LOCAL STRUCTURE PLAN

Lot 502 Tamblyn Place, Wellard

Prepared by Development Works for Ascari Developments Pty Ltd

15 August 2016

DOCUMENT CONTROL

Prepared by Development Works Pty Ltd
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Phone: 0412 955 505

Revision	Author	Reviewer	Date
1	FF	FF	25.9.2015
2	FF	FF	15.8.2016

TABLE OF AMENDMENTS

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

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

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: 2 November 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

2 November 2016

Date

Date of Expiry: 2 November 2026

EXECUTIVE SUMMARY

The preparation of this Local Structure Plan has been undertaken to fulfill the statutory obligations of the *Planning and Development (Local Planning Schemes) Regulations 2015* and the *City of Kwinana Town Planning Scheme No. 2* for the subdivision and development of Lot 502 Tamblyn Place, Wellard (Lot 502).

Lot 502 is located within the City of Kwinana and situated within the suburb of Wellard. Lot 502 is a total of 10.7428ha in area, with approximately 4.4378ha zoned Urban under the Metropolitan Region Scheme. The balance of Lot 502 is zoned Rural. Lot 502 is predominantly cleared over the Urban zoned portion, with the majority of the Rural zoned portion forming part of the Bollard Bulrush Swamp wetland system.

The Local Structure Plan has been prepared for the Urban zoned portion of Lot 502 only to accommodate subdivision and development for residential purposes, including supporting areas of public open space and drainage.

The Local Structure Plan is consistent with the established strategic planning framework including the Western Australian Planning Commission's recently released *South Metropolitan Peel Sub-regional Planning Framework*; *Jandakot District Structure Plan*; and *City of Kwinana Eastern Residential Intensification Concept District Structure Plan.*

Local Structure Plan particulars:

Item	Data	Section number
Total area covered by the Structure Plan	4.4378 hectares	1.2 CTs – Appendix A
Area of each Land Use Zone • Residential Reserves • Road and Drainage • Public Open Space	 2.5237 hectares | 68 lots 0.916 hectares 1.0442 hectares	3.3
Estimated Lot and Dwelling Yield	65-70 lots / dwellings	3.1 Subdivision Plan Concept – Figure 4
Estimated Residential Density (based on 65 lots) • Dwellings per gross hectare (as per Directions 2031) • Dwellings per site hectare (residential zoned land) (as per Liveable Neighbourhoods and Perth and Peel@3.5million)	 14.6 dwellings per gross hectare (includes wetland buffer) 38.8 dwellings per site hectare	3.3
Estimated Population	182 people @ 2.8 people/household	3.3
Estimated area and percentage of Public Open Space to be ceded: • Local Parks	 0.3055 hectares or 10.0% Creditable POS	3.3 POS Calculation Table / Figure 5

Item	Data	Section number
• Other Parks (wetland buffer)	0.7387 hectares or 16.54% (0.0755 hectares credited)	
Estimated percentage of natural area	1.0442 hectares or (23.3%)	3.3

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PART ONE – IMPLEMENTATION

1. STRUCTURE PLAN AREA

This Structure Plan applies to the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map.

2. OPERATION

This Structure Plan comes into effect on the date it is approved by the Western Australian Planning Commission (WAPC).

3. STAGING

Subdivision is likely to occur in a single stage extending from the eastern portion of the land which is provided with existing road access from Tamblyn Place, to the western portion of the land containing POS and the wetland buffer.

4. SUBDIVISION AND DEVELOPMENT REQUIREMENTS

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

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

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

d) This structure plan is supported by a Bushfire Management Plan (BMP), *(Ref. 5434 V1.1 August 2016)* by RUIC Fire, as amended. Any land falling within 100 metres of a bushfire hazard identified in the BMP is designated as a Bushfire Prone Area for the purpose of the Building Code of Australia.

e) Notifications on Title

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

- That a lot(s) with a bushfire attack level (BAL) rating of 12.5 or higher is subject to a *Bushfire Management Plan*.

f) Management plans

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

- The preparation, approval and implementation of a wetland management plan providing for the protection of the adjoining conservation category wetland; and
- A mosquito and midge management plan.

5. Local Development Plan

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

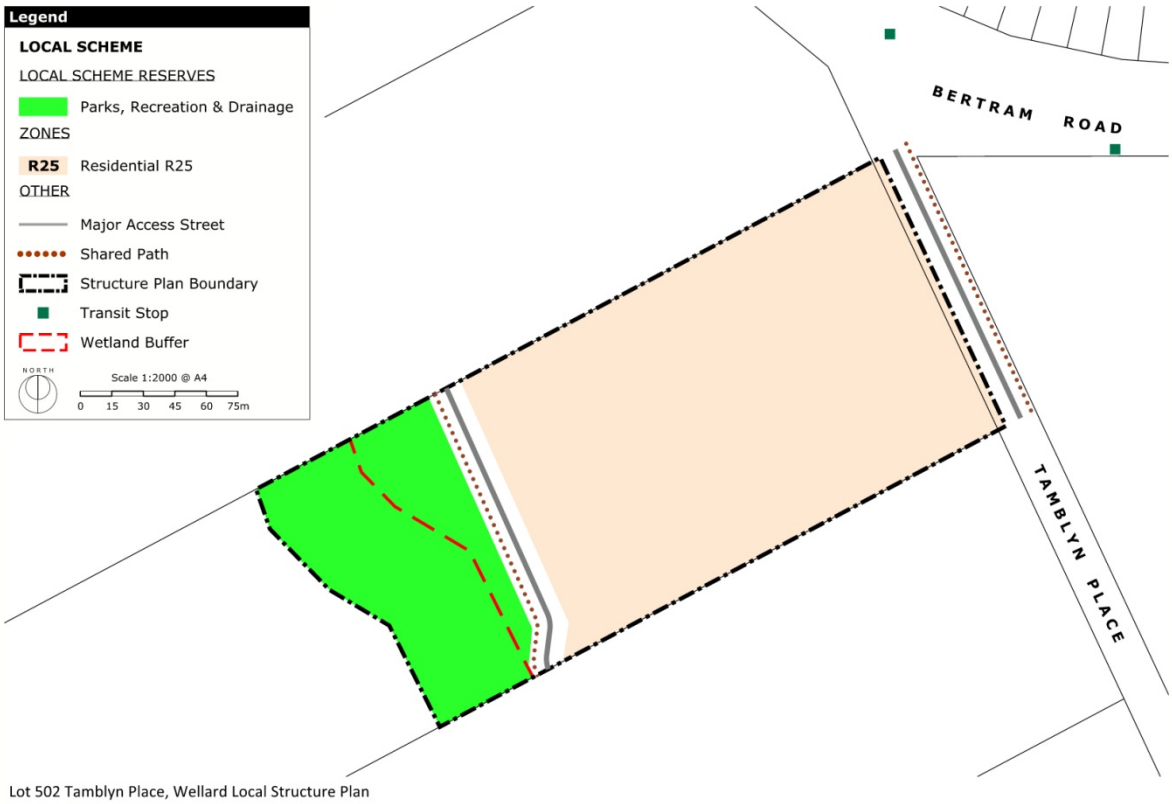
a) rear-loaded vehicle access;
b) having the potential for grouped and/or multiple dwellings;
c) with frontages of less than 12 metres;
d) abutting public open space; and
e) with a bushfire attack level of 12.5 or greater.

6. Other requirements

a) Development Contribution Arrangements

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

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



Lot 502 Tamblyn Place, Wellard Local Structure Plan

PART TWO – EXPLANATORY SECTION

1 BACKGROUND

1.1 Introduction and purposes

The LSP has been prepared by Development Works on behalf of the registered proprietor of Lot 502, Ascari Developments Pty Ltd.

The LSP will cover the Urban zoned portion of Lot 502 which is located east of the wetland associated with the Bollard Bulrush Swamp, and extends to Tamblyn Place.

The LSP will establish the guiding principles for the subdivision and development of Lot 502 for residential purposes. This will be in the form of a structure of Residential land use, Public Open Space (POS) and local roads, building on the established strategic planning framework under the WAPC's recently released South Metropolitan Peel Sub-regional Planning Framework; Jandakot District Structure Plan; and City of Kwinana Eastern Residential Intensification Concept District Structure Plan (ERIC).

The LSP addresses the requirements of the *Planning and Development (Local Planning Schemes) Regulations 2015* and the *City of Kwinana Town Planning Scheme No. 2* (TPS 2). The LSP and associated report is prepared in accordance with the WAPC's Structure Plan Framework (August 2015).

Extensive technical reporting has been prepared over the land located east of the Peel Main Drain extending to Johnson Road in the east as part of Lot 502's rezoning from Rural to Urban under the Metropolitan Region Scheme (MRS). This technical documentation has been used in support of the LSP and is supplemented with a combined Local Water Management Strategy / Urban Water Management Plan (prepared by PDC) which addresses drainage associated with the residential development of Lot 502.

1.2 Land description

1.2.1 Location

Lot 502 is located east of the Peel Main Drain and west of Tamblyn Place in Wellard. Tamblyn Place connects with Bertram Road and Johnson Road with the former connecting into the Kwinana Freeway via the Mortimer Road intersection (Figure 1).

Surrounding Lot 502 is:

- Urban zoned land to the north and south which is similarly undeveloped and is currently being used for rural residential purposes.
- Land east of Tamblyn Place and Johnson Road has been developed for residential purposes, including Emerald Park estate and smaller residential subdivisions undertaken by independent developers.
- Land west of the Peel Main Drain which is predominately associated with the Bollard Bulrush Swamp wetland system.

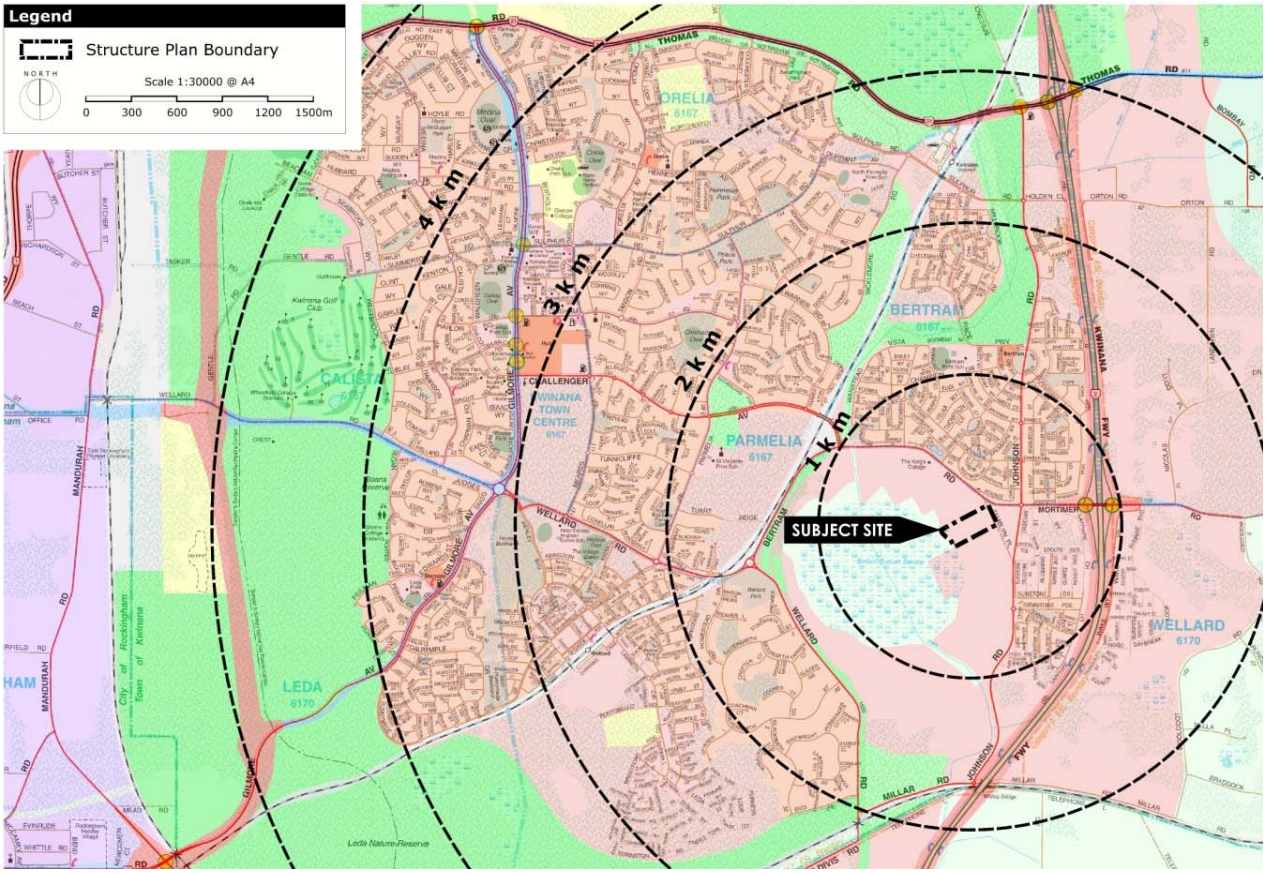


FIGURE 1: LOCATION

1.2.2 Area and land use

Lot 502's overall area of 10.7428ha consists of 4.4378ha zoned Urban and 6.205ha zoned Rural. Lot 502 is predominantly cleared and has been grazed in the past. There is an existing dwelling located on it which is likely to be removed as part of future subdivision (Figure 2).

1.2.3 Legal description and ownership

Lot 502 is legally described as Lot 502 on Deposited Plan 70999, Volume 2796 Folio 131 (Appendix A).

The registered proprietor is Ascari Developments Pty Ltd.

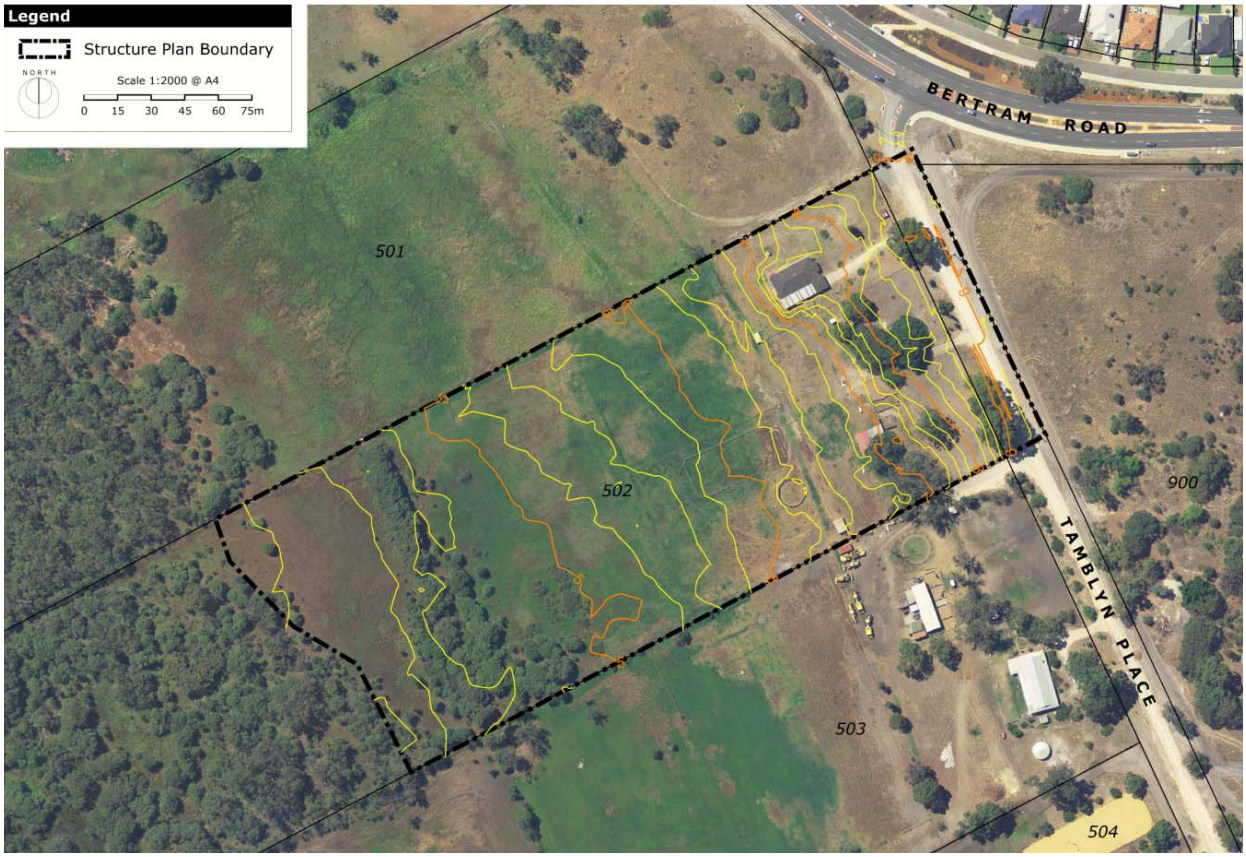


Figure 2: Lot 502

1.3 Planning framework

1.3.1 Zoning

Metropolitan Region Scheme

Lot 502 is zoned Urban and Rural and under the *Metropolitan Region Scheme* (MRS) (Figure 3). The delineation between the Urban and Rural zone was determined as part of MRS Amendment No 1158/57. As part of the Environmental Protection Authority's (EPA) environmental assessment, the extent of the developable area and wetland covering the western portion of Lot 502 were confirmed. The EPA's advice resulted in the WAPC determining the wetland be retained in the Rural zone with the Urban zone accommodating a 50m buffer to the wetland.

City of Kwinana Town Planning Scheme No. 2

Consistent with the MRS, Lot 502 is zoned Development and Rural under TPS 2.

Under TPS 2 the Development zone requires an LSP to be prepared prior to the subdivision and development of land; Clause 16.17.2.1 of TPS 2 states:

"Within the Development Zone or a Development Area, or the relevant portion of the Zone or Area, unless there is an adopted Structure Plan the Local Government is not to:

a) consider recommending subdivision; or
b) approve an application for Planning Approval."

This LSP has been prepared to fulfill the obligations under TPS 2 for the future subdivision and development of Lot 502.

The other applicable requirements under TPS 2 relating to the future subdivision and development of Lot 502 include the subdivider meeting its obligations relating to Developer Contributions. In this regard, Lot 502 is included within:

- Development Contribution Area 1 (DCA 1) relating to traditional infrastructure (hard);
- Development Contribution Area 7 (DCA 7) – Standard infrastructure for a district sporting ground; and
- Development Contribution Area 12 (DCA 12) – Wellard West relating to community infrastructure (soft).



FIGURE 3: METROPOLITAN REGION SCHEME

Planning and Development (Local Planning Schemes) Regulations 2015

The WAPC has recently released the *Planning and Development (Local Planning Schemes) Regulations 2015* (the Regulations). The LSP will be considered by Council during a transition phase, awaiting the Regulations to come into effect on 19 October 2015. In this regard, the LSP will be considered by the WAPC and Council under the provisions of Schedule 2 Part 4 of the Regulations. The content of the LSP has been prepared in accordance with the Regulations, with its further consideration and approval to follow the deemed provisions under the Regulations.

1.3.2 Regional and sub-regional structure plans

Directions 2031 and Beyond

Directions 2031 and Beyond: Metropolitan Planning Beyond the Horizon provides the high level spatial strategic planning framework for the development and growth of the metropolitan Perth and Peel regions. Its primary purpose is to provide a framework which guides further planning and then the delivery of housing, infrastructure and services, necessary to accommodate a range of growth scenarios.

Lot 502 is contained within the south-west sub-region of Directions 2031 which has experienced considerable economic and population growth driven by its coastal locations. Directions 2031 suggests:

"Under the connected city scenario it is estimated that by 2031 the population of the south-west sub-region will have grown by 34 per cent to 278,000. The sub-region currently enjoys a relatively strong employment self-sufficiency rate of 60 per cent; however, with the intensification of Rockingham and progressive development of the Latitude 32 industrial area, Directions 2031 expects the sub-region to increase its employment self-sufficiency rate to 70 per cent, which will require 41,000 new jobs by 2031."

Perth and Peel@3.5 Million and South Metropolitan Peel Sub-regional Planning Framework

The Department of Planning recently released *Perth and Peel@3.5 Million* to engage the community on the expectations of what Perth should look like in the future and how the population's valued lifestyle can be maintained through the substantially increasing population. In addition to the primary document four draft sub-regional planning frameworks for the Perth and Peel metropolitan regions were released. These will be converted to Sub-regional Structure Plans as part of the approval process to guide the development of the regions into the future.

Lot 502 is contained within the *South Metropolitan Peel Sub-regional Planning Framework* with the eastern portion of Lot 502 identified as "*Urban*"; reflecting the Urban zone under the MRS. The Rural zoned portion of Lot 502 is identified as "*proposed open space – nature / passive recreation*".

1.3.3 Planning Strategies and Structure Plans

City of Kwinana Local Planning Strategy

The City of Kwinana's *Local Planning Strategy 2015* identifies Lot 502 as "*Future Residential Areas*". We understand the City of Kwinana is currently reviewing the Planning Strategy.

Jandakot Structure Plan

The *Jandakot Structure Plan* was adopted in 2007 and was prepared as a broad planning framework at the regional level. The Structure Plan addresses future land use and infrastructure planning and development expectations, while balancing environmental issues.

The Urban zoned portion of Lot 502 is identified under the Structure Plan as "*short-term urban*". Given the wetland considerations pertinent to Lot 502 and its surrounds, the Structure Plan also indicates "*further investigations to determine specific areas that may be available for future urban land uses.*"

Significant investigative work was undertaken as part of locality's rezoning under the MRS which included environmental assessment by the EPA, culminating in a defined area agreed to as suitable for residential development.

City of Kwinana Eastern Residential Intensification Concept Plan

ERIC was prepared by the City of Kwinana as an additional level of strategic planning detail building on the recommendations of the Jandakot Structure Plan. ERIC identifies Lot 502 as part of a larger area subject to the Bollard Bulrush Swamp wetland system, identified specifically as *"Future urbanisation may be considered following full technical environmental review of impacts of urbanisation on wetland area (to be undertaken by landowner/developer in consultation with DoE)."* As mentioned above, environmental review and assessment was undertaken as part of the locality's rezoning under the MRS.

Local Structure Plans

Lot 502 forms part of a larger area located west of Johnson Road which requires local structure planning. Contact has been made with representatives of the adjoining landowner who is undertaking the development of the land directly south of Lot 502. They have advised that a Local Structure Plan has recently been submitted to the City of Kwinana for consideration. The subject LSP has been prepared to fit seamlessly with the Local Structure Plan to the south providing a north-south road connection along the eastern edge of the wetland buffer.

Contact has also been made with the landowners of Lots 500 and 501 to the north of Lot 502, with an offer presented for a joint LSP to be prepared. However, this offer was declined and it is understood the adjoining landowners will prepare a separate LSP in the future. The land to the north will be able to connect with Lot 502 with the north-south road along the eastern edge of the wetland buffer.

1.3.4 Planning policies

State Planning Policy 2.1 – Peel-Harvey Coastal Plan Catchment

As a result of land use change from Rural to Residential over Lot 502 as will be accommodated under the LSP, the requirements of *State Planning Policy 2.1 – Peel-Harvey Coastal Plain Catchment* apply.

The objectives of this policy are to:

- Improve the social, economic, ecological, aesthetic, and recreational potential of the Peel-Harvey coastal plain catchment.
- Ensure that changes to land use within the catchment to the Peel-Harvey estuarine system are controlled so as to avoid and minimise environmental damage.
- Balance environmental protection with the economic viability of the primary sector.
- Increase high water-using vegetation cover within the Peel-Harvey coastal plain catchment.
- Reflect the environmental objectives in the draft Environmental Protection Policy (Peel-Harvey Estuarine System) 1992.
- Prevent land uses likely to result in excessive nutrient export into the drainage system.

Through the design of the LSP and the supporting drainage management, the objectives and requirements of State Planning Policy 2.1 are addressed.

State Planning Policy 3.7 – Planning in Bushfire Prone Areas

State Planning Policy 3.7 – Planning in Bushfire Prone Areas has been prepared to assist in reducing the risk of bushfire to people, property and infrastructure by encouraging a conservative approach to strategic planning, subdivision, development and other planning decisions proposed in bushfire-prone areas. Specifically, the State Planning Policy:

- addresses land use planning elements of the Keelty report;
- elevates bushfire issues to be addressed by the highest level of planning policy available, giving it clear status and effect in the land use planning policy framework;
- emphasises the need to consider bushfire management measures in strategic level policy documents, including regional and local planning schemes, sub-regional and local planning strategies and structure plans, as well as during statutory planning processes for subdivision and development applications; and
- seeks to achieve the consistent implementation of bushfire management measures across the community.

State Planning Policy 3.7 will be addressed through the LSP design and implemented through the Bushfire Hazard Assessment and Bushfire Management Plan, which form part of this report.

Liveable Neighbourhoods

Liveable Neighbourhoods has been adopted by the WAPC as operational policy, and is to be followed in the design and approval of urban development. Liveable Neighbourhoods applies to structure planning and subdivision for greenfield sites and for the redevelopment of large brownfield and urban infill sites. The requirements of Liveable Neighbourhoods have been applied in the preparation of the LSP through the design of the road network, location of public open space and application of residential densities.

2 SITE CONDITIONS AND CONSTRAINTS

Extensive environmental analysis and review has been undertaken as part of the locality's rezoning under the MRS which has included:

- Environmental Report prepared to support the land's rezoning under MRS Amendment 1188/57 (Appendix B).
- Environmental Assessment by the EPA as part of the rezoning process under MRS Amendment 1188/57 (Appendix C).
- Determination of the extent of Urban development area appropriate under MRS Amendment 1188/57, which included defining the extent of the wetland.
- District Water Management Strategy prepared as part of the lifting of Urban Deferred zone for the land rezoned under MRS Amendment 1188/57.

The EPA's assessment of the MRS Amendment clearly defined a developable area through analysis of the environmental conditions of the Bollard Bulrush Swamp and the surrounding land. The EPA's recommendation to the Minister for Environment was:

1. That the Minister notes that the scheme amendment being assessed proposes to rezone the site from 'Rural' to 'Urban Deferred' under the Metropolitan Region Scheme.

2. That the Minister considers the report on the key environmental factor and principles as set out in Section 3.

3. That the Minister notes that the EPA has concluded that Metropolitan Region Scheme Amendment 1188/57 Wellard Urban Precinct East can meet the EPA's environmental objective for Inland Waters Environmental Quality.

4. That the Minister notes that the EPA has not included in this report "conditions and procedures to which Metropolitan Region Scheme Amendment 1188/57 should be subject, if implemented", because the EPA holds the view that the amendment as proposed can meet the EPA's environmental objective.

5. That the Minister notes the EPA's other advice presented in Section 4 in relation to a future Metropolitan Region Scheme amendment to reserve the wetland area, the rehabilitation of the Resource Enhancement Wetland area, and Acid Sulfate Soils.

Of particular relevance, it was clearly identified that a 50m buffer from the wetland boundary, within the Urban zone, would be sufficient to protect the Conservation Category Wetland function and the wetland habitat.

The existing environmental reporting and determinations described above have been applied in the preparation of the LSP. The existing site conditions and constraints summarized below are referenced from the Environmental Report prepared by ENV as part of the Environmental Review for MRS Amendment 1188/57 (Appendix B) and the combined LWMS/UWMP prepared by PDC (Appendix D).

2.1 Biodiversity and natural area assets

2.1.1 Flora and vegetation

ENV's Environmental Report identifies the western extent of the Urban zoned portion of Lot 502, extending into the wetland, as containing "*Scattered Melaleuca rhaphiophylla*"; with the majority of the wetland area consisting of "*Low Woodland Melaleuca rhaphiophylla, Eucalyptus rudis subsp. Rudis *Rubus anglocandicans,*Zantedeschia aethiopica,*Paspalum dilatatum,*Holcus lanatus, Centella asiatica, *Rumex crispus and Baumea articulate*".

The Urban zoned portion of Lot 502 has been mapped by ENV as "*Completely Degraded*" with the majority of the wetland identified as "*Good to Degraded*".

ENV found no Threatened or Priority species, nor Threatened or Priority Ecological Communities within the Urban zoned portion of Lot 502.

2.1.2 Fauna

The only habitat contained on Lot 502 is "*Melaleuca Dampland*" which covers the majority of the wetland outside of the Urban zoned portion of Lot 502. ENV suggest that the "Melaleuca Dampland" is degraded with limited midstorey and understorey and a high level of weed infestation. The remainder of Lot 502 is considered of low value given its cleared nature and previous use for grazing.

ENV undertook a search of State and Federal databases for the area which resulted in 28 conservation significant fauna species identified as potentially occurring.

Based on the ecological requirements, known distributions and the type and quality of fauna habitats, only two species listed were considered as "*Likely"* to occur within Lot 502. These being bird species, including the Cattle Egret and Eastern Great Egret. These two bird species are unlikely to be impacted by future development as they are highly mobile and can easily move to other areas.

The Southern Brown Bandicoot was recorded on site, and there is a long historical presence of the species on the Swan Coastal Plain. Lot 502 is not considered to be capable of supporting a large population due to the lack of native understorey species and the inundation of low lying areas during rain events.

2.1.3 Wetlands

Lot 502 is contained within the Department of Parks and Wildlife geomorphic wetland system with the western portion categorised as a Conservation Category Wetland, corresponding with the Rural zoned portion of Lot 502, and the eastern portion categorised as a Multiple Use Wetland, corresponding with the Urban zoned portion of Lot 502. During the Environmental Assessment associated with MRS Amendment 1188/57 the wetland was reviewed resulting in reclassification from Resource Enhancement to Conservation Category.

As part of the environmental review a clearly defined boundary was set defining a developable area. The Conservation Category Wetland was to be retained in the Rural zone for protection with a 50m buffer. The resulting developable portion of Lot 502 was zoned Urban. The LSP adheres to the recommendations of the EPA.

2.2 Landform and soils

2.2.1 Topography, soils and geology

Lot 502 declines from Tamblyn Place in the east to the wetland area in the west. Tamblyn Place is approximately 9m AHD with the western portion of Lot 502, near the wetland at approximately 4.2m AHD (Figure 1).

A geotechnical investigation has been undertaken by CMW Geosciences to review ground conditions and provide recommendations relating to a ground remediation strategy to achieve a Class A footing for future residential development. The geotechnical investigation is attached to the combined LWMS/UWMP document (Appendix D).

The eastern portion of Lot 502 is characterised by poorly developed sandy topsoils layer typically 0.2m thick, overlaying medium dense Bassendean sand interbedded with silt, sand and clay

alluvium of the Guildford Formation (below 8m from existing ground level). Over the western portion of Lot 502 (below 6.5m AHD) the topsoil layer is dominated by clayey/peat to 0.5m thick. The Upper Bassendean sand across Lot 502 is loose to medium dense with relative density increasing with depth.

The majority of Lot 502 is mapped as a "*high risk area for ASS occurring within 3m of the natural surface*" by *The Perth Metropolitan Acid Sulphate Soils Map* (Department of Environmental Regulation).

2.3 Groundwater and surface water

Lot 502's hydrology is influenced by its proximity to the Peel Main Drain, the low permeability topsoil and the gently inclined topography. The low permeability of the clayey / peaty topsoil results in low infiltration and high volumes of runoff in the form of sheet flow travelling towards the wetland.

Groundwater contours based on local and regional data over the Urban zoned portion of Lot 502 range from 4-5m+. There is a substantial set of existing data available for Lot 502 and surrounding area relating to groundwater levels with additional monitoring being undertaken specifically for Lot 502 by Ascari Development Pty Ltd. Sufficient clearance to groundwater will be provided as part of the development, with the finished lot levels based on providing suitable separation (0.5m) to the 100 year flood level of the Peel Main Drain (5.6m).

2.4 Bushfire hazard considerations

A Bushfire Management Plan has been prepared by RUIC Fire (Appendix E) to address the requirements of *State Planning Policy 3.7 – Planning in Bushfire Prone Areas.* The BMP suggests the subdivision and development of the Lot 502 can be appropriately mitigated against bushfires in accordance with the BMP. It should be noted that a conservative approach has been applied to assessing Bushfire Attack Levels and with the development of adjoining land and finalised of the landscape strategy for the abutting wetland buffer, the BALs can be reassessed at the subdivision stage and or building permit stage.

2.5 Aboriginal and European Heritage

A search of the Department of Aboriginal Affairs Aboriginal Inquiry System was undertaken on 24 September 2015 and no matches were recorded.

A search of the Heritage Council's inHerit database was undertaken with one match recorded for Bollard Bulrush Swamp. Given a defined developable area with a 50m buffer to the wetland was set through MRS Amendment 1188/57, this matter has been addressed.

3 LAND USE AND SUBDIVISION REQUIREMENTS

3.1 Local Structure Plan

The LSP has been prepared over the Urban and Development zoned portions of Lot 502 under the relevant Planning Schemes. As agreed with the City of Kwinana's town planning officers, the LSP will cover Lot 502 only. This approach is on the basis of fitting seamlessly with the Structure Plan prepared over the adjoining land to the south; and providing suitable connections to Lot 501 to the north, which a separate Structure Plan will be prepared over prior to subdivision and development.

3.1.1 Design response to site constraints

The main constraints and factors influencing the future subdivision of Lot 502 include:

- the location of the wetland and associated buffer over the western portion of Lot 502;
- Lot 502's topography and the resultant drainage strategy incorporating the treatment of stormwater in an east to west direction;
- the location of Tamblyn Place; and
- the north-south road connection from the abutting land to the south.

The LSP and accompanying Subdivision Concept Plan as detailed in section 3.1.2, respond to the site constraints by:

- incorporating a 50m buffer to the wetland into POS;
- an east to west road layout which will accommodate the treatment of stormwater, which will then overflow into POS and the wetland area;
- local road network connecting to Tamblyn Place; and
- north-south road connecting with the LSP layout for the land to the south whilst providing an opportunity for connection to the north. This road will also provide a public interface to the POS and wetland buffer continuing the approach required by Council surrounding the Bollard Bulrush Swamp wetland system.

3.1.2 Subdivision Concept Plan

A Subdivision Concept Plan (Figure 4) has been prepared to depict an indicative subdivision layout in support of the LSP, encompassing a hypothetically compliant subdivision. The Subdivision Concept Plan depicts:

- a grid road layout based on a predominately east to west configuration;
- 68 freehold lots;
- predominately north and south facing lots;
- major access street (17m wide) along the western edge of the subdivision area providing a continuous north-south link along the wetland buffer's edge;
- access streets of 15m wide;
- a lot typology which will accommodate a range of lot types all with access from the primary street, whilst providing opportunities for future refinement as part of the subdivision stage, if necessary. The lot typology, includes:
    - 12.5m x 25m
    - 15m x 25m
    - 12.5m x 30m
    - 15m x 30m
- a single, consolidated open space area comprising a 50m buffer to the adjoining wetland area and unrestricted open space area which will accommodate passive recreation uses.



FIGURE 4: SUBDIVISION CONCEPT PLAN

3.2 Land Use

This LSP provides an extension of the Structure Plan prepared over the land to the south, which, with the land to the north, forms a residential urban cell located between Johnson Road, Bertram Road and the Bollard Bulrush Swamp wetland system. The land use structure is based on residential with a supporting open space network accommodating protection of the sensitive natural environment. The land use composition on the LSP consists of:

Land use	Area (ha)
Residential	2.5240
Public Open Space	1.0442
Road and Drainage	0.9160

3.2.1 Residential

The Residential zone will form the basis of the subdivision area and will include the R25 density code to control future subdivision and built form. The R25 density code will be the predominant density code accommodating the lot typology as detailed on the Subdivision Concept Plan and which will be consistent with the prevailing density code in the area, thereby ensuring a seamless fit with the adjoining structure plan to the south.

As detailed under Part One, the density targets specified for new residential areas under key strategic documents such as Directions 2031 and Beyond; South Metropolitan Peel Sub-regional Structure Plan, under Perth and Peel@3.5million; and Liveable Neighbourhoods are addressed as follows:

Strategy	Density Target	Provided (based on 65 lots)
Directions 2031 and beyond	15 dwellings per gross hectare	14.6 dwellings per gross hectare (includes wetland buffer)
Perth and Peel@3.5million	26 dwellings per residential site hectare	38.8 dwellings per site hectare
Liveable Neighbourhoods	22 dwellings per site hectare	

A potential population of approximately 182 persons could be accommodated within the subdivision based on 2.8 people per household (65).

3.2.2 Public Open Space

The location of POS on the LSP has been determined by the location of the wetland and the need to accommodate a 50m buffer to this wetland in accordance with the EPA's recommendation as part of the assessment of MRS Amendment No. 1188/57. The wetland buffer will logically form part of the open space network surrounding the Bollard Bulrush Swamp through a local reserve managed and maintained by the City of Kwinana. For efficiencies and to accommodate a greater open space area, unrestricted open space has been located adjacent the wetland buffer, providing a consolidated POS area. POS in this location will also ensure additional fill is not required and will compliment the drainage strategy.

In accordance with the requirements of Liveable Neighbourhoods a POS calculation has been prepared which coincides with the areas depicted on the POS plan (Figure 5).

A Landscape management strategy will be prepared at the subdivision stage to guide the development of the open space areas, noting the minimum requirements of Liveable Neighbourhoods. It should also be noted that any re-vegetation works undertaken will be in accordance with AS3959-2009 relating to low threat vegetation so as to not create a further fire hazard.

TABLE – Public Open Space Calculation

Lot 502 – Structure Plan area	4.4378	
Land obtained from Tamblyn Place Road Closure	0.0433	
Gross Site Area		**4.4811**
Deductions		
Drainage Reserves - N/A as contained within road reserves		
Surplus Restricted Public Open Space	0.6632	
Total	**0.6623**	
Gross Subdivisible Area		**3.8188**
10% Required Public Open Space		**0.3819**
PUBLIC OPEN SPACE COMPOSITION		
Unrestricted (minimum 80% of total)	0.3055	
Restricted (maximum 20% of total)	0.0764	
Total		**0.3819**
PUBLIC OPEN SPACE PROVISION		
Unrestricted Public Open Space		
Formalised Public Open Space provided	0.3055	
Total		**0.3055**
Restricted Public Open Space		
Wetland Buffer	0.7387	
Total		**0.7387**
Total Credited Restricted Public Open Space		**0.0764**
Total Credited Public Open Space Provided		**0.3819**
Percentage of Public Open Space Provided		**10%**



Figure 5: Public Open Space

3.3 Movement Network

3.3.1 Road Network

Lot 502 is influenced by Tamblyn Place which connects to the existing district road network including Bertram Road (District Distributor B) and Johnson Road (Local Distributor). Whilst we understand a slight modification to the southern end of Tamblyn Place will occur as depicted on the adjoining landowner's LSP, this will not impact the traffic environment to Lot 502 as access will be taken from the northern section of Tamblyn Place where it intersects with Bertram Road.

A localised network of streets will be applied to the future subdivision of Lot 502 with a Major Access Street (17m wide) depicted on the LSP along the edge of the wetland buffer / open space area, that will surround the Bollard Bulrush Wetland (Figure 6). Details relating to the cross section of this road are contained within the LWMS / UWMP. This road will form a public interface to the open space network and will join seamlessly with future subdivision to the north and south. This road will run parallel with Tamblyn Place, which is likely to form a similar Major Access Street function.

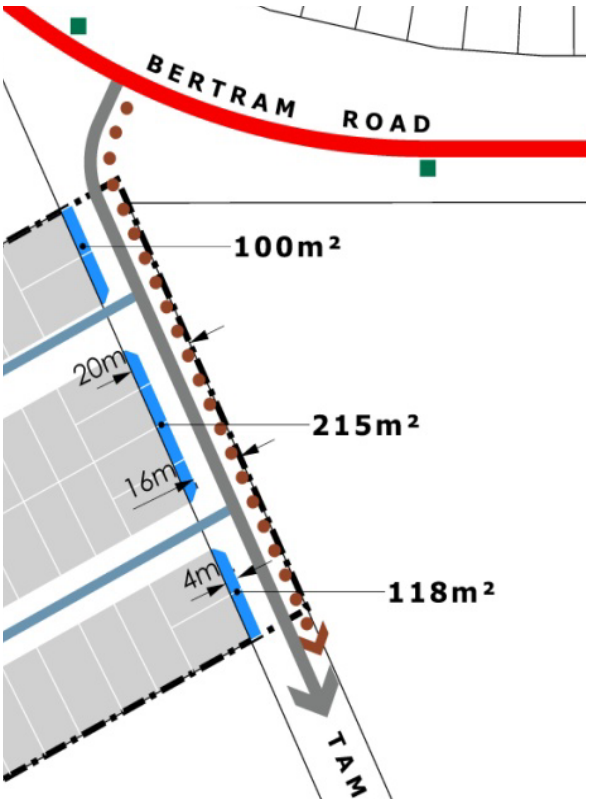
It is likely two access streets (15m wide) will connect the new Major Access Street and Tamblyn Place forming an efficient localised road network without impacting the subdivision of the adjoining land.



FIGURE 6: MOVEMENT NETWORK

3.3.2 Tamblyn Place Road Closure

Through discussions with the adjoining landowner and City of Kwinana, a reduction in the width of Tamblyn Place is being applied as the existing 20m wide road reserve is surplus to the infrastructure needs under the road hierarchy. Consequently, a 4m wide closure along the western side of Tamblyn Place will be undertaken to match that applied by the adjoining landowner. A request to close the relevant portion of Tamblyn Place as detailed in Figure 6 was formally lodged with Council.



The matter was considered at the Ordinary Council Meeting held on 13 April 2016, whereby Council resolved – *"That Council in accordance with Section 58(1) of the Land Administration Act 1997, formally request that the Minister for Lands grant the request to close the portions of road reserve detailed…".*

The matter is currently being finalized by the Department of Land.

3.3.3 Path Network

A shared path is depicted along the new Major Access Street which will connect with the shard path to be provided within Lot 503. This path will then continue into the future development of Lot 501 to the north. We understand a shared path will be provided on the eastern side of Tamblyn Place to be constructed by the landowner as part of the subdivision of Lot 900.

Links to the shared path network which extend along Bertram and Johnson Roads will be provided by footpaths along the new access streets, constructed as part of the subdivision of Lot 502.

3.3.4 Public Transport

There are two bus stops located 50-150m from Lot 502 on Bertram Road. One of these stops also provides a direct link to the Kwinana Train Station. Consequently, Lot 502 is well served by the public transport system which residents will be able to utilise via the path network.

3.4 Water Management

As a result of the localised nature of the subdivision of Lot 502 it was agreed with the Department of Water and City of Kwinana that a combined Local Water Management Strategy (LWMS) and Urban Water Management Plan (UWMP) be prepared (Appendix D). The drainage strategy provides management techniques to address the following:

- compliance with the design objectives in the DWMS;
- detailed stormwater management design including the size, location and design of public open space area, integrating flood management capability;
- specific structural and non-structural best management practices and treatment trains;
- management of groundwater levels;
- management of groundwater contamination and other specific site conditions;
- protection of waterways, wetlands (and associated buffers), remnant vegetation and ecological linkages;
- measures to achieve water conservation and efficiencies of use;
- management of subdivision works (to ensure no impact on conservation areas and management of dust);
- management of disease vector and nuisance insects (mosquitoes and midges);
- monitoring programme and / or contribution; and
- implementation including roles, responsibilities, funding and maintenance arrangements.

The combined LWMS and UWMP for Lot 502 was approved by both the City of Kwinana and Department of Water on 5 May 2016.

3.5 Education

Lot 502 is located approximately 1,000m from a planned primary school located to the south of *Emerald Park* on Johnson Road. The Department of Education has committed funding to this school to be completed by 2018. This school will form the primary education facility for future residents. Lot 502 is also located approximately 300m from a private high school to the north and there are other schooling opportunities within the suburbs of Bertram and Kwinana in close proximity to Lot 502.

3.6 Activity centres and employment

Lot 502 is located approximately 1,000m to a planned Local Centre adjacent to the future primary school to the south of *Emerald Park*. Residents will utilise the Kwinana Town Centre for their major shopping needs. Neighbourhood and Local centres also exist in close proximity to Lot 502 at *The Village* in Wellard and within the suburbs of Wellard and Bertram.

3.7 Infrastructure coordination, servicing and staging

An engineering service report (Appendix F) has been prepared by PDC in support of the LSP, which provides a preliminary assessment of the engineering aspects required for servicing the subdivision of Lot 502.

3.7.1 Road works

Tamblyn Place which is currently of an unsealed standard will require upgrading to accommodate vehicle and pedestrian access to Lot 502.

3.7.2 Sewer

The subdivision of Lot 502 is reliant on a wastewater pump station 'M' being constructed within Lot 503 abutting Lot 502 to the south. This pump station is currently being considered by the Water Corporation following design and lodgement of a scoping report by the adjoining landowner. The pump station will be pre-funded and forms part of Water Corporation's five year capital works; programmed to be constructed by 2018.

Sewer will be delivered to Lot 502 and new lots as part of the Water Corporation's standard detailed design process.

3.7.3 Water

Water Corporation has advised that Lot 502 is located within the current boundary for the Water Supply Scheme and overall planning has made allowance for residential development within the area.

Water supply will be provided to Lot 502 and the new lots as part of the Water Corporation's standard design requirements, via a new connection to the future main in Tamblyn Place.

3.7.4 Power

A new switchgear unit and transformer will be required for the subdivision of Lot 502 and new lots.

3.7.5 Gas

To service the subdivision of Lot 502 and the new lots a medium pressure main extension will be required to be constructed in Tamblyn Place. The main extension will connect to the existing medium pressure network in Johnson Road. The medium pressure network has sufficient capacity to service the subdivision.

3.7.6 Telecommunications

NBN is not planned for the development area in the next 12 months. Therefore, Telstra is considered the 'Infrastructure Provider of Last Resort'.

3.7.7 Drainage

The proposed drainage strategy which is detailed under Section 3.4 addressing the LWMS/UWMP, has been prepared to follow Water Sensitive Urban Design principles to promote infiltration of stormwater at the source and to minimise the pit and pipe network. Roadside rain gardens are proposed to address these requirements in addition to providing aesthetic amenity for the development.

3.7.8 Summary

In summary, it is achievable and feasible to provide all essential servicing infrastructure to accommodate the subdivision and development of Lot 502. This will occur through standard

infrastructure extensions and upgrade of existing services through the relevant design and approval processes.

3.8 Consultation

The project team prior to and during the preparation of the LSP has engaged with the following stakeholders:

- City of Kwinana;
- Department of Water;
- Water Corporation;
- ATCO Gas; and
- Adjoining landowners.

APPENDICES

Appendix A – Certificate of Title

205E

REGISTER NUMBER	
502/DP70999	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	1/12/2015

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE

VOLUME 2796 FOLIO 131

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 502 ON DEPOSITED PLAN 70999

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ASCARI DEVELOPMENTS PTY LTD OF 9 HAIG PARK CIRCLE EAST PERTH
(T N182436) REGISTERED 23 NOVEMBER 2015

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

1. N182437 MORTGAGE TO MARIA MCHENRY REGISTERED 23.11.2015.

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:	DP70999.
PREVIOUS TITLE:	1304-280.
PROPERTY STREET ADDRESS:	14 TAMBLYN PL, WELLARD.
LOCAL GOVERNMENT AREA:	CITY OF KWINANA.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Dec 21 09:48:21 2015 JOB 49731427

Landgate
www.landgate.wa.gov.au

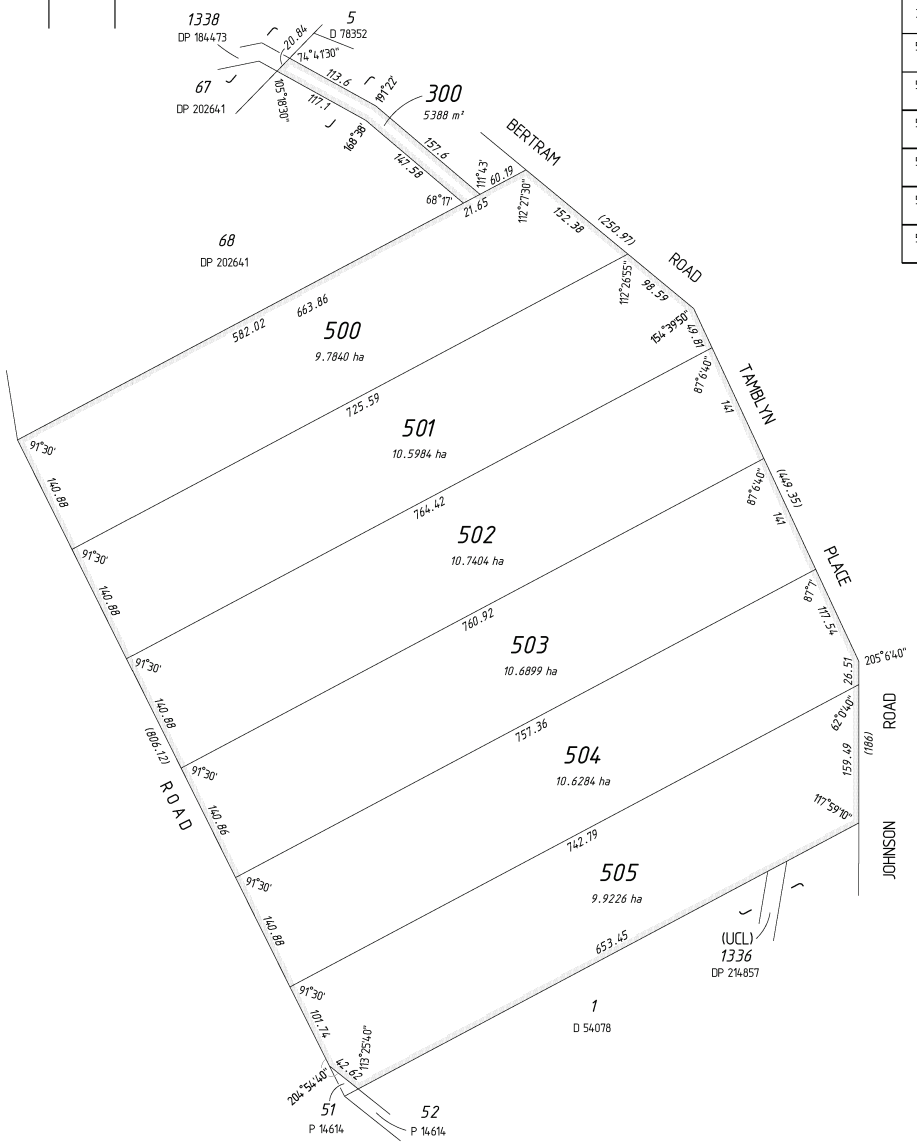
LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Jun 15 12:24:13 2015 JOB 48021144

www.landgate.wa.gov.au

VER	AMENDMENT	AUTHORISED BY	DATE

LIMITED IN DEPTH TO 60.96 METRES

COMPILED FROM D 49377, D 54078, DP 66357, DP 202641, DP 214857 AND P 14614



LOT	FORMER TENURE	ON PLAN/DIA	TITLE
300	PT LOT 44 (UCL)	DP 202641	LR 3013/112
500	LOT 72 PT LOT 44 (UCL)	DP 202641 DP 202641	CT 1281/799 LR 3013/112
501	LOT 74 PT LOT 44 (UCL)	DP 202641 DP 202641	CT 1318/810 LR 3013/112
502	LOT 76 PT LOT 44 (UCL)	DP 202641 DP 202641	CT 1304/280 LR 3013/112
503	LOT 4 PT LOT 44 (UCL)	D 49377 DP 202641	CT 1659/529 LR 3013/112
504	LOT 5 PT LOT 44 (UCL)	D 49377 DP 202641	CT 1492/179 LR 3013/112
505	LOT 6 PT LOT 44 (UCL)	D 49377 DP 202641	CT 2019/98 LR 3013/112

HELD BY LANDGATE IN DIGITAL FORM ONLY.

INTERESTS AND NOTIFICATIONS

SUBJECT	PURPOSE	STATUTORY REFERENCE	ORIGIN	LAND BURDENED	BENEFIT TO	COMMENTS

dex-fx ref : 1205-47

TYPE: FREEHOLD

PURPOSE: CROWN LAND AMALGAMATION

PLAN OF

LOTS 300, 500, 501, 502, 503, 504 AND 505

DISTRICT: COCKBURN SOUND (PEEL ESTATE)

TOWNSITE

SSA: YES/NO

DPI FILE: 01617-1985

LOCALITY: WELLARD

LOCAL AUTHORITY: TOWN OF KWINANA

FORMER TENURE: SEE TABLE

INDEX: ON BG33 (2) 12.31, BG33 (5) 5.12, BG33 (5) 5.13

FIELD BOOK: COMPILED

SCALE 1 : 4000 @A2 (0 40 80 120 160 200m)

ALL DISTANCES ARE IN METRES

SURVEYOR'S CERTIFICATE - Reg 54

I, ... hereby certify that this plan is accurate and is a correct representation of the -

(a) *survey, and/or

(b) *calculations from measurements,

[*delete if not applicable]

undertaken for the purposes of this plan and that it complies with the relevant written law(s) in relation to which it is lodged.

Licensed Surveyor ..... Date .....

SURVEYOR'S CERTIFICATE - Compiled

I, M. H. VAN ASSELT hereby certify that this compiled plan -

(a) is a correct and accurate representation of the survey(s) of the subject land; and

(b) is in accordance with the relevant law in relation to which it is lodged.

Martin Van Asselt 2012.06.01 22:53:46 +08'00'

Licensed Surveyor ..... Date .....

SURVEY FIRM

WELLARD SURVEYS
Land and Engineering Surveyors
202 BERTRAM ROAD
WELLARD, 6170
Ph: 9419 4729 Fax: 9419 1808

LODGED	TYPE OF VALIDATION	APPROVED BY
DATE: 7-Jun-12	FULL AUDIT	WESTERN AUSTRALIAN PLANNING COMMISSION
FEE PAID: $661.00	LEGAL COMPONENT: RL	FILE: EXEMPT FROM WAPC APPROVAL
ASSESS No.: 10793957	DOCKET PLAN/DIAGRAM: TRIM	
	CERTIFIED CORRECT: 14-6-2012	
	I.S.C.	DELEGATED UNDER S.16 P&D Act 2005 DATE
	F.S.C.	

IN ORDER FOR DEALINGS

SUBJECT TO: Sec 87 LAA Amalgamation

14-6-2012

For INSPECTOR OF PLANS & SURVEYS / AUTHORIZED LAND OFFICER DATE

APPROVED

10-8-2012

INSPECTOR OF PLANS & SURVEYS / AUTHORIZED LAND OFFICER DATE

Landgate
Western Australian Land Information Authority

DEPOSITED PLAN

70999

SHEET 1 OF 1

VERSION 1

A2 ORIGINAL

Appendix B – Environmental Report – ENV





ENVIRONMENTAL REVIEW

METROPOLITAN REGION SCHEME AMENDMENT 1188/57

WELLARD URBAN PRECINCT EAST









Invitation to make a submission

The Western Australian Planning Commission (WAPC) invites people to make a submission on this proposal. Both electronic and hard copy submissions are most welcome.

Wellard Landowners' Group proposes an amendment of the Metropolitan Region Scheme to Urban for land to the east of Bollard Bulrush Swamp. In accordance with the *Environmental Protection Act 1986* (EP Act), an Environmental Review (ER) has been prepared which describes this proposal and its likely effects on the environment. The ER is available for a public review period of 60 days from 18 June 2013 closing on 23 August 2013.

After receipt of comments from Government agencies and from the public, the WAPC will forward submissions to the Environmental Protection Authority (EPA). The EPA will prepare an Assessment Report with recommendations to the Government, taking into account issues raised in public submissions. Any environmental conditions, which may be set from this process, will be required to be incorporated into the MRS Amendment.

Why write a submission?
A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach.

It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the WAPC will be acknowledged. Submissions will be treated as public documents and may be quoted in full or in part in each report. Submissions may be fully or partially utilised in compiling a summary of the issues raised or where complex or technical issues are raised, a confidential copy of the submission (or part of it) may be sent to the proponent.

A summary of issues is normally included in the EPA's Assessment Report.

Why not join a group?
If you prefer not to write your own comments, it may be worthwhile joining a group interested in making a submission on similar issues.

Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information.

If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the ER or the specific proposal. It helps if you give reasons for your conclusions, supported byways to make the proposal more environmentally acceptable.

When making comments on specific elements of the Environmental Review:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the ER;
- if you discuss different sections of the ER, keep them distinct and separate, so there is no confusion as to which section you are considering;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address; and
- date.

Please present your comments on the WAPC submission form (Form 57) provided. It is attached to this report, the planning Amendment Report, and is also available from the display locations and the PlanningWA internet site www.planning.wa.gov.au

Alternatively, written submissions can be posted to:

Secretary
Western Australian Planning Commission
Locked Bag 2506
PERTH WA 6001

or hand delivered to:

Secretary
Western Australian Planning Commission
140 William Street
PERTH WA 6000

The closing date for submissions is: 23 August 2013.

Planning and Development Act 2005

Section 57 Amendment (Minor)
Form 57

Submission

Metropolitan Region Scheme Amendment 1188/57

Wellard Urban Precinct (East)

OFFICE USE ONLY

SUBMISSION NUMBER
RLS/0388

To: Secretary
Western Australian Planning Commission
Locked Bag 2506
PERTH WA 6001

Name .....
(PLEASE PRINT CLEARLY)

Address ..... Postcode .....

Contact phone number ..... Email address .....

Submission (Please attach additional pages if required. It is preferred that any additional information be loose rather than bound)

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turn over to complete your submission

(Submission continued. Please attach additional pages if required)

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You should be aware that:

- The WAPC is subject to the *Freedom of Information Act 1992* and as such, submissions made to the WAPC may be subject to applications for access under the act.
- In the course of the WAPC assessing submissions, or making its report on these submissions, copies of your submission or the substance of that submission, may be disclosed to third parties.

To be signed by person(s) making the submission

Signature …… Date ……

Note: Submissions MUST be received by the advertised closing date, being close of business (5pm) on 23 August 2013. Late submissions will NOT be considered.

ENVIRONMENTAL REVIEW

METROPOLITAN REGION SCHEME AMENDMENT 1188/57

WELLARD URBAN PRECINCT EAST

Prepared for:

Wellard Landowner's Group

Prepared by:

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Fax: (08) 9226 4109
Email: env@env.net.au

Job Number:	*10.127*
Report Number:	*11/079*
Prepared by:	*Kate Thomson*
Status:	*Final*
QA Review:	*Damian Buller*
Technical Review:	*Karen Godridge*
Content Review:	*Peter Jobson*
Date:	*04/06/2013*

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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 by Greg Rowe and Associates on behalf of the Wellard Landowners Group to undertake this Environmental Review in support of the rezoning of the subject land from Rural to Urban Deferred under the Metropolitan Region Scheme (MRS).

The application of the MRS Amendment (1188/57) was referred to the EPA where the level of assessment was set at a formal assessment with the following objectives identified:

- To maintain the integrity, ecological functions and environmental values of wetlands;
- To maintain the integrity, ecological functions and environmental values of fauna habitat; and
- To maintain the integrity, ecological functions and environmental values of waterways.

This report covers the following issues:

- Regional and local context;
- Flora, vegetation, fauna and habitat;
- Wetland value, functions and boundary;
- Groundwater and surface water quality and quantity; and
- Legislation and Planning.

The report identifies all environmental factors and their management in relation to potential impacts, management objectives and proposed mitigation and management actions. The Environmental Management Framework outlines the following necessary environmental plans:

- Construction Environmental Management Plan;
- Wetland Management Plan; and
- Water Management Plans.

1 INTRODUCTION

ENV. Australia (ENV) was commissioned by Greg Rowe and Associates on behalf of the Wellard Landowners Group to undertake this Environmental Review in support of the rezoning of the subject site from 'Rural' to 'Urban Deferred' under the Metropolitan Region Scheme (MRS).

1.1 LOCATION AND CURRENT LAND USE

The site is located in the suburb of Wellard in the Town of Kwinana, and is situated approximately 35 km south of the Perth CBD (see Figure 1). The land is located on the eastern side of Bollard Bulrush Swamp and is bound by Bertram Road and Tamblyn Place to the north, Johnson Road to the east, and the Peel Main Drain to the west and south.

The subject site consists of the following land parcels in Wellard:

- Lot 1 Johnson Road;
- Lot 6 Johnson Road;
- Lot 86 Johnson Road;
- Lot 4 Tamblyn Place;
- Lot 5 Tamblyn Place;
- Lot 74 Tamblyn Place;
- Lot 76 Tamblyn Place;
- Lot 67 Bertram Road;
- Lot 68 Bertram Road;
- Lot 72 Bertram Road;
- Lot 1338 Bertram Road;
- Unallocated Crown Land 44 in Wellard; and
- Unallocated Crown Land 1336 in Wellard.

The western portion of the site includes parts of Bollard Bulrush Swamp itself, and although the site is largely cleared, there are vegetated areas remaining within the wetland itself. The cleared areas are currently used predominantly for cattle grazing.

1.2 DESCRIPTION OF AMENDMENT

The site is zoned 'Rural' under both the MRS and the Town of Kwinana Town Planning Scheme No. 2 (TPS2) (see Figure 2). MRS Amendment 1188/57 proposes rezone the site from 'Rural' to 'Urban Deferred'. Following the eventual lifting of Urban deferment,

structure planning and subdivision approval will facilitate the ultimate urban development of the site.

Table 1: Key characteristics

AMENDMENT DETAIL	CHARACTERISTICS
Purpose	To develop the land for residential use
Land Area	Wetland Area: 32.3 ha Wetland Buffer: 9.4 ha Developable Area: 57.5 ha
Local Government	Town of Kwinana
Existing Land Uses	Farming and grazing
Existing Zoning	Rural
Proposed Zoning	Urban Deferred
Environmental Factors	Wetlands, fauna and water (surface and groundwater)
Proposed Environmental Management Measures	Preparation and implementation of the following management plans: • Construction Environmental Management Plan, • Wetland Management Plan, • District Water Management Strategy, • Local Water Management Strategy, and • Urban Water Management Plan,

1.3 PURPOSE OF THIS ENVIRONMENTAL REVIEW

The application for amendment of the MRS (Amendment 1188/57) was referred to the Environmental Protection Authority (EPA) under section 48A of the *Environmental Protection Act 1986* (EP Act) to set the level of assessment for the proposal.

The EPA concluded that this amendment should be formally assessed (Assessment 1830), and issued instructions under section 48C(1)(a) of the EP Act. The EPA identified the most relevant 'Environmental Factors' as identified in Table 2 (please note that the wetland management categories have been amended subsequently to the table of Environmental Factors being released).

Table 2: Environmental Factors Relevant to the Scheme

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
BIOPHYSICAL			
Wetlands	Bollard Bulrush Swamp	To maintain the integrity, ecological functions and environmental values of wetlands	*Regional and Local Context* Describe the extent of the relevant wetland suite. What is the significance (percentage and area representation) of the Bollard Bulrush Swamp in relation to the wetland suite? What is the ecological linkage value of Bollard Bulrush Swamp? *Wetland Value and Functions* The Bollard Bulrush Swamp is currently identified as *Conservation Category (UFI 15866), Resource Enhancement* (UFI 15867) and *Multiple Use* (UFI 13327) management category in the Department of Environment and Conservation's (DEC) *Geomorphic Wetlands Swan Coastal Plain* dataset. The Environmental Review should review the classification of Bollard Bulrush to ensure that the current attributes of the wetland reflect the management category. Confirm the wetland management category with DEC. This should be done in accordance with the *Protocol for proposing modifications to the Geomorphic Wetlands Swan Coastal Plain dataset* (2006). Map the boundary of the EPP 1992 boundary and hydric soils overlaying on an aerial photograph. A portion of Bollard Bulrush Swamp is protected from unauthorized activities under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (Lakes EPP 1992).* Map and describe vegetation types (overlaid on aerial photography) and condition (using the *Bush Forever* scale) in accordance with *Guidance Statement No 51. Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.*

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
			Wetland Boundary Identification of a wetland boundary is reliant upon hydrology, hydric soils and wetland vegetation. Wetland vegetation is a reliable indicator of a wetland boundary. When the vegetation has been cleared, hydric soils may be the only indicator remaining. *Determination of Buffer Width* The purpose of a wetland buffer is to safeguard and maintain the functions and processes of a wetland and protect the wetland from potential adverse impacts. The buffer around Bollard Bulrush Swamp should be based on the appropriate distance required to separate the environmental values (vegetation, roosting, summer refuge, nesting, nursery and feeding) from the land uses permitted by the proposed amendment. The EPA expects that a minimum 50 metre buffer be provided (Guidance Statement No 33). Matters to be considered in the Environmental Review should include: • Description of the potential direct and indirect impacts that may result from use or development, including use for drainage purposes, allowed by the Amendment; and • Determination of the appropriate buffer distance required to protect the environmental values and functions of Bollard Bulrush Swamp from these potential impacts using the EPA *Guidance Statement No. 33 Environmental Guidance for Planning and Development* (available from www.epa.wa.gov.au) and Western Australian Planning Commission's *Guidelines for the Determination of Wetland Buffer Requirements* (available at www.planning.wa.gov.au) .

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
			The Environmental Review should demonstrate how the proposed buffer will protect and maintain the values of Bollard Bulrush Swamp.
Fauna	Bollard Bulrush Swamp	To maintain the integrity, ecological functions and environmental values of fauna habitat	Fauna survey of Bollard Bulrush Swamp in accordance with the EPA's *Guidance Statement No. 56 Terrestrial Fauna for Environmental Impact Assessment in Western Australia* (available at www.epa.wa.gov.au). Use the outcomes of the fauna survey to determine the habitat values (roosting, summer refuge, nesting and feeding) and defining an appropriate buffer to determine the buffer requirements of Bollard Bulrush Swamp.
POLLUTION MANAGEMENT			
Water	Surface groundwater quality and quantity	To maintain the integrity, ecological functions and environmental values of waterways	*How will the Amendment ensure that surface and groundwater quality and quantity is not adversely affected as a result of any use or development allowed by the Amendment?* Demonstrate that the proposal complies with the *Jandakot Structure Plan* (Government of Western Australia; 2007) and the *Jandakot Water Resource Management Strategy* (Department of Water). Both policies require that future development within this catchment does not impact on the quality of water entering Jandakot water resources. Demonstrate that the proposal complies with the objectives of the EPA's "*Draft Water Quality Improvement Plan*" (WQIP) for the Peel Harvey Coastal Plain Catchment (2007). Document how stormwater management will be implemented in accordance with the Department of Water's *Stormwater Management Manual* including the following: • Provide a site specific profile of the maximum groundwater level across the wetland and details of site drainage. • Assess the impact of residential development will have on local surface and ground water quality, including the risk of acid sulfate soils, salinity problems, and surface and groundwater quantity.

CONTENT		SCOPE OF WORK	
Factors	**Site Specific**	**EPA Objectives**	**Work required for the environmental review**
			Detail measures proposed to: • Ensure the quality and quantity of surface and ground water is maintained so that existing and potential uses, including ecosystem maintenance are protected; and • Management impacts. Describe management measures, including: • Effluent disposal; and • Drainage and nutrient management, to be implemented to reduce the quantity of drainage runoff from the site and to prevent impacts on water quality.

The purpose of this report is to fulfil the instructions of the EPA in the investigation, definition and proposal of management measures for the environmental constraints to development of the site. The commitments outlined in this document will become statutory obligations for the client to ensure that long term environmental protection and management of the site is fulfilled.

2 LEGISLATIVE AND POLICY CONTEXT

2.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth legislation relating to the protection of the environment and the conservation of biodiversity. The EPBC Act defines Matters of National Environmental Significance (NES), which include World and National Heritage sites, wetlands of international importance, threatened species and communities, migratory species and Commonwealth marine areas. Proposals which may have a significant impact on Matters of NES should be referred to the federal Department of Sustainability, Environment, Water, Populations and Communities. Proposals deemed to be Controlled Actions require assessment and approval under the EPBC Act.

2.1.1 THREATENED SPECIES OF FLORA AND FAUNA PROTECTED UNDER THE EPBC ACT

Section 179 of the EPBC Act identifies the categories for threatened flora and fauna species, as listed in Table 3 below.

Table 3: Federal Threatened Flora and Fauna Categories

CATEGORY	DESCRIPTION
Extinct	There is no reasonable doubt that the last member of the species has died
Extinct in the Wild	Either the species: • 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.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild in the immediate future
Endangered	The species is not critically endangered; and it is facing a very high risk of extinction in the wild in the near future
Vulnerable	The species is not critically endangered or endangered; and it is facing a high risk of extinction in the wild in the medium term future
Conservation Dependent	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

2.1.2 THREATENED ECOLOGICAL COMMUNITIES

Threatened species and ecological communities listed under the EPBC Act are recognised as Matters of NES. Therefore, any actions that are likely to significantly impact on a listed species or community will require an environmental assessment and approval process.

2.1.3 MIGRATORY SPECIES

All migratory species protected under the Bonn Convention, the Japan-Australia Migratory Bird Agreement, the China-Australia Migratory Bird Agreement, or any other approved international agreement, are protected under the EPBC Act.

2.2 ENVIRONMENTAL PROTECTION ACT 1986

The *Environmental Protection Act 1986* (EP Act) empowers the EPA to act to prevent, control or abate pollution and environmental harm, and to ensure the conservation, preservation, protection, enhancement and management of the environment.

Part V of the EP Act also provides for the declaration of Environmentally Sensitive Areas (ESA's) for which there is a presumption against clearing of native vegetation. Values such as Declared Rare Flora (DRF), habitat for Threatened Fauna, Threatened Ecological Communities (TEC's) and Conservation Category Wetlands are deemed to be Environmentally Sensitive Areas under the Act.

Clearing of native vegetation requires permission under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions for a clearing permit under the *Regulations* do not apply in an ESA.

2.3 WILDLIFE CONSERVATION ACT 1950

The *Wildlife Conservation Act 1950* (WC Act) provides for the conservation and protection of native flora and fauna, including rare flora and fauna, primarily through the gazettal of a DRF species list and a Specially Protected Fauna species list. Any action that will result in the 'taking' of a listed species must be licensed under the Act.

2.3.1 RARE FLORA

Section 23F of the act provides for the publishing of the W*ildlife Conservation (Rare Flora) Notice* in the Government Gazette. Rare Flora may fall under either of the following two categories described in Table 4.

Table 4: Management Categories for Flora Protected under the WC Act

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Schedule 1	**S1**	Taxa that are extant and considered likely to become extinct or rare
Schedule 2	**S2**	Taxa that are presumed to be extinct in the wild

2.3.2 SPECIALLY PROTECTED FAUNA

Section 14(2) of the WC Act provides for the publishing of the *Wildlife Conservation (Specially Protected Fauna) Notice* in the Government Gazette. Specially Protected Fauna may fall under any of the following categories described in Table 5.

Table 5: Management Categories for Fauna Protected under the WC Act

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Schedule 1	**S1**	Fauna that is rare or likely to become extinct
Schedule 2	**S2**	Fauna that is presumed to be extinct
Schedule 3	**S3**	Birds that are protected under an international agreement
Schedule 4	**S4**	Other fauna in need of protection

2.4 PRIORITY FLORA AND FAUNA LISTS - DEPARTMENT OF ENVIRONMENT AND CONSERVATION

The Department of Environment and Conservation (DEC) maintains lists of priority flora and fauna which are under consideration for inclusion in the formal WC Act lists, but are in need of further survey.

The priority levels of the flora species are defined in Table 6 below.

Table 6: Priority Flora Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Priority 1	**P1**	Taxa with few (generally less than 5) occurrences which are under threat. These taxa are under consideration for declaration as Rare Flora, but are in urgent need of further study.
Priority 2	**P2**	Taxa with few (generally less than 5) occurrences, at least some of which are not under immediate threat. These taxa are under consideration for declaration as Rare Flora, but are in urgent need of further study.
Priority 3	**P3**	Taxa known from several populations which are not believed to be under immediate threat. These taxa are under consideration for declaration as Rare Flora, but are in need of further study.
Priority 4	**P4**	Taxa which have been adequately surveyed, and which while rare are not under current threat. These taxa require monitoring.

The priority levels of the fauna species are defined in Table 7 below.

Table 7: Priority Fauna Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Priority 1	**P1**	Taxa with few, poorly known populations on threatened lands. They require urgent survey and evaluation.
Priority 2	**P2**	Taxa with few, poorly known populations on conservation lands. They require urgent survey and evaluation of conservation status.
Priority 3	**P3**	Taxa with several, poorly known populations, some on conservation lands. They require urgent survey and evaluation of conservation status.
Priority 4	**P4**	Taxa which have been adequately surveyed, and are usually represented on conservation lands. They are not under current threat, but could become threatened should circumstances change. These taxa require monitoring.
Priority 5	**P5**	Conservation dependent taxa which although not currently threatened, would become so within 5 years should their specific conservation program cease.

2.5 THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES LISTS - DEPARTMENT OF ENVIRONMENT AND CONSERVATION

There is no mechanism available for the formal listing of ecological communities under the WC Act, however the DEC maintains a list of threatened and priority ecological communities, which are classified as described in Table 8 and Table 9, below.

Table 8: Threatened Ecological Communities Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Presumed Totally Destroyed	**PD**	A community which has been adequately searched for, but for which no representative occurrences have been located.
Critically Endangered	**CR**	A community which has been adequately surveyed and found to be facing extremely high risk of extinction in the near future.
Endangered	**EN**	A community that has been adequately surveyed and found to be facing high risk of extinction in the near future.
Vulnerable	**VU**	A community which has been adequately surveyed and found to be facing high risk of total destruction or significant modification in the medium to long-term future.

Table 9: Priority Ecological Communities Management Categories

MANAGEMENT CATEGORY	Abbrev.	DESCRIPTION
Priority 1	**P1**	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation, for which current threats exist.
Priority 2	**P2**	Ecological communities that are known from few, small occurrences, all or most actively managed for conservation and not under imminent threat of destruction.
Priority 3	**P3**	Communities that are known from: • Several to many occurrences, a significant number of which are not under threat of habitat destruction or degradation; • A few widespread occurrences, which are large or in significant remaining habitat, in which other occurrences may survive, much of which is not under imminent threat; or • Large and/or widespread occurrences (that may or may not be represented in the reserve system) but are under threat of modification across much of their range.
Priority 4	**P4**	Communities that are adequately known, rare but not threatened, or meet the criteria for Near threatened, or have been recently removed from the threatened list.

2.6 GEOMORPHIC WETLANDS OF THE SWAN COASTAL PLAIN DATASET - DEPARTMENT OF ENVIRONMENT AND CONSERVATION

Classifications and management objectives for wetlands of the Swan Coastal Plain (from Gingin to Dunsborough) have been identified and are held in a database maintained by the DEC. The wetland classification system defines wetlands in terms of their geomorphic character and inundation patterns (see Table 10), while the management category of a wetland is based on its condition and function, and defines objectives for their future management (see Table 11) (EPA 2008a).

Table 10: Geomorphic Wetland Classification System

WATER LONGEVITY	LANDFORM				
	Basin	**Channel**	**Flat**	**Slope**	**Highland**
Permanent inundation	Lake	River	-	-	-
Seasonal inundation	Sumpland	Creek	Floodplain	-	-
Intermittent inundation	Playa	Wadi	Barlkarra	-	-
Seasonal Waterlogging	Dampland	Trough	Palusplain	Paluslope	Palusmont

Table 11: Wetland Management Categories

MANAGEMENT CATEGORY	GENERAL DESCRIPTION	MANAGEMENT OBJECTIVES
Conservation	Wetlands which support a high level of attributes and functions	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: ▪ reservation in national parks, crown reserves, and State owned land, ▪ protection under Environmental Protection Policies, and ▪ wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.

MANAGEMENT CATEGORY	GENERAL DESCRIPTION	MANAGEMENT OBJECTIVES
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is 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 their wetland function, structure and biodiversity.
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 land care.

2.7 ENVIRONMENTAL PROTECTION (SWAN COASTAL PLAIN LAKES) POLICY 1992

Environment Protection (Swan Coastal Plain Lakes) Policy 1992 (EPP Lakes) is a policy under Part III of the EP Act which aims to protect the environmental values of lakes on the Swan Coastal Plain through the prevention of filling, excavation and discharge into these lakes (unless authorised by the EPA).

2.8 WETLANDS CONSERVATION POLICY FOR WESTERN AUSTRALIA

The Wetlands Conservation Policy for Western Australia (Government of Western Australia 1997) provides recognition of wetland values and commits the State Government to identifying, maintaining and managing the State's wetland resource, including the full range of wetland values, for the long term benefit of the people of Western Australia.

2.9 PLANNING AND DEVELOPMENT ACT 2005

The *Planning and Development Act 2005* is an Act to provide for a system of land use planning and development in Western Australia.

The Act establishes the framework for preparation, amendment and function of Regional Planning Schemes and Local Planning Schemes. It also provides statutory procedures for the preparation and adoption of State Planning Policies (SPPs) by the Western Australian Planning Commission. SPPs are developed by the State Government to provide strategic guidance in land use planning decision making.

2.10 METROPOLITAN REGION SCHEME

The Metropolitan Region Scheme (MRS) guides land use in the Perth Metropolitan Region, which consists of a number of local government areas, including the Town of Kwinana. The MRS defines the use of land, dividing it into broad zones and reservations.

2.11 TOWN OF KWINANA TOWN PLANNING SCHEME NO 2

The Town of Kwinana Town Planning Scheme No. 2 outlines reserving and zoning of land in the Town and provides for the control of land use and development for the purposes of orderly and properly planned use and development of land to occur.

The policy provides the framework for the mapping, classification and categorisation for the State's wetland resources.

3 EXISTING ENVIRONMENT

3.1 CLIMATE

Perth enjoys a warm Mediterranean climate, with an average maximum summer temperature of 28.3°C and an average minimum winter temperature of 10.9°C (BOM 2010). The region receives an average annual rainfall of 765.3 mm, with the majority of precipitation occurring in winter (see Figure 3, below) (BOM 2010).

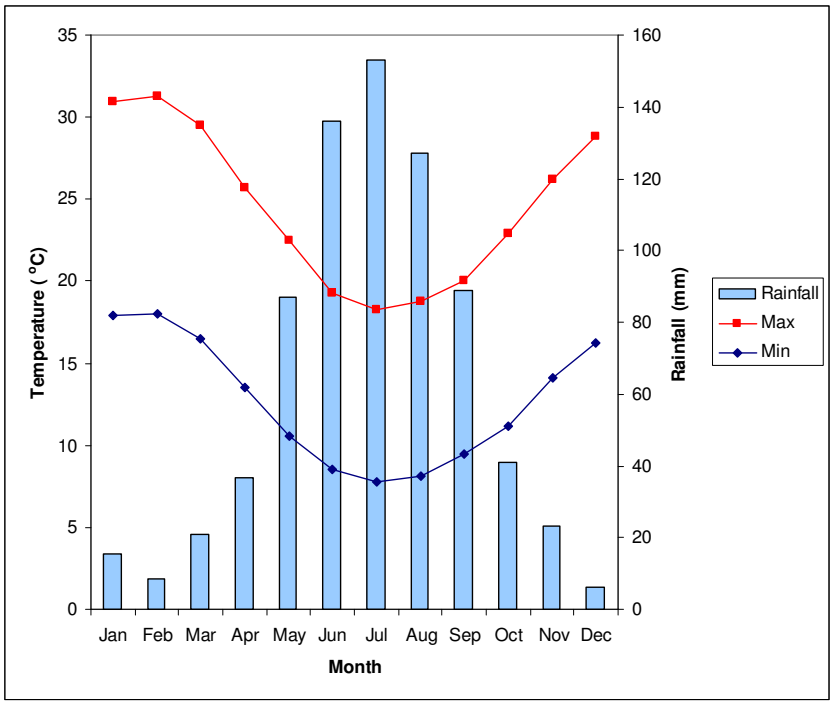


Figure 3: Temperature and Rainfall (BOM 2010)

3.2 SOILS AND GEOLOGY

Bollard Bulrush Swamp is part of the Beeliar Chain of Wetlands that represents the divide between the Bassendean Dune System to the east and the Spearwood Dune System to the west. Bassendean sands are generally white to grey, fine to medium-grained, quartz-based sands of an Aeolian origin, while Spearwood sands are calcareous and derived from Tamala limestone (Gozzard 1983). The sands have a yellowish to brown colour and a medium to coarse grain size.

The soils of the Beeliar Wetlands are of a lacustrine origin, being formed by sedimentation in lakes, and comprise of dark brownish-grey sandy silts with disseminated fine grains of quartz and variable organic matter content (Gozzard 1983).

3.3 ACID SULPHATE SOILS

The site is mapped almost entirely as 'high to medium risk of acid sulphate soils within 3m of the natural soil surface' (see Figure 4) (WAPC 2003).

3.4 ABORIGINAL HERITAGE SITES

The Department of Indigenous Affairs' Aboriginal Heritage Enquiry System identified a number of Aboriginal heritage surveys that have been conducted in the area encompassing the site. However, according to the enquiry system no Aboriginal Heritage Sites were found in the development area (DIA 2010).

3.5 FLORA AND VEGETATION

ENV was commissioned in 2010 to undertake a flora and vegetation assessment for the Bollard Bulrush East survey area. Included below is a summary of the Assessment, the complete Draft report is available in Appendix A.

3.5.1 METHODOLOGY

A thorough desktop review was conducted, including a DEC database search for Threatened Flora and the WA Herbarium (DEC 2010b), NatureMap (DEC 2010a), Department of Sustainability, Environment, Water, Population and Communities Protected Matters Search Tool (DSEWPAC 2010a) and previous flora surveys (completed by other consultants and the DEC). This was supplemented by a vegetation survey completed in September 2010 by an ENV botanist which included 10 m x 10 m quadrats, one relevé, photographs and samples (see Appendix A).

3.5.2 RESULTS

Vegetation Complex

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

- Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of Eucalyptus rudis - Melaleuca spp.

The EPA Guidance Statement 10 estimates the percentage of each mapped vegetation complex that remains on the Swan Coastal Plain compared to its pre-European extent. Complexes with 10-30% remaining are considered regionally significant, and complexes with 10% or less remaining in constrained areas may be formally assessed by the EPA (EPA 2006).

Across its extent 34.6% of the Herdsman Complex is estimated to remain (EPA 2006), with 31% remaining within protected Bush Forever sites across the Swan Coastal Plain (Government of Western Australia 2000). Based on the EPA Guidance Statement 10, the vegetation complex is unlikely to be considered regionally significant.

Flora

Sixteen families, twenty two genera and twenty three taxa were recorded in the survey area (seven native flora taxa and sixteen introduced)(see Appendix A for complete flora list). An average of thirteen species was recorded within each quadrat.

Vegetation Condition

The majority of vegetation onsite is considered to be Degraded, with a range of conditions from Completely Degraded to Good occurring on the site (Figure 5). This is in contrast to the condition of the other side of Bulrush Swamp as delineated in a 2008 survey undertaken for Dev-X Pty Ltd (shown in Appendix B).

Disturbances onsite include invasive weeds, livestock grazing and trampling and historical clearing. The high level of disturbance within the subject site and the high diversity and cover of invasive species indicates that the native species have been displaced.

Vegetation Unit

One vegetation unit was identified within the survey area:

MpEr Low Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp*. rudis*, **Rubus anglocandicans, *Zantedeschia aethiopica,*Paspalum dilatatum, *Holcus lanatus, Centella asiatica, *Rumex crispus* and *Baumea articulata.*

In addition, stands of native trees including *Eucalyptus rudis* subsp*. rudis* and *Melaleuca preissiana* were recorded (Figure 6). No native understorey species were recorded under these trees and thus, they have not been discussed as vegetation units.

Floristic Community Type

Due to the low native species diversity and the degraded condition of the site, ENV is unable to confidently infer a specific Floristic Community Type (FCT). The vegetation has been assessed as representing a highly disturbed example of FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands' as several common and typical species of FCT SCP 17 are absent from the site.

The species richness recorded at the subject site has been influenced by the high diversity of introduced species recorded (which incorporated 69% of the total taxa recorded). Introduced species dominate the middle storey and understorey.

Protected Flora

A database search of the Wellard area resulted in ten Declared Rare and eight Priority Flora species being identified as potentially occurring in the subject area. Additionally the desktop search identified five Threatened Ecological Communities and three Priority Ecological Communities within a 5km radius of the site, also identifying these as potentially occurring on the site (Appendix A).

No Threatened species pursuant to the EPBC Act, no plant taxa gazetted as Declared Rare pursuant to the WC Act and no Priority Flora listed by the DEC were recorded in the survey area.

Climatic factors may have influenced the emergence of flora, such as annuals. However ENV considers it to be very unlikely that the subject site supports flora of conservation significance or provides the appropriate habitat for conservation significant flora and that, as such, the potential for Threatened, Declared Rare or Priority Flora is low.

The vegetation has been assessed as representing a highly disturbed example of FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands' as several common and typical species of FCT SCP 17 are absent from the site. This FCT is not representative of any TEC or PEC complexes.

Introduced Species

The field survey identified sixteen dominant weed species listed in the Environmental Weed Strategy for Western Australia. The majority of these are common agricultural, bushland or wetland weeds in the region, but three of them are rated as High by the Environmental Weed Strategy for Western Australia (CALM 1999) (refer to Appendix A for ranking criteria). These are *Cortaderia selloana*, *Typha orientalis*, and *Zantedeschia aethiopica*.

Two of these species are listed as Declared Plants on the Swan Coastal Plain (DAFWA 2010); Arum Lily (**Zantedeschia aethiopica*); and Blackberry (**Rubus anglocandicans*). The level of infestation of both species was considered to be high, as a result of the wide distribution and high number of individuals within the survey area (see Figure 7). Arum Lily and Blackberry are both listed as Priority 1 for the whole State and require management strategies to reduce their distribution.

3.6 FAUNA

The EPA's instructions defined the fauna habitat values of the site as a factor to be assessed in this Environmental Review. In accordance with Guidance Statement 56: *Terrestrial Fauna Surveys for Environmental Impact Assessment* (EPA 2004), ENV was commissioned in June 2010 to undertake a Level One fauna and fauna habitat

assessment, including targeted trapping, for the subject site. Included below is a summary of the assessment, the complete (draft) report is available in Appendix C.

3.6.1 METHODOLOGY

A thorough desktop review was conducted and included a DEC database search for Threatened and Priority Fauna (DEC 2010c), Western Australian Museum (WAM) & NatureMap (DEC 2010a), DSEWPaC Protected Matters Search Tool (DSEWPaC 2010a), Birds Australia's Birdata (Birdata 2010), previous surveys/reports (from ENV, other consultants and DEC reports) and discussions with important stakeholders. This was supplemented with a field survey conducted by a qualified Zoologist on the 30th September 2010. During the assessment only vegetated areas were assessed for fauna habitat, and fauna were opportunistically observed and recorded including scats, tracks, burrows and other evidence of animal presence. Conservation significant species were located and coordinates recorded with a GPS. Refer to Appendix C for a detailed methodology.

3.6.2 RESULTS

Habitat

One potential habitat type was identified onsite: *Melaleuca* Dampland, which covered approximately 22.7 ha (32%) of the site (Figure 8). The remaining of the site is in Degraded or Completely Degraded condition, and is considered to provide limited or no habitat value for fauna species.

The *Melaleuca* Dampland is characterised by Swamp Paperbark (*Melaleuca rhaphiophylla*), Flooded Gum (*Eucalyptus rudis* subsp. *rudis*), **Paspalum dilatatum*, Yorkshire Fog (**Holcus lanatus*), *Centella asiatica*, Curled Dock (**Rumex crispus*) and Jointed Rush (*Baumea articulata*). The Dampland is in Good-to-Degraded Condition however the midstorey and understory are heavily disturbed and dominated by weed species such as Blackberry and Arum Lily.

The *Melaleuca* Dampland within the subject site is degraded with limited midstorey and understorey species and a high level of weed infestation; consequently it is considered unlikely to support any species of conservation significance. The remainder of the site is considered to be of low value to fauna due to the lack of microhabitats and clearing of the site for grazing domestic animals creating a highly fragmented habitat.

Ecological Linkage

Ecological connectivity facilitates many life-history functions of fauna, and the ability to utilise connected habitats is integral to the life histories of a broad spectrum of species, with connectivity between habitats being crucial to important functions such as

breeding. Where undeveloped areas provide ecological connectivity, this can increase their ability to support fauna species.

Although the wetland on the site comprises only half of Bollard Bulrush Swamp, the link to the western side is disjointed partially by the Peel Main Drain running through the centre of the wetland. The wetland as a whole remains within a highly fragmented setting, with little habitat connectivity with the surrounding area. This reduces the value and functionality of the survey area to fauna, particularly those that require larger areas or home ranges.

Despite the nearby occurrence of Bush Forever Site 349 (Leda and adjacent bushland) to the south-west of the survey area, the site remains relatively isolated from other similar habitats in the local vicinity. This is largely due to its location between residential housing to the west and pastoral land to the east.

Fauna

In previous surveys two hundred and eleven species of fauna have been recorded in the vicinity of the subject site. During the Level One fauna survey conducted by ENV in 2010, 29 terrestrial vertebrate fauna were recorded. A summary of both is detailed below (for complete lists refer to the full Fauna Report in Appendix C):

- One amphibian species;
- One reptile species;
- 25 native bird species and one introduced bird species; and
- One native mammal species and one introduced mammal species.

All fauna identified during the field survey are commonly encountered on the Swan Coastal Plain.

Conservation Significant Fauna

A search of State and Federal databases for the area resulted in 28 conservation significant fauna species identified as potentially occurring.

Based on the ecological requirements, known distributions and the type and quality of fauna habitats, only two species listed were considered as 'Likely' to occur within the subject site. These being bird species, the Cattle Egret and Eastern Great Egret. These two bird species may not be impacted by potential development as they are highly mobile and can easily move to other areas.

The Southern Brown Bandicoot was recorded on site, and there is a long historical presence of the species on the Swan Coastal Plain. The survey area is not considered to be capable of supporting a large population due to the lack of native understorey species and the inundation of low lying areas during rain events.

3.7 WETLANDS - BOLLARD BULRUSH SWAMP

The subject site includes part of the eastern portion of Bollard Bulrush Swamp, extending as far west as the Peel Main Drain, which bisects the Swamp. This wetland is identified in both the Geomorphic Wetlands Swan Coastal Plain dataset, and the Environmental Protection (Swan Coastal Plains Lakes) Policy, discussed below.

The wetland is one of the 19 wetlands that form the Bibra Suite, which occur in depressions of the Spearwood and Bassendean Dunes (Hill *et al* 1996). Bollard Bulrush swamp comprises an area of 185.9 ha according to Hill *et al* (1996), out of a total area of 696 ha of sumplands in the Bibra Suite (26.7%). Its environmental values at the time of the Hill *et al* (1996) assessment led to it being assigned a percentile ranking of 58, indicating that it is below the 60th percentile of examples of Bibra suite sumplands. It is also indicated that Bollard Bulrush Swamp is in the bottom 20% of Bibra Suite sumplands on the basis of vegetation cover (percentile ranking 16). It should be noted that the condition and extent of the wetland represented in the Hill *et al* report is 16 years old, and may not reflect the current status of the wetland.

Hydric soils analysis of soil profiles at groundwater bore locations show that three of the locations display hydric properties (evidence of soil features produced under waterlogged conditions) and three do not (see Appendix D and Figure 9). However, while hydric soil properties demonstrate that an area is a wetland, or has been one in the past, they do not contribute to an assessment of management category. Given that most of the site is classified as wetland (Conservation category, Resource Enhancement and Multiple Use), it is to be expected that a large area of the site display hydric soils properties. The construction of the Peel Main Drain through the centre of this wetland, also means that it is likely that there are relic soils present on the site from a time prior to this major alteration of the hydrological regime, unrelated to the current regime.

Historically the site has been farmed since the 1920's, and large areas have previously been cleared. From 1973 until the present, grazing has occurred throughout the wetland. Vegetation has regenerated in recent years in the central part of the wetland as stock has been less frequently permitted to graze the wetland. The wetland habitat type is considered to be of low value to fauna within the survey area.

3.7.1 GEOMORPHIC WETLANDS SWAN COASTAL PLAIN DATASET

The DEC maintains a database of wetlands on the Swan Coastal Plain which includes:

- location and boundary of the wetland;
- wetland type / geomorphic classification (see Table 10); and
- management category (see Table 11).

Bollard Bulrush Swamp is classified by the DEC geomorphic wetland system as a Sumpland, which means that its character is that of a basin, and it is seasonally inundated with water.

Bollard Bulrush Swamp has areas classified under three of the management categories described by the DEC; the central area of the wetland is classified as a Conservation category wetland area (Unique Feature Identifier 15866), a small area is classified as Resource Enhancement Category wetland (Unique Feature Identifier 15867), and the outer area is classified as a Multiple Use Category wetland (Unique Feature Identifier 13327) (see Figure 10).

Management objectives for Conservation category wetlands is preservation of the wetland attributes and functions – these are the highest priority wetlands. Resource Enhancement category wetlands objectives encourage their management, restoration and protection with the aim of achieving Conservation category status. The management objectives of Multiple Use category wetlands allows for development within them, provided that planning for the development incorporates ecologically sustainable design principles. This may include such measures as nutrient, sediment and drainage management; fire management; and weed control.

Recent Vegetation Assessment

The three wetland areas currently identified by the DEC Geomorphic Wetlands Swan Coastal Plain dataset as occurring within the survey, support vegetation that is regarded as representative of wetland communities. However, the condition of this vegetation varies. The Conservation category and Resource Enhancement wetland areas within the survey area represent the core of the wetland vegetation. The high level of disturbance has reduced the ecological value of the vegetation in the area identified as Multiple Use wetland - it is Completely Degraded, as this area has been cleared and utilised for agricultural purposes.

3.7.2 ENVIRONMENTAL PROTECTION (SWAN COASTAL PLAINS LAKES) POLICY 1992

Bollard Bulrush Swamp is also protected under the *Environment Protection (Swan Coastal Plain Lakes) Policy 1992* (Lakes EPP) (see Figure 11). The Lakes EPP aims to protect the environmental values of lakes on the Swan Coastal Plain and does not allow filling with materials, clearing, excavation or discharge into lakes (amongst other activities) (EPA 1992).

The mapped boundaries of the Geomorphic Wetlands Swan Coastal Plain dataset do not correspond with the mapped EPP lake boundary.

Interpretation of Wetland Boundary in relation to the Environmental Protection (Swan Coastal Plain Lakes) Policy, 1992

Under the 1992 Lakes EPP, a lake was identified if it contained an area of standing water of more than 1000 square metres as at 1 December 1991. Evidence in the form of historical photographs suggests the original EPP policy criteria of standing water no longer applies to Bollard Bulrush Swamp, and has not applied for many years, even at the key date in 1991.

A photograph taken of Bollard Bulrush Swamp when the EPP Lakes Policy came into effect is shown in Figure 12. The photograph was taken 22 November 1991 which is closest to the 1 December 1991 that Landgate (Western Australian Land Information Authority) could supply. Figure 13 has the 1991 aerial with the EPP Lakes boundary overlayed. No standing water is observable in the aerial photograph, and the EPP boundary extends far beyond the vegetated wetland area.

While Bollard Bulrush Swamp is a wetland, the boundary of the EPP Lake appears to be inaccurate; it does not represent standing water in the aerial photography at the time of the Policy's inception. Appendix E contains historical aerial photographs of Bollard Bulrush Swamp starting from 1953 and continuing on through to the present year. These photographs clearly show the years when the area is inundated with water. Table 12 below lists the years the photographs were taken and if open water was present.

Table 12: Historical Aerial Photograph Inventory for Appendix E

Photograph Year	Month	Water Present
1953	November	Yes
1965	March	No
1974	September	Yes
1977	June	No
1981	August	No
1985	June	No
1991	November (Figure 12)	No
1995	February	No
2000	February	No
2001	January	No
2003	January	No
2004	December	No
2006	March	No
2008	July	No
2010	November	No

On this basis, it can be reasonably concluded that the EPP mapping is incorrect in this case. Hence, a case exists for the EPP delineation to be amended to a more reasonable boundary. Strategies for the future management of the wetland in light of these issues are discussed in Section 4.1.

3.8 GROUNDWATER

ENV has installed groundwater monitoring bores at six locations within the site to monitor groundwater levels and groundwater quality. Monitoring bore locations are shown on Figure 14. Water levels in the bores were first measured on the 3rd October 2006. An eighteen month water monitoring program including monthly monitoring of water levels and quarterly monitoring of water quality commenced on the 1st July 2010. To date, ENV has undertaken 10 occasions of groundwater levels monitoring and three occasions of groundwater quality monitoring, capturing two "winter" (peak water level) periods. The results of this monitoring undertaken to date are summarised below. More detailed analysis can be found in Appendix F, which contains a short letter report from December 2010 on the results of the monitoring program.

3.8.1 GROUNDWATER LEVELS

Average Annual Maximum Groundwater Levels (AAMGLs) have been calculated for the site using the water levels recorded from the bores on 3 October 2006 and the historical record of water levels for DoW bore T-250. The AAMGLs for each bore and the depth to AAMGL from ground surface are shown in Table 13 below.

Table 13: Average Annual Maximum Groundwater Levels (AAMGL) and Depth to AAMGL for each Bore.

Bore Name	AAMGL (m AHD)	Depth to AAMGL (m)
MW1-E	5.918	0.953
MW2-E	4.636	-0.227
MW3-E	5.737	0.645
MW4-E	4.362	-0.283
MW5-E	4.256	-0.390
MW6-E	4.332	0.463

The AAMGL for the site varied between 4.256 m AHD at MW5-E and 5.918 m AHD at MW1-E. The depth from the surface to AAMGL varied between -0.39m at MW5-E and 0.953 m at MW1-E. The negative depth to AAMGL at MW2-E, MW4-E and MW5-E indicates that these areas could expect to be waterlogged or inundated at the surface during winter in an average year. MW5-E is within the Conservation category area and is

consequently not being considered for development. The bores MW2-E and MW4-E roughly represent the lowest areas that will be developed under the current proposal. The AAMGLs in these areas are between 0.227 and 0.283 m above the natural surface. Groundwater contours for the site are shown in Figure 14.

Groundwater flow is expected to be generally south-westerly, towards the Peel Main Drain (DoW 2009) and this is confirmed by the recorded groundwater results from the site. However, groundwater levels and flow directions on the site will be affected by the Peel Main Drain. When the groundwater levels are higher than the drain, groundwater will flow towards the drain. When the water level in the drain is higher than the groundwater, the drain will recharge the groundwater.

3.8.2 GROUNDWATER QUALITY

The full set of groundwater quality results for the site is contained in Table 14.

Field pH measurements indicate groundwater was close to neutral (6.3 to 7.6) in all bores located within the site (Table 14). Some of the lower pH's recorded at the site are slightly below the ANZECC (2000) default trigger value for slightly disturbed wetlands (7.0 to 8.5). This may be due to the presence of tannins which can cause pHs as low as 4.5 in highly coloured wetlands (ANZECC 2000). Some of the higher pHs are slightly above the target range stated in the Jandakot Drainage and Water Management Plan (DWMP) (5.2 to 7.3) but within the ANZECC trigger values (DoW 2009).

Electrical conductivity (EC) levels measured in the bores indicate that groundwater at the site ranges from being fresh to brackish (307 to 1856 mg/L calculated TDS). Some of the higher salinities recorded at the site were slightly above the ANZECC (2000) trigger values (300 to 1500 us/cm EC) but were within the range stated in the Jandakot DWMP (up to 5 000 mg/L TDS). Higher salinities were generally recorded in early winter, closer to the drain and in areas with a shallow water table, indicating the likely cause of the brackish groundwater is the higher concentration of salts caused by evaporation and transpiration.

Water quality sampling indicates that nitrogen and phosphorus are elevated in groundwater below the site, probably due to the historical agricultural use at the site. Total Nitrogen (TN) levels were up to 13 times above the Swan Canning Cleanup Program (SCCP) Long-Term target of 1 mg/L in all of the samples collected. Total Nitrogen (TN) levels were also above the ANZECC (2000) trigger value of 1.5 mg/L in eight of the 12 of the samples collected (by up to 8.7 times). However, the TN levels recorded at the site were within the range of concentrations outlined in the Jandakot DWMP (DoW 2009) (<1 to 123.7 mg/L). Four of the 12 concentrations were greater than 3 mg/L, hence above typical values for the area. The breakdown of nitrogen in Table 14 indicates that the predominant form of nitrogen at groundwater at the site is organic nitrogen, as given by the low proportion of nitrate and nitrite (NOx).

Total Phosphorus (TP) levels were above both the Swan Canning Cleanup Program (SCCP) Long-Term target of 0.1 mg/L in just over three quarters of the samples collected, by up to 13 times. TP concentrations also exceeded the ANZECC (2000) trigger value of 0.06 mg/L in all but one of the samples collected, by up to 22 times. All TP levels recorded on the site were within the range of concentrations outlined in the Jandakot DWMP (DoW 2009) (0.01 to 34.7 mg/L). Five of the 12 concentrations were greater than 0.5 mg/L, hence above typical values for the area. In all of the bores, except MW1-E, phosphate (PO_4^{3-}) concentrations were negligible. This suggests that phosphorus in groundwater across most of the site exists predominantly in a particulate form and therefore is likely to present less of a risk to aquatic life.

Metals also occur in the groundwater at concentrations above ANZECC (2000) trigger values. For the July 2010 water quality sampling event only copper and zinc exceeded the trigger values of 0.0014 mg/L and 0.008 mg/L, by less than three times. Metal concentrations were higher in the October 2010 and January 2011 sampling rounds with arsenic, chromium, copper, lead, nickel, zinc and mercury all exceeding the trigger values by more than four times. In all bores aside from MW5, copper concentrations had increased by between ten and 100 fold and were up to 321 times higher than the trigger value. Lead and nickel concentrations also exceeded the NHMRC (2004) Australian Drinking Water Guidelines (ADWGs) of 0.01 mg/L and 0.02 mg/L by up to 18 and 5.5 times respectively. The source of the elevated metals could be infiltration of stormwater from the surrounding urban development which would explain the increase in concentrations from July to October. The historical agricultural use could also be a contributing source.

Table 14: Water Quality

Date	Bore ID	Field pH	Field EC uS/cm	Calculated TDS (mg/L)	Total N mg/L	TKN mg/L	NO3+NO2 mg/L	NO3-N mg/L	NO2-N mg/L	NH3-N mg/L	Total P mg/L	PO4 mg/L	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Mercury mg/L	Nickel mg/L	Zinc mg/L
8/07/10	MW1E	7.0	690	442	3.8	3.0	NA	0.72	0.039	0.02	1.3	0.25	0.001	<0.0001	<0.005	0.003	0.001	<0.0001	0.003	<0.01
	MW2E	7.4	1150	736	1.1	1.1	NA	0.01	<0.005	0.57	0.58	<0.005	<0.001	<0.0001	<0.005	0.003	0.001	<0.0001	0.002	<0.01
	MW4E	7.6	1620	1037	2.3	2.1	NA	0.14	0.023	0.53	0.46	<0.005	<0.001	<0.0001	<0.005	0.002	<0.001	<0.0001	0.003	<0.01
	MW5E	7.3	1690	1082	1.7	1.6	NA	0.07	0.036	0.37	0.38	<0.005	<0.001	<0.0001	<0.005	0.002	<0.001	<0.0001	0.004	<0.01
	MW6 (New)	6.8	2900	1856	13	10.0	NA	1.50	1.500	1.10	0.88	<0.005	0.002	<0.0001	<0.005	0.001	<0.001	<0.0001	0.007	0.003
	MW6	6.3	1570	1005	12	7.8	NA	4.00	0.220	0.28	0.38	<0.005	0.002	<0.0001	<0.005	0.004	<0.001	<0.0001	0.005	0.01
28/10/10	MW1E	6.6	480	307	1.3	1.2	0.092	NA	NA	0.02	1.3	0.3	<0.01	<0.002	0.04	0.057	0.067	0.003	0.006	0.02
	MW2E	7.2	1080	691	1.3	1.2	0.008	NA	NA	0.64	0.12	0.005	0.02	<0.002	0.028	0.033	0.013	<0.0001	0.006	<0.01
	MW4E	7.6	840	538	1.7	1.6	0.033	NA	NA	0.53	0.15	<0.005	0.1	<0.002	0.18	0.024	0.024	0.0004	0.05	0.02
	MW5E	7.1	580	371	1.3	1.3	0.031	NA	NA	0.19	0.12	0.008	<0.01	<0.002	0.006	<0.005	<0.001	<0.0001	<0.005	<0.01
	MW6 (New)	6.4	2190	1402	2.7	2.4	0.36	NA	NA	0.36	0.03	<0.005	0.07	<0.002	0.26	0.45	0.18	<0.0001	0.074	0.16
	MW6	6.4	580	371	3.3	3.1	0.18	NA	NA	0.56	0.07	<0.005	0.05	<0.002	0.12	0.046	0.086	0.0003	0.043	0.16
20/01/11	MW1E	6.5	670	429	3.7	0.9	2.8	NA	NA	0.05	0.79	0.17	0.004	<0.002	0.032	0.079	0.017	0.0002	<0.005	0.03
	MW2E	7.4	520	333	1.7	1.4	0.28	NA	NA	0.65	0.21	0.03	0.091	<0.002	0.048	0.059	0.004	0.0001	0.01	0.06
	MW4E	7.5	790	506	7.2	6.9	0.26	NA	NA	0.75	0.12	0.03	0.62	0.003	0.081	0.019	0.008	0.001	0.014	0.06
	MW5E	7.3	1400	896	7.2	6.9	0.31	NA	NA	1.00	0.3	0.03	0.41	0.006	0.35	0.13	0.02	0.0004	0.11	0.11
	MW6 (New)	7.5	1200	768	8.3	7.6	0.72	NA	NA	0.49	0.091	0.05	0.13	0.002	0.25	0.32	0.17	0.0002	0.063	0.14
	MW6	7.3	1700	1088	7.1	6.7	0.4	NA	NA	0.26	0.08	0.03	0.059	<0.002	0.047	0.036	0.014	0.0001	0.017	0.08
SCCP Long Term Target[1]					1						0.1									
ANZECC Trigger Value[2]		7.0 – 8.5	300 – 1500		1.5		0.1			0.04	0.06	0.03	0.024	0.0002	0.01	0.0014	0.0034	0.00006	0.011	0.008
Drinking Water Guideline[3]								11.3					0.007	0.002	0.05	2	0.01	0.001	0.02	3*

3.9 SURFACE WATER HYDROLOGY

Surface water exists seasonally at the site as Bollard Bulrush Swamp and as the Peel Main Drain, an artificial drainage line. The Peel Main Drain is a rural drain which runs through the Bollard Bulrush Swamp area and forms part of the regional drainage network. The drain is located within the catchment of the Serpentine River which eventually discharges into the Peel Harvey Estuary.

Coincident with the groundwater monitoring program outlined previously, ENV has undertaken eight occasions of surface water level measurement at four surface water monitoring locations. Inundation of Bollard Bulrush Swamp is monitored at two locations (SW1E and SW2E) and water levels in the Peel Main Drain upstream and downstream of the site is monitored at the other two locations (Culvert North and Culvert South).

Surface water quality monitoring of Bollard Bulrush Swamp could not be undertaken because the two surface water sites were dry throughout the monitoring period as detailed below.

3.9.1 SURFACE WATER LEVELS

Bollard Bulrush swamp inundation is caused by direct runoff from the local catchment area and tailwater conditions in the Serpentine River. During periods of high rainfall causing floodwaters from the Serpentine River flood the Peel Main Drain and in turn, inundate the surrounding low lying areas of Bollard Bulrush Swamp. Maximum Surface Water Levels (MSWL) recorded from the site are presented in Table 15, below.

Table 15: Maximum Surface Water Levels

MONITORING LOCATION	MSWL (m AHD)
SW1	dry
SW2	dry
Culvert North	7.19
Culvert South	3.95

The results indicate that surface water inundation did not occur to the east of the main drain during the monitoring period. It is likely that this is due to below average rainfall during this time. Water levels in the Peel Main Drain at the time of sampling were over 0.7 m below the 10 Year ARIs presented in Table 16.

3.9.2 ESTIMATED FLOOD CHARACTERISTICS

As shown on Figure 15 the site is partially located within the flood fringe of the Peel Main Drain (DoW 2009). The floodway, or area of fast flowing water, is limited to the Peel Main Drain itself.

The Jandakot DWMP (DoW 2009) provides flood levels for the Peel Main Drain at Bollard Bulrush. These are summarised in Table 16 below.

Table 16: Peel Main Drain Flows (DoW 2009)

Location	Peak Flows (m3/s)		Peak levels (m AHD)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Peel Main Drain at Bertram Road	3.25	3.82	7.9	8.2
Bollard Bulrush Swamp (the site)	3.38	4.00	4.82	5.61
Peel Main Drain at Millar Rd	4.38	5.06	4.70	5.59

The 1 in 100 year Average Recurrence Interval (ARI) flood level for Bollard Bulrush Swamp is given as 5.6 m AHD in the DWMP (DoW 2009). Approximately 1,900 ML of storage is currently provided within Bollard Bulrush's flood fringe in the 1 in 100 year flood level (DoW 2009). Bollard Bulrush Swamp is the largest storage location in the northern part of the Peel Main Drain. The total flood area at Bollard Bulrush is estimated at 149 Ha. Of this, less than 10 ha (or 10%) is considered to be within the subject site.

3.9.3 WATER BALANCE

An estimate of the pre-development quantity of water that either drains from the site or infiltrates was made based on an infiltration rate of 15% of rainfall. This value was compared to an estimate of the post-development drainage and infiltration quantities. The post-development values were determined using standard water use figures for each of the land uses in the development. This information is provided in Table 17 and shows that post-development, there will be a 250% increase in discharge. This is typical of developments of this density.

Table 17: Pre and Post-Development Water Balance

Pre-Development	Drainage and Infiltration (ML/yr)
Pre Development	**92.59**

Post-Development	Drainage and Infiltration (ML/yr)
Groundwater Input	
Low Density	131.89
Medium Density	126.54
School recharge from rainfall &irrigation	25.50
POS recharge from rainfall &irrigation	17.62
Drainage areas and roads	54.05
Total Input	**355.61**
Groundwater Extraction	
Low Density	-29.31
Medium Density	0.00
Groundwater for School irrigation	0.00
Groundwater for POS irrigation	0.00
Total Extraction	**-29.31**

Total recharge to groundwater and drainage leaving site	**326.29**
Extra volume recharge/outlfow	**233.71**
% increase of recharge/outflow	**252%**

4 ENVIRONMENTAL FACTORS AND MANAGEMENT

The instructions from the EPA on the scope and content of this Environmental Review have led to further environmental research and investigation in order to quantify the environmental assets of the site. The risks posed to these assets by the development of the Wellard Urban Precinct East have been identified and defined, and are discussed in detail. Management responses to these risks have been defined as part of an overall environmental management framework for the development.

The key environmental issues requiring a management response during the development of the Wellard Urban Precinct East are identified by the EPA as follows:

- Wetlands: Bollard Bulrush Swamp;
- Fauna: the fauna of Bollard Bulrush Swamp; and
- Water: particularly surface and groundwater quality and quantity.

4.1 WETLAND

Bollard Bulrush Swamp is recognised in the DEC's *Geomorphic Wetlands of the Swan Coastal Plain* dataset (as a mixture of Conservation category, Resource Enhancement and Multiple Use), and as an EPP Lake under the *Environmental Protection (Swan Coastal Plains Lakes) Policy 1992*. These classifications afford varying levels of protection to the wetland. The floristic community of the wetland is "*M. rhaphiophylla – Gahnia trifida* seasonal wetlands".

4.1.1 POTENTIAL SOURCES OF IMPACT

Residential development in proximity to the Swamp may result in both positive and negative modifications. On the positive side, there is likely to be more passive surveillance of the site, which should lead to less uncontrolled access by mountain bike riders and walkers, which is noted as a highly destructive practise. However, residents living nearby may seek to gain access themselves to the naturalistic environment preserved in the wetland, leading to potential negative impacts on vegetation, fauna and fauna habitat, and the physical structure of the shore and swamp through increased pedestrian traffic (in the case of uncontrolled access).

Potential threats to wetlands in association with the change in land use to Urban/Residential are identified as follows:

- alteration to the water regime;
- habitat modification;
- inappropriate recreational usage;
- weed invasion; and
- diminished water quality.

4.1.2 MANAGEMENT OBJECTIVES

The management objectives recognised by the State Government for Multiple Use wetlands are to allow for "*Use, development and management…in the context of ecologically sustainable development and best management practice catchment planning through landcare*" (EPA 2008a).

The management objectives for Resource Enhancement wetlands "*to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category status. This can be achieved by restoring their wetland function, structure and biodiversity."* (EPA 2008a).

The management objectives for Conservation category wetlands is the "*preservation of wetland attributes and functions through various mechanisms including:*

- reservation in national parks, crown reserves and State owned land,
- protection under Environmental Protection Policies, and
- wetland covenanting by landowners.

These are the most valuable wetlands and the Commission will oppose any activity that may lead to further loss or degradation. No development." (EPA 2008a).

4.1.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

The effective mitigation and management actions for Bollard Bulrush Swamp rely on an approach which will provide a consolidated wetland area for conservation into the future.

In 2012, staff from Strategen attended the site and took a series of photographs from points surrounding the wetland (these are provided in Appendix G). This process was used by Strategen to re-define the functional boundary of the wetland (Figure 16 - Strategen). Figure 16 has been developed in consultation with the EPA based on the extent and condition of existing vegetation as determined by aerial photographs and site assessment.

Determination of Wetland Buffer

It is relevant to note that there is an area surrounding the Conservation category and Resource Enhancement Wetland areas that is categorised as Multiple-Use. The Multiple-Use portion of the wetland is degraded and severely infested with weeds and therefore ENV considers that a portion of it should be used as a separation area to protect the attributes of the other portion.

This buffer will protect the vegetation and fauna values of the wetland, and provide areas for roosting, nesting, feeding and refuge. This separation from the urban land use will reduce the impact of human activities on both the vegetation and fauna of the wetland area. This will occur through limiting exposure to the following:

- Passive and active recreation by nearby residents which have the potential to disturb waterbirds and vegetation of the wetland;
- Domestic animals;
- Construction effects such as noise and vibration; and
- Effects of housing such as noise, movement and light.

The WAPC draft *Guideline for the Determination of Wetland Buffer Requirements* (2005) recommends a 50 m buffer, but this may vary depending on the threatening processes. A buffer distance of 50m is considered as appropriate to adequately protect the wetland function area and wetland habitat from further weed infestation and from inappropriate recreational uses (see Figure 16 for the outline of the wetland function area and buffer as defined by Strategen).

This will result in a manageable, cohesive wetland area, which encompasses the important features of the wetland and can be rehabilitated to provide net benefit in terms of the enhancement of native vegetation, fauna habitat, and aesthetics.

Subdivision Design

The subdivision design has been carefully considered in order to provide appropriate planning and environmental outcomes (Figure 17 – Greg Rowe and Associates).

Appropriate development setbacks will be incorporated into subdivision design and the Wetland Management Plan. Details of landscaping and design interface solutions, such as protective fencing and creation of a hard edge to the agreed wetland area, will also be included in a Wetland Management Plan.

Management Control

The effectiveness of management of the wetland area will be greatly enhanced through its transfer from fragmented, private ownership, to a cohesive unit under public ownership. The consolidation and rehabilitation of a central conservation area which

encapsulates the wetland function area will provide a more cohesive vegetated area and habitat.

Urbanisation of the adjacent area will provide the opportunity to exclude grazing and uncontrolled access to the swamp. This will in turn allow the rehabilitation and recovery of the wetland core vegetation (where the key environmental values are located), and reduce the threats posed by increased nutrient loading. Provision of formal, controlled public access to the swamp will increase the amenity and recreation values available to the surrounding community.

A Construction Environmental Management Plan will be implemented during development, and this will include management strategies to reduce the likelihood of the Priority 1 weeds on the site spreading further within the site, or to other sites.

A Wetland Management Plan will be developed to manage the impacts of the proposed development on the wetland, and its flora and fauna values. The implementation of the Wetland Management Plan will allow progress towards the enhancement of the wetland core habitat, vegetation and function, including the reduction of weed dominance. This will lead to a greatly improved environmental outcome which is otherwise unlikely to be achieved under current conditions, in the absence of any formal management.

4.2 FAUNA

The fauna survey of the subject site found fauna typical of a highly disturbed wetland environment on the Swan Coastal Plain. Two migratory bird species listed under the EPBC Act were considered to be likely to occur in the wetland portion of the site (the Cattle Egret and Eastern Great Egret), and evidence of the presence of one conservation significant Priority Four species (the Southern Brown Bandicoot).

4.2.1 POTENTIAL SOURCES OF IMPACT

The primary sources of impact on migratory birds utilising the wetland environment as a result of the project would most likely stem from altered hydrological regimes impacting on the wetland, the continued degradation of the wetland vegetation as a result of uncontrolled access and further weed dominance, and the possibility of predation by feral animals such as the black rat, the domestic cat, and the domestic dog.

4.2.2 MANAGEMENT OBJECTIVES

Management of the wetland should aim to protect the fauna present, particularly migratory birds, and the Southern Brown Bandicoot. This is most likely to be achieved through the rehabilitation of the potential fauna habitat represented by the site.

4.2.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

Design

The design of the wetland interface will allow a greater level of control of access by feral animals and control for weed infestation. In combination with revegetation and weed control actions, this will encourage the recovery of fauna habitat in the agreed wetland area.

Management Control

Revegetation of the wetland area can focus on the creation of appropriate habitat for the Southern Brown Bandicoot, the Cattle Egret, and the Eastern Great Egret. Improvement of the quality of the habitat will serve to encourage use by all native fauna, including conservation significant fauna.

4.3 SURFACE WATER

4.3.1 POTENTIAL SOURCES OF IMPACT

Change of land use from rural to urban can result in an increase in the surface run-off from the development area due to an increase in non-permeable surfaces. Urban development may also increase the volume of pollutants, both chemical and physical, which are transported by that run-off.

4.3.2 MANAGEMENT OBJECTIVES

Surface water management is not only about restricting the increase in runoff due to development but must also manage and restore desirable environmental flows where potential impacts on significant ecosystems are identified; in this case Bollard Bulrush Swamp. The potential movement of pollutants from the site in stormwater also needs to be addressed. Appropriate management intervention can facilitate improvements in surface water quality post-development.

4.3.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

Surface Water - Design and Management Control

Surface water management in the subject site will:

- Ensure that adequate protection is provided to buildings and infrastructure against flooding;
- Ensure downstream flood risks are mitigated;

- Maintain catchment runoff within the development are to pre-development peak flow velocities;
- Maintain sub-catchment discharge point flow velocities to pre-development peak flow velocities;
- Promote on-site retention of events up to the one–year–one–hour average recurrence interval; and
- Minimise the release of anthropogenic pollutants from the subject site.

Flooding - Design and Management Control

GHD was commissioned in 2010 to undertake flood modelling for the Bollard Bulrush Swamp. The full report undertaken by GHD is provided in Appendix H. The model was based on the model conducted for the Jandakot Drainage and Water Management Plan (DoW 2009). The Bollard Bulrush model reflected the proposed development of the area, hence used increased percentage of impermeable area. This will give a worst case scenario of the likely impact because urban sensitive design was not factored into the model.

The results indicate that the maximum water level within the Bollard Bulrush Swamp changes by less than 100 mm for the 100 year ARI event and that levels both upstream and downstream of the Peel Main Drain remain relatively unchanged during such a storm. Results are presented in Table 18.

Table 18: Modelling of Full Extent of Proposed Development (GHD 2010)*

LOCATION	TOP WATER LEVEL (m AHD)		PEAK FLOW (m^3/S)	
	10 year ARI	100 year ARI	10 year ARI	100 year ARI
Bollard Bulrush Swamp	4.85 *(+ 30 mm)*	5.65 *(+ 4 0mm)*	3.38 *(no change)*	4.00 *(no change)*
Peel Main Drain and Bertram Rd	7.90 *(no change)*	8.20 *(no change)*	3.25 *(no change)*	3.82 *(no change)*
Peel Main Drain at Millar Rd	4.72 *(+ 20 mm)*	5.62 *(+ 30 mm)*	4.73 *(+ 350 L/s)*	5.77 *(+ 710 L/s)*

** brackets indicate change from Jandakot DWMP modelling results*

To protect against flooding, the site will be filled to achieve finished floor levels at least 0.5 m above the 100 year peak water level. Preliminary estimates indicate up to 1.5 m of fill is required for house pads in the area adjacent to the wetland (below the 5.6 m AHD contour) to meet requirements for flooding. The fill requirements for flooding are greater than the requirements for groundwater separation, as discussed previously.

A water balance model was prepared to compare flows discharged from the site pre-development and post-development. Model inputs and assumptions were obtained from the MRS Amendment report and GHD Flood Modelling study.

An increase in recharge volume of approximately 250% is estimated post-development as shown in Appendix H. The pre-development recharge is estimated at 93 ML/year. Water balance calculations indicate that approximately 233 ML/yr additional recharge will occur on site once developed. This expected increase in recharge is a direct result of the increase in impervious area associated with development of residential and school areas.

Conceptual Stormwater Management System

The environmental flow objectives of the *Water Quality Improvement Plain (WQIP) for the Rivers and Estuary of the Peel-Harvey System* (EPA 2008b) are to maintain natural flow variability, protect wetlands and floodplains (mimic natural inundation and drying patterns) and minimise the effect of dams on water quality (mimic natural frequency, duration and seasonal flow).

Stormwater design will aim to achieve these objectives via the following:

- Retention of the 1 in 1 year ARI storm on site;
- Detention of flow to pre-development discharge for events up to the 1-year-1-hour average recurrence interval; and
- Maintenance of the hydrological regime of the wetlands.

Details to achieve this will be provided in a Local Water Management Plan (LWMS).

Surface Water Quality Best Management Practices

Surface water quality management within the site will aim to achieve phosphorus reductions and meet water quality targets specified in EPA (2008b) WQIP including a mean phosphorus concentrations of 0.1 mg/L in streams in winter. Both structural and non-structural Best Management Practices (BMP's) will be implemented to improve the quality of drainage from the development. The selection of BMPs will be guided by the Department of Water's *Stormwater Management Manual* (2004-2007) and the recommendations within the *Jandakot Water Resource Management Strategy* (DoW 2004).

Structural BMP's to be implemented will include:

- Water sensitive urban design to promote infiltration and treat stormwater before its discharge into waterways;
- Stormwater basins and swales to minimise sediment and pollutant movement;
- Subsoil drainage outlet points will run into a swale or bioretention area;
- Separation of stormwater from clean sources (such as roofs) from 'dirty' sources such as roads and industrial areas into separate basins; and
- Revegetation of cleared areas following construction, except where there will be buildings, paving or detention basins, where possible.

Non-structural BMP's will include:

- Various Environmental Management Plans will be prepared and implemented that present details of stormwater management during both the construction and operational stages;
- Inclusion of stormwater and spill management and environmental awareness training for construction staff; and
- Community education.

Stormwater management system design and proposed BMPs will be detailed in the LWMS and Urban Water Management Plans (UWMP's).

Post-development Surface Water Monitoring

Post development monitoring should be for 3 years from 80% completion of the development include sampling of surface water for pH, electrical conductivity, nutrients and metals.

The post-development monitoring program will follow the program summarised in Table 19.

Table 19: Post-Development Surface Water Monitoring Program

Frequency	Parameters to be Monitored
Site Specific	Water Levels
Quarterly	*In Situ*: pH, EC, Temperature TSS, Total N, Total P, NH_3, NO_3, NO_2, TKN, SRP/FRP

A site specific contingency action plan with associated trigger values based on the predevelopment monitoring results must be developed and presented in the Local Water Management Strategy. When trigger values are breached, communication must occur with the department of water and the Town of Kwinana as per the Jandakot DWMP (DoW 2009).

4.4 GROUNDWATER

4.4.1 POTENTIAL SOURCES OF IMPACT

Changes to the water that result from development may include alterations to the groundwater level or quality. Reduction of groundwater levels as a result of development have the potential to negatively impact on groundwater dependent ecosystems. Conversely, increases in groundwater level have the potential to increase the risk to infrastructure and assets from flooding, as well as promote transportation of nutrients and other pollutants held in the soil.

Changes in land use may also bring about changes to the groundwater quality of an area – often the quality of the groundwater may improve. The subject site also occurs within an area of high risk for Acid Sulfate Soils (ASS). Dewatering, soil disturbance, compaction or lateral displacement in areas of ASS during residential development can result in the contamination of soil and groundwater.

4.4.2 MANAGEMENT OBJECTIVES

The key objectives for groundwater management outlined in the Jandakot DWMP are:

- Protection of infrastructure and assets from flooding and inundation by high seasonal groundwater levels, perching and/or soil moisture;
- Protection of groundwater- dependent ecosystems from the impacts of urban runoff or water table decline; and
- Managing and minimising changes in groundwater levels and groundwater quality following development/redevelopment (DoW 2009).

4.4.3 PROPOSED MITIGATION AND MANAGEMENT ACTIONS

Groundwater Level Management

Groundwater levels will be maintained post-development through the use of imported fill and subsoil drainage where required. Filling to protect against flooding should also provide sufficient clearance to maximum groundwater, making any dewatering at the site highly unlikely to be necessary.

Groundwater Quality Management

Groundwater quality will be maintained to pre-development levels (median winter concentrations) and if possible improve the quality leaving the development area, which will be facilitated through the urban development of the site. The following best management measures will be implemented to manage groundwater quality as per the EPA (2008b) WQIP, the *Jandakot Structure Plan* (WAPC 2007) and the DoW's *Jandakot Water Resource Management Strategy* (DoW 2004):

- Urban fertiliser management, including limiting the use of fertilisers in Public Open Space (POS), promotion of fertiliser wise gardens and public education;
- Incorporation of soil amendments, swales and infiltration basins and irrigated POS, where required.
- Encouragement of soil amendments in residential lawns and gardens via Waterwise landscaping packages.
- Where groundwater is extracted for irrigation, extract that portion of the shallow groundwater that is enriched with nutrients.
- Connection of the development to reticulated sewage as detailed in Section 5.5.3.

Groundwater management system design will be detailed in the LWMS and UWMPs.

Post-development Groundwater Monitoring

Post development monitoring should be for 3 years from 80% completion of the development include sampling of groundwater for pH, electrical conductivity, nutrients and metals.

Groundwater bores will be sampled across the site in the post-development monitoring program ensuring in bores located at the upstream side of the development and bores at the downstream side of the development.

The post-development monitoring program will follow the program summarised in Table 20.

Table 20: Post-Development Groundwater Monitoring Program

Frequency	Parameters to be Monitored
Quarterly	Water Levels
	In Situ: pH, EC, Temperature TSS, Total N, Total P, NH_3, NO_3, NO_2, TKN, SRP/FRP
Annually	Heavy Metals

A site specific contingency action plan with associated trigger values based on the predevelopment monitoring results must be developed and presented in the Local Water Management Strategy. When trigger values are breached, communication must occur with the department of water and the Town of Kwinana as per the Jandakot Drainage and Water Management Plan (DoW 2009).

Acid Sulphate Soils Management

Dewatering, soil disturbance, compaction or lateral displacement in areas of ASS during residential development of the site will be avoided where possible. The design of the development is highly likely to involve the importation of fill during development to achieve the required separation from groundwater levels, and to reduce flooding risk. This will reduce the likelihood of disturbing ASS through reducing the need for dewatering and large-scale excavations.

Should design development later in the planning process involve the disturbance or dewatering of any areas of potential ASS, a compliant investigation will be undertaken and an Acid Sulfate Soils and Dewatering Management Plan will be implemented for the site as a condition of subdivision.

Management of Effluent Disposal

Because of the high groundwater levels on the site and the size of residential lots, the use of on-site wastewater systems is not considered appropriate. The EPA (2008) WQIP states that all new developments in the Peel-Harvey Catchment are to be connected to reticulated sewage or Alternative Treatment Units (ATU's). The development will therefore be connected to the urban sewerage system.

5 ENVIRONMENTAL MANAGEMENT FRAMEWORK

5.1 CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN

The Construction Environmental Management Plan will provide a series of guidelines which will address the following issues during the construction phase of the future development of the site:

- Clearing protocols;
- Protection of wetland values;
- Protection of any native fauna present on the site;
- Reduction of noise pollution caused increased large vehicle traffic in the area, as well as construction noise and vibration;
- Spill mitigation and management in terms of chemicals and fuels either kept onsite or used onsite;
- Dust management during site clearing activities;
- Dieback management;
- Provision of a hygiene station to wash vehicles down prior to leaving the site to reduce the likelihood of spread of declared weed plants;
- Minimisation of disturbance of any Acid Sulphate Soils that occur on the site; and
- Revegetation and rehabilitation of preserved areas of native vegetation, and restriction of public access to rehabilitation and vegetated areas to reduce further degradation.

5.2 WETLAND MANAGEMENT PLAN

A Wetland Management Plan will be prepared at the subdivision stage of the development, outlining specific strategies for the preservation of the agreed area of Bollard Bulrush Swamp. This plan will detail the following:

- How preservation of the hydrological regime will be achieved; and
- How the vegetation and ecological values of the agreed portion of the wetland will be maintained and enhanced, including interface management.

The wetland management plan will include:

- A specific vision to ensure the wetland's values and attributes are conserved and enhanced;
- Outline of the existing environment;
- Identification of potential threats and sources of impacts;
- Outline current management issues;
- Specify management undertaken to date;
- Identify new management strategies, including;
    - Detail of the interface between the development and the wetland, and how this will assist in the control of weed infestation;
    - Rehabilitation works to be undertaken in the agreed wetland area and buffer (see Figure 16), including planting of appropriate native plant species and wetland-sensitive weed treatments;
    - Location and details of any infrastructure proposed to protect wetland values, such as fencing, paths, boardwalks and signposting;
    - Control of direct public access to the wetland, possibly through the installation of pathways or boardwalks to allow passive recreation;
    - Location and detail of interpretive signage;
    - Description of community education program, which may include provision of educational materials to residents; and
    - Any fauna relocation (if necessary);
- An implementation plan, including definition of responsible parties; and
- Guidelines for future monitoring programs, including methodology, performance criteria, and contingency measures.

5.3 WATER MANAGEMENT PLANS

A series of reports focussing on total water cycle management for the site will be produced in concert with further development planning of the site. These will provide an increasing level of detail in support of each stage of the planning process, as required by *Better Urban Water Management* (WAPC 2008).

5.3.1 DISTRICT WATER MANAGEMENT STRATEGY

A District Water Management Strategy (DWMS) will be prepared to accompany any future application for lifting of Urban deferment for the site. This will be based upon the guidelines presented in *Better Urban Water Management* (WAPC 2008) and will include the following:

- Design and management objectives;
- A summary of the pre-development environment including a summary of any previous studies; in particular the modelling work completed for this Environmental Review, and the analysis and management options contained within it;
- An analysis of potential development impacts and options for enhancing water conservation in future development at the site;
- A presentation of the site water balance and a discussion on fit-for-purpose water source planning, including allocation of water for different uses and any existing and required infrastructure;
- A water management strategy; including a presentation of the stormwater model and a discussion on the appropriate management of surface water, groundwater, wastewater and drinking water management and how to enhance water efficiency at the site; and
- An Implementation framework.

5.3.2 LOCAL WATER MANAGEMENT STRATEGY

A Local Water Management Strategy consistent with the requirements of *Better Urban Water Management* (WAPC 2008) will be prepared alongside the Local Structure Plan for the development. This Strategy will include the following sections:

- Principles and objectives of total water cycle management;
- Details of the proposed development;
- Design criteria;
- A description of the pre-development environment;
- Average Annual Maximum Groundwater Levels based on groundwater monitoring;
- Minimum floor levels to provide protection from the groundwater table and local flood levels;
- Description of the conceptual stormwater water modelling;
- Detail structural and non-structural controls for stormwater quality to be used in the development;
- An assessment of potential potable water conservation measures for the site; and
- Guidance on future management of the site including requirements for monitoring, roles, responsibilities and construction.

5.3.3 URBAN WATER MANAGEMENT PLAN

In line with *Better Urban Water Management* (WAPC 2008) and the *Urban Water Management Plan Guidelines* developed by DoW (2008), an Urban Water Management Plan will be produced alongside the subdivision application for the development, and will include:

- A summary of the pre-development environment including a summary of previous studies;
- Design objectives for water management;
- Pre and post-development water balances and a discussion of how the potable water management strategies will be met;
- Summary of the stormwater design undertaken by project engineers to demonstrate that the design complies with Department of Water and Town of Kwinana requirements and accompanying engineer's drawings;
- A groundwater management plan to demonstrate protection of groundwater resources;
- Specific design information regarding engineering design and landscape architecture in the UWMP;
- Proposed nutrient management approaches, including both structural and non-structural controls;
- A plan for management of subdivision works;
- Design of a post-development monitoring programme; and
- An implementation plan.

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FIGURES

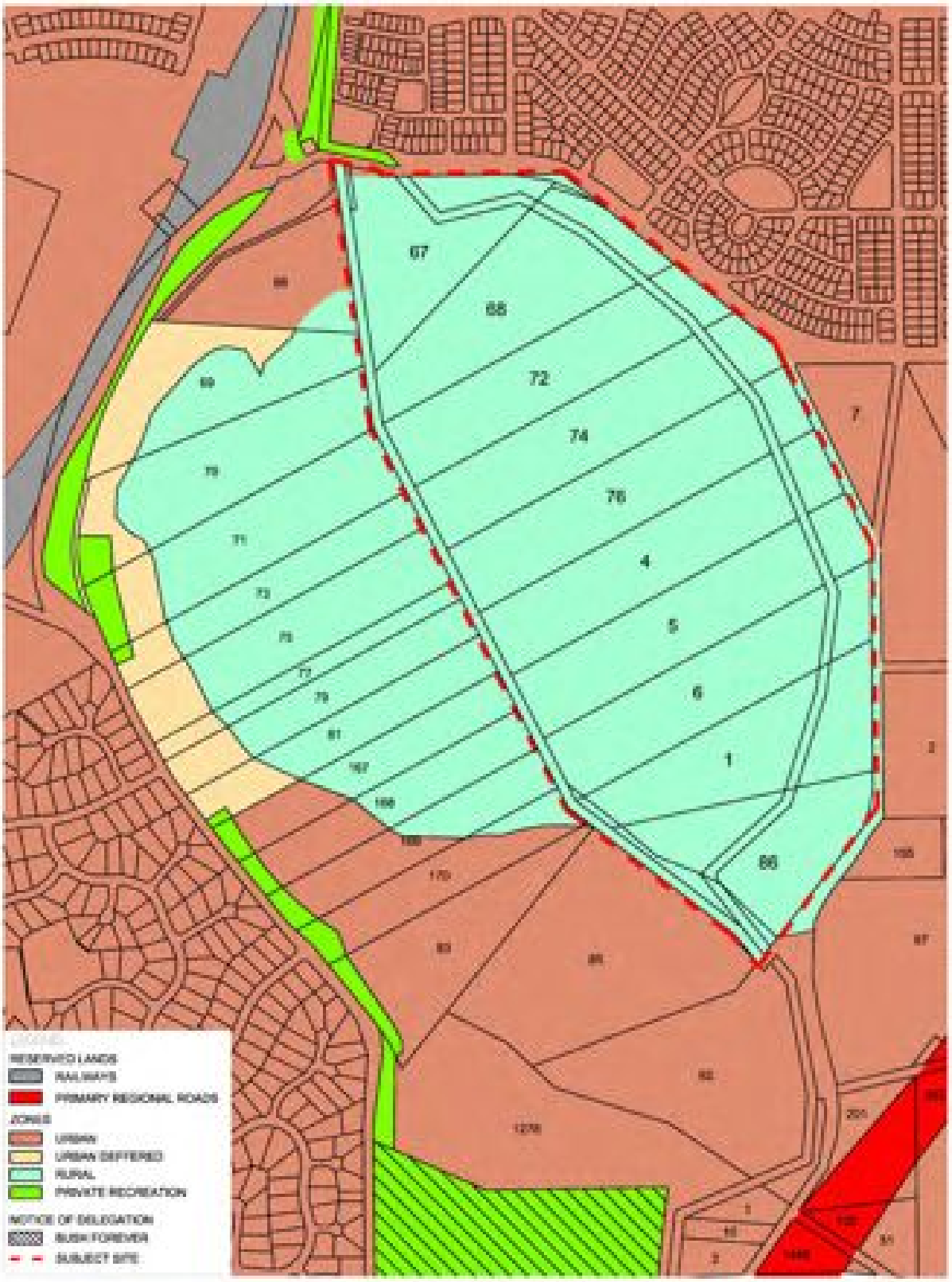


CLIENT: Wellard Landowner's Group
JOB NO.: 10.127
AUTHOR: K. Thomson
DRAWN: T. Ellis
DATE: 9-03-2011
SCALE: 1:8,000 @ A4
PROJECTION: GDA94 MGA50

Location Map

Wellard Urban Precinct East
Environmental Review

FIGURE 1



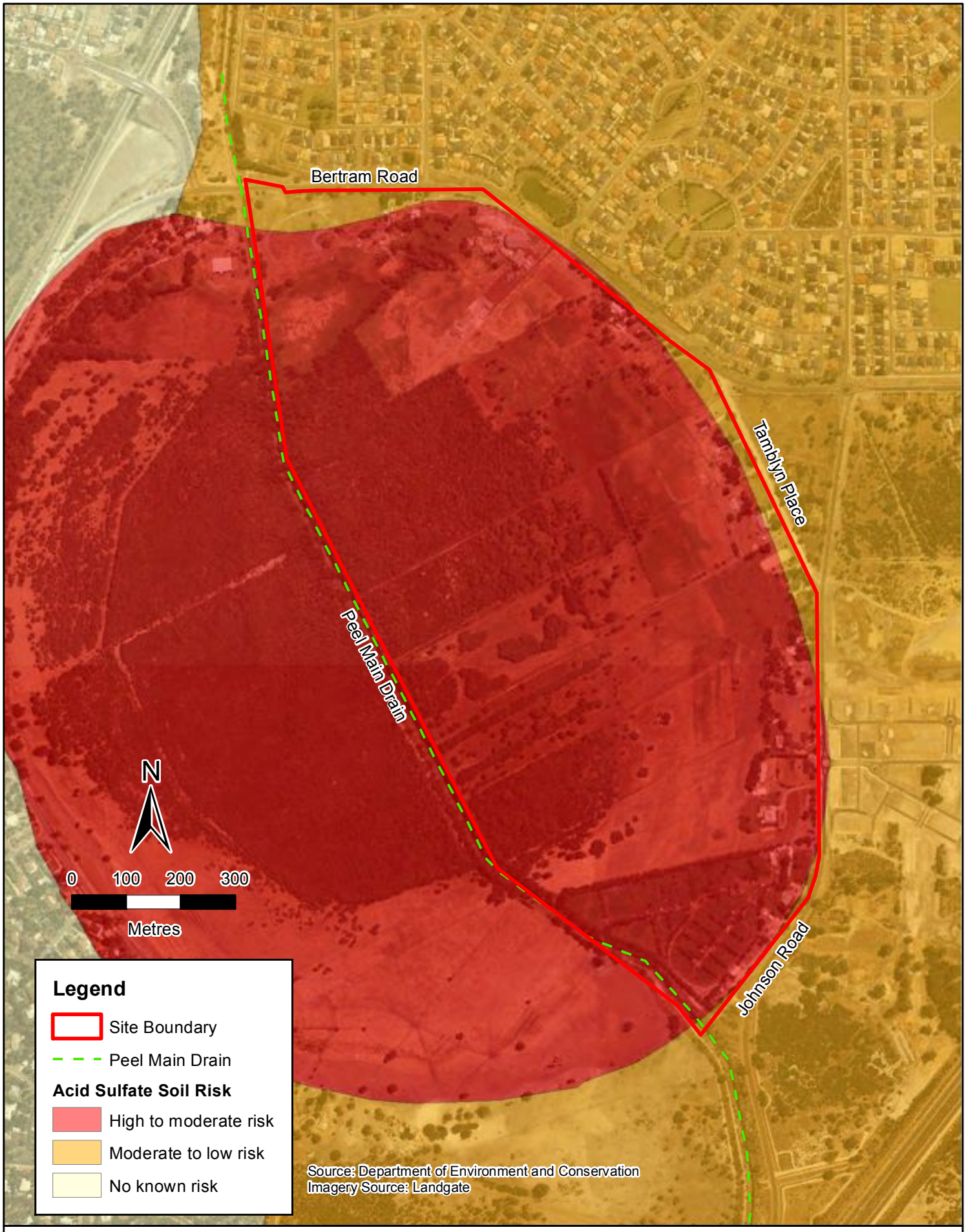
Source: Greg Rowe & Associates

CLIENT			**JOB NO.**
Wellard Landowner's Group			10.127
AUTHOR	**DRAWN**		**DATE**
K. Thomson	M. Mikkonen		12-09-2012
SCALE	**PROJECTION**		
NTS @ A4	GDA94 MGA50		

Existing Zoning Plan

Wellard Urban Precinct East
Environmental Review

FIGURE 2



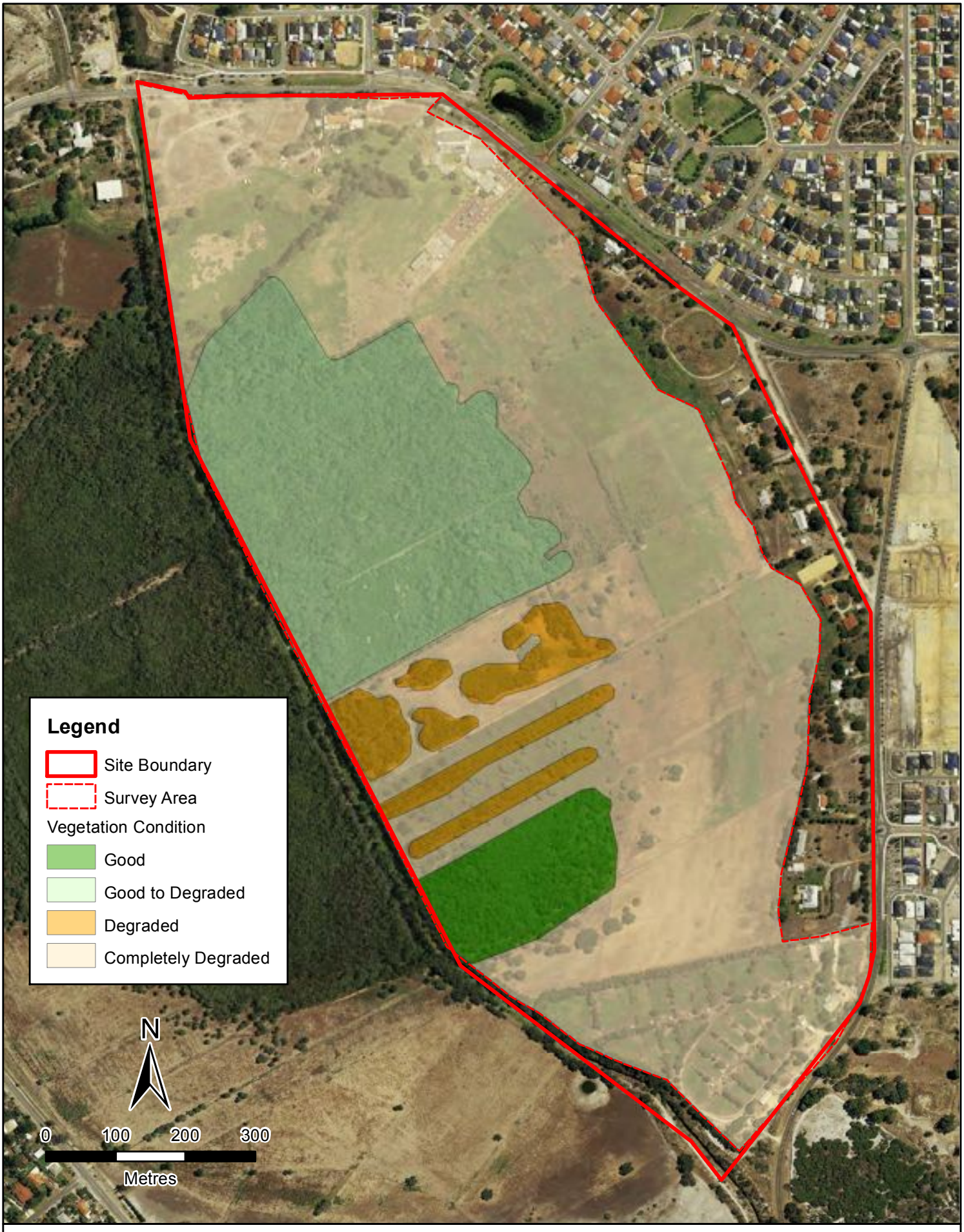
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CLIENT		JOB NO.	
Wellard Landowner's Group		10.127	
AUTHOR	DRAWN	DATE	
K. Thomson	T. Ellis	12-09-2012	
SCALE	PROJECTION		
1:9,000 @ A4	GDA94 MGA50		

Acid Sulfate Soil Risk Mapping

Wellard Urban Precinct East
Environmental Review

FIGURE 4

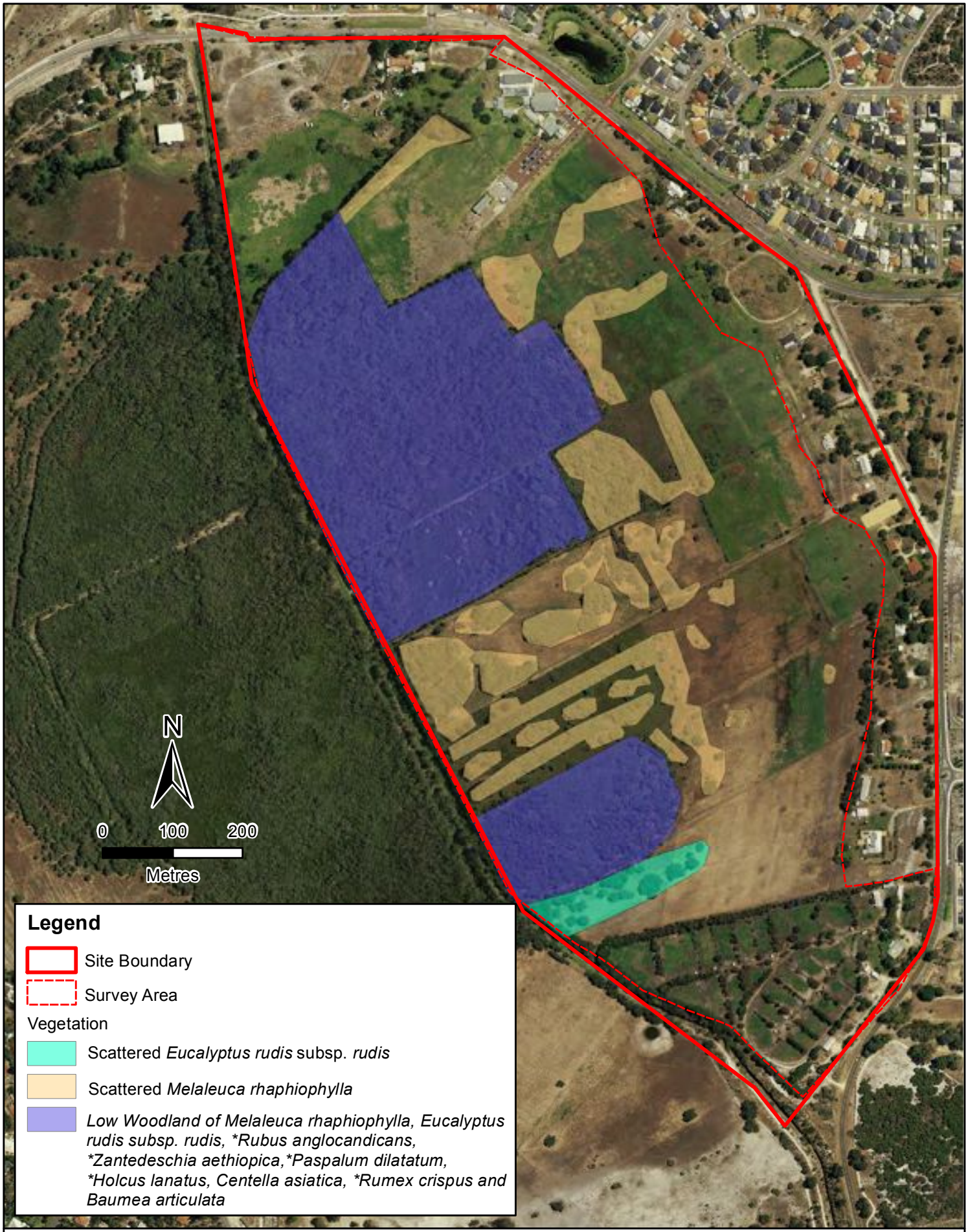


CLIENT: Wellard Landowners Group
JOB NO.: 10.127
AUTHOR: C. Sgherza
DRAWN: T. Ellis
DATE: 12-09-2012
SCALE: 1:7,000 @ A4
PROJECTION: GDA 94 MGA 50

Vegetation Condition

Wellard Urban Precinct East
Environmental Review

FIGURE 5



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CLIENT
Wellard Landowner's Group

JOB NO.
10.127

AUTHOR
C. Sgherza

DRAWN
T. Ellis

DATE
12-09-2012

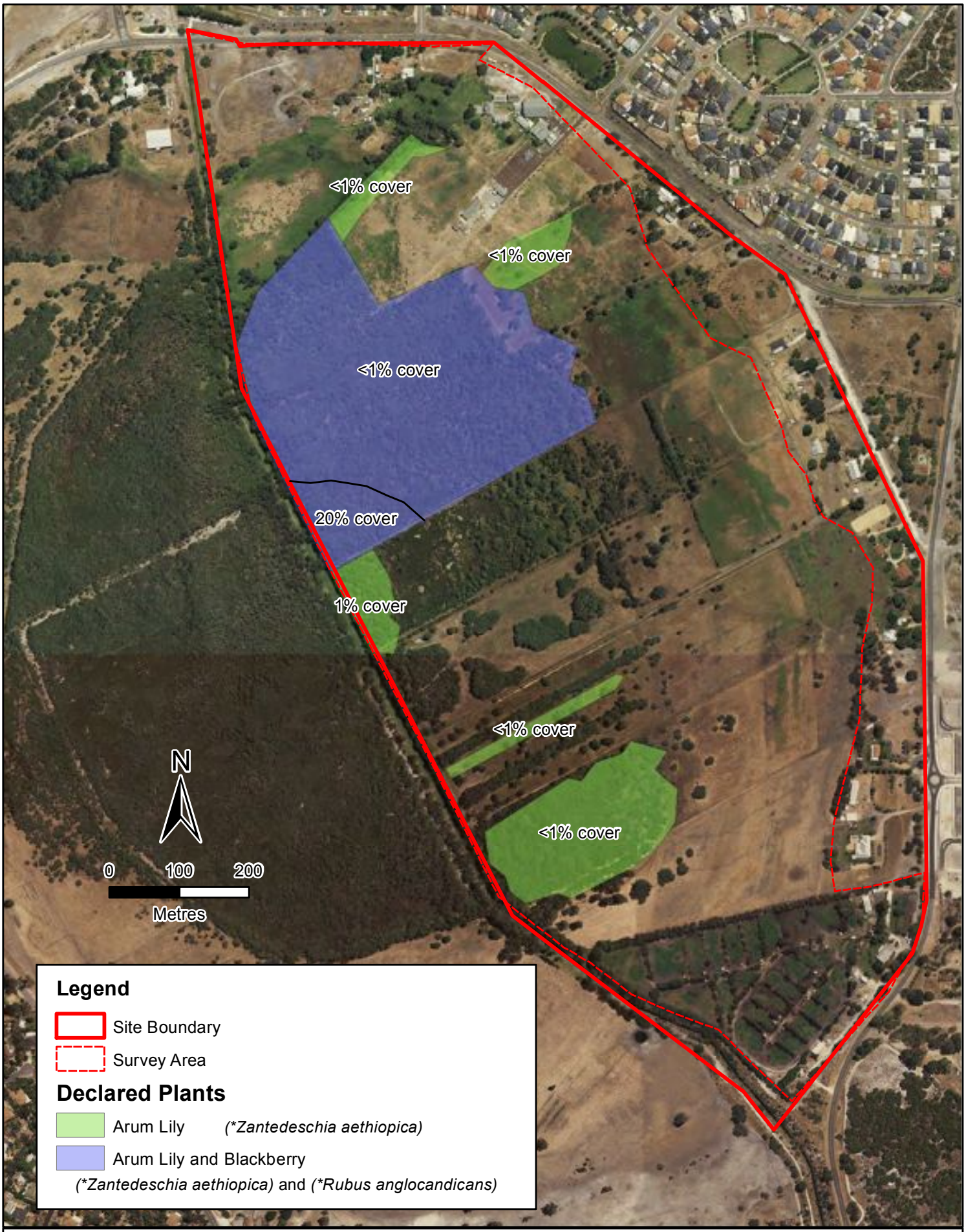
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1:7,000 @ A4

PROJECTION
GDA94 MGA50

Vegetation Complex

Wellard Urban Precinct East
Environmental Review

FIGURE 6



CLIENT: Wellard Landowner's Group
JOB NO.: 10.127
AUTHOR: C. Sgherza
DRAWN: T. Ellis
DATE: 12-09-2012
SCALE: 1:7,000 @ A4
PROJECTION: GDA94 MGA50

Location of Declared Plants

Wellard Urban Precinct East
Environmental Review

FIGURE 7



CLIENT
Wellard Landowner's Group

JOB NO.
10.127

AUTHOR
K. Thomson

DRAWN
T. Ellis

DATE
12-09-2012

SCALE
1:7,000 @ A4

PROJECTION
GDA94 MGA50

Fauna Habitat

Wellard Urban Precinct East
Environmental Review

FIGURE 8



CLIENT
Wellard Landowner's Group

JOB NO.
10.127

AUTHOR
K. Thomson

DRAWN
T. Ellis

DATE
12-09-2012

SCALE
1:10,000 @ A4

PROJECTION
GDA94 MGA50

Hydric Soils Distribution

Wellard Urban Precinct East
Environmental Review

FIGURE 9



env Australia

CLIENT	JOB NO.
Wellard Landowner's Group	10.127
AUTHOR / DRAWN / DATE	
K. Thomson / M. Mikkonen / 11-09-2012	
SCALE / PROJECTION	
1:8,000 @ A4 / GDA94 MGA50	

Geomorphic Wetlands

Wellard Urban Precinct East
Environmental Review

FIGURE 10



CLIENT
Wellard Landowner's Group

JOB NO.
10.127

AUTHOR
K. Thomson

DRAWN
T. Ellis

DATE
12-09-2012

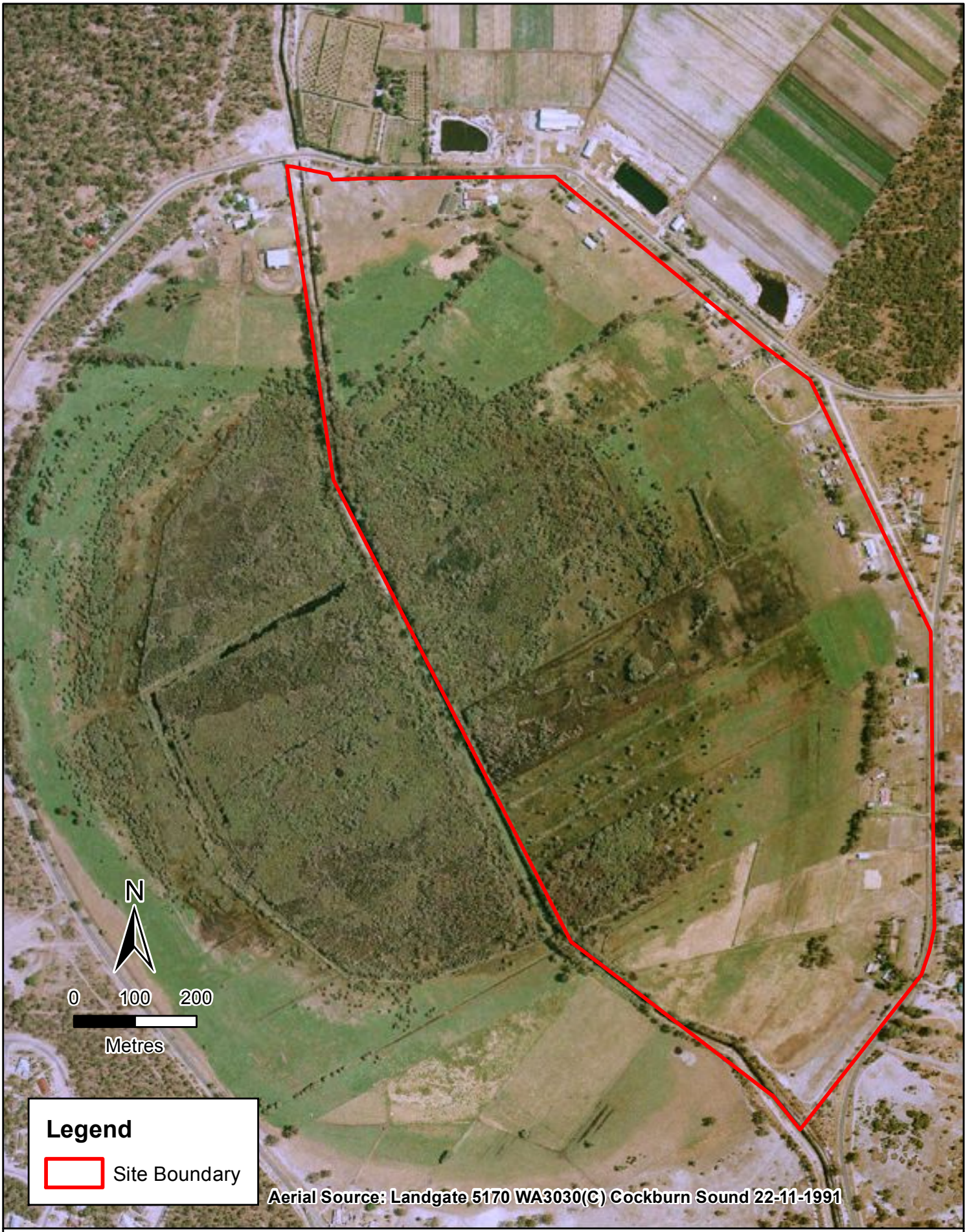
SCALE
1:8,000 @ A4

PROJECTION
GDA94 MGA50

EPP Lakes

Wellard Urban Precinct East
Environmental Review

FIGURE 11



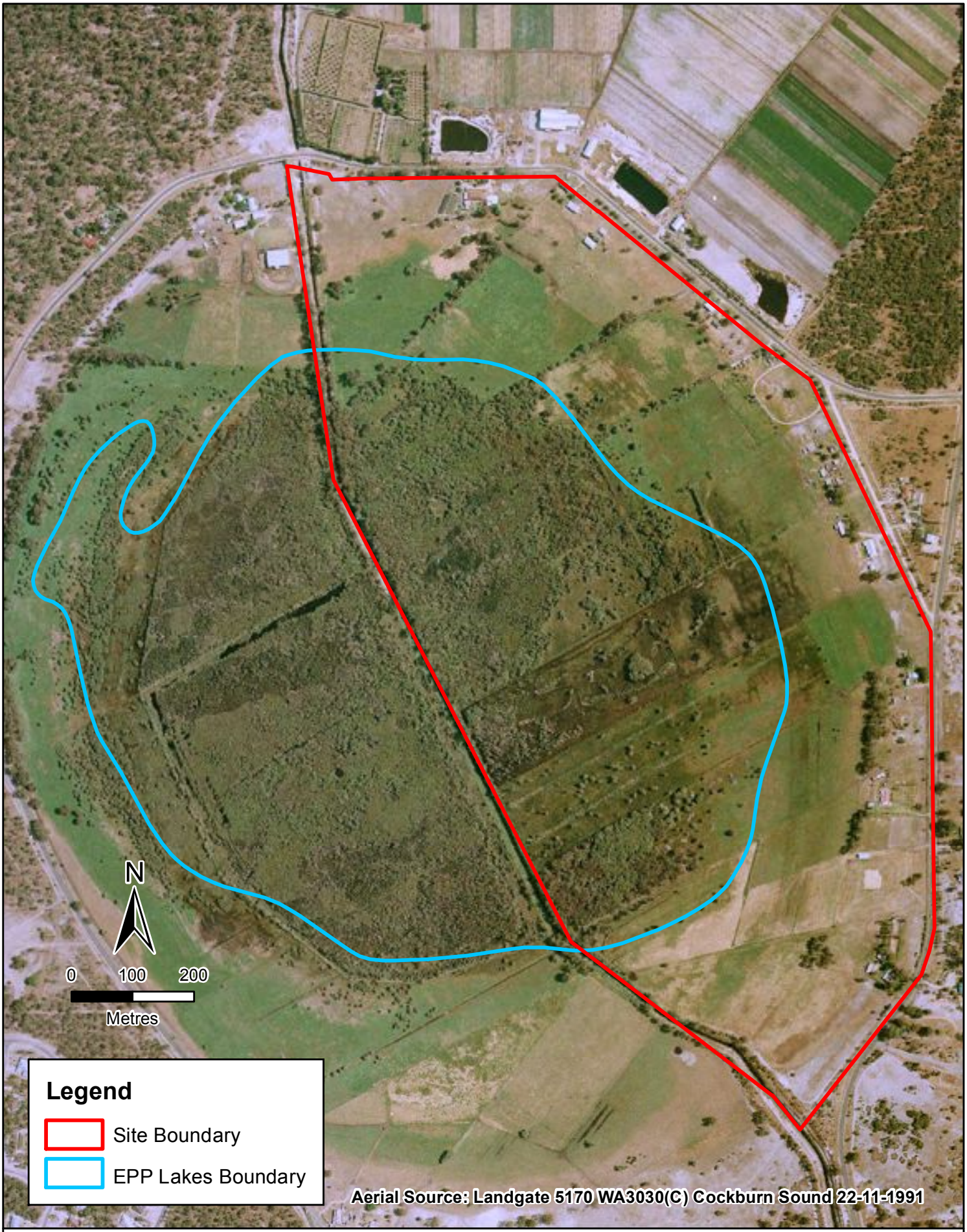
env Australia

CLIENT		JOB NO.	
Wellard Landowner's Group		10-127	
AUTHOR	DRAWN	DATE	
K. Thomson	T. Ellis	12-09-2012	
SCALE	PROJECTION		
1:8,000 @ A4	GDA94 MGA50		

Aerial Photograph 22-11-1991

Wellard Urban Precinct East
Environmental Review

FIGURE 12



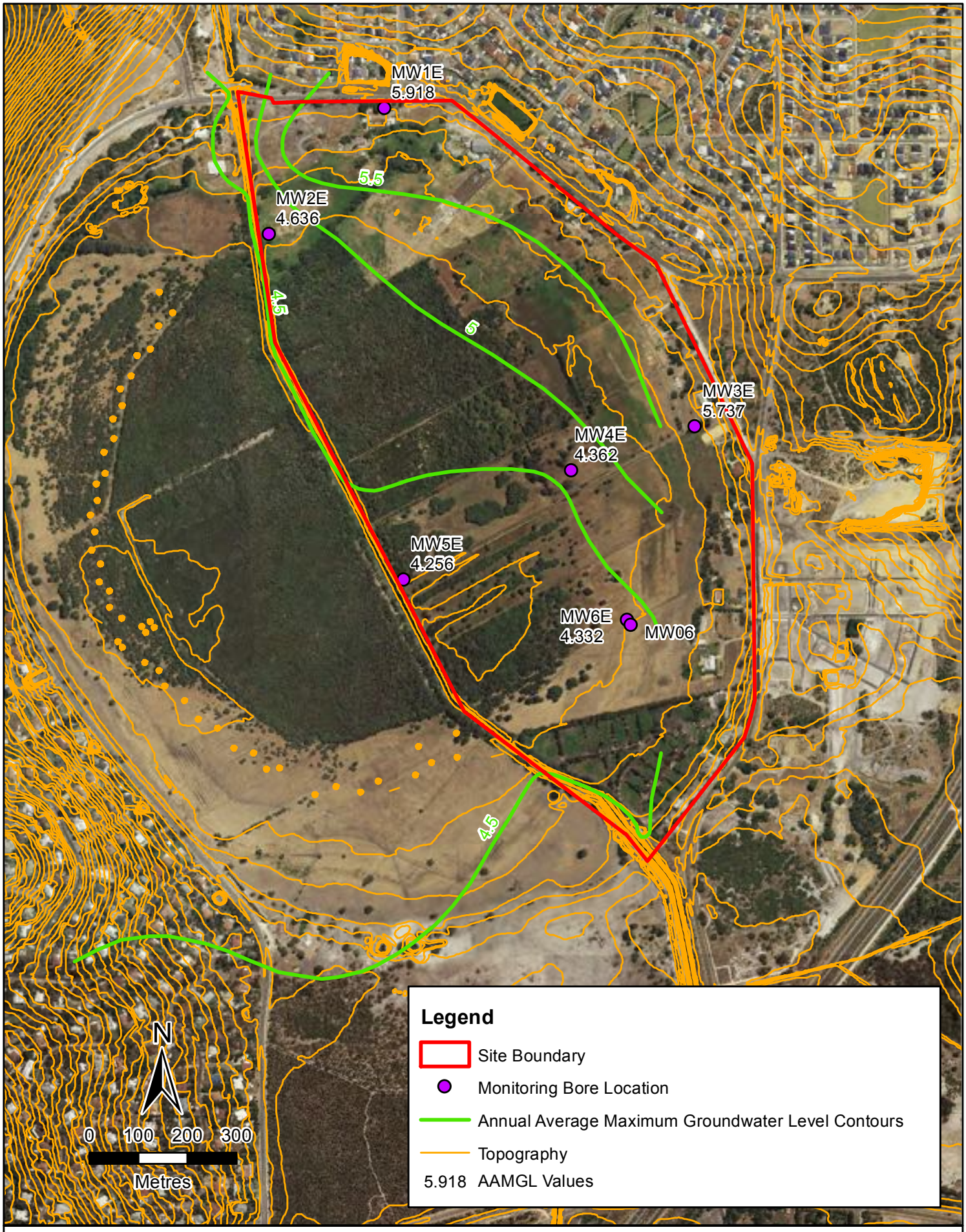
env Australia

CLIENT		JOB NO.	
Wellard Landowner's Group		10-127	
AUTHOR	DRAWN	DATE	
K. Thomson	T. Ellis	12-09-2012	
SCALE	PROJECTION		
1:8,000 @ A4	GDA94 MGA50		

EPP Mapping 22-11-1991

Wellard Urban Precinct East
Environmental Review

FIGURE 13



CLIENT
Wellard Landowner's Group

JOB NO.
10.127

AUTHOR
B. Woodward

DRAWN
S. Rho

DATE
12-09-2012

SCALE
1:10,000@ A4

PROJECTION
GDA 94 MGA 50

Groundwater Plan

Wellard Urban Precinct East
Environmental Review

FIGURE 14



CLIENT		JOB NO.	
Wellard Landowner's Group		10.127	
AUTHOR	DRAWN	DATE	
B. Woodward	S. Rho	12-09-2012	
SCALE	PROJECTION		
1:10,000 @ A4	GDA 94 MGA 50		

Surface Water Plan

Wellard Urban Precinct East
Environmental Review

FIGURE 15



CLIENT		JOB NO.	
Wellard Landowner's Group		10.127	
AUTHOR	DRAWN	DATE	
B. Woodward	S. Rho	12-09-2012	
SCALE	PROJECTION		
1:10,000 @ A4	GDA 94 MGA 50		

Wetland Boundary and 50m Buffer (Strategen)

Wellard Urban Precinct East Environmental Review

FIGURE 16



CLIENT		**JOB NO.**	
Wellard Landowner's Group		10.127	
AUTHOR	**DRAWN**	**DATE**	
B. Woodward	S. Rho	12-09-2012	
SCALE	**PROJECTION**		
1:10,000 @ A4	GDA 94 MGA 50		

Concept Structure Plan (Greg Rowe)

Wellard Urban Precinct East
Environmental Review

FIGURE 17

APPENDIX A

BOLLARD BULRUSH EAST FLORA AND VEGETATION ASSESSMENT





BOLLARD BULRUSH EAST

FLORA AND VEGETATION ASSESSMENT









BOLLARD BULRUSH EAST
FLORA AND VEGETATION ASSESSMENT

Prepared for

WELLARD LANDOWNERS GROUP

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Date:	*29 July 2011*

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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 in June by Greg Rowe and Associates, on behalf of the Wellard Landowners Group, in 2010 to undertake a flora and vegetation assessment for the Bollard Bulrush East site within the Town of Kwinana. The survey area is approximately 73 hectares in size and consists of cleared agriculture land and remnant vegetation.

The purpose of this assessment is to provide information on the significance of the flora and vegetation present within the survey area.

The field survey was conducted on the 29th September and recorded 23 taxa from 16 families and 22 genera.

No plant species listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999*, as Declared Rare pursuant to the *Wildlife Conservation Act 1950* or as Priority species listed by the Department of Environment and Conservation were located during the survey. The survey area is highly disturbed and ENV considers that it is unlikely that the Bollard Bulrush East survey area supports species of conservation significance.

Sixteen introduced species were identified during the survey. The majority of the introduced species present are typical bushland weeds. Two Declared Plants were recorded within the survey area, Arum Lily (**Zantedeschia aethiopica*) and Blackberry (**Rubus anglocandicans*). Both of these species require management in accordance with the *Agriculture and Related Resources Protection Act 1976.*

The Bollard Bulrush East survey area is mapped as the Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of *Eucalyptus rudis* - *Melaleuca* species. This complex exceeds the 10% recommended retention status for the Bush Forever study area.

One vegetation unit was identified within the survey area, Low Woodland of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*. This unit was described as being in Good to Degraded and therefore it could not be confidently inferred to a Floristic Community Type. However, the vegetation was considered to be similar to the Floristic Community Type: SCP17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands'. This Floristic Community Type is not listed as a Threatened Ecological Community under Federal or State legislation or a Priority Ecological Community by the Western Australian Department of Environment and Conservation.

The remnant vegetation within the survey area is described as being in Good to Completely Degraded condition. Disturbances to the vegetation include clearing, invasion by introduced species as well as grazing and trampling by domestic livestock (cattle).

The Department of Environment and Conservation's Geomorphic Wetlands Dataset identifies two wetlands within the survey area; one Resource Enhancement and Multiple Use wetland. In addition the Bollard Bulrush Swamp is listed as a wetland of high ecological value under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*.

1 INTRODUCTION

ENV.Australia Pty Ltd ('ENV') was commissioned in June by Greg Rowe and Associates, on behalf of the Wellard Landowners Group, in 2010 to undertake a flora and vegetation assessment for the Bollard Bulrush East site ('the survey area').The site consists of Lots 1, 4, 5, 6 and 86 Johnson Road and Lots 67, 68, 72 and 74 Bertram Road. The survey area is approximately 73 hectares (ha) in size and consists of remnant vegetation within cleared paddocks.

The purpose of this assessment is to provide information on the significance of the flora and vegetation present within the survey area.

1.1 LOCATION

The survey area is located approximately 35 kilometres (km) south of Perth CBD, in the suburb of Wellard, in the Town of Kwinana. The survey area is bound by private property on its northern, eastern and southern sides. The Peel Harvey Main Drain is located on the western boundary of the survey area (Figure 1).

1.2 CLIMATE

The climate of this region is warm Mediterranean, with an average maximum summer temperature of 28.3°C and an average minimum winter temperature of 10.9°C (Bureau of Meteorology (BoM) 2010). The region receives an average annual rainfall of 765.3 mm, with the majority of precipitation occurring in winter (BOM 2010) (Figure 2).

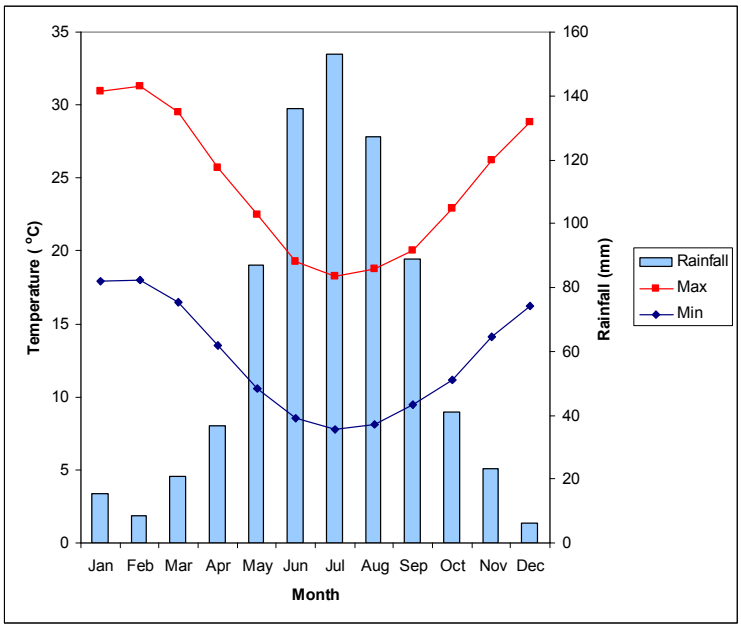


Figure 2: Average Monthly Rainfall and Maximum and Minimum Temperatures at Medina Research Station (1983-2010) (BoM 2010)

1.3 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 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* (Department of Conservation and Environment 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.

The soils and landform unit, as well as the vegetation complex supported by the survey area, are described below:

1.3.1 Soils and Landforms

The survey area occurs on the Swan Coastal Plain portion of the Darling System (Churchward & McArthur 1978). The Swan Coastal plain consists of aeolian and fluviatile deposits, specifically the site is on:

- Herdsman unit: Peaty swamps associated with Bassendean and Karrakatta units.

1.3.2 Beard Vegetation Mapping

The survey area is in the South West Botanical Province and the Darling Botanical District (Beard 1990). This region typically consists of forest country with related woodlands and is divided into four subregions or botanic subdistricts.

The survey area is within the Swan Coastal Plain Subregion of the Drummond Botanical Subdistrict (Beard 1990). The Drummond Botanical Subdistrict consists mainly of the following vegetation communities:

- *Banksia* Low Woodland on leached sands and *Melaleuca* Swamps in poorly drained areas;
- Woodland of Tuart (*Eucalyptus gomphocephala*); and
- Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands on the less leached soils (Beard 1990).

1.3.3 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:

- Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of *Eucalyptus rudis* - *Melaleuca* spp.

The Environmental Protection Authority's (EPA) document *Levels of Assessment for Proposals Affecting Natural Areas Within System 6 Region and Swan Coastal Plain Portion of the System 1 Region* (EPA 2006) gives an estimate of the percentage of each complex that remains compared to its pre-European settlement extent, so an estimate of the scarcity of each complex can be determined.

Across its extent 34.6% of the Herdsman Complex is estimated to remain (EPA 2006). Within the Bush Forever project area, which covers the Swan Coastal Plain portion of the Perth Metropolitan Area (PMA), 31% of the Herdsman Complex is estimated to remain (Government of Western Australia 2000).

The EPA recognises vegetation complexes that are not well represented in reserves as being significant. Vegetation complexes which have 10%-30% remaining may be considered regionally significant. Proposals that would impact on a vegetation complex with 10% or less remaining may be formally assessed by the EPA (EPA 2006).

1.4 PROTECTION OF FLORA AND VEGETATION

Flora species are 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) ('the EPBC Act') aims to protect matters of national environmental significance, which are detailed in Appendix A.

Under the EPBC Act, the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities ('SEWPAC') 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 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 SEWPAC for assessment under the EPBC Act.

Wildlife Conservation Act 1950 (WA)

The Western Australian DEC recommends flora taxa for listing under the provisions of the *Wildlife Conservation Act 1950* (WA) ('WC Act') as protected according to its need for protection (see Appendix A).

Flora species are given Declared Rare status when their 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 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 is a 'clearing principle' 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 species 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 TEC status.

Although DEC Priority species and communities have no formal 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 be sensitive to community concerns as to locally significant species or communities.

1.5 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 1976* (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 2010).

1.6 WETLAND CLASSIFICATIONS

1.6.1 Geomorphic Wetlands

In an effort to protect wetlands on the Swan Coastal Plain, the DEC developed a dataset, mapping the location, type and management category of wetlands on the Swan Coastal Plain (DEC 2010a). A management category is assigned to each wetland which provides guidance on the nature of the management and protection the wetland should be afforded.

Table 1: 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 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 be fully protected. A minimum buffer of 50 m from the edge of wetland-dependent vegetation is typically allocated to CCWs. However, the policy is that the buffer be determined on a case-by-case basis.

Management Category	General Description	Management Objectives
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. 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 be taken to minimise the potential impacts on REWs and their buffers. A minimum buffer of 50 m from the edge of wetland-dependent vegetation is typically allocated to REWs.
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 be taken to retain the wetland's hydrological functions (including onsite water infiltration and flood detention) and, where possible, other wetland functions. There is usually no minimum buffer requirement allocated to Multiple Use Wetlands.

(After: EPA 2008)

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

The DEC Geomorphic Wetlands Dataset identifies two wetlands as occurring within the survey area. One of these wetlands (UFI 6730) has a Resource Enhancement management category and the other (UFI 13327) has a Multiple Use management category (Figure 3).

1.6.2 Environmental Protection Policy Wetlands

To protect and conserve the remaining wetlands on the Swan Coastal Plain, the EPA developed the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP) under section 26 of the EP Act. EPP Lakes are managed by the EPA and amendments require approval under the EP Act. The Bollard Bulrush Swamp is listed under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (Figure 3).

1.7 BUSH FOREVER

Bush Forever is a State Government Policy and program which identifies 51,200 ha of regionally significant bushland for protection, covering 26 vegetation complexes. This amounts to about 18% of the original vegetation on the Swan Coastal Plain portion of the PMA, and excludes local conservation reserves.

Regionally significant bushland has been identified on the basis of criteria relating to its conservation value. Important among these criteria is the achievement, where possible, of a comprehensive representation of all the ecological communities originally occurring in the region, principally through protecting a target of at least 10 per cent of each vegetation complex (Government of Western Australia 2000).

The Government of Western Australia has endorsed Bush Forever as the means of seeking the appropriate protection and management of areas of regionally significant bushland on the Swan Coastal Plain Portion of the PMA and a balance between environmental, social and economic objectives. As an endorsed government policy it is used as a basis for decision-making and an agreed framework for the protection and management of Bush Forever Sites through the implementation mechanisms identified in the plan (Government of Western Australia 2000).

The survey area has not been identified as being required to meet the Bush Forever biodiversity retention targets within Western Australia.

2 SCOPE OF WORK

The flora and vegetation assessment undertaken within the survey area specifically included:

- a desktop assessment of relevant literature and databases to determine Threatened Flora and Ecological Communities that may occur in the area;
- a flora and vegetation field survey, incorporating a search for conservation significant flora and the establishment of two permanent quadrats;
- a review of data collected against criteria established in Federal and State processes for species conservation;
- the production of vegetation mapping and vegetation condition mapping;
- interim identification and mapping of any TECs, PECs and any other areas of ecological importance (e.g. Wetlands, ESAs); and
- the production of a technically sound report presenting the results of the survey and recommendations.

3 METHODS

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

- *Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with Particular Reference to Agricultural Areas, Position Statement No. 2* (EPA 2000); 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 EPBC Act, WC Act and EP Act.

The methodology for the work involved the following key steps:

3.1 DESKTOP SURVEY

A request for a database search was submitted to the DEC to obtain a list of Declared Rare and Priority Flora species, TECs and PECs in the area of Wellard. The search area included a 5 km radius around the following coordinates; 32° 15' 32" S - 115° 50' 31" E (GDA94) (DEC 2010b).

A desktop review was undertaken of the following databases and documents:

- DEC combined biological database NatureMap (DEC 2010c);
- SEWPAC Protected Matters Search Tool (SEWPAC 2010), also known as an EPBC search; and
- previous flora surveys (e.g. previous consultants reports, DEC reports).

3.2 FIELD SURVEY

On the 29th September 2010 an ENV botanist visited the site and conducted a vegetation survey by traversing the property on foot. Data was collected from quadrats in the survey area, and geographic coordinates noted for changes in vegetation units[1]. Three 10 m x 10 m quadrats and one relevé were assessed in the vegetation unit. At each site a photograph was taken, the vegetation unit was described and a condition statement

[1] For the purposes of this flora and vegetation assessment, a vegetation unit is described on a fine scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

made. The sampling intensity was selected in consideration of the landforms, habitat, vegetation structure, diversity and seasonality. Refer to Appendix C for the Flora Field Data Sheets and Site Photographs and Appendix D for the Vegetation Condition Scale.

During the field survey, plants that were suspected as being significant were described and their geographic coordinates noted.

3.2.1 Taxonomy

Where field identification of plant taxa was not possible, specimens were collected systematically for later identification at the Western Australian Herbarium (WAH) by use of identification keys and by comparison with the reference collection.

3.2.2 Vegetation Mapping

Vegetation unit descriptions were tabulated, and their boundaries were mapped. The vegetation descriptions for the units across the survey area were referenced against Gibson *et al.,* (1994) to determine the Floristic Community Types ('FCTs') present and the consequent potential for the survey area to support TECs or PECs. FCTs were defined according to Gibson *et al.,* (1994) on the basis of Multivariate Analysis of quadrat data, species composition, soils and topography.

The Multivariate Analysis of the quadrat data involved transformation (presence-absence) and computation of a similarity matrix based on Bray-Curtis similarity. The matrix allows for comparison of the vegetation within the study area with Gibson *et al.,* (1994) FCT data. This allows determination of the similarity between the vegetation communities mapped and TECs or PECs.

3.3 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 variables concerning the flora and vegetation survey are detailed in Table 2.

Table 2: 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 who executed the work were practitioners suitably qualified in their respective fields. • Coordinating Botanist: Ciaran Sgherza (Environmental Scientist/ Botanist); • Field Staff: Ciaran Sgherza; • Taxonomy: Peter Jobson (Senior Botanist / Taxonomist); and • Data Interpretation: Ciaran Sgherza.
Timing [2], weather, season in relation to Flora	The survey was undertaken in spring on the 29th September 2010. The area had received 455.4 millimetres (mm) of rain in the year to date (January to September) which is significantly below the long term average of 604.7 mm for the same period (1983 – 2007) (BOM 2010). 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). 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.

[2] EPA Guidance Statement 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.

Variable	Impact on Survey Outcomes
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 issuing, but it should be noted this may change.

3.4 PERMITS

Specimens collected during the survey were taken by permit of and subject to the conditions of the following licences issued under sections 23C and 23F of the WC Act:

- SL008481 (General Scientific Licence) and 73-0910 (DRF Licence) issued to Ciaran Sgherza.

4 RESULTS

4.1 DESKTOP SURVEY

The desktop database search of the Wellard area resulted in ten Declared Rare and eight Priority Flora species being identified as potentially occurring in the area. For a list of species found during the desktop survey search, please refer to Appendix E.

The Desktop survey determined that five TECs and three PECs are known to occur within a 5 km radius of the survey area. Refer to Appendix E for the full list.

4.2 FIELD SURVEY - FLORA

4.2.1 Flora

Sixteen families, 22 genera and 23 taxa were recorded in the survey area (seven native flora taxa and 16 introduced), refer to Appendix F for the flora species list.

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

- Poaceae five species:
- Myrtaceae three species; and
- Asteraceae two species.

An average of 13 species was recorded in each of the three quadrats conducted within the survey area; refer to Appendix G for the Matrix of Taxa by Site.

4.2.2 Protected Flora

No Threatened species pursuant to the EPBC Act were located during the survey.

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

No Priority Flora species listed by the DEC were located in the survey area.

4.2.3 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).

Table 3: Weed Species Identified

Taxon	Common Name	Criteria			
		Rating	Invasiveness	Distribution	Impacts
**Cortaderia selloana*	Pampas Grass	High	Yes	Yes	Yes
**Typha orientalis*	Bulrush	High	Yes	Yes	Yes
**Zantedeschia aethiopica*	Arum Lily	High	Yes	Yes	Yes
**Briza maxima*	Blow fly grass	Moderate	Yes	Yes	-
**Cirsium vulgare*	Slender Thistle	Moderate	Yes	Yes	-
**Ficus carica*	Fig	Moderate	Yes	-	Yes
**Gomphocarpus fruticosus*	Cotton Bush	Moderate	Yes	Yes	-
**Holcus lanatus*	Yorkshire Fog	Moderate	Yes	Yes	-
**Paspalum dilatatum*	Paspalum	Moderate	Yes	Yes	-
**Sonchus oleraceus*	Common Sowthistle	Moderate	Yes	Yes	-
**Rumex crispus*	Curled Dock	Mild	-	Yes	-
**Prunella vulgaris*	Self Heal	Low	-	-	-
**Lolium perenne* x *rigidum*	-	TBA	-	-	-
**Schinus terebinthifolius*	-	TBA	-	-	-
**Livistona australis*	-	Not Listed	-	-	-
**Rubus anglocandicans*	Blackberry	Not Listed	-	-	-

Two species listed as Declared Plants on the Swan Coastal Plain were located during the survey (DAFWA 2010) (Figure 4). These are:

- Arum Lily (**Zantedeschia aethiopica*) (Plate 1) listed as P1 for the whole State; and
- Blackberry (**Rubus anglocandicans*) (Plate 2) listed as P1 for the whole State.



Plate 1: Arum Lily (**Zantedeschia aethiopica*)



Plate 2: Blackberry (**Rubus anglocandicans*)

4.3 FIELD SURVEY - VEGETATION

4.3.1 Vegetation

One vegetation unit was identified within the survey area (Figure 5):

MpEr Low Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp*. rudis*, **Rubus anglocandicans, *Zantedeschia aethiopica,*Paspalum dilatatum, *Holcus lanatus, Centella asiatica, *Rumex crispus* and *Baumea articulata.*

In addition stands of native trees including *Eucalyptus rudis* subsp. *rudis* and *Melaleuca preissiana* have been indentified in Figure 5. No native understorey species were recorded under these trees and thus, they have not been discussed as vegetation units.

Refer to Appendix C for site photographs. For further discussion and interpretation of the site floristics, refer to Section 5.

4.3.2 Floristic Community Types

The FCT represented by the vegetation unit within the survey area was inferred by statistical analysis, along with dominant species presence and distribution, as set out in Table 5 below.

Table 5: Floristic Community Type Analysis

Vegetation Type	Floristic Community Type	Percentage Similarity (%)	Comments	Inferred Floristic Community Type
Low Woodland of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*	SCP 17 – '*M. rhaphiophylla* – *Gahnia trifida* seasonal wetlands'	21	ENV considers that the vegetation unit is most similar to FCT SCP17 based on species present and location in the landscape. However, due to the low native species diversity and the condition of the vegetation the FCT is not able to be confidently inferred.	SCP 17 – '*M. rhaphiophylla* – *Gahnia trifida* seasonal wetlands'
	SCP 13 – 'Deeper wetlands on heavy soils'	14		
	SCP 14 'Deeper wetlands on sandy soils'	13		

4.3.3 Priority and Threatened Ecological Communities

FCT SCP 17 '*M. rhaphiophylla* – *Gahnia trifida* seasonal wetlands' is well reserved and considered to be at Low risk (Gibson *et al.,* 1994). Therefore, no Threatened or Priority Ecological communities are present within the Bollard Bulrush East survey area.

4.3.4 Vegetation Condition

The vegetation condition within the site varied from Good to Completely Degraded (Figure 6). All vegetation within the survey area had been disturbed. Disturbances included invasion by introduced species, grazing and trampling by domestic livestock (cattle) and historical clearing. Many of the lots within the survey area are still utilised for cattle grazing.

4.3.5 Wetlands

The Resource Enhancement wetland (UFI 6730) identified by the DEC Geomorphic Wetlands Dataset is described as being in Good to Degraded condition. The Multiple Use wetland (UFI 13327), identified by the DEC Geomorphic Wetlands, is described as being in Completely Degraded condition as it has been historically cleared and used for agricultural purposes. Both of the wetlands identified by the DEC supported vegetation that is representative of a wetland.

5 DISCUSSION

Flora

The average flora species richness per quadrat recorded during this survey, 13 species per quadrat, is similar to the species richness of wetland communities recorded by Gibson *et al.,* (1994). For example, Gibson *et al.,* (1994) recorded mean species richness of 13.6 species within SCP17 and a mean species richness of 17.4 within SCP13. However, the flora species richness recorded within the Bollard Bulrush East survey area has been influenced by the high diversity of introduced species recorded, 69% of the total taxa. Therefore, it is not an accurate representation of the native flora diversity within the survey area. Currently, the vegetation does not support a native middle or understorey. Both of these layers within the vegetation are dominated by introduced species and thus the diversity of native species has been reduced.

Threatened, Declared Rare and Priority Flora

No Threatened species pursuant to the EPBC Act, no plant taxa gazetted as Declared Rare pursuant to the WC Act and no Priority Flora listed by the DEC were recorded in the survey area.

ENV considers it to be very unlikely that the survey area supports flora of conservation significance. The survey was undertaken at the appropriate time of year (spring) and the entire survey area was adequately searched for species of conservation significance. The low rainfall experienced during the winter of 2010 may have affected the emergence of some species of conservation significance, in particular orchid species (*Drakaea elastica* and *Drakaea micrantha*). Thus, these species may not have been present or identifiable at the time of the survey. Despite this, the survey area is not considered to support appropriate habitat for flora of conservation significance, as a result of the reduced condition of the vegetation as well as trampling and grazing by cattle. ENV considers that the potential for the survey area to contain Threatened, Declared Rare or Priority Flora is low.

Weeds

Sixteen introduced species were recorded within the survey area. The majority of these are considered to be common agricultural (**Lolium perenne x rigidum*) and bushland weeds (**Briza maxima* and **Sonchus oleraceus*) in the region (Hussey *et al.,* 2007). Two species, **Cortaderia selloana* and **Typha orientalis*, are common wetland weeds and are rated as High by the Environmental Weed Strategy for Western Australia (Department of Conservation and Land Management 1999).

Two Declared Plants were recorded within the survey area: Arum Lily (**Zantedeschia aethiopica*); and Blackberry (**Rubus anglocandicans*). The level of infestation of these species within the survey area was considered to be high, as a result of the wide

distribution and high number of individuals within the survey area. Arum Lily and Blackberry are both listed as P1 for the whole State and require management strategies to reduce their distribution. A management plan including a hygiene station to wash vehicles down prior to leaving the site during development would address this requirement.

Vegetation Condition

The condition of the vegetation with the survey area has been reduced by agricultural land uses. The clearing of land and the presence of cattle has facilitated the invasion of introduced species within the site. The high diversity (approximately 69% of the species recorded) and cover of introduced species indicates that native species have been displaced. The presence of cattle within the survey area has also reduced the condition of the vegetation by grazing and trampling of the soil.

Floristic Community Types

The vegetation within the survey area is considered to be most similar to FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands'. However, as a result of the low native species diversity and the reduced condition of the vegetation it is difficult to confidently infer it to any FCT. The vegetation within the survey area has been assessed as representing a highly disturbed example of SCP 17. Several of the common and typical species of this FCT, as defined by Gibson *et al.,* (1994) are absent from the vegetation, such as *Gahnia trifida, Lobelia alata* and *Lepidosperma longitudinale*. However, the presence of the overstorey species, *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*, and the percentage similarity (21%) result in the allocation of the of the vegetation unit to FCT SCP 17.

The vegetation community recorded within the survey area is not listed as a TEC by Federal or State legislation or on the DECs PEC database. Thus, it is not representative of a TEC or PEC.

Vegetation Complexes

The survey area is mapped as the Herdsman Complex: Vegetation consists of sedgelands and fringing woodland of *Eucalyptus rudis* - *Melaleuca* species, which has an estimated 31% remaining in the Bush Forever project area (Government of Western Australia 2000).

This complex exceeds the 10% recommended retention status for Western Australia by the *EPA's Position Statement No. 2* and targets set under Bush Forever. Therefore it is considered to be adequately represented within the Bush Forever study area.

Wetlands

The two wetlands identified by the DEC as occurring within the survey supported vegetation that is representative of wetland communities, however, the condition of this vegetation varied. The Resource Enhancement wetland (UFI 6730) within the survey area represents the core of the wetland vegetation within the survey area. The high level of disturbance to this vegetation, however, has reduced the ecological value of the vegetation. The area identified as a Multiple Use wetland (UFI 13327) is Completely Degraded, as this area has been cleared and utilised for agricultural purposes. However, the Bollard Bulrush East survey area is listed as a wetland of high ecological value and protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.*

6 SUMMARY AND CONCLUSION

The flora and vegetation survey undertaken by ENV.Australia determined that:

- Twenty-three taxa, including seven native flora taxa and 16 introduced taxa, were recorded within the Bollard Bulrush East survey area;
- No plant species listed as Threatened pursuant to the EPBC Act, as Declared Rare pursuant to the WC Act or as Priority by the DEC were located during the survey and it is considered unlikely that the survey area supports species of conservation significance;
- One vegetation community representative of wetland vegetation, Low Woodland of *Melaleuca rhaphiophylla* and *Eucalyptus rudis* subsp. *rudis*, was recorded within the survey area;
- The vegetation within the survey area is described as being in Good to Completely Degraded condition;
- The vegetation within the survey area is considered to be similar to the FCT SCP 17 '*M. rhaphiophylla – Gahnia trifida* seasonal wetlands'. However, it should be noted that an FCT can not be confidently inferred to the vegetation as a result of the low native species diversity and the reduced condition of the vegetation; and
- The vegetation community recorded during the survey is not listed as a TEC or PEC by the SEWPAC or by the DEC.

No species or vegetation of conservation significance were identified within the survey area. The survey was undertaken at an appropriate time and methods allow for the conclusion that no species or vegetation of conservation significance potentially occurs within the Bollard Bulrush East survey area. Therefore, no flora or vegetation values that require protection were identified during the survey.

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FIGURES

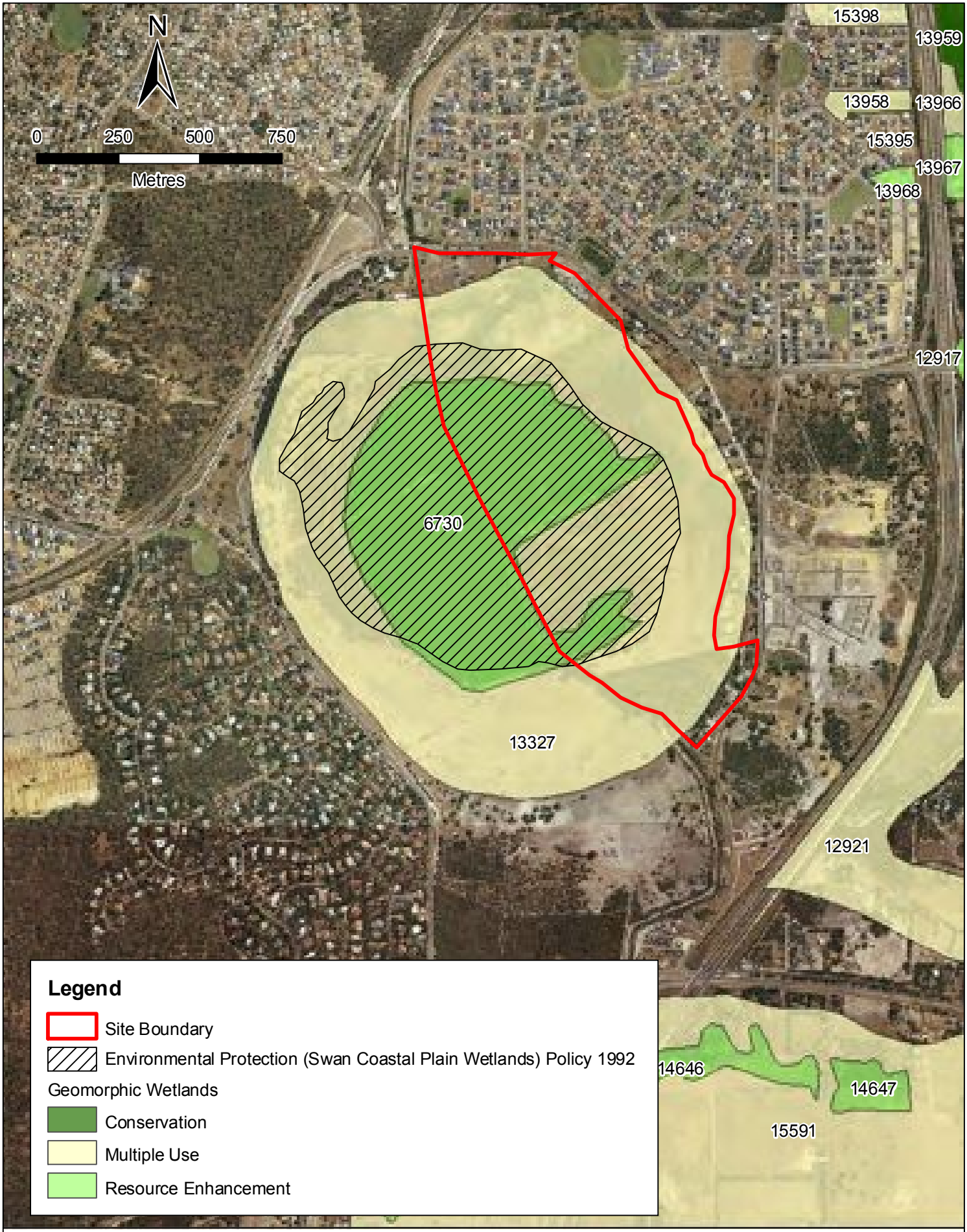


CLIENT: Wellard Landowners Group
JOB NO.: 10.127
AUTHOR: C. Sgherza
DRAWN: S. Rho
DATE: 25-10-2010
SCALE: 1:25,000 @ A4
PROJECTION: GDA 94 MGA 50

Location Map

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 1



CLIENT
Wellard Landowners Group

JOB NO.
10.127

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T. Ellis

DATE
25-10-2010

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PROJECTION
GDA 94 MGA 50

Wetlands

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 3



CLIENT: Wellard Landowners Group

JOB NO.: 10.127

AUTHOR: C. Sgherza

DRAWN: T. Ellis

DATE: 25-10-2010

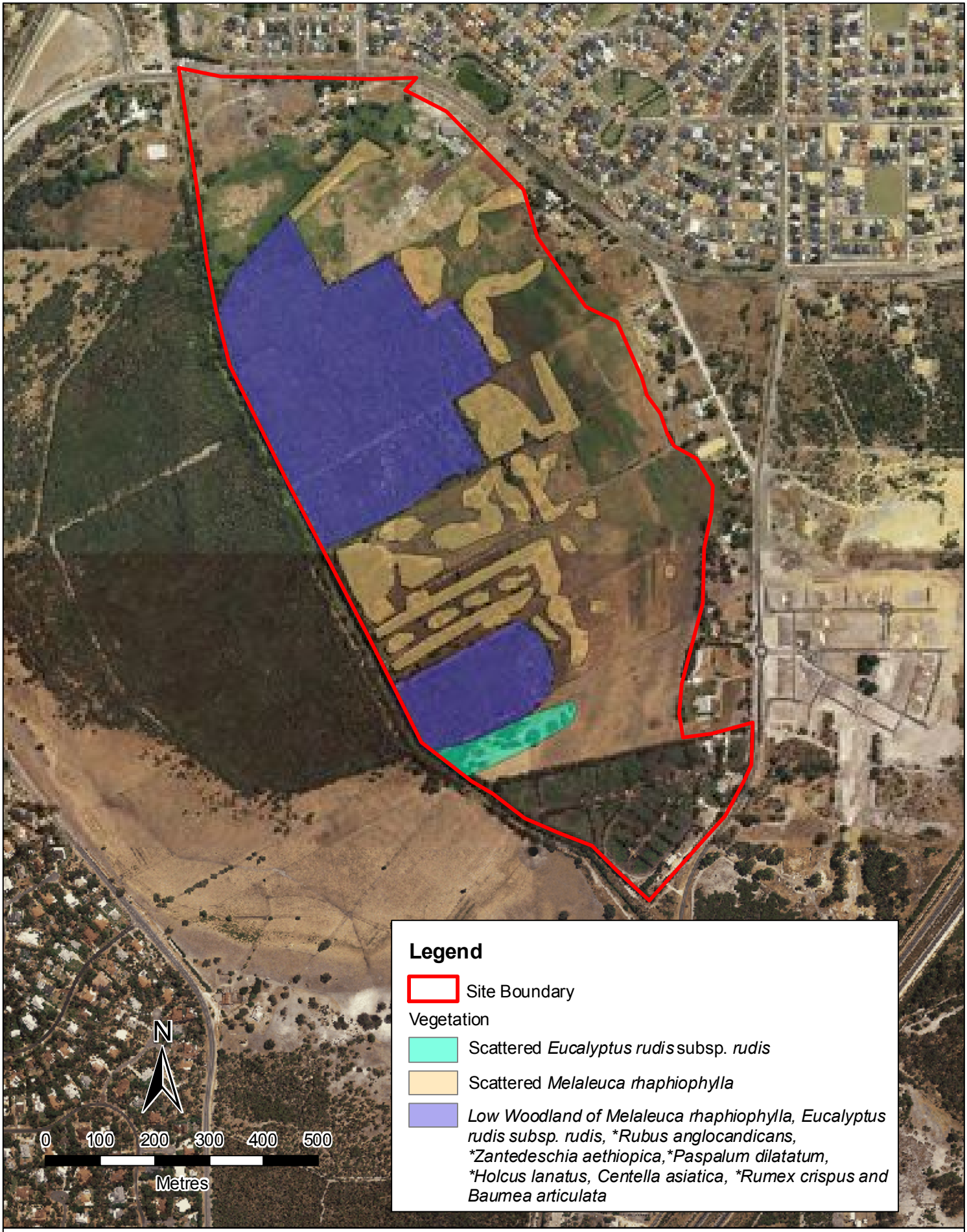
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PROJECTION: GDA 94 MGA 50

Location of Declared Plants

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 4

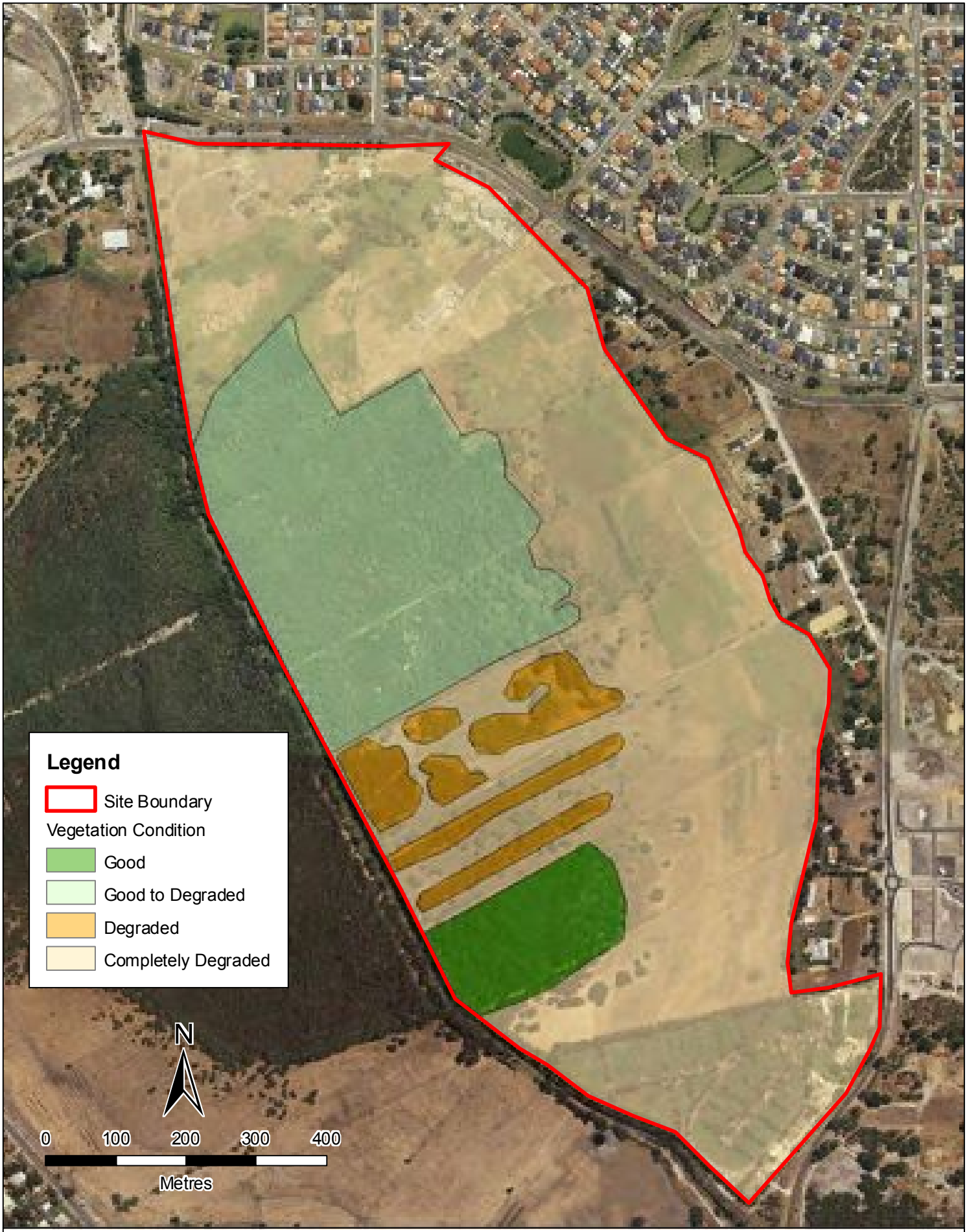


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Vegetation

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 5



CLIENT
Wellard Landowners Group

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DATE
27-10-2010

SCALE
1:7,000 @ A4

PROJECTION
GDA 94 MGA 50

Vegetation Condition

Bollard Bulrush East Flora and Vegetation Assessment

FIGURE 6

APPENDIX A

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

APPENDIX A

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

A1: Categories of Declared Rare and Priority Flora

Conservation Code	Category
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.
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.
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.

Source: Department of Environment and Conservation (2010). *Western Australian Flora Conservation Codes*. Department of Environment and Conservation, Perth, Western Australia. Online: http://florabase.calm.wa.gov.au.

A2: Categories of Threatened Flora Species

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.

Source: *Environment Protection and Biodiversity Conservation Act 1999*

A3: 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.

Source: Department of Environment and Conservation (2010). *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*. Department of Environment and Conservation, Perth, Western Australia. Online: www.naturebase.net/

A4: Definitions of Priority Ecological Communities

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.

Source: Department of Environment and Conservation (2010). *Definitions, Categories and Criteria for Threatened and Priority Ecological Communities*. Department of Environment and Conservation, Perth, Western Australia. Online: www.naturebase.net/

APPENDIX B
ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES

APPENDIX B

ENVIRONMENTAL WEEDS AND DECLARED PLANT CATEGORIES

B1: 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.

Source: Department of Conservation and Land Management (1999). *Environmental Weed Strategy for Western Australia*. Department of Conservation and Land Management, Perth, Western Australia.

B2: 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.

Source: Department of Agriculture and Food (2010). *List of Declared Plants*. Department of Agriculture and Food, Western Australia. Online: http://www.agric.wa.gov.au/.

APPENDIX C

FLORA SURVEY FIELD DATA SHEETS AND SITE PHOTOGRAPHS

APPENDIX C

FLORA SURVEY FIELD DATA SHEETS AND SITE PHOTOGRAPHS

Site Q01

Described by NW



Location Wellard

MGA Zone50 390520mE 6430676mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Open Forest of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum, *Holcus lanatus, Centella asiatica, *Rumex crispus, Baumea articulata, Typha* sp. and **Cortaderia selloana*.

Veg Condition Good

Fire Age Young

Notes Aspect: N/A.
Bare ground: 1%.
Litter cover: 1% Logs; 1% Twigs; 15% Lvs.
Disturbance type: Weeds.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	5%	0.9m	01.03	
Cassytha racemosa	+	CR	01.04	
Centella asiatica	30%	0.2m	01.05	
**Cirsium vulgare*	+	0.4m	NC	
**Cortaderia selloana*	1%	4m	NC	
Eucalyptus rudis subsp. *rudis*	+	9m	01.12	
**Ficus carica*	+	0.4m	01.01	
**Holcus lanatus*	10%	0.3m	01.06	
**Livistona australis*	+	0.1m	NC	
Melaleuca rhaphiophylla	40%	7m	NC	
**Paspalum dilatatum*	40%	0.3m	01.09	
**Rubus anglocandicans*			NC	Associated Species
**Rumex crispus*	1%	0.3m	01.07	
**Schinus terebinthifolius*	+	3m	01.02	
**Typha orientalis*	3%	1m	NC	
**Zantedeschia aethiopica*	+	0.4m	NC	

Site Q02

Described by NW



Location Welland

MGA Zone50 390881 mE 6430533mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Open Woodland of *Melaleuca rhaphiophylla, Eucalyptus rudis* subsp. *rudis,* Paspalum dilatatum, *Holcus lanatus, Centella asiatica,* Zantedeschia aethiopica, *Rumex crispus* and *Baumea articulata.*

Veg Condition Good to Degraded

Fire Age Old

Notes Aspect: N/A.
Bare ground: 5%.
Litter cover: 1% Logs; 13% Twigs; 20% Lvs.
Disturbance type: Weeds and clearing.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	1%	0.6m	01.03	
Cassytha racemosa	+	CR	01.04	
Centella asiatica	60%	0.25m	01.05	
**Cirsium vulgare*	+	0.3m	NC	
Eucalyptus rudis subsp. *rudis*	2%	6m	NC	
**Gomphocarpus fruticosus*	+	0.1m	NC	
**Holcus lanatus*	1%	0.5m	01.06	
Melaleuca lateritia	+	1m	02.06	
Melaleuca rhaphiophylla	6%	5m	NC	
**Paspalum dilatatum*	2%	0.4m	02.04	
**Prunella vulgaris*	+	0.3m	02.02	
**Rumex crispus*	1%	0.4m	02.03	
**Zantedeschia aethiopica*	2%	0.5m	NC	

Site Q03

Described by NW



Location Wellard

MGA Zone 50 390936mE 6429912mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Woodland of *Eucalyptus rudis subsp. rudis, Melaleuca rhaphiophylla, Centella asiatica* and *Baumea articulata.*

Veg Condition Good to Degraded

Fire Age Old

Notes Aspect: N/A.
Bare ground: 2%.
Litter cover: 2% Logs; 15% Twigs; 30% Lvs.
Disturbance type: Weeds and clearing.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	30%	1m	01.03	
**Briza maxima*	+	0.4m	NC	
Cassytha racemosa	+	CR	01.04	
Centella asiatica	20%	0.2m	01.05	
Eucalyptus rudis subsp. *rudis*	20%	10m	NC	
**Holcus lanatus*	+	0.2m	01.06	
**Lolium perenne* x *rigidum*	+	0.4m	03.01	
Melaleuca rhaphiophylla	5%	6m	NC	
**Sonchus oleraceus*	+	0.1m	03.02	
**Zantedeschia aethiopica*	+	0.5m	NC	

Site R01

Described by NW



Location Wellard

MGA Zone 50 390725mE 6430290mN

Habitat Dampland

Soil Wet brown loam

Rock Type

Vegetation Low Open Forest of *Melaleuca rhaphiophylla* and *Baumea articulata.*

Veg Condition Good

Fire Age Moderate

Notes Aspect: N/A.
Bare ground: 60%.
Litter cover: 1% Logs; 2% Twigs; 5% Lvs.
Disturbance type: Cattle and weeds.

SPECIES LIST:

Name	Cover	Height	Specimen	Notes
Baumea articulata	20%	0.6m	R01.02	
Caesia micrantha	+	0.3m	R01.01	
Centella asiatica	+	0.2m	01.05	
Melaleuca rhaphiophylla	60%	4m	NC	

APPENDIX D
BUSH FOREVER CONDITION SCALE

APPENDIX D

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 E
DATABASE SEARCH RESULTS

APPENDIX E

DATABASE SEARCH RESULTS

E1: Declared Rare and Priority Flora

FAMILY	TAXA	Conservation Status Code		Source	Life Cycle[1]	Flowering Time[1]	Habitat[1]
		STATE	FEDERAL				
Aponogetonaceae	*Aponogeton hexatepalus*	P4	-	DEC	Perennial	Jul-Oct	Pools (Aquatic)
Centrolepidaceae	*Centrolepis caespitosa*	P4	Endangered	EPBC Search	Perennial	Oct - Dec	Salt flats
Cyperaceae	*Cyathochaeta teretifolia*	P3	-	DEC	Perennial	Not Available	Swamps and creek edges
Cyperaceae	*Lepidosperma rostratum*	DRF	Endangered	EPBC Search	Perennial	Not Available	Peaty sand and clay
Ericaceae	*Andersonia gracilis*	DRF	Endangered	EPBC Search	Perennial	Sept - Nov	Winter-wet areas
Fabaceae	*Aotus cordifolia*	P3	-	DEC	Perennial	Aug-Jan	Swamps
Malvaceae	*Lasiopetalum pterocarpum*	DRF	Endangered	EPBC Search	Perennial	Sep- Dec	Sand over Limestone
Myrtaceae	*Darwinia foetida*	DRF	Crit End	EPBC Search	Perennial	Not known	Not known
Orchidaceae	*Caladenia huegelii*	DRF	Endangered	DEC / EPBC Search	Perennial	Sept-Oct	Sandy soils
Orchidaceae	*Diuris micrantha*	DRF	Vulnerable	DEC / EPBC Search	Perennial	Sept-Oct	Seasonally wet flats
Orchidaceae	*Drakaea elastica*	DRF	Endangered	EPBC Search	Perennial	Oct-Nov	Near seasonally wet flats
Proteaceae	*Grevillea curviloba* subsp. *incurva*	DRF	Endangered	EPBC Search	Perennial	Aug - Sept	Winter-wet health
Proteaceae	*Synaphea stenoloba*	DRF	Endangered	EPBC Search	Perennial	Aug - Oct	Winter-wet flats
Proteaceae	*Synaphea* sp. Fairbridge Farm (D.Papenfus 696)	DRF	Endangered	EPBC Search	Perennial	Oct	Near seasonally wet flats
Proteaceae	*Synaphea* sp. Serpentine (G.R. Brand 103)	P3	-	DEC	Perennial	Oct	Slumpland
Sapindaceae	*Dodonaea hackettiana*	P4	-	DEC	Perennial	Jul-Oct	Outcropping Limestone
Rutaceae	*Boronia juncea* subsp. *juncea*	P1	-	DEC	Perennial	Apr	Sand
Stylidiaceae	*Stylidium ireneae*	P4	-	DEC	Perennial	Sept-Oct	Saline clay flats
Stylidiaceae	*Stylidium longitubum*	P3	-	DEC	Annual	Oct-Dec	Seasonally wet flats

[1] Source: Western Australian Herbarium [WAH] (2010) *FloraBase - Information on the Western Australian Flora.* Department of Environment and Conservation, Perth. Online: http://florabase.calm.wa.gov.au [October 2010].

E2: Threatened and Priority Ecological Communities

Ecological Community	Description	Conservation Status		Source
		State	Federal	
SCP3a	*Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain	Endangered	Endangered	EBPC Search
SCP3c	*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain	Critically Endangered	Endangered	EBPC Search
SCP19b	Woodlands over sedgelands in Holocene dune swales of the southern Swan Coastal Plain	Critically Endangered	Endangered	DEC / EBPC Search
SCP26a	*Melaleuca huegelii - Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges	Endangered	-	DEC
SCP09	Dense shrublands on clay flats	Vulnerable	-	DEC
SCP22	*Banksia ilicifolia* woodlands	Priority 2	-	DEC
SCP24	Northern Spearwood shrublands and woodlands	Priority 3	-	DEC
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	Priority 3	-	DEC

APPENDIX F
FLORA SPECIES LIST

APPENDIX F

FLORA SPECIES LIST

* denotes foreign introduced species

Abbreviations:

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

FAMILY	TAXA
Anacardiaceae	**Schinus terebinthifolius*
Anthericaceae	*Caesia micrantha*
Apiaceae	*Centella asiatica*
Araceae	**Zantedeschia aethiopica*
Arecaceae	**Livistona australis*
Asclepiadaceae	**Gomphocarpus fruticosus*
Asteraceae	**Cirsium vulgare*
Asteraceae	**Sonchus oleraceus*
Cyperaceae	*Baumea articulata*
Lamiaceae	**Prunella vulgaris*
Lauraceae	*Cassytha racemosa*
Moraceae	**Ficus carica*
Myrtaceae	*Eucalyptus rudis* subsp. *rudis*
Myrtaceae	*Melaleuca lateritia*
Myrtaceae	*Melaleuca rhaphiophylla*
Poaceae	**Briza maxima*
Poaceae	**Cortaderia selloana*
Poaceae	**Holcus lanatus*
Poaceae	**Lolium perenne* x *rigidum*
Poaceae	**Paspalum dilatatum*
Polygonaceae	**Rumex crispus*
Rosaceae	**Rubus anglocandicans*
Typhaceae	**Typha orientalis*

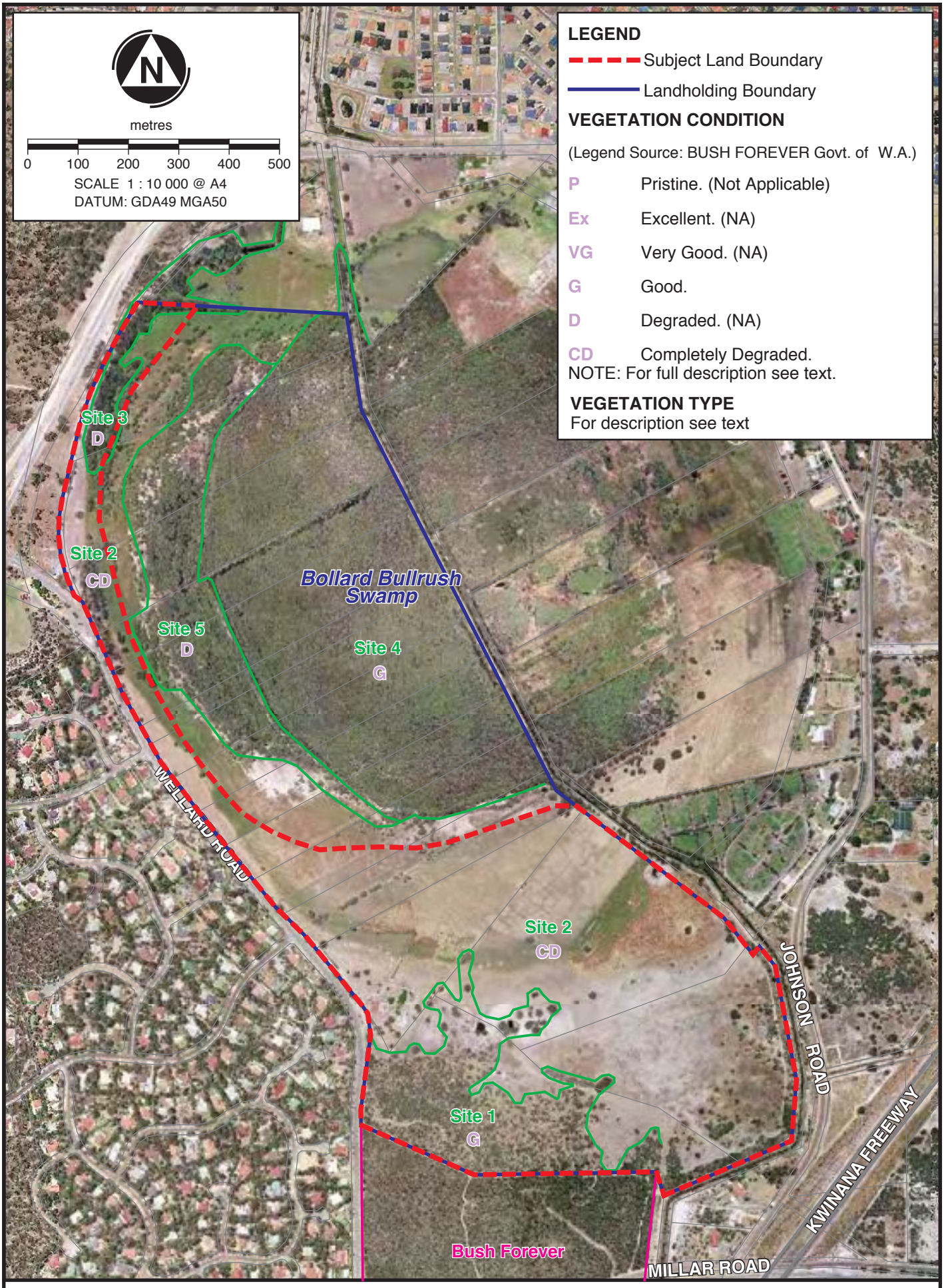
APPENDIX G
MATRIX OF TAXA BY SITE

APPENDIX G

MATRIX OF TAXA BY SITE

Species Name	Q01	Q02	Q03	R01
Baumea articulata	5%	1%	30%	20%
**Briza maxima*			+	
Caesia micrantha				+
Cassytha racemosa	+	+	+	
Centella asiatica	30%	60%	20%	+
**Cirsium vulgare*	+	+		
**Cortaderia selloana*	1%			
Eucalyptus rudis subsp. *rudis*	+	2%	20%	
**Ficus carica*	+			
**Gomphocarpus fruticosus*		+		
**Holcus lanatus*	10%	1%	+	
Livistona australis	+			
**Lolium perenne* x *rigidum*			+	
Melaleuca lateritia		+		
Melaleuca rhaphiophylla	40%	6%	5%	60%
**Paspalum dilatatum*	40%	2%		
**Prunella vulgaris*		+		
**Rubus anglocandicans*	nc			
**Rumex crispus*	1%	1%		
**Schinus terebinthifolius*	+			
**Sonchus oleraceus*			+	
**Typha orientalis*	3%			
**Zantedeschia aethiopica*	+	2%	+	

APPENDIX B
BOLLARD BULRUSH SWAMP WEST VEGETATION CONDITION MAPPING (ENV 2009)



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DevX - BOLLARD BULLRUSH SWAMP WEST
ENVIRONMENTAL ASSESSMENT TO SUPPORT
SPECIAL RESIDENTIAL & RESIDENTIAL SUBDIVISION

VEGETATION TYPE AND CONDITION

Environmental Geology: Geological Survey of Western Australia, 1:50 000 Environmental Series

FIGURE 5

env Australia

APPENDIX C
BOLLARD BULRUSH EAST FAUNA ASSESSMENT





BOLLARD BULRUSH EAST

FAUNA ASSESSMENT









BOLLARD BULRUSH EAST

FAUNA ASSESSMENT

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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 Pty Ltd was commissioned by Greg Rowe and Associates, on behalf of the Wellard Landowners Group, in June 2010 to undertake a fauna and fauna habitat assessment for the Bollard Bulrush East survey area. The survey area is approximately 73 hectares in size.

The purpose of this assessment is to provide supporting documentation for proposed future residential development of the survey area. The objectives of the fauna assessment are to:

- Document the general fauna habitat types in the survey area as they relate to faunal assemblages.
- Compile a list of terrestrial vertebrate fauna previously recorded in the region, based on database searches.
- Identify terrestrial vertebrate fauna of conservation significance that potentially occur within the survey area, based on databases and past work in the surrounding area.
- Develop a map illustrating the fauna habitat types present.
- Provide technical advice on fauna issues likely to constrain the proposed development.

A Level One assessment was undertaken in the survey area, in consideration of the Environmental Protection Authority *Guidance Statement No. 56.*

One fauna habitat type was identified in the survey area; a *Melaleuca* Dampland. This fauna habitat type represents 32% of the survey area; the remaining 68% is largely made up of degraded land previously used for agriculture. Based on a site assessment and survey, the fauna habitat type is considered to be of low value and is unlikely to support a wide suite of fauna species and/or species of conservation significance. There is a lack of microhabitat diversity due to the presence of weed species which dominate the understorey and midstorey layers of the fauna habitat. There is also a lack of important habitat structures such as large trees with hollows, loose bark and fallen hollow logs (used by many fauna species as den and nest sites).

Two-hundred and eleven species of fauna have been previously recorded within the vicinity of the survey area, including six amphibians, 33 reptiles, 150 birds and 22 mammals. During the fauna survey twenty-nine terrestrial vertebrate fauna were recorded, comprising of one amphibian species, one reptile species, 18 bird species and two mammal species. Of these only the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) is a species of conservation significance and is listed on the Department of Environment and Conservation Priority list. Secondary evidence in the

form of species specific conical diggings was recorded in moderate density across the survey area.

Twenty-eight species of conservation significance have been previously recorded within the vicinity of the survey area. This includes three reptile species, 18 bird species and seven mammal species. Of these one was 'Recorded', two species were considered as 'Likely', three species 'Possible', 18 as 'Unlikely' to occur. Four were considered as 'Highly Unlikely' to occur within the survey area. This is based on the ecological requirements and known distribution of the species and the type and quality of fauna habitats within the survey area. Species considered as 'Likely' to occur are bird species namely the Cattle Egret and Eastern Great Egret.

Generally the site was degraded and cleared and did not provide much value to a wide suite of fauna species. Approximately 32% of the survey area contained fauna habitat and the remaining was in degraded condition and depauperate of faunal assemblages. In addition the survey area has been subject to past and present agriculture activities and this has largely reduced the sites value for fauna particularly species with conservation significance.

1 INTRODUCTION

ENV.Australia Pty Ltd ('ENV') was commissioned by Greg Rowe and Associates, on behalf of the Wellard Landowners Group in June 2010 to undertake a fauna and fauna habitat assessment for the Bollard Bulrush East site ('the survey area'). The survey area is approximately 73 hectares (ha) in size.

The purpose of this assessment is to provide supporting documentation for proposed future residential development of the survey area.

1.1 OBJECTIVES

The objectives of the fauna assessment are to:

- Document the general fauna habitat types in the survey area as they relate to faunal assemblages.
- Compile a list of terrestrial vertebrate fauna previously recorded in the region, based on database searches.
- Identify terrestrial vertebrate fauna of conservation significance that potentially occur within the survey area, based on databases and past work in the surrounding area.
- Develop a map illustrating the fauna habitat types present.
- Provide technical advice on fauna issues likely to constrain the proposed development.

1.2 LOCATION

The Bollard Bulrush East survey area is located approximately 35 kilometres (km) south of the Perth Central Business District, in the suburb of Wellard, in the Town of Kwinana. The survey area is bounded by housing and a school on its northern, eastern and southern sides and remnant vegetation on its western side (Figure 1).

1.3 CLIMATE

The climate of this region is warm Mediterranean, with an average maximum summer temperature of 28.3°C and an average minimum winter temperature of 10.9°C (Bureau of Meteorology (BoM) 2010). The region receives an average annual rainfall of 765.3 mm, with the majority of precipitation occurring in winter (BOM 2010) (Figure 2).

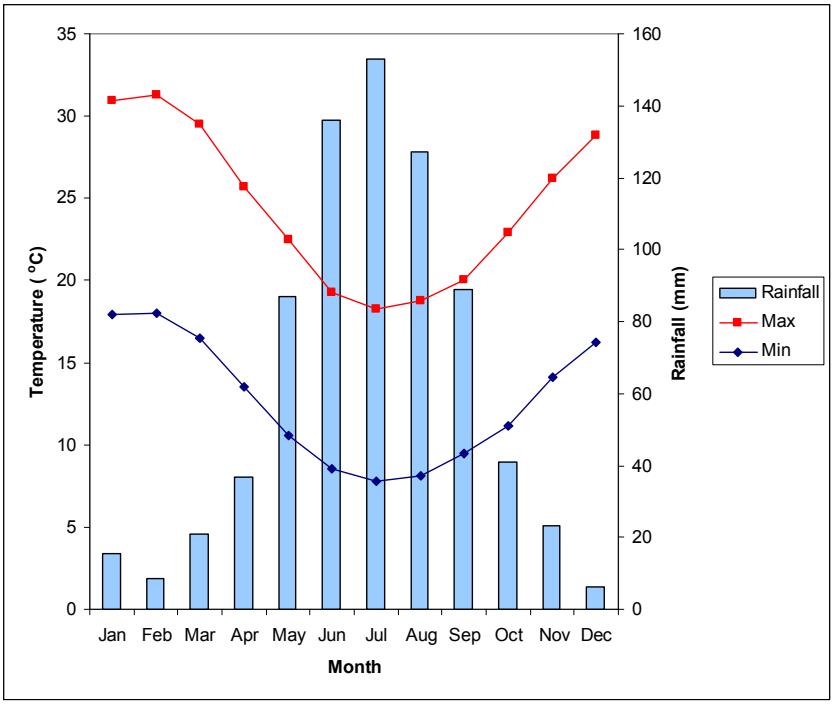


Figure 2: Average monthly rainfall and maximum and minimum temperatures at Medina Research Station (1983-2010) (BoM 2010)

1.4 REGIONAL SOILS, LANDFORMS AND VEGETATION

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

A widely-used vegetation classification system that maps and describes vegetation communities in southwest Western Australia is *Vegetation of the Darling System* in the *Atlas of Natural Resources, Darling System, Western Australia* (Department of Conservation and Environment 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, and 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.

The soils and landform unit, as well as the vegetation complex the survey area supports, are described below.

1.4.1 Soils and Landforms

The survey area occurs on the Swan Coastal Plain portion of the Darling System (Churchward and McArthur 1978). The Swan Coastal plain consists of aeolian and fluviatile deposits, specifically the survey area is on:

- Herdsman unit: Peaty swamps associated with Bassendean and Karrakatta units.

1.4.2 Beard Vegetation Mapping

The survey area is in the South West Botanical Province and the Darling Botanical District (Beard 1990). The vegetation of this region typically consists of forest with related woodlands and is divided into four subregions or botanic subdistricts.

The survey area is within the Swan Coastal Plain Subregion in the Drummond Botanical Subdistrict (Beard 1990). The Drummond Botanical Subdistrict consists mainly of the following vegetation communities:

- *Banksia* Low Woodland on leached sands and *Melaleuca* Swamps in poorly drained areas.
- Woodland of Tuart (*Eucalyptus gomphocephala*).
- Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands on the less leached soils (Beard 1990).

1.4.3 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:

- Herdsman Complex: Vegetation consists of sedgeland and fringing woodland of *Eucalyptus rudis* - *Melaleuca* species.

The Environmental Protection Authority's (EPA) document *Levels of Assessment for Proposals Affecting Natural Areas Within System 6 Region and Swan Coastal Plain Portion of the System 1 Region* (EPA 2006) gives an estimate of the percentage of each complex that remains compared to its pre-European settlement extent, so an estimate of the scarcity of each complex can be determined.

In Western Australia 34.6% of the Herdsman Complex is estimated to remain (EPA 2006). While within the Perth Metropolitan Area (PMA), 31% of the Herdsman Complex is estimated to remain (Government of Western Australia 2000).

The EPA recognises certain vegetation complexes that are not well represented in reserves as being significant. Vegetation complexes which have 10%-30% remaining may be considered regionally significant. Proposals that would impact on a vegetation

complex with 10% or less remaining are likely to be formally assessed by the EPA (EPA 2006).

1.5 PREVIOUS FAUNA STUDIES

There is only a limited amount of published or publicly available biological survey work undertaken within the vicinity of Wellard. The most recent of these are within 15 km of the survey area and include:

- Fauna Survey (Level 2) East Rockingham WWTP Site (Harewood 2009).
- Fauna Survey (Level 1) East Rockingham WWTP Site (Harewood 2008).
- Fauna Assessment of Bush Forever Site 355 (Bamford 2005).
- Fauna Assessment of a Portion of the Sepia Depression Ocean Outlet Landline, Lake Richmond (ENV 2005).

2 METHODOLOGY

2.1 BACKGROUND TO SURVEY METHODOLOGY

2.1.1 Protection of Fauna and Fauna Habitat

Fauna, habitat, and fauna ecological communities are protected formally and informally by various legislative and non-legislative measures, which are outlined below. Species listed under these Acts and non-legislative measures are considered 'conservation significant' in this assessment.

Legislative Protection

- Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Western Australian *Wildlife Conservation Act 1950* (WC Act).
- Western Australian *Environmental Protection Act 1986* (EP Act).

Non-Legislative Protection

- Department of Environment and Conservation (DEC) Priority lists.
- Informal recognition of fauna of interest.

A short description of these legislative and non-legislative measures is given below, and definitions of the species conservation codes and ecological community categories they use, are provided in Appendix A.

Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act aims to protect matters of national environmental significance, which are detailed in Appendix A. Under the EPBC Act, the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the act (Commonwealth of Australia 2007). Species are considered to be conservation significant if they are listed as Threatened (i.e. Vulnerable, Endangered etc.), or Migratory.

Migratory bird species listed under the EPBC Act are also listed under international migratory bird agreements relating to the protection of birds which migrate between Australia and other countries. These includes the: Japan-Australia Migratory Bird Agreement (JAMBA); China-Australia Migratory Bird Agreement (CAMBA); Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA); and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Some marine fauna or terrestrial fauna that use marine habitats are listed as Marine under the EPBC Act. These species are only considered conservation significant when a proposed development occurs in a Commonwealth marine area (i.e. any Commonwealth Waters or Commonwealth Marine Protected Area). Outside of such areas the EPBC Act does not consider these species to be matters of national environmental significance, so they are not protected under the Act. As such species only listed as Marine under the EPBC Act are not considered in this assessment.

Wildlife Conservation Act 1950

The DEC, lists taxa under the provisions of the WC Act as protected and are classified as Schedule 1 to Schedule 4 according to their need for protection (see Appendix A). The Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the WC Act.

Environmental Protection Act 1986

Significant habitat necessary for the maintenance of indigenous fauna to Western Australia as well as TECs is given special consideration in environmental impact assessment, and areas with TECs present have special status as Environmentally Sensitive Areas (ESAs) under the EP Act, and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

The protection of 'significant habitats' for fauna indigenous to Western Australia and TECs is a 'clearing principle' 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 for unlawfully damaging ESAs.

DEC Priority Lists

The DEC produces a list of Priority species that have not been assigned statutory protection under the WC Act. 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. Appendix A provides definitions of Priority codes.

In addition, the DEC maintains a list of Priority Ecological Communities which identifies those communities that need further investigation before being nomination as a TEC.

Although DEC Priority species and communities have no formal legal protection, they are under consideration as 'Scheduled' taxa under the WC Act or as ESAs under the EP Act. Sensitivities to harm Priority species or communities can therefore be expected to be heightened.

Informal Recognition of Threatened Fauna

Certain populations or communities may be of local significance or interest because of their distribution and or abundance. For example, fauna may be locally significant because they represent a range extension (i.e. outside of known distribution) or are newly discovered taxa and therefore have the potential to be listed as Threatened in the future. In addition, many species are in decline as a result of threatening processes, and relict populations of such species maybe locally important.

2.1.2 EPA Requirements for Fauna Surveys

The survey was carried out in a manner consistent with the EPA requirements for environmental surveying and reporting of fauna surveys in Western Australia:

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

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

According to the EPA *Guidance Statement No. 56* (EPA 2004), a baseline field fauna survey for environmental impact assessment should at the very least provide a comprehensive list of species within a given area. There are two levels of fauna survey as outlined by the EPA:

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

- ***Level Two:*** trapping and opportunistic field survey to characterise the fauna present, combined with a Level One survey. Where the scale and nature of the proposed impact is moderate to high, a Level Two survey will be required in most areas of the state, and is typically required for resource development projects.

The methodology of the current survey, a Level One survey, has been developed in consideration of the EPA *Guidance Statement No. 56.* The relatively small size of the survey area and extensive level of faunal assemblage knowledge on the Swan Coastal Plain, a Level One survey is appropriate for the proposed development.

2.2 DESKTOP REVIEW

The purpose of the desktop review was to gather background information on the survey area and the fauna that it may support. This involved a search of the following sources:

- Western Australian Museum (WAM) and DEC combined biological database *NatureMap* (DEC 2010a) (an approximate 10 km buffer surrounding the survey area was searched).

- DEC Threatened and Priority Fauna Database (DEC 2010b) (area search was as above).
- SEWPAC *Protected Matters Search Tool* (SEWPAC 2010), also known as an EPBC search (an approximate 10 km buffer surrounding the survey area was searched).
- Birds Australia's Birdata (Birdata 2010) (area search was based on a one degree square which encompassed the survey area).
- Previous fauna surveys (e.g. previous ENV reports, other consultant's reports, DEC reports).

Collectively, these sources were used to compile a list of species that have been previously recorded in the vicinity of the survey area (Appendix B). This list will invariably include some species that do not occur in the survey area, because some fauna have a limited or patchy distribution, high level of habitat specificity, are locally extinct or were erroneously identified in previous surveys. Some records were excluded from this list, such as extinct species and clearly erroneous records.

2.3 FIELD SURVEY

The purpose of the field survey was to verify the accuracy of the desktop survey and to further delineate and characterise the fauna and faunal assemblages in the study area. The fauna field survey consisted of a fauna habitat assessment and opportunistic observations.

2.3.1 Fauna Habitat Assessment

During the field survey, broad fauna habitats were identified based on vegetation structure and landforms. These fauna habitats were then assessed for their potential to support species of conservation significance and the quality of habitat they provide to a wider suite of fauna. Habitats were rated as high, moderate or low on the basis of the complexity of microhabitats, including significant trees with hollows, loose bark, fallen hollow logs and leaf litter, and their representation in the region and survey area.

The locations of the fauna habitat assessment sites are included in Figure 3 and the information recorded presented in Appendix C.

2.3.2 Opportunistic Observations

Fauna was opportunistically observed and recorded during the field component of the field assessment. Field staff searched for and investigated scats, tracks, burrows and other traces of animals throughout the entire survey area. Where conservation significant species were located, the coordinates were recorded with a GPS.

2.4 TAXONOMY

If there were any taxonomic nomenclature issues for species identified in the desktop assessment (through subsequent name changes or taxonomic reviews) an effort was made to determine the currently accepted scientific name for each taxon. In cases where correct taxonomy of an old record cannot be determined, previous scientific names may be presented. Some taxa names may be followed by 'sp.', indicating that the species name was not provided in the data source or the taxonomy is in doubt. Where there are previously recorded taxa such as this that have the potential to be a conservation significant species, they will be discussed specifically in the results section.

Species were identified in the field using relevant field guides. Tyler *et al*. (2000) and Cogger (2000) were used to identify frogs. Wilson and Swan (2008), Storr *et al*. (1999, 2002) and Cogger (2000) were used to identify reptiles. Pizzey and Knight (2007), Simpson and Day (2004) and Geering *et al*. (2007) were used to identify birds. Menkhorst and Knight (2004), van Dyck and Strahan (2008) and Churchill (2008) were used to identify mammals, while Triggs (1996) was used to identify mammal scats, tracks and traces.

3 RESULTS

3.1 VARIABLES INFLUENCING THE FAUNA SURVEY

As per EPA *Guidance Statement No. 56* (EPA 2004), variables which may influence a survey need to be documented. These variables are detailed in Table 1.

Table 1: Variables Associated with the Fauna Assessment

Variable	Impact on Survey Outcomes
Experience levels/ Resources	The biologists that executed these surveys included practitioners that are regarded as suitably qualified in their respective fields. Field Reconnaissance: • Mr John Trainer – Zoologist. Data Interpretation / Report Writing: • Mr Matthew Love – Senior Zoologist. • Mr John Trainer – Zoologist.
Scope: sampling methods/ Intensity	A Level One survey was carried out, which included a desktop review and site reconnaissance. A site reconnaissance involved performing fauna habitat assessments and opportunistic recordings, therefore many species that occur in the survey area would not have been observed, particularly small ground-dwelling fauna that are typically captured by trapping techniques employed in a Level Two survey.
Sources of Information	At the bioregion level, the south west of Western Australia has been the subject of many targeted biological surveys, primarily for the resource and residential development sector. Site-specific data is limited, but this is not considered a limiting factor for this survey. Previous fauna surveys in the general vicinity are highlighted in Section 1.5.
Timing, weather, season.	The survey was undertaken in spring on the 29 September 2010. The area had received 455.4 millimetres (mm) of rain in the year to date (January to September) which is significantly below the long term average of 604.7 mm for the same period (1983 – 2007) (BOM 2010). This below average rainfall may reduce the number of flora species in the area and the number which can be identified (reduced fruit, seed and flowering) particularly for groundcover species e.g. grasses and herbs. This in turn reduces foraging and sheltering sites for ground dwelling fauna e.g. small mammals and reptiles.

Variable	Impact on Survey Outcomes
Disturbances	No disturbances affected the outcomes of the fauna survey.
Access problems	No access problems affected the outcome of the fauna survey.

3.2 HABITAT ASSESSMENT

3.2.1 Habitat Types

There was one fauna habitat type identified in the survey area - *Melaleuca* Dampland. This fauna habitat type is mapped in Figure 4, and with detailed results presented in Appendix C.

The survey area also contains areas that have been cleared (and so are degraded). These areas provide little to no value as habitat and are principally cleared areas as a consequence of historical agriculture activity.

Table 2: Major habitat types of the survey area

Habitat Type	Habitat Value	Approximate Area of Habitat Type (ha)
Melaleuca Dampland	Low	22.7 ha
Degraded	n/a	50.2 ha
Total		72.9 ha

***Melaleuca* Dampland**

The *Melaleuca* Dampland low woodland habitat forms a small portion of the survey area (32%) and is the only fauna habitat type present. The dominant vegetation in this fauna habitat type consists of Swamp Paperbark (*Melaleuca rhaphiophylla*), Flooded Gum (*Eucalyptus rudis* subsp. *Rudis*), **Paspalum dilatatum*, Yorkshire Fog (**Holcus lanatus*), *Centella asiatica*, Curled Dock (**Rumex crispus*) and Jointed Rush (*Baumea articulata*). The midstorey and understorey are heavily disturbed and dominated by weed species such as the Blackberry (**Rubus anglocandicans*) and Arum Lily (**Zantedeschia aethiopica*). The soils were generally low-lying, black sand and will often inundate during or after rain events. Frog species may become prevalent during these times when surface water is present. Fauna typically associated with this habitat include the Marbled Gecko (*Christinus marmoratus*), Western Swamp Skink (*Egernia luctuosa*), and Tiger Snake (*Notechis scutatus*). The *Melaleuca* Dampland was in Good - Degraded condition as per the Keighery condition scale which is used in Bush Forever assessment

(Government Western Australia 2000). The Wetland habitat type is considered to be of low value to fauna within the survey area.

3.3 FAUNA ASSEMBLAGE

Twenty-nine terrestrial vertebrate fauna were recorded during the survey, comprising one amphibian species, one reptile species, 25 bird species, and two mammal species (Appendix B). Two-hundred and eleven species of fauna have been previously recorded within the vicinity of the survey area, including six amphibians, 33 reptiles, 150 birds and 22 mammals. All fauna previously recorded in the vicinity of the survey area also listed in Appendix B.

3.3.1 Amphibians

One amphibian species recorded during the fauna assessment was Glauert's Froglet (*Crinia glauerti*) (Appendix B1).

Six species of amphibians have been previously recorded in the vicinity of the survey area (Appendix B1). Species likely to occur in the survey area include the common Motorbike Frog (*Litoria moorei*) and Moaning Frog (*Heleioporus eyrei*).

3.3.2 Reptiles

One species of reptile was recorded during the fauna assessment, Buchanan's Snake-eyed Skink (*Cryptoblepharus buchananii*) (Appendix B2).

Thirty-three species of reptiles have been previously recorded in the vicinity of the survey area (Appendix B2). Reptiles likely to occur in the survey area include the Southwestern Cool Skink (*Acritoscincus trilineatum*), the Two-toed Earless Skink (*Hemiergis quadrilineata*) and the Bobtail (*Tiliqua rugosa*).

3.3.3 Birds

Twenty-five species of bird were recorded in the survey area, including species like the Pacific Black Duck (*Anas superciliosa*), Whistling Kite (*Haliastur sphenurus*), Splendid Fairy-wren (*Malurus splendens*), Grey Fantail (*Rhipidura fuliginosa*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) and Australian Magpie (*Cracticus tibicen*) (Appendix B3).

One species of introduced bird was recorded during the fauna assessment, the Rainbow Lorikeet (**Trichoglossus haematodus moluccanus*).

One hundred and fifty species of birds have been previously recorded in the vicinity of the survey area (Appendix B3). Many of these species are unlikely to occur in the survey area, since these records are from a larger area encompassing a wide range of habitats and include migratory birds that only occur on a transitory basis. In addition many of

these birds are also associated with fresh water and marine systems and are included due to the close proximity of the survey area to the ocean.

3.3.4 Mammals

During the fauna assessment one mammal species of conservation significance, the Southern Brown Bandicoot (*Isoodon obesulus* subsp. *fusciventer*) was recorded in the survey area (Appendix B4).

The only introduced mammal recorded during the fauna assessment was the European Rabbit (**Oryctolagus cuniculus*).

Twenty-two species of mammal have previously been recorded in the vicinity of the survey area (Appendix B4). Many of these species are unlikely to occur in the survey area, since these records are from a large area encompassing a wide range of habitats that don't occur in the survey area.

3.4 CONSERVATION SIGNIFICANT FAUNA

A database search of the Bollard area resulted in 28 conservation significant fauna species being identified as potentially occurring in the area (Appendix D). This is comprised of three reptile species, 18 bird species and seven mammal species. Some of the conservation significant fauna previously recorded in the region will not occur in the survey area as they have a limited or patchy distribution, high level of habitat specificity, are locally extinct or were erroneously recorded in previous surveys.

One species, the Southern Brown Bandicoot was recorded in the survey area. This species is listed as Priority 5 on the DEC Priority Fauna List. Secondary evidence in the form of species specific conical diggings was recorded in moderate density across the survey area.

Two species were considered as 'Likely', three species as 'Possible', 18 as 'Unlikely' and four as 'Highly Unlikely' to occur within habitats of the survey area. This is based on the ecological requirements and known distribution of the species and the type and quality of fauna habitats within the survey area. The species considered as 'Likely' to occur are bird species namely the Cattle Egret and Eastern Great Egret.

4 DISCUSSION

4.1 FAUNAL ASSEMBLAGE

Twenty-nine terrestrial vertebrate fauna were recorded during the survey, comprising one amphibian species, one reptile species, 25 bird species, and two mammal species. As this was a Level One survey that included a reconnaissance survey to assess fauna habitat types, many of the potentially occurring species were not recorded. For example, many ground dwelling reptiles and mammals are mainly recorded or captured when trapping techniques are employed during a Level Two survey. This level of fauna species is expected given the poor condition of the survey area. In addition a clear lack of vegetation in the midstorey and understorey of the survey area restricts the number of micro-niches available, which further results in less diversity, particularly of ground-dwelling species.

The Swamp Paperbark and Flooded Gum could provide shelter and foraging opportunities for a number of different species including arboreal reptiles and mammals and a number of bird species. These species however would be commonly recorded urban species and none would have any conservation significance.

The conservation significant Southern Brown Bandicoot was recorded during the survey. The survey area would not support a large population of this species given the clear lack of native understorey species (which it requires) and the low-lying areas that would become inundated during rain events (van Dyck and Strahan 2008). The Southern Brown Bandicoot has been recorded in the vicinity of the survey area and has a long historical presence on the Swan Coastal Plain.

Historically twenty-eight fauna species of conservation significance have been recorded within the vicinity of the survey area. Three species were considered as 'Likely'; seven species were 'Possible'; 31 were considered as 'Unlikely'; and two were considered as 'Highly Unlikely' to occur within habitat of the survey area. This was based on the ecological requirements and known distribution of the species and the type and quality of fauna habitats present.

The species considered as 'Likely' to occur are bird species namely the Cattle Egret and Eastern Great Egret. These species and the Southern Brown Bandicoot that was recorded in the survey area will be discussed in more depth regarding any potential impacts.

4.2 SIGNIFICANCE OF FAUNA HABITAT

The *Melaleuca* Dampland within the survey area is degraded as a result of the lack of midstorey and understorey species and the presence of weeds; consequently it is of little value to conservation significant species (unlikely to support any additional species of conservation significance) or to common species. The understorey contains a large

array of weed species such as Blackberry and Arum Lilies which restricts the micro-niche diversity of the fauna habitat type.

The survey area is approximately 73 ha in size and is located between residential housing to the west and pastoral land to the east. The survey area is isolated from other similar habitats in the local vicinity. The fauna habitat in the survey area is highly fragmented with little habitat connectivity with surrounding area. This greatly reduces the value and functionality of the survey area to fauna, particularly those that require larger areas or home ranges. Ecological connectivity facilitates many life-history functions of fauna, particularly fauna of the area. The ability to utilise connected habitats is integral to the life histories of a broad spectrum of species, with connectivity between habitats being crucial to important functions such as breeding.

4.3 SIGNIFICANCE OF FAUNA SPECIES

The species recorded in the fauna assessment were common species often recorded in the general area, and have many historic records for the Swan Coastal Plain.

The species recorded in the survey area and the Egrets that were considered as 'Likely' to occur may not be impact by any potential development within the survey area. The Cattle Egret and Easter Great Egret are highly mobile and can easily move to other areas with similar habitat. The Southern Brown Bandicoot is ground-dwelling so their capacity to translocate to other areas outside of the survey area is not as easy as for more mobile species. However the habitat within the survey area is largely degraded as is not expected to support a significant population.

5 CONCLUSION

The fauna assessment undertaken by ENV determined that:

- One fauna habitat type was identified in the survey area; a *Melaleuca* Dampland. This fauna habitat type was considered to have low habitat value.
- Two-hundred and eleven species of fauna have been previously recorded within the vicinity of the survey area, including six amphibians, 33 reptiles, 150 birds and 22 mammals.
- During the fauna survey twenty-nine terrestrial vertebrate fauna were recorded, comprising of one amphibian species, one reptile species, 18 bird species, and two mammal species.
- One species is of conservation significance, the Southern Brown Bandicoot (Priority 5).
- Twenty-eight species of conservation significance have been previously recorded within the vicinity of the survey area. This was comprised of three reptile species, 18 bird species and seven mammal species.
- Three species were considered as 'Likely'; seven species were 'Possible'; 31 were considered as 'Unlikely'; and two were considered as 'Highly Unlikely' to occur within habitat of the survey area.

Generally the site was degraded and cleared and did not provide much value to a wide suite of fauna species. Approximately 32% of the survey area contained fauna habitat and the remaining was in degraded condition and depauperate of faunal assemblages. In addition the survey area has been subject to past and present agriculture activities and this has largely reduced the sites value for fauna particularly species with conservation significance.

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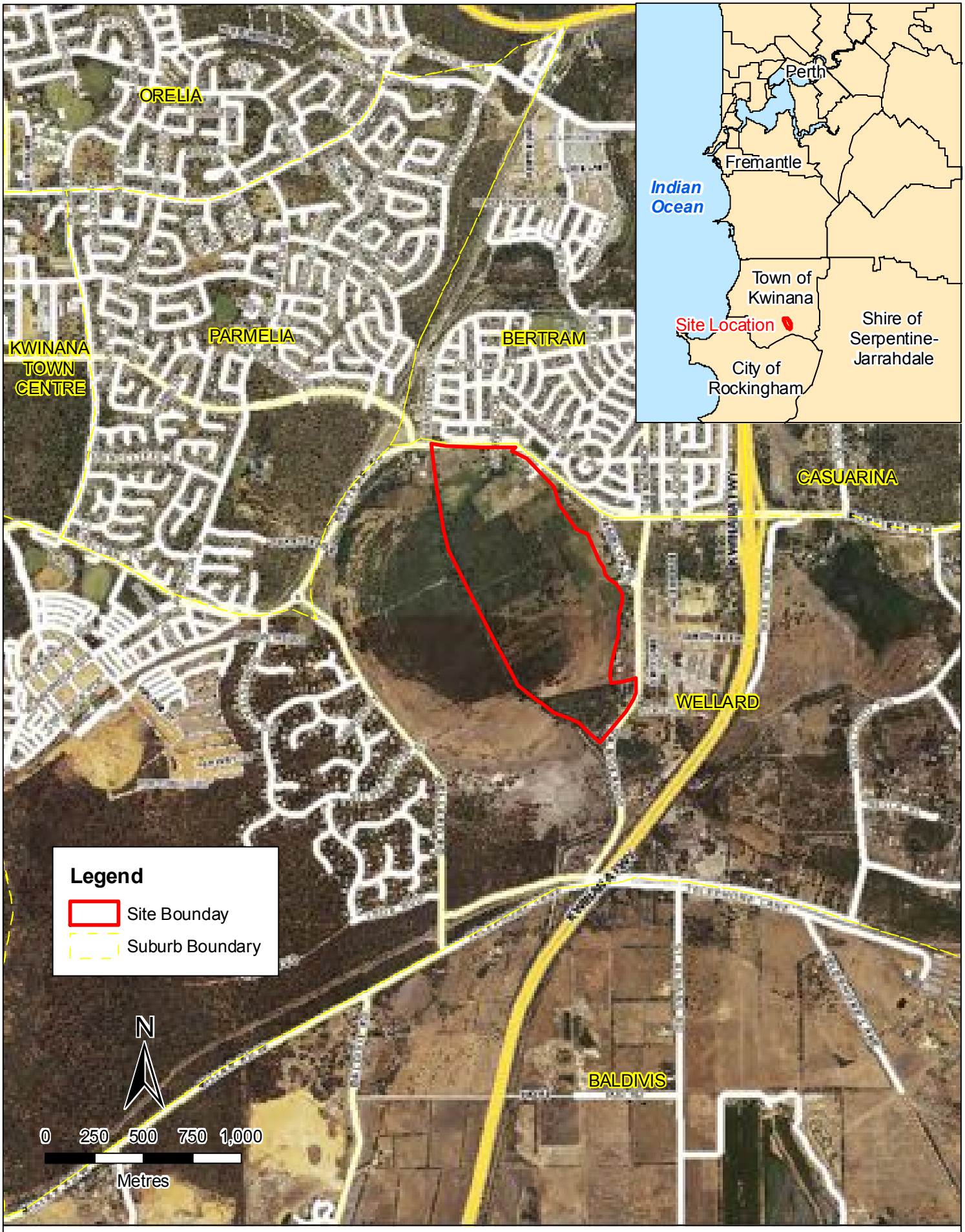
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FIGURES



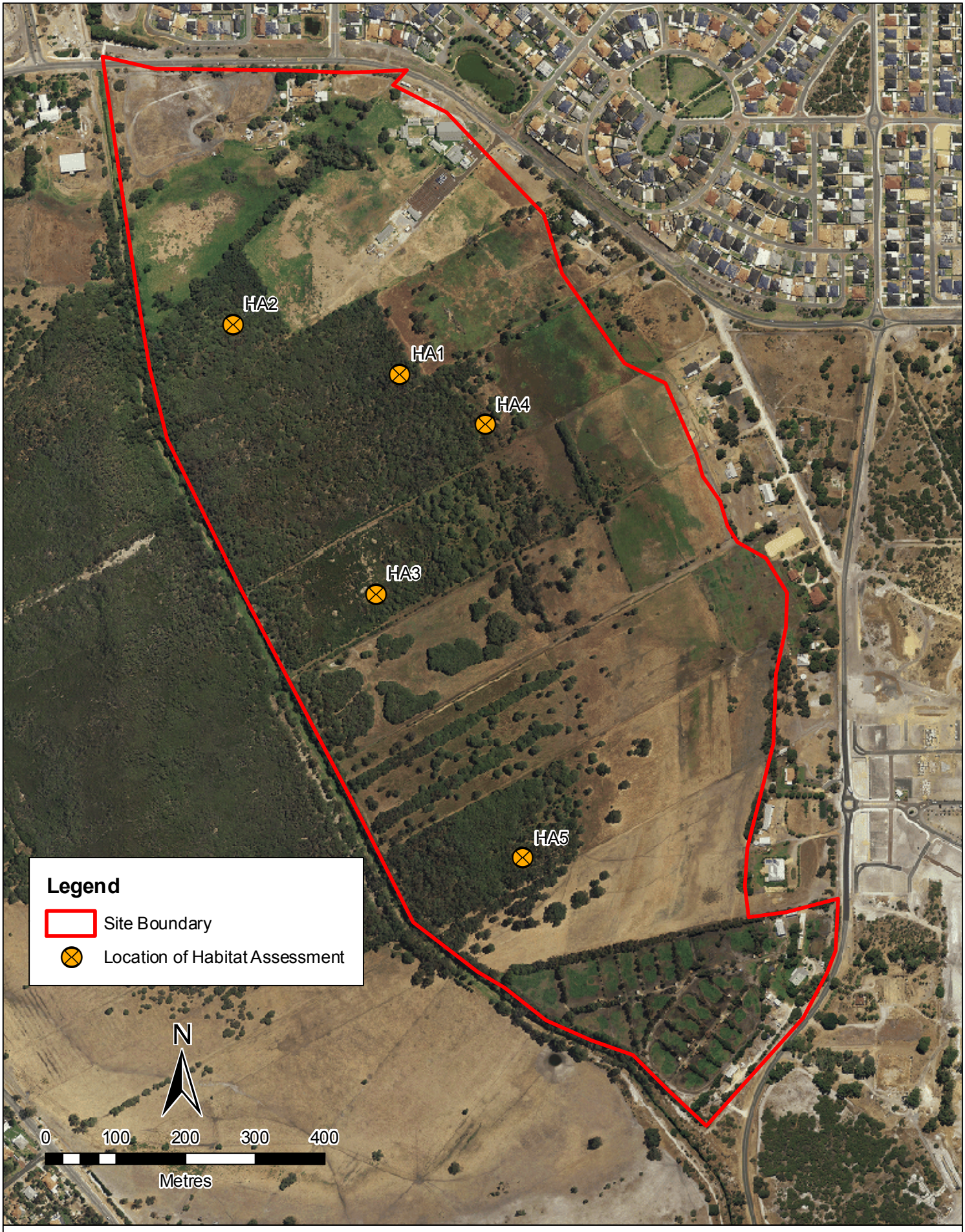
CLIENT: Wellard Landowners Group
JOB NO.: 10.127

Location Map

Bollard Bulrush East Fauna Assessment

AUTHOR: M. Love
DRAWN: T. Ellis
DATE: 16-11-2010
SCALE: 1:25,000 @ A4
PROJECTION: GDA 94 MGA 50

FIGURE 1



CLIENT
Wellard Landowners Group

JOB NO.
10.127

AUTHOR:
M. Love

DRAWN
T. Ellis

DATE
16-11-2010

SCALE
1:7,000 @ A4

PROJECTION
GDA 94 MGA 50

Location of Fauna Habitat Assessments

Bollard Bulrush East
Fauna Assessment

FIGURE 3



CLIENT: Wellard Landowners Group
JOB NO.: 10.127

Fauna Habitat Map

AUTHOR: M. Love
DRAWN: T. Ellis
DATE: 16-11-2010

Bollard Bulrush East
Fauna Assessment

SCALE: 1:7,000 @ A4
PROJECTION: GDA 94 MGA 50

FIGURE 4

APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

BOLLARD BULRUSH EAST FAUNA ASSESSMENT

APPENDIX A

DEFINITIONS OF CONSERVATION CODES FOR FAUNA OF CONSERVATION SIGNIFICANCE

A1: *Environment Protection and Biodiversity Conservation Act 1999* (*Cth*): Threatened Species and Threatened Ecological Communities Codes

The *EPBC Act* prescribes seven matters of national environmental significance:-

- World Heritage properties;
- National Heritage places;
- Wetlands of international importance;
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas; and
- Nuclear actions (including uranium mining).

Species in the categories ExW, CE, E, V and M (see below), and Threatened Ecological Communities in the CE and E categories are protected as matters of national environmental significance under the *EPBC Act*.

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

Category	Code	Category
Migratory	**Mi**	Taxa that migrate to Australia and its external territories, or pass through or over Australian waters during their annual migrations, that are included in an international agreement approved by the Minister for the Environment, Heritage and the Arts and that have been placed on the national List of Migratory Species under the provisions of the EPBC Act. At present there are four such agreements: • the Bonn Convention • the China-Australia Migratory Bird Agreement (CAMBA) • the Japan-Australia Migratory Bird Agreement (JAMBA) • the Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)
Marine	**Ma**	Taxa protected in a Commonwealth Marine Protected Area by virtue of section 248 of the *EPBC Act*. These taxa include certain seals, crocodiles, turtles and birds, as well as various marine fish. Commonwealth marine areas are matters of national environmental significance under the *EPBC Act*. An action will require approval if the: • action is taken in a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment, or • action is taken outside a Commonwealth marine area and the action has, will have, or is likely to have a significant impact on the environment in a Commonwealth marine area[1] The Commonwealth marine area is any part of the sea, including the waters, seabed, and airspace, within Australia's exclusive economic zone and/or over the continental shelf of Australia, that is not State or Northern Territory waters. The Commonwealth marine area stretches from 3 to 200 nautical miles (approximately 5-370 km) from the coast. Marine protected areas are marine areas which are recognised to have high conservation value.

A2: Western Australian Threatened Fauna Categories

Wildlife Conservation Act 1950 (WA)

Category	Code	Description
Schedule 1	S1	Rare or likely to become extinct.
Schedule 2	S2	Presumed extinct.
Schedule 3	S3	Birds subject to an agreement between the governments of Australia and Japan, the People's Republic of China & the Republic of Korea relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Other specially protected fauna.

A3: Department of Environment and Conservation 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: not currently threatened or in need of special protection, but could become so. Usually represented on conservation lands.
Priority 5	P5	Taxa in need of monitoring: not considered threatened, but the subject of a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

APPENDIX B

PREVIOUSLY RECORDED FAUNA IN THE REGION

APPENDIX B

B1: AMPHIBIAN SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

AMPHIBIANS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family HYLIDAE								
Litoria adelaidensis	Slender Tree Frog				x			
Litoria moorei	Motorbike Frog, Bell Frog				x			
Family MYOBATRACHIDAE								
Crinia glauerti	Glauert's Froglet				x			x
Crinia insignifera	Squelching Froglet				x			
Heleioporus eyrei	Moaning Frog				x			
Limnodynastes dorsalis	Bullfrog or Banjo Frog				x			

[X] fauna species recorded from the survey area.

APPENDIX B

B2: REPTILE SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

REPTILES		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family CHELUIDAE								
Chelodina oblonga	Oblong Turtle						x	
Family AGAMIDAE								
Ctenophorus adelaidensis	Western Heath Dragon				x		x	
Pogona minor	Bearded Dragon				x		x	
Family GEKKONIDAE								
Christinus marmoratus	Marbled Gecko				x		x	
Strophurus spinigerus spinigerus	Southwestern Spiny-tailed Gecko				x		x	
Family PYGOPODIDAE								
Aprasia repens	Sand-plain Worm-lizard						x	
Delma fraseri	Fraser's Delma				x		x	
Delma grayii	Side-barred Delma						x	
Lialis burtonis	Burrton's Legless Lizard				x		x	
Pletholax gracilis	Keeled Legless Lizard				x			
Pygopus lepidopodus	Common Scaly-foot				x			
Family SCINCIDAE								
Acritoscincus trilineatum	Southwestern Cool Skink				x		x	
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink						x	x
Ctenotus australis					x		x	
Ctenotus fallens					x		x	
Ctenotus gemmula	Jewelled Ctentous			P3	x			
Hemiergis quadrilineata	Two-toed Earless Skink				x		x	
Lerista elegans					x		x	
Lerista lineata	Lined Skink			P3	x		x	
Menetia greyii	Common Dwarf Skink				x		x	
Morethia lineoocellata					x		x	
Morethia obscura	Woodland Flecked Skink				x		x	
Tiliqua occipitalis	Western Blue-tongue				x		x	
Tiliqua rugosa	Southwestern Bobtail				x		x	
Family VARANIDAE								
Varanus tristis	Black-headed Monitor				x		x	
Family TYPHLOPIDAE								
Ramphotyphlops australis	Southern Blind Snake				x		x	
Family ELAPIDAE								
Brachyurophis semifasciata	Southern Shovel-nosed Snake				x			
Neelaps bimaculatus	Black-naped Snake				x			
Neelaps calonotos	Black-striped Snake			P3	x			
Notechis scutatus	Tiger Snake				x			
Pseudonaja affinis	Dugite				x		x	
Pseudonaja nuchalis	Gwardar				x			
Simoselaps bertholdi	Jan's Banded Snake				x			

[X] fauna species recorded from the survey area.
[*] denotes introduced species.

APPENDIX B

B3: BIRD SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family PHASIANIDAE								
Coturnix pectoralis	Stubble Quail	Ma			x			
Family ANATIDAE								
Anas gracilis	Grey Teal				x	x		
Anas rhynchotis	Australasian Shoveler				x	x		
Anas superciliosa	Pacific Black Duck				x	x		x
Aythya australis	Hardhead				x	x		
Biziura lobata	Musk Duck	Ma			x	x		
Chenonetta jubata	Australian Wood Duck				x	x		x
Cygnus atratus	Black Swan				x	x		
Malacorhynchus membranaceus	Pink-eared Duck				x	x		
Oxyura australis	Blue-billed Duck				x	x		
Tadorna tadornoides	Australian Shelduck				x	x		
Family PODICIPEDIDAE								
Poliocephalus poliocephalus	Hoary-headed Grebe				x	x		
Podiceps cristatus	Great Crested Grebe				x	x		
Tachybaptus novaehollandiae	Australasian Grebe				x	x		
Family ANHINGIDAE								
Anhinga melanogaster	Darter				x	x		
Family PHALACROCORACIDAE								
Phalacrocorax carbo	Great Cormorant				x	x		
Phalacrocorax melanoleucos	Little Pied Cormorant				x	x		
Phalacrocorax sulcirostris	Little Black Cormorant				x	x		x
Phalacrocorax varius	Pied Cormorant				x	x		
Family PELECANIDAE								
Pelecanus conspicillatus	Australian Pelican	Ma			x	x		
Family ARDEIDAE								
Ardea garzetta	Little Egret	Ma			x	x		
Ardea ibis	Cattle Egret	Mi, Ma			x	x		
Ardea modesta	Eastern Great Egret	Mi, Ma			x	x		
Ardea novaehollandiae	White-faced Heron				x	x	x	
Ardea pacifica	White-necked Heron				x	x		
Ixobrychus minutus	Little Bittern			P4	x			
Nycticorax caledonicus	Rufous Night Heron	Ma			x	x		
Family THRESKIORNITHIDAE								
Platalea flavipes	Yellow-billed Spoonbill				x	x		
Platalea regia	Royal Spoonbill				x	x		
Threskiornis molucca	Australian White Ibis	Ma			x	x		x
Threskiornis spinicollis	Straw-necked Ibis	Ma			x	x		x
Family ACCIPITRIDAE								
Accipiter cirrocephalus	Collared Sparrowhawk				x	x	x	
Accipiter fasciatus	Brown Goshawk	Ma			x	x	x	
Aquila audax	Wedge-tailed Eagle				x	x		
Aquila morphnoides	Little Eagle				x	x	x	
Circus approximans	Swamp Harrier	Ma			x	x		
Elanus axillaris	Black-shouldered Kite				x	x	x	
Haliaeetus leucogaster	White-bellied Sea-Eagle	Mi, Ma			x	x		
Haliastur sphenurus	Whistling Kite	Ma			x	x	x	x
Lophoictinia isura	Square-tailed Kite				x			
Family FALCONIDAE								
Falco berigora	Brown Falcon				x	x		
Falco cenchroides	Australian Kestrel	Ma			x	x	x	

BIRDS		Conservation Codes						
Scientific Name	**Common Name**	**EPBC**	**WC**	**DEC**	**A**	**B**	**C**	**D**
Falco longipennis	Australian Hobby				x	x	x	
Falco peregrinus	Peregrine Falcon		S4		x	x	x	
Family RALLIDAE								
Fulica atra	Eurasian Coot				x	x		
Gallinula tenebrosa	Dusky Moorhen				x	x		
Gallirallus philippensis	Buff-banded Rail	Ma			x			
Porphyrio porphyrio	Purple Swamphen	Ma			x	x		x
Porzana pusilla	Baillon's Crake				x	x		
Porzana tabuensis	Spotless Crake	Ma			x	x		
Tribonyx ventralis	Black-tailed Native-hen				x			
Family TURNICIDAE								
Turnix varia	Painted Button-quail				x	x		
Family SCOLOPACIDAE								
Actitis hypoleucos	Common Sandpiper	Mi, Ma			x	x		
Calidris acuminata	Sharp-tailed Sandpiper	Mi, Ma			x	x		
Calidris ferruginea	Curlew Sandpiper	Mi, Ma			x	x		
Calidris ruficollis	Red-necked Stint	Mi, Ma			x	x		
Numenius madagascariensis	Eastern Curlew	Mi, Ma		P4	x			
Tringa glareola	Wood Sandpiper	Mi, Ma			x	x		
Tringa nebularia	Common Greenshank	Mi, Ma			x	x		
Family BURHINIDAE								
Burhinus grallarius	Bush Stone-curlew			P4	x			
Family RECURVIROSTRIDAE								
Cladorhynchus leucocephalus	Banded Stilt				x	x		
Himantopus himantopus	Black-winged Stilt	Ma			x	x		
Recurvirostra novaehollandiae	Red-necked Avocet	Ma			x	x		
Family CHARADRIIDAE								
Charadrius melanops	Black-fronted Dotterel				x	x		
Charadrius rubricollis	Hooded Plover	Ma		P4	x			
Charadrius ruficapillus	Red-capped Plover	Ma			x	x		
Vanellus tricolor	Banded Lapwing				x			
Family LARIDAE								
Larus novaehollandiae	Silver Gull	Ma			x	x		
Sterna caspia	Caspian Tern	Mi,Ma				x		
Family COLUMBIDAE								
**Columba livia*	Domestic Pigeon				x	x		
Ocyphaps lophotes	Crested Pigeon				x	x		
Phaps chalcoptera	Common Bronzewing				x	x	x	x
**Streptopelia chinensis*	Spotted Turtle Dove				x	x		
**Streptopelia senegalensis*	Laughing Turtle-Dove				x	x	x	
Family PSITTACIDAE								
Cacatua roseicapilla	Galah				x	x	x	x
Cacatua sanguinea	Little Corella				x	x		x
**Cacatua tenuirostris*	Eastern Long-billed Corella				x	x		
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	S1		x	x		
Calyptorhynchus baudinii	Baudin's Cockatoo	VU	S1					
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	S1		x	x	x	
Neophema elegans	Elegant Parrot				x	x		
Polytelis anthopeplus	Regent Parrot				x	x		
Platycercus zonarius	Australian Ringneck				x	x	x	x
Platycercus spurius	Red-capped Parrot				x	x	x	
Platycercus icterotis	Western Rosella				x	x		
**Trichoglossus haematodus*	Rainbow Lorikeet				x	x		x
Family CUCULIDAE								
Cacomantis flabelliformis	Fan-tailed Cuckoo	Ma			x	x		
Chrysococcyx basalis	Horsfield's Bronze Cuckoo	Ma			x	x	x	
Chrysococcyx lucidus	Shining Bronze Cuckoo	Ma			x	x		
Cuculus pallidus	Pallid Cuckoo	Ma			x	x		
Family STRIGIDAE								
Ninox novaeseelandiae	Boobook Owl	Ma			x	x		
Family TYTONIDAE								
Tyto javanica	Eastern Barn Owl				x		x	
Family PODARGIDAE								
Podargus strigoides	Tawny Frogmouth				x	x		

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Family APODIDAE								
Apus pacificus	Fork-tailed Swift	Mi, Ma			x	x		
Family HALCYONIDAE								
**Dacelo novaeguineae*	Laughing Kookaburra				x	x	x	
Todiramphus sanctus	Sacred Kingfisher	Ma			x	x		
Family MEROPIDAE								
Merops ornatus	Rainbow Bee-eater	Mi, Ma			x	x	x	
Family MALURIDAE								
Malurus elegans	Red-winged Fairy-wren				x			
Malurus splendens	Splendid Fairy-wren				x	x	x	x
Family PARDALOTIDAE								
Pardalotus punctatus	Spotted Pardalote				x	x		
Pardalotus striatus	Striated Pardalote				x	x	x	x
Family ACANTHIZIDAE								
Acanthiza apicalis	Broad-tailed Thornbill (Inland Thornbill)				x	x	x	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill				x	x		
Acanthiza inornata	Western Thornbill				x	x	x	
Gerygone fusca	Western Gerygone				x	x	x	x
Sericornis frontalis	White-browed Scrubwren				x	x	x	
Smicrornis brevirostris	Weebill				x	x	x	
Family MELIPHAGIDAE								
Anthochaera carunculata	Red Wattlebird				x	x	x	x
Anthochaera lunulata	Western Little Wattlebird				x	x		
Acanthorhynchus superciliosus	Western Spinebill				x	x		
Lichmera indistincta	Brown Honeyeater				x	x	x	x
Lichenostomus ornatus	Yellow-plumed Honeyeater				x			
Lichenostomus virescens	Singing Honeyeater				x	x	x	
Manorina flavigula	Yellow-throated Miner				x			
Melithreptus chloropsis	Western White-naped Honeyeater				x	x		
Phylidonyris melanops	Tawny-crowned Honeyeater				x	x		
Phylidonyris nigra	White-cheeked Honeyeater				x	x		
Phylidonyris novaehollandiae	New Holland Honeyeater				x	x	x	
Family PETROICIDAE								
Eopsaltria georgiana	White-breasted Robin				x			
Melanodryas cucullata	Hooded Robin				x	x		
Petroica goodenovii	Red-capped Robin				x	x		
Petroica multicolor	Scarlet Robin				x	x	x	
Family NEOSITTIDAE								
Daphoenositta chrysoptera	Varied Sittella				x	x	x	
Family PACHYCEPHALIDAE								
Colluricincla harmonica	Grey Shrike-thrush				x	x	x	
Pachycephala pectoralis	Golden Whistler				x	x		
Pachycephala rufiventris	Rufous Whistler				x	x	x	
Family DICRURIDAE								
Grallina cyanoleuca	Magpie-lark	Ma			x	x	x	
Rhipidura fuliginosa	Grey Fantail				x	x	x	x
Rhipidura leucophrys	Willie Wagtail				x	x	x	x
Family CAMPEPHAGIDAE								
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Ma			x	x	x	x
Lalage sueurii	White-winged Triller				x	x		
Family ARTAMIDAE								
Artamus cinereus	Black-faced Woodswallow				x	x		
Artamus cyanopterus	Dusky Woodswallow				x	x		
Family CRACTICIDAE								
Cracticus tibicen	Australian Magpie				x	x	x	x
Cracticus torquatus	Grey Butcherbird				x	x	x	x
Strepera versicolor	Grey Currawong				x	x		
Family CORVIDAE								
Corvus coronoides	Australian Raven				x	x	x	x
**Corvus splendens*	House Crow				x			
Family HIRUNDINIDAE								
Cheramoeca leucosternus	White-backed Swallow				x	x		
Hirundo ariel	Fairy Martin				x			
Hirundo neoxena	Welcome Swallow	Ma			x	x	x	x

BIRDS		Conservation Codes						
Scientific Name	Common Name	EPBC	WC	DEC	A	B	C	D
Hirundo nigricans	Tree Martin	Ma			x	x	x	
Family ZOSTEROPIDAE								
Zosterops lateralis	Silvereye	Ma			x	x	x	x
Family SYLVIIDAE								
Acrocephalus australis	Australian Reed-warbler	Ma			x	x		
Cincloramphus cruralis	Brown Songlark				x	x		
Megalurus gramineus	Little Grassbird				x	x		
Family DICAEIDAE								
Dicaeum hirundinaceum	Mistletoebird				x	x		
Family PASSERIDAE								
**Passer montanus*	Eurasian Tree Sparrow				x			
Family MOTACILLIDAE								
Anthus australis	Australian Pipit; Richard's Pipit				x	x	x	

[X] fauna species recorded from the survey area.
[*] denotes introduced species.

APPENDIX B

B4: MAMMAL SPECIES PREVIOUSLY RECORDED IN THE REGION

Key: EPBC = Environmental Protection and Biodiversity Conservation Act 1999, WC = Wildlife Conservation Act 1950, DEC = Department of Conservation Priority Code, A = Listed in Naturemap, B = Listed by Birds Australia, C = Previous fauna surveys records (<15km), D = Current Survey

Note: For Definitions of Conservation Codes see Appendix A.

MAMMALS		Conservation Codes						
Scientific Name	**Common Name**	**EPBC**	**WC**	**DEC**	**A**	**B**	**C**	**D**
Family DASYURIDAE								
Dasyurus geoffroii	Western Quoll, Chuditch	VU	S1		x			
Phascogale calura	Red-tailed Phascogale	EN	S1					
Phascogale tapoatafa ssp. (WAM M434)	Southern Brush-tailed Phascogale		S1		x			
Family PERAMELIDAE								
Isoodon obesulus fusciventer	Southern Brown Bandicoot, Quenda			P5	x		x	x
Family MACROPODIDAE								
Macropus fuliginosus	Western Grey Kangaroo						x	
Macropus irma	Western Brush Wallaby			P4	x			
Setonix brachyurus	Quokka	VU	S1					
Family PHALANGERIDAE								
Trichosurus vulpecula vulpecula	Common Brushtail Possum				x			
Family TARSIPEDIDAE								
Tarsipes rostratus	Honey Possum, Noolbenger				x			
Family VESPERTILIONIDAE								
Chalinolobus gouldii	Gould's Wattled Bat						x	
Nyctophilus timoriensis timoriensis	Greater Long-eared Bat						x	
Vespadelus regulus	Southern Forest Bat						x	
Family MOLOSSIDAE								
Austrononus australis	White-striped Freetail-bat						x	
Mormopterus planiceps	Southern Freetail-bat						x	
Family MURIDAE								
Hydromys chrysogaster	Water-rat			P4	x			
**Mus musculus*	House Mouse				x		x	
Rattus fuscipes	Western Bush Rat						x	
**Rattus rattus*	Black Rat				x		x	
Family LEPORIDAE								
**Oryctolagus cuniculus*	Rabbit						x	x
Family CANIDAE								
**Vulpes vulpes*	Red Fox						x	
Family FELIDAE								
**Felis catus*	Cat				x		x	
Family SUIDAE								
**Sus scrofa*	Pig				x			

[X] fauna species recorded from the survey area.
[*] denotes introduced species.

APPENDIX C

HABITAT ASSESSMENT DATA SHEETS

BOLLARD BULRUSH EAST FAUNA ASSESSMENT

APPENDIX C

HABITAT ASSESSMENT DATA SHEETS

Habitat Assessment - HA 1

Broad Fauna Habitat: *Melaleuca* Dampland

UTM Co-ordinates: Easting: 390760 Northing: 64340605

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.



Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: 20%	**Woody Debris:** 5%	**Bare Ground:** 25%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*	30-70%	6-12 m
Midstory	*Typha* sp., Blackberry (**Rubus anglocandicans*), Common Fig (**Ficus carica*)	30-70%	< 2 m
Understory	**Paspalum dilatatum*, Curled Dock (**Rumex crispus*)	< 2%	< 0.3 m

Condition Rating: Very Good
Disturbance: Weeds, Fencelines
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat, Numerous Quenda Diggings.

Habitat Assessment - HA 2

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates: Easting: 390520 Northing: 6430676

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.



Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: < 1%	**Woody Debris:** < 1%	**Bare Ground:** < 1%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*	30-70%	6 m
Midstory	Common Fig (**Ficus carica*), Arum Lily (**Zantedeschia aethiopica*)	< 2%	< 1 m
Understory	**Paspalum dilatatum*, Curled Dock (**Rumex crispus*), *Centella asiatica*	70-100%	< 0.3 m

Condition Rating: Excellent
Disturbance: Weeds
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat; Vegetation 100% very little bare ground and / or woody debris; small amounts of surface water damp low-lying areas; Quenda diggings.

Habitat Assessment - HA 3

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates : Easting: 390725 Northing: 6430290

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.



Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: 5%	**Woody Debris:** 5%	**Bare Ground:** 50%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	nil		
Midstory	*Melaleuca rhaphiophylla*, Jointed Rush (*Baumea articulata*)	30-70%	< 2 m
Understory	**Paspalum dilatatum*, Curled Dock (**Rumex crispus*)	< 2%	< 0.3 m
Condition Rating:	Very Good		
Disturbance:	Weeds, cattle damage		
Fire Age	Old		

Other Relevant Information:

No Black Cockatoo foraging habitat; vegetation 40%.

Habitat Assessment - HA 4

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates: Easting: 390881 Northing: 6430533

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.



Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: < 1%	**Woody Debris:** < 1%	**Bare Ground:** 30%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*	30-70%	6 m
Midstory	Jointed Rush (*Baumea articulata*), Arum Lily (**Zantedeschia aethiopica*)	10-30%	< 2 m
Understory	*Centella asiatica*	70-100%	< 0.1 m

Condition Rating: Very Good
Disturbance: Weeds
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat, significant number of weeds; Quenda diggings, excessive damp areas; vegetation 70%.

Habitat Assessment - HA 5

Broad Fauna Habitat: *Eucalyptus* Dampland

UTM Co-ordinates: Easting: 390936 Northing: 6429912

Habitat Value: Low

Low Woodland of *Melaleuca rhaphiophylla*, *Eucalyptus rudis* subsp. *rudis*, **Paspalum dilatatum*, **Holcus lanatus*, *Centella asiatica*, **Rumex crispus* and *Baumea articulata*.



Total Area of Habitat: 22.7 ha
Proportion of Project Area: 32%

Habitat Structure and Microhabitats

Aspect:	n/a	**Exfoliating Slabs:**	None	
Soils:	Brown / Black Sand	**Surface rocks:**	Small: None	Large: None
Boulders:	None	**Tree Hollows:**	Small: None	Large: None
Cracks:	None	**Caves:**	None	Crevices: None
Cliffs :	None	**Suitability for bats:**	Nil	
Litter Cover: 10%	**Woody Debris:** 5%	**Bare Ground: 5**%		

Vegetation

Stratum	Vegetation Species	Cover	Height
Overstory	*Melaleuca rhaphiophylla*, *Eucalyptus rudis*	30-70%	6-15 m
Midstory	Jointed Rush (*Baumea articulata*)	30-70%	< 1 m
Understory	*Centella asiatica*, **Paspalum dilatatum*, **Holcus lanatus*	30-70%	< 0.1 m

Condition Rating: Excellent
Disturbance: Weeds
Fire Age Old

Other Relevant Information:

No Black Cockatoo foraging habitat

APPENDIX D

CONSERVATION SIGNIFICANT FAUNA RECORDED WITHIN THE VICINITY OF THE SURVEY AREA

BOLLARD BULRUSH EAST FAUNA ASSESSMENT

APPENDIX D

CONSERVATION SIGNIFICANT FAUNA RECORDED WITHIN THE VICINITY OF THE SURVEY AREA

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
REPTILES				
Jewelled *Ctenotus* (*Ctenotus gemmula*)	P3	The Swan Coastal Plain population of the Jewelled *Ctenotus* occurs in coastal heaths and semi-arid woodlands. This species has a patchy distribution along the coastal plains and adjacent interior of the southwest (Wilson and Swan 2008). This species is particularly difficult to locate, and is infrequently collected in biological surveys.	The project area does not contain coastal heaths which is the preferred habitat type for this species. In addition very little is known of its current distribution on the Swan Coastal Plain.	Unlikely
Lined Skink (*Lerista lineata*)	P3	The Lined Skink occurs in sandy coastal heath and shrubland areas in isolated populations in the southwest and midwest coast of Western Australia and in disjunct and isolated populations (Wilson and Swan 2008). This burrowing species is found in loose soil or sand beneath logs and termite mounds, where it feeds on termites and other small insects (Cogger 2000).	The project area lacks coastal heath and shrublands that is the preferred habitat type for this species.	Unlikely
Black-striped Snake (*Neelaps calonotos*)	P3	The Black-striped Snake favours sandy soils of coastal and near coastal dunes and sandplains supporting heath and *Banksia* Eucalypt Woodlands (Nevill 2005, Bush *et al*. 2007). The Black-striped Snake is typically	The project area is not found in coastal to near coastal areas therefore lacks the costal heath vegetation type that is preferred by this species. This species of snake is also very cryptic and is infrequently	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		found in these sandplain habitats having a very limited distribution exclusive to the Swan Coastal Plain. This taxon is particularly difficult to locate, and is infrequently collected during biological surveys.	collected and or recorded during biological assessments.	
BIRDS				
Cattle Egret (*Ardea ibis*)	Mi	The Cattle Egret occurs in the wetter parts of Western Australia, in particular the Kimberley and the south-west. This species inhabits short grass, in particular damp pastures and wetlands, usually in the company of cattle and occasionally other livestock. In Western Australia it is an irregular visitor, occurring mostly in autumn, and is not thought to breed regularly in Western Australia (Johnstone and Storr 1998).	The project area does contain damp pastures and wetlands which are the preferred habitat for this species. In addition the project area does contain some areas that may be inundated or flooded during peak rain events	Likely
Eastern Great Egret (*Ardea modesta*)	Mi	The Eastern Great Egret occurs in the Kimberley, Pilbara, and on the west coast from the Murchison River south, throughout the south-west, and east to Cape Arid. This species is considered common to very common in the Kimberley, and scarce to moderately common elsewhere (Johnstone and Storr 1998). It inhabits mostly shallow fresh lakes, pools in rivers, lagoons, lignum swamps, clay pans and samphire flats, large dams and sewage ponds. It also inhabits shallow saltwater habitat such as mangrove creeks, tidal pools, samphire swamps and salt work ponds. It breeds colonially at wooded swamps and river pools, nesting in riparian	The project area does contain low-lying areas that may be inundated during peak rain events. The Eastern Great Egret may potentially forage in these areas.	Likely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		trees.		
Little Bittern (*Ixobrychus minutus*)	P4	The Little Bittern occurs north to Moora and south-east to Two Peoples Bay (Johnstone and Storr 1998). It is usually recorded on dense vegetation beds of freshwater pools, swamps and lagoons, well screened with trees. This species often shelters in dense beds of *Typha* sp., *Baumea* sp., and tall rushes in freshwater swamps around lakes and along rivers (Johnstone and Storr 1998).	The Little Bittern prefers well screened wetlands with rush and sedge species, but can also be found roosting in *Melaleuca* which are often found fringing the water bodies. However the quality of the fauna habitat type in the project area is not extensive and a true wetland does not exist for the project area. No roosting or foraging potential exists within habitats of the project area.	Unlikely
White-bellied Sea-Eagle (*Haliaeetus leucogaster*)	Mi	The White-bellied Sea Eagle is distributed along the coast, islands and estuaries of Western Australia but not the lower west and southwest or far east (Johnstone and Storr 1998). They feed on fish, sea snakes and nesting seabirds. Nests are usually placed on high ground such as rock pinnacles, rigid shrubs or in tall trees (Simpson and Day 2004).	This species predominantly inhabits coastal areas or wetlands (Pizzey and Knight 2007) but rarely inland. This species may fly over the project area but no suitable habitat exists in the project area.	Unlikely
Peregrine Falcon (*Falco peregrinus*)	S4	The Peregrine Falcon occurs mainly along coastal cliffs, rivers and ranges as well as wooded watercourses and lakes (Johnstone and Storr 1998). The Peregrine Falcon nests primarily on cliffs, granite outcrops and quarries, and feeds mostly on birds (Johnstone and Storr 1998).	The Peregrine Falcon may forage on an infrequent basis in the project area as part of a larger home range. There are no suitable nesting sites for this species.	Possible

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Common Sandpiper (*Actitis hypoleucos*)	Mi	This Migratory bird breeds from the British isles to Siberia and Japan. It migrates to Australian waters in August to May (Pizzey and Knight 2007). It is moderately common to uncommon around Perth and Mandurah. This species requires marine waters for habitat such as banks, rocks, and sandy beaches (Simpson and Day 2004).	The survey area lacks suitable habitat for this species as they are typically found in more marine environments.	Unlikely
Sharp-tailed Sandpiper (*Calidris acuminata*)	Mi	This Migratory bird breeds in Siberia and migrates to Australian waters in August to April (Pizzey and Knight 2007). It is common around Perth and Mandurah. This species is found widespread in coastal and interior wetlands (Simpson and Day 2004).	The project area does not contain the preferred habitat for this species.	Unlikely
Curlew Sandpiper (*Calidris ferruginea*)	Mi	This migratory bird breeds in Siberia and migrates to Australian waters in August to April (Pizzey and Knight 2007). It is abundant to common around Perth and Mandurah. This species is found in coastal and inland mudflats, sometimes saltworks (Simpson and Day 2004).	The survey area lacks suitable habitat for this species such as coastal inland mudflats and estuarine environments.	Unlikely
Red-necked Stint (*Calidris ruficollis*)	Mi	This migratory bird breeds in Siberia and Alaska and migrates to Australian waters in August to April (Pizzey and Knight 2007). It is abundant to common around Perth and Mandurah during this time. This species requires marine waters for habitat such as coastal and inland shores (Simpson and Day 2004).	This species prefers drying inland freshwater and salt lakes where exposed mud and sand provide foraging and roosting potential. These types of fauna habitats do not exist in the project area.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Eastern Curlew (*Numenius madagascariensis*)	Mi, P4	The Eastern Curlew is a large non-breeding migratory shorebird, found commonly along the north coast of Western Australia, but rarely south of Shark Bay. It inhabits a range of coastal habitats, but primarily inter-tidal mudflats, particularly on exposed seagrass beds or mudflats feeding on burrowing crabs or shrimps (Geering *et al*. 2007).	The Survey area does not contain the intertidal mudflats which are the preferred habitat for this species	Unlikely
Wood Sandpiper (*Tringa glareola*)	Mi	The Wood Sandpiper is a summer non-breeding migratory shorebird that occurs along the coast and inland regions of Western Australia. It primarily inhabits freshwater wetlands and rarely inter-tidal mudflats (Geering *et al*. 2007).	No freshwater wetlands such as shallows swamps and drying lakes exist in the project area, suggesting this species is unlikely to occur.	Unlikely
Common Greenshank (*Tringa nebularia*)	Mi	This migratory bird breeds from Scotland to Siberia and migrates to Australian waters in September to April (Pizzey and Knight 2007). It is commonly found around Perth and Mandurah. This species prefers estuaries, inland lakes and open swamps (Simpson and Day 2004).	Shallow fresh waters (claypans, lagoons, open swamps, river pools and dams) do not exist within the survey area making this species unlikely to occur.	Unlikely
Caspian Tern (*Hydroprogne caspia*)	Mi	The Caspian Tern is distributed along the coast of Western Australia. It is scarce or uncommon north of Broome and uncommon to moderately common further south (Johnstone and Storr 1998). This species inhabits coastal areas as well as inland watercourses, saline and brackish lakes (Simpson and Day 2004).	The Caspian Tern is usually found foraging and sheltering in marine habitats such as beaches and estuaries and inlets. This species may fly over the survey area on an infrequent basis but will not use habitats of the survey area for any purpose.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii* subsp. *naso*)	VU,S1	The Forest Red-tailed Black Cockatoo is distributed through the humid and sub-humid southwest of Western Australia from Gingin through the Darling Ranges to the southwest from approximately Bunbury to Albany (Johnstone and Storr 1998).	The vegetation of the project area does not contain any potential foraging resources for this species. The Flooded Gums on survey area (*Eucalyptus rudis*) are not a known feeding resource for black cockatoos and or breeding resource on the Swan Coastal Plain. The trees on survey area did not contain any hollows to be considered as potential nesting sites.	Unlikely
Baudin's Cockatoo (*Calyptorhynchus baudinii*)	VU,S1	Baudin's Cockatoo is distributed through the south-western humid and sub-humid zones, from the northern Darling Range and adjacent far east of the Swan Coastal Plain (south of the Swan River), south to Bunbury and across to Albany (Johnstone and Storr 1998). Baudin's Cockatoo rarely occurs near the coast north of Mandurah, and rarely occurs north of the Swan River (Johnstone and Kirkby 2008, Johnstone and Storr 1998).	The vegetation of the project area does not contain any potential foraging resources for this species. The Flooded Gums on survey area (*Eucalyptus rudis*) are not a known feeding resource for black cockatoos and or breeding resource on the Swan Coastal Plain. The trees on survey area did not contain any hollows to be considered as potential nesting sites.	Unlikely
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	EN,S1	Carnaby's Cockatoo is endemic to southwest Western Australia, and is distributed from the Murchison River to Esperance and inland to Coorow, Kellerberrin and Lake Cronin (Cale 2003). The species was once common, but the population has declined significantly in the last half century (Johnstone and Storr 1998).	The vegetation of the project area does not contain any potential foraging resources for this species. The Flooded Gums on survey area (*Eucalyptus rudis*) are not a known feeding resource for black cockatoos and or breeding resource on the Swan Coastal Plain. The trees on survey area did not contain any hollows to be considered as potential nesting sites.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
Fork-tailed Swift (*Apus pacificus*)	Mi	The Fork-tailed Swift is a summer migrant (October-April) to Australia, that has not been recorded breeding in Australia (Barrett *et al*. 2003). The Fork-tailed Swift is an aerial species, which forages high above the tree canopy and rarely lower so is independent of terrestrial habitats in Australia (Johnstone and Storr 1998). It usually occurs in flocks of up to 2000 and is often seen accompanying Tree Martins and Masked Woodswallows (Johnstone and Storr 1998).	As this species forages high in the airspace it is reasonably independent of the ground habitat. This species may fly over the survey area from time to time but only as a temporary migrant.	Possible
Rainbow Bee-eater (*Merops ornatus*)	Mi	The Rainbow Bee-eater is a common breeding migrant that occurs in Western Australia in the Kimberley, and Pilbara through to the southwest (Johnstone and Storr 1998). It generally breeds in summer in the greater southwest and occurs as a passage migrant or visitor in the northern part of its range throughout the rest of the year (Johnstone and Storr 1998, Barrett *et al.* 2003). It occurs in lightly wooded, often sandy country, preferring areas near water. The Rainbow Bee-eater feeds on airborne insects, and nests in burrows excavated in sandy ground or banks, often at the margins of roads and tracks (Johnstone and Storr 1998).	The Rainbow Bee-eater is a commonly recorded migrant that occurs in a variety of habitats. No suitable nesting sites were present in the project area.	Possible
MAMMALS				
Chuditch (*Dasyurus geoffroii*)	VU,S1	The Chuditch (Western Quoll) previously occurred over 70% of Australia, but now only occurs in the southwest of Western Australia.	The lack of suitable habitat suggests this species should not occur within the survey area. The Chuditch needs large logs as den	Highly Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		Being a relatively large predator, it occurs at low densities. Adult females inhabit a core area of 55-200 hectares around their den, while the corresponding figure for males is 400 hectares or more (van Dyck and Strahan 2008). The Chuditch is now only found in sclerophyll forest, woodland and mallee shrubland (van Dyck and Strahan 2008, Menkhorst and Knight 2004). It is highly mobile, and appears able to utilise bush remnants and corridors. Numbers have decreased because of habitat alteration, removal of suitable den logs and dens, and competition for food and predation by foxes and cats (van Dyck and Strahan 2008). The Chuditch has been locally extinct through-out the metropolitan area for some time.	sites which are not found in this area. The Chuditch has a large home range and there is no connectivity with surrounding bush land sufficient enough to support this species. It is highly unlikely to occur in the survey area as it is presumed locally extinct on the Swan Coastal Plain.	
Red-tailed Phascogale (*Phascogale calura*)	EN, S1	The Red-tailed Phascogale is found in isolated reserves from the Wheatbelt to the south coast, and prefers Wandoo and Sheoak woodlands. It has a preference for long unburnt habitat with continuous canopy and tree hollows. Numbers have decreased because of fragmentation and loss of habitat (Menkhorst and Knight 2004).	The project area resides far outside of this species current distribution (van Dyck and Strahan 2008) and no suitable nesting vegetation occurs in the project area for this species to be present.	Highly Unlikely
Southern Brush-tailed Phascogale, Wambenger (*Phascogale tapoatafa* ssp. [WAM M434))		The Wambenger is an undescribed subspecies of the Brush-tailed Phascogale (Phascogale tapoatafa) that occurs in south-west Western Australia (van Dyck and Strahan 2008, Peter Mawson pers. com. [DEC]). The Wambenger's distribution is believed to have been reduced	This species preferred habitat type does not occur within the project area. The Wambenger is typically found in the south-west in dry sclerophyll forests and not on the Swan Coastal Plain.	Highly Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		to approximately 50% of its former range. It is restricted to the extreme south-west, and its characteristic low population densities make it vulnerable to localised extinction (van Dyck and Strahan 2008). This subspecies has been observed in dry sclerophyll forests and open woodlands containing hollow-bearing trees but a sparse ground cover. Habitat destruction, in particular, the loss of hollow-bearing trees and predation by feral animals, are thought to be the major threats to surviving populations.		
Southern Brown Bandicoot, Quenda (*Isoodon obesulus* subsp. *fusciventer*)	P5	The Quenda (Southern Brown Bandicoot) occurs in forest, heath or coastal scrub and occurs along the coast of south-western WA from Moore River mouth to approximately Israelite Bay (Menkhorst and Knight 2004). They typically seek daytime refuge from predators in very thick ground-storey vegetation, often associated with swamps or damplands, and forage by night in more open areas, leaving distinctive conical feeding holes in the ground. The Quenda is threatened by clearing and fragmentation of its preferred habitat (van Dyck and Strahan 2008).	The Southern Brown Bandicoot produces conical diggings that are easily identifiable and are species specific. These diggings were recorded in the project area.	Recorded
Western Brush Wallaby (*Macropus irma*)	P4	The Western Brush Wallaby occurs in open forest or woodland, particularly where there is grassy understory and scrubby thickets present (Menkhorst and Knight 2004). It is found only in south-western Western	This species preferred habitat type does not occur within the project area. In addition, due to the level of development around the project area it is unlikely that the Western Brush Wallaby would occur.	Unlikely

Conservation Significant Species	Conservation Status	Distribution and Ecology	Habitat Relevance	Likelihood
		Australia, where it appears to be in decline, probably as a result of an increase in the numbers of foxes.		
Quokka (*Setonix brachyurusis*)	VU,S1	The Quokka found in the southwest regions of Western Australia, from south of Perth in Jarrah, Marri and Karri Forest to Two People's Bay (Menkhorst and Knight 2004). It mostly occurs in densely vegetated swamps, tea tree thickets on sandy soils along creek lines and dense heath on slopes (van Dyck and Strahan 2008). Quokka numbers have declined because of predation by foxes and the clearing and burning of swamp habitats.	There is a lack of suitable habitat in the project area and the Quokka occurs in only small pockets on the mainland in forested areas of south-west. This species is considered locally extinct on the Swan Coastal Plain.	Highly Unlikely
Water-rat (*Hydromys chrysogaster*)	P4	The Water Rat occupies a wide variety of freshwater habitats, from sub-alpine streams and other inland waterways to lakes, drainage lines, swamps and farm dams (van Dyck and Strahan 2008). It favours areas close to water with thick vegetation cover. The species is widespread in south-western and northern WA, and is also found on various offshore islands.	The project area does not contain the vegetated waterways required for this species to become resident which is the preferred habitat for this species. The Damplands are low-lying inundated areas which are not true wetlands.	Unlikely

KEY:

En	**Listed as Endangered under the EBPC Act 1999.**
Vu	**Listed as Vulnerable under the EBPC Act 1999.**
Mi	**Listed as Migratory under the EBPC Act 1999.**

S	**Scheduled under the WC Act 1950.**
P	**Listed as Priority by the DEC.**
Recorded	**Recorded during the field survey or site reconnaissance.**
Likely	**Suitable habitat is present in the project area and the project area is in the species' known distribution.**
Possible	**Limited or no suitable habitat is present in project area but is nearby, the species has good dispersal abilities and is known from the general area.**
Unlikely	**No suitable habitat is present in project area but is nearby, the species has poor dispersal abilities, but is known from the general area; or suitable habitat is present, however the project area is outside of the species' known distribution.**
Highly Unlikely	**The species has poor dispersal abilities, no suitable habitat is present, and the species is uncommon; or the species is thought to be locally extinct.**

APPENDIX D
BORE SOIL LOGS

Client:
Logged By: D.P & E.S
Drilled By: Strataprobe Pty Ltd
Soil Bore No: MW2

Project:
Job No: 06.127
Date Logged: 20-Jul-06
Installation Method: Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm, VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
		Indication Level										
			0 - 0.5	CLAYEY/SAND - Dark brown Medium grained Moderately sorted - Dry								
	0.25											
	0.50											
			0.5 - 1.0	SAND - Grey Medium grained Poorly sorted - Dry								
	0.75											
1.0	1.00											
			1.0 - 1.5	SAND - Light brown/almost brown Medium grained Poorly sorted								
	1.25											
	1.50											
			1.5 - 2.0	SAND - Olive brown Medium grained Moderately sorted - Damp								
	1.75											
2.0	2.00											
			2.0 - 3.75	SAND - Olive brown Medium grained Moderately sorted - Wet								
	2.25											
	2.50											
	2.75											
3.0	3.00					GPS 50390461 E 6430946 N Total Depth of Well - 3.75m Depth to Water - 1.5m Screen: 3.75m - 0.75m Blank: 0.75m - 0m Gravel: 3.75m - 0.5m Bent: 0.5m - 0m						
	3.25											
	3.50											
	3.75											
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW2 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm, VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
				Indication Level								
			0 - 0.5	CLAYEY/SAND - Brown Fine grained Moderately sorted - Dry								
	0.25											
	0.50											
			0.5 - 1.0	CLAY - Dark brown Fine grained Moderatley sorted - Damp								
	0.75											
1.0	1.00					Colour change to grey at 0.95m						
			1.0 - 1.5	CLAY - Grey/olive Fine grained Well sorted - Wet								
	1.25											
	1.50											
			1.5 - 2.0	GRAVELLY/CLAY - Orange/brown Medium grained Moderatley sorted - Wet		Colour change at 1.65m Gravelly rocks present						
	1.75											
2.0	2.00											
			2.0 - 2.5	CLAYEY/GRAVEL - Grey Fine grained Moderately sorted - Wet		Limestone between 2.0m - 2.5m Gravelly Colour change at 2.2m						
	2.25											
	2.50					Like sludge						
			2.5 - 3.0	CLAY - Grey Fine grained Moderately sorted - Saturated		2.7m - 3.0m dark green/blue/grey mottled shell fragments becoming more prominent with depth						
	2.75											
3.0	3.00											
						GPS 50390469 E 6430730 N						
	3.25											
	3.50											
	3.75					Total Depth of Well - 3.1m Depth To Water - 0.56m						
4.0	4.00					Screen: 3.1m - 0.1m Blank: 0.1m - + 0.1m Gravel: 3.1m - 0.2m Bent: 0.2m - 0m						
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW3 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm, VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
			Indication Level									
			0 - 0.5	SILTY/SAND - Brown Medium grained Moderately sorted - Dry								
	0.25											
	0.50					Colour change at 0.5m						
			0.5 - 1.0	SAND - Light grey Medium grained Well sorted - Damp		Quartz sand						
	0.75											
1.0	1.00											
			1.0 - 1.5	SAND - Grey Medium grained Well sorted - Damp								
	1.25					Colour change between 0.4m - 0.6m coffee coloured sand						
	1.50											
			1.5 - 2.0	CLAYEY/SAND - Grey (darker) Medium grained Well sorted - Wet								
	1.75											
2.0	2.00					Colour change from grey to dark brown at approximately 2.0m						
			2.0 - 2.5	CLAYEY/SAND - Brown Medium grained Well sorted - Wet								
	2.25											
	2.50											
			2.5 - 3.0	CLAYEY/SAND - Brown/olive Medium grained Well sorted - Wet								
	2.75											
3.0	3.00											
						GPS 50391262 E 6430374 N						
	3.25											
	3.50					Total Depth of Well - 3.5m Depth to Water - 1.3m						
	3.75											
						Screen: 3.5m - 0.5m Blank: 0.5m - 0m Gravel: 3.5m - 0.5m Bent: 0.5m - 0m						
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW4 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
				Indication Level								
			0 - 0.5	SANDY/CLAY - Brown black Fine grained Well sorted Damp		Organic matter present						
	0.25											
	0.50											
			0.5 - 1.0	SANDY/CLAY - Brown Fine grained Well sorted Damp								
	0.75											
1.0	1.00											
			1.0 - 1.5	SANDY/CLAY - Brown/orange Fine grained Well sorted Damp								
	1.25											
	1.50											
			1.5 - 2.0	CLAYEY/SAND - Grey Medium grained Well sorted - Wet								
	1.75											
2.0	2.00											
			2.0 - 2.5	SILTY/SAND - Light greeny grey Coarse grained Well sorted Wet								
	2.25											
	2.50											
			2.5 - 3.0	SILTY/GRAVEL - Grey Coarse grained Poorly sorted Wet								
	2.75											
3.0	3.00					Hit limestone at 3.0m						
			3.0 - 3.1	SILTY/GRAVEL/SAND - Grey Coarse grained Poorly sorted Wet		Coarse fragments of limestone throughout						
	3.25											
	3.50					GPS 5039096 E 6430240 N						
	3.75											
4.0	4.00					Total Depth of Well - 3.1m Depth to Water - 0.5m						
	4.25					Screen: 3.1m - 0.1m Blank: 0.1 - +0.2m Gravel: 3.1m - 0.2m Bent: 0.2m - 0						
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

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182 St Georges Terrace
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Client:
Logged By: D.P & E.S
Drilled By: Strataprobe Pty Ltd
Soil Bore No: MW5

Project:
Job No: 06.127
Date Logged: 20-Jul-06
Installation Method: Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm$_v$ VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
Indication Level												
			0 - 0.5	CLAY - Brown black Fine grained Well sorted Damp								
	0.25											
	0.50		0.5 - 1.0	CLAY - Brown Fine grained Well sorted Damp								
	0.75											
1.0	1.00		1.0 - 1.5	CLAY/LIMESTONE - Dark grey Fine grained Well sorted Damp		Hitting limestone at 1.2m						
	1.25											
	1.50		1.5 - 2.0	CLAY/LIMESTONE - Grey Fine grained Well sorted Wet								
	1.75											
2.0	2.00					Can not core more than 2.0m						
	2.25					GPS 50390681 E 6430064 N						
	2.50					Total Depth of Well - 3.43m Depth to Water - 0.1m						
	2.75					Screen: 3.43m - 0m Blank: 0m - +0.43m Gravel: 3.43m - 0.2m Bent: 0.2m - 0m						
3.0	3.00											
	3.25											
	3.50											
	3.75											
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Client: **Project:**
Logged By: D.P & E.S **Job No:** 06.127
Drilled By: Strataprobe Pty Ltd **Date Logged:** 20-Jul-06
Soil Bore No: MW6 **Installation Method:** Push Tube

Depth BGL (m)	Sample Taken	Monitor Well Log	Profile	Lithology	Field Rank	Observations (PID in ppm_v VOC)	ASS sample (depth)	pH	pH fox	Change in pH	Rxn	Sample analysed
				Indication Level								
			0 - 0.5	CLAYEY/SAND - Brown Fine grained Well sorted Damp								
	0.25											
	0.50											
			0.5 - 1.0	CLAY - Brown Fine grained Well sorted Damp								
	0.75											
1.0	1.00					Change to sand at approximately 1.0m						
			1.0 - 1.5	CLAYEY/SAND - Brown/olive Medium grained Well sorted Wet								
	1.25											
	1.50											
			1.5 - 2.0	CLAYEY/SAND - Grey Fine grained Well sorted Wet		Colour change to grey at 0.65m						
	1.75											
2.0	2.00											
			2.0 - 2.5	CLAYEY/SAND - Grey Fine grained Well sorted Saturated								
	2.25											
	2.50											
			2.5 - 3.0	SANDY/CLAY - Grey Medium grained Moderately sorted Wet								
	2.75											
3.0	3.00											
						GPS 50391120 E 6429960 N						
	3.25											
	3.50					Total Depth to Well - 3.36m Depth to Water - 1.1m						
	3.75											
						Screen: 3.36m - 0.3m Blank: 0.3m - 0.1m Gravel: 3.36m - 0.5m Bent: 0.5m - 0m						
4.0	4.00											
	4.25											
	4.50											
	4.75											
5.0	5.00											
	5.25											
	5.50											
	5.75											
6.0	6.00											

ASS reactions:
x - slight reaction
xx - Medium reaction
xxx - strong reaction
xxxx - Vigorus reaction

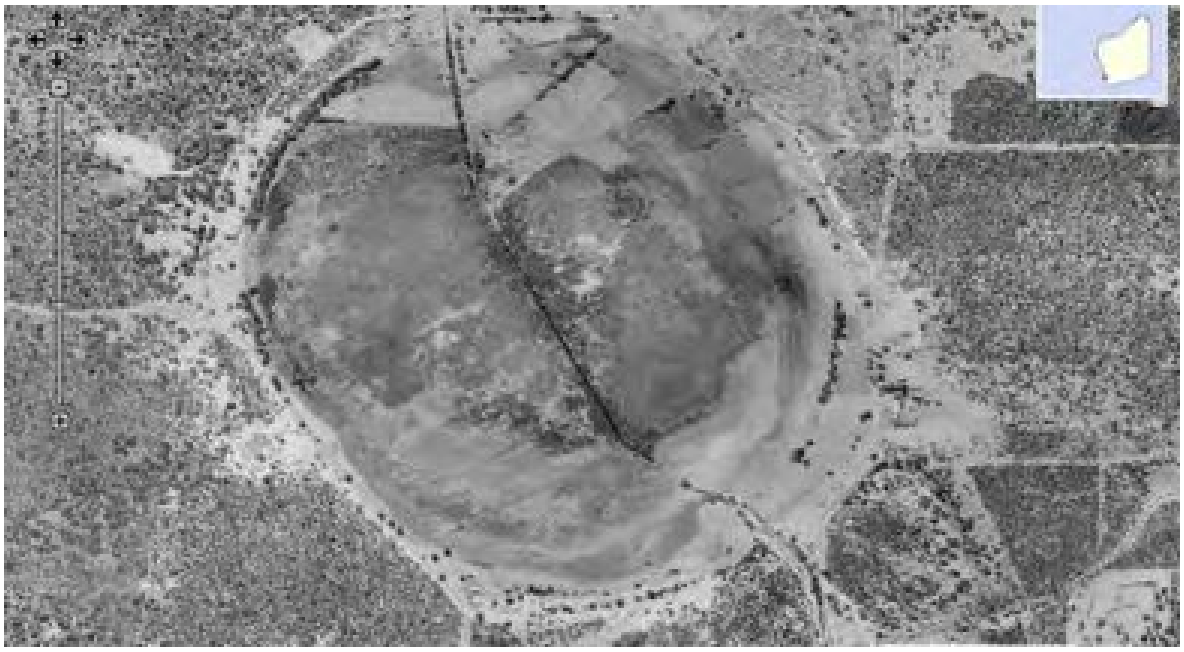
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Level 7
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Perth, WA, 6000.

APPENDIX E
HISTORICAL AERIAL PHOTOGRAPHS

APPENDIX D
HISTORICAL AERIAL PHOTOGRAPHS



Photograph 27/11/1953



Photograph 11/03/1965



Photograph 06/09/1974



Photograph 07/06/1977



Photograph 30/08/1981



Photograph 19/06/1985



Photograph 06/02/1995



Photograph 24/02/2000



Photograph 26/01/2001



Photograph 26/01/2003



Photograph 12/12/2004



Photograph 16/03/2006



Photograph 06/07/2008



Photograph 02/11/2010

APPENDIX F
INTERIM WATER MONITORING SUMMARY (ENV 2010)

23 December 2010

Our Ref: 10.102-L001-KD

Greg Rowe and Associates
Level 3, 369 Newcastle Street
Northbridge WA 6003

ATTENTION: Darren Evans

Dear Darren

SUBJECT: WATER MONITORING SUMMARY AT BOLLARD BULLRUSH EAST

ENV Australia Pty Ltd (ENV) is pleased to provide Greg Rowe and Associates with the following summary of hydrological monitoring at the Bollard Bullrush East site.

There are seven groundwater monitoring bores located across Bollard Bullrush East site (see Attachment for bore locations). ENV has undertaken six occasions of groundwater level monitoring and two occasions of groundwater quality monitoring between July 2010 and December 2010.

Groundwater Levels

Groundwater on the site generally flows west towards the Peel Main Drain and the centre of Bollard Bullrush Swamp. Groundwater levels were closest to the surface at MW5-E and MW4-E located in the central areas of the swamp with a depth of 0.18 m to 0.3 m below ground level respectively. In August, water levels for all bores on site were closer to ground level, indicating an average groundwater level rise of 0.3 m across the site. In September, groundwater levels dropped their August readings. Groundwater level decline continued into October, with the exception of MW1-E which increased, with depth to groundwater levels varying from surface to 1 metre.

Groundwater levels did not fluctuate greatly over the monitoring period likely due to low rainfall over winter 2010.

PO Box 7480, Cloisters Square
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ENV•Australia ABN 72 091 839 520

Table 1: Bore details and groundwater levels (m AHD)

Sample ID	Ground Level (m AHD)	Top of Casing (mAHD)	Depth of Bore (m)	Depth to Water (m AHD)					
				1/07/2010	8/07/2010	5/08/2010	8/09/2010	28/10/2010	11/11/2010
MW1-E	6.87	8.60	4.35	6.29	6.277	6.440	6.418	6.222	6.204
MW2-E	4.41	5.35	5.80	3.55	3.568	4.057	4.199	3.902	3.776
MW3-E	6.38	6.81	3.73	Dry	Dry	Dry	Dry	Dry	Dry
MW4-E	4.08	4.44	3.59	3.78	3.754	3.983	4.135	3.884	3.784
MW5-E	3.87	4.37	3.42	3.69	3.678	3.910	3.958	3.954	3.918
MW6-E old	4.80	5.18	3.68	4.11	4.107	4.462	4.594	4.547	4.836
MW6-E new	4.89	5.49	4.30	4.07	4.037	4.344	4.605	4.223	4.176

Groundwater Quality – Physical Parameters and Nutrients

Water sampling results were compared against ANZECC Lowland River Guidelines (2000) and the Short and Long Term Targets outlined in the Swan Canning Clean-up Program Action Plan (SCCP).

Water sampling analysis indicates that groundwater is relatively neutral, with an average pH of 7.3. pH levels for the site are within the ANZECC Guidelines of 6.5 to 8.

Salinity onsite ranges from 3000 uS/cm (Brackish) to 530 uS/cm (Fresh). The higher salinities onsite are located to the south of the site at MW6-E new and MW6-E old. Progression to the north of the site to MW1-E records a reduction in salinity. Across the sampling period all bores on site recorded a variable reduction in salinity. The October sampling demonstrated that bores to the north (MW1-E and MW2-E) reduced by an average of 240 uS/cm, bores in the central Swamp region (MW4-E and MW5-E) reduced by an average of 835 uS/cm. To the south MW6-E New dropped dramatically by 900 uS/cm while MW6-E Old only dropped by 100 uS/cm. Salinity is consistent with the results shown in the Perth Groundwater Atlas.

Water quality data shows that Total Nitrogen ranges from 3.8 mg/L to 1.1 mg/L; with a site average of 2.0 mg/L. These results are above the ANZECC Guidelines of 1.2 mg/L and the long term SCCP Targets (1 mg/L).

Total Phosphorus ranges from of 1.3 mg/L to 0.07 mg/L; with a site average of 0.48 mg/L. All records are above the ANZECC Guidelines of 0.065 mg/L. All bores across the site recorded an average reduction of 0.38 mg/L between July and October, with the exception of MW1-E to the north which remained the same at a very high 1.3 mg/L.

The water quality results recorded to date show variability, further monitoring on this site will likely clarify the results.

Table 2: Water Quality – Physical Parameters and Nutrients

Date	Bore ID	pH	EC uS/cm	Total P mg/L	PO4 mg/L	Total N mg/L	NO2-N mg/L	NO3-N mg/L	NH3-N mg/L	TKN mg/L
8/07/2010	**MW1E**	7.3	810	1.30	0.250	3.8	0.039	0.720	0.02	3.0
28/10/2010	**MW1E**	7.6	530	1.30	0.300	1.3	0.092		0.02	1.2
8/07/2010	**MW2E**	7.6	1200	0.58	0.005	1.1	0.005	0.007	0.57	1.1
28/10/2010	**MW2E**	7.4	1000	0.12	0.005	1.3	0.008		0.64	1.2
8/07/2010	**MW4E**	7.8	1600	0.46	0.005	1.7	0.023	0.140	0.53	2.1
28/10/2010	**MW4E**	7.6	780	0.15	0.005	1.7	0.033		0.53	1.6
8/07/2010	**MW5E**	7.5	1800	0.38	0.005	1.3	0.036	0.068	0.37	1.6
28/10/2010	**MW5E**	7.1	950	0.12	0.008	1.3	0.031		0.19	1.3
8/07/2010	**MW6 (New)**	7.1	3000	0.88	0.005	2.3	1.500	1.500	1.10	10.0
28/10/2010	**MW6 (New)**	6.9	2100	0.03	0.005	2.7	0.360		0.36	2.4
8/07/2010	**MW6**	7.4	2200	0.38	0.005	2.3	0.220	4.000	0.28	7.8
28/10/2010	**MW6**	6.5	2100	0.07	0.005	3.3	0.180		0.56	3.1
Average		**7.3**	**1506**	**0.48**	**0.050**	**2.0**	**0.211**	**1.073**	**0.43**	**3.0**
Median		**7.4**	**1400.0**	**0.38**	**0.005**	**1.7**	**0.038**	**0.430**	**0.45**	**1.9**
	SCCP Long Term Target			0.1		1				
	SCCP Short Term Target			0.2		2				
	ANZECC Fresh Water	6.5 - 8		0.065		1.2				

Water Quality – Dissolved Metals

Samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury.

Table 3: Water Quality (Dissolved Metals)

		Metals							
Date	Bore ID	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Mercury mg/L
8/07/2010	**MW1E**	0.001	0.0001	0.005	0.003	0.001	0.003	0.01	0.0001
28/10/2010	**MW1E**	0.010	0.0020	0.040	0.057	0.067	0.006	0.02	0.0003
8/07/2010	**MW2E**	0.001	0.0001	0.005	0.003	0.001	0.002	0.01	0.0001
28/10/2010	**MW2E**	0.020	0.0020	0.028	0.033	0.013	0.006	0.01	0.0001
8/07/2010	**MW4E**	0.001	0.0001	0.005	0.002	0.001	0.004	0.01	0.0001
28/10/2010	**MW4E**	0.100	0.0020	0.180	0.024	0.024	0.050	0.02	0.0004
8/07/2010	**MW5E**	0.002	0.0001	0.005	0.001	0.001	0.007	0.01	0.0001
28/10/2010	**MW5E**	0.010	0.0020	0.006	0.005	0.005	0.005	0.01	0.0001
8/07/2010	**MW6 (New)**	0.001	0.0001	0.005	0.002	0.001	0.003	0.01	0.0001
28/10/2010	**MW6 (New)**	0.070	0.0020	0.260	0.450	0.180	0.074	0.16	0.0001
8/07/2010	**MW6**	0.002	0.0001	0.005	0.004	0.001	0.005	0.01	0.0001
28/10/2010	**MW6**	0.050	0.0020	0.120	0.046	0.086	0.043	0.16	0.0003
Average		**0.022**	**0.0011**	**0.055**	**0.053**	**0.032**	**0.017**	**0.04**	**0.0002**
	ANZECC & ARMCANZ Guidelines (2000)*	0.024	0.0002	0.01	0.0014	0.0034	0.011	0.008	0.00006

On average only arsenic was recorded below ANZECC guidelines and cadmium, chromium, copper, lead, nickel, zinc and mercury were all above the guidelines. Variation between bores for certain metals was recorded, in particular arsenic, chromium and nickel which recorded concentrations both within the ANZECC guidelines and exceeding them.

Further monitoring for dissolved metals is recommended.

Summary

- Groundwater flow westerly towards Bollard Bulrush Swamp and the Peel Main Drain;
- Groundwater levels are falling sporadically;
- pH levels are neutral and within ANZECC Guidelines;
- Salinity across the site ranges from fresh to brackish;
- Total Phosphorus and Total Nitrogen exceed the ANZECC guidelines; and
- On average, dissolved metals were above ANZECC guidelines, only Arsenic was recorded below ANZECC guidelines.

Further monitoring of dissolved metals and water quality parameters is to be undertaken.

Should you have questions regarding the above please contact the undersigned on 9214 6100.

Yours sincerely
ENV Australia Pty Ltd



SUZANNE SMART
Senior Environmental Scientist

ATTACHMENT

Bollard Bullrush East Sampling Locations – Bore Locations

REFERENCES

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand 2000, *Australian Water Quality Guidelines for Fresh and Marine Waters, National Water Quality Management Strategy*, Australian and New Zealand Environment and Conservation Council, Canberra.



env Australia

CLIENT		JOB NO.	
Greg Rowe		10.102	
AUTHOR:	DRAWN	DATE	
P. Arthur	S. Rho	02-07-2010	
SCALE	PROJECTION		
1:10,000 @ A4	GDA 94 MGA 50		

Bollard Bullrush East Sampling Locations

Bollard Bullrush East Bore Locations

FIGURE 1

APPENDIX G
SITE ASSESSMENT, BOLLARD BULRUSH SWAMP (STRATEGEN 2012)

STRATEGEN
Level 2, 322 Hay Subiaco WA 6008 PO Box 243 Subiaco WA 6904
Phone (08) 9380 5500 Fax (08) 9380 4606
Podium Level, Bunbury Tower, 61 Victoria Street Bunbury WA 6230 PO Box 287 Bunbury WA 6231
Phone 08 9792 4797 Fax 08 9792 4798

To Darren Evans Date 15 February 2012

Company Greg Rowe and Associates Reference No GRA11202-01

Fax/Email Inquiries Julia Morgan / Darren Walsh

Site assessment – Bollard Bulrush Swamp, Wellard

Numbers below each photographic plate correspond with photo point numbers in Figure 1.



Sketch 1 Field photo locations

Legend

photo location & angle

STRATEGEN

Scale

metres

1:5,000

@ A4



Photograph 1



Photograph 2



Photograph 3



Photograph 4



Photograph 5



Photograph 6



Photograph 7



Photograph 8



Photograph 9



Photograph 10



Photograph 11



Photograph 12



Photograph 13



Photograph 14



Photograph 15



Photograph 16



Photograph 17



Photograph 18



Photograph 19



Photograph 20



Photograph 21



Photograph 22



Photograph 23



Photograph 24



Photograph 25



Photograph 26



Photograph 27



Photograph 28

APPENDIX H
BOLLARD BULRUSH SWAMP FLOOD MODELLING (GHD 2010)

Memorandum

10 December 2010

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

Introduction

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

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

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

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

Methodology

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

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

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

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

Table 1 Land use impervious areas

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

Table 2 Runoff surface characteristics

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

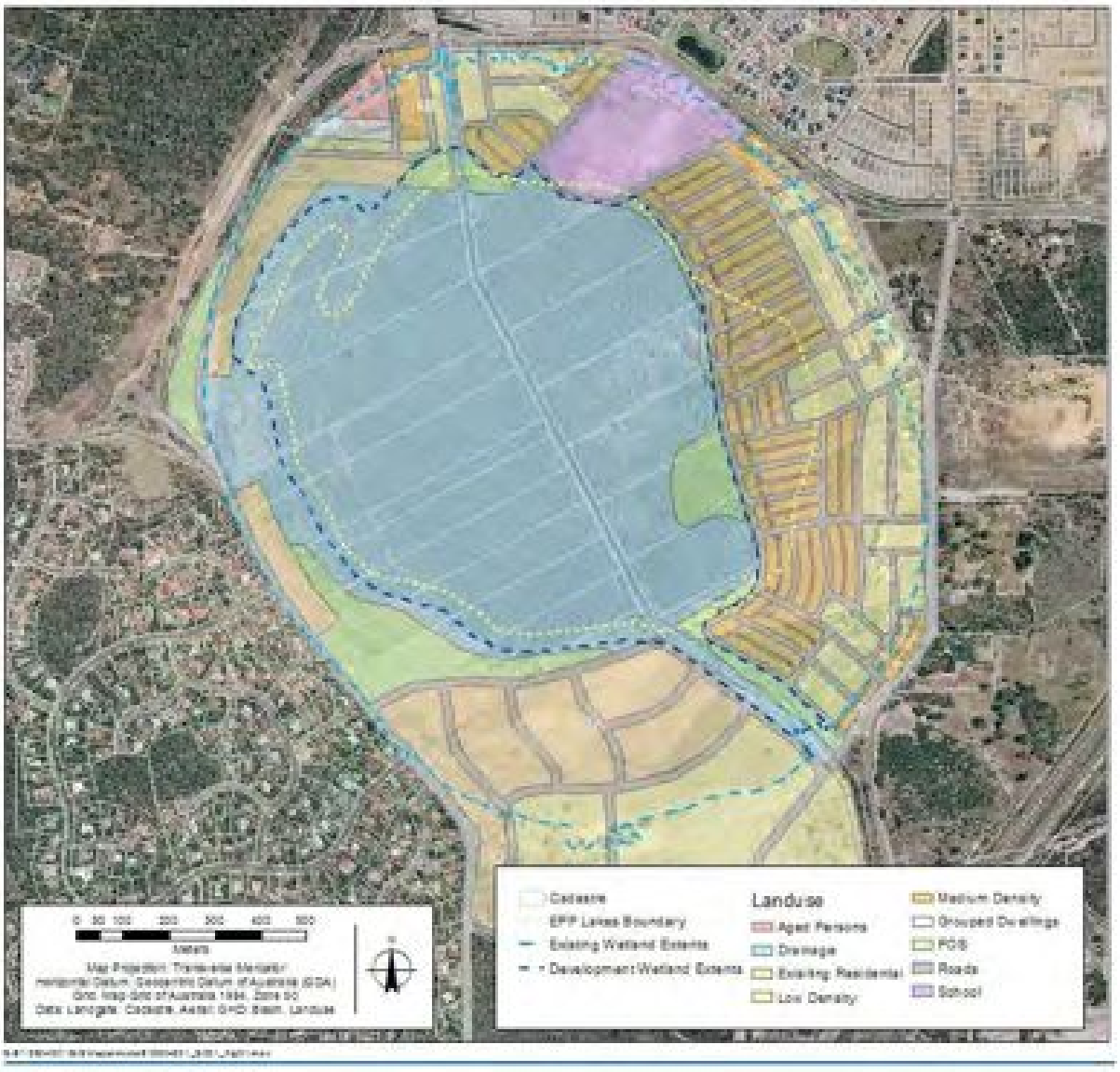


Figure 1 Exiting and Ultimate Wetland Extents with Proposed Landuse

Notes to figure 1:

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

Results

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

Table 3 Jandakot Drainage and Water Management Plan modelling results

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

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

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

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

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

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

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

Notes to table 6:

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

Conclusions

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

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

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

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

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

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

Recommendations:

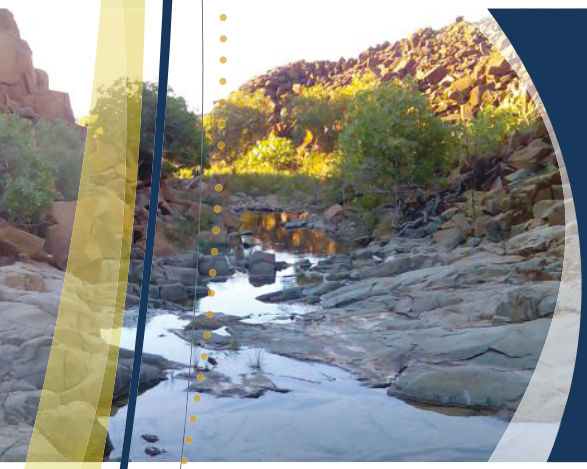
1. Rezoning submissions should indicate that the change in top water level is predicted to be zero in the 10 and 100 year ARI events as a result of the proposed development.
2. Rezoning submissions should also indicate that there is less than 100 L/s predicted increase in peak downstream flow rates in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

Helen Brookes

Manager, Waterways

Appendix C – Environmental Assessment – EPA

Report and recommendations of the Environmental Protection Authority



Metropolitan Region Scheme Amendment 1188/57 – Wellard Urban Precinct

Western Australian Planning Commission

Report 1500

January 2014

Environmental Impact Assessment Process Timelines

Date	Progress stages	Time (weeks)
29/3/2010	**Level of Assessment set**	
19/8/2010	**Instructions issued**	**3**
18/6/2013	**Environmental Review Document Released for Public Comment**	**148**
23/8/2013	**Public Comment Period Closed**	**9**
26/11/2013	**Final Responsible Authority response to the issues raised**	**13**
15/1/2014	**EPA report to the Minister for Environment**	**6**
20/1/2014	**Publication of EPA report**	**3 days**
3/2/2014	**Close of appeals period**	**2**

Timelines for an assessment may vary according to the complexity of the project and are usually agreed with the proponent soon after the level of assessment is determined.

In this case, the Environmental Protection Authority (EPA) met its timeline objective in the completion of the assessment and provision of a report to the Minister, noting that the Western Australian Planning Commission requested an extension from the Minister for Planning in order to finalise a response to submissions to the EPA.



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Summary and recommendations

The Western Australian Planning Commission's (WAPC) Metropolitan Region Scheme (MRS) Amendment 1188/57 proposes to rezone 70.37 hectares (ha) of land at Wellard East from 'Rural' to 'Urban Deferred' to facilitate urban development. The amendment will define the boundary between future urban development and Bollard Bulrush Swamp, which is protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes) and mapped as a Conservation Category Wetland (CCW).

This report provides the Environmental Protection Authority's (EPA) advice to the Minister for Environment on the environmental factors, conditions and procedures relevant to Amendment 1188/57.

Section 48D of the *Environmental Protection Act 1986* (EP Act) requires the EPA to report to the Minister for Environment on the key environmental factors for Amendment 1188/57 and on the conditions and procedures to which the amendment should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

The EPA is also required to have regard for the principles set out in section 4A of the EP Act.

Key environmental factors and principles

The EPA decided that the key environmental factor relevant to Amendment 1188/57 that required detailed evaluation in the report is Inland Waters Environmental Quality (Bollard Bulrush Swamp).

The EPA's environmental objective for this factor is *to maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected*.

The following principles were considered by the EPA in relation to the proposed scheme amendment:

(a) Precautionary Principle;

(b) Principle of intergenerational equity; and

(c) Principle of the conservation of biological diversity and ecological integrity.

Conclusion

The area subject to Amendment 1188/57 is located in the suburb of Wellard, City of Kwinana, and is situated approximately 35 kilometres (km) south of Perth. The land is located on the eastern side of a Conservation Category Wetland (CCW); Bollard Bulrush Swamp. Approximately 1.3 ha of the CCW is located within the area subject to Amendment 1188/57. The amendment area is also bounded by urban development to the north and east, and the Peel Main Drain to the west and south. The majority of the amendment area has been previously cleared for rural purposes including large lot rural living.

Prior to the lifting of the 'Urban Deferred' zoning, the WAPC will require the preparation of a District Water Management Strategy (DWMS) that has been

approved by the Department of Water (DoW) and a bush fire hazard assessment approved by the Department of Fire and Emergency Services.

A Local Water Management Plan (LWMP) and an Urban Water Management Plan (UWMP) will also be required to be prepared at the local structure plan and subdivision application stages respectively. The DoW has advised that surface water and groundwater impacts can be managed through the preparation and implementation of these water management plans.

A 50 metre (m) wetland buffer has been proposed to protect the wetland from weed infestation and inappropriate access. The EPA notes that this is consistent with the WAPC draft *Guideline for the Determination of Wetland Buffer Requirements* (2005) and the EPA's *Guidance Statement No. 33 Environmental Guidance for Planning and Development* (2008).

A Wetland Management Plan (WMP) will also be required to be prepared and implemented as a condition of subdivision by the WAPC. The WMP will detail the management of the impacts of the proposed development on the wetland, and its flora and fauna values. The WMP will facilitate the enhancement of the wetland core habitat, vegetation and function, including the reduction of weed species. The EPA considers that the preparation and implementation of a WMP in consultation with the Department of Parks and Wildlife (DPaW) and the City of Kwinana will ensure that the EPA's objective for the environmental quality of Bollard Bulrush Swamp will be met. The EPA also considers that the alignment of the proposed 'Urban Deferred' boundary around the wetland and the wetland buffer are adequate to protect the wetland function and wetland habitat (Figure 5).

When Amendment 1188/57 was originally referred to the EPA, urban development was proposed within a significant portion of the EPP Lakes boundary (Figure 3). The EPA considers that the appropriate procedure has been followed in revising the wetland mapping management category and modifying Amendment 1188/57 to rezone only the cleared land outside of the boundary of the CCW.

The EPA further considers that given the current rural land use practices within the amendment area and uncontrolled access to the wetland, it is unlikely that improvements to the wetland would be achieved under current conditions. Future urban development will provide the opportunity to exclude grazing and uncontrolled access, and allow the rehabilitation and recovery of the environmental values within the boundary of the CCW. The EPA also considers that the consolidation and rehabilitation of a central conservation area which encapsulates the wetland function area will provide a more cohesive vegetated area and habitat.

The EPA supports the DoW's advice that surface water and groundwater impacts can be managed through engineering and design in the preparation and implementation of future water management plans; the DWMP, LWMP and UWMP.

The EPA has, therefore, concluded that Amendment 1188/57 can be managed to meet the EPA's environmental objective for Inland Waters Environmental Quality without the requirement for environmental conditions, as the proposal has been substantially modified to reduce the impact on the Bollard Bulrush Swamp and impacts can be managed through future management plans.

Recommendations

The EPA submits the following recommendations to the Minister for Environment:

1. That the Minister notes that the scheme amendment being assessed proposes to rezone the site from 'Rural' to 'Urban Deferred' under the Metropolitan Region Scheme.
2. That the Minister considers the report on the key environmental factor and principles as set out in Section 3.
3. That the Minister notes that the EPA has concluded that Metropolitan Region Scheme Amendment 1188/57 Wellard Urban Precinct East can meet the EPA's environmental objective for Inland Waters Environmental Quality.
4. That the Minister notes that the EPA has not included in this report "conditions and procedures to which Metropolitan Region Scheme Amendment 1188/57 should be subject, if implemented", because the EPA holds the view that the amendment as proposed can meet the EPA's environmental objective.
5. That the Minister notes the EPA's other advice presented in Section 4 in relation to a future Metropolitan Region Scheme amendment to reserve the wetland area, the rehabilitation of the Resource Enhancement Wetland area, and Acid Sulfate Soils.

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1. List of submitters
2. References
3. Identification of Key Environmental Factors and Principles
4. Summary of Submissions and Responsible Authority's Response to Submissions

1 Introduction

The Western Australian Planning Commission (WAPC), the Responsible Authority, has initiated Metropolitan Region Scheme (MRS) Amendment 1188/57 to rezone approximately 70.37 ha of land in Wellard from 'Rural' to 'Urban Deferred' (Figure 1). This amendment area is referred to as 'Wellard Urban Precinct East'.

Amendment 1188/57, covering 81.53 ha (Figure 2), was referred to the Environmental Protection Authority (EPA) on 2 March 2010. On 29 March 2010, the EPA set the level of assessment as *Scheme Assessed – Environmental Review*. Instructions concerning the scope and content required for the Environmental Review were issued to the WAPC on 30 April 2010 and the appeal period for the Instructions closed 17 May 2010. Appeals were received and upheld by the Minister for Environment and the final Instructions were issued on 19 August 2010. The Environmental Review document was then prepared and advertised concurrently with Amendment 1188/57 from 18 June to 23 August 2013. Twenty six (26) submissions were received from Government departments, members of the public and organisations.

The area subject to Amendment 1188/57 is located in the suburb of Wellard, City of Kwinana, and is situated approximately 35 km south of Perth. The site is located on the eastern side of a Conservation Category Wetland (CCW) called Bollard Bulrush Swamp. Approximately 1.3 ha of the CCW boundary is located within Amendment 1188/57. The amendment area is also bounded by urban development to the north and east, and the Peel Main Drain to the west and south. The majority of the amendment area has been previously cleared for rural purposes including large lot rural living.

At the time of referral, Amendment 1188/57 originally proposed 'Urban Deferred' zoning over a significant portion of Bollard Bulrush Swamp which was mapped as a Resource Enhancement Wetland (REW) under the then Department of Environment and Conservation (DEC) *Geomorphic Wetlands Swan Coastal Plain* dataset, and protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP Lakes) (Figure 3).

In 2012, on behalf of the EPA, the *Geomorphic Wetlands Swan Coastal Plain* dataset mapping over Bollard Bulrush Swamp was reviewed by the then Department of Environment and Conservation. The majority of the wetland was reclassified from a REW to a CCW. In 2013, Amendment 1188/57 was revised to reflect the updated wetland mapping, reducing the proposed 'Urban Deferred' zoning from 81.53 ha to approximately 70 ha, removing any proposed development from the wetland areas and reducing impacts to the EPP Lakes area (Figure 4).

In compiling this report, the EPA has considered the key environmental factors and principles associated with Amendment 1188/57, issues raised in public submissions, specialist advice from the departments of Water (DoW), Planning (DoP), and Parks and Wildlife (DPaW), the WAPC's response to submissions and the EPA's own research and expertise.

Further details of Amendment 1188/57 are presented in Section 2 of this report while Section 3 discusses the key environmental factor and principles for the proposed scheme amendment. Section 4 presents the EPA's other advice and Section 5 presents the EPA's recommendations.

A list of people and organisations that made submissions is included in Appendix 1. References are listed in Appendix 2 and Identification of key environmental factors and principles are listed in Appendix 3. Appendix 4 contains a summary of the public submissions and the Responsible Authority's responses. The summary of public submissions and the Responsible Authority's responses is included for information only and does not form part of the EPA's report and recommendations. The EPA has considered issues raised in public submissions when identifying and assessing key environmental factors and principles.

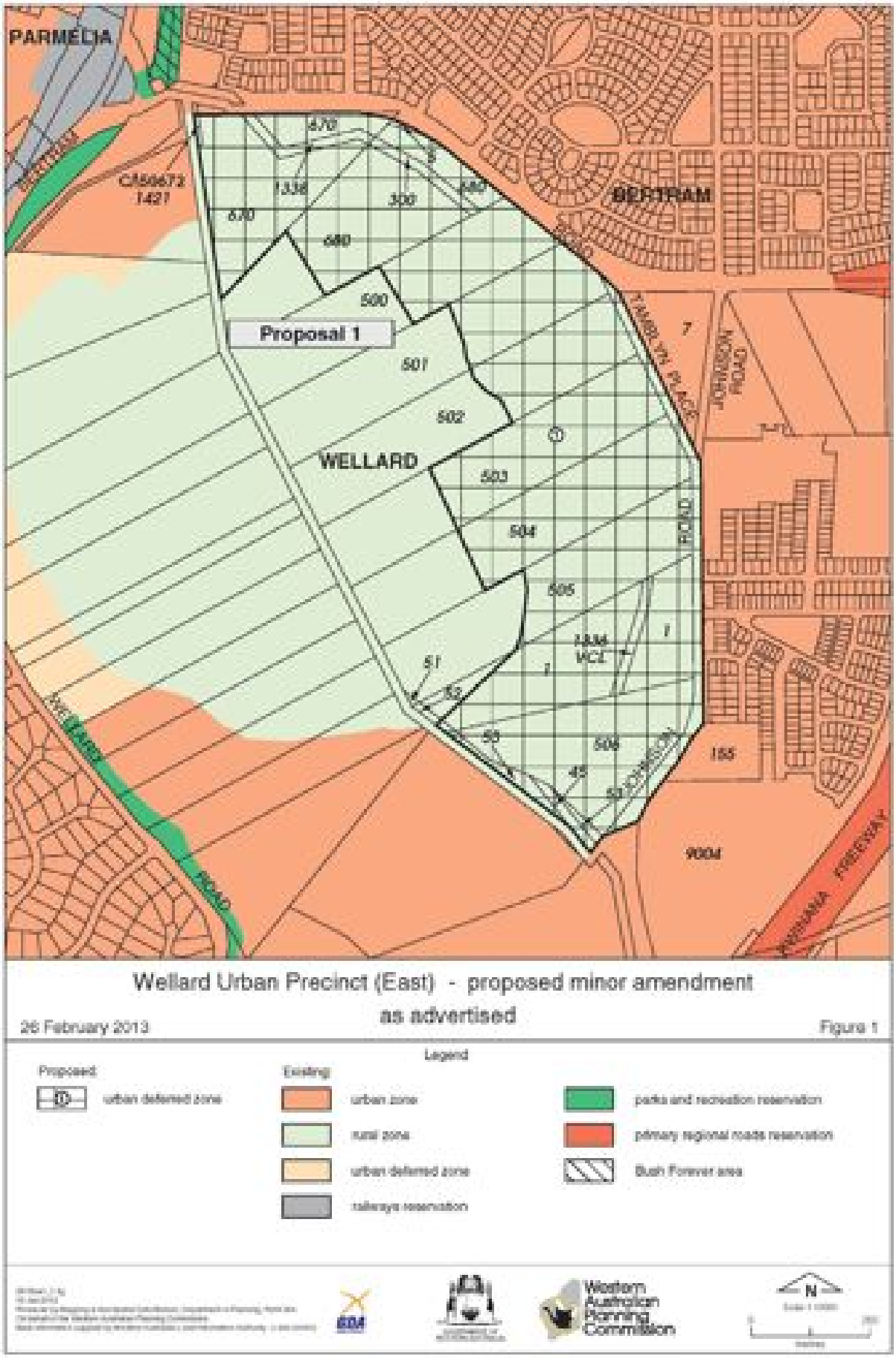


Figure 1: Current MRS Amendment 1188/57 Area

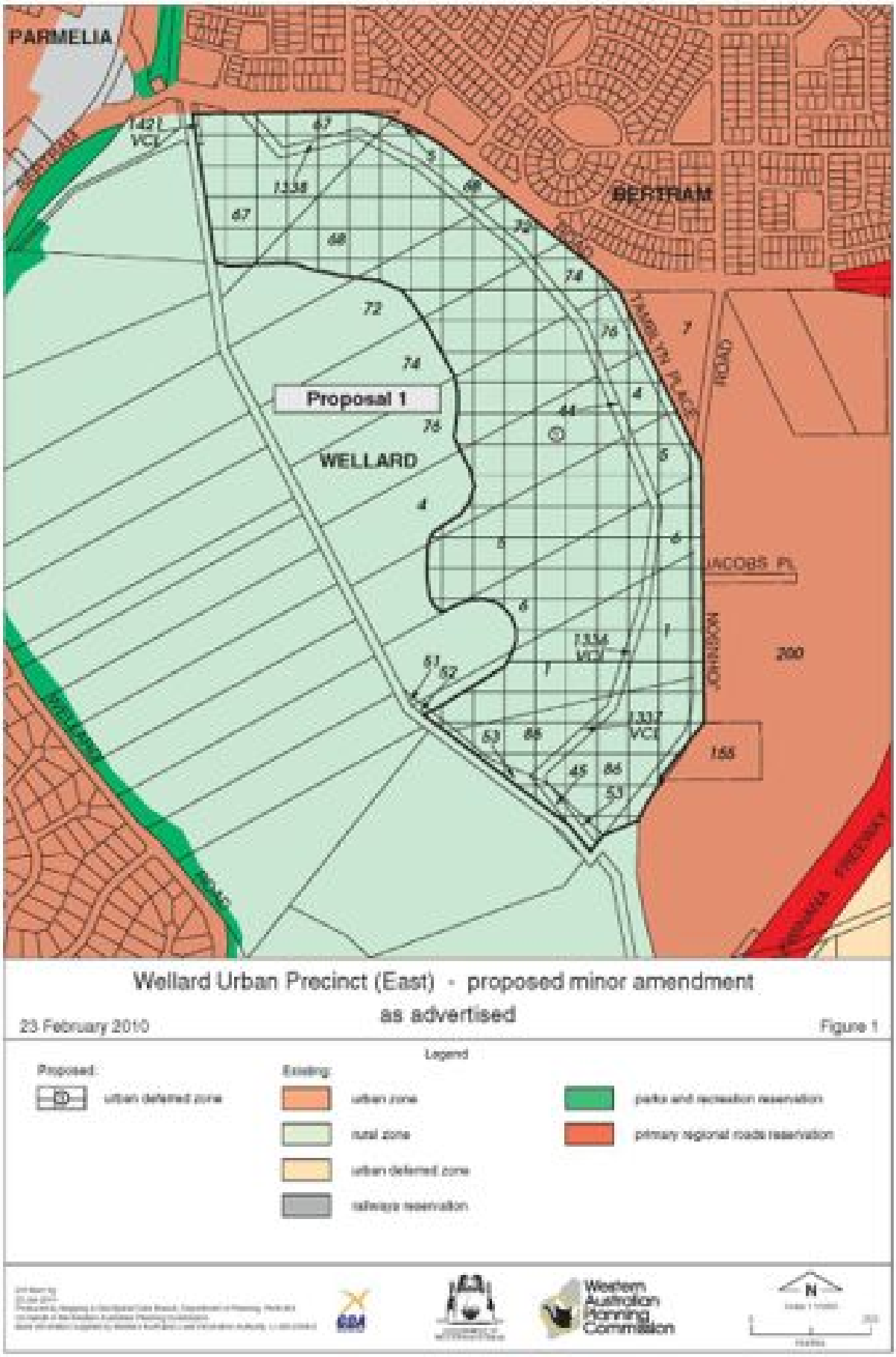


Figure 2: MRS Amendment 1188/57 area as originally referred



Figure 3: MRS Amendment 1188/57 area as referred and wetland management categories

2 The scheme amendment

The purpose of Amendment 1188/57 is to rezone 70.37 ha in Wellard from 'Rural' to 'Urban Deferred' under the MRS (Figure 1). The amendment area is largely privately owned, with the ownership being represented by the Wellard Landowners Group.

The site is currently zoned 'Rural' under both the MRS and the City of Kwinana's Town Planning Scheme No. 2. Amendment 1188/57 proposes to define the boundary between the proposed 'Urban Deferred' zone and the Bollard Bulrush Swamp area, which is to remain in the 'Rural' zone.

'Urban Deferred' zoning provides a strong indication that the land is suitable for urban purposes, although certain requirements have to be met before the WAPC will agree to the land being transferred to the 'Urban' zone. The amendment report states that the following issues are to be addressed prior to the lifting of 'Urban Deferment':

- a district water management strategy (DWMS) is to be approved for the site by the DoW; and
- a bush fire hazard assessment is to be undertaken for the site to the satisfaction of the Department of Fire and Emergency services.

Bollard Bulrush Swamp will remain under the 'Rural' zone in the MRS. The intent is for the proponent to cede Bollard Bulrush Swamp to the Crown free of cost as development progresses. Management of the wetland will initially be undertaken by the developer and it is expected that the responsibility will be assumed by the local authority or the DPaW.

A draft Concept Structure Plan (CSP) has also been prepared for the amendment area (Figure 5). This draft structure plan requires approval once the land has been rezoned and is subject to modification.

The main characteristics of Amendment 1188/57 are summarised in Table 1 below. A detailed description of Amendment 1188/57 is provided in Section 1 of the Environmental Review (ENV Australia, 2013)

Table 1 - Key characteristics of proposed scheme amendment

Element	Description
Urban Deferred Zone, Wellard.	70.37 ha. The CSP proposes residential, recreational and conservation land uses.

3 Key environmental factors and principles

Section 48D of the EP Act requires the EPA to report to the Minister for Environment on the key environmental factors for the scheme amendment and the conditions and procedures to which the scheme amendment should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

The EPA decided that the key environmental factor relevant to Amendment 1188/57 that required detailed evaluation in the report is the environmental quality of inland waters (Bollard Bulrush Swamp).

The above key environmental factor was identified from the EPA's consideration and review of all environmental factors (preliminary factors) generated from the Environmental Review document (ENV, 2013) and the submissions received, in conjunction with the scheme amendment characteristics and alternative approvals processes which ensure that the factors will be appropriately managed. On this basis, the EPA considers that the preliminary factors and other issues raised in the submissions do not require further evaluation by the EPA. The identification process is summarised in Appendix 3.

The key environmental factor is discussed in Section 3.1 of this report.

3.1 Inland Waters Environmental Quality

The EPA's environmental objective for this factor is *to maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected*.

Submissions on this factor related to the impact of Amendment 1188/57 on the wetland, retention of the whole EPP Lakes area, the adequacy of the wetland buffer, and the reservation of the wetland as a Parks and Recreation reserve in the MRS.

Bollard Bulrush Swamp lies to the west of the amendment area and largely outside the boundary of the amendment. This wetland is protected under the EPP Lakes, and mapped as a CCW and REW (Figure 4). Surface water exists seasonally adjacent to the site in Bollard Bulrush Swamp and the Peel Main Drain; an artificial drainage line which runs through Bollard Bulrush Swamp and forms part of the regional drainage network. Groundwater flow is expected to be generally south-westerly, towards the Peel Main Drain.

In 2012, the vegetation surveys undertaken for the Environmental Review indicated high conservation value within the wetland area. On behalf of the EPA, the Office of the EPA (OEPA) requested the then DEC to review the management categories assigned to Bollard Bulrush Swamp in the *Geomorphic Wetlands Swan Coastal Plain* dataset. The majority of Bollard Bulrush Swamp was reclassified and upgraded from a REW to a CCW.

The DPaW subsequently advised that a minor Geographic Information System (GIS) error occurred during the 2012 review of the wetland management category mapping. This resulted in 1.3 ha of Bollard Bulrush Swamp not being identified as CCW. The boundary of the Bollard Bulrush Swamp CCW was corrected by the DPaW in May 2013 to reflect the required boundary alignment. However, the boundary correction was done after the WAPC modified the amendment to comply

with the 2012 upgraded mapping and 1.3 ha area of CCW is situated within the amendment area. However, 1.09 ha of this area is within the 50 m wetland buffer, and 0.2 ha is within the area identified in the concept structure plan for future Public Open Space (Figure 5) and therefore will be protected from residential development.

The Environmental Review states that there will be a 252% increase in post-development recharge to the wetland. However, the assumptions behind this projection are not provided in the Environmental Review. Flood modelling undertaken by GHD (2010) indicates that changes in surface flows as a result of development are not anticipated to significantly alter flood levels in the wetland. GHD (2010) further advised that any groundwater level rises as a result of development are anticipated to be within the range of groundwater levels currently experienced as a result of flood events. With the appropriate drainage and groundwater control system, the effects of the development on the wetland water levels should be minimal.

The DoW has advised that significant water planning has been undertaken in this area through the *Jandakot Drainage and Water Management Plan* (DoW, 2009) and the water modelling undertaken in the Environmental Review. The DoW has further advised that additional infiltration associated with urbanisation is considered to be environmentally acceptable. Surface water and groundwater impacts can be managed through engineering and design in the preparation of the future water management plans.

Specifically, these plans are:

- District Water Management Plan (DWMS) required to be completed before the land is changed from 'Urban Deferred' to 'Urban', to be approved by the DoW with DPaW input if required.
- Local Water Management Strategy (LWMS) to be completed at the local structure planning stage and approved by the DoW and the City of Kwinana.
- Urban Water Management Plan (UWMP) to be completed at the subdivision stage and approved by the City of Kwinana on advice from the DoW.

The EPA notes that the management plans will address the following matters:

The District Water Management Plan:

- Design and management objectives.
- A summary of the pre-development environment including a summary of any previous studies; in particular the modelling work completed for this Environmental Review, and the analysis and management options contained within it.
- An analysis of potential development impacts and options for enhancing water conservation in future development at the site.
- A presentation of the site water balance and a discussion on fit-for-purpose water source planning, including allocation of water for different uses and any existing and required infrastructure.
- A water management strategy; including a presentation of the stormwater model and a discussion on the appropriate management of surface water, groundwater, wastewater and drinking water management and how to enhance water efficiency at the site.
- An implementation framework.

The Local Water Management Strategy:

- Principles and objectives of total water cycle management.
- Details of the proposed development.
- Design criteria.
- A description of the pre-development environment.
- Average Annual Maximum Groundwater Levels based on groundwater monitoring.
- Minimum floor levels to provide protection from the groundwater table and local flood levels.
- Description of the conceptual stormwater water modelling.
- Detail structural and non-structural controls for stormwater quality to be used in the development.
- An assessment of potential potable water conservation measures for the site.
- Guidance on future management of the site including requirements for monitoring, roles, responsibilities and construction.

The Urban Water Management Plan:

- A summary of the pre-development environment including a summary of previous studies.
- Design objectives for water management.
- Pre and post-development water balances and a discussion of how the potable water management strategies will be met.
- Summary of the stormwater design undertaken by project engineers to demonstrate that the design complies with Department of Water and Town of Kwinana requirements and accompanying engineer's drawings.
- A groundwater management plan to demonstrate protection of groundwater resources.
- Specific design information regarding engineering design and landscape architecture in the UWMP.
- Proposed nutrient management approaches, including both structural and non-structural controls.
- A plan for management of subdivision works.
- Design of a post-development monitoring programme.
- An implementation plan.

These water management plans will address the total water management of the site, providing a greater level of detail at each stage of the planning process. All development on site will also be connected to reticulated sewerage, removing any risk of sewage input into the wetland area.

The EPA notes that:

- these plans are routinely prepared as part of the usual planning process once the rezoning process has been completed, and
- requirements for post-development water quality monitoring and duration will be addressed through the DWMS process, to be approved by the DoW.

A 50 m wetland buffer is identified in the concept structure plan (Figure 5) to protect the wetland and wetland habitat from weed infestation and inappropriate access. The OEPA notes that this is consistent with the WAPC draft *Guideline for the Determination of Wetland Buffer Requirements* (2005) and the EPA's *Guidance Statement No. 33 Environmental Guidance for Planning and Development* (2008).

The preparation and implementation of a Wetland Management Plan (WMP) will also be required by the WAPC as a condition of future subdivision. The WMP will detail the management of the impacts of the proposed development on the wetland, and its flora and fauna values. The WMP will facilitate the enhancement of the wetland core habitat, vegetation and function, including the reduction of weed species. Details of landscaping and design interface solutions, such as protective fencing and creation of a hard edge to the agreed wetland area, will also be included in a WMP. The WMP will be prepared in consultation with the DPaW and the City of Kwinana.

The REW portion of Bollard Bulrush Swamp will also be included in the wetland enhancement works undertaken in the WMP.

A Construction Environmental Management Plan (CEMP) is also proposed to be prepared. The CEMP will address environmental issues such as protection of wetlands and fauna, reduction of noise pollution, dieback management and revegetation and rehabilitation of preserved areas of native vegetation during the construction phase of the site. CEMPs are not a requirement for development but are standard practice.

The EPA considers that, following the original referral of Amendment 1188/57 which proposed development within a significant portion of the EPP Lakes, the appropriate procedure has been followed in revising the wetland mapping management category and modifying the amendment to rezone only the cleared land outside of the wetland area.

The EPA is aware that the preparation of a WMP is a standard land development practice, and supports the future preparation of a WMP to facilitate rehabilitation of Bollard Bulrush Swamp. The EPA is satisfied that the proposed 'Urban Deferred' boundary around the wetland and the wetland buffer (Figure 4) are adequate to protect the wetland. Furthermore, provision of formal, controlled public access to the wetland will increase the amenity and recreation values available to the surrounding community. The EPA considers that the local community and associated organisations should be engaged in the preparation of the WMP, and involved in its implementation.

The EPA is of the view that, given the current rural land use practices within the amendment area and uncontrolled access to the wetland, it is unlikely that

improvements to the wetland would be achieved under current conditions, in the absence of any formal management. The future urban development will provide the opportunity to exclude grazing and uncontrolled access, and allow the rehabilitation and recovery of the environmental values within the wetland. Potential impacts posed by increased nutrient loading from residential fertiliser use can be addressed through local government education programs and incentives regarding appropriate fertilisers and plant species located near wetlands.

Furthermore, from 1 January 2013, the existing regulations on phosphorus in domestic-use garden fertiliser have been strengthened to reduce the concentration from 2.5 to 2 percent. The amount of phosphorus in all-purpose and lawn fertiliser is limited to one percent. Controlled release and processed organic fertilisers, such as 'blood and bone', composts and composted chicken manure-based products also need to comply with these requirements.

The EPA also notes that the WAPC *Jandakot Structure Plan* (JSP) was finalised in August 2007. The JSP provides a guide to future development of the Jandakot area and management of key environmental values. The proposed amendment zones the final urban cell proposed under the JSP and will complete the urbanisation of the Wellard locality. The EPA considers that, given the above context, MRS Amendment 1188/57 fits appropriately within the surrounding land uses and is consistent with previous EPA decisions.

The EPA also supports the proposal that the WMP will be implemented by the development company, and that the ongoing management of the wetland will be handed over to the City of Kwinana or the DPaW, depending on which agency agrees to future management responsibility for Bollard Bulrush Swamp.

Summary

Having particular regard to:

a) the modification of Amendment 1188/57 to propose development outside of the CCW area, and reduce impacts to the EPP Lakes;
b) the preparation of the future water management strategies and plans at relevant stages of planning;
c) the proposed 50 m wetland buffer to protect the CCW wetland function area and wetland habitat; and
d) the preparation of the WMP to facilitate the enhancement of the wetland core habitat, vegetation and function,

it is the EPA's opinion that Amendment 1188/57 can be managed to meet the EPA's objective for inland waters environmental quality without the requirement for environmental conditions.

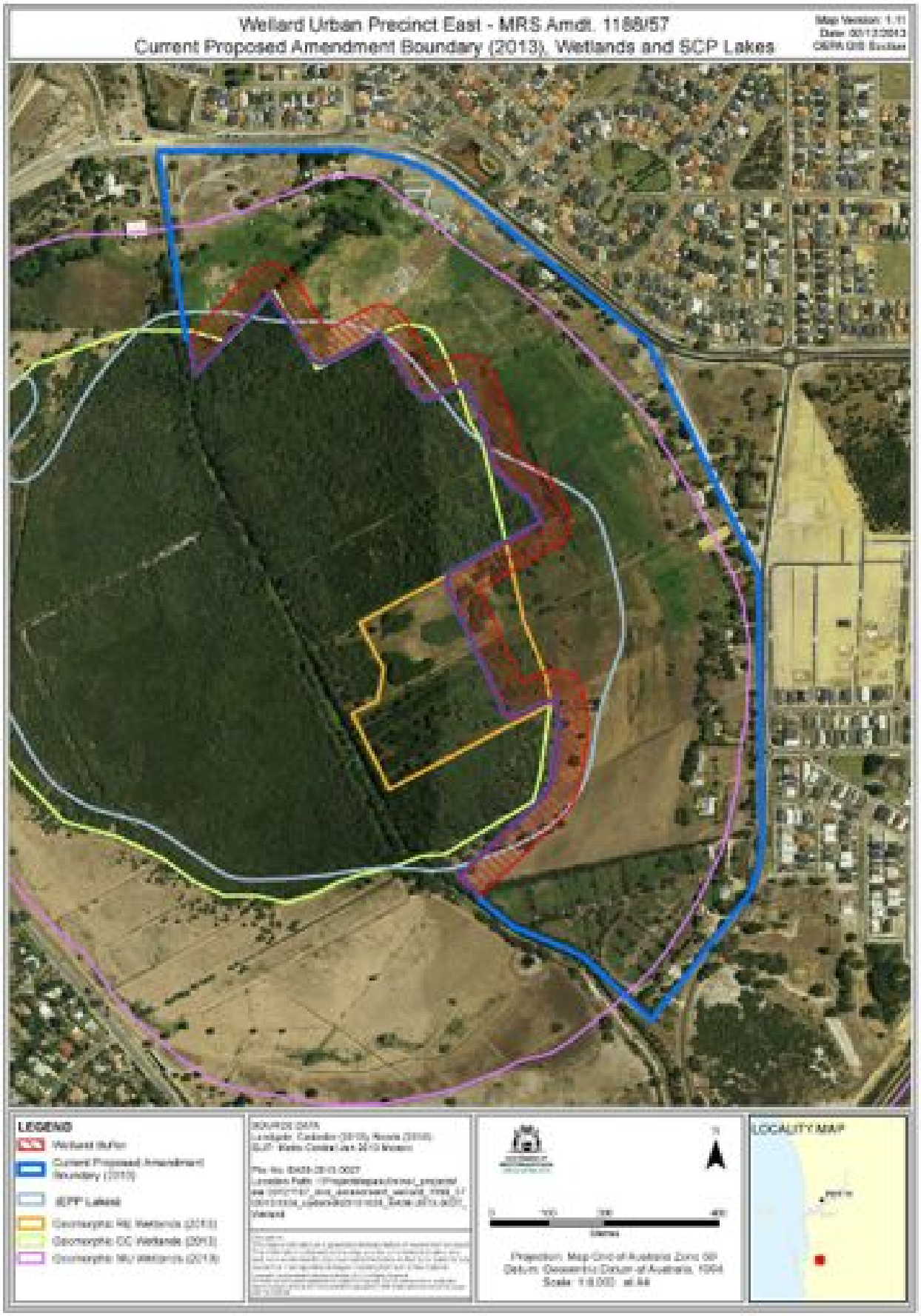


Figure 4: Current MRS Amendment 1188/57 Area and wetland management categories

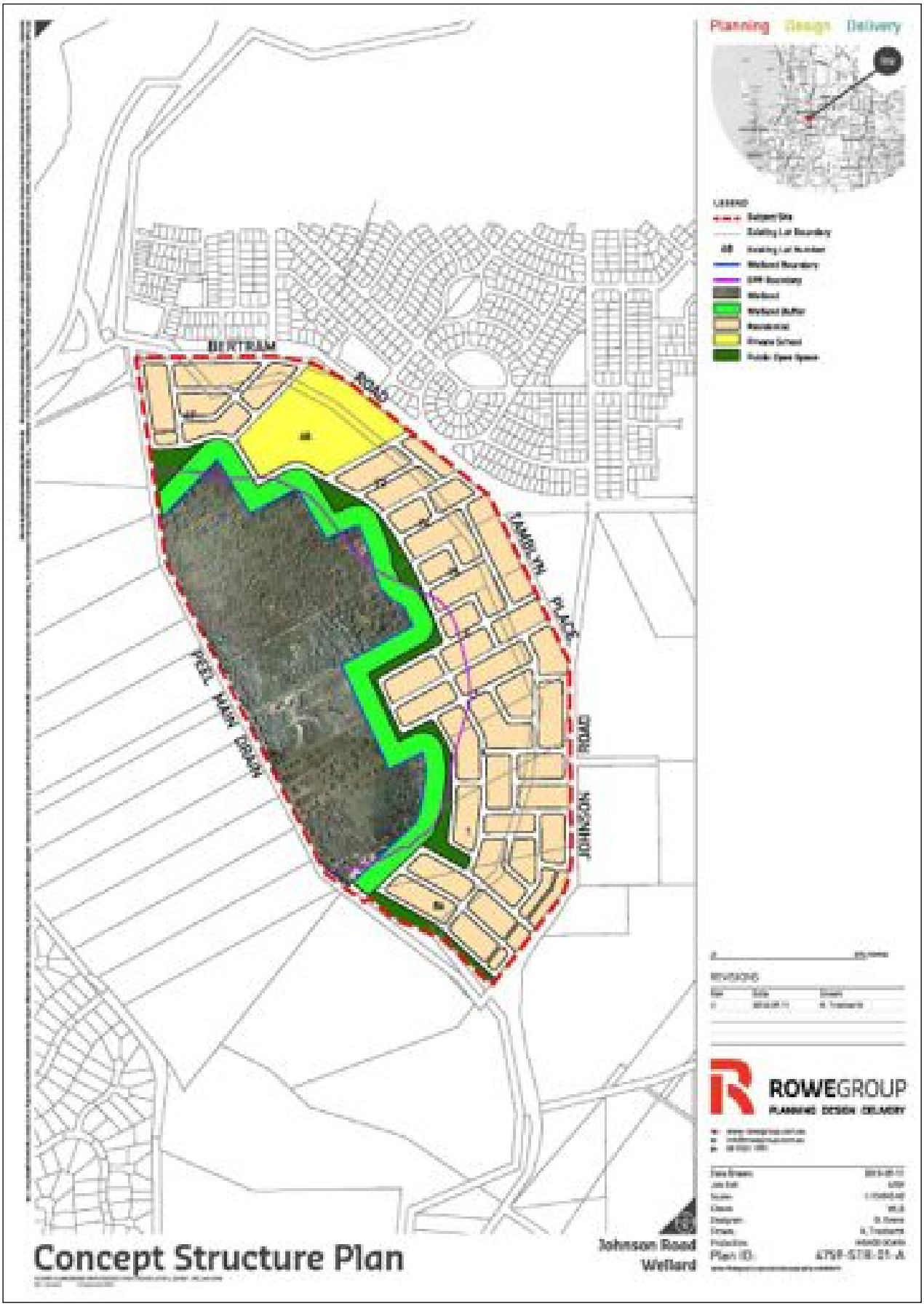


Figure 5: Concept Structure Plan

3.2 Environmental principles

In preparing this report and recommendations, the EPA has had regard for the object and principles contained in s4A of the EP Act. Table 2 contains a summary of the EPA's consideration of the principles.

4 Other advice

4.1 Future Parks and Recreation Reserve MRS Amendment

The EPA notes that Amendment 1188/57 does not address the reservation of the Bollard Bulrush Swamp as a whole. The EPA understands that the reservation of the wetland is a separate matter to this amendment and may be reserved as Parks and Recreation in the MRS under a future amendment.

The EPA would support the reservation of all of Bollard Bulrush Swamp as a Parks and Recreation reserve to provide a consolidated wetland conservation area, and a valuable community asset.

4.2 Bollard Bulrush Swamp - Resource Enhancement Wetland section

A small area of Bollard Bulrush Swamp mapped as a REW under the DPaW *Geomorphic Wetlands Swan Coastal Plain* dataset is proposed for development (Figure 4). This area is in a degraded to completely degraded condition and is considered to have limited fauna habitat value. The EPA notes that the habitat values of the balance of the REW will be retained and enhanced through the design, revegetation and management of the wetland interface. Revegetation will focus of creation of suitable habitats for Quenda, Cattle Egret and Eastern Cattle Egret.

The EPA expects that the portion of the REW within the wetland buffer be managed, restored and protected with the aim of achieving Conservation Category status.

4.3 Acid Sulfate Soils

The EPA notes that the amendment area also occurs within an area of high risk for Acid Sulfate Soils (ASS). With regard to ASS, the Environmental Review states that dewatering, soil disturbance, compaction or lateral displacement in areas of ASS during development will be avoided where possible. It is highly likely that fill will be required during development to achieve the required separation from groundwater levels, and to reduce flooding risk. If disturbance of ASS occurs during development, a compliant investigation and an ASS and Dewatering Management Plan is proposed as a condition of subdivision.

5 Recommendations

Section 48D of the EP Act requires the EPA to report to the Minister for Environment on the key environmental factors for the proposed scheme amendment and on the conditions and procedures to which the proposed scheme amendment should be subject, if implemented. The EPA is also required to have regard for the principles

set out in section 4A of the EP Act. In addition, the EPA may make recommendations as it sees fit.

The EPA submits the following recommendations to the Minister for Environment:

1. That the Minister notes that the scheme amendment being assessed proposes to rezone the site from 'Rural' to 'Urban Deferred' under the Metropolitan Region Scheme.
2. That the Minister considers the report on the key environmental factor and principles as set out in Section 3.
3. That the Minister notes that the EPA has concluded that Metropolitan Region Scheme Amendment 1188/57 Wellard Urban Precinct East can meet the EPA's environmental objective for Inland Waters Environmental Quality.
4. That the Minister notes that the EPA has not included in this report "conditions and procedures to which Metropolitan Region Scheme Amendment 1188/57 should be subject, if implemented", because the EPA holds the view that the amendment as proposed can meet the EPA's environmental objective.
5. That the Minister notes the EPA's other advice presented in Section 4 in relation to a future Metropolitan Region Scheme amendment to reserve the wetland area, the rehabilitation of the Resource Enhancement Wetland area, and Acid Sulfate Soils.

Appendix 1

List of submitters

Organisations:

Beeliar Regional Park Community Advisory Committee
City of Kwinana
Department of Aboriginal Affairs
Department of Agriculture and Food
Department of Education
Department of Fire & Emergency Services
Department of Health
Department of Mines and Petroleum
Department of Parks and Wildlife
Department of State Development
Department of Transport
Department of Water
Main Roads Western Australia
Peel-Harvey catchment Council
Rowe Group on behalf of Wellard landowners Group
State Heritage Office
South West Aboriginal Land & Sea Council
Urban Bushland Council
Western Australian Police
Western Power
Wetlands Conservation Society
Wildflower Society of Western Australia

Individual:

Keil McCreery
Marinus and Jillian Van Asselt
Robyn Pickering

Appendix 2

References

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DoW (2009) *Jandakot Drainage and Water Management Plan.* Department of Water, 2010.

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WAPC (2005) draft *Guideline for the Determination of Wetland Buffer Requirements.* Western Australian Planning Commission.

WAPC (2007) *Jandakot Structure Plan*. Western Australian Planning Commission.

WAPC (2013) *Metropolitan Region Scheme Amendment 1188/57 Wellard Urban Precinct East Amendment Report.* Western Australian Planning Commission.

Appendix 3

Identification of Key Environmental Factors and Principles

Identification of Key Environmental Factors and Principles

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
BIOPHYSICAL			
Inland waters environmental quality		***Department of Water*** • Significant water planning has been undertaken in this area through the Jandakot Drainage and Water Management Plan (DoW, 2009) and specifically to Bollard Bulrush through modelling presented in the report Wellard Urban Precincts East and West (GHD, 2010). • The proposed rezoning of the site to urban deferred is considered appropriate, subject to a District Water Management Strategy being prepared and approved prior to the lifting of urban deferment. ***Department of Parks and Wildlife*** • Further investigation is required to determine the boundaries of the wetland area to be retained and protected, including determination of the appropriate buffer distance. • Recommend that the boundary of the CCW (UFI 15866) be updated to reflect the revised 2013 mapping of the Geomorphic Wetlands Swan Coastal Plain dataset. • Recommend that the proposed Concept Plan be redesigned to ensure protection of the CCW (UFI 15866) and REW (UFI 15867) and a minimum 50 metre buffer. • Recommend that the proponent commits to fencing the outer edge of the buffer and ensuring a “hard edge” between the wetland and buffer development. • Recommend the proponent commits to the development and implementation of a Wetland Management Plan to the satisfaction of the OEPA and DPaW.	**Considered to be a key environmental factor.**

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
		• Recommend that the proponent commits to development of a Construction Environmental Management Plan. • The DPaW would not be supportive of any infrastructure in the wetland or buffer that would potentially result in increased impacts to the wetland. • Recommend that the proponent present the surface water monitoring data prior to any development approval. • Recommend that the proponent commits to locating all new constructed drainage infrastructure outside of the CCW and REW and associated buffer. • Recommend the proponent commits to development of a surface water and ground water monitoring programme. • The DPaW should be consulted on the District and Local Water Management Strategies and the Urban Water Management Plan with regard to potential impacts to Bollard Bulrush Swamp. • Recommend that the proponent present the surface water monitoring data prior to any development approval. • Recommend that the proponent commits to locating all new constructed drainage infrastructure outside of the CCW and REW and associated buffer. • Recommend the proponent commits to development of a surface water and ground water monitoring programme. • The DPaW should be consulted on the District and Local Water Management Strategies and the Urban Water Management Plan with regard to potential impacts to Bollard Bulrush Swamp.	

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
		City of Kwinana • The ER does not address the statement in the Jandakot Drainage and Water Management Plan which does not appear to support new urban development in the Bollard Bulrush Swamp area. • The ER does not explain what will be done to avoid the need for a buffer (greater than 50 metres for a CCW) that will give adequate protection from hydrological change to the wetland. • The ER states that a District Water Management Strategy (DWMS) will be prepared on lifting of urban deferment. Given the risks associated with the site it would be more appropriate to have a DWMS prepared before rezoning. • The ER states that water quality monitoring will be for three years post development. The Jandakot Drainage and Water Management Plan states that monitoring should be undertaken for at least five years. ***Public and non-government organisations*** • Inability of wetland impacts to be mitigated. • Bollard Bulrush swamp should be protected under Parks and Recreation reservation under the MRS. • The proposal excludes portions of the freehold lots which contain portions of Bollard Bulrush Swamp. • The wetland values need to be set in the context of the entire Bollard Bulrush Swamp. • Redefinition of the functional boundary of Bollard Bulrush Swamp. All of the CCW and REW should be protected. • The current proposed wetland buffer is inadequate and needs to be reviewed. • The ER states that a Wetland Management Plan will be	

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
		prepared at the subdivision stage. The Wetland Management Plan should be prepared at the Structure Plan process. • No urban development within the EPP wetland boundary. • Hydric soils mapping should be undertaken for the whole of the site to assess the location of the buffer. • The ER has demonstrated that the surface water hydrology of the site will be significantly altered. • The ER does not state what contingency measures will be put in place if pre-development groundwater levels are significantly altered. • The ER does not demonstrate that the nutrient reduction targets can be met on site. • The ER does not aim to meet the Peel-Harvey Water Quality Improvement Plan phosphorus reduction target. • It is recommended that the Environmental Conditions to the scheme amendment state that Local Water Management Strategy and Urban Water Management Plans are to achieve a 38% reduction in phosphorous loads leaving the site. • The ER has not adequately addressed the current relationship between groundwater on the Site and flows in the Peel main Drain. • The post-development groundwater monitoring program as proposed in the ER will not be able to determine if the development will meet the objectives of the Water Quality Improvement Plan. • The Environmental Conditions attached to the amendment should require that all fill brought on the Site have a Phosphorous Retention Index of at least 15.	

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
Flora and vegetation		***Department of Parks and Wildlife*** • Recommend that a targeted flora survey for declared rare and priority flora known to occur in wetland habitats in the local area be undertaken in areas proposed for development. • Recommend that the proponent commits to the rehabilitation of the wetland conservation and buffer area, including locally native revegetation of degraded area and weed control as necessary. • Recommend the proponent considers revegetating the Public Open Space along the Peel Main Drain to create a wildlife corridor. ***Public and non-government agencies*** • The vegetation surveys have not been conducted correctly and do not reflect the vegetation condition correctly. • The amendment area should be resurveyed. • Bollard Bulrush Swamp should be fully rehabilitated and rezoned Parks and Recreation and be included in the Beeliar Regional Park as an important wetland. It is the last major wetland in the chain connecting the Beelier Wetlands to the Rockingham lakes. It is important for supporting wildlife migration up and down the Swan Coastal Plain. • Not correct as proponents imply, that degraded wetland cannot be successfully restored. • The importation of soil on site for development also has the potential to cause changes to wetland vegetation. • Fencing off of the wetlands has shown to be successful in the regeneration of wetland understorey and eco-system functions.	The site consists of land that has been cleared and consistently grazed since the 1920s.ENV considers it “very unlikely that the subject site supports flora conservation significance or provides the habitat for conservation significant flora and therefore the potential for Threatened, declared rare or Priority Flora is low”. The areas of the site that contain remnant vegetation are being retained. Should Threatened, Declared Rare or Priority Flora occur within the remnant vegetation, then it will be retained and preserved. The proposed MRS amendment does not address the reservation of the retained wetland area. The reservation of this area is a separate matter to the current amendment. The Wetland Management Plan as identified on page 34 of the ER states “Details of landscaping and design interface solutions, such as protective fencing and creation of a hard edge to the agreed wetland area, will be also included in a Wetland Management Plan”. The Wetland Management Plan will be developed as a condition of subdivision in consultation with the DPaW and the City of Kwinana. Not considered to be a key

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
			environmental factor. Factor does not require further EPA evaluation.
Terrestrial fauna		***Department of Parks and Wildlife*** • Recommend that the proponent reassesses the habitat values of Bollard Bulrush Swamp. The ER states that the Melaleuca Dampland has a 'low' value. This is not supported by the information provided in the technical appendices. • Recommend that the proponent commits to a range of management and mitigation measures for potential impacts to conservation significant fauna, both with respect to the construction phase impacts and ongoing impacts. This could be addressed in the Wetland Management Plan. • Recommend the proponent considers the implementation of a "Cat Prohibited Area".	The site consists of land that has been cleared and grazed since the 1920s. The areas of the site that contain remnant vegetation that have habitat value will be retained. The value of the wetland providing habitat for Quenda has been identified and acknowledged. Revegetation will focus on creating appropriate habitat for significant species, including Quenda. The Wetland Management Plan will be prepared at the subdivision stage of the development, and addressing issues such as rehabilitation, weed and feral animal control. The *Cat Act 2011* has now come into effect, requiring owners to exercise more control in the movement of cats and increase sterilisation rates. A cat prohibition area can be further addressed at the local structure planning stage with input from the DPaW and the City of Kwinana. The Peel main drain will remain as a linkage for species utilising the area. Not considered to be a key environmental factor. Factor does not require further EPA evaluation.

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
POLLUTION			
Terrestrial Environmental Quality	The proposal may disturb Acid Sulfate Soils (ASS).	***Public and non-government organisations*** • Believes the disturbance of ASS could lead to the acidification of the groundwater and wetlands, resulting in loss of biodiversity. ***Town of Kwinana*** • The ER provided is inadequate to provide confidence that the risk of ASS are able to be satisfactory mitigated.	Acid Sulfate Soils will be identified and managed consistent with the DoP and WAPC 2008b *Acid Sulfate Soils Planning Guidelines* and DEC 2013 *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes.* These processes require ASS to be assessed at the LSP stage. If ASS are identified then additional investigations and management plans will be required. Management plans will be required as a condition of subdivision. This process is used to effectively manage ASS in Western Australia. Not considered to be a key environmental factor. Factor does not require further EPA evaluation.
OTHER			
Heritage	Potential impact on Aboriginal heritage sites and European heritage values.	***Department of Aboriginal Affairs*** •The area does not intersect with the boundaries of any known Aboriginal heritage sites or places. Previous heritage surveys over areas in close proximity to Wellard Urban precinct (East) have Identified Aboriginal Cultural material within a sub-surface context. ***South West Aboriginal Land & Sea Council*** Not identified any Registered Aboriginal Heritage Sites within the vicinity of the amendment.	The Department of Aboriginal Affairs recommends prior to any development occurring prospective developers should refer to the States Cultural Due Diligence Guidelines. The *Aboriginal Heritage Act 1972* protects Aboriginal heritage sites and materials. Not considered to be a key environmental factor.

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
		State Heritage Office •No comment.	Factor does not require further EPA evaluation.
Landforms	Potential Impact on landform and biodiversity.	***Department of Mines and Petroleum*** The agency's environmental geological map for Rockingham indicates that the land in its present form may be unsuitable for residential development. The underlying clayey silt and high water table of the area, as mapped by this agency, suggest th that the land is prone to flooding and will not absorb liquid waste.	The Department of Water, the agency responsible for flooding matters, has not raised any objections to the development. Hydrological investigations have identified that some areas of the site could be subject to waterlogging or inundation during an average winter (Appendix F of Environmental Review). Appropriate management of this issue will be addressed in the District Water Management Strategy (DWMS). The DWMS will be prepared to support the rezoning of the site from 'Urban Deferred' to 'Urban' under the MRS. The DWMS will be consistent with Planning Bulletin 92: *Urban Water Management* (WAPC 2008) and *Better Urban Water Management* (WAPC and DPI 2008a) and will address protection of infrastructure and assets from high water tables under peak groundwater level conditions. The DWMS will include: • assessment of pre- and likely post-development groundwater and surface water levels • assessment of the need for groundwater control

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
			• potential outlet locations and invert levels of outlets for groundwater control systems. The DWMS will require approval by Department of Water prior to rezoning to 'Urban' under the MRS. The Local Water Management Strategy (LWMS) will be prepared at the Local Structure Plan (LSP) stage and will address: • refinement of post-development groundwater levels • fill requirements (including existing and likely final surface levels) to address waterlogging and flooding requirements • areas in which subsoil drainage is to be utilised or excluded from use because of environmental sensitivities. The LWMS will require approval by Department of water and City of Kwinana prior to the LSP being approved. Urban Water Management Plans (UWMPs) will be required at the subdivision stage. The UWMPs will include: • confirmation of final surface levels and post-development groundwater levels

PRELIMARY ENVIRONMENTAL FACTORS	AMENDMENT COMPONENT WITH POSSIBLE IMPACT	GOVERNMENT AGENCY AND PUBLIC COMMENTS	IDENTIFICATION OF KEY ENVIRONMENTAL FACTORS
			• detailed design of subsoil drainage system, including design and potential impacts near sensitive environments. As the development will be connected to reticulated sewerage, disposal of liquid waste will not occur on site and is consequently not an issue. Not considered to be a key environmental factor. Factor does not require further EPA evaluation.

PRINCIPLES		
Principle	**Yes/No**	**Consideration**
1. The precautionary principle *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.* *In the application of the precautionary principle, decisions should be guided by —* *(a) careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and* *(a) an assessment of the risk-weighted consequences of various options.*		
	Yes	

2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*		
	Yes	
3. The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*		
	Yes	
4. Principles relating to improved valuation, pricing and incentive mechanisms *(1) Environmental factors should be included in the valuation of assets and services.* *(2) The polluter pays principle — those who generate pollution and waste should bear the cost of containment, avoidance or abatement.* *(3) The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any wastes.* (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solutions and responses to environmental problems.		
	No	
5. The principle of waste minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.		
	Yes	

Appendix 4

Summary of Submissions

and Responsible Authority's Response to Submissions

Appendix D – Combined LWMS / UWMP – PDC

Combined LWMS and UWMP

Lot 502 Tamblyn Place - Wellard



Prepared by PDC for:
Ascari Developments

Reporter:
Martin Wright

Report Number: 5009_REP_001_C

Job Number: 5009

Report Date: 16/03/2015

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Authority to Release

This document is authorised for release only when the following signatures have been obtained.

Authored

M. Wright — Signed
Martin Wright — Civil Engineer
17.03.16 — Date

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Authorised *(Management)*

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Marino Evangelisti — General Manager – Property and Infrastructure
18.3.2016 — Date

Revision	Date	Revision Description	Authored	Approved
A	09/09/15	Issue to authorities	MW	AB
B	13/10/15	Amended for DoW Comments	MW	AB
C	16/3/15	Amended for CoK Comments	MW	AB

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Figure 1.2 **Local Structure Plan**

Figure 3.1 **Topography and Existing Land Use**

Figure 3.2 **Geotechnical Features**

Figure 3.3 **ASS Risk Mapping**

Figure 3.4 **Surface Water Drainage Features**

Figure 3.5 **Wetland Mapping**

Figure 3.6 **Groundwater Monitoring Bore Locations**

Figure 4.1 **Detention and Flow Paths 2 Yr ARI**

Figure 4.2 **Rain Garden Design**

Figure 5.1 **Preliminary Earthwork Levels**

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I. Summary

Key LWMS/UWMP Elements	Design and Compliance Objectives
Topography (Section 3.2)	• The site slopes towards the Peel Main Drain from approximately 9m AHD in the East to 4.2m AHD in the West.
Geology and Soils (Section 3.3)	• The majority of the site is underlain by Bassendean sand with an increasing layer of topsoil and clay/peat content as the site approaches the Bollard Bullrush swamp.
Acid Sulphate Soil (Section 3.4)	• DER regional mapping shows that the majority of the site has a high risk of encountering Acid Sulphate Soils (ASS) within 3m of the natural soil surface. • An Acid Sulphate Soils and Dewatering Management Plan (ASSDMP) will need to be prepared and approved prior to any construction activities being undertaken
Wetlands and Surface Water (Section 3.5)	• Pre-development hydrology a result of inclined topography and low permeability topsoil causing surface sheet flow towards the Bollard Bullrush swamp • The Peel Main Drain (PMD) Bisects the Bollard Bullrush swamp and forms part of the regional drainage network, ultimately discharging in to the Peel-Harvey Estuary • Pre-development flood levels provided in the Jandakot Drainage and Water Management Plan (JDWMP) give a 100 year flood level for the site of 5.62m AHD. Finished Lot Levels require a minimum 500mm freeboard above the 100 year flood level. • The site is bound to the West by the Bollard Bullrush swamp, a Conservation Category Wetland (CCW) and to the South-West by a Resource Enhancement Category Wetland (REW) associated with the Bollard Bullrush Swamp. The remaining Western portion of the site is classified as Multiple Use Wetland.
Groundwater Elevation and Flow Direction (Section 3.6)	• The Perth Groundwater Atlas and on-site monitoring bore indicate that groundwater grades towards the Southwest. • Extensive pre-development groundwater monitoring has been undertaken in the area between 2010 - 2011 with additional monitoring being undertaken by RPS in adjacent sites and dedicated monitoring within the site by PDC to capture the 2015 annual peak groundwater level. • The 2010-2011 groundwater monitoring program indicates that the critical AAMGL in the development area is approximately 4.1m AHD.
Stormwater and Flood Management (Section 4)	• Water Sensitive Urban Design Principles (WSUDP) have been implemented to follow the design objectives in the JDWMP and outcomes from consultation with the City of Kwinana and Department of Water. • Minimum habitable floor levels will be set with a minimum freeboard to the 100 year flood level of 500mm, giving a recommended minimum lot level of 6.12m AHD • The critical 2 year ARI event will be treated and infiltrated at source in roadside swales/raingardens lined with biofilter media. • Events that exceed the critical 2 year ARI will be directed via overland flow paths in the road reserve towards the POS. Stormwater discharges via the POS occurs as sheet flow across a vegetated surface to replicate the pre-development hydrology. • No drainage infrastructure or outfalls are to be constructed in the CCW or the 50m buffer.
Groundwater Management (Section 5)	• Minimum finished lot levels provide in excess of 1.5m clearance to AAMGL
Water Quality Management (Section 6)	• It is not proposed to impact on the pre-development hydrology

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	• As part of the panning process 50m Wetland buffer is provided around the CCW to protect the wetland core changes in hydrology and reduce the risk of migration of non-native species into the wetland. • Education of lot owners in recommended fertilising practices and the use of loamy topsoil to increase fertiliser efficiency

Water Conservation Strategy (Section 7)	• Several water saving initiatives have been implemented to reduce water consumption to under the 100KL/person/year *State Water Plan* consumption target. These initiatives include:
	  ○ Water wise landscaping principles will be implemented in all landscaped areas and promoted to to lot owners through educational material.
	  ○ Use of native vegetation, hydrozoning and use of only bore water for irrigation within the POS

Management of Subdivision Works (Section 8)	• Dust Management is to be in accordance with Department of Conservation (DEC) and City of Kwinana guidelines. • An ASSDMP will be required prior to dewatering or earthworks due to the risk of ASS on the site.
Monitoring (Section 9)	• Post-development groundwater monitoring will be under taken for a minimum of 5 years following completion of the development • Inspection of BMPs will be carried out during and 3 years post construction by the City of Kwinana

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1 Introduction

1.1 Background

The residential development of 64 lots is proposed for Lot 502 Tamblyn Place Wellard. The site is approximately 40km south of the Perth Central Business District and is located on the Eastern fringe of the Bollard Bullrush Swamp, 1 Km West of the Kwinana Freeway. The area proposed for development covers approximately 10Ha and is located in the municipality of the City of Kwinana.

1.2 Planning Approval

Metropolitan Regional Scheme (MRS) Amendment 1188/57 for the Wellard Urban Precinct (East) rezoned approximately 70ha of land from “Rural” to “Urban Deferred” to assist in facilitating urban land uses. The MRS amendment 1188/57 included Lot 502 Tamblyn Place within the amendment area.

To support the lifting of the “Urban Deferred” zoning, the Western Australian Planning Commission (WAPC) required the preparation of a District Water Management Strategy, to be approved by the Department of Water (DoW) and a Bushfire Hazard Assessment, to be approved by the Department of Fire and Emergency Services. These requirements have now been assessed and the land is now zoned “Urban”

A District Water Management Strategy (DWMS) (Emerge Associates 2015) was prepared in January 2015 in support of the DSP. This has defined the water management objectives at a district level. The management objectives from the DWMS have been incorporated into this combined Local Water Management Strategy (LWMS) and Urban Water Management Plan (UWMP).

The site is located within the City of Kwinana local government area and is currently zoned as “development” under the most recent Town Planning Scheme (TPS No. 2). The Local Structure Plan (LSP) for the site is shown in Figure 1.2.

Following discussions with Brett Dunn (Dow) and Nino Scidone (CoK) a combined LWMS and UWMP has been prepared to support both the LSP and pave the way for subdivision approval.

1.3 Content of this LWMS and UWMP

This combined LWMS and UWMP provides management techniques to address the following;

- Compliance with the design objectives in the DWMS.
- Detailed stormwater management design including the size, location and design of public open space areas, integrating flood management capability.
- Specific structural and non-structural best management practices and treatment trains.
- Management of groundwater levels.
- Management of groundwater contamination and other specific site conditions.
- Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages.
- Measures to achieve water conservation and efficiencies of use.
- Management of subdivisional works (to ensure no impact on conservation areas and management of dust).

- Management of disease vector and nuisance insects (mosquitoes and midges).
- Monitoring program and/or contribution.
- Implementation including roles, responsibilities, funding and maintenance arrangements.

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2 Principles and objectives

This document should be read in conjunction with the Jandakot Drainage and Water Management Plan (JDWMP) (DoW, 2009) and the DWMS (Emerge Associates, 2015) prepared for the District Management Plan.

This combined LWMS and UWMP has been developed to follow the principles and design objectives based on the requirements in the following documents:

- Jandakot Drainage and Water Management Plan (JDWMP) (DoW, 2009)
- District Water Management Strategy Wellard Urban Precinct East (Emerge Associates, 2015)
- Australian Rainfall and Runoff (ARR) (Engineers Australia, 2001)
- Stormwater Management Manual for Western Australia (DoW, 2007)
- Better Urban Water Management Framework (WAPC, 2008)

Specific design objectives for the site are outlined in the table below.

Table 2.1: Design Objectives

Design Criteria & Principles	Design Objectives
Water Conservation • Consider all potable water sources in water supply planning • Integrate water and land use planning • Maximise stormwater reuse • Minimise use of potable water	• Minimise potable water usage outside of homes and buildings • Achieve a water consumption target of 100KL/person/year • If possible, achieve a potable water consumption target of40-60KL/person/year
Groundwater levels and Quality • Manage subsurface groundwater levels and minimise change in peak winter levels at groundwater dependant wetlands due to change in groundwater flux associated with urbanisation • Improve groundwater quality in subject land	• Post-development peak groundwater levels at wetlands to be maintained at pre-development levels • As compared to a development that does not actively manage water quality: o 60% reduction in TP o 45% reduction in TN • Address DEC and EPA requires for sensitive environments
Surface Water Quality • Post development peak flows are to be maintained at predevelopment conditions, unless otherwise established through determination of EWR for sensitive environments	• For ecological protection, the 2 year flow will be treated and infiltrated on site • For flood management, manage the catchment runoff for up to the 100 year event to pre-development peak flows • The flood path for water exceeding the design level of the flood storage area to be directed away from the development by providing overland flow paths and maintain a minimum of 500mm freeboard between the 100 year ARI flood level and finished floor levels.
Surface Water Quality • Reduce average annual load of stormwater pollutants as compared to with development that uses traditional, directly connected stormwater drainage design	• Surface water for events up to the 2 year ARI should be treated at source

• Maintain or improve surface water quality within subject land	• As compared to typical urban developments which do not have stormwater treatment measures, the following nutrient reductions in surface water quality are to be achieved ○ 80% reduction in TSS ○ 60% reduction TP ○ 45% reduction in TN ○ 70% reduction in gross pollutants
Structural and non-structural BMP's • To improve surface water quality and prevent pollution of surface water within the subject land	• Implement source controls to prevent pollution or treat stormwater as high in the catchment as possible • Install in-transit measures to treat stormwater though the conveyance systems • Implement end-of-pipe measures to mitigate any contaminants remaining in the stormwater prior to discharging to receiving environments
Wetland and Waterway Protection • Retaining and restore waterways and wetlands	• Ensure no constructed stormwater infrastructure within conservation category wetlands or their buffers
Vector and Nuisance Management • Prevent favourable conditions for mosquito breeding	• Ensure, as far as practical, the design of constructed wetlands, road gullies and bioretention basins etc. do not contribute to onsite mosquito breeding • Provide ongoing maintenance and management of stormwater system to ensure that it continues to operate as designed, thereby reducing the risk of creating conditions likely to promote mosquito breeding

3 Predevelopment Environment

3.1 Site Location and Existing Land Use

The site is located approximately 40km south of the Perth CBD within the City of Kwinana and encompasses 10Ha of land, 1 km West of Kwinana Freeway. The site is presented in Figure 1.1 and is bound by Tamblyn Place to the North East and Bollard Bullrush Swamp to the South West.

The North Eastern half of the site is currently utilised as farmland with large paddock for grazing cattle. A residence and stables is located adjacent to Tamblyn Place. The South Western portion of the site is the wetland that forms part of the Bollard Bullrush swamp, with the Peel Main Drain (PMD) running along the length of the South West boundary of the site.

3.1.1 Surrounding Land Use

The site is bound to the South West by the PMD, which bisects the Bollard Bullrush swamp and Tamblyn Place to the North East. The site is bordered by large rural lots however a local structure plan is in place for the development of the lands to the South and the North East of the site, as part of the Wellard District Structure plan.

The Bollard Bullrush swamp, inclusive of a portion of the PMD is classified as a conservation category wetland and is protected under the Environmental Protection (Swan Coastal Plain Lakes) Policy Approval Order 1992.

The PMD flows in a Southerly direction before discharging into the Serpentine River and ultimately the Peel – Harvey Estuary.

3.2 Topography

The topography of the site uniformly declines in elevation from the Tamblyn Place in the North East to Bollard Bullrush swamp in the South West. The ground elevation at Tamblyn place is approximately 9m AHD, which declines to approximately 4.2m AHD at the border of the Bollard Bullrush swamp. The remainder of the site grades towards the Peel Main Drain, which adjacent to the site has in invert level of approximately 3.5m AHD. Survey of the existing topography of the site is shown in Figure 3.1.

3.3 Geotechnical Investigations

A geotechnical investigation of Lot 502 was conducted by CMW Geosciences to review ground conditions and provide recommendations relating to a ground remediation strategy required to achieve a Class A footing to facilitate urbanisation. The geotechnical report is attached in Appendix B

The North Eastern portion of the site along Tamblyn Place is characterised by a poorly developed sandy topsoil layer typically 0.2m thick , overlaying medium dense Bassendean sand interbedded with silt, sand and clay alluvium of the Guildford Formation (below 8m from existing ground level). Towards the South Western boundary, where the existing ground level falls below 6.5m AHD the topsoil layer is dominated by clayey/peet topsoil up to 0.5m thick. The upper Bassendean sand across the site is loose to medium dense, with relative density increasing with depth. A summary of the ground conditions and bore hole and cone penetrometer test (CPT) locations are shown in Figure 3.2

Falling Head Permeability Tests were carried out on the underlying Bassendean sand material to give an estimate of the coefficient of permeability of 10m/day.

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3.4 Acid Sulphate Soils and Contamination

The Perth Metropolitan Acid Sulphate Map, developed by the Department of Environmental Regulation (DER), refer to Figure 3.3 indicates that the vast majority of the site is located in a "high risk area for ASS occurring within 3m of the natural surface". The North Eastern Fringe of the site along Tamblyn Place is categorised as "moderate risk area for ASS occurring within 3m of the natural surface"

Actual and Potential ASS are likely to be prominent across the majority of the site. Disturbance of any insitu material exceeding 100m^3 of soil below the water table or dewatering during the earthworks and civil construction will require an Acid Sulphate Soil and Dewatering Management Plan (ASSDMP).

An ASSDMP will be required to outline the soil management measures; the groundwater and dewatering effluent measures; and contingency management measures require to minimise any potential environmental impacts. The ASSDMP will be required to be forwarded to the DER prior to the commencement of Earthworks.

A review of the DER's Contaminated Sites database on the18 August 2015 indicated that there was no registered contaminated sites within the site. Given the age of the property and the agricultural nature of the site, there is some risk of encountering asbestos material as a result of demolition of existing structures on site. Any asbestos as a result of demolition will be removed in accordance with Work Safe Australia Code of Practice - Demolition Works (March 2015)

3.5 Wetlands and Surface Water

3.5.1 Pre-development Drainage

The hydrology of the site is chiefly dominated by the proximity to the Peel Main Drain (PMD), the low permeability topsoil and the gently inclined topography. The low permeability of the clayey/ peaty topsoil results in low infiltration and high volumes of run-off, in the form of sheet flow travelling towards the lower lying swamp and PMD (see Figure 3.4). The low infiltration rates of the topsoil layer is evident in localised ponding in depressions on the site towards the Bollard Bullrush swamp.

The PMD is a Water Corporation owned and maintained main drain which bisects the Bollard Bullrush swamp and forms part of the regional drainage network. The PMD flows in a southerly direction adjacent to the South Western Boundary of the site and links to the Serpentine River, discharging into the Peel-Harvey Estuary.

Predevelopment flood levels within the PMD and the extent of flooding within the Bollard Bullrush swamp have been provided in the JDWMP (DoW 2009). Flood levels at the culvert upstream of the Bollard Bullrush swamp for the 10 and 100 year ARI events are 4.99m AHD and 5.60m AHD respectively. At the midpoint of the Bollard Bullrush swamp, directly adjacent to the site, the 10 and 100 year ARI events are 4.81m AHD and 5.62m AHD respectively. The 100 year flood levels set the minimal allowable habitable structure floor levels which require 500mm freeboard to the 100 year ARI flood level.

3.5.2 Pre-development Surface Water Quality

Water quality monitoring has been undertaken in the PMD just downstream of the site as part of the JDWMP.

The JDWMP suggest that between 2002 & 2004 the concentration of Total Phosphorous (TP) and Total Nitrogen (TN) within the PMD are low (TP <0.065 mg/L) relative to the trigger values specified in the *Australian and New Zealand guidelines for fresh marine water quality* (ANZECC, 2000).

However, more recent water quality data collected between 2008 and 2009 within the PMD downstream of the development area showed relatively high concentrations of TP and TN. The *Water Information Reporting* (DoW) PMD average water quality data for these downstream locations is represented in Table 3.1 Below.

Table 3.1: Average Water Quality

Site Location	Temperature	pH	No_3-N (mg/L)	PO_4-P (mg/L)
Downstream	13.13	6.13	0.28	0.54

Downstream DoW sites: WIN 23027580 and 23027581 (DoW 2014)

The JDWMP proposes long-term targets for nutrient concentrations in the PMD are 0.1mg/L for Total Phosphorous and 1.0mg/L for Total Nitrogen.

3.5.3 Wetlands

Lot 502 is bound to the West by the conservation category wetland (CCW) Bollard Bullrush swamp (UFI 15466) and a resource enhancement (RE) wetland (UFI 15867) associated with the Bollard Bullrush swamp to the South of the site. The remaining portion of the site is classified as Multiple Use Wetland. The Swan Coastal Plain geomorphic wetland mapping (DoW) for the site is presented in Figure 3.5 and includes the 50m wetland buffer required for the CCW and MRS Amendment No 1188/57.

3.6 Groundwater

A study of the Perth Groundwater Atlas (DoW, 2015) and current onsite monitoring bores indicate that groundwater levels on the site grade in a south-west direction, with superficial groundwater flowing towards the PMD. Seasonal groundwater fluctuations of 1.2m in combination with the depressed terrain and low permeability topsoil towards the Bollard Bullrush swamp result in water logging towards the edge of the swamp.

Underlying the site is the following succession of aquifers:

- Perth-Superficial Swan (unconfined) aquifer
- Perth Leederville (confined) aquifer
- Perth Yarragadee North (confined) aquifer

Recharge of the shallowest Superficial Swan occurs through direct infiltration of rainfall through the overlying Bassendean sand. The Leederville Aquifer is a major confined aquifer that consists of sandstones, siltstones and shales up to 250m thick. The deeper Yarragadee occurs at a depth of approximately 450m below ground surface.

3.6.1 Predevelopment Groundwater Monitoring

Groundwater levels from the site and the surrounding area have been compiled, with locations of monitoring bores shown in Figure 3.6. Raw Monitoring data has been provided in Appendix C and a summary of the monitoring programs is as follows:

- From July 2010 to December 2011 ENV monitored groundwater from six bores (MW1-E to MW6-E) located in surrounding lots
- A ground water monitoring event was conducted by Bayley Environmental Services in August 2012 on 5 monitoring bores in lot 900 Tamblyn Place
- Starting May 2015 and ending October 2015, RPS is currently monitoring groundwater bores in the southern lots adjacent to the site.

- In July 2015 three additional monitoring bores (W1 - W3) were been installed exclusively for this LWMS/UWMP in the site

Groundwater level monitoring from 2010 - 2011 has been used to determine the Maximum Groundwater Levels (MGL) and Average Annual Maximum Groundwater Levels (AAMGL) for the site as it contains two annual groundwater peaks. The ground water levels recorded between September to October 2011 for this monitoring program represent a year with above average rainfall (BoM, 2015). The estimated pre-development AAMGL and MGL is summarised in Table 3.2 below.

Table 3.2 Estimated Pre-development AAMGL and MGL

Monitoring Program	2010 - 2011							August - March2015		
Site ID	MW1-E	MW2-E	MW3-E	MW4-E	MW5-E	MW6-E (old)	MW6-E (new)	W1	W2	W3
AAMGL (mAHD)	6.515	4.11	NA*	4.11	4.00	4.69	4.625	-	-	-
MGL (mAHD)	6.59	4.20	NA*	4.14	4.04	4.84	4.64	6.82	5.67	4.99#

*Bore MW3-E is dry and has no groundwater level data recorded

Groundwater level at surface

At the South Western boundary of the site the groundwater level is approximately 4.1m AHD, which is approximately the existing ground level in the Bollard Bullrush swamp adjacent to the PMD. Moving away from the PMD, ground water mounding is apparent as a result of the inclined topography, with groundwater levels at the Western end of the development area at approximately 5m AHD. The groundwater level adjacent to Tamblyn Place (the high point of the site) is approximately 6.8 m AHD.

A preliminary analysis of the groundwater quality at the site to date is included in the table below. It should be noted that the guideline values referred to in the following points are the guidelines given in the Australian and New Zealand guidelines for freshwater quality ANZECC (2000). These guidelines are for application on un-modified or slightly modified ecosystems and do not readily apply to stormwater management. They are reference guidelines only and while they may indicate areas where further investigation is warranted, they should be taken in the contact of the JDWMP which is specific to this area.

- As expected given the historical use of the site, groundwater is nutrient enriched. This is the primary water quality issue that requires management. Elevated nutrient loads pose a risk to the ecological health of receiving environments immediately surrounding the site as well as lower in the Serpentine River and Peel-Harvey Estuary.
- Median concentration of phosphorous are significantly higher than relevant guideline values.
- Median concentrations of TN, oxidised nitrogen and ammonium nitrogen are higher than relevant guideline values.

Table 3.3 Average Pre-Development Groundwater Quality

Field data, Nutrients and Pesticides	Monitoring Period	EC (field)	pH (Field)	TDS	Nitrogen (Total)	Nitrogen (Total Oxidised)	Ammonia as N	Phosphorus (Total)	Reactive Phosphorus as P	Disolved Oxygen	Redox
Units		uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mV
MW1-E	2010-2011	762.5	7.55		3.2	0.99	0.05	1.02	0.21		
MW2-E	2010-2011	1144	7.54		2.07	0.27	0.41	0.4	0.02		
MW4-E	2010-2011	927	7.76		3.86	0.24	0.68	0.23	0.02		
MW5-E	2010-2011	1605	7.49		4.59	0.15	0.47	0.25	0.02		
MW6-E	2010-2011	2082	6.97		8.13	1.6	0.37	0.39	0.02		
MW6	2010-2011	1840	7.24		7.52	1.74	0.29	0.31	0.03		
W1	July 15 – March 16	324.18	6.08	196.39						0.52	3.34
W2	July 15 – March 16	283.30	5.60	182.82						0.13	-28.94
W3	July 15 – March 16	240.36	5.41	157.61						0.13	-11.84
ANZECC Lowland River Guidline Values		120-300	6.5-8		1.20	0.15	0.08	0.065	0.04		

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3.7 Flora and Fauna

A Flora and Vegetation Assessment was undertaken in 2010 by ENV as part of the assessment for the MRS Amendment 1188/57. The Assessment found that within Lot 502 the majority of the site was in a Completely Degraded condition and that no threatened or Priority species, nor Threatened or Priority Ecological Communities were recorded.

No Bush forever sites are located within the Development area. The closest bush forever site is located approximately 1 km south of the site.

3.8 Aboriginal Heritage

A search of the department of Aboriginal Affairs (DAA) Aboriginal Heritage Inquiry System was undertaken on the 24 September 2015 and no matches were recorded for the site. Coupled with the highly-modified nature of the site (primarily used for grazing and horses) it is considered a low risk that aboriginal artefacts would be identified/unearthed within the site during the development process.

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4 Storm Water Management

4.1 Flood Management

Stormwater discharge from Lot 502 Tamblyn place is intended to discharge to the Bollard Bullrush swamp, discharging in turn to the PMD. The land surrounding the Bollard Bullrush swamp is not highlighted for development within the JDWMP (DoW 2009) therefore no storage requirements within the swamp are detailed.

Post development hydraulic modelling of the floodplain was undertaken by GHD as part of the DWMS to assess the impact of developing within the wetland defined in the JDWMP (DoW 2009). A summary of the GHD flood modelling is provided in Appendix D

A comparison of the Pre and Post-development top water levels from the JDWMP and GHD modelling for the extent of the PMD within the bollard Bullrush swamp is shown in Table 4.1 below.

Table 4.1: PMD Pre vs. Post-Development Peak Top Water Levels

Location	JDWMP Pre-development Peak Top Water Level		Post-development Peak Top Water Level	
	10 Year ARI Peak Top Water Level (mAHD)	100 Year ARI Peak Top Water Level (mAHD)	10 Year ARI Peak Top Water Level (mAHD)	100 Year ARI Peak Top Water Level (mAHD)
Peel Main Drain at Bertram Road	7.90	8.20	7.90	8.20
Bollard Bullrush Swamp	4.82	5.61	4.82	5.62
Peel Main Drain at Millar Road	4.70	5.59	4.70	5.59

The post development flood modelling results show that there is a negligible increase in the pre-development top water level in the PMD, particularly in the extent of the PMD adjacent to the site (Bollard Bullrush Swamp).

Minimum habitable floor levels will be set with a minimum freeboard to the 100 year flood level of 500mm, giving a recommended minimum lot level of 6.12m AHD. The finished lot levels across the site are illustrated in Figure 5.1

4.2 Subdivisional Stormwater Management

The surface water objectives for the proposed development are achieved by implementing the following:

- Implement WSUD and structural BMP treatment trains for pre-treatment of stormwater prior to discharge to Bollard Bullrush swamp.
- Flows for events up to 2 year ARI will be treated through roadside bioinfiltration swales/rain gardens at source.
- Events greater than the critical 2 year ARI should be directed towards the POS via gutter flow within the road towards the POS. Flows across the POS should occur as sheet flow across a vegetated surface towards the wetland buffer, replicating pre-development surface flow regimes.
- The 100 year ARI event overland flows will be directed to the Bollard Bullrush Swamp.

- No stormwater infrastructure will be located within the CCW/RE wetlands or buffers.
- The minimum habitable lot level is 6.12mAHD, which is 500mm above the 100 year ARI top water level of the Peel Main Drain adjacent to the site.
- No direct groundwater control measures (ie subsoil drains) are to be implemented to create a controlled groundwater level.

These strategies will be achieved by implementing the following items in the detailed design.

4.2.1 Lot Runoff

No drainage connections will be provided to convey runoff from roofs to pit and pipe systems. As the proposed lots are greater than 300 meters square, impervious areas such as driveways, roofs and paving will be connected to soakwells to detain up to the 1 in 20 year ARI event as per City of Kwinana requirements. This system is achievable due to the adequate separation to the groundwater table and the hydraulic conductivity of the underlying Bassendean sand.

Soakwells are to be provided by property owners or builders to detain flows at the lot level as part of the development application process

4.2.2 Stormwater Drainage Design

The proposed stormwater drainage strategy for the site follows WSUD principles to promote infiltration of stormwater at source and eliminate the need for a pit and pipe network. Roadside rain gardens have been proposed to fulfil the above requirements in addition to providing aesthetic amenity to the development.

Flows < 2 Year ARI Event

Runoff from events up to the critical 2 year ARI (6 hour) will be conveyed through kerb breaks into the raingarden, which serves to detain and infiltrate the first flush of stormwater though a layer of bio-media. Runoff from the road adjacent to the POS will be conveyed via sheet flow to a roadside bioremediation swale (using flush kerbing) running the length of the POS. These areas are designed to capture and infiltrate the 2 year ARI storm event and provide treatment/bioinfiltration to runoff.

A key part of the design is the reduction of turbulence to achieve greater settling out of particulates within the rain garden. The base of the raingardens are filled to a depth of 850mm with aggregate to trap particulates within the voids and separate rubbish at the surface for easy disposal. The aggregate also limits the possible trip height and ensures that when full of water does not pose a drowning hazard for small children.

The 2 year ARI water levels and required basin areas and volumes are shown in Figure 4.1. The Rain gardens have been sized to accommodate 2 year ARI event volume and a minimum 300mm clearance between the invert of the garden and the MGL is achieved.

Rain gardens have been located at all low points and on the upstream side of intersections to limit the appropriate gutter flow spread rates to 1.5m (for a 2-way cross fall) in accordance IPWEA guidelines

Details of the rain gardens are shown in Figure 4.2.

Flows > 2 Year ARI Event

Flows in excess of the critical 2 year ARI event are conveyed via gutter flows in the road reserve towards the POS. Flows across the POS should occur as sheet flow across a vegetated surface towards the wetland buffer,

replicating pre-development surface flow regimes. Gutter flow widths for flows in excess of the 2 year ARI will exceed 1.5m for high intensity short duration storm events.

Flows >100 Year ARI Event

The roads have been graded to convey flows from the 100 year ARI towards the Bollard Bullrush swamp. As per Section 4.1 lot levels have been provided a 500mm freeboard to the 100 year top water level.

Surrounding Lands: Tamblyn Place

For events less than the 5 year ARI, stormwater from the Tamblyn Place road catchment will be captured and treated external to lot 502, as part of the adjacent development to Lots 900, 503 & 502 Tamblyn place.

Flows in excess of the 5 year ARI from the Tamblyn Place road catchment will be permitted to overland flow through Lot 502 via the road reserve towards the Bollard Bulrush Swamp. The proposed subdivisional roads within Lot 502 grade uniformly from Tamblyn place to the Bollard Bullrush swamp with no trapped low points. This allows the conveyance of external flows without loss of service to infrastructure and property within Lot 502.

4.3 Hydrologic and Hydraulic modelling

4.3.1 XP Storm Modelling

Hydrologic and hydraulic modelling has been undertaken to determine peak flow rates and detention requirements of the stormwater drainage system.

Hydrologic and hydraulic modelling was carried out using XP-Storm software. XP-Storm is a drainage design package capable of carrying out both hydrologic and hydraulic modelling of urban and rural catchments. It consists of a link-node model, with the conduit system being idealised as a series of links or conduits which are connected at nodes or junctions. Links and nodes have well defined properties which, when taken together, permit representation of the entire drainage network.

The hydrologic module is based on the XP-RAFTS package by XP Software and carries out runoff analysis. This module generates surface runoff hydrographs, which interface directly with the hydraulic module. The hydraulic module is based on the XP-EXTRAN software package and carries out dynamic hydraulic routing as determined by the physical parameters of the drainage network.

4.3.2 Hydrologic Modelling

4.3.2.1 Subcatchment Area and Land Uses

Post development subcatchment boundaries for the detailed design of the subdivisional stormwater drainage system are shown in Figure 4.1.

4.3.2.2 Rainfall

Hydrologic modelling was undertaken using Intensity Frequency Duration (IFD) data from the Bureau of Meteorology database with the design storms used for the analysis presented in Table 4.1 below.

Table 4.1: Wellard Rainfall Data

ARI (years)	Rainfall (mm) Duration (hours)									
	15min	30min	1hr	2hr	6 hr	12 hr	24 hr	36 hr	48 hr	72 hr
1			17.12							
2	11.76	15.87	20.47	26.24	38.16	48.48	62.16	71.28	77.76	86.40
5	15.80	21.03	26.70	35.18	53.12	69.96	92.16	106.92	118.08	115.92
100			47.41		89.05	119.52	152.04	178.91	198.2	227.55

4.3.2.3 Runoff Generation

Table 4.2 presents the directly connected impervious portions of the various land use zones that were assumed for the modelling.

Table 4.2: Post-development land use impervious area assumptions

Land use type	Impervious portion (%)	Pervious portion (%)
POS/Conservation	0	100
Road Reserve	80	20
Residential Lots 5Yr	No Runoff	No Runoff
Residential Lots 100Yr	28	72

From the geotechnical analysis completed and from ground water monitoring undertaken, conditions are favourable for the infiltration of roof runoff to soakwells given the presence of well-draining sand and sufficient separation between predevelopment maximum groundwater levels and proposed pad levels. Thus it was assumed in the modelling that soakwells within lots will directly infiltrate runoff generated from residential lots.

The initial losses and fixed runoff coefficients applied to the pervious and impervious areas are presented in Table 4.3.

Table 4.3: Loss model assumptions

Land use type	Initial loss (mm)	Fixed Runoff Coefficient
Impervious	1.5	1
Pervious	0	0
Residential Lot Pervious	0	0.2
Residential Lot Impervious	15	1

4.3.2.4 Roughness Coefficients

The Manning's 'n' roughness coefficients used for the study were:

- 0.015 for road surfaces.
- 0.025 for all pervious surfaces

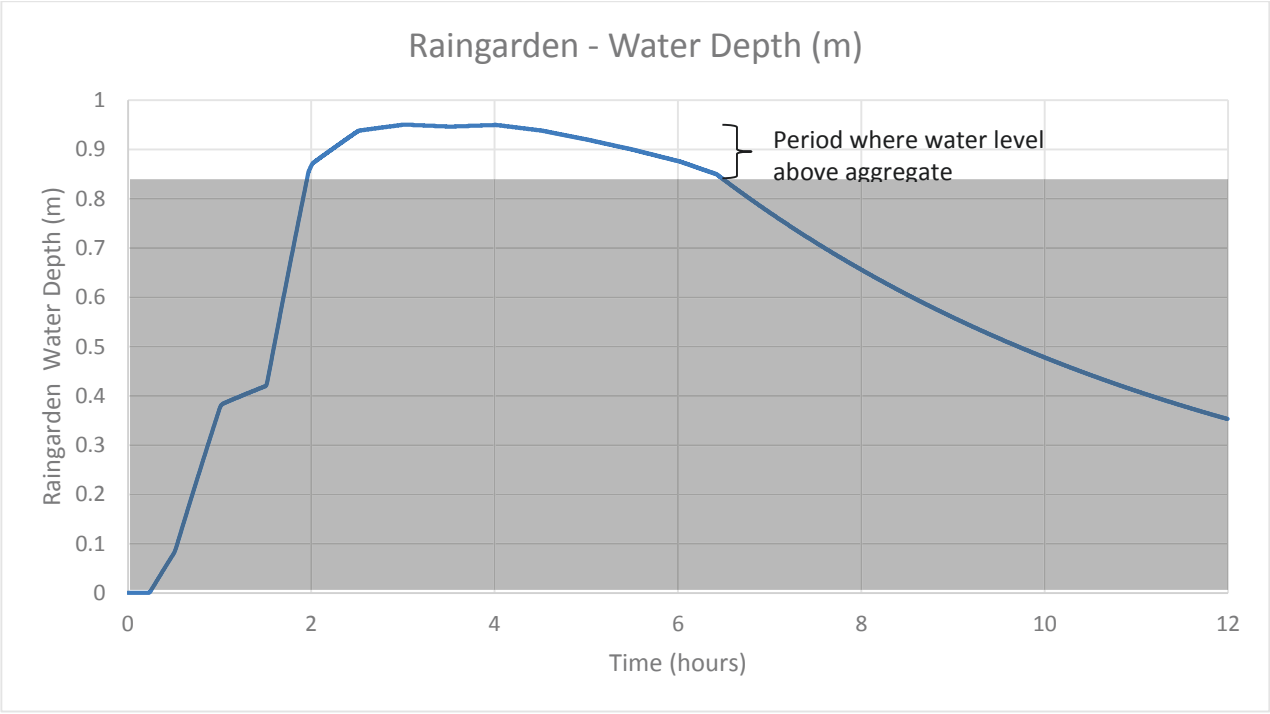
4.3.2.5 Infiltration Rates

PCSump (clogged model) was used to determine infiltration curves. Permeability values within bio retention areas (e.g. raingardens and swales) were taken to have a 100mm thick clogged layer with a permeability of 0.15m/day to account for the clogging of the bio filtration media between maintenance intervals. The permeability of the underlying sands were taken as 10m/day as per the CMW infiltration recommendations in Appendix B.

4.3.3 Modelling Results

Stormwater modelling indicates that the roadside raingardens and swale have sufficient volume available in order to adequately treat and attenuate flows for storm events up to the 2 year ARI storm event emanating from the catchments, refer to Figure 4.1 for details.

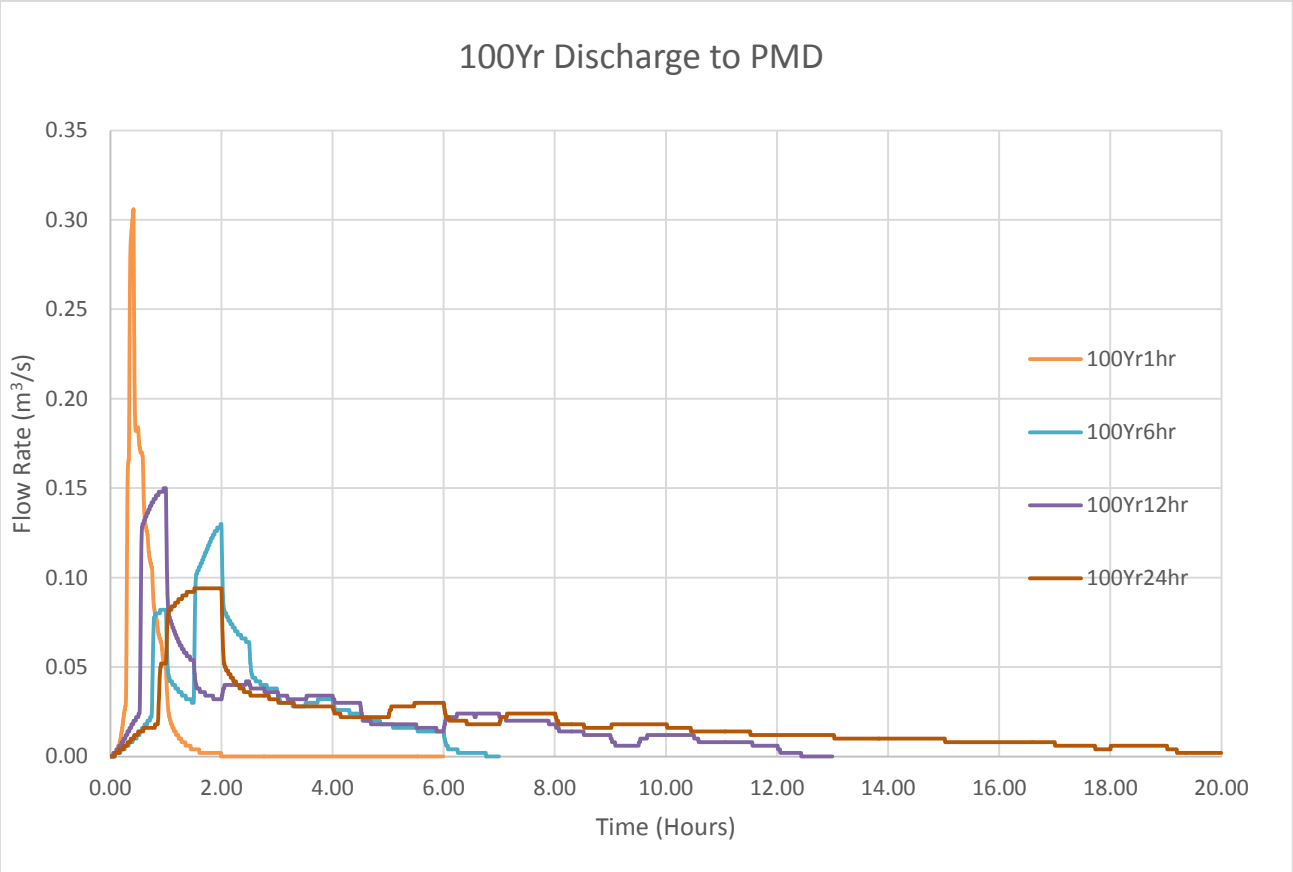
Analysis has been conducted in time to empty for the raingardens. In accordance with the infiltration modelling for a clogged scenario the exposed water above the aggregate layer drains in less than 4 hours, refer to Graph 4.1 below.



Graph 4.1 - Raingardens - Time to Empty

Analysis of 100 year ARI Discharge to the PMD has been calculated in accordance with the JDWMP (DoW 2009) and the GHD Flood Modelling Summary in Appendix A. The peak flood discharge leaving the site into

the PMD is 0.3m³/s for the 100 year 1 hour storm event. For events with a duration greater than 2 hours the peak discharge drops to 0.1 m³/s. Refer to Graph 4.2 for the critical 100 year ARI discharge to the PMD



Graph 4.2 –100 Yr ARI Discharge to PMD

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5 Groundwater Management

5.1 Groundwater Levels

Groundwater contours based on local and regional data are presented in Figure 3.6.

5.1.1 Subsoil Drains

The site has sufficient clearance to groundwater and as such no subsoil drainage will be utilised.

5.1.2 Earthworks levels

There is sufficient structural fill material to achieve a Class A footing in accordance with AS2870. Filling of the site however will be required to provide sufficient freeboard to the 100 year flood level. Preliminary finished earthworks levels based on minimum clearance to the 100 year flood level and preliminary road levels are shown in Figure 5.1.

6 Water Quality Management

6.1 Surface water quality

The design objective for surface water quality is to achieve the following theoretical nutrient reduction targets, as compared with development that does not actively manage water quality:

- at least 80 percent reduction of Total Suspended Solids (TSS)
- at least 60 percent reduction of Total Phosphorus (TP)
- at least 45 percent reduction of Total Nitrogen (TN)
- at least 70 percent reduction of Gross Pollutants (GP)

The methodology established in the *Stormwater management manual for Western Australia* (DoW, 2007) recommends that the above targets are achieved though adopting a treatment train approach including:

- on-site retention of 1-year-1-hour average recurrence interval event
- non-structural measures to reduce applied nutrient loads.

Bioinfiltration systems as proposed are in excess of these requirements.

6.2 Groundwater Quality

The design objective for groundwater quality is to achieve the following theoretical nutrient targets as compared with a development that does not actively manage water quality:

- at least 60% reduction of Total Phosphorous (TP)
- at least 45% reduction of Total Nitrogen (TN)

Subsoil drains at the proposed development form part of the drainage network and provide in-transit exfiltration for stormwater. The storm events that enter the subsoil drains will have had the first flush intercepted by the rain garden bioinfiltration area and any further sediment trapped in the base of the connecting bypass pit

To further improve groundwater quality information packages will be provided by the developer to individual lot owners recommending the use of loamy topsoil to increase the efficiency of fertilisers and retain a proportion of phosphorous that would otherwise have percolated through the Bassendean sands and into the groundwater.

6.2.1 Treatment of Infiltrated Water

Where stormwater is collected from directly connected impervious areas, it is directed to roadside rain gardens or a bioinfiltration swale. These structures are sized to accommodate flows from a 2 year ARI storm event, and can therefore be expected to contain the vast majority (over 99%) of stormwater, including the first flush of any larger storms. Raingardens and Indicative POS infiltration areas are shown in Figure 4.1.

6.2.1.1 Biofilter Media

Bioinfiltration areas should be lined with a minimum of 300mm of biofilter media. This media should be a limestone derived sand, or sand and crushed limestone mix in a ratio of 65:35 (sand to limestone). Limestone acts as a buffer and alkaliser of acid sulphate soils lowering the pH. Note that limestone must be tested for phosphorus content and should have PRI > 80.

This media shall be placed in a single lift, and compacted by hand in a single pass – heavy compaction or multiple passes must not be used.

6.2.1.2 Bioinfiltration Area Planting

Plants selected for use in the bioinfiltration areas will be required to be suitable for periodic inundation but also able to survive dry periods without irrigation. Due to the course aggregate in the raingardens, drought tolerance is a higher priority than tolerance to inundation, hence plant species should be selected primarily for this feature, as irrigation will not occur after establishment. The selected plants should be good at stripping nutrients and easy to maintain. Aesthetically, the planting should deter the public from entering the area, so plants should not be smaller than 10cm, and features like prickly leaves are desirable. Department of Water recommend planting a variety of species to maximise the chances of success. The City of Kwinana's Parks department should be consulted for their most recent recommendations.

6.3 Wetland and Waterway Protection

The stormwater receiving environments are the CCW and RE wetlands (shown in Figure 3.5) and the Peel-Harvey estuary downstream of the PMD. Protection of these environments involves managing the post-development nutrient levels and the export of pollutants offsite.

As part of the MRS amendment 1188/57 a 50m wetland buffer has been implemented to protect the integrity of the wetland core as indicated by the EPA report 1500 (WAPC 2014). The buffer helps to provide protection from hydrological changes as a result of development and minimises the potential for migration of non-native species from adjoining landscaped areas. No drainage infrastructure is to be located within the wetland buffer nor piped drainage directly connected to the buffer or wetland.

Surface water and runoff from regular storm events (up to 2 year 6 hour ARI), will be treated at source in bioinfiltration systems to ensure water quality objectives are met. This will protect water quality in the Bollard Bullrush swamp and the PMD.

Stormwater runoff from major events that exceed the capacity of the bioinfiltration areas (rain gardens and swale) will be directed via the slotted drainage network and overflow into the POS. The stormwater discharge

into the POS will be conveyed via sheet flow over a vegetated surface towards the wetland to replicate the predevelopment surface flows.

A Wetland Management Plan (WMP) will be required to specify the exact requirements to protect the wetland such as fencing, weed management and rehabilitation. The WMP will be prepared as a condition to subdivision and outline the interface treatments and management strategies adjacent to the wetland and identify parties responsible for the management of these areas.

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7 Water Conservation

The *State Water Strategy* (Government of Western Australia, 2003) target for scheme water usage was to achieve a reduction from 180 KL/person/year to 155 KL/person/year. As this target has been achieved in recent years, the more recent *State Water Plan* (Government of Western Australia, 2007) set a water consumption target of 100kL/person/year.

Further to this target, an aspirational consumption target of 40-60kL of scheme water per person per year has been set for new developments. In order to achieve this target, all outdoor water use would need to be supplied by non-potable sources.

7.1 Domestic Water Use

Using the Water Corporations Water Supply Consumption Tool (Excel-based spreadsheet), a preliminary estimate of the development potable water consumption was made. The potable water consumption is expected to be approximately 62 KL/person/year, which is within the State Water Plan consumption target. This assumes that no groundwater is used for irrigation of residential areas and that rainwater tanks are not installed in lots for either irrigation or in-house (non-drinking) use.

The installation of rainwater tanks, while encouraged by the developer, will not be mandatory. However if individual lot owners install rainwater tanks, potable water consumption is estimated to reduce to 57 KL/person/year.

The Water Corporation's Water Supply consumption tools is included in Appendix E, showing scheme water consumption patterns if rainwater tanks are not installed.

7.2 Public Open Space

Public Open Space (POS) will be irrigated using groundwater. The POS at Lot 502 is approximately 1.04 ha of which 0.74 ha is wetland buffer and 0.30 ha is unrestricted POS. It is estimated that around 50% of the unrestricted POS will be used for turf and irrigated at a rate of 7500 KL/ha/year, with the remaining 50% used for native[1] (or other water wise) garden beds and irrigated at 5000 KL/ha/yr. The wetland buffer will be planted with indigenous species which will not be irrigated beyond the establishment phase.

Bore abstraction will follow the requirements set out in the City of Kwinana's Sustainable Water Management Plan as; ultimately, the POS will be ceded to council and will form part of their requirement under these documents. Specifically the following will be undertaken:

- Metering of all production bores,
- Hydrozoning: 1) grouping plants of similar water requirements to conserve water, 2) designing the irrigation system for these plant species,
- Soil moisture sensors within all POS and within changes in landscape (hydrozone). The length of watering required will be determined based on the information collected from soil moisture sensors within each hydrozone,
- Define watering program based on the amount of water able to be abstracted,

[1] This refers to planted waterwise gardens as opposed to retained indigenous vegetation, which will not be irrigated beyond the establishment phase.

- Planting appropriate trees that require minimal water,
- Watering outside the hours of 9am-6pm (excluding the establishment of vegetation; inspection testing and maintenance; and watering in of fertilizer or pesticides),
- Winter sprinkler ban between 1 June and 31 August. During this time irrigation will only be used for turf maintenance (fertilizing, weed/pest control, verti-mowing) and installation, repair, testing and maintenance of irrigation system.

It is also envisaged that heavy water use (twice daily outside 9am-6pm) will be required within the first 28 days of POS establishment.

7.3 Irrigation Source

The site is located in the Jandakot Mound 2 sub-area of the Serpentine Groundwater Management Area. There is currently no existing groundwater licence for Lot 502, but a review of the DoW Water Register indicates that there is water availability for the Superficial Swan aquifer. PDC has lodged a Form 1 and Form 3G (September 2015) requesting a groundwater licence with an allocation of 2273 KL/year which would make sufficient provision for the water supply needs of the developments POS.

If the application for groundwater for Lot 502 is unsuccessful, there is the option to source groundwater from the existing groundwater licence (Licence No. GWL159291) of the adjacent Lots 503, 504, 505, 507 and 900 which have an allocation volume of 19695KL/year. If Lot 502 is unable to source groundwater though an addendum to the adjacent lots groundwater licence then xeriscaping will be implemented within the POS.

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8 Management of Subdivision Works

The issues that will require management in order to ensure the construction activities will not detrimentally impact on the environment are:

- Management of dust
- Dewatering
- Acid sulphate soils
- Sediment control

8.1 Dust Management

The Department of Environment and Conservation (DEC) current guideline regarding the management of dust is *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities* (DEC, 2011). This document provides guidelines for dust management provisions, contingency arrangement and monitoring requirements for dust producing activities.

The City of Kwinana's Standard Conditions of Planning Approval 2012 also require that dust control measures be put in place prior to any works being undertaken.

8.1.1 Site Specific Implications

The DEC guidelines recommend the completion of dust generating activities during winter to minimise the risk of dust generation. However the completion of earthworks outside of winter months may not necessarily feasible, due to the level of the groundwater table.

The requirement to minimise dewatering to manage potential acid sulphate soils together with the cost of dewatering outweighs the additional effort required to mitigate the dust resulting from construction activities during summer. As a result, it is recommended that there be no restrictions to earthworks being undertaken during summer months.

8.2 Dewatering and Acid Sulphate Soils

Dewatering is likely to be required in some areas to enable subdivision works to proceed (predominantly sewer installation). It will be necessary for dewatering licences to be obtained from the DoW prior to dewatering works to proceed.

There is a potential for works requiring dewatering and/or excavation of soils below the groundwater tables to cause acid generation in areas where acid sulphate soils are present.

As highlighted in Section 3.4 disturbance of any insitu material exceeding 100m^3 of soil below the water table or dewatering during the earthworks and civil construction will require an ASSDMP to be submitted to the DER prior to any works earthworks being carried out.

8.3 Sediment Control

In order to prevent excess sediment accumulating in the raingardens during housing construction, sediment management devices are required to protect the raingardens. Kerb inlet silt traps (an aggregate filled geotextile sock) shall be place at the entrance of the raingarden to stop sediments being washed off the road during

rainfall events. A geotextile sediment fence erected around the boundary of the raingardens will minimise eroded or windblown sand from Lots under construction entering the raingarden whilst visually delineating the raingardens from the rest of the verge.

In keeping with the City of Kwinana Sustainable Water Management Plan (2013) the implementation of a sediment compliance and education program for builders in areas of new construction is recommended in order to reduce the export of sediment and pollutants into the stormwater system and smothering of vegetation.

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9 Monitoring Program

The basis for the post-development water quality monitoring program is outlined in the JDWMP (DoW 2009) and the *Water Quality Improvement Plan for Rivers and Estuary of the Peel Harvey System* (WQIP) (EPA, 2008). In addition, Water quality results will be compared against the ANZECC & ARMCANZ (2000) Freshwater guidelines for slightly-moderately disturbed wetlands in south-west Australia.

As outlined in Table 9.2 of the JDWMP the developer shall have responsibility for the monitoring program for a period of 5 years post development, including at least 1 year following the completion of 80% of the development. This shall include but is not limited to:

- Monitor key criteria for maintenance of hydrologic regimes, buffers and ecological corridors/linkages of environmental assets
- Monitor local superficial aquifer groundwater levels
- Monitor flow and water quality (including nutrients, total suspended solids, and gross pollutants) at regular intervals
- Monitor peak flows within developments and wetlands
- Monitor performance of new drainage structures

Hence, the duties outlined within the JDWMP and WQIP documents for the first 5 years post development are the responsibility of the developer. After 5 years, the responsibility for monitoring is borne by the City of Kwinana, through the Development contribution Scheme No.3.

The recording of monitoring results as well as any exceedances and actions taken will be required for the comparison of post and pre-development data for reporting to the City of Kwinana and DoW at the end of the 5 year program. The report will provide details on the effects the development had on the hydrological conditions and propose necessary contingency actions if required.

9.1 Surface water monitoring

There is no surface water within Lot 502 Tamblyn Place and as such there will be no requirement to complete post development monitoring.

The PMD is a Water Corporation Drain and lies outside of Lot 502. Monitoring of the PMD is thus the responsibility of the Water Corporation, with collected data to be passed onto the DoW.

9.2 Groundwater Monitoring

Ongoing water monitoring will be required during construction, as a condition of the dewatering licence and ASS management of the site. This will take place in the vicinity of service installation works during and after dewatering activities.

Ongoing construction phase and post-development water monitoring will be undertaken to ensure the baseline conditions have not worsened due to development of the site and to maintain continuity between the pre and post-development results.

Groundwater monitoring locations in the site will be those identified in Figure 3.6. Should development works destroy the existing locations, replacement bores will be installed to aim to replicate the predevelopment monitoring locations.

Groundwater levels are to be measure monthly for the first 5 years with sampling occurring quarterly for that period. This is the responsibility of the developer. Thereafter it is the responsibility of the City of Kwinana to conduct measurements and sampling.

9.3 BMP Monitoring

Various Best Management Practices (BMPs) are proposed within the development to minimise stormwater pollutant loads, groundwater pollution, pollution to adjoining wetlands and variations in hydrology. Some of these are structural (e.g. raingardens, roadside swales etc.) while others are non-structural (eg. Education of fertiliser use, xeriscaping etc.). Chapter 10 of the Stormwater Management Manual for Western Australia provides advice on the performance of monitoring such BMPs (Dow, 2007)

Monitoring in the form of inspections by the Developers' representative (i.e. civil engineering consultant) and the City of Kwinana are recommended to ensure that BMP designs are fully implemented in accordance with the approved drawings and UWMP. Such inspections could occur during construction and upon completion of each stage of development and at handover of the POS/infrastructure after initial bedding down and maintenance period by the developer. Following the completion of the development and handover of the POS/infrastructure, the City of Kwinana is required to monitor performance of the BMPs from 3 years post development.

9.4 Contingency Procedures

If post development monitoring finds that water quality related objectives are not being met, the following procedures would be undertaken by the developer:

- Immediately sample the groundwater to confirm that the exceedance is not a result of mishandling or contamination.
- Determine whether the exceedance is attributed to the development or regional factors.
- Inform the City of Kwinana.

After the above procedure has been completed, the following contingency actions in consultation with the City of Kwinana and DoW will be undertaken:

- Ensure that the development has fully complied with development conditions relating to water quality management (i.e. installation and operation of BMPs). If such BMPs have not been design and installed as approved, then the developer would do so or council would be entitled to take regulatory action for a breach of development conditions.
- Investigate opportunities to apply additional BMPs to the study area (e.g. education programs, street sweeping nutrient management plans, alteration of maintenance procedures, soil amendment, local rainwater tank scheme etc.). Funding for such additional measures may require extraneous finding and further liaison with state government and relevant agencies.
- The DoW would be advised and recommended to review their calibration of water modelling and their advice in respect to subsequent or similar development proposals.

10 Roles and responsibilities

Table 7.1: Roles, responsibilities and funding for water management strategies

Organisation	Role	Funding
Developer	Satisfies relevant WAPC conditions including preparation of UWMP. Undertakes pre-development groundwater monitoring. Designs and constructs the potable water supply and sewer supply to Water Corporation standards. Designs, constructs and maintains (maintenance period to be negotiated between the Developer and the LGA) public open spaces. Undertakes post-development monitoring activities for submission to regulatory authorities. Carries out construction and management consistent with UWMP. Promote Water-wise appliances and fittings in Display Homes and through the Design Essentials package (details still in development). Collect and manage all monitoring data.	Developer
LGA	Review and approval of all reporting and design documentation for subdivision.	Developer
LGA	Assumes responsibility for roads and stormwater drainage infrastructure constructed including the ongoing operations and maintenance. Maintains the public open space (including irrigation) at the completion of the developer's maintenance period. Takes over groundwater license for POS irrigation and either complies with or amends Basic Operating Strategy to the satisfaction of the Department of Water.	Rates
Water Corporation	Assumes responsibility for the potable water supply and sewerage infrastructure constructed including the ongoing operations and maintenance.	Rates
Land Owner	Responsible for meeting all requirements of the relevant local authority and building codes during the built form phase (including construction and maintenance of soakwells for onsite stormwater disposal). Compliance with Water Corporation's waterwise program.	Land Owner

11 Appendices

Appendix A – Figures

Appendix B – Geotechnical Investigation Report

Appendix C – Ground Water Monitoring Data

Appendix D – GHD Flood Modelling Summary (GHD 2010)

Appendix E – Water Supply Consumption Tool

Appendix F – Landscaping Concept Plan

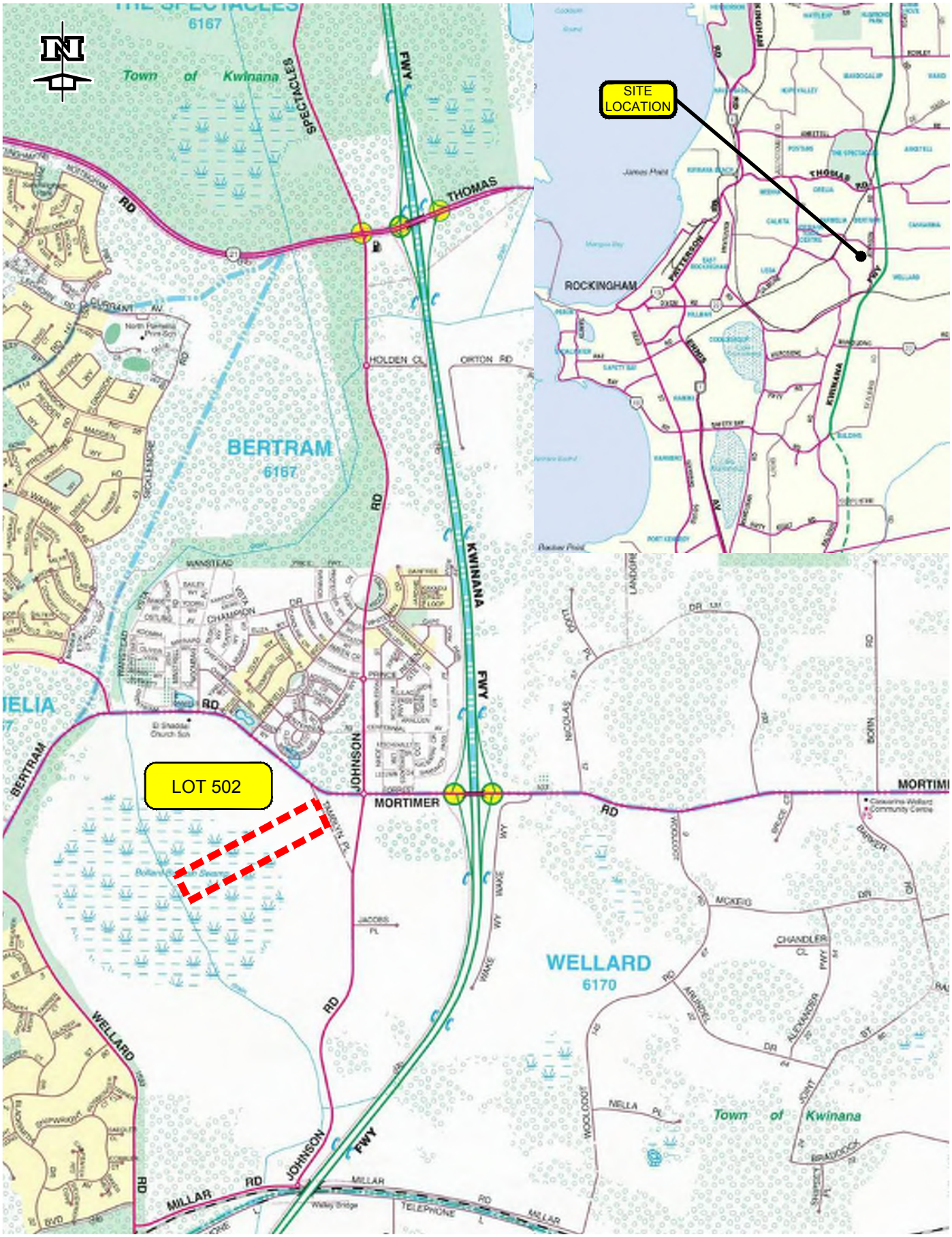
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Combined LWMS and UWMP
Lot 502 Tamblyn Place - Wellard

Appendix

A

Figures



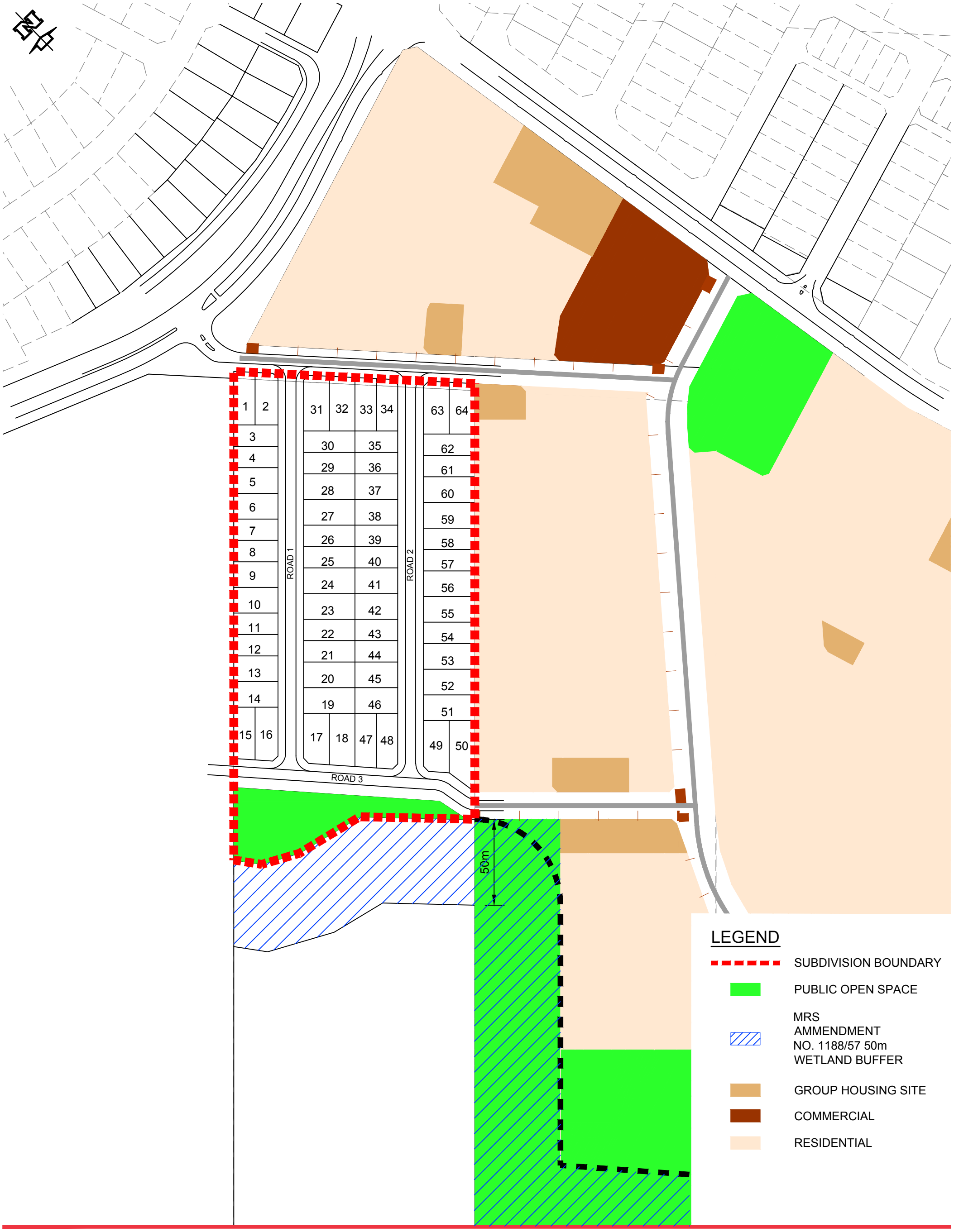
CLIENT ASCARI DEVELOPMENTS
DATE 20/08/15
DRAWN M.PERKINS
CHECKED M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD
LOCALITY PLAN
FIGURE 1.1
REVISON A

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CLIENT	ASCARI DEVELOPMENTS
DATE	20/08/15
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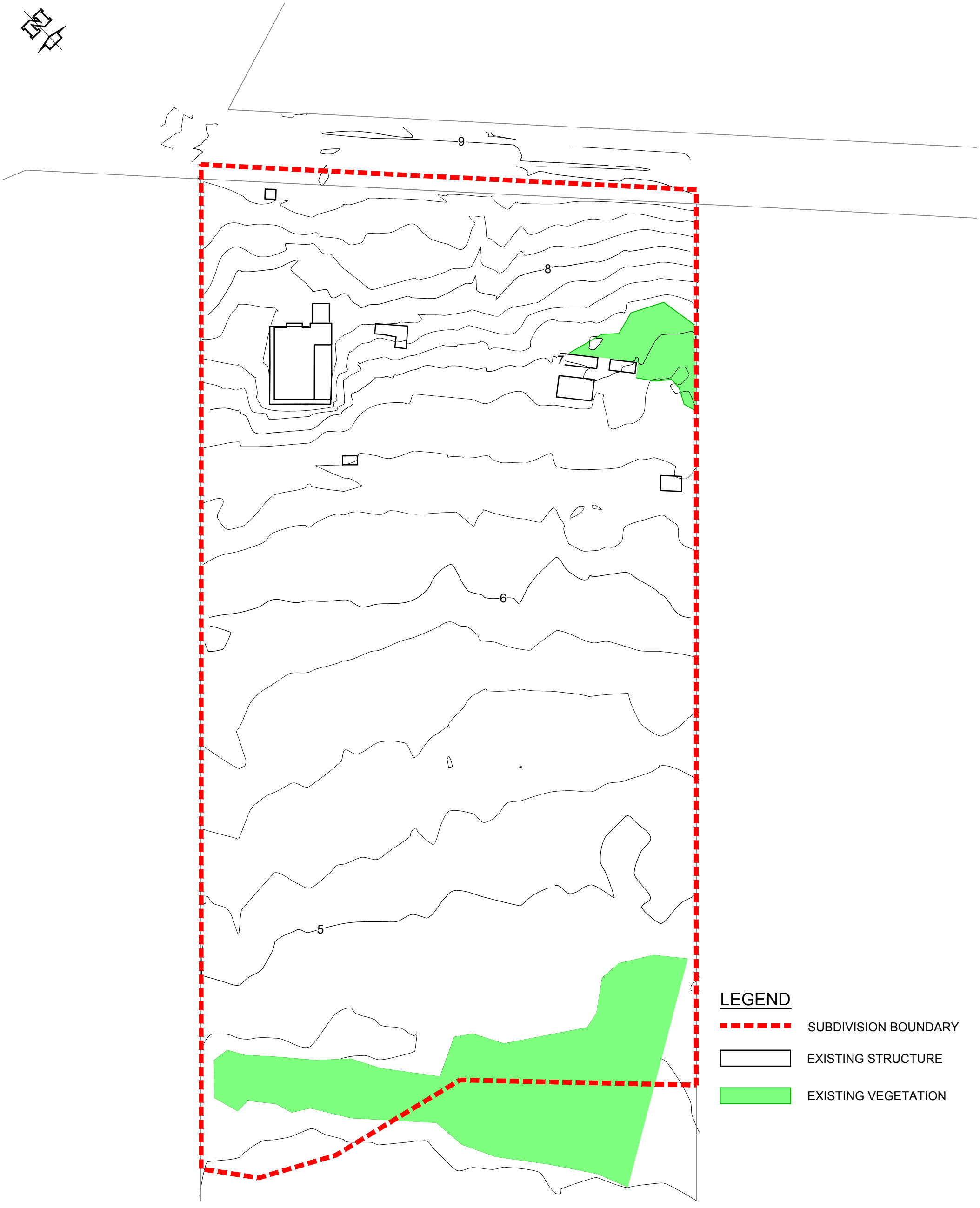
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LOT 502 TAMBLYN PLACE WELLARD
LOCAL STRUCTURE PLAN
FIGURE 1.2
REVISION A

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CLIENT	ASCARI DEVELOPMENTS
DATE	20/08/15
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CHECKED	M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD

TOPOGRAPHY AND EXISTING LAND USE

FIGURE 3.1

REVISION A

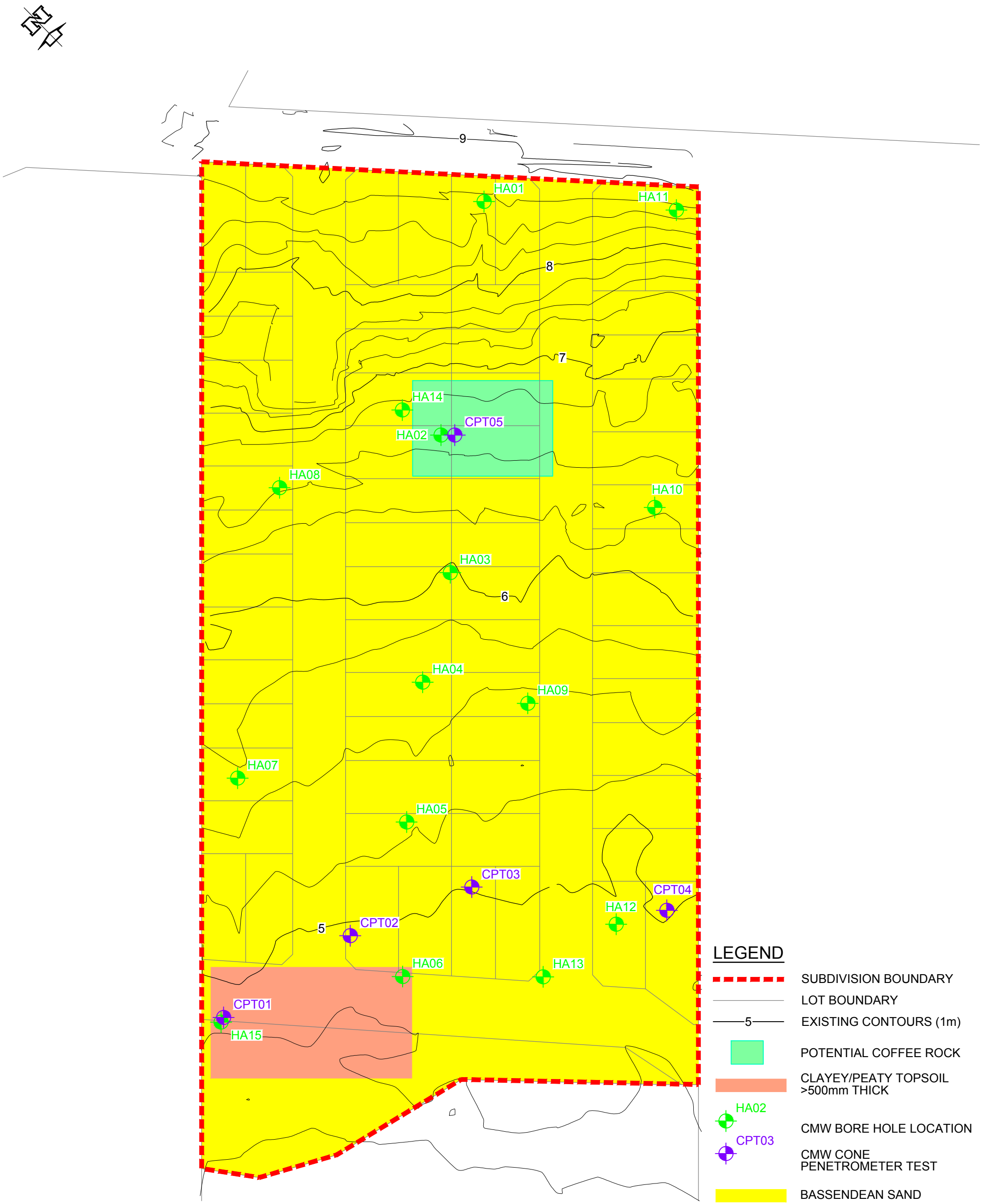
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NOTE:
REFER TO APPENDIX B FOR BORE HOLES, CONE PENETROMETER TESTS AND PERMEABILITY TESTS.

CLIENT	ASCARI DEVELOPMENTS
DATE	20/08/15
DRAWN	M.PERKINS
CHECKED	M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD

GEOTECHNICAL FEATURES

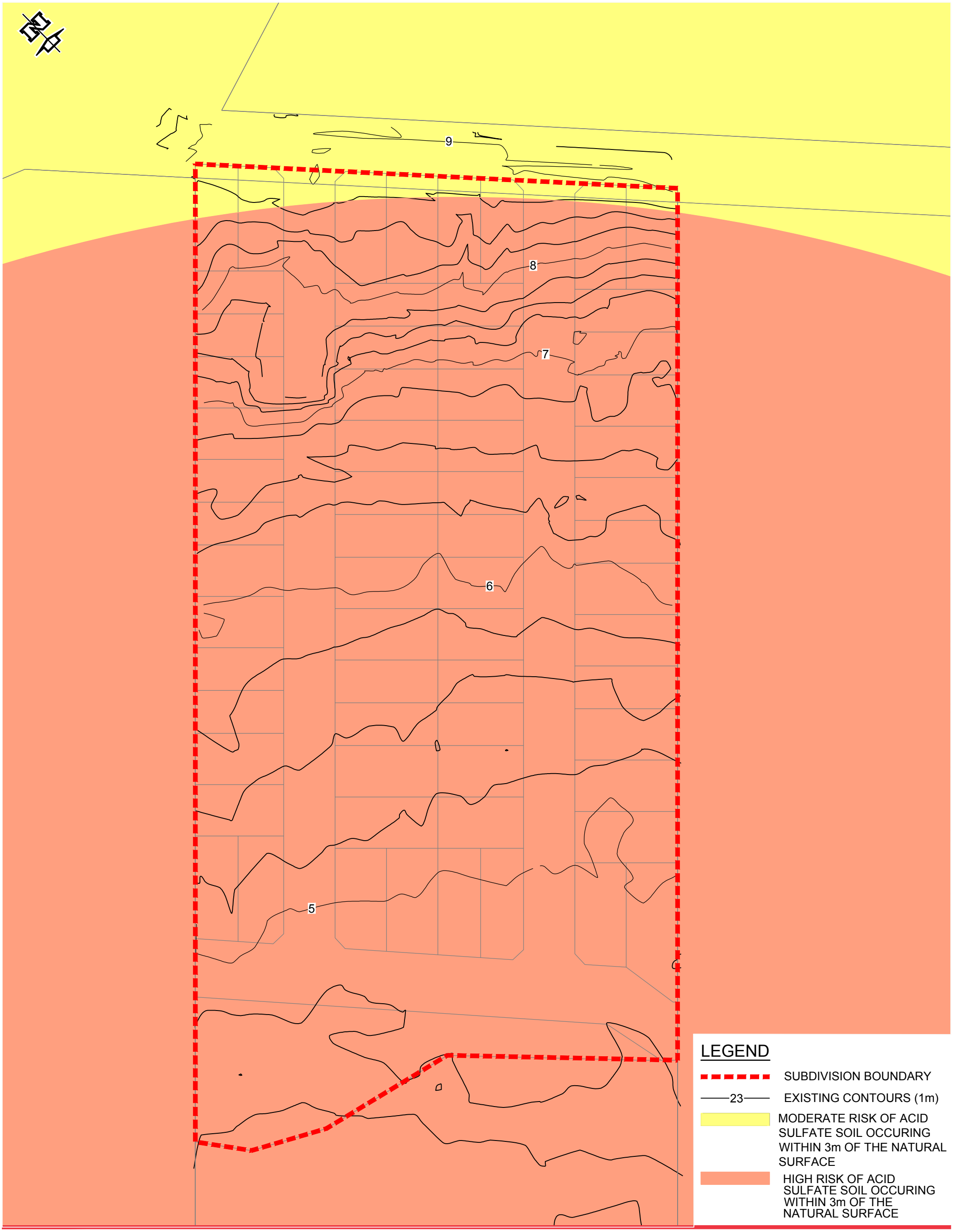
FIGURE 3.2
REVISION A

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SCALE (m)

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CLIENT ASCARI DEVELOPMENTS
DATE 20/08/15
DRAWN M.PERKINS
CHECKED M.WRIGHT

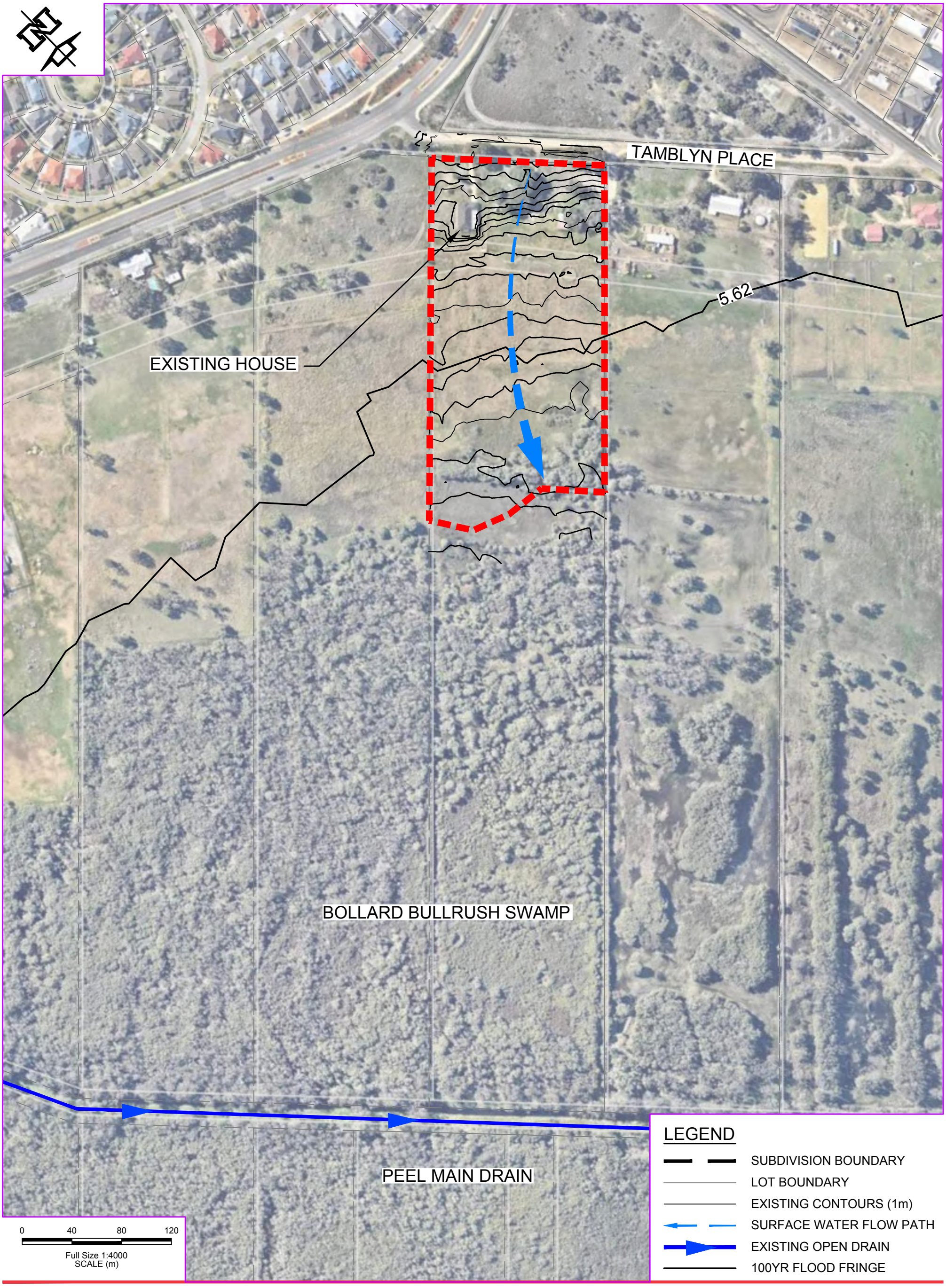
LOT 502 TAMBLYN PACE WELLARD
ASS MAPPING
FIGURE 3.3
REVISION A

0 10 20 30
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SCALE (m)

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CLIENT ASCARI DEVELOPMENTS
DATE 20/08/2015
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CHECKED M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD

SURFACE WATER DRAINAGE FEATURES

FIGURE 3.4
REVISION B

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CLIENT ASCARI DEVELOPMENTS
DATE 20/08/15
DRAWN M.PERKINS
CHECKED M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD
WETLAND MAPPING
FIGURE 3.5
REVISION A

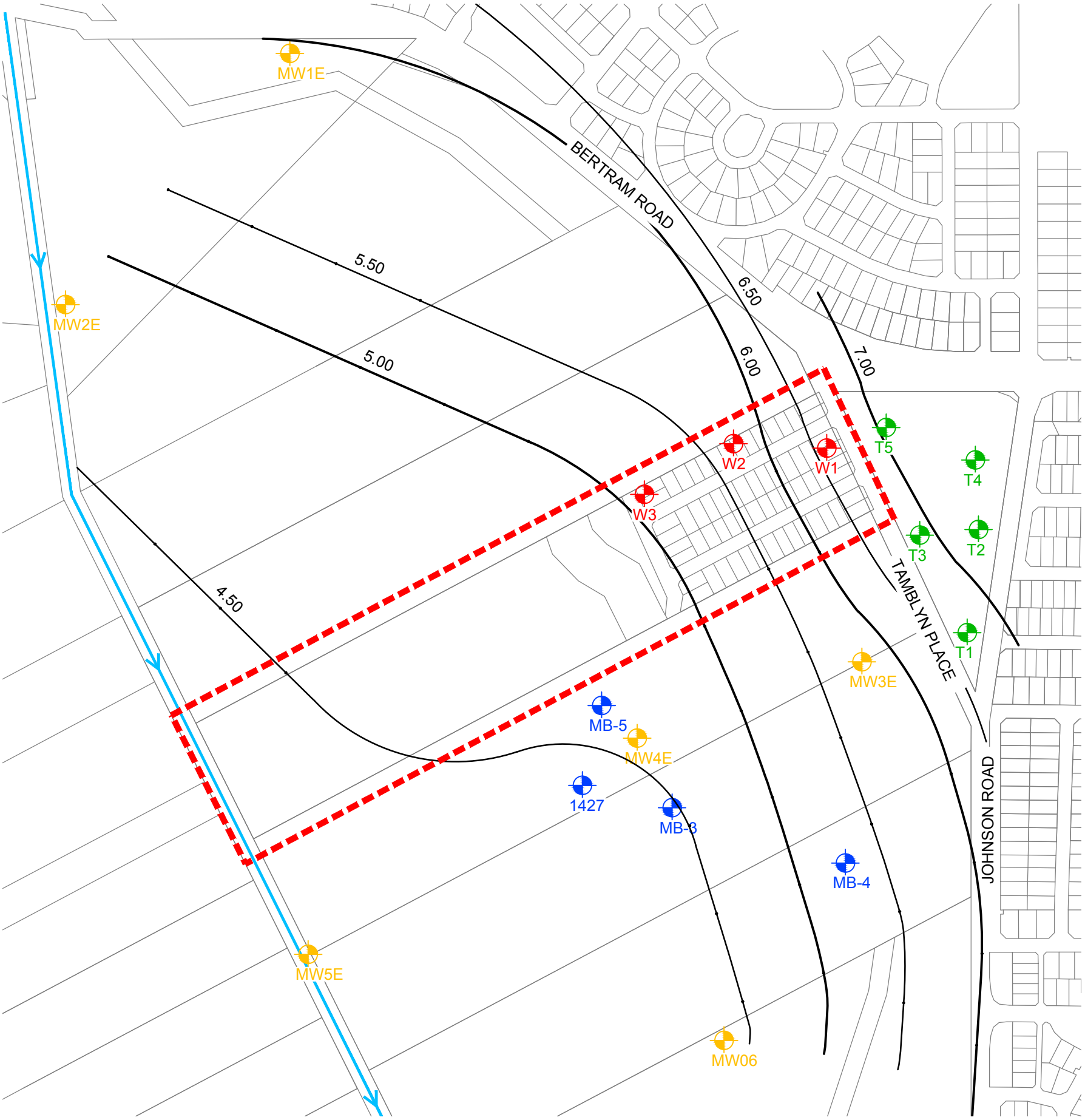
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LEGEND

- SITE BOUNDARY
- GROUNDWATER CONTOURS (mAHD)
- RPS MONITORING BORE (MB5)
- BAYLEY ENV SERVICE MONITORING BORE (T1)
- ENV MONITORING BORE (MW1E)
- PDC MONITORING BORE (W1)
- PEEL MAIN DRAIN



CLIENT	ASCARI DEVELOPMENTS
DATE	20/08/15
DRAWN	M.PERKINS
CHECKED	M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD

GROUNDWATER MONITORING BORE LOCATIONS

0 50 100 150

Full Size 1:5000
SCALE (m)

FIGURE 3.6
REVISION B

48 Kishorn Rd, Applecross Western Australia 6153
+61 8 9315 6600 +61 8 9364 7860 PDCGROUP.COM

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BASIN IL: 6.10 AHD
TwL: 7.05 AHD
AREA: 19.60m²
VOLUME: 13.90m³

BASIN IL: 6.10 AHD
TwL: 7.05 AHD
AREA: 19.60m²
VOLUME: 13.90m³

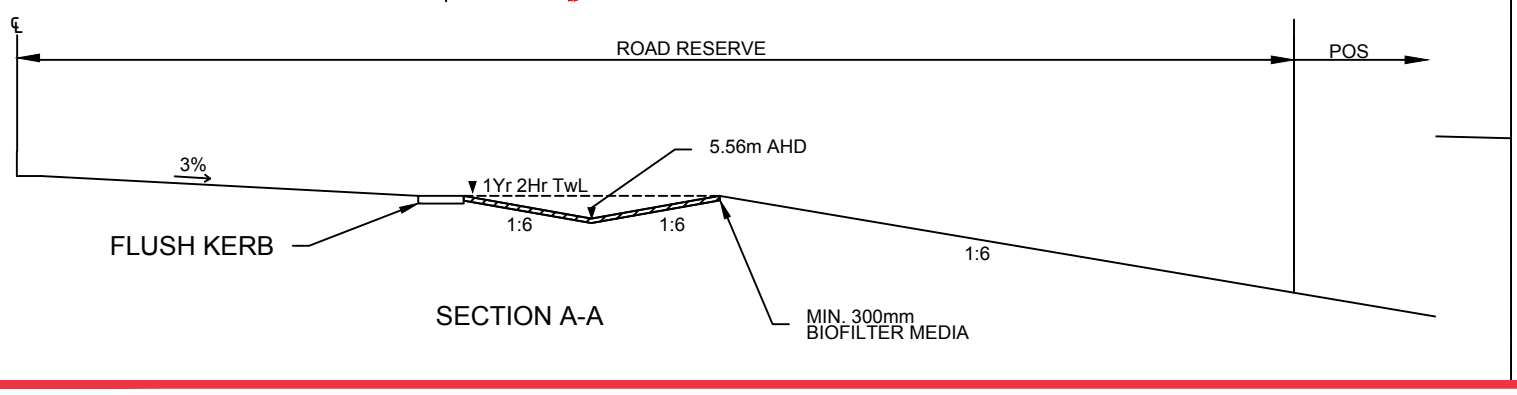
BASIN IL: 5.30 AHD
TwL: 6.16 AHD
AREA: 19.60m²
VOLUME: 13.90m³

BASIN IL: 5.30 AHD
TwL: 6.16 AHD
AREA: 19.60m²
VOLUME: 13.90m³

BASIN IL: 4.90 AHD
TwL: 5.89 AHD
AREA: 25.20m²
VOLUME: 17.66m³

BASIN IL: 4.90 AHD
TwL: 5.89 AHD
AREA: 25.20m²
VOLUME: 17.66m³

BASIN IL: 5.56 AHD
TwL: 5.71 AHD
AREA: 181.5m²
VOLUME: 12.5m³



LEGEND

- SUBDIVISION BOUNDARY
- CATCHMENT BOUNDARY
- ① CATCHMENT NUMBER
- SURFACE FLOW PATHS
- BIO-FILTRATION AREA
- SHEET FLOW

CLIENT	ASCARI DEVELOPMENTS
DATE	17/03/16
DRAWN	N.RENAUD
CHECKED	M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD

DETENTION AND FLOW PATHS 1 IN 2 Yr ARI

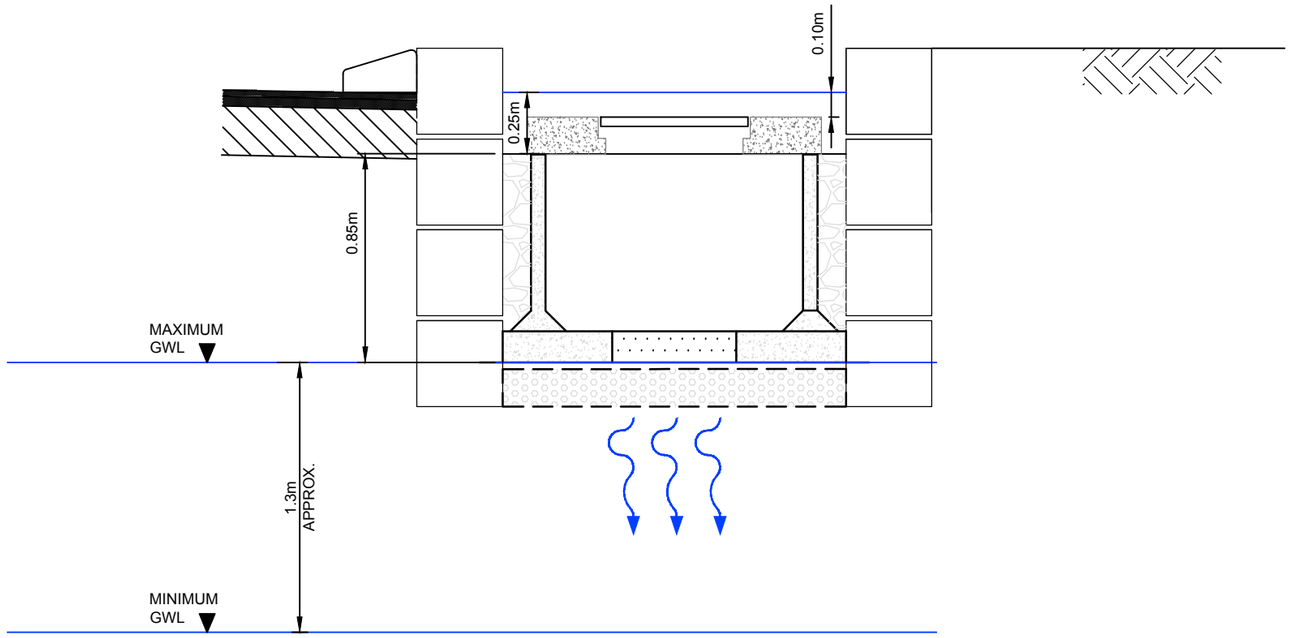
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SCALE (m)

FIGURE 4.1
REVISION C

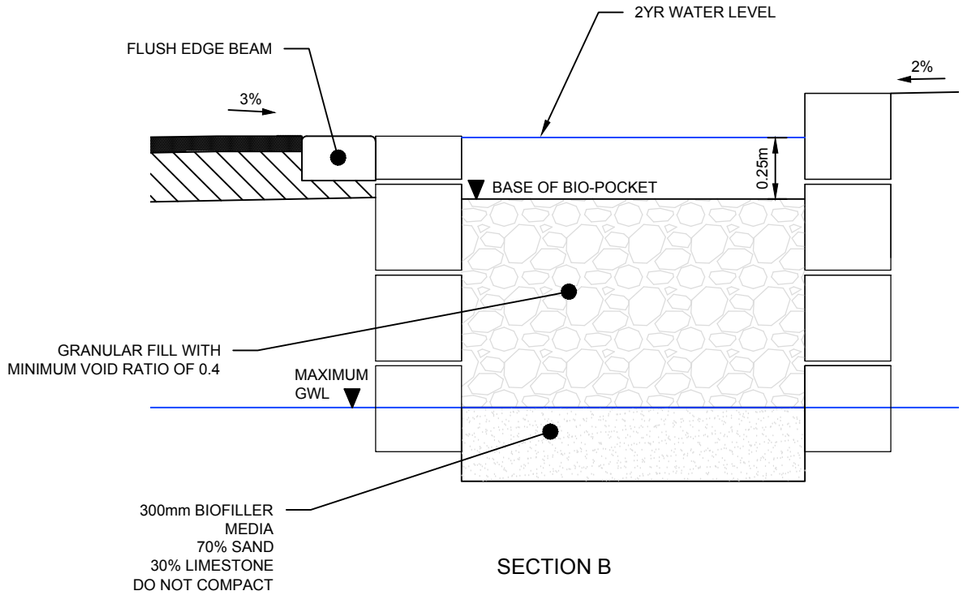
21 Kintail Rd, Applecross Western Australia 6153
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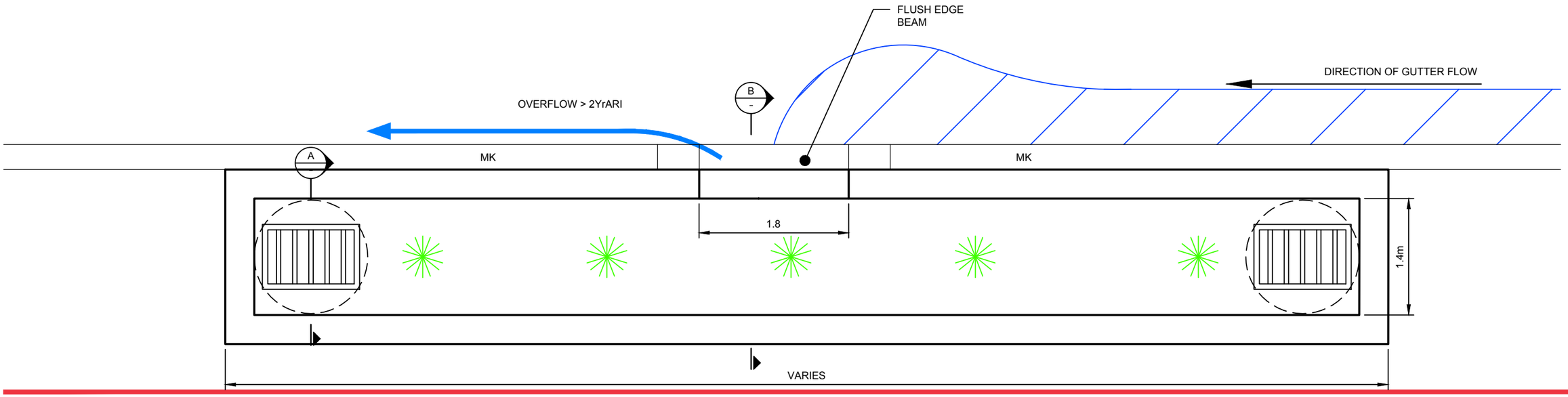


SECTION A



SECTION B

NOTE: DRAINAGE DETAILS INDICATIVE ONLY. ALL DETAILS TO COMPLY WITH THE CITY OF KWINANA STANDARD DRAWINGS.



CLIENT	ASCARI DEVELOPMENT
DATE	17/03/16
DRAWN	N.RENAUD
CHECKED	M.WRIGHT

0 0.5 1 1.5 — Full Size 1:50 SCALE (m)

0 0.25 0.5 0.75 — Full Size 1:25 SCALE (m)

LOT 502 TAMBLYN PLACE WELLARD

RAIN GARDEN DESIGN

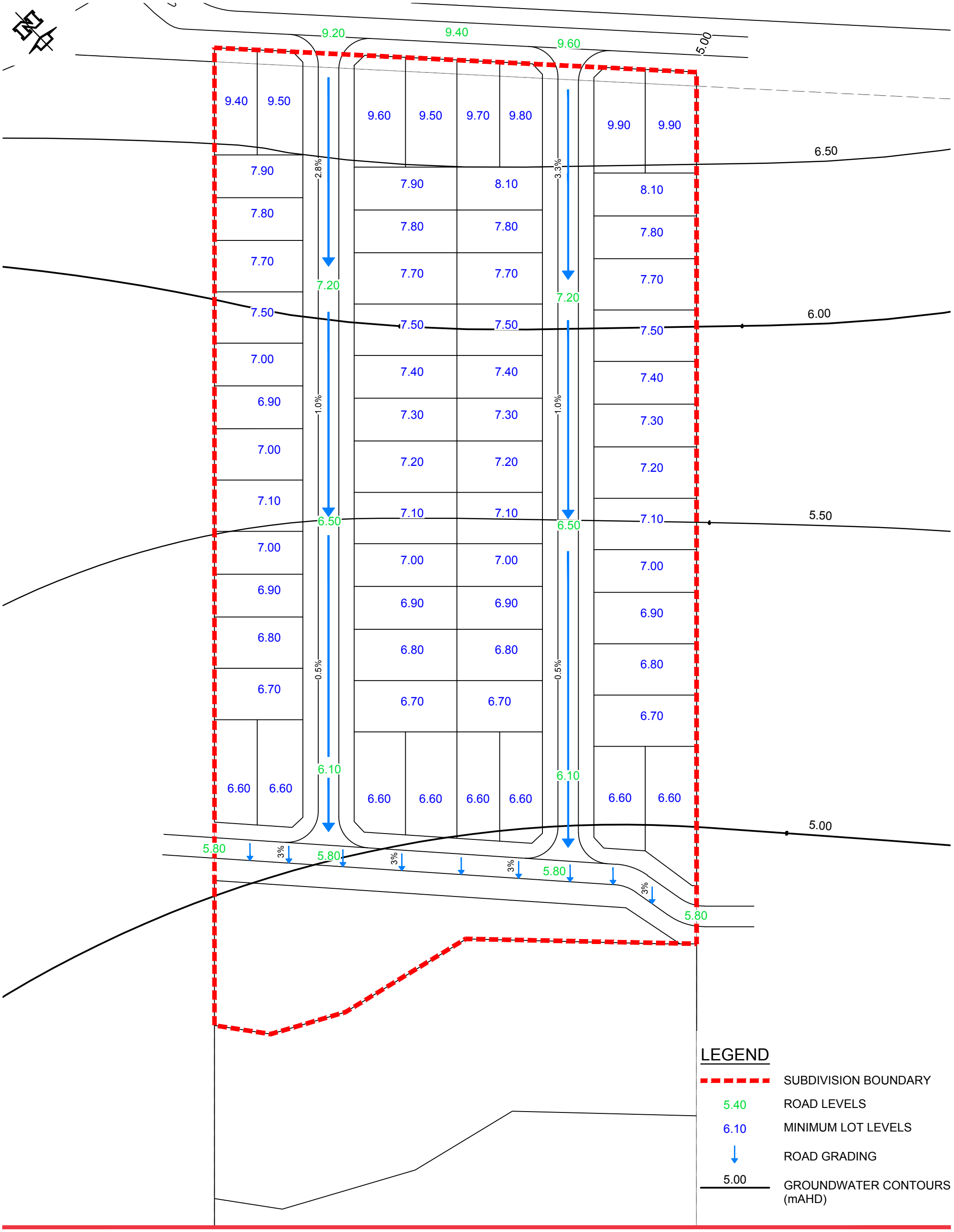
FIGURE 4.3

REVISION B

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CLIENT	ASCARI DEVELOPMENTS
DATE	17/03/16
DRAWN	N.RENAUD
CHECKED	M.WRIGHT

LOT 502 TAMBLYN PLACE WELLARD

PRELIMINARY EARTHWORK LEVELS

0 10 20 30

Full Size 1:1000
SCALE (m)

FIGURE 5.1
REVISION B

21 Kintail Rd, Applecross Western Australia 6153
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pdc Engineering Evolved

Cad File: T:\5000\900 Working Documents\901 Engineering\00\5000-00-501.dwg

Appendix

B

Geotechnical Investigation Report

CMW Geosciences Pty Ltd
Chapman Morton Woodward

23 July 2015

PROPOSED RESIDENTIAL DEVELOPMENT
LOT 502 TAMBLYN PLACE, WELLARD, WA
GEOTECHNICAL INVESTIGATION REPORT

Ascari Developments

Ref. 2015-0625AB, Rev0

Unit 19 Wembley Green Offices,
127 Herdsman Parade, Wembley, WA 6014
www.cmwgeosciences.com

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Appendix A – Hand Auger Borehole Logs

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1 EXECUTIVE SUMMARY

This report presents the results of a geotechnical site investigation carried out at Lot 502 Tamblyn Place, Wellard, WA. The concept plan provided indicates that the proposed development will comprise 59 residential lots, a public open space, a wetland plus associated roads and accessways.

Based on the investigation results, the site is assessed to be underlain, to the depth investigated, by clayey/peaty sand topsoil up to 0.5m thick overlying medium dense Bassendean Sand Interbedded silt, sand and clay alluvium was encountered below 8m to 9m depth. Groundwater was encountered between 0.1m and 1.0m below existing ground levels during the investigation with surface water noted at the south-western end of the proposed development.

Recommendations pertaining to geotechnical aspects of the development are summarised as follows:

- Class A Site Classification to AS2870, subject to the recommendations provided in Section 7.2;
- Following a 150mm topsoil/vegetation strip, the remaining “deeper” topsoil may be reused subject to it being mixed with clean sand at a ratio of up to 4:1 (sand:topsoil);
- Earthworks comprising topsoil stripping, topsoil mixing, proof rolling and compaction of sand fill in layers must be carried out in accordance with AS3798 and the recommendations provided in Section 7.2;
- A design subgrade CBR value of 12% for the sandy soils across the site is considered suitable subject to our earthworks recommendation detailed in Section 7.2.1 and 7.2.2; and,
- Due to the presence of an elevated groundwater, on-site soak wells are not considered suitable at existing ground levels. However, if the site is raised with engineered fill, for soakage design purposes, a soil permeability of 10m per day may be applied to the natural sands above the groundwater table.

2 INTRODUCTION

CMW Geosciences Pty Ltd (CMW) was commissioned by Ascari Developments Pty Ltd to carry out a geotechnical investigation at Lot 502 Tamblyn Place, Wellard, WA by way of a signed authorisation dated 2 July 2015. The scope of work and associated terms and conditions of our engagement were detailed in our services proposal letter 2015-0625AA, Rev1 dated 2 July 2015.

The purpose of this report is to describe the investigation completed, ground conditions encountered and provide recommendations with respect to geotechnical aspects of the proposed residential development including site preparation, subgrade CBR and site classification, as detailed in our proposal letter.

3 SITE DESCRIPTION

The proposed development site comprises an area of approximately 10Ha and is located at Lot 502 Tamblyn Place, Wellard, WA as shown on the attached Site Location Plan – Figure No. 1.

It is located on the eastern margin of the Bollard Bulrush Swamp wetland. Ground surface elevations range from in excess of 8mAHD along the eastern boundary of the site down to approximately 5mAHD along the western margin of proposed residential development. Tamblyn Place forms the north-eastern boundary with existing farmland to the east and west. Bollard Bulrush Swamp is located beyond the south-western boundary.

The southern portion of the proposed development area is currently utilised as farmland with thick grass cover and a number of medium sized trees. South of the proposed development area can be described as a wetland. There is a residential dwelling and a farm shed in the north.

4 PROPOSED DEVELOPMENT

The plans supplied depict the approximately 3.5ha development comprises 59 residential lots plus associated roads and accessways. We also understand that a 0.4ha public open space (POS) will be developed south-west of the lots adjacent to a buffer zone which separates the development from 6.3ha of the lower lying wetland.

No engineering design drawings have been supplied to date, however, based on nearby developments, we have assumed that the site will be raised with imported sand fill materials to form finished ground levels.

5 FIELD INVESTIGATION

Following a dial before you dig search, the field investigation was carried on 6 and 7 July 2015. All fieldwork was carried out under the direction of CMW in general accordance with AS1726 (1993), Geotechnical Site Investigations. The scope of fieldwork completed was as follows:

- Undertake a walkover survey of the site to assess the general landform and site conditions;
- Fifteen hand auger boreholes, denoted HA01 to HA15, were drilled using a 100mm diameter auger to depths of between 0.8m and 1.4m below existing ground levels to visually observe the near surface soil profile and to facilitate in-situ permeability testing. Engineering logs of the hand auger boreholes are presented in Appendix A;
- Perth Sand Penetrometer (PSP) tests were carried out adjacent to relevant hand auger boreholes, in general accordance with AS1289.6.3.2, to depths of up to 2.10m to provide soil density profiles and to provide a subgrade CBR value for pavement design purposes. Graphical results of the PSP testing are presented on the borehole logs in Appendix A; and,
- Five Cone Penetrometer Tests (CPT's) to depths of up to 10.8 metres were completed to assess the depth of loose sands, the presence and depth of lacustrine deposits and the depth to suitable bearing strata for foundation design. The results of the CPT tests are presented in Appendix B; and,
- In-situ falling head permeability tests were completed in the open standpipe piezometers established in HA10 and HA14 at depth of 1.1m. The results of the permeability tests are presented in Appendix C.

The approximate locations of the respective investigation sites referred to above are shown on the attached Site Investigation Plan (Figure No. 02).

6 GROUND MODEL

6.1 Geology

A review of the geological references for the area suggests the site is underlain by peaty topsoil associated with the adjacent wetlands which is underlain by a thin layer of Bassendean Sand which at depth transitions into the clayey sands / clays of the Guildford Formation.

Based on the known history of the site and surrounding land levels, some superficial depths of fill could be anticipated as a result of previous earthworks to create pad for the existing buildings/sheds.

6.2 Subsurface Conditions

The ground conditions encountered and inferred from the investigation were considered to be generally consistent with the published geology for the area and can be generalised below.

The north-eastern part of the site along Tamblyn Place is characterised by deep sand conditions with a poorly developed sandy topsoil layer typically 0.2m thick. Towards the west where the ground surface level falls below about 6.5mAHD the sandy topsoil layer becomes more dominated by organic clay and gradually increases in thickness extending up to 0.5m thick along the south-western margin of the proposed development area.

The upper sands were typically loose to medium dense with the relative density increasing with depth. At test location CPT5, near the north-eastern boundary, CPT refusal occurred at 3.5m. This is inferred to possibly be the result of cemented sand (Coffee Rock) within the sequence. At depth along the south-western margin of the proposed development area the subsurface sand profile grades into the interbedded sands and sandy clays of the Guildford Formation.

The distribution of these units is summarised in Table 1 below:

Table 1: Summary of Soil Stratigraphy

Description	Depth to top of layer (m)		
	Minimum	Maximum	Average
TOPSOIL	0		
BASSENDEAN SAND	0.2	0.5	0.3
GUILDFORD FORMATION	8.2	8.4	8.3

6.3 Groundwater

Groundwater elevations measured at a nearby site in November 2014 ranged from approximately RL 7mAHD on the eastern edge of Bollard Bulrush Swamp to approximately RL 4mAHD in the lower lying areas of the wetland. These November groundwater levels are considered to be close to the mid-point of the seasonal range between end of winter (high) and end of summer (low).

During our site investigation (July) groundwater was recorded at between 0.1m and 1.05m depth which equates to elevations of approximately RL 7mAHD to 5mAHD. It is also important to note that surface water was observed at the south-western margin of the proposed development area.

6.4 Laboratory Test Results

6.4.1 Civil Engineering

Results of the civil engineering laboratory tests provided in Appendix D are summarised in Table 2 below:

Table 2: Summary of Civil Engineering Laboratory Test Results

Test Location	Depth (mbgl)	Fines (%)	Sand (%)	Gravel (%)	LL (%)	PL (%)	PI (%)	LS (%)
HA03	0.15-0.30	28	72	0	65	52	13	5.5
HA04	0.20-0.30	24	76	0	73	61	12	5.5
HA06	0.20-0.40	28	72	0	48	37	11	5.0

Note: Gravel, sand and fines percentages are by weight, LL = liquid limit, PL = plasticity limit, PI = plasticity index, LS = linear shrinkage, NO = Not obtainable, NP = Non Plastic

6.4.2 Organic Content

The organic content test results are summarised in Table 3 below:

Table 3: Organic Soil Test Results		
Test Location	**Depth (m)**	**Loss on Ignition (%)**
HA01	0.05-0.20	1.1
HA02	0.05-0.20	7.0
HA03	0.05-0.15	3.4
HA04	0.05-0.20	19
HA05	0.05-0.20	15
HA06	0.05-0.20	27
HA07	0.05-0.20	8.7
HA08	0.05-0.20	3.7
HA09	0.05-0.20	20
HA11	0.05-0.15	1.4
HA15	0.05-0.30	9.8

Based on the loss on ignition test results the organic content of the topsoil is inferred to range between 2% and 40% (by volume). The relatively high results from boreholes HA04, HA06 and HA09 suggest that these samples may have included fragments of root matter that may not be representative of the overall topsoil material.

6.5 Permeability

The results of the falling head permeability tests carried out were used to estimate the soil coefficient of permeability in accordance with the method described in CIRIA Report No. 113 (falling head test). Table 4 below summarises the results obtained.

Table 4: Summary of Rising Head Permeability Tests					
Standpipe	**Screen Depth (mbgl)**	**Screened Formation**	**Test Method**	**Approximate Permeability**	
				(m/sec)	**(m/day)**
HA10	0 to 1.1	Bassendean Sand	CIRIA	1.19×10^{4}	10
HA14	0 to 1.1	Bassendean Sand	CIRIA	2.09×10^{4}	18

7 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS

7.1 Site Classification

We have assessed the site classification for the Lot 502 Tamblyn Place residential development in accordance with Australian Standard AS 2870-2011, “Residential Slabs and Footings”. It is assessed that subject to our remediation recommendations in Section 7.2, the sandy soils beneath the site within the depth investigated will have little to no characteristic surface movements (Ys) due to moisture changes. The site can therefore be classified as CLASS A in accordance with AS2870

We understand that in parts of the development significant amounts of fill are to be placed and compacted to form finished ground levels. If the imported fill is sandy in nature, free of organic or deleterious inclusions with a fines content of less than 12% and is compacted in accordance with Section 7.2, a CLASS A Site Classification will remain applicable.

7.2 Earthworks

We understand that cut and fill earthworks will be required to form finished ground levels. This activity is considered appropriate for the site subject to the earthworks construction recommendations described below.

7.2.1 Topsoil Remediation

Approaches that have been used for topsoil remediation at similar sites including others adjacent to Bollard Bulrush Swamp, incorporate the stripping of all topsoil materials and blending with clean imported or site won sand at ratios to produce a suitable structural fill material with less than 2% organic material (by weight).

The extent to which the above topsoil remediation can extend to the south-west across the site will be limited by groundwater elevation at the time of earthworks and the clay content of the peaty topsoil material. The area within the eastern half of the site where the existing ground surface level is above approximately RL 5.5mAHD is considered amenable to remediation as outlined above for most of the year, possibly excluding the winter groundwater peak period. Organic contents of the topsoils within the north-eastern portion of the site above approximately RL 6.5mAHD are expected to range from about 1% to 7% (by weight) resulting in a required blending ratio in the order of 1 (clean sand) to 1 (topsoil).

Within the lower lying south-western portion of the site, where the existing ground surface falls below 6.5mAHD the topsoil material becomes thicker, more variable and includes layers that are dominated by organic clay. It is recommended that topsoil stripping within the south-western half of the site is limited to the late summer/autumn months (Feb to April) when groundwater levels will be at their seasonal low point. Topsoil stripping during this period will allow a greater area to be completely remediated. Organic contents across the south-western half of the site are variable, ranging from about 3% to as high as 30% (by weight). This variability will require close monitoring during stripping to ensure optimal blending is achieved.

The upper limit for efficient topsoil blending is likely to be a ratio of approximately 4 (clean sand) to 1 (topsoil) resulting in an upper organic content in the order of 10% (by weight). Efficient excavation and placement of this material will be limited to the end of summer/autumn period when conditions are dry. Once the winter rains commence, topsoil stripping earthworks and filling within the south-western end of the site will need to be suspended. The viability of the above topsoil remediation approach is contingent on being able to schedule these works during the late summer/autumn period.

7.2.2 Topsoil Strip and Subgrade Preparation

We recommend the following during topsoil strip and subgrade preparation:

- All vegetation and the top 150mm of topsoil material/rootmat must be stripped and removed from site or reused for landscaping purposes;
- Existing trees must be removed and it must be ensured that their root systems are completely grubbed out. The soil beneath all tree root systems must be recompacted and filled to the method specification. This is especially important for the large trees located near the south-western boundary of the proposed development;
- The remaining dark brown topsoil/clayey sand; must be completely stripped, exposing the underlying clean sands and stockpiled prior to blending;

- Topsoil blending must be carried out a ratio of up to 4 (clean sand) to 1 (topsoil);
- Following topsoil stripping, the upper 300mm of the exposed subgrade must be moisture conditioned and compacted with a suitable roller to achieve at least 8 blows per 300mm penetration with a PSP, which is equivalent to a dry density ratio of at least 95% based on Modified Compaction (AS1289 5.2.1). Any loose, weak, cohesive or organic materials observed during this proof roll shall be removed and replaced with compacted clean sand fill;

7.2.3 Bulk Earthworks

We recommend the following during bulk earthworks:

- General fill layers should be placed in maximum 500mm thick loose layers, moisture conditioned to within ±3% of the optimum moisture content and compacted with a suitable roller to achieve a dry density ratio of at least 95% based on modified compaction (AS1289 5.2.1);
- Site won material from proposed excavations is considered suitable for use in bulk earthworks subject to the material being well graded, granular in nature, free of organic or deleterious inclusions with a fines content of less than 12% and a maximum particle size of 300mm; and
- Imported general sandy fill should contain less than 5% by weight of soil <0.075mm and have 100% of clasts smaller than 200mm;

7.2.4 Retaining Wall Backfill

We recommend the following during retaining wall backfilling:

- Backfill layers should be placed in maximum 300mm thick loose layers, moisture conditioned to within ±3% of the optimum moisture content and compacted with a suitable vibrating plate compactor to achieve a dry density ratio of at least 95% based on modified compaction (AS1289 5.2.1); and
- Backfill must comprise the same material as the retained lot to reduce the risk of differential settlements.

7.2.5 Earthworks Monitoring

Variations in ground conditions may occur between test locations. If conditions other than those described above are encountered, then further advice should be sought without delay. During earthworks, site visits should be made by a Geotechnical Engineer or Engineering Geologist who is familiar with the contents of this report to ensure that topsoil stripping and blending is carried out adequately, proof compaction and cut to fill earthworks are conducted in accordance with AS3798-2007, and to audit the compaction of earthworks. Earthworks control testing should be undertaken in accordance with the guidelines set out in AS3798-2007. CMW would be pleased to perform this function if required.

7.3 Preliminary Foundation Recommendations

Foundations may be preliminarily designed on the basis of a maximum allowable bearing pressure of 100 kPa for foundations as per AS2870.

Foundation bearing pressures should be re-evaluated for each individual lot following the completion of bulk earthworks to align recommended bearing pressures and settlement profiles with the thickness of fill placed.

7.4 Retaining Wall Design

Localised cut and fill earthworks are envisaged along proposed property boundaries for subdivision layout and drainage purposes. Recommended retaining wall design parameters are summarised in Table 5 below:

Table 5: Retaining Wall Design Parameters (No wall friction)

Soil Type	Density (kN/m^3)	Ø' (deg.)	K_0	K_a	K_p	E' (MPa)
Medium dense Sand	18	33	0.50	0.29	3.4	50

Notes:
1. Ø' - angle of internal soil friction; K_0 - coefficient of earth pressure at rest based on normally consolidated soils, K_a - coefficient of active earth pressure, K_p - coefficient of passive earth pressure; E' – long term Youngs modulus.
2. The above parameters are based on the condition of a horizontal ground surface behind the retaining structure. Applicable surcharge loads behind the wall must also be considered in the design.

Retaining structures should be designed in accordance with AS 4678-2002 "*Earth Retaining Structures*" or an alternate approved factor of safety approach. Should any fill be placed against the permanent retaining walls after construction, it is expected that the compaction induced pressures will be much greater than the above active earth pressures. The compaction equipment used to compact backfill behind the wall must be carefully selected and preferably light-weight compaction equipment with reduced lift heights should be used. The load on the retaining wall due to compaction equipment may be estimated from Figure J5 in AS4678-2002 *"Earth Retaining Structures"*.

7.5 Soak Wells

Due to near surface groundwater levels, on-site soak wells are not considered suitable at existing ground levels. If the site is raised with engineered fill, for soakage design purposes, a soil permeability of 10m per day may be applied to the natural sands above the groundwater table.

Soak well efficiency reduces where the depth to groundwater is less than 1.5m. Where the depth to groundwater is expected to be less than 1.0m, the provision of a stormwater over flow connection to the lots is recommended.

7.6 Pavements

Based on the laboratory test results and PSP testing carried out in the field, a design subgrade CBR value of 12% for the sandy soils across the site is considered suitable. A design subgrade CBR value of 15% is considered suitable for compacted sand fill.

These design CBR values are subject to the exposed subgrade being moisture conditioned to within ±3% of the optimum moisture content and compacted with a large (minimum 10 tonne static weight) suitable roller. It is recommended that appropriate QA / QC testing be undertaken on subgrade and pavement materials during construction.

7.7 Acid Sulphate Soils

The Perth Metropolitan Acid Sulfate Soils Map shows that the site is located in a "high risk area for ASS occurring within 3m of natural surface". Therefore, if earthworks are to include disturbance of the in situ materials exceeding $100m^3$ of soil from below the water table or if any dewatering is required during earthworks or civil construction, an acid sulfate soils investigation is likely to be required. We are able to recommend a suitably qualified and experienced environmental consultant for this work if required.

8 ADDITIONAL INVESTIGATION WORK

More detailed information is required to refine the topsoil remediation strategy. The current data base for the site includes only ten organic content tests on the topsoil materials. It is recommended that an intensive topsoil investigation programme be undertaken to assess in more detail the topsoil layer thickness, sand content, organic content and variation of organic content with depth. A total of approximately 30 shallow hand excavated test locations with a commensurate number of organic content and percentage fines tests are recommended to allow for the optimal design of topsoil remediation.

9 CLOSURE

The findings contained within this report are the result of limited discrete investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, can it be considered that these findings represent the actual state of the ground conditions away from our investigation locations.

If the ground conditions encountered during construction are significantly different from those described in this report and on which the conclusions and recommendations were based, then we must be notified immediately.

This report has been prepared for use by Ascari Developments in relation to the proposed residential development at Lot 502 Tamblyn Place in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. Use of this report by parties other than Ascari Developments and their respective consultants and contractors is at their risk as it may not contain sufficient information for any other purposes.

For and on behalf of
CMW Geosciences Pty Ltd





Matthew Watts
Engineering Geologist

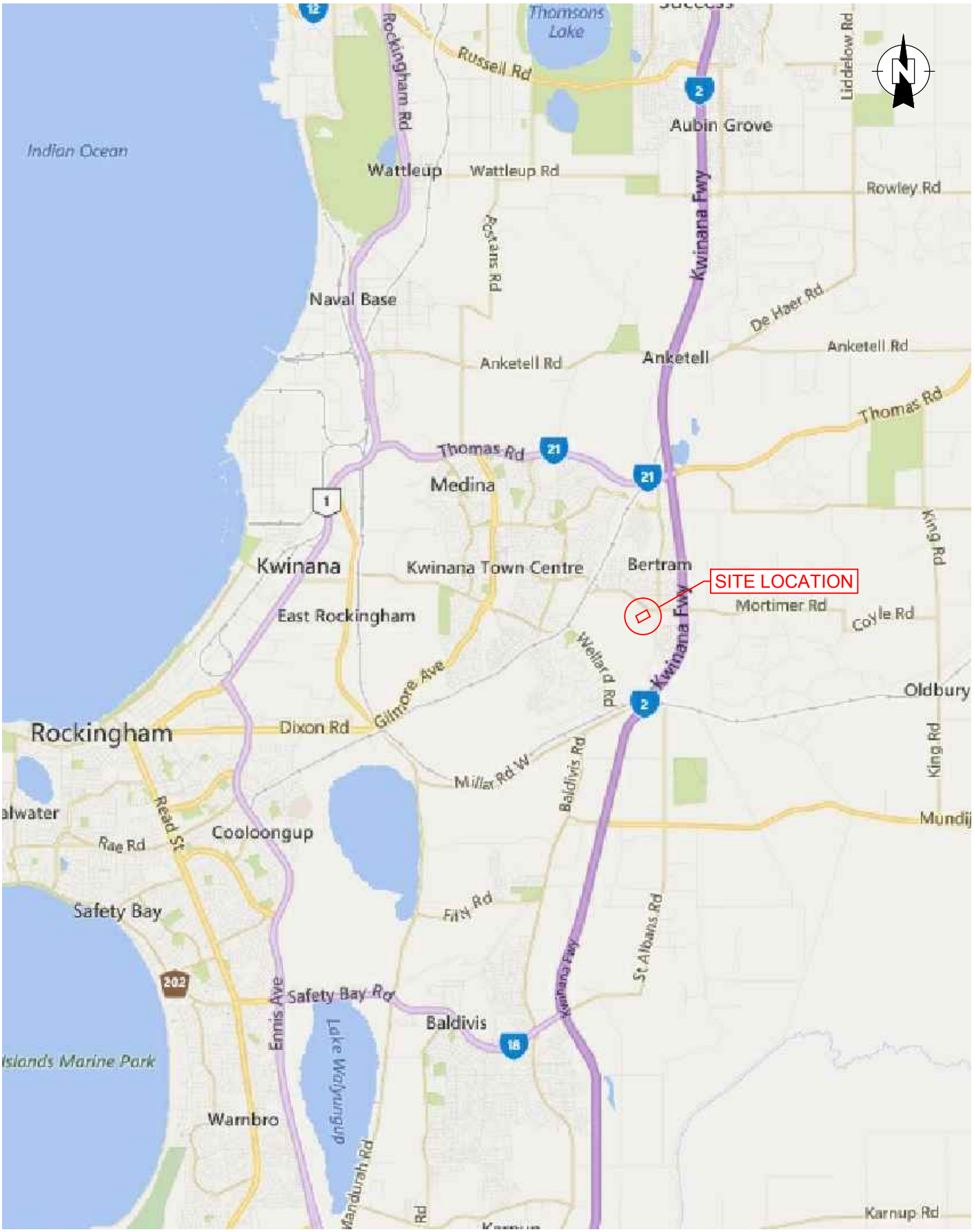
Philip Mather
Principal

Distribution: 1 copy to Ascari Developments Pty Ltd (electronic)
Original held by CMW Geosciences Pty Ltd

10 REFERENCES

- Appendix 4, Control of Groundwater for Temporary Works (CIRIA Report No. 113)
- AS 1289, *Methods of testing soils for engineering purposes,* Standards Australia, Sydney
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- WA Online Atlas, Shared Land Information Platform – ASS Risk Map, https://www2.landgate.wa.gov.au/bmvf/app/waatlas/.

Figures



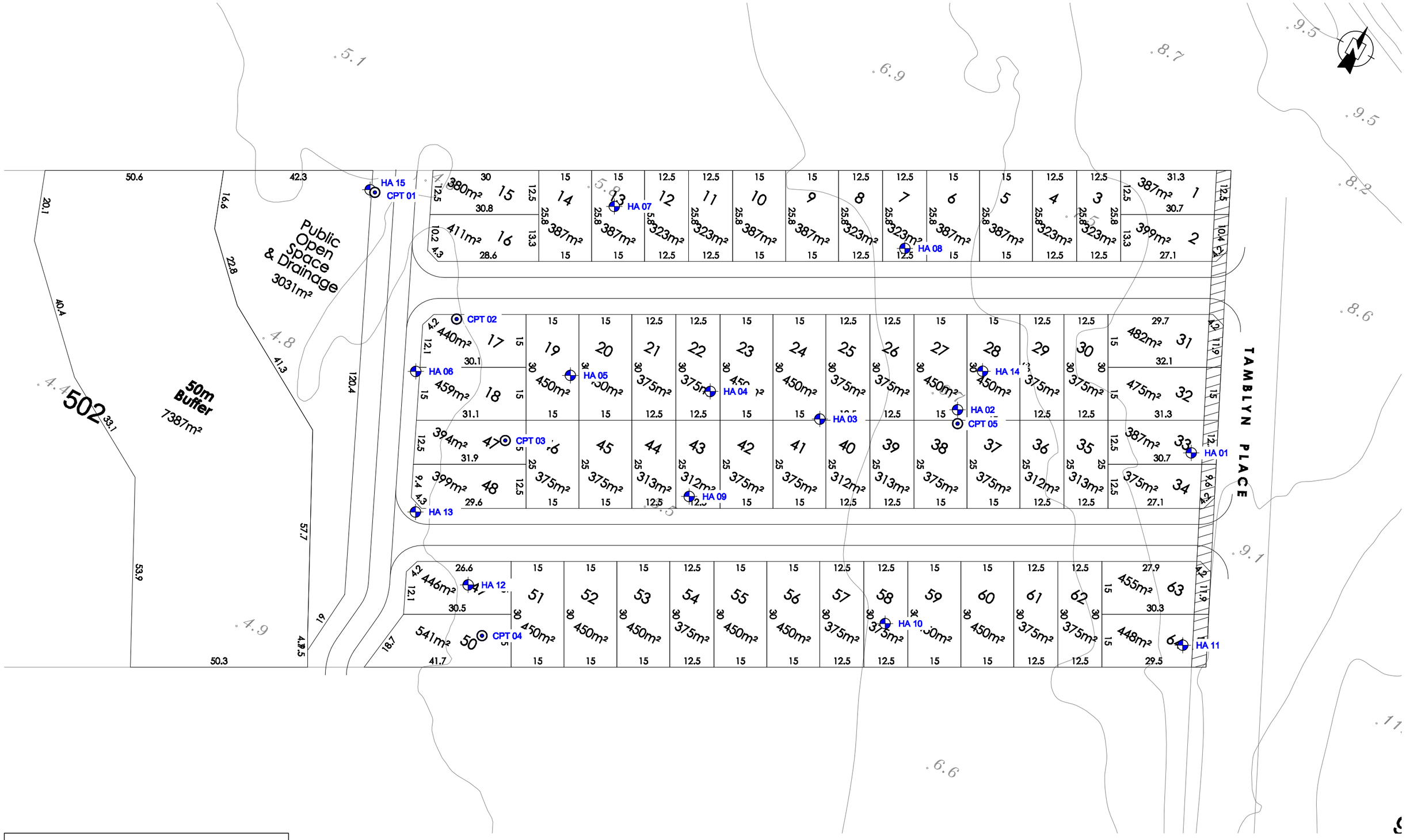
0 1 2 3 4 5 km

1:100 000

NOTE: IMAGERY SOURCED FROM BING.COM

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CLIENT: ASCARI DEVELOPMENTS		DRAWN: CJ	PROJECT: 2015-0625
PROJECT: LOT 502 TAMBLYN PLACE WELLARD, WA		CHECKED: MW	FIGURE: 01
		REVISION: 0	SCALE: 1:100 000
TITLE: SITE LOCATION PLAN		DATE: 22/07/2015	SHEET: A4 P



LEGEND:

- HA 01 DENOTES HAND AUGER (HA) LOCATION
- CPT 01 DENOTES CONE PENETROMETER TEST (CPT) LOCATION

1:1000 0 10 20 30 40 50 m

NOTE: BASE PLAN ADAPTED FROM: SUBDIVISION CONCEPT PLAN, DATED: 08/07/2015

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CLIENT: ASCARI DEVELOPMENTS		DRAWN: CJ	PROJECT: 2015-0625
PROJECT: LOT 502 TAMBLYN PLACE WELLARD, WA		CHECKED: MW	FIGURE: 02
		REVISION: 0	SCALE: 1:1000
TITLE: SITE INVESTIGATION PLAN		DATE: 22/07/2015	SHEET: A3 L

Appendix A
Hand Auger Borehole Logs

BOREHOLE LOG - HA01

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391242m N.6430590m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description: Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
		0.0 - 0.2	1 B		0		TOPSOIL: SAND: fine to medium grained, dark-grey; trace fines.	M	L		
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.				
		1.2 - 1.4	2 B		1		Borehole terminated at 1.40 m		MD		
					2						
					3						
					4						

Termination Reason: Target Depth Reached.
Remarks: Groundwater not encountered. Backfilled.

BOREHOLE LOG - HA02

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391178m N.6430569m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
		0.0 - 0.2	1 B		0		TOPSOIL: SILTY SAND: fine to medium grained, dark-grey to dark brown; silt, low plasticity.				
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	M	VD		
					1			W			
							Borehole terminated at 1.40 m				
					2						
					3						
					4						

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA03

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391145m N.6430548m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
		0.0 - 0.2	1 B				TOPSOIL: SAND: fine to coarse grained, brown to dark-brown; trace fines; trace organic rich lenses.				
		0.2 - 0.3	2 B				SM: TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay, high plasticity; trace rootlets.	M			
	▼						SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	W	D		
					1						
							Borehole terminated at 1.40 m				
					2						
					3						
					4						

Perth Sand Penetrometer (Blows/150mm): 5 10 15

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA04

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391114m N.6430540m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description: Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
		0.0 - 0.2	1 B				TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay high plasticity; with roots and rootlets.	M			
		0.2 - 0.3	2 B				SP: SAND: fine to medium grained, grey to pale-grey; trace fines.				
							...from 0.80m, sand is pale brown-grey.	W			
					1				D		
							Borehole terminated at 1.40 m				
					2						
					3						
					4						

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA05

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391077m N.6430525m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
		0.0 - 0.2	1 B		0		TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay, high plasticity; with roots and rootlets.	M			
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	W	D		
					1				VD		
							Borehole terminated at 1.40 m				
					2						
					3						
					4						

Perth Sand Penetrometer (Blows/150mm): 5 10 15

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA06

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW
Position: E.391038m N.6430505m (MGA 51)
Elevation:
Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
	▼	0.0 - 0.2	1 B				TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay, high plasticity; with roots and rootlets.	W			Groundwater perched on the surface.
		0.2 - 0.4	2 B					M			
					1		SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	W	D		
							Borehole terminated at 1.30 m				
					2						
					3						
					4						

Perth Sand Penetrometer (Blows/150mm): 5 10 15

Termination Reason: Target Depth Reached.

Remarks: Backfilled. Groundwater level rose from 0.40m to 0.10m BGL.

BOREHOLE LOG - HA07

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391065m N.6430573m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
	▼	0.0 - 0.2	1 B		1		TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay, high plasticity, with rootlets.	M	MD	5 10 15	
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	M to W			
								W	D		
							Borehole terminated at 1.40 m		VD		
					2						
					3						
					4						

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA08

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

CMW Geosciences Pty Ltd
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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW
Position: E.391143m N.6430602m (MGA 51)
Elevation:
Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
		0.0 - 0.2	1 B				TOPSOIL: SAND: fine to coarse grained, brown; with roots and rootlets; trace fines.				
		0.2 - 0.3	2 B				SM: TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay high plasticity; with roots and rootlets.	M			
	▼						SP: SAND: fine to medium grained, grey to pale-grey; trace fines.		D		
							...from 0.80m white to pale-grey.	W			
					1						
							Borehole terminated at 1.40 m		VD		
					2						
					3						
					4						

Perth Sand Penetrometer (Blows/150mm): 5 10 15

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA09

Client: Ascari Developments

Project: Lot 502 Tamblyn Place

Location: Wellard, WA

Project ID: 2015-0625

Date:06/07/2015

Sheet 1 of 1

Logged By:ACE	Postion: E.391123m N.6430511m (MGA 51)	Hole Diameter:100mm
Checked By:MW	Elevation: (AHD)	Angle from Horizontal:90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Charasteristic; Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Structure & other observations
		0.05 - 0.20	B				TOPSOIL: Organic CLAYEY SAND: fine to medium grained, black; clay, high plasticity; with roots and rootlets.	M		
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	W		
					1					
							End of borehole at 1.40 m			
					2					
					3					
					4					

Termination Reason: Target Depth Reached.

Remarks: Backfilled.

BOREHOLE LOG - HA10

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 07/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391189m N.6430506m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
					0		TOPSOIL: SILTY SAND: fine to coarse grained, dark-brown; silt, low plasticity; with organics.				
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	M			
	▼				1			W			
							Borehole terminated at 1.40 m				
					2						
					3						
					4						

Termination Reason: Target Depth Reached.

Remarks: In-situ permeability test undertaken within test hole. Backfilled.

BOREHOLE LOG - HA11

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 06/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391266m N.6430541m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm)	Structure & other observations
		0.0 - 0.2	1 B		1		TOPSOIL: SAND: fine to medium grained, dark-grey to grey; trace fines.	M	MD	5 10 15	
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.				
							...from 0.80m, white to pale-grey.				
					2		Borehole terminated at 1.40 m				
					3						
					4						

Termination Reason: Target Depth Reached.
Remarks: Groundwater not encountered. Backfilled.

BOREHOLE LOG - HA12

Client: Ascari Developments
Project: Lot 502 Tamblyn Place
Location: Wellard, WA
Project: 2015-0625
Date: 07/07/2015

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1:20 Sheet 1 of 1

Logged by: ACE
Checked by: MW

Position: E.391080m N.6430459m (MGA 51)
Elevation:

Hole Diameter: 100mm
Angle from horizontal: 90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Characteristics, Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Perth Sand Penetrometer (Blows/150mm) 5 10 15	Structure & other observations
	▼				1		TOPSOIL: Organic CLAYEY SAND: fine to coarse grained, dark brown; clay, high plasticity.	M			Groundwater perched on the surface.
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	W			
					2		Borehole terminated at 1.40 m				
					3						
					4						

Termination Reason: Target Depth Reached.
Remarks: Backfilled.

BOREHOLE LOG - HA13

Client: Ascari Developments

Project: Lot 502 Tamblyn Place

Location: Wellard, WA

Project ID: 2015-0625

Date:07/07/2015

Sheet 1 of 1

Logged By:ACE	Postion: E.391057m N.6430470m (MGA 51)	Hole Diameter:100mm
Checked By:MW	Elevation: (AHD)	Angle from Horizontal:90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Charasteristic; Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	▼				0		TOPSOIL: Organic CLAYEY SAND: fine to coarse grained, dark-brown; clay, high plasticity.	M		Groundwater perched on the surface.
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	W		
					1					
							End of borehole at 1.40 m			
					2					
					3					
					4					

Termination Reason: Target Depth Reached.

Remarks: Backfilled.

BOREHOLE LOG - HA14

Client: Ascari Developments

Project: Lot 502 Tamblyn Place

Location: Wellard, WA

Project ID: 2015-0625

Date:07/07/2015

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Sheet 1 of 1

Logged By:ACE	Postion: E.391179m N.6430582m (MGA 51)	Hole Diameter:100mm
Checked By:MW	Elevation: (AHD)	Angle from Horizontal:90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Charasteristic; Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Structure & other observations
					0		TOPSOIL: SAND: fine to coarse grained, dark-brown; with fines; with organics.			
							SP: SAND: fine to medium grained, grey to pale-grey; trace fines.	M		
	▼				1			W		
							End of borehole at 1.40 m			
					2					
					3					
					4					

Termination Reason: Target Depth Reached.

Remarks: In-situ permeability test undertaken within test hole. Backfilled.

BOREHOLE LOG - HA15

Client: Ascari Developments

Project: Lot 502 Tamblyn Place

Location: Wellard, WA

Project ID: 2015-0625

Date:07/07/2015

Sheet 1 of 1

Logged By:ACE | Postion: E.391002m N.6430544m (MGA 51) | Hole Diameter:100mm

Checked By:MW | Elevation: (AHD) | Angle from Horizontal:90°

Well	Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil Type, Plasticity or Particle Charasteristic; Colour, Secondary and Minor Components)	Moisture Condition	Consistency/ Relative Density	Structure & other observations
	▼	0.20 - 0.30	B		0		TOPSOIL: Organic CLAYEY SAND: fine to coarse grained, dark-brown; clay, high plasticity.	M		
							...from 0.40m, sand content increasing.	W		
							SP: SAND: fine to medium grained, grey to pale grey; trace fines.			
							End of borehole at 0.80 m			
					1					
					2					
					3					
					4					

Termination Reason: Target Depth Reached.

Remarks: Backfilled.

Appendix B
CPT Test Results

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045
F: 08 6278 1595

CPT 1
Total depth: 10.77 m, Date: 7/07/2015
Surface Elevation: 5.15 m
Coords: X:391003.52, Y:6430543.99
Cone Operator: Andrew

Project: Lot 502 Tamblyn Way (Project No.: 2015-0625)
Location: Wellard (Client: Ascari Developments)

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045
F: 08 6278 1595

CPT 2
Total depth: 8.58 m, Date: 7/07/2015
Surface Elevation: 5.15 m
Coords: X:391041.05, Y:6430523.58
Cone Operator: Andrew

Project: Lot 502 Tamblyn Way (Project No.: 2015-0625)
Location: Wellard (Client: Ascari Developments)

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045
F: 08 6278 1595

CPT 3
Total depth: 9.68 m, Date: 7/07/2015
Surface Elevation: 5.17 m
Coords: X:391069.64, Y:6430499.97
Cone Operator: Andrew

Project: Lot 502 Tamblyn Way (Project No.: 2015-0625)
Location: Wellard (Client: Ascari Developments)

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045
F: 08 6278 1595

CPT 4
Total depth: 8.61 m, Date: 7/07/2015
Surface Elevation: 5.16 m
Coords: X:391090.34, Y:6430448.26
Cone Operator: Andrew

Project: Lot 502 Tamblyn Way (Project No.: 2015-0625)
Location: Wellard (Client: Ascari Developments)

info@cptwest.com.au
www.cptwest.com.au
T: 0403 370 045
F: 08 6278 1595

CPT 5
Total depth: 3.69 m, Date: 7/07/2015
Surface Elevation: 6.76 m
Coords: X:391179.89, Y:6430565.56
Cone Operator: Andrew

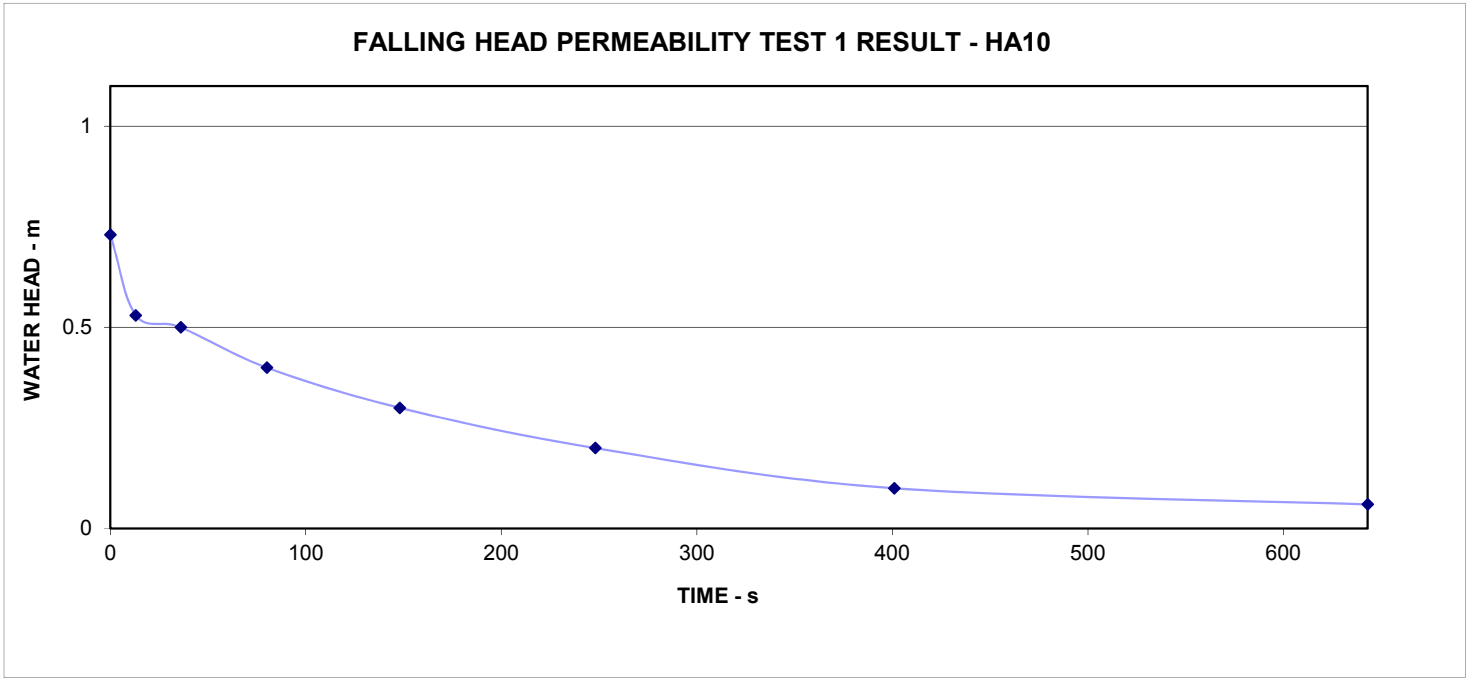
Project: Lot 502 Tamblyn Way (Project No.: 2015-0625)
Location: Wellard (Client: Ascari Developments)

Appendix C
In-situ Permeability Test Results

CLIENT: ASCARI DEVELOPMENTS
PROJECT: LOT 502 TAMBLYN PLACE
LOCATION: WELLARD, WA
JOB NUMBER: 2015-0625
TEST DATE: 7/07/2015

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FALLING HEAD PERMEABILITY TEST 1 RESULT - HA10



STRATIGRAPHIC LOG	
	TOPSOIL: SILTY SAND (0m - 0.3m)
	SAND (0.3m - 1.1m)
Bottom of soakage test hole= 1.1m	

Reference: Appendix 4, Control of Groundwater for Temporary Works (CIRIA Report No. 113)

Borehole diameter = 90 mm

Hydraulic conductivity $$k = \left(\frac{log\left(\frac{h_1}{h_2}\right) - log\left(\frac{\alpha h_1 + 1}{\alpha h_2 + 1}\right)}{(t_2 - t_1)} \right) \times I$$

where I = average piezometric head over chosen time interval

$$= \frac{(h_1 + h_2)}{2}$$

h_1 = piezometric head at start of chosen interval (m)

h_2 = piezometric head at end of chosen interval (m)

$t_2 - t_1$ = chosen time interval (seconds)

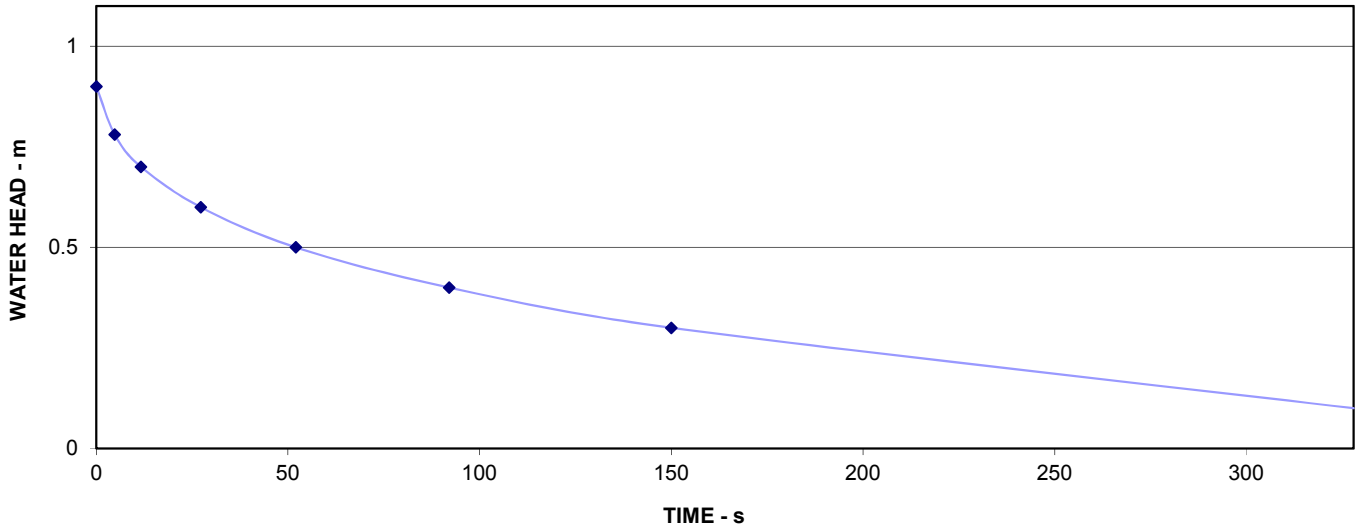
$$\alpha = \frac{\pi d}{\left(\frac{\pi d^2}{2}\right)} = 22.2$$

Elapsed Time (s)	t2 - t1 (secs)	Piezometric Head h (m)	*Avg head* *I* (m)	log (h_1/h_2)	Hydraulic Conductivity k (m/sec)	k (m/day)
0		0.73				
13	13	0.53	0.63	0.14	4.56E-04	39
36	23	0.5	0.52	0.03	4.56E-05	4
80	44	0.4	0.45	0.10	9.08E-05	8
148	68	0.3	0.35	0.12	7.41E-05	6
248	100	0.2	0.25	0.18	6.86E-05	6
401	153	0.1	0.15	0.30	7.18E-05	6
643	242	0.06	0.08	0.22	2.70E-05	2
				Average =	1.19E-04	10

CLIENT: ASCARI DEVELOPMENTS
PROJECT: LOT 502 TAMBLYN PLACE
LOCATION: WELLARD, WA
JOB NUMBER: 2015-0625
TEST DATE: 7/07/2015

CMW Geosciences Pty Ltd
Chapman Morton Woodward

FALLING HEAD PERMEABILITY TEST 2 RESULT - HA14



STRATIGRAPHIC LOG	
	TOPSOIL: SILTY SAND (0m - 0.25m)
	SAND (0.3m - 1.1m)
Bottom of soakage test hole= 1.1m	

Reference: Appendix 4, Control of Groundwater for Temporary Works (CIRIA Report No. 113)

Borehole diameter = 90 mm

Hydraulic conductivity $$k = \left(\frac{log\left(\frac{h_1}{h_2}\right) - log\left(\frac{\alpha h_1 + 1}{\alpha h_2 + 1}\right)}{(t_2 - t_1)} \right) \times I$$

where I = average piezometric head over chosen time interval

$$= \frac{(h_1 + h_2)}{2}$$

h_1 = piezometric head at start of chosen interval (m)

h_2 = piezometric head at end of chosen interval (m)

$t_2 - t_1$ = chosen time interval (seconds)

$$\alpha = \frac{\pi d}{\left(\frac{\pi d^2}{2}\right)} = 22.2$$

Elapsed Time (s)	t2 - t1 (secs)	Piezometric Head h (m)	*Avg head* *I* (m)	log (h_1/h_2)	Hydraulic Conductivity k (m/sec)	k (m/day)
0		0.9				
4.8	5	0.78	0.84	0.06	5.55E-04	48
11.65	7	0.7	0.74	0.05	2.92E-04	25
27.22	16	0.6	0.65	0.07	1.82E-04	16
52.05	25	0.5	0.55	0.08	1.33E-04	12
92.05	40	0.4	0.45	0.10	9.98E-05	9
150.01	58	0.3	0.35	0.12	8.69E-05	8
328.01	178	0.1	0.20	0.48	1.13E-04	10
				Average =	2.09E-04	18

Appendix D
Laboratory Test Results

mpl Laboratories
Part of the Envirolab Group ENVIROLAB
16 - 18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
Tel: +61 8 9317 2505 / Fax: +61 8 9317 4163
email: laboratory@mpl.com.au
www.envirolabservices.com.au
Envirolab Services (WA) Pty Ltd ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 168237

Client:
CMW Geosciences
Unit 19 Wembley Green Offices
127 Herdsman Parade
WA 6104

Attention: A Economo

Sample log in details:

Your Reference:	**Ascari Developments**
No. of samples:	11 Soil
Date samples received:	08/07/2015
Date completed instructions received:	08/07/2015
Location:	Lot 502 Tamblyn Place Wellard

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	15/07/15
Date of Preliminary Report:	Not Issued
Issue Date:	15/07/15

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Tests not covered by NATA are denoted with *.

Results Approved By:

Pamela Adams
Assistant Operations Manager

Miscellaneous Inorg - soil						
Our Reference:	UNITS	168237-1	168237-2	168237-3	168237-4	168237-5
Your Reference	----------	HA01	HA02	HA03	HA04	HA05
Depth	----------	0.05-0.2	0.05-0.2	0.05-0.15	0.05-0.2	0.05-0.2
Type of sample		Topsoil	Topsoil	Topsoil	Topsoil	Topsoil
Date prepared	-	13/07/2015	13/07/2015	13/07/2015	13/07/2015	13/07/2015
Date analysed	-	13/07/2015	13/07/2015	13/07/2015	13/07/2015	13/07/2015
Loss on Ignition	%	1.1	7.0	3.4	19	15

Miscellaneous Inorg - soil						
Our Reference:	UNITS	168237-6	168237-7	168237-8	168237-9	168237-10
Your Reference	----------	HA06	HA07	HA09	HA11	HA15
Depth	----------	0.05-0.2	0.05-0.2	0.05-0.2	0.05-0.15	0.05-0.3
Type of sample		Topsoil	Topsoil	Topsoil	Topsoil	Topsoil
Date prepared	-	13/07/2015	13/07/2015	13/07/2015	13/07/2015	13/07/2015
Date analysed	-	13/07/2015	13/07/2015	13/07/2015	13/07/2015	13/07/2015
Loss on Ignition	%	27	8.7	20	1.4	9.8

Miscellaneous Inorg - soil		
Our Reference:	UNITS	168237-11
Your Reference	----------	HA08
Depth	----------	0.05-020
Type of sample		Topsoil
Date prepared	-	13/07/2015
Date analysed	-	13/07/2015
Loss on Ignition	%	3.7

Method ID	Methodology Summary
INORG-092	LOI - Sample is dried, then ignited in a furnace.

Report Comments:

Asbestos Signatories:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Airborne fibres were analysed by Approved Counter: Not applicable for this job

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

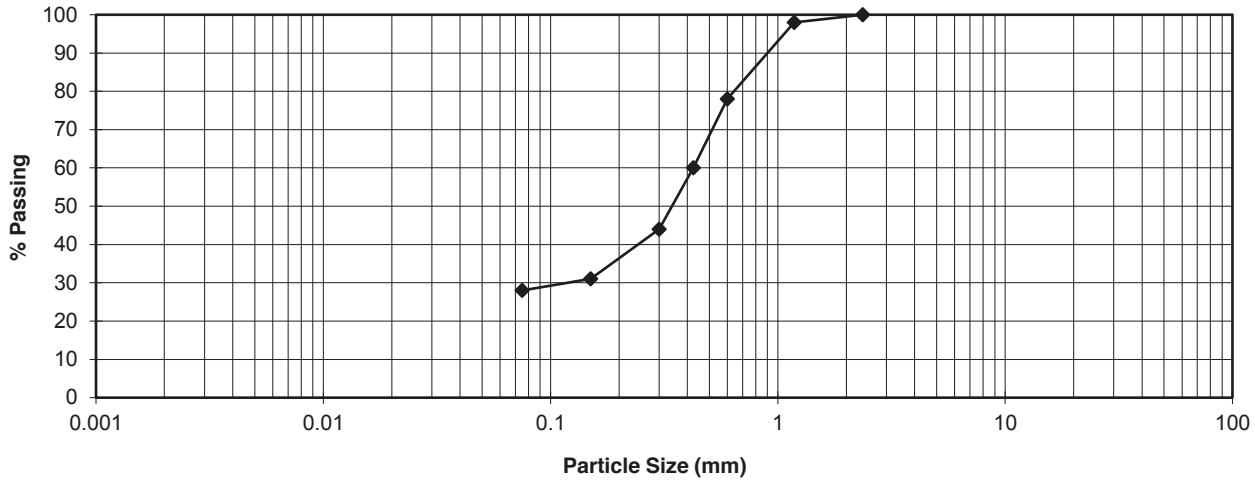
Particle Size Distribution and Plasticity Index tests

Mining &
Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60138
Report No:	60138-P15/4615
Sample No:	P15/4615
Issue Date:	21 July 2015

Client: CMW Geosciences
Project: Lot 502 Tamblyn Place
Location: Wellard

Sample ID: HA03
Sample Depth(m): 0.15 - 0.30



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	78
0.425	60
0.300	44
0.150	31
0.075	28

Plasticity index tests
AS 1289

Liquid limit 3.1.1	65	%
Plastic limit 3.2.1	52	%
Plasticity index 3.3.1	13	%
Linear shrinkage 3.4.1	5.5	%

Cracked ☐

Curled ☐

Client Address: 127 Herdsman Parade, Wembley WA 6014

Sampling Procedure: Tested as received

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Matthew van Herk
AS PSDPI May 2009

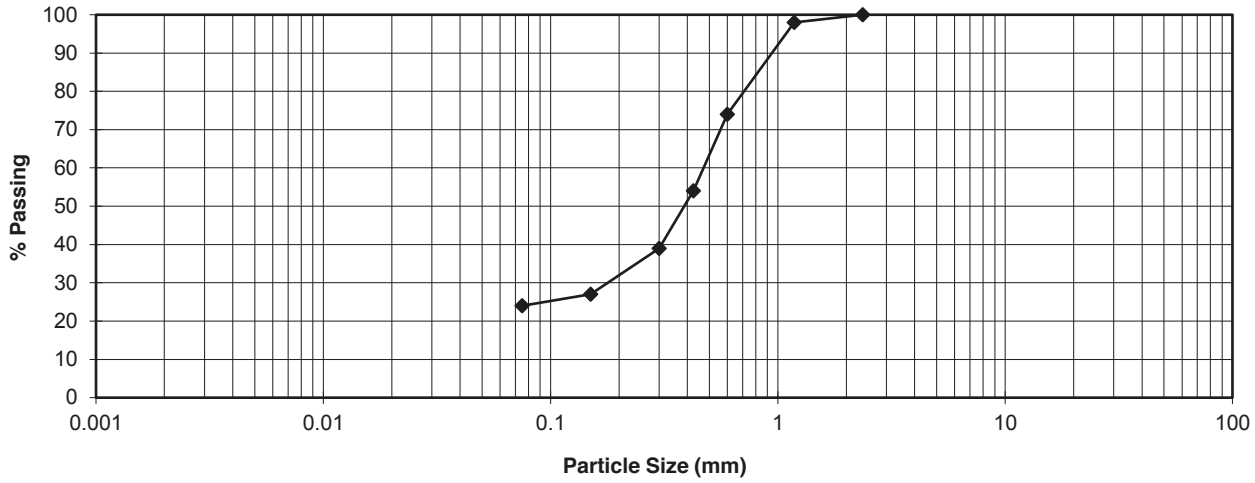
Particle Size Distribution and Plasticity Index tests

Mining &
Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60138
Report No:	60138-P15/4616
Sample No:	P15/4616
Issue Date:	21 July 2015

Client: CMW Geosciences
Project: Lot 502 Tamblyn Place
Location: Wellard

Sample ID: HA04
Sample Depth(m): 0.2 - 0.3



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	74
0.425	54
0.300	39
0.150	27
0.075	24

Plasticity index tests
AS 1289

Liquid limit 3.1.1	73	%
Plastic limit 3.2.1	61	%
Plasticity index 3.3.1	12	%
Linear shrinkage 3.4.1	5.5	%

Cracked ☐

Curled ☑

Client Address: 127 Herdsman Parade, Wembley WA 6014

Sampling Procedure: Tested as received

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Matthew van Herk
AS PSDPI May 2009

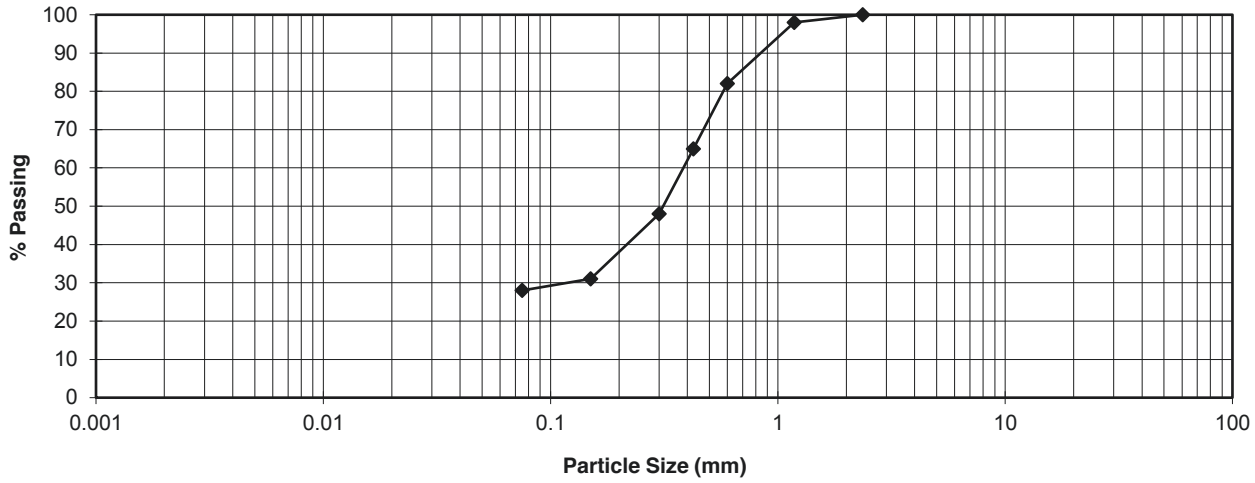
Particle Size Distribution and Plasticity Index tests

Mining &
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Email: matt@mcgeotest.com.au

Job No:	60138
Report No:	60138-P15/4617
Sample No:	P15/4617
Issue Date:	21 July 2015

Client: CMW Geosciences
Project: Lot 502 Tamblyn Place
Location: Wellard

Sample ID: HA06
Sample Depth(m): 0.2 - 0.4



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	98
0.600	82
0.425	65
0.300	48
0.150	31
0.075	28

Plasticity index tests
AS 1289

Liquid limit 3.1.1	48	%
Plastic limit 3.2.1	37	%
Plasticity index 3.3.1	11	%
Linear shrinkage 3.4.1	5.0	%

Cracked ☐

Curled ☐

Client Address: 127 Herdsman Parade, Wembley WA 6014

Sampling Procedure: Tested as received

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Matthew van Herk
AS PSDPI May 2009

Appendix

C

Ground Water Monitoring Data

Table C1 Groundwater Monitoring Date from Lot 502

Date	Bore ID	Time:	Water Level Below TOC (m)	Bore Depth (m)	Confirm Bore Depth	Stick Up Height (m)	Top Of Casing (mAHD)	Ground Level (mAHD)	Depth to Water (mBGL)	Water Level (mAHD)	Well Depth (mBGL)
	W1										
24/08/2015		10:30	2.72	5.92		0.71	9.45	8.74	2.01	6.74	
17/09/2015		8:30	2.63	5.89		0.71	9.45	8.74	1.92	6.82	
26/10/2015		10:15	2.95	6.00	6.01	0.71	9.45	8.74	2.24	6.50	
25/11/2015		16:00	3.03	6.00	6.05	0.71	9.45	8.74	2.32	6.42	
30/12/2015		13:00	3.03	6.00	6.00	0.71	9.45	8.74	2.32	6.42	
19/01/2016		8:30	3.33	5.99		0.71	9.45	8.74	2.62	6.12	
22/02/2016		9:30	3.32	6.00	5.81	0.71	9.45	8.74	2.61	6.13	
15/03/2016		15:00	3.39	6.00	5.79	0.71	9.45	8.74	2.68	6.06	
	W2										
30/07/2015		15:30	1.19	5.00	5.65	0.68	6.75	6.07	0.52	5.56	
24/08/2015		11:00	1.08	5.62	5.65	0.68	6.75	6.07	0.41	5.67	
17/09/2015		9:00	1.08	5.61	5.65	0.68	6.75	6.07	0.41	5.67	
26/10/2015		10:35	1.45	6.00	5.75	0.68	6.75	6.07	0.77	5.30	
25/11/2015		16:15	1.68	6.00	5.76	0.68	6.75	6.07	1.00	5.07	
30/12/2015		13:15	1.72	6.00	5.75	0.68	6.75	6.07	1.04	5.03	
19/01/2016		9:00	1.95	5.76		0.68	6.75	6.07	1.28	4.80	
22/02/2016		9:45	1.89	6.00	5.59	0.68	6.75	6.07	1.22	4.86	
15/03/2016		15:15	1.95	6.00	5.58	0.68	6.75	6.07	1.27	4.80	
	W3										
30/07/2015		15:00	0.66	5.00	5.65	0.64	5.62	4.99	0.02	4.96	
24/08/2015		11:30	0.63	5.64	5.65	0.64	5.62	4.99	-0.01	4.99	
17/09/2015		9:30	0.64	5.64	5.65	0.64	5.62	4.99	0.00	4.99	
26/10/2015		10:50	0.86	6.00	5.78	0.64	5.62	4.99	0.23	4.76	
25/11/2015		16:30	1.12	6.00	5.77	0.64	5.62	4.99	0.49	4.50	
30/12/2015		13:30	1.18	6.00	5.76	0.64	5.62	4.99	0.55	4.44	
19/01/2016		9:30	1.33	5.78		0.64	5.62	4.99	0.69	4.30	
22/02/2016		10:00	1.23	6.00	5.58	0.64	5.62	4.99	0.60	4.39	
15/03/2016		15:30	1.37	6.00	5.57	0.64	5.62	4.99	0.74	4.25	

Source PDC

Table C2 – Groundwater Quality Data from Lot 502

		Time:	Temperature	DO	EC field	TDS	pH fiel	Redox
Date	Bore ID		°C	mg/L	µS/cm	mg/L	pH	mV
	W1							
24/08/2015		10:30	19.5	1.13	336	206	6.51	100
17/09/2015		8:30	19.2	0.71	299	187	6.17	103
26/10/2015		10:20	19.3	0.12	332.2	207.35	6.1	100.2
25/11/2015		16:10	19.9	1.52	339.9	207.35	5.65	-54.2
30/12/2015		13:00	20.5	0.33	321.5	193.6	6.15	-47.7
19/01/2016		8:30	20.7	0.16	313	187	5.91	-81
22/02/2016		9:30	21.5	0.14	320.8	189.2	5.86	-33.1
15/03/2016		15:00	21.8	0.08	331	193.6	6.25	-60.5
			20.30	**0.52**	**324.18**	**196.39**	**6.08**	**3.34**
	W2							
30/07/2015		15:30	15.5	0.16	249.5	171.6	5.57	71.6
24/08/2015		11:00	15.4	0.3	307	207	5.69	40
17/09/2015		9:00	15.2	0.17	361	250	6.05	-74
26/10/2015		10:40	16.4	0.09	291.6	195.8	5.56	-34.1
25/11/2015		16:20	17.9	0.14	293.2	184.25	5.24	-55.2
30/12/2015		13:15	18.9	0.06	283.1	176	5.7	-45.1
19/01/2016		9:00	19.7	0.1	264	161	5.41	-83
22/02/2016		9:45	20.6	0.1	241	144.1	5.4	-31.4
15/03/2016		15:15	20.6	0.06	259.3	155.65	5.75	-49.3
			17.80	**0.13**	**283.30**	**182.82**	**5.60**	**-28.94**
	W3							
30/07/2015		15:00	16.8	0.16	261.4	173.8	5.71	31.7
24/08/2015		11:30	16.5	0.3	261	172	5.4	82
17/09/2015		9:30	16.2	0.14	231	156	5.78	15
26/10/2015		10:55	16.5	0.09	252.9	169.4	5.35	27.1
25/11/2015		16:35	16.9	0.08	258.8	168.3	5.43	-52
30/12/2015		13:30	17.1	0.08	247.1	160.05	5.55	-43.4
19/01/2016		9:30	17.1	0.12	232	150	4.89	-71
22/02/2016		10:00	17.4	0.13	205.3	132	5.11	-43.2
15/03/2016		15:30	17.6	0.06	213.7	136.95	5.51	-52.8
			16.90	**0.13**	**240.36**	**157.61**	**5.41**	**-11.84**

Source PDC

Table C3 – Groundwater Monitoring Data from Lots 503, 504, 505, and Lot 1

Date	MW1-E	MW2-E	MW3-E	MW4-E	MW5-E	MW6-E OLD	MW6-E NEW
1/07/2010	6.29	3.55	Dry	3.78	3.69	4.11	4.07
8/07/2010	6.28	3.57	Dry	3.75	3.68	4.11	4.04
5/08/2010	6.44	4.06	Dry	3.98	3.91	4.46	4.34
8/09/2010	6.42	4.2	Dry	4.14	3.96	4.59	4.61
28/10/2010	6.22	3.9	Dry	3.88	3.95	4.55	4.22
11/11/2010	6.2	3.78	Dry	3.78	3.92	4.84	4.18
9/12/2010	6.09	3.4	Dry	3.33	3.29	3.56	4.6
20/01/2011	5.94	2.71	Dry	2.85	2.77	3.19	3.56
3/02/2011	5.91	2.62	Dry	2.77	2.7	3.13	3.49
8/03/2011	5.79	2.31	Dry	2.55	2.37	3	3.27
12/04/2011	5.6	2.23	Dry	2.53	2.48	3.17	3.13
10/05/2011	Dry	2.38	Dry	2.66	2.6	3.18	3.17
26/07/2011	6.19	3.38	Dry	3.79	3.68	4.01	3.84
7/09/2011	6.58	3.21	Dry	4.05	3.98	4.54	4.64
6/10/2011	6.59	4.02	Dry	4.08	4.045	4.286	4.206

Source: ENV

Table C4 – Groundwater Quality Data from Lots 503, 504, 505, and Lot 1

		pH	EC	Total P	FRP	Total N	NH3	TKN	Nox	Nitrate	Nitrite
Date	Bore ID		uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	MW1-E										
8/07/2010		7.3	810	1.3	0.25	3.8	0.02	3		0.72	0.039
28/10/2010		7.6	530	1.3	0.3	1.3	0.02	1.2	0.092		
20/01/2011		7.7	510	0.79	0.17	3.7	0.047	0.9	2.8		
1/12/2011		7.6	1200	0.67	0.12	4	0.1	3.9	0.09	0.04	0.04
	MW2-E										
8/07/2010		7.6	1200	0.58	<0.005	1.1	0.57	1.1		0.007	<0.05
28/10/2010		7.4	1000	0.12	<0.005	1.3	0.64	1.2	0.008		
20/01/2011		7.7	910	0.21	0.03	1.7	0.65	1.4	0.28		
10/05/2011		7.5	1200	0.17	0.02	5.6	0.13	5.6	<0.03		
14/06/2011		7.2	1100	0.86	0.05	1.9	0.41	1.9	<0.04		
6/10/2011		7.7	1300	0.46	0.02	1	0.43	1	<0.05	<0.02	<0.02

1/12/2011		7.7	1300	0.43	0.04	1.9	0.05	1.4	0.52	0.41	0.12
	MW4-E										
8/07/2010		7.8	1600	0.46	<0.005	2.3		2.1		0.14	0.023
28/10/2010		7.6	780	0.15	<0.005	1.7	0.53	1.6	0.033		
20/01/2011		7.6	670	0.12	0.03	7.2	0.75	6.9	0.26		
10/05/2011		8	800	0.32	0.02	7.3	0.55	7.3	<0.05		
14/06/2011		7.7	810	0.09	0.03	5.1	0.25	5	0.11		
6/10/2011		7.8	880	0.21	<0.01	1.6	0.35	1.1	0.53	0.04	0.48
1/12/2011		7.8	950	0.27	0.03	1.8	0.21	1.5	0.28	0.22	0.06
	MW5-E										
8/07/2010		7.5	1800	0.38	<0.005	1.7	0.37	1.6		0.068	0.036
28/10/2010		7.1	950	0.12	0.008	1.3	0.19	1.3	0.031		
20/01/2011		7.6	1200	0.3	0.03	7.2	1	6.9	0.31		
10/05/2011		7.6	1400	<0.05	0.03	13	0.72	13	<0.05		

14/06/2011		7.3	3400	0.3	0.04	5.8	0.15	5.8	<0.05		
6/10/2011		7.7	890	0.47	<0.01	1.5	0.41	1.4	0.1	0.1	<0.02
1/12/2011		7.6	1600	0.14	0.01	1.6	0.47	1.6	<0.05	<0.02	0.07
	MW6-E										
8/07/2010		7.1	3000	0.88	<0.005	13	1.1	10		1.5	1.5
28/10/2010		6.5	2100	0.07	<0.005	3.3	0.56	3.1	0.18		
20/01/2011		7.3	1900	0.08	0.03	7.1	0.26	6.7	0.4		
10/05/2011		7.4	2500	0.09	0.02	5.6	0.32	5.4	0.19		
14/06/2011		7.3	680	0.79	0.04	13	0.02	6.5	6.2		
6/10/2011		6.8	2000	<0.05	<0.01	11	0.03	8.1	2.4	2.2	0.22
1/12/2011		6.4	2400	0.41	<0.01	3.9	0.31	3.7	0.23	0.2	0.03
	MW6										
8/07/2010		7.4	2200	0.38	<0.005	12	0.28	7.8		4	0.22
28/10/2010		6.9	2100	0.03	<0.005	2.7	0.36	2.4	0.36		

20/01/2011		7.5	1300	0.091	0.05	8.3	0.49	7.6	0.72		
10/05/2011		7.3	1700	0.46	0.04	5.7	0.31	5.5	0.18		
14/06/2011		7.1	1900	0.58	0.05	8.9	0.02	3.2	5.7		

ANZECC Lowland River	6.5-8		0.065	0.04	1.2			0.15		
SCCP Long Term Target			0.1		1					
SCCP Short Term Target			0.2		2					

Source: ENV

Table C5 – Lot 900 Groundwater Quality Data

Parameter (all units mg/L except where stated)	Aquatic Ecosystems **A**	Irrigation Water **B**	ASS **C**	T1	T2	T3	T4	T5
pH (field)	6.5 - 8	6.5 - 8	6	6.2	6.5	8.8	6.7	7.7
pH (lab)	6.5 - 8	6.5 - 8	6	6.4	6.5	6.8	6.2	7
Temp (field) (C̊)	ng	ng	ng	20.4	21.4	20.4	20.9	19
Conductivity (field) (mS/cm)	0.12-0.3	1.3	ng	0.34	0.33	0.41	0.37	0.43
Total Dissolved Solids	ng	ng	ng	280	340	410	230	360
Total Acidity (CaCO3)	ng	ng	40	6	<5	8	<5	<5
Total Alkalinity (CaCO3)	ng	ng	ng	26	23	65	27	95
Sulphate (SO4)	ng	ng	ng	30	27	42	24	41
Acidity:Alkalinity Ratio	ng	ng	1	0.32	<0.22	0.12	<0.19	<0.05
Alkalinity:Sulphate Ratio	ng	ng	5	0.87	0.85	1.55	1.13	2.32
Total Nitrogen	1.2	5	ng	7.4	7.5	5.8	3.6	4.6
Total Kjeldahl Nitrogen	ng	ng	ng	<0.2	<0.2	<0.2	<0.2	<0.2
Nitrate + Nitrite	0.15	ng	ng	7.4	7.5	5.8	3.5	4.6
Total Filterable Phosphorus	0.065	ng	ng	0.61	0.83	0.31	0.12	0.56

Filterable Reactive Phosphorus	0.04	ng	ng	<0.01	<0.01	<0.01	<0.01	0.04
Aluminium	0.055	5	1	<0.1	0.1	<0.1	<0.1	<0.1
Arsenic	0.013	0.1	ng	<0.001	0.002	<0.001	<0.001	0.003
Cadmium	0.0002	0.01	ng	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (VI)	0.013	0.1	ng	<0.002	<0.002	<0.002	<0.002	<0.002
Copper			ng	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	ng	0.2	ng	0.06	1.3	0.04	0.05	0.43
Lead			ng	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury			ng	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Zinc	0.008	2	ng	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

ng denotes " no guideline ".

A.ANZECC (2000) Aquatic Ecosystem trigger values for nutrients and pH in lowland rivers.

B. ANZECC (2000) Irrigation trigger values (long term irrigation upto 100 years

C. Standing Advice from DoE LWQB on dewatering trigger values taken from ASS Guideline Series (2004)

D. Guidelines for Al applies only to waters with pH > 6.5

Values in **BOLD** indicate Breach of relevant criterion

Source: Bayley Environmental Services

pdc
Engineering Evolved

Appendix

D

GHD Flood Modelling Summary (GHD 2010)

Memorandum

25 November 2010

To	Darren Evans, Greg Rowe & Associates		
Copy to			
From	Helen Brookes	Tel	61 8 6222 8702
Subject	Development of Bollard Bullrush Swamp	Job no.	61/25042/01

Please note that this memorandum supersedes all previous communications on this matter and that it should not be released or reproduced by any party until the Department of Water have given formal approval for the modelling.

Introduction

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

GHD have been engaged to undertake preliminary investigations into the impact of the proposed fill for the purposes of a rezoning application. The results of this preliminary modelling are not intended for publication at this time and may not be published until they have been reviewed and approved by the Department of Water and the Water Corporation.

Methodology

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

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

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

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

Table 1 Land use impervious areas

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

Table 2 Runoff surface characteristics

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

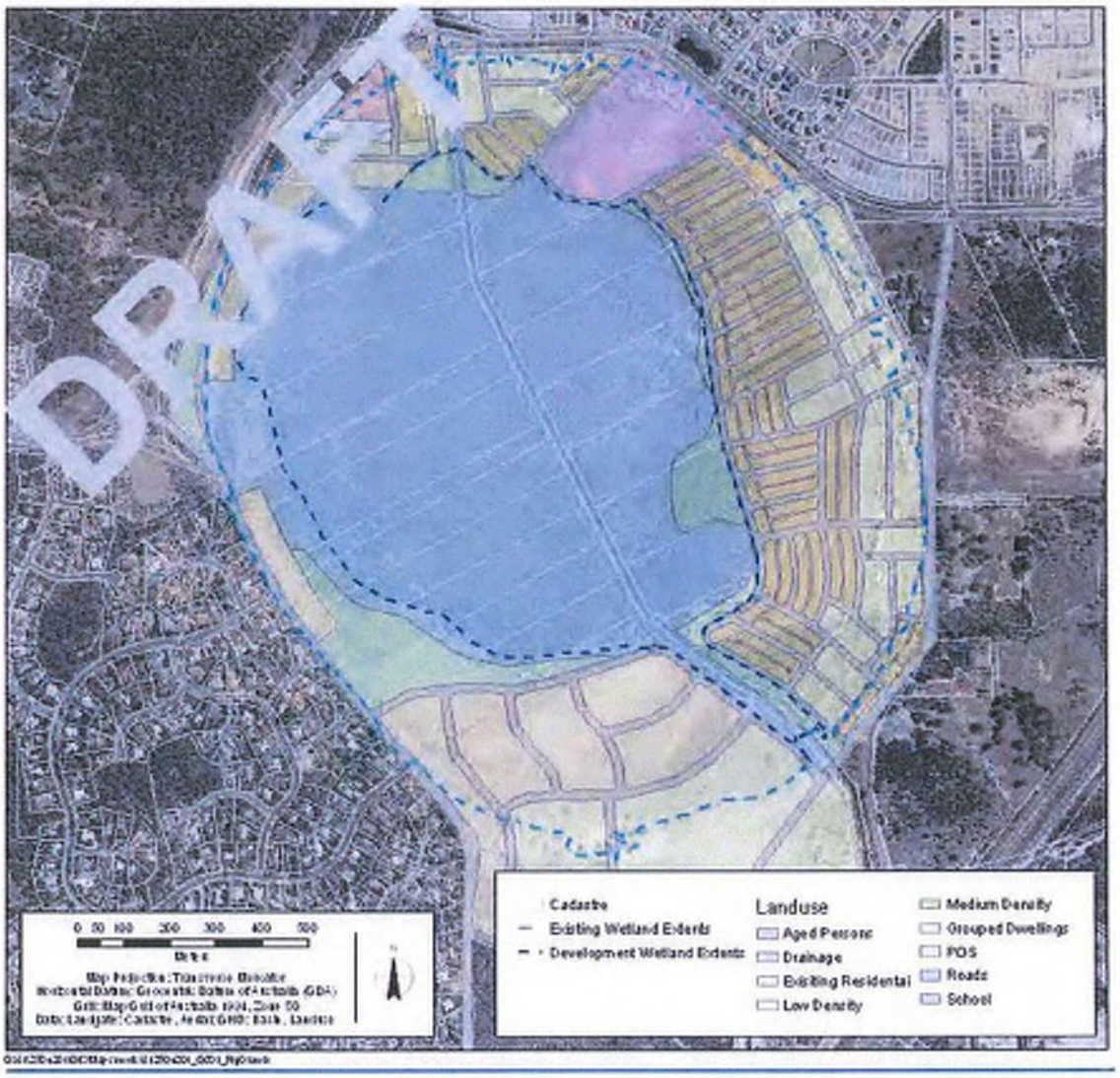


Figure 1 Exiting and Ultimate Wetland Extents with Proposed Landuse

Notes to figure 1:

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

Results

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

Table 3 Jandakot Drainage and Water Management Plan modelling results

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

Table 4 Modelling of full extent of proposed development

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

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

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

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

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

Conclusions

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

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

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

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

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

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

Recommendations:

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

Helen Brookes
Manager, Waterways

Appendix

E

Water Supply Consumption Tool

Introduction

Welcome to the Water Corporation's Water Supply Consumption Tool. This tool is designed to assist in profiling anticipated water use for your development. It can be used to characterise water use in Residential developments, Schools, Commercial and Industrial areas.

Simply enter information about your development into the yellow boxes in each data sheet, and the model calculates the water consumption per annum based on the figures in the Parameters & Assumptions data sheet.

To ensure that you capture all of your land, the model will check the information you enter in each sheet against the total development area you have specified, for example the total area of Residential development, and the model adds up the block sizes specified and checks if that matches the total. A warning message is displayed if it does not, however this won't stop the model from working.

Below are some notes to assist you as you work through each of the data sheets in the model. To get started select the Water Summary data sheet and then work through each of the pages.

Water Summary

This page shows the Water Supply and Water Use summaries including the kL/person/year (both Total and Scheme) and the total kL/year metrics. It also asks for information such as the total area of the development (yellow boxes), this is then checked against each of the area totals for each subsection (which is taken from the respective page). All other information is taken from the other sheets you complete.

1. Residential

The household types, number of lots and lot sizes are entered here. The total area of the Residential component is entered at the top of the page. The model allows for up to 20 different household type/lot size combinations. For example, Traditional houses with lot sizes 400 and 450 m^2 can be entered on different lines. The Irrigation area is set as a default of 25% of the lot size but this can be overwritten.

Your Alternative Water Supply Source is specified at the bottom of the page. Note that if a check box is not ticked then the model will ignore this source, even if a value is entered in one of the boxes.

2. Schools

The type of School and numbers of students are entered here. The total area of the School should be entered at the top of the page. Up to five schools can be entered into the model. The model requires the total number of students per school and the total area, including Irrigation area. The Irrigation area is set as a default of 40% of the school but this can be overwritten.

Your Alternative Water Supply Source is specified at the bottom of the page. Note that if a check box is not ticked then the model will ignore this source, even if a value is entered in one of the boxes.

3. Commercial & Industrial

Commercial & Industrial types are entered here. The total area of the Commercial & Industrial component should be entered at the top of the page. Up to 15 types of Industry can be specified in the model. Depending on the type of industry, different information is required. In all cases the total land area of the industry type is required.

Your Alternative Water Supply Sourceis specified at the bottom of the page. Note that if a check box is not ticked then the model will ignore this source, even if a value is entered in one of the boxes.

4. POS, Roads & Verges

The total area of the POS, Roads & Verges component should be entered at the top of the page. The areas of POS are required including Bushland – which is assumed to have a zero water requirement. For Active POS, you are also asked to estimate the Water Use of Amenities associated – such as drinking water fountains, shower blocks, etc – as this is out of scope for the model.

Your Alternative Water Supply Source is specified at the bottom of the page. Note that if a check box is not ticked then the model will ignore this source, even if a value is entered in one of the boxes.

5. Other

The total area of the Other component should be entered at the top of the page. This data sheet is designed to capture any small areas that have not been covered and also Infrastructure Corridors. The areas specified should not be substantive (with the possible exception of Infrastructure Corridors) and should only be used as a means to ensure the total area of the development tallies.

This data sheet requires that the subsection totals have been entered otherwise the area entered here will be ignored.

Your Alternative Water Supply Source is not specified here as it is assumed the alternatives specified in the respective pages are used.

Water Use Summary

The Water Use tool is primarily aimed at residential developments but can handle mixed developments.

Developer:	Ascari Developments
Development Name:	Lot 502 Tamblyn Place Wellard
Date Of Entry:	1/09/2015
Total Area of Development (m^2):	44,792

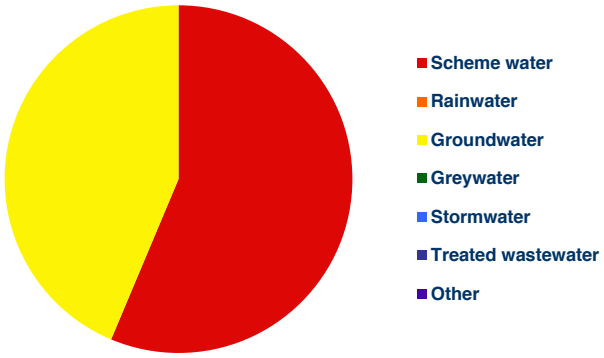
Area Totals Match

Help/Notes (Click)

Water Supply

Water supply by source type in kL/year.

Scheme water[1]	11,105
Rainwater	0
Groundwater	8,607
Greywater	0
Stormwater	0
Treated wastewater	0
Other	0



Water Use

Water use for total development and by sub-section.

	Total Water (kL/person/year)	Scheme Water (kL/person/year)	Development Consumption (kL/year)
Consumption Indicators	62	62	19,712

Development Summary

Click on subsection to go to page.

		Area (m^2)	Irrigation (kL/year)	Drinking[1] (kL/year)	Non-Drinking (kL/year)
1.	Residential	25,216	46	6,167	4,891
2.	Schools				
3.	Commercial & Industrial				
4.	Public Open Spaces, Roads, Footpaths & Verges	19,576	8,607		
5.	Other				
	TOTAL	44,792	8,653	6,167	4,891

[1] All drinking water needs are met by Scheme water.

1. Residential



Please Enter Total Residential Area

Total Area (m^2): 25,216

Area Running Total (m^2): 25,216 **Area Totals Match**

Total Residential Water Use

Summary Page (Click)

Summary

kL/Person/Year (Total)	62
kL/Person/Year (Scheme)	62
kL/Year (Total)	11,105
kL/Year (Irrigation)	46
kL/Year (Drinking)	6,167
kL/Year (Non-Drinking)	4,891

Residential Information

Summary Page (Click)

Multiple residency types are possible.

Help/Notes (Click)

Household Type	Lots	Households (per Lot)	Area (m^2/Lot)	Irrigation Area (m^2/Lot)
Traditional	64	1	394	1

Water Sources

Summary Page (Click)

Select possible water sources and their contribution to Irrigation or Non-Drinking water use.

Model only uses water source when check box is ticked.

Source	Select Source(s)	Source Contribution (%) Irrigation	Non-Drinking
Scheme water		100	100
Rainwater*		0	0
Groundwater			
Greywater			
Stormwater			
Treated wastewater			
Other	☐		
TOTAL ALTERNATE		0	0

Apply Rainwater to:
Irrigation
Non-drinking

* Rainwater proportion calculated automatically and split between Irrigation and Non-drinking

2. Schools

Please Enter Total School Area

Total Area (m^2):

Area Running Total (m^2):

Total Schools Water Use

Summary Page (Click)

Summary

kL/Year (Total)	0
kL/Year (Irrigation)	0
kL/Year (Drinking)	0
kL/Year (Non-Drinking)	0

School Information

Summary Page (Click)

Multiple school sizes are possible.

Help/Notes (Click)

School Type	Students	Area (m^2/School)	Irrigation Area (m^2/School)

Water Sources

Summary Page (Click)

Select possible water sources and their contribution to Irrigation or Non-Drinking water use.

Model only uses water source when check box is ticked.

Source	Select Source(s)	Source Contribution (%) Irrigation	Non-Drinking
Scheme water		0	100
Rainwater*	☐	0	0
Groundwater	☑	100	0
Greywater	☐		
Stormwater	☐		
Treated wastewater	☐		
Other	☐		
TOTAL ALTERNATE		100	0

Apply Rainwater to:
- ☐ Irrigation
- ☐ Non-drinking

* Rainwater proportion calculated automatically and split between Irrigation and Non-drinking

3. Commercial & Industrial



Please Enter Total Commercial & Industrial Area

Total Area (m^2):

Area Running Total (m^2):

Total Commercial & Industrial Water Use

Summary Page (Click)

Summary

kL/Year (Total)	0
kL/Year (Irrigation)	0
kL/Year (Drinking)	0
kL/Year (Non-Drinking)	0

Commercial & Industrial Information

Summary Page (Click)

Multiple types of Hotel, Nursing Home and Hospital are possible.

Help/Notes (Click)

Use the check boxes at the end of each line to indicate the use of alternative water sources.

Commercial Type	Gross Area (m^2)	Gross Lettable Area[1] (m^2)	Number of Units[2]	Unit Type	
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐

[1] For Commercial/Office spaces, Retail Centres and Light Industrial/General Purpose only.

[2] For Aquatic Centres, Other Sporting Facilities and Commercial Laundries only.

Water Sources

Summary Page (Click)

Select possible water sources and their contribution to Irrigation or Non-Drinking water use.

Model only uses water source when check box is ticked.

Source	Select Source(s)	Source Contribution (%) Irrigation	Non-Drinking
Scheme water		100	100
Rainwater*			
Groundwater	☐		
Greywater	☐		
Stormwater	☐		
Treated wastewater	☐		
Other	☐		
TOTAL ALTERNATE		0	0

* Rainwater not an alternative source for Commercial & Industrial

4. POS, Roads & Verges



Please Enter Total POS, Roads & Verges Area

Total Area (m^2): 19,576

Area Running Total (m^2): 19,576 Area Totals Match

Total POS, Roads & Verges Water Use

Summary Page (Click)

Summary

kL/Year (Total)	8,607
kL/Year (Irrigation)	8,607
kL/Year (Drinking)	0
kL/Year (Non-Drinking)	0

POS, Roads & Verges Information

Summary Page (Click)
Help/Notes (Click)

For Active POS, please estimate the total water use by amenities.
E.g. water fountains and shower cubicles.

Public Open Space	Area (m^2)	Amenities (kL/Year)
Active	3,031	
Passive	7,387	
Bushland		
Roads & Paths	9,158	
Verges		
Street Scaping	0	

Water Sources

Summary Page (Click)

Select possible water sources and their contribution to Irrigation or Non-Drinking water use.
Model only uses water source when check box is ticked.

Source	Select Source(s)	Source Contribution (%) Irrigation	Non-Drinking[1]
Scheme water		0	100
Rainwater[2]			
Groundwater	☑	100	0
Greywater	☐		
Stormwater	☐		
Treated wastewater	☐		
Other	☐		
TOTAL ALTERNATE		100	0

[1] Non-Drinking water use for POS amenities.
[2] Rainwater not an alternative source for POS, Roads & Verges

5. Other

Please Enter Total Other Area

Total Area (m^2):

Area Running Total (m^2):

Total Other Water Use

Summary Page (Click)

Summary	
kL/Year (Total)	0
kL/Year (Irrigation)	0
kL/Year (Drinking)	0
kL/Year (Non-Drinking)	0

Other Information

Summary Page (Click)

Total Areas on each subsection must have been completed for this to function. Help/Notes (Click)

At least one Total Area has not been completed. The component will be ignored until they have.

Area Type	Area (m^2)
Residential	
Schools	
Commercial & Industrial	
POS, Roads & Verges	
Infrastructure Corridor	





WATER USAGE

1. Residential

1.1 Household Use	Estimate	Units	Source	Water Use	Notes
Garden Irrigation	0.002	kL/m^2/day	Water Corporation	Irrigation	10mm*9apps*8months/365.25days
Shower	0.050	kL/person/day	Diversity Australia	Drinking Water	
Kitchen sink	0.008	kL/person/day	Diversity Australia	Drinking Water	
Bathroom basin	0.006	kL/person/day	Diversity Australia	Drinking Water	
Dishwasher	0.003	kL/person/day	Diversity Australia	Drinking Water	
Bath	0.001	kL/person/day	Diversity Australia	Drinking Water	
Laundry trough	0.004	kL/person/day	Diversity Australia	Drinking Water	
Leaks	0.029	kL/household/day	Diversity Australia	Drinking Water	
Pool	0.020	kL/household/day	Diversity Australia	Drinking Water	
Spa	0.002	kL/household/day	Diversity Australia	Drinking Water	
Car washing	0.002	kL/household/day	Diversity Australia	Drinking Water	
Evaporative cooling	0.006	kL/household/day	Diversity Australia	Drinking Water	
Other	0.004	kL/household/day	Diversity Australia	Drinking Water	
Toilet	0.033	kL/person/day	Diversity Australia	Non-Drinking Water	
Washing machine	0.042	kL/person/day	Diversity Australia	Non-Drinking Water	

1.2 Household Type	Estimate	Units	Source	Notes
Traditional	2.790	Average # of Residents	2001 ABS Census	
Terraced	1.730	Average # of Residents	2001 ABS Census	
Cottage	1.810	Average # of Residents	2001 ABS Census	
Apartment	1.480	Average # of Residents	2001 ABS Census	
Lifestyle	2.790	Average # of Residents	2001 ABS Census	

2. Schools

2.1 School Size	Estimate	Units	Source	Notes
<100 Students	31.070	kL/Student/year	Water Corporation	
100 to 500 Students	8.710	kL/Student/year	Water Corporation	
501 to 1000 Students	7.060	kL/Student/year	Water Corporation	
>1000 Students	10.140	kL/Student/year	Water Corporation	
Irrigation	0.960	kL/m2/year		This is the midpoint between Active and Passive POS irrigation requirements.

2.2 School Non-Irrigation Water Usage Percentage

Parameter	Estimate	Units	Source	Notes
Drinking	60	%	Diversity Australia	Specify Drinking proportion and non-drinking is automatically calculated
Non-Drinking	40	%	Diversity Australia	
Scheme Water Supply/Total Water Supply For Schools	100	%	Estimate	

3. Commercial and Industrial

3.1 Entity Type	Constraint	Estimate	Units	Source	Notes
Shopping Centre	N/A	1.080	kL/m^2 GLA/year	Water Corporation	
Office Building	N/A	0.800	kL/m^2 GLA/year	Water Corporation	
Light Industrial	N/A	0.940	kL/m^2 GLA/year	Estimate	Mid point between Shopping Centres and Office Buildings
Hospital	≤300 Beds	185.820	kL/bed/year	Water Corporation	
Hospital	>300 Beds	269.350	kL/bed/year	Water Corporation	
Nursing Home	≤60 Beds	144.490	kL/bed/year	Water Corporation	
Nursing Home	>60 Beds	109.390	kL/bed/year	Water Corporation	
Hotel	≤250 Rooms	104.530	kL/room/year	Water Corporation	
Hotel	>250 Rooms	192.010	kL/room/year	Water Corporation	
Commercial Laundry	N/A	44834.400	kL/entity/year	Water Corporation	
Aquatic Centre	N/A	14600.000	kL/entity/year	Water Corporation	
Other Sporting Facility	N/A	14600.000	kL/entity/year	Water Corporation	

3.2 Commercial Laundries	
Assumed kgs/week for Commercial Laundries	60,000
L/kg/week	14

3.3 Aquatic Centres	
Assumed visitors/day	500
L/visitor/day	80

3.4 Water Usage Percentage Entity Type	Irrigation	Drinking Water	Non-Drinking Water
Shopping Centre	5%	60%	35%
Office Building	5%	60%	35%
Light Industrial	5%	60%	35%
Hospital	5%	60%	35%
Nursing Home	5%	60%	35%
Hotel	5%	60%	40%
Commercial Laundry	0%	5%	95%
Aquatic Centre	5%	80%	15%
Other Sporting Facility	5%	80%	15%

3.5 Scheme Water Supply/Total Water Supply for Entity Type Entity Type	Percentage
Shopping Centre	100%
Office Building	100%
Light Industrial	100%
Hospital	100%
Nursing Home	100%
Hotel	100%
Commercial Laundry	100%
Aquatic Centre	100%
Other Sporting Facility	100%





4. Public Open Spaces

4.1 Public Open Space	Estimate	Units	Source	Water Use
Public Open Space - Active	1.280	kL/m^2/year	Water Corporation	Irrigation
Public Open Space - Passive	0.640	kL/m^2/year	Water Corporation	Irrigation
Public Open Space - Amenity Drinking/Non-drinking ratio	0.50	%	Estimate	Drinking

4.2 Verges and Street Scaping	Estimate	Units	Source	Water Use
Verges	0.640	kL/m^2/year	Water Corporation	Irrigation
Street Scaping	0.640	kL/m^2/year	Water Corporation	Irrigation

WATER SUPPLY

1. Rainwater

1.1 Rainfall Collection	Estimate	Units	Source	Notes
Average Annual Rainfall	700	mm/m2/year	Estimate	Metro area only
Rain correction	24	mm/m2/year	http://enhealth.nphp.gov.au	For evaporation, roof wetting, etc
Efficiency factor	80%	%	Estimate	Conversion of rainfall to rain capture

1.2 Storage capacity	Estimate	Units	Source	Notes
Traditional	2.000	kL/household	Estimate	Total capacity per household
Terraced	2.000	kL/household	Estimate	Total capacity per household
Cottage	2.000	kL/household	Estimate	Total capacity per household
Apartment	5.000	kL/lot	Estimate	Total capacity per lot
Lifestyle	10.000	kL/household	Estimate	Total capacity per household
Schools	10.000	kL/household	Estimate	Total capacity per school
Proportion used for Irrigation (Residential)	0.50	%	Estimate	The remainder is then allocated to Non-drinking water use
Proportion used for Irrigation (Schools)	0.50	%	Estimate	The remainder is then allocated to Non-drinking water use

1.3 Percentage of lot that is roofing	Estimate	Units	Source	Notes
Traditional	50	%	Estimate	
Terraced	50	%	Estimate	
Cottage	50	%	Estimate	
Apartment	50	%	Estimate	
Lifestyle	25	%	Estimate	
Schools	10	%	Estimate	

Appendix

F

Landscaping Concept Plan

MAINTENANCE ACCESS TO POS (HARDSTAND)

SITE BOUNDARY

BIOFILTRATION AREA : ROADSIDE GARDENS (RAIN GARDENS) AS PER PREPARED LWMS AND UWMP. LOW PLANTING SO AS NOT TO OBSTRUCT SIGHTLINES WITH UPPER STOREY TREE CANOPY.

OPEN LAWN AREA (IRRIGATED TURF) FOR PASSIVE RECREATION. NATIVE SHADE TREES TO ENHANCE VIEWS TO WETLAND.

CONCRETE SHARED-USE PATH PROVIDES ACCESS INTO POS AND A HARD EDGE DEFINING IRRIGATED TURF AREA FROM NUTRIENT INTERCEPTION BUFFER.

DOG-PROOF FENCE ALONG 50.0 METRE BUFFER BOUNDARY

TURF

WETLAND BUFFER

50.0 METRE WETLAND BUFFER

NUTRIENT INTERCEPTION BUFFER PLANTED WITH LOCAL NATIVE SPECIES, AND FIRE RETARDANT PLANTS.

THE WETLAND BUFFER WILL CONSIST OF NON-IRRIGATED DRYLAND TUBESTOCK PLANTING TO ASSIST IN PROVIDING A STABLE PLANTED SURFACE THAT ACCOMMODATES SOME ENVIRONMENTAL IMPROVEMENT WHILE MAINTAINING ALL FIRE SETBACK AND PLANTING DENSITY REQUIREMENTS. PLANT SPECIES WILL COMPLY WITH THE REQUIREMENTS FOR LOW THREAT VEGETATION LISTED IN AS3959-2009 AND CROSS-REFERENCED WITH COUNCIL'S PREFERRED ENVIRONMENTAL PLANTING SUGGESTIONS. CLEAR VIEWS TO THE EXISTING WETLAND TREES WILL BE MAINTAINED.

EXISTING DENSE VEGETATION (TREES) RETAINED WHERE POSSIBLE

BOLLARD BULRUSH SWAMP

REVEGETATION OF WETLAND BUFFER TO BE IN ACCORDANCE WITH THE WETLAND MANAGEMENT PLAN.

SITE BOUNDARY

BIOFILTRATION AREA : ROADSIDE GARDENS (RAIN GARDENS) AS PER PREPARED LWMS AND UWMP.

DOG-PROOF FENCE TO WETLAND BUFFER BOUNDARY TO RESTRICT ACCESS & PROTECT WETLAND.

LOT 502 TAMBLYN PLACE, WELLARD

PUBLIC OPEN SPACE - LANDSCAPE CONCEPT PLAN

NORTH

SCALE 1:500@A3

OCTOBER 2015

Appendix E – Bushfire Management Plan – RUIC Fire

BAL ASSESSMENTS | BUSHFIRE MANAGEMENT PLANS | CONSULTANCY

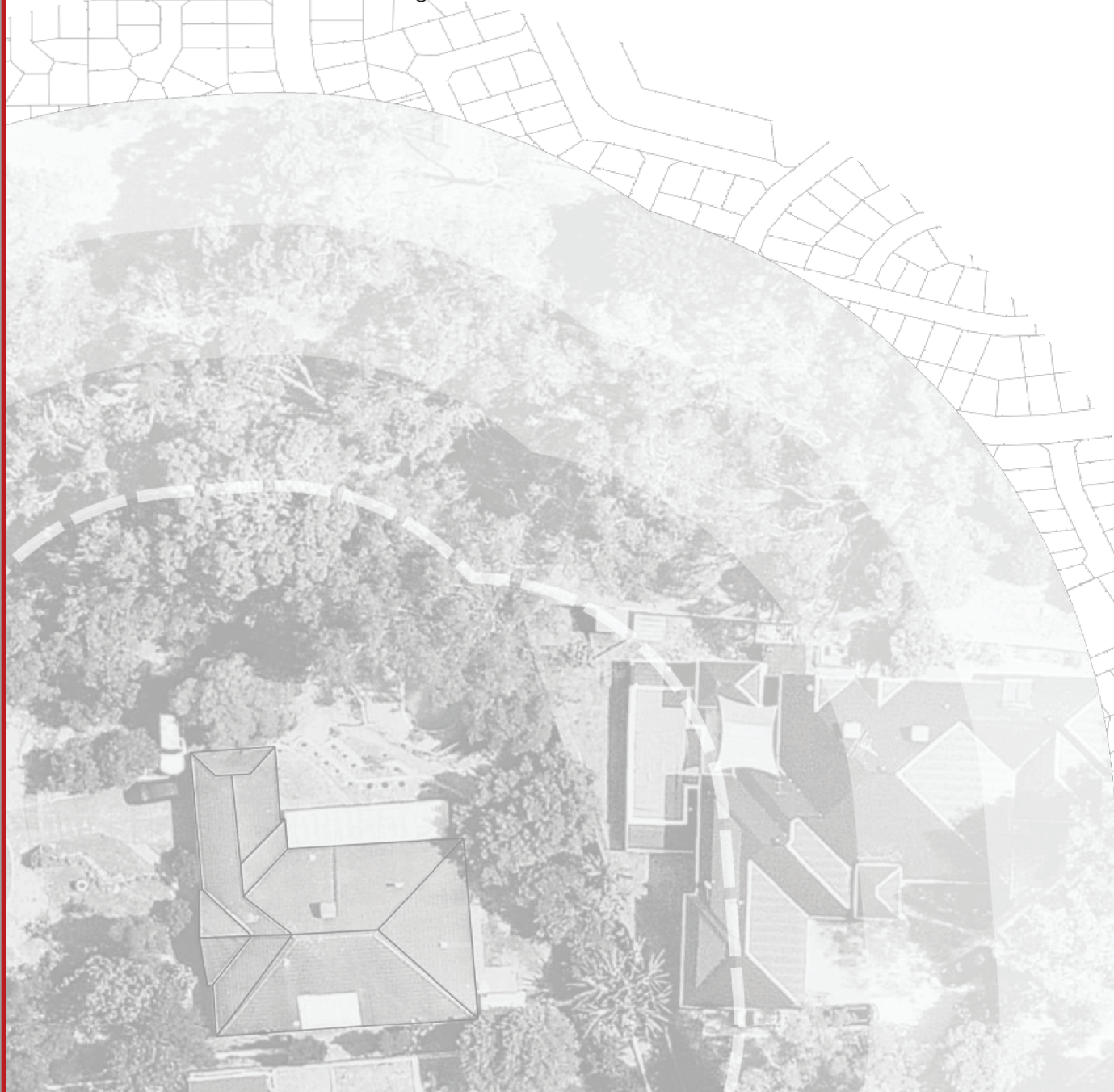
RUIC FIRE

BUSHFIRE MANAGEMENT PLAN

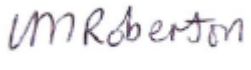
Subdivision Application

Lot 502 Tamblyn Place, Wellard

Version: 1.1 Reference: 5434 August 2016



Project Number:	5434
Project Name:	Lot 502 Tamblyn Place, Wellard
Author:	Louisa Robertson, BPAD36748 Level 1, MSc
Approved by:	Darrel Krammer, BPAD33412 Level 1, Grad Cert Bushfire Protection
Version:	1.1
Date of issue:	12th August 2016



Author: Louisa Robertson
Date: 12th August 2016



Approved by: Darrel Krammer
Date: 12th August 2016

In the signing the above, the author declares that this Bushfire Management Plan meets the requirements of State Planning Policy 3.7. This report supersedes all previous Bushfire Management Plans for the site.

DISCLAIMER AND LIMITATION

This report is prepared solely for **Ascari Developments Pty Ltd** (the 'proponent') and any future landowners of the subject lot(s)and is not for the benefit of any other person and may not be relied upon by any other person.

The mitigation strategies contained in this Bushfire Management Plan are considered to be prudent minimum standards only, based on the writer's experience as well as standards prescribed by relevant authorities. It is expressly stated that RUIC Fire and the writer do not guarantee that if such standards are complied with or if a property owner exercises prudence, that a building or property will not be damaged or that lives will not be lost in a bush fire.

Fire is an extremely unpredictable force of nature. Changing climatic factors (whether predictable or otherwise) either before or at the time of a fire can also significantly affect the nature of a fire and in a bushfire prone area it is not possible to completely guard against bushfire.

Further, the growth, planting or removal of vegetation; poor maintenance of any fire prevention measures; addition of structures not included in this report; or other activity can and will change the bushfire threat to all properties detailed in the report. Further, the achievement of the level of implementation of fire precautions will depend on the actions of the landowner or occupiers of the land, over which RUIC Fire has no control. If the proponent becomes concerned about changing factors then a new Fire Risk Management Plan should be requested.

To the maximum extent permitted by the law, RUIC Fire, its employees, officers, agents and the writer ("RUIC Fire") excludes all liability whatsoever for:

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2. errors or omissions in this report except where grossly negligent; and

the proponent expressly acknowledges that they have been made aware of this exclusion and that such exclusion of liability is reasonable in all the circumstances.

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This report is valid for a period of three years only from the date of its issue. All BAL ratings identified in this report are indicative and are required to be verified at the time of construction of individual buildings to ensure appropriate setbacks identified in the proposed development have been achieved.

RUIC Fire is a trading name of

Rural Fire Risk Consultancy Pty Ltd

ABN: 48 151 451 713

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1.0 Introduction

1.1 Subject Site

The site the subject of this Bushfire Management Plan (BMP) is Lot 502 Tamblyn Place, Wellard. The site is located within the municipality of the City of Kwinana. Figure 1A illustrates the subject site and its immediate surrounds.

The site is identified as being Bushfire Prone on the State Bushfire Prone Maps.

The site contains a Conservation Category Wetland (CCW) that is to be retained within the site as well as a 50 metre wide wetland buffer that is to be revegetated. The urban portion of the site was not found to contain any Threatened or Priority Flora Species or Threatened or Priority Ecological Communities or Rare Fauna (ENV Australia, 2013). The Landscape Master Plan and Landscape Concept Plans for the site are included in the Appendices.

1.2 Development Description

The development involves the subdivision of Lot 502 Tamblyn Place into 68 residential lots and 1.0442 hectares of POS and drainage (the development). The proposed development is illustrated in Figure 1B.

Development within the subject site is expected to be staged, with the southern lots (e.g. Lots 35 to68) being released before the northern lots (e.g. Lots 1 to 34). The final lot makeup of each stage is yet to be confirmed. All earthworks on the site will occur during Stage 1.

Development of adjacent Lots 503, 502 (the site) and 501 will also be staged. Lot 503, located adjacent to the southern site boundary is expected to be subdivided before Lot 502 as development within Lot 502 is dependent on the sewer pump station being installed within Lot 503. Likewise, development within Lot 501, north of the subject site, is dependent on the sewer being extended to the Lot 501 boundary, so subdivision of this is expected to occur after Lot 502.

1.3 Previous Bushfire Assessments

A Bushfire Hazard Assessment for the wider Concept Structure Plan Area was completed by FirePlan WA in 2014. The current BMP provides an assessment against the Bushfire Protection Criteria of Guidelines for Planning in Bushfire Prone Areas (the Guidelines) as a requirement of the subdivision application stage.



Figure 1A: Site Overview

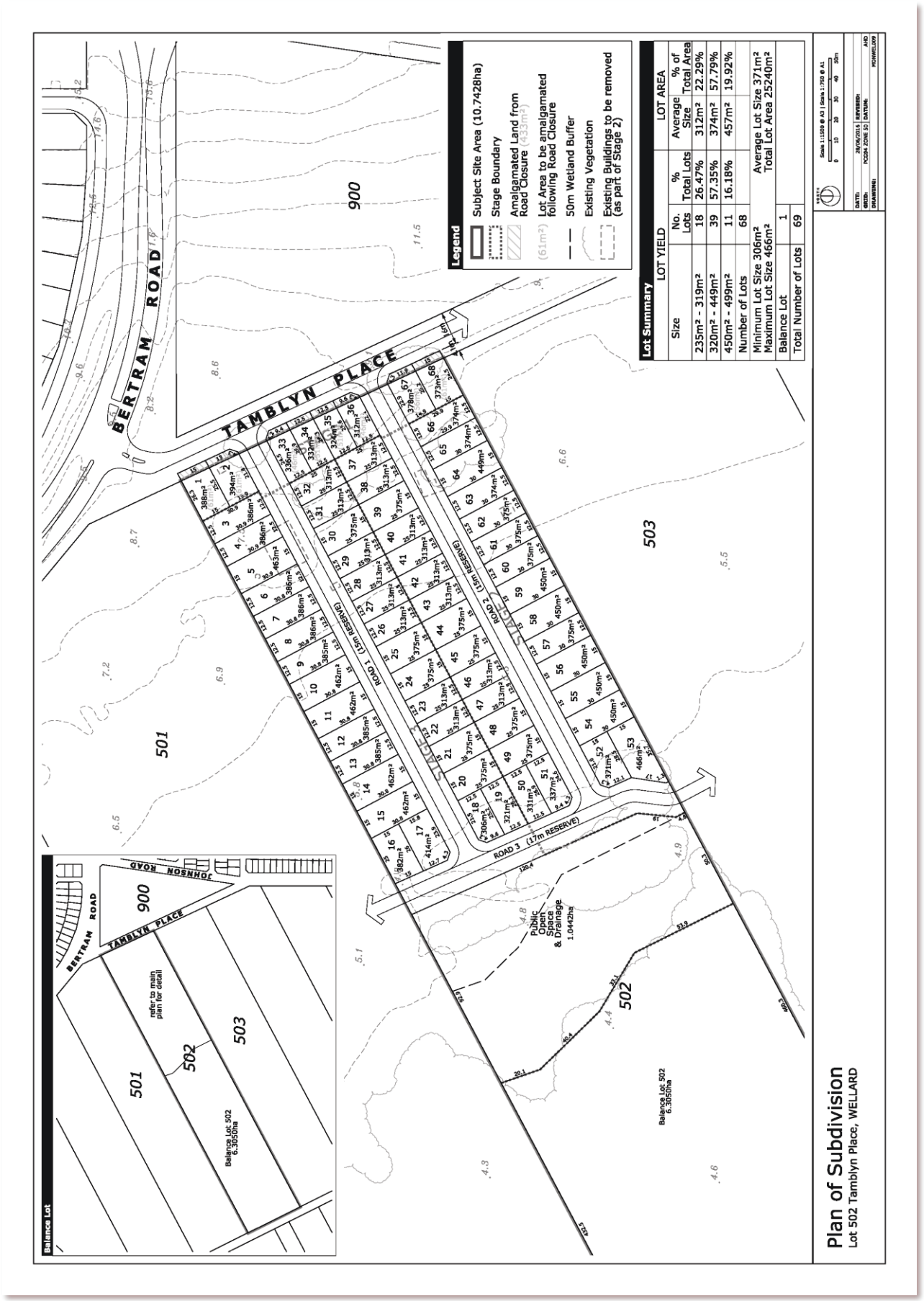


Figure 1B: Subdivision Concept Plan

2.0 Spatial consideration of bushfire threat

2.1 Vegetation classifications

The location and extent of AS 3959 vegetation structures, including clause 2.2.3.2 exclusions, within 100 metres of the site are mapped in Figure 2A and illustrated in the photos below. Bushfire fuel loads are identified as consistent with AS 3959 Table B2 for radiant heat flux modelling purposes. All bushfire structures and fuel loads are assessed in their mature states (including revegetation and rehabilitation areas) unless otherwise identified.

As proposed in the Landscape Master Plan (Appendix 1), the 50 metre wetland buffer will be partially revegetated. The Landscape Master Plan notes that the buffer zone is to contain irregular 'organic' batter to create a natural look with high quality revegetation focused around areas of retained vegetation. For the purposes of the BAL assessment, a precautionary approach has been adopted at this time, whereby the entire buffer zone has been classified as Class D Scrub. This is consistent with the existing vegetation within the wetland area. It should be noted, however, that the final design of the buffer zone is still being developed to achieve an outcome appropriate for bushfire management as well as urban water management and wetland conservation. Once a site specific Landscape Management Plan has been finalised, it is probable that the buffer zone will consist of vegetation able to be excluded under AS 3959 Clause 2.2.3.2. The BAL Contour Map will need to be updated to reflect this and the result could be a reduction in the BALs for some of the proposed lots.

All other vegetation within the site will be removed as part of the subdivision development during Stage 1. The POS area will be managed as low threat vegetation in accordance with AS 3959 Clause 2.2.3.2(f) and is also subject to the preparation of an endorsed Landscape Management Plan.

The separation distance between the site and the Class G Grassland within Plots 4 (Lot 501) and 5 (Lot 503) is based on the installation and maintenance of a three metre wide firebreak along the internal perimeter of Lots 501 and 503 in accordance with the City of Kwinana firebreak notice.

2.1.1 Vegetation Plot photos

Site



Pre Development
Managed (grazed) grassland
Exclusion 2.2.3.2 (f)

Post Development
Residential development
Exclusion 2.2.3.2 (e) and (f)

Plot 1



Pre Development
Low threat – Exclusion 2.2.3.2 (e)

Post Development
Low threat – Exclusion 2.2.3.2 (e) and (f)

Plot 2



Pre Development
Residential development
Exclusion 2.2.3.2 (e) and (f)

Post Development
Residential development
Exclusion 2.2.3.2 (e) and (f)

Plot 3



Pre Development
Nature strip
Exclusion 2.2.3.2 (f)

Post Development
Nature strip
Exclusion 2.2.3.2 (f)

Plot 4



Pre Development
Class G Grassland

Post Development

a. Lots 501 and 503 not developed
Class G Grassland

b. Lots 501 and 503 developed
Residential development
Exclusion 2.2.3.2 (e) and (f)

Plot 5



Pre Development
Managed grassland and existing residence
Exclusion 2.2.3.2 (f)

Post Development

a. Lots 501 and 503 not developed
Managed grassland and existing residence
Exclusion 2.2.3.2 (f)

b. Lots 501 and 503 developed
Residential development
Exclusion 2.2.3.2 (e) and (f)

Plot 6



Pre Development
Class G Grassland

Post Development

a. Lots 501 and 503 not developed (Fig. 2A)
Class G Grassland

b. Lots 501 and 503 developed (Fig. 2B)
Residential development
Exclusion 2.2.3.2 (e) and (f)

Plot 7



Pre Development
Class B Woodland

Post Development
Class B Woodland

Plot 8



Pre Development
Class D Scrub

Post Development
Fully landscaped Public Open Space
Exclusion 2.2.3.2 (f)

Plot 9



Pre Development
Class D Scrub

Post Development
Class D Scrub

Existing vegetation to be retained. 50m wetland buffer to be revegetated (conservatively mapped entire buffer as Class D Scrub)

2.2 Potential bushfire impact

Potential bushfire impact analysis was undertaken in accordance with AS 3959 Methodology 1 to determine the potential worst case scenario radiant heat impact on each of the lots in the proposed development. In accordance with SPP 3.7, BAL Contour Maps have been prepared to illustrate the potential radiant heat.

Development of the subject lot is dependent on Lot 503 being developed first. However, the BAL Contour map cannot simply exclude vegetation within Lot 503 on this basis as the proponent has no control over the development of Lot 503 and there is no guarantee that this will indeed go ahead. Further to this, there is a subdivision proposal over Lot 501, which is dependent on the development of the subject site happening first. Again, the BAL Contour map cannot exclude vegetation within Lot 501 on the basis of future development that is yet to occur and is out of the proponents control.

To address both the independent development of the subject site, as well as the expected future situation, two BAL Contour Maps have been prepared:

1. Figure 2A considers the BAL impacts for the site should the site be developed before Lots 501 and 503 (independent subdivision)

2. Figure 2B considers the BAL impacts for the site in the expected future scenario that both lots 501 are developed as well as the subject site.

2.2.1 Independent subdivision of Lot 502

The following table (Table 2A) outlines the worst case BAL for each of the vegetation plots based on separation distance to the proposed lots. The worst case BAL applicable to the lots is BAL-FZ.

Table 2A: Maximum BAL that applies to the site - independent subdivision of Lot 502

Vegetation Plot	Vegetation Classification	Effective Slope	Separation	BAL
Plot 1	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 2	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 3	Exclusion 2.2.3.2(f)	N/A	N/A	N/A
Plot 4	Class G Grassland	Flat	3 m*	BAL-FZ
Plot 5	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 6	Class G Grassland	Flat	3 m*	BAL-FZ
Plot 7	Class B Woodland	Flat	>100 m	BAL-LOW
Plot 8	Exclusion 2.2.3.2(f)	N/A	N/A	N/A

Vegetation Plot	Vegetation Classification	Effective Slope	Separation	BAL
Plot 9	Class D Scrub	Flat	16 m	BAL-29
Notes: *Based on a three metre wide firebreak being installed directly adjacent to the site boundary by the owners of Lots 501 and 503				

Table 2B lists the BAL applicable to each lot and the Asset Protection Zone setbacks required to achieve BAL-29 where applicable.

Table 2B: Maximum BAL that applies to each lot - independent subdivision of Lot 502

Lot	Initial BAL	Asset Protection Zone/ Setback	Revised BAL
1, 3-16	BAL-FZ	5 m* from northern lot boundaries	BAL-29
53-61	BAL-FZ	5 m* from southern lot boundaries	BAL-29
62	BAL-29	N/A	BAL-29
2, 17, 52	BAL-19	N/A	BAL-19
18-33, 40-51, 63-65	BAL-12.5	N/A	BAL-12.5
34-39, 66-68	BAL-LOW	N/A	BAL-LOW
Notes: *Based on a three metre wide firebreak being installed directly adjacent to the site boundary by the owners of Lots 501 and 503			

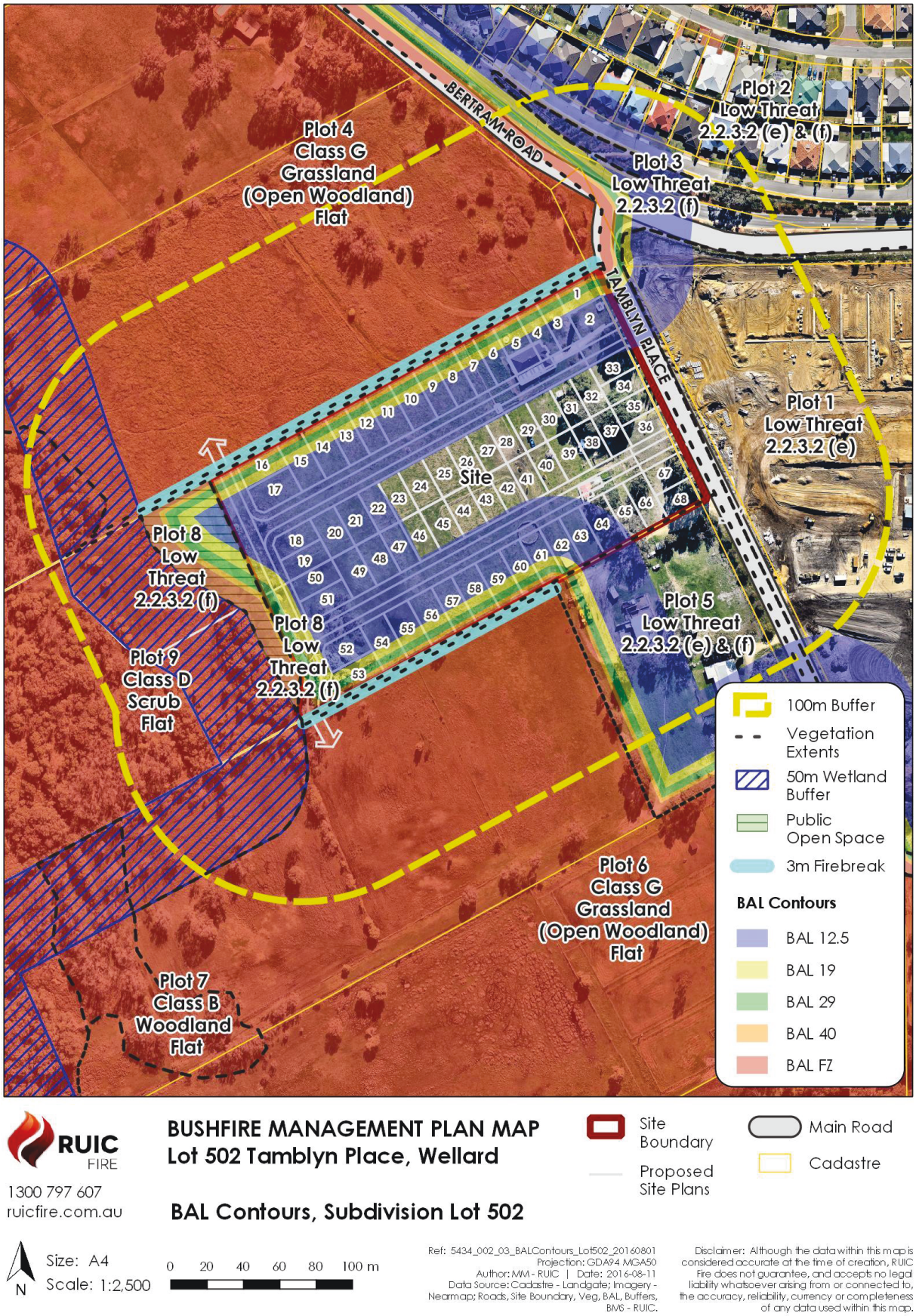


Figure 2A: BAL Contour Map - independent subdivision of Lot 502

2.2.2 Expected future scenario – Lots 501 and 503 are also developed

The following table (Table 2C) outlines the worst case BAL for each of the vegetation plots based on separation distance to the proposed lots. The worst case BAL applicable to the lots would be BAL-29.

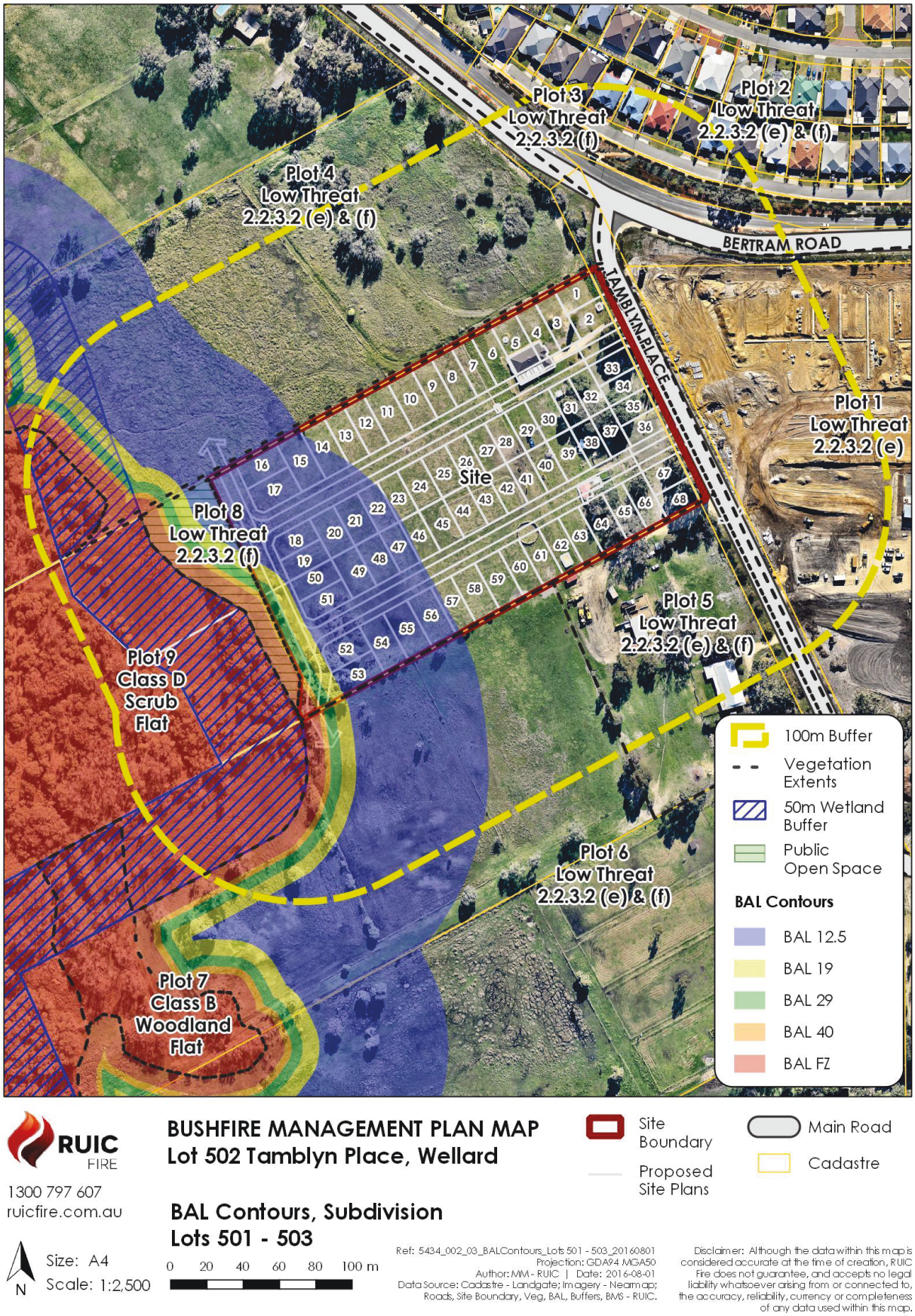
Table 2C: Worst case BAL that applies to the site when Lots 501 and 503 are also developed

Vegetation Plot	Vegetation Classification	Effective Slope	Separation	BAL
Plot 1	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 2	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 3	Exclusion 2.2.3.2(f)	N/A	N/A	N/A
Plot 4	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 5	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 6	Exclusion 2.2.3.2(e)(f)	N/A	N/A	N/A
Plot 7	Class B Woodland	Flat	>100 m	BAL-LOW
Plot 8	Exclusion 2.2.3.2(f)	N/A	N/A	N/A
Plot 9	Class D Scrub	Flat	16 m	BAL-29

Table 2D lists the worst case BAL applicable to each lot on completion of the development. All lots would achieve BAL-29 or lower. An Asset Protection Zone setback of 27 metres is to be applied to Lot 53 to achieve a worst case BAL for the development of BAL-12.5.

Table 2D: Worst case BAL that applies to each lot when Lots 501 and 503 are also developed

Lot	Initial BAL	Asset Protection Zone/ Setback	Revised BAL
53	BAL-29	27 m from western lot boundary	BAL-12.5
13-23, 46-57	BAL-12.5	N/A	BAL-12.5
Remainder of lots	BAL-LOW	N/A	BAL-LOW



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BUSHFIRE MANAGEMENT PLAN MAP
Lot 502 Tamblyn Place, Wellard

BAL Contours, Subdivision
Lots 501 - 503

Size: A4
Scale: 1:2,500
N

0 20 40 60 80 100 m

Site Boundary
Proposed Site Plans
Main Road
Cadastre

Ref: 5434_002_03_BALContours_Lots 501 - 503_20160801
Projection: GDA94 MGA50
Author: MM - RUIC | Date: 2016-08-01
Data Source: Cadastre - Landgate; Imagery - Nearmap; Roads, Site Boundary, Veg, BAL, Buffers, BMS - RUIC.

Disclaimer: Although the data within this map is considered accurate at the time of creation, RUIC Fire does not guarantee, and accepts no legal liability whatsoever arising from or connected to, the accuracy, reliability, currency or completeness of any data used within this map.

Figure 2B: BAL Contour Map - Lots 501 and 503 are also developed

2.3 Bushfire Hazard Issues

From the BAL Contour Map, the following bushfire hazard issues have been identified.

- Although Lot 503 is expected to be developed before Lot 502, in the event that the site is subdivided first, a 5m setback within Lots 53 to 61 would be required for future habitable buildings to achieve BAL-29. If the setbacks result in the lots being undevelopable, the lots are to be held back from sale until Lot 503, south of the site is developed.
- In the event that the site is subdivided before Lot 501, which is the expected situation, a 5m setback would be required for habitable buildings within Lots 1 and 3 to 16 to achieve BAL-29. If this setback results in the lots being undevelopable, the lots are to be held back from sale until Lot 501, north of the site is developed.
- As the site is subject to a BAL above BAL-LOW, the bushfire protection criteria relevant to the development are addressed in section 4.

3.0 Proposal compliance and justification

3.1 State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP 3.7)

SPP3.7 applies to all subdivision applications in designated bushfire prone areas.

3.1.1 Objectives

Policy Measure 5 contains the objectives of SPP3.7. The following demonstrates how the proposed development meets each of the objectives.

Objective 1: ***Avoid any increase in the threat of bushfire to people, property, and infrastructure. The preservation of life and management of bushfire impact is paramount.***

Development Response

Objective 1 is satisfied through the compliance of the proposed development with all required Policy Principles as detailed below and all GPBPA Performance Principles as detailed in Section 4 of this report.

Objective 2: ***Reduce vulnerability to bushfire through the identification and consideration of bushfire risks in decision-making at all stages of the planning and development process.***

Development Response

Objective 2 is satisfied through the appropriate identification and assessment of all relevant bushfire hazards as detailed in Section 2 of this report, specifically the BAL Contour Mapping.

Objective 3: ***Ensure that higher order strategic planning documents, strategic planning proposals, subdivision and development applications take into account bushfire protection requirements and include specified bushfire protection measures.***

Development Response

Objective 3 is satisfied through the compliance of the proposed development with all required Policy Principles as detailed below and all GPBPA Performance Principles as detailed in Section 4 of this report.

Objective 4: ***Achieve an appropriate balance between bushfire risk management measures and, biodiversity conservation values, environmental protection and biodiversity management and landscape amenity, with consideration of the potential impacts of climate change.***

Development Response

Objective 4 is satisfied through the appropriate consideration of all biodiversity and environmental assets as detailed in Section 1 of this report in the development of bushfire related risk mitigation strategies detailed in Section 4 of this report.

3.1.2 Policy Measures

3.1.2.1 Subdivision Applications

Policy Measure 6.2 requires that subdivision applications within designated bushfire prone areas and that have a BAL above BAL-LOW are to comply with Policy Measure 6.4.

3.1.2.2 Information to Accompany Subdivision Applications

Policy Measure 6.4 applies to subdivision applications. It requires certain information to be provided with such applications. The following outlines where the required information has been provided.

Table 3A: Compliance of the proposed development with the Policy Measures of SPP 3.7.

Policy Measure	Description	Development Response
a	A BAL Contour Map to determine the indicative acceptable BAL ratings across the subject site, in accordance with the Guidelines. BAL Contour Maps should be prepared by an accredited Bushfire Planning Practitioner	Figures 2A and 2B provide the BAL Contour Maps.
b	The identification of any bushfire hazard issues arising from the BAL Contour Map;	Section 2.2 addresses the bushfire hazard issues.
c	An assessment against the bushfire protection criteria requirements contained within the Guidelines demonstrating compliance within the boundary of the subdivision site.	Section 4 provides an assessment of the development against the bushfire protection criteria.

3.1.2.3 Vulnerable or High Risk Land Uses

The proposed subdivision does not contain any vulnerable or high risk land uses.

3.1.2.4 Applications in BAL-40/BAL-FZ Areas

On completion of development, the developable land would not be subject to BAL-40 or BAL-FZ as outlined in Section 2.1.

3.1.2.5 Advice of State/Relevant Authority/s for Emergency Services to be Sought

The proposed subdivision:

- Complies with the SPP3.7 Policy measures;
- Does not propose any additional/alternative measures; and
- Does not contain unavoidable development, vulnerable or high risk land uses.

Therefore, the advice of State/Relevant Authorities for Emergency Services is not required to be sought for this application.

3.1.2.6 Advice of State/Relevant Agencies/Authorities for Environmental Protection to be Sought

The proposed subdivision:

- Is not known to propose clearing of vegetation within environmentally sensitive areas protected under State or Federal legislation;
- Is not known to propose clearing of locally significant native vegetation; and
- Does not abut vegetated land managed by that authority.

Therefore, the advice of State/Relevant Agencies/Authorities for Environmental Protection is not required to be sought for this application.

3.2 Guidelines for Planning in Bushfire Prone Areas (the Guidelines)

The Guidelines apply to subdivision applications located within designated bushfire prone areas. The Guidelines provide supporting information for implementation of SPP3.7. Specifically, they provide the Bushfire Protection Criteria to be address for all applications.

This report has also been developed in order to comply with the requirements of all referenced and applicable documents. No non-compliances have been identified.

4.0 Bushfire Risk Management Measures

The bush fire risk mitigation strategies detailed in this report are designed to comply with the Bushfire Protection Criteria detailed in *Guidelines for Planning in Bushfire Prone Areas* (the Guidelines) Appendix 4 (2015).

i. The notation (P3) refers to Performance Principle 3 of the Guidelines Appendix 4.

ii. The notation (A3.1) refers to Acceptable Solution 3.1 of the Guidelines Appendix 4.

iii. The notation (E3.1) refers to Explanatory Note 3.1 of the Guidelines Appendix 4.

iv. Where discrepancy occurs between State and Local bushfire planning provisions the higher standard of mitigation has been selected.

4.1 Element 1 - Location

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

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

Acceptable Solution A1.1 Development location

The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.

Development Response/Recommendations

As outlined in Figures 2A and 2B and Tables 2B and 2D, the subdivision would ensure all future habitable buildings are, upon completion of development, located in an area subject to BAL-12.5 or lower.

Although Lot 503 is expected to be developed before Lot 502, in the event that the site is subdivided first, a 5m setback within Lots 53 to 61 would be required for future habitable buildings to achieve BAL-29. If these setbacks result in the lots being undevelopable, the lots are to be held back from sale until Lot 503, south of the site is developed.

In the event that the site is subdivided before Lot 501, which is the expected situation, a 5m setback would be required for habitable buildings within Lots 1 and 3 to 16 to achieve BAL-29. If this setback results in the lots being undevelopable, the lots are to be held back from sale until Lot 501, north of the site is developed.

An Asset Protection Zone setback of 27 metres from the western lot boundary is to be applied to Lot 53 to ensure future habitable buildings are located on maximum BAL-12.5 land.

4.2 Element 2 - Siting and design of Development

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

Performance Principle (P2): The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. That it minimises the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.

Acceptable Solution A2.1 Asset Protection Zone (APZ)

Every building is surrounded by an Asset Protection Zone (APZ), depicted on submitted plans, which meets the following requirements:

a. Width: 20 metres measured from any external wall of the building or building envelope. Where the slope increases above 10 degrees, the APZ should be increased to ensure the potential radiant heat impact of a fire does not exceed 29kW/m². Where a full 20 metre APZ is not possible, the APZ should be sufficient enough to ensure the potential radiant heat impact of a fire does not exceed 29kW/m²;

b. Location: within the boundaries of the lot on which the building is situated;

c. Fine fuel load: reduced to and maintained at 2 tonnes per hectare;

d. Trees (crowns) are a minimum distance of ten metres apart. A small group of trees within close proximity to one another may be treated as one crown provided the combined crowns do not exceed the area of a large or mature crown size for that species;

e. No tall shrubs or trees located within 2 metres of a building;

f. No tree crowns overhanging the building;

g. Fences and sheds within APZ are constructed using non-combustible materials (eg. iron, brick, limestone, metal post and wire); and

h. Sheds within the APZ should not contain flammable materials.

Development Response/Recommendations

The Asset Protection Zone (APZ) is a low fuel area immediately surrounding a building and is designed to minimise the likelihood of flame contact with buildings.

Features such as driveways, footpaths, roads, vegetable patches, lawn or landscaped garden (including deciduous trees and fire resistant plant species) may form part of asset protection zones. Areas of vegetation deemed Low Threat Vegetation and managed in a reduced fuel state inclusive of Public Open Space and nature strips may form part of a buildings defendable space. Isolated shrubs and trees may be retained within asset protection zones.

The APZ(s) proposed as part of this subdivision are illustrated in Figure 4A. The entire residential area of the subdivision, including all proposed lots and roads are to be maintained as an APZ.

Implementation

i. APZs to be implemented prior to the clearance of subdivision in accordance with Figure 4A and provisions c-h above.

ii. It is the responsibility of the developer to ensure the APZ standard is established.

iii. It is the responsibility of the individual property owner to ensure the APZ standard continues to be achieved post completion of the construction.

Acceptable Solution A2.2 Hazard Separation Zone (HSZ)

Every building and its contiguous APZ is surrounded by a Hazard Separation Zone (HSZ), depicted on submitted plans, that meets the following requirements:

a. Minimum width: 80 metres, measured from the outer edge of the APZ, for any vegetation classified in AS 3959 as forests, woodlands, closed shrub, open shrub, mallee/mulga and rainforest; OR 30 metres, measured from the outer edge of the APZ, for unmanaged grassland;

b. Location: within the boundaries of the lot on which the building is situated or, where this is not possible or desirable, within the boundaries of the development precinct in which the building is proposed to be located; and

c. Fine Fuel load (Dead Material <6mm diameter and <3mm for live material): reduced to and maintained at between five and eight tonnes per hectare for jarrah/marri dominated forest and woodlands, below 12-15 tonnes per hectare in mallee heath and below 15 tonnes per hectare in karri forest.

Note: A HSZ may not be required if the proposed construction meets the standard appropriate to the BAL for that location, and does not exceed BAL–29.

Development Response/Recommendations

No BAL on site exceeds BAL-29. Construction standards will be applied to relevant buildings in accordance with AS 3959 as part of the Building Permit. In this regard a HSZ is not required for this subdivision.

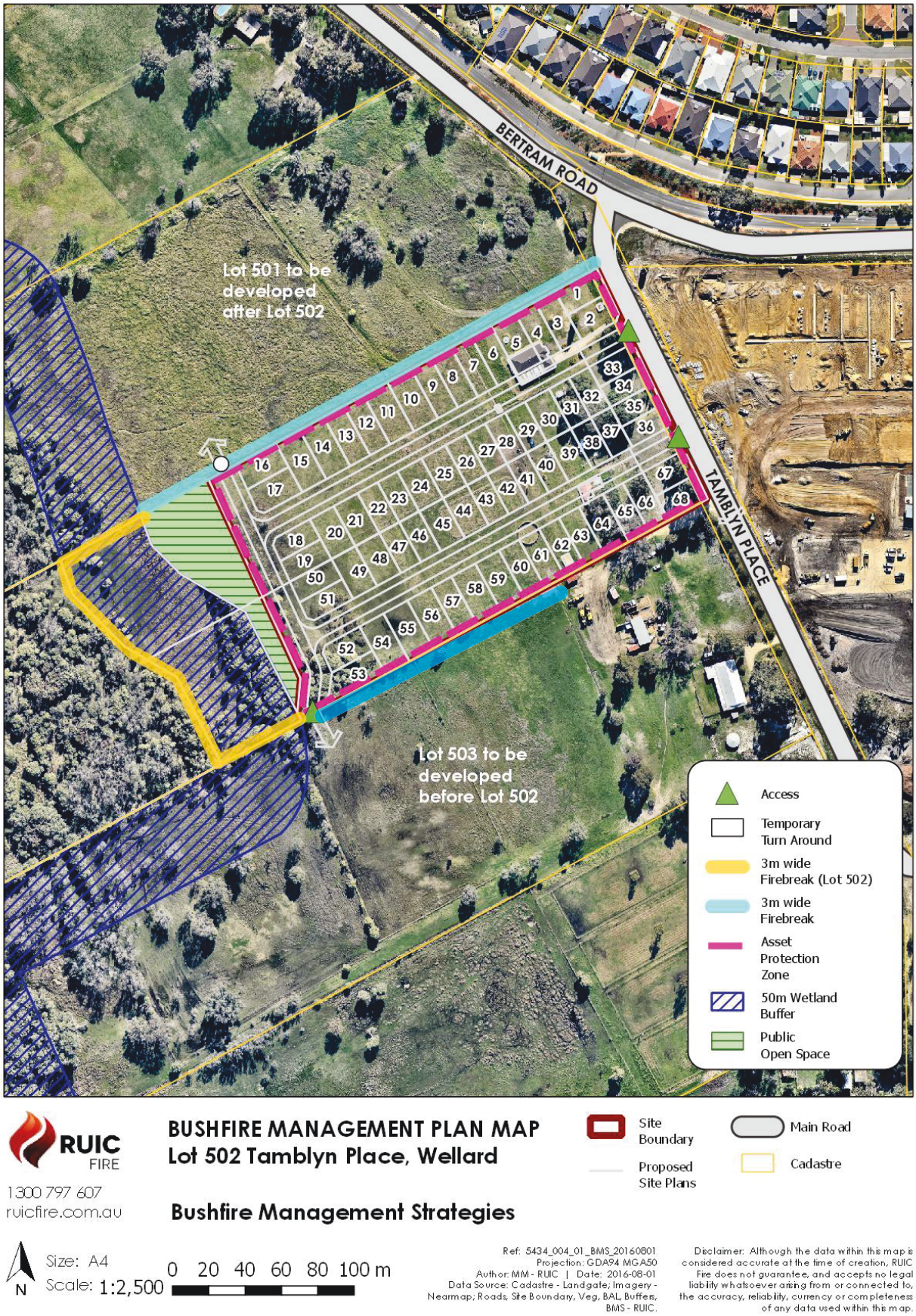


Figure 4A: Bushfire Management Strategies Map

4.3 Element 3 - Vehicular Access

Intent: To ensure that the vehicular access serving a subdivision/ development is safe in the event of a bush fire occurring.

Performance Principle (P3): The internal layout, design and construction of public and private vehicular access in the subdivision/development allows emergency and other vehicles to move through it easily and safely at all times.

	Solution	AS	PS	N/A	Comment
A4.1	Two Access Routes	☒	☐	☐	
A4.2	Public Road	☒	☐	☐	
A4.3	Cul-de-sacs (including dead-end road)	☒	☐	☐	
A4.4	Battle-axe	☐	☐	☒	
A4.5	Private Driveway longer than 50 metres	☐	☐	☒	
A4.6	Emergency Access Way	☐	☐	☒	
A4.7	Fire Service Access Routes	☐	☐	☒	
A4.8	Firebreak width	☒	☐	☐	

Acceptable Solution A3.1 Two access routes

Two different vehicular access routes are provided, both of which connect to the public road network, provide safe access and egress to two different destinations and are available to all residents/the public at all times and under all weather conditions.

Development Response/Recommendations

Figure 4B illustrates access available to the site. The development achieves at least two different vehicular access routes, both connecting to the public road network to provide egress to two different destinations at all times.

On completion of Stage 2 of the development, the site will be accessible from two direct access points off Tamblyn Place. Tamblyn Place connects to Bertram Road approximately 30 metres north of the site and Johnson Road approximately 235 metres south east of the site. Bertram Road provides access to the east and west and Johnson to the north and south. The site will also be accessed by future road linkages to development within lots 501 and 503.

Two access routes will also be available during Stage 2 of the development. On completion of Stage 1 the site will have one direct access point from Tamblyn Place as well as a road linkage with development within Lot 501 which is expected to occur before Lot 502.

On completion of the subdivision of Lots 501 and 503, the western north-south aligned road will connect directly to the road network within these lots (connection points are denoted by arrows in Figure 4B).



Figure 4B: Site Access

Acceptable Solution A3.2 Public roads

A public road is to meet the requirements in Table 4A, Column 1.

Table 4A: Vehicular access technical requirements

Technical Requirement	Public road	Cul-de-sac	Private driveway	Emergency access way	Fire service access routes
Minimum trafficable surface (m)	6	6	4	6	6
Horizontal clearance (m)	6	6	6	6	6
Vertical clearance (m)	4	N/A	4.5	4.5	4.5
Maximum grade over <50m	1 in 10	1 in 10	1 in 10	1 in 10	1 in 10
Minimum weight capacity (t)	15	15	15	15	15
Maximum crossfall	1 in 33	1 in 33	1 in 33	1 in 33	1 in 33
Curves minimum inner radius (m)	8.5	8.5	8.5	8.5	8.5

Development Response/Recommendations

Public roads proposed within the subdivision are required to comply with A3.2.

During Stage 1, a portion of the proposed public road will be constructed and sealed to service the Stage 1 lots. To avoid this ending in a dead end, and in order to provide a second access point into the site, the portion of the public road servicing Stage 2 will also be constructed during Stage 1. The road will be a limestone access track compliant with A3.2 that will be upgraded to a sealed road during Stage 2.

Implementation

i. Public roads are to be constructed prior to the clearance of subdivision for affected lots serviced by the public road.

ii. It is the responsibility of the developer to ensure the public road standard is established in accordance with Table 4A.

iii. It is the responsibility of Local and State Government (as appropriate) to ensure the maintenance of public roads vested within their jurisdiction.

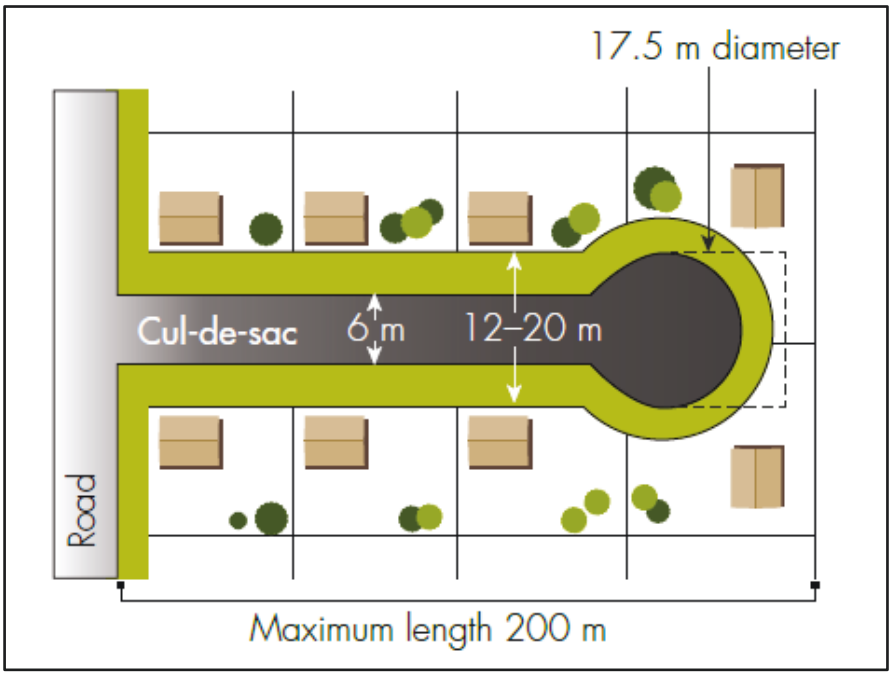
Acceptable Solution A3.3 Cul-de-sac (including a dead-end road)

A cul-de-sac and/or a dead end road should be avoided in bushfire prone areas. Where no alternative exists (i.e. the lot layout already exists and/or will need to be demonstrated by the proponent), the following requirements are to be achieved:

a. Requirements in Table 4A, Column 2;

b. Maximum length: 200 metres (if public emergency access is provided between cul-de-sac heads maximum length can be increased to 600 metres provided no more than eight lots are serviced and the emergency access way is no more than 600 metres); and

c. Turn-around area requirements, including a minimum 17.5 metre diameter head.



Source: Guidelines for Planning in Bushfire Prone Areas, Appendix 4, Fig. 18

Development Response/Recommendations

The subdivision does not include any permanent cul-de-sacs. One temporary cul-de-sac will be installed within adjacent lot 501, located north of the site, until such a time as the land to the north is developed (see Figure 4A).

A temporary turnaround is not included within Lot 503 south of the site as it is expected that Lot 503 will be subdivided before Lot 502, therefore the western north-south aligned road will connect to the public road network within Lot 503. Should Lot 502 be subdivided before Lot 503, a temporary turnaround is to be provided within Lot 503.

The temporary cul-de-sacs are to comply with Table 4A, Column 2. None of the temporary cul-de-sacs would be more than 200m in length.

Implementation

i. To be implemented prior to the clearance of subdivision for affected lots that the cul-de-sac services.

ii. It is the responsibility of the developer to ensure the cul-de-sacs meets the required standard in accordance with Table 4A.

iii. It is the responsibility of the Local Government to ensure the cul-de-sacs continue to meet the required standard.

Acceptable Solution A3.4 Battle-axe

Battle-axe access should be avoided in bushfire prone areas. Where no alternative exists, (this will need to be demonstrated by the proponent) all of the following requirements are to be achieved:

a. Requirements in Table 4A, Column 3;

b. Maximum length: 600 metres; and

c. Minimum width: six metres.

Development Response/Recommendations

Battle-axe lots are not included in the subdivision design. Therefore, A3.4 is not applicable to this development.

Acceptable Solution 3.5 Private Driveway longer than 50 metres

A private driveway is to meet all of the following requirements:

a. Requirements in Table 4A, Column 3;

b. Required where a house site is more than 50 metres from a public road;

c. Passing bays: every 200 metres with a minimum length of 20 metres and a minimum width of two metres (i.e. the combined width of the passing bay and constructed private driveway to be a minimum six metres);

d. Turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres) and within 50 metres of a house; and

e. Any bridges or culverts are able to support a minimum weight capacity of 15 tonnes.

f. All-weather surface (i.e. compacted gravel, limestone or sealed).

Development Response/Recommendations

The subdivision does not include private driveways longer than 50 metres. Therefore, A3.5 is not applicable to this development.

Acceptable Solution 3.6 Emergency Access Way

An access way that does not provide through access to a public road is to be avoided in bushfire prone areas. Where no alternative exists (this will need to be demonstrated by the proponent), an emergency access way is to be provided as an alternative link to a public road during emergencies. An emergency access way is to meet all of the following requirements:

a. Requirements in Table 4, Column 4;

b. No further than 600 metres from a public road;

c. Provided as right of way or public access easement in gross to ensure accessibility to the public and fire services during an emergency; and

d. Must be signposted.

Development Response/Recommendations

The subdivision does not require emergency access ways to enhance access. Therefore, A3.6 is not applicable to this development.

Acceptable Solution 3.7 Fire Service Access Routes (Perimeter Roads)

Fire service access routes are to be established to provide access within and around the edge of the subdivision and related development to provide direct access to bushfire prone areas for fire fighters and link between public road networks for firefighting purposes. Fire service access routes are to meet the following requirements:

a. Requirements Table 4, Column 5;

b. Provided as right of ways or public access easements in gross to ensure accessibility to the public and fire services during an emergency;

c. Surface: all-weather (i.e. compacted gravel, limestone or sealed)

d. Dead end roads are not permitted;

e. Turn-around areas designed to accommodate type 3.4 appliances and to enable them to turn around safely every 500 metres (i.e. kerb to kerb 17.5 metres);

f. No further than 600 metres from a public road;

g. Allow for two-way traffic and;

h. Must be signposted.

Development Response/Recommendations

The subdivision does not require fire service access routes to enhance access. Therefore, A3.7 is not applicable to this development.

Acceptable Solution A3.8 Firebreak width

Lots greater than 0.5 hectares must have an internal perimeter firebreak of a minimum width of three metres or to the level as prescribed in the local firebreak notice issued by the local government.

Development Response/Recommendations

During Stage 1, the entire site will be fully cleared. Firebreaks are therefore not required for the residential portion of the balance lot during Stage 1.

On completion of the development, the residential portion of the site will not contain any lots greater than 0.5 hectares in area, therefore firebreaks are not required for the subdivided lots (Lots 1 to 64).

The balance Lot 502 is greater than 0.5 hectares is area and is required to have a three metre wide internal perimeter firebreak installed in accordance with A3.8 and the City of Kwinana Fire Breaks Notice.

Due to the presence of the Conservation Category Wetland (CCW) within the balance lot, the proponent is advised to apply for a firebreak variation from the City of Kwinana so that the firebreak extends the perimeter of the CCW and connects to firebreaks in adjacent lots instead of cutting through the wetland. The Landscape Master Plan proposes a three metre wide firebreak located adjacent to the existing vegetation line and inside the conservation fencing with 4 metre wide passing lanes provided every 200 metres. An indicative firebreak is shown in Figure 4A.

4.4 Element 4 – Water

Intent: To ensure that water is available to the subdivision, development or land use to enable people, property and infrastructure to be defended from bushfire.

Performance Principle (P4): The subdivision, development or land use is provided with a permanent and secure water supply that is sufficient for firefighting purposes.

	Solution	AS	PBS	N/A	Comment
A4.1	Reticulated Areas	☒	☐	☐	
A3.2	Non-reticulated Areas	☐	☐	☒	
A3.3	Individual lots within non-reticulated areas	☐	☐	☒	

Acceptable Solution A4.1 Reticulated areas

The subdivision, development or land use is provided with a reticulated water supply in accordance with the specifications of the relevant water supply authority and Department of Fire and Emergency Services.

Development Response/Recommendations

The site will be serviced by reticulated scheme water and firefighting hydrants, satisfying Acceptable Solution A4.1.

Acceptable Solution A4.2 Non-reticulated areas

Water tanks for fire fighting purposes with a hydrant or standpipe are provided and meet the following requirements:

a. Volume: minimum 50,000 litres per tank;

b. Ratio of tanks to lots: minimum one tank per 25 lots (or part thereof);

c. Tank location: no more than two kilometres to the further most house site within the residential development to allow a 2.4 fire appliance to achieve a 20 minute turnaround time at legal road speeds;

d. Hardstand and turn-around areas suitable for a type 3.4 fire appliance (i.e. kerb to kerb 17.5 metres) are provided within three metres of each water tank; and

e. Water tanks and associated facilities are vested in the relevant local government.

Development Response/Recommendations

The site will be serviced by reticulated scheme water and firefighting hydrants. Therefore, A4.2 is not applicable to this development.

Acceptable Solution A4.3 Individual lots within non-reticulated areas (Only for use if creating one additional lot and cannot be applied cumulatively)

Single lots above 500 square metres need a dedicated static water supply on the lot that has the effective capacity of 10,000 litres.

Development Response/Recommendations

The site will be serviced by reticulated scheme water and firefighting hydrants. Therefore, A4.3 is not applicable to this development.

5.0 Implementation and Enforcement

Table 5A: Developer Schedule of Works

Strategy	Implementation		Maintenance	
	Responsible	Time Frame	Responsible	Time Frame
Amendments to BMP	Any amendments to this BMP shall be approved by the relevant Jurisdiction Having Authority			
Asset Protection Zone	Developer	Prior to subdivision clearance	Individual Land Owners	Ongoing
Hazard Separation Zone	N/A	N/A	N/A	N/A
Construction to AS 3959	Individual Land Owners & Local Government	On construction of all habitable buildings	Individual Land Owners	Ongoing
Public roads	Developer	Prior to subdivision clearance	Local or State Government (as appropriate)	Ongoing
Cul-de-sacs	Developer	Prior to subdivision clearance	Local Government	Ongoing
Battle-Axes	N/A	N/A	N/A	N/A
Private Driveways	N/A	N/A	N/A	N/A
Emergency Access Ways	N/A	N/A	N/A	N/A
Fire Service Access Routes	In accordance with firebreak notice	In accordance with firebreak notice	In accordance with firebreak notice	In accordance with firebreak notice
Firebreaks (subject site)	Developer	In accordance with firebreak notice	N/A – post development	N/A
Firebreaks (Lot 501)	Owner of Lot 501	Prior to subdivision clearance	Owner of Lot 501	In accordance with firebreak notice
Firefighting Water (hydrants)	Developer	Prior to subdivision clearance	Water Corporation	Ongoing
Firefighting Water (private tanks)	N/A	N/A	N/A	N/A
Firefighting Services & Response	DFES and Local Government	Ongoing	DFES and Local Government	Ongoing
Fuel Load Reduction and Fire Break Notice	Local Government	In accordance with firebreak notice	Local Government	In accordance with firebreak notice

Strategy	Implementation		Maintenance	
	Responsible	**Time Frame**	**Responsible**	**Time Frame**
Inspection and Issue of Works Orders or Fines	Local Government	Ongoing	Local Government	Ongoing

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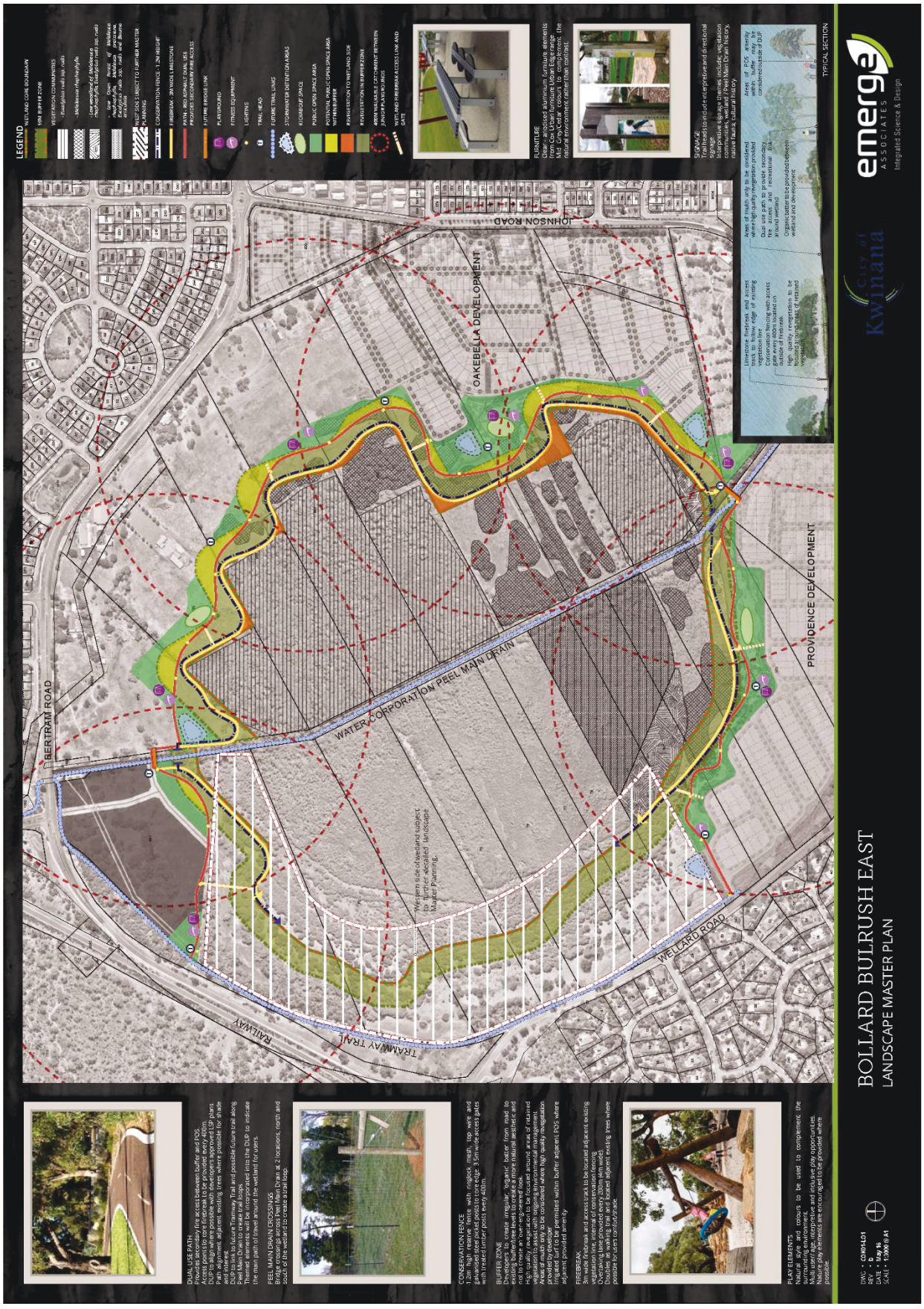
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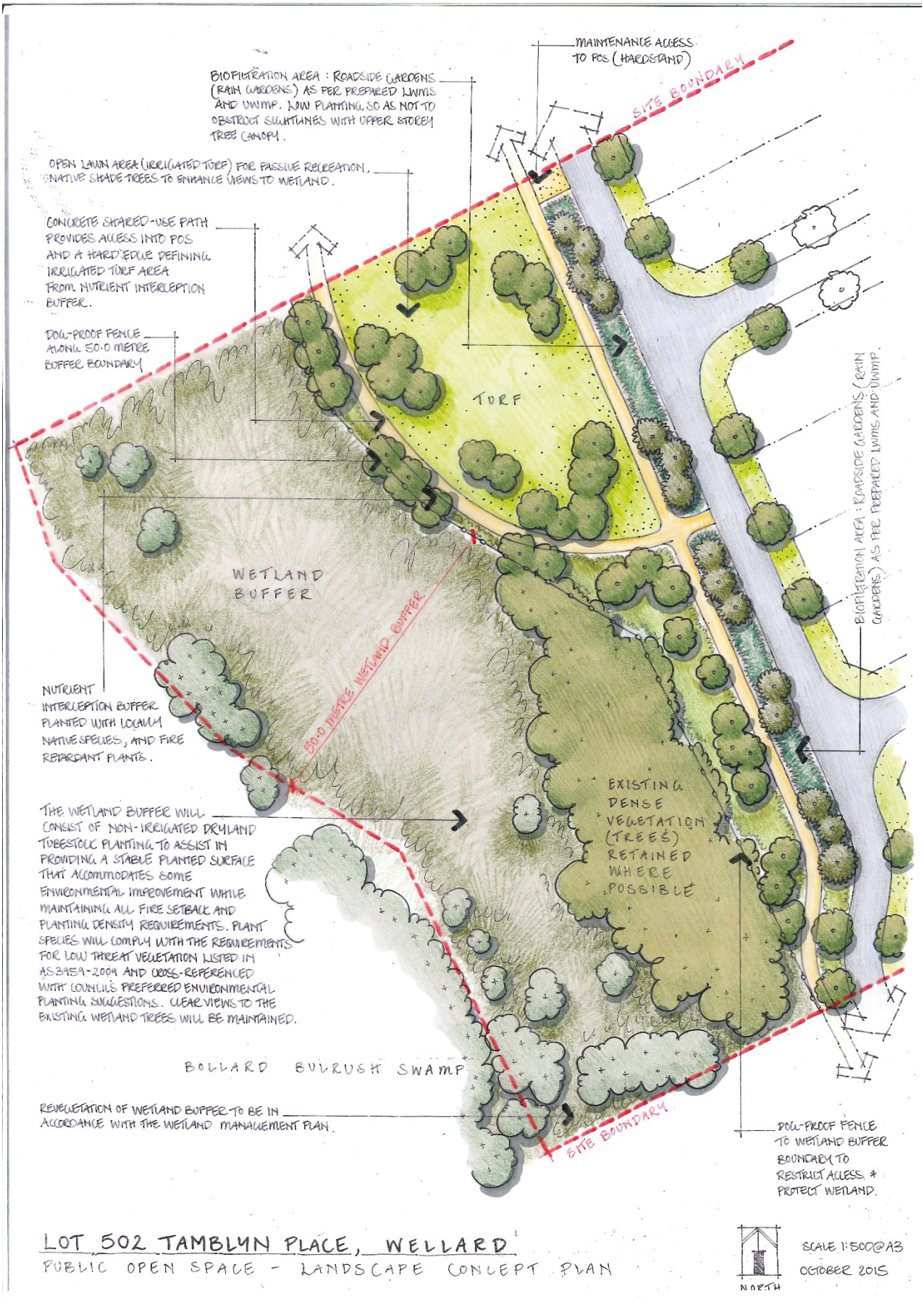
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7.0 Appendices

7.1 Appendix 1: Landscape Master Plan



7.2 Appendix 2: Landscape Concept Plan



Appendix F – Engineering Servicing Report – PDC

pdc
Engineering Evolved

Servicing Report

Lot 502 Tamblyn Place - Wellard



Prepared by PDC for:
Ascari Developments

Reporter:
Patrick Hayes

Report Number:
5009-REP-002_RevA

Job Number:
5009

Report Date:
10/09/2015

Servicing Report
Lot 502 Tamblyn Place - Wellard 502 Tamblyn Place - Wellard

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Authority to Release

This document is authorised for release only when the following signatures have been obtained.

Authored

Signed — Patrick Hayes, Civil Engineer — Date: 15/09/2015

Approved *(Quality)*

Signed — Andrew Barry, Senior Civil Engineer — Date: 15/9/15

Authorised *(Management)*

Signed — Marino Evangelisti, General Manager – Property and Infrastructure — Date: 15.9.2015

Revision Description	Revision	Date	Prepared	Approved	Authorised
Original Servicing Report	A		PH	AB	ME

This document was based on the PDC Template Servicing Report Design Report Template - Long Template Revision 1.

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Servicing Report
Lot 502 Tamblyn Place - Wellard 502 Tamblyn Place - Wellard

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Servicing Report
Lot 502 Tamblyn Place - Wellard 502 Tamblyn Place - Wellard

1 Introduction

PDC Design was engaged by Ascari Developments to produce an engineering servicing report for the Development on Lot 502 Tamblyn Place, Wellard WA. This report provides a preliminary assessment of the engineering aspects required for servicing the proposed development on Lot 502 Tamblyn Place, Wellard.

The subject site is bound by Tamblyn place to the east, Lot 503 to the South, Lot 501 to the north and parts of a conservation wetland to the west, as shown in Appendix A. The subject site is approximately 10.7 ha and is located within the City of Kwinana. The eastern end of the Lot is cleared and the western portion consists of dense vegetation and a wetland buffer. The site is currently utilised as a rural Lot with one dwelling and a number of buildings related to the housing of livestock. These buildings will require demolishing in order to construct the proposed development.

Although originally zoned rural, the subject land was allocated for short-term residential development in the Jandakot Structure Plan (August 2007) and following a Metropolitan Region Scheme Amendment was rezoned to urban-deferred. An urban deferred lifting request has recently been approved, granting the site to urban status.

It should be noted that as Lot 502 Tamblyn Place is at preliminary design stage, the servicing requirements presented here are based on current information available. This servicing report has been developed to incorporate responses from the City of Kwinana, Water Corporation, Western Power and ATCO Gas.

2 Roadworks & Footpaths

2.1 Existing Infrastructure

The subject land is served by existing roads which include Johnson Road, Tamblyn Place and Bertram Road.

Tamblyn Place is an un-sealed road, with a sealed intersection to the north (constructed during the upgrade of Bertram Road). The intersection to the south has been upgraded as part of the works on Johnson Road.

There is an existing footpath on Bertram Road, North of the development.

2.2 Required Infrastructure

Tamblyn Place will require upgrading to accommodate the development along with the review of the intersection of Tamblyn Place and Johnson Road. Based on current information, the works are being designed and installed by LWP as part of their adjacent development. It is likely that a contribution will be sought by LWP as part of cost sharing for this infrastructure.

The footpath on Bertram Road will need to be extended to service the proposed development.

3 Sewer Reticulation

3.1 Sewer Infrastructure Headworks

The development of Lot 502 will be dependent on the construction of a future Wastewater Pump Station "M". A pump station is currently pre-funded and forms part of Water Corporation five year capital works programmed to be constructed in 2018. This Pump Station is currently planned to be constructed on Lot 503.

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3.2 Internal Sewer Infrastructure

The sewer delivery will be completed as part of the standard Water Corporation detailed design process. Infrastructure will be designed in accordance with the Water Corporation Design Standard "DS50 – Design and Construction Requirements for Gravity Sewers DN 150 to DN 600". The developer shall be responsible for the provision of sewer servicing to Lots. Refer Table 3.1 below for sewer design flow.

Catchment	Area (ha)	R-Code	Expected Occupation	Wet Ground Gravity Sewer Design Flow (L/s)
A	2.52	25	August 2016	0.81

Table 3.1 Sewer Design Flow
Source: DS50- Table 4.1 Wastewater Design Flows from Residential Areas South of Latitude 26 South

4 Water Reticulation

4.1 Water Infrastructure Headworks

The Perth Residential Water Use Study (Water Corporation, 2008/2009) carried out by the Water Corporation was used as the basis for assumptions to calculate the water requirements per household.

The annual average daily usage has been determined as per Table 4.1 below:

Water Usage	kL/person/year
Ex-house Usage	46
In-house Usage	56
Leaks	4
Total	106

Table 4.1 Annual Average Daily Usage
Source: Perth Residential Water Use Study (Water Corporation, 2008/2009) Table 1.

This is an annual average water demand per person per year and for Lots zoned R25 we have assumed an occupancy rate of 3.5 people per household based on WSA 02-2002.2.3 Table A1. Water supply infrastructure is sized to meet peak instantaneous demands in summer. Therefore a peaking factor of 2.28 is applied to determine the peak monthly (Dec, Jan) demand rate of 2317.48 L/house/day and a peaking factor of 1.9 is applied to estimate peak simultaneous demands (peak day 7:00 pm) of 0.05 L/house/sec (DWUS, Figure 3.3).

Assuming a 64 Lot development at Lot 502 Tamblyn Place, a **peaking water demand estimate** of 3.26 L/sec is used, and a contingency of 30% is applied which results in a requirement of **4.24 L/sec**.

Water Corporation advised that the development area is located with the current boundary for the Water Supply Scheme and overall planning has made allowance for residential development within the area.

The development would likely require the extension of a main off the existing DN300 on Johnson Road. The cost to construct this would form part of the headworks agreement signed between the developer and Water

Corporation. It is likely that these headworks will be installed by LWP in order to provide their development with an appropriate water service.

However, it may be practical and efficient for the developer to construct headworks assets on behalf of the Water Corporation through a Developer Constructed Headworks Asset Process. A prerequisite for entering this process is that the project required must be within the current 5 year Water Corporation Capital Investment Program (CIP). The developer will be asked to "prefund" the assets design and construction, with the Water Corporation recouping the funds in accordance with the scheduled funding in the CIP.

If funding is scheduled in the CIP for the year of construction desired by the developer then the project may be funded under a "Direct funding" arrangement where the works are funded in full at the completion of the project.

4.2 Internal Water Infrastructure

Water supply reticulation within the proposed development area will be in accordance with standard Water Corporation design requirements, with connection to the new main on Tamblyn Place.

The water reticulation design will be completed during the detailed design phase of the redevelopment, and will be designed in accordance with the Water Corporation Design Standard "DS 63 – Water Reticulation Pipes DN 250 and Smaller". The developer will be responsible for servicing of Lots with water reticulation.

5 Power Infrastructure

5.1 Existing Infrastructure

There is a pole mounted transformer (TX) on the opposite side of Tamblyn Place which currently supplies a small section of overhead line (Tamblyn Place). This TX is supplied by a high voltage (HV) cable from Mortimer Rd.

5.2 Required Infrastructure

A new switchgear unit and 630kVA transformer (TX) will be required for the overall development (64 Lots).

Western Power may request that the existing pole mounted transformer be removed (and a section of overhead line) as part of the project which will require the new TX to backfeed the existing LV overhead line (existing properties south of this development). Due to volt drop limitations on the LV, the preferred location of the new HV substation will be along Tamblyn Rd within this development, not the POS/Drainage area to the south west.

An Earth Potential Rise hazard zone assessment is required for all new HV substations. This will require soil resistivity testing on-site as well as an EPR report prepared for Western Power.

No metallic infrastructure had been identified in the area and no major issues are foreseen for this development.

6 Drainage

6.1 General

The proposed stormwater drainage strategy for the site follows WSUD principles to promote infiltration of stormwater at source and to minimize the pit and pipe network. Roadside rain gardens have been proposed to fulfil the above requirements in addition to providing aesthetic amenity to the development.

6.2 Flows < 1 Year ARI Event

Runoff from events up to the 1 Yr 1 hour ARI will be conveyed through kerb breaks located at the upstream ends of the rain-garden and into the garden itself which serves to detain and infiltrate the first flush of stormwater though a layer of bio-media. Runoff from the road adjacent to the POS will be conveyed via sheet flow to a roadside bioremediation swale (using flush kerbing) running the length of the POS. These areas are designed to capture and infiltrate the 1Yr 1 hour ARI storm event and provide treatment/bio-infiltration to runoff.

6.3 Flows: 1Yr 1hour < 5Yr ARI

For events greater than the 1Yr 1 hour ARI the rain-gardens fill to the gutter level and stormwater is directed past the entrance of the rain-garden and into the bypass pit. In line with WSUD principles, slotted pipes have been used in lieu of traditional sealed drainage pipes to promote in-transit exfiltration of stormwater en-route to the outfall.

Upon exiting the drainage networks in the POS, stormwater will flow overland into the Bollard Bullrush swamp.

Rain gardens have been located at all low points and on the upstream side of intersections to limit the appropriate gutter flow spread rates to 1.5m (for a 2-way cross fall) in accordance IPWEA guidelines.

6.4 Flows: > 5 Year ARI Event

Flows in excess of the critical 5 Yr ARI event are conveyed via the subsoil drainage network and overland flow paths in the road reserve towards the Bollard Bullrush swamp. Gutter flow widths for flows in excess of the 5Yr ARI will exceed 1.5m.

6.5 Flows: >100 Year ARI Event

The roads have been graded to convey flows from the 100Yr ARI towards the Bollard Bullrush swamp. Lot levels have been provided a 500mm freeboard to the 100Yr ARI top water level.

7 Gas

ATCO Gas provided the following advice on 1st September 2015 as per correspondence shown in appendix E of this report. The calculations for gas demand were based on the 2015 model in severe winter conditions with metersets at 60% capacity.

Meterset AL8 (m^3/hr)	8
Appliances per dwelling	2
Diversity Factor	1.2
No. Dwellings	64
Total (SCMH)	91

Table 7.1 Peak Gas Demand Volumes
Source: ATCO Gas Advice 01/09/2015

To service the development a 340m x 110PE medium pressure main extension will be required to be constructed in Tamblyn Place. The main extension will connect to the existing medium pressure network on Johnson Road. The medium pressure network has sufficient capacity to service the 64 Lots proposed.

It is envisaged that the mains extension will be delivered by LWP as part of the Tamblyn Place upgrade.

8 Telecommunications

The NBN Co. rollout map was accessed on the 27th of August 2015 which informed that the NBN is not planned for the development area in the next 12 months. Therefore Telstra are considered the "infrastructure Provider of Last Resort" (IPOLR).

8.1 NBN

The developer can enter into a commercial agreement with NBN Co. A feasibility study can be requested to be undertaken through NBN Co. to obtain an indicative cost for servicing the development ($600 per Single Dwelling Unit Lot plus any applicable network extension costs).

8.2 Telstra

A dial before you dig enquiry revealed that there is currently no optical fibre cable adjacent to the site. However, there is a Telstra owned optical fibre cable on Mortimer Road. The developer may wish to enter an agreement with Telstra Smart Communities to provide the development with Fibre Optic Broadband. This would likely be a costly alternative to the NBN extension.

The developer shall provide fibre ready pit and pipe infrastructure for new developments and will be required to contribute costs of other infrastructure such as cable, headworks and backhaul infrastructure. Telstra would then acquire the installed network as part of a commercial agreement.

An Application for Reticulation (AFR) should be lodged at least 6 months prior to the expected project completion date should the developer provide the pit and pit infrastructure. If the developer chooses to install their own fibre-ready pit and pipe, Telstra would expect to acquire the installed network as part of a commercial agreement.

Alternatively, Telstra may include the pit and pipe quote for consideration as part of a commercial offer to provide infrastructure for the development. There is no obligation for the developer to engage Telstra to install the pit and pipe.

Should the developer seek Telstra to consider quoting on pit and pipe installation, an AFR for each stage of the development will need to be lodged at least 3 months prior to the commencement of any subdivision road works or building civil works associated with the development.

9 Conclusion

On the basis of the current information available, informal discussions with service providers and preliminary assumptions, it is considered feasible and achievable to provide all of the required servicing infrastructure to the proposed residential development Lot 502 Tamblyn Place, Wellard, as follows:

- The site requires the upgrade of Tamblyn Place for the proposed development. Along with a review of the suitability of the Tamblyn Place/Johnson Road intersection.

- Sewerage reticulation will be provided by a gravity sewer reticulation network that flows to a wastewater pump station in Lot 503. The pump station is pre-funded and forms part of Water Corporations planning strategy.
- Water supply requires the extension of a watermain from the existing DN300 main on Johnson Road.
- Water reticulation for the servicing for of Lots will be the responsibility of the developer. The water reticulation design will be completed during the detailed design phase of the redevelopment, and will be designed in accordance with the Water Corporation Design Standard "DS 63 – Water Reticulation Pipes DN 250 and Smaller".
- Stormwater drainage network shall be designed in line with the LWMS/UWMP.
- The extension of the existing medium pressure network on Johnson Road is required with a 310m 110PE main on Tamblyn Place
- Telecommunication services are not currently available through NBN however a feasibility study should be sought from NBN Co. to service the development with fibre optic cable. An agreement with NBN would be preferential to Telstra on a cost basis.

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10 References

PDC, 2015, *"Lot 502 Wellard, Combine LWMS and UWMP"* for Ascari Developments, unpublished

Perth Residential Water Use Study 2008/2009, Water Corporation.

Loh, M. & Coghlan, P., Mar 2003, "*Domestic Water Use Study, In Perth, Western Australia, 1998 - 2001*", Water Corporation

Water Corporation, Design Standard No. DS 50 *"Design and construction requirements for gravity sewers – Sewers DN 150 to DN 600"*

11 Appendices

Appendix A: Subdivision Concept Plan

Appendix B: Service Plans

Appendix C: ATCO Gas Advice

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Appendix A

Subdivision Concept Plan

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Legend

- Subject Site Area (10.7428ha)
- Amalgamated Land from Road Closure (434m²)
- 50m Wetland Buffer
- Existing Vegetation
- Existing Buildings

Lot Summary

LOT TYPE	NO. LOTS
SQUAT	
12.5m x 25m (312.5m2)	11
15m x 25m (375m2)	12
TRADITIONAL	
12.5m x 30m (375m2)	18
15m x 30m (450m2)	23
TOTAL LOTS	**64**

Total Area Lots	2.5237ha
Average Lot Size	394m²
Area Roads	0.9158ha
Total POS Area	1.0418ha
POS Unrestricted Area	0.3031ha
Wetland Buffer Area	0.7387ha
Urban Zoned Area	4.4378ha

BERTRAM ROAD

TAMBLYN PLACE

ROAD 1 (15m RESERVE)

ROAD 2 (15m RESERVE)

ROAD 3 (17m RESERVE)

Public Open Space & Drainage 1.0418ha

6.3050ha

501

502

503

504

900

Subdivision Concept Plan

Lot 502 Tamblyn Place, WELLARD

NORTH

Scale 1:1500 @ A3

0 10 20 30 40 50m

DATE:	03/08/2015	REVISED:	
GRID:	PCG94 ZONE 50	DATUM:	AHD
DRAWING:			MONWEL001

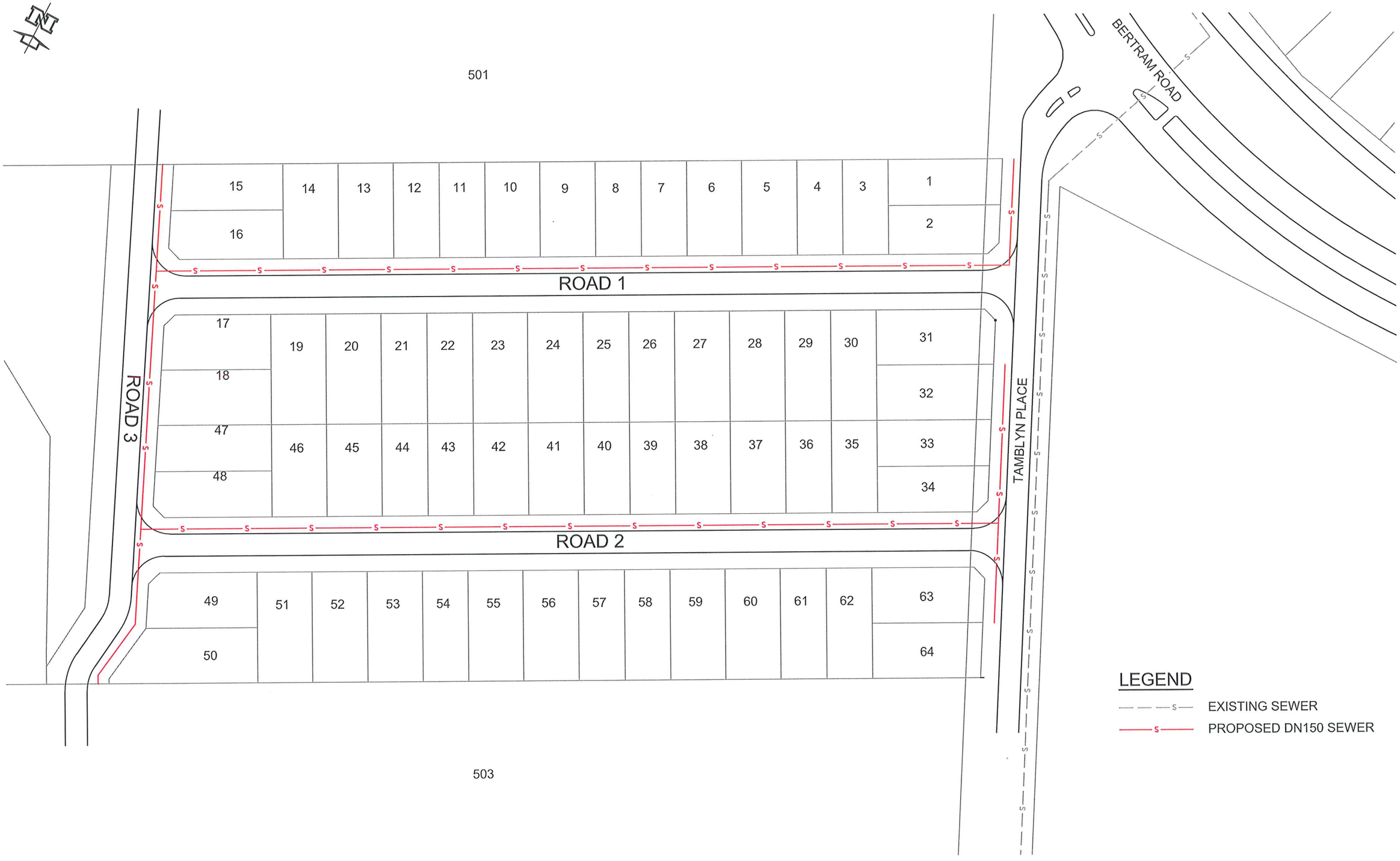
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Servicing Report
Lot 502 Tamblyn Place - Wellard

Appendix
B

Service Plans

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CLIENT ASCARI
DATE 07/09/2015
DRAWN N.RENAUD
CHECKED P.HAYES

0 10 20 30
Full Size 1:1000
SCALE (m)

LOT 502 TAMBLYN PLACE WELLARD
ROAD & SEWER PLAN
FIGURE 5.3
REVISION A

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Engineering Evolved

48 Kishorn Rd, Applecross Western Australia 6153 +61 8 9315 6600 +61 8 9364 7860 PDCGROUP.COM

Cad File: T:\5009\900 Working Documents\901 Engineering\00\5009-00-503.dwg
Plotted By: renaud Plot Date: 15/09/15 - 10:50



CLIENT	ASCARI
DATE	07/09/2015
DRAWN	N.RENAUD
CHECKED	P.HAYES

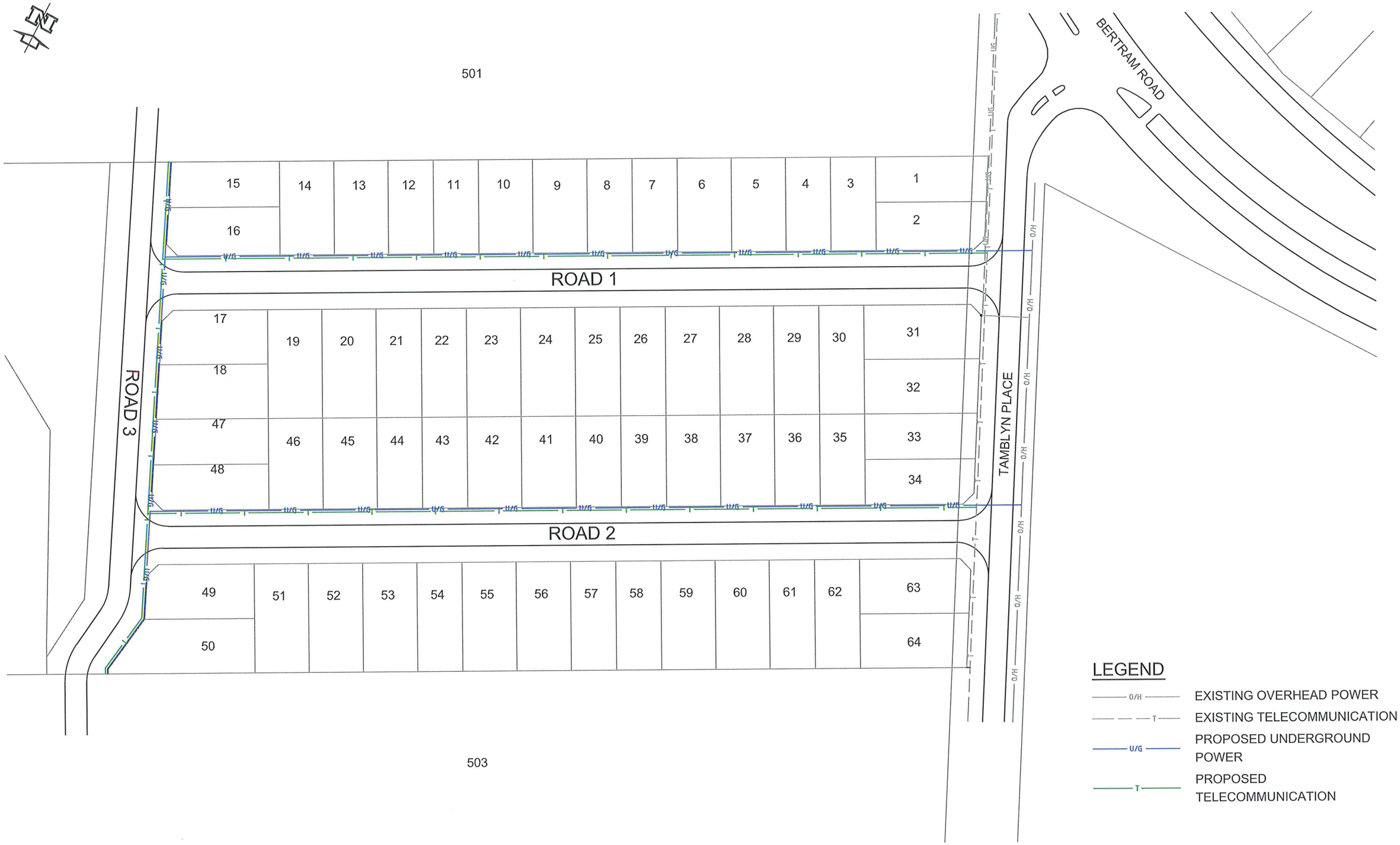
0 10 20 30
Full Size 1:1000
SCALE (m)

LOT 502 TAMBLYN PLACE WELLARD
WATER & GAS PLAN
FIGURE 5.4
REVISION A

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Plotted By: renaud Plot Date: 15/09/15 - 10:51



CLIENT ASCARI
DATE 07/09/2015
DRAWN N.RENAUD
CHECKED P.HAYES

0 10 20 30
Full Size 1:1000
SCALE (m)

LOT 502 TAMBLYN PLACE WELLARD
POWER & TELECOMMUNICATION PLAN
FIGURE 5.5
REVISION A

pdc Engineering Evolved

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Cad File: T:\5009\900 Working Documents\901 Engineering\00\5009-00-505.dwg
Plotted By: renaud Plot Date: 15/09/15 - 10:50

Servicing Report
Lot 502 Tamblyn Place - Wellard

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Appendix
C

ATCO Gas Advice

W: www.pdcgroup.com E: pdc@pdcgroup.com P: (08) 9315 6600 F: (08) 9364 7860

Patrick Hayes

To: Hassija, Manish
Subject: RE: LOT 502, Tamblyn Place Wellard-ES201508176

From: Hassija, Manish [mailto:Manish.Hassija@atcogas.com.au]
Sent: Tuesday, 1 September 2015 11:58 AM
To: Patrick Hayes
Subject: RE: LOT 502, Tamblyn Place Wellard-ES201508176

Hi Patrick

This is based on 2015 model in severe winter conditions with metersets in vicinity are at 60% of its capacity.

Gas load calculations assumptions:
Assuming AL8 for each dwelling.
Assuming 2 appliances per dwelling.
Using diversity factor of 0.19

An approx. 340 m X 110PE, MP main extension up in Tamblyn Place is required to supply the lot (Map attached).
Modelling shows that the MP Parmelia network can supply 91 SCMH to the proposed 64 dwellings.

Regards

Manish Hassija
Project Coordinator

ATCO Gas AUSTRALIA | Connecting WA to natural gas

www.atcogas.com.au

81 Prinsep Road, Jandakot, Western Australia, 6164
Telephone: (08) 6163 5150 | Mobile: 0475 809 960

From: Patrick Hayes
Sent: Friday, 28 August 2015 7:59 AM
To: 'Hassija, Manish'
Subject: RE: LOT 502, Tamblyn Place Wellard-ES201508176

Hi Manish,

We've got 64 dwellings on 64 lots.

I don't know what gas demand is for this development. I was hoping you could tell me.

Kind Regards,

Patrick Hayes
Civil Engineer

pdc
Engineering Evolved

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W pdcgroup.com

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From: Hassija, Manish [mailto:Manish.Hassija@atcogas.com.au]
Sent: Friday, 28 August 2015 7:47 AM
To: Patrick Hayes
Subject: FW: LOT 502, Tamblyn Place Wellard-ES201508176

Hi Patrick

How many Lots are we looking at and what will be the overall capacity required

Regards

Manish Hassija
Project Coordinator

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Telephone: (08) 6163 5150 | Mobile: 0475 809 960

From: Patrick Hayes [mailto:Patrick.Hayes@pdcgroup.com]
Sent: Thursday, 27 August 2015 10:54 AM
To: Enquiries
Subject: LOT 502, Tamblyn Place Wellard

Sir/Madam,

Can you please advise if the existing gas network can supply the proposed development?

And if not can you please advise what infrastructure upgrades will be required and at what cost?