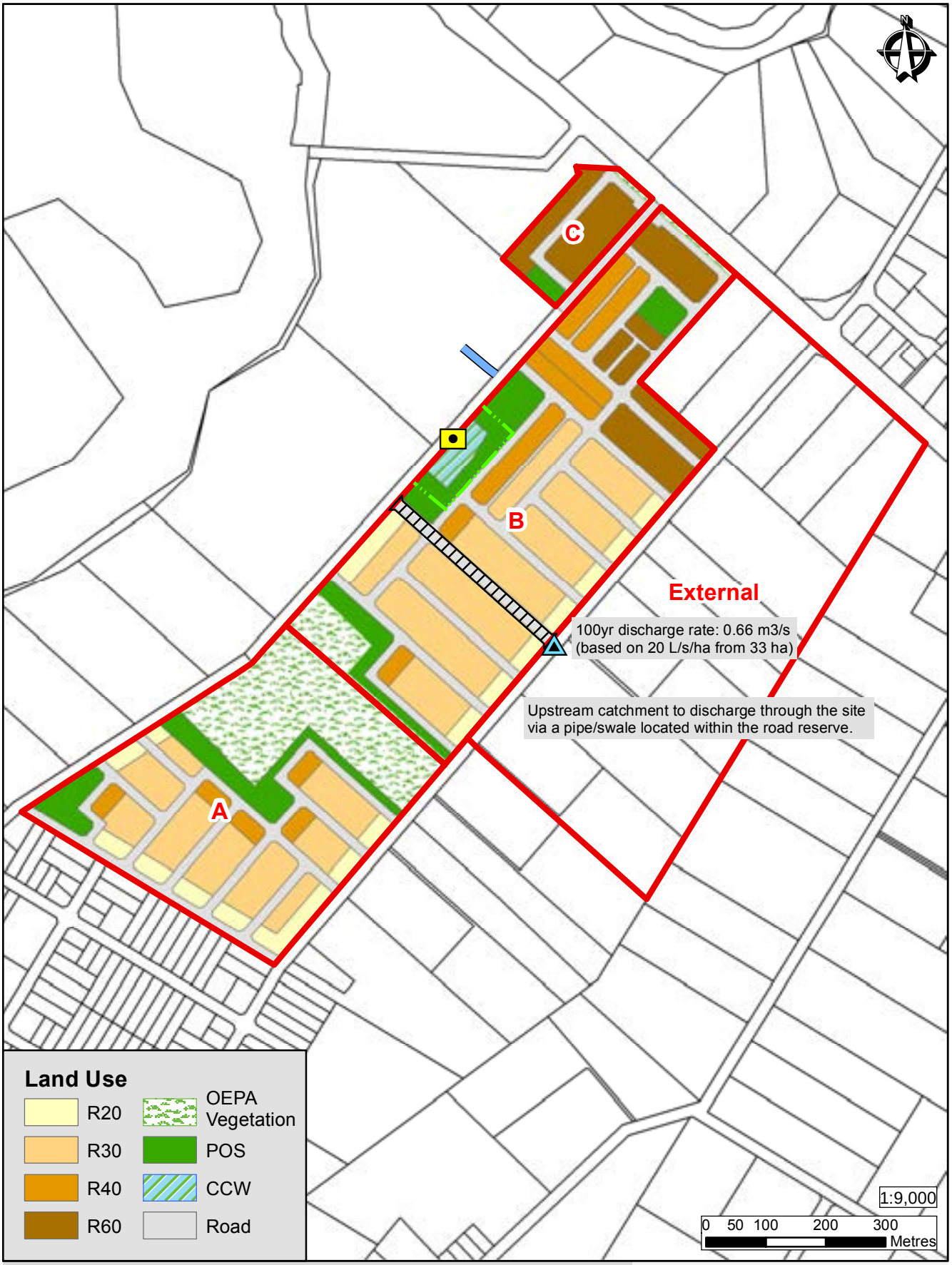
hyd2o

Furnissdale LWMS

Groundwater Plan

Figure 7

Date:23/07/2015 Job No. H13013



hyd2o

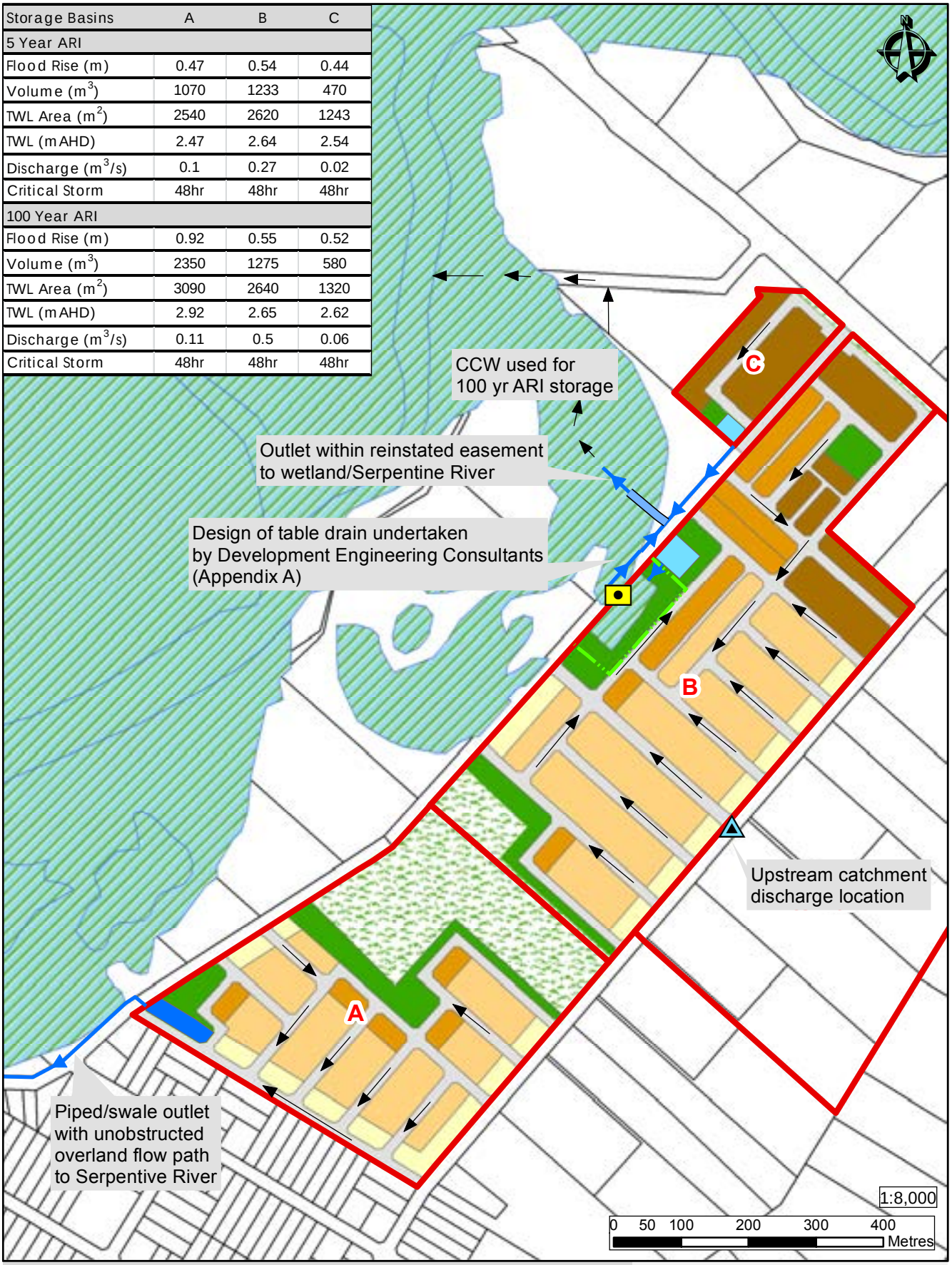
Furnissdale LWMS

Post Development Plan

Figure 8

Date: 1/10/2015 Job No. H13013

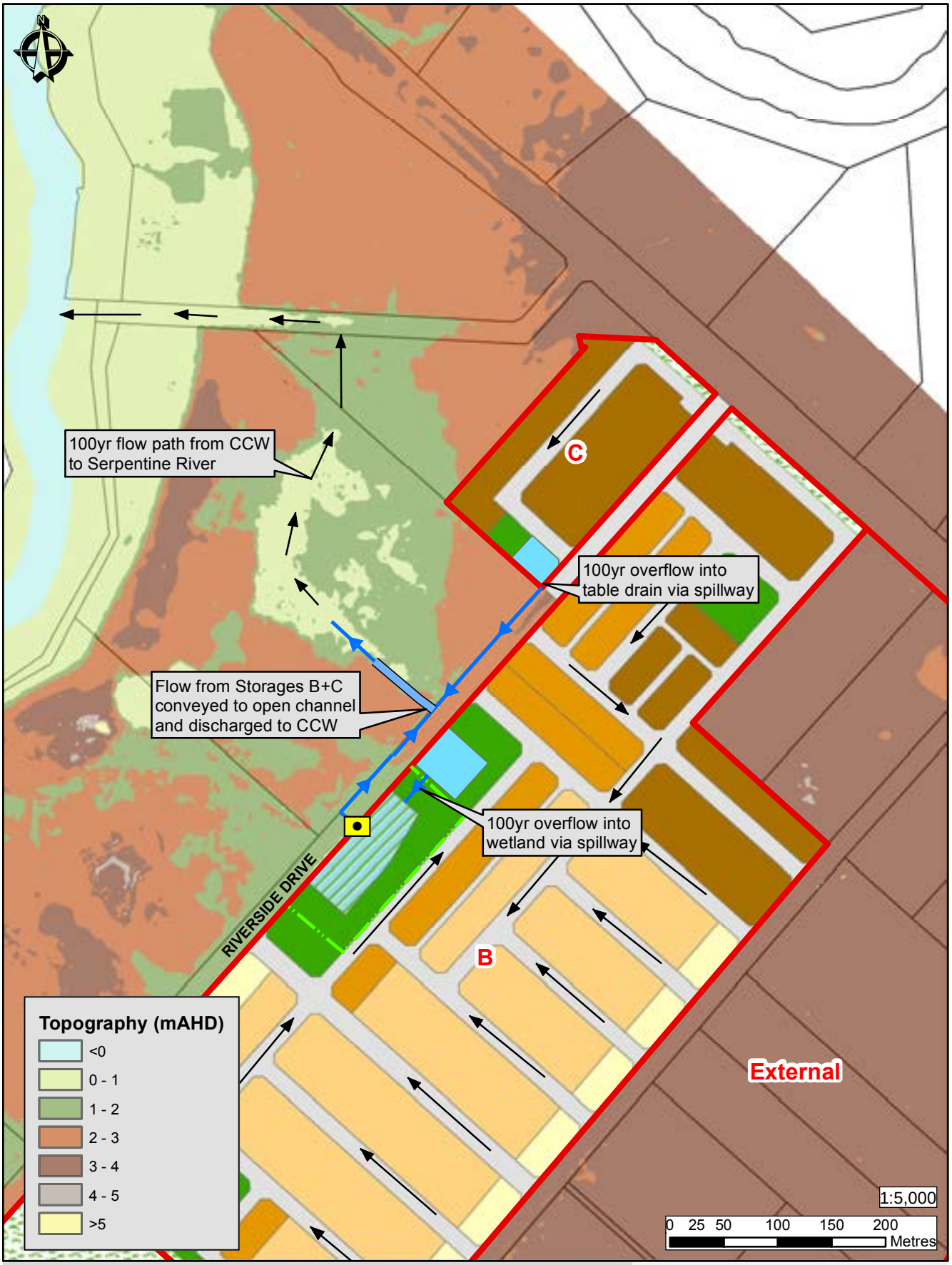
Storage Basins	A	B	C
5 Year ARI			
Flood Rise (m)	0.47	0.54	0.44
Volume (m^3)	1070	1233	470
TWL Area (m^2)	2540	2620	1243
TWL (mAHD)	2.47	2.64	2.54
Discharge (m^3/s)	0.1	0.27	0.02
Critical Storm	48hr	48hr	48hr
100 Year ARI			
Flood Rise (m)	0.92	0.55	0.52
Volume (m^3)	2350	1275	580
TWL Area (m^2)	3090	2640	1320
TWL (mAHD)	2.92	2.65	2.62
Discharge (m^3/s)	0.11	0.5	0.06
Critical Storm	48hr	48hr	48hr



Post Dev Catchments
5 Year Storage Area
100 Year Storage Area
100 Year Flow Path
Easement
Wetland Buffer
Discharge Flow Path
Existing Culverts

hyd2o
Furnissdale LWMS
Stormwater Management Plan
Figure 9

Date: 23/7/2015 Job No. H13013



Post Dev Catchments

5 Year Storage Area

100 Year Flow Path

Easement

Wetland Buffer

Discharge Flow Path

Existing Culverts

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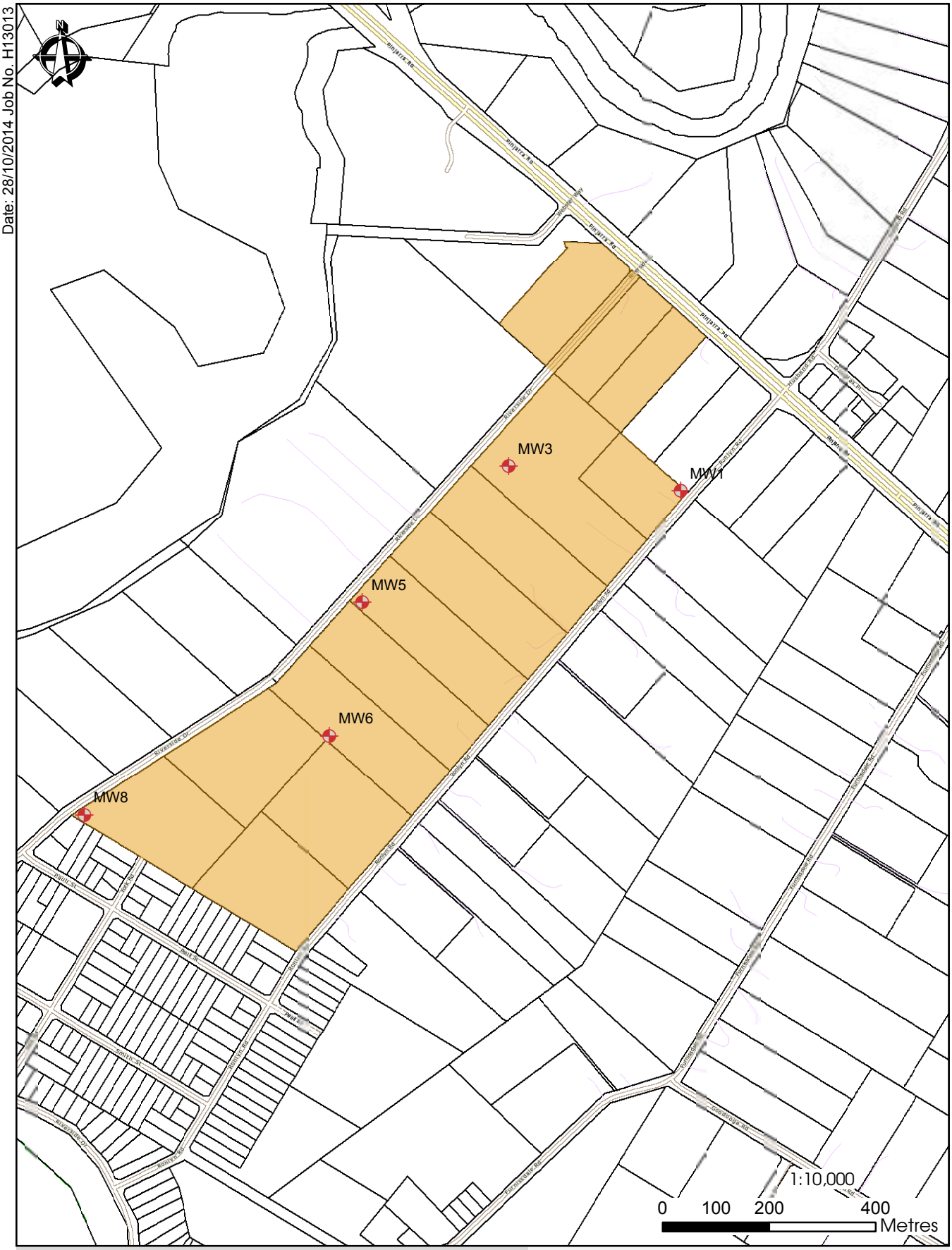
Furnissdale LWMS

100 Year Stormwater Plan

Figure 9B

Date: 28/10/2014 Job No. H13013



Site

Proposed Monitoring Bores

hyd2o

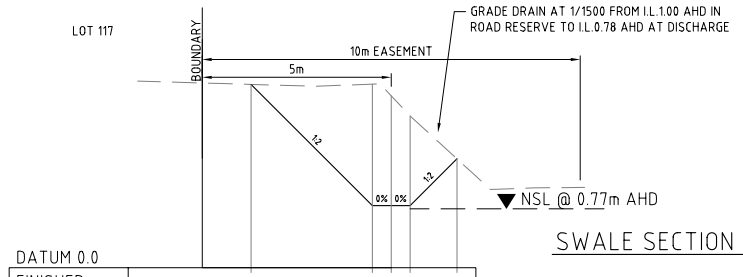
Furnissdale LWMS

Post Development Monitoring Plan

Figure 10

APPENDIX A

Proposed Drainage Swale and Pipe Plan and Longsection (Development Engineering Consultants, 2010)



DATUM 0.0

FINISHED SURFACE	2.426	0.821	0.821	0.821	1.441
NATURAL SURFACE	2.426	2.429	2.275	2.010	1.441
OFFSET FROM CL	-3.708	-0.500	0.000	0.500	1.740

CH. 240

SWALE SECTION WITHIN LOT 118 AT CH 240.00

HORIZ: 1:100
VERT: 1:50

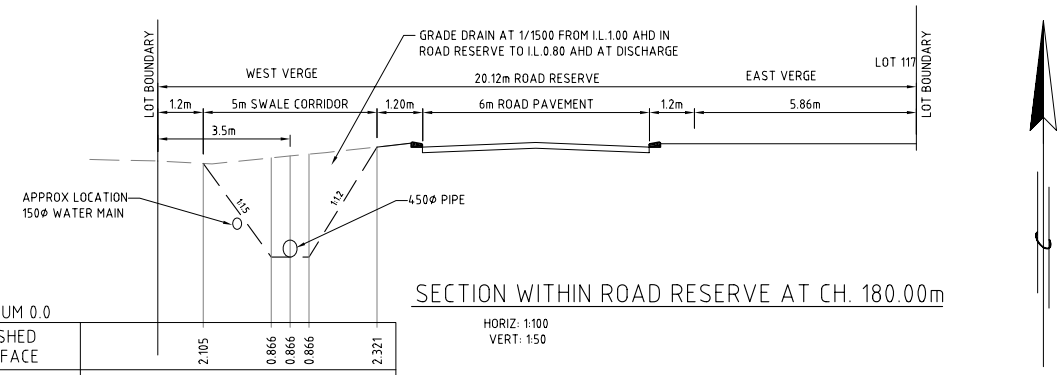


DETAIL OF DRAINAGE PIT & HEADWALL

SCALE: 1:1000

SECTION A
SCALE 1:50

AT LOW POINT IN ROAD - CH0.00



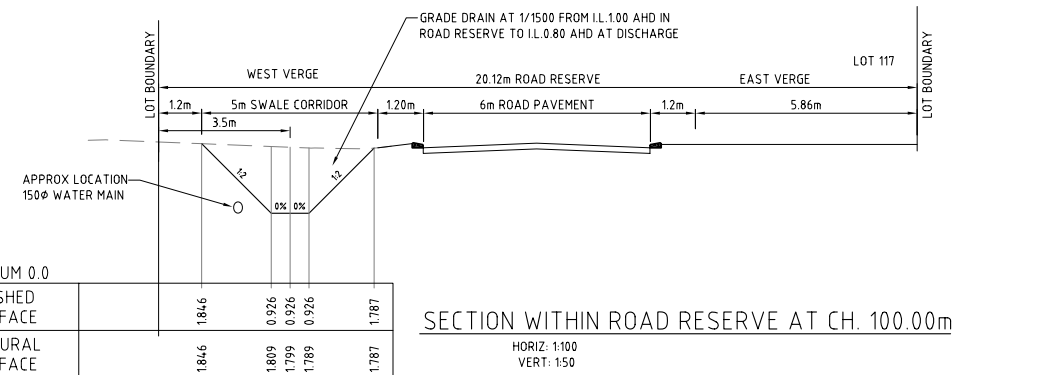
SECTION WITHIN ROAD RESERVE AT CH. 180.00m

HORIZ: 1:100
VERT: 1:50

DATUM 0.0

FINISHED SURFACE	2.105	0.866	0.866	0.866	2.321
NATURAL SURFACE	2.105	2.178	2.203	2.229	2.321
OFFSET FROM CL	-2.300	-0.500	0.000	0.500	2.300

CH. 180



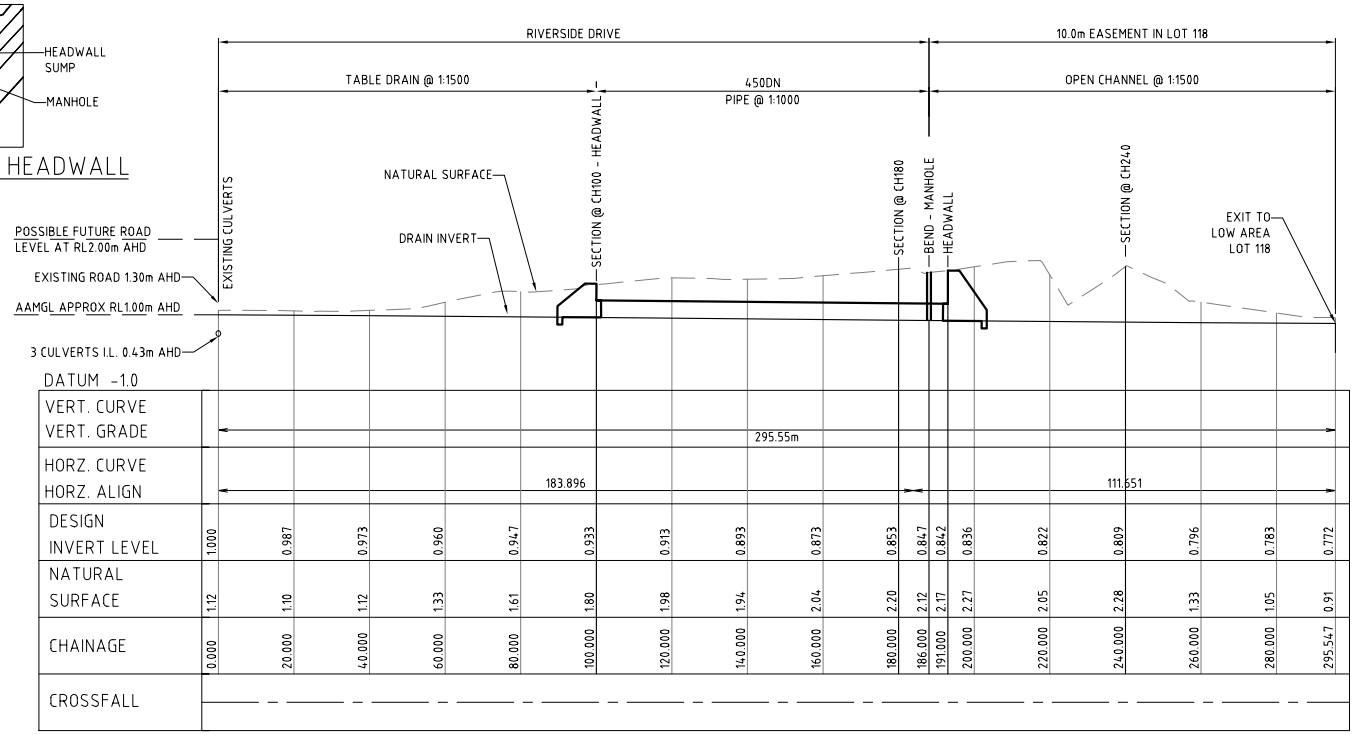
DATUM 0.0

FINISHED SURFACE	1.846	0.926	0.926	0.926	1.787
NATURAL SURFACE	1.846	1.809	1.799	1.789	1.787
OFFSET FROM CL	-2.340	-0.500	0.000	0.500	2.224

CH. 100

SECTION WITHIN ROAD RESERVE AT CH. 100.00m

HORIZ: 1:100
VERT: 1:50



DATUM -1.0

VERT. CURVE / VERT. GRADE	295.55m																					
HORZ. CURVE / HORZ. ALIGN	183.896															111.651						
DESIGN INVERT LEVEL	1.000	0.987	0.973	0.960	0.947	0.933	0.913	0.893	0.873	0.853	0.847	0.842	0.836	0.822	0.809	0.796	0.783	0.772				
NATURAL SURFACE	1.12	1.10	1.12	1.33	1.61	1.80	1.98	1.94	2.04	2.20	2.12	2.17	2.27	2.05	2.28	1.33	1.05	0.91				
CHAINAGE	0.000	20.000	40.000	60.000	80.000	100.000	120.000	140.000	160.000	180.000	186.000	191.000	200.000	220.000	240.000	260.000	280.000	295.547				
CROSSFALL																						

TABLE DRAIN / PIPE / CHANNEL

HORIZ. - 1:1000
VERT. - 1:100

1:4000 (A3)

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No.	DATE	BY	REVISION	
C	10/03/10	JEG	TABLE DRAIN EXTENDED, NEW CROSS SECTIONS ADDED.	SRA
B	4/3/10	JEG	CROSS SECTIONS ADDED	SRA
A	04/02/10	SWW	ISSUED FOR APPROVAL/TENDER	SRA

CLIENT: **BRAD HANKINSON**

DEVELOPMENT ENGINEERING CONSULTANTS
SUITE 3, 123A COLIN ST, WEST PERTH, 6005 WESTERN AUSTRALIA
Ph: (08) 9481 1900
Fax: (08) 9481 1700

PROJECT: **LOTS 112 TO 119 RIVERSIDE DRIVE FURNISSDALE**
W.A.P.C. No. -

DRAWING: **PROPOSED DRAINAGE SWALE & PIPE PLAN AND LONGSECTION**
CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No.
AS SHOWN	SWW	SRA	C
DATE	DESIGNED	APPROVED	
04/02/10	SWW	SRA	

PROJECT NUMBER **PRO680 SK03**
S:\PROPOSALS\PRO680\PRO680 SK03.dwg 11/03/2010

APPENDIX B

Groundwater Monitoring Results (ENV Australia, 2009)

North Furnissdale - 07.269

pH								
	3/10/2007	**28/02/2008**	**28/05/2008**	**6/10/2008**	**10/12/2008**	**1/04/2009**	**7/07/2009**	**12/10/2009**
MW1	6.24	6.17	6.29	6.3	6.19			5.85
MW2	5.27	4.92	5.83	5.22	5.08	5.09	5.7	5.39
MW3	6.33	6.22	6.34	6.29	6.28			6.25
MW4	5.92			5.91	5.89			5.72
MW5	5.12	5.35	5.48	5.77	5.73	5.43	5.56	5.71
MW6	5.7	5.56	5.5	5.56	5.5	5.53	5.2	5.51
MW7	6.08	5.65	5.73	5.87	5.78		5.51	5.57
MW8	6.11		6.38	6.62	6.62	6.37	6.52	6.52

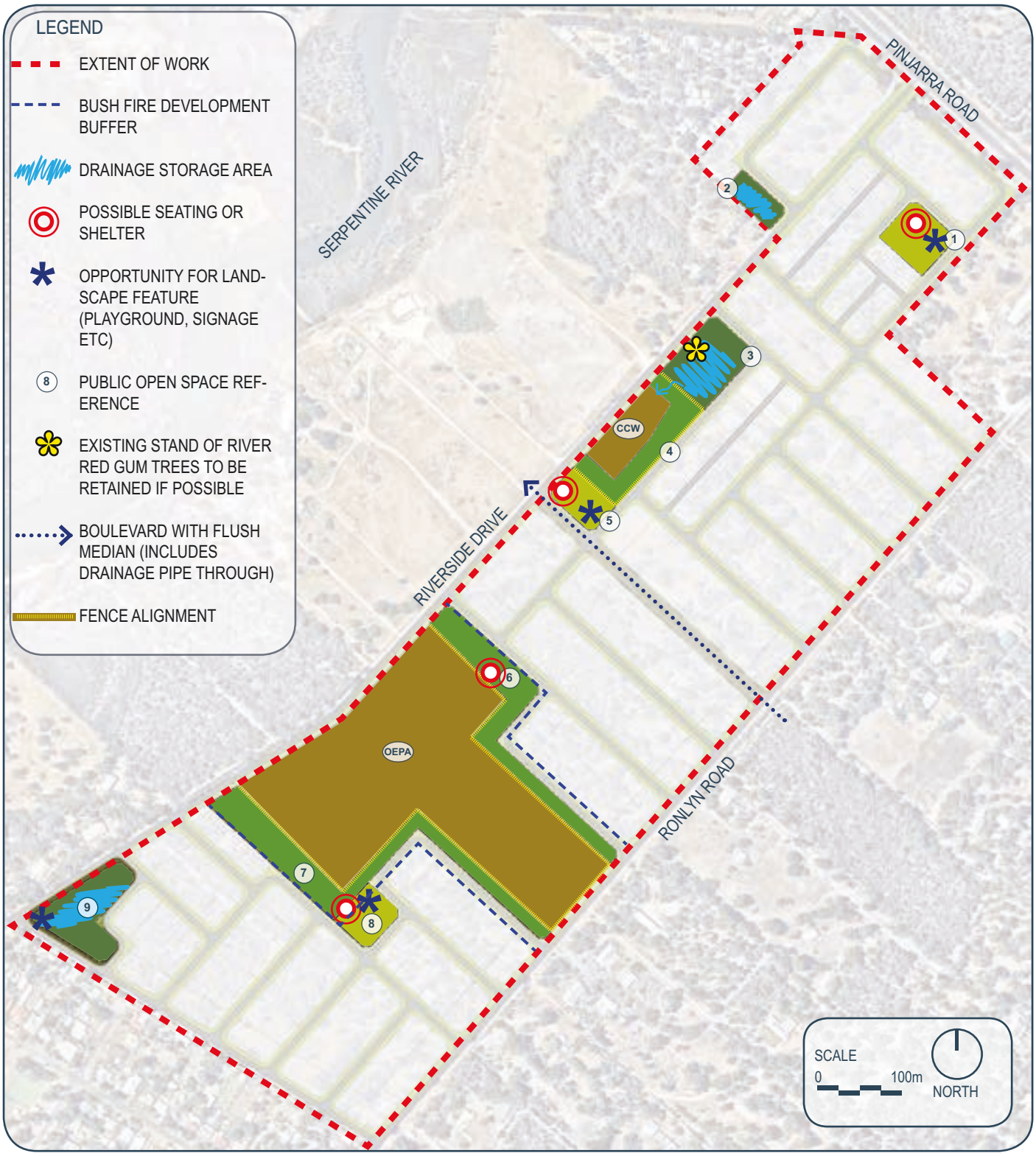
EC (uS)								
	3/10/2007	**28/02/2008**	**28/05/2008**	**6/10/2008**	**10/12/2008**	**1/04/2009**	**7/07/2009**	**12/10/2009**
MW1	0.61	0.19	0.18	0.574	0.32			0.59
MW2	0.57	0.81	0.45	1.6	1.22	1.02	0.56	0.86
MW3	1.53	1.75	1.36	1.333	0.97			2.83
MW4	0.64			0.594	0.72			0.51
MW5	1.22	0.62	1.37	1.57	0.89	0.58	1.76	1.32
MW6	5.46	4.62	4.26	6.44	5.35	6.27	6.51	6.83
MW7	0.24	0.37	0.33	0.236	0.27		0.34	0.25
MW8	14.66		3.62	12.83	10.83	7.17	5.99	12.38

North Furnissdale - 07.269

		Total P	PO4	Total N	NO3-N	NH3-N	NH4_N	TKN		Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Date		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3/10/2007		<0.01	<0.01	1	0.200	0.232		0.8									
28/02/2008		0.04	<0.01	0.6	0.022	0.058		0.6									
28/05/2008	**MW1**	0.03	<0.01	0.7	0.414	0.070		0.3									
10/12/2008		0.66	<0.01	3.3	0.310	0.080		3.0		0.022	0.0001	0.053	0.008	0.178	0.017	0.016	<0.0001
12/10/2009		0.80	0.57	91	360		0.15	6.7		<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	0.012	<0.0001
3/10/2007		0.01	<0.01	1.7	1.340	<0.01		0.4									
28/02/2008		<0.01	<0.01	0.4	0.028	0.104		0.4									
28/05/2008		0.03	<0.01	1	0.698	0.049		0.3									
10/12/2008	**MW2**	0.37	<0.01	1.8	0.070	0.030		1.8		0.050	0.0001	0.093	0.007	0.059	0.014	0.010	<0.0001
1/04/2009		1.43	<0.01	2.2	0.020	<0.01		2.2		0.009	<0.0001	0.014	0.008	0.207	0.004	0.063	<0.0001
7/07/2009		0.03	<0.005	1.6	<0.1	0.300		1.6		<0.0001	<0.0001	0.002	<0.001	<0.001	<0.001	0.007	<0.0001
12/10/2009		0.14	0.056	7.8	6.5		<0.005	6.3		0.044	0.0005	0.029	<0.005	<0.005	0.012	0.017	<0.0001
3/10/2007		0.44	0.42	26.1	24.0	0.023		2.1									
11/12/2008		0.24	0.231	26	24.8	0.047		1.2									
28/02/2008	**MW3**	0.1	0.1	25.2	23.3	0.017		1.9									
28/05/2008		0.14	0.141	12.3	11.5	0.720		0.8									
10/12/2008		0.94	0.17	44.2	41.3	0.020		2.9		0.037	0.0001	0.171	0.008	0.174	0.016	0.072	<0.0001
12/10/2009		0.05	<0.005	2.4	0.4		<0.005	2.3		0.005	<0.0001	0.004	<0.001	<0.001	0.005	0.011	<0.0001
3/10/2007		0.02	0.012	1.7	0.084	0.095		1.6									
10/12/2008	**MW4**	0.75	<0.01	5.8	0.360	0.040		5.4		0.018	0.0002	0.118	0.014	0.126	0.024	0.012	<0.0001
12/10/2009		<0.01	<0.005	6.1	<0.1		0.11	6.1		<0.005	<0.0005	0.003	<0.005	<0.005	0.009	0.010	0.0004
3/10/2007		0.07	0.056	6.1	0.165	0.132		6.0									
28/02/2008		0.08	<0.05	3.6	0.216	0.167		3.4									
28/05/2008		0.04	0.03	5.7	0.288	0.079		5.4									
10/12/2008	**MW5**	0.77	0.04	10.4	0.130	0.080		10.3		0.049	0.0004	0.177	0.004	0.137	0.014	0.008	<0.0001
1/04/2009		0.94	0.02	3.2	0.040	0.180		3.2		0.014	<0.0001	0.097	0.002	0.087	0.01	0.008	<0.0001
7/07/2009		0.06	0.005	5.4	0.200	0.280		5.4		0.024	<0.0001	0.092	0.008	0.005	0.008	0.034	0.0021
12/10/2009		0.01	0.005	0.58	0.8		<0.005	0.41		0.043	<0.0001	0.100	<0.001	<0.001	0.007	0.021	<0.0001
3/10/2007		0.01	0.01	1.6	0.066	0.512		1.5									
28/02/2008		0.01	0.01	1.5	0.049	0.365		1.4									
28/05/2008		0.03	0.01	1	0.028	0.374		0.9									
10/12/2008	**MW6**	0.26	0.01	1.9	0.040	0.430		1.9		0.029	0.0001	0.084	0.004	0.101	0.008	0.009	<0.0001
1/04/2009		0.32	0.01	1.8	0.020	0.430		1.8		0.014	0.0001	0.02	0.003	0.019	0.005	0.008	<0.0001
7/07/2009		0.03	0.01	2.4	0.100	0.850		2.4		0.012	0.005	0.003	0.006	<0.005	0.02	0.007	0.0003
12/10/2009		0.01	0.007	0.76	0.1		0.14	0.74		0.003	0.0001	0.001	<0.001	<0.001	<0.001	0.016	<0.0001
3/10/2007		0.03	0.016	1.3	0.096	0.289		1.2									
28/02/2008		0.06	0.01	1.2	0.025	0.319		1.2									
28/05/2008	**MW7**	0.03	0.01	0.8	0.010	0.203		0.8									
10/12/2008		0.89	0.01	3.4	0.060	0.270		3.3		0.039	0.0001	0.068	0.007	0.054	0.011	0.013	<0.0001
7/07/2009		0.28	0.006	2.8	0.100	0.650		2.7		0.002	0.0001	0.007	0.008	<0.001	0.008	0.100	0.0001
12/10/2009		0.01	0.005	1.3	0.1		0.40	1.3		0.003	0.0001	0.009	0.003	0.001	0.004	0.012	<0.0001
3/10/2007		0.03	0.01	4.2	0.064	0.180		4.1									
28/05/2008		0.03	0.01	2.5	0.069	0.622		2.5									
10/12/2008	**MW8**	0.2	0.01	5.1	0.040	0.360		5.1		0.058	0.0002	0.117	0.004	0.059	0.009	0.013	<0.0001
1/04/2009		0.73	0.01	5	0.010	1.330		5.0		0.094	0.0004	0.048	0.003	0.092	0.005	0.027	<0.0001
7/07/2009		0.03	0.005	3.6	0.100	0.830		3.6		0.026	0.005	0.024	0.006	<0.005	<0.005	0.007	0.0003
12/10/2009		0.03	0.005	0.88	0.1		<0.005	0.88		0.005	0.0001	0.001	<0.001	<0.001	0.004	0.011	<0.0001

APPENDIX C
Landscape Strategy Plan
(Emerge Associates, 2015)

LANDSCAPE STRATEGY PLAN



PUBLIC OPEN SPACE SUMMARY

LOCAL PARK (POS 1,5,8)
- Informal active open space / kickabout areas
- Predominantly native planted areas with Pockets of turf
- Small gathering nodes and basic picnic facilities with shade structures and nature play opportunities
- Path network / connectivity
- Primary focus on passive recreation
- Fully irrigated

DRAINAGE BASIN (POS 2,3,9)
- Predominantly native planted areas with turf / planted basin
- Retention of existing signif cant trees where possible
- Drainage retention within basin
- Informal active recreation uses on open grasses areas

CCW BUFFER (POS 4)
- Predominantly rehabilitated / re-vegetated
- Conservation fencing to boundary
- Access path / Connectivity through
- Buffer to take up level difference between existing and adjacent lots

OEPA BUFFER (POS 6,7)
- Predominantly native planting with linear turf pockets
- Fence to OEPA boundary
- Access paths / Connectivity through
- limestone access paths connect through OEPA
- Seating nodes and small nature play opportunities

*OEPA and CCW areas to remain protected / rehabilitated where required

FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

emerge ASSOCIATES

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LANDSCAPE MASTER PLAN

LEGEND

- EXTENT OF WORK
- (8) PUBLIC OPEN SPACE REFERENCE
- EXISTING STAND OF RIVER RED GUM TREES TO BE RETAINED IF POSSIBLE

PINJARRA ROAD

SERPENTINE RIVER

RIVERSIDE DRIVE

RONLYN ROAD

OEPA

SCALE 0 100m

NORTH



CONSIDERED



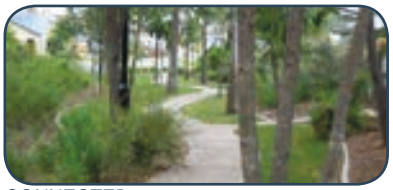
HOMELY



COMFORTABLE



INTERACTIVE



CONNECTED



PRACTICAL

FURNISSDALE LANDSCAPE STRUCTURE PLAN

LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

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STREET TREE MASTER PLAN





Corymbia ficifolia - Red Flowering Gum



Eucalyptus marginata - Jarrah



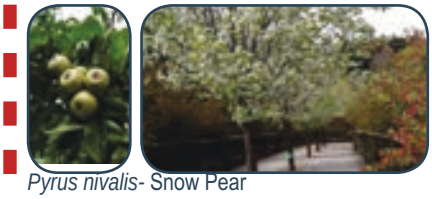
Agonis flexuosa - WA Peppermint



Corymbia calophylla - Marri



Eucalyptus sideroxylon - Red Ironbark



Pyrus nivalis- Snow Pear

FURNISSDALE LANDSCAPE STRUCTURE PLAN
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POS TREE PLANTING PALETTE





Eucalyptus Sideroxylon



Xanthorrhoea preisii



Eucalyptus marginata



Eucalyptus leucoxylon rosea



Corymbia ficifolia



Melaleuca preissiana



Melaleuca quinquinervia



Agonis flexuosa



Platanus acerifolia



Ulmus parvifolia



Eucalyptus rudis



Corymbia calophylla

FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

emerge ASSOCIATES

THIS DRAWING IS INDICATIVE ONLY AND MAY NOT REPRESENT THE FINAL SCOPE OF LANDSCAPE WORKS

POS 1, 5, 8 CONCEPT

POS TYPOLOGY
- Local Parks

SIZE
- POS 1 - 4,007 m2
- POS 5 - 2,869 m2
- POS 8 - 3,183.67 m2

CONCEPT
- Provide a series of POS primarily focussed on passive recreation with pockets of turf and feature nodes at key locations
- Sheltered seating and BBQ facilities
- Provide seating nooks along path networks
- Predominantly native planted garden beds
- Nature based play areas with informal seating

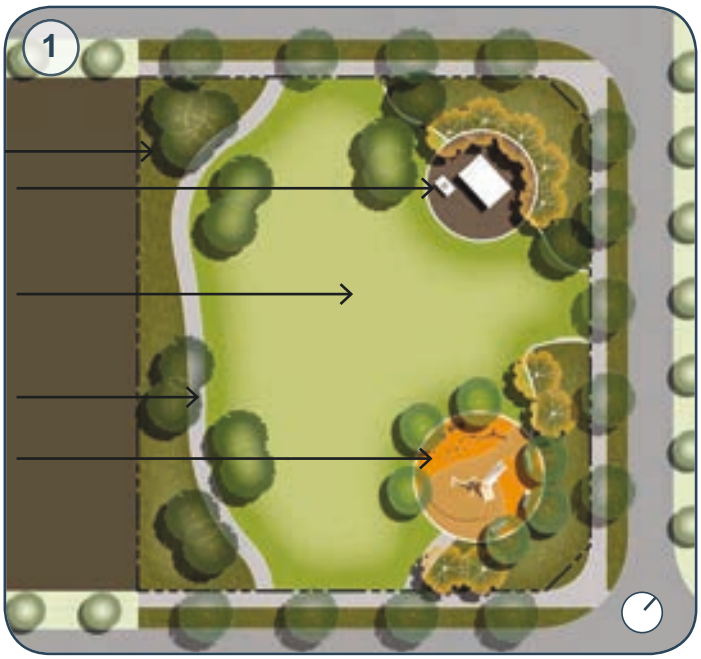
FUNCTIONS / MATERIALS
- Provide informal recreation uses with small gathering nodes with picnic / BBQ facilities.
- Turf pockets allow for kickabout areas
- Nature play instances allow for reuse of salvaged site logs.

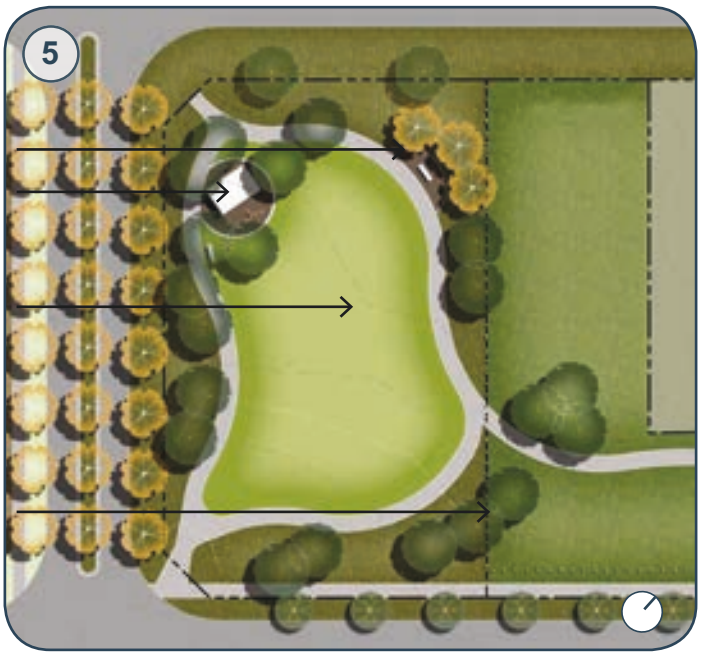
ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible
- Fence to CCW buffer (POS 5)
- Fence to OEPA (POS8)

DRAINAGE CONSIDERATIONS
- NA











SCALE
0 20m

FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

emerge ASSOCIATES

THIS DRAWING IS INDICATIVE ONLY AND MAY NOT REPRESENT THE FINAL SCOPE OF LANDSCAPE WORKS

POS 2, 3, 9 CONCEPT

POS TYPOLOGY
- Local Parks (Drainage inclusive)

SIZE
- POS 2 - 2,111 m2
- POS 3 - 6,232 m2
- POS 9 - 6,426.m2

CONCEPT
- Provide a series of POS primarily focussed on passive recreation with pockets of turf and seating nodes at key locations
- Predominantly native planted garden beds
- Retention of existing trees where possible

FUNCTIONS / MATERIALS
- Provide informal recreation uses with small gathering nodes and turf pockets

ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible (location not surveyed)
- Fence to CCW buffer (POS 3)

DRAINAGE CONSIDERATIONS

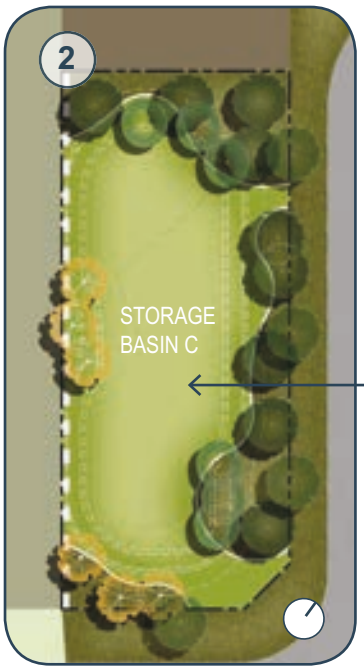
BASIN A (POS 9)
- 1 Year Storm volume : 272 m3
- 5Year Storm volume : 1,070 m3
- 100 Year Storm volume : 2,350m3

BASIN B (POS 3)
- 1 Year Storm volume : 510 m3
- 5Year Storm volume : 1,233 m3
- 100 Year Storm volume : 1,275 m3

BASIN C (POS 2)
- 1 Year Storm volume : 100 m3
- 5Year Storm volume : 470 m3



SCALE
0 20m





FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

emerge ASSOCIATES

THIS DRAWING IS INDICATIVE ONLY AND MAY NOT REPRESENT THE FINAL SCOPE OF LANDSCAPE WORKS

POS 6, 7 CONCEPT



* Note:
Limestone paths through OEPA are shown indicatively and are to be located so as to not disturb existing vegetation, on existing trails, f re breaks and already clear areas.

POS TYPOLOGY
- Local Parks (OEPA Buffer)

SIZE
- POS 6 - 9,202 m2
- POS 7 - 11,321 m2

CONCEPT
- Provide a series of POS primarily focussed on passive recreation with pockets of turf and seating nodes along path network axis
- Entirely native planted garden beds
- Retention of existing trees where possible
- Take up level change between existing levels in OEPA and adjacent lot levels.

FUNCTIONS / MATERIALS
- Provide informal recreation uses with small gathering nodes and turf pockets

ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible
- Conservation Fence to OEPA boundary
- Access links through OEPA via crushed limestone paths

DRAINAGE CONSIDERATIONS
- NA



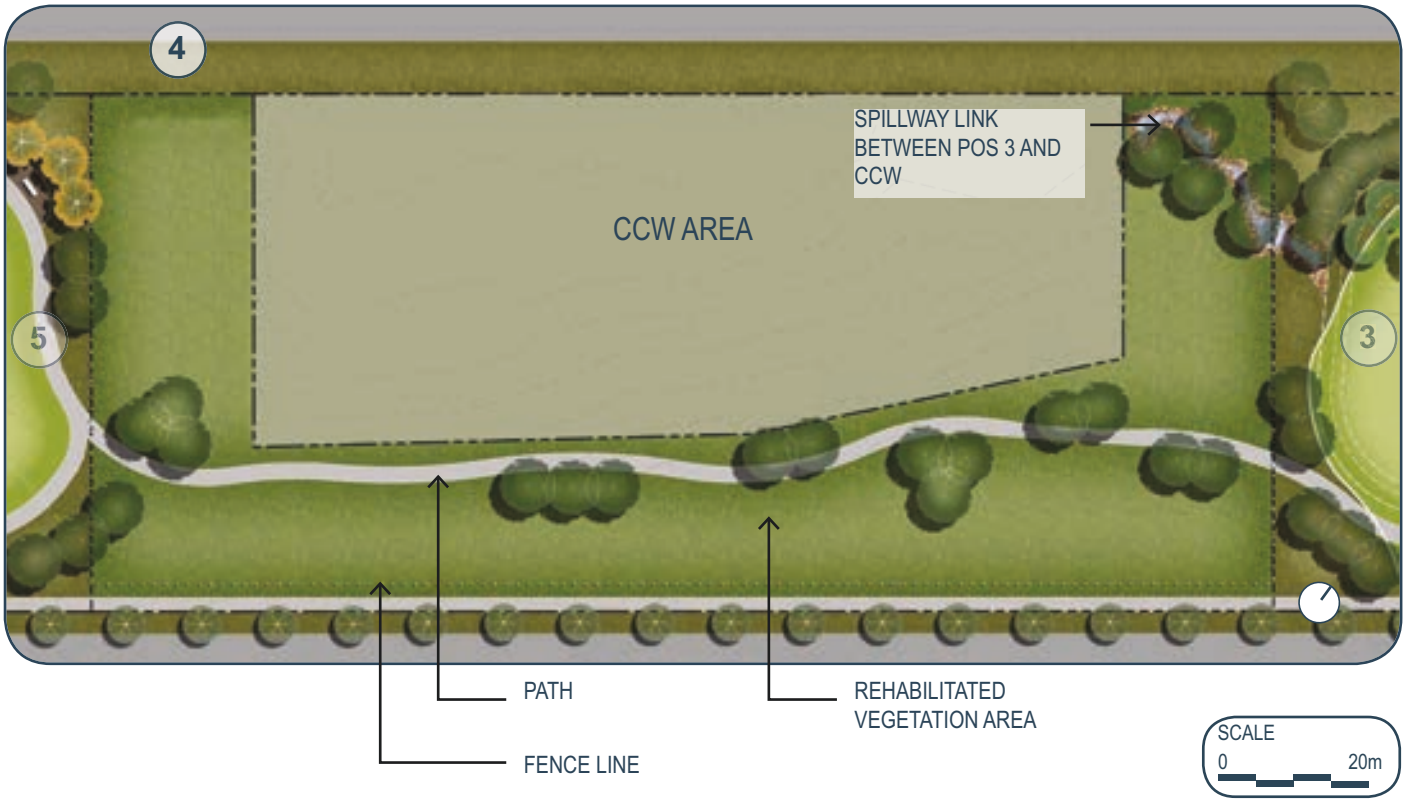
SCALE
0 50m

FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

emerge ASSOCIATES

THIS DRAWING IS INDICATIVE ONLY AND MAY NOT REPRESENT THE FINAL SCOPE OF LANDSCAPE WORKS

POS 4 CONCEPT



POS TYPOLOGY
- Local Parks (CCW Buffer)

SIZE
- POS 4 - 5.692 m2

CONCEPT
- Provide linear path linkages through
- Rehabilitation to vegetation with Native species only

FUNCTIONS / MATERIALS
- Primarily provide buffer to CCW
- Take up level change between existing CCW and adjacent lots. No fill within CCW area

ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible
- Conservation Fence from CCW boundary

DRAINAGE CONSIDERATIONS
- 1:100 flood overflow from basin B (POS3) to connect to CCW via spillway







THIS DRAWING IS INDICATIVE ONLY AND MAY NOT REPRESENT THE FINAL SCOPE OF LANDSCAPE WORKS

APPENDIX D
Detailed Bulk Earthworks Plans
(Porter Consulting Engineers, 2015)

LEGEND

- EXISTING GROUND CONTOUR (0.5m INTERVAL)
- PROPOSED GROUND CONTOUR (0.2m INTERVAL)
- EXISTNG GROUND SPOT LEVEL
- 8.37 PROPOSED LOT / PAD LEVEL
- EARTHWORKS BOUNDARY
- FUTURE RETAINING WALL
- GROUND WATER CONTOURS (AAMGL)

JOINS DRG. No 15-4-60/0/101

RIVERSIDE DRIVE

ROAD 'A'

ROAD 'B'

ROAD 'G'

ROAD 'H'

ROAD 'C'

ROAD 'D'

ROAD 'E'

ROAD 'F'

ROAD 'I'

ROAD 'J'

ROAD 'K'

ROAD 'L'

ROAD 'M'

ROAD 'N'

BATTER TO EXISTING GROUND AT 1 in 6

OEPA VEGETATION

FUTURE BOUNDARY RETAINING WALL

RONLYN DRIVE

MATCHLINE

0m 20 40 60m

1:1000

PROJECT:					
FURNISSDALE WEST URBAN EXPANSION					
No	DATE	REVISION	BY
A	20.05.14	ISSUED FOR APPROVAL	DPE

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DRAWING No.	15-4-60/0/100
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NOTE:
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RIVERSIDE DRIVE

FUTURE BOUNDARY RETAINING WALL

POS +D

ROAD 'AE'

PINJARRA ROAD

BATTER TO EXISTING GROUND AT 1 in 6

ROAD 'O'

POS

CCW / TEC

ROAD 'P'

ROAD 'AC'

ROAD 'AB'

ROAD 'AD'

ROAD 'Y'

ROAD 'Z'

ROAD 'AA'

ROAD 'R'

ROAD 'S'

ROAD 'W'

ROAD 'T'

ROAD 'U'

ROAD 'V'

ROAD 'X'

ROAD 'Q'

151

403

250 SL

160 HDPE

RONL YN DRIVE

MATCHLINE

0m 20 40 60m
1:1000

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PROJECT:
FURNISSDALE WEST URBAN EXPANSION

No.	DATE	REVISION	BY
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BULK EARTHWORKS PLAN SHEET 2

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ORIGINAL DRAWING SIZE **A1**

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EARTHWORK VOLUMES

TOTAL AVAILABLE CUT	-450
TOTAL REQUIRED FILL	112000
BALANCE (SHORTFALL)	111550

- SURVEY TIN: EXISTING GROUND
- DESIGN TIN: DESIGN
- NO BULKING FACTOR APPLIED
- VOLUMES SHOWN IN m^3

LEGEND

- EXISTING GROUND CONTOUR (0.5m INTERVAL)
- PROPOSED GROUND CONTOUR (0.2m INTERVAL)
- EXISTNG GROUND SPOT LEVEL
- PROPOSED LOT / PAD LEVEL
- EARTHWORKS BOUNDARY

JOINS DRG. No 15-4-60/0/103

RIVERSIDE DRIVE

ROAD 'A'

ROAD 'B'

ROAD 'G'

ROAD 'H'

ROAD 'C'

ROAD 'D'

ROAD 'E'

ROAD 'F'

ROAD 'I'

ROAD 'J'

ROAD 'K'

ROAD 'L'

ROAD 'M'

ROAD 'N'

OEPA VEGETATION

RONL YN DRIVE

MATCHLINE

1:1000 0m 20 40 60m

PROJECT:

FURNISSDALE WEST URBAN EXPANSION

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CLIENT:

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DRAWING:

BULK EARTHWORKS CUT/FILL SHEET 1

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JOINS DRG No 15-4-60/0/102

EARTHWORK VOLUMES

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TOTAL REQUIRED FILL	132760
BALANCE (SHORTFALL)	130830

- SURVEY TIN EXISTING GROUND
- DESIGN TIN DESIGN
- NO BULKING FACTOR APPLIED
- VOLUMES SHOWN IN m^3

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RIVERSIDE DRIVE
ROAD 'O'
POS
CCW / TEC
POS
ROAD 'P'
ROAD 'R'
ROAD 'S'
ROAD 'W'
POS +D
ROAD 'AE'
ROAD 'AC'
ROAD 'AB'
ROAD 'Z'
ROAD 'AA'
POS
ROAD 'Y'
ROAD 'AD'
ROAD 'Y'
PINJARRA ROAD
ROAD 'O'
ROAD 'Q'
ROAD 'T'
ROAD 'U'
ROAD 'V'
ROAD 'X'
857
403
RONLYN DRIVE
MATCHLINE
250 SL
160HDPE
0m 20 40 60m
1:1000

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FURNISSDALE WEST URBAN EXPANSION

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DRAWING:
BULK EARTHWORKS CUT/FILL SHEET 2

STATUS: **FOR APPROVAL**

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APPENDIX E
Furnissdale ODP Infrastructure Report
(Porter Consulting Engineers, 2013)

FURNISSDALE OUTLINE DEVELOPMENT PLAN

INFRASTRUCTURE

Report Prepared For:

COODE PTY LTD

Report Prepared By:

PORTER CONSULTING ENGINEERS
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Job No: 13-06-068
Date: 4/09/2013
Our Ref: R43.13
Rev: A
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Figure 1 – Outline Development Plan
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1.0 INTRODUCTION

Coode Pty Ltd commissioned Porter Consulting Engineers to identify and advise on infrastructure required to service the land encompassed by the Furnissdale Outline Development Plan. Porter Consulting Engineers are part of the design team assembled to inform an overall Structure Plan for the area. Zoning and landuse is being reviewed by the Rowe Group; water management and surface geology by Hyd20; traffic and transport also by Porter Consulting Engineers.

This report examines the existing services within the area, identifies the capacity of those services and any upgrading works required to enable development of the intended land use.

2.0 BACKGROUND REVIEW

In undertaking the investigation of services, the Outline Development Plan shown in Figure 1 has been the guide for the extent of development and the likely land use. Reference has been made to the following:

- Peel Region Scheme Amendment 034/57 Furnissdale (West) Urban Expansion.
- Shire of Murray advice in relation to the proposed Scheme Amendment 283 for the Furnissdale Barragup Business Precinct which is incorporated within the Outline Development Plan.
- Previous servicing investigations by BPA Engineering in 2011 and Porter Consulting Engineers in 2008.

In order to obtain up to date information, the service agencies responsible for infrastructure within the area were contacted in July 2013 and requested to provide information identifying their existing infrastructure and network capacities. Responses received from those Authorities form the basis of the comment on infrastructure requirements.

3.0 EXISTING INFRASTRUCTURE

3.1 Roads

Pinjarra Road, which bisects the northern section of the precinct, is classified as a Primary Regional Road and is under the care and control of Main Roads WA. It is currently configured as a four lane divided carriageway within a generally 40m wide road reserve.

Traffic signals have been recently constructed at the Pinjarra Road/Ronlyn Road/Husband Road intersection.

The intersection with Furnissdale Road and Watson Drive is a four way sign controlled junction with right turn pockets on Pinjarra Road.

The intersection with Riverside Drive is a signal controlled T-junction with right turn entry pocket on Pinjarra Road and a U-turn pocket on the eastern approach.

Riverside Drive, Ronlyn Road and Furnissdale Road are:

- all local roads constructed to a sealed but un-kerbed standard;
- provide direct lot access; and
- provide entry to the Furnissdale residential area at the southern end of the Structure Plan area.

3.2 Sewer

No gravity sewer exists in the area.

There is a pressure main (Culleenup Road Pressure Main) which is located in the southern verge of Pinjarra Road. This conveys effluent in a westerly direction and services development east of the Site.

There is a vacuum sewage system at the Furnissdale townsite south of the area, serviced by a vacuum pump station. The Water Corporation has indicated they have no intention to extend this system further to the north to Pinjarra Road.

3.3 Water

A 700mm diameter and 450mm diameter water trunk main exists along the northern verge of Pinjarra Road. A 200mm diameter water main extends from these large mains across Pinjarra Road along Furnissdale Road to a pressure reducing valve at the southern corner of Lot 157. A 150mm diameter water main exists in the mid section of Riverside Road, a 100mm diameter increasing to a 200mm diameter main in Ronlyn Road and a 200m diameter main in Furnissdale Road.

3.4 Power

Western Power distribution infrastructure in the area comprises of three phase 22kV high voltage aerial power lines along Pinjarra Road. The Pinjarra Road feed originates from the Western Power 132kV/22kV Mandurah sub-station near Mandurah Road. There are a number of smaller 63kVA, 100kVA and 200kVA pole top transformers in the vicinity providing aerial feeds to adjacent properties.

3.5 Telecommunications

A telecommunication cable network exists in the area with both Telstra local and optic fibre cables in the vicinity.

3.6 Gas

There is no gas infrastructure currently in the area.

3.7 Drainage

Drainage in the area is by on-site retention and soakage.

There is limited drainage infrastructure at road intersections and this conveys water to verges for direct infiltration.

The local roads are unkerbed with direct run-off to verge swales.

The local drainage follows natural depressions and discharges to the north west towards the Serpentine River. Where local roads cross the natural valley lines, the flow is transferred by piped culverts.

3.8 Services Plan

The existing services are shown in Figure 2.

4.0 INFRASTRUCTURE CAPACITY AND UPGRADING

4.1 General

The advice received from the respective infrastructure authorities and the local authority is based on the current planning expectation for the area. The authorities were provided with the Outline Development Plan and have made their comments on that basis.

4.2 Roads

Pinjarra Road is the main transport route through the area. It is planned to widen the Pinjarra Road reserve by 10m either side to a 60m nominal width in order to accommodate an ultimate configuration of six lane divided carriageway. The timing of the construction of these additional lanes depends on growth in traffic volumes. Typically the additional lanes would not be required until traffic volumes reached at least 40,000 vehicles per day.

Traffic signals that have recently been constructed at the Pinjarra Road/Ronlyn Road/Husband Road intersection are likely to be repeated at the Pinjarra Road/Furnissdale Road/Watson Drive intersection. The forecast traffic volumes for the area will require multiple vehicular access points in order to distribute traffic and reduce the volume on any individual access point.

Main Roads WA will insist upon a control of access along Pinjarra Road frontage and at least 30m down each connecting road.

The local roads that will form part of the connector road network, being Ronlyn Road, Riverside Drive, Furnissdale Road, and a proposed north-south connector, will be expected to be constructed as two lane/two way roads with facilities for on-road parking and limited access to adjacent development.

The section of Ronlyn Road in the vicinity of the commercial precinct is likely to be developed in a main street style with main street planning principles to be applied. These roads may be 10m wide roads with a central at-grade median with additional tree planting.

The intersection control at four way junctions on the primary network are expected to be roundabout controlled with four way intersections on local roads having a priority control through combination of signing and pavement texture.

4.3 Sewer

The Water Corporation has advised that the area is within the Barragup Planning and it is proposed to install gravity sewers feeding to a new pump station on Ronlyn Road. The most recent conveyance planning is shown on the attached Figure 2. Servicing of this general area will require a new pump station (Barragup Pump Station C) roughly located on the northern side, mid way along Barragup Road.

The ultimate pump station at this point connects to a suite of projects including a type 90 sewer pump station with an initial duty of 40l/second approximately 850m of DN250 pressure main, 450m of DN375 gravity sewer, 300m^3 of emergency storage.

Any proposal for smaller, temporary pump stations, and alternative pump station locations or staging options need to be considered by the Water Corporation Infrastructure Planning Branch, and may require some further review.

There have been proposals for a temporary pumping station to service the commercial precinct located on Ronlyn Road south side, just west of Pinjarra Road.

A portion of the ODP area overlaps with the catchment of the existing permanent Vacuum Pump Station (VPS) on Ronlyn Road (PS '1'). This is currently the only permanent Pump Station (PS) in the Sewer District. This VPS has a limited capacity and has not been designed to take any out of catchment flows. The flow into the VPS is presently conveyed to the Gordon Road WWTP via a temporary pressure main heading west via the Beacham Street PS and onward through other pump station catchments. The flows to the VPS will eventually be redirected to discharge via a short length of pressure main into the ultimate DN300 gravity sewer along Ronlyn Road heading to the future PS'C'.

The actual capacity of the VPS has not yet been determined due to some differences between design, build and operation. The VPS currently serves approximately 200 lots in the Furnissdale townsite. The pump station will require further analysis to determine if it is large enough to take the design flows shown in our long term planning. An upgrade of the VPS may be required by around 2020-2025 depending on the rate of development of vacant land in its limited catchment.

Current planning indicates that the flow diversion pressure main to the future DN300 gravity sewer in Ronlyn Road will likely be required when/if the pumps are upgraded at the VPS, or the capacity of its present downstream discharge point (the Beacham Street PS) is exceeded.

4.4 Water

The area is situated within the Corporation's Yunderup Pressure Reduction Valve (PRV) Water Supply zone.

Water supply to this Yunderup-Furnissdale-Barragup area is currently via a system of PRV's off the large distribution mains along Pinjarra Rd – DN700 and DN460.

Supply to the proposed Furnissdale urban development area will need to be via reticulation-sized mains DN200, DN250 with smaller retic as needed. Retic. layout to be worked up in consultation with the Corporation's Land Servicing Branch when adopted LSP and spatial staging information becomes available.

The Corporation's long-term planning for the Pinjarra and Mandurah areas is currently under review. Among other things, this planning will decide whether the Yunderup PRV zone continues to be served from the Stirling Trunk main, or from a future Pinjarra scarp tank to the east, or from the north-west via the Mandurah tanks and distribution system.

4.5 Power

Western Power has indicated that they have made arrangements for a new terminal and sub-station land purchase in Furnissdale. This is a strategic acquisition for a potential zoned sub-station to meet anticipated future load growth in the Furnissdale area. They have also indicated that a recent upgrade to the Meadow Springs Sub-station distribution feeder will increase supply capacity to the South Metro 22kV area, which includes Furnissdale.

Western Power has indicated there are no voltage instability issues forecast to arise in the Mandurah load area over the next five or so years.

Western Power has a network mapping facility which uses anticipated development data provided by the Western Australian Planning Commission and can be used to predict the load availability over time. The network mapping indicates that there is 5MVA capacity in the network at the moment with this increasing to 15MVA capacity over five years and in 20 years back to 5MVA capacity after development.

The current demand for residential development is typically around 4.7kVa per lot and it could be expected that the ODP area would create a load of 12.2MVA.

Western Power typically will cater for increase demand in accordance with the planning predictions for the area.

4.6 Telecommunications

The National Broadband Network Company (NBN Co.) will provide optic fibre for the new development. This will replace the local Telstra copper network. NBN Co. will review the ODP and advise if any land is required for hub facilities.

4.7 Gas

AtcoGas propose to install a 225mm PE high pressure gas main along Pinjarra Road. AtcoGas will review the ODP and advise further if any upgrades are required. At this stage, it is expected that gas could be reticulated from the high pressure main into the ODP area.

4.8 Drainage

The Shire of Murray requires the road network within the development area to be kerbed and drained. Due to the higher water table it is likely that much of the drainage will be shallow swale related drainage, or shallow pipe systems feeding to the local natural drainage system.

The Local Water Management Strategy will identify the primary drainage routes. The Shire will adopt water sensitive urban design principles and require stormwater to be managed as high in the catchment as possible. The Department of Water require developments to manage the 1 year 1 hour storm event (about the first 10mm of rainfall) within their respective sites.

Prior to discharging of any stormwater to the natural system, water quality improvement initiatives will be required. These may be structural separator pits if there is insufficient land, but a natural approach employing rain gardens and filtration will be preferred.

The intent of the design will be to preserve the natural watercourses where possible, protect the topographic lows, minimise the pipe drainage network and maximise use of the natural surface drainage elements of the site.

The Shire of Murray will require the drainage for the base road network to be designed for at least the 1 in 5 year average recurrence interval (ARI) storms, with treatment and detention areas to manage the 1 in 10 year ARI storms and overland flow paths defined and protected to manage the 1 in 100 year ARI storms.

An integral part of the drainage network will involve filling or earth-working much of the site. Filling may be required to improve site classification for structural purposes, to reduce the amount of swell or shrink in the soil or to provide an appropriate separation between the maximum groundwater and buildings.

Currently, the average annual maximum groundwater level varies from 1m AHD to 1.5m AHD across the site and the surface level varies from 2m AHD to 4m AHD. The drainage requirements will seek to have 0.5m clearance between the 100 year storage level in any retention or detention basins and 0.3m above the 100 year flood level in local drainage networks.

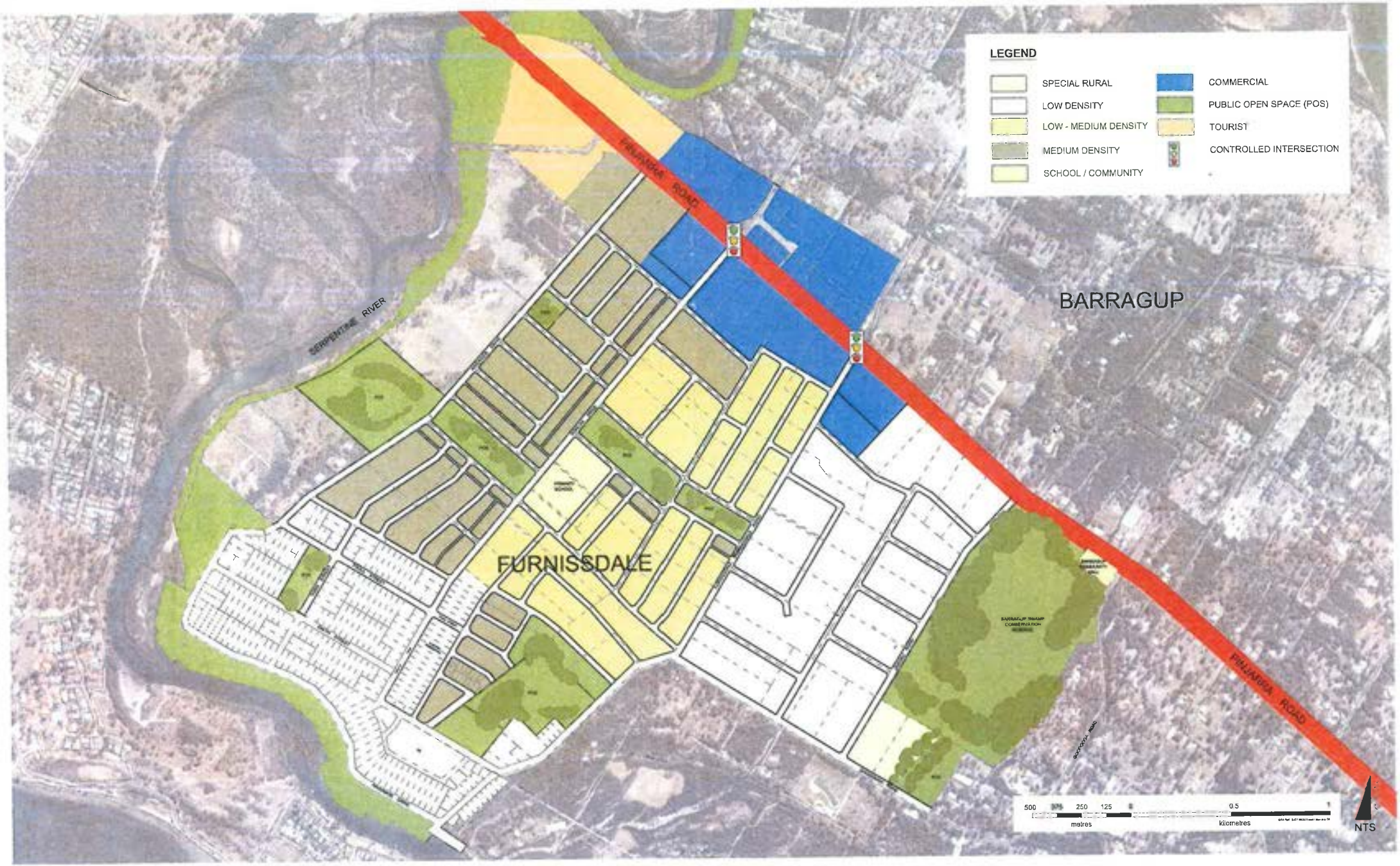
The maintenance of the clearance can be achieved by introducing sub-soil drains or importing fill. The issue with sub-soil drains is that there may be further treatment required if the groundwater is acidic or has legacy nutrients that require treating before being discharged to the local waterways.

At this stage it is likely that the site will require filling to at least 3.5m AHD in the eastern section to about 3m AHD in the southern section. This suggests in the order of 1m of fill in the western part of the site tapering to 0.5m of fill near the centre and zero in the eastern part.

4.9 Indicative Servicing

An indicative servicing plan is shown in Figure 5.

FIGURE 1
Outline Development Plan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SPECIAL RURAL
LOW DENSITY
LOW - MEDIUM DENSITY
MEDIUM DENSITY
SCHOOL / COMMUNITY
COMMERCIAL
PUBLIC OPEN SPACE (POS)
TOURIST
CONTROLLED INTERSECTION
PINJARRA ROAD
SERPENTINE RIVER
BARRAGUP
FURNISSDALE
PINJARRA ROAD
500
250
125
0.5
metres
kilometres
NTS

FIGURE 2
Existing Services Plan

LEGEND

- EXISTING GROUND CONTOUR
- EXISTING GAS LINE
- EXISTING SEWER PIPE
- EXISTING SEWER PRESSURE MAIN
- EXISTING TELSTRA CABLE
- EXISTING WATER MAIN
- EXISTING HIGH VOLTAGE UNDERGROUND POWER LINE
- EXISTING HIGH VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE UNDERGROUND POWER LINE
- EXISTING OVERHEAD POWER LINE
- EXISTING UNDERGROUND POWER LINE
- EXISTING DRAINAGE LINE
- EXISTING OPTUS
- EXISTING NEXTGEN

WEBSTER WAY
HUSSAND
DOUGLAS PL
RIVERSIDE
BONLYN RD
BINJARRA RD
WATSON DR
WATSON DR
FURNISSDALE RD
FURNISSDALE RD

MATCH LINE 13-6-68/3

PROJECT

WEST FURNISSDALE PRECINCT
FURNISSDALE

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CLIENT

COODE PTY LTD

DRAWING

EXISTING SERVICES PLAN
SHEET 1 OF 2

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MATCH LINE 13-6-68/3

RIVERSIDE DR

RIVERSIDE

SMITH

YORK RD

PAVEL

RONELYN

FURNISSDALE RD

GOOOOOGA RD

BERTRAM

LEGEND

- EXISTING GROUND CONTOUR
- EXISTING GAS LINE
- EXISTING SEWER PIPE
- EXISTING SEWER PRESSURE MAIN
- EXISTING TELSTRA CABLE
- EXISTING WATER MAIN
- EXISTING HIGH VOLTAGE UNDERGROUND POWER LINE
- EXISTING HIGH VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE UNDERGROUND POWER LINE
- EXISTING OVERHEAD POWER LINE
- EXISTING UNDERGROUND POWER LINE
- EXISTING DRAINAGE LINE
- EXISTING OPTUS
- EXISTING NEXTGEN

PROJECT

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FURNISSDALE

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CLIENT

COODE PTY LTD

DRAWING

EXISTING SERVICES PLAN
SHEET 2 OF 2

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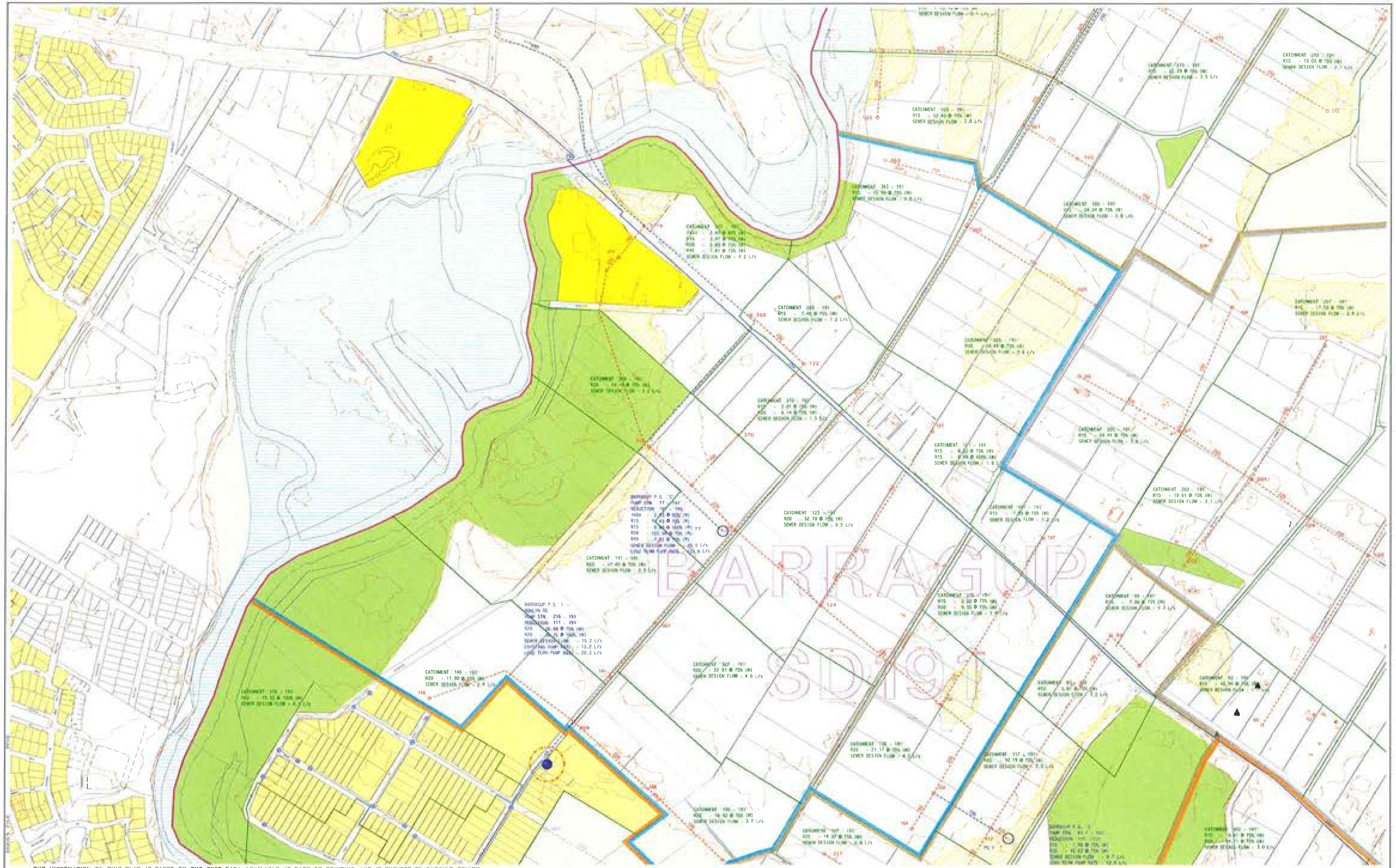
FIGURE 3
Water Corporation Conceptual Planning



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LEGEND

- EXISTING PUMPING STATION
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- PARKS AND PUBLIC OPEN SPACE
- EXISTING SEWERED AREAS
- SEWERED BY PRIVATE PS
- NODE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT
- WWTP CATCHMENT
- FLOODWAY/FLOOD FRINGE
- FLOOD PLAIN
- CUT/FILL

NOTATION

SEWER DISTRICT NUMBER
CATCHMENT NODE
CATCHMENT 7001 - 121
R15 - 108.4 @75% (W)
GROSS AREA (ha)
'R' CODE ZONING
% OF LAND DEVELOPMENT
(W) - WET CONDITIONS
(D) - DRY CONDITIONS

SEWER DESIGN FLOW = 1.5 x AVERAGE DAILY FLOW RATE

SHEET INDEX

WATER CORPORATION

ISSUED WITH THE AUTHORITY OF THE MANAGER
INFRASTRUCTURE PLANNING BRANCH
629 NEWCASTLE STREET LEEDERVILLE 6007
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TELEPHONE (08) 9420 2420 FAX (08) 9420 3179

WASTEWATER SCHEME PLANNING SERIES

BARRAGUP - SD191
CONCEPTUAL PLANNING
LONG TERM SCHEME: SHEET 2 OF 4

R. NICHOLSON	L. GABRIEL	T. ZHENG
1:5000	28 JUNE 2012	0806 - 01

A1

FIGURE 4
Indicative Bulk Earthworks Plan



LEGEND

- 2.0 EXISTING GROUND CONTOURS
- 1.75 GROUND WATER LEVEL CONTOURS
- 1.75 PROPOSED BULK EARTHWORK LEVELS
- 3.00 PROPOSED FILL LEVELS

100 0 100 200 300 400 500 600 700 m

SCALE 1:10000

PROJECT
WEST FURNISSDALE PRECINCT
FURNISSDALE

B 16-9-2013 PRELIMINARY PLAN FOR APPROVAL MJV
No. DATE REVISION BY

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DRAWING
BULK EARTHWORK CONCEPT

STATUS **FOR COMMENT**

SCALE	1:10000	DRAWING No.	13-6-68/1
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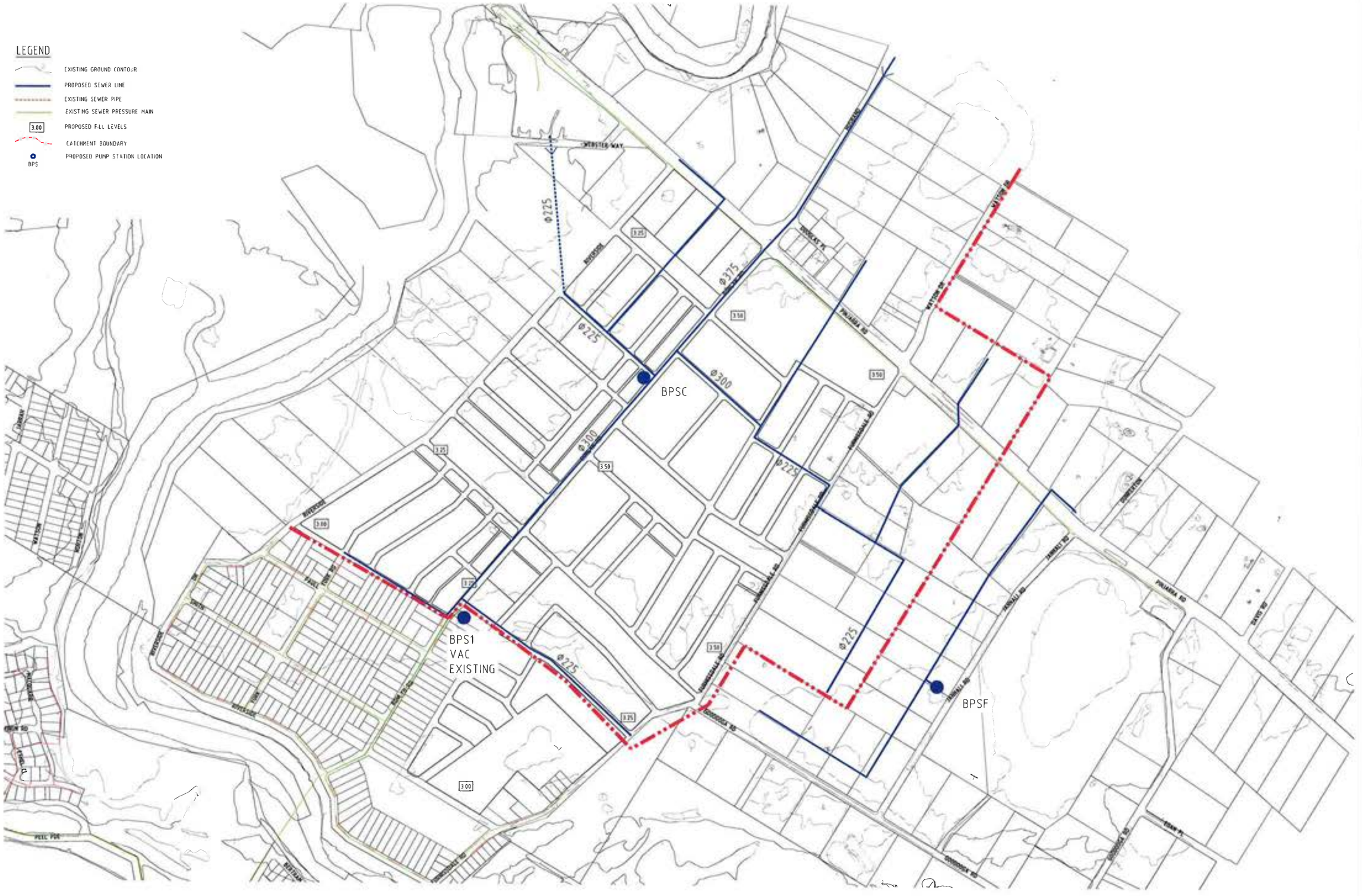
DESIGN	DEP	PAPER SIZE	A3
DRAWN	MJV	FILE NAME	S:\ACTIVE PROJECTS\13-06-068\13668-1.dwg
CHECK		APPD	

FIGURE 5
Indicative Servicing Plan

LEGEND

- EXISTING GROUND CONTOUR
- PROPOSED SEWER LINE
- EXISTING SEWER PIPE
- EXISTING SEWER PRESSURE MAIN
- 3.00 PROPOSED FILL LEVELS
- CATCHMENT BOUNDARY
- BPS PROPOSED PUMP STATION LOCATION



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LEGEND

EXISTING GROUND CONTOUR

PROPOSED WATER LINE

EXISTING WATER PIPE

WEBSTER WAY

RIVERSIDE

RONLYN RD

HUSBAND

DOUGLAS PL

PINJARRA RD

WATSON DR

FURNISSDALE RD

150

150

200

PROJECT: WEST FURNISSDALE PRECINCT FURNISSDALE	0 14.9.2013 APPROVAL	COPYRIGHT: COPYRIGHT IN THIS DRAWING IS THE PROPERTY OF THE CONSULTANT. THE CLIENT HAS LICENCE TO USE THIS DRAWING FOR THE PROJECT ONLY. THE USER SHALL BE RESPONSIBLE FOR ... ONLY PLANS WITH NUMBER, REVISION DEV 0 OR HIGHER AND SIGNED AS APPROVED SHALL BE USED FOR CONSTRUCTION	Porter Consulting Engineers	Level 2 Kishorn Court, 58 Kishorn Road, Mt Pleasant 6153 WA; PO Box 1016, Canning Bridge 6153 WA; Tel (08) 9315 9955, Fax (08) 9315 9959, Email s78c@portereng.com.au, www.portereng.com.au	CLIENT: COODE PTY LTD	DRAWING: PROPOSED WATER RETICULATION	STATUS: FOR APPROVAL	SCALE: AS SHOWN; DATE: SEPT 2013; DESIGN: DEP; DRAWN: MEB; CHKD: ; APVD: ; DRAWING No: 13-6-68/5; REV No: A; SIZE: A1; FILE NAME: S:\ACTIVE PROJECTS\13-06-068\13668-S.dwg

APPENDIX

References

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GHD, November 2003, *Furnissdale Structure Plan and Traffic Impact Study for Shire of Murray*

Greg Rowe & Associates, September 2010, *PRS Rezoning Justification Report Lots 181-185, 197, 198, 1186, 1187 Ronlyn Road and Lots 179 and 180 Riverside Drive, Furnissdale*

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WA Planning Commission, September 2012, *Peel Region Scheme Amendment 034/57 Furnissdale (West) Urban Expansion*

APPENDIX 5

FIRE MANAGEMENT PLAN

ROWEGROUP

FIRE MANAGEMENT PLAN

for

Local Structure Plan Riverside Drive & Ronlyn Road Furnissdale

Shire of Murray



FirePlan WA

March 2015

V1.4

Fire Management Plan.

Prepared For
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Document Status

Version	Comment	Reviewer	Review Date
Version 1			
Version 2			

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.

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1.0 PURPOSE OF THE MANAGEMENT PLAN

The purpose of this Fire Management Plan is to detail the fire management methods and requirements that will be implemented for the subdivision of Local Structure Plan (LSP) area located in the Riverside Drive and Ronlyn Road Furnissdale (Site). The "Site" is located to the south of Pinjarra Mandurah Rd between Riverside Drive and Ronlyn Road. . Refer Figure 1: Locality Plan.

This *Fire Management Plan* is based on the assessment prepared for the site on April the 17th 2014 by Fire plan.

This Fire Management Plan satisfies the requirements of the Shire of Murray and the Western Australian Planning Commission (WAPC) via *Planning for Bush Fire Protection Guidelines* Edition 2 (WAPC and Department of Fire and Emergency Services 2010), referred to in this document as the Guidelines.

This *Fire Management Plan* (FMP) will likewise outline the responsibility and timing for implementing and maintaining the fire protection measures and strategies contained within, allocating these responsibilities between individual land owners, the developers and the Shire of Murray.

In the event of large bushfires it is essential that landowners understand that fire appliances may not be available to protect each dwelling/building so it is in the Landowners best interest to provide adequate fire protection to their assets, the minimum requirements are detailed in this FMP.

The recommendations made within this Plan relating to the clearing or modification of vegetation to meet setback requirements does not constitute approval or authority to modify or remove vegetation. All such approvals must be undertaken in consultation with the relevant authorities.

2.0 PROPOSED DEVELOPMENT

The development proposes to create lots ranging from R20 to R60 zoning, the site currently cover existing lots shown on the LSP plan on Page 5.There is a limited number of lots marked on that plan that have indicated they are not part of this proposal.

The number of individual lots will be determined later in the planning approval process. The site has significant sections of bush land held on a number of titles some of which will be maintained in the future development as a regional park and POS. These parks will be identified in the plan and bushfire management requirement identified in the plan and implemented at the time of development. The site has been identified as being bushfire prone in the Shire of Murray Town Planning Scheme. The lots will be created with all services and surfaced roads that will link back to Riverside Drive and Ronlyn Road which access out of the local area via Pinjarra Rd.

Fire hydrants will be installed on road verges in accordance with the WAWA standards.

See layout of proposed development Figure1 below

Figure 1 LSP Site.



3.0 SITE DETAILS

The Vegetation within the site on the Office of the Environmental Protection Authority (OEPA) veg area is rated as (Class B) Woodland 2.2 05 from Figure 1 of Planning for Bushfire Protection (PfBFP).
The remainder of the area shown on the Hazard Map to the south of the OEPA area has the same classification (ClassB) Woodland 2.2 05 together with a small section north of the OPEA. The rest of the site has a limited area of Grassland (Class G with the majority of the area where dwellings are present being (ClassB) Woodland 2.2 06.
The neighbouring vegetation in all directions again ranges from open grass land to (ClassB) Woodland 2.2 05 or 2.2.06 see hazard map (on page 7&8)

Slope within the site are generally rated flat for the purpose of classification in accordance with PfBFP, the adjoining land in again considered 0° to a distance of 100 meters from the site as required by the guidelines.

There are a significant number of dwellings currently within the site; the requirements of this plan are not retrospective in any way on those building as the requirements of PfBFP only relate to new construction.
The requirements of this plan would be required on any new dwelling constructed after the Shire of Murray has adopted the plan.

Access to the site is currently off Pinjarra Rd on to Riverside Drive and Ronlyn Rd, future roads will comply with the standards set in PfBFP.A2.2, A2.3, and A2.4
See appendix A Access Standards.
.



Figure 2 Location of Development marked in yellow

4.0 STATUTORY CONDITIONS

The Western Australian Planning Commission and the Shire of Murray requires the preparation of a 'Bushfire Management Plan' as part of the approval process to be implemented at the time of subdivision. This document has been prepared to satisfy that requirement in accordance with *Planning for Bush Fire Protection 2010.*

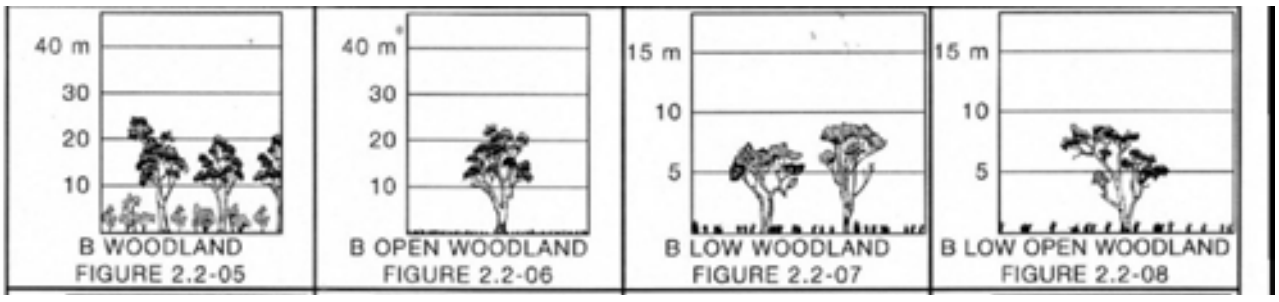
As fire management strategies may require altering to meet changing climate, weather patterns, environmental and land use needs, landowners/occupiers are advised that provisions of the Bush Fires Act 1954 may still be enforced in addition to this Fire Management Plan. The Shire of Murray in conjunction with Landowners will be responsible for initiating a review of this fire management plan as it may see necessary to do so.

5.0 BUSH FIRE HAZARD ASSESSMENT

Bush Fire Hazard Assessment is determined by rating the vegetation type in accordance with Table 2 and Group G of AS 3959 2009. It is also based on the underlying assumption that land in Western Australia is predominantly undulating with relatively short, steep inclines. In Planning for Bush Fire Protection (Edition 2 2010) (PFBP) the bush fire hazard assessment methodology identifies 3 three levels low, moderate and extreme.

The Bush Fire Hazard Assessment for the proposed development area is rated Moderate (Group B Woodland 2.2.05 and Woodland 2.2.06 and Group G Sown Grassland 2.2.26), the grass land is rated low as per the Australian Standard. The vegetation adjoining the site to the north and east is rated *Moderate. See illustration next page*
The bush fire hazard assessment is based on the vegetation types and class (ClassB) Woodland as described in Table 2 Planning for Bushfire Protection and Group B of AS 3959 2009. This bush fire assessment does not relate directly to the fuel loading within that vegetation. Fuel loading is described as grass, leaf litter and live vegetation which changes over time and can be modified. The rating is for all the land depicted inside the yellow line shown on the site map on page 13.

The Mediterranean climate experienced by this area is such that the majority of rain falls in late autumn through to early spring. This rainfall supports substantial vegetation growth which dries off in Summer/Autumn.
The diagram 5 below shows the total area of the site and vegetation types rated as Low and Medium under the (PFBP) guidelines. The Minimum standard for all dwellings affected by the proximity of the remaining vegetation will be set out in 6.4.2.



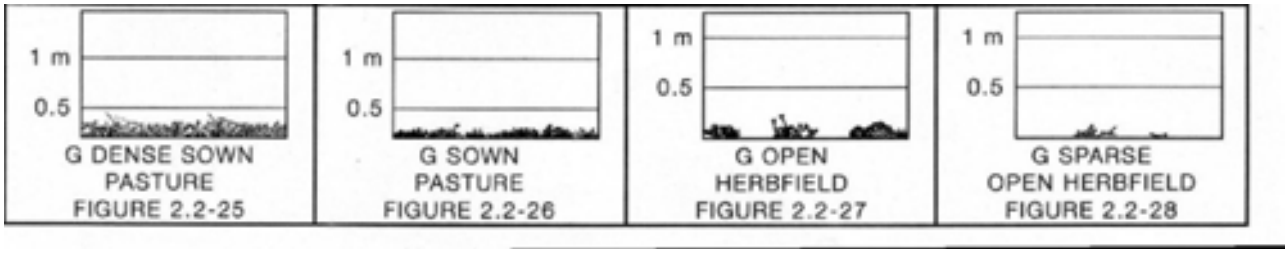


Figure 3 Classification type from AS3959



to the Figure 4 Photo taken south west corner site on future POS area.



Figure 4a Photo taken northern end of OEPA of Riverside Driveside of Property at the northern end.



Figure 5 Bush Fire Hazard Rating Moderate and Low as per AS3959

6.0 BUSH FIRE MITIGATION

In this Section of the Fire Management Plan when complying with the Acceptable Solutions detailed in *Planning for Bush Fire Protection* 2010 it will be shown as (A2.1) meaning Acceptable Solution 2.1 of the guidelines and the requirements of AS3959.

The subdivision has been designed so as to take into account the following fire mitigation measures:-

- Location of Development
- Vehicle Access
- Private driveways
- Water Supplies
- Siting of Development
- Building Protection Zones, Hazard Separation Zones, Hazard Reduction
- Planting of trees
- Dwelling Construction Standards

6.1 LOCATION OF DEVELOPMENT

The Bush Fire Hazard Assessment has identified the subject land as having "Low and Moderate" bush fire hazard levels under the AS 3959 requirements.
. The removal of bushfire fuels from the site will remove the requirement to have increased construction standard for dwellings on the site except adjacent to the OEPA vegetation that is to remain, the POS areas marked on the map below will be cleared to Building Protection Zone standards. *See map at section page 13.*

Building Protection Zones Hazard Separation Zone will be introduced to increase protection around the dwellings immediately adjacent to the reserve, these dwellings will be constructed to AS 3959-2009 as per 6.4.2

6.2 VEHICLE ACCESS

6.2.1 Road System

The site will be serviced by new internal roads from Paul Street and Ronlyn Rd. All roads will be constructed to the Shire of Murray standards; the internal road network will be as shown on the map Figure 2 on page 5. The road network will satisfy the requirements of A 2.1. A2.2. A2.3.

6.2.2 Firebreaks

The requirements of the Shire of Murray fire break notice will apply on individual lots. Staging of the development may require interim management of the fuel loads during the development stage; those requirements are to be in accordance with the Firebreak Notice.

6.3 WATER SUPPLIES

Reticulated water supplies are to be provided to each lot and Fire Hydrants will be provided as per Water Corp Standard 63 to satisfy A3.1 of the Planning for Bushfire Protection guidelines.

6.4 SITING OF DEVELOPMENT

This development will comply with Planning for Bush Fire Protection guideline by applying increased building standards and applying appropriate BPZ, together with the fire breaks as documented in this plan and the provision of firefighting water supply requirements will ensure the development complies with element 4 of PBFP.

6.4.1 Building Protection Zone (BPZ)

The aim of the Building Protection Zones is to reduce the amount of accumulated bush fire fuel and to lower the intensity of the impact of a bush fire by flame contact or radiated heat. The Building Protection Zone is to be installed by the developer prior to the commencement of new dwelling construction and maintained by the landowner and reserve authority on the sites identified on the map page 13.

Non flammable features such as roadway, driveways, paths, vegetable patches, reticulated lawn, or landscaped gardens should form part of Building Protection Zones. Isolated trees and shrubs may be retained within Building Protection Zones.
A Building Protection Zone is to be constructed within the Lot around all buildings as follows (A4.3): The size of the BPZ will be for BAL 19 construction which will require a 20>29 meter set back from bush fire fuels. This requirement will only affect houses as on the shown on the map below, the standard for the total area of the BPZ will in accordance with the guidelines set out here.

- The first 5m around all building is to be cleared
- Dry grass below 50mm
- The spacing of trees should be 15-20 metres apart to provide for a separation of 10 metres between crowns;
- Trees are to be under/low pruned, to a height of 2 metres;
- No tall shrub or tree is to be planted within 2 metres of a building including windows;
- There are no tree crowns over hanging the building;
- Shrubs within the building protection zone have no dead material within the plant;
- Trees in the Building protection zone have no dead material within the plant's crown or on the bole (tree trunk)
- All grass to be maintained below 50mm

- Sheds within the Building Protection Zone are to be constructed using non combustible materials (e.g. colour bond iron, brick, limestone); sited 6 meters or greater from the dwelling or be constructed to the same BAL rating as the dwelling.

- Branches, must be removed at least 2 metres back from the eaves of all buildings;

- All leaves, twigs, logs, branches must be periodically removed from within the building protection zone. Annual falls of leaf litter must be raked up and removed or burnt.

Trees planted within the BPZ must comply with the standard outlined in Section 6.4.1
Any planting of trees and re-vegetation within the site is to be carried out so as not to increase the fire risk to existing and proposed dwellings/ buildings and also to ensure a safe refuge for residents in the event of bush fires.

6.4.2 Dwelling Standards

All new habitable buildings on lots fronting the OEPA and the CCW TEC shown in the map **Figure 6** below (colour coded in yellow) are to comply with Australian Standard AS 3959-2009 'Construction of Buildings in Bush Fire Prone Areas' – BAL 19 in order to ensure the safety of future residents.
This will require a minimum BPZ/HSZ of 20 to 29 meters. This distance will include land that is part of the OEPA reserve which will require the responsible body to maintain the reduced fuels within the buffer on the edge of the reserve.
Those dwellings within the area more than 42 meters and less than 100 meters from the vegetation within these reserves are to have construction standard BAL12.5 applied.

A diagram at Figure 7 shows how BPZ provide protection including roadway and reserve buffer to those areas required, this is in compliance with E4.3 and E4.4.

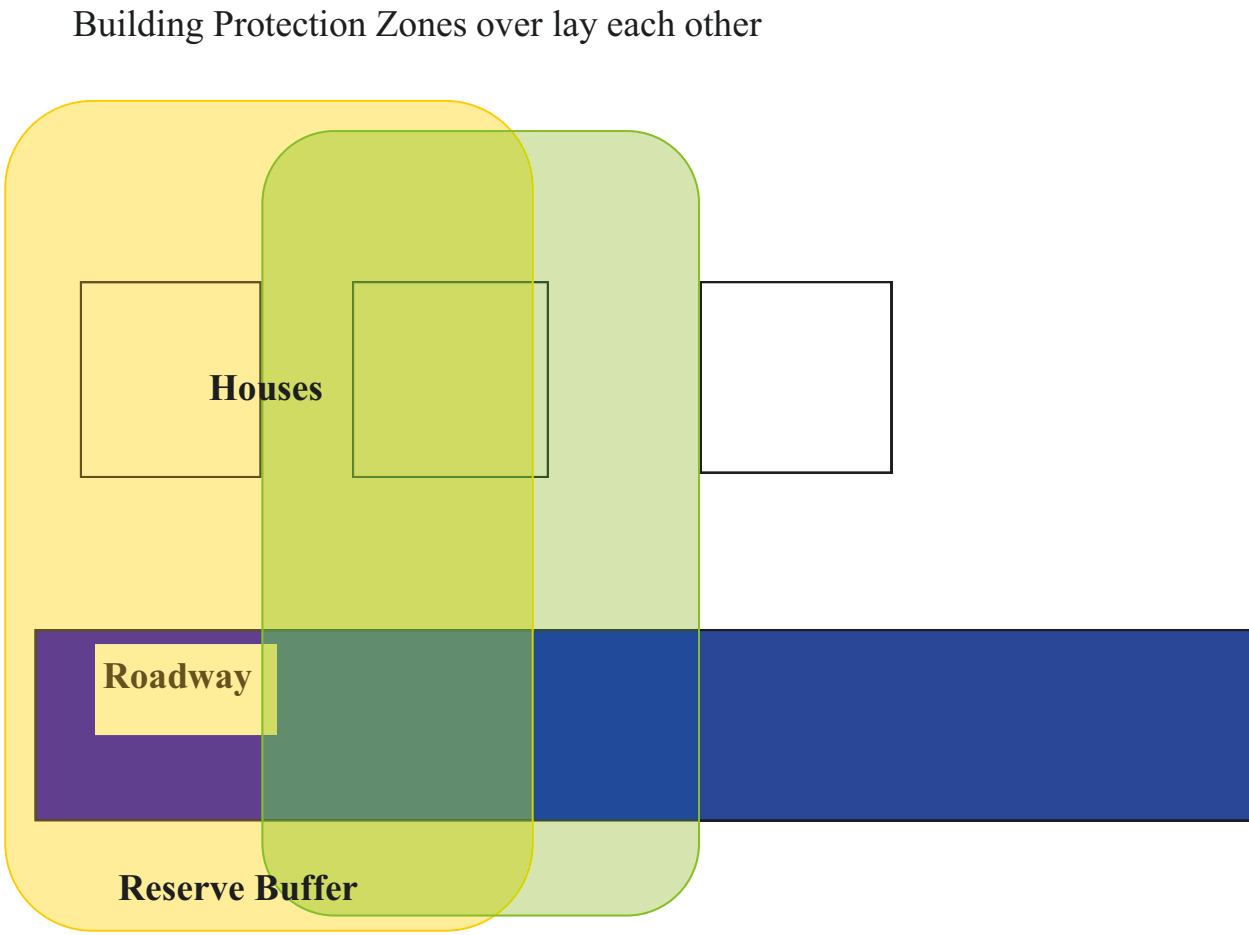
Lots fronting Ronlyn Rd and Riverside Drive will require BAL assessment prior to the issue of building Licenses to ensure vegetation opposite will not constitute a bushfire hazard.



Figure 6a Lots affected by requirements of AS3959



Figure 6b Lots affected by requirements of AS3959



. *Figure 7 Indicative BPZ Sample of Building Protection Zone Distances for this development are as described in 6.4.2.*

6.5 DESIGN OF DEVELOPMENT

The development complies with acceptable solutions A4.1, A4.2, A4.3 & A4.4.

Lots will have a BPZ installed around each dwelling shown in Figure 6 appropriate to the Lot and location of each dwelling prior to commencement of construction. The BPZ will be no less than 20 meters and dwelling constructed to BAL19 unless otherwise approved by the Shire of Murray.

6.5.1 Public Open Space Reserves

The Public Open Space other than the OEPA reserve will be cleared to BPZ standards by the developer at the time the reserve is created. This clearing is to be created to ensure the trees remaining are done in consultation with the Shire of Murray.

6.5.2 Staging of the Subdivision Development

Should staging of the development occur, all land not redeveloped will be maintained between the months of December 1st to April 30th every year to comply with the Shire of Murray Firebreak Notice.

7.0 SUMMARY

7.1 OVERALL FIRE THREAT

The design of this proposed development and the facilities constructed at the time of development are such that with implementation of this Fire Management Plan, fire threat to persons and property within the subdivision is significantly reduced.

7.2 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 bush fire.

.

- Ensure all future planting on their property comply with the requirements of section 6.4.2

- Ensure all habitable buildings required to have Building Protection Zones, are constructed to AS 3959-2009, planting of trees/shrubs and revegetation are implemented and maintained as detailed in Section 6.4.1

7.3 DEVELOPER'S RESPONSIBILITIES

To facilitate the creation of the proposed lots, the developer/landowner shall be required to carry out the following works as described below.

- Construct the new roads prior to clearance of title to A2.2 standards or greater

.

- Maintain all lands in accordance with 6.4.1 once survey has been completed until lots are sold.

- Install fire hydrants as per section 6.3

- Create Building Protection Zone where required prior to clearance of title as per 6.4.1

- Identify the responsible body for the OEPA reserve and advise the Shire in writing prior to clearance of title of lots within the LSP

- During staged development ensure the relevant measures in this plan are implemented to ensure dwelling are protected to the AS3959 requirements.

7.4 SHIRE OF SHIRE OF MURRAY RESPONSIBILITIES

The responsibility for compliance with the law rests with individual property owners and occupiers and the following conditions are not intended to unnecessarily transfer some of the responsibilities to the Shire.

The Shire of Shire of Murray shall be responsible for:

- Provide an inspectoral service to ensure the requirements of this plan are carried out by all land owners.
- Ensure all buildings comply with the construction standards set out in this plan.
- Maintain road verges to Building Protection Zone Standards as required in this plan.
- Ensure the responsible body for the OEPA reserve maintains the buffer zone marked on the map at figure 6.
- Maintains the POS reserves other than the OEPA reserve are maintained as parkland cleared to BPZ standards.

Appendix A Access Standards

A2.3 Cul-de-sacs (including dead end roads) are generally not encouraged in bush fire prone areas. Where used, however, cul-de-sac standards are to be as follows:

- maximum length: 200 metres (if emergency access is provided between cul-de-sac heads maximum length can be increased to 600 metres provided no more than 8 lots are serviced)
- minimum trafficable surface: 6 metres
- horizontal clearance: 6 metres
- maximum grades: 1 in 8
- maximum grade over <50 metres: 1 in 5
- maximum average grade: 1 in 7
- minimum weight capacity: 15 tonnes
- maximum crossfall: 1 in 33
- curves minimum inner radius: 12 metres
- as per turn around area requirements – including 21 metre diameter head.

A2.4 Battle axes

Battle axe access legs meet the following requirements:

- maximum length: 600 metres
- minimum width: 6 metres
- minimum trafficable surface: 4 metres
- horizontal clearance: 6 metres
- vertical clearance: 4 metres
- maximum grades: 1 in 8
- maximum grade over <50 metres: 1 in 5
- maximum average grade: 1 in 7
- minimum weight capacity: 15 tonnes
- maximum crossfall: 1 in 33
- curves minimum inner radius: 12 metres.

FIRE MANAGEMENT PLAN

Compliance checklist for performance criteria and acceptable solutions

PROPERTY DETAILS: **Lot 157 Ronlyn Rd & 91 Paul St Furnissdale**

Local Government: Shire of Murray

Element 1: Location

Does the proposal comply with the performance criteria by applying acceptable solution A1.1?	**Yes**	✓	**No**	

Element 2: Vehicular Access

Does the proposal comply with the performance criteria by applying acceptable solution A2.1?	**Yes**	✓	**No**	
Does the proposal comply with performance criteria by applying acceptable solution A2.2?	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.3?	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.4? N/A	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.5?	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.6? N/A	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.7? N/A N/A	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.8?	**Yes**		**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.9?	**Yes**	✓	**No**	
Does the proposal comply with the performance criteria by applying acceptable solution A2.10?	**Yes**		**No**	

N/A

Element 3: Water

Does the proposal comply with the performance criteria by applying acceptable solution A3.1 **Yes** ✓ **No** ☐

Does the proposal comply with the performance criteria by applying acceptable solution A3.2? **Yes** ☐ **No** ☐

N/A

Does the proposal comply with the performance criteria by applying acceptable solution A3.3? N/A **Yes** ☐ **No** ☐

Element 4: Siting of Development

Does the proposal comply with the performance criteria by applying acceptable solution A4.1? **Yes** ✓ **No** ☐
BPZ, installed increase in construction standard

Does the proposal comply with the performance criteria by applying acceptable solution A4.2? **Yes** ✓ **No** ☐

Does the proposal comply with the performance criteria by applying acceptable solution A4.3? **Yes** ✓ **No** ☐

Does the proposal comply with the performance criteria by applying acceptable solution A4.4? **Yes** ✓ **No** ☐

Does the proposal comply with the performance criteria by applying acceptable solution A4.5? **Yes** ☐ **No** ☐

N/A

Element 5: Design of Development

Does the proposal comply with the performance criteria by applying acceptable solution A5.1? **Yes** ✓ **No** ☐

Does the proposal comply with the performance criteria by applying acceptable solution A5.2?N/A **Yes** ☐ **No** ☐

Applicant Declaration:

I declare that the information provided is true and correct to the best of my knowledge.

Name of Person Preparing the Fire Management Plan:



Full Name: **A C Moran** *for* FirePlan WA **Date: May 8th 2014**

Developer:

Full Name: _____ **Signature:** _____

Date:

APPENDIX 6

TRANSPORT REPORT

ROWEGROUP

Porter
Consulting Engineers

FURNISSDALE WEST URBAN EXPANSION RIVERSIDE TO RONLYN ODP

REVISED TRANSPORT ASSESSMENT

Porter

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1.0 INTRODUCTION

Porter Consulting Engineers has been engaged by Coode Pty Ltd to provide transport assessment of the proposed Outline Development Plan for the Furnissdale West Urban Expansion. This report assesses undeveloped land for residential housing that is expected to also include areas of conservation, public open spaces and stormwater drainage storage/infiltration.

The purpose of this report is to examine transport aspects, in particular the land-use/transport integration with respect to accessibility, circulation and safety for all transport modes. Assessment is made of the strategic transport aspects of land use/transport integration for the developable land, including:

- Traffic volumes and street hierarchy
- Street cross-sections
- Traffic management
- Public transport
- Pedestrians and cyclists

This report has been prepared in accordance with the intentions of the Western Australian Planning Commission (WAPC) draft Guidelines for Developments, Volume 2 – Structure Plans, August 2006.

Porter Consulting Engineers prepared a previous traffic impact assessment of Furnissdale covering a larger area of potential residential housing development land. The reader may wish to refer to that report for the context of this development area within Furnissdale.

2.0 SCOPE OF REPORT

The scope of this report is primarily to review and address the following:

- Proposed development traffic generation and road network operation.
- Assess traffic impacts on the surrounding environment.
- Assess impact on the road network traffic safety and efficiency.

3.0 TRANSPORT MODELLING

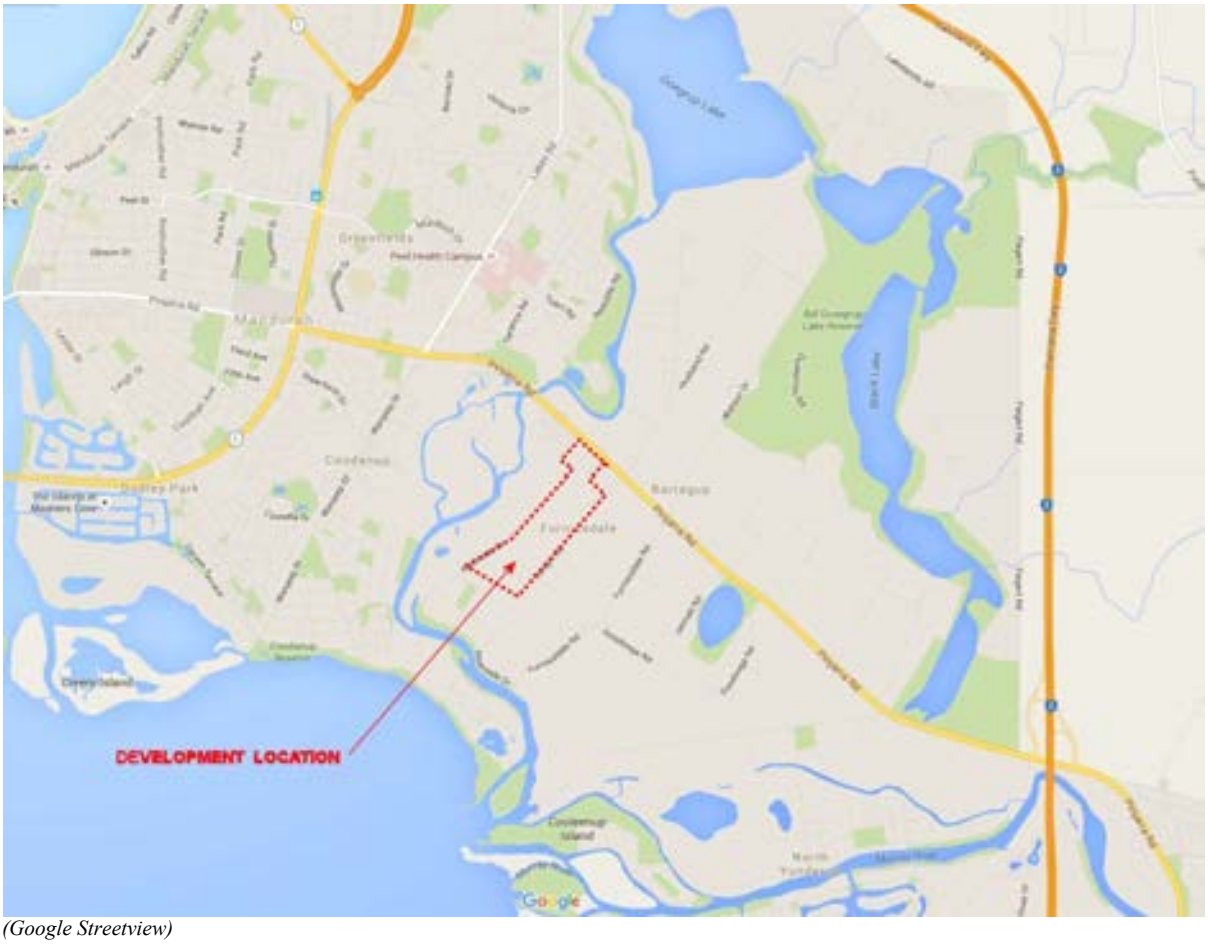
Traffic modelling prepared by Main Roads Western Australia (MRWA) for 2031 includes other surrounding development. As a result trip generation figures presented in the traffic model are not necessarily limited to only the Furnissdale West Urban Expansion trip generation but include other assessed future developable area and future roads that may be included within the MRWA transport model.

4.0 EXISTING SITE AND ACCESS

4.1 Development Location

The Furnissdale West Urban Expansion area (the Site) is located in the suburb of Furnissdale within the Local Government Authority of the Shire of Murray. The Shire of Murray's Town Planning Scheme No.4 maps 4 and 6 cover this area.

The Site is located on land approximately bounded by Pinjarra Road, Riverside Drive, Paull Street and Ronlyn Road. The location of the approximate boundary area of the Development Site is indicated in the following diagram.



(Google Streetview)

Figure 1. Location of Development Area

Main Roads Western Australia provides details of the Functional Road Hierarchy Classification for the Rural and Metropolitan road network. Details of the roads surrounding the development site according to the Main Roads WA Rural Road Hierarchy are listed in the following table.

Table 1. Surrounding Roads

Road	Classification	Speed Limit	Capacity veh/hr/ln	Geometry	Capacity Daily Flow
Pinjarra Road	Primary Distributor	80	1,250 at LoS C	4 lane median-divided dual carriageway	50,000
Riverside Drive	Local Distributor	60	950 at LoS C	Undivided two way single carriageway	19,000
Ronlyn Road	Local Distributor	60	950 at LoS C	Undivided two way single carriageway	19,000
Paull Street	Access Road	50	540 at LoS B	Undivided two way single carriageway	10,800

The density of development, extent of area and characteristics of development in Furnissdale are aligned with Metropolitan development. The road network presented in this report for the proposed development is on the basis of a Metropolitan Road Hierarchy.

Table 2. Road Volumes

Road Category	Street	Recorded Volume ADT (veh/day)	Desirable Maximum Volume ADT (veh/day)
Primary Distributor	Pinjarra Road	17,110 to 19,710 (2006/07)	over 35,000
District Distributor	n/a	-	15,000 - 35,000
Neighbourhood Connector A	n/a	-	7,000 - 15,000
Neighbourhood Connector B (Local Distributor)	Riverside Drive Ronlyn Road	- -	3,000 - 7,000
Access Road	Various	-	1,000 - 3,000

4.2 Pinjarra Road

Pinjarra Road is intended to perform the function of carrying traffic and freight between districts. To achieve that function, traffic flow must receive as little constraint and interruption as possible. Although no special provision is generally made for small numbers of vehicles entering and exiting, where large volumes must do so then dependant on the volume an appropriate treatment at the connecting road should be provided. Pinjarra Road through the Development area is a median-divided dual-carriageway classified as a Primary Distributor under the MRWA Road Hierarchy and speed zoned at 80km/h. It is the major transport route between Mandurah and Pinjarra and is under the control of MRWA. An Intersection and Access Strategy for Pinjarra Road undertaken by MRWA suggests that ultimately the reserve be widened from 40m to 60m and increased from 4 to 6 traffic lanes.

The most recent traffic counts available on Pinjarra Road recorded by Main Roads Western Australia abutting the development area are shown in the following table.

Location	AWT Volume 2006/07	AWT Volume 2007/08	AWT Volume May 2013
E of Riverside Drive	19,710	-	-
E of Ronlyn Road	17,110	17,140	15,430

Main Roads WA interactive web site provides summary crash data. In the 5 years from 2010 to 2014 the following table shows the number of crashes recorded at the connecting intersections.

Table 3. Crash Data for Pinjarra Road

Intersection	No. of Crashes over 5 Years
Pinjarra Road / Riverside Drive	0
Pinjarra Rd / Ronlyn Rd / Husband Rd	16



(Google Streetview)

4.3 Riverside Drive

Riverside Drive is an existing unkerbed, sealed road within the development area. It has an approximately 6.1m seal width with unsealed shoulders varying in width from 2.5m to 3.0m. This road does not have street lighting along the section of road that is the subject of the proposed area for development. There are no pedestrian or cycle paths. The subdivision layout proposes a grid style network of interconnecting roads with Riverside Drive.

According to the MRWA online mapping it is classified a Local Distributor under the MRWA Road Hierarchy and speed zoned at 60km/h. Main Roads WA interactive web site provides summary crash data. In the 5 years from 2010 to 2014 the following table presents the number of crashes recorded midblock.

Table 4. Crash Data for Riverside Drive

Location	No. of Crashes over 5 Years
Midblock	2



(Google Streetview)

4.4 Ronlyn Road

Ronlyn Road is an existing unkerbed, sealed road within the development area. It has an approximately 6.1m seal width with unsealed shoulders varying in width from 2.5m to 3.0m. Some sections along the north-west side of road are kerbed to provide separation to an abutting pedestrian path. The path is continuous along the north-west verge from Paull Street to Pinjarra Road.

This road does not have street lighting along the section of road that is the subject of the proposed area for development. The subdivision layout proposes a grid style network of interconnecting roads connecting with Ronlyn Road.

The road is classified a Local Distributor under the MRWA Road Hierarchy and is speed zoned at 60km/h. Main Roads WA interactive web site provides summary crash data. In the 5 years from 2010 to 2014 the following table presents the number of crashes recorded midblock.

Table 5. Crash Data for Ronlyn Road

Location	No. of Crashes over 5 Years
Midblock	3



(Google Streetview)

4.5 Paull Street

Paull Street is an existing kerbed and sealed road south of the development area. It has an approximately 7.2m seal width in a 20m road reserve. It has no footpaths however the verges are typically grassed and walkable. The road has street lighting located along the southern verge. It is classified as an Access Street under the MRWA Road Hierarchy and is speed zoned at 60km/h. Main Roads WA interactive web site provides summary crash data. In the 5 years from 2010 to 2014 no crashes were recorded.

The subdivision proposes to create a new road along the rear boundary of the current Paull Street Lots.



(Google Streetview)

4.6 York Road

York Road is an existing kerbed and sealed road within the development area. It has an approximately 7.2m seal width in a 20m road reserve. It has no footpaths however the verges are typically grassed and walkable. This road has street lighting located along the western verge. It is classified as a Local Distributor under the MRWA Road Hierarchy and is speed zoned at 60km/h. Main Roads WA interactive web site provides summary crash data. In the 5 years from 2010 to 2014 no crashes were recorded. The section of York Road north of Paull Street ends in a cul-de-sac and no change is proposed. The Shire of Murray has requested a pedestrian path from the new residential subdivision to link with York Road.



(Google Streetview)

5.0 PROPOSED ROAD NETWORK

This section of the report details the investigations required to estimate the traffic generated by the development.

5.1 Previous Studies

Previous reports prepared relating to Pinjarra Road traffic and development include:

- Peel Regional Road Network Development Strategy, MRWA, 1999
- Furnissdale Structure Plan and Traffic Impact Study by GHD, 2003
- Traffic and Access Plan by Worley Parsons, 2008
- Transport Assessment Pinjarra Road, Furnissdale by Shawmac, 2011

5.2 Network Operation

The proposed Outline Development Plan for the total land area requires construction of an internal road network servicing the created lots. External access to the internal road network requires direct connection with the existing bounding roads consisting of Riverside Drive and Ronlyn Road.

The Outline Development Plan is presented in Appendix 1 and has six main zone types consisting of:

- Low Density Residential (R20)
- Low-Medium Density Residential (R30-R40)
- Medium Density Residential (R60)
- Drainage Basin
- Public Open Space
- OEPA Protection Zone

5.3 Trip Generation

There are a number of resource documents used to determine the traffic generated by particular development land use types. The two most relevant in Australia are:

- Land Use Traffic Generating Guidelines, Director General of Transport, South Australia, 1986.
- Guide to Traffic Generating Developments, Roads and Traffic Authority, NSW, 2002.
- Trip Generation, Institute of Transportation Engineers, 7th Edition, 2003.

These are the industry recognised documents used by Traffic Engineers and Planners Australia wide.

There are currently 220 existing residential Lots to the south of the proposed development area and having road network connection to Riverside Drive and Ronlyn Road.

Based on Table 1 of the State Planning Policy 3.1 Residential Design Codes in the proposed development area the potential range of yield is from 750 to 1,000 residential dwellings.
To be robustly conservative the maximum figure of 1,000 residential dwellings has been used as the basis for trip generation in this report.

Clustered around the intersection of Ronlyn Road/Pinjarra Road is other abutting commercial development land area (Spud Shed) which is approximately 4ha on the western side of Ronlyn Road. On the eastern side of Ronlyn Road is additional commercial development area which is estimated at up to a further 4ha.

These are potentially future developable areas that are not a part of this development proposal, however the Shire of Murray desires inclusion for the potential traffic generation from these sites included in this report's assessment of the intersection of Ronlyn Road/Pinjarra Road.

5.4 Road Hierarchy

The classification of roads in Western Australia is provided under the Main Roads Act 1930. Under the Act, the Governor (following recommendation by the Commissioner for Main Roads) has the power to proclaim roads or part of roads into the following classifications:

- Highways
- Main Roads
- Secondary Roads

Concurrence of local government authorities concerned is required before the Commissioner can recommend a proclamation to the Governor. Declared 'Highways' and 'Main Roads' form the State Road Network of which Main Roads WA is the owner, manager and financier. Secondary Roads, whilst still provided for under Section 26 of the Act are no longer used. A review of the Secondary Road Network in 1995 saw all Secondary Roads either upgraded to Main Roads or decommissioned completely. Roads that are not declared as either Highway, Main Roads or Secondary Roads under the Act are unclassified roads. Most unclassified roads are commonly referred to as Local Roads and are the responsibility of Local Government Authorities. Other unclassified roads depending on their location can be under the jurisdiction of other Government Authorities. There are also a number of private roads owned, for example, by mining companies. Some of these roads are accessible to the public.

Main Roads WA, in cooperation with Local Government, developed a Road Hierarchy to further designate the type and function required of each road in the network. In general, road networks are designated with regard to two main documents:

- Main Roads WA Metropolitan Functional Road Hierarchy
- WA Planning Commission Liveable Neighbourhoods

Table 8. Functional Road Hierarchy Designations and Main Characteristics

Type	Function	Responsible Authority	Development Access	Speed Km/h	Volume Veh/day
Primary Distributor	Arterial routes that are highly connective with service roads where possible, limited intersections and often signal controlled.	Main Roads WA	None or restricted	60-110 depending on operating characteristics	Over 35,000
District Distributor Integrator A	An arterial route that has frequent connections to local streets, development frontage along its length. Typically have services roads with on-street parking and direct vehicle access where there are no service roads.	Local Government	Limited. May have some commercial access.	60-80	15,000 to 35,000
District Distributor Integrator B	An arterial route that has frequent connections to local streets, development frontage along its length, typically has one lane in each direction with on-street parking.	Local Government	Residential and commercial access	60-70	7,000 to 15,000
Neighbourhood Connectors/ Industrial Road	Provide the sub-arterial network servicing and linking neighbourhoods. Spread local traffic loads, act as bus route, have frequent connections to local streets and may typically be traffic calmed to facilitate pedestrians and cycling.	Local Government	Access is permitted except at controlled intersections.	50	3,000 to 7,000
Access Streets	Streets providing predominantly residential access where the local environment is dominant, traffic speeds are low and pedestrian and cycle movements are allocated.	Local Government	Access is permitted	40-50	Less than 3,000

In this assessment the functional road hierarchy has been assessed in line with the above table of main characteristics via a process which includes the following:

- **Surrounding areas** – this includes an assessment of surrounding land use to establish higher order road links to key uses. Differentiation of roads which have a traffic carrying function to commercial destinations and lower order roads to medium and lower density residential.
- **Abutting land use** – the use of land abutting each road establishes trip generation contributing to the traffic volumes on the road. Land uses such as Town Centres and Main Streets generate traffic onto the through traffic component and therefore should be assigned a higher order of road classification.
- **Road connections** – the road hierarchy should be such that lower order roads connect to the next higher order roads and that their traffic feeds on to them.
- **Catchments** – the road hierarchy needs to be assessed against the catchment of the higher order roads. The role of lower order roads is to collect traffic and provide connections onto higher order roads and then to District roads. It is important that the

catchment onto these roads is not overly substantial and that each of these roads is able to perform its intended function in the current and anticipated future context. If the catchment onto any road link is too great and the intended maximum volume is exceeded, then congestion may result and the road system could lose its ability to operate efficiently and safely.

- **Orderly hierarchy** – the road hierarchy should be such that lower order roads perform a traffic access function and that higher order roads perform a traffic carrying function. Higher order roads are therefore generally longer creating spines through an area and have priority over connecting lower order roads.

Based on the above practice we have prepared and included in the Appendix a recommendation for the road network hierarchy of roads for the development area to provide suitable street environments consistent with the functions of the proposed development.

5.5 Speed Zones

Main Roads Western Australia has the responsibility to set and post speed zones on public roads in Western Australia. It provides Technical Guidelines on Speed Zoning on their web site.

A Speed Zone is defined on a carriageway by a speed limit sign at the beginning and at the end by means of either an END speed limit sign, another speed limit sign, or a T-junction where that carriageway ends. The Main Roads desirable minimum lengths between speed zone changes are given in the following table. Main Roads table differs from the Australian Standard AS1742.4-2008, Table 2.2.

Table 9. Main Roads Minimum Length of Speed Zones

Speed Limit (km/h)	Minimum Length of Speed Zone (km)
30	0.3
40	0.4
40 (School Zone)	0.2
50	0.5
60	0.6
60 (School Zone)	0.3
70	0.7
80	0.8
90	0.9
100	2.0
110	4.0
Buffer Zones	0.3 (minimum) 0.5 (preferred)

The most important consideration in assessment of speed zones is a determination of the crash rate of the road. Crash history can be viewed in two ways:

1. the risk faced by individuals, which is measured by the casualty rate per 100 million vehicle kilometres; and
2. the collective risk, which is measured by the casualty rate per kilometre of road.

Collective risk represents the total risk along a length of road as opposed to the risk faced by the individual driver. Using collective risk as a basis for setting speed limits may create anomalies. Focusing on individual risk can provide a more consistent relationship between speed limits to the characteristics of the road and to the road environment, giving a hierarchy of limits that provides a more apparent association to most road users.

Non-geometric enforcement is usually negligible on low volume roads and this limits the extent to which lower speed limits can reduce individual risk. Consequently reducing the speed limit on low volume roads often requires geometric changes (e.g. Local Area Traffic Management Devices) to be made to the carriageway and/or the road environment in order for a reduced speed limit to be effective.

The matching of road function with road design must be correct to minimise the collision risk. Higher speeds are only achievable where the road design meets the safety standards appropriate to the function and the speed limit reflects the road as it is, not as it should be.

Other major factors considered in the speed zoning assessment are.

Pedestrians and cyclists

- the presence and type of pedestrian and cyclist facilities provided to separate them from motorised vehicles;
- volume and composition of unseparated traffic (including heavy vehicles, cyclists and pedestrians);
- traffic patterns or special activities that impact on the unconstrained traffic flow and speed (including schools and school crossings, bus stops and frequency, pedestrians and cyclists).

Geometry

- geometric features including alignment and gradient;
- cross-section and separation of opposing traffic flow;
- number and width of traffic lanes;
- presence and width of sealed or unsealed shoulders;
- offset from roadside features.
- pavement surface.

Abutting Development and Activity

- restriction of access to one or both sides of road;
- differences in development along length of road and between opposite sides of road;
- number, distance between and types of intersections;
- number, distance between and types of driveways;
- type of roadside development activity (e.g. residential, office, shopping and industrial).

A traditional consideration in assessing or reviewing speed limits is the 85th percentile speed. This has been discontinued by many road authorities as a key factor as it is not supported by the Safe System approach to road safety. Accordingly, it is not used in this assessment.
The road network has been assessed and recommendations presented for speed zones with the intent of providing a road network of streets in accordance with the function, operation and safety of the road hierarchy.

Based on the above practice we have prepared and included in the Appendix a recommendation for the road network speed zones to provide suitable street environments consistent with the function of the proposed residential development.

5.6 Network Staging

The potential staging of development for new residential land and development of commercial premises are unknowns. The staging of development for these areas cannot be predicted with any certainty.

The staging of the road network is therefore assumed in the following manner. However, a review should be undertaken when considered appropriate to identify if the progress of development has changed to the extent that priorities need to be re-assessed.

Stage 1

Assuming initial development of residential land subdivision will occur to the north of Paull Street abutting the existing developed residential land.

- This will entail construction of minor local roads including connections between Riverside Drive and Ronlyn Road.
- The intersection of Ronlyn Road/Pinjarra Road is signalised and will provide the main source of access for traffic entering and leaving. No modification is required.

Stage 2

Assuming the next stage of land subdivision development will comprise a greater area and include development of land adjacent and connecting with Furnissdale Road. This area of development will increase trip generation to the point where upgrading to the intersection of Furnissdale Road/Pinjarra Road is required.

Stage 3

All currently proposed development areas are completed.

- This will entail modification to the Ronlyn Road approach to Pinjarra Road to accommodate the increase in traffic generation and activity.
- This will entail modification to Pinjarra Road at the intersections with Riverside Drive and Ronlyn Road.

6.0 ASSESSMENT OF TRAFFIC IMPACTS

The proposed residential development Site abuts the existing local Furnissdale Commercial Centre, Caravan/Chalet Parks, Serpentine River and Barragup Conservation Reserve. The following is an assessment of the trip generation and distribution to determine the local traffic impacts.

Mandurah Caravan and Tourist Park, 522 Pinjarra Road and the Riverglades Resort, 490 Pinjarra Road each have their own direct and separate access to Pinjarra Road. There is no provision or future ability for access to these developments via Riverside Drive. Trips generated by these two sites therefore do not impact on the operation of the intersection of Riverside Drive/Pinjarra Road.

Some consideration was indicated earlier this year in locating a Service Station on the south-east corner of Riverside Drive/Pinjarra Road. We have been given to understand there is currently no active interest in commercial development at this location , however estimated trip generation arising from a Service Station is included in the assessment for this intersection to ensure a robust assessment of the potential for future traffic generation.

6.1 Traffic Distribution

A possible proposed future widening of Pinjarra Road from the existing median-divided 4 lanes to 6 lanes has not yet been finalised by the various government department stakeholders. This assessment assumes that the proposed upgrading will occur and be constructed by the responsible government authorities at a time to be determined when capacity of the existing 4 lane road is reached. Future land development in the surrounding district in conjunction with staging of new roads will result in some changes to travel patterns as and when new roads in the network are constructed and in particular, as major roads are constructed. Therefore, the work trip destinations and attraction by population density for the purpose of this evaluation are distributed at the full development stage.

In determining the estimated peak hour entry and exit traffic flows the following assumptions have been made based on directional distributions from the Institute of Traffic Engineers.

- AM Residential Peak Hour trips will be split 75% exiting and 25% entering.
- PM Residential Peak Hour trips will be split 35% exiting and 65% entering.
- AM Commercial Peak Hour Trips will be split 39% exiting and 61% entering.
- PM Commercial Peak Hour Trips will be split 52% exiting and 48% entering.

In the absence of other information, the following are the assumptions made in developing the estimated daily traffic generation presented in Appendix 2.

1. Land use is based on the estimated maximum permitted that could be developed. This may exceed the actual available or permitted arising from factors not currently known.
2. The Department of Planning and the Local Government Authority may impose restriction on locations and areas of developable land, road network and recreation space which may differ from the Structure Plan used for this assessment.
3. Service Authorities may impose restriction on the availability and location of services and infrastructure. It has been assumed there are no restrictions.

6.2 Furnissdale Local Centre Precinct

There is limited information available for our use about what may be proposed for future development in this Precinct. The following assumptions have been developed from a concept sketch prepared by Mackay Urban Design dated January 2014.

North-West Side of Ronlyn Road

This location is the "Spud Shed" site which is indicatively estimated as proposing development comprising elements of:

- A Spud Shed consisting of approximately 3,000m^2 comprising 1,500m^2 of trading floor and 1,500 m^2 of back of house storage/service.
- A Liquor Shed consisting of approximately 1,500m^2 comprising 1,000m^2 of trading floor and 500m^2 of back of house.
- A mini-major scale pharmacy of approximately 400m^2 comprising 200m^2 of trading floor and 200m^2 of back of house.
- Tavern/restaurant of approximately 600m^2
- Fast foods of approximately 500m^2
- Additional 1,250m^2 of tenancy space that may include bistro and café, post office and other retail /commercial tenancies to complement the larger tenancies.

South-East Side of Ronlyn Road

This location is estimated as proposing development comprising key elements of:

- Two blocks of smaller retail tenancies of approximately 2,250m^2 of total floor space.

Trip generation on the sites under the proposed use types may be estimated using the Roads and Traffic Authority NSW Guide to Traffic Generating Developments where vehicle trips per 100m^2 may be derived as:

Residential:

Land Use	No. of Dwellings	Trip Generation			
		Peak Hour Rate	No. of Peak Hour Trips	Daily Rate	No. of Daily Trips
Residential (R20 to R40)	800	0.85/dwelling	680	9/dwelling	7,200
Residential (R60)	200	0.65/dwelling	130	6.5/dwelling	1,300
Total	1,000		810		8,500

Commercial/Retail:

Land Use	Gross Floor Area	Trip Generation			
		Peak Hour Rate	No. of Peak Hour Trips	Daily Rate	No. of Daily Trips
Spud Shed	1,500m^2 1,500m^2	10/100m² GFA 0.5/100m² GFA	150 7.5	90/100m² GFA 4/100m² GFA	1,350 60
Liquor Shed	1,000m^2 500m^2	12.3/100m² GFA 0.5/100m² GFA	123 2.5	121/100m² GFA 4/100m² GFA	1,210 20
Pharmacy	200m^2 200m^2	11/100m² GFA 0.5/100m² GFA	22 1	90/100m² GFA 4/100m² GFA	180 8
Tavern/Restaurant	600m^2	5/100m² GFA	30	60/100m² GFA	360
Fast Food	500m^2	20/100m² GFA	100	200/100m² GFA	1,000
Specialty Retail	3,500m^2	5/100m² GFA	17.5	40/100m² GFA	140
Total	9,500m^2		454		4,328

Service Station:

In the absence of any detail about a service station that may be considered suitable for this location the following assumptions are made which includes the assumption that the number of bowsers could be up to 8. It is assumed that a convenience store will be included as this is now typical for service stations and the area of the convenience store is the measuring factor for trip generation in the NSW RTA Guide for Traffic Generating Developments.

Land Use	Gross Floor Area	Trip Generation			
		Peak Hour Rate	No. of Peak Hour Trips	Daily Rate	No. of Daily Trips
Service Station	100m^2 store	0.66 x GFA	66	17 x Peak Hour	1,122

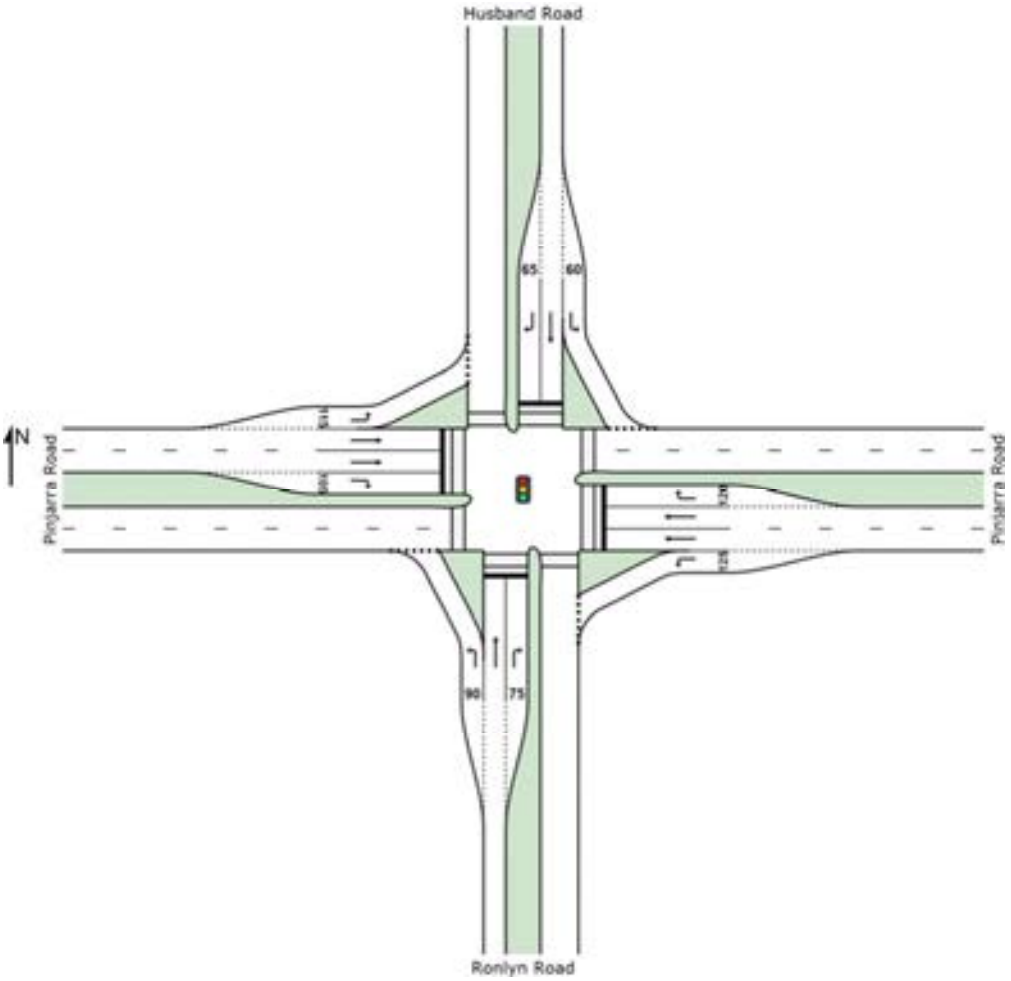
6.3 External Intersections

6.3.1 Ronlyn Road/Pinjarra Road/Husband Road

The following SIDRA modelling makes assessment and comparison with the current traffic signalised intersection to identify required modification to the intersection and when any modifications should need to be introduced.

CURRENT INTERSECTION OPERATION (2015)

The existing 4-way traffic signal controlled intersection is operating below capacity. The overall Level of Service is C and there are no notable delays or queuing with saturation for all movements well below 1 indicating the intersection has considerable unutilised capacity.



AM PEAK HOUR 2015 (Current)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Ronlyn Road											
1	L2	56	3.0	0.049	8.1	LOS A	0.5	3.6	0.32	0.62	56.1
2	T1	3	3.0	0.010	19.7	LOS B	0.1	0.5	0.87	0.54	45.4
3	R2	33	3.0	0.239	45.8	LOS D	1.3	9.3	0.97	0.72	35.7
Approach		92	3.0	0.239	22.0	LOS C	1.3	9.3	0.58	0.65	46.3
East: Pinjarra Road											
4	L2	23	3.0	0.016	7.9	LOS A	0.1	0.6	0.17	0.63	58.8
5	T1	646	3.0	0.608	17.0	LOS B	8.2	59.1	0.92	0.77	46.9
6	R2	15	3.0	0.109	46.7	LOS D	0.6	4.2	0.96	0.69	36.3
Approach		684	3.0	0.608	17.4	LOS B	8.2	59.1	0.90	0.77	47.0
North: Husband Road											
7	L2	15	3.0	0.013	7.2	LOS A	0.1	0.7	0.26	0.59	56.9
8	T1	3	3.0	0.007	25.7	LOS C	0.1	0.6	0.79	0.51	42.3
9	R2	29	3.0	0.210	45.7	LOS D	1.1	8.2	0.97	0.71	35.7
Approach		47	3.0	0.210	32.1	LOS C	1.1	8.2	0.73	0.66	41.0
West: Pinjarra Road											
10	L2	40	3.0	0.026	7.8	LOS A	0.1	0.9	0.15	0.63	58.9
11	T1	446	3.0	0.342	21.5	LOS C	6.6	47.2	0.79	0.66	44.4
12	R2	65	3.0	0.472	48.6	LOS D	2.6	18.9	1.00	0.75	35.6
Approach		551	3.0	0.472	23.7	LOS C	6.6	47.2	0.77	0.67	43.9
All Vehicles		1374	3.0	0.608	20.7	LOS C	8.2	59.1	0.82	0.72	45.4

PM PEAK HOUR 2015 (Current)

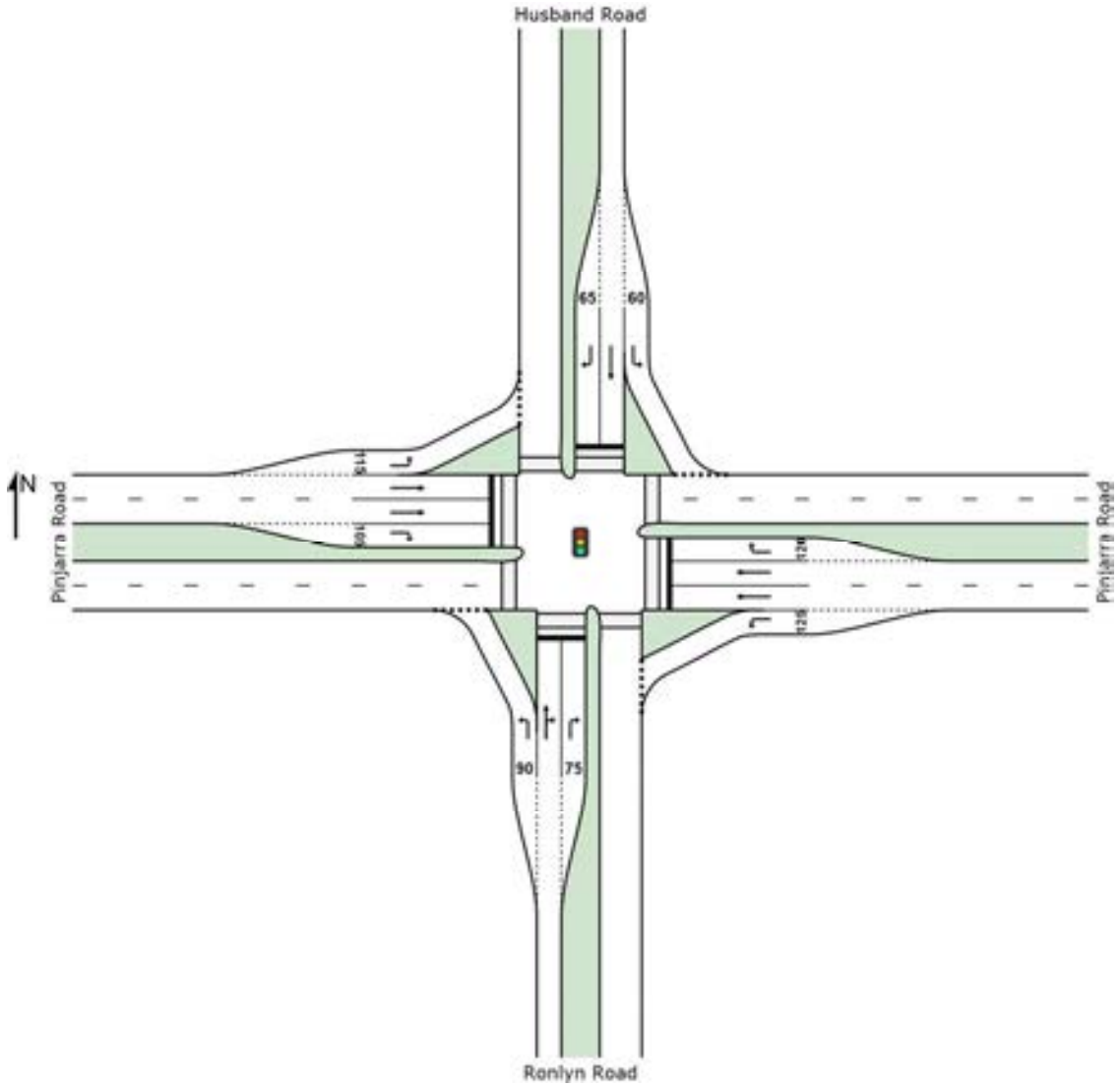
Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Ronlyn Road											
1	L2	89	3.0	0.080	8.7	LOS A	0.9	6.5	0.36	0.64	55.6
2	T1	6	3.0	0.021	19.9	LOS B	0.2	1.1	0.87	0.57	45.3
3	R2	45	3.0	0.327	46.3	LOS D	1.8	12.9	0.98	0.73	35.5
Approach		140	3.0	0.327	21.3	LOS C	1.8	12.9	0.58	0.67	46.7
East: Pinjarra Road											
4	L2	64	3.0	0.044	8.0	LOS A	0.3	1.8	0.19	0.64	58.7
5	T1	666	3.0	0.627	17.1	LOS B	8.5	61.3	0.93	0.78	46.9
6	R2	34	3.0	0.247	47.5	LOS D	1.3	9.6	0.98	0.72	36.0
Approach		764	3.0	0.627	17.7	LOS B	8.5	61.3	0.87	0.77	47.0
North: Husband Road											
7	L2	18	3.0	0.016	7.8	LOS A	0.1	1.1	0.30	0.60	56.4
8	T1	12	3.0	0.028	26.0	LOS C	0.4	2.6	0.80	0.56	42.1
9	R2	60	3.0	0.435	46.8	LOS D	2.4	17.4	0.99	0.75	35.4
Approach		90	3.0	0.435	36.2	LOS D	2.4	17.4	0.83	0.69	39.1
West: Pinjarra Road											
10	L2	31	3.0	0.020	7.8	LOS A	0.1	0.7	0.16	0.63	58.9
11	T1	598	3.0	0.458	22.6	LOS C	9.2	66.3	0.83	0.71	43.8
12	R2	79	3.0	0.573	49.3	LOS D	3.2	23.3	1.00	0.78	35.4
Approach		708	3.0	0.573	24.9	LOS C	9.2	66.3	0.82	0.71	43.2
All Vehicles		1702	3.0	0.627	22.0	LOS C	9.2	66.3	0.82	0.73	44.9

PROPOSED INTERSECTION OPERATION 2025 (RESIDENTIAL DEVELOPMENT)

The following SIDRA modelling assesses the traffic signals at Pinjarra Road for the increased traffic generated by the proposed residential land development only. This scenario does not include any of the abutting potential commercial development by others that will contribute additional traffic generation.

Under this scenario Ronlyn Road will require that its existing northbound through lane be changed to a combined through and right turn lane. This will modify the intersection to give two right turn lanes for the capacity needed to accommodate the increased number of right turns expected to be generated to travel eastbound toward Pinjarra.



AM PEAK HOUR 2025 RESIDENTIAL ONLY (NO NEW COMMERCIAL)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Ronlyn Road											
1	L2	461	3.0	0.541	15.8	LOS B	10.3	73.7	0.71	0.78	50.2
2	T1	6	3.0	0.873	49.1	LOS D	5.5	39.7	1.00	0.99	31.8
3	R2	235	3.0	0.873	54.7	LOS D	5.5	39.7	1.00	0.99	32.9
Approach		702	3.0	0.873	29.1	LOS C	10.3	73.7	0.81	0.85	42.5
East: Pinjarra Road											
4	L2	90	3.0	0.065	8.8	LOS A	0.6	4.3	0.26	0.66	58.1
5	T1	1251	3.0	0.863	21.6	LOS C	17.9	128.8	0.99	0.98	44.4
6	R2	29	3.0	0.105	39.8	LOS D	1.0	7.2	0.90	0.72	39.0
Approach		1370	3.0	0.863	21.1	LOS C	17.9	128.8	0.94	0.95	44.9
North: Husband Road											
7	L2	29	3.0	0.034	9.8	LOS A	0.3	2.5	0.40	0.63	54.7
8	T1	6	3.0	0.041	38.6	LOS D	0.2	1.6	0.95	0.62	36.8
9	R2	56	3.0	0.406	46.6	LOS D	2.3	16.2	0.99	0.74	35.4
Approach		91	3.0	0.406	34.4	LOS C	2.3	16.2	0.80	0.70	40.0
West: Pinjarra Road											
10	L2	77	3.0	0.052	7.9	LOS A	0.2	1.7	0.16	0.64	58.9
11	T1	863	3.0	0.541	19.2	LOS B	12.8	91.9	0.81	0.70	45.7
12	R2	200	3.0	0.871	53.9	LOS D	9.1	65.3	1.00	0.97	33.9
Approach		1140	3.0	0.871	24.5	LOS C	12.8	91.9	0.80	0.75	43.7
All Vehicles		3303	3.0	0.873	24.4	LOS C	17.9	128.8	0.86	0.85	43.8

PM PEAK HOUR 2025 RESIDENTIAL ONLY (NO NEW COMMERCIAL)

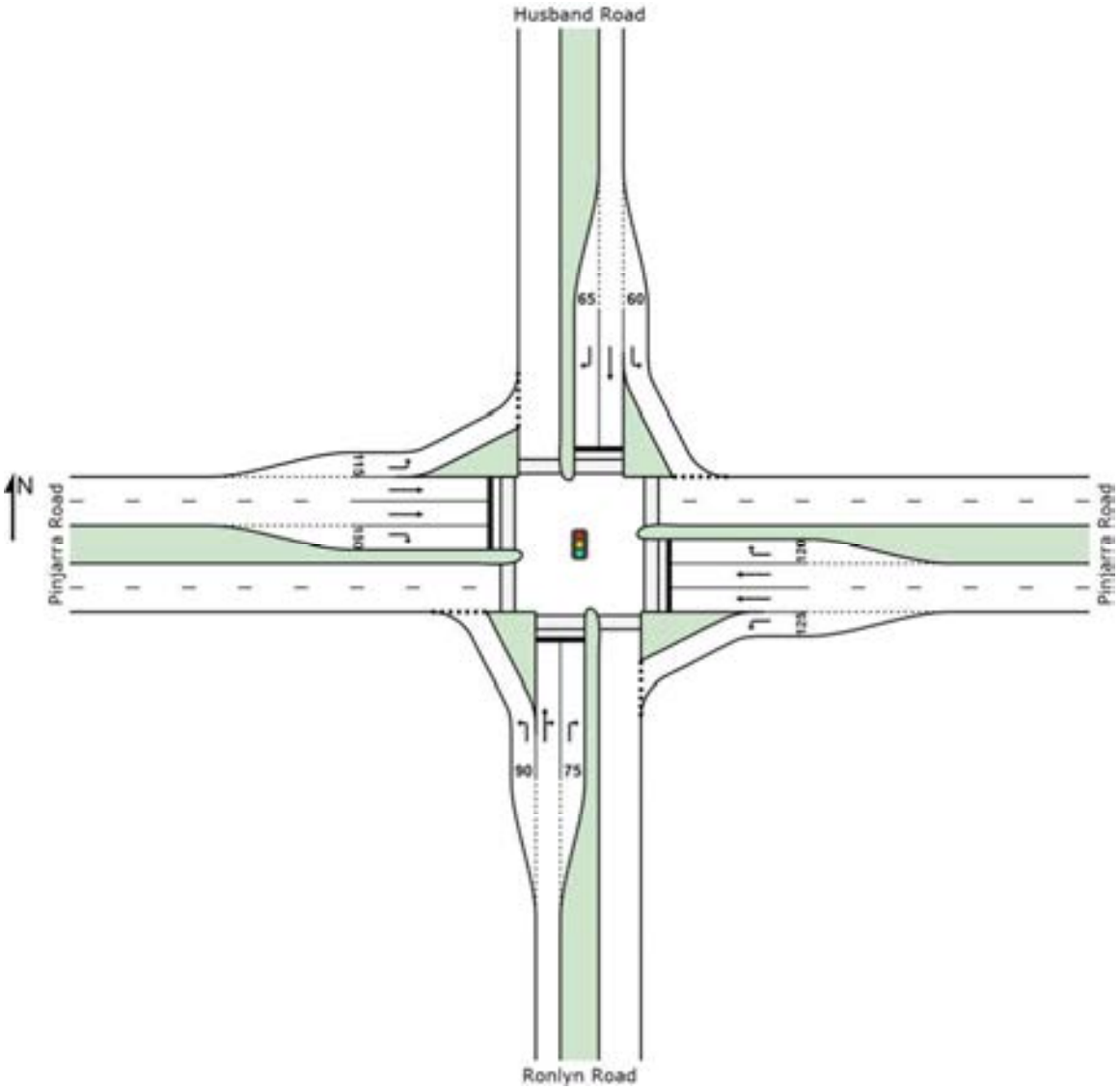
Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Ronlyn Road											
1	L2	278	3.0	0.312	19.7	LOS B	8.2	58.9	0.61	0.74	47.7
2	T1	12	3.0	0.824	69.5	LOS E	5.0	35.7	1.00	0.90	27.2
3	R2	140	3.0	0.824	75.2	LOS E	5.0	35.7	1.00	0.90	27.9
Approach		430	3.0	0.824	39.1	LOS D	8.2	58.9	0.75	0.79	38.1
East: Pinjarra Road											
4	L2	240	3.0	0.199	13.1	LOS B	4.4	31.6	0.40	0.71	54.4
5	T1	1289	3.0	0.889	30.4	LOS C	25.6	184.1	1.00	0.99	40.1
6	R2	66	3.0	0.172	49.4	LOS D	3.2	22.9	0.86	0.75	35.4
Approach		1595	3.0	0.889	28.6	LOS C	25.6	184.1	0.90	0.94	41.5
North: Husband Road											
7	L2	35	3.0	0.042	12.0	LOS B	0.6	4.6	0.39	0.63	53.0
8	T1	23	3.0	0.159	58.0	LOS E	1.3	9.4	0.97	0.69	30.9
9	R2	116	3.0	0.842	73.4	LOS E	7.5	54.0	1.00	0.94	28.2
Approach		174	3.0	0.842	59.0	LOS E	7.5	54.0	0.87	0.84	31.5
West: Pinjarra Road											
10	L2	60	3.0	0.040	7.9	LOS A	0.3	1.9	0.14	0.64	59.0
11	T1	1158	3.0	0.631	25.1	LOS C	25.1	180.4	0.81	0.72	42.5
12	R2	429	3.0	0.876	63.0	LOS E	27.5	197.4	1.00	0.94	31.3
Approach		1647	3.0	0.876	34.4	LOS C	27.5	197.4	0.83	0.78	39.3
All Vehicles		3846	3.0	0.889	33.6	LOS C	27.5	197.4	0.85	0.85	39.6

PROPOSED INTERSECTION OPERATION 2025 (RESIDENTIAL + COMMERCIAL)

The addition of the potentially proposed commercial developments by others on Ronlyn Road south of Pinjarra Road is expected to add further traffic entering and exiting via Ronlyn Road and Pinjarra Road.

Under this scenario Pinjarra Road will require that the existing Pinjarra Road eastbound right turn lane in to Ronlyn Road southbound will need to be extended from its current 105m vehicle storage length to 150m of vehicle storage length.



AM PEAK HOUR 2025 (RESIDENTIAL + NEW COMMERCIAL)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ronlyn Road											
1	L2	554	3.0	0.597	18.2	LOS B	15.9	113.8	0.72	0.80	48.6
2	T1	6	3.0	0.870	58.4	LOS E	8.0	57.7	1.00	0.99	29.4
3	R2	282	3.0	0.870	64.0	LOS E	8.0	57.7	1.00	0.99	30.4
Approach		842	3.0	0.870	33.9	LOS C	15.9	113.8	0.82	0.86	40.3
East: Pinjarra Road											
4	L2	162	3.0	0.126	10.7	LOS B	2.0	14.2	0.34	0.69	56.5
5	T1	1251	3.0	0.899	31.9	LOS C	23.0	165.3	1.00	1.04	39.4
6	R2	29	3.0	0.121	49.7	LOS D	1.3	9.2	0.92	0.72	35.3
Approach		1442	3.0	0.899	29.9	LOS C	23.0	165.3	0.92	0.99	40.7
North: Husband Road											
7	L2	29	3.0	0.037	10.1	LOS B	0.4	2.9	0.36	0.62	54.5
8	T1	6	3.0	0.052	49.9	LOS D	0.3	2.1	0.97	0.63	33.1
9	R2	56	3.0	0.508	58.6	LOS E	2.9	20.5	1.00	0.75	31.8
Approach		91	3.0	0.508	42.6	LOS D	2.9	20.5	0.79	0.70	36.7
West: Pinjarra Road											
10	L2	77	3.0	0.050	7.8	LOS A	0.2	1.7	0.13	0.64	59.0
11	T1	863	3.0	0.456	17.9	LOS B	13.7	98.4	0.70	0.62	46.4
12	R2	345	3.0	0.894	61.7	LOS E	19.7	141.2	1.00	0.97	31.6
Approach		1285	3.0	0.894	29.0	LOS C	19.7	141.2	0.75	0.72	41.7
All Vehicles		3660	3.0	0.899	30.8	LOS C	23.0	165.3	0.83	0.86	40.9

PM PEAK HOUR 2025 (RESIDENTIAL + NEW COMMERCIAL)

Movement Performance - Vehicles

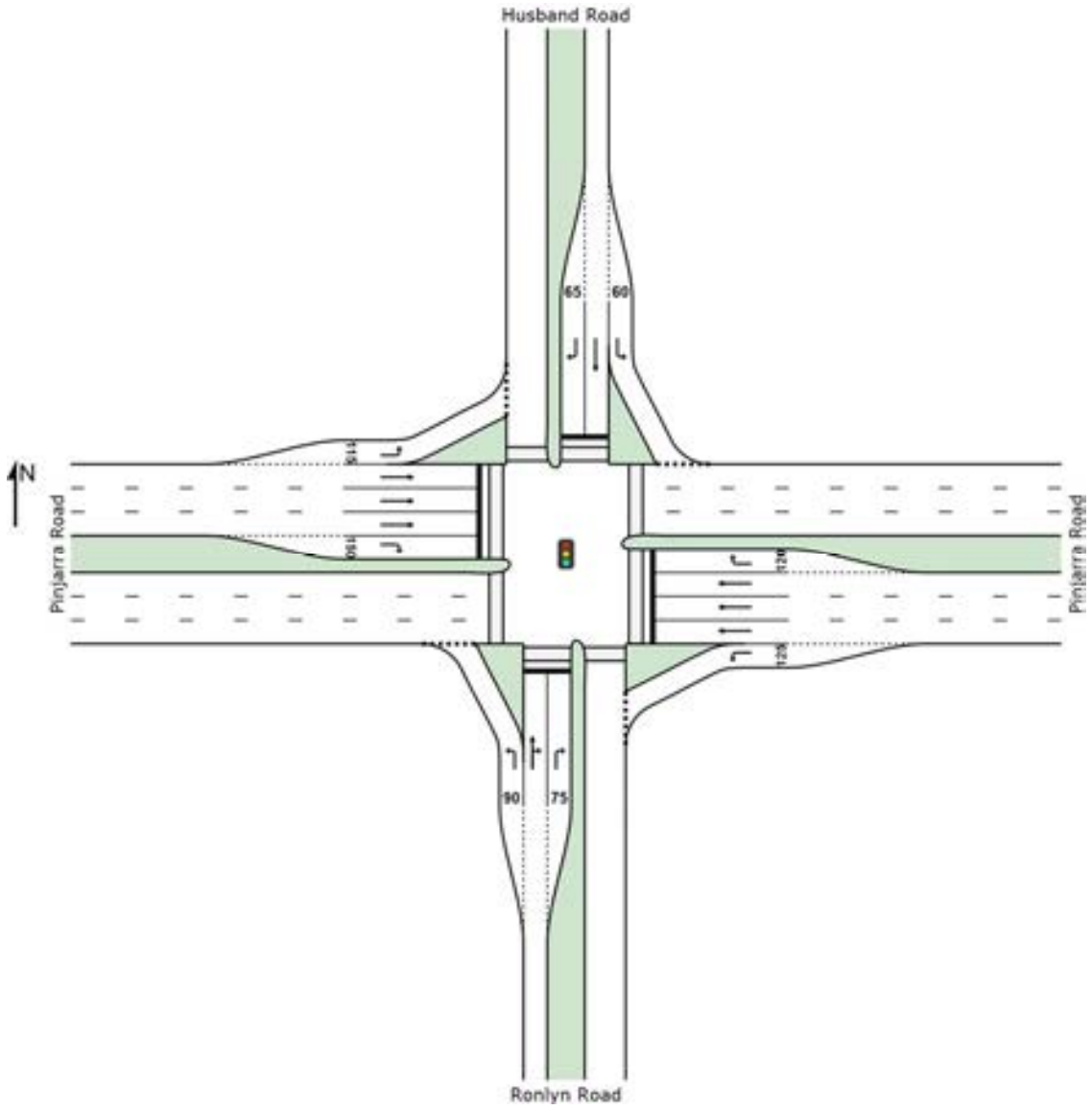
Mov ID	ODMov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Ronlyn Road											
1	L2	402	3.0	0.417	24.4	LOS C	15.9	113.9	0.64	0.76	45.0
2	T1	12	3.0	0.968	104.0	LOS F	9.7	69.6	1.00	1.06	21.6
3	R2	202	3.0	0.968	109.7	LOS F	9.7	69.6	1.00	1.06	22.1
Approach		616	3.0	0.968	53.9	LOS D	15.9	113.9	0.77	0.86	33.1
East: Pinjarra Road											
4	L2	297	3.0	0.266	17.4	LOS B	8.3	59.8	0.47	0.73	51.2
5	T1	1289	3.0	0.962	68.7	LOS E	42.4	304.2	1.00	1.20	28.3
6	R2	66	3.0	0.299	73.2	LOS E	4.5	32.2	0.95	0.76	28.8
Approach		1652	3.0	0.962	59.7	LOS E	42.4	304.2	0.90	1.10	30.8
North: Husband Road											
7	L2	35	3.0	0.054	11.7	LOS B	0.7	5.0	0.33	0.63	53.3
8	T1	23	3.0	0.179	73.4	LOS E	1.6	11.8	0.98	0.70	27.3
9	R2	116	3.0	0.947	103.3	LOS F	10.2	72.9	1.00	1.04	22.9
Approach		174	3.0	0.947	80.9	LOS F	10.2	72.9	0.86	0.91	26.5
West: Pinjarra Road											
10	L2	60	3.0	0.038	7.9	LOS A	0.3	2.2	0.12	0.63	59.0
11	T1	1158	3.0	0.499	18.0	LOS B	23.6	169.7	0.62	0.56	46.4
12	R2	544	3.0	0.951	86.2	LOS F	47.7	342.2	1.00	1.00	26.1
Approach		1762	3.0	0.951	38.7	LOS D	47.7	342.2	0.72	0.70	37.6
All Vehicles		4204	3.0	0.968	50.9	LOS D	47.7	342.2	0.80	0.89	33.4

PROPOSED INTERSECTION OPERATION 2031 (PINJARRA ROAD WITH 6 LANES)

Discussion with Main Roads Western Australia and the Department for Planning has indicated that a future upgrading of Pinjarra Road to 6 lanes is proposed.

For the purpose of this assessment it has been assumed that this upgrading will take place before 2031 as the Regional Operations Model (ROM) traffic flow data supplied by Main Roads WA suggest the current 4 lanes will be insufficient and the proposal for 6 lanes will be required by 2031.

The SIDRA modelling of this intersection with 6 lanes in 2031 indicates that the intersection will operate satisfactorily without excessive delays and an Overall Level of Service of C.



AM PEAK HOUR 2031 (PINJARRA ROAD WITH 6 LANES)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Ronlyn Road											
1	L2	554	3.0	0.538	17.8	LOS B	17.7	127.4	0.62	0.77	48.9
2	T1	23	3.0	0.883	72.4	LOS E	10.8	77.8	1.00	1.00	26.6
3	R2	282	3.0	0.883	79.3	LOS E	10.8	77.8	1.00	0.99	27.1
Approach		859	3.0	0.883	39.4	LOS D	17.7	127.4	0.76	0.85	38.0
East: Pinjarra Road											
4	L2	162	3.0	0.125	11.3	LOS B	2.5	17.8	0.31	0.68	55.9
5	T1	1739	3.0	0.886	36.1	LOS D	26.5	190.2	1.00	1.00	37.7
6	R2	15	3.0	0.076	64.4	LOS E	0.9	6.2	0.93	0.70	31.0
Approach		1916	3.0	0.886	34.3	LOS C	26.5	190.2	0.94	0.97	38.7
North: Husband Road											
7	L2	15	3.0	0.020	10.6	LOS B	0.2	1.8	0.32	0.61	54.1
8	T1	9	3.0	0.034	52.1	LOS D	0.5	3.5	0.89	0.61	32.6
9	R2	29	3.0	0.342	74.8	LOS E	1.9	13.7	1.00	0.72	28.0
Approach		53	3.0	0.342	52.8	LOS D	1.9	13.7	0.79	0.67	33.3
West: Pinjarra Road											
10	L2	40	3.0	0.025	7.8	LOS A	0.2	1.1	0.12	0.63	59.1
11	T1	1248	3.0	0.444	23.3	LOS C	17.1	122.4	0.70	0.62	43.5
12	R2	345	3.0	0.872	70.6	LOS E	23.9	171.3	1.00	0.94	29.5
Approach		1633	3.0	0.872	32.9	LOS C	23.9	171.3	0.75	0.69	39.7
All Vehicles		4461	3.0	0.886	35.0	LOS C	26.5	190.2	0.83	0.84	38.9

PM PEAK HOUR 2031 (PINJARRA ROAD WITH 6 LANES)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Ronlyn Road											
1	L2	402	3.0	0.306	9.4	LOS A	6.0	42.7	0.38	0.67	55.0
2	T1	16	3.0	0.797	57.2	LOS E	6.2	44.8	1.00	0.91	29.9
3	R2	202	3.0	0.797	64.8	LOS E	6.2	44.8	1.00	0.90	30.4
Approach		620	3.0	0.797	28.7	LOS C	6.2	44.8	0.60	0.75	42.8
East: Pinjarra Road											
4	L2	297	3.0	0.291	15.7	LOS B	6.5	46.5	0.51	0.74	52.4
5	T1	821	3.0	0.865	33.8	LOS C	9.5	68.6	1.00	0.95	38.7
6	R2	34	3.0	0.226	60.5	LOS E	1.8	12.8	0.97	0.73	32.1
Approach		1152	3.0	0.865	29.9	LOS C	9.5	68.6	0.87	0.89	41.2
North: Husband Road											
7	L2	18	3.0	0.021	9.2	LOS A	0.2	1.7	0.31	0.61	55.3
8	T1	45	3.0	0.142	42.9	LOS D	2.1	15.0	0.89	0.67	35.4
9	R2	60	3.0	0.599	65.1	LOS E	3.4	24.5	1.00	0.78	30.2
Approach		123	3.0	0.599	48.8	LOS D	3.4	24.5	0.86	0.71	34.3
West: Pinjarra Road											
10	L2	31	3.0	0.020	7.8	LOS A	0.1	0.9	0.14	0.63	59.0
11	T1	1139	3.0	0.416	20.3	LOS C	13.2	94.9	0.70	0.61	45.1
12	R2	544	3.0	0.857	51.1	LOS D	30.5	219.3	1.00	0.94	34.9
Approach		1714	3.0	0.857	29.8	LOS C	30.5	219.3	0.79	0.72	41.4
All Vehicles		3609	3.0	0.865	30.3	LOS C	30.5	219.3	0.78	0.78	41.3

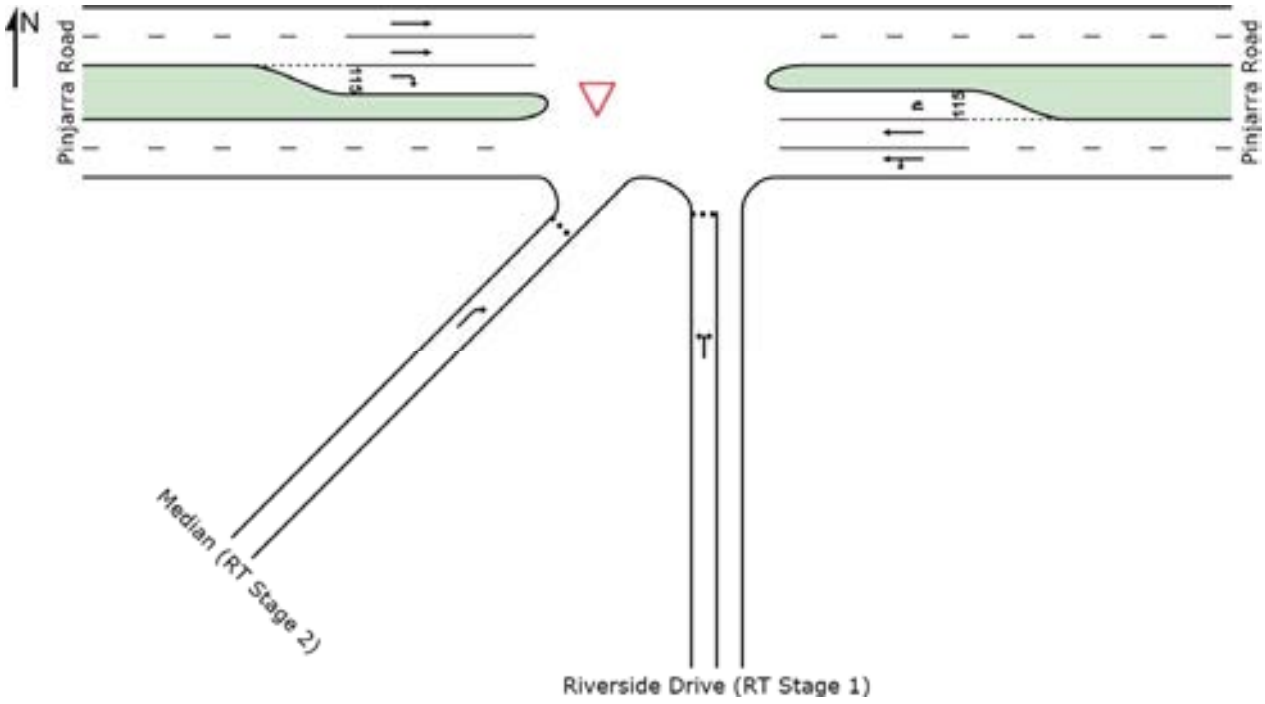
6.3.2 Riverside Drive/Pinjarra Road

The estimated daily traffic flows presented in the Appendix are at the assumed full future development. At full development of the proposed residential plus service station there will be a predicted total future 4,450veh/day volume for Riverside Drive which is within the 3,000 to 7,000veh/day range recommended for a Local Distributor.

The intersection of Riverside Drive with Pinjarra Road has been modelled under various scenarios which include retaining full operation of the T-junction under Give Way Control and limiting right turns in and right turns out of Riverside Drive to Pinjarra Road.

Right turns not able to enter or exit Riverside Drive on to Pinjarra Road will re-direct to the Ronlyn Road/Pinjarra Road signalised intersection via interconnecting local streets.

CURRENT INTERSECTION OPERATION (2015)



AM PEAK HOUR 2015 (Current)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Riverside Drive (RT Stage 1)											
1	L2	50	3.0	0.459	17.9	LOS C	1.7	12.3	0.86	1.04	39.3
3	R2	24	3.0	0.459	72.1	LOS F	1.7	12.3	0.86	1.04	23.4
Approach		74	3.0	0.459	35.5	LOS E	1.7	12.3	0.86	1.04	32.2
East: Pinjarra Road											
4	L2	9	3.0	0.182	7.0	LOS A	0.0	0.0	0.00	0.02	73.0
5	T1	693	3.0	0.182	0.0	LOS A	0.0	0.0	0.00	0.01	79.8
6u	U	2	3.0	0.004	11.6	LOS B	0.0	0.1	0.55	0.68	48.9
Approach		704	3.0	0.182	0.1	NA	0.0	0.1	0.00	0.01	79.5
West: Pinjarra Road											
11	T1	527	3.0	0.136	0.0	LOS A	0.0	0.0	0.00	0.00	80.0
12	R2	16	3.0	0.025	10.8	LOS B	0.1	0.6	0.57	0.75	55.3
Approach		543	3.0	0.136	0.3	NA	0.1	0.6	0.02	0.02	78.9
SouthWest: Median (RT Stage 2)											
32a	R1	24	3.0	0.452	86.4	LOS F	1.4	8.5	0.96	1.07	16.0
Approach		24	3.0	0.452	86.4	LOS F	1.4	8.5	0.96	1.07	16.0
All Vehicles		1345	3.0	0.459	3.7	NA	1.7	12.3	0.07	0.09	70.9

PM PEAK HOUR 2015 (Current)

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Riverside Drive (RT Stage 1)											
1	L2	23	3.0	0.459	30.4	LOS D	1.4	10.4	0.93	1.04	28.7
3	R2	12	3.0	0.459	145.4	LOS F	1.4	10.4	0.93	1.04	19.1
Approach		35	3.0	0.459	69.8	LOS F	1.4	10.4	0.93	1.04	24.5
East: Pinjarra Road											
4	L2	21	3.0	0.211	7.0	LOS A	0.0	0.0	0.00	0.03	72.7
5	T1	794	3.0	0.211	0.0	LOS A	0.0	0.0	0.00	0.02	79.6
6u	U	2	3.0	0.005	14.4	LOS B	0.0	0.1	0.65	0.74	47.1
Approach		817	3.0	0.211	0.2	NA	0.0	0.1	0.00	0.02	79.3
West: Pinjarra Road											
11	T1	696	3.0	0.180	0.0	LOS A	0.0	0.0	0.00	0.00	79.9
12	R2	43	3.0	0.078	12.1	LOS B	0.3	2.0	0.63	0.85	54.2
Approach		739	3.0	0.180	0.7	NA	0.3	2.0	0.04	0.05	77.8
SouthWest: Median (RT Stage 2)											
32a	R1	12	3.0	0.446	167.1	LOS F	1.2	7.6	0.98	1.05	9.5
Approach		12	3.0	0.446	167.1	LOS F	1.2	7.6	0.98	1.05	9.5
All Vehicles		1603	3.0	0.459	3.2	NA	1.4	10.4	0.05	0.06	73.0

PROPOSED INTERSECTION OPERATION 2025 (RESIDENTIAL DEVELOPMENT)

In this option all right turn exit movements from Riverside Drive on to Pinjarra Road are banned and the u-turn on Pinjarra Road is removed.

Under the scenario of full development of the residential land the following SIDRA modelling indicates that in the PM Peak Hour the Pinjarra Road eastbound to southbound right turn is not expected to operate within acceptable parameters as it becomes oversaturated and queuing extends out to 335m with average delay in the order of 14.5 minutes.

AM PEAK HOUR 2025

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Riverside Drive											
1	L2	249	0.0	0.628	19.7	LOS C	3.3	23.2	0.86	1.12	44.4
Approach		249	0.0	0.628	19.7	LOS C	3.3	23.2	0.86	1.12	44.4
East: Pinjarra Road											
4	L2	29	0.0	0.480	5.6	LOS A	0.0	0.0	0.00	0.02	57.7
5	T1	1861	0.0	0.480	0.0	LOS A	0.0	0.0	0.00	0.01	59.8
Approach		1890	0.0	0.480	0.1	NA	0.0	0.0	0.00	0.01	59.7
West: Pinjarra Road											
11	T1	1285	0.0	0.326	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
12	R2	55	0.0	0.736	102.3	LOS F	2.6	18.4	0.99	1.11	22.1
Approach		1340	0.0	0.736	4.2	NA	2.6	18.4	0.04	0.05	55.2
All Vehicles		3479	0.0	0.736	3.1	NA	3.3	23.2	0.08	0.10	56.3

PM PEAK HOUR 2025

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Riverside Drive											
1	L2	117	0.0	0.268	13.6	LOS B	1.0	7.0	0.74	0.92	48.0
Approach		117	0.0	0.268	13.6	LOS B	1.0	7.0	0.74	0.92	48.0
East: Pinjarra Road											
4	L2	72	0.0	0.478	5.6	LOS A	0.0	0.0	0.00	0.05	57.4
5	T1	1807	0.0	0.478	0.0	LOS A	0.0	0.0	0.00	0.02	59.6
Approach		1879	0.0	0.478	0.3	NA	0.0	0.0	0.00	0.02	59.5
West: Pinjarra Road											
11	T1	1704	0.0	0.788	4.3	LOS A	5.7	39.7	0.09	0.00	55.2
12	R2	144	0.0	1.876	874.8	LOS F	47.9	335.4	1.00	3.13	3.9
Approach		1848	0.0	1.876	72.1	NA	47.9	335.4	0.16	0.24	24.7
All Vehicles		3844	0.0	1.876	35.2	NA	47.9	335.4	0.10	0.16	35.3

PROPOSED INTERSECTION OPERATION 2025 (RESIDENTIAL + COMMERCIAL)

In this option all right turn exit movements from Riverside Drive on to Pinjarra Road are banned and the u-turn on Pinjarra Road is removed.

Under the scenario of full development of the residential land plus a possible Service Station the following SIDRA modelling indicates that in both the AM and the PM Peak Hours the Pinjarra Road eastbound to southbound right turn is not expected to operate within acceptable parameters as it becomes oversaturated and queuing extends out to 164m in the AM and 518m in the PM with average delay in the order of 8 minutes in the AM and 23 minutes in the PM peak hour.

AM PEAK HOUR 2025

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Riverside Drive											
1	L2	293	0.0	0.722	21.9	LOS C	4.4	31.1	0.89	1.22	43.2
Approach		293	0.0	0.722	21.9	LOS C	4.4	31.1	0.89	1.22	43.2
East: Pinjarra Road											
4	L2	52	0.0	0.486	5.6	LOS A	0.0	0.0	0.00	0.03	57.6
5	T1	1861	0.0	0.486	0.1	LOS A	0.0	0.0	0.00	0.02	59.7
Approach		1913	0.0	0.486	0.2	NA	0.0	0.0	0.00	0.02	59.6
West: Pinjarra Road											
11	T1	1285	0.0	0.598	1.9	LOS A	4.3	30.3	0.08	0.00	57.8
12	R2	100	0.0	1.424	494.9	LOS F	23.5	164.2	1.00	2.32	6.5
Approach		1385	0.0	1.424	37.5	NA	23.5	164.2	0.15	0.17	34.4
All Vehicles		3591	0.0	1.424	16.4	NA	23.5	164.2	0.13	0.17	45.3

PM PEAK HOUR 2025

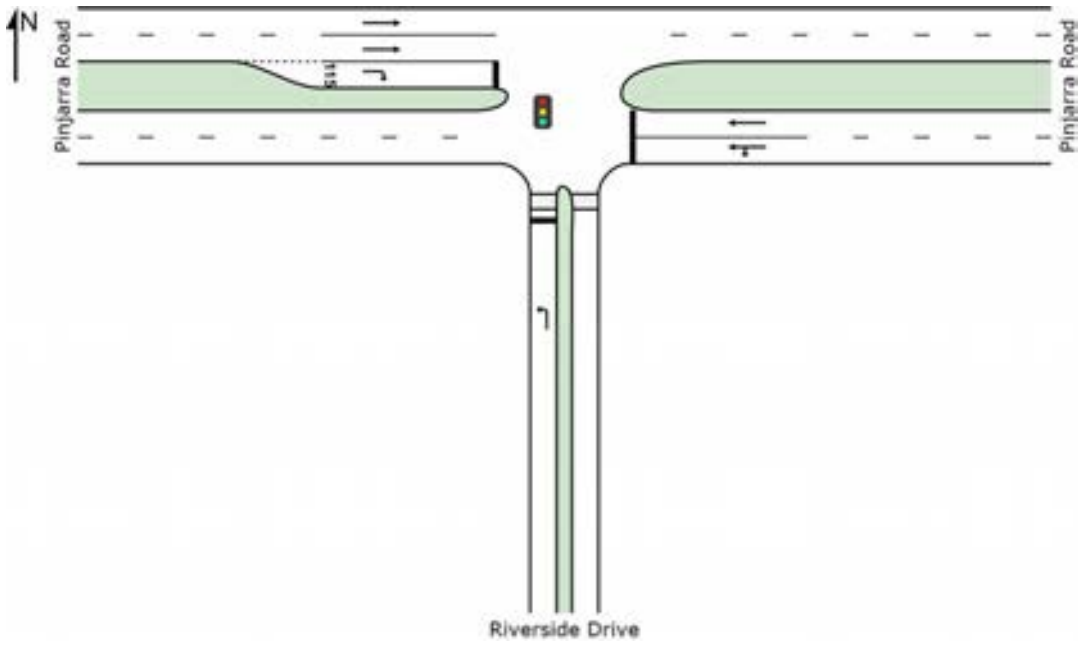
Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Riverside Drive											
1	L2	175	0.0	0.394	14.7	LOS B	1.7	11.7	0.77	0.97	47.3
Approach		175	0.0	0.394	14.7	LOS B	1.7	11.7	0.77	0.97	47.3
East: Pinjarra Road											
4	L2	90	0.0	0.483	5.6	LOS A	0.0	0.0	0.00	0.06	57.3
5	T1	1807	0.0	0.483	0.0	LOS A	0.0	0.0	0.00	0.03	59.6
Approach		1897	0.0	0.483	0.3	NA	0.0	0.0	0.00	0.03	59.4
West: Pinjarra Road											
11	T1	1704	0.0	0.800	4.1	LOS A	5.0	34.8	0.07	0.00	55.4
12	R2	180	0.0	2.460	1395.3	LOS F	74.1	518.4	1.00	3.55	2.5
Approach		1884	0.0	2.460	137.0	NA	74.1	518.4	0.16	0.34	16.2
All Vehicles		3956	0.0	2.460	66.1	NA	74.1	518.4	0.11	0.22	26.0

PROPOSED INTERSECTION OPERATION 2025 (RESIDENTIAL + COMMERCIAL) WITH RIGHT TURN SIGNALISED EAST TO SOUTH

In this option all right turn exit movements from Riverside Drive on to Pinjarra Road are banned and the u-turn on Pinjarra Road is removed.

Introducing signalisation of right turns on Pinjarra Road eastbound to southbound will provide for safe and efficient right turns in the PM Peak Hour. The Pinjarra Road eastbound lanes are not required to be traffic signal controlled and maintain free flow. The westbound Pinjarra Road traffic lines are required to be stopped for short periods to enable the eastbound to southbound right turns to flow. The Riverside Drive left turn exit on to Pinjarra Road may be either traffic signal controlled or Give Way sign controlled. This analysis includes the higher order control of signalisation.



AM PEAK HOUR 2025

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Riverside Drive											
1	L2	293	3.0	0.797	30.9	LOS C	8.0	57.3	1.00	0.96	39.1
Approach		293	3.0	0.797	30.9	LOS C	8.0	57.3	1.00	0.96	39.1
East: Pinjarra Road											
4	L2	52	3.0	0.885	26.9	LOS C	28.3	203.3	0.94	1.08	40.8
5	T1	1861	3.0	0.885	21.3	LOS C	28.4	203.7	0.94	1.08	42.0
Approach		1913	3.0	0.885	21.4	LOS C	28.4	203.7	0.94	1.08	41.9
West: Pinjarra Road											
11	T1	1285	3.0	0.332	0.0	LOS A	0.0	0.0	0.00	0.00	59.9
12	R2	100	3.0	0.272	24.7	LOS C	2.2	15.6	0.88	0.76	41.7
Approach		1385	3.0	0.332	1.8	LOS A	2.2	15.6	0.06	0.05	57.7
All Vehicles		3591	3.0	0.885	14.6	LOS B	28.4	203.7	0.61	0.67	46.5

PM PEAK HOUR 2025

Movement Performance - Vehicles

Mov ID	ODMov	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Average Speed
		veh/h	%	v/c	sec		veh	m		per veh	km/h
South: Riverside Drive											
1	L2	175	3.0	0.680	30.4	LOS C	4.5	32.6	1.00	0.87	39.2
Approach		175	3.0	0.680	30.4	LOS C	4.5	32.6	1.00	0.87	39.2
East: Pinjarra Road											
4	L2	90	3.0	0.794	16.3	LOS B	19.9	143.0	0.81	0.82	47.5
5	T1	1807	3.0	0.794	10.7	LOS B	20.0	143.6	0.81	0.81	49.2
Approach		1897	3.0	0.794	11.0	LOS B	20.0	143.6	0.81	0.81	49.1
West: Pinjarra Road											
11	T1	1704	3.0	0.441	0.1	LOS A	0.0	0.0	0.00	0.00	59.9
12	R2	180	3.0	0.700	30.7	LOS C	4.7	33.8	1.00	0.88	39.0
Approach		1884	3.0	0.700	3.0	LOS A	4.7	33.8	0.10	0.08	56.4
All Vehicles		3956	3.0	0.794	8.0	LOS A	20.0	143.6	0.48	0.47	51.6

6.4 Internal Road Network

The proposed Preliminary Concept Plan road network is intended to accommodate all internal traffic movements between lots and connection with major roads in the existing network.

This report seeks to illustrate a road system which provides an acceptable balance between the diverse uses of outer-urban style living where personal private transport comprises the majority of means of travel for residents.

The report seeks to balance the conflict in function between the road network as a traffic route for vehicles and pedestrians and as a place for a range of residential dwelling densities and community activities. The report also acknowledges conventional urban and community guidelines, such as the West Australian Planning Commission Liveable Neighbourhoods, but seeks to adapt those to reflect the local environment and community activities.

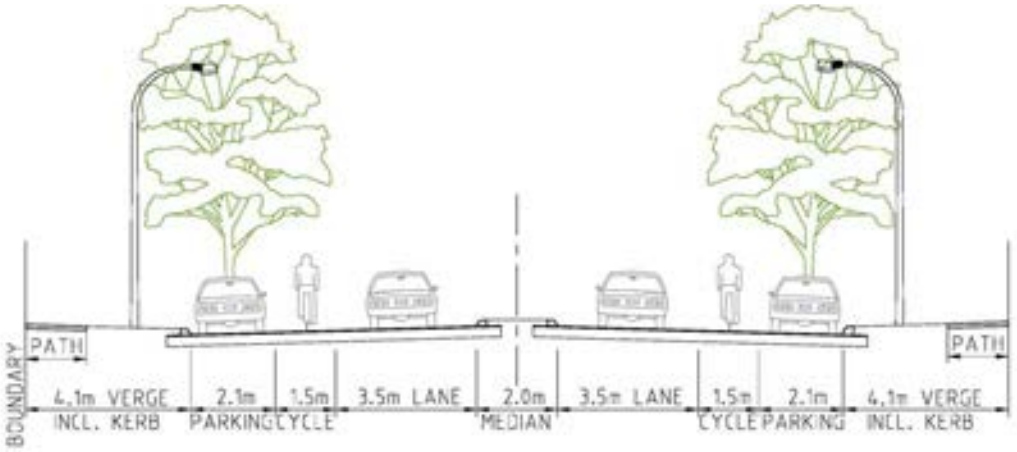
6.4.1 Neighbourhood Connectors

Riverside Drive and Ronlyn Road

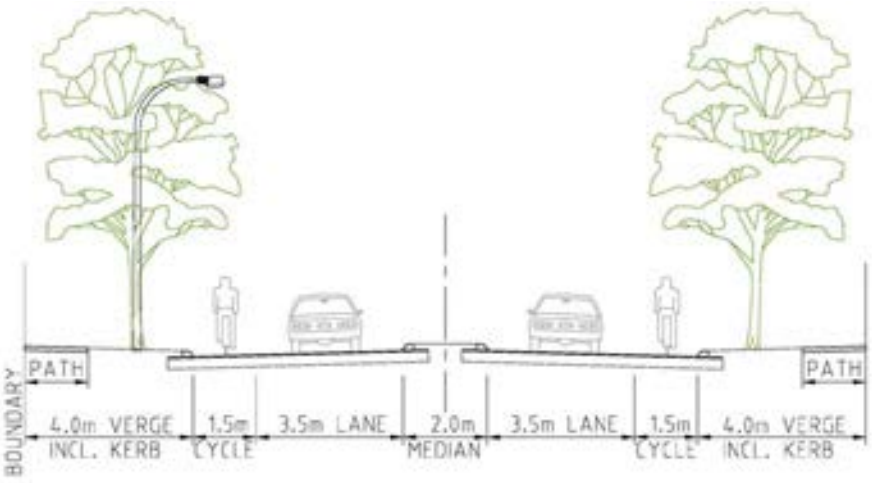
Neighbourhood Connector streets mostly have residential frontage providing the road link between neighbourhoods. Liveable Neighbourhoods suggests networks may have two types of Neighbourhood Connector. Those carrying traffic volumes between 3,000 to 7,000 veh/day and those carrying less than 3,000 veh/day. Where a Neighbourhood Connector Road carries 3,000 to 7,000 veh/day then a Type 3a street cross-section would apply and where the Connector serves a lesser traffic carrying function then Type 3b street cross-section is applicable. Where appropriate, those streets may also provide for on-street parking without significant impact on their lower volume traffic carrying function.

Road Reservation Width	20 metres to 24.4 metres
Speed Limit	50km/h
Intersection controls	Median/islands at 3-way major connections. Roundabout at 4-way and major 3-way.

Two alternate cross sections for a Neighbourhood Connector Type Road are presented The 24.4m cross section to be introduced on Riverside Drive and Ronlyn Road for the length of carriageway from Pinjarra Road south to the first interlink road connecting Riverside Drive and Ronlyn Road. The intersection of each of those streets with Ronlyn Road and Riverside Drive to be controlled by roundabout to enable the anticipated right turns to be made with good safety and limited delay to enable a high level of movements to the traffic signal controlled intersection of Ronlyn Road/Pinjarra Road.



TYPE 3a. - 24.4m WITH MEDIAN AND CYCLING
NOT TO SCALE



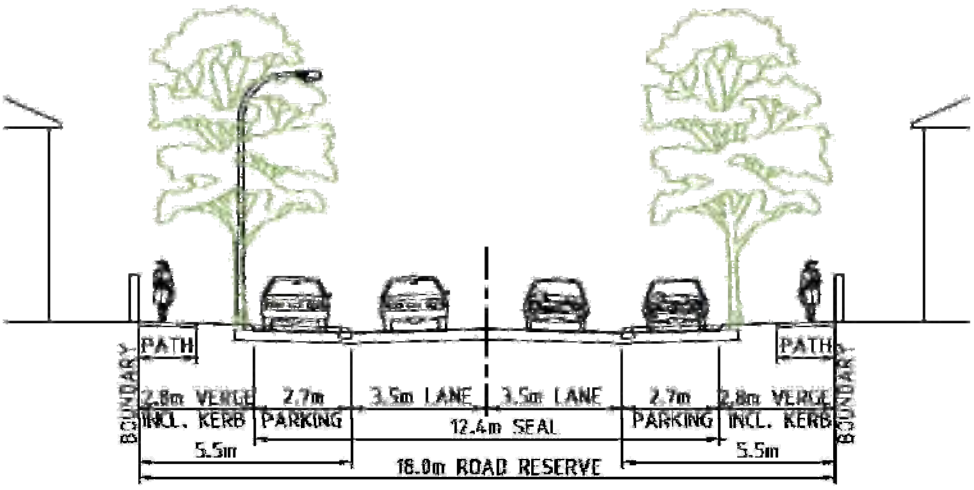
TYPE 3b. - 20.0m WITH MEDIAN AND CYCLING
NOT TO SCALE

6.4.2 Local Access Streets

The following cross-sections are recommended depending on application.

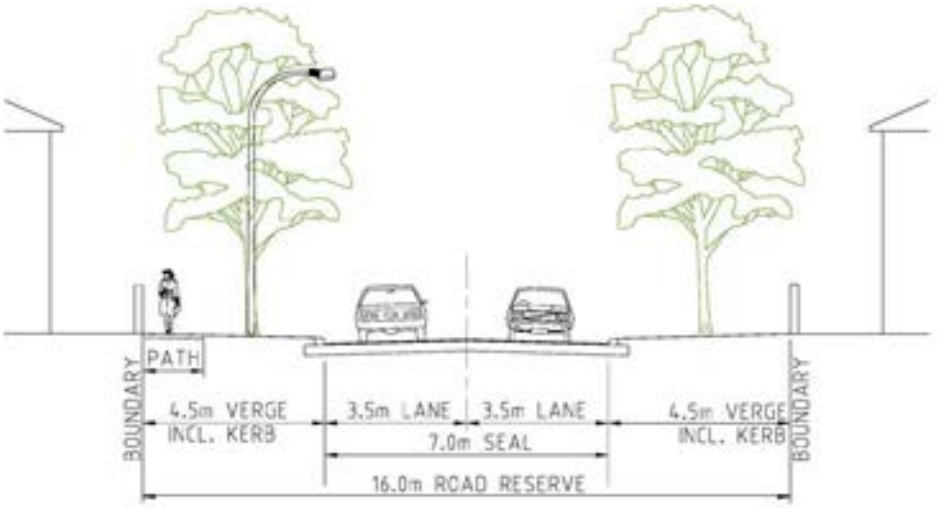
Road Reservation Width	Varies from 16 to 18 metres
Speed Limit	50km/h
Intersection controls	Give Way/Stop control at connections. Roundabout at major 4-way connections.

Type 5



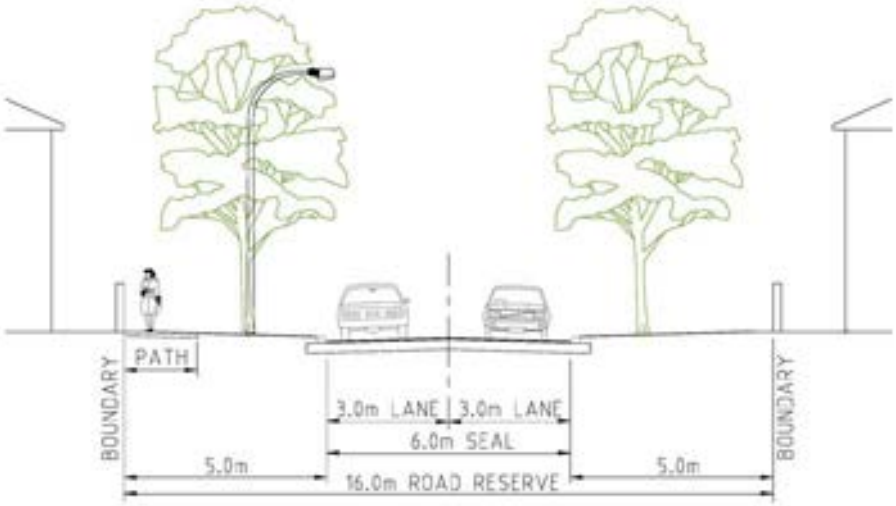
TYPE 5. - 18m AND 7.0m WITH PARKING
NOT TO SCALE

Type 6



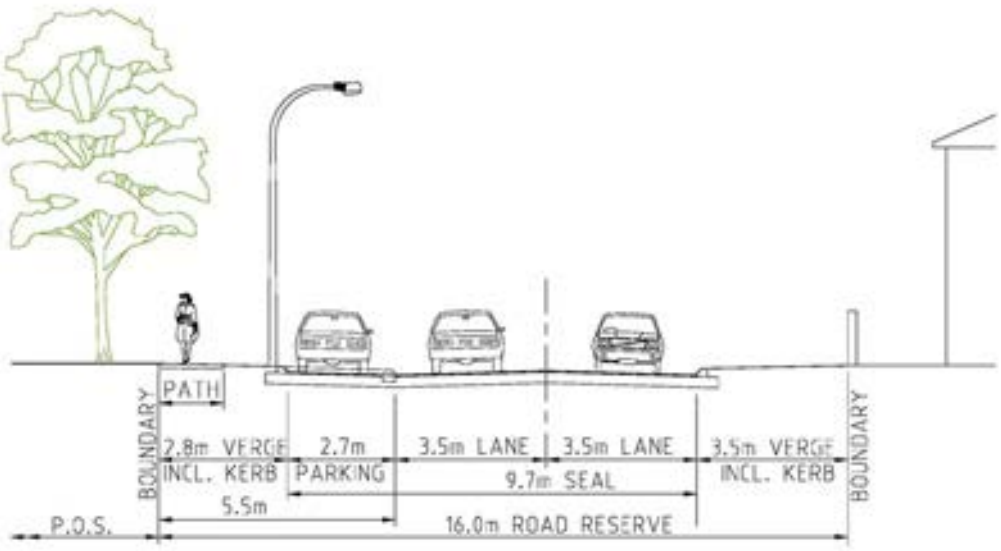
TYPE 6. - 16m AND 7.0m
NOT TO SCALE

Type 7



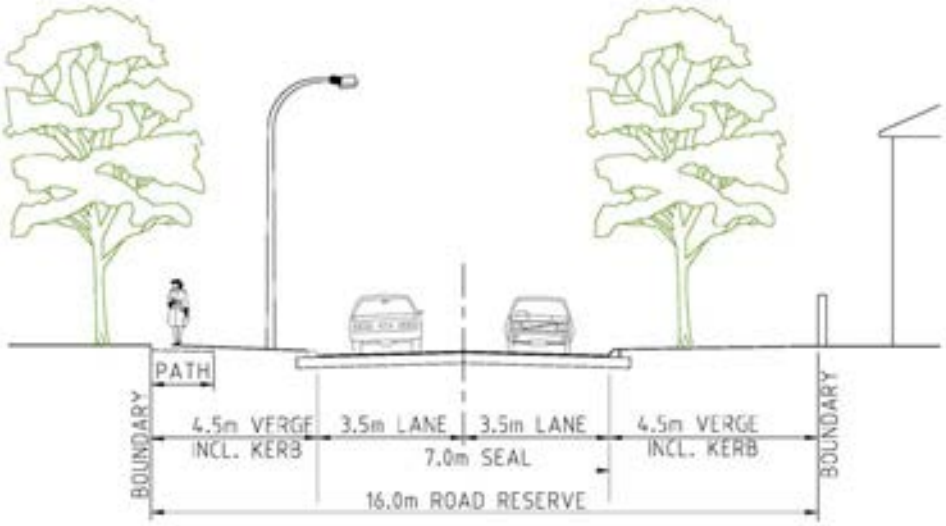
TYPE 7. - 16m AND 6.0m
NOT TO SCALE

Type 9



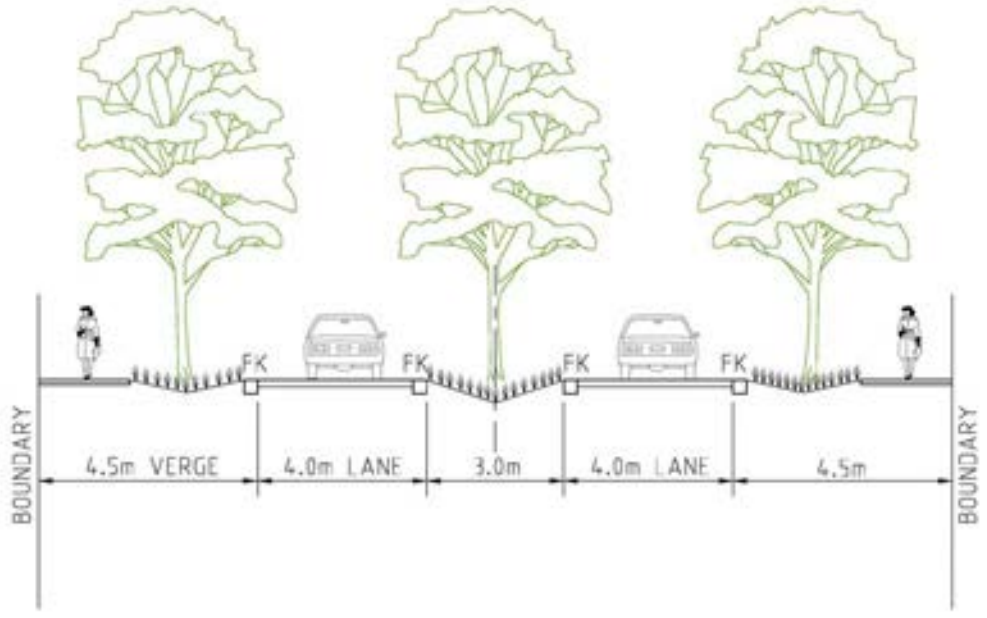
TYPE 9. - 16m AND 7.0m WITH PARKING ON POS SIDE
NOT TO SCALE

Type 10



TYPE 10. - 16m AND 7.0m
NOT TO SCALE

Type 11 - With Stormwater Drainage Swales



SECTION B - ROAD 'O' BOULEVARD
NOT TO SCALE

6.4.3 Intersections

The purpose of preparing a Road Network for a Development Plan is to provide a designed solution achieving a layout of streets which spreads local traffic loads which leads on to the higher order streets which in turn lead to the major District Distributor roads. Included in the street network design are the locations, types and operation of intersections which are intended to manage traffic flow and provide for the safe movement of vehicles, pedestrians and cyclists.

Street network design guides, including Liveable Neighbourhoods, promote a highly interconnected street network with frequent junctions. Intersections are designed for vehicle and pedestrian safety taking into account traffic volume, types of vehicle, likely traffic speed, turning movements, topography and any potential need for an intersection to act as a speed reducing device in one or more directions. The spacing between intersections will typically be provided at not less than 20m for Access streets and not less than 40m for Neighbourhood Connectors.

6.5 Traffic Management

Management of traffic flows on roads and at intersections within the proposed road network is a necessary requirement to maintain safe operation of the road network by minimising risk. T-junctions must be provided with adequate sight distance and where that is available the intersection requires only normal Give Way control. Where sight distance is restricted then Stop Sign control may be more appropriate.

High traffic speeds exceeding the designated Speed Limit should not occur within the road network under the proposed cross-sections and where there are relatively short road lengths between controlled intersections.

The Shire of Murray has indicated a preference for the inclusion of 3 roundabouts at suitable locations along each of Riverside Drive and Ronlyn Road. Preferred locations that will aid in the safe movement of traffic and the operation of intersections have been identified on the proposed road network diagram presented in Appendix 2.

The use of roundabouts at intersections offers the benefits of managing traffic speed, controlling intersection operation and potentially mimising limitations of access to the abutting the properties.

Alternately, mid-block traffic management devices may be considered, however depending on the location of the device and the width of property frontage such devices can inhibit property access and will reduce the width of verge thereby inhibiting the provision of footpaths, cycle paths, serves, etc.

6.6 Pedestrians and Cyclists

Planning guidelines recommend provision of a footpath along every street with a developed frontage. Footpaths should be a minimum of 1.5m on residential access streets and 2.0m in the vicinity of schools, commercial centres and other activity centres.

Other than for the Neighbourhood Connectors the Access streets in the network have low daily traffic volumes suitable for on-road cycling. Informal on-street parking will, however, create some interference for on-road cycling but typically this will occur on very low traffic volume roads where the opportunity for conflict should be low.

In the Appendix a diagram is presented on which are indicated where the pedestrian footpaths and cycle paths are recommended to be located on the new roads. The main shared path routes are presented and also indicate connections with the Shire's existing path network.

6.7 Public Transport

Transperth Bus Route 598 services between Furnissdale and the Mandurah Bus Station. Through Furnissdale Bus Route 598 commences from the western end of Smith Street and travels eastward on to York Road, Riverside Drive, Ronlyn Road and then turning westward on to Pinjarra Road in to Mandurah.

Figure 2. Transport Bus Route 598 - Furnissdale Stop Locations



The existing Furnissdale developed area is currently adequately serviced. However, as the proposed area of residential development expands under the Structure Plan the Bus Route will need to be reviewed to encompass new residential developments. The change to the route will depend on the staging of new roads as they are constructed and new dwellings as they are inhabited.

Figure 3. Existing Public Transport Bus Route 598



7.0 SUMMARY

Estimated traffic generation and arrangements for operation of the proposed Structure Plan road network have been assessed. Traffic generation by the proposed development area is anticipated to be in accordance with permitted land use as described by current practice trip generation rate guidelines. This report includes anticipated trip generation but is not intended to address the specifics of any future commercial development's driveway access on to Ronlyn Road and Pinjarra Road. The details of any such access requirements should be addressed by the relevant applicant in their Planning Development Approval submission. Development of a service station or any other similar commercial development on the corner of Riverside Drive/Pinjarra Road is included only for the purpose of a robust assessment of the potential for future traffic generation at this intersection.

For the proposed Structure Plan the following is notable:

- The proposed Furnissdale Residential Development internal street network layout and operation will be sufficient to provide for the proposed residential dwellings, public open space and ancillary development land use.
- Provision of a high quality pedestrian and bicycle network inter-connected with the existing and network will be sufficient to meet the needs of the proposed land development area.
- At full development of all subdivisible land under this assessment there is impact on the road network that will require the intersections with the major transport road (Pinjarra Road) to be upgraded. Depending on when it is intended to occur this could potentially be undertaken in conjunction with the Main Roads WA proposed major upgrading of Pinjarra Road. This will need discussion with the relevant authorities.
- The current signalised intersection of Ronlyn Road with Pinjarra Road will require that the Ronlyn Road approach is modified to reconfigure the northbound through lane as a combined through and right lane to provide two right turn lanes by 2025. This will be required under the residential only scenario and the residential plus additional commercial development scenario.
- The current signalised intersection of Ronlyn Road with Pinjarra Road will require that when additional commercial development is introduced the eastbound right turn lane on Pinjarra Road west of Ronlyn Road will need to be extended from 105m to 150m to accommodate the additional right turning vehicles by 2025.
- The current intersection of Riverside Drive with Pinjarra Road will need to be modified by 2025 to remove the Pinjarra Road U-turn and remove right turn exit from Riverside Drive on to Pinjarra Road.
- Right turn entry from Pinjarra Road on to Riverside Drive will need to be retained so as not to exceed the capacity of the right turn from Pinjarra Road on to Ronlyn Road.
- The right turn from Pinjarra Road on to Riverside Drive will need to be signalised by 2025 to avoid excessive queuing and delay for this turn on Pinjarra Road.

APPENDIX 1

Indicative Structure Plan

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All areas and dimensions are subject to survey.



Outline Development Plan

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Matt Sullivan 12 October 2015

Furnissdale West Plan 1

Planning Design Delivery



RESIDENTIAL
- Residential - R20
- Residential - R30
- Residential - R40
- Residential - R60

PARKS,RECREATION & CONSERVATION
- Public Open Space
- Conservation (OEPA Vegetation)

WATER
- Wetland Buffer
- Wetland

TRANSPORT
- Neighbourhood Connector
- Access Street - Local Road

OTHER
- Outline Development Plan Boundary

0 125 250 Metres

REVISIONS

Rev	Date	Drawn
A	2015.05.13	M. Sullivan
B	2015.07.08	M. Sullivan

ROWEGROUP
PLANNING DESIGN DELIVERY

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Date Drawn:	2015-05-13
Job Ref:	5527
Scale:	1:5,000 @ A3
Client:	Coode Pty Ltd
Designer:	R. Dial
Drawn:	M. Sullivan
Projection:	MGA50 GDA94
Plan ID:	5227-LSP-04-B

Cadastre supplied by LANDGATE

APPENDIX 2

Development Traffic Management Plans



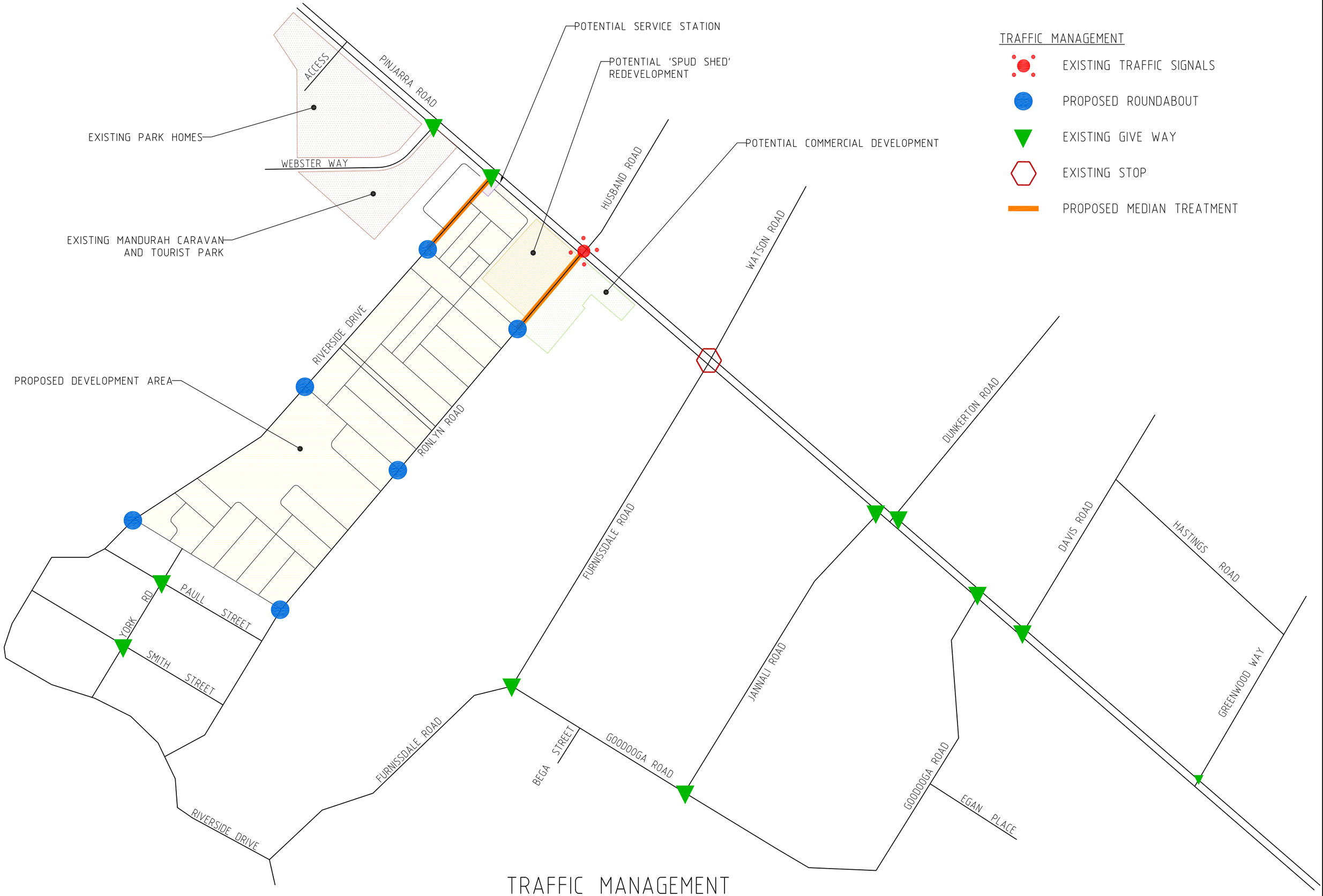
PEDESTRIAN AND CYCLE PATHS

N.T.S.



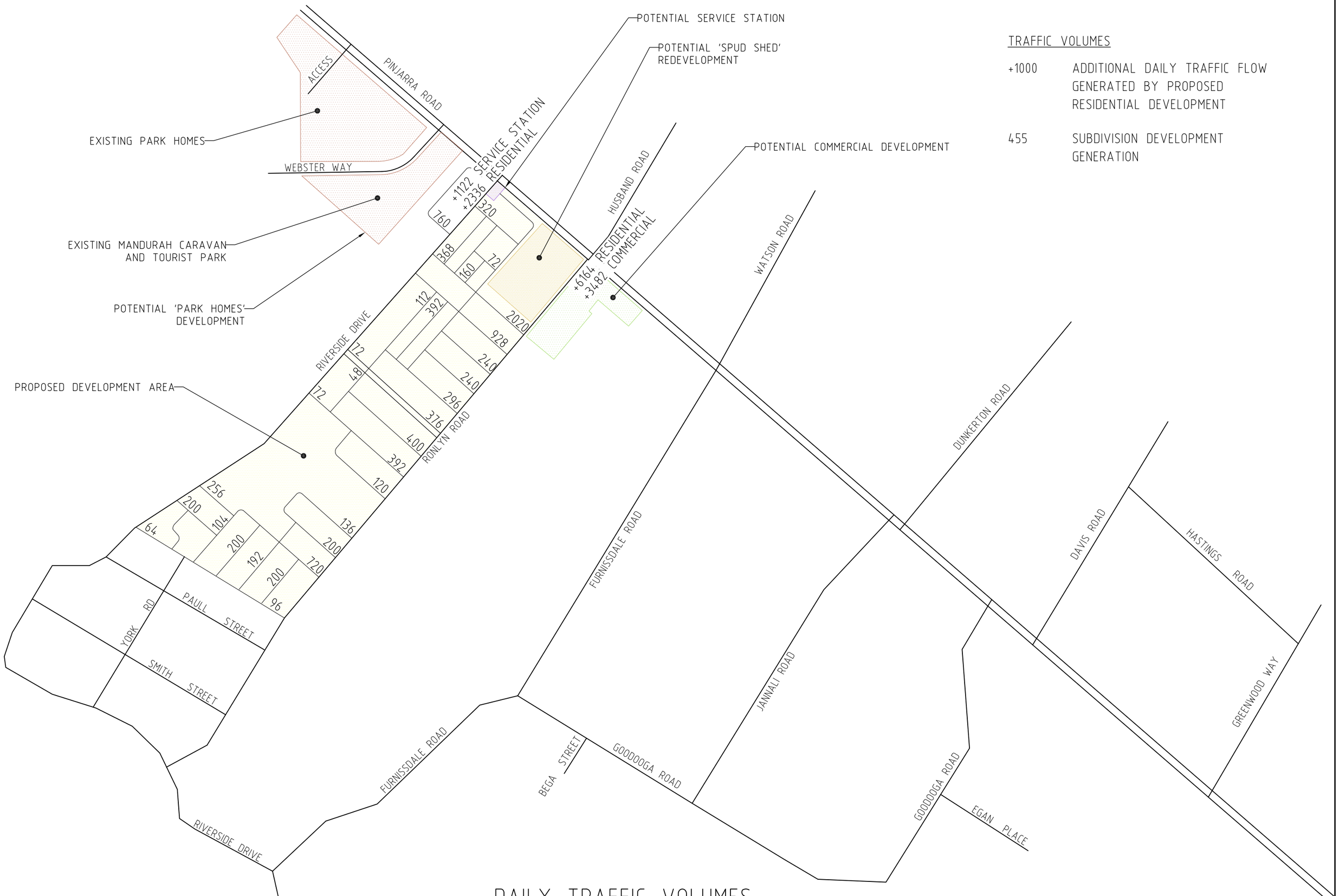
ROAD HIERARCHY

N.T.S.



TRAFFIC MANAGEMENT

N.T.S.



DAILY TRAFFIC VOLUMES

N.T.S.

APPENDIX 7

NOISE REPORT

ROWEGROUP

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ROWE GROUP

FURNISSDALE DEVELOPMENT

RIVERSIDE DRIVE AND RONLYN ROAD

ACOUSTIC ASSESSMENT

MAY 2014

OUR REFERENCE: 17783-2-14080

DOCUMENT CONTROL PAGE

ACOUSTIC ASSESSMENT

RIVERSIDE DRIVE AND RONLYN ROAD

Job No: 14080

Document Reference : 17783-2-14080

FOR

ROWE GROUP

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Author:	**Geoffrey Harris**	**Checked By:**	**Paul Daly**
Date of Issue :	**7 May 2014**		

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Revision	Description	Date	Author	Checked
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B	Noise Contours – No Noise Control
C	Noise Contours – 2.4m High Wall/Bund
D	Quiet House' Design
E	Quiet House' Design – Package B

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Rowe Group to carry out an acoustical assessment of noise received at the proposed residential development located on Riverside Drive and Ronlyn Road, Furnissdale. The subject area is located to the South of Pinjarra Drive, along Riverside Drive and Ronlyn Road. As part of the study, the following was carried out:

- Determine by noise modelling the noise that would be received at residences within the development from vehicles travelling on Pinjarra Road.
- Assess the predicted noise levels for compliance with the appropriate criteria.
- If exceedances are predicted, investigate possible noise amelioration options for compliance with the appropriate criteria.

2. SUMMARY

The noise modelling indicates that noise received within the proposed sub-division (with the inclusion of a 2.4m wall) from vehicles travelling along the Pinjarra Road could exceed the Western Australian Planning Commission (WAPC) State Planning Policy 5.4 "Road and Rail Transport Noise And Freight Considerations In Land Use Planning" 'day time' "Limit" criteria by up to 3 dB(A) and exceed the "Target" by 8 dB(A). Therefore, 'Quiet House' design construction techniques would be required to be implemented for the row of houses adjacent to the road to achieve acceptable internal noise levels.

Under the planning policy it is recommended that the residence located adjacent to a major road, such as Pinjarra Road, be designed so internal noise levels do not exceed an $L_{Aeq(Night)}$ of 35 dB(A) in a bedroom or an $L_{Aeq(Day)}$ 40 dB(A) in a living space. Outdoor entertainment areas should be designed or located , as practicable, such that they comply with an L_{Aeq} noise level during the night period of 50 dB(A).

To achieve the required internal noise level, 'Quiet House Package B' design is to be incorporated into the first row of residence located adjacent to Pinjarra Road. More information on 'Quiet House' design is provided in Appendix D and E.

For the residences located adjacent to Pinjarra Road (within the $L_{Aeq(Day)}$ 60 dB(A) contour (see Appendix C)), under the Policy, that notification of vehicle noise are to be stated on the titles.

It is noted that it is likely that residences located adjacent to Pinjarra Road will have a personal privacy wall and if this wall is 2.4m in height it will suffice.

If no noise wall is appropriate for the development, further quiet house design will have to be taken under consideration during the subdivision stage.

3. CRITERIA

3.1 WAPC PLANNING POLICY

The Western Australian Planning Commission (WAPC) released on 22 September 2009 State Planning Policy 5.4 "Road and Rail Transport Noise and Freight Considerations In Land Use Planning". Section 5.3 – Noise Criteria, which outlines the acoustic criteria, states:

"5.3 - Noise Criteria

Table 1 sets out the outdoor noise criteria that apply to proposals for new noise-sensitive development or new major roads and railways assessed under this policy.

These criteria do not apply to—

- *proposals for redevelopment of existing major roads or railways, which are dealt with by a separate approach as described in section 5.4.1; and*
- *proposals for new freight handling facilities, for which a separate approach is described in section 5.4.2.*

The outdoor noise criteria set out in Table 1 apply to the emission of road and rail transport noise as received at a noise-sensitive land use. These noise levels apply at the following locations—

- *for new road or rail infrastructure proposals, at 1 m from the most exposed, habitable façade of the building receiving the noise, at ground floor level only; and*
- *for new noise-sensitive development proposals, at 1 m from the most exposed, habitable façade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.*

Further information is provided in the guidelines.

TABLE 1 - OUTDOOR NOISE CRITERIA

Time of day	*Noise Target*	*Noise Limit*
Day (6 am–10 pm)	$L_{Aeq(Day)}$ *= 55 dB(A)*	$L_{Aeq(Day)}$ *= 60 dB(A)*
Night (10 pm–6 am)	$L_{Aeq(Night)}$ *= 50 dB(A)*	$L_{Aeq(Night)}$ *= 55 dB(A)*

The 5 dB difference between the outdoor noise target and the outdoor noise limit, as prescribed in Table 1, represents an acceptable margin for compliance. In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin. In relation to Greenfield sites, however, there is an expectation that the design of the proposal will be consistent with the target ultimately being achieved.

Because the range of noise amelioration measures available for implementation is dependent upon the type of proposal being considered, the application of the noise criteria will vary slightly for each different type. Policy interpretation of the criteria for each type of proposal is outlined in sections 5.3.1 and 5.3.2.

The noise criteria were developed after consideration of road and rail transport noise criteria in Australia and overseas, and after a series of case studies to assess whether the levels were practicable. The noise criteria take into account the considerable body of research into the effects of noise on humans, particularly community annoyance, sleep disturbance, long-term effects on cardiovascular health, effects on children's learning performance, and impacts on vulnerable groups such as children and the elderly. Reference is made to the World Health Organization (WHO) recommendations for noise policies in their publications on community noise and the Night Noise Guidelines for Europe. See the policy guidelines for suggested further reading.

5.3.1 Interpretation and application for noise-sensitive development proposals

In the application of these outdoor noise criteria to new noise-sensitive developments, the objective of this policy is to achieve –

- *acceptable indoor noise levels in noise-sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and*
- *a reasonable degree of acoustic amenity in at least one outdoor living area on each residential lot[1].*

If a noise-sensitive development takes place in an area where outdoor noise levels will meet the noise target, no further measures are required under this policy.

In areas where the noise target is likely to be exceeded, but noise levels are likely to be within the 5dB margin, mitigation measures should be implemented by the developer with a view to achieving the target levels in a least one outdoor living area on each residential lot[1]. Where indoor spaces are planned to be facing any outdoor area in the margin, noise mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply measures detailed in the guidelines.

In areas where the outdoor noise limit is likely to be exceeded (i.e. above $L_{Aeq(Day)}$ of 60 dB(A) or $L_{Aeq(Night)}$ of 55 dB(A)), a detailed noise assessment in accordance with the guidelines should be undertaken by the developer. Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin. Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces, as specified in the following paragraphs.

For residential buildings, acceptable indoor noise levels are $L_{Aeq(Day)}$ of 40 dB(A) in living and work areas and $L_{Aeq(Night)}$ of 35 dB(A) in bedrooms[2]. For all other noise-sensitive buildings, acceptable indoor noise levels under this policy comprise noise levels that meet the recommended design sound levels in Table 1 of Australian Standard AS 2107:2000 Acoustics—Recommended design sound levels and reverberation times for building interiors.

1 For non residential noise-sensitive developments, (e.g. schools and child care centres) consideration should be given to providing a suitable outdoor area that achieves the noise target, where this is appropriate to the type of use.
2 For residential buildings, indoor noise levels are not set for utility spaces such as bathrooms. This policy encourages effective 'Quiet House' design, which positions these non-sensitive spaces to shield the more sensitive spaces from transport noise (see guidelines for further information).

These requirements also apply in the case of new noise-sensitive developments in the vicinity of a major transport corridor where there is no existing railway or major road (bearing in mind the policy's 15-20 year planning horizon). In these instances, the developer should engage in dialogue with the relevant infrastructure provider to develop a noise management plan to ascertain individual responsibilities, cost sharing arrangements and construction time frame.

If the policy objectives for noise-sensitive developments are not achievable, best practicable measures should be implemented, having regard to section 5.8 and the guidelines."

The Policy, under Section 5.7, also provides the following information regarding "Notifications on Titles" :

"5.7 - Notification on title

If the measures outlined previously cannot practicably achieve the target noise levels for new noise-sensitive developments, this should be notified on the certificate of title.

Notifications on certificates of title and/or advice to prospective purchasers advising of the potential for noise impacts from major road and rail corridors can be effective in warning people who are sensitive to the potential impacts of transport noise. Such advice can also bring to the attention of prospective developers the need to reduce the impact of noise through sensitive design and construction of buildings and the location of outdoor living areas.

The notification is to ensure that prospective purchasers are advised of –

- *the potential for transport noise impacts; and*
- *the potential for quiet house design requirements to minimise noise intrusion through house layout and noise insulation (see the guidelines).*

Notification should be provided to prospective purchasers and be required as a condition of subdivision (including strata subdivision) for the purposes of noise-sensitive development as well as planning approval involving noise-sensitive development, where noise levels are forecast or estimated to exceed the target outdoor noise criteria, regardless of proposed noise attenuation measures. The requirement for notification as a condition of subdivision and the land area over which the notification requirement applies, should be identified in the noise management plan in accordance with the guidelines.

An example of a standard form of wording for notifications is presented in the guidelines."

4. MEASUREMENTS AND OBSERVATIONS

Noise logging was conducted in the vicinity of the site over a continuous six day period commencing Tuesday 8th April 2014 to determine the existing traffic noise levels on the site. Noise monitoring was conducted on Lot 150 Pinjarra Road approximately 16m from the road edge.

The logger used was an Rion NL22 statistical noise data logger. The Noise Logger was calibrated prior to and after use with a Bruel and Kjaer 4230 Calibrator. All equipment used is currently factory calibrated. Calibration certificates are available on request.

TABLE 4.1: SUMMARY OF MEASURED NOISE LEVELS

Logger Location	Measured Noise Level, dB(A)		
	$L_{A10\ (18\ hour)}$	$L_{Aeq,\ day\ (6am\ to\ 10pm)}$	$L_{Aeq,\ night\ (10pm\ to\ 6am)}$
Pinjarra Road (10m)	67.9	65.5	59.9

5. MODELLING

To determine the noise levels from Pinjarra Road, acoustic modelling was carried out using SoundPlan Version 7.2, using the Calculation of Road Traffic Noise (CoRTN)[3] algorithms.

The input data for the model included:

- Topographical and cadastral data supplied by client (Shown in Figure 1);
- Traffic data supplied by MRWA, as listed in Table 5.1;
- Adjustments as listed in Table 5.2; and
- A 2.4m wall on the lots adjacent to Pinjarra Road.

TABLE 5.1 - NOISE MODELLING INPUT DATA

Parameter	Pinjarra Road (Current)	Pinjarra Road (2031)
Traffic Volumes	~22,600 vpd	31700 vpd
Percentage traffic 0600 – 2400 hours (Assumed)	94%	94%
Heavy Vehicles (%) (Assumed)	7.9%	7.9%
Speed (km/hr)	80	80
Road Surface	Dense Graded Asphalt	Dense Graded Asphalt

3 *Calculation of Road Traffic Noise* UK Department of Transport 1987

TABLE 5.2 – ADJUSTMENTS FOR NOISE MODELLING

Description	Value
Façade Reflection Adjustment	+2.5 dB
Conversion from $L_{A10\ (18\ hour)}$ to $L_{Aeq\ (16\ hour)}$ (Day)*	-2.4 dB
Conversion from $L_{A10\ (18\ hour)}$ to $L_{Aeq\ (8\ hour)}$ (Night)*	-8.0 dB

* As per previously listed monitoring results in Table 4.1.

Base on the above parameters, 2 scenarios were modelled :

- Scenario 1 – Future traffic flows, no noise control.
- Scenario 2 – Future traffic flows with a 2,4m wall included at the development façade.

Note : Various other scenarios were modelled for different wall heights but for simplicity, only results for the 2.4m wall have been included as this was the optimal height.

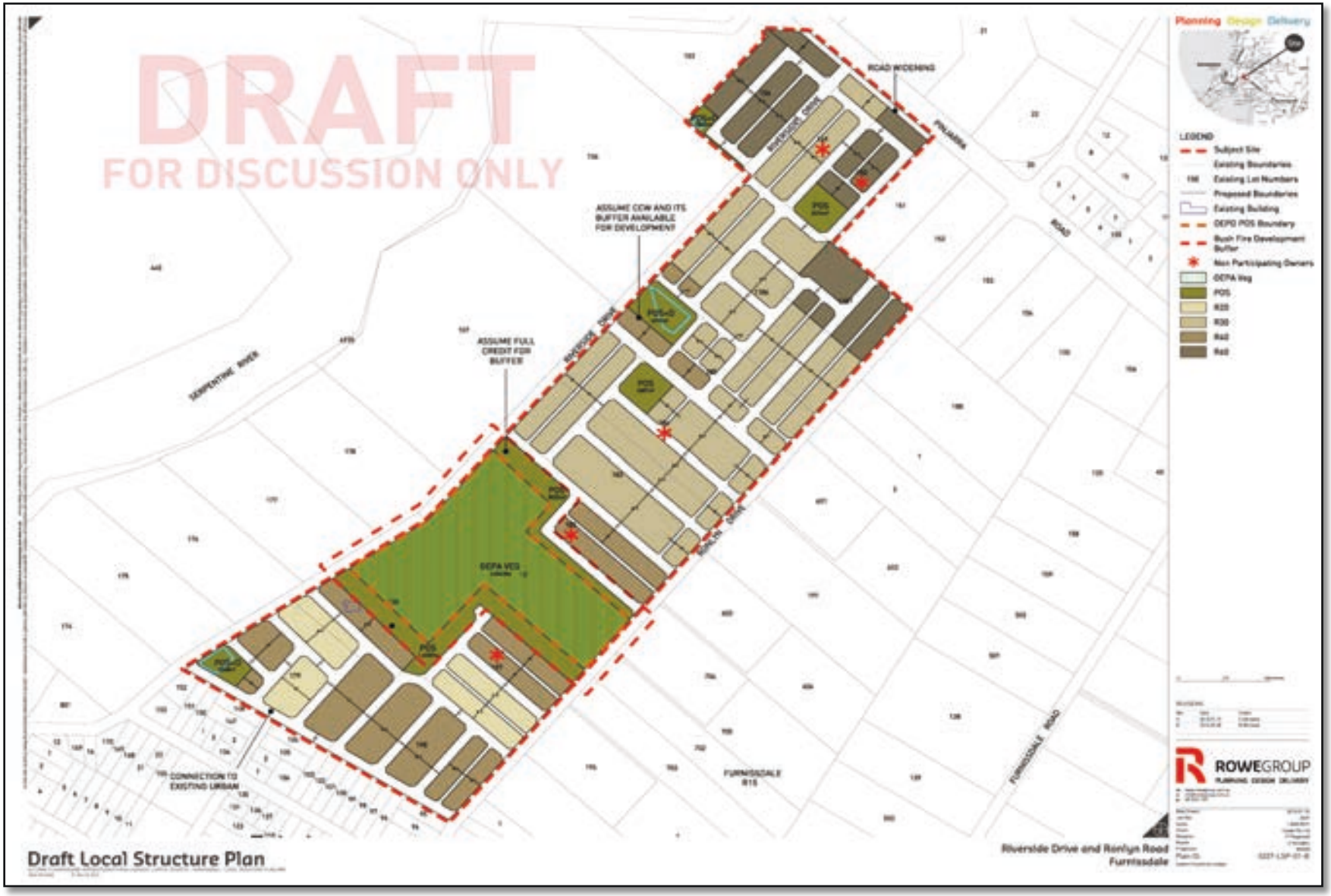


Figure 1 – Sub-Division Layout Plan

6. TRAFFIC NOISE ASSESSMENT

Using the data contained in Table 5.1, modelling was carried out under existing conditions for calibration. The SoundPlan model for the site has been set up for the 2031 scenario as defined in Table 5.1. The following assumptions have been made:

- 18 hour traffic count will be 94% of daily figures;
- The same diurnal relationship will exist in the future between the $L_{A10\ (18\ hour)}$ and the L_{Aeq} parameters; and
- 2.5 dB(A) has been added to the results for façade reflection.

The noise criteria set by MRWA and WAPC are stated in terms of the L_{Aeq} (6am to 10pm) and the L_{Aeq} (10pm to 6am). The CoRTN algorithms do not predict these parameters. As such, the empirical offsets between the $L_{A10\ (18\ hour)}$ and the L_{Aeq} values presented in Table 3.2 have been used to determine the values as follows:

$L_{Aeq\ day}$ (6am to 10pm) = $L_{A10\ (18hour)}$ – 2.1 dB(A)

$L_{Aeq\ night}$ (10pm to 6am) = $L_{A10\ (18hour)}$ – 7.7 dB(A)

The following tabulation presents the results of the noise modelling to the closest residences, for receiver locations refer to Figure A1 of Appendix A.

TABLE 6.1 – PREDICTED TRAFFIC NOISE LEVELS AT CLOSEST RESIDENCES

Receiver Number	Predicted Noise Level, $L_{Aeq\ night\ (8\ hour)}$, dB(A)	
	No Noise Control (Without Wall)	With Noise Control (With 2.4m Wall)
Lot A	71	63
Lot B	71	63
Lot C	71	63

Noise level contour plots for 2031 traffic flows have been produced and are presented in Appendices B and C.

7. DISCUSSION / RECOMMENDATION

Under the WAPC State Planning Policy 5.4, the Noise Limits as listed in Table 1 are the appropriate noise levels for this development. From the noise monitoring results presented in Table 4.1, there is a difference of 5.6 dB(A) between the $L_{Aeq(16hr)}$ and the $L_{Aeq(8hr)}$. Therefore, if compliance with the day period noise limit is achieved, then compliance with the night period noise limits would also be achieved.

The policy states that the outdoor criteria applies to the ground floor level only, however, it also states that noise mitigation measures should be implemented with a view to achieving the target levels in least one outdoor living area.

For residential premises, the Policy states that residence should be designed to meet the following acceptable internal noise levels:

Living and Work Areas	$L_{Aeq(Day)}$ of 40 dB(A)
Bedrooms	$L_{Aeq(Night)}$ of 35 dB(A)

Additionally, it is recommended that noise mitigation measures be implemented as far as practicable so that at least one outdoor living area complies with the Target Noise Level of an $L_{Aeq(Night)}$ of 50 dB(A).

The noise modelling indicates that noise received within the proposed development from vehicles travelling along Pinjarra Road could exceed the day period "Noise Limits" as outlined in the Western Australian Planning Commission (WAPC) State Policy 5.4 by up to 11 dB(A) without any noise control.

With the introduction of a 2.4m wall along the proposed Development (Pinjarra Road) noise levels are reduced to 63 dB(A) for the day period, which is still above the noise Limit (by 3 dB(A)).

Residences located adjacent to Pinjarra Road require consideration so that internal noise levels do not exceed an $L_{Aeq(Night)}$ of 35 dB(A) in a bedroom or an $L_{Aeq(Day)}$ 40 dB(A) in a living space. Additionally an outdoor entertainment area should be designed or located (opposite the side of the house facing the wall) such that they comply with an L_{Aeq} noise level during the night period of 50 dB(A). To achieve the required internal noise level, 'Quiet House' design be incorporated for the residences located adjacent to Pinjarra Road. More information regarding 'Quiet House' design is provided in Appendix D.

For the first row of residences located adjacent to the Pinjarra Road (within the $L_{Aeq(Day)}$ 60 dB(A) contour as shown in Appendix C), as required under the Policy, in addition to the "Quiet House" design, notifications of vehicle noise are to be stated on the titles.

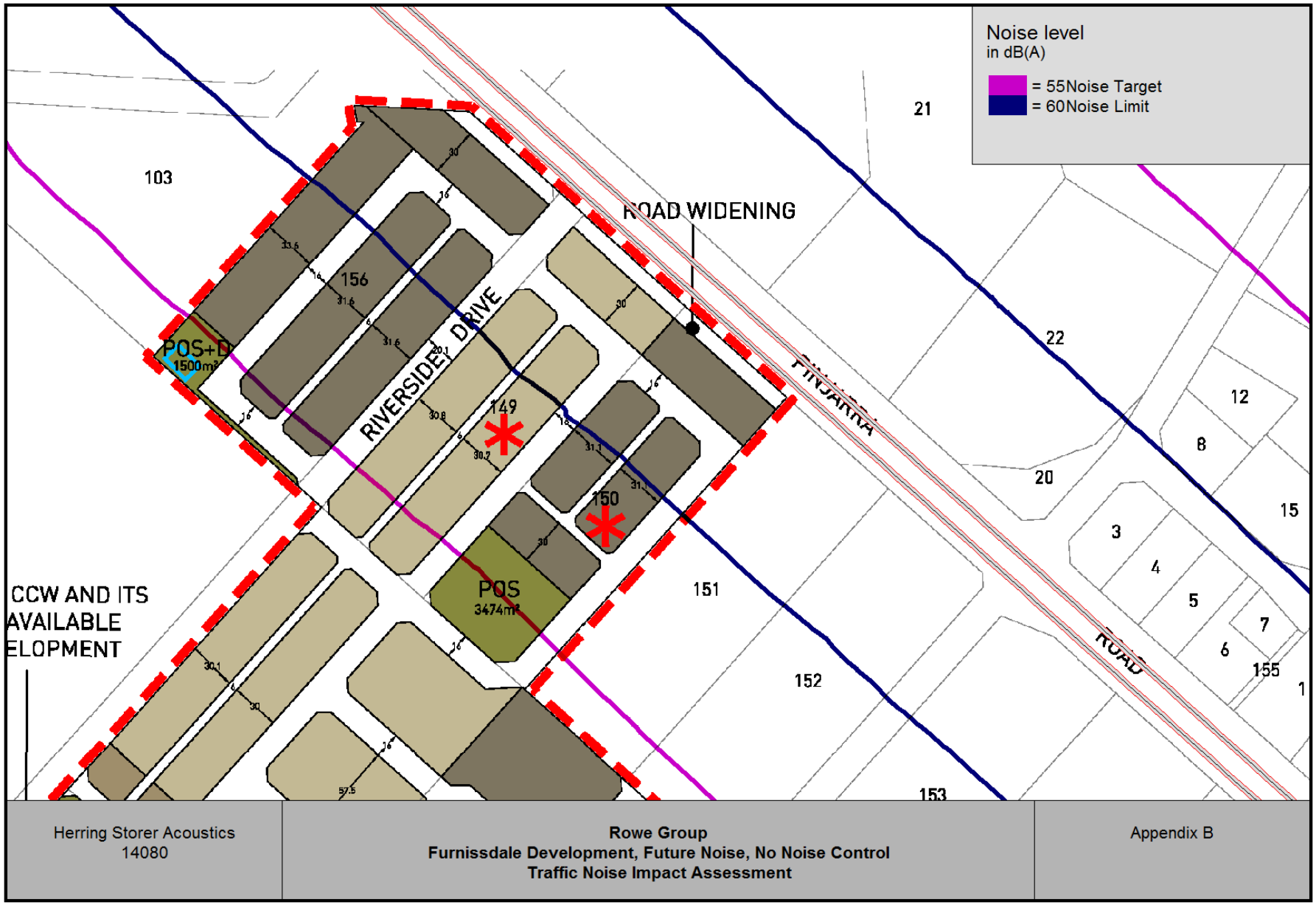
APPENDIX A

RECEIVER LOCATIONS


DRAFT
FOR DISCUSSION ONLY
Rec A
Rec B
Rec C
ROAD WIDENING
ASSUME FULL CREDIT FOR BUFFER
CONNECTION TO EXISTING URBAN
FURNISSDALE
Draft Local Structure Plan
Riverside Drive and Renlyn Road
Furnissdale
ROWEGROUP

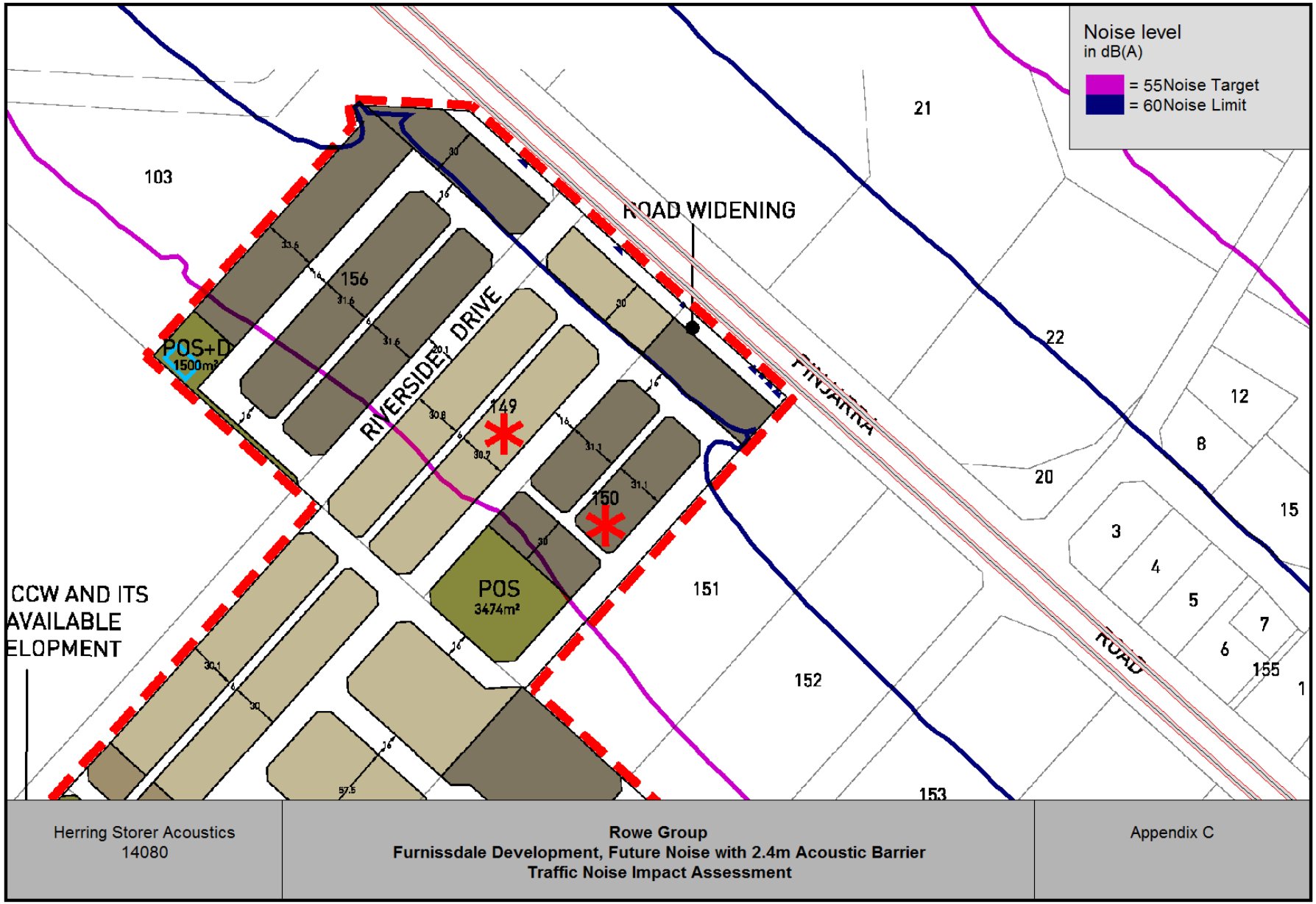
APPENDIX B

NOISE CONTOURS – NO NOISE CONTROL


Noise level
in dB(A)
= 55Noise Target
= 60Noise Limit
ROAD WIDENING
RIVERSIDE DRIVE
POS+D
1500m²
POS
3474m²
149
150
151
152
153
156
103
21
22
20
12
8
15
3
4
5
7
6
155
1
CCW AND ITS
AVAILABLE
ELOPMENT
ROAD
Herring Storer Acoustics
14080
Rowe Group
Furnissdale Development, Future Noise, No Noise Control
Traffic Noise Impact Assessment
Appendix B

APPENDIX C

NOISE CONTOURS – 2.4m HIGH WALL/BUND


Noise level
in dB(A)
= 55Noise Target
= 60Noise Limit
ROAD WIDENING
RIVERSIDE DRIVE
POS+D
1500m²
POS
3474m²
149
150
151
152
153
156
103
21
22
20
12
8
15
3
4
5
7
6
155
1
CCW AND ITS
AVAILABLE
ELOPMENT
ROAD
Herring Storer Acoustics
14080
Rowe Group
Furnissdale Development, Future Noise with 2.4m Acoustic Barrier
Traffic Noise Impact Assessment
Appendix C

APPENDIX D

‘QUIET HOUSE’ DESIGN

Treatment to houses in the form of double glazing, door seals and roof / ceiling treatment can give reductions of up to 10 dB(A) over and above that of closed windows. However, this requires that one is inside with the windows shut and often necessitates the use of mechanical ventilation or air conditioning. Also, such reductions tend to reduce mid to high frequency noise leaving the sometimes more annoying low frequency noise.

The following provides some techniques that can be incorporated in >Quiet House= designs:-

- Locating bedrooms on opposite side of residence from road.
- Locating of laundries / bathrooms on same side of road.
- Protecting main entrance from road noise.
- Enclosing eaves.
- Roof insulation.
- Use of thicker glazing, with casement windows using winders.
- Double brick construction.

Australian Standard AS 2021-1994 “Acoustics - Aircraft noise intrusion - Building siting and construction” can also provide guidance on construction requirements for various maximum noise levels.

The barriers should be solid in nature, with no gaps. However, their construction can range from a close timber or compressed cement sheet fence to a masonry wall. Landscaped earth bunds could also be used in this instance.

Some specific building guidelines to satisfy the quiet house design requirements includes:

- Double brick or tilt up concrete construction.

- Casement windows in timber or commercial steel frames and compressible seals (windows visible from Pinjarra Road only).

- First floor glazing to bedrooms to be 10.38mm thick laminated glass. Other glazing on side(s) of residence visible from Pinjarra Road to be minimum of 6.38mm laminated glass to bedrooms and 6mm float glass to living spaces.

- Eaves to be enclosed using 6mm thick compressed cement sheeting or equivalent.

- Sliding doors are only acceptable on the face, which is on the opposite side to the road.

- Roofs to be colourbond (or equivalent) with 50mm anticon, with ceilings on top floor to be one layer of 13mm plasterboard and 50mm thick (minimum 32 kg/m3) insulation laid over the top.

- No recessed light fittings allowed in bedroom ceilings (on top storey).

Additionally, residences are to be designed to achieve an L_{Aeq} of 50 dB(A) at outdoor living areas, by either the layout / orientation of the residence and / or construction of fencing.

Note: An acceptable solution to the top storey is to allow lofts. These spaces can have higher noise levels, and so long as the floor is concrete and there is a door to the loft then noise would be acceptable.

Notifications of vehicle traffic noise and the above requirements are to be placed on titles.

For these residences, designs are to be checked by an acoustical consultant with a report stating that the construction adequately attenuates noise emissions from passing vehicles on Pinjarra Road and based on an external L_{Aeq} of 55 dB(A), to achieve an internal L_{Aeq} of 35 dB(A) within bedrooms and 40 dB(A) within living spaces.

For the residences closest to Pinjarra Road the suggested wording for the notification of vehicle traffic is:

> *"This property is situated in proximity to Pinjarra Road and therefore may be effected by vehicle noise. Information about measures to insulate against noise is available on request from the developer".*

The above building criteria are for the first row of residences closest to Pinjarra Road, as these residences will provide the barrier to the residences behind.

APPENDIX E

'QUIET HOUSE' DESIGN
Package B

QUIET HOUSE DESIGN PACKAGES

AREA TYPE	ORIENTATION	PACKAGE A	PACKAGE B
Bedrooms	Facing Road	Casement or awning windows with 6.38mm laminated glass Eaves enclosed with 6mm compressed fibre cement board Hinged doors only, fitted with acoustic seals No vents to outside walls/eaves	Casement or awning windows with 10.38mm or 6.5mm laminated glass Eaves enclosed with 6mm compressed fibre cement board No external doors No vents to outside walls/eaves
	Side-on to Road	Casement or awning windows with 6.38mm laminated glass Eaves enclosed with 6mm compressed fibre cement board No vents to outside walls/eaves	Casement or awning windows with 6.38mm laminated glass Eaves enclosed with 6mm compressed fibre cement board No vents to outside walls/eaves
	Away from Road	No Requirements	No Requirements
Living and Work Areas	Facing Road	Casement or awning windows with 6.38mm laminated glass Eaves enclosed with 6mm compressed fibre cement board 35mm (min) solid core external doors with acoustic seals Sliding doors to be fitted with acoustic seals and have overlapping meeting stiles No vents to outside walls/eaves	Casement or awning windows with 10.38mm or 6.5mm laminated glass Eaves enclosed with 6mm compressed fibre cement board No vents to outside walls/eaves Sliding doors to be fitted with acoustic seals and have overlapping meeting stiles Front door to be 40mm solid core with acoustic seals
	Side-on to Road	Casement or awning windows with 6mm glass Eaves enclosed with 6mm compressed fibre cement board	Casement or awning windows with 6.38mm laminated glass Eaves enclosed with 6mm compressed fibre cement board
	Away from Road	No Requirements	No Requirements
Other indoor areas	Any orientation	No Requirement	No Requirements

Note : Package B+ is as for Package B but with reduced window areas (Maximum of $2m^2$) for bedroom windows facing Stock Road.

APPENDIX 8

ENGINEERING REPORT

ROWEGROUP

FURNISSDALE OUTLINE DEVELOPMENT PLAN

INFRASTRUCTURE

Report Prepared For:

COODE PTY LTD

Report Prepared By:

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Job No: 13-06-068
Date: 4/09/2013
Our Ref: R43.13
Rev: A
Checked:



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- 3.5 Telecommunications 2
- 3.6 Gas 3
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Figure 1 – Outline Development Plan
Figure 2 – Existing Services Plan
Figure 3 – Water Corporation Conceptual Planning
Figure 4 – Indicative Bulk Earthworks Plan
Figure 5 – Indicative Servicing Plan

Appendix – References

1.0 INTRODUCTION

Coode Pty Ltd commissioned Porter Consulting Engineers to identify and advise on infrastructure required to service the land encompassed by the Furnissdale Outline Development Plan. Porter Consulting Engineers are part of the design team assembled to inform an overall Structure Plan for the area. Zoning and landuse is being reviewed by the Rowe Group; water management and surface geology by Hyd20; traffic and transport also by Porter Consulting Engineers.

This report examines the existing services within the area, identifies the capacity of those services and any upgrading works required to enable development of the intended land use.

2.0 BACKGROUND REVIEW

In undertaking the investigation of services, the Outline Development Plan shown in Figure 1 has been the guide for the extent of development and the likely land use. Reference has been made to the following:

- Peel Region Scheme Amendment 034/57 Furnissdale (West) Urban Expansion.
- Shire of Murray advice in relation to the proposed Scheme Amendment 283 for the Furnissdale Barragup Business Precinct which is incorporated within the Outline Development Plan.
- Previous servicing investigations by BPA Engineering in 2011 and Porter Consulting Engineers in 2008.

In order to obtain up to date information, the service agencies responsible for infrastructure within the area were contacted in July 2013 and requested to provide information identifying their existing infrastructure and network capacities. Responses received from those Authorities form the basis of the comment on infrastructure requirements.

3.0 EXISTING INFRASTRUCTURE

3.1 Roads

Pinjarra Road, which bisects the northern section of the precinct, is classified as a Primary Regional Road and is under the care and control of Main Roads WA. It is currently configured as a four lane divided carriageway within a generally 40m wide road reserve.

Traffic signals have been recently constructed at the Pinjarra Road/Ronlyn Road/Husband Road intersection.

The intersection with Furnissdale Road and Watson Drive is a four way sign controlled junction with right turn pockets on Pinjarra Road.

The intersection with Riverside Drive is a signal controlled T-junction with right turn entry pocket on Pinjarra Road and a U-turn pocket on the eastern approach.

Riverside Drive, Ronlyn Road and Furnissdale Road are:

- all local roads constructed to a sealed but un-kerbed standard;
- provide direct lot access; and
- provide entry to the Furnissdale residential area at the southern end of the Structure Plan area.

3.2 Sewer

No gravity sewer exists in the area.

There is a pressure main (Culleenup Road Pressure Main) which is located in the southern verge of Pinjarra Road. This conveys effluent in a westerly direction and services development east of the Site.

There is a vacuum sewage system at the Furnissdale townsite south of the area, serviced by a vacuum pump station. The Water Corporation has indicated they have no intention to extend this system further to the north to Pinjarra Road.

3.3 Water

A 700mm diameter and 450mm diameter water trunk main exists along the northern verge of Pinjarra Road. A 200mm diameter water main extends from these large mains across Pinjarra Road along Furnissdale Road to a pressure reducing valve at the southern corner of Lot 157. A 150mm diameter water main exists in the mid section of Riverside Road, a 100mm diameter increasing to a 200mm diameter main in Ronlyn Road and a 200m diameter main in Furnissdale Road.

3.4 Power

Western Power distribution infrastructure in the area comprises of three phase 22kV high voltage aerial power lines along Pinjarra Road. The Pinjarra Road feed originates from the Western Power 132kV/22kV Mandurah sub-station near Mandurah Road. There are a number of smaller 63kVA, 100kVA and 200kVA pole top transformers in the vicinity providing aerial feeds to adjacent properties.

3.5 Telecommunications

A telecommunication cable network exists in the area with both Telstra local and optic fibre cables in the vicinity.

3.6 Gas

There is no gas infrastructure currently in the area.

3.7 Drainage

Drainage in the area is by on-site retention and soakage.

There is limited drainage infrastructure at road intersections and this conveys water to verges for direct infiltration.

The local roads are unkerbed with direct run-off to verge swales.

The local drainage follows natural depressions and discharges to the north west towards the Serpentine River. Where local roads cross the natural valley lines, the flow is transferred by piped culverts.

3.8 Services Plan

The existing services are shown in Figure 2.

4.0 INFRASTRUCTURE CAPACITY AND UPGRADING

4.1 General

The advice received from the respective infrastructure authorities and the local authority is based on the current planning expectation for the area. The authorities were provided with the Outline Development Plan and have made their comments on that basis.

4.2 Roads

Pinjarra Road is the main transport route through the area. It is planned to widen the Pinjarra Road reserve by 10m either side to a 60m nominal width in order to accommodate an ultimate configuration of six lane divided carriageway. The timing of the construction of these additional lanes depends on growth in traffic volumes. Typically the additional lanes would not be required until traffic volumes reached at least 40,000 vehicles per day.

Traffic signals that have recently been constructed at the Pinjarra Road/Ronlyn Road/Husband Road intersection are likely to be repeated at the Pinjarra Road/Furnissdale Road/Watson Drive intersection. The forecast traffic volumes for the area will require multiple vehicular access points in order to distribute traffic and reduce the volume on any individual access point.

Main Roads WA will insist upon a control of access along Pinjarra Road frontage and at least 30m down each connecting road.

The local roads that will form part of the connector road network, being Ronlyn Road, Riverside Drive, Furnissdale Road, and a proposed north-south connector, will be expected to be constructed as two lane/two way roads with facilities for on-road parking and limited access to adjacent development.

The section of Ronlyn Road in the vicinity of the commercial precinct is likely to be developed in a main street style with main street planning principles to be applied. These roads may be 10m wide roads with a central at-grade median with additional tree planting.

The intersection control at four way junctions on the primary network are expected to be roundabout controlled with four way intersections on local roads having a priority control through combination of signing and pavement texture.

4.3 Sewer

The Water Corporation has advised that the area is within the Barragup Planning and it is proposed to install gravity sewers feeding to a new pump station on Ronlyn Road. The most recent conveyance planning is shown on the attached Figure 2. Servicing of this general area will require a new pump station (Barragup Pump Station C) roughly located on the northern side, mid way along Barragup Road.

The ultimate pump station at this point connects to a suite of projects including a type 90 sewer pump station with an initial duty of 40l/second approximately 850m of DN250 pressure main, 450m of DN375 gravity sewer, 300m^3 of emergency storage.

Any proposal for smaller, temporary pump stations, and alternative pump station locations or staging options need to be considered by the Water Corporation Infrastructure Planning Branch, and may require some further review.

There have been proposals for a temporary pumping station to service the commercial precinct located on Ronlyn Road south side, just west of Pinjarra Road.

A portion of the ODP area overlaps with the catchment of the existing permanent Vacuum Pump Station (VPS) on Ronlyn Road (PS '1'). This is currently the only permanent Pump Station (PS) in the Sewer District. This VPS has a limited capacity and has not been designed to take any out of catchment flows. The flow into the VPS is presently conveyed to the Gordon Road WWTP via a temporary pressure main heading west via the Beacham Street PS and onward through other pump station catchments. The flows to the VPS will eventually be redirected to discharge via a short length of pressure main into the ultimate DN300 gravity sewer along Ronlyn Road heading to the future PS'C'.

The actual capacity of the VPS has not yet been determined due to some differences between design, build and operation. The VPS currently serves approximately 200 lots in the Furnissdale townsite. The pump station will require further analysis to determine if it is large enough to take the design flows shown in our long term planning. An upgrade of the VPS may be required by around 2020-2025 depending on the rate of development of vacant land in its limited catchment.

Current planning indicates that the flow diversion pressure main to the future DN300 gravity sewer in Ronlyn Road will likely be required when/if the pumps are upgraded at the VPS, or the capacity of its present downstream discharge point (the Beacham Street PS) is exceeded.

4.4 Water

The area is situated within the Corporation's Yunderup Pressure Reduction Valve (PRV) Water Supply zone.

Water supply to this Yunderup-Furnissdale-Barragup area is currently via a system of PRV's off the large distribution mains along Pinjarra Rd – DN700 and DN460.

Supply to the proposed Furnissdale urban development area will need to be via reticulation-sized mains DN200, DN250 with smaller retic as needed. Retic. layout to be worked up in consultation with the Corporation's Land Servicing Branch when adopted LSP and spatial staging information becomes available.

The Corporation's long-term planning for the Pinjarra and Mandurah areas is currently under review. Among other things, this planning will decide whether the Yunderup PRV zone continues to be served from the Stirling Trunk main, or from a future Pinjarra scarp tank to the east, or from the north-west via the Mandurah tanks and distribution system.

4.5 Power

Western Power has indicated that they have made arrangements for a new terminal and sub-station land purchase in Furnissdale. This is a strategic acquisition for a potential zoned sub-station to meet anticipated future load growth in the Furnissdale area. They have also indicated that a recent upgrade to the Meadow Springs Sub-station distribution feeder will increase supply capacity to the South Metro 22kV area, which includes Furnissdale.

Western Power has indicated there are no voltage instability issues forecast to arise in the Mandurah load area over the next five or so years.

Western Power has a network mapping facility which uses anticipated development data provided by the Western Australian Planning Commission and can be used to predict the load availability over time. The network mapping indicates that there is 5MVA capacity in the network at the moment with this increasing to 15MVA capacity over five years and in 20 years back to 5MVA capacity after development.

The current demand for residential development is typically around 4.7kVa per lot and it could be expected that the ODP area would create a load of 12.2MVA.

Western Power typically will cater for increase demand in accordance with the planning predictions for the area.

4.6 Telecommunications

The National Broadband Network Company (NBN Co.) will provide optic fibre for the new development. This will replace the local Telstra copper network. NBN Co. will review the ODP and advise if any land is required for hub facilities.

4.7 Gas

AtcoGas propose to install a 225mm PE high pressure gas main along Pinjarra Road. AtcoGas will review the ODP and advise further if any upgrades are required. At this stage, it is expected that gas could be reticulated from the high pressure main into the ODP area.

4.8 Drainage

The Shire of Murray requires the road network within the development area to be kerbed and drained. Due to the higher water table it is likely that much of the drainage will be shallow swale related drainage, or shallow pipe systems feeding to the local natural drainage system.

The Local Water Management Strategy will identify the primary drainage routes. The Shire will adopt water sensitive urban design principles and require stormwater to be managed as high in the catchment as possible. The Department of Water require developments to manage the 1 year 1 hour storm event (about the first 10mm of rainfall) within their respective sites.

Prior to discharging of any stormwater to the natural system, water quality improvement initiatives will be required. These may be structural separator pits if there is insufficient land, but a natural approach employing rain gardens and filtration will be preferred.

The intent of the design will be to preserve the natural watercourses where possible, protect the topographic lows, minimise the pipe drainage network and maximise use of the natural surface drainage elements of the site.

The Shire of Murray will require the drainage for the base road network to be designed for at least the 1 in 5 year average recurrence interval (ARI) storms, with treatment and detention areas to manage the 1 in 10 year ARI storms and overland flow paths defined and protected to manage the 1 in 100 year ARI storms.

An integral part of the drainage network will involve filling or earth-working much of the site. Filling may be required to improve site classification for structural purposes, to reduce the amount of swell or shrink in the soil or to provide an appropriate separation between the maximum groundwater and buildings.

Currently, the average annual maximum groundwater level varies from 1m AHD to 1.5m AHD across the site and the surface level varies from 2m AHD to 4m AHD. The drainage requirements will seek to have 0.5m clearance between the 100 year storage level in any retention or detention basins and 0.3m above the 100 year flood level in local drainage networks.

The maintenance of the clearance can be achieved by introducing sub-soil drains or importing fill. The issue with sub-soil drains is that there may be further treatment required if the groundwater is acidic or has legacy nutrients that require treating before being discharged to the local waterways.

At this stage it is likely that the site will require filling to at least 3.5m AHD in the eastern section to about 3m AHD in the southern section. This suggests in the order of 1m of fill in the western part of the site tapering to 0.5m of fill near the centre and zero in the eastern part.

4.9 Indicative Servicing

An indicative servicing plan is shown in Figure 5.

FIGURE 1
Outline Development Plan

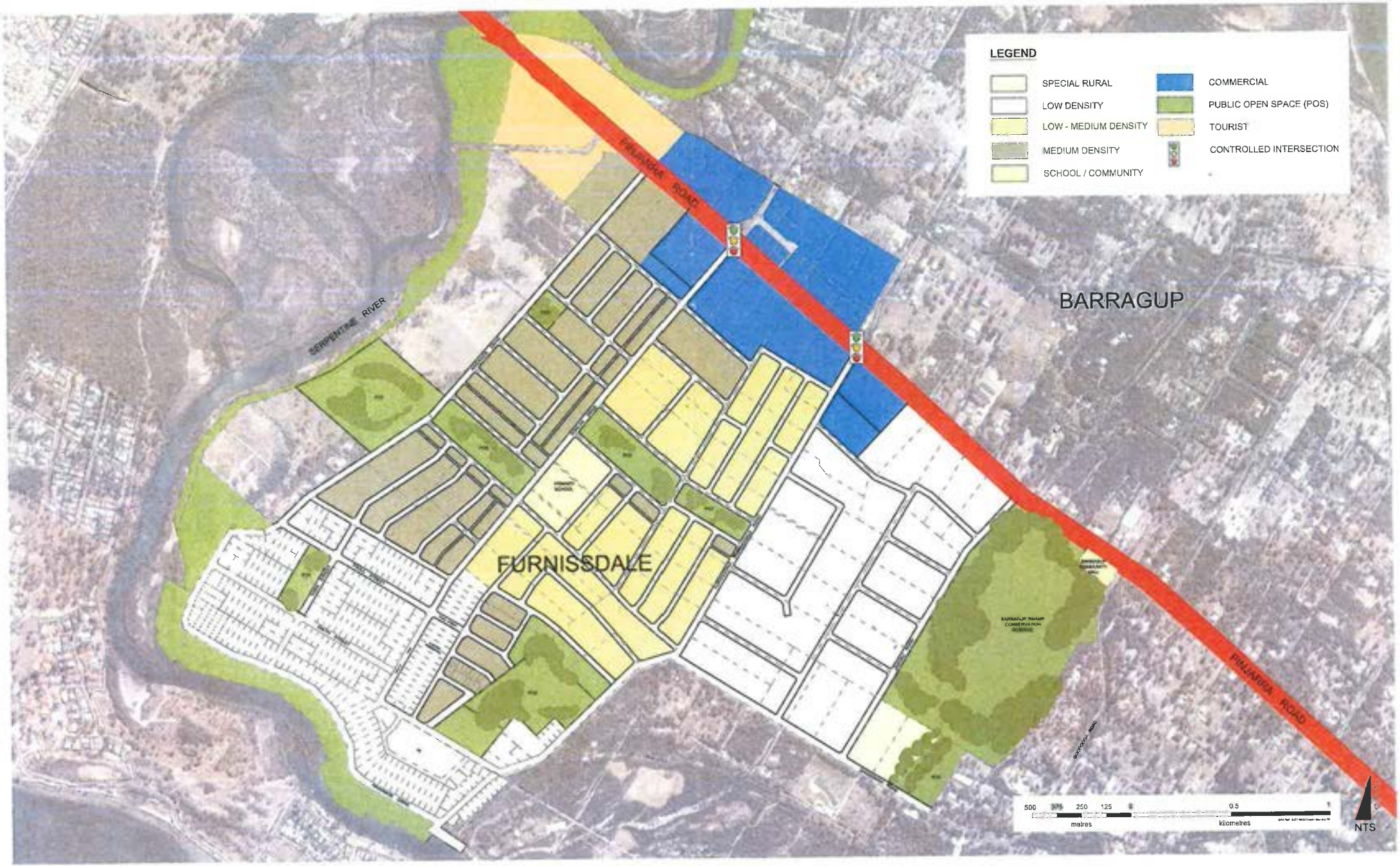
LEGEND
SPECIAL RURAL
LOW DENSITY
LOW - MEDIUM DENSITY
MEDIUM DENSITY
SCHOOL / COMMUNITY
COMMERCIAL
PUBLIC OPEN SPACE (POS)
TOURIST
CONTROLLED INTERSECTION
PINJARRA ROAD
SERPENTINE RIVER
BARRAGUP
FURNISSDALE
PINJARRA ROAD
500
250
125
0.5
metres
kilometres
NTS

FIGURE 2
Existing Services Plan

LEGEND

- EXISTING GROUND CONTOUR
- EXISTING GAS LINE
- EXISTING SEWER PIPE
- EXISTING SEWER PRESSURE MAIN
- EXISTING TELSTRA CABLE
- EXISTING WATER MAIN
- EXISTING HIGH VOLTAGE UNDERGROUND POWER LINE
- EXISTING HIGH VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE UNDERGROUND POWER LINE
- EXISTING OVERHEAD POWER LINE
- EXISTING UNDERGROUND POWER LINE
- EXISTING DRAINAGE LINE
- EXISTING OPTUS
- EXISTING NEXTGEN

WEBSTER WAY
HUSSAND
DOUGLAS PL
RIVERSIDE
BONLYN RD
BINJARRA RD
WATSON DR
WATSON DR
FURNISSDALE RD
FURNISSDALE RD

MATCH LINE 13-6-68/3

PROJECT

WEST FURNISSDALE PRECINCT
FURNISSDALE

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CLIENT

COODE PTY LTD

DRAWING

EXISTING SERVICES PLAN
SHEET 1 OF 2

STATUS **FOR APPROVAL**

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DATE	SEPT 2013
DESIGN	DEP
DRAWN	MEB
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DRAWING No.	13-6-68/2
REV No.	A
PAPER SIZE	A1
FILE NAME	S:\ACTIVE PROJECTS\13-6-68\13E68-2.dwg
APPD	

MATCH LINE 13-6-68/3

RIVERSIDE DR

RIVERSIDE

SMITH

YORK RD

PAVEL

RONELYN

FURNISSDALE RD

GOOOOOGA RD

BERTRAM

LEGEND

- EXISTING GROUND CONTOUR
- EXISTING GAS LINE
- EXISTING SEWER PIPE
- EXISTING SEWER PRESSURE MAIN
- EXISTING TELSTRA CABLE
- EXISTING WATER MAIN
- EXISTING HIGH VOLTAGE UNDERGROUND POWER LINE
- EXISTING HIGH VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE OVERHEAD POWER LINE
- EXISTING LOW VOLTAGE UNDERGROUND POWER LINE
- EXISTING OVERHEAD POWER LINE
- EXISTING UNDERGROUND POWER LINE
- EXISTING DRAINAGE LINE
- EXISTING OPTUS
- EXISTING NEXTGEN

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DRAWING

EXISTING SERVICES PLAN
SHEET 2 OF 2

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DATE	SEPT 2013
DESIGN	DEP
DRAWN	MEB
CHECK	

DRAWING No. **13-6-68/3** | A | A1

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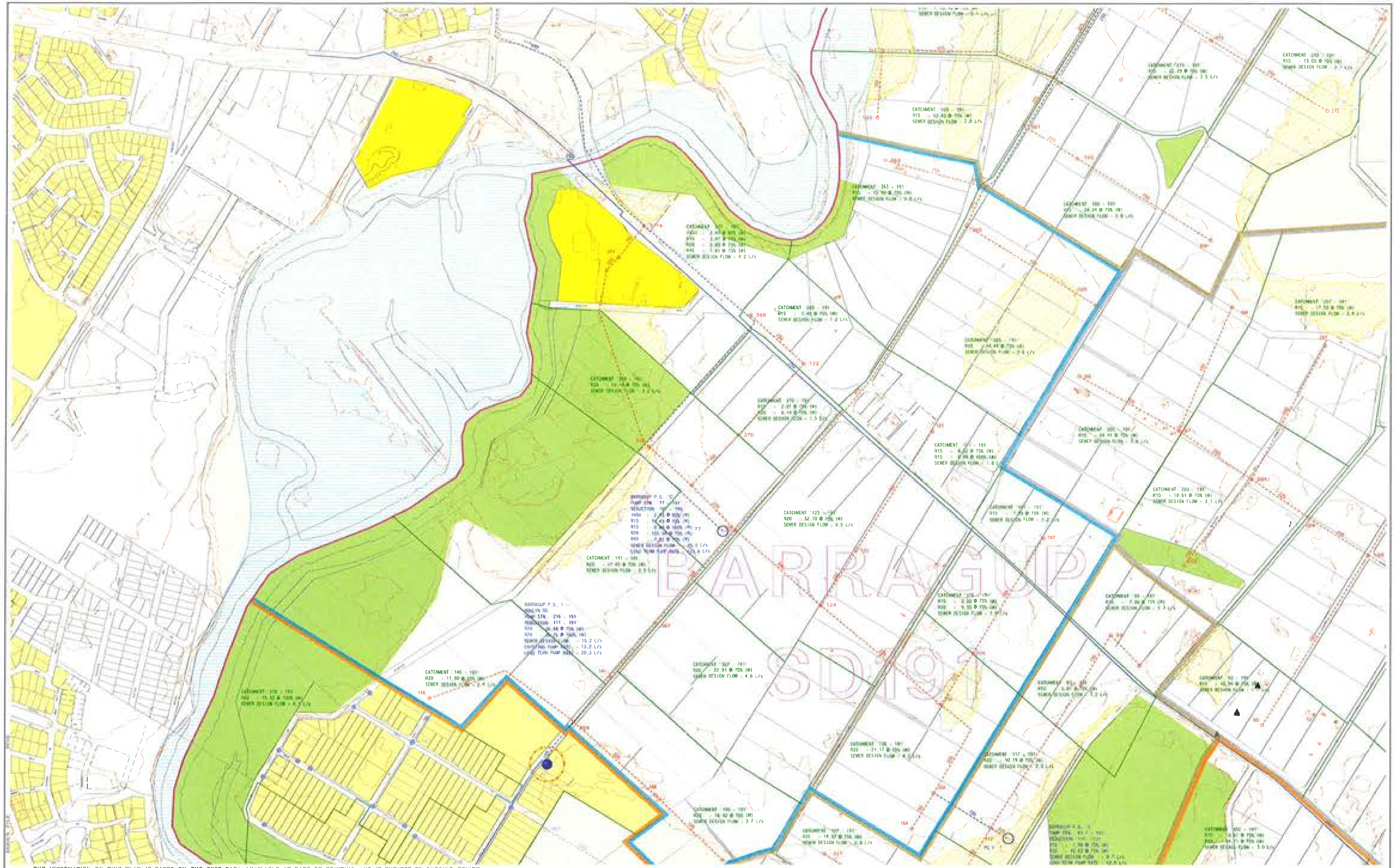
FIGURE 3
Water Corporation Conceptual Planning



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LEGEND

- EXISTING PUMPING STATION
- EXISTING PRESSURE MAIN
- EXISTING GRAVITY SEWER
- PROPOSED PUMPING STATION
- PROPOSED PRESSURE MAIN
- PROPOSED GRAVITY SEWER
- PARKS AND PUBLIC OPEN SPACE
- EXISTING SEWERED AREAS
- SEWERED BY PRIVATE PS
- NODE CATCHMENT
- PS AND SEWER CATCHMENTS
- SEWER DISTRICT CATCHMENT
- WWTP CATCHMENT
- FLOODWAY/FLOOD FRINGE
- FLOOD PLAIN
- CUT/FILL

NOTATION

SEWER DISTRICT NUMBER
CATCHMENT NODE
CATCHMENT 7001 - 121
R15 108 4 @75% (W)
GROSS AREA (ha)
'R' CODE ZONING
% OF LAND DEVELOPMENT
(W) - WET CONDITIONS
(D) - DRY CONDITIONS

SEWER DESIGN FLOW = 1 5 x AVERAGE DAILY FLOW RATE

SHEET INDEX

WATER CORPORATION
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TELEPHONE (08) 9420 2420 FAX (08) 9420 3179

WASTEWATER SCHEME PLANNING SERIES

BARRAGUP - SD191
CONCEPTUAL PLANNING
LONG TERM SCHEME: SHEET 2 OF 4

R NICHOLSON	L GABRIEL	T ZHENG
1 5000	28 JUNE 2012	0806 - 01

A1

FIGURE 4
Indicative Bulk Earthworks Plan



LEGEND

- 2.0 EXISTING GROUND CONTOURS
- 1.75 GROUND WATER LEVEL CONTOURS
- 1.75 PROPOSED BULK EARTHWORK LEVELS
- 3.00 PROPOSED FILL LEVELS

100 0 100 200 300 400 500 600 700 m

SCALE 1:10000

PROJECT
WEST FURNISSDALE PRECINCT
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B 16-9-2013 PRELIMINARY PLAN FOR APPROVAL MJV
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BULK EARTHWORK CONCEPT

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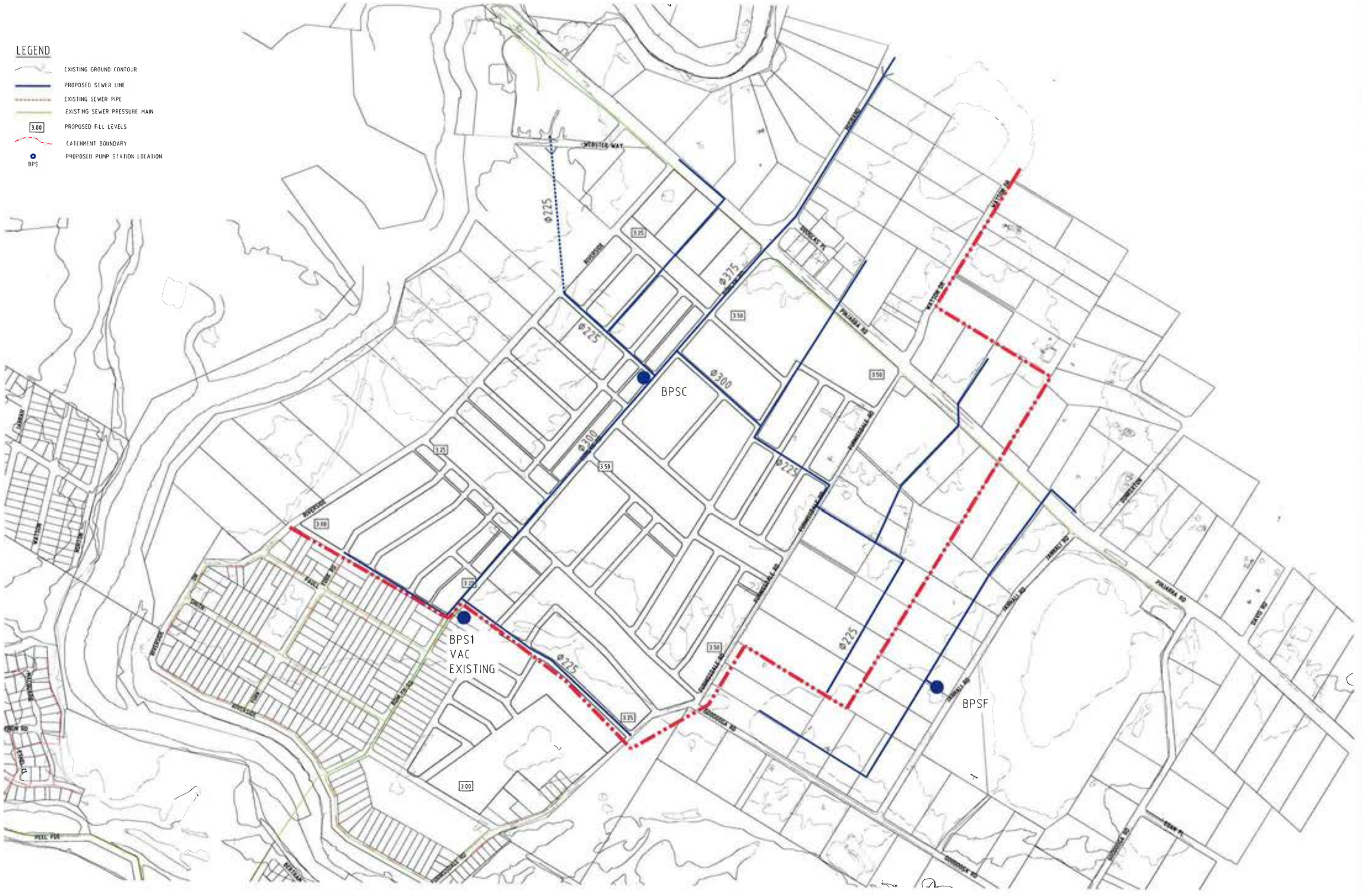
DRAWN	MJV	FILE NAME	S:\ACTIVE PROJECTS\13-06-068\13668-1.dwg
CHECK		APPD	

FIGURE 5
Indicative Servicing Plan

LEGEND

- EXISTING GROUND CONTOUR
- PROPOSED SEWER LINE
- EXISTING SEWER PIPE
- EXISTING SEWER PRESSURE MAIN
- 3.00 PROPOSED FILL LEVELS
- CATCHMENT BOUNDARY
- BPS PROPOSED PUMP STATION LOCATION



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LEGEND

EXISTING GROUND CONTOUR

PROPOSED WATER LINE

EXISTING WATER PIPE

WEBSTER WAY

RIVERSIDE

RONLYN RD

HUSBAND

DOUGLAS PL

PINJARRA RD

WATSON DR

FURNISSDALE RD

150

150

200

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APPENDIX

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APPENDIX 9

LANDSCAPE MASTER PLAN

ROWEGROUP

PUBLIC OPEN SPACE SUMMARY

1 POS 1
- INFORMAL ACTIVE OPEN SPACE / KICKABOUT PLAY AREA
- SHELTERED SEATING

2 POS 2
- PREDOMINANTLY DRAINAGE BASIN
- > 1:100 YEAR ARI TO SPILL TO CCW AT SOUTH WEST

3 POS 3
- PREDOMINANTLY DRAINAGE BASIN
- >1:5 YEAR ARI TO SPILL TO ADJACENT CCW
- LARGE STAND OF RIVER REDGUM TREES TO BE RETAINED IF POSSIBLE

4 POS 4
- CCW BUFFER
- PREDOMINANTLY REVEGETATED
- CONSERVATION FENCING
- ACCESS PATH
- BUFFER POS TO TAKE UP LEVEL DIFFERENCE BETWEEN CCW AND ADJACENT LOT LEVEL

5 POS 5
- INFORMAL ACTIVE OPEN SPACE / KICKABOUT
- SEATING NODES
- SMALL NATURE PLAY NODE

6 POS 6
- OEPA VEGETATION ZONE BUFFER
- PARKLAND INTERFACE
- ACCESS PATHS
- TURF POCKETS
- SEATING NODES

7 POS 7
- OEPA PROTECTION ZONE BUFFER
- PARKLAND INTERFACE
- ACCESS PATHS
- TURF POCKETS
- SEATING NODES

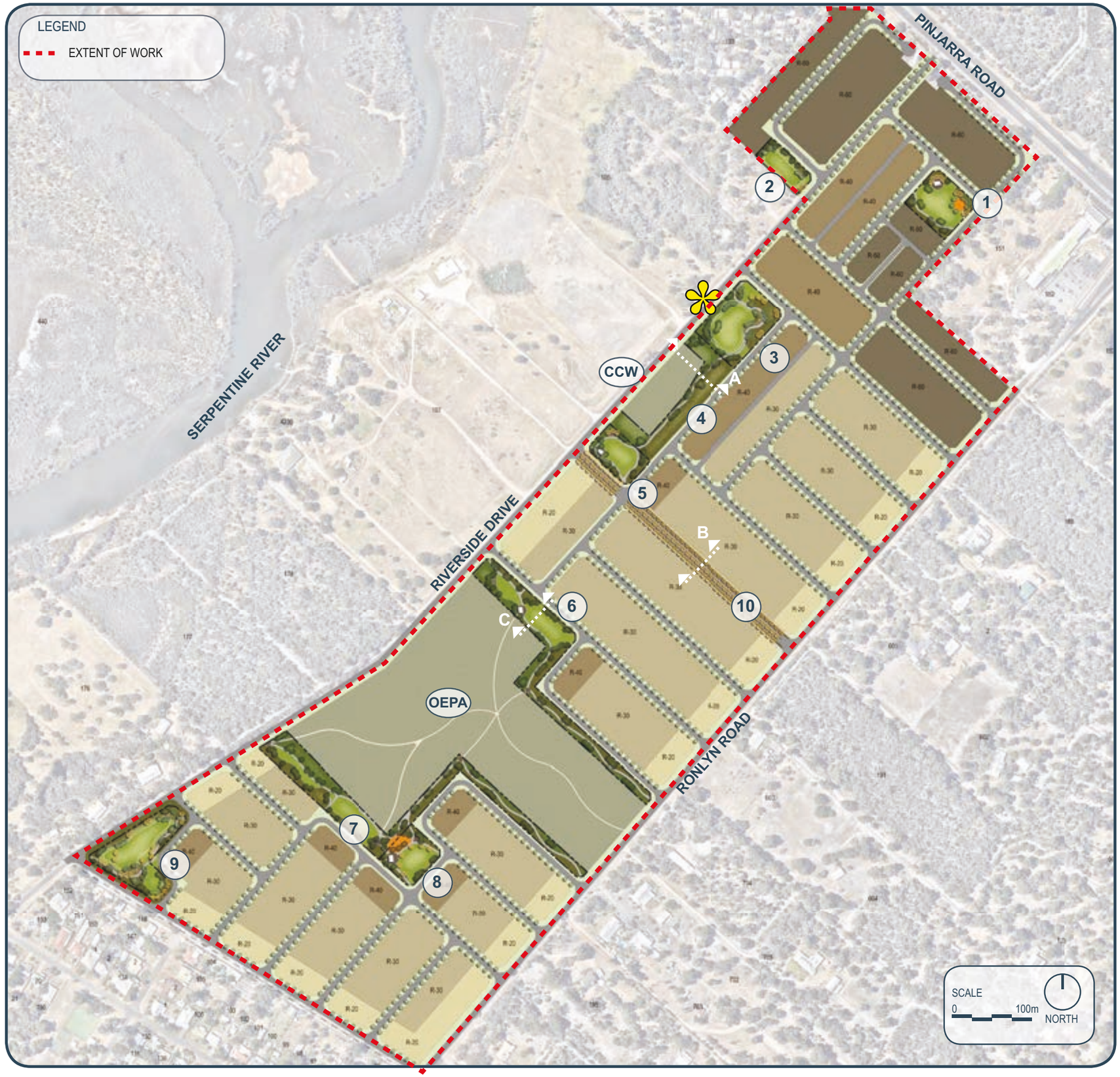
8 POS 8
- INFORMAL ACTIVE OPEN SPACE / KICKABOUT
- NATURE PLAYGROUND
- SHELTERED SEATING NODES

9 POS 9
- PREDOMINANTLY DRAINAGE BASIN

10 BOULEVARD
- 20M WIDE ROAD RESERVE
- FLUSH MEDIAN (3M) WITH TREES

CCW CCW ZONE
- REHABILITATION WORKS AS REQUIRED

OEPA OEPA PROTECTION ZONE
- CONSERVATION FENCING TO PERIMETER
- INFORMAL TRAIL CONNECTIONS WHERE POSSIBLE WITHOUT DISTURBANCE TO EXISTING VEGETATION



FURNISSDALE LANDSCAPE MASTER PLAN

AUGUST 2015 : REV B

emerge ASSOCIATES Integrated Science & Design

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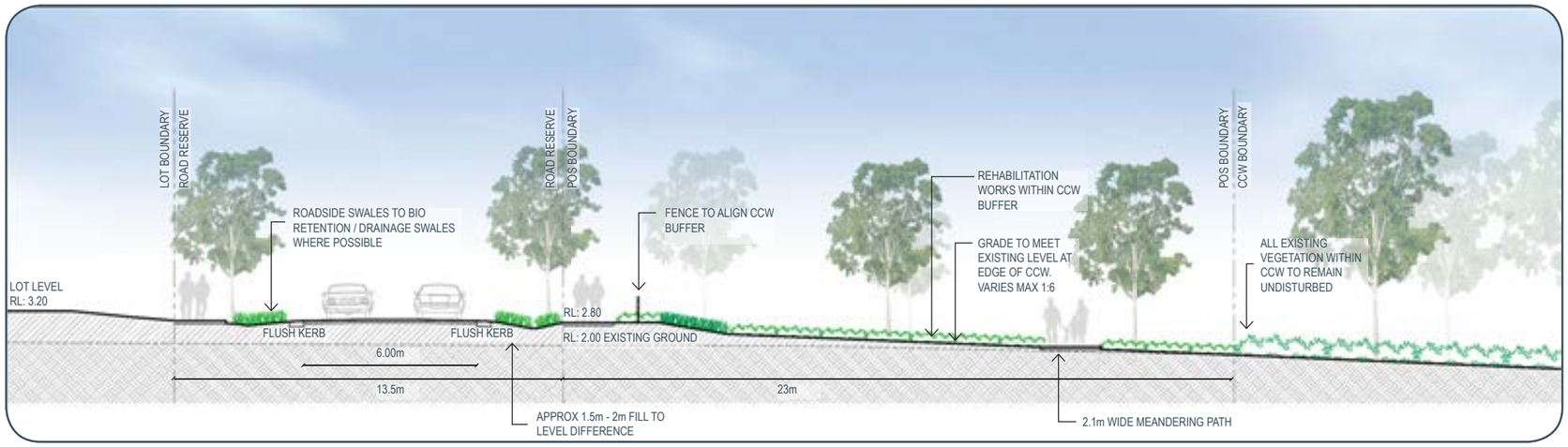
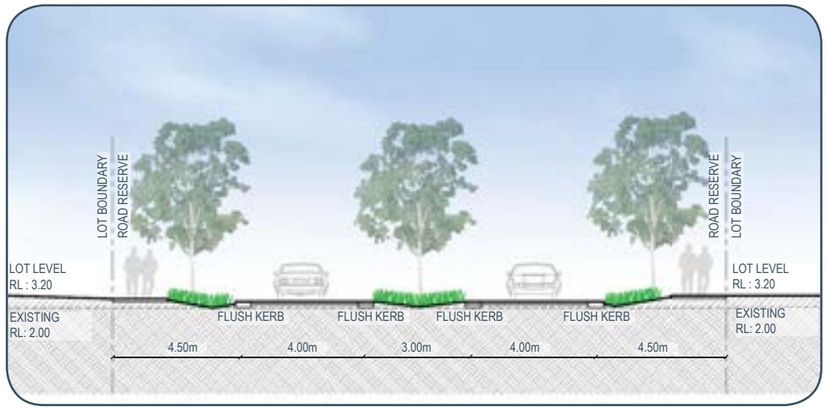
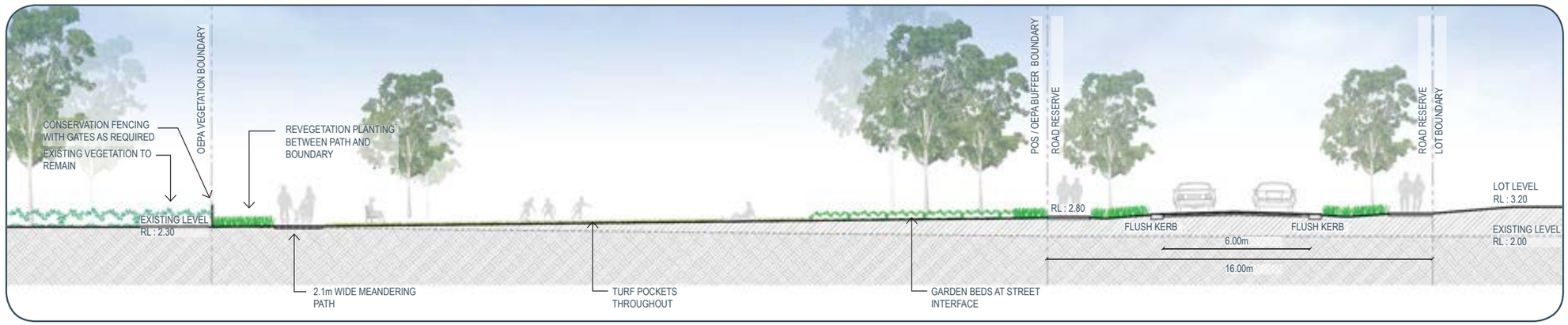


SECTION A - POS 4 (CCW BUFFER)



SECTION B - ENTRY BOULEVARD



SECTION C - POS 6 (OEPA BUFFER)

SCALE: 1:200 @ A3
0 5m

FURNISSDALE LANDSCAPE SECTIONS

AUGUST 2015 : REV B

emerge ASSOCIATES Integrated Science & Design

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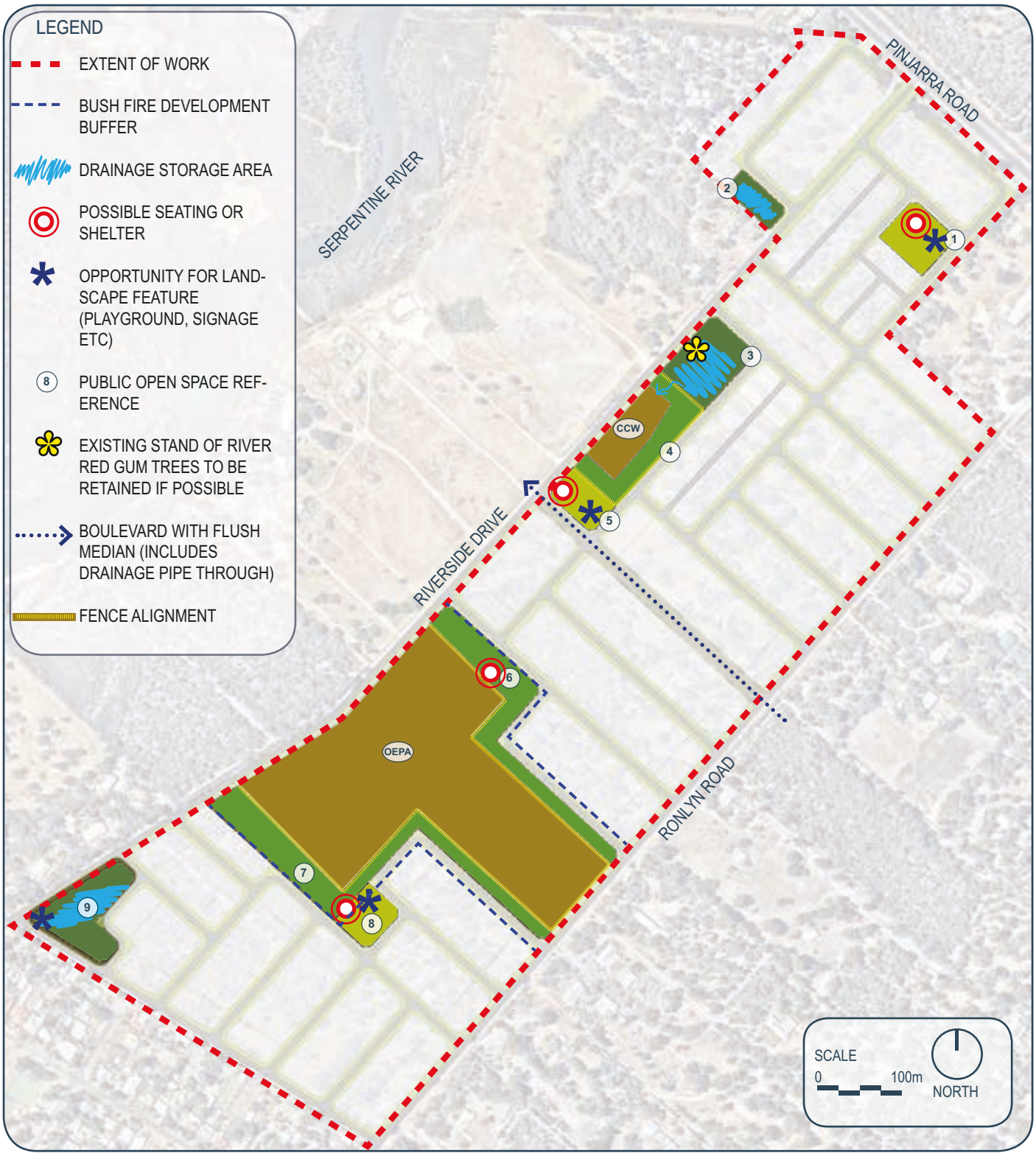
LANDSCAPE STRATEGY PLAN



PUBLIC OPEN SPACE SUMMARY

LOCAL PARK (POS 1,5,8)
- Informal active open space / kickabout areas
- Predominantly native planted areas with Pockets of turf
- Small gathering nodes and basic picnic facilities with shade structures and nature play opportunities
- Path network / connectivity
- Primary focus on passive recreation
- Fully irrigated

DRAINAGE BASIN (POS 2,3,9)
- Predominantly native planted areas with turf / planted basin
- Retention of existing signif cant trees where possible
- Drainage retention within basin
- Informal active recreation uses on open grasses areas

CCW BUFFER (POS 4)
- Predominantly rehabilitated / re-vegetated
- Conservation fencing to boundary
- Access path / Connectivity through
- Buffer to take up level difference between existing and adjacent lots

OEPA BUFFER (POS 6,7)
- Predominantly native planting with linear turf pockets
- Fence to OEPA boundary
- Access paths / Connectivity through
- limestone access paths connect through OEPA
- Seating nodes and small nature play opportunities

*OEPA and CCW areas to remain protected / rehabilitated where required

FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

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LANDSCAPE MASTER PLAN

LEGEND

- EXTENT OF WORK
- (8) PUBLIC OPEN SPACE REFERENCE
- EXISTING STAND OF RIVER RED GUM TREES TO BE RETAINED IF POSSIBLE

PINJARRA ROAD

SERPENTINE RIVER

RIVERSIDE DRIVE

RONLYN ROAD

OEPA

SCALE 0 100m

NORTH



CONSIDERED



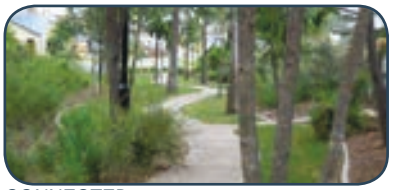
HOMELY



COMFORTABLE



INTERACTIVE



CONNECTED



PRACTICAL

FURNISSDALE LANDSCAPE STRUCTURE PLAN

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STREET TREE MASTER PLAN





Corymbia ficifolia - Red Flowering Gum



Eucalyptus marginata - Jarrah



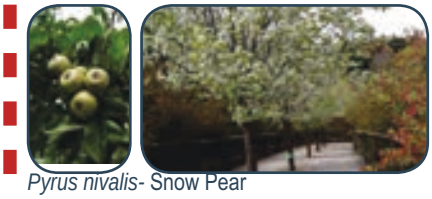
Agonis flexuosa - WA Peppermint



Corymbia calophylla - Marri



Eucalyptus sideroxylon - Red Ironbark



Pyrus nivalis- Snow Pear

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POS TREE PLANTING PALETTE





Eucalyptus Sideroxylon



Xanthorrhoea preisii



Eucalyptus marginata



Eucalyptus leucoxylon rosea



Corymbia ficifolia



Melaleuca preissiana



Melaleuca quinquinervia



Agonis flexuosa



Platanus acerifolia



Ulmus parvifolia



Eucalyptus rudis



Corymbia calophylla

FURNISSDALE LANDSCAPE STRUCTURE PLAN
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POS 1, 5, 8 CONCEPT

POS TYPOLOGY
- Local Parks

SIZE
- POS 1 - 4,007 m2
- POS 5 - 2,869 m2
- POS 8 - 3,183.67 m2

CONCEPT
- Provide a series of POS primarily focussed on passive recreation with pockets of turf and feature nodes at key locations
- Sheltered seating and BBQ facilities
- Provide seating nooks along path networks
- Predominantly native planted garden beds
- Nature based play areas with informal seating

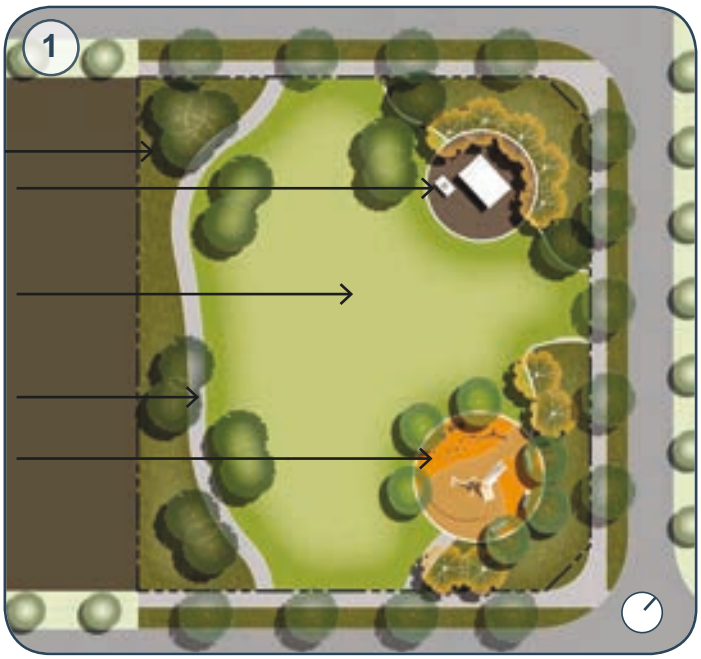
FUNCTIONS / MATERIALS
- Provide informal recreation uses with small gathering nodes with picnic / BBQ facilities.
- Turf pockets allow for kickabout areas
- Nature play instances allow for reuse of salvaged site logs.

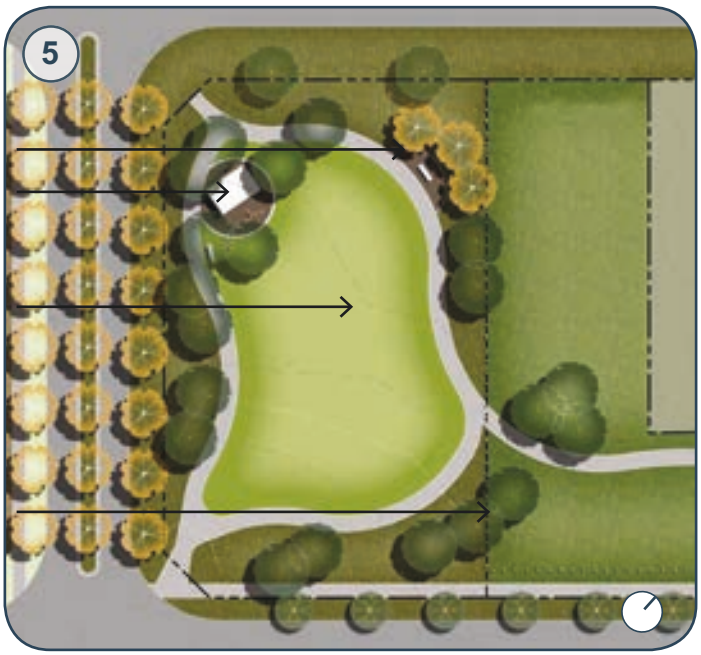
ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible
- Fence to CCW buffer (POS 5)
- Fence to OEPA (POS8)

DRAINAGE CONSIDERATIONS
- NA











SCALE
0 20m

FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

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POS 2, 3, 9 CONCEPT

POS TYPOLOGY
- Local Parks (Drainage inclusive)

SIZE
- POS 2 - 2,111 m2
- POS 3 - 6,232 m2
- POS 9 - 6,426.m2

CONCEPT
- Provide a series of POS primarily focussed on passive recreation with pockets of turf and seating nodes at key locations
- Predominantly native planted garden beds
- Retention of existing trees where possible

FUNCTIONS / MATERIALS
- Provide informal recreation uses with small gathering nodes and turf pockets

ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible (location not surveyed)
- Fence to CCW buffer (POS 3)

DRAINAGE CONSIDERATIONS

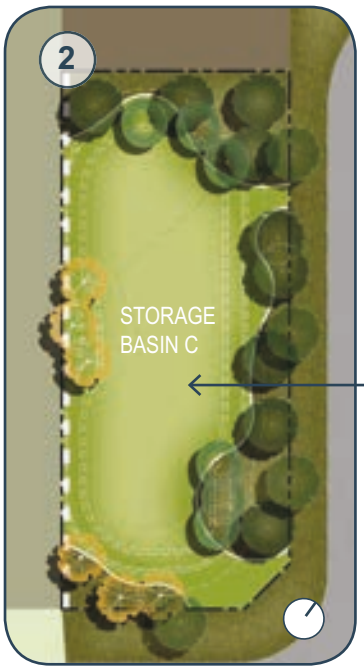
BASIN A (POS 9)
- 1 Year Storm volume : 272 m3
- 5Year Storm volume : 1,070 m3
- 100 Year Storm volume : 2,350m3

BASIN B (POS 3)
- 1 Year Storm volume : 510 m3
- 5Year Storm volume : 1,233 m3
- 100 Year Storm volume : 1,275 m3

BASIN C (POS 2)
- 1 Year Storm volume : 100 m3
- 5Year Storm volume : 470 m3



SCALE
0 20m





FURNISSDALE LANDSCAPE STRUCTURE PLAN
LANDSCAPE JOB NUMBER: FUR-SK01 : OCT 2015 : REV C

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POS 6, 7 CONCEPT



* Note:
Limestone paths through OEPA are shown indicatively and are to be located so as to not disturb existing vegetation, on existing trails, f re breaks and already clear areas.

POS TYPOLOGY
- Local Parks (OEPA Buffer)

SIZE
- POS 6 - 9,202 m2
- POS 7 - 11,321 m2

CONCEPT
- Provide a series of POS primarily focussed on passive recreation with pockets of turf and seating nodes along path network axis
- Entirely native planted garden beds
- Retention of existing trees where possible
- Take up level change between existing levels in OEPA and adjacent lot levels.

FUNCTIONS / MATERIALS
- Provide informal recreation uses with small gathering nodes and turf pockets

ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible
- Conservation Fence to OEPA boundary
- Access links through OEPA via crushed limestone paths

DRAINAGE CONSIDERATIONS
- NA



SCALE
0 50m

FURNISSDALE LANDSCAPE STRUCTURE PLAN
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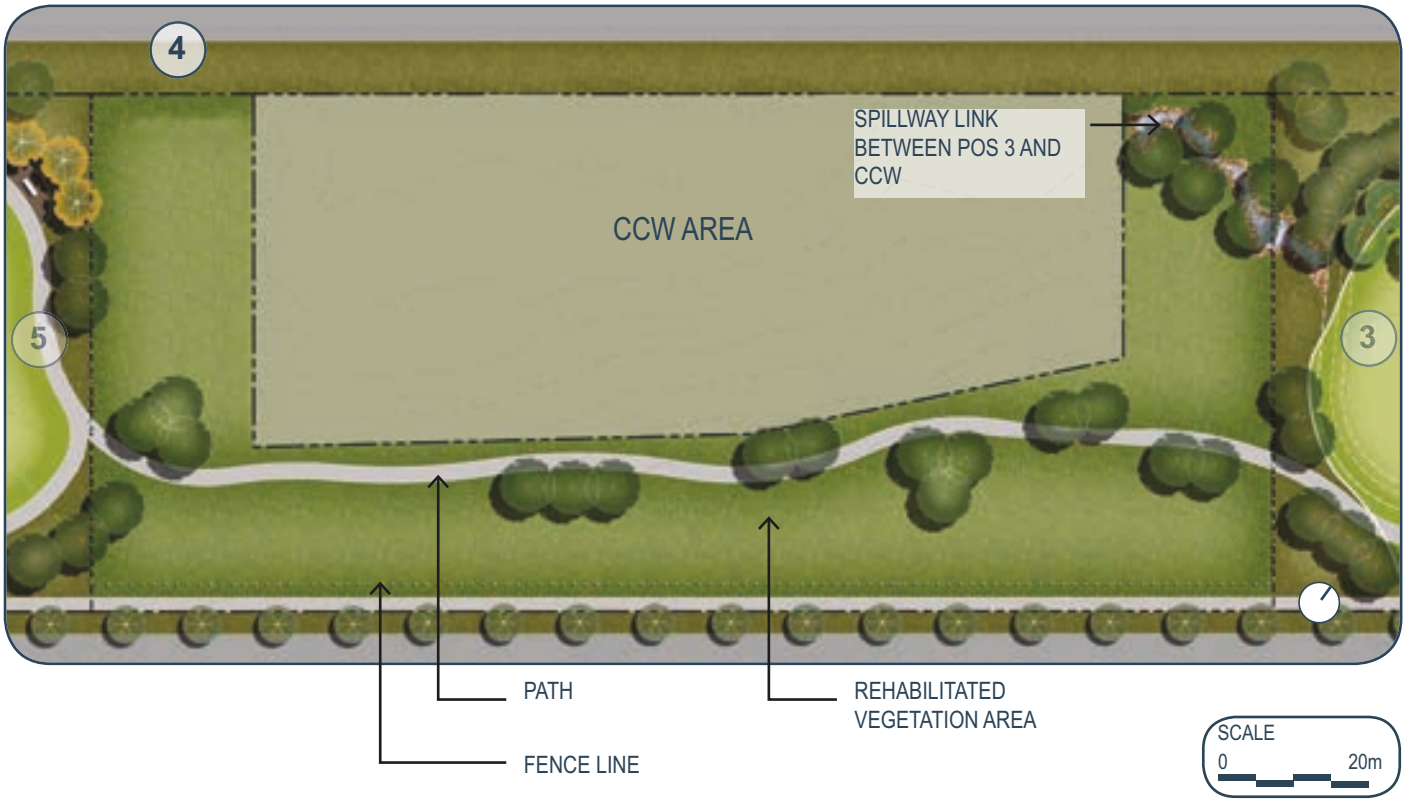
POS 4 CONCEPT



POS TYPOLOGY
- Local Parks (CCW Buffer)

SIZE
- POS 4 - 5.692 m2

CONCEPT
- Provide linear path linkages through
- Rehabilitation to vegetation with Native species only

FUNCTIONS / MATERIALS
- Primarily provide buffer to CCW
- Take up level change between existing CCW and adjacent lots. No fill within CCW area

ENVIRONMENTAL CONSIDERATIONS
- Water wise plant strategy
- Hydrozoning of plant species
- Controlled fertilizer to landscape areas
- Retain existing trees where possible
- Conservation Fence from CCW boundary

DRAINAGE CONSIDERATIONS
- 1:100 flood overflow from basin B (POS3) to connect to CCW via spillway







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