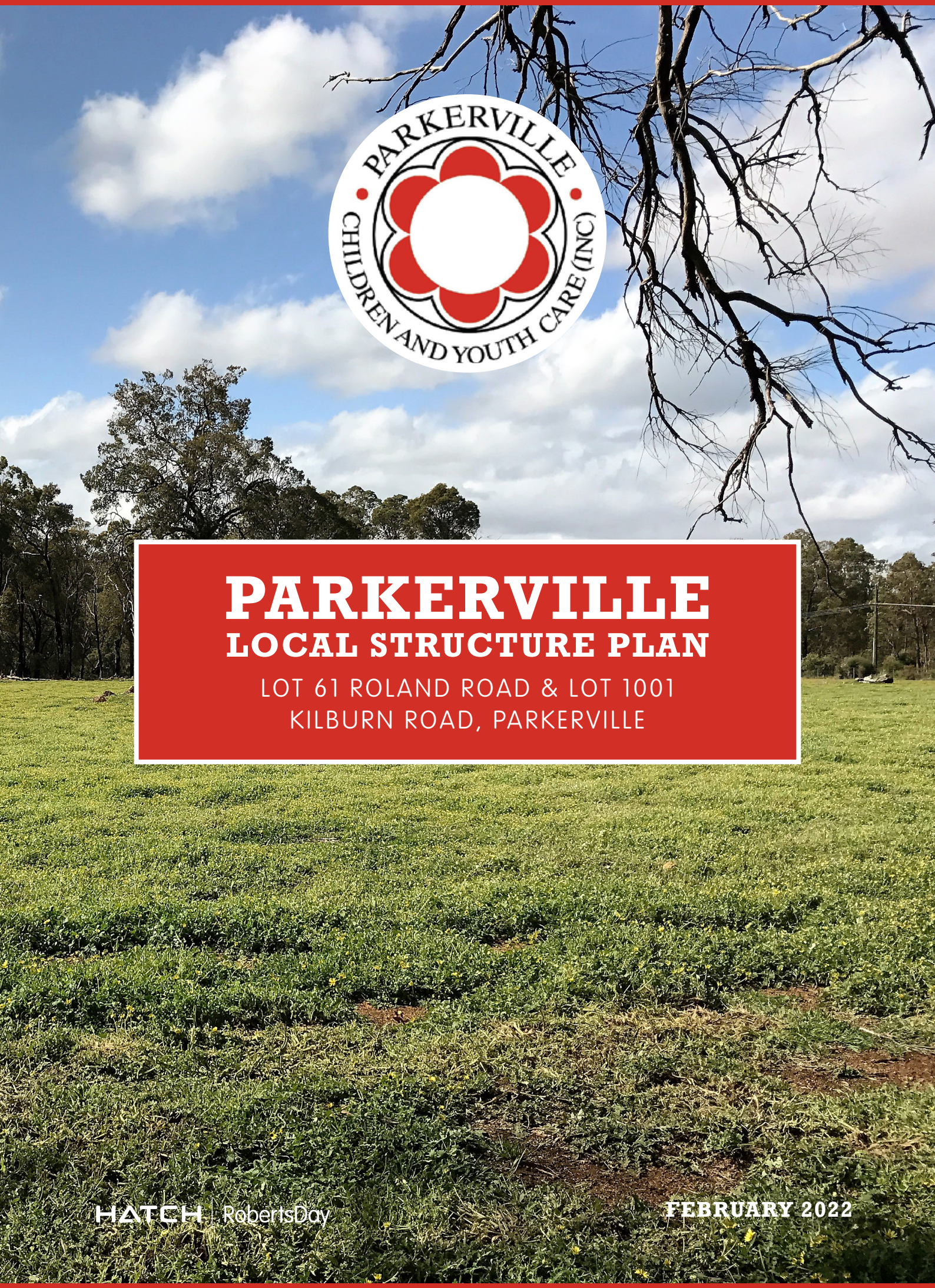

PARKERVILLE
LOCAL STRUCTURE PLAN

LOT 61 ROLAND ROAD & LOT 1001
KILBURN ROAD, PARKERVILLE

HATCH | RobertsDay

FEBRUARY 2022

DOCUMENT CONTROL		
Title:	Parkerville Local Structure Plan Lot 61 Roland Road & Lot 1001 Kilburn Road, Parkerville	
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	Bushfire	Strategen-JBS&G
	Hydrology	Coterra Environmental
	Planning + Urban Design	RobertsDay

REVISION	COMMENT	AUTHOR	APPROVED BY	DATE ISSUED
A	Draft for client review	EVDL	RD	20.05.2020
B	WAPC Endorsed LSP	RD	PC	14.02.22

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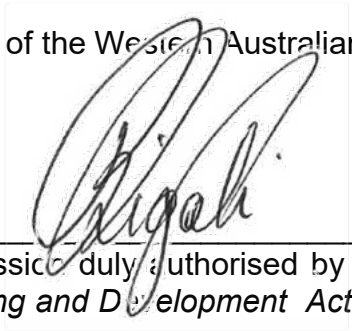
www.robertsday.com.au

This structure plan is prepared under the provisions of the Shire of Mundaring Local Planning Scheme No. 4.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: **31 MARCH 2022**

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

31 March 2022 Date

31 March 2032 Date of Expiry

TABLE OF AMENDMENTS

AMENDMENT NO.	SUMMARY OF AMENDMENT	AMENDMENT TYPE	DATE ENDORSED BY WAPC
1			
2			

EXECUTIVE SUMMARY

The Parkerville Local Structure Plan (Structure Plan) has been prepared to guide the subdivision and development of land which partially falls within Lot 61 Roland Road & Lot 1001 Kilburn Road, Parkerville (the subject site). Implementation of a Structure Plan over this 16.55ha development site will assist in the delivery of strategic planning objectives set out by the State Government and the Shire of Mundaring in relation to housing supply, affordability and delivery of urban development.

The Structure Plan area is identified as 'Urban Investigation' under the WAPC's North-East Sub-Regional Framework being land which is suitable for development, but requires further detailed planning to address the locational attributes of the Parkerville area. The subject site is identified in the WAPC endorsed Shire of Mundaring Local Planning Strategy (2015) as suitable for residential development to facilitate the incremental expansion the Parkerville townsite. An Amendment to the Metropolitan Region Scheme (MRS) was submitted to rezone the subject site from 'Rural' to 'Urban', this amendment was gazetted on 31 January 2020. The land was concurrently rezoned under the Shire of Mundaring Local Planning Scheme No. 4 to 'Development' zone. This Structure Plan provides further detailed planning to enable the development of the site for low-density residential purposes.

The Structure Plan design is responsive to the unique attributes to the site, with the road and public open space network augmented to retain existing large mature trees and aligned to take advantage of the topographical views to Clutterbuck Creek. The proposed Concept Plan is representative of a multidisciplinary approach balancing bushfire, aesthetic, environmental, traffic and engineering conditions. The outcome is a proposal that enhances the 'hills lifestyle' of Parkerville area.

ITEM	DATA	STRUCTURE PLAN REF (SECTION NO.)
Total area covered by the Structure Plan	29.4ha	1.2.2
Area of each land use proposed: • Residential • Public Open Space • Local Roads • Foreshore reserve • Rural smallholding	 12.33ha 2.14ha 3.23ha 6.77ha 4.93ha	5.1
Estimated lot yield	54 lots (Urban) 2 lots (Rural)	5.1
Estimated number of dwellings	56 dwellings	5.1
Estimated percentage of public open space (Urban Zone)	5.14% (.8394ha)	4.2.2

PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

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Appendix F: Bushfire Management Plan (Strategen-JBS&G)

Appendix G: Servicing and Infrastructure Report (Pritchard Francis)

Appendix H: Structure Plan Map (RobertsDay)

PART ONE: IMPLEMENTATION

1.0 Structure Plan Area

This Structure Plan applies to a portion of Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville, being the land contained within the inner edge of the line denoting the structure plan boundary on the Structure Plan Map (refer Plan 1).

2.0 Operation

This Structure Plan comes into effect on the date on which it is approved by the Western Australian Planning Commission (WAPC) and is valid for a period of 10 years from that date, or another period determined by the WAPC in accordance with the *Planning and Development (Local Planning Scheme) Regulations 2015* Schedule 2 – Deemed Provisions.

The Structure Plan is to be given due regard when making decisions on the development and subdivision of land within the Structure Plan area.

3.0 Staging

The staging is anticipated to commence from the western portion of the site, with access provided via Kilburn Road. The staging will then progress in an easterly direction towards Brindle Road.

4.0 Subdivision and Development Requirements

4.1 Land Use Zones and Reserves

Land Use permissibility within the Structure Plan area shall be in accordance with Plan 1 and the corresponding Zones and Reserves under the Shire of Mundaring *Local Planning Scheme No. 4* (LPS4). Where there is a conflict with the Structure Plan and LPS4, the standards of LPS4 shall prevail to the extent of any inconsistency, in accordance with the *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 – Deemed Provisions.

4.2 Reserves

4.2.1 Public Open Space is to be provided, generally in accordance with Plan 1, and shall be ceded to the Crown and managed by the Shire of Mundaring in perpetuity.

4.2.2 Clutterbuck Creek foreshore reserve is to be provided, generally in accordance with Plan 1, and shall be ceded to the Crown and managed by the Shire of Mundaring in perpetuity.

4.2.3 Foreshore Management Plan, which includes an environmentally responsive design for a dedicated non-vehicular/pedestrian access way, which also functions as a Fire Service Access Route (FSAR), running within the perimeter of the proposed foreshore reserve, as well as watercourse crossings in a north-south and east-west direction, with connections to public roads. These treatments will require the strategic placement of watercourse crossing(s) and installation of culverts where required, and the ongoing management requirements.

4.2.4 A cash-in-lieu payment will be required at the subdivision stage equivalent to the balance of public open space not provided.

4.3 Residential Development

Residential densities applicable to the Structure Plan area shall be those densities shown on the Structure Plan Map (Plan 1).

4.4 Battleaxe Lots

Subdivision applications proposing the creation of battleaxe lots will not be supported.

5.0 Local Development Plan

Local Development Plan/s (LDPs) are to be prepared in accordance with Part 6 of the *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 – Deemed Provisions. LDPs may be required as a condition of subdivision approval to address the following site matters:

- Vehicle access;
- Location of on-site effluent disposal to achieved minimum clearance to groundwater; and
- Retaining within lots to consist of gravel rock, laterite blocks or reconstituted limestone blocks of a colour natural to the Parkerville area; and
- Provision of building envelopes to accommodate the protection of significant vegetation on lots; and
- Trees within the Kilburn Road reserve shall be retained where possible when considering vehicular access.

6.0 Other Requirements

6.1 Bushfire Management

This Structure Plan is supported by Bushfire Management Plan (Appendix F) which has been prepared in accordance with *State Planning Policy 3.7.*

6.2 Kilburn Road Vegetation

Trees within the Kilburn Road reserve shall be retained where possible when considering vehicular access.

7.0 Additional Information

Prior to subdivision or development of land the Shire of Mundaring may require the following information to be prepared, as applicable, at the relevant submission stage nominated in Table 1.

Table 1: Information required prior to subdivision or development approval

ADDITIONAL INFORMATION	APPROVAL STAGE	APPROVING AUTHORITY
Urban Water Management Plan	Condition of Subdivision	Shire of Mundaring
Local Development Plan	Condition of Subdivision	Shire of Mundaring
Foreshore Management Plan	Subdivision Application	Shire of Mundaring
Significant Tree Survey and Retention/ Removal Plan	Subdivision Application	Shire of Mundaring

Plan 1: Parkerville Local Structure Plan Map

PART TWO: EXPLANATORY

1.0 Introduction

1.1 Purpose

The Parkerville Local Structure Plan (Structure Plan) has been prepared by RobertsDay and the project team on behalf of Parkerville Children and Youth Care Inc (the landowner). The purpose of the Structure Plan is to guide the orderly and proper subdivision and development over land which forms part of Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville (subject site) for low-density residential use.

The Structure Plan is prepared in accordance with the requirements of *Planning and Development (Local Planning Schemes) Regulations 2015* and the Western Australian Planning Commission (WAPC) Structure Plan Framework, with regard to the Shire of Mundaring *Local Planning Scheme No. 4* (LPS4) Clause 5.17 – Structure Plans.

The Structure Plan has been prepared based on a comprehensive review of relevant town planning, environmental, bushfire, traffic and engineering considerations. The Structure Plan design responds to the unique topographical and landscape characteristics of the site which are reflective of the 'hills lifestyle' of the Parkerville area.

1.2 Land Description

1.2.1 Location

The Structure Plan area is located within the municipality of the Shire of Mundaring and in the locality of Parkerville, which is located approximately 28km north-east of central Perth and 13km of the Midland Town Centre (refer Figure 1).

The Structure Plan area is bound by Kilburn Road to the south, Roland Road to the west and Brindle Road to the east; with Clutterbuck Creek foreshore reserve forming the extent of the northern boundary.

The site is connected regionally by Roland Road which links north to Toodyay Road and south via Seaborne Street to Great Eastern Highway, providing access to Midland Town Centre.

The site is located on the northern periphery of the Parkerville townsite. The townsite provides access to existing local services and amenities for immediate benefit to future residents, including: Silver Tree Steiner School, Mundaring Christian College, St Michael and All Angels Church, Parkerville Primary School, Parkerville Hall, Parkerville General Store, Parkerville Tavern, Parkerville Children and Youth Care, and the Railway Heritage Trail network (refer Figure 2).

1.2.2 Area and Land Use

The Structure Plan area is largely cleared and is used for grazing. One dwelling and ancillary sheds are located on the southern portion of the site (refer Figure 3). Remnant vegetation is largely confined along the boundaries of the Structure Plan area with a scattering of large mature trees within the site.

1.2.3 Legal Description and Ownership

The Structure Plan encompasses 16.55ha area which falls within two landholdings, under single ownership (refer Table 2).

Table 2: Lot Details

LOT	PLAN/DIAGRAM	CERTIFICATE OF TITLE		AREA	OWNERSHIP
		VOLUME	FOLIO		
61	63931	2758	990	13.1973ha	Parkerville Children and Youth Care Inc.
1001	302094	999	145	16.1874ha	

1.3 Project Team

The following multi-disciplinary project team have been engaged to progress the preparation of the Structure Plan:

Table 3: Project Team

DISCIPLINE	CONSULTANT
Project Manager	Cuttone Property Group
Planning + Urban Design	RobertsDay
Servicing and Infrastructure	Pritchard Francis
Environmental	Coterra Environmental
Bushfire	Strategen-JBS&G
Hydrology	Coterra Environmental
Traffic and Transport	GTA Consultants

Figure 1: Regional Location Plan

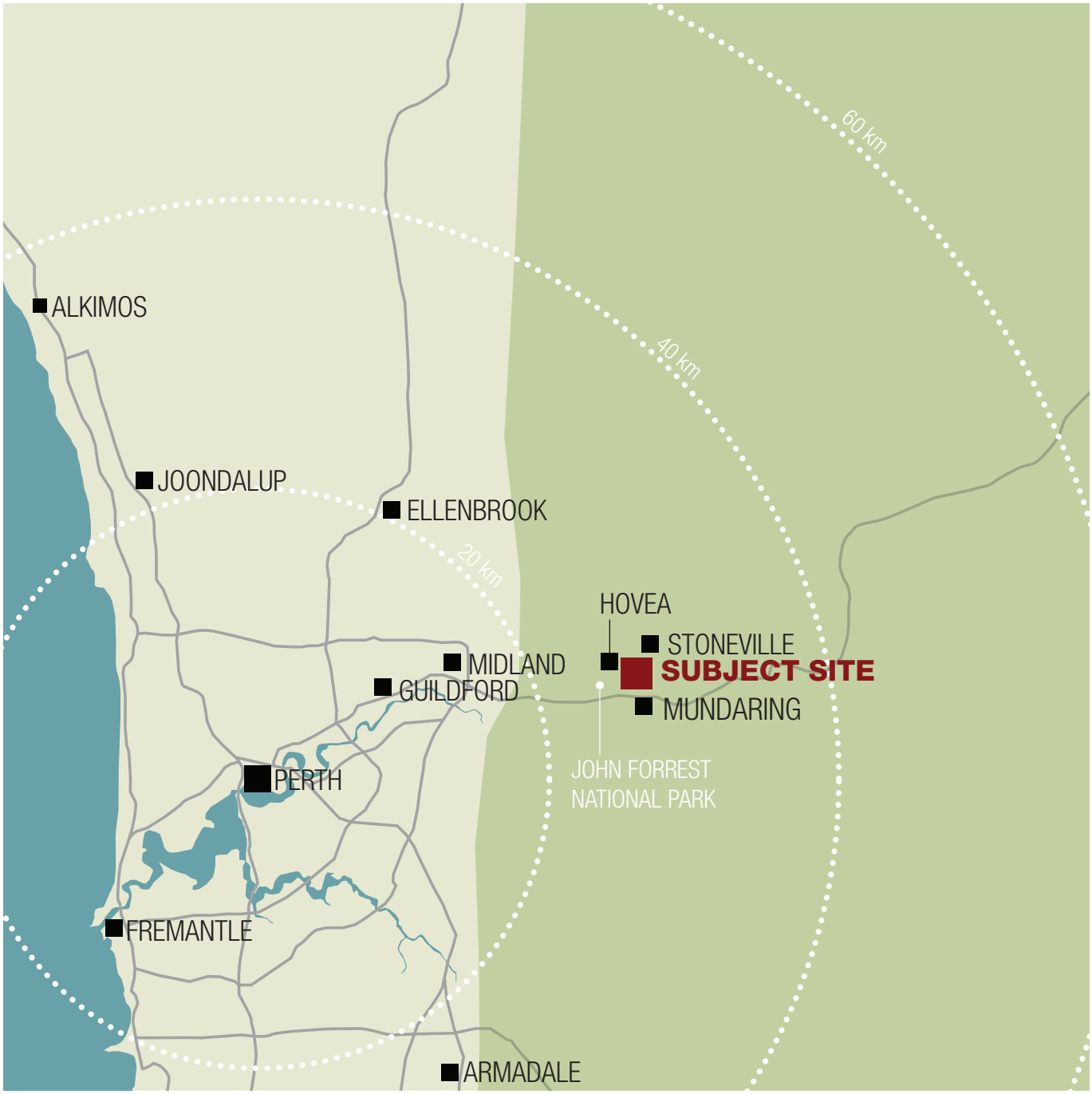


Figure 2: Location Plan

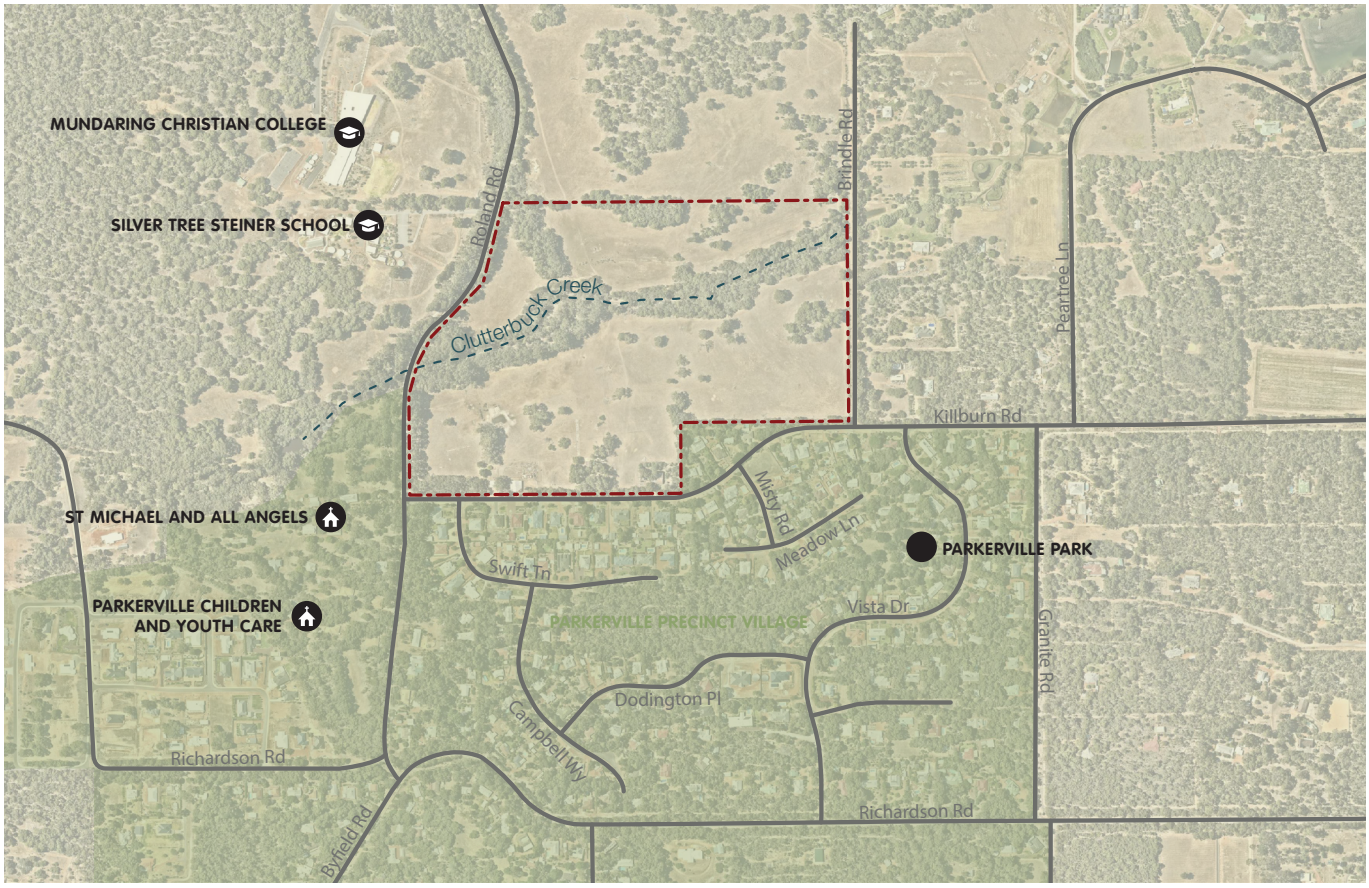


Figure 3: Site Plan

2.0 Planning Framework

2.1 Zoning and Reservations

2.1.1 Metropolitan Region Scheme

The current *Metropolitan Region Scheme* (MRS) zones and reservations are shown in Figure 4.

Amendment 1347/57 to the MRS was gazetted on 31 January 2020, rezoning the Structure Plan area from 'Rural' to 'Urban'.

More broadly, land north of Clutterbuck Creek is zoned 'Rural' under the MRS and is vacant used for rural animal agistment with a scattering of mature trees. Land to the east is zoned 'Rural' and contains a number of rural residential properties and land to the west is zoned 'Rural' and has been developed for the Silver Tree Steiner School and Mundaring Christian College. Land to the south of Kilburn Road is zoned 'Urban' and has been developed as low scale residential with lot sizes ranging from 2,000m², forming part of the Parkerville townsite.

2.1.2 Shire of Mundaring Local Planning Scheme No. 4

The current zones and reservations under the Shire of Mundaring *Local Planning Scheme No. 4* (LPS4) are shown in Figure 5.

The Structure Plan area was concurrently rezoned to 'Development' as part of Amendment 1347/57 to the MRS. Land to the north of Clutterbuck Creek remained zoned 'Rural Smallholding'.

The objective of the 'Development' zone under LPS4 is:

"To provide for the orderly planning of large areas of land for residential and other purposes through comprehensive structure planning which will provide the basis for future subdivision and development".

Pursuant to Clause 5.16 of LPS4 a Structure Plan is required for land zoned 'Development' prior to further subdivision or development. This Structure Plan has therefore been prepared in accordance with Part 4 of the *Planning and Development (Local Planning Schemes) Regulations 2015* Schedule 2 – Deemed Provisions and LPS4, to enable the development of the land for low-density residential purposes.

In accordance with Clause 5.7.12.5 of LPS4 a 10m widening of Roland Road is indicated on the Structure Plan map for the retention of vegetation and possible future road widening.

2.2 Strategic Planning Framework

2.2.1 Perth and Peel @ 3.5 million

Perth and Peel @ 3.5 million is the highest-level strategic planning document which establishes a vision for the future expansion of Perth Metropolitan and Peel Regions, which is projected to grow to a population of 3.5 million, with a total 800,000 new dwellings to be provided by 2050. To achieve this expected growth without impacting on our way of life, natural environment and physical infrastructure, the State set housing targets for each Sub Region. Of all new dwellings, 47% (380,000 dwellings) will be planned within existing infill areas, whilst the remaining 53% (420,000 dwellings) will be built in outer sub-regions. This 'Connected City' model ensures a wide range of choices to future home buyers across Perth and Peel. The suitability of development in the outer sub-regions is based on proximity to employment and services, protection of major environmental assets and capacity for efficient provision of infrastructure and essential services.

The North-East Sub-Region has a housing target of 102,560 to be provided by 2050, of which the 'Urban Investigation' areas will contribute 35,330 new dwellings. The Sub-Regional Framework also includes anticipated timeframes for the delivery of development sites, with the Structure Plan area identified as 'short-medium term' to be delivered between 2015-2031.

The Structure Plan area is located within the North-East Sub-Regional Framework. The site is identified as 'Urban Investigation', being land which is suitable for development but requires further detailed planning to address the following matters of the Parkerville area which may constrain residential development:

- Bushfire risk;
- Protection of significant environmental attributes (including Carnaby Black Cockatoo habitat);
- Suitable effluent disposal; and
- Availability of reticulated water supply.

These matters were addressed as part of the MRS rezoning.

Figure 4: Metropolitan Region Scheme Map

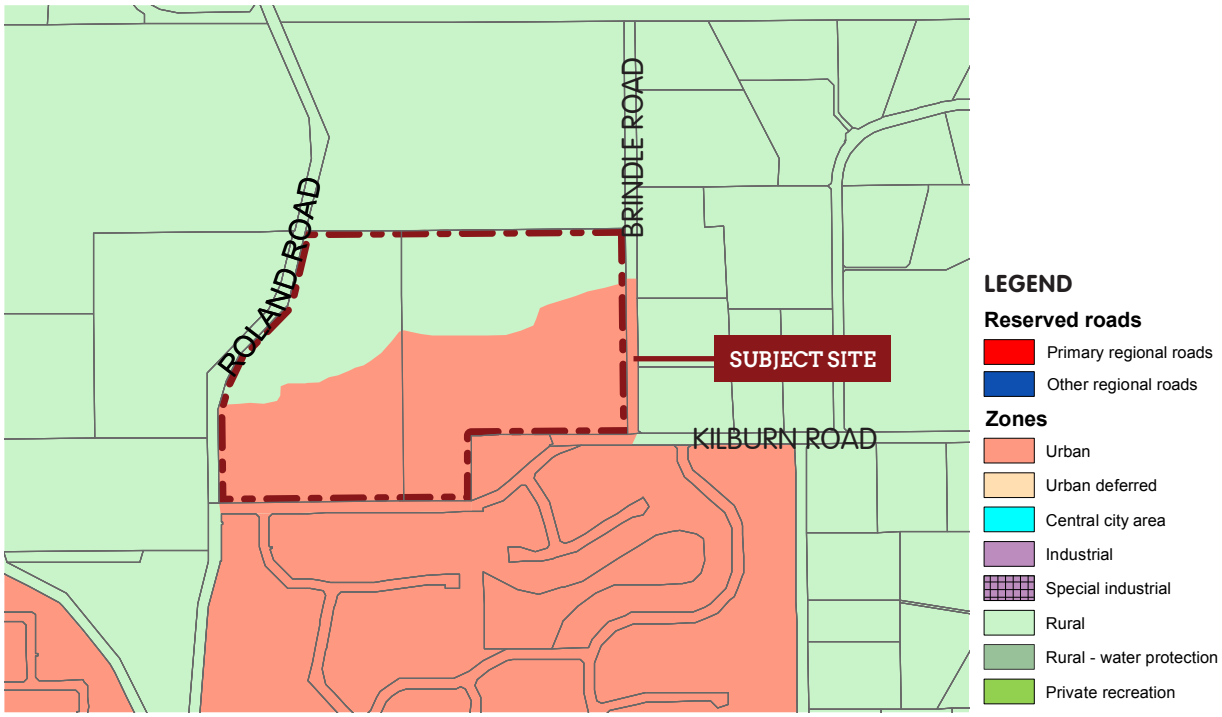
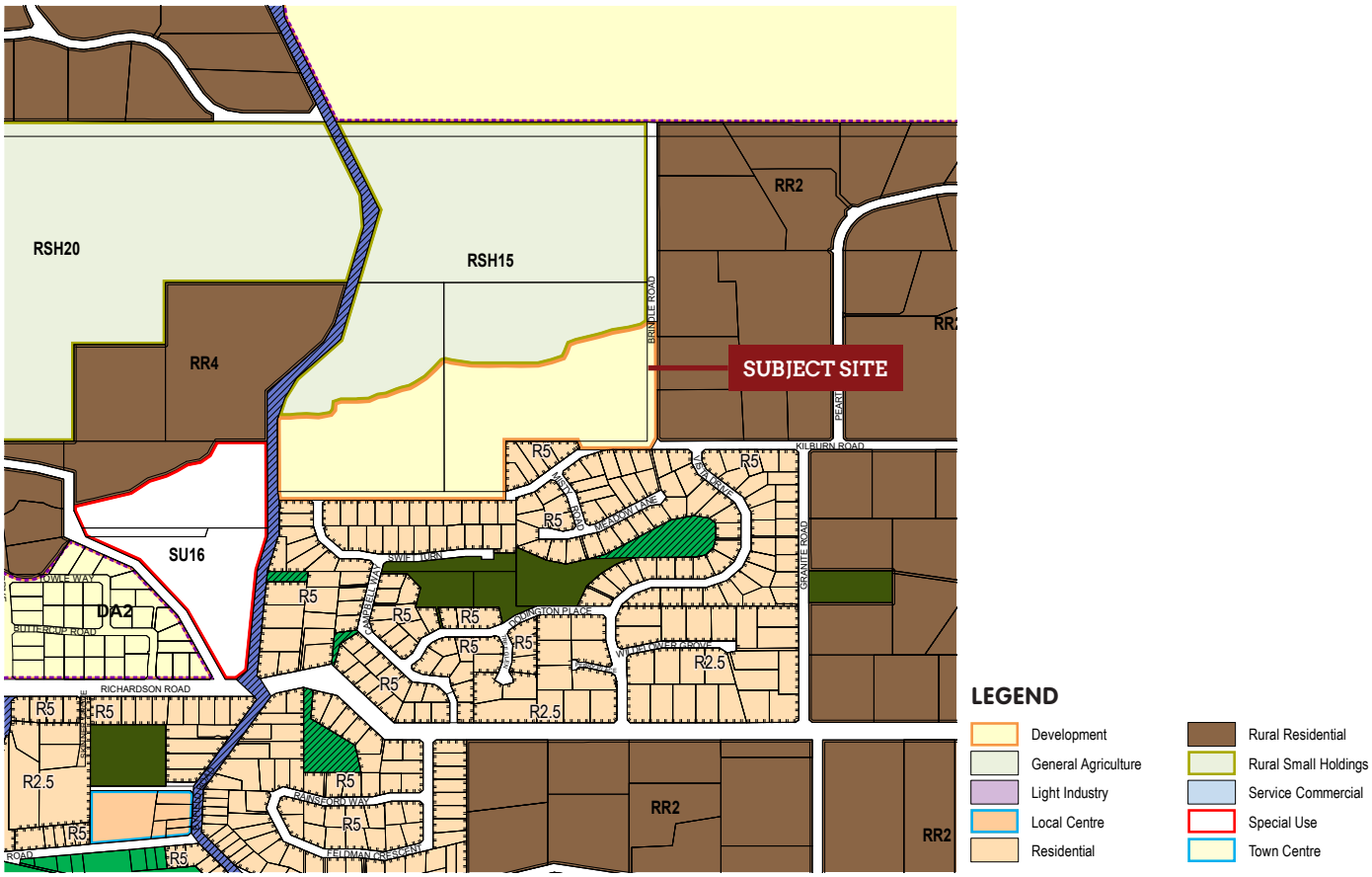


Figure 5: Shire of Mundaring Local Planning Scheme No.4



2.2.2 Shire of Mundaring Local Planning Strategy

The Shire of Mundaring Local Planning Strategy provides the local context to interpret State and regional policies for the Shire. It provides the planning rationale for zones, reservations and development controls contained in LPS4.

The Strategy outlines the intended development outcome over a 10-15 year period, to achieve the State's housing target of 8,070 new dwellings to be provided by 2050. The Strategy outlines to achieve the housing target and improve the Shire's self-sufficiency, the incremental expansion of residential development around existing villages is recommended where suitable adjacent land exists. This objective informed the identification of six (6) suitable sites across the Shire that were zoned 'Rural' in close proximity to existing residential areas, including the subject site. Subsequently the Structure Plan area was rezoned under the MRS to 'Urban' and concurrently zoned to 'Development' under LPS4 to facilitate low density residential development.

The Structure Plan area provides a logical progression the Parkerville townsite, with existing residential development located directly south of Kilburn Road. Clutterbuck Creek runs along the northern boundary of the Structure Plan, providing a natural development barrier and buffer to rural zoned land to the north.

2.2.3 Shire of Mundaring Local Biodiversity Strategy

The aim of this strategy is to provide a framework to facilitate the retention, protection and manage Local Natural Areas (LNAs) within the Shire. LNAs are natural areas that are not currently protected in the public conservation estate or classified as state forest, water catchment areas or Bush Forever sites.

All LNAs within the Shire have been assigned a preliminary protection category based on characteristics of the land, including conservation significance, land zoning and other planning constraints.

Clutterbuck Creek which boarders the north of the Structure Plan area is identified as 'Protection' category due to its ecological significance. Coterra Environmental have undertaken a Biophysical Environmental Assessment of the Clutterbuck Creek to determine the extent of the foreshore boundary, the details of this assessment are included in the Local Water Management Strategy (LWMS), refer to Part 5.4 of this report and Appendix E. As part of future subdivision or development the foreshore reserve shall be ceded to the Crown and managed in perpetuity by the Shire of Mundaring.

2.2.4 Shire of Mundaring Public Open Space Strategy

This Strategy is intended to coordinate the provision of Public Open Space (POS) within the Shire. The Strategy recognises that the application of standard legislation and policy measures often fail to meet the community needs, due to the unique nature of settlement within the Shire.

The objectives of the Strategy include:

- Provide useable POS to meet the active and passive recreation needs of the residential and rural/residential communities within this Shire;
- Reserve land where needed to ensure the protection of unique or irreplaceable features of the natural environment;
- Promote linkages between reserves to foster movement of native fauna;
- Reduce the risk of pollution of waterways;
- Identify POS areas over landscape and conservation features and watercourses and land for recreation, bridle trails, pedestrian links and buffer areas on designated rural-residential zone lots with potential for subdivision; and
- Identify existing POS areas in need of upgrading to serve the additional residents generated by nearby subdivision.

Watercourses, such as Clutterbuck Creek, are identified in the Strategy as being required to be ceded from private landholdings and managed by the Shire as POS reserves due to their ecological values.

Due to the previous Rural zoning under the MRS the Structure Plan area was not identified in the Strategy as contributing to provisions of POS for the region. POS for the Parkerville area was identified in the Strategy to be accommodated in the Parkerville townsite, which has now been developed.

The provision of POS within the Structure Plan area is further detailed and justified in accordance with this Strategy in Part 5.2 of this report.

2.3 Planning policies

2.3.1 Liveable Neighbourhoods

Liveable Neighbourhoods (LN) is an operational policy used to guide the design and assessment of structure plans and subdivision applications in greenfield areas and larger infill sites.

The key initiatives of LN are covered under eight design elements: community design, movement network, lot layout, public parkland, urban water management, utilities, activity centres and employment and schools.

LN is a performance-based code where the requirements of LN may be satisfied in a number of ways. LN aims to balance the maintenance of acceptable standards and strategic vision, by encouraging greater innovation in response to market needs.

The Structure Plan design meets the requirements of LN with a particular focus on the following key aims:

- An urban structure based on interconnected, safe and walkable neighbourhoods;
- Creating a sense of community, identity and place by responding to the site's unique characteristics and supporting the Hills lifestlye;
- Providing for an alternative housing type that caters for the diverse housing needs of the community;
- Incorporating significnat environmental features of the site into the design;
- Providing a more integrated approach to the provision of Public Open Space and urban water managemnet; and
- Maximising land efficiency.

2.3.2 State Planning Policy 3.1 Residential Design Codes

State Planning Policy 7.3 Residential Design Codes Volume 1 (R-Codes) provides a comprehensive basis for the control of residential development throughout the State. The key objectives of the policy are:

a. To encourage design which is responsive to the site, size and geometry of the development site;
b. To allow variety and diversity as appropriate where it can be demonstrated this better reflects context or scheme objectives;
c. To ensure clear scope of scheme objectives to influence the assessment of proposals; and
d. To ensure certainty in timely assessment and determination of proposals applied consistently across the State and local governments.

The R-Codes is a performance based document, where an application can either be assessed to satisfy the 'deemed-to-comply' provisions or by addressing the 'design principles' under the exercise of judgment by the Shire of Mundaring.

The R-Codes set the minimum and average lot size, which any future subdivision application must comply. Any future development will also be subject to the applicable built form controls of the R-Codes.

2.3.3 Government Sewerage Policy – Perth Metropolitan Region

This policy establishes the State Government's position on the provision of sewage in the State for structure planning, subdivision and development of land. This policy considers a general presumption against the establishment of new on-site disposal systems, unless the exemptions of the policy apply.

The Structure Plan meets the criteria under the policy satisfying the following:

- A Geotechnical Report has been prepared by Douglas Partner (refer Appendix A) demonstrating the sites suitability to accommodate on-site sewage disposal;
- The site is not located within a public drinking water source or sewerage sensitive area; and
- The site will be developed for lots with minimum area of 2,000m².

In this instance, as the site is not located within an area currently serviced by reticulated sewer, wastewater will be treated and disposed of on-site via Aerobic Treatment Units (ATUs) within individual lots. This is consistent with the existing Parkerville townsite to the south, which is also reliant on on-site effluent disposal. The use of ATUs was detailed in the endorsed District Water Management Strategy (DWMS) which was prepared to support the MRS Amendment to rezone the site 'Urban' and was approved by DWER.

The Government Sewage Policy specifies that on-site sewerage systems must have a setback of: *"100m of a waterway of significant wetland and not within a waterway foreshore area or wetland buffer. The separation distance should be measured outwards from the outer edge of riparian or wetland vegetation".* The majority of lots (67%) will have effluent disposal areas located greater than 100m from Clutterbuck Creek, whilst the remaining lots will have effluent disposal areas located between 50m and 100m. The reduced setback of 50m from Clutterbuck Creek was proposed in the endorsed DWMS.

An assessment against the Policy and preliminary liaison with the Department of Water and Environmental Regulation (DWER) regarding the setbacks of ATUs and wastewater management, is addressed in full in the LWMS prepared by Coterra Environmental (refer Appendix E)

2.3.4 Shire of Mundaring Local Planning No. 8 – Street Trees (LPP 08)

LPP08 outlines the Shire's expectations when interpreting Liveable Neighbourhoods for the design of road reserves. The Policy requires that all new roads be designed with a minimum 16m wide reservation to accommodate adequate space for street trees.

The Structure Plan is consistent with the Policy with provisions of minimum 18m wide streets (reduced to a minimum of 15m where abutting POS) with existing mature trees to be retained as future street trees and the provisions for new street trees to be detailed in a Landscaping Plan at subdivision stage. Further details of the road network and function of these roads is provided in Part 5.3 of this report.

3.0 Pre-lodgement consultation

The following summarises the pre-lodgement consultation that has informed the progression of the Structure Plan design.

Table 4: Summary of consultation

DATE	ATTENDANCE	POINTS OF DISCUSSION
21 November 2019	Shire of Mundaring	Present draft Structure Plan design for Shire of Mundaring feedback and discuss: • Ceding foreshore reserve to Shire; • Allocation of POS; • Retention of vegetation; • Road access points; • Brindle Road upgrade requirements; • Structure Plan process and preparation of technical reports; and • Timing of on-site earthworks.
10 December 2019	DWER	Coterra to present outcomes of Biophysical Assessment amending boundaries of Clutterbuck Creek foreshore reserve
14 May 2020	Shire of Mundaring	Pre-lodgement meeting to present revised Structure Plan design and discuss: • Road widths; • Provision of Public Open Space; and • Lodgement timeframe.

4.0 Existing site conditions

4.1 Landform and Soils

The site has an approximate fall of 14m, from RL 257m AHD near Kilburn Road to RL 243m AHD near Clutterbuck Creek, which equals a grade of 6% from North to South.

A Geotechnical Report was prepared by Douglas Partners as part of the MRS Amendment 1347/57 to support the MRS rezoning of the Structure Plan area from 'Rural' to 'Urban'. This report assesses the soil and groundwater conditions underlying the site and commented on the suitability of the soils for onsite effluent disposal. As the site has not been disturbed since the MRS Amendment was gazetted on 31 January 2020, the Geotechnical report is still relevant.

As detailed in the report, the site is underlain by clay, with clayey gravelly sand, gravel and laterite above. There are outcrops of laterite across the site in different locations.

The site is mapped by the Australian Soil Resource Information System (ASRIS) has having 'Extremely low probability' of occurrence of Acid Sulphate Soils (ASS) at depths of up to 3.0m and below the surface.

The Geotechnical report concludes that the majority of the site can be classified as "Class S" in accordance AS2870-2011 and is suitable for domestic effluent disposal in accordance with AS 1547-2012.

4.2 Heritage

A desktop search indicates there are no European or Aboriginal Registered Heritage site within the Structure Plan area.

4.3 Hydrology

4.3.1 Ground Water

The site is underlain by a fractured rock aquifer within the (unproclaimed) Karri Groundwater Area. The Perth Groundwater Map indicates that the site is outside of the range of DWER groundwater contour mapping.

As part of Douglas Partners Geotechnical Report (refer Appendix A) groundwater was encountered as part of testing pits at depths of 0.8m and 1.7m. It is possible that perched groundwater will collect on the lower permeability materials such as laterite and sandy clay in the winter months.

4.3.2 Surface Water

Clutterbuck Creek traverses east-west along the northern boundary of the Structure Plan area.

The creek flows from Stoneville in the Darling Ranges and discharges to Jane Brook to the west, and ultimately to the Swan River on the Swan Coastal Plain. The creek bed contains riffles, substantial meanders and in-stream logs and branches. The creek is seasonal, being dry in summer months with shallow slow-moving water during winter and spring months.

4.4 Existing Movement Networks

A Transport Impact Assessment, prepared by GTA Consultants (refer Appendix D), identified the following characteristics of the existing movement network.

The site is bound by Roland Road to the west which provides connection between Toodyay Road to the north and Great Eastern Highway to the south (via Seaborne Street). Roland Road is classified as a 'Regional Distributor' under Main Roads Functional Road Hierarchy, being a road which links significant destinations and are designed for efficient movement of people and goods within and beyond regional areas, which are under the management of Local Government. The road has a 20m wide reservation including 7m carriageway.

Kilburn Road borders the southern boundary of the Structure Plan and runs east-west, with a T-intersection to Roland Road. Kilburn Road has a 20m wide reservation including 6m carriageway. Brindle Road borders to the eastern boundary of the Structure Plan and runs north-south, with a T-intersection with Kilburn Road. Brindle Road is constructed to a rural standard. Both Kilburn and Brindle roads are 'Access Roads' under Main Roads Functional Road Hierarchy.

Due to the rural and low scale residential nature of the area, the pedestrian and cycle network in the area is limited. There is a 3.0m wide footpath along the western side of Roland Road, north of Kilburn Road, and 2.3m wide footpath to the eastern side of Roland Road, south of Kilburn Road.

The closest bus service to the site runs along Richardson Road, approximately 800m south of the subject site, providing services to bus route 328 which connects between Midland Train Station and Wundowie. These services run approximately every hour.

4.5 Biodiversity and Natural Area Assets

An Environmental Assessment Report has been prepared by Cottera Environmental (refer Appendix B) which outlines the environmental features, attributes and values of the site, which is summarised below.

4.5.1 Flora

Parkerville is located within the Jarrah Forest Bioregion of Thackway and Cresswell, located on the Darling Scarp and the Darling Plateau. The site consists of Yarragil Complex, this vegetation complex is well represented in the area (82.05% remaining), with approximately 10.18% protected in formal reserves.

The site is described as 'Parkland Cleared' with some pockets of vegetation remaining (mostly Marris and other planted Eucalypts) over introduced grasses. Most of the remnant vegetation is located within the Clutterbuck Creek foreshore reserve.

The riparian vegetation within the Clutterbuck Creek foreshore reserve is currently in a "Good" to "Excellent" condition within Lot 1001 and "Degraded" to "Good" condition in Lot 61. The far western portion of the reserve is identified as "Completely Degraded" due to the lack of native species.

A Flora and Vegetation Survey was undertaken including a targeted search for species of conservation significant and Threatened or Priority Ecological Communities, as listed by DBCA. The survey found:

- No Threatened or Priority Ecological Communities were recorded on site; and
- No Threatened or Priority flor were recorded on site.

4.5.2 Fauna

A fauna survey was undertake in accordance with Environmental Protection Authority (EPA) Guidance Statement, which found 22 fauna species of conservation significance were listed as potentially occurring, of these three (3) species are likely or known to occur within the area and may be potentially impacted by the proposed development, they include:

- Carnaby's Black Cockatoo;
- Forest Red-tailed Black-Cockatoo; and
- Baudin's Black Cockatoo.

Site investigations found 14 trees were identified (including one dead tree) as having hollows, (however there were no signs of nesting) and signs of foraging by all three cockatoo species. Given the trees will be retained within Clutterbuck Creek foreshore reserve, and retained (where possible) within the site, development of the site is unlikely to have a significant impact on black cockatoos.

The Clutterbuck Creek riparian vegetation is likely to support small mammals, numerous frog species, reptiles and crustacea (marron), as well as birdlife. The creek line acts as a wildlife corridor connecting other vegetated areas. Given the site is largely cleared and utilised for animal agistment, the proposal will have minimal impact to fauna species, with most species likely to continue to traverse within the foreshore reserve.

5.0 Design Philosophy

Site conditions highlight opportunities and constraints the Structure Plan design must respond to. These include:

- Topographical grade to Clutterbuck Creek;
- Protection of Clutterbuck Creek as an ecological corridor;
- Retention of mature trees onsite;
- Accessibility to Clutterbuck Creek;
- Land predominantly cleared;
- Remnant vegetation fringing the Structure Plan area; and
- Minimise road connections to Kilburn Road.

The following section provides a response to these considerations.

5.1 Concept Plan

A Concept Plan has been prepared to support the Structure Plan and provide a greater degree of certainty on the future pattern of subdivision and development (refer Figure 6). The Concept Plan will facilitate the creation of 54 lots for single residential houses, consistent with the low scale development pattern of the Parkerville townsite and 2 rural smallholding lots to the north of Clutterbuck Creek. The Concept Plan is subject to detailed refinement at the subdivision stage.

In accordance with the principles of LN, the Concept Plan has been predicated on the following objectives:

- Enhance the conservation values of Clutterbuck Creek as an ecological corridor;
- Drainage to be retained within cleared, naturally low-lying areas;
- Retention of existing landform and mature trees where possible;
- Clutterbuck Creek to interface with public open space in a natural way;
- Views to be capitalised through road alignment;
- Lot layout that allows for stepped retaining to mimic the natural topography; and
- Roads to deviate around existing mature trees for points of interest and passive traffic calming.

At the heart of the Structure Plan design is the aspiration to integrate human activity with the natural environment in a respectful and responsive way. The design responds to the opportunity presented by the unique bush landscape and the topographical views to Clutterbuck Creek, whilst incorporating traditional neighbourhood design principles.

The street network is a modified grid layout which provides an efficient design, maximising walkability, accessibility to POS and utilises natural low points for drainage. A road interface is proposed along the POS to maximise public accessibility. This road varies in width, designed to deviate around existing mature trees. Intersecting roads, running north-south, have been designed for efficiency for drainage, accessibility and will capture the views down to Clutterbuck Creek for vehicles entering the site from Kilburn Road.

Lots fronting Clutterbuck Creek will take advantage of the views afforded by the topography of the site. The remaining lots will orientate east-west to allow for stepped retaining between lots. This will assist in reducing the amount of fill required for Building Pads.

Building Pads will be retained by individual landowners to provide flexibility for housing design and siting within the lot. The colours and materials of retaining will be managed through Local Development Plan/s provisions to ensure consistency with the 'hills lifestyle' character of the area.

Figure 6: Concept Plan

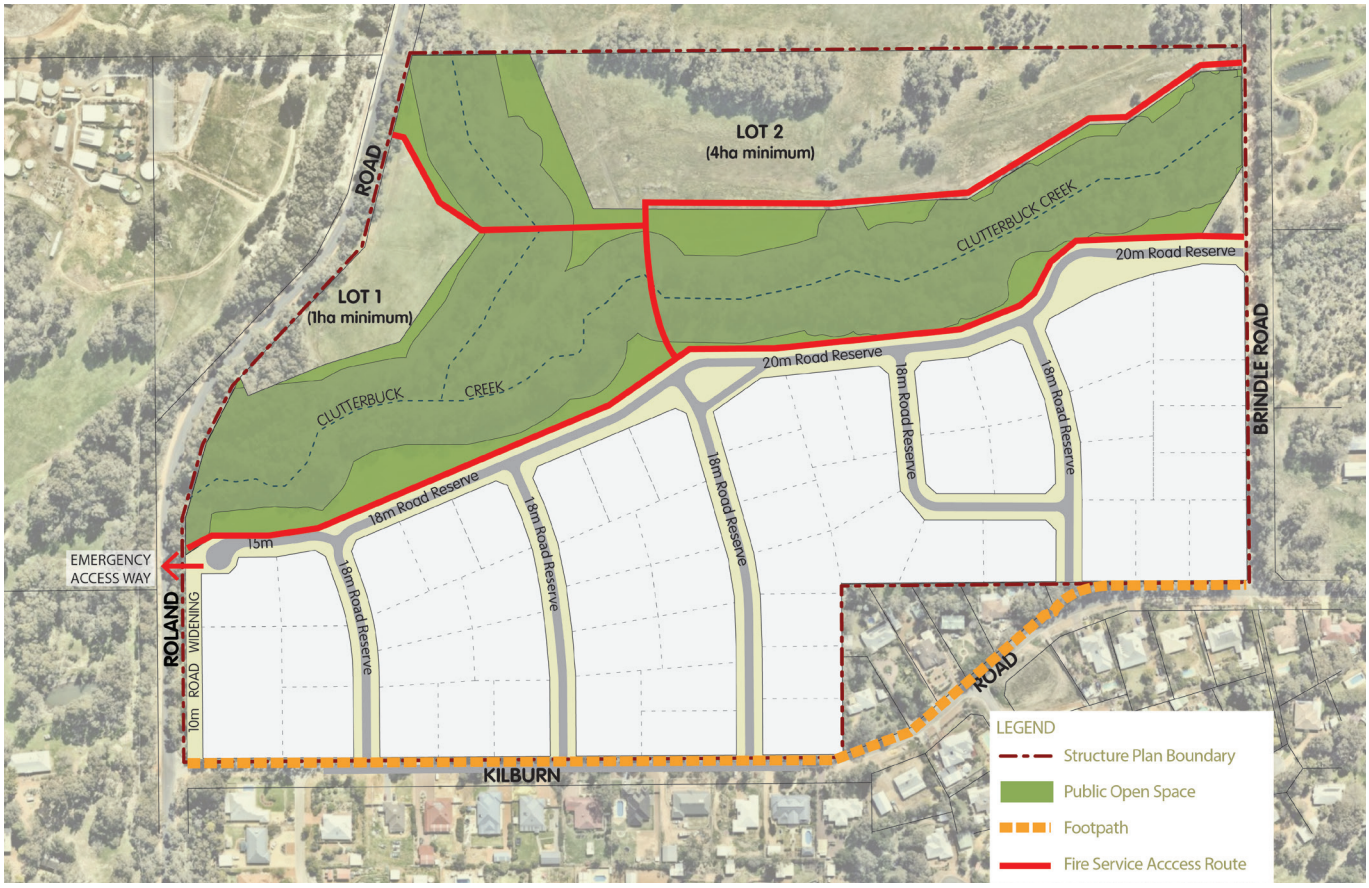
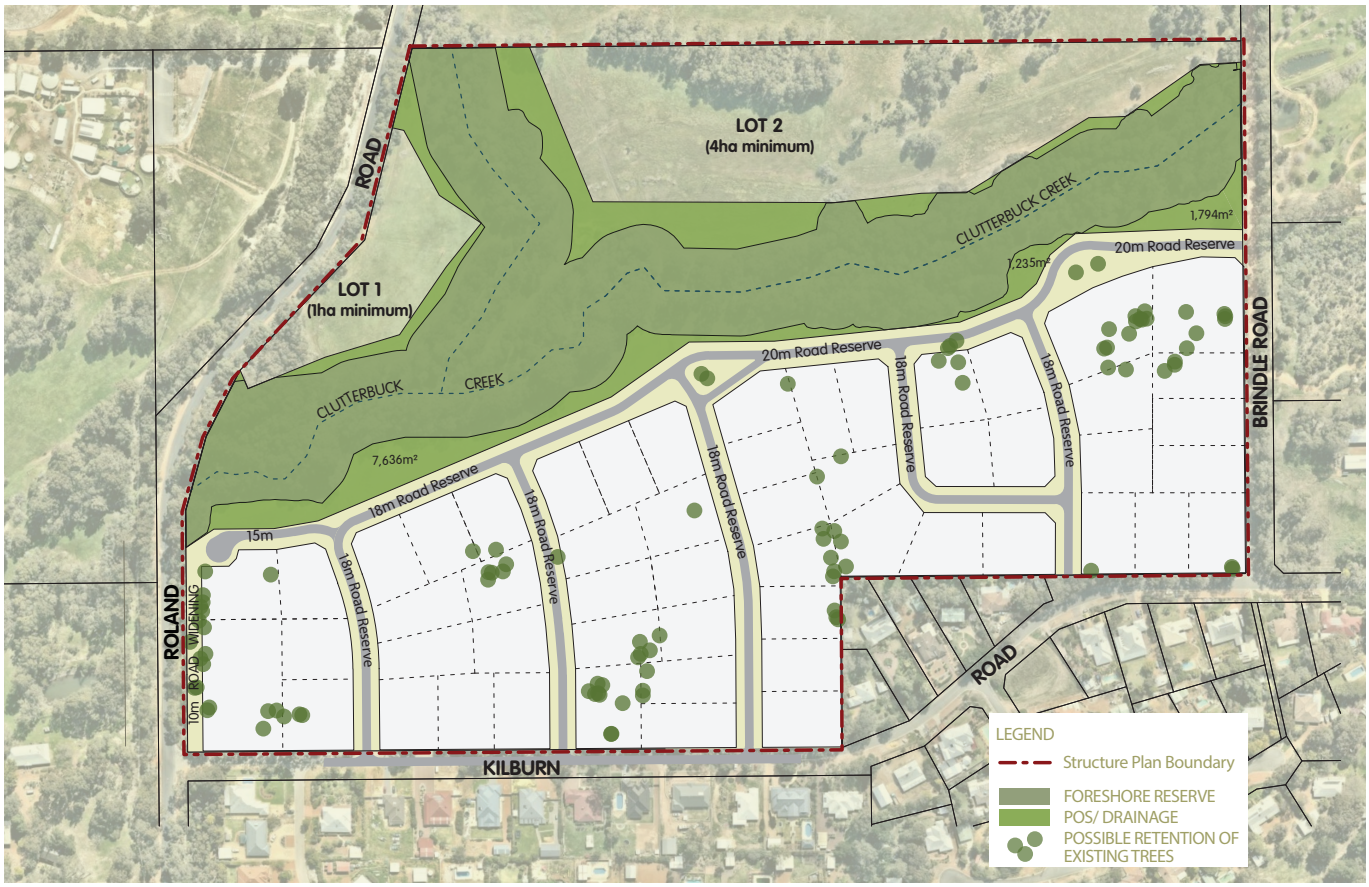


Figure 7: Public Open Space Network



5.2 Public Open Space

The provision of POS is influenced by a number of factors including, drainage requirements, topography, road layout and the need to provide local amenity and proximity to POS equitably to future residents. The POS will be designed to be low maintenance recognising the on-going management by the Shire in perpetuity.

The Structure Plan proposes three areas of POS in addition to the Clutterbuck Creek Foreshore Reserve (refer Figure 7). The location of linear POS enhances the amenity offered by Clutterbuck Creek, providing landscape setting that is distinctive to the Perth hills.

Dedicated drainage basins within the areas of POS will be revegetated with water quality treatment vegetation. The areas of POS that do not provide a drainage function will be turfed to provide recreational and amenity function, as well as a buffer between Clutterbuck Creek and residence for bushfire protection. These areas of POS may, subject to council approval, incorporate play equipment, shared path, kickabout and reflection spaces with park benches to cater for a variety of ages and abilities.

5.2.1 Tree Retention

The Concept Plan proposes to retain existing mature trees onsite, where possible. The identification of trees for retention has been informed by:

- Arborist Report prepared by Arbologic, which is included as Appendix 4 of the Environmental Assessment Report (Refer Appendix B) which provides an assessment on the health of each tree;
- Tree survey undertaken by Coterra Environmental (refer Appendix B) which reviewed the ecological value of each tree; and
- Bushfire Management Plan prepared by Strategen JBS&G (refer Appendix F) which assessed the necessary separation distance between adjoining or nearby tree crowns to manage bushfire risk.

Large mature trees will be retained by the developer where possible within road reserves and open space (refer Figure 7). The lot layout has also been considered, with trees located near lot boundaries to avoid potential conflict with future Building Pads. Removal of existing vegetation by future landowners is not permitted unless a clearing permit is first obtained from DWER. This will afford existing trees within individual lots future protection.

5.2.2 Clutterbuck Creek Foreshore Reserve

Coterra Environmental prepared a Biophysical Environmental Assessment of the Clutterbuck Creek, in accordance with the DWER *Operational Policy 4.3: Identifying and establishing waterways foreshore areas*, to determine the extent of the foreshore boundary. The details of this assessment are included in the LWMS, refer Part 5.4 of this report and Appendix E.

Rather than applying a 30m generic setback from a waterway, a Biophysical Assessment is based on a site's attributes evaluating the watercourse, hydrology and vegetation to determine the extent of the foreshore boundary.

The result of this assessment concluded:

- Inclusion of an additional 3.6ha within the foreshore reserve to include vegetated areas identified as 'Very Good' bordering on 'Excellent' and 'Good' to 'Degraded';
- Additional retention of 10 good conditioned gum trees;
- Achieve a minimum setback of 40m-60m in some locations; and
- Exclude 1.4ha from the generic buffer in two areas that were cleared with no vegetation, with a reduction in setback to 20m in one location and 15m in the other.

The new foreshore reserve has a setback from the creek between 15m to 60m in various locations. The revised boundary is expected to provide conservation to an additional 3.6ha of vegetation, within a total foreshore area of 6.77ha. The two areas which have been excluded from the foreshore reserve are cleared of existing vegetation and are located at natural low-lying areas, making them conducive for drainage. The outcomes of the assessment were submitted to DWER and received preliminary support for inclusion in the LWMS (refer Appendix E).

Revegetation of the foreshore reserve is not proposed as the existing vegetation structure is reasonably intact and additional planning would lead to increased bushfire risk implications.

5.2.3 POS Allocation

A contribution of 5.14% creditable POS is proposed within the Structure Plan area in lieu of the standard 10% (refer Table 5). Justification for this shortfall is provided hereafter.

Table 5: Public Open Space Schedule (not including Clutterbuck Creek reserve)

SITE AREA			16.5489HA
DEDUCTIONS			
1 EY (including swales and dedicated drainage)	0.2271ha		
GROSS SUBDIVISIBLE AREA			16.3218HA
PUBLIC OPEN SPACE 10%		1.63218	
PUBLIC OPEN SPACE CONTRIBUTIONS MAY COMPRISE:			
Minimum 80% Unrestricted Public Open Space	1.305744ha		
Maximum 20% Restricted use Public Open Space	0.326436ha		
	AREAS	DRAINAGE	POS
POS A	0.7636ha	0.1656ha	0.598ha
POS B	0.1235ha	0.0378ha	0.0857ha
POS C	0.1794ha	0.0237ha	0.1557ha
TOTAL	1.0665HA	0.2271HA	0.8394
TOTAL PUBLIC OPEN SPACE (UNRESTRICTED)			5.14%

Recent updates to the Australian Rainfall and Runoff have resulted in the following changes in terminology:

1 EY = 1 in 1 year
0.2 EY = 1 in 5 year
1% AEP = 1 in 100 year

The Shire of Mundaring's POS Strategy recognises that the generic application of 10% POS contribution within the Shire does not address the unique nature of settlement and 'hills lifestyle' choice by its residents. Clause 3.7 of the Strategy states that where land is required to be ceded as POS from private properties, special consideration will be given to land that:

- Is contiguous with existing POS and/or watercourse;
- Has environmental significance; or
- In the opinion of Council has special historical or cultural significance.

The Shire's Strategy incentivises the retention of existing waterways with the inclusion of these area as creditable POS. A substantial portion of private land has been set aside for conservation and landscape amenity as part of the Clutterbuck Creek foreshore reserve. As discussed in Part 5.2.2 of this report, the Biophysical Assessment undertaken by Cotterra Environmental has resulted in an additional 3.6ha of land being retained, within a total foreshore reserve of 6.77ha. If the foreshore reserve were to be credited towards POS, consistent with the Shire's POS Strategy, then the total provision of POS would equate to 46.6%. The location of the POS is contiguous with the foreshore reserve therefore it is reasonable that the land be included as creditable POS.

In addition to the foreshore reserve, a further 10m road reservation widening is proposed for the retention of vegetation adjacent to Roland Road. These areas play a key role in the established sense of place by retaining the landscape value important to the character of the 'hills lifestyle', and are not reflected in the credited POS across the site.

Following meetings with the Shire it is understood the need to keep the maintenance of POS areas to a minimum. The site does not have ground water allocation for irrigation of POS and the Shire have confirmed that future reticulation will not be provided. Additional areas of POS would mean increasing pressure on Council resources, would not provide improved quality of spaces for residents, and would pose an increasing bushfire risk. The areas of POS consolidated with road reservation, drainage and Clutterbuck Creek provide efficiency and accessibility for the on-going maintenance by the Shire.

The required POS contribution is generic to land area and does not reflect the scale of development. The proposal seeks 54 lots for low density development, which would not generate the demand required additional POS. The proposed larger lot size of 2,000m² allows for adequate space for residents to pursue 'hills lifestyle' activities, consistent with the Shire's POS Strategy.

The Shire has a significant oversupply of Regional Open Space which provide high quality areas for active and passive recreation including the Parkerville Natural Reserve, John Forrest National Park and Railway Heritage Trail network. The proposed POS is therefore only likely to be used by the residents of the development, the visitor numbers will therefore not generate the need for additional areas of POS.

5.3 Proposed Movement Network

In support of the Structure Plan design a Transport Impact Assessment has been prepared by GTA Consultants (refer Appendix D), to identify the likely traffic generation associated with the proposed development, its impact on the internal and external road network, and public transport, walking and cycling requirements.

Primary access to the site will be via Kilburn Road which connects to Roland Road to the west. No direct access to Roland Road is provided, with 10m road widening proposed to facilitate future upgrades. Three roads are proposed to intersect with Kilburn Road and one road to Brindle Road, these will provide full movement T-intersections. To limit the number of crossovers to Kilburn Road, two cul-de-sacs are proposed.

Based on generation of 8 vehicles per day (vpd) per dwelling, the Structure Plan is estimated to generate approximately 460 trips per day, with 35 trips within the AM peak period and 46 trips within the PM peak period.

As a result of GTA assessment, the following conclusions were made:

- The estimated traffic volumes can be accommodated within the capacity of the existing road network;
- The proposed roads will be designed to carry a capacity of up to 1,000vpd with a speed limit of 50km/hr, therefore restrictions to direct lot access is not required;
- Given the low traffic volumes generated from the site, the intersection of Roland Road and Kilburn Road can continue to operate at an acceptable level to 2031 without the need for any upgrades;
- Brindle Road will be upgraded to provide 6.0m sealed carriageway within the existing road reservation from the northern most proposed road; and
- A footpath will be installed along Kilburn Road and the road interfacing with POS to provide connection to the existing pedestrian network on Roland Road.

5.3.1 Brindle Road

Brindle Road is currently an unsealed rural grade road with 4.0m wide carriageway and 1.0m shoulders. It is proposed that the carriageway be widened to 6.0m to accommodate a higher traffic flow. The Structure Plan is expected to generate 100 vpd to Brindle Road, with the ultimate road design to provide for carrying capacity of 1,000 vpd.

5.3.2 Kilburn Road

Kilburn Road provides the primary route to the Structure Plan from Roland Road, with traffic volumes expected to approximately 1,000vpd. Kilburn Road has a 6.0m wide carriageway and typical traffic carrying capacity of 1,000vpd. The projected traffic volumes generated from the site to 2031 demonstrate the intersection of Roland Road and Kilburn Road can continue to operate at an acceptable levels without the need for any upgrades.

5.3.3 Access Street D

In accordance with Liveable Neighbourhoods the proposed road network will comprise 'Access Street D' (refer Figure 8).

The road design incorporates 18m wide reserve with 6.0m trafficable road, and 5.0m verges which will accommodate street tree planting to both sides (refer Figure 9).

The road interfacing with Clutterbuck Creek will vary between 15m-40m, deviating to retain existing mature trees and drainage (refer Figure 10). The reduction of 1.0m to this road reserve is acceptable as there is development only to one side and the verge is contiguous with the POS on the northern side.

Figure 8: Road Network Plan

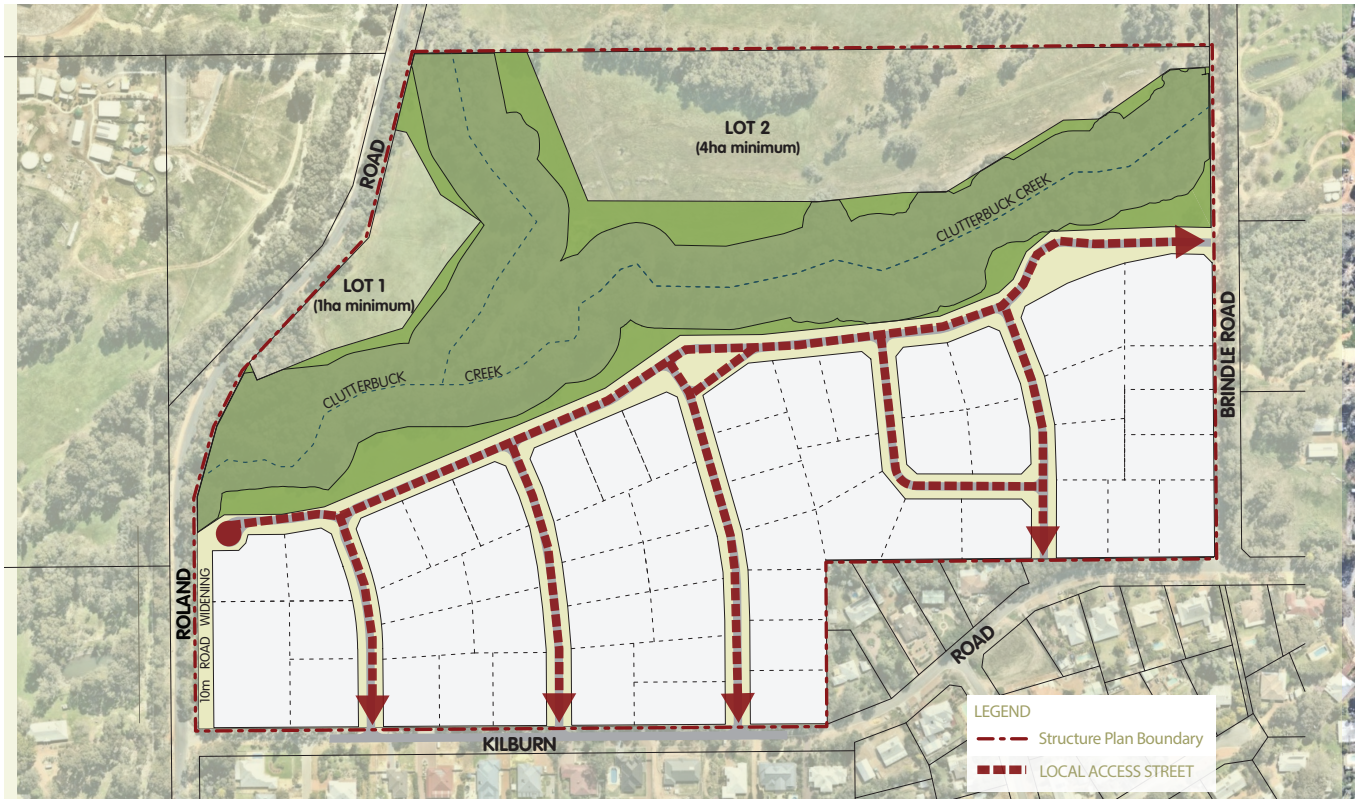


Figure 9: Typical 16.0m wide Road Cross Section

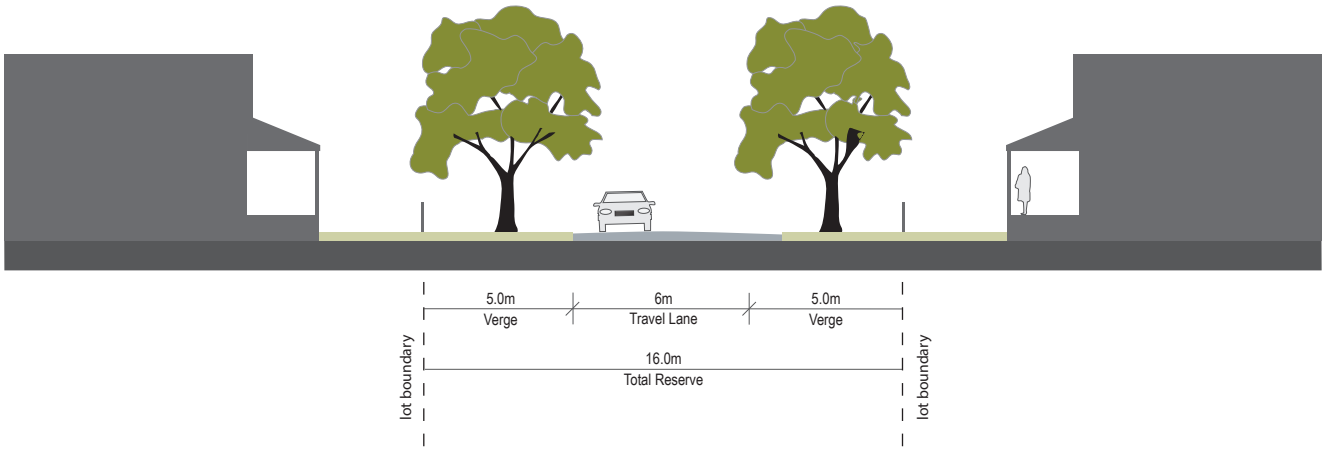
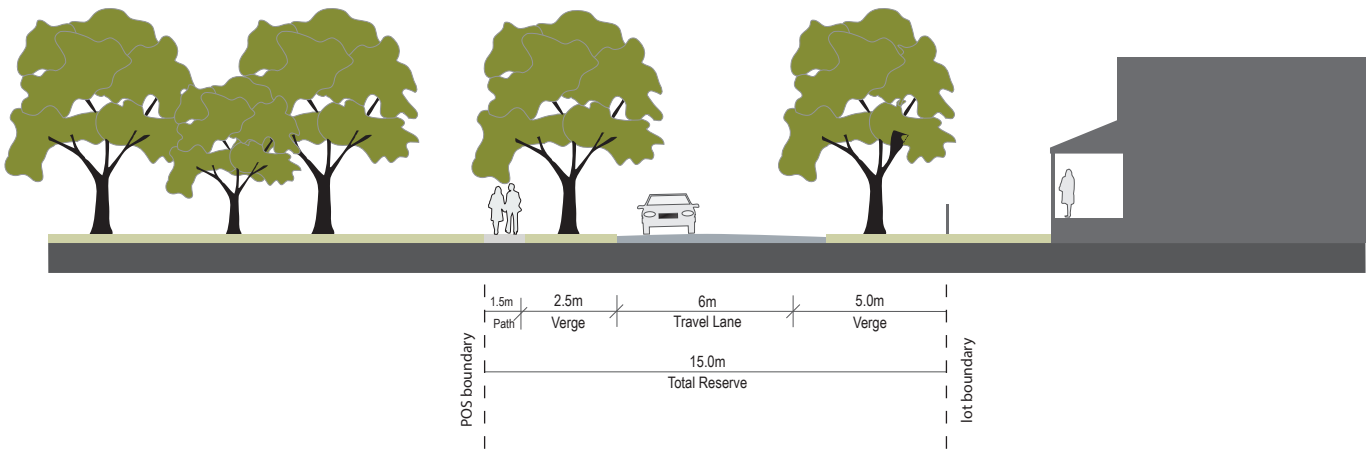


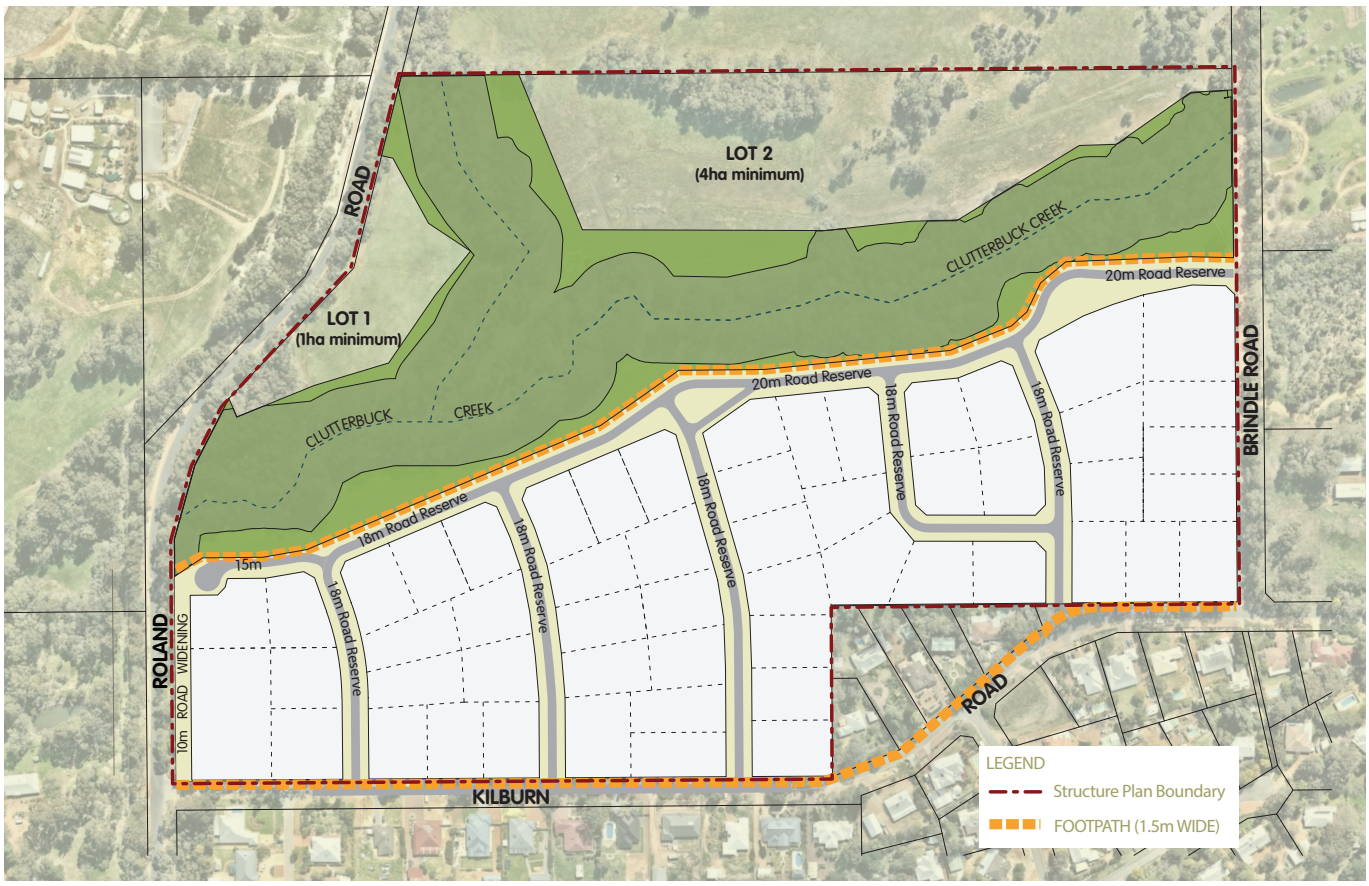
Figure 10: Typical 15.0m wide Road Cross Section



5.3.4 Footpath

The road network is based on a modified grid format, providing a legible pedestrian and cyclist connection between Kilburn Road and Clutterbuck Creek. All roads will have low traffic volumes which will allow for on-street walking and cycling. A 1.5m wide footpath is proposed within the road reserve interfacing with Clutterbuck Creek, and along the northern side of Kilburn Road to provide connection to the existing pedestrian network along Roland Road (refer Figure 11).

Figure 11: Path Network Plan



5.4 Water Management

A District Water Management Strategy (DWMS) was prepared to support MRS Amendment 1347/57 to rezone the Structure Plan area from 'Rural' to 'Urban'. The approved DWMS identified that pre-development peak flow rates and discharging should be maintained to Clutterbuck Creek. The DWMS assumed that management of up to the 5% AEP event (the 1 in 20 year ARI event) predevelopment flows would occur on the site.

Based on the assumptions within the DWMS a LWMS has been prepared by Coterra Environmental to support the Structure Plan. The LWMS is consistent with the Water Sensitive Urban Design (WSUD) principles and Best Management Practices (BMPs), taking advantage of the natural geological and topographical features of the site. The post-development stormwater management systems and catchment flows will ensure that the pre-development hydrological regime and conditions will be mimicked, as practical, post-development.

The LWMS details the following:

- Lots will infiltrate roof runoff into individual lot soakwells;
- Lot runoff for larger events and road run off, up to 20% AEP event (previously referred to as the 1 in 5-year ARI), will be conveyed in the road reserves via pipes to the drainage basins;
- There are five drainage basins proposed, which will treat the first 15mm before eventual discharging to Clutterbuck Creek;
- One of the drainage basins is larger to attenuate flows in the 5% AEP event (the 1 in 20 year ARI event) to maintain the pre-development flows;

As there is no reticulated sewer available, all lots are required to provide ATU's. Building Pads may be required to be filled by landowner to achieve the adequate separation to groundwater for soakwells and ATU's for wastewater disposal.

The proposed drainage basins are located outside of the foreshore reserve, in areas already cleared. This was proposed to DWER during the Biophysical Assessment, discussed in Part 5.2.2 of this report and included in the LWMS (refer Appendix E).

5.5 Bushfire Hazard

The Structure Plan is identified as a Bush Fire Prone Area under the state-wide Map of Bush Fire Prone Areas as such a Bushfire Management Plan (BMP), has been prepared by Strategen JBS&G (refer Appendix F). This BMP has been prepared in accordance with the *State Planning Policy 3.7 Planning in Bushfire Prone Ares* (SPP3.7), the *Guidelines for Planning in Bushfire Prone Areas* and *Australian Standards 3959-2009 Construction of Building in Bushfire Prone Areas* (AS 3959).

The BMP assumes all vegetation within Clutterbuck Creek foreshore reserve will be retained in its current state and will not require removal to achieve an appropriate BAL rating for the proposed development. Whilst no revegetation is proposed, should any new planting occur within Clutterbuck Creek foreshore it will not have bearing on the BAL outcome as the worst-case Class A forest classification has already been applied.

Some vegetation is required to be cleared within Roland, Kilburn and Brindle Road verges to achieve a low threat/non-vegetated state, as well as conversion of the current on-site grassland to a managed low threat/non-vegetated state.

As outlined in the BMP the bushfire risk can be managed through standards application of acceptable solutions under the Guidelines, including provisions for and implementation of Asset Protection Zones, relevant bushfire construction standards under AS3959, provisions of adequate emergency water supply and vehicle access, as well as through a direct bushfire suppression response if required. The location of Asset Protection Zones will be identified at the time of subdivision.

The BMP demonstrates that all future development can be located to avoid areas of extreme Bushfire Hazard Level and achieve a rating of BAL-19 or lower via building setbacks.

5.6 Services and Infrastructure

An Engineering Servicing Report has been prepared by Pritchard Francis (refer Appendix G) to progress the proposed LSP. The report concludes that no major issues preclude the development of the LSP area.

5.6.1 Water Reticulation

The existing 150mm water main which runs along Kilburn Road will be extended north up Brindle Road and into the future roads to service the lots with potable water supply.

5.6.2 Power

The site is primarily serviced by 22kV three phase aerial High Voltage (HV) and aerial three phase Low Voltage (LV) network. The network is serviced by the Darlington Zone substation.

Based on 5kVA per lot allocation, this development will require a total allocation of 285kVA. Western Power's public Network Capacity Mapping Tool there is extra 25MVA capacity in the Darlington Zone substation, which is not forecast to change in the next 10 years, suggesting that the growth in power demand in the area has stabilised. The development can therefore be serviced by the existing network. Confirmation of the spare capacity in the network will be confirmed with Western Power at the time of subdivision.

For this project it is expected to service the site by either two 315kVA transformers or five 63kVA transformers fed by an isolation transformer. The servicing options will be discussed with Western Power at the time of subdivision.

5.6.3 Gas

As there is no natural gas network in the area, the lots will not be connected to gas supply.

5.6.4 Telecommunications

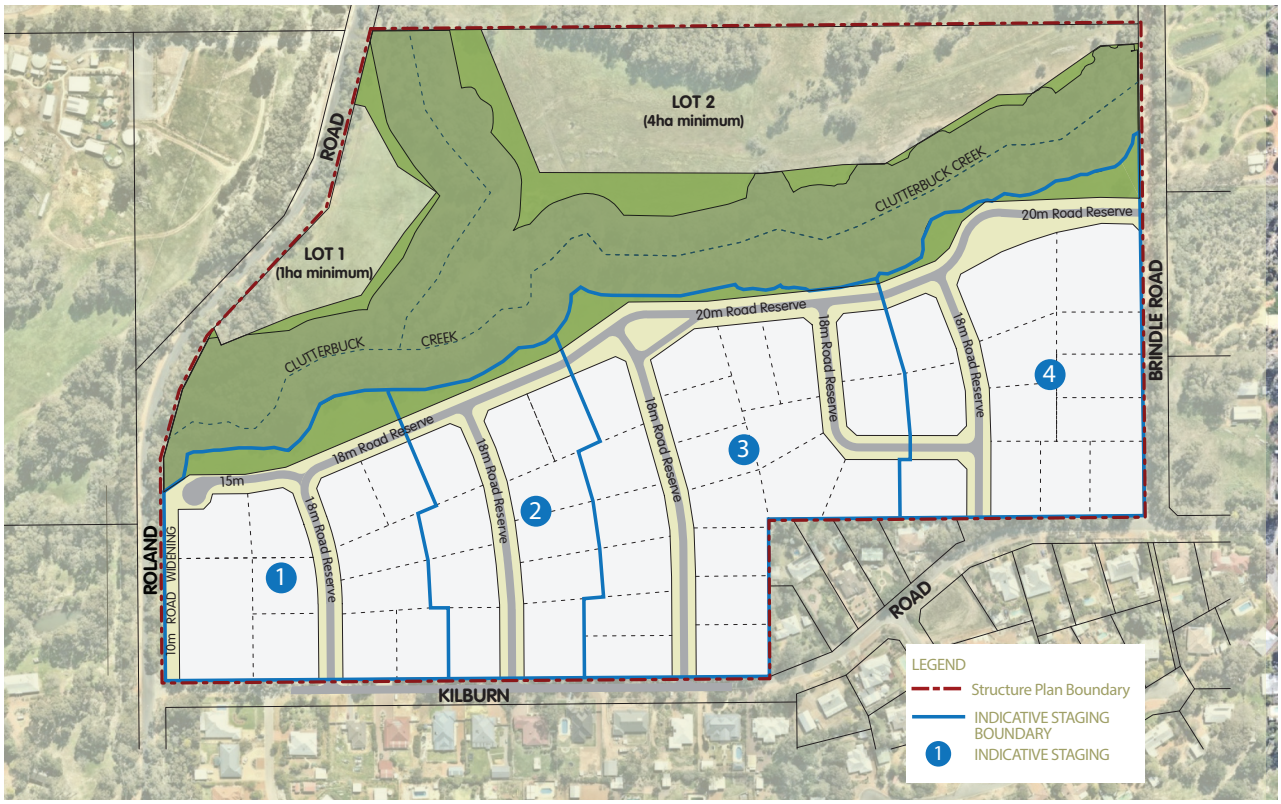
The site is serviced by the Telstra Parkerville Exchange, approximately 800m south of the site, on Byfield Road. There is an existing Telstra network near the eastern side of Roland Road, south of Kilburn Road.

The proposed development falls in an area that has already been partly converted to NBN Co broadband under the Brownfields Rollout within Lot 1001 classified within the Fixed Line Footprint, the southern portion of Lot 61 not classified and the northern portion falling within the Fixed Wireless Footing.

Staging

The staging is anticipated to commence in the from the western portion of the site, with access provided via Kilburn Road. The staging will then progress in an easterly direction towards Brindle Road, refer Figure 12.

Figure 12: Indicative Staging Plan



6.0 Conclusion

The Parkerville Local Structure Plan will facilitate the development of 54 lots with minimum size of 2,000m² and 2 rural smallholding lots. The Structure Plan appropriately responds to the applicable planning framework, providing low scale residential development, for the incremental expansion of the Parkerville townsite, located south of Kilburn Road.

The Structure Plan design responds to the opportunity presented by the unique bush landscape and the topographical views to Clutterbuck Creek and incorporates traditional neighbourhood design. The outcome is a proposal that enhances the 'hills lifestyle' of Parkerville.

PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX A
GEOTECHNICAL REPORT
(DOUGLAS PARTNERS)

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Assessment of Site Suitability for On-Site Sewage Disposal
Lots 61 and 1001 Kilburn Road, Parkerville, WA

Prepared for
Parkerville Children and Youth Care Inc.

Project 89041.00
June 2018

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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Report prepared for	Parkerville Children and Youth Care Inc.		
File name	89041.00.R.001.Rev0.PARKERVILLE, Lot 61 and 1001 Kilburn Road		

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Revision 0			Phil Cuttone, Parkerville Children and Youth Care Inc.

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		21 JUNE 2018
Reviewer		21 June 2018

bsi. ISO 9001 Quality Management

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Appendix C: Laboratory Testing

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This report presents the results of a geotechnical investigation undertaken for an assessment of site suitability for on-site sewage disposal at Lots 61 and 1001 Kilburn Road, Parkerville, WA. The investigation was commissioned in an email dated 25 May 2018 by Phil Cuttone on behalf of Parkerville Children and Youth Care Inc. and was undertaken in accordance with Douglas Partners' proposal PER180204 dated 24 May 2018.

It is understood that the site is to be rezoned to allow for residential development. The site will not be serviced by the sewerage network. Therefore, in order to progress the rezoning process, an assessment of the suitability of the site for on-site disposal of sewage is required.

The aim of the geotechnical investigation was to assess the soil and groundwater conditions (if encountered) underlying the site and subsequently provide comment on the suitability of soils encountered during investigation for acceptance of domestic on-site effluent disposal in accordance with AS 1547:2012. Additionally, the investigation was to provide an indicative site classification for the site in current condition in accordance with AS2870-2011.

The investigation included the excavation of twelve test pits, dynamic cone penetrometer tests adjacent to each test pit, the performance of seven in situ permeability tests using the constant head method, and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

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The irregular shaped site is identified as Lots 61 and 1001 Kilburn Road in Parkerville, Western Australia (refer to Drawing 1, Appendix A). It is bounded by Kilburn road to the south, by Roland road to the west, by Brindle Road to the east, and by Clutterbuck Creek to the north. The site has a developable area of approximately 15.4 ha.

At the time of the investigation, the site generally comprised grass pasture, with medium to large sized trees located mostly around the perimeter of the site but also occasionally in the pasture area. A residential dwelling and several agricultural buildings were located along the southern boundary of the site. The foundations, ground slab and a wall of a partially demolished structure and adjacent derelict water tank were observed within the centre of the site, with a water dam nearby. Numerous piles of laterite boulders were observed on the surface, which was also generally scattered with laterite cobbles. Several felled trees and timber stockpiles were present. The site falls gently from a high point in the south east corner to a low point in the north western corner.

Some typical views of the site, indicating some of the features described above, are presented in Figures 1 to 6 (below and following pages).

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The ground surface level is estimated to falls from a high point of approximately RL 257 m AHD in the south east corner to a low point of approximately RL 243 m AHD in the north western corner, based on data provided by Google Earth.

The Mundaring 1: 50 000 Environmental Geology sheet indicates that shallow sub surface conditions beneath the most of the site consist of laterite gravel, described as fine to coarse, loose ferruginous pisolites within a sand and silt matrix, of colluvial origin. The eastern part of the site is indicated to be underlain by laterite, described as massive, hard and cemented, and overlain by associated gravels of residual origin. The north western boundary of the site is indicated to be underlain by gravelly clayey sand of colluvial origin.

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Field work was carried out on 31 May and 1 June 2018 and comprised the excavation of twelve test pits, seven in situ permeability tests and dynamic penetrometer testing adjacent to each test pit location.

The test pits (TP1 to TP12) were excavated to a maximum depth of 2.0 m using an 8 tonne excavator equipped with a 450 mm wide toothed bucket and were logged in general accordance with AS 1726-2017 by a suitably experienced geotechnical engineer from DP. Soil samples were recovered from selected locations for subsequent laboratory testing. Refusal occurred prior to the target depth of 2 m at TP2, TP3, TP7, TP10 and TP11 due to slow or hard digging.

Dynamic cone penetrometer (DCP) tests were carried out adjacent to all test locations in accordance with AS 1289.6.3.2 to assess the in situ density of the shallow soils.

Seven in situ permeability tests were carried out using the constant head method in accordance with AS 1547-2012 at BH13 to BH19 at depths of 0.25 m.

Test locations were determined using hand held GPS coordinates and are marked on Drawing 1 in Appendix A. Surface elevations at each test location were interpolated from data provided by Google Earth.

Detailed logs of the ground conditions and results of the field testing at the test pit locations are presented in Appendix B, with notes defining descriptive terms and classification methods provided in Appendix A.

The encountered ground conditions generally comprised topsoil overlying clayey sandy gravel or gravelly clayey sand. Laterite or clayey sand / sandy clay were generally encountered underlying the gravelly soils.

A summary of the ground conditions encountered or inferred at the test locations is given below:

- **T** – generally dark brown-black, fine to medium grained gravelly silty sandy topsoil with some roots, encountered to a depth of 0.1 m. The topsoil was filling at TP9.
- – medium dense, dark brown, fine to medium grained gravelly sand filling encountered to a depth of 0.4 m at TP9.
- – generally loose, locally medium dense or dense, brown, fine to medium grained gravelly clayey sand or fine to coarse sized clayey sandy gravel encountered underlying the topsoil or filling at all locations to depths of between 0.3 m and 1.3 m, except at TP3 and TP12 where this soil extended to the termination depth of the test pits at depths of 1.7 m and 2.0 m respectively. The gravelly clayey sand contained cobbles and boulders of laterite at some test locations. It behaved as an extremely low strength, extremely weathered rock at TP3 and TP8.
- – generally high strength laterite encountered underlying the gravelly soils described above at TP1, TP2, TP7 and TP10 from depths of approximately 0.25 m and 0.5 m. Refusal occurred within 50 mm to 300 mm of the top of the laterite due to hard digging, except at TP1 where the full depth of the laterite as excavated with the 8 tonne excavator (base of laterite at TP1 approximately 0.9 m). Possible laterite is inferred from test pit refusal due to hard digging at TP3 and TP11 at depths of 1.7 m. The depth to the top of the encountered laterite is summarised in Table 1 below.
- – generally very dense or hard, light yellow-brown or light grey-brown mottled brown, clayey sand or sandy clay, encountered underlying the gravelly soils or laterite at most test locations. The sand is medium to coarse grained and the clay is of medium plasticity. The material was very hard sandy clay at TP1. The material contained some gravel at some locations. The soil behaved as extremely low strength, extremely weathered rock at TP8 and TP11.

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T	D	D T	T D
TP1	236	0.3	235.7
TP2	241	0.4	240.6
TP3	244	1.7[2]	242.3
TP7	240	0.5	239.5
TP10	248	0.2	247.8
TP11	248	1.7[2]	246.3

Notes: [1]: Interpolated from data provided by Google Earth (estimated accuracy +/- 1 m)
[2]: Laterite inferred due to hard digging

Seepage of groundwater was observed at TP1 and TP4, both located at the north western end of the site, during the field work undertaken on 31 May 2018. A summary of the observed groundwater levels is provided in Table 2 below. A local aquifer was not encountered at any of the test locations.

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T	D	D	D
TP1	236	0.8[2]	235.2
TP4	238	1.7[2]	235.3

Notes: [1]: Interpolated from data provided by Google Earth (estimated accuracy +/- 1 m)
[2]: Seepage observed from the given depth

BOM records indicate that more than 90 mm of rain fell in Parkerville area in the week preceding the field works.

It should be noted that groundwater levels are affected by climatic conditions and soil permeability, and will therefore vary with time.

Seven in situ permeability tests using the constant head method were carried out in accordance with AS 1547-2012 at depths of 0.25 m at BH13 to BH19. Field permeability values were estimated using the test results in accordance with AS 1547-2012. The results of the in situ permeability test are presented in Table 3 (next page).

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T	D	M		T M
BH13	0.25	3.9×10^{-5}	3.5	Gravelly Clayey Sand
BH14	0.25	2.6×10^{-5}	2.0	Clayey Sandy Gravel
BH15	0.25	2.5×10^{-5}	2.0	Clayey Sandy Gravel
BH16	0.25	4.2×10^{-5}	3.5	Gravelly Clayey Sand
BH17	0.25	5.3×10^{-5}	4.5	Gravelly Clayey Sand
BH18	0.25	10.5×10^{-5}	9.0	Clayey Sandy Gravel
BH19	0.25	4.3×10^{-5}	3.5	Clayey Sandy Gravel

Notes: [1]: AS1547:2012 Appendix 4.1F.

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A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of:

- the particle size distribution of four samples;
- the Atterberg limits of four samples;
- the Emerson Class of three samples; and
- the pH, electrical conductivity, action exchange capacity and phosphorous retention index on two samples.

The detailed test certificates are given in Appendix C, with the results summarised in Tables 4 and 5 (next page).

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T	D									M
TP1	1.1-1.3	5	40	55	56	24	32	7.0	0.5	Sandy Clay
TP4	1.0-1.2	11	44	45	55	30	25	6.5	0.9	Sandy Clay
TP6	0.5	75	21	4	-	-	-	-	-	Clayey Sandy Gravel
TP8	1.5	28	45	27	44	29	16	8.0	-	Gravelly Clayey Sand
TP11	0.5	40	45	15	34	21	13	5.5	-	Clayey Gravelly Sand

Where:

- % fines is the amount of particles smaller than 75 µm.
- % gravel is the amount of particles larger than 2.36 mm.
- LL: liquid limit.
- LS: linear shrinkage
- PL: plastic limit
- PI: plasticity Index
- '-' means 'Not Tested'

T **T** **D**

T	D						M
TP1	1.1-1.3	5.4	0.088	2	418.3	6	Sandy Clay
TP4	1.0-1.2	-	-	-	-	6	Sandy Clay
TP6	0.5	6.3	0.004	<1	188.0	5	Clayey Sandy Gravel
TP11	0.5	6.6	0.019	4	177.9	-	Clayey Gravelly Sand

Notes:

- pH and EC tests are carried out in 1:5 (soil:water) solution.
- EC: Electrical conductivity
- CEC: Cation exchange capacity in meq/100g.
- PRI: Phosphorous retention index

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It is understood that the site is to be rezoned to allow for residential development. The site will not be serviced by the sewerage network. Therefore, in order to progress the rezoning process, an assessment of the suitability of the site for on-site disposal of sewage is required.

The site is generally underlain by mixed clayey soils and laterite. The encountered shallow soils were generally loose. Uncontrolled filling was encountered at one location.

Because of the presence of uncontrolled filling and loose shallow soils, the site should be strictly classified as Class 'P' in current condition. However, the encountered filling should generally form a suitable foundation material and the depth of loose material is less than 1 m and consequently can be compacted to medium dense or denser by conventional earthworks methods and plant.

Therefore, based on the encountered conditions, the majority of the site is suitable to be classified as "Class S" in accordance AS2870-2011, provided the density of the loose soils underlying the site is increased to medium dense or denser.

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Site characteristics observed during the field work and soil properties determined during subsequent laboratory testing have been assessed in relation to the anticipated limitations that they pose to onsite disposal of domestic effluent.

For this assessment, reference has been made to AS1547-2012, the Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001, Government Sewerage Policy – Consultation Draft, Department of Health, December 2011 and NSW Environment and Health Protection Guidelines. This later guideline evaluates various soil and site characteristics and assigns either a minor, moderate or major limitation depending on the restrictions to the disposal of domestic effluent. Minor limitations are regarded as not posing a constraint to the application of domestic effluent. Site and soil characteristics which are considered to be major limitations will require site or soil improvement measures to allow on-site effluent disposal at the site.

Site and soil characteristics, including, the moderate and major limitations for effluent disposal within the site, are discussed below.

Saturated hydraulic conductivity (permeability) is a measure of the ability of soil to transmit water based on soil properties such as structure, texture and porosity. The soil types noted within the test pits are predominantly gravelly clayey sand / clayey sandy gravel overlying clayey sand / sandy clay. Laterite was encountered close to the ground surface at some locations (see Section 4.1 and Table 1).

A soil permeability category Groups 2 to 5 (reference to AS 1547-2012 Tables 5.1 and E1) are considered suitable for encountered uncemented soils underlying most of the site, with measured permeability ranging between approximately 2.5 x 10^{-5} m/s and 10.5 x 10^{-5} m/s (approximately

2.0 m/day and 9.0 m/day). It is suggested that a preliminary design permeability of 2.5 x 10^{-5} m/s (approximately 2.0 m/day) is adopted for the uncemented soils underlying the site.

The laterite should be regarded as impermeable for drainage or sewage disposal design, as discussed in Section 7.2.2 below.

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Laterite was encountered at shallow depth at some locations, as summarised in Table 1, Section 4.1. The laterite should be regarded as hardpan and impermeable for drainage or sewage disposal design.

The laterite was not encountered at most test locations, and hard pan material was not generally present within the investigation depth. Therefore, depth to hardpan is not considered a limitation for most of the site.

However, at the depths encountered at TP1, TP2, TP7 and TP10, it is considered a major limitation and will need to be addressed.

Therefore, to allow on-site disposal of sewage where shallow laterite is currently present, either:

- the laterite should be excavated and replaced with soil similar to the uncemented soils encountered at the site; or
- the elevation of the site should be raised to provide sufficient depth of soil above the laterite for drainage to occur.

It may be possible to re-use the laterite following excavation, and crushing of the cemented material. Further investigation, testing and field trials would be required to provide further comment on the reuse of the laterite and appropriate methods of crushing the material.

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Groundwater seepage was encountered at depths of 0.8 m and 1.7 m at TP1 and TP4 during the field work on 31 June 2018. BOM records indicate that over 90 mm of rainfall fell during the week immediately preceding the field work.

It is possible that perched groundwater will collect on the lower permeability materials such as laterite and sandy clay in the winter period but such phenomenon is likely to be short lived and was not observed during the investigation except at TP1 and TP4. Therefore, the groundwater table is considered a minor limitation for on-site disposal of sewage. Investigation of groundwater levels at the end of winter is suggested to further assess possible impacts of groundwater levels for on-site sewage disposal, particularly the low lying areas of the site. Groundwater levels are affected by climatic conditions and soil permeability and groundwater levels higher than those encountered during the field work may occur.

Coarse fragments are defined as particles greater than 2 mm in AS 1547-2012. The abundance of coarse fragments in the soils encountered underlying the site is generally common to abundant, in accordance with Table E2, AS 1547-2012. Such an abundance of coarse fragments may pose limitations on root growth of surface vegetation and reduce the soil capacity to supply water and nutrients to the vegetation, though there is no evidence of this being the case on the study site. The piles of boulders on the site surface should be removed.

The abundance of coarse fragments may also present difficulty in trench and excavation construction. This is considered to be likely for the massive laterite, which will be hard digging and may require large plant or rock breakers to excavate. The abundance of coarse fragments is considered a moderate limitation.

The site slopes generally slopes gently towards the north western corner, with gradients estimated to be less than 10%. Slopes of this gradient are considered a minor limitation due to the potential rapid runoff of the effluent from surface and subsurface irrigation and absorption systems, possibly resulting in accumulation of runoff and consequent waterlogging where the gradient reduces.

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Laboratory testing of soil samples taken from the site indicate an Emerson class of 5 or 6. Therefore, the soils generally have a low potential for dispersion and dispersivity does not form a limitation for on-site sewage disposal at the site.

Laboratory testing indicates a pH value of generally above 6, though one result returned a pH of 5.4. Therefore, pH is a minor limitation for on-site sewage disposal at the site.

Laboratory testing indicates that the electrical conductivity of soils underlying the site is less than 0.1 dS/m and therefore electrical conductivity is not a limitation to on-site sewage disposal.

The cation exchange capacity (CEC) is the total number of cations a soil can retain on its absorbent complex at a given pH, and is therefore a good measure of a soil ability to retain specific pollutants. The laboratory tests carried out on the samples collected from test pits TP1, TP6 and TP11, indicate CEC values of less than 5 meq/100g or cmol+/kg. A cation exchange capacity of less than 5 cmol+/kg is considered as a major limitation for on-site effluent disposal and therefore secondary treatment of effluent, using equipment such as aerobic treatment units (ATU) is required.

The laboratory test carried out on samples collected from TP1, TP6 and TP11 indicate a phosphorus retention index (PRI) of between 177.9 mL/g and 418.3 mL/g for the soils underlying the site, indicating the soils are moderately to highly absorbing. PRI is considered a minor limitation for on-site sewage disposal.

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Owing to the occurrence of soils with the major limitations on permeability mentioned above, it is suggested that the treatment of the primary effluent is undertaken to produce secondary quality effluent, prior to on-site disposal over the land surface.

Several treatment options are possible and include the following:

- Aerobic Treatment Unit (ATU);
- sand filters; and
- closed cell (amended soil) evapo-transpiration systems.

It is understood that sequential batch reactor (SBR) units, an advanced form of ATU, are proposed for this site.

The effluent treatment system selected for use should be approved by the WA Department of Health.

Once the effluent has been treated by an approved system, the resulting effluent would be sent to the disposal area.

The disposal area required will be dependent on number of factors, including the following:

- treatment system adopted and quality of effluent produced;
- soil characteristics;
- climate conditions; and

- effluent loading, as determined by the number of people within the proposed workshop and the water reduction fixtures present.

Guidance on the minimum areas for land application of effluent which has been treated by an ATU/SBR system is provided in Table 13 of the "Code of Practice for On-Site Sewage Management, Consultation Draft – November 2012", issued by Department of Health, Government of Western Australia.

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The performance of an effluent disposal system is dependent on proper maintenance which should incorporate the following:

- regular maintenance of surface vegetation to encourage water and nitrogen uptake.
- maintenance of surface drains to prevent the ponding of water in the vicinity of the disposal area.

Disposal areas should be constructed to comply with AS 1547-2012 and the general recommendations contained within this report, the methods detailed in AS 1547-2012, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001 and the respective local or state authority. Disposal area should also observe the setback distances listed in Table 10 of the "Code of Practice for On-Site Sewage Management, Consultation Draft – November 2012", issued by Department of Health, Government of Western Australia.

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The site is considered suitable for the disposal of domestic effluent in general accordance with AS1547-2012, local government conditions and WA Department of Health, provided that the limitations described in Section 7.2 are addressed and that treatment of primary effluent is undertaken.

As there are a variety of Department of Health WA approved proprietary systems available, the choice of system is ultimately made by the purchaser of the properties within the guidelines of AS 1547:2012, local government authorities, the WA Department of Health and the site characteristics described above.

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
3. Australian Standard AS 1726-2017, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings.
5. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.

6. Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001.
7. Environment & Health Protection Guidelines: On-site Sewage Management for Single Households - January 1998.
8. Australian Standard AS 1547-2012, On-site Domestic-wastewater Management.
9. Government Sewerage Policy – Consultation Draft, Department of Health, December 2011.
10. Code of Practice for Onsite Sewage Management, Consultation Draft, November 2012.

Douglas Partners (DP) has prepared this report for this project at Lots 61 and 1001, Kilburn road, Parkerville, WA, in accordance with DP's proposal dated 24 May 2018 and acceptance received from Phil Cuttone on behalf of Parkerville Children and Youth Care Inc. dated 25 May 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Parkerville Children and Youth Care Inc. for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition

materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

Asbestos has been detected by observation on the surface of the site near building demolition materials, and these are considered as indicative of the possible presence of hazardous building materials (HBM), including asbestos.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above), or to parts of the site being inaccessible and not available for inspection/sampling [where appropriate], or to vegetation preventing visual inspection and reasonable access [where appropriate]. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

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About This Report
Drawing

About this Report

Douglas Partners

These notes have been provided to amplify DP s report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP s reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

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The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to ustify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than straight line variations between the test locations.

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open
- A localised, perched water table may lead to an erroneous indication of the true water table
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency
- Changes in policy or interpretations of policy by statutory authorities or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

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Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

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Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

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The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only ma or changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

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A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

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Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7

  N = 13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

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Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

Douglas Partners

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

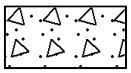
Symbols & Abbreviations

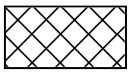
Graphic Symbols for Soil and Rock

General

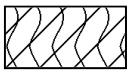
Asphalt

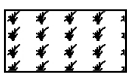
Road base

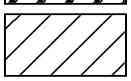

Concrete


Filling

Soils


Topsoil

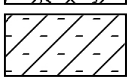

Peat


Clay

Silty clay

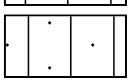
Sandy clay

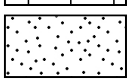
Gravelly clay

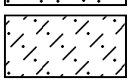

Shaly clay

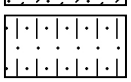
Silt

Clayey silt


Sandy silt

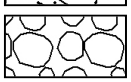

Sand


Clayey sand


Silty sand

Gravel

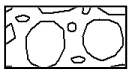
Sandy gravel


Cobbles, boulders

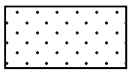
Talus

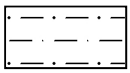
Sedimentary Rocks

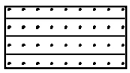
Boulder conglomerate

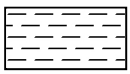

Conglomerate

Conglomeratic sandstone

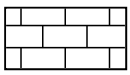

Sandstone


Siltstone

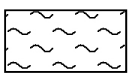

Laminite

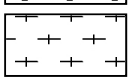

Mudstone, claystone, shale

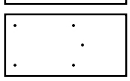
Coal


Limestone

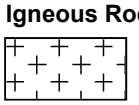
Metamorphic Rocks

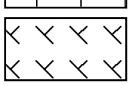

Slate, phyllite, schist

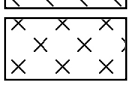

Gneiss

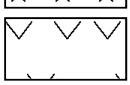

Quartzite

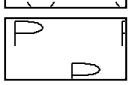
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Aerial Photography Source: NearMap, flown April 2018.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Parkerville Children and Youth Care Inc	**Test Location Plan**	PROJECT No:	89041.00
	OFFICE:	Perth	**Proposed On-Site Sewage Disposal**	DRAWING No:	1
	DATE:	14-6-2018	**Lots 61 & 1001 Kilburn Road, Parkerville, WA**	REVISION:	0

Results of Field Work

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 236 m AHD*
EASTING: 418624
NORTHING: 6473668

PIT No: TP01
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
236	0.1	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained, silty sandy topsoil with some gravel to slightly gravelly, some roots, moist.							
	0.3	GRAVELLY CLAYEY SAND - loose, brown, fine to medium grained, gravelly clayey sand, moist. Gravel is laterite.							
		LATERITE - medium to high strength, orange-brown and brown, laterite with some clay seams. Excavated as cobbles and boulders.						▽	
	0.9	SANDY CLAY - very stiff to hard, light grey-brown mottled brown, medium plasticity, sandy clay with some gravel, moist.		D	1.1				
235	1			U	1.2				1
		- becoming light grey and no gravel from 1.4 m depth.			1.35				
234	2 2.0	Pit discontinued at 2.0m (Target depth)							2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Groundwater seepage at 0.8 m depth.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 241 m AHD*
EASTING: 418654
NORTHING: 6473579

PIT No: TP02
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
241	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.		D	0.3				
	0.45			D	0.47				
	0.5	LATERITE - high strength, orange-brown and brown, laterite.							
		Pit discontinued at 0.5m (Hard digging)							
240	1								
239	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 244 m AHD*
EASTING: 418774
NORTHING: 6473596

PIT No: TP03
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
244	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
	0.7	GRAVELLY CLAYEY SAND - light brown and brown, gravelly clayey sand, moist. Behaves as extremely low strength, extremely weathered rock.							
243	1			D	1.0				1
	1.7	Pit discontinued at 1.7m (Slow, hard digging)							
242	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 238 m AHD*
EASTING: 418787
NORTHING: 6473703

PIT No: TP04
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
238	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
	0.8	CLAYEY SAND - very dense, light yellow-brown mottled brown, medium to coarse grained, clayey sand, moist.							
237	1			U	1.0				1
					1.22				
				D	1.3				
		- becoming light grey mottled red-brown from 1.4 m depth.						▽	
236	2 2.0	Pit discontinued at 2.0m (Target depth)							2

5 10 15 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Groundwater seepage at 1.7 m depth.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 246 m AHD*
EASTING: 418867
NORTHING: 6473646

PIT No: TP05
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
246	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist. PACM observed on surface.		D	0.0 0.05		PACM Sample		
		CLAYEY SANDY GRAVEL - dense, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
245	1								1
	1.3	CLAYEY SAND - light yellow-brown mottled brown, medium to coarse grained, clayey sand, moist.							
244	2 2.0	Pit discontinued at 2.0m (Target depth)							2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 247 m AHD*
EASTING: 418949
NORTHING: 6473664

PIT No: TP06
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
247	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.		D	0.5				
		- becoming dense from 0.6 m depth.							
246	1								1
	1.3	CLAYEY SAND - light yellow-brown mottled brown, medium to coarse grained, clayey sand, moist.							
		- becoming light brown mottled light grey from 1.6 m depth.							
245	2 2.0	Pit discontinued at 2.0m (Target depth)							2

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 240 m AHD*
EASTING: 418902
NORTHING: 6473755

PIT No: TP07
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
240	0.1	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained, silty sandy topsoil with some gravel to slightly gravelly, some roots, moist.							5 10 15 20
		GRAVELLY CLAYEY SAND - loose, brown, fine to medium grained, gravelly clayey sand with some laterite boulders, moist. Gravel is laterite.							
	0.5								
	0.6	LATERITE - high strength, orange-brown and brown, laterite.							
		Pit discontinued at 0.6m (Hard digging)							
239	1								
238	2								

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 245 m AHD*
EASTING: 419042
NORTHING: 6473770

PIT No: TP08
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
245	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
	0.4	CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
		GRAVELLY CLAYEY SAND - dense, light brown, medium to coarse grained, gravelly clayey sand, moist.							
244	1.0	CLAYEY SAND - light yellow-brown mottled brown, medium to coarse grained, clayey sand with some gravel, moist. Behaves as an extremely low strength, extremely weathered rock.		D	1.5				
243	2.0	Pit discontinued at 2.0m (Target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 250 m AHD*
EASTING: 419074
NORTHING: 6473711

PIT No: TP09
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
250	0.05	FILLING (TOPSOIL) - dark brown, fine to medium grained, gravelly silty sandy topsoil with some roots, moist.		D	0.1				
	0.4	FILLING (GRAVELLY SAND) - medium dense, dark brown, fine to medium grained, gravelly sand with some silt, moist. Gravel is laterite. - becoming dark grey from 0.2 m depth.							
249	1	GRAVELLY CLAYEY SAND - medium dense, brown, fine to medium grained, gravelly clayey sand with cobbles and boulders of laterite, moist.							1
	1.3	CLAYEY SAND - light yellow-brown and light brown, medium to coarse grained, clayey sand with some gravel to slightly gravelly, moist.							
248	2	2.0 Pit discontinued at 2.0m (Target depth)							2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 248 m AHD*
EASTING: 419162
NORTHING: 6473797

PIT No: TP10
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
248	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
	0.25	CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
	0.35	LATERITE - high strength, orange-brown mottled red-brown, laterite.							
		Pit discontinued at 0.35m (Hard digging)							
247	1								
246	2								

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 248 m AHD*
EASTING: 419248
NORTHING: 6473857

PIT No: TP11
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
248	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.		D	0.5				
	0.7	CLAYEY SAND - loose, light yellow-brown and light brown, medium to coarse grained, clayey sand, moist.							
247	1	- behaves as an extremely weathered, extremely low strength rock from 1.1 m depth.							1
	1.7	Pit discontinued at 1.7m (Slow, hard digging)							
246	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 256 m AHD*
EASTING: 419227
NORTHING: 6473689

PIT No: TP12
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
256	0.05	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
255	1			D	1.0				1
254	2	2.0 Pit discontinued at 2.0m (Target depth)							2

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Laboratory Testing

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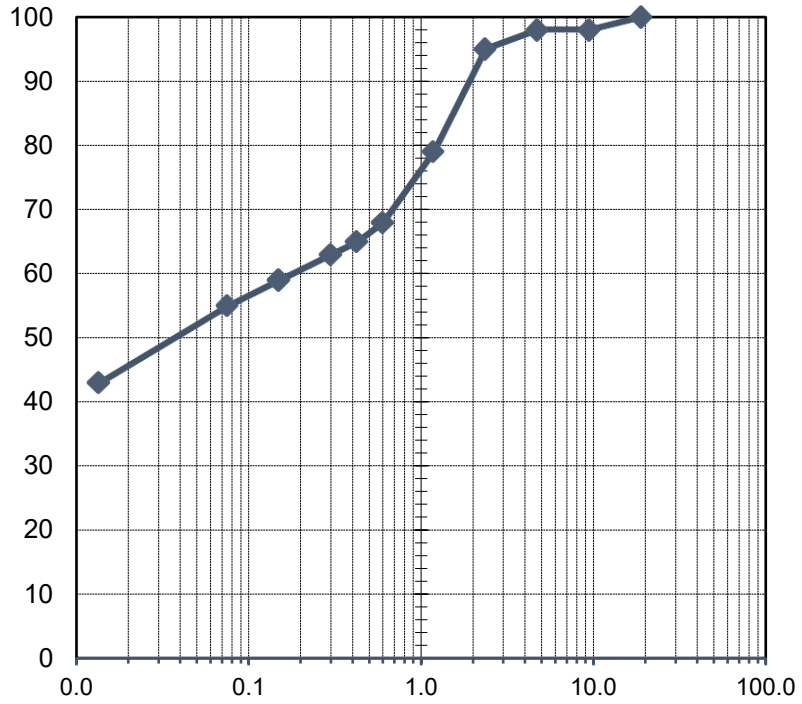
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

T D T T

WA 115.1



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M. van Herk
Laboratory Manager
18- une-2018

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T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

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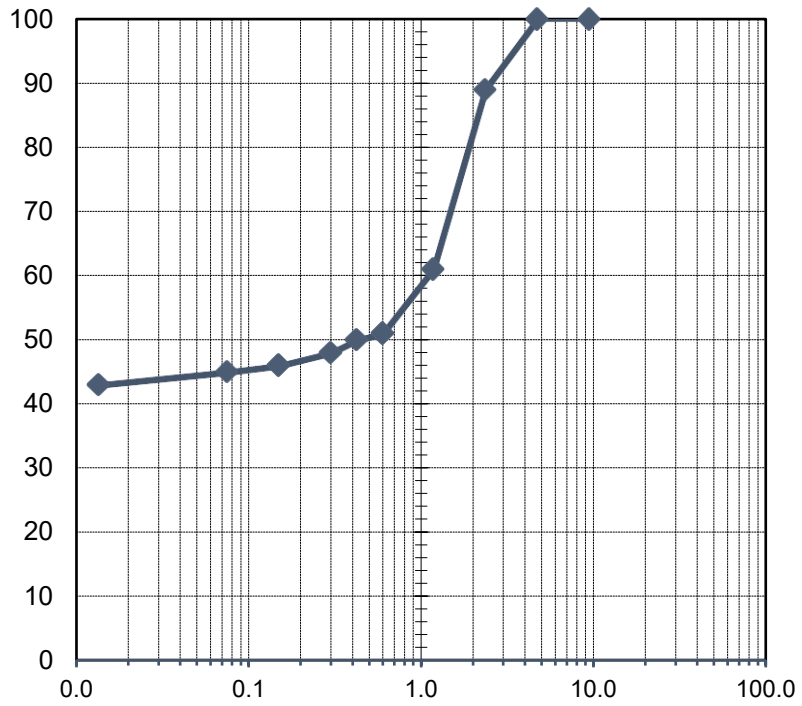
WA 115.1



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AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1

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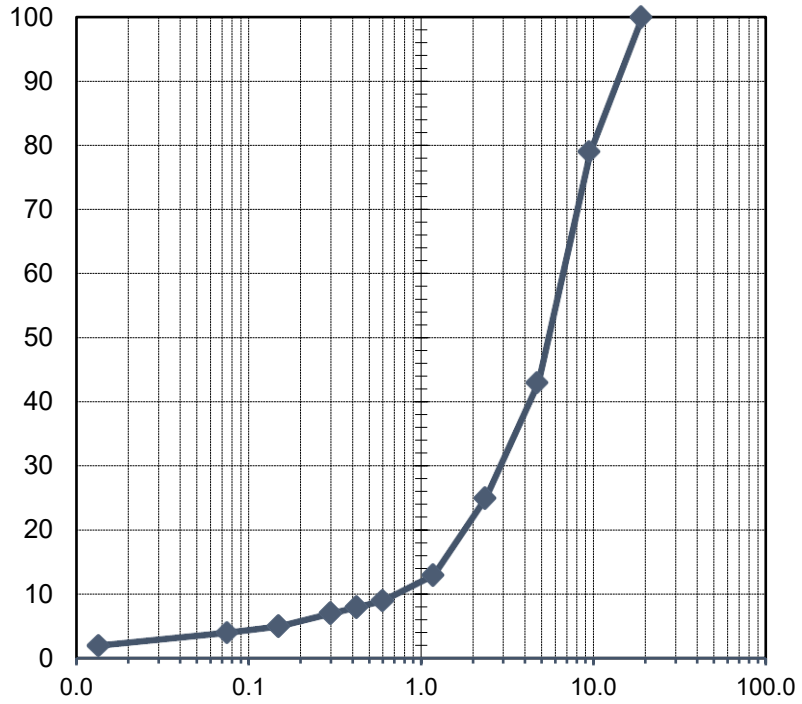
T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

T D T T

WA 115.1



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M. van Herk
Laboratory Manager
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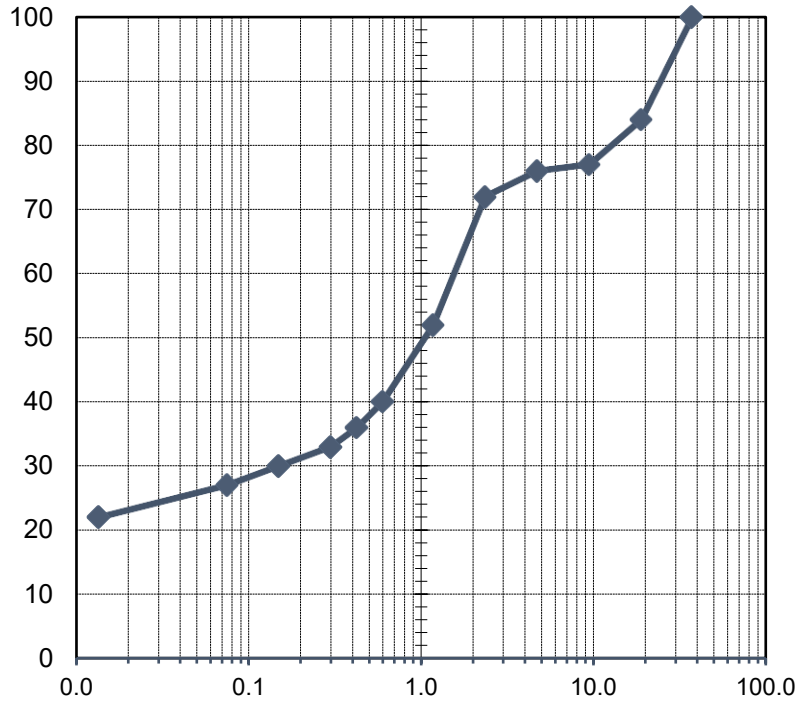
T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

T D T T

WA 115.1



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M. van Herk
Laboratory Manager
18- une-2018

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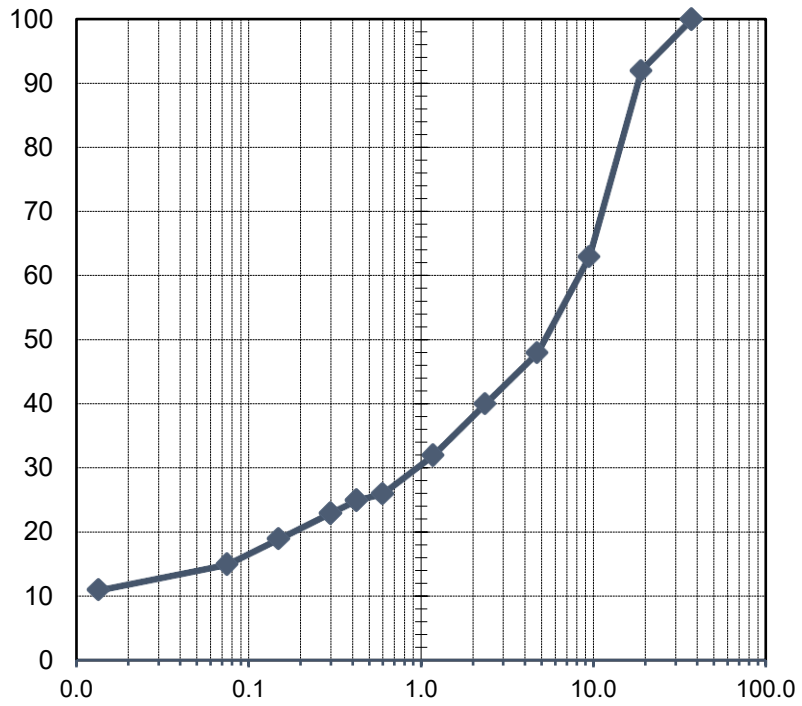
T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

T D T T

WA 115.1



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AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1

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M. van Herk
Laboratory Manager
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D T T T

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Client		Ticket No.	
Client Address		Report No.	
Pro ect	D	Sample No.	
ob Number		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D
Sample Description			

Moisture Content - Initial ( )	15.8	Moisture Content - Final ( )	17.7
Dry Density - Initail (t/m^3)	1.81	Estimated Inert Inclusions ( )	2

Moisture Content - Initial ( )	16	Length/Diameter Ratio	2.2
Extent of Crumbing	Nil	Extent of Cracking	Nil

Shrinkage Strain ( )	0.8	Shrink Swell Index I $_{ss}$	0.5
Swell Strain ( )	0.0		

en s

M. van Herk
Laboratory Manager
D 18- une-2018

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
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Client		Ticket No.	
Client Address		Report No.	
Pro ect	D	Sample No.	
ob Number		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D
Sample Description			

Moisture Content - Initial ( )	17.9	Moisture Content - Final ( )	18.7
Dry Density - Initail (t/m^3)	1.7	Estimated Inert Inclusions ( )	0

Moisture Content - Initial ( )	18.0	Length/Diameter Ratio	2.3
Extent of Crumbing	Nil	Extent of Cracking	Nil

Shrinkage Strain ( )	1.5	Shrink Swell Index I $_{ss}$	0.9
Swell Strain ( )	0.0		

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D 18- une-2018

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M T T T

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Client		Ticket No.	
Client Address		Report No.	M
Pro ect	D	Sample No.	
Location		Sampled By	
Sample Identification			

Sampling Method: T

M M

D

LLS18/2504	TP01 1.10-1.35m	
LLS18/2505	TP04 1.00-1.22m	
LLS18/2506	TP06 0.5m	

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M. van Herk
Laboratory Manager
18- une-2018

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CERTIFICATE OF ANALYSIS 211769

Client Details

Client	Liquid Labs WA
Attention	Matt Van Herk
Address	Unit 4, 96 Briggs Street, WELSHPOOL, WA, 6106

Sample Details

Your Reference	**Proposed On-Site Sewage Disposal**
Number of Samples	3 Soil
Date samples received	08/06/2018
Date completed instructions received	08/06/2018
Location	Lots 61 & 1001 Kilburn Road, Parkerville

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.

Report Details

Date results requested by	14/06/2018
Date of Issue	14/06/2018

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Results Approved By
Todd Lee, Laboratory Manager, Perth

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil				
Our Reference		211769-1	211769-2	211769-3
Your Reference	UNITS	LLS18/2505 TP04	LLS18/2506 TP06	LLS18/2508 TP11
Depth		1.0-1.22	0.5	0.5
Type of sample		Soil	Soil	Soil
Date prepared	-	13/06/2018	13/06/2018	13/06/2018
Date analysed	-	13/06/2018	13/06/2018	13/06/2018
pH	pH Units	5.4	6.3	6.6
Electrical Conductivity (EC)	µS/cm	88	4.4	19

ESP/CEC				
Our Reference		211769-1	211769-2	211769-3
Your Reference	UNITS	LLS18/2505 TP04	LLS18/2506 TP06	LLS18/2508 TP11
Depth		1.0-1.22	0.5	0.5
Type of sample		Soil	Soil	Soil
Date digested	-	13/06/2018	13/06/2018	13/06/2018
Date analysed	-	14/06/2018	14/06/2018	14/06/2018
Calcium	mg/kg	190	<50	460
Potassium	mg/kg	<50	<50	84
Magnesium	mg/kg	91	<50	120
Sodium	mg/kg	<50	100	94
Aluminium	mg/kg	<10	<10	<10
Exchangeable Ca	meq/100g	0.9	<0.25	2.3
Exchangeable K	meq/100g	<0.13	<0.13	0.2
Exchangeable Mg	meq/100g	0.8	<0.41	1
Exchangeable Na	meq/100g	<0.22	0.4	0.4
Exchangeable Al	meq/100g	<0.07	<0.07	<0.07
Cation Exchange Capacity	meq/100g	2	<1	4

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
METALS-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
METALS-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
METALS-020	Metals in soil and water by ICP-OES.

QUALITY CONTROL: Miscellaneous Inorg - soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			13/06/2018	[NT]	[NT]	[NT]	[NT]	13/06/2018	[NT]
Date analysed	-			13/06/2018	[NT]	[NT]	[NT]	[NT]	13/06/2018	[NT]
pH	pH Units		INORG-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]

QUALITY CONTROL: ESP/CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date digested	-			13/06/2018	[NT]	[NT]	[NT]	[NT]	13/06/2018	[NT]
Date analysed	-			14/06/2018	[NT]	[NT]	[NT]	[NT]	14/06/2018	[NT]
Calcium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	105	[NT]
Potassium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	100	[NT]
Magnesium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	100	[NT]
Sodium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	94	[NT]
Aluminium	mg/kg	10	METALS-020	<10	[NT]	[NT]	[NT]	[NT]	104	[NT]

Result 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
NR	Not Reported

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.

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.

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.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

92702
Liquid Labs WA

Soil & Plant Analysis Laboratory

ANALYSIS REPORT

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	Lab No	XTS18145	XTS18146	XTS18147
	Name	TP04 0-1.22m	TP06 0.5m	TP11 0.5m
	Code	LLS18/2505	LLS18/2506	LLS18/2508
	Customer	Liquid Labs WA	Liquid Labs WA	Liquid Labs WA
	Depth	0-10	0-10	0-10
Phosphorus Retention Index		418.3	188.0	177.9

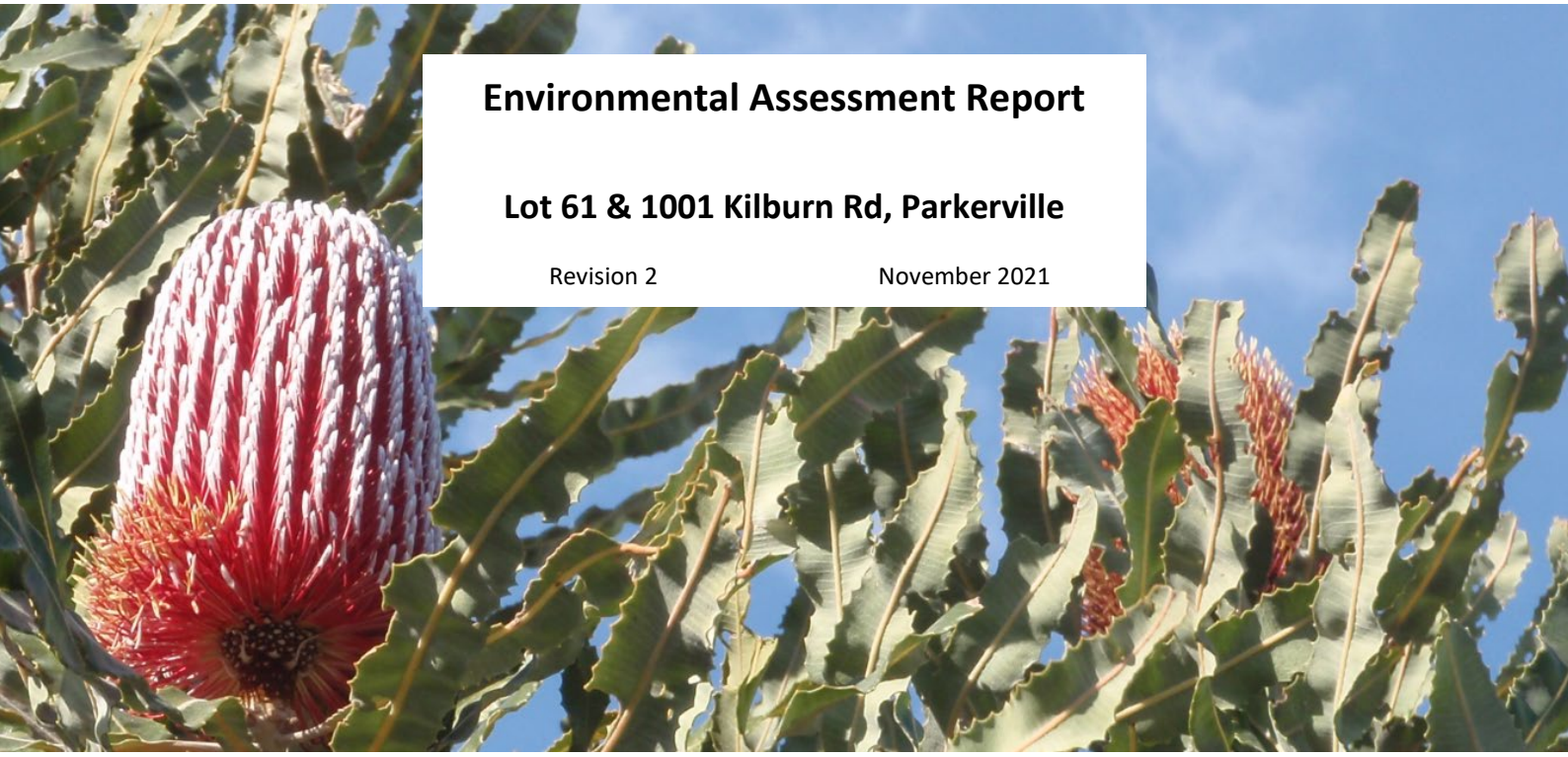
PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX B

ENVIRONMENTAL ASSESSMENT REPORT

(COTERRA ENVIRONMENTAL)

COTERRA
ENVIRONMENT



Environmental Assessment Report

Lot 61 & 1001 Kilburn Rd, Parkerville

Revision 2 November 2021

CALIBRE | COMMITMENT | COLLABORATION

This report was prepared by: Coterra Pty Ltd trading as COTERRA ENVIRONMENT
ABN: ABN: 92 143 411 456
Our Ref: CUTKIL08
Author(s): K. Watts
Reviewer: S. Harley
Report Version: Revision 2
Date: November 2021

This report was prepared for:

Parkerville Children and Youth Care Inc.
c/o Cuttone Property Group
64 Ogilvie Road
Mount Pleasant WA 6153

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Appendix 2	Fauna Species List
Appendix 3	Fauna Database Search Results
Appendix 4	Arborist Report
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1 Introduction

1.1 Background

Lot 61 and 1001 Kilburn Road, Parkerville ('the subject area') is approximately 29.4 ha in size and is located approximately 30 km north-east of the Perth CBD (Figure 1). It is bound by Roland Road to the west, Kilburn Road and a pocket of residential lots to the south, rural lots to the north and east, and is intersected by Clutterbuck Creek (Figure 2).

The subject area is largely cleared, with some pockets of vegetation remaining, consisting mainly of parkland cleared trees. Clutterbuck Creek and a tributary of the creek within the subject area are vegetated with planted and native vegetation.

1.2 Planning Context

1.2.1 Town Planning Process

The site is zoned Urban under the Metropolitan Region Scheme (MRS) and Urban under the Shire of Mundaring Local Planning Scheme No. 4 (LPS4).

This Environmental Assessment Report has been prepared to accompany the Local Structure Plan (LSP) documentation for the site.

1.2.2 Local Structure Plan

The proposed LSP comprises the following:

- 57 proposed residential lots south of Clutterbuck Creek with a minimum lot size of 2000 m^2
- Two larger residential lots north of Clutterbuck Creek of approximately 1 ha and 4 ha
- Clutterbuck Creek foreshore reserve
- Areas of Public Open Space (POS) and drainage.

A copy of the concept plan showing the location of these features is provided in Figure 3.

1.3 Objectives

This report provides environmental and hydrological information pertinent to the subject area, based on desktop analysis of site features as well as on-site assessments of the remnant vegetation and fauna habitat in relation to the proposed development.

The objective of this report is to outline the environmental and hydrological characteristics and features of the subject area, and detail management measures proposed to minimise potential environmental impacts resulting from the proposed development.

2 Existing Environment

2.1 Landform, Geology and Soils

2.1.1 Topography

The subject area forms a valley, with the low points of the land coinciding with the Clutterbuck Creek alignment. The river valley lies at 234 mAHD on the western boundary and 242 mAHD on the eastern boundary. The subject area slopes upward to approximately 248 mAHD on the northern boundary and to approximately 254 – 256 mAHD on the southern boundaries. Topography of the subject area is shown in Figure 4.

2.1.2 Geology and Soils

Regional geology and soil mapping are presented in Figure 4 and consists of the following three geological units (Smurthwaite, 1986):

- G2 – GRAVEL – yellow brown to reddish-brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor recementation; colluvial origin.
- Sgc – CLAYEY GRAVELLY SAND – grey and yellow, kaolinitic, decomposed bedrock, sand and gravel veneer; granitic / gneissic origin.
- LA1 – LATERITE – massive, hard, cemented, vuggy and pisolitic; up to 1 m thick, overlain by and associated with gravels (G2 and G3) or residual origin.

The Department of Agriculture (DoA, 2004) soil landscape mapping indicates that the upland portions of the subject area lie within the Dwellingup 'DW2' soil-landscape unit on the lateritic uplands of the Darling Plateau (Figure 4). These soils are described as:

- DW2 – Very gently to gently undulating terrain (<10%) with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust.

The low-lying portions of the subject area associated with Clutterbuck Creek are largely mapped as Yarragil YG1 and YG4 (Figure 4), described as:

- YG4 – Valley floors with poorly drained mottled yellow duplex soils.
- YG1 – Gently to moderately inclined sideslopes with moderately well-drained yellow duplex soils, and yellow and brown massive earths.

2.1.3 Land Capability Mapping

The Department of Agriculture has mapped the Land Resources of Rural Areas of the Darling Range to accompany the Darling Range Rural Land Capability Study (King and Wells, 1990) to guide land use based on the capability of the soil to support different types of agriculture or development. The land qualities and characteristics of the land units DW2, YG4 and YG1 are described in Table 2-1 (King and Wells, 1990).

Table 2-1: Desktop Land Capability Assessment

Land Qualities	DW2-Dwellingup	YG1- Yarragil	YG4- Yarragil
Water erosion risk	Low	Low	Moderate
Wind erosion risk	Low	Low	Low
Microbial purification ability	Low	Moderate	Low

Land Qualities	DW2-Dwellingup	YG1- Yarragil	YG4- Yarragil
Water pollution risk	N/A	N/A	High (overland flow) Low (subsurface leaching)
Ease of excavation	Moderate	Moderate	Moderate
Waterlogging inundation risk	Low	Low	Moderately high
Flood risk	Nil	Nil	Low
Rural retreat (housing, roads and effluent disposal)	Fair capability (III)	High capability (II)	Very low capability (V)
House and road construction	High capability (II)	High capability (II)	Fair capability (III)
Effluent disposal (septic tanks)	Fair capability (III)	High capability (II)	Very low capability (V)

Source: King and Wells (1990)

2.1.4 Phosphorous Retention Index

Phosphorous binds to iron and aluminium oxides within the soil profile (Beek, 1979). The ability and extent to which a soil can adsorb phosphorus is indicated by the Phosphorus Retention Index (PRI) which has implications on the ability of the natural in situ soils to treat stormwater.

As stormwater infiltrates, the upmost soil particles become saturated, then phosphorous will leach through the sands to the next soil layer where they will become fixed. This method of adsorption allows for phosphorous to be removed from the stormwater prior to infiltrating. The rate of adsorption to the soil varies depending on the type and depth of soil. A higher PRI indicates that the soil has a higher capacity for retaining phosphorous (therefore leaching through the profile will take a greater amount of time), and the greater the soil layer depth prior to groundwater, the greater the fixation availability.

Site specific PRI testing was undertaken at three locations as part of the preliminary geotechnical investigation (Douglas Partners, 2018). The results are provided in Table 2-2 below. The results of this testing indicate the site soils are very strongly adsorbing (Table 2-3 below).

Table 2-2: PRI Test Results

Test location	Depth (m)	PRI
TP1	1.1-1.3	418.3
TP6	0.5	188.0
TP11	0.5	177.9

Table 2-3: PRI Fixation Properties

PRI	Description
Negative	desorbing
0–2	weakly adsorbing
2–20	moderately adsorbing

PRI	Description
20–100	strongly adsorbing
>100	very strongly adsorbing

Source: Department of Agriculture and Food

2.1.5 Acid Sulfate Soils

The entire subject area is mapped by the Australian Soil Resource Information System (ASRIS) as having 'Extremely low probability of occurrence' of Acid Sulfate Soils (ASS) at depths of up to three metres below ground level (ASRIS, 2016).

2.2 Groundwater

The site is underlain by a fractured rock aquifer within the (un-proclaimed) Karri Groundwater Area.

The Perth Groundwater Map indicates that the site is outside of the range of Department of Water's groundwater contour mapping.

WIN bore 5466 is located approximately 60 m west of the site (Figure 5) in proximity to the Clutterbuck Creek. Monitoring was undertaken within this bore between February 1983 and September 1990. The maximum groundwater level recorded over this time was 232.515 mAHD.

As no bore construction information is available it is unclear whether this level represents a perched or regional groundwater level. It is noted that the bore is located in the valley of the Clutterbuck Creek near the lowest point of the site.

2.2.1 Site Monitoring

Five groundwater bores were installed at the site during August 2018 for the purpose of determining the extent and depth of groundwater (particularly perching) at the site. The bores were monitored for groundwater levels, in August – October 2018, and June - September 2019 (to date), to capture two peak periods. The results of this monitoring is provided in Table 2-4.

Table 2-4: Groundwater monitoring results (mAHD)

	MBK01	MBK02	MBK03	MBK04	MBK05
Aug-18	242.88	243.19	240.01	234.86	244.18
Sep-18	243.21	244.32	239.28	234.13	243.51
Oct-18	242.63	244.11	239.08	234.03	243.04
Jun-19		244.22	239.36	234.12	241.99
Jul-19	243.11	244.38	239.43	234.27	243.71
Aug-19	242.78	244.32	239.53	234.40	243.36
Sep-19	243.33	244.36	239.40	234.21	243.72
	Annual Maximum				

The results of the monitoring indicate that groundwater varies spatially and temporally across the site, with shallowest levels occurring in the western portion of the site (MBK03 and MBK04).

2.3 Surface Water and Wetlands

2.3.1 Watercourses

Clutterbuck Creek is located in an east-west alignment across the site. Clutterbuck Creek is a small ephemeral watercourse with headwaters in Stoneville in the Darling Ranges. Clutterbuck Creek discharges to Jane Brook to the west of the subject area, and ultimately to the Swan River on the Swan Coastal Plain.

A small unnamed tributary (referred to as Clutterbuck tributary in this report) is aligned north to south (in the northern portion of the site). The Clutterbuck tributary enters the site from the neighbouring property to the north, creating a confluence with Clutterbuck Creek on the western side of the site.

Both the Clutterbuck Creek and tributary are dammed in multiple locations upstream of the site. The watercourse locations relative to the subject area are shown in Figure 5.

2.3.1.1 Water Quality and Flow Rate

Pre-development surface water monitoring within the Clutterbuck Creek and Clutterbuck Tributary has been undertaken from June 2018 until September 2019 at location upstream and downstream of the proposed development. Monitoring was only undertaken during the winter months at the site due to the ephemeral nature of the creek.

The results indicate that the water in the Clutterbuck Creek ranges in pH from 5.23 – 8.23. A minor trend of increasing pH, decreasing electrical conductivity and increasing dissolved oxygen was observed as the winter progresses from most events. In general, downstream site readings do not range as high in pH than the upstream quality results, and dissolved oxygen concentration is fairly consistent with upstream readings.

The nutrient concentrations at the site indicated the following trends;

- The total nitrogen (TN) concentrations at the upstream and downstream locations both exceeded ANZECC upland river guidelines of 0.45mg/l.
    - The was a little improvement between the upstream and downstream TN quality overall, indicating that there was some net improvement in general across the site (upstream average TN of 1.9 mg/l and downstream average TN of 1.5 mg/l).
    - The TN water quality coming from the small tributary (catchment to the north of the site) was better than the upstream concentrations (average TN of 0.5 mg/l) so this probably accounted for the improvement in concentration downstream (dilution effect).
- The total phosphorus concentrations at the upstream and downstream locations generally both exceeded ANZECC upland river guidelines of 0.02mg/l slightly.
    - The was no improvement between the upstream and downstream TP quality overall, however both concentrations were generally quite low (upstream average TP of 0.039 mg/l and downstream average TP of 0.045 mg/l).
    - The TP water quality coming from the small tributary (catchment to the north of the site) was similar to the downstream concentration (average TN of 0.046 mg/l), again demonstrating that the tributary inflow is likely impacting the downstream water quality.

Flow monitoring during the 2018 and 2019 winter periods demonstrate the ephemeral nature of the Clutterbuck Creek, with low to no flow observed during early winter monitoring, generally in June. The maximum flow rate was recorded during August 2018.

A full detailed account of the monitoring is presented in the Kilburn Road Local Water Management Strategy (Coterra Environment, 2020).

2.3.2 Wetlands

There are no mapped wetlands within the subject area according to the Department of Biodiversity, Conservation and Attractions (DBCA) Geomorphic Wetlands Database.

2.4 Surrounding Land Uses and Potential Buffers

Land uses in areas adjacent to and surrounding the subject area are largely residential and small-scale agricultural.

John Forrest National Park occurs approximately 2 km to the west of the subject area, and Beelu National Park occurs approximately 4 km to the south of the subject area. This national park boundary also coincides with the boundary of the Middle Helena Valley Catchment Area Public Drinking Water Source Protection Area; however, the subject area is not within the catchment protection areas.

None of the surrounding land uses are likely to impede development of the subject area.

2.5 Potential Contamination

A search of the Department of Water and Environmental Regulation (DWER) Contaminated Sites database identified no known contamination within the subject area or the near vicinity. Previous and current land use of the subject area includes low-level agriculture, such as sheep grazing, which is generally not considered a risk for potential contamination.

2.6 Vegetation and Flora

Parkerville occurs within the Jarrah Forest Bioregion of Thackway and Cresswell (1995), located on the Darling Scarp and the Darling Plateau. Of this bioregion, the site occurs in the Jarrah Forest South division (JF2) (Hearn et al, 2002).

Heddle et al. (1980) described the vegetation complexes of the Darling System at a scale of 1:250 000. The subject area occurs in the Yarragil (Yg1) Complex (Minimum Development Swamps) in Medium to High rainfall. This complex is described as follows:

- Yarragil Complex (Minimum Development Swamps) in Medium to High Rainfall – consists of predominantly a mixture of open forest of *Corymbia calophylla - Eucalyptus marginata* with a mixture of *E. patens* and *E. megacarpa* on the valley floors. The dominant vegetation types are *Acacia alata, Agonis linearifolia, Astartea fascicularis, Lepidospermum angustatum, Mesomelaena tetragona, Dampiera alata, Hypocalymma angustifolium, Leptospermum ellipticum and Synaphea petiolaris.*

As per the information in Table 2-5, this complex is well-represented in the area, and approximately 10.18% of the original extent is protected in formal reserve.

Table 2-5: Remnant Regional Vegetation Complex Information

Vegetation Association	Pre-European Extent (ha)	Current Extent (ha)	% Remaining	% Remaining in Formal Protection
Yarragil 1 Complex (Yg1)	80202	65804	82.05	10.18

The majority of vegetation remaining on the subject area is associated with the water courses.

2.6.1 EPA Biodiversity Principles

The Environmental Protection Authority (EPA) has an established set of Biodiversity Principles, which are applied where native vegetation clearing is proposed (EPA, 2008).

The national target is to implement clearing controls to prevent the removal of ecological communities with an extent below 30% of the pre-European extent (i.e. that present before 1750). A level of 30% of the pre-clearing extent of an ecological community is considered to be the threshold level below which species loss appears to accelerate exponentially at the ecosystem level. The EPA therefore considers it important that ecological communities are maintained above the threshold level of 30% of the original pre-clearing extent of each vegetation type / community. The EPA also suggests that ecological communities now at levels below 30% of their original extent in regions should be fully retained and threatened ecological communities should be fully retained and protected.

As can be seen from Table 2-5, the vegetation complex present onsite has greater than 30% of the original extent remaining.

2.6.2 Flora and Vegetation Survey

On 29 November 2016, Dr. Eleanor Bennett undertook a Level 1 Flora and Vegetation Survey over vegetation within the subject area. This survey included a targeted search for flora species of conservation significance that may potentially occur in the area (Bennett Environmental Consulting (BEC), 2016). The survey also included a search for Threatened or Priority Ecological Communities, as listed by DBCA. The survey report is provided as Appendix 1 and a summary of the findings of the survey are provided as follows:

- No Threatened or Priority Ecological Communities were found to be listed for the subject area, and none were recorded during the survey.
- No Threatened or Priority flora were recorded during the survey.
- The remnant and planted vegetation units recorded within the survey area are mapped in Figure 6 and described as:
    - Cc - Tall Forest of *Corymbia calophylla* over Dense Tall Grass of introduced species. This was the dominant vegetation on the slopes above the creek. It was represented by GPS locations ki1 and ki3.
    - Jp - Open Tall Sedges of *Juncus pallidus* over Dense Herbs of introduced species. This vegetation unit occurred in the damper areas above the creek. This was represented by GPS location ki2.
    - Tl - Tall Forest to Woodland A of *Corymbia calophylla*, *Eucalyptus patens* and Eucalyptus *rudis* subsp. *rudis* over Open Low Woodland of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Open Low Grass dominated by *Microlaena stipoides*. The species present varied considerably along the length, represented by GPS locations ki4, ki5, ki6, ki7, ki8, ki9, ki10, ki11 and ki12Appendix 1. **Acacia decurrens* (Eastern Australian Wattle) was dominant in some sections.
    - Mv - Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species. This was the dominant vegetation along the creek in Lot 61 and represented by GPS locations ki13, ki14, ki15 and ki16;
    - Fc - Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia* over Low Grass of mixed species including *Microlaena stipoides*. This was recorded along the tributary, where **Ficus carica* was common and was represented by GPS locations ki18, ki19 and ki20;
    - Pc - Planted corridors. These consisted of mainly Eastern Australian Eucalyptus species and were planted in distinct rows. The corridor beside Roland Road included the Western Australian species *Eucalyptus marginata* (jarrah) and *Corymbia calophylla* (marri), both of which were endemic to the area and *Eucalyptus gomphocephala* (Tuart), a near coastal species. These were represented by GPS locations ki17, ki21 and ki22; and

- PT – Planted trees, mostly non-endemic.

The vegetation condition within the creekline, rated according to the vegetation condition scale devised by Keighery (1994), ranged from Excellent to Very Good in one small section and Good to Degraded in the western portion. The remainder of the survey area was considered to be in either Degraded or Completely Degraded condition, being either entirely cleared or parkland cleared in most parts (Figure 7).

2.6.3 Shire of Mundaring Local Biodiversity Strategy

The Shire of Mundaring released their Local Biodiversity Strategy in March 2009 (Ironbark Environmental & Ecological Australia, 2009). The strategy aims to provide a framework to facilitate the retention, protection and management of the majority of Local Natural Areas (LNAs) within the Shire. LNAs are considered to be the natural areas that are not currently protected in the public conservation estate or classified as state forests, water catchment areas or Bush Forever sites.

All LNAs within the Shire have been assigned to a preliminary protection category based on a number of characteristics of the land, including conservation significance, land zoning, and other planning constraints (e.g. structure plans and lot size). The five protection categories assigned to LNAs are Conservation, Protection, Retention, Limited Protection/Already Committed by Zoning and To Be Determined/Negotiated.

The vegetation associated with Clutterbuck Creek that traverses the subject area has been assigned 'Protection' status (Figure 8). The intent of the Protection category is to protect these LNAs in perpetuity and encourage landowners to actively manage them for biodiversity conservation (Ironbark Environmental & Ecological Australia, 2009). As such, these areas have been retained in the foreshore reserve and / or Public Open Space.

LNAs have also been categorised into priority categories, namely Priority 1, 2 or 3, based on environmental merits of the land and their relationship to other natural areas. The main vegetated creekline has been assigned Priority 1 status (for vegetation within 20 m of a waterway), whilst fringing areas are Priority 2 (for vegetation within 20 – 50 m of a waterway) and Priority 3 (all other LNA areas) (Figure 8).

2.7 Fauna and Habitat

Coterra Environment undertook a Level 1 Fauna Survey on 29 November 2016 in accordance with the following Environmental Protection Authority (EPA) Guidance Statements:

- Environmental Protection Authority (EPA) Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA, 2004)
- EPA & Department of Environment and Conservation Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA & DEC 2010)
- EPA Position Statement 3: Terrestrial Biological Surveys as an Element of Biodiversity Protection (EPA, 2002)

A black cockatoo habitat tree survey of areas that may be developed was included as a component of the fauna survey.

2.7.1 Levels of Conservation Significance

The conservation status of Australian fauna species is identified at a federal level under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and at a state level under the Western Australian *Biodiversity Conservation Act 2016* (BC Act). The conservation significance levels for fauna listed under the EPBC Act List are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN, 2001) refer to Table 2-6.

In Western Australia, threatened, extinct and specially protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special

protection, and have been gazetted. The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the BC Act 2016. Categories of Threatened, Extinct and Specially Protected fauna and flora are shown in Table 2-6.

Table 2-6: Categories of Threatened, Extinct and Specially Protected Fauna and Flora

Conservation Codes for WA Flora and Fauna	Definition
Threatened species	Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act). Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna. Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora. The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.
(CR) Critically endangered species	Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.
(EN) Endangered species	Threatened species considered to be "facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.
(VU) Vulnerable species	Threatened species considered to be "facing a high risk of extinction in the wild in the medium term future, as determined in accordance with criteria set out in the ministerial guidelines". Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.
Extinct Species	Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

Conservation Codes for WA Flora and Fauna	Definition
(EX) Extinct species	Species where "there is no reasonable doubt that the last member of the species has died", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act). Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.
(EW) Extinct in the wild	Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act). Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.
Specially protected species	Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection. Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.
(MI) Migratory species	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act). Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species. Published as migratory birds protected under an international agreement under schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018.
(CD) Species of special conservation interest (conservation dependent fauna)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the Wildlife Conservation Act 1950, in Schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice*.
(OS) Other specially protected fauna	Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act). Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

Additional to the categories shown in Table 2-6, specially protected species listed by order of the Minister as specially protected under section 13(1) of the BC Act are defined in Table 2-7. These species meet one or

more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species. Assessments in this report are based on the most recent version of the DBCA Threatened and Priority fauna species list (3 January 2019).

Table 2-7: DBCA Specially protected species definitions

Conservation Codes	Definition
Priority 1 (P1) – Poorly-known species	Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey. Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2) – Poorly-known species	Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.
Priority 3 (P3) – Poorly-known species	Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.
Priority 4 (P4) – Near Threatened and other species in need of monitoring	(a) Rare. Species 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 species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

2.7.2 Database Searches and Literature Review

A database search was undertaken to identify any fauna species that may potentially occur within and utilise the resources of the area for foraging and / or shelter. A comprehensive potential fauna species list is included in Appendix 2. The databases searched are provided in Table 2-8, and results are provided in Appendix 3.

Table 2-8: Databases Searched as part of Desktop Study

Database (Governing Body)	Type of Records Held	Area Searched
EPBC Act database - EPBC Protected Matters Search Tool (Department of Agriculture, Water and Environment (DAWE))	Records and distribution information on matters protected under the EPBC Act, including threatened species and conservation estate	Central point plus 2 km buffer
NatureMap Database (DBCA and WA Museum)	Records on all fauna species, based on location (area) or species	Central point plus 2 km buffer
Species Profile and Threats (SPRAT) Database (DAWE)	Information and records on all federally protected species	Search conducted by species, not area.

2.7.3 Field Survey and Conditions

The reconnaissance field survey of the subject area was undertaken on 29 November 2016 by Emma McSweeney (Coterra Environment) and the site was re-visit to record any changes to conditions and habitat trees by Merrilyn Barnes (Coterra Environment) on 23 – 24 January 2020.

Both surveys were undertaken on a fine, clear day with light to moderate winds.

2.7.4 Licenses and Permits

No permit or license was required to undertake the survey.

2.7.5 Results

Fauna Species

A list of the fauna species that were identified to potentially occur within the subject area is provided in Appendix 2 (this list also includes all fauna species recorded onsite during the fauna survey). The databases searched are provided in Table 2-8, and database results are provided in Appendix 3.

Twenty-two fauna species of conservation significance were listed as potentially occurring within the subject area under the EPBC Act Matters of National Environmental Significance (NES) or listed under the BC Act. The likelihood of the species occurring on the site is also shown in Table 2-9.

Table 2-9: Conservation Significant Fauna Desktop Search Results

Species	WA Status (ranking)	EPBC Status (ranking)	Description and likelihood of occurrence (EPBC unless otherwise referenced)
Birds			
Actitis hypoleucos (Common sandpiper)	MI	MI	The Common Sandpiper is found in coastal or inland wetlands, both saline or fresh. It is found mainly on muddy edges or rocky shores but breeds in the northern hemisphere. Due to lack of habitat, highly unlikely to occur within subject area.
Apus pacificus (Fork-tailed Swift)	MI	MI	Widespread across coastal and subcoastal areas, scattered distribution on southern coast and inland areas. Scattered across Pilbara and Kimberley, sparse records inland (Goldfields). Nests in rock caves or cliffs but does not breed in Australia. Almost exclusively aerial over almost all habitat types. Could potentially occur in transitory capacity on most sites. Occurs mostly over inland plains but sometimes above coastal cliffs. Forages aerially on insects.

Species	WA Status (ranking)	EPBC Status (ranking)	Description and likelihood of occurrence (EPBC unless otherwise referenced)
Ardea alba (Great Egret)	-	MI	Widespread across the state, avoiding the dry and hot interior. Breeding records in south-western WA and Kimberley region. Wide range of wetland habitats (fresh/saline, inland/coastal, open/vegetated, permanent/ephemeral). In south-western Australia breeding colonies nest predominantly in Melaleuca swamps in Nov/Dec. Forage by wading in shallow to relatively deep water or walking over dry ground. May occur in a transitory capacity but unlikely to be impacted by development due to lack of habitat.
Ardea ibis (Cattle Egret)	-	MI	Widespread across the state, avoiding the dry and hot interior. Breeding records between Wyndham in WA and Arnhem Land in the NT. Wide range of wetland habitats (fresh/saline, inland/coastal, open/vegetated, permanent/ephemeral). Commonly found in cattle fields and other farm areas that contain livestock. Forages in pastured or grassy areas. May occur in a transitory capacity but unlikely to be impacted by development due to lack of habitat.
Botaurus poiciloptilus (Australasian Bittern)	EN	EN	Species or species habitat may occur within area. Occurs in the wetlands of southern Australia with the largest concentration in the Albany and Lake Muir wetlands. There have been no confirmed records from the Swan Coastal Plain since 1992 and surveys conducted in 2007 and 2008 found that half the wetlands that supported the species in 1980 now retained no suitable habitat. Due to lack of habitat, highly unlikely to occur within subject area.
Calidris acuminate (*Sharp-tailed Sandpiper)*	MI	MI	The Sharp-tailed Sandpiper is a summer migrant from Arctic Siberia, being found on wetlands throughout Australia. The Sharp-tailed Sandpiper prefers the grassy edges of shallow inland freshwater wetlands. It is also found around sewage farms, flooded fields, mudflats, mangroves, rocky shores and beaches. Due to lack of habitat, highly unlikely to occur within subject area.
Calidris ferruginea (Curlew Sandpiper)	CR	CR & MI	Widespread across the coast but is also common at inland sites. Inhabits intertidal mudflats in sheltered coastal areas, such as estuaries, inlets, bays, as well as swamps and lakes. Breeds in Siberia and migrates south during Australia summer. Forages on bare areas of mud or sand. Due to lack of habitat, highly unlikely to occur within subject area.
Calyptorhynchus banksia naso (Forest Red-tailed Black-Cockatoo)	VU	VU	Occurs on the Swan Coastal Plain / Perth Hills and greater south-west in small fragmented populations. Inhabits remnant native eucalypt woodlands. It nests in tall eucalypts with hollows for breeding. Favours open habitats for roosting, sourcing small clumps of marri trees or sites adjacent to rocky outcrops or fields / open tracks. Feeds on seeds, nectar and fruit, particularly of Banksia, Eucalyptus and *Corymbia calophylla*. Observed utilising the subject area (daytime roosting), foraging signs observed within the subject area.
Calyptorhynchus baudinii	EN	EN	Only known to occur in the south-west corner of Western Australia. Range extends from Albany in the south to Mundaring east of Perth. Occurs in heavily forested areas, generally associated with large

Species	WA Status (ranking)	EPBC Status (ranking)	Description and likelihood of occurrence (EPBC unless otherwise referenced)
(Baudin's Black Cockatoo)			gums such as marri, karri and jarrah trees, also occurring in woodlands characterised by other Eucalyptus species. Nesting is generally confined to areas containing karri trees, although research has confirmed that breeding also occurs in southern jarrah-marri forests, with some birds nesting as far north as Perth. Forages in marri trees and other trees/shrubs, occasionally sourcing seeds and grubs from the ground. Foraging signs observed within subject area.
Calyptorhynchus latirostris (Carnaby's Black Cockatoo)	EN	EN	Occurs in subpopulations across south-west WA. Residential in high-rainfall areas. Inhabits remnant native eucalypt woodlands, primarily in the semi-arid region and southern jarrah-marri forests. Is a seasonal visitor to pine plantations where it feeds on pine seeds. It nests in tall eucalypts with hollows for breeding. Feeds on seeds, nectar and fruit of Banksia, Dryandra, Pinus, Eucalyptus and *Corymbia calophylla*. Foraging signs observed within subject area.
Haliaeetus leucogaster (White-bellied Sea Eagle)	-	MI	Distributed along the coastline and is restricted to a narrow band of coastline in south-western Australia. Australian population is estimated at 500 mating pairs. Found in coastal habitats and tends to occupy dunes, tidal flats, woodlands, forests and grasslands (generally in areas associated with large bodies of water). Often occupies urban areas. Nests constructed in large trees, cliffs, rocky outcrops, mangroves, caves or on artificial structures, usually coastal but sometimes terrestrial. Forages opportunistically over large expanses of open water, though they are also known to forage over terrestrial habitats. Carnivorous. Unlikely to inhabit the subject area.
Leipoa ocellata (Malleefowl)	VU	VU	Occurs in the semi-arid and arid regions of southern Australia. Inhabits shrublands and low woodlands that are dominated by mallee vegetation and/or low-growing multi-stemmed eucalypt species. Occasionally inhabit Acacia shrublands. Due to lack of habitat and known range, highly unlikely to occur within subject area.
Motacilla cinerea (Grey Wagtail)	MI	MI	Non-breeding summer visitor to mostly northern Australia. Inhabits areas near running water, in disused quarries, sandy or rocky streams, rainforests, sewage ponds and ploughed fields. Due to known range, unlikely to occur within subject area.
Numenius madagascariensis (Eastern Curlew)	CR	CR & MI	Discontinuous distribution along the coast of the Australian continent, rarely recorded inland. Common migrant to northern parts of Australia, less common in the south-west of WA. Active at night and inhabits estuaries, tidal mudflats, sandspits, saltmarshes, mangrove swamps and occasional fresh or brackish lakes. Forages on soft sheltered intertidal sandflats or mudflats. Due to known range and lack of habitat, highly unlikely to occur within subject area.
Pandion haliaetus (Osprey)	MI	MI	Breeds from April to February in Australia. The breeding range extends around the northern coast of Australia from Albany to Lake Macquarie in NSW with a second isolated breeding population on

Species	WA Status (ranking)	EPBC Status (ranking)	Description and likelihood of occurrence (EPBC unless otherwise referenced)
			the coast of South Australia. Non-breeding range extends east to Esperance. Occurs in coastal habitats and terrestrial wetlands, occasionally travelling inland along major rivers. Due to known range and lack of habitat, highly unlikely to occur within subject area.
Rostratula australis (Australian Painted Snipe)	EN	EN	Dispersive/part-migratory, dependent on local conditions. Patchy distribution in the south-west of WA. Occupies shallow wetlands (generally freshwater or brackish) and flooded plains, usually requiring areas of bare, wet mud and dense undergrowth and canopy cover. Also known to inhabit flooded grasslands, paddocks or crops as a secondary habitat. Forages in dense cover or on mudflats and grasslands. Unlikely to occur in the subject area due to lack of habitat and known range.
Tringa nebularia (Common Greenshank)	MI-	MI	This species does not breed within Australia, but overwinters in all states, including Western Australia between Cape Arid on the south coast and Carnarvon in the north-west, as well as further north within the Kimberley region. Most widespread waterbird species in Australia, occupying all types of wetlands and coastal areas. Forages in shallow water on the edges of water bodies and water courses, feeding on a range of molluscs, crustaceans, insects, and occasionally fish and frogs. Unlikely to occur within subject area, unless in a transitory capacity.
Mammals			
Bettongia penicillate (Woylie)	CR	EN	Species or species habitat may occur within area. There are currently 42 sites throughout the south-west of WA where woylies are monitored. The majority of these sites are part of the department's Western Shield animal conservation program. Due to lack of suitable habitat, unlikely to occur within the subject area.
Dasyurus geoffroii (Chuditch)	VU	VU	Only known to occur in WA and is generally restricted to the south-west with some populations in the Wheatbelt and scattered in the Goldfields. Inhabits eucalypt forests (particularly jarrah), dry woodland and mallee shrubland. Utilises fallen hollow logs and burrows for dens in wooded habitats. Due to lack of suitable habitat, unlikely to occur within the subject area.
Hydromys chrysogaster (Rakali, Water Rat)	P4	-	Occurs across the northern area of Australia, in the south-western corner and across the eastern states coastline. It is not found within the hot interior or the mid-western coastline. This species is adapted to live in both fresh and saline water bodies, and is partly diurnal (Breed and Ford, 2007). The rakali constructs its nests in hollow logs or at the end of tunnels built into banks of wetlands and rivers, and breeds throughout the year, though most often in spring to late summer. Feeds opportunistically, foraging for large aquatic invertebrates, fish, frogs, lizards, small mammals and birds, and fresh carrion (DEC 2012).

Species	WA Status (ranking)	EPBC Status (ranking)	Description and likelihood of occurrence (EPBC unless otherwise referenced)
			May occur within the subject area, though no signs of inhabitation noted.
Isoodon fusciventer (Quenda, southwestern brown bandicoot)	P4	-	Widespread in the south-west of WA, ranging from Guilderton to east of Esperance. Patchy distribution on the Swan Coastal Plain and in the jarrah and karri forests of the south-west, and inland towards Hyden. Inhabits areas with dense, swampy understorey vegetation, particularly near fresh-water sources. In habitat areas, runnels can be observed that have been formed by quenda through undergrowth. Forages nocturnally in the undergrowth, feeding on invertebrates and subterranean plant and fungi material (DEC 2012). May occur within the subject area, though no signs of inhabitation noted.
Setonix brachyurus (Quokka)	VU	VU	Located on Rottnest Island, Bald Island and at a few sites in the south-west of WA, including the northern and southern jarrah forests, karri forests, south coast and Stirling Ranges. Habitat for mainland populations includes dense, streamside vegetation, heaths, shrublands, swamps and jarrah / karri forest regrowth areas. This species prefers vegetation communities that have been burnt in the previous ten years, and also requires low, dense vegetation for coverage and food. It feeds on the leaves and stems of low shrubs, foraging during cooler parts of the day. Unlikely to occur within the subject area; no recent records in the area.

Of the species listed in Table 2-9, the following conservation significant species are likely or known to occur within the subject area and may be potentially impacted by the proposed development of the subject area:

- *Calyptorhynchus latirostris* (Carnaby's Black Cockatoo)
- *Calyptorhynchus banksii* subsp. *naso* (Forest Red-tailed Black-Cockatoo)
- *Calyptorhynchus baudinii* (Baudin's Black Cockatoo)

Fauna Habitat

The subject area is largely cleared, with some parkland cleared areas (mostly marris and other planted eucalypts over introduced grasses, as per vegetation units Cc, Pc and PT in Figure 6). The other major fauna habitat present is the vegetated Clutterbuck Creek, which consists of eucalypts (many species being introduced / planted) over native understorey.

Marri (*Corymbia calophylla*), jarrah (*Eucalyptus marginata*), tuart (*Eucalyptus gomphocephala*) and blackbutt (*Eucalyptus patens*) trees are known to have the potential to support the roosting, foraging and breeding (marri and tuart) requirements of the three black cockatoo species in Table 2-9 to various extents, when sufficiently large. In particular, Forest Red-tailed Black Cockatoo prefer to nest in the hollows of large marris. The areas containing remnant native eucalypts could be considered suitable habitat for protected black cockatoo species. A total of 169 potential black cockatoo habitat trees were recorded within the subject area, consisting of marris (Plate 2-1), tuarts, blackbutt and jarrahs measured to be greater than 500 mm Diameter at Breast Height (DBH) (Figure 9). Of these trees 14 were identified (including one dead tree) as having hollows present or forming, but no signs of nesting were observed onsite. Signs of foraging by all three black cockatoo species were recorded during the fauna survey (Plate 2-2). These trees are also likely to provide

habitat to other species, including arboreal mammals and reptiles, and a range of bird species, for foraging and nesting.

Plate 2-1: Stand of Large Marri trees in the northern extent of subject area

Plate 2-2: Evidence of foraging on Marri fruit by WA black cockatoo species

A summary of results of the black cockatoo habitat tree numbers are provided in Table 2-10. Details of these trees are provided in the Arboricultural Report (Appendix 4).

Table 2-10: Black Cockatoo Habitat Trees

Species	No. of Trees Recorded (>500 mm DBH)	Habitat Uses (DEC, 2011)
Corymbia calophylla (marri)	138	Feeding, Nesting & Roosting
Eucalyptus marginata (jarrah)	10	Feeding & Roosting
Eucalyptus gomphocephala (tuart)	13	Feeding, Nesting & Roosting
Eucalyptus patens (blackbutt)	8	Feeding & Roosting

The vegetation units occurring within the foreshore area, as described by BEC (2016) include:

- Tall Forest to Woodland A of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Open Low Grass dominated by *Microlaena stipoides*.
- Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. r*udis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species.
- Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia* over Low Grass of mixed species including *Microlaena stipoides*.

Clutterbuck Creek and the associated riparian vegetation, though degraded in parts, is likely to support small mammals, numerous frog species, reptiles and crustacea (marron), as well as a range of birdlife. Such species are likely to use this habitat as a wildlife corridor connecting other vegetated areas. The creek is ephemeral (seasonally inundated) and is shallow and slow-moving during winter and spring months. There are sedentary sections that contribute to the diversity of habitat types within the creek, which also includes riffles, substantial meanders and in-stream logs and branches (WRC, 2001).

The lack of understorey vegetation across the subject area outside of the creekline and associated foreshore limits opportunities for inhabitation by small mammals and reptiles, which require this cover for protection, food and nesting. However, there are a number of large trees, largely marri (*Corymbia calophylla*) but with some scattered and planted jarrah (*Eucalyptus marginata*) and tuart (*Eucalyptus gomphocephala*) that provide valuable habitat to avian fauna for foraging, roosting and nesting.

2.8 Bushfire

A Bushfire Management Plan has been developed for the subject area by Strategen JBS&G (2020), as the project area is designated as bushfire prone on the WA Map of Bush Fire Prone Areas due to the extent of on-site and adjacent vegetation. The BMP was prepared to meet planning requirements triggered under State Planning Policy 3.7 Planning in Bushfire-Prone Areas (SPP 3.7) (WAPC, 2015).

The BMP takes into account vegetation retention and clearing as follows (Strategen JBS&G, 2020):

- All vegetation within the Clutterbuck Creek foreshore reserve will be retained in its current state since the proposal and BMP do not require removal of this vegetation to achieve an appropriate BAL rating for proposed development.
- The individual and small stands of paddock trees situated north and south of Clutterbuck Creek will be retained where possible.

- Road verge vegetation along Roland, Kilburn and Brindle Roads will be impacted by the proposal due to the necessary road widening and access construction required as part of the proposal.

The bushfire risks posed by post-development hazards can be managed through standard application of acceptable solutions under the Guidelines for Planning in Bushfire-Prone Areas (WAPC, 2017), including provision for and implementation of Asset Protection Zones (APZs), relevant bushfire construction standards under AS 3959, provision of adequate emergency water supply and vehicular access, as well as through a direct bushfire suppression response if required (Strategen JBS&G, 2020).

2.9 Heritage

2.9.1 Aboriginal Heritage

A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal heritage database identified no Registered Sites of Aboriginal heritage significance within the landholdings (DPLH, 2020). Three 'Other' - Artefacts / Scatter sites are identified within the subject area ('Parkerville 10', 'Parkerville 11' and 'Darling Range'), however these are considered Stored Data / Not a Site and are therefore not subject to any restrictions under the *Aboriginal Heritage Act 1972*.

2.9.2 European Heritage

A search was conducted of the DPLH State Heritage Office Inherit database in 2020. No places of heritage significance were located within the subject area. The following heritage places are located to the west of the site:

- Parkerville Children's Home and Cemetery (Place No. 8546; State Registered Place)
- St Michaels and All Angels Church (Place No. 11604)
- Parkerville Saw Mill (Place No. 24387)

3 Potential Impacts and Proposed Management

3.1 Land Capability

The land capability assessment for the area indicates that the land units on which the site is based are generally capable of supporting urban development. The Dwellingup landform unit covers the majority of the site area and is conducive to development given its relative ease of excavation and capability for house and road construction. The Yarragil landform unit Yg1 is conducive to development with high capabilities for rural retreat, house and road construction and on-site effluent disposal. The area characteristic of the Yarragil landform unit Yg4 is likely not to be as conducive to development (Section 2.1.3). Yg4 also may have implications for drainage capabilities and effluent disposal, with low microbial purification ability and high waterlogging risk.

As land capability mapping is undertaken on a broad scale, more detailed investigations of the suitability for non-sewered effluent disposal in Aerobic Treatment Units (ATUs) was undertaken for the LWMS and as part of the geotechnical investigation.

3.1.1 Effluent Disposal

The site is not located within an area currently serviced by a reticulated sewage system. As such, wastewater will be treated and disposed of on-site using Alterative Treatment Units (ATUs) on individual lots. These systems use biological processes to treat wastewater. Proposals for non-sewered effluent will be consistent with Department of Health's Code of Practice for On-site Sewage Management and A/NZ Standard 1547 On-site Domestic Wastewater Management and all lots will use DoH approved ATU systems.

The individual lots have been assessed against the Government Sewerage Policy (2019) to address the requirements. Liaison has been undertaken with DWER officers regarding the setbacks, and the wastewater management is addressed in full in the LWMS (Coterra, 2020).

3.2 Stormwater Management

Stormwater management is proposed to be undertaken consistent with Water Sensitive Urban Design (WSUD) principles and best management practices (BMPs), utilising the natural geological and topographical features of the subject area. The post-development stormwater management system and catchment flows will ensure that the pre-development hydrological regime and conditions will be mimicked as far as possible following development.

A summary of the stormwater management is addressed below. This has been comprehensively addressed in the Kilburn Road Local Water Management Strategy (Coterra Environment, 2020) and liaison has been undertaken with DWER regarding the strategy proposed.

- Lots will infiltrate roof runoff into soakwells (building pad will be raised above the groundwater or a clay layer to ensure infiltration can occur).
- Lot runoff in larger events will be incorporated into the road drainage system.
- Runoff from the first flush event (first 15mm) will be treated in bioretention treatment basins along the foreshore. The basins will be outside the foreshore area in areas already cleared for pre development farming. This was proposed to DWER during the Biophysical Assessment and presented in the LWMS.
- Hydrological modelling has been undertaken for the 5% AEP event (5 year ARI). This was agreed in the District Water Management Plan. Modelling indicated that due to the non coincidental peak flows occurring post development (two peaks), no storage was required to retain flows post development to meet the predevelopment flows in the 5% AEP event. This is addressed in the LWMS.

3.3 Vegetation and Flora

3.3.1 Vegetation Retention

As per the information in Table 2-5, the Yarragil 1 native vegetation complex is well-represented in the area (82.05% remaining), and approximately 10.18% of the original extent is protected in formal reserve.

The subject area is largely cleared, with the majority of the remnant vegetation located within the foreshore reserve (Figure 3). The remnant vegetation categorised as 'Protection' under the Shire Local Biodiversity Strategy (Figure 8) is largely limited to the foreshore reserve, which is to be retained for its ecological value and will be managed and maintained into perpetuity under the control of the Shire. Portions of the area mapped 'Protection' in the south-western corner of the subject area are not considered to be natural remnant vegetation, consisting of planted eucalypts over introduced grasses, however given their habitat and aesthetic value these trees will be retained where possible (these trees were planted approximately 40 years ago in land adjacent to Roland Road and Kilburn Road to create a boulevard aesthetic).

Urbanisation of the subject area will improve the condition of the riparian vegetation, as sheep currently have direct access to this area which places additional pressure on the ecosystem. The vegetation is currently in Good to Excellent condition within Lot 1001, and Degraded to Good condition in Lot 61 (with the exception of the planted eastern Australian eucalypts in the far western portion of the foreshore reserve, which due to the lack of native species is considered Completely Degraded). Some of the planted trees, whilst not native, will be retained for amenity and soil stabilisation.

3.3.2 Foreshore Vegetation Management

The vegetation within the foreshore reserve will be managed for two years by the developer in accordance with an endorsed Foreshore Management Plan, after which the reserve will be transferred to the Shire of Mundaring for ongoing management and maintenance. Management within the first two years will include strategic planting and revegetation works to assist with water quality / bank stabilisation / erosion control, weed control, management of ladder fuels on the advice of DWER and the Shire of Mundaring

Large, mature trees will be retained throughout the development area where possible within road reserves and open space.

3.3.2.1 Weed Control

Weed control is to be undertaken throughout the foreshore reserve area (indicated in Figure 3). Liaison with the Shire of Mundaring is to be undertaken prior to undertaking weed control, to confirm in detail the priority areas and species to be controlled. Priority species proposed to be targeted (as described in WRC (2001) and BEC (2016)) include:

- Watsonia (*Watsonia bulbillifera*)
- Edible Fig (*Ficus carica*)
- Bridal Creeper (*Asparagus asparagoides*)
- Eastern States Wattle (*Acacia decurrens; Acacia longifolia*)
- Arum lily (*Zantedeschia aethiopica*)
- Typha bulrush (*Typha orientalis*) (except where removal would result in bank destabilisation / erosion)

Weed control methods for each priority species are provided in Table 3-1.

Particular care will be taken to protect the endemic grass species *Microlaena stipoides* during spraying events. This species is dominant in the damper sections of the foreshore reserve and occurs naturally in this area. If any bank stabilisation works are required in the future this species be considered to be utilised for this purpose. Additional information on this species is provided in BEC (2016) (Appendix 1).

Table 3-1: Weed control methods for priority species

Species	Seeding time	Control Timing	Control Method
Watsonia (*Watsonia bulbillifera)*	March - May	July – August (spraying) Sept – Nov (leaf painting)	Remove corms by digging out a large area surrounding plant and sieving away sand. Remove flowers to prevent seed spread. Remove plants in nodes along waterway to minimise risk to stability of banks. Spray with Glean and Ally/Brushoff and paint leaves with Glyphosate, then remove bulk of dead biomass.
Edible Fig (*Ficus carica*)	Dec - March	Sept - Nov	Small plants removable by hand. Mature plants can be injected with full-strength Glyphosate at 15 cm intervals around the trunk. Fruit removal reduces rate of seed spread
Bridal Creeper (*Asparagus asparagoides*)	Oct - Dec	Jul - Sept	Remove young plants by hand. Remove bulk of plant material on larger plants prior to spraying (after one fortnight). Kings Park recommends Glyphosate 360 at a rate of 2.5 to 5 g per ha in 250 L of water, or 1 in 100 L. Repeat applications necessary.
Eastern States Wattle (*Acacia spp.)*	Various	Prior to flowering	Hand weed juvenile plants. Cut mature specimens at main trunk below widest part of stem beneath the ground. This will kill all plants.
Arum lily (*Zantedeschia aethiopica*)	Dec	April - Nov	Remove entire plants by digging up rhizomes. Spot spray from April to November using Glyphosate 1 in 100 or Gleen Ally / Brushoff 1 in 50 (20g / ha). Respraying may be required 8 weeks later. In wetland environments Roundup Biactive should be used to minimise fauna impacts.
Typha bulrush (*Typha orientalis*)	Sept - Dec	Winter	Remove seed heads prior to ripening (Sept – Dec). Cut stems below water levels in May and continue to cut if sufficient water is present. In wetland areas use only Roundup Biactive 1 to 10 in spring after slashing plants and wipe new growth when 1 m tall.

Source: WRC (2001)

The weed control actions proposed above will be undertaken in stages over two to three separate visits. This staged approach to treatment will also ensure that erosive damage to the waterway and banks is minimised. Weed control will be undertaken in the direction of areas of dense infestation, starting in healthy tracts of bushland.

Following the initial works undertaken by the developer, ongoing management of weeds in the foreshore reserve will be carried out by the Shire.

3.3.3 Approvals Required to Clear Native Vegetation

Clearing of native vegetation is regulated under the *Environmental Protection Act 1986* and *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. A permit must be sought from DWER for clearing, unless for an exempt purpose. Possible exemptions related to this development proposal would include (DWER, 2019):

- Clearing for roads to provide access to or within a subdivision.
- Clearing to provide water services to the satisfaction of the Water Corporation.
- Clearing within a building envelope described in the approved plan or diagram.
- Clearing to meet the requirements of the Shire of Mundaring annual Firebreak Notice, or to meet the requirements of the approved Bushfire Management Plan.

As such, clearing by future landowners outside of the building envelope (unless for a exempt purpose related to bushfire matters) would not be permitted unless a clearing permit is received from DWER. This will afford trees within individual lots future protection.

3.3.4 Dieback Control

No signs of dieback were noted during the vegetation and flora survey undertaken by BEC (2016). Specific management procedures proposed to prevent the potential spread of dieback into this area includes the following:

- Any fill required to be imported to the subject area will be obtained from a dieback free source.
- Prior to entering the site any construction equipment and construction materials (i.e. pipes, bricks etc) must be clean and free of any adhered soil / mud.
- Construction equipment is to stay within the construction zone and avoid moving into bushland areas.

3.4 Fauna and Habitat

Given the large lots sizes and limited clearing proposed for the development of the subject area (as the land is already largely cleared and utilised for sheep grazing), there are expected to be minimal impacts to fauna species currently utilising the subject area for habitat. Most ground-dwelling fauna species will traverse the subject area through the foreshore reserve, which is proposed to be retained in its entirety as an ecological corridor. The trees within the subject area provide avifauna habitat opportunities, in particular the protected black cockatoo species known to occur in the area. The road and lots layouts has been designed to minimise impacts to trees, where possible.

3.4.1 Protection of conservation significant fauna

The three Western Australian black cockatoo species (Carnaby's black cockatoo, Baudin's black cockatoo and the Forest Red-tailed black cockatoo) are considered to be Matters of National Environmental Significance (MNES) under the EPBC Act. The site investigation found the following:

- 14 trees with suitable for forming potentially suitable breeding hollows were observed onsite, but no breeding was observed.
- Tree species present onsite would provide potential foraging opportunities

Given that trees will be retained along the Clutterbuck Creek alignment and that clearing of existing paddock trees will be minimised as much as possible, it appears unlikely that the development would have a significant impact on black cockatoos.

Consultation with the Department of Agriculture, Water and Environment will be undertaken in regard to this matter, and a referral made under the *Environment Protection and Biodiversity Conservation Act 1999* made if required.

3.4.2 Other fauna management measures

The clearing of native vegetation for land development has the potential to result in injuries and fatalities of native fauna currently inhabiting the area if no impact management measures are established. Unintentional damage can also be inflicted on areas of vegetation to be retained, such as the foreshore reserve. As such, the following will be undertaken:

- During clearing and construction of the subject area, native vegetation and individual trees to be retained within the development (i.e. foreshore reserve, POS, trees in road reserves, etc.) will be clearly demarcated and fenced off temporarily, to restrict entry of vehicles, machinery or people into these areas, which could potentially result in damage to retained vegetation.

- Clearing of trees should, if possible, be undertaken outside of the main breeding season for bushland birds (i.e. between July and November), to avoid inflicting damage to nesting birds and their young.
- Clearing will be undertaken in the direction of remaining vegetation wherever possible.
- Logs and branches will be retained in the foreshore reserve, to provide valuable habitat for fauna within this ecological corridor.

3.4.3 Arboricultural Assessment of fauna habitat trees.

An assessment of all identified fauna habitat trees (Figure 9) was conducted by a qualified Arborist to determine their species, approximate height, main stem diameter, canopy spread, estimated age, health and structural condition. All trees assessed by the Arborist were tagged for future reference and to ensure accurate pick up by the site surveyor.

Additional information provided from the Arborist included:

- Suitability for retention of each tree on the site in the context of development
- Comments regarding any required canopy works to management risk
- High level recommendations for input into the design of the development.

A copy of the Arborist report is attached as Appendix 4. Plans show the location of trees potentially suitable for retention are provided in Appendix 5.

3.5 Bushfire Management

Bushfire management measures outlined in Strategen JBS&G (2020) include:

- All proposed residential lots have capacity for building envelopes to be located within areas of BAL-29 or lower. The final location of Asset Protection Zones (APZs) will be identified at the subdivision stage, once individual lot building envelopes have been determined.
- POS will need to be managed on a regular and ongoing basis through slashing, weed control and manual fuel removal to ensure the understorey and surface fuels are kept in a low threat, minimal fuel condition. POS management will be the responsibility of the developer until such time that these management responsibilities are transferred to the Shire.
- The existing cleared area within the foreshore reserve adjoining the proposed 1 ha lot adjacent to Roland Road in the northwest will not be subject to revegetation but will instead be subject to management in a low threat state.
- Proposed internal roads will be established and maintained in a non-vegetated state. Existing surrounding road reserves (Roland Road, Kilburn Road and Brindle Road) will be subject to vegetation modification and clearing associated with road widening and access construction
- Developer will adhere to the Shire of Mundaring annual firebreak notice, which requires all grass located outside of APZs to be maintained at a height no greater than 5 cm on all lots less than 5 ha in size and installation of 3m wide firebreaks around all structures and inside all external boundaries for lots 5,000m^2 or greater.
- At least two different vehicular access routes into the site which connect to the surrounding public road network will be provided.
- All lots within the project area will be provided a reticulated water supply.
- Notification will be placed on the Title of all proposed lots located within a designated bushfire prone area and that a BMP is applicable to the site.

Further detail on these items is provided in the BMP (Strategen JBS&G, 2020).

3.6 Aboriginal Heritage

The presence of 'Other' Aboriginal heritage sites within the subject area does not place any restrictions on the development of the site.

All contractors working on the development will be made aware of their responsibilities under the *Aboriginal Heritage Act 1972* with regard to finding potential archaeological sites. In the event a potential site is discovered, all work in the area will cease and the DPLH will be contacted.

4 Conclusion

Coterra Environment considers the subject area to be appropriate for residential development. The subject area is relatively unconstrained in terms of ecological values, with the majority of remnant bushland to be retained within the foreshore reserve of Clutterbuck Creek. The LSP design also provides opportunities for retention of numerous individual trees in road reserve and lots.

Management of effluent disposal and the application of Better Urban Water Management techniques will ensure the protection of water resources in the area and the maintenance of existing drainage processes onsite.

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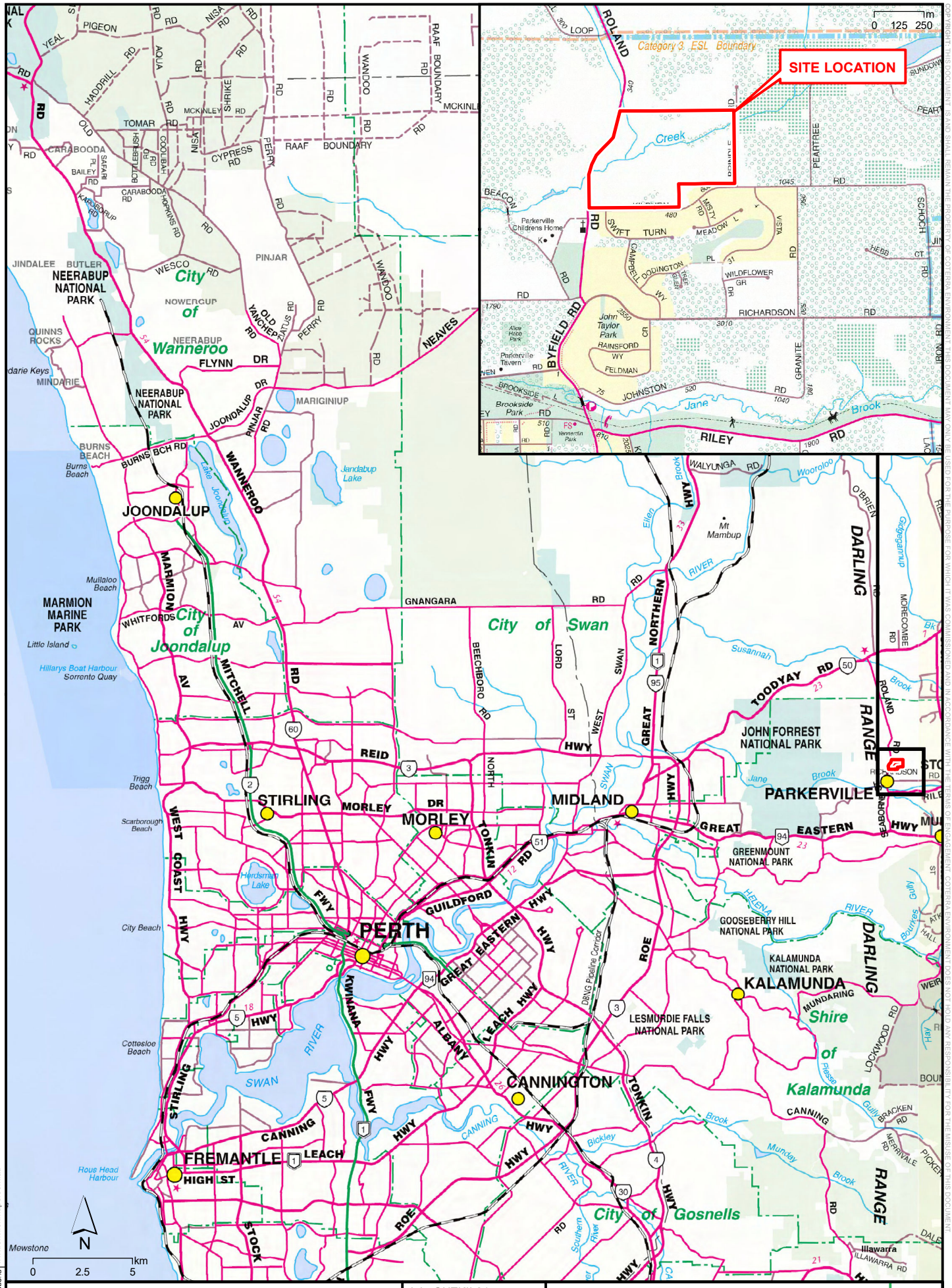
Figures



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Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 & 1001 KILBURN ROAD, PARKERVILLE

SITE LOCATION

Figure 1

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LEGEND

- Site Boundary
- Cadastre
- Watercourse

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

N

ROLAND RD

BRINDLE RD

CLUTTERBUCK CREEK

KILBURN RD

SWIFT TURN

MISTY RD

MEADOW LN

1 148 8 7 6 60 61 1001 1636 3304 9001 1684 101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128 2 3 4 5 29 30 31 32 33 34 35 55 36 22 28 23 21 27 24 25 26 20 37 19 38 10

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16

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Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

SUBJECT AREA

Figure 2

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Contour (mAHD)

Geology

- Sgc: CLAYEY GRAVELLY SAND - grey and yellow, kaolinitic, decomposed bedrock, sand and gravel veneer; granitic/gneissic origin
- G2: GRAVEL - yellow-brown to reddish brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor recementation; colluvial origin
- LA1: LATERITE - massive hard, cemented, vuggy and pisilitic; up to 4m thick, overlain by and associated with gravels (G2 and G3) of residual origin

Soil Subsystems

- DpYG4: Valley floors and gentle lower slopes with poorly drained mottled yellow duplex soils. Slightly prone to salinity. Low woodland of E. wandoo, E. marginata and Acacia spp..
- DpYG1: Very gentle to moderately inclined concave sideslopes.Moderately well drained yellow duplex soils and yellow and brown massive earths. Woodland of E. wandoo, E. marginata, E. Accedens. Casuarina obesa on salt affected areas.
- DpDW2: Very gently to gently undulating terrain (<10%) with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust.

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

N

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK

LA1
DpDW2
DpYG1
DpYG4
Sgc
G2

1
61
1001
1636
1684

148 8 7 6 5 4 3 2 1 101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128 30 31 32 33 34 35 55 36 29 28 27 24 23 22 21 20 37 38 25 26 19 240 235 245 250 255 260

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Topography, Landgate, 2017
Soil Landscape Subsustems - DAFWA, 13.06.13
Geology - DoIR: Geological Survey of W.A., 1999

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ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

TOPOGRAPHY, GEOLOGY AND SOILS

Figure 4

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Surface Water Location
- WIN Groundwater Bore

N

0 25 50 100 150 200 m

Scale: 1:5,000 @ A3
GDA 1994 MGA Zone 50

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16

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SURFACE AND GROUNDWATER FEATURES

Figure 5

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LEGEND
- Site Boundary
- Cadastre
- Watercourse

Vegetation Units
- Cc
- Fc
- Jp
- Mv
- PT
- Pc
- Tl

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK

SCATTERED / SMALL CLUMPS OF MARRI TREES

SCATTERED / SMALL CLUMPS OF MARRI TREES

SCATTERED / SMALL CLUMPS OF MARRI TREES

1884 1 148 8 60 61 1001 7 6 1636 2304 1684 101 102 103 104 105 106 107 108 109 110 111 112 125 126 127 128 124 123 122 121 120 37 38 20 19 25 26 1 10

Vegetation Description Abbreviations

Abbreviation	Description
Cc	Tall Forest of *Corymbia calophylla* over Dense Tall Grass
Jp	Open Tall Sedges of *Juncus pallidus* over Dense Herbs of introduced species
Tl	Tall Forest to Woodland of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland A of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Low Open Grass dominated by *Microlaena stipoides*
Mv	Open Woodland of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species
Fc	Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia*
Pc	Planted corridors of mainly Eastern Australian *Eucalyptus* species
PT	Planted trees non-endemic

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Vegetation Units - Bennett Enviro Consulting, Dec, 2016

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Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

VEGETATION UNITS

Figure 6

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LEGEND

- Site Boundary
- Cadastre
- Watercourse

Vegetation Condition

- 3(2): Very Good Bordering on Excellence
- 3: Very Good
- 3-4: Good to Very Good
- 4: Good
- 4-5: Good to Degraded
- 5: Degraded
- 5-6: Degraded to Completely Degraded
- 6: Completely Degraded
- 6?: Completely Degraded but trees planted in corridor which should be retained

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD

BRINDLE RD

CLUTTERBUCK CREEK

KILBURN RD

SWIFT TURN

MISTY RD

MEADOW LN

1 148 8 7 6 1636 61 1001 1684 3304

101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128

2 3 4 5 29 30 31 32 33 34 35 55 1 28 27 24 23 22 21 36 7 6 8 25 26 1 20 37 19 38 10

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Vegetation - Bennett Enviro Consulting, Dec, 2016

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ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

VEGETATION CONDITION

Figure 7

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LEGEND

- Site Boundary
- Cadastre

Local Natural Area

Protection Level

- Protection

Conservation Priority

- 1
- 2
- 3

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3

GDA 1994 MGA Zone 50

ROLAND RD

BRINDLE RD

KILBURN RD

SWIFT TURN

MISTY RD

MEADOW LN

CLUTTERBUCK CREEK

1884 1 148 8 60 7 61 1001 6 1636 5 4 3 2 30 31 32 33 34 35 55 29 1 28 22 23 21 36 27 24 7 6 8 25 26 1 20 37 19 38 10 101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128 1684

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
LNA - Shire of Mundaring

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LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

LOCAL NATURAL AREAS

Figure 8

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LEGEND

- Site Boundary
- Cadastre
- Watercourse

Fauna Habitat Trees

- Jarrah, No Visible Hollow
- Jarrah, Contains Viable Hollow / Potential Hollow Forming
- Marri, No Visible Hollow
- Marri, Contains Viable Hollow / Potential Hollow Forming
- Tuart, No Visible Hollow

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
CLUTTERBUCK CREEK
SWIFT TURN
MISTY RD
MEADOW LN

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16

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Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

FAUNA HABITAT MAPPING

Figure 9

Appendix 1 Botanical Assessment of Lots 61 and 1001 Kilburn Road Parkerville

Botanical Assessment of Lots 61 and 1001 Kilburn Road Parkerville Parkerville

Prepared for:
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Level 3, 25 Prowse Street,
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Prepared by:
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Sollya heterophylla

PO Box 341
KALAMUNDA 6926
December 2016

STATEMENT OF LIMITATIONS

Scope of Services

This 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 Eleanor Bennett ("the Author"). In some circumstances a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services.

Reliance on Data

In preparing the report, the Author 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, the Author 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. The Author 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 the Author.

Environmental Conclusions

In accordance with the scope of services, the Author 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.

The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment 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. The Author 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 the Author 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

The Author 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.

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1 INTRODUCTION

1.1 Background

Coterra Environment commissioned Bennett Environmental Consulting Pty Ltd to undertake a Level 1 vegetation assessment of Lots 61 and 1001 Kilburn Road, between Roland and Brindle Roads Parkerville in the Shire of Mundaring (the site). Diagram 1 illustrates the site which consisted of mainly cleared ground. Clutterbuck Creek has dense vegetation along its length which in Diagram 1 occurs from the north east corner to the western side. In addition there is a small tributary from the north west corner into the creek. The remainder of the site consists of scatter to small groups of trees.

Lot 61 is 13.197ha in area and Lot 1001 16.187ha. There is a drivable creek crossing at the junction of the two lots.

Diagram 1. Location of survey area Lots 61 and 10001.

1.2 Scope of Works

The requirements for this project were to:

i. Undertake a Level 1 vegetation survey (Environmental Protection Authority and Department of Parks and Wildlife, 2015); and to

ii. Search for and record all significant species at the site.

2. BACKGROUND INFORMATION

2.1 Geology and Landform

The site is included in the Darling Plateau which has lateritic uplands dominated by duricrust, gravels and sands. These form a gently undulating surface. The Darling Plateau has a trend from north to south in elevation, relief, incidence of duricrust and the nature and extent of gravels. Parkerville is included in the Dwellingup unit which has a low level of fine gravels (Churchward and McArthur, 1980).

2.2 Vegetation

The Interim Biogeographical Regionalisation for Australia (IBRA) (Thackway and Cresswell, 1995) recognizes 85 bioregions. The IBRA is used as the common unit to compare biological and biophysical attributes. Bioregions represent a landscape-based approach to classifying the land surface and each region is defined by a set of major environmental influences, which shape the occurrence of flora and fauna and their interaction with the physical environment. This was an Australia-wide mapping exercise that resulted in the production of the Interim Biogeographic Regionalisation of Australia (IBRA), a system that divides Australia into bioregions on the basis of their dominant landscape-scale attributes. IBRA was developed as a framework primarily to identify deficiencies in the Australian network of protected areas and to set priorities for further enhancing the reserve system. The site occurs within the Jarrah Forest Bioregion of Thackway and Cresswell (1995) wich was

divided into Jarrah Forest North and Jarrah Forest South. Parkerville occurs in the Jarrah Forest South (abbreviated JF2) (Hearn *et al.*, 2002).

The survey area is mapped by Beard (1981) as Jarrah (*Eucalyptus marginata* subsp. *thalassica* – Marri (*Corymbia calophylla*) Forest abbreviated e2,3Mi. Shepherd *et al*. (2002) have determined the pre-European and current extent of the vegetation associations described by Beard. In addition they have assessed the percentage of each vegetation association remaining, the amount in IUCN reserves and the percentage in other reserves. In 2002 the pre-European area of e2,3Mi is estimated to be 114,848ha ands the current extent 5,415ha which represents 4.7% remaining vegetated of which 46% is included in conservation.

Heddle *et al.* (1980) described the vegetation complexes of the Darling System at a scale of 1: 250 000. There was found to be a distinct pattern of plant distribution linked to landforms, soils and climate. The most obvious trend was associated with increasing aridity from west to east on the Darling Plateau. The vegetation changes observed were a decrease in height and percentage cover of the tallest stratum and a distinct change in floristics. Parkerville occurs in the Dwellingup, Yalanbee and Hester Complex in Low to Medium rainfall.

The Regional Forest Agreement (RFA) (Mattiske and Havel, 1998) mapped the vegetation complexes of the forest areas of Western Australia. This included the Jarrah Forest which covers the site. The RFA vegetation complex recorded for the site is:

- **Yarragil 1 –** Open Forest of *Eucalyptus marginata* subsp. *thalassica – Corymbia calophylla* on slopes with mixture of *Eucalyptus patens* and *Eucalyptus megacarpa* on the valley floors in humid and subhumid zones.

2.3 Threatened Ecological Communities

An ecological community is a naturally occurring biological assemblage that occurs in a particular type of habitat. A Threatened Ecological Community is one which falls into one of the following categories, presumed totally destroyed, critically endangered, endangered or vulnerable (Department of Parks and Wildlife (2016b)..

A possible threatened ecological community which does not meet the above is added to the Priority Ecological Community List. Priorities 1, 2, and 3 are adequately known but are not currently believed to be threatened. Those that have recently been removed from the threatened list are listed as Priority 4. Conservation dependent ecological communities are placed in Priority 5.

No Threatened of Priority Ecological Communities are listed for the site (Department of Parks and Wildlife (2016b).

2.4 Significant Flora

Prior to undertaking the field work a search was undertaken of NatureMap (Department of Parks and Wildlife, 2016c) for a 5km buffer from the centre at 116° 08' 39" E,32° 52' 05"S. This search resulted in the species listed in Table 2.

Table 1 presents the definitions of Declared Rare and the four Priority Flora ratings under the Wildlife Conservation Act (1950) as extracted from Government Gazette (2015). The listings in the Government Gazette (2015) now equate well with the definitions of the threatened species under the Environmental Protection and Biodiversity Conservation Act, 1999 (Department of Environment 2016). Table 2 lists those taxa recorded from the search area.

Table 1. Code and description of Threatened and Priority Flora (W.A. Government Gazette (2015

Code	Declared Rare and Priority Flora Categories
T	T (Threatened) -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. This category is further subdivided: CE: Flora that are considered likely to become extinct or rare, as critically endangered flora. E: Flora that are considered likely to become extinct or rare, as endangered flora. V: Flora that are considered likely to become extinct or rare, as vulnerable flora
X	DRF (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.
1	Priority One -Poorly Known Taxa. Taxa, which are known from one or a few (generally <5) populations, which are under threat.
2	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.
3	Priority Three -Poorly Known Taxa. Taxa, which are known from several populations, at least some of which are not believed to be under immediate threat.
4	Priority Four -Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

Table 2. Threatened and Priority Flora Species List recorded in the selected area with W.A. Government Gazette Threatened Flora code and categories and Priority Flora code and categories listed by the Department of Parks and Wildlife (2016a). Description extracted from FloraBase (Western Australian Herbarium, 2016)

Taxon	Code	Description
Acacia aphylla	V	Divaricately branched, spinescent, glaucous shrub, 0.9-2.5 m high. Fl. yellow, Aug to Oct. Sand, loam, clay loam. Granite outcrops, hills.
Priority Species		
Thelymitra variegata	2	Tuberous, perennial, herb, 0.1-0.35 m high. Fl. orange & red & purple & pink, Jun to Sep. Sandy clay, sand, laterite.
Acacia oncinophylla subsp. *oncinophylla*	3	Shrub, 0.9-2.5 m high, 'minni-ritchi' bark, phyllodes mostly 8-13 cm long, 1-2 mm wide. Fl. yellow, Aug to Oct. Granitic soils.
Adenanthos cygnorum subsp. *chamaephyton*	3	Prostrate, mat-forming, non-lignotuberous shrub, to 0.3 m high. Fl. white-cream-pink-green/green, Jul or Sep to Dec or Jan. Grey sand, lateritic gravel.
Grevillea manglesii subsp. *dissectifolia*		Spreading, virgate shrub, 1.5-3(-5) m high, up to 3 m wide. Fl. white & red & brown, Jun or Sep or Nov. Gravelly loam, moist. Roadsides.
Halgania corymbosa	3	Erect shrub, 0.35-1 m high. Fl. blue-purple, Aug to Nov. Gravelly soils, soils over granite.
Lepyrodia heleocharoides	3	Rhizomatous, slender, tufted perennial, herb (sedge-like), 0.15-0.25 m high. Fl. Dec. Moist peaty sand. Dry or seasonally inundated heath or woodland, swamps.
Tetratheca pilifera	3	Spreading shrub, 0.1-0.3 m high. Fl. purple, Aug to Oct. Gravelly soils.
Thysanotus anceps	3	Rhizomatous, leafless perennial, herb, to 0.4 m high. Fl. purple, Oct to Dec. White or grey sand, lateritic gravel, laterite.
Boronia tenuis	4	Procumbent or erect & slender shrub, 0.1-0.5 m high. Fl. blue/pink-white, Aug to Nov. Laterite, stony soils, granite
Grevillea pimeleoides	4	Non-lignotuberous shrub, 0.4-2.4 m high. Fl. yellow-orange, May to Nov. Gravelly soils over granite. Rocky hillsides.
Lasiopetalum bracteatum	4	Erect, open shrub, 0.4-1.5 m high. Fl. pink-purple, Aug to Nov. Sandy clay, clay, lateritic gravel. Along drainage lines, creeks, gullies, granite outcrops.

Taxon	Code	Description
Persoonia sulcata	4	Erect, spreading to decumbent shrub, 0.2-1 m high. Fl. yellow, Sep to Nov. Lateritic or granitic soils.
Pimelea rara	4	Shrub, 0.2-0.35 m high. Fl. white, Dec or Jan. Lateritic soils.
Senecio leucoglossus	4	Erect annual, herb, to 1.3 m high. Fl. white, Aug to Dec. Gravelly lateritic or granitic soils. Granite outcrops, slopes.

3. METHODS

Transects were walked through the remnant bushland listing the vegetation units in the area and the dominant taxa. Transects were walked the total length of Clutterbuck Creek to record the changes in the dominant vegetation. As this was being undertaken the bushland was searched for Threatened and Priority Flora. The vegetation at the site is described using the vegetation classification of Muir (1977) as described in Table 3.

Table 3 Vegetation Classification (from Muir, 1977)

LIFE FORM / HEIGHT CLASS	Canopy Cover			
	DENSE 70 % - 100%	MID DENSE 30% - 70%	SPARSE 10% - 30%	VERY SPARSE 2% - 10%
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee (tree form)	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee (shrub form)	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 - 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 - 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass > 0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < 0.5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

4. RESULTS

Field work was undertaken on 29th November 2016. A total of 22 GPS locations recorded the variation in the vegetation at the site. Each of the GPS locations are mapped in Appendix B, Map 1 and recorded in detail in Appendix A. Sixteen of the GPS locations were along Clutterbuck Creek, two were in the larger groups of trees visible at the site, one in a damp area that was not along the creek and three were in planted corridors which included no or few endemic trees.

4.1 Vegetation

The remnant vegetation units from the site were:

1. Tall Forest of *Corymbia calophylla* over Dense Tall Grass of introduced species. This was the dominant vegetation on the slopes above the creek. It was represented by GPS locations ki1 and ki3.
2. Open Tall Sedges of *Juncus pallidus* over Dense Herbs of introduced species. This vegetation unit occurred in the damper areas above the creek. This was represented by GPS location ki2.
3. Tall Forest to Woodland A of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Open Low Grass dominated by *Microlaena stipoides.* The species present varied considerably along the length as is illustrated in Appendix A by GPS locations ki4, ki5, ki6, ki7,

ki8, ki9, ki10 and ki11. **Acacia decurrens* an Eastern Australian Wattle was dominant in some sections.

4. Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species. This was the dominant vegetation along the creek in Lot 61 and represented by GPS locations ki12, ki13, ki14, ki15 and ki16; and
5. Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia* over Low Grass of mixed species including *Microlaena stipoides.* This was recorded along the tributary, where **Ficus carica*, the edible Fig, was common and was represented by GPS locations ki18, ki19 and ki20;
6. Planted corridors. These consisted of mainly Eastern Australian Eucalyptus species and were planted in distinct rows. The corridor beside Rowland Road included the Western Australian species *Eucalyptus marginata* (Jarrah) and *Corymbia calophylla* (Marri), both of which were endemic to the area and *Eucalyptus gomphocephala* (Tuart) a near coastal species. These were represented by GPS locations ki17, ki21 and ki22

4.2 Vegetation Condition

Bushland has been historically subject to ongoing degradation and is especially susceptible to disturbances arising as a result of indirect impacts from surrounding developments and human activity. Degradation is caused by a wide range of factors, including isolation, edge effects, weed invasion, plant diseases, changes in fire frequency, landscape fragmentation, increased predation on native fauna by feral animals, decrease in species richness and general modification of ecological function. These issues affect the biodiversity rating and ecological viability of areas of remnant vegetation and should be assessed in line with conservation values. Vegetation condition was rated according to the vegetation condition scale, Table 4, used in Keighery (1994.

Table 4. Explanation of Vegetation Condition Rating (Keighery, 1994)

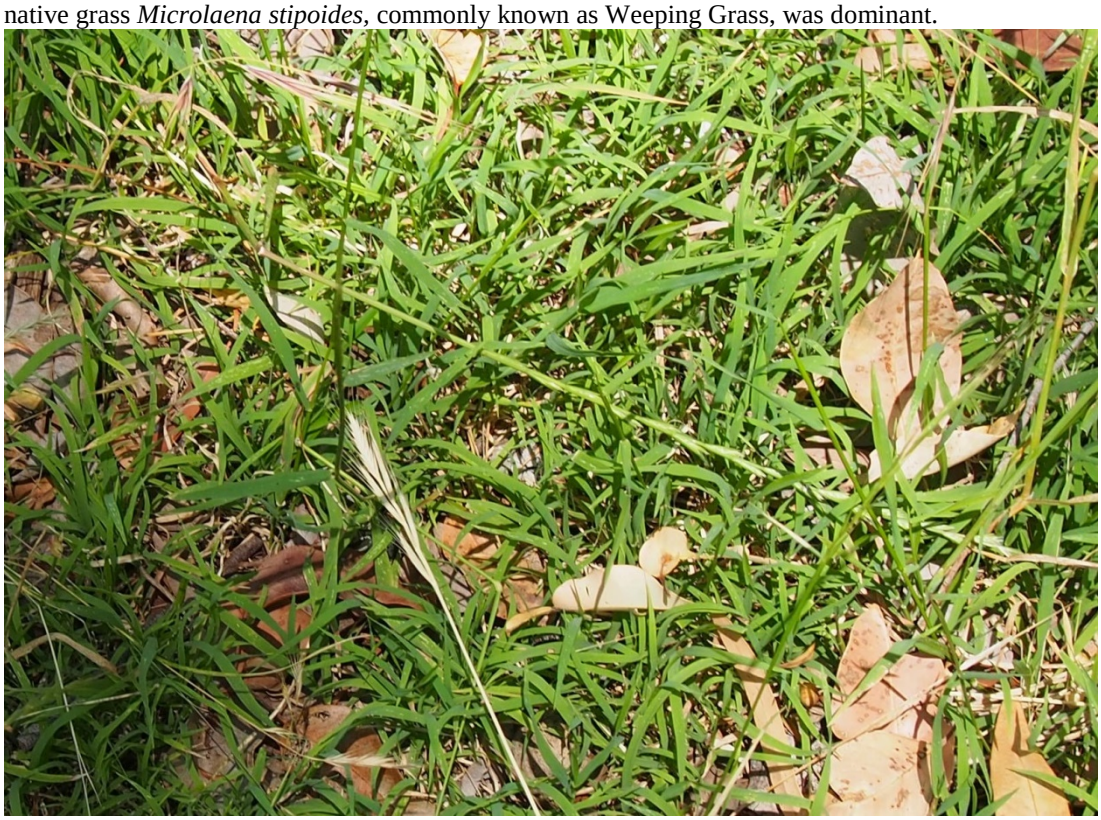
Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Table 5. Vegetation condition rating for survey sites

Rating	Description	GPS location number
2-3	Very good bordering on excellent	ki10
3	Very good	ki7, ki8
3-4	Varying between very good and good	ki6
4	Good	ki4, ki5, ki9, ki11, ki12, ki14, ki19, ki20
4-5	Varying between good and degraded	Ki13, ki15, ki16, ki18
5	Degraded	ki1
5-6	Varying between degraded and completely degraded	ki2, ki3, ki22
6	Completely degraded	ki17, ki21

From Table 5 it can be seen that the creek on Lot 1001 was in good to very good condition with a section bordering on excellent. The section of the main creek on Lot 61 was also in good condition but did have some degraded sections, .and the minor creek on Lot 61 was in good condition.

Along nearly the total length of the creek, especially in the damper ground just above the creek itself a native grass *Microlaena stipoides*, commonly known as Weeping Grass, was dominant.



4.3 Significant Flora

No Threatened or Priority Flora were recorded.

5. DISCUSSION

No threatened or priority flora or vegetation communities were recorded at the site.

The higher ground consisted of clumps or scattered trees of *Corymbia calophylla* (Marri) over grass weeds throughout the paddocks. A few Jarrah (*Eucalyptus marginata*) were recorded on the boundary with the houses along the southern edge. Where possible as many of these endemic trees should be retained with any proposed subdivision.

Around the infrastructures (sheds etc.) on Kilburn Road, there are a few fruit trees and lines of cultivated trees including **Eucalyptus cladocalyx, *Eucalyptus botryoides, *Eucalyptus saligna, *Lagunaria patersonii* and **Lophostemon conferta*. Around the dam on the property some of these species were also planted and cultivated plants are around the home on the property. None of these are of significance.

About 40 years previously tree corridors were planted along Kilburn Road and Rowley Road to connect to the creek on the site. These were planted with predominantly Eastern Australian *Eucalyptus* species but along Rowley Road two endemic species *Corymbia calophylla* (Marri) *and Eucalyptus marginata* (Jarrah) were also planted. Several healthy trees of *Eucalyptus gomphocephala* (Tuart), well outside of its natural range, but a Western Australian species, were recorded along Rowley Road. These trees should not be removed but could be inter planted with some endemic shrubs e.g. *Acacia pulchella, Calothamnus quadrifidus* and where the ground is damper with *Taxandria linearifolia*.

The section of Clutterbuck Creek on Lot 1001 was in good to very good condition and at the time of the survey still had water present. Minor variations in the vegetation along its length were recorded. Many very tall and often dense trees of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis*

subsp. *rudis* were recorded. Only certain sections recorded shrubs of *Taxandria linearifolia* or *Acacia pulchella*.

The tributary of Clutterbuck Creek on Lot 61 was in good condition with some sections in a degraded condition. Again the trees of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* were tall and dense in a few sections but the dominant understorey species was *Melaleuca viminea* subsp. *viminea*. This section of the creek recorded only small section with water along its length. Most of it was dry.

The access to the back paddocks is via a track across the creek on the boundary of Lot 61 and Lot 1001. Once the winter water starts to recede this may work as a dam which retains the water in Lot 1001 but allows the creek to dry out in Lot 61. *Melaleuca viminea* occurs in winter wet depressions along creeks whereas *Taxandria linearifolia* borders swamps and water courses (Western Australian Herbarium, 2016).

The vegetation along the tributary was in good condition consisting of predominantly trees of *Corymbia calophylla* with *Taxandria linearifolia* and *Astartea leptophylla* as understorey species. There were several of the edible fig trees (**Ficus carica*) along its length which should be removed. It is not unusual to find Fig trees in damp places as they are often introduced via birds.

An endemic grass species, *Microlaena stipoides* was dominant along the damper area. In Florabase (Western Australian Herbarium 2016) *Microlaena stipoides* is described as a rhizomatous, perennial, grass growing from 30 cm to 75cm in height with a green-purple flower in August to November. It occurs naturally from the mountains of the Cape York Peninsula through New South Wales and Victoria to Tasmania, the wetter coastal districts of South Australia and the south west of Western Australia. In parts of Eastern Australia, cultivar seed is readily available and this species is being cultivated as a lawn.

As this grass occurs naturally along the creek propagation of this species should be undertaken and planted during rehabilitation of the site. It is essential that seed is collected or plants propagated from those along the creek and not obtained from Eastern Australia.

As it is proposed to conserve Clutterbuck Creek and its tributary with any development of the site, rehabilitation along its length should be considered. This should include the removal of **Acacia decurrens* trees along the main creek and **Ficus carica* along the tributary as well as the seedlings of these species which will continue to germinate after the parent plants are removed. Some of the smaller litter, especially the dead shrubs of *Melaleuca viminea* subsp. *viminea* should be removed as it is a fire risk, but the larger logs should be retained for fauna conservation, in particular lizards and frogs. General weed removal should be undertaken ensuring that the plants of *Microlaena stipoides* are not killed.

Clutterbuck Creek will be an asset for any development and it would be excellent if future residents could form a Friends of Group to maintain it in its rehabilitated condition.

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Appendix A

GPS Locations

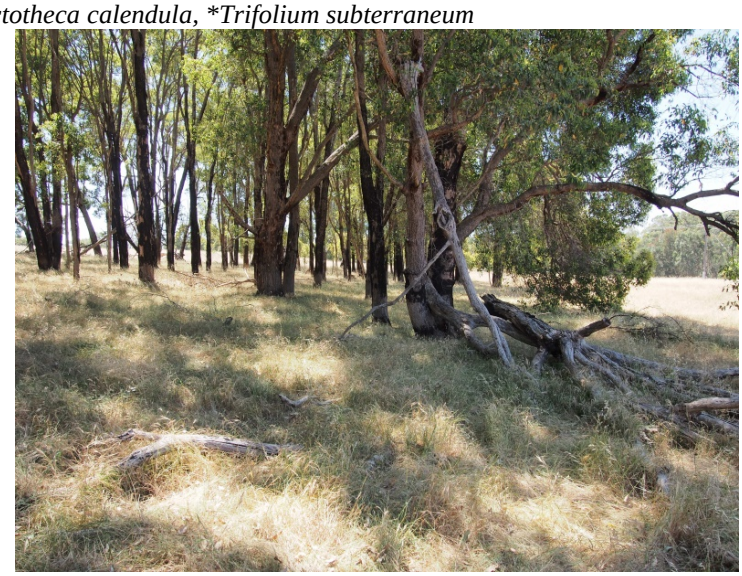
LEGEND

ABBREVIATION	DESCRIPTION
subsp.	Subspecies
var.	Variety
*	Weed

ki1

GPS (WGS 84): 418916E; 6473990N
Vegetation Description: Dense Tall Forest of *Corymbia calophylla* over Dense Tall Grass of introduced species
Vegetation Condition: Degraded
Topography: Middle slope to south
Soil: Sandy loam gravel with few outcropping laterite rocks
Dominant Species:

Trees: *Corymbia calophylla*
Grasses: **Avena barbata,* Bromus diandrus, *Ehrharta longiflora, *Hordeum leporinum, *Setaria parviflora*
Herbs: **Arctotheca calendula, *Trifolium subterraneum*



ki2

GPS (WGS 84): 418876E; 6473937N
Vegetation Description: Open Tall Sedges of *Juncus pallidus* over Dense Herbs of introduced species
Vegetation Condition: Degraded to completely degraded
Topography: Lower area
Soil: Sandy loam, damp
Dominant Species Present:

Grasses: **Avena barbata, *Hordeum leporinum, *Lolium perenne*
Herbs: **Hypochaeris glabra, *Lotus subbiflorus, *Moraea flaccida*
Sedges*: Juncus pallidus*

ki3

GPS (WGS 84): 419059E; 6473995N
Vegetation Description: Tall Forest of *Corymbia calophylla* over Tall Grass of introduced species and litter
Vegetation Condition: Degraded to completely degraded
Topography: Lower slope to south
Soil: Sandy loam gravel with laterite rocks on the surface
Dominant Species Present:

Trees: *Corymbia calophylla*
Grasses:**Avena barbata, *Bromus diandrus, *Ehrharta longifolia, *Vulpia bromoides*
Herbs: **Trifolium campestre*

ki4

GPS (WGS 84): 419258E: 6474027N
Vegetation Description: Open Low Woodland A of *Corymbia calophylla* over Thicket of *Taxandria linearifolia* over weeds
Vegetation Condition: Good
Topography: Narrow creek
Soil: Clay
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus patens*
Shrubs: *Acacia pulchella* var. *pulchella, Taxandria linearifolia*
Grasses: **Briza maxima*
Herbs: **Romulea rosea*, **Watsonia meriana* subsp. *bulbillifera*

ki5

GPS (WGS 84): 419259E; 6473991N
Vegetation Description: Tall Forest of *Corymbia calophylla* and *Eucalyptus patens* over Open Low Grass dominated by *Microlaena stipoides*
Vegetation Condition: Good
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis*
Shrubs: *Taxandria linearifolia*
Grasses: **Avena barbata, *Briza minor, Microlaena stipoides*
Herbs: **Asparagus asparagoides, Lobelia anceps, *Lysimachia arvensis, *Romulea rosea, **Watsonia meriana* subsp. *bulbillifera*
Sedges; **Isolepis prolifera, Juncus pallidus, Luzula meridionalis*

ki6

GPS (WGS 84): 419184E; 6473923N
Vegetation Description: Forest of **Acacia decurrens* and *Corymbia calophylla* over Open Low Woodland A of *Melaleuca rhaphiophylla* over Open Low Grass dominated by **Microlaena stipoides*
Vegetation Condition: Good to very good
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:

Trees: **Acacia decurrens, Corymbia calophylla, Melaleuca rhaphiophylla*
Shrubs: *Taxandria linearifolia*
Grasses: **Avena barbata, Microlaena stipoides*

ki7

GPS (WGS 84): 419144E; 6473929N
Vegetation Description: Dense Tall Forest of *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Low Grass of *Microlaena stipoides* and litter
Vegetation Condition: Very good
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:

Trees: **Acacia decurrens, Corymbia calophylla, Eucalyptus paten, Eucalyptus rudis* subsp. *rudis, Melaleuca rhaphiophylla*
Grasses: **Briza maxima, *Holcus lanatus, Lachnagrostis filiformis, Microlaena stipoides, *Polypogon monspeliensis*
Shrubs: *Acacia pulchella* var. *pulchella, *Lavender stoechadis*
Herbs: **Lotus subbiflorus, *Trifolium subterraneum*
Sedges*: Isolepis cyperoides, Juncus pallidus, Luzula meridionalis*

Ki8

GPS (WGS 84): 418909E; 6473874N
Vegetation Description: Tall Forest of *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Low Woodland A of *Melaleuca rhaphiophylla* over Low Grass dominated by *Microlaena stipoides* over litter
Vegetation Condition: Very good
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:

Trees: **Acacia decurrens, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis, Melaleuca rhaphiophylla*
Shrubs: *Acacia pulchella* var. *pulchella, Taxandria linearifolia*
Grasses: **Avena barbata, Microlaena stipoides*
Sedges:: **Isolepis prolifera*

ki9

GPS (WGS 84): 419069E; 6473878N
Vegetation Description: Woodland of *Corymbia calophylla, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis* and *Melaleuca rhaphiophylla* over Low Grass of *Microlaena stipoides*
Vegetation Condition: Good
Topography: Dam on creek
Soil: loamy clay
Dominant Species Present:
1 On bank - Trees: **Acacia longifolia, Corymbia calophylla, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis, Melaleuca rhaphiophylla*
Shrubs*: Acacia pulchella* var. *pulchella, Taxandria linearifolia, *Lavender stoechadis*
*Grasses: *Avena barbata, Lachnagrostis filiformis*
2. In water: Trees: *Eucalyptus rudis* subsp. *rudis*
Herbs: *Lobelia anceps, *Sonchus asper*
Sedges: **Isolepis prolifera, *Juncus microcephalus, Lepidosperma longitudinale *Typha orientalis,*
Fern*: *Cyathea cooperi*

ki10

GPS (WGS 84): 419053E; 6473882N
Vegetation Description: Dense Tall Forest of *Eucalyptus patens* over Thicket of *Taxandria linearifolia* over Low Grass of *Microlaena stipoides* and litter
Vegetation Condition: Very good bordering on excellent
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:
Trees: *Eucalyptus patens, Eucalyptus rudis* subsp. *rudis*
Shrubs: *Taxandria linearifolia*
Grasses: Microlaena stipoides
*Herbs: *Asparagus asparagoides, Lobelia anceps, *Lotus subbiflorus*
*Sedges: *Juncus microcephala, Juncus pallidus*

ki11

GPS (WGS 84): 418987E; 6473875N
Vegetation Description: Tall Woodland of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland A of *Melaleuca rhaphiophylla* over Open Scrub of *Taxandria linearifolia* over introduced grasses and herbs
Vegetation Condition: Good
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis, Melaleuca rhaphiophylla*
Shrubs*: Taxandria linearifolia* (several were dead or dying)
Grasses*: *Avena barbata, *Ehrharta longiflora*
Herbs: **Hypochaeris radicata, *Moraea flaccida*
Sedges: *Isolepis cyperoides, *Isolepis prolifera, Juncus pallidus*

ki12

GPS (WGS 84): 418873E; 7573862N
Vegetation Description: Open Woodland of *Eucalyptus rudis* subsp. *rudis* over Dense Thicket of *Melaleuca viminea* subsp. *viminea* over herbs, introduced grasses and litter
Vegetation Condition: Good
Topography: Along wider creek with very little water
Soil: Loamy clay
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus rudis* subsp. *rudis, Eucalyptus wandoo* subsp. *wandoo, *Ficus carica, Melaleuca rhaphiophylla*
Shrubs: *Calothamnus quadrifidus, Melaleuca viminea* subsp. *viminea*
Grasses*: *Ehrharta longiflora*
Herbs*: *Lotus subbiflorus, *Zantedeschia aethiopica*

ki13

GPS (WGS 84): 418826E; 6473855N
Vegetation Description: Open Woodland of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species
Vegetation Condition: Degraded to good
Topography: Along broader stream
Soil: Sandy clay
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus marginata* subsp. *thalassica, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis*
Shrubs*: Acacia pulchella* var. *pulchella, Calothamnus quadrifidus, Melaleuca viminea* subsp. *viminea*
Grasses: **Briza maxima, *Bromus diandrus, *Ehrharta longiflora, *Holcus lanatus, Lachnagrostis filiformis, Microlaena stipoides, *Polypogon monspeliensis, *Setaria parviflora, *Vulpia bromoides*
Herbs: **Zantedeschia aethiopica*
Sedges*: Juncus pallidus *Typha orientalis*

ki14

GPS (WGS 84): 418741E; 6473826N
Vegetation Description:
Vegetation Condition: Good
Topography: Creek bed
Soil: Sandy clay
Dominant Species Present:

Shrubs: *Taxandria linearifolia*
Grasses: **Briza minor, Lachnagrostis filiformis*
Herbs: **Lotus subbiflorus, *Lysimachia arvensis, *Moraea flaccida, Myriophyllum crispatum, *Plantago lanceolata*
Sedges: *Cyperus tenellus, Isolepis cyperoides, *Juncus bufonius, Juncus pallidus, Luzula meridionalis*

ki15

GPS (WGS 84): 418754E; 6473836N
Vegetation Description: Woodland of *Casuarina obesa, Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland A of *Melaleuca rhaphiophylla*
Vegetation Condition: Degraded to good
Topography: Creek banks
Soil: Sandy loam
Dominant Species Present:

Trees: *Casuarina obesa, Corymbia calophylla, Eucalyptus marginata* subsp. *thalassica, Eucalyptus patens, Eucalyptus rudis* subsp. *rudis*
Shrubs*: Acacia pulchella* var. *pulchella, Calothamnus quadrifidus, Melaleuca viminea* subsp. *viminea*
Grasses: **Briza maxima, *Bromus diandrus, *Ehrharta longiflora, Microlaena stipoides, *Vulpia bromoides*

ki16

GPS (WGS 84): 418645E; 6473784N
Vegetation Description: Tall Forest of *Eucalyptus rudis* subsp. *rudis* over Open Scrub of *Taxandria linearifolia* and *Melaleuca viminea* subsp. *viminea* over Dense Low Grass dominated by **Vulpia bromoides*
Vegetation Condition: Degraded to good
Topography: Small creek
Soil: Sandy loam
Dominant Species Present:

Trees: *Eucalyptus rudis* subsp. *rudis*
Shrubs: *Taxandria linearifolia, Melaleuca viminea subsp. viminea*
Grasses: **Avena barbata, Ehrharta longiflora*
Herbs: **Lotus subbiflorus*
Sedges: *Juncus pallidus*

ki17

GPS (WGS 84): 418627E; 6473777N
Vegetation Description: Eastern Australian *Eucalyptus* species planted in rows over deep litter
Vegetation Condition: Completely degraded
Topography: Flat
Soil: sandy loam
Dominant Species Present:

Trees: **Eucalyptus grandis, *Eucalyptus nicholii, Eucalyptus rudis* subsp. *rudis, *Eucalyptus saligna*
Grasses*: *Avena barbata, *Ehrharta longiflora, *Lolium perenne, Microlaena stipoides*

ki18

GPS (WGS 84): 418731E; 6474004N
Vegetation Description: Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia* over Low Grass of mixed species including *Microlaena stipoides*.
Vegetation Condition: Good to degraded
Topography: Narrow creek
Soil: Sandy loam
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus rudis* subsp. *rudis, *Ficus carica*
Shrubs: *Taxandria linearifolia*
Grasses: **Avena barbata, *Briza maxima, *Lolium perenne, Microlaena stipoides*
Herbs: **Lysimachia arvensis, *Plantago lanceolata, *Sonchus oleraceus*
Sedges: *Isolepis cyperoides, Juncus pallidus*

ki19

GPS (WGS 84): 418737E; 6474003N
Vegetation Description: Tall Forest of *Corymbia calophylla* over Low Woodland A of **Ficus carica* over Open Dwarf Scrub C of *Astartea leptophylla* and *Calothamnus quadrifidus* over Low Grass of mixed species
Vegetation Condition: Good
Topography: Creek
Soil: Sandy loam
Dominant Species Present:

Trees: *Corymbia calophylla, *Ficus carica*
Shrubs: *Astartea leptophylla, Calothamnus quadrifidus*
Grasses: **Ehrharta longiflora, Microlaena stipoides, *Vulpia bromoides*
Herbs: **Plantago lanceolata*

ki20

GPS (WGS 84): 418786E; 6473910N
Vegetation Description: Tall Forest of *Corymbia calophylla* over Low Woodland A of **Ficus carica* over Open Dwarf Scrub C of *Astartea leptophylla* and *Calothamnus quadrifidus* over Low Grass of mixed species
Vegetation Condition: Good
Topography: Creek
Soil: Sandy loam
Dominant Species Present:

The same as ki19 but more plants of Astartea *leptophylla* present

No photograph taken. This was the end of creek

ki21

GPS (WGS 84): 418639E; 6473554N
Vegetation Description: Planted corridor mainly with Eastern Australian trees
Vegetation Condition: Completely degraded
Topography: Flat
Soil: Sandy loam
Dominant Species Present:

Trees: **Acacia decurrens, *Corymbia maculata, *Eucalyptus botryoides, *Eucalyptus grandis, *Eucalyptus nicholii, *Eucalyptus saligna*
Grasses*: *Avena barbata, *Ehrharta longiflora, *Lolium perenne, Microlaena stipoides*

ki22

GPS (WGS 84): 418553E; 6473635N
Vegetation Description: Planted trees
Vegetation Condition: Degraded to completely degraded
Topography: slope to north
Soil: Sandy loam
Dominant Species Present:

Trees: *Corymbia calophylla, Eucalyptus gomphocephala, Eucalyptus marginata, *Eucalyptus melleodora *Eucalyptus nicholii, *Eucalyptus saligna*

No photograph taken

Appendix B

Maps

Map 1. Location of GPS sites
Map 2. Vegetation units
Map 3. Vegetation condition

LEGEND

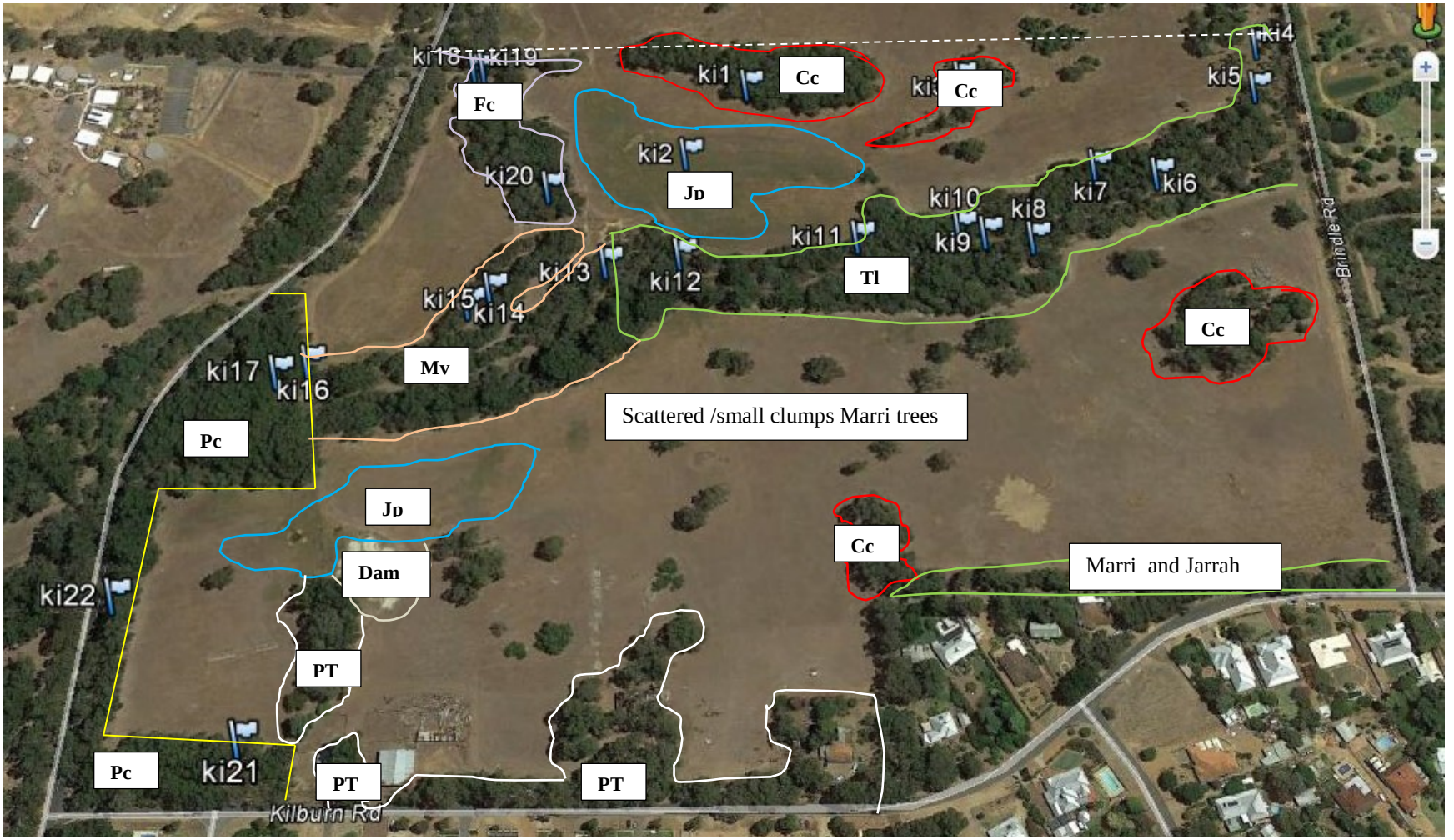
Vegetation Description Abbreviations

Abbreviation	Description
Cc	Tall Forest of *Corymbia calophylla* over Dense Tall Grass
Jp	Open Tall Sedges of *Juncus pallidus* over Dense Herbs of introduced species
Tl	Tall Forest to Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland A of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Low Open Grass dominated by *Microlaena stipoides*
Mv	Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species
Fc	Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia*
Pc	Planted corridors of mainly Eastern Australian *Eucalyptus* species
PT	Planted trees non-endemic

Vegetation Condition Abbreviations

Abbreviation	Condition
3(2)	Very good bordering on excellent
3	Very good
3-4	Good to very good
4	Good
4-5	Good to degraded
5	Degraded
5-6	Degraded to completely degraded
6	Degraded
6?	Degraded but trees planted in corridor which should be retained

Location of GPS sites



Map 2. Vegetation units

Map 3. Vegetation condition

Appendix C

Illustrations of *Microlaena stipoides*

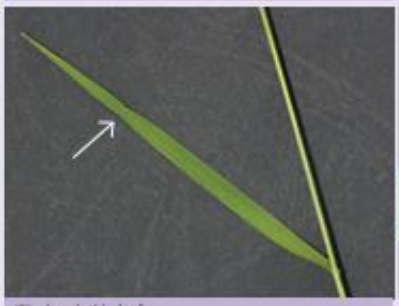
The Government of South Australia (2016) has prepared an excellent publication on the Natural Grasses of Adelaide and the Mount Lofty Ranges. It is extremely well illustrated and the information provided for *Microlaena stipoides* is provided below.

Weeping Rice-grass *Microlaena stipoides*

Habit; low tussock with short running roots and fine seed heads

Flower

Seeding head; small glumes, white when young



'Pinch point' in leaf

Ligule; white collar where leaf meets stem

Description	Low growing green perennial tussock with short running root system which may give the impression of a 'couch-like growth'. Leaves green, broad. Flowering heads very slender, arching, with a few slender flowers along it. Flowers with fine long awns.
Key features	Flower stalks have distinctive slender arching or weeping look. Tiny shiny white 'triangles' (small glumes) near base of each flower. A white encircling 'waist' where leaf meets stem. Many leaves have a small pinch point about 1 cm from blade tip.
Height	Tussock from 10 to 30 cm high. Flowering heads to 50 cm long but spreading so usually less than 30 cm tall.
Flowering time	Summer to autumn
Fertiliser	Responds well to increased soil fertility
Frost	Tolerant
Drought	Tolerant
Grazing	Moderate to high tolerance when actively growing. Keep short to maintain quality. Rotationally graze for better leaf production. High forage value. Metabolisable energy 9.8-11.4 MJ/Kg DM. Crude protein 15-25%. Digestibility 66-75%.
Growing season	Winter active grass, with growth spurts and flowering in spring and autumn.
Distribution	MLR: Usually damp soil and often shady sites where it can dominate the ground layer. High rainfall areas of SA. Also in WA, Qld, NSW, Vic, Tas. Widespread in all mainland states.

Illustration of flowering head of *Microlaena stipoides* taken from Simon, B.K and **&** Y. Alfonso (2015). The weeping habit is obvious in this photograph.

The above illustrations should aid in the identification of this grass.

Appendix 2 Fauna Species List

Scientific Name	Common Name	Recorded on site	Locally significant (DEP, 2000)	Naturemap	WCA (WA)	EPBC Act
Birds						
Acanthiza apicalis	Broad-tailed Thornbill		X			
Acanthiza chrysorrhoa	Yellow-rumped Thornbill		X			
Acanthiza inornata	Western Thornbill		X			
Acanthorhynchus superciliosus	Western Spinebill					
Accipiter fasciatus	Brown Goshawk		X			
*Anas platyrhynchos**	Mallard					I
Anas superciliosa	Pacific Black Duck					
Anthochaera carunculata	Red Wattlebird	X				
Anthochaera lunulata	Western Little Wattlebird		X			
Apus pacificus	Fork-tailed Swift				IA	Mi, Ma
Aquila audax	Wedge-tailed Eagle	X**	X			
Ardea alba	Great Egret					Mi, Ma
Ardea ibis	Cattle Egret				IA	Mi, Ma
Artamus cyanopterus	Dusky Woodswallow		X			
Barnardius zonarius	Australian Ringneck	X				
*Cacatua galerita**	Sulphur-crested Cockatoo					
Cacatua sanguinea	Little Corella					
Cacatua sp.		X**				
*Cacatua tenuirostris**	Eastern Long-billed Corella					
Cacomantis pallidus	Pallid Cuckoo					
Calidris ferruginea	Curlew Sandpiper				T	CE, Mi, Ma
Calyptorhynchus banksii	Red-tailed Black Cockatoo					
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	X			T	V
Calyptorhynchus baudinii	Baudin's Black Cockatoo	X**			T	V
Calyptorhynchus latirostris	Carnaby's Cockatoo	X**			T	E
*Carduelis carduelis**	European Goldfinch					I
Chenonetta jubata	Australian Wood Duck	X				
Colluricincla harmonica	Grey Shrike-thrush		X			
*Columba livia**	Domestic Pigeon					I
Coracina novaehollandiae	Black-faced Cuckoo-shrike					
Corvus coronoides	Australian Raven	X				

Scientific Name	Common Name	Recorded on site	Locally significant (DEP, 2000)	Naturemap	WCA (WA)	EPBC Act
Cracticus nigrogularis	Pied Butcherbird					
Cracticus tibicen	Australian Magpie	X				
Cracticus torquatus	Grey Butcherbird					
*Dacelo novaeguineae**	Laughing Kookaburra	X				
Daphoenositta chrysoptera	Varied Sittella		X			
Egretta novaehollandiae	White-faced Heron					
Elanus axillaris	Black-shouldered Kite					
Eolophus rosiecapillus	Galah	X				
Falco cenchroides	Australian Kestrel					
Gerygone fusca	Western Gerygone					
Grallina cyanoleuca	Magpie-lark	X				
Haliaeetus leucogaster	White-bellied Sea Eagle				IA	Mi, Ma
Haliastur sphenurus	Whistling Kite		X			
Hirundo neoxena	Welcome Swallow					
Leipoa ocellata	Malleefowl				T	V, Mi
Lichmera indistincta	Brown Honeyeater					
Malurus splendens	Splendid Fairy Wren		X			
Merops ornatus	Rainbow Bee-eater				IA	Ma
Milvus migrans	Black Kite					
Motacilla cinerea	Grey Wagtail					Mi, Ma
Neophema elegans	Elegant Parrot					
Ninox novaeseelandiae	Boobook Owl					
Numenius madagascariensis	Eastern Curlew				T	CE, Mi, Ma
Pachycephala pectoralis	Golden Whistler		X			
Pachycephala rufiventris	Rufous Whistler					
Pandion haliaetus	Osprey					Mi, Ma
Pardalotus punctatus xanthopyge	Yellow-rumped Pardalote					
Pardalotus striatus	Striated Pardalote					
*Passer domesticus**	House Sparrow					I
*Passer montanus**	Eurasian Tree Sparrow					I
Petroica boodang	Scarlet Robin					
Phaps chalcoptera	Common Bronzewing		X			
Phylidonyris novaehollandiae	New Holland Honeyeater		X			

Scientific Name	Common Name	Recorded on site	Locally significant (DEP, 2000)	Naturemap	WCA (WA)	EPBC Act
Platycercus icterotis	Western Rosella		X			
Podargus strigoides	Tawny Frogmouth					
Purpureicephalus spurius	Red-capped Parrot					
Rhipidura leucophrys	Willie Wagtail	X				
Rostratula australis	Australian Painted Snipe					E, Mi, Ma
Sericornis frontalis	White-browed Scrubwren		X			
Smicrornis brevirostris	Weebill		X			
*Streptopelia chinensis**	Spotted Turtle Dove					I
*Streptopelia senegalensis**	Laughing Turtle-Dove					I
*Sturnus vulgaris**	Common Starling					I
Threskiornis spinicollis	Straw-necked Ibis	X				
Todiramphus sanctus	Sacred Kingfisher					
*Trichoglossus haematodus**	Rainbow Lorikeet					I
Tringa nebularia	Common Greenshank				IA	Mi, Ma
Zosterops lateralis	Grey-breasted White-eye					
Reptiles						
Parasuta gouldii	Gould's Hooded Snake					
Pogona minor minor	Dwarf Bearded Dragon					
Pseudonaja affinis affinis	Dugite					
Varanus gouldii	Bungarra or Sand Monitor	X**				
Mammals						
Antechinus flavipes subsp. leucogaster	Mardo					
*Bos taurus**	Domestic Cattle					I
*Canis lupus familiaris**	Domestic Dog					I
*Capra hircus**	Goat					I
Chalinolobus gouldii	Gould's Wattled Bat					
Dasyurus geoffroii	Chuditch				T	V
*Felis catus**	Cat					I
*Funambulus pennantii**	Northern Palm Squirrel					I
Hydromys chrysogaster	Rakali, Water Rat				P4	
Isoodon obesulus	Southern Brown Bandicoot				P4	
Isoodon obesulus fusciventer	Quenda				P4	

Scientific Name	Common Name	Recorded on site	Locally significant (DEP, 2000)	Naturemap	WCA (WA)	EPBC Act
Macropus fuliginosus	Western Grey Kangaroo	X				
*Mus musculus**	House Mouse					I
*Oryctolagus cuniculus**	European Rabbit	X**				I
*Rattus rattus**	Black Rat					I
Setonix brachyurus	Quokka				T	V
*Sus scrofa**	Wild Pig					I
Tarsipes rostratus	Honey Possum					
Trichosurus vulpecula	Common Brushtail Possum					
*Vulpes vulpes**	Red Fox					I
Invertebrates						
Aname mainae	Spider					
Araneus senicaudatus	Spider					
Argiope protensa	Spider					
Argiope trifasciata	Spider					
Austracantha sp.	Jewel Spider	X				
Austracantha minax	Jewel Spider					
Cercophonius squama	Scorpion					
Cercophonius sulcatus	Scorpion					
Eriophora biapicata	Orb-weaving Spider					
Isopeda leishmanni	Spider					
Latrodectus hasseltii	Redback Spider					
Missulena granulosa	Trapdoor Spider					
Nicodamus mainae	Spider					
Phryganoporus nigrinus	Spider					
Storosa tetrica	Spider					
Zachria flavicoma						

* = introduced (overseas or from the eastern Australian states)

**= species not directly observed but evidence of species found occurring onsite, eg. scats, feeding signs, anecdotal evidence from landowner / neighbours

T = Threatened / Schedule 1 of the *Wildlife Conservation Act 1950* – 'rare or likely to become extinct'

S4 = Schedule 4 of the *Wildlife Conservation Act 1950* – 'other specially protected fauna'

P4 = Priority 4 (under the DEC) – 'taxa in need of monitoring'

P5 = Priority 5 (under the DEC) – 'taxa in need of monitoring (IUCN conservation dependent)'

E = Endangered (under the EPBC Act 1999)

V = Vulnerable (under the EPBC Act 1999)

I = Introduced (under the EPBC Act 1999)

Mi = Migratory (under the EPBC Act 1999)

Ma = Marine (under the EPBC Act 1999)

Appendix 3 Fauna Database Search Results

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 24/11/2016

Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	116° 08' 34" E,31° 52' 07" S
Buffer	2km
Group By	Kingdom

Kingdom	Species	Records
Animalia	89	662
Fungi	4	6
Plantae	118	177
TOTAL	**211**	**845**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Animalia					
1.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
2.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
3.	24262	*Acanthiza inornata (Western Thornbill)*			
4.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
5.	25536	*Accipiter fasciatus (Brown Goshawk)*			
6.		*Aname mainae*			
7.	24316	*Anas superciliosa (Pacific Black Duck)*			
8.	24088	*Antechinus flavipes subsp. leucogaster (Yellow-footed Antechinus, Mardo)*			
9.	24561	*Anthochaera carunculata (Red Wattlebird)*			
10.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
11.	24285	*Aquila audax (Wedge-tailed Eagle)*			
12.		*Araneus senicaudatus*			
13.		*Argiope protensa*			
14.		*Argiope trifasciata*			
15.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
16.		*Austracantha minax*			
17.		*Barnardius zonarius*			
18.	25713	*Cacatua galerita (Sulphur-crested Cockatoo)*			
19.	25716	*Cacatua sanguinea (Little Corella)*			
20.	24729	*Cacatua tenuirostris (Eastern Long-billed Corella)*	Y		
21.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
22.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
23.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black-Cockatoo)*		T	
24.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo (long-billed black-cockatoo), Baudin's Cockatoo)*		T	
25.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo)*		T	
26.		*Cercophonius squama*			
27.		*Cercophonius sulcatus*			
28.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
29.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
30.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
31.	24399	*Columba livia (Domestic Pigeon)*	Y		
32.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
33.	25592	*Corvus coronoides (Australian Raven)*			
34.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
35.	25595	*Cracticus tibicen (Australian Magpie)*			
36.	25596	*Cracticus torquatus (Grey Butcherbird)*			
37.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
38.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
39.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
40.		*Egretta novaehollandiae*			
41.		*Elanus axillaris*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
42.		*Eolophus roseicapillus*			
43.		*Eriophora biapicata*			
44.	25622	*Falco cenchroides (Australian Kestrel)*			
45.	25530	*Gerygone fusca (Western Gerygone)*			
46.	24443	*Grallina cyanoleuca (Magpie-lark)*			
47.	24295	*Haliastur sphenurus (Whistling Kite)*			
48.	24491	*Hirundo neoxena (Welcome Swallow)*			
49.	25478	*Isoodon obesulus (Southern Brown Bandicoot)*		P5	
50.	24153	*Isoodon obesulus subsp. fusciventer (Quenda, Southern Brown Bandicoot)*		P5	
51.		*Isopeda leishmanni*			
52.		*Latrodectus hasseltii*			
53.	25661	*Lichmera indistincta (Brown Honeyeater)*			
54.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
55.	25654	*Malurus splendens (Splendid Fairy-wren)*			
56.	24598	*Merops ornatus (Rainbow Bee-eater)*		IA	
57.	25542	*Milvus migrans (Black Kite)*			
58.		*Missulena granulosa*			
59.	24738	*Neophema elegans (Elegant Parrot)*			
60.		*Nicodamus mainae*			
61.	25748	*Ninox novaeseelandiae (Boobook Owl)*			
62.	25679	*Pachycephala pectoralis (Golden Whistler)*			
63.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
64.	25253	*Parasuta gouldii*			
65.	24626	*Pardalotus punctatus subsp. xanthopyge (Yellow-rumped Pardalote)*			
66.	25682	*Pardalotus striatus (Striated Pardalote)*			
67.	24660	*Petroica multicolor subsp. campbelli (Scarlet Robin)*			
68.	24409	*Phaps chalcoptera (Common Bronzewing)*			
69.		*Phryganoporus nigrinus*			
70.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
71.	25720	*Platycercus icterotis (Western Rosella)*			
72.	25703	*Podargus strigoides (Tawny Frogmouth)*			
73.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
74.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
75.		*Purpureicephalus spurius*			
76.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
77.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
78.	30948	*Smicrornis brevirostris (Weebill)*			
79.		*Storosa tetrica*			
80.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
81.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
82.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
83.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
84.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
85.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
86.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
87.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
88.		*Zachria flavicoma*			
89.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			
Fungi					
90.	38794	*Hydnum repandum*			
91.	38816	*Omphalotus nidiformis*			
92.		*Phytophthora cinnamomi*			
93.		*Russula clelandii*			
Plantae					
94.	3220	*Acacia aphylla (Leafless Rock Wattle)*		T	
95.	15466	*Acacia applanata*			
96.	15469	*Acacia barbinervis subsp. barbinervis*			
97.	11661	*Acacia drummondii subsp. drummondii*			
98.	3331	*Acacia extensa (Wiry Wattle)*			
99.	3557	*Acacia stenoptera (Narrow Winged Wattle)*			
100.	14970	*Adenanthos barbiger*			
101.	6314	*Andersonia lehmanniana*			
102.	20249	*Astartea leptophylla*			
103.	6334	*Astroloma pallidum (Kick Bush)*			
104.	36441	*Babingtonia camphorosmae (Camphor Myrtle)*			
105.	3157	*Billardiera floribunda (White-flowered Billardiera)*			
106.	25788	*Billardiera fraseri (Elegant Pronaya)*			
107.	4432	*Boronia ovata*			
108.	11381	*Boronia ramosa subsp. anethifolia*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
109.	4443	*Boronia subsessilis*			
110.	3717	*Bossiaea pulchella*			
111.	18497	*Bossiaea sp. Waroona (B.J. Keighery & N. Gibson 229)*			
112.	1603	*Caladenia longiclavata (Clubbed Spider Orchid)*			
113.	15377	*Caladenia reptans subsp. reptans*			
114.	2952	*Cassytha glabella (Tangled Dodder Laurel)*			
115.	2957	*Cassytha racemosa (Dodder Laurel)*			
116.	3753	*Chorizema dicksonii (Yellow-eyed Flame Pea)*			
117.	4564	*Comesperma virgatum (Milkwort)*			
118.	12035	*Conostylis caricina subsp. caricina*			
119.	1455	*Conostylis setosa (White Cottonhead)*			
120.	13470	*Cryptandra arbutiflora var. arbutiflora*			
121.	4802	*Cryptandra mutila*			
122.	15404	*Cyanicula sericea*			
123.	3799	*Daviesia cordata (Bookleaf)*			
124.	3805	*Daviesia decurrens (Prickly Bitter-pea)*			
125.	3835	*Daviesia preissii*			
126.	3839	*Daviesia rhombifolia*			
127.	17691	*Desmocladus fasciculatus*			
128.	3895	*Gastrolobium calycinum (York Road Poison)*			
129.	20475	*Gastrolobium capitatum*			
130.	3933	*Gastrolobium villosum (Crinkle-leaved Poison)*			
131.	3954	*Gompholobium polymorphum*			
132.	12520	*Goodenia fasciculata*			
133.	19628	*Grevillea bipinnatifida subsp. bipinnatifida*			
134.	13451	*Grevillea manglesii subsp. dissectifolia*		P3	
135.	13450	*Grevillea manglesii subsp. manglesii*			
136.	2066	*Grevillea pilulifera (Woolly-flowered Grevillea)*			
137.	14421	*Grevillea synapheae subsp. synapheae*			
138.	2128	*Hakea amplexicaulis (Prickly Hakea)*			
139.	2152	*Hakea cyclocarpa (Ramshorn)*			
140.	2175	*Hakea lissocarpha (Honey Bush)*			
141.	2203	*Hakea ruscifolia (Candle Hakea)*			
142.	2214	*Hakea trifurcata (Two-leaf Hakea)*			
143.	2215	*Hakea undulata (Wavy-leaved Hakea)*			
144.	45534	*Hibbertia hypericoides subsp. hypericoides*			
145.	5169	*Hibbertia serrata (Serrate Leaved Guinea Flower)*			
146.	5172	*Hibbertia stellaris (Orange Stars)*			
147.	3968	*Hovea trisperma (Common Hovea)*			
148.	12741	*Hyalosperma cotula*			
149.	12007	*Hybanthus floribundus subsp. floribundus*			
150.	7396	*Isotoma hypocrateriformis (Woodbridge Poison)*			
151.	1195	*Juncus subsecundus (Finger Rush)*			
152.	4037	*Kennedia coccinea (Coral Vine)*			
153.	4044	*Kennedia prostrata (Scarlet Runner)*			
154.	3669	*Labichea punctata (Lance-leaved Cassia)*			
155.	45082	*Lasiopetalum glutinosum subsp. latifolium*			
156.	7568	*Lechenaultia biloba (Blue Leschenaultia)*			
157.	940	*Lepidosperma pubisquameum*			
158.	2342	*Leptomeria cunninghamii*			
159.	1086	*Lepyrodia heleocharoides*		P3	
160.	1088	*Lepyrodia macra (Large Scale Rush)*			
161.	1090	*Lepyrodia muirii*			
162.	15562	*Lepyrodia riparia*			
163.	6367	*Leucopogon capitellatus*			
164.	44227	*Leucopogon darlingensis subsp. darlingensis*			
165.	6400	*Leucopogon gracillimus*			
166.	6439	*Leucopogon pulchellus (Beard-heath)*			
167.	28302	*Leucopogon sp. Parkerville (A. Meebold 11654)*			
168.	6444	*Leucopogon sprengelioides*			
169.	6447	*Leucopogon strictus*			
170.	1222	*Lomandra brittanii*			
171.	1092	*Loxocarya cinerea*			
172.	17636	*Marianthus coeruleopunctatus (Blue-spotted Marianthus)*			
173.	957	*Mesomelaena tetragona (Semaphore Sedge)*			
174.	4100	*Mirbelia spinosa*			
175.	7085	*Misopates orontium (Lesser Snapdragon)*	Y		
176.	11749	*Orthrosanthus laxus var. laxus (Morning Iris)*			
177.	4354	*Oxalis incarnata*	Y		
178.	2262	*Persoonia elliptica (Spreading Snottygobble)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
179.	2284	*Petrophile biloba (Granite Petrophile)*			
180.	2297	*Petrophile heterophylla (Variable-leaved Cone Bush)*			
181.	20460	*Pheladenia deformis*			
182.	11402	*Pimelea imbricata var. piligera*			
183.	5260	*Pimelea rara (Summer Pimelea)*		P4	
184.	12041	*Pimelea suaveolens subsp. suaveolens*			
185.	5269	*Pimelea sylvestris*			
186.	2742	*Ptilotus manglesii (Pom Poms, Mulamula)*			
187.	20506	*Rubus anglocandicans*	Y		
188.	20496	*Rubus laudatus*	Y		
189.	7602	*Scaevola calliptera*			
190.	1026	*Schoenus unispiculatus*			
191.	9070	*Stackhousia pubescens (Downy Stackhousia)*			
192.	7684	*Stylidium amoenum (Lovely Triggerplant)*			
193.	7702	*Stylidium ciliatum (Golden Triggerplant)*			
194.	7736	*Stylidium hispidum (White Butterfly Triggerplant)*			
195.	7752	*Stylidium lineatum (Sunny Triggerplant)*			
196.	7783	*Stylidium pycnostachyum (Downy Triggerplant)*			
197.	4251	*Templetonia drummondii*			
198.	4535	*Tetratheca hirsuta (Black Eyed Susan)*			
199.	11053	*Thelymitra macrophylla*			
200.	1328	*Thysanotus dichotomus (Branching Fringe Lily)*			
201.	1483	*Tribonanthes longipetala*			
202.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			
203.	13479	*Trymalium ledifolium var. rosmarinifolium*			
204.	7107	*Verbascum virgatum (Twiggy Mullein)*	Y		
205.	7111	*Veronica persica (Creeping Speedwell)*	Y		
206.	6088	*Verticordia huegelii (Variegated Featherflower)*			
207.	12429	*Verticordia huegelii var. decumbens*			
208.	15618	*Verticordia plumosa var. plumosa*			
209.	4325	*Viminaria juncea (Swishbush, Koweda)*			
210.	6283	*Xanthosia atkinsoniana*			
211.	44861	*Xerochrysum macranthum*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

Australian Government
Department of the Environment and Energy

EPBC Act Protected Matters Report

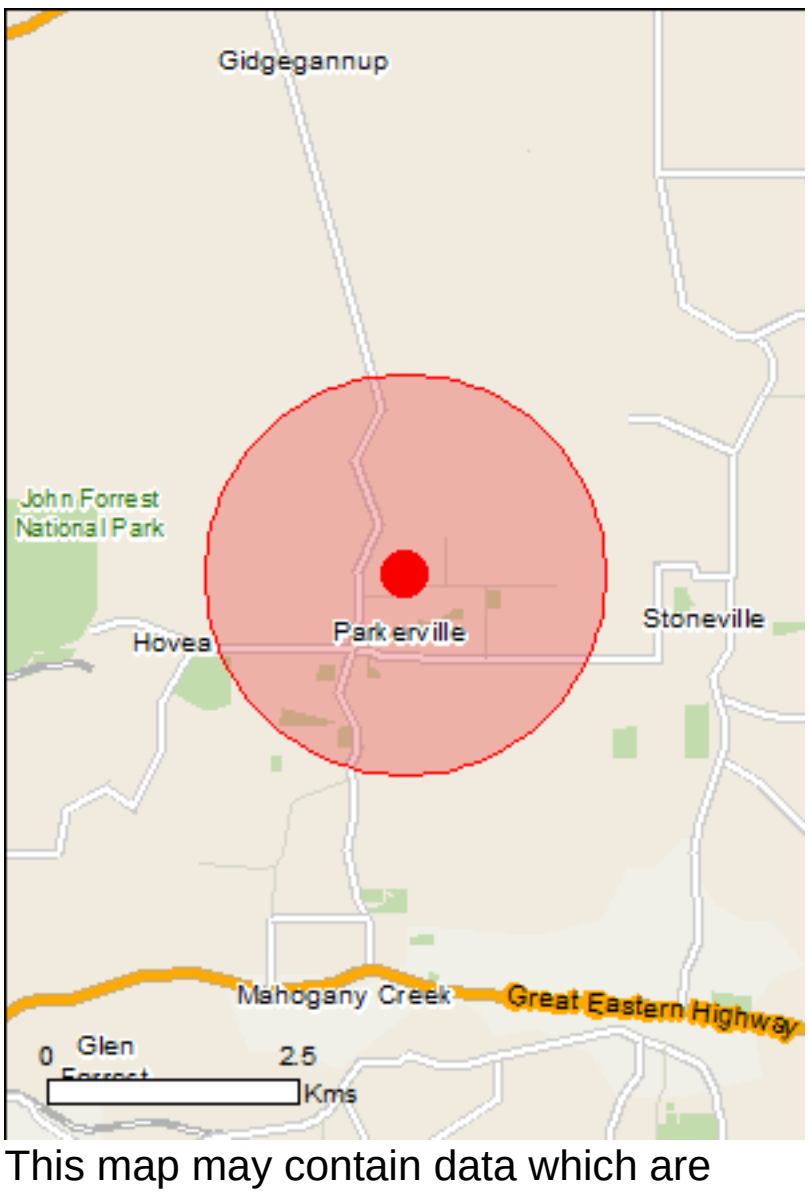
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

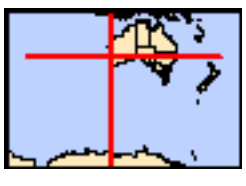
Report created: 24/11/16 15:32:39

Summary
Details
Matters of NES
Other Matters Protected by the EPBC Act
Extra Information
Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 2.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	17
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	1
Invasive Species:	32
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso		
Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii		
Baudin's Cockatoo, Baudin's Black-Cockatoo, Long-billed Black-Cockatoo [769]	Vulnerable	Roosting known to occur within area
Calyptorhynchus latirostris		
Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii		
Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Setonix brachyurus		
Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Acacia aphylla		
Leafless Rock Wattle [13553]	Vulnerable	Species or species habitat likely to occur within area
Caladenia huegelii		
King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Grevillea christineae Christine's Grevillea [64520]	Endangered	Species or species habitat likely to occur within area
Grevillea flexuosa Zig Zag Grevillea [2957]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur

Name	Threatened	Type of Presence within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

Regional Forest Agreements	[Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.86895 116.14278

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix 4 Arborist Report

January 30, 2020
February 10, 2020 (Rev1)

Coterra Environment
Level 3, 25 Prowse Street
West Perth, WA 6005

ATTENTION: **Merrilyn Barnes**

RE: **Preliminary assessment of identified Trees; Lot 61 and 1001 Kilburn Road, Parkerville**

Dear Merrilyn,

Further to your request, the following is a summary of my assessment of the identified trees within Lot 61 and 1001 Kilburn Road, Parkerville.

Should you have any queries regarding the findings of this report, or if I can be of any further assistance during the development process, please do not hesitate to contact me.

Yours sincerely

JASON ROYAL

Dip. Arboriculture (UK)
Tech. Arbor A

Preliminary assessment of Identified Trees; Lot 61 and 1001 Kilburn Road, Parkerville

Prepared For

Coterra Environment

Prepared By

ARBOR logic

Jan 31, 2020	Rev 0
Feb 10,2020	Rev 1

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2. Purpose of the Assessment Page 1

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5. Summary of the Key Findings of the Assessment Pages 3 - 10

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7. Further Considerations; Development Design and Construction Pages 36 - 38

Attachments to the Report

Glossary of arboricultural terms

Company Information & Disclaimer

1. Terms Used

The following terms have been used in this report:

'Site'	meaning the area of Lot 61 & 1001 Kilburn Road, Parkerville that was included in this assessment
'Tree'	meaning any of the 169 individual trees identified on the Site that were to be included in this assessment
'TPZ'	meaning the Tree's nominal 'Tree Protection Zone'; the area where the majority of the Tree's root mass is considered likely to be found. Any works required in this zone are considered likely to have some potential to impact the Tree's future health.
'AS 4970'	meaning Australian Standards 4970; Protection of Trees on Development Sites
'AS 4373'	meaning Australian Standards 4373; Pruning of Amenity Trees

2. Purpose of the Assessment

- Provide basic information on each of the identified Trees in terms of their species, approximate height, main stem diameter, canopy spread, estimated age, health and structural condition and any comments deemed pertinent to the Tree.
- Provide an opinion on the suitability of retention of each of the identified Trees on the Site in the context of a development process.
- Provide comment on any canopy works that may be required in view of risk management requirements.
- Provide any broad-brush purposeful and practical recommendations for any design and construction implications that may apply for any trees identified as being suitable for retention within the proposed development so to ensure their preservation if undertaken remains successful.

3. Particulars of this Assessment

The findings and opinion provided in this report are my own and have been based on the visual observations of the Trees January 9, 28 and 29, 2020.

All observations of the Trees were undertaken from ground level.

No exploratory excavations have been undertaken as part of this particular assessment to verify the actual root spread of any given Tree.

As such the allocation of TPZ for each Tree has at this stage been based on AS 4970 guidelines with some amendments being made for the physical size and canopy dimensions of the Tree, its condition, the known root zone morphology of its given species in the sort of soil profile considered to be typical to this area of Western Australia.

4. Methodology of the Assessment

The Trees were visually inspected from ground level in accordance with general visual tree assessment ("VTA") methods and principles.

The VTA method is based on the sciences of tree biology, physiology, tree structure, and tree bio-mechanics. It is a method widely used by arborists worldwide to identify visible signs on trees that indicate any health or potential structural issues that in turn could increase the risks associated with the given tree or impact its potential life span and use as an amenity tree in the urban environment.

The height of each Tree was measured using a Nikon Pro Forestry Rangefinder.

The trunk diameter of each Tree was measured using a standard 'DBH' measuring tape.

The overall health of each Tree was adjudged from an inspection of its leaf, overall percentage of leaf mass present in its canopy, and the presence (or absence) of any pest or disease factor that could have an effect on its health and vitality.

The structural integrity of each Tree was determined from a visual inspection of its main stem, primary (and secondary) branch unions to determine the presence of any areas considered to be a structural 'defect' or 'imperfection' such as unions with included bark, swelling, or noticeable splitting at them.

Symptoms of decay, growth patterns and defects are identified and assessed as to their potential to cause whole tree, part tree or branch failure, and where considered necessary further investigation by way of the use of sounding techniques was utilised to determine the presence and general extent of any areas of cavity or associated decay within a tree's main stem structure.

Each Tree's species and its ability to cope with disturbances to its root zone that typically occur as part of a development process, as well as its ability to cope with the new parameters that are commonly created by an urban development (i.e. decreased soil oxygen due to compaction, increased un-seasonal watering from irrigation, increased pollution, increased radiated heat/light from urban infrastructure (roads, walls, buildings etc.) are all also taken into consideration.

The known root zone morphology of the Tree's given species was also taken into consideration when allocating the recommended TPZ for each of the identified Trees. Note: Whilst some reference and acknowledgment is given to the guidelines set down in AS 4970, the TPZ for each Tree has been based on the known typical root zone morphology for specimens of their species, the condition of the given Tree, and the known tolerance to root zone disturbance of the given species.

The Trees were also assessed using the principles of SULE; "Safe-Useful-Life-Expectancy"[1].

SULE is a system that can be used to provide an indication of the length of time an individual tree can be retained with an acceptable level of risk based on the information available at the time of inspection.

It is a snapshot in time of the potential an individual tree has for survival in the eyes of the assessor based on the tree's current health and structural condition, and the known typical life span of specimens of its given species for the given area/situation.

There are many factors that can affect SULE of a tree, and as such, at best the SULE for any given tree can only be estimated within a 'range' of years, with the following ranges typically used; Long Term (>40 years), Medium Term (15-40 years), Short Term (5-15 years), and Limited (<5yrs).

[1] SULE: Its use and status into the new millennium; J Barrell; 2001

5. Summary of Key Findings of the Assessment

5.1 No of Trees Included in the Assessment

169 Trees were identified and included in the assessment.

5.2 Species Identified

Species identified included Tuart (*Eucalyptus gomphocephala*), Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata*), and Blackbutt (*Eucalyptus patens*).

5.3 Health Condition

The majority of the Trees showed to be in good health at this time.

Marri Canker (*Quambalaria coyrecup*) was noted in many of the Marri specimens and looks to be having varying impact to their health. Some show severe decline as a result of the Canker whereas others show no signs of any impact to their health at this time.

Note: Observations have shown that trees with Canker can become more susceptible to its presence when they are subject to other stresses. This factor needs to be considered when considering design of any development around the Trees so to limit disturbances to the root zone of Trees with Canker as any loss of root mass during a development process could increase the potential for the Canker to adversely affect the health of the Tree.

There was no visible evidence of any other pest or disease pathogen that could have a major impact to the health of the Trees at the time of the assessment.

Five dead Trees were identified along with one near dead Tree. Four other Trees were considered to be in a poor health condition and look to have limited life span remaining.

5.4 Structural Condition

The majority of the Trees show to have what is considered to be good structural form with no major noticeable issues or concerns visible at this time.

Three Trees were however considered to have hazardous structural form (where failure looks highly likely to occur in the near future) due to areas of cavity and/or decay.

A further seven were considered to have a poor structural form (mostly due to main stem failures).

A further 21 Trees were considered to have 'questionable' structural form/condition that look likely to cause future issues longer-term; particularly if adjacent Trees are removed during the development process (thus increasing exposure to wind forces that they may currently be protected from which would increase the potential for failures).

5.5 Area overview

The following pages provide further general comments on the Trees in various areas identified during the assessment.

5. Summary of Key Findings of the Assessment

Client;	Coterra Environment
Site;	*Lot 61 & 1001 Kilburn Road, Parkerville*
Drawn by;	J Royal
Revision;	0
Date;	31/01/2020
Arial Source;	Nearmap.com
Scale;	1:4,000

ARBOR logic
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5. Summary of Key Findings of the Assessment

Area 1; Trees #25 - #30, #62 - #85

Large densely treed area. All Marri (*Corymbia calophylla*). Most show good health/structural form.

A number look to be on the other side of the Site boundary based on the Plan provided.

There are also a larger number of Trees in this area than shown on the Plan provided and included in this survey; possibly as many as another 30-40 trees of notable size (although some may be over the Site boundary line).

Overall a good area of mature Trees.

Worth retaining as a group in an area of public open space, rather than individuals as thinning the area out may cause issues with the remaining Trees due to impact of sudden exposure to wind forces as well as impact from disturbances to their root zone.

The physical size of some of the Trees in this area may also become a cause of issue if located within or adjacent to a residential Lot situation; particularly some of the Trees towards the western end and on the northern side of the group.

Area 2; Trees #31 - #40

Small densely treed area.

All Marri (*Corymbia calophylla*).

Most show good health/structural form. A few Trees in this area are slightly one-sided due to powerline clearance pruning.

Larger number of Trees in this area than shown on the Plan provided and included in this survey; mostly smaller trees but some may still be worthy of retention as part of a development process.

5. Summary of Key Findings of the Assessment

Area 3; Trees #118 - #141

Large densely treed area. All Marri (*Corymbia calophylla*). Most show good health/structural form although there are dead and declining Trees in this area; notably one very large very old Tree on the southern side (seen in the image left).

There are also a larger number of Trees in this area than shown on the Plan provided and included in this survey; possibly as many as another 10-20 trees of notable size /age that would be worth retaining as part of a development process.

Overall a good area of Trees. Worth retaining as a group in an area of public open space, rather than individuals as thinning the area out may cause issues with the remaining Trees due to impact of sudden exposure to wind forces as well as impact from disturbances to their root zone.

The physical size of some of the Trees in this area may also become a cause of issue if located within or adjacent to a residential Lot situation.

Area 4; Trees #94 - #99

Small group of Trees. Mostly Marri (*Corymbia calophylla*), with one Jarrah (*Eucalyptus marginata*).

Most show good health/structural form although the Jarrah specimen is sparse and possibly in decline.

Worth retaining as a group and in a POS situation rather than as individual Trees; particularly given their physical size as that is considered likely to cause issues if located in or adjacent to a residential Lot situation.

5. Summary of Key Findings of the Assessment

Area 5; Trees #103 - #110

Small densely treed area. All Marri (*Corymbia calophylla*). Most show good health/structural form although the form of some has been influenced by the proximity of others.

Overall a good area of Trees. Worth retaining as a group and in an area of public open space, rather than individuals as thinning the area out may cause issues with the remaining Trees due to impact of sudden exposure to wind forces as well as impact from disturbances to their root zone.

Area 6; Trees #146 - #169

Large group of Trees.

Mostly Marri (*Corymbia calophylla*), with one Jarrah (*Eucalyptus marginata*).

Most show good health/structural form although the Jarrah specimen is sparse and possibly in decline and the structural form of some of the other Trees has been influenced by the proximity of others.

Worth retaining as a group and in a POS situation rather than as individual Trees; particularly given their physical size as that may cause issues if located in or adjacent to a residential Lot. Thinning the group out may also cause issues with some of the remaining Trees due to their structural form.

There are also a small number of additional trees in this area (that were excluded from the survey due to their size) that would be suitable for inclusion into an urban development.

5. Summary of Key Findings of the Assessment

Area 7; Trees #18 - #24

Small group of Trees

All Marri (*Corymbia calophylla*). Most show good health/structural form although the form of some has been influenced by the proximity of others.

Overall a good area of Trees. Worth retaining as a group and in an area of public open space, rather than individuals as thinning the area out may cause issues with the remaining Trees due to impact of sudden exposure to wind forces as well as impact from disturbances to their root zone.

Area 8; Trees #53 - #62

Row of Trees. Mostly Blackbutt (*Eucalyptus patens*), with one Jarrah (*Eucalyptus marginata*) and one Tuart (*Eucalyptus gomphocephala*).

Most show good health/structural form although the structural form of most of the Trees in this area has clearly been influenced by the proximity of others causing them to develop a 'leggy' canopy form/habit with relatively poor stem taper and high bending motion in winds.

Worth retaining as a group and in a POS situation rather than as individual Trees; particularly as thinning the group out may also cause issues with some of the remaining Trees due to their structural form.

There are also a large number of other trees in this area (varying species) that may also be suitable for retention as part of a development process.

Area 9; Trees #2 - #17

Dense area of Trees. Mostly Tuart (*Eucalyptus gomphocephala*) and Marri (*Corymbia calophylla*).

Most show good health/structural form although the structural form of most of the Trees in this area has been influenced by the proximity of others causing them to develop a 'leggy' canopy form/habit with relatively poor stem taper and high bending motion in winds.

Worth retaining as a group and in a POS situation rather than as individual Trees; particularly as thinning the group out may also cause issues with some of the remaining Trees due to their structural form.

There are also a large number of other trees in this area (varying species) that may also be suitable for retention as part of a development process.

5. Summary of Key Findings of the Assessment

5.6 Suitability for Retention as part of a Development

Retention value of the various tree species found on this Site and even individual tree specimens will always be open to some personal opinion. In general the Trees displaying good health and deemed to have a good aesthetic quality will be generally considered to have a high retention value. Conversely, dead or declining trees, or tree species known (or considered) to be problematic in terms of having a propensity for branch failures, or ones that could self-seed freely, or one that display low aesthetic traits would typically be considered to have a low retention value.

Whilst all of these trees may have high environmental benefits as part of ascertaining the suitability for inclusion into a development other aspects of the tree must be considered; primarily its structural form and suitability for inclusion into an urbanised area with high volumes of potential targets (such as people, structures etc.), and its potential to cope with changes to its soil and surrounding environment that typically occur as part of a development process; even if it is only to be landscape works.

Some of the physically larger specimens on this Site would also be better suited to an area of public open space where potential issues with their physical size (such as potential 'psychological' hazards that large trees can sometimes present to people residing in their vicinity) and any risks associated with the given Tree can be better managed by way of physical distance from buildings and structures.

Based on this, the Trees were further 'categorised' with a retention value to aid in the design and decisions process.

Of the 169 Trees identified during this survey;

- 1 Tree was considered to have a high retention value; being a very good, large, old specimen of its given species (Jarrah).
- 94 were considered to be good specimens and suitable for retention in the context of an urban development.
- 18 would be better suited to an area of POS; either due to their size and/or their structural condition so that potential issues with them can be better managed by way minimising the introduction of 'targets' (people, structures) into their fall zone by way of good design.
- The retention of 19 would be considered questionable *if* the adjacent Trees were removed (due to concerns of potential impact from sudden increased exposure to wind forces onto their structure)
- 18 were considered to have 'questionable' retention value (mostly due to their structural form and risks of failure). Such Trees may be able to be retained within area of open space depending on the design of the area around them.
- 7 were considered to have a low retention value due to their size/stature and or health/structure issues. And;
- 10 were NOT considered suitable for inclusion into an urban development; all dead and/or snapped Trees.

This retention opinion has been represented on the aerial overleaf and should be considered as part of the design process to ensure that future management and risk issues associated with these Trees can be effectively managed once the area has been developed and is in use as a car park.

5. Summary of Key Findings of the Assessment

6. Table of the Findings of the Assessment

The following pages provides further information on each of the Trees identified during the survey.

Explanation of Fields of Information in the Table

Tree No. Provides an identification number for the identified Tree

Species Provides the botanical and most commonly used species name of the Tree.

Estimated Height Provides an estimated height (in metres).

Estimated Trunk Calliper (DBH) Provides an estimated trunk calliper of the Tree (in mm, and generally measured at 1.4 metres ("DBH") above ground level as per the industry standard). Should lower canopy formation start below 1.4 metres above ground level, the DBH is estimated at the point below the furcation of its main stem.

In instances where the tree has multiple main stem structures, the DBH of all has been provided.

Estimated Canopy Spread Provides an estimated spread of the Tree's canopy; provided in metres diameter. Both north-south and east – west canopy dimensions have been provided.

Health Condition Provides a view of the Tree's health/vigour condition at the time of inspection based on a number of predetermined criteria.

Health Rating	Explanation
Excellent	Shows to have typical foliage condition and amount of foliage mass for a specimen of the species. May have a minor amount of deadwood, but no signs of any pest or disease factor that may affect its health.
Good	Shows to have typical foliage condition. Canopy foliage may be slightly chlorotic, or it may have a slightly higher percentage of deadwood than usual, or exhibit signs of being affected by environmental conditions. May have a minor pest or disease present that could start to affect its health.
Fair	Shows to have a relatively high percentage of deadwood than considered typical for a specimen of the given species and/or a low volume of live canopy leaf mass for a specimen of the given species. Apical sections of the canopy (may also be) dead. Signs of a pest or disease factor evident.
Poor	Canopy mass and foliage condition shows to be in a poor state for a specimen of the species. Has a high percentage of deadwood material in its canopy and a low volume of live canopy mass (typically <20%).
Dead	Shows to have either no live tissue within its structure, or at best has <5% live foliage mass remaining in its canopy.

6. Table of the Findings of the Assessment

Structural Form

Provides a view of the Tree's structural form at the time of inspection based on a number of predetermined criteria.

Structure Rating	Explanation
Good	Shows typical structural form for a specimen of the species. Branch unions show typical form at the point of attachment. May have a small number of minor structural defects; but are within the scope of tree surgery management to rectify. Looks to be root-stable.
Acceptable	Shows an acceptable form, but may have a number of structural defects present i.e. bi-furcation (but with no major swelling or movement), or areas of stem cavities, but structure remains within the scope of management at this stage; albeit with a higher risk/management requirement. Can include previously lopped trees that are known to have good points of attachment of any regrowth that occurs.
Questionable	Shows evidence of structural defects that may be starting to adversely impact the given tree's structural integrity. Generally includes trees with large areas of cavity and/or associated decay that may be starting to affect its structural integrity, trees with bi-furcated unions with notable included bark and swelling that are considered to have an increased potential to fail.
Undesirable	Shows an undesirable structure for a specimen of the species. Structural condition looks likely to cause future issues in regards to the potential for branch or even complete tree failure to occur. Generally applies to smaller trees whose structure looks likely to be a cause of issues longer-term.
Poor	Major structural defects evident. May have very large stem cavities, extensive termite damage, or noticeable movement in main stem, branch unions or root plate area.
Hazardous	Major structural defects evident and looks likely to be subject to failure in the near future.

Age Class

Provides the age class of the given Tree.

Juvenile	<5% of the Tree's anticipated life span
Semi-mature	10-20% of the Tree's anticipated life span
Early-mature	20-40% of the Tree's anticipated life span
Mature	>40% of the Tree's anticipated life span

SULE

Provides an opinion of the 'safe-useful-life-expectancy' of the given Tree (range in years)

Long Term (>40 years),
Medium Term (15-40 years),
Short Term (5-15 years),
Limited (<5yrs).

6. Table of the Findings of the Assessment

Comment Provides any additional information (seen as relevant in the context of this report) to the Tree.

Comments are (generally) self-explanatory.

TPZ Meaning the Tree's nominal tree protection zone; the area where the majority of the given Tree's root mass is considered likely to be found. **This dimension is given as a metres RADIUS of the given Tree's main stem, and any works required in this zone are considered likely to have some potential to impact the Tree.**

Opinion Provides an overall 'opinion' on the quality of the Tree and its suitability for retention as part of the development.

Category	Definition
High Retention Value	meaning a very good specimen of its given species and one that would be seen as having a high amenity value and highly suitable for inclusion into an urban development
Suitable	meaning a good/reasonably good specimen of its given species and one that would be seen as being suitable for inclusion into an urban development and an asset to the landscape
Better suited to a POS	meaning the structural form or physical size of the Tree suggests that it would be better suited to an area of public open space where any risks or issues that it may represent can be better managed due to a reduced volume of potential targets within its fall zone area
Question retention if the adjacent tree was removed	meaning trees that have developed a structural condition/form that looks to be partly reliant on the other surrounding Trees to help maintain its structural integrity. Removal of surrounding Trees looks likely to increase the risks for failure to occur
Questionable retention	meaning Trees that look to have structural and/or health issues that look likely to cause future issues in terms of risks, or require (potentially disproportionate) management requirements if retained and included into an urbanised area. Such Trees may be able to be retained within area of open space depending on the design of the area around them
Low retention value	meaning a tree that is highly likely be problematic if retained into an urbanised area, or may have limited life span remaining and is unlikely to survive the development process regardless of any protection measures implemented
Not suitable	generally a dead and/or a snapped tree that would be recommended to be removed during the development process. Such trees may have environmental benefits but generally provide little value in terms of amenity

Canopy Works provides an indication of any canopy works that may be required in view of risk or other management requirements.

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
1	Jarrah (Eucalyptus marginata)	17	101	11--12	11--12	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Reasonably good specimen. Area of decay. Possibly starting to impact its structural integrity. Canopy is one-sided east	12.1	Better suited to POS due to form	Remove larger/moderate diameter sized deadwood, Raise canopy
2	Tuart (Eucalyptus gomphocephala)	26	70	5--6	8--9	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy	8.4	Better to retain as a group and more suited to POS	
3	Tuart (Eucalyptus gomphocephala)	26	80	7--8	9--10	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Included bark at the union. Union looks to be ok at this time but may cause future issues	9.6	Better to retain as a group and more suited to POS	Remove larger/moderate diameter sized deadwood, Raise canopy
4	Tuart (Eucalyptus gomphocephala)	26	58	5--6	7--8	Excellent	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy	7.0	Better to retain as a group and more suited to POS	
5	Tuart (Eucalyptus gomphocephala)	26	59	5--6	7--8	Excellent	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy	7.1	Better to retain as a group and more suited to POS	
6	Tuart (Eucalyptus gomphocephala)	26	68	5--6	7--8	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy. Co-dominant leader. Union looks to be ok at this time but may cause future issues	8.2	Better to retain as a group and more suited to POS	Ok to remove the co-dominant leader if desired
7	Tuart (Eucalyptus gomphocephala)	22	101	9--10	11--12	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy. Main stem furcates into three. Union looks to be ok	12.1	Better to retain as a group and more suited to POS	
8	Marri (Corymbia calophylla)	17	63	9--10	12--13	Excellent	Undesirable	Mature	Medium term (15-40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is one-sided west due to proximity of the adjacent tree. Marri Canker noted. Looks to be minimal impact at this time	7.6	Question retention if the adjacent tree was removed	

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
9	Tuart (Eucalyptus gomphocephala)	23	58	8--9	8--9	Excellent	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy	7.0	Better to retain as a group and more suited to POS	
10	Tuart (Eucalyptus gomphocephala)	21	53	6--7	8--9	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is one-sided north due to proximity of the adjacent tree. Grown on a lean but not considered an issue at this time	6.4	Question retention if the adjacent tree was removed	
11	Tuart (Eucalyptus gomphocephala)	21	51	6--7	8--9	Excellent	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is relatively one-sided north due to proximity of the adjacent tree	6.1	Better to retain as a group and more suited to POS	Ok to remove lowest 2 lateral branches if desired
12	Marri (Corymbia calophylla)	16	53	3--4	6--7	Poor	Acceptable	Mature	Short-term (5-15 yrs)	Canopy condition suggests possibly limited life remaining. Marri Canker noted. Major impact to health	6.4	Low retention value	
13	Marri (Corymbia calophylla)	16	66	6--7	9--10	Fair	Acceptable	Mature	Medium term (15-40 yrs)	Marri Canker noted. Looks to be some impact to its health. Ok tree. Section of its canopy is dead. Remainder ok	7.9	Questionable retention	Remove larger/moderate diameter sized deadwood
14	Tuart (Eucalyptus gomphocephala)	21	53	5--6	6--7	Excellent	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. No issues or concerns visible at this time. Part of a group of trees in close proximity that effectively form the one canopy	6.4	Better to retain as a group and more suited to POS	
15	Tuart (Eucalyptus gomphocephala)	22	57	5--6	5--6	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Reasonably good specimen. No issues or concerns visible at this time. Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form. Canopy is relatively one-sided north due to proximity of the adjacent tree	6.8	Better to retain as a group and more suited to POS	
16	Tuart (Eucalyptus gomphocephala)	22	54	6--7	6--7	Excellent	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. No issues or concerns visible at this time. Part of a group of trees in close proximity that effectively form the one canopy	6.5	Better to retain as a group and more suited to POS	Remove crossing/rubbing branch

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
17	Marri (Corymbia calophylla)	20	115	10--11	10--11	Good	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Area of decay. Possibly starting to impact its structural integrity. Marri Canker noted. Looks to be minimal impact at this time	13.8	Better suited to POS	Remove larger/moderate diameter sized deadwood.
18	Marri (Corymbia calophylla)	23	101	9--10	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	12.1	Suitable	Remove larger/moderate diameter sized deadwood
19	Marri (Corymbia calophylla)	23	67	9--10	11--12	Excellent	Poor	Mature	Short-term (5-15 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly (probably) impacting structural integrity	8.0	Questionable retention	Suggest remove to ground level, Structure looks likely to cause issues longer term
20	Marri (Corymbia calophylla)	20	57	8--9	7--8	Good	Acceptable	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Canopy is relatively one-sided north due to proximity of the adjacent tree. Reasonably good specimen	6.8	Question retention if the adjacent tree was removed	
21	Marri (Corymbia calophylla)	21	98	10--11	15-16	Good	Questionable	Mature	Short-term (5-15 yrs)	Large mature specimen. Area of decay. Possibly impacting structural integrity. Leaning slightly north	11.8	Questionable retention	Remove larger/moderate diameter sized deadwood
22	Marri (Corymbia calophylla)	23	92	11--12	11--12	Good	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Canopy is one-sided west	11.0	Suitable	Remove larger/moderate diameter sized deadwood
23	Marri (Corymbia calophylla)	24	83	11--12	16-17	Good	Questionable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Reasonably good specimen. Bees suggest presence of an area of cavity. Area of decay & cavity noted in parts of its main stem structure	10.0	Questionable retention	Remove larger/moderate diameter sized deadwood
24	Marri (Corymbia calophylla)	18	83	8--9	8--9	Excellent	Good	Mature	Long term (>40 yrs)	Good specimen. Good aesthetic form/value	10.0	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
25	Marri (Corymbia calophylla)	22	76	11--12	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	9.1	Suitable	Remove larger/moderate diameter sized deadwood
26	Marri (Corymbia calophylla)	22	67	9--10	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	8.0	Suitable	Raise canopy, Remove larger/moderate diameter sized deadwood
27	Marri (Corymbia calophylla)	22	68	9--10	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	8.2	Suitable	Remove larger/moderate diameter sized deadwood
28	Marri (Corymbia calophylla)	22	65	9--10	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	7.8	Suitable	Remove larger/moderate diameter sized deadwood, Raise canopy
29	Marri (Corymbia calophylla)	15	64	7--8	9--10	Good	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Reasonably good specimen. Canopy slightly sparse. Remaining leaf still good condition. Marri Canker noted. Looks to be minimal impact at this time	7.7	Suitable	Remove larger/moderate diameter sized deadwood
30	Marri (Corymbia calophylla)	7	57	8--9	10--11	Excellent	Poor	Mature	Short-term (5-15 yrs)	Main stem has previously snapped	6.8	Low retention value	Suggest remove to ground level
31	Marri (Corymbia calophylla)	18	63	10--11	11--12	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Canopy is one-sided west due to proximity of the adjacent tree. Ok tree	7.6	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
32	Marri (Corymbia calophylla)	21	57	7--8	7--8	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is relatively one-sided north due to proximity of the adjacent tree	6.8	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
33	Marri (Corymbia calophylla)	24	73	7--8	7--8	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Union looks to be Ok at this stage	8.8	Suitable	Remove larger/moderate diameter sized deadwood
34	Marri (Corymbia calophylla)	24	83	9--10	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Union looks to be Ok at this stage	10.0	Suitable	Remove larger/moderate diameter sized deadwood
35	Marri (Corymbia calophylla)	18	72	7--8	7--8	Good	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	8.6	Suitable	Remove larger/moderate diameter sized deadwood
36	Jarrah (Eucalyptus marginata)	18	62, 60	7--8	7--8	Fair	Good	Mature	Long term (>40 yrs)	Two trees in close proximity and effectively form the one canopy. One tree is dead. The other ok but sparse	7.4	Questionable retention	Suggest remove the dead tree
37	Marri (Corymbia calophylla)	24	75	7--8	7--8	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	9.0	Suitable	Remove larger/moderate diameter sized deadwood
38	Marri (Corymbia calophylla)	18	85	11--12	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Main stem bi-furcates. Union looks to be Ok at this stage. Part of a group of trees in close proximity that effectively form the one canopy. Evidence of previous branch failure (100-200mm diameter)	10.2	Suitable	Remove larger/moderate diameter sized deadwood
39	Marri (Corymbia calophylla)	24	79, 65	11--12	11--12	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Multi-stemmed from ground level possibly more than one tree. Area of decay. Possibly starting to impact its structural integrity	9.5	Questionable retention	Remove larger/moderate diameter sized deadwood
40	Marri (Corymbia calophylla)	15	78, 55, 47	12--13	11--12	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Main stem furcates into three. Union looks to be ok	9.4	Suitable	Raise canopy, Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
41	Marri (Corymbia calophylla)	19	114	13-14	14-15	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Union looks to be ok. Main stem furcates into three	13.7	Suitable	Remove larger/moderate diameter sized deadwood
42	Marri (Corymbia calophylla)	26	85	11--12	11--12	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Section of its canopy is dead. Remainder ok. Main stem bi-furcates. Union looks to be Ok at this stage. Canopy is relatively one sided due to powerline clearance pruning	10.2	Questionable retention	Remove larger/moderate diameter sized deadwood
43	Marri (Corymbia calophylla)	18	57	11--12	11--12	Good	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Section of its canopy is dead. Remainder ok. Canopy is relatively one sided due to powerline clearance pruning	6.8	Questionable retention	Remove larger/moderate diameter sized deadwood
44	Jarrah (Eucalyptus marginata)	12	79	5--6	5--6	Excellent	Good	Mature	Medium term (15-40 yrs)	Looks to be regrowth around an original dead tree	9.5	Questionable retention	Remove dead sections
45	Marri (Corymbia calophylla)	18	84	11--12	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Main stem bi-furcates. Union looks to be Ok at this stage. Minor amount of moderate and larger diameter deadwood present in its canopy	10.1	Suitable	Remove larger/moderate diameter sized deadwood
46	Marri (Corymbia calophylla)	22	108	11--12	9--10	Excellent	Poor	Mature	Short-term (5-15 yrs)	Area of decay. Possibly starting to impact its structural integrity. Canopy is one-sided north. Second main stem has previously snapped	13.0	Questionable retention	Remove larger/moderate diameter sized deadwood
47	Marri (Corymbia calophylla)	22	98	15-16	11--12	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	ok tree. Area of decay. Not of a major concern at this time. Good aesthetic form/value	11.8	Suitable	Remove larger/moderate diameter sized deadwood
48	Marri (Corymbia calophylla)	15	97	12--13	11--12	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Ok tree. Part of a group of trees in close proximity that effectively form the one canopy. Top of main leader has snapped (storm damage). Marri Canker noted. Looks to be some impact to its health. Structure looks to be ok at this time but equally looks likely to cause issues in foreseeable future	11.6	Questionable retention	Remove larger/moderate diameter sized deadwood, Raise canopy

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
49	Marri (Corymbia calophylla)	25	72	15-16	11--12	Excellent	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Good aesthetic form/value. Part of a group of trees in close proximity that effectively form the one canopy	8.6	Suitable	Remove larger/moderate diameter sized deadwood
50	Marri (Corymbia calophylla)	25	69, 61	13-14	11--12	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Good aesthetic form/value. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Union looks to be Ok at this stage	8.3	Suitable	Remove larger/moderate diameter sized deadwood
51	Marri (Corymbia calophylla)	22	76	9--10	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Good aesthetic form/value. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Union looks to be Ok at this stage	9.1	Suitable	Remove larger/moderate diameter sized deadwood
52	Marri (Corymbia calophylla)	18	71, 49	11--12	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Good aesthetic form/value. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Union looks to be Ok at this stage	8.5	Suitable	Raise canopy, Remove larger/moderate diameter sized deadwood
53	Blackbutt (Eucalyptus patens)	18	62	7--8	7--8	Good	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition.	7.4	Suitable	
54	Tuart (Eucalyptus gomphocephala)	25	53	7--8	7--8	Excellent	Acceptable	Early-mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form. Main stem bi-furcates. Included bark at the union. Ok tree. Union looks to be ok at this time but may cause future issues	6.4	Question retention if the adjacent tree was removed	
55	Blackbutt (Eucalyptus patens)	17	65	7--8	7--8	Good	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition. Main stem bi-furcates. Union looks to be ok	7.8	Suitable	
56	Blackbutt (Eucalyptus patens)	12	38, 38	5--6	5--6	Good	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition. Main stem bi-furcates. Included bark at the union	4.6	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
57	Blackbutt (Eucalyptus patens)	17	48, 34	7--8	5--6	Good	Good	Early-mature	Long term (>40 yrs)	Ok tree. Co-dominant leader. Union looks to be ok. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition.	5.8	Suitable	
58	Blackbutt (Eucalyptus patens)	17	55, 43, 37	8--9	6--7	Good	Good	Early-mature	Long term (>40 yrs)	Ok tree. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition. Union looks to be ok. Main stem bi-furcates. Union looks to be Ok at this stage. Canopy is one-sided north due to proximity of the adjacent tree	6.6	Suitable	Remove larger/moderate diameter sized deadwood
59	Blackbutt (Eucalyptus patens)	19	59	8--9	6--7	Good	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition. Broken branch in canopy. Canopy is one-sided north due to proximity of the adjacent tree	7.1	Suitable	Remove broken branch
60	Jarrah (Eucalyptus marginata)	20	60	8--9	7--8	Good	Good	Early-mature	Long term (>40 yrs)	Reasonably good specimen. Evidence of a history of (various sized) branch failures (storm damage). Part of a group of trees in close proximity that effectively form the one canopy. Union looks to be ok. Canopy is relatively one-sided north due to proximity of the adjacent tree.	7.2	Suitable	Remove the remains of the broken branch
61	Blackbutt (Eucalyptus patens)	24	65	7--8	5--6	Good	Acceptable	Early-mature	Long term (>40 yrs)	Ok tree. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is one-sided north due to proximity of the adjacent tree. Leggy canopy form. Main stem bi-furcates. Included bark at the union. Union looks to be ok at this time but may cause future issues	7.8	Suitable	
62	Blackbutt (Eucalyptus patens)	20	56	7--8	5--6	Fair	Acceptable	Early-mature	Short-term (5-15 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Canopy is one-sided north due to proximity of the adjacent tree. Canopy is fairly sparse. Remaining leaf still good condition. Ok tree	6.7	Question retention if the adjacent tree was removed	
63	Marri (Corymbia calophylla)	24	99	16-17	13-14	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Canopy is one-sided west due to proximity of the adjacent tree. Main stem bi-furcates. Union looks to be Ok at this stage. Part of a group of trees in close proximity that effectively form the one canopy.	11.9	Suitable	Remove larger/moderate diameter sized deadwood. ,Raise canopy
64	Marri (Corymbia calophylla)	22	76	14-15	13-14	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy.	9.1	Suitable	Remove larger/moderate diameter sized deadwood, Raise canopy

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
65	Marri (Corymbia calophylla)	25	103	14-15	11--12	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Main stem bi-furcates. Included bark at the union. Union looks to be ok at this time but may cause future issues. Part of a group of trees in close proximity that effectively form the one canopy.	12.4	Suitable	Remove larger/moderate diameter sized deadwood
66	Marri (Corymbia calophylla)	25	60	4--5	3--4	Excellent	Acceptable	Mature	Long term (>40 yrs)	Reasonably good specimen. Leggy canopy form. Part of a group of trees in close proximity that effectively form the one canopy.	7.2	Suitable	
67	Marri (Corymbia calophylla)	20	75	6--7	6--7	Excellent	Undesirable	Mature	Long term (>40 yrs)	Ok specimen. Main stem bi-furcates. Included bark at the union. Union looks to be ok at this time but may cause future issues. Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form.	9.0	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
68	Marri (Corymbia calophylla)	22	47	6--7	6--7	Excellent	Acceptable	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form. Reasonably good specimen	5.6	Suitable	Remove larger/moderate diameter sized deadwood
69	Marri (Corymbia calophylla)	22	47	7--8	6--7	Excellent	Acceptable	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form. Reasonably good specimen	5.6	Suitable	Remove larger/moderate diameter sized deadwood
70	Marri (Corymbia calophylla)	10	43	7--8	11--12	Excellent	Questionable	Mature	Short-term (5-15 yrs)	Canopy is one-sided due to proximity of the adjacent tree. Leaning. Part of a group of trees in close proximity that effectively form the one canopy. Structure looks to be ok at this time but equally looks likely to cause issues in foreseeable future	5.2	Questionable retention	Suggest remove to ground level
71	Marri (Corymbia calophylla)	18	56	8--9	8--9	Excellent	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Effectively forms the one canopy with the adjacent Tree. Good specimen	6.7	Suitable	Remove larger/moderate diameter sized deadwood
72	Marri (Corymbia calophylla)	18	46	8--9	8--9	Excellent	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Effectively forms the one canopy with the adjacent Tree. Good specimen	5.5	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
73	Marri (Corymbia calophylla)	25	56, 34	8--9	13-14	Good	Good	Mature	Medium term (15-40 yrs)	Canopy slightly sparse. Remaining leaf still good condition. Large mature specimen. Multi-stemmed from near ground level. Part of a group of trees in close proximity that effectively form the one canopy	6.7	Suitable	Remove larger/moderate diameter sized deadwood
74	Marri (Corymbia calophylla)	25	48	8--9	8--9	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form	5.8	Suitable	Remove larger/moderate diameter sized deadwood
75	Marri (Corymbia calophylla)	25	49, 42, 26	8--9	8--9	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form. Multi-stemmed from near ground level	5.9	Suitable	Remove larger/moderate diameter sized deadwood
76	Marri (Corymbia calophylla)	25	81	13-14	10--11	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Effectively forms the one canopy with the adjacent Tree. Canopy is one-sided due to proximity of the adjacent tree	9.7	Suitable	Raise canopy, Remove larger/moderate diameter sized deadwood
77	Marri (Corymbia calophylla)	25	45	7--8	7--8	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form. Effectively forms the one canopy with the adjacent Tree	5.4	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
78	Marri (Corymbia calophylla)	25	55	7--8	11--12	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Leggy canopy form	6.6	Suitable	Remove larger/moderate diameter sized deadwood
79	Marri (Corymbia calophylla)	28	60	10--11	8--9	Excellent	Acceptable	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Main stem bi-furcates. Swelling at the union. Union looks to be ok at this time but may cause future issues	7.2	Suitable	Remove larger/moderate diameter sized deadwood
80	Marri (Corymbia calophylla)	21	65	11--12	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is relatively one-sided north due to proximity of the adjacent tree	7.8	Suitable	Raise canopy, Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
81	Marri (Corymbia calophylla)	24	54	8--9	8--9	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	6.5	Suitable	
82	Marri (Corymbia calophylla)	24	90	8--9	11--12	Excellent	Poor	Mature	Short-term (5-15 yrs)	Canopy is one-sided north. Large mature specimen. Leaning. Area of decay and cracking in lower main stem. Part of a group of trees in close proximity that effectively form the one canopy	10.8	Not suitable	Suggest remove to ground level
83	Marri (Corymbia calophylla)	23	67	15-16	11--12	Good	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Not of a major concern at this time. Large mature specimen. Main stem bi-furcates. Union looks to be Ok at this stage	8.0	Suitable	Remove larger/moderate diameter sized deadwood
84	Marri (Corymbia calophylla)	22	67	8--9	11--12	Excellent	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Good specimen. Co-dominant leader	8.0	Suitable	Remove larger/moderate diameter sized deadwood
85	Marri (Corymbia calophylla)	19	55	8--9	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Good specimen	6.6	Suitable	Remove larger/moderate diameter sized deadwood
86	Marri (Corymbia calophylla)	16	77	9--10	9--10	Poor	HAZARDOUS	Mature	n/a. Dead tree	Upper canopy is dead. Main stem has snapped	9.2	Not suitable	
87	Marri (Corymbia calophylla)	21	89	13-14	13-14	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Canopy slightly sparse. Remaining leaf still good condition	10.7	Questionable retention	Remove larger/moderate diameter sized deadwood
88	Marri (Corymbia calophylla)	22	59	8--9	11--12	Excellent	Questionable	Mature	Short-term (5-15 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly impacting structural integrity. Canopy is one-sided east. Was multi stemmed but one sided has failed	7.1	Questionable retention	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
89	Marri (Corymbia calophylla)	18	75	11--12	13-14	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Low spreading canopy. Main stem bi-furcates. Union looks to be Ok at this stage. Effectively forms the one canopy with the adjacent Tree. Canopy slightly sparse. Remaining leaf still good condition	9.0	Suitable	Remove larger/moderate diameter sized deadwood
90	Marri (Corymbia calophylla)	18	95	16-17	12--13	Excellent	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Low spreading canopy. Main stem bi-furcates. Union looks to be Ok at this stage. Effectively forms the one canopy with the adjacent Tree	11.4	Suitable	Remove larger/moderate diameter sized deadwood
91	Marri (Corymbia calophylla)	17	128	17-18	14-15	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Low spreading canopy. Main stem bi-furcates. Union looks to be Ok at this stage but some signs to suggest that the two stems may be starting to slowly separate	15.4	Suitable	Raise canopy, Remove larger/moderate diameter sized deadwood, Reduce weight loading
92	Marri (Corymbia calophylla)	28	109	9--10	8--9	Dead	Questionable	Mature	n/a. Dead tree	Dead tree	13.1	Not suitable	
93	Marri (Corymbia calophylla)	17	94	14-15	11--12	Good	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Canopy is one-sided north. Widespread canopy form. Area of decay. Possibly starting to impact its structural integrity	11.3	Questionable retention	Raise canopy, Remove larger/moderate diameter sized deadwood.
94	Marri (Corymbia calophylla)	25	100	11--12	9--10	Good	Questionable	Mature	Short-term (5-15 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly impacting structural integrity. Some root plate heave/mounding noted. Investigation required	12.0	Questionable retention	Remove larger/moderate diameter sized deadwood
95	Marri (Corymbia calophylla)	19	90	9--10	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	10.8	Suitable	
96	Marri (Corymbia calophylla)	32	119	11--12	13-14	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	14.3	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
97	Marri (Corymbia calophylla)	19	90	9--10	9--10	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	10.8	Suitable	Remove larger/moderate diameter sized deadwood
98	Jarrah (Eucalyptus marginata)	12	64	5--6	4--5	Poor	Acceptable	Mature	Short-term (5-15 yrs)	Main stem is dead. Minor amount of lower canopy regrowth	7.7	Low retention value	
99	Marri (Corymbia calophylla)	25	105	13-14	12--13	Good	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	12.6	Better suited to POS	Remove larger/moderate diameter sized deadwood
100	Marri (Corymbia calophylla)	3	77	12--13	14-15	Dead	Poor	Mature	n/a. Dead tree	Snapped	9.2	Not suitable	
101	Marri (Corymbia calophylla)	15	64	12--13	14-15	Good	Acceptable	Mature	Medium term (15-40 yrs)	Area of decay. Possibly starting to impact its structural integrity. Canopy is slightly sparse & suggests decline. Marri Canker noted. Looks to be some impact to its health. Reasonably good specimen	7.7	Suitable	Remove larger/moderate diameter sized deadwood
102	Marri (Corymbia calophylla)	17	87	7--8	7--8	Excellent	Questionable	Mature	Short-term (5-15 yrs)	Area of decay & cavity noted in the base of its main stem that is probably impacting its structural integrity	10.4	Low retention value	Remove larger/moderate diameter sized deadwood
103	Marri (Corymbia calophylla)	28	103	11--12	11--12	Poor	Acceptable	Mature	Short-term (5-15 yrs)	Large mature specimen. Apical sections of its canopy are dead/declining. Canopy condition suggests possibly limited life remaining. Marri Canker noted. Major impact to health	12.4	Questionable retention	Remove larger/moderate diameter sized deadwood
104	Marri (Corymbia calophylla)	25	73	10--11	10--11	Good	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Large mature specimen	8.8	Suitable	Remove larger/moderate diameter sized deadwood, Raise canopy

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
105	Marri (Corymbia calophylla)	13	90	11--12	11--12	Excellent	Questionable	Mature	Short-term (5-15 yrs)	Large mature specimen. Area of decay & cavity noted. Canopy is one-sided north. Part of a group of trees in close proximity that effectively form the one canopy. Widespread canopy form	10.8	Questionable retention	Remove larger/moderate diameter sized deadwood, Raise canopy
106	Marri (Corymbia calophylla)	24	119	12--13	12--13	Good	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Large mature specimen. Main stem furcates into four	14.3	Suitable	Remove larger/moderate diameter sized deadwood
107	Marri (Corymbia calophylla)	23	154	13-14	12--13	Good	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Large mature specimen. Main stem furcates into five. Termites but possibly just in the outer bark	18.5	Suitable	Remove larger/moderate diameter sized deadwood
108	Marri (Corymbia calophylla)	16	91	12--13	11--12	Fair	Good	Mature	Short-term (5-15 yrs)	Marri Canker noted. Looks to be some impact to its health. Part of a group of trees in close proximity that effectively form the one canopy. Canopy is fairly sparse. Remaining leaf still good condition. Some moderate and larger diameter deadwood in canopy	10.9	Suitable	Remove larger/moderate diameter sized deadwood
109	Marri (Corymbia calophylla)	16	52	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Marri Canker noted. Looks to be some impact to its health. Reasonably good specimen. Part of a group of trees in close proximity that effectively form the one canopy	6.2	Suitable	Remove larger/moderate diameter sized deadwood
110	Marri (Corymbia calophylla)	16	72	9--10	8--9	Good	Acceptable	Mature	Medium term (15-40 yrs)	Canopy is one-sided west due to proximity of the adjacent tree. Marri Canker noted. Looks to be some impact to its health	8.6	Suitable	Remove larger/moderate diameter sized deadwood
111	Marri (Corymbia calophylla)	16	74	9--10	8--9	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Canopy is one-sided west due to proximity of the adjacent tree. Evidence of previous branch failure (100-200mm diameter). Section of its canopy is dead. Remainder ok. Marri Canker noted. Looks to be minimal impact at this time	8.9	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
112	Marri (Corymbia calophylla)	20	63	6--7	6--7	Poor	Good	Mature	Limited (<5 yrs)	Apical sections of its canopy are dead/declining. Canopy condition suggests possibly limited life remaining	7.6	Low retention value	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
113	Marri (Corymbia calophylla)	16	64	9--10	7--8	Excellent	Good	Mature	Long term (>40 yrs)	Good specimen. Canopy is one-sided west due to proximity of the adjacent tree	7.7	Suitable	Remove larger/moderate diameter sized deadwood
114	Marri (Corymbia calophylla)	26	49	7--8	7--8	Good	Acceptable	Early-mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Reasonably good specimen. No issues or concerns visible at this time. Leggy canopy form	5.9	Suitable	
115	Marri (Corymbia calophylla)	20	77, 40	9--10	8--9	Good	Poor	Mature	Short-term (5-15 yrs)	Area of decay & cavity noted. One previous main stem has previously snapped	9.2	Not suitable	
116	Marri (Corymbia calophylla)	12	68	10--11	10--11	Excellent	Undesirable	Mature	Medium term (15-40 yrs)	Slightly leaning NW and some signs to suggest root plate heave/partial failure has occurred	8.2	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood, Raise canopy
117	Marri (Corymbia calophylla)	23	128	13-14	15-16	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. High aesthetic and amenity value. Slightly leaning NW and some signs to suggest root plate heave/partial failure has occurred	15.4	Better suited to POS due to size	Remove larger/moderate diameter sized deadwood
118	Marri (Corymbia calophylla)	19	68	9--10	8--9	Good	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Good specimen. No issues or concerns visible at this time. Some moderate and larger diameter deadwood in canopy	8.2	Suitable	Remove larger/moderate diameter sized deadwood
119	Marri (Corymbia calophylla)	21	71	9--10	8--9	Good	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Good specimen. No issues or concerns visible at this time	8.5	Suitable	Remove larger/moderate diameter sized deadwood
120	Jarrah (Eucalyptus marginata)	21	64	9--10	8--9	Good	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Good specimen. No issues or concerns visible at this time	7.7	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
121	Marri (Corymbia calophylla)	21	76	11--12	11--12	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Upper canopy slightly sparse but lower canopy still ok	9.1	Suitable	Remove larger/moderate diameter sized deadwood
122	Marri (Corymbia calophylla)	21	72	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Not of a major concern at this time	8.6	Suitable	Remove larger/moderate diameter sized deadwood
123	Marri (Corymbia calophylla)	35	149	15-16	18-20	Fair	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Canopy is one-sided west. Evidence of a history of branch failures. Canopy is relatively sparse. Section of its canopy is dead. Remainder ok at this time but suggests decline. Area of decay. Possibly starting to impact its structural integrity	17.9	Better suited to POS due to size and age	Remove larger/moderate diameter sized deadwood
124	Marri (Corymbia calophylla)	21	79	13-14	12--13	Excellent	Good	Mature	Long term (>40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Good specimen. No issues or concerns visible at this time. Some moderate and larger diameter deadwood in canopy	9.5	Suitable	Remove larger/moderate diameter sized deadwood, Raise canopy
125	Marri (Corymbia calophylla)	21	57	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	6.8	Suitable	Remove larger/moderate diameter sized deadwood
126	Marri (Corymbia calophylla)	21	60	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	7.2	Suitable	Remove larger/moderate diameter sized deadwood
127	Marri (Corymbia calophylla)	21	28	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	3.4	Suitable	Remove larger/moderate diameter sized deadwood
128	Marri (Corymbia calophylla)	21	58	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	7.0	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
129	Marri (Corymbia calophylla)	16	35	4--5	3--4	Near Dead	Questionable	Mature	Limited (<5 yrs)	Mostly dead tree	4.2	Not suitable	Suggest remove to ground level
130	Marri (Corymbia calophylla)	21	51	5--6	5--6	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	6.1	Suitable	Remove larger/moderate diameter sized deadwood
131	Marri (Corymbia calophylla)	18	76	9--10	7--8	Dead	Questionable	Mature	n/a. Dead tree	Dead tree	9.1	Not suitable	Remove to ground level
132	Marri (Corymbia calophylla)	21	77	9--10	7--8	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition. Effectively forms the one canopy with the adjacent Tree. Area of decay. Not of a major concern at this time	9.2	Suitable	Remove larger/moderate diameter sized deadwood
133	Marri (Corymbia calophylla)	21	61	9--10	7--8	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition. Effectively forms the one canopy with the adjacent Tree. Area of decay. Not of a major concern at this time	7.3	Suitable	Remove larger/moderate diameter sized deadwood
134	Marri (Corymbia calophylla)	21	47	6--7	5--6	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	5.6	Suitable	Remove larger/moderate diameter sized deadwood
135	Marri (Corymbia calophylla)	21	79, 51	12--13	11--12	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Multi-stemmed from ground level	9.5	Suitable	Remove larger/moderate diameter sized deadwood
136	Marri (Corymbia calophylla)	21	62	7--8	7--8	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Canopy slightly sparse. Remaining leaf still good condition	7.4	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
137	Marri (Corymbia calophylla)	17	67	7--8	7--8	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Marri Canker noted. Looks to be minimal impact at this time	8.0	Suitable	Remove larger/moderate diameter sized deadwood
138	Marri (Corymbia calophylla)	24	74	7--8	7--8	Fair	HAZARDOUS	Mature	Limited (<5 yrs)	Large mature specimen. Decay and cracking in lower main stem and looks to have a high probability for failure	8.9	Not suitable	Suggest remove to ground level
139	Marri (Corymbia calophylla)	24	75	7--8	7--8	Good	Questionable	Mature	Short-term (5-15 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly impacting structural integrity	9.0	Questionable retention	Remove larger/moderate diameter sized deadwood
140	Marri (Corymbia calophylla)	24	84	7--8	7--8	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy	10.1	Suitable	Remove larger/moderate diameter sized deadwood
141	Marri (Corymbia calophylla)	24	74	7--8	7--8	Good	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Not of a major concern at this time	8.9	Suitable	Remove larger/moderate diameter sized deadwood
142	Jarrah (Eucalyptus marginata)	28	177	18-20	15-16	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. High aesthetic and amenity value. Old tree. Canopy is relatively one sided West due to past pruning for powerline clearance	21.2	High Retention Value	Remove larger/moderate diameter sized deadwood
143	Jarrah (Eucalyptus marginata)	10	91	0	0	Dead	Acceptable	Mature	n/a. Dead tree	Dead tree. Cavity in base of its main stem	10.9	Low retention value	
144	Marri (Corymbia calophylla)	22	117	12--13	14-15	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Main stem bi-furcates. Union looks to be Ok at this stage. Marri Canker noted. Looks to be minimal impact at this time	14.0	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
145	Jarrah (Eucalyptus marginata)	20	102	8--9	8--9	Dead	Acceptable	Mature	n/a. Dead tree	Dead tree	12.2	Low retention value	
146	Marri (Corymbia calophylla)	30	153	11--12	11--12	Good	HAZARDOUS	Mature	Short-term (5-15 yrs)	Large mature specimen. Upper canopy slightly sparse but lower canopy still ok. Termites seen. Split in main stem. Likely to fail in foreseeable future	18.4	Not suitable	
147	Marri (Corymbia calophylla)	30	104	8--9	11--12	Fair	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Upper canopy slightly sparse but lower canopy still ok. Main stem bi-furcates. Union looks to be Ok at this stage. Section of its canopy is dead. Remainder ok. Area of decay. Possibly starting to impact its structural integrity. Marri Canker noted. Looks to be some impact to its health	12.5	Questionable retention	Remove larger/moderate diameter sized deadwood
148	Marri (Corymbia calophylla)	24	106	11--12	9--10	Good	Questionable	Mature	Medium term (15-40 yrs)	Large mature specimen. Area of decay. Possibly starting to impact its structural integrity. Canopy is one sided north. Marri Canker noted. Looks to be some impact to its health	12.7	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
149	Marri (Corymbia calophylla)	24	79	8--9	8--9	Good	Good	Mature	Medium term (15-40 yrs)	Large mature specimen. Canopy is one sided north. Marri Canker noted. Looks to be minimal impact at this time	9.5	Suitable	Remove larger/moderate diameter sized deadwood
150	Marri (Corymbia calophylla)	15	75	8--9	8--9	Good	Acceptable	Mature	Long term (>40 yrs)	Canopy is one-sided north due to proximity of the adjacent tree. Minor amount of moderate (5-10cm diameter) deadwood. Reasonably good specimen	9.0	Suitable	Remove larger/moderate diameter sized deadwood
151	Marri (Corymbia calophylla)	17	89	10--11	9--10	Good	Poor	Mature	Short-term (5-15 yrs)	Main stem has previously snapped. Areas of decay noticeable in parts of its main stem and canopy structure. Structure looks to be ok at this time but equally looks likely to cause issues in foreseeable future	10.7	Not suitable	
152	Jarrah (Eucalyptus marginata)	15	60	4--5	3--4	Fair	Acceptable	Mature	Medium term (15-40 yrs)	Canopy is relatively sparse. Main stem bi-furcates. Union looks to be Ok at this stage. Minor amount of moderate (5-10cm diameter) deadwood. Ok tree	7.2	Suitable	

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
153	Marri (Corymbia calophylla)	28	68	7--8	7--8	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Large mature specimen. Evidence of a history of branch failures. Part of a group of trees in close proximity that effectively form the one canopy	8.2	Suitable	Remove larger/moderate diameter sized deadwood
154	Marri (Corymbia calophylla)	19	56	7--8	7--8	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Reasonably good specimen. Broken branch in canopy. Section of its canopy is dead. Remainder ok. Canopy is relatively one-sided north due to proximity of the adjacent tree	6.7	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood. ,Remove broken branch
155	Marri (Corymbia calophylla)	26	98	14-15	12--13	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly impacting structural integrity. Evidence of a history of branch failures. Large mature specimen. Section of its canopy is dead. Remainder ok at this time but suggests decline	11.8	Better suited to POS	Remove larger/moderate diameter sized deadwood
156	Marri (Corymbia calophylla)	19	59	7--8	7--8	Excellent	Acceptable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Canopy is relatively one-sided north due to proximity of the adjacent tree. Area of decay. Second main stem looks to have previously snapped	7.1	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
157	Marri (Corymbia calophylla)	20	139	16-17	20-22	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. High aesthetic and amenity value. Marri Canker noted. Looks to be minimal impact at this time	16.7	Suitable	Remove larger/moderate diameter sized deadwood, Raise canopy
158	Marri (Corymbia calophylla)	15	100	14-15	11--12	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Area of decay. Possibly starting to impact its structural integrity. Canopy is one-sided north. Signs to suggest root plate heave/partial failure has occurred	12.0	Question retention if the adjacent tree was removed	Raise canopy, Remove larger/moderate diameter sized deadwood.
159	Marri (Corymbia calophylla)	15	59	4--5	10--11	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly starting to impact its structural integrity. Evidence of a history of branch failures. Canopy is one-sided west due to proximity of the adjacent tree. Main stem has previously snapped	7.1	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
160	Marri (Corymbia calophylla)	25	99	11--12	18-20	Excellent	Good	Mature	Long term (>40 yrs)	Large mature specimen. Canopy is relatively one-sided west due to proximity of the adjacent tree. Part of a group of trees in close proximity that effectively form the one canopy	11.9	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
161	Marri (Corymbia calophylla)	30	84	9--10	16-17	Excellent	Questionable	Mature	Medium term (15-40 yrs)	Canopy is relatively one-sided west due to proximity of the adjacent tree. Large mature specimen. Part of a group of trees in close proximity that effectively form the one canopy. Area of decay. Possibly starting to impact its structural integrity. Evidence of a history of branch failures	10.1	Better suited to a POS	Remove larger/moderate diameter sized deadwood
162	Marri (Corymbia calophylla)	22	70	8--9	8--9	Fair	Acceptable	Mature	Short-term (5-15 yrs)	Ok tree. Canopy is relatively one-sided east due to proximity of the adjacent tree. Part of a group of trees in close proximity that effectively form the one canopy. Looks to be declining. Marri Canker noted. Looks to be some impact to its health.	8.4	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
163	Marri (Corymbia calophylla)	18	44	3--4	3--4	Good	Acceptable	Mature	Medium term (15-40 yrs)	Ok tree. Part of a group of trees in close proximity that effectively form the one canopy. Top of main leader is dead	5.3	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
164	Marri (Corymbia calophylla)	22	84	11--12	18-20	Good	Good	Mature	Long term (>40 yrs)	Minor amount of moderate (5-10cm diameter) deadwood. Canopy is relatively one-sided west due to proximity of the adjacent tree. Large mature specimen	10.1	Suitable	Remove larger/moderate diameter sized deadwood
165	Marri (Corymbia calophylla)	21	60	9--10	9--10	Good	Good	Mature	Long term (>40 yrs)	Minor amount of moderate (5-10cm diameter) deadwood. Canopy is relatively one-sided south due to proximity of the adjacent tree. Reasonably good specimen	7.2	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood
166	Marri (Corymbia calophylla)	22	61	9--10	9--10	Good	Good	Mature	Long term (>40 yrs)	Minor amount of moderate (5-10cm diameter) deadwood. Reasonably good specimen	7.3	Suitable	Remove larger/moderate diameter sized deadwood
167	Marri (Corymbia calophylla)	26	76	10--11	11--12	Good	Good	Mature	Long term (>40 yrs)	Minor amount of moderate (5-10cm diameter) deadwood. Large mature specimen	9.1	Suitable	Remove larger/moderate diameter sized deadwood
168	Marri (Corymbia calophylla)	18	76	9--10	9--10	Good	Good	Mature	Long term (>40 yrs)	Minor amount of moderate (5-10cm diameter) deadwood. Large mature specimen. Canopy is one-sided north due to proximity of the adjacent tree	9.1	Suitable	Remove larger/moderate diameter sized deadwood

Tree No.	Species	Approx. Height (metres)	Approx. DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Age Class	SULE	Comments	Nominal TPZ (metres radius)	Opinion	Canopy Works
				N-S	E-W								
169	Marri (Corymbia calophylla)	23	62	7--8	10--11	Good	Undesirable	Mature	Medium term (15-40 yrs)	Part of a group of trees in close proximity that effectively form the one canopy. Canopy is one-sided due to proximity of the adjacent tree. Canopy slightly sparse. Remaining leaf still good condition. Structure looks to be ok at this time but equally looks likely to cause issues in foreseeable future	7.4	Question retention if the adjacent tree was removed	Remove larger/moderate diameter sized deadwood

7. Further Considerations; Development Design and Construction

7.1 Protection of Trees as part of a Development

It is difficult to provide any further specific comments for each Tree as to the potential of the impact from the development of this Site at this stage, as much of the impact caused will be very much dependent on the detailed design aspects of any proposed development.

At this time any design changes proposed to this Site are strongly recommended to take into consideration the 'retention value' of each Tree identified on Site and use that information to influence some of the design parameters for this Site.

Removing the 'questionable' and 'not-suitable' Trees and using those areas for any major infrastructure required as part of the development process may enable lesser amounts of disturbance to be required to occur in other areas of the Site.

There are also other trees throughout this Site that may also be suitable for retention as part of an urban development, so a secondary tree survey is recommended to be considered to identify if there are any other trees that will be suitable for retention as part of the development process.

Effective tree protection must also begin with good design and specifications, so that protection during the construction/landscape stages of a development will be achievable and practicably possible.

As an initial recommendation **the TPZ of any Tree desired to be retained is strongly recommended to be overlaid onto all drawings and designs of the proposed development**. Where encroachments into a designated TPZ are found to be required, further discussion with an experienced independent arboricultural consultant is an important part of the tree protection process.

The nominal TPZ of each Tree to be retained would then be recommended to be overlaid onto any design plans used during the design process. Where encroachments into a designated TPZ are found to be required, further discussion with an experienced independent arboricultural consultant will be required if the Tree is desired to be retained as part of the development.

This is not to say that some encroachment and development activity would not be permitted to be undertaken within a TPZ area as part of a development process.

However any encroachment required/proposed will require further input and discussion with the arboricultural consultant as part of any detailed design process to determine what the potential impact on the given Tree will be, and what design modifications or measures may need to be implemented to mitigate any potential negative impact on the given Tree.

This particularly applies to any Marri that shows signs of the presence of Marri Canker as observations have found that trees affected by the canker can become more susceptible to decline if impacted by development activity as well.

Aspects such as resulting levels, delineation of any underground service pipework, drainage, sewerage etc. can all have (potentially) a major impact on a tree's root zone, and in turn its future health and potential lifespan.

During the design process further arboricultural input will likely be required to discuss:

- Current existing ground levels and proposed resulting levels of the various areas of the Site. Note: As previously mentioned, retaining and maintaining current existing ground levels within the designated TPZ of any tree is of paramount importance to the success of tree retention.

7. Further Considerations; Development Design and Construction

- Delineation of any new underground services pipework, or upgrades to existing infrastructure and pipework including drainage, sewerage, water, gas, electricity, telecommunications and the like; specifically should they pass through any designated TPZ.
- Location of any drainage within the POS near to the Trees and their TPZ.
- Any site remediation requirements within TPZ areas as part of any Site clearing process.
- Proximity of buildings and any other built structures to each Tree and its TPZ and the methodology of its construction.
- Final landscape of the area around any Tree selected for retention (including any irrigation pipework, underground services, hardscape structures, and even soft-scape landscaping).

Including arboricultural input during the design process is generally considered critical to the success of minimising impact to any Tree to be retained and ensuring other parties involved do not result in the compromise of any Tree to be retained.

Once designs have been finalised, tree protection method statements are recommended to be drafted to be included into any tender specification so that protection of the Trees to AS 4970 guidelines will occur during the construction and landscape stages of the development.

These documents are recommended to include specific details of any:

- Protection measures for each Tree's TPZ area,
- Specifications for any works designed to occur within a TPZ area during the construction process,
- Canopy pruning works,
- Watering requirements,
- Monitoring requirements during construction

7.2 Physical Protection of Trees during Development

Physical protection measures in accordance with AS 4970 will also be required for any Tree selected for retention; details of any measures to be implemented will be very much dependent on the final detailed design.

It will be of critical importance that the appropriate protection measures are set up and maintained from the outset; i.e. before any Site clearing/demolition works commence.

Implementing tree protection measures after damage has occurred from works is often of little to no value other than affording some protection from further damages occurring.

Fencing will need to be set-up before any Site works commence in accordance with AS 4970 guidelines.

However effective protection of trees must begin with good design and then good specifications.

7. Further Considerations; Development Design and Construction

7.3 Canopy Works

Depending on the final designs of any development some canopy works may be required for a number of the Trees on/adjacent to the Site as part of the works.

At this stage canopy works are likely to be restricted to the removal of any larger diameter deadwood (i.e. any dead branches 50mm or greater in diameter) and/or the raising of canopy's where necessary to provide clearances for future footpaths, structures etc. Other canopy works may be required pending results of detailed design and what targets will be within the given Tree's projected fall zone; particularly for any of the Rose Gum (in the event that any are retained).

All canopy works are recommended to be undertaken by suitably qualified and experienced tree surgeons, who possess a minimum qualification of AQF certificate 3 arboriculture, or recognised equivalent qualification.

All canopy pruning works to comply with Australian Standards 4373; Pruning of Amenity Trees.

Including arboricultural input during the design stages of the development is seen as critical to the success of minimising impact to the Trees during the actual construction stages of the development.

Attachment 1; Glossary of Commonly Used Arboricultural Terms

Absorbing Root Smaller root structures that are utilised in the uptake of water and essential elements and soil minerals from the surrounding soil profile.

Bark All tissue outside the vascular cambium. Bark can be divided into 'inner bark' (active phloem) and 'outer bark' (aging and dead phloem).

Basal Lower trunk area of the tree.

Branch Part of the tree which supports its leaves flowers and fruit organs.

Can be further classified into:

Primary Branch Structures; meaning the larger first order branches that arise off the main stem or trunk of the tree.

Secondary Branch Structures; meaning smaller diameter sized branches that arise off the Primary Branch Structures.

Branch Collar Bark tissue that forms around the base of a branch where it meets its 'parent source' be it the main stem/trunk of the tree or primary branch structure. Formed as the bark layers of both sections of the plant meet and by their expansion as part of their natural growth processes and radial expansion.

Branch Bark Ridge Bark tissue that forms at the union of a branch where it meets its 'parent source' be it the main stem/trunk of the tree or another branch structure. Formed as the bark layers of both sections of the plant meet and by their expansion as part of their natural growth processes.

Canopy The part of the crown of a tree composed of the branch and leaf mass.

Cavity An open wound, characterized by the presence of decay and resulting in a hollow. (Matheny & Clarke, 1994).

Co-dominant stem A primary branch structure of about the same size as the trunk, arising from the trunk and competing to become the main dominant leading stem/trunk.

Compaction Compaction of soils causes roots to die due to lack of oxygen and water.

Compartmentalization Dynamic tree defence process involving protection features that resist the spread of pathogens.

Decay Degeneration and delignification of plant tissue, including wood, by pathogens and/or micro organisms.

Decline Decline is a general loss of vitality over the entire tree either caused by a systemic disease or by a series of events that disrupt the essential plant processes.

Epicormic shoots Shoots produced by dormant buds within the bark or stems of a tree as a result of stress, lopping or increased light factors. Epicormic shoots usually have a weaker form of branch attachment.

Furcation A point where two (or more) trunk or branch structures arise from the same point of union and subsequently compete for the same physical space at the point of attachment.

Glossary of Commonly Used Arboricultural Terms

Hollows	Hollows from when wood-digesting microorganisms digest wood within the boundaries set by the reaction zone or the barrier zone.
Included bark	Inwardly formed bark or bark found in between the union of a co-dominant or 'furcated' branch/trunk. Typically (although not always) this leads to an area of decay forming at the point of union leading to an increased risk of failure.
Kino	A dark red to brown resin-like substance produced by the trees in the genera *Eucalyptus* and *Corymbia*. Kino forms when living cells are injured and infected.
Live Crown Ratio	The volume of canopy of the tree relative to its overall height.
Lopping	Random cutting of branches or a tree's trunk between a union or not at a proper pruning point or in accordance with Australian Standards Guidelines.
Main Stem Structure	The main stem section of the tree. Also commonly referred to as the trunk of a tree.
Mycorrhiza	A symbiotic non-pathogenic (or weakly pathogenic) relationship between fungi and the non-woody absorbing roots of plants. Note: Research has shown that certain mycorrhiza can aid a tree with mineral absorption, especially phosphorus.
Micro-organisms	An organism of microscopic size.
Pathogen	Any agent that causes disease or adversely affects the health of the plant. Can include insect, fungal, viral and bacterial agents.
Photosynthesis	A process where a combination of water, sunlight and carbon dioxide are utilised by the plant for the production of simple sugars.
Scaffolding Limbs/Branch Structures	The parts of the tree that provide support to the smaller secondary branch structures. Can also be sometimes referred to as the primary branch structures, or stems.
Supportive Root Structures	An organ of a tree that serves to maintain the mechanical support and in-ground stability of the plant.
Stem	The parts of the tree that provide support to the smaller secondary branch structures. Can also be sometimes referred to as the primary branch structures, or 'scaffolding' limbs/branch structures.
Tree	Long lived woody perennial plant greater than (or potentially greater than) 3m in height with one or relatively few stems.
Trunk	The main stem section of the tree. Also commonly referred to as a stem or main stem.
Wound	An opening that is created when the bark is cut, removed or injured.

Attachment 2; Company Information and Disclaimer

Company Name:	ARBOR logic
A.C.N.:	107 194 061
A.B.N.:	66 566 369 687

Insurance Details:

General Liability;	Hollard	$20 million
Professional Indemnity;	DUAL	$10 million
Personal Protection;	Zurich	

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Arboriculture Australia MEMBER Member No. 1254

MEMBER International Society of Arboriculture ISA J. Royal; 172723

QTRA Registered User Lisc. No. 1743

Disclaimer

This Report has been provided in good faith and based upon the material information provided by the Client to Arbor logic, and/or based on the visual inspection of the tree(s) at the time this advice was prepared.

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- The provision of misleading or incorrect information by the Client or any other party to Arbor logic upon which this advice was prepared.
- This advice being used by the Client or any other party in circumstances or situations other than the specific subject of this advice.
- Failure by the Client to follow this advice.
- The action(s) or inaction(s) of the Client or any other party that gives rise to the loss of, or damage to, the tree(s) that are the subject of this advice.

It is also important to take into consideration that all trees are living organisms and as such there are many variables that can affect their health and structural properties that remain beyond the scope of reasonable management practices or the advice provided in this Report based on the visual inspection of the tree(s).

As such a degree of risk will still remain with any given tree(s) despite the adoption of any best management practices or recommendations made in this Report.

Appendix 5 Tree Assessment Recommendations

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LEGEND

Site Boundary
Cadastre
Watercourse

Tree Assessment

High Retention Value
Better suited to POS
Questionable if adjacent tree is removed
Suitable

N

0 5 10 20 30 40 m

Scale: 1:1,000 @ A3
GDA 1994 MGA Zone 50

61

KILBURN RD

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 30.11.19

ENVIRONMAPS | t: 0406 590 006 | Environmental Mapping Solutions | www.environmaps.com.au

C:\GIS\Jobs\CoTerra\CUTKIL05 - Lots 61 and 1001 Kilburn Rd, Parkerville\Figures\CUTKIL05_F01A Tree Assessment_200514.mxd

COTERRA ENVIRONMENT

Job: CUTKIL05
Doc: F01
Date: 14/05/2020
Ph: (08) 9381 5513
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E: info@coterra.com.au

Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

TREE ASSESSMENT

Figure 1A

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LEGEND

Site Boundary
Cadastre
Watercourse

Tree Assessment

High Retention Value
Better suited to POS
Questionable if adjacent tree is removed
Suitable

N

0 5 10 20 30 40 m

Scale: 1:1,000 @ A3
GDA 1994 MGA Zone 50

61
1001
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162
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22
18
17

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 30.11.19

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Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

TREE ASSESSMENT

Figure 2A

ENVIRONMAPS Environmental Mapping Solutions t: 0406 590 006 www.environmaps.com.au

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LEGEND

Site Boundary
Cadastre
Watercourse

Tree Assessment

High Retention Value
Better suited to POS
Questionable if adjacent tree is removed
Suitable

N

0 5 10 20 30 40 m

Scale: 1:1,000 @ A3
GDA 1994 MGA Zone 50

BRINDLE RD

KILBURN RD

1001

1 2 3 4 5

95 96 97 99 116 117 118 119 120 121 122 123 124 125 126 127 128 130 132 133 134 135 136 137 140 141 142 144

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 30.11.19

ENVIRONMAPS | t: 0406 590 006 | www.environmaps.com.au | Environmental Mapping Solutions

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Parkerville Children and Youth Care Inc.
ENVIRONMENTAL ASSESSMENT REPORT
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

TREE ASSESSMENT

Figure 3A

C:\GIS\Jobs\CoTerra\CUTKIL05 - Lots 61 and 1001 Kilburn Rd, Parkerville\Figures\CUTKIL05_F03A Tree Assessment_200514.mxd

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PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX C

CONCEPT PLAN

(ROBERTSDAY)

N

LEGEND

- Proposed Site
- Foreshore Reserve
- Indicative Wastewater Disposal Area within 100m of the Riparian Vegeatation
- Watercourse (Clutterbuck Creek)

EXISTING TREE ASSESSMENT
(to be read in conjunction with Coterra Fauna Habitat Tree Assessment Mapping)

- to be retained (where possible)

ROAD
BRINDLE ROAD
ROLAND ROAD
KILBURN ROAD
KILBURN
DAM
OVERFLOW OUT AND RUNS INTO CREEK
4.0056ha
1.0ha
61
13.197ha
1001
16.187ha
CLUTTERBUCK CREEK
750m² POS/DRAINAGE
550m² POS/DRAINAGE
2645m² POS/DRAINAGE
20m Road Reserve
18m Road Reserve
15m
EMERGENCY ACCESS ONTO ROLAND ROAD
2306m²
2005m²
2006m²
4998m²
2390m²
2014m²
2040m²
2061m²
2071m²
2116m²
2016m²
2002m²
2008m²
2006m²
2018m²
2045m²
2031m²
2026m²
2241m²
2001m²
2025m²
2026m²
2013m²
2010m²
2001m²
2563m²
2016m²
2130m²
2014m²
2008m²
2024m²
2020m²
2016m²
2012m²
2013m²
2758m²
2002m²
2144m²
2099m²
2012m²
2162m²
2145m²
2117m²
4039m² Bld env 1046m²
4000m² Bld env 1494m²
2400m²
2003m²
2075m²
2085m²
2083m²
2073m²
2061m²
2191m²

CADASTRAL INFORMATION
SOURCE: COTERRA
YYMMDD: 190521
DWG REF: CUTKIL02_GIS-Datasets
PROJECTION: GDA94

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 190209

HATCH | RobertsDay

SIZE A3_1:2500

0 metres 25 50 75 100 125

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
S	MODS TO LOTS - CNR ROLAND + KILBURN	210915	SB	RDa
R	MODS TO LOTS - ROAD RESERVE	210906	SJ	RDa
Q	PUSH CULDESAC THRU TO KILBURN	210505	SB	RDa
P	ADD EMERGENCY ACCESS ROADS	210204	SB	RDa

FINAL CONCEPT DESIGN

Lot 61 & 1001 Kilburn Road, Parkerville

Shire of Mundaring

REF NO.	DRAW NO.	REV.
PCH PAR	**RD1 002**	**S**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX D

TRANSPORT IMPACT ASSESSMENT

(GTA CONSULTANTS)

Lot 61 Roland Road & Lot 1001 Kilburn Road, Parkerville

Structure Plan
Transport Impact Assessment

Prepared by: GTA Consultants (WA) Pty Ltd for Parkerville Children & Youth Care (Inc)

on 18/05/20

Reference: W181710

Issue #: Final

GTAconsultants

Lot 61 Roland Road & Lot 1001 Kilburn Road, Parkerville

Structure Plan
Transport Impact Assessment

Client: Parkerville Children & Youth Care (Inc)

on 18/05/20

Reference: W181710

Issue #: Final

Quality Record

Issue	Date	Description	Prepared By	Checked By	Approved By	Signed
A-Dr	18/11/19	A-Draft	AZ/GS	RD/TM	-	-
B-Dr	09/03/2020	B-Draft	RD	TM	-	-
Final	14/05/2020	Minor amendment to Access Road cross-section in accordance with Council's request.	RD	TM	TM	
C-Final	18/05/2020	Updated planning comments from RobertsDay	RD	TM	TM	

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1. INTRODUCTION

1.1. Background & Proposal

A structure plan is proposed for Lot 61 Roland Road and Lot 1001 Kilburn Road in Parkerville. The structure plan proposes approximately 58 low density R5 zoned residential lots ranging in size from approximately 2,000m^2 to 2,500m^2. The structure plan area also includes a watercourse (Clutterbuck Creek), foreshore reserve and associated public open space.

GTA Consultants (GTA) has been engaged by Cuttone Property Group on behalf of the landowner Parkerville Children and Youth Care (Inc), in October 2019 to undertake a transport impact assessment of the proposed Structure Plan.

1.2. Purpose of this Report

Volume 2 of the Western Australian Planning Commission Transport Assessment Guidelines (WAPC Guidelines) provide direction on the preparation of a Transport Impact Assessment (TIA) for Planning Schemes and Structure Plans. The WAPC Guidelines identify that a TIA for a Structure Plan is to provide a broad-brush assessment.

The current WAPC policy requires structure plans to be supported by a transport assessment.

In accordance with the WAPC Guidelines, this TIA outlines:

- Existing transport conditions proximate to the site
- Suitability of the proposed parking provision within the site
- The adequacy of the proposed site layout
- The traffic generating characteristics of the proposed development
- The anticipated impact of the proposed development on the surrounding road network.

1.3. Summary of key issues

From a traffic and transport point of view, the following key provisions are immediately identified for this TIA:

- Suitable access from the development onto the adjoining road network
- Integration of pedestrian/cyclist connectivity between the nearby proposed local school and the structure plan area.

1.4. Previous Studies

The following studies were previously prepared and are relevant to the subject sites due to their proximity:

- Stoneville Local Structure Plan, Lot 48 Stoneville Road & Lot 1 Roland Road – Revised TIA, Transcore, dated November 2018.

1.5. References

In preparing this report, reference has been made to the following:

- Shire of Mundaring Local Planning Scheme No.4 (LPS 4)
- Liveable Neighbourhoods Guidelines
- WAPC Transport Assessment Guidelines Volume 2: Planning Schemes, Structure Plans and Activity Centres Plans

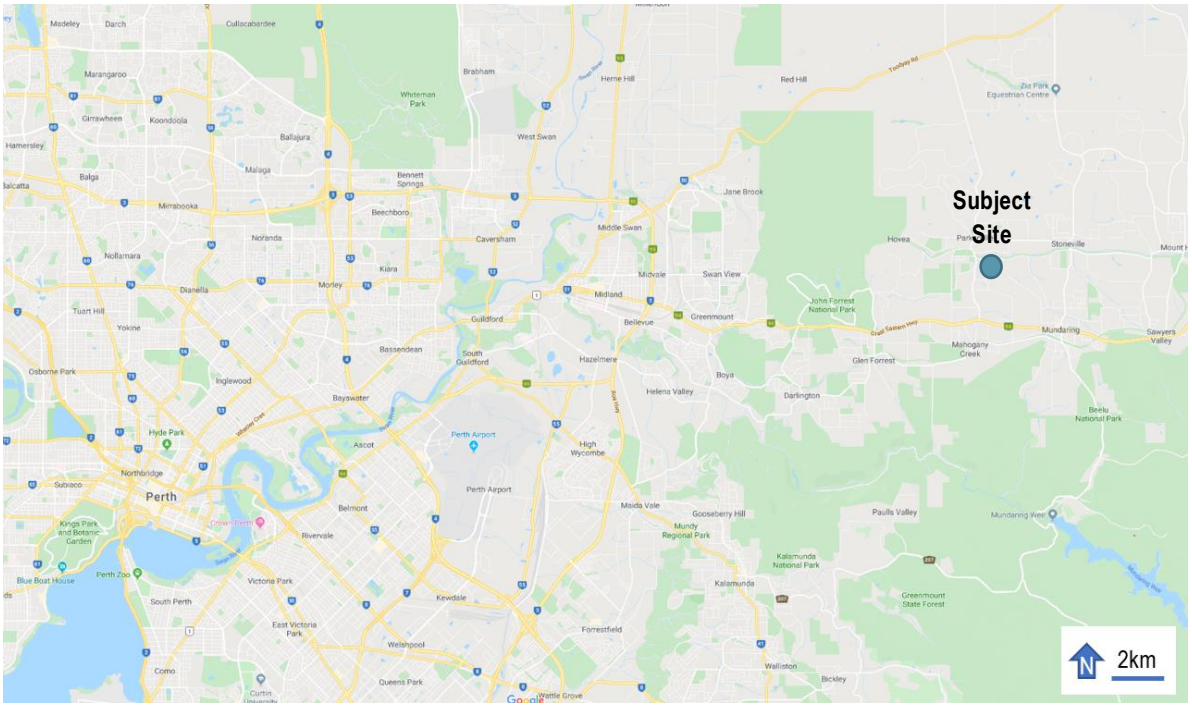
- plans for the proposed structure plan PCH PAR RD 002 Rev O prepared by RobertsDay
- Stoneville Local Structure Plan, Lot 48 Stoneville Road & Lot 1 Roland Road – Revised TIA dated November 2018 – Prepared by Transcore
- traffic surveys undertaken by Matrix Traffic & Transport Data and GTA Consultants in November 2019 as referenced in the context of this report
- various technical data as referenced in this report
- an inspection of the site and its surrounds undertaken by GTA in November 2019
- other documents as nominated.

2. STRUCTURE PLAN OUTLINE

2.1. Regional Context

The subject site is located in the suburb of Parkerville, within the Shire of Mundaring. The site comprises of two lots and is approximately 28km north-east of the Perth CBD, approximately 12km north-east of Midland and approximately 6km north of Great Eastern Highway.

Figure 2.1: Location Map



(PhotoMap courtesy of GoogleMaps)

2.2. Proposed Land Uses

The structure plan proposes a number of land uses, as summarised in Table 2.1. In total there are proposed to be approximately 58 low density residential lots typically 2,000m^2 to 2,500m^2 in area, typical for an R5 zoning. The proposed Structure Plan is show in Appendix A.

Table 2.1: Land Uses

Land Use	Yield / Area
Residential	17.19ha
Foreshore Reserve	6.77ha
Public Open Space	2.05ha
Total	**29.40ha**

2.3. Attractors or Generators of Traffic (non-residential)

Being a residential structure plan, there are no non-residential attractors of generators being proposed within the structure plan area. However, Clutterbuck Creek may be a local attraction to developments south of Kilburn Road with people walking to the foreshore area for recreational purposes.

2.4. Specific issues

Based on the proposed structure plan the following transport specific issues will be required to be considered:

- Potential Roland Road widening to accommodate increased traffic flows and pedestrian movements
- All access to the structure plan area being proposed along Kilburn Road or Brindle Road, for a total of four access points to/from the structure plan
- Sightlines at the proposed intersections.

3. EXISTING SITUATION

3.1. Subject Site

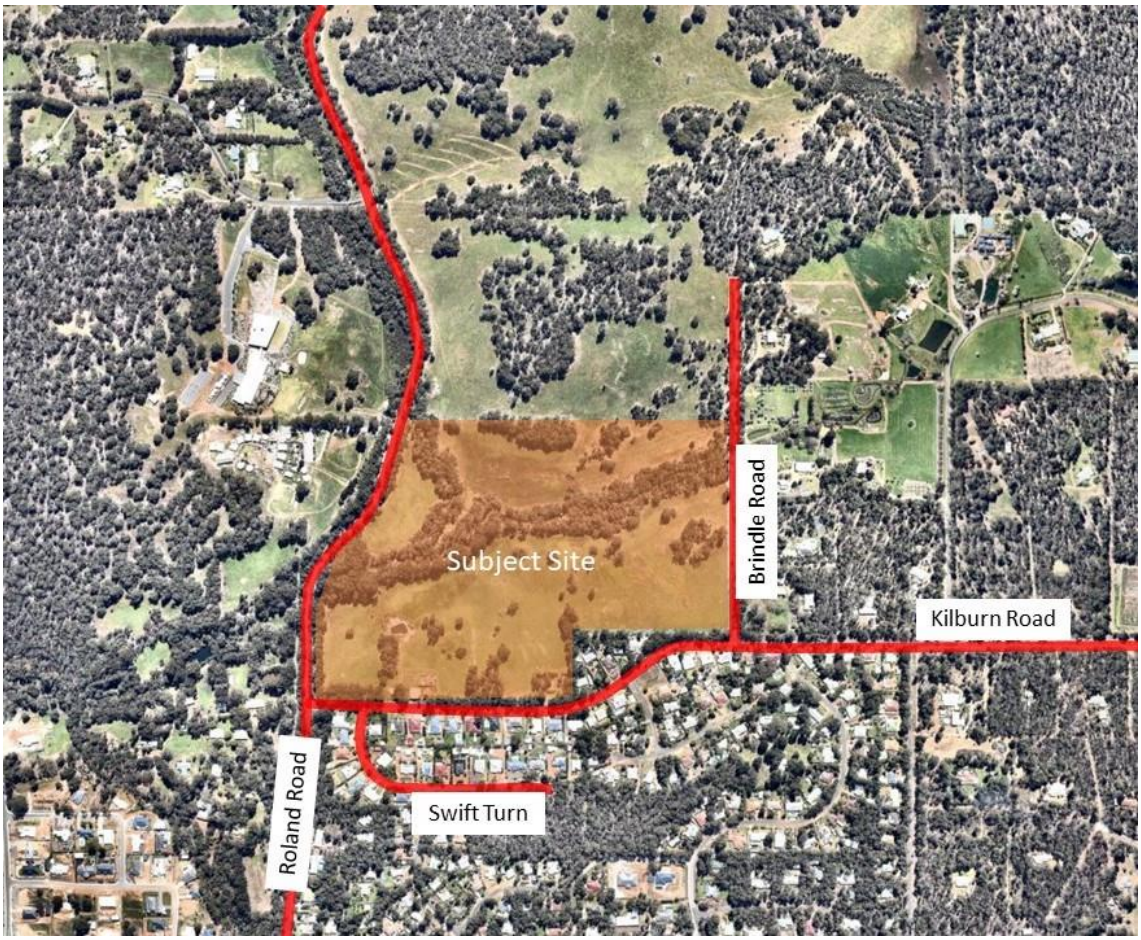
The subject site comprises of two lots, and is bound by Roland Road to the west, Kilburn Road to the south and Brindle Road to the east. To the north of the site is private property.

The subject site was previously zoned Rural under the Metropolitan Region Scheme (MRS) and zoned Rural Small Holdings under the Shire's LPS 4. Amendment 1347/57 to the MRS was gazetted on 31 January 2020, rezoning the Structure Plan area from 'Rural' to 'Urban'.

The surrounding properties include a mix of zones including Residential (with a Residential Density Code of R5) and Rural Residential zoned land.

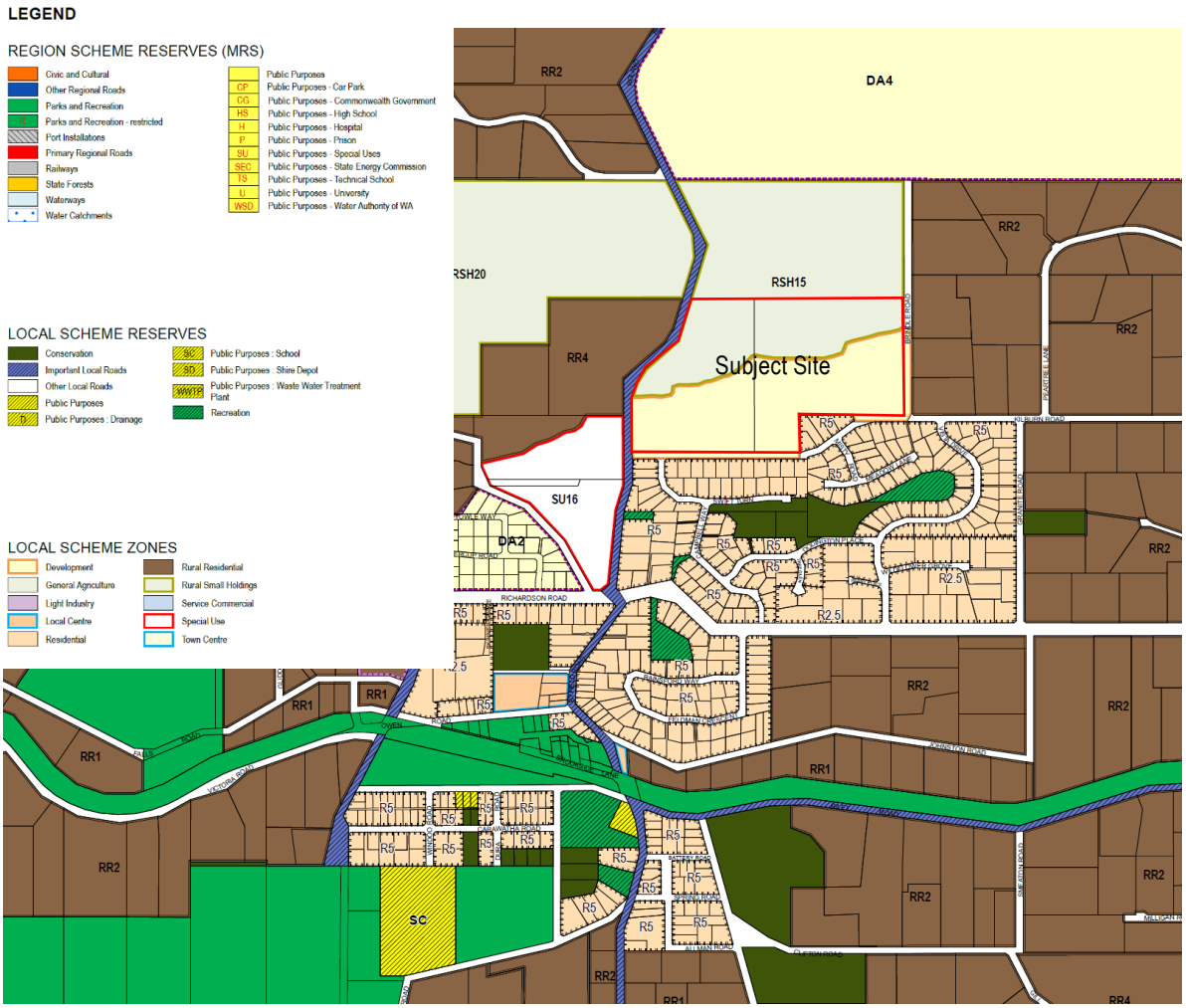
The location of the subject site and the surrounding environs is shown in Figure 3.1, and the land zoning is shown in Figure 3.2.

Figure 3.1: Subject Site and its Environs



(PhotoMap courtesy of NearMap Pty Ltd)

EXISTING SITUATION

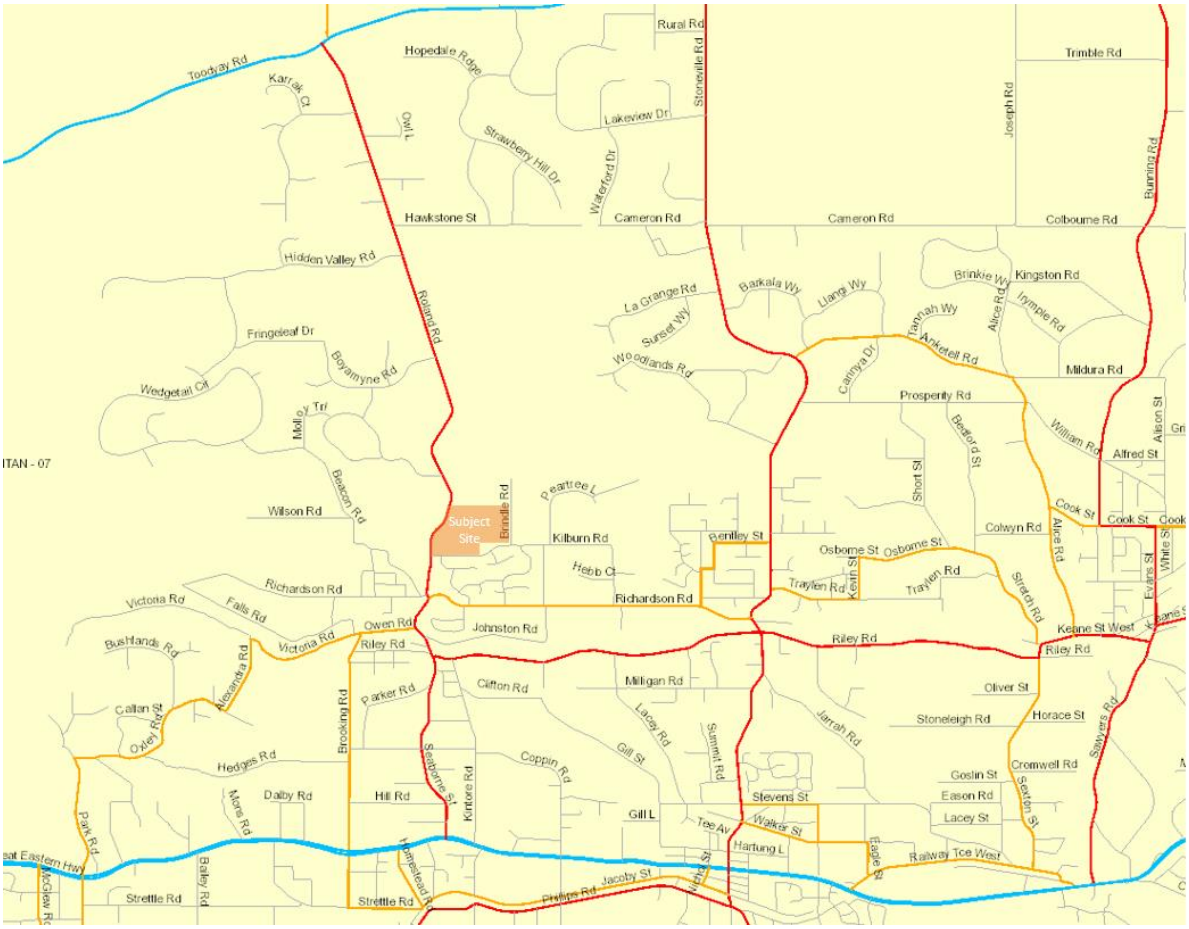


Reproduced from Shire of Mundaring LPS4

3.2. Existing Movement Network

3.2.1. Roads

The urban development of the Parkerville area is quite varied, with some areas zoned urban / residential, whilst others are rural.



(Reproduced from Main Roads WA Road Information Mapping System)

Roland Road

Roland Road runs north-south between Toodyay Road to the north and Great Eastern Highway to the south, and is located west of the subject site. It is a Regional Distributor as per the Main Roads Western Australia Functional Road Hierarchy and Road Information Mapping System with a posted speed limit of 70km/h past the site, which then reduces to 50km/h approximately from just north of Kilburn Road towards the south.

Roland Road is a single carriageway and has a minimum 20m wide reserve with an 7m carriageway. Roland Road north of Kilburn Road was upgraded in late 2016 from a rural standard road to a kerbed urban road format and includes a 3m wide footpath/shared path on the western side of the roadway.

South of its intersection with Kilburn Road there is a traffic island installed, which is wide enough to allow for a vehicle to undertake a two-stage crossing of Roland Road.

There have been no recorded crashes in the past five years to December 2018 on Roland Road from its intersection with Kilburn Road to approximately 160m north.

Kilburn Road

Kilburn Road is a local road, with a default built up area speed limit of 50km/h. Kilburn Road runs east-west south of the subject site and intersects Roland Road as a T-junction, with Roland Road as the priority road. Kilburn Road is a single carriageway and has a minimum 20m wide reserve with an 6m carriageway and there is presently no footpaths along it.

There have been no recorded crashes on Kilburn Road from its intersection with Roland Road to Brindle Road in the past five years to December 2018.

Brindle Road

Brindle Road is a local road, with a default speed limit of 50km/h. Brindle Road runs north-south, east of the subject site, and intersects Kilburn Road as a T-Junction with Kilburn Road as the priority road. Brindle Road is constructed to a rural standard and is sealed for the first 150m from Kilburn Road before it becomes unsealed. The seal width is approximately 4.0m between unsealed shoulders.

There have been no recorded crashes on Brindle Road from its intersection with Kilburn Road to approximately 320 to the north in the past five years to December 2018.

3.2.2. Pedestrian and Cyclist Network

The existing active transport network in the area is quite limited. Roland Road [1]was upgraded in late 2016 and paths have now been provided on its western side in the vicinity of the proposed structure plan area. A 3m wide path is present along the western side of Roland Road, north of Kilburn Road, and a 2.3m wide path is present on the eastern side of Roland Road, south of Kilburn Road.

3.2.3. Public Transport

The bus services in the area are currently limited given the rural nature of the area. The closest bus service runs along Richardson Road to the south and is an approximate 800m walk from the subject site. Bus route 328 services the area and runs between Midland Train Station to Wundowie. The bus operates with limited services in both the AM and PM peak with services running approximately once every hour.

3.3. Existing Road Network (Within 2km)

As discussed earlier in this TIA, Kilburn Road is to the south of the structure plan area and runs east/west between Roland Road and Schoch Road.

Within a 2km radius of the structure plan area, Kilburn Road connects to Roland Road to the west and Richardson Road to the southeast via Schoch Road.

3.4. Traffic Counts (within 2km)

No existing traffic counts are available within 2km of the structure plan area from Main Roads WA online Traffic Map system. However, traffic counts were undertaken by *Matrix Traffic & Transport Data* for this TIA. With assessment of development within the nearby local area and review of traffic counts from Main Roads WA outside the 2km area, revealed the following traffic volumes on roads in the vicinity of the site:

- Roland Road 1,920 vpd (based on 2018/19 Main Roads counts south of Toodyay Road)
- Kilburn Road 500 vpd (Nov 2019 Matrix count east of Swift Turn)
- Brindle Road 40 vpd (based on expected generation from the current 4 properties which access it)

[1] Based on observation using Nearmap Imagery

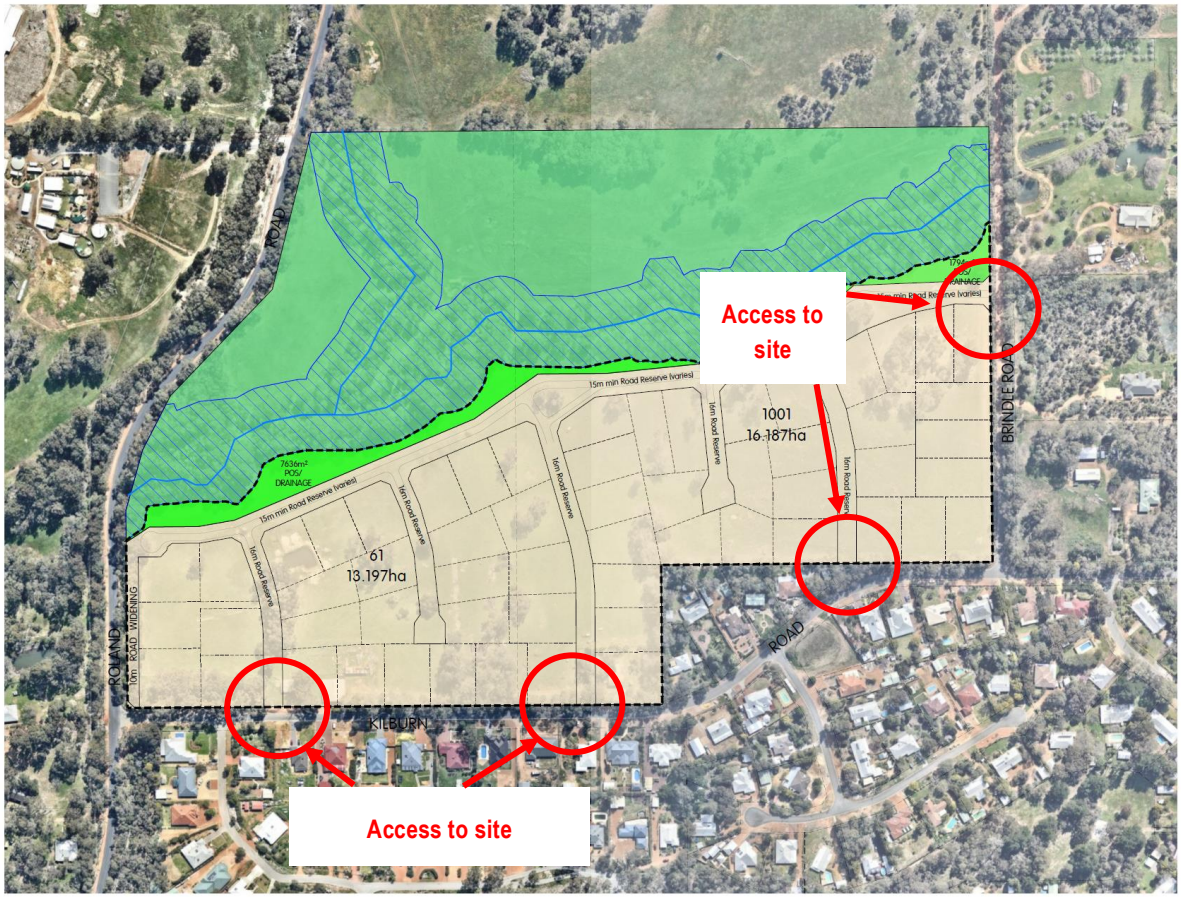
- Swift Turn 150 vpd (based on expected generation from the current 20 properties which access it).

3.5. Changes to Existing Road Network

There is proposed to be four changes to the external road network to integrate the structure plan with the surrounding road network, that is, three T-Junction Intersection at Kilburn Road and a T-Junction intersection at Brindle Road as shown in Figure 3.3. All movements will be allowed at these new proposed junctions and this is considered satisfactory given the low traffic flows generated by the site.

No other changes to the external network are proposed.

Figure 3.3: Structure Plan Area



(Reproduced from Structure Plan map by Roberts Day)

4. INTERNAL ROAD NETWORK

4.1. Proposed Road Hierarchy, Road Reserve Widths and Speed Limits

4.1.1. Local Access Streets

The Structure Plan area comprises entirely local access streets due to its residential nature and therefore the low traffic volumes expected to be generated. The local streets proposed as part of this Structure Plan are detailed below, and are based on typical cross sections specified within *Liveable Neighbourhoods*.

- Access Street D – six streets of Access Street D types are proposed within the structure plan, three of the Access Street D being the north/south connections onto Kilburn Road, two being the north/south cul-de-sac and one being the east/west road connecting to Brindle Road and running along the foreshore area of the creek.

4.2. Road Cross Sections

The general road cross sections proposed are of 16m width with the east-west street alongside the southern side of Clutterbuck Creek narrowed to 15m as it is adjacent to the POS. Refer to Figures 4.1 and 4.2 for the corresponding road cross sections.

Figure 4.1: 16m Wide typical Cross Section

Figure 4.2: 15m Wide typical Cross Section adjacent to POS

(Images courtesy of Streetmix)

4.3. Intersection Controls

All internal intersections are proposed to have the "Give-Way" control management with through road to be the priority road. The external intersections leading into the structure plan area from Kilburn Road and Brindle Road will also be T-Junction intersections.

Given the low traffic volumes expected to be generated from the site, there will be minimal impact on the capacity of Kilburn Road and the intersection between Roland Road and Kilburn Road. This is confirmed in more detail in subsequent sections of this TIA report.

4.4. Pedestrian/Cycle Networks and Crossing Facilities

The integration of pedestrian/cyclist connectivity between the nearby schools and the structure plan area is important as the eventual residents within the structure plan area may rely on the proximity of these sites to local schools to allow increased non-motorised movements to and from these schools. Footpaths are proposed on the majority of the internal roads and wide enough for cycling to assist the movement network.

All cycling within the structure plan area is proposed to be either on-road or on proposed footpaths. Internal traffic volumes are expected to be low enough such that on-road cycling will not pose a high risk to cyclists.

On April 27 2016, WA's laws were changed to allow cyclists of all ages to use footpaths, unless otherwise signed. The amendment to the *Road Traffic Code 2000* brought WA's bicycle laws into line with the rest of Australia, making it legal for parents to cycle alongside their children on footpaths, improving safety.

4.5. Public Transport Routes

No public transport services are expected or proposed to be altered as a result of this development, and therefore no special measures have been adopted to incorporate them into the internal transport network. As discussed previously, the remoteness of this site to existing public transport routes will not make public transport a high mode use. There is likely to be some pedestrian movement to and from the bus stops on Richardson Road via Swift Turn to the south of Kilburn Road, near Roland Road. In the development of the Stoneville Structure Plan (Lot 48 Stoneville Road and Lot 1 Roland Road further to the north of this site) this had identified that Route 328 could be extended north along Roland Road, past this Structure Plan area. This proposal is supported to improve public transport accessibility for this Structure Plan also.

4.6. Proposed Road Access Strategies

Typically, the residential lots proposed as part of this structure plan area will not have any direct access onto Kilburn Road or Brindle Road. All access will be via internal roads, and three access points onto Kilburn Road and one access point onto Brindle Road. However, there is expected to be the following direct access:

- Kilburn Road 4 lots
- Brindle Road 3-5 lots.

These lots directly accessing the frontage roads are on sections of road where the alignment is straight with relativity good sight lines in each direction.

5. EXTERNAL TRANSPORT NETWORKS

Other than the three access points onto Kilburn Road and the access point onto Brindle Road and proposed footpath leading to the attractors along Roland Road, this development will not result in any other changes to the external transport network.

Brindle Road which will act as one of the access roads the subject site, is recommended to be widened for the increase in traffic flows. The current road width of a 4m seal with the current traffic flow of approximately 40vpd as an uninterrupted rural road traffic flow regime is considered acceptable. With the proposed Structure Plan having direct access and road connection to Brindle Road, the expected traffic flow should be approximately 100 vpd and the road becomes more of an urban type roadway with interrupted traffic flows. At this slightly higher traffic flow and the residential nature of the access, Brindle Road should be widened to a 6m wide kerbed and sealed road.

6. INTEGRATION WITH SURROUNDING AREA

6.1. Surrounding Attractors and Trip Generators

There are a number of attractors in the area, with the majority located on the western side of Roland Road. These attractors include:

- Mundaring Christian College (access off McDowell Loop, which intersects with Roland Road)
- Silver Tree Steiner School (access off McDowell Loop, which intersects with Roland Road)
- St Michael and All Angels (access off Roland Road)
- Parkerville Children and Youth Care (access of Roland Road).

6.2. Proposed Changes to Land Uses within 800m

It should also be noted that there is the Stoneville Structure Plan, approximately 1.1km north of the subject site, which is a large residential subdivision consisting of some 1400 dwellings, a public primary school (with 300 students), a private K-12 school (with 500 students) and 1,500m^2 GFA of retail/commercial. This development is likely to generate approximately 11,200 vehicle trips per day for a typical weekday[2]. This is expected to lead to traffic flows of approximately 1,400 vpd on Brindle Road in addition to the expected 100 vpd following the development of this Structure Plan area.

6.3. Travel Desire Lines from Structure Plan to these Attractors/Generators

Travel desire lines to local attractors such as the nearby school will be well catered for when developed as they all lie on direct road routes which will cater for motor vehicles, pedestrians and cyclists. There are no other trip attractors/generators within 800m of the structure plan areas as the surrounding land is predominantly Rural and/or Residential. Access to and from the schools to the north-west of the Structure Plan area will attract pedestrians to walk along the main east-west roadway along the northern side of the Structure Plan area and then cross Roland Road near the creek crossing.

6.4. Adequacy and Deficiencies in External Transport Networks

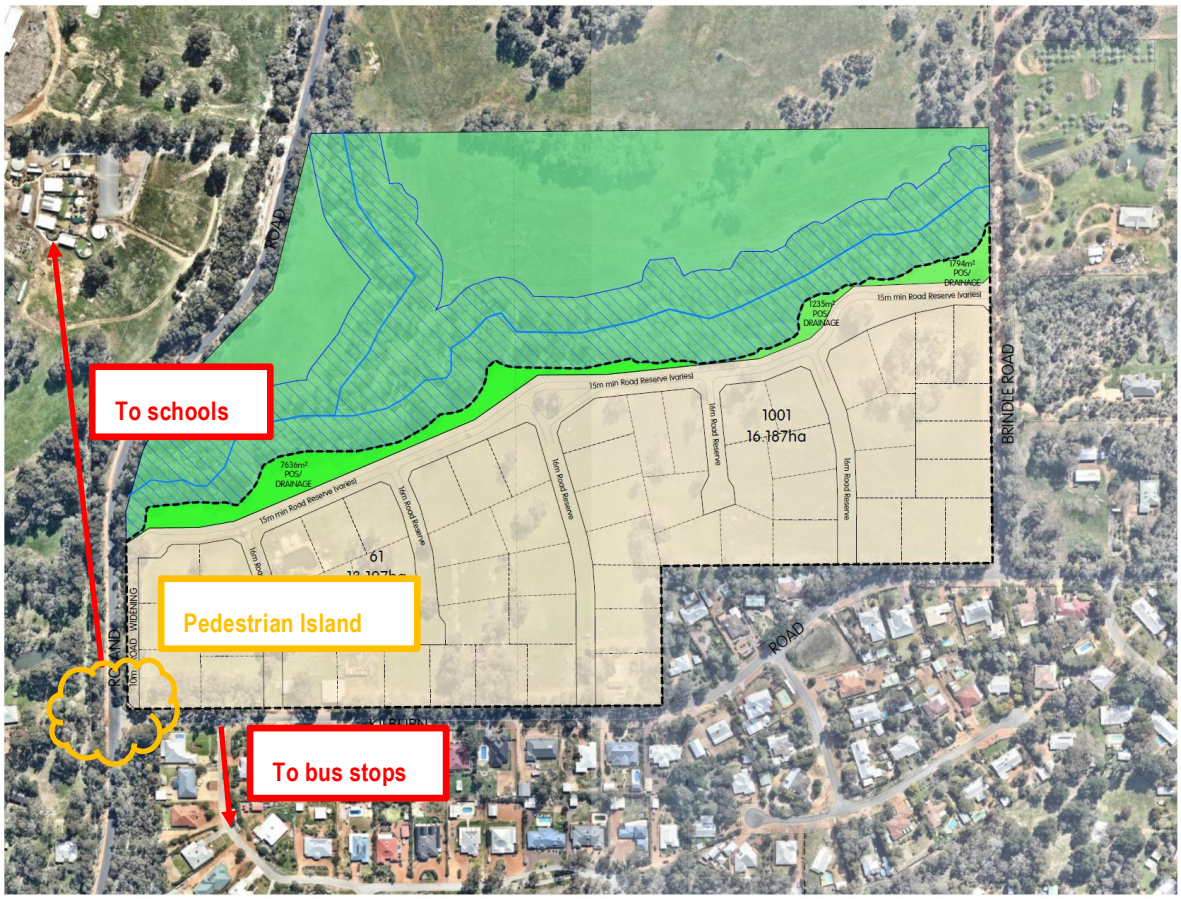
Key desire lines have been found to have the following deficiencies:

6.4.1. Kilburn Road access to local schools west of the site

There is currently a lack of footpath on either side of Kilburn Road along the structure plan frontage to allow pedestrians walking to and from the nearby attractors (e.g. schools and church). A footpath should be provided so that pedestrians are not forced to travel along the verge of the road. In addition, access to and from the schools to the north-west is expected to be via Kilburn Road and then across Roland Road at the pedestrian island south of Kilburn Road. Refer to Figure 6.1 below which identifies this location.

[2] Stoneville Local Structure Plan, Lot 48 Stoneville Road & Lot 1 Roland Road – Revised TIA dated November 2018 – Prepared by Transcore

Figure 6.1: External Pedestrian Desire Lines and Roland Road crossing sight lines



6.4.2. Swift Turn and Campbell Way to access to bus stops

With proposed access to the structure plan, there may be pedestrians who may use Swift Turn and Campbell Way to access bus services which stop on Richardson Road. There is no footpath along Swift Turn and Campbell Way between the structure plan and the bus stops.

6.4.3. Brindle Road

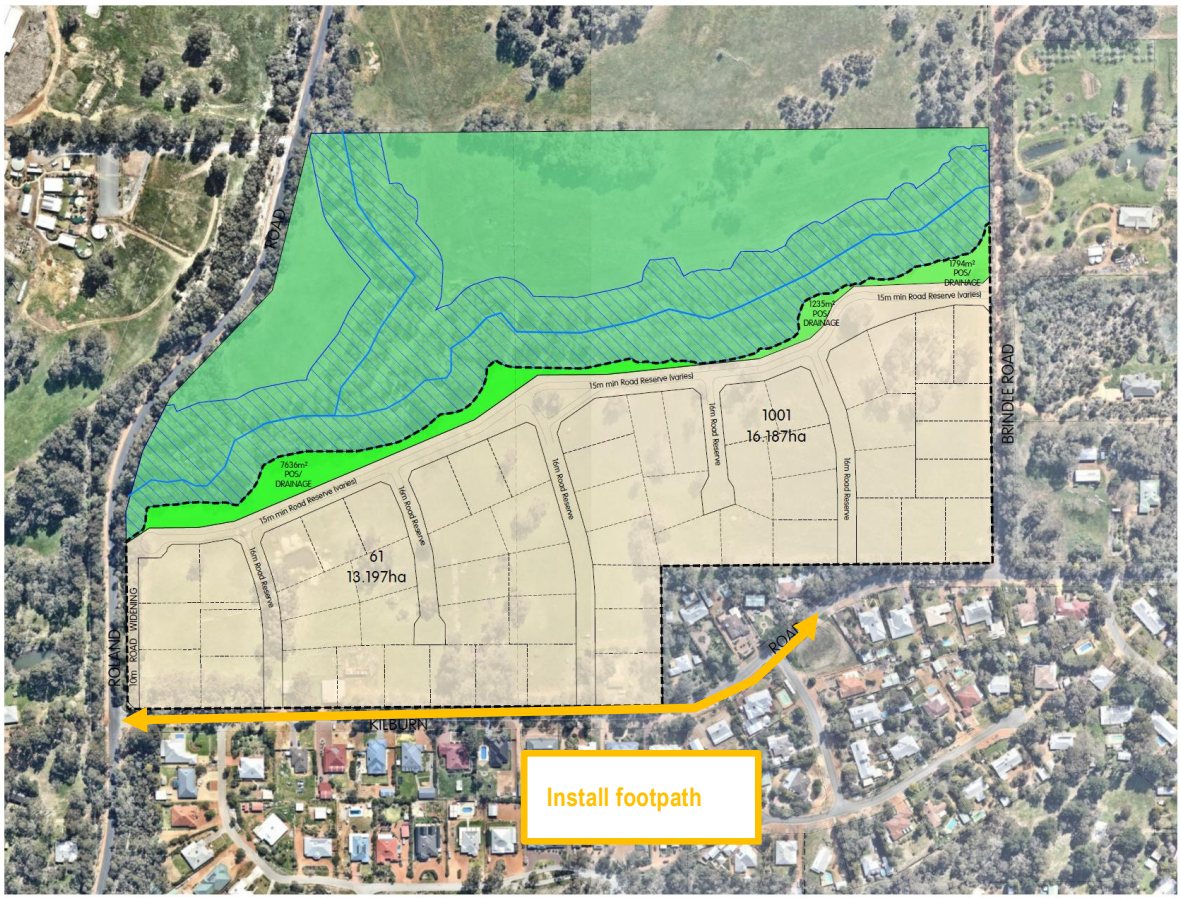
Brindle Road is currently a 4m seal with approximate 1m unsealed shoulders either side. Near the proposed access for the Structure Plan, Brindle Road is entirely unsealed and the road has an approximate 10% downgrade from south to north towards the creek. With increased traffic flows and residential nature of the Structure Plan area, this combination is considered unsafe. However, the widening of Brindle Road as recommend as part of the development of the land will resolve this issue.

6.5. Remedial Measures to Address Deficiencies

Footpaths are required along the north of Kilburn Road along the structure plan frontages to allow pedestrian walking between the structure plan and the nearby attractors.

These are shown in Figure 6.2 on the following page.

Figure 6.2: Remedial Measures



7. ANALYSIS OF INTERNAL TRANSPORT NETWORKS

7.1. Assessment Year(s) and Time Period(s)

The Structure Plan has been assumed to be fully developed by 2031.

7.2. Structure Plan Generated Traffic

7.2.1. Trip Generation Rate

The proposed development is a residential subdivision. The traffic generation rates used for the site is based on the Western Australian Planning Commission's *Transport Impact Assessment* guidelines. Western Australian Planning Commission's *Transport Impact Assessment* guidelines rates suggest a daily rate of approximately 8 trips per day per single dwelling.

The rate adopted was based on the daily rate for a detached dwelling occupied by families and children, which is 8 trips per day per dwelling. This rate is considered conservative, given the location of the development in a developing district.

7.2.2. Trip Generation of Site

Using the above generation rates for the proposed development suggests that the overall structure plan should generate approximately **460 trips per day** with 230 entering and 230 exiting over an entire day, based on the proposed approx. 58 residential lots. For the AM peak there should be about **35 trips per hour** (7.5% of the daily number) with 26 exiting (75% of the total AM peak trips) and 9 (25%) entering. In the PM peak there should be about **46 trips per hour** (10% of the daily trips) with 15 exiting (33%) and 31 entering (67%).

This traffic generation of the site assumes that there is no traffic generated from the current land-uses on the site.

All of these trips will enter and exit the Structure Plan via the new roads connecting to Kilburn Road and Brindle Road, then onto Roland Road.

7.3. Extraneous (Through) Traffic

It is expected to be no extraneous traffic through the structure plan area.

7.4. Design Traffic Flows (i.e. Total Traffic)

The expected daily traffic flows on the internal road network are shown at Appendix B. Internal traffic volumes vary from 20 to 100 vpd on the road running east/west while roads running north/south onto Kilburn Road are expected to carry approximately 80 to 190 vpd.

7.5. Road Cross-Sections

The proposed road cross sections proposed internally have a traffic carrying capacity of approximately 1,000 vpd. With traffic flows expected to be no more than 190 vpd, the proposed road cross sections are considered more than adequate for the resultant traffic flows.

With all vehicular traffic travelling to and from the Structure Plan area ultimately via Kilburn Road to access Roland Road, the resultant traffic flows on Kilburn Road are expected to approximately 1,000 vpd. With the current 6.0m wide pavement roadway, Kilburn Road has a typical traffic carrying capacity of 1,000 vpd and thus the traffic flow regime is considered appropriate.

Finally, the resultant traffic volumes on Brindle Road of approximately 100 vpd is expected to be significantly less than the traffic carrying capacity of 1,000 vpd for the proposed 6.0m wide roadway.

7.6. Intersection Controls

Assessing the expected traffic volumes in the Structure Plan, the proposed intersection controls are still valid and appropriate. The traffic volumes are within acceptable ranges for roads of the proposed width and there are no notable imbalances in traffic flows at T-junctions.

With regards to intersections, Table 2.4 from the Austroads publication, *Guide to Traffic Management Part 6 – Intersections, Interchanges and Crossings* (2007) provided advice as to intersection performance in peak flow conditions with regards to possible further analysis. This is summarised in Table 7.1.

Table 7.1: Austroads Guidelines

Major Road Type	Major Road Flow (two-way, vph)	Minor Road Flow (two-way, vph)
Two-lane	400	250
	500	200
	650	100
Four-lane	1,000	100
	1,500	50
	2,000	25

The total vehicles in the peak hour would be roughly 7.5% of the daily flows for the AM peak and 10% in the PM peak. The traffic volumes are low enough so as to not warrant further assessment for the structure plan internal roads. For example, the highest flow intersection in the Structure Plan area would have a traffic flow of less than 100vph on both the major and minor roads. This falls well below the first row of traffic flows set out in the Austroads Guidelines, as shown in Table 7.1 and thus requires no further assessment. It is therefore concluded that all other internal intersections are acceptable as they would have traffic flows below these levels. At this low level of traffic flow the intersections are expected to operate at LoS A with DoS significantly less than 1.0.

7.7. Sightlines

A high level assessment of the internal sight lines found that the generally 16m wide road reserves should provide suitable sight distances at internal intersections within the Structure Plan area. This is based on the proposed traditional 6m x 6m corner truncations at intersections which are more generous than the 3m x 3m that can be provided under Liveable Neighbourhoods. Sight-line Assessments for intersections within the Structure Plan area should be undertaken at the detailed design stages

7.8. Access Strategy

As discussed previously, the Structure Plan is proposed to have access to the existing road network via the four access points, three being new road connections onto Kilburn Road and the other being a road connection onto Brindle Road and then onto Kilburn Road.

The impact of development traffic to the existing T-junction intersection between Roland Road and Kilburn Road is further assessed in the subsequent sections of this report.

7.9. Pedestrian / Cycle Networks

The internal road network is expected to carry traffic volumes that should not impede pedestrians or cyclists detrimentally. Hourly traffic flows are expected to be, at worst, approximately 20vph, this on the access roads connecting to Kilburn Road. This falls comfortably well below the 1,100vph level for an undivided two-way road at which point the traffic flow affects pedestrian crossing amenity.

For cyclists, as traffic volumes on internal streets are expected to be less than 1,500vpd and typical 50km/hr speeds, on-street cycling is acceptable mixed with traffic, with no strict requirement to provide on-street cycle lanes.

7.10. Safe Routes to Schools

There are no schools within the structure plan but there are two existing schools within 800m. Any children going to these schools will be able to use the proposed internal footpath network and the proposed footpath network located on Kilburn Road (as suggested on the north side of Kilburn Road) to access the current schools.

Traffic volumes on Kilburn Road and Roland Road are expected to be approximately 100vph and 230vph respectively, these being significantly less than the upper limit of 1,100vph which is the traffic volume for a undivided two-way road at which the ability of pedestrians to cross the roadway is severely impacted and is unsafe.

7.11. Pedestrian Permeability & Efficiency

As discussed previously, access to public transport is via the existing bus stops on Richardson Road. However, there is no existing footpath network between the subject site and the existing bus stops. The structure plan is within an 800m or 10-minutes walking distance of these stops. This level of access to the bus stops falls below the *Liveable Neighbourhood* requirement of 60% of dwellings within a 400m walking distance of an existing or potential bus stop.

7.12. Access to Public Transport

In terms of the broad Transperth requirements of a bus stop within 500m of 90% of Perth's population, this distance measured in a straight line from the current bus stops. Based on the proposed structure plan, the Structure Plan falls well beyond this 500m straight line distance. However, as areas develop north of this proposed Structure Plan area, there could be bus route changes with Roland Road a possible bus route. If Roland Road does become a bus route approximately 50-60% of the Structure Plan area could be within Roland Road which might have a bus route.

8. ANALYSIS OF EXTERNAL TRANSPORT NETWORKS

8.1. Extent of Analysis

The extent of the assessment of the external road networks is:

- Intersection of Roland Road/Kilburn Road.

8.2. Impact Assessment

8.2.1. Trip Distribution

With the site bordered by Roland Road, Kilburn Road and Brindle Road, and the location and regional context, the expected distribution of trips are as summarised below. This is based on observed turning vehicle patterns from the intersection traffic counts undertaken by GTA in November 2019.

- Roland Road to the north – 70%; and
- Roland Road to the south – 30%.

8.2.2. Traffic Impact of Development Traffic

All the bordering and connecting roads are expected to have traffic volumes within their theoretical capacities. These volumes are not expected to exceed the maximum daily flor rates expected for roads of the classification and should be manageable (see the following intersection assessments). The maximum flows that these roads should carry are shown in Table 8.1 and Table 8.2.

Table 8.1: Current Traffic Flows

Road	Indicative Maximum Daily Flow (two-way)	Actual Daily Flow (two-way)
Roland Road	15,000[3]	2,300
Kilburn Road	1,000[4]	500
Brindle Road	150[5]	32

Table 8.2: Expected Traffic Flows

Road	Indicative Maximum Daily Flow (two-way)	Expected Daily Flow (two-way)
Roland Road	15,000	2,650
Kilburn Road	1,000	1,000
Brindle Road	1,000[6]	100

To further assess the performance of the intersections of Roland Road/Kilburn Road during the AM and PM peaks a computer program, SIDRA Intersection (Version 8), was utilised. The output tables from SIDRA for the current and expected traffic flows are shown on the following pages.

[3] Based on uninterrupted flow with 900vph one-way peak hour lane capacity with 60/40 directional split and 10% daily flow in peak period (k-factor of 0.1)
[4] Based on urban type Access Street D cross section from Liveable Neighbourhoods, January 2009 Update 02
[5] Based on rural type road with 3.7m seal and uninterrupted traffic flow
[6] Based on urban type Access Street D cross section from Liveable Neighbourhoods, January 2009 Update 02

8.2.3. Level of Service Concepts

The level of service concept describes the quality of traffic service in terms of six levels, designated A to F, with level of service A (LOS A) representing the best operating condition (i.e. at or close to free flow), and level of service F (LOS F) the worst (i.e. forced flow). More specifically:

- *LOS A*: Primarily free flow operations at average travel speeds, usually about 90% of the FFS (free flow speed) for the given street class. Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at signalised intersections is less than 10 seconds. At non-signalised movements at intersections the average control delay is less than 10 seconds;
- *LOS B*: Reasonably unimpeded operations at average travel speeds, usually about 70% of the FFS for the street class. The ability to manoeuvre within the traffic stream is only slightly restricted, and control delays at signalised intersections are between 10 and 20 seconds. At non-signalised movements at intersections the average control delay is between 10 and 15 seconds;
- *LOS C*: Stable operations; however, ability to manoeuvre and change lanes in mid-block locations may be more restricted than at LOS B, and longer queues, adverse signal coordination, or both may contribute to lower average travel speeds of about 50% of the FFS for the street class. Signalised intersection delays are between 20 and 35 seconds. At non-signalised movements at intersections the average control delay is between 15 and 25 seconds;
- *LOS D*: A range in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LOS D may be due to adverse signal progression, inappropriate signal timing, high volumes, or a combination of these factors. Average travel speeds are about 40% of FFS. Signalised intersection delays are between 35 and 55 seconds. At non-signalised movements at intersections the average control delay is between 25 and 35 seconds;
- *LOS E:* Characterised by significant delays and average travel speeds of 33% of the FFS or less. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections (between 55 and 80 seconds), and inappropriate signal timing. At non-signalised movements at intersections the average control delay is between 35 and 50 seconds; and,
- *LOS F*: Characterised by urban street flow at extremely low speeds, typically 25% to 33% of the FFS. Intersection congestion is likely at critical signalised locations, with high delays (in excess of 80 seconds), high volumes, and extensive queuing. At non-signalised movements at intersections the average control delay is greater than 50 seconds.

In addition to the above:

- Average Delay: is the average of all travel time delays for vehicles through the intersection; and,
- Queue: is the queue length below which 95% of all observed queue lengths fall.
- Degree of Saturation: Ratio of the traffic flow to the capacity for that particular lane/movement

8.2.4. Roland Road/Kilburn Road Intersection Performance

The Roland Road/Kilburn Road intersection was assessed based on the expected traffic volumes with the wider development in the vicinity included and the traffic flows from the proposed development. Table 7.3 and 7.4 (excerpts from the SIDRA Intersection output table for Movements) show the expected performance of the intersection at 2031 at anticipated full buildout. This assessment assumes full buildout of adjoining structure plan areas and future structure plan areas also.

Table 8.3: Roland Road/Kilburn Road - Expected 2031 AM Peak Performance

Approach	Performance Criteria		
	Lane	DoS	Non-Priority Av. Delay (s) Intersection LoS
Roland Rd (S)	Through/Right	0.20	0
Kilburn Rd (E)	Left/Right	0.08	5
Roland Rd (N)	Left/Through	0.21	
Intersection	**ALL**	**0.21**	**A**

Table 8.4: Roland Road/Kilburn Road - Expected 2031 PM Peak Performance

Approach	Performance Criteria		
	Lane	DoS	Non-Priority Av. Delay (s) Intersection LoS
Roland Rd (S)	Through/Right	0.19	1
Kilburn Rd (E)	Left/Right	0.04	5
Roland Rd (N)	Left/Through	0.22	
Intersection	**ALL**	**0.22**	**A**

Overall, this intersection is expected to have a DoS significantly less than 1.0 with LoS of A in both the AM and PM peak periods. This indicates this intersection should operate at an acceptable level with the Structure Plan area fully developed in conjunction with the impacts of other nearby development areas.

8.2.5. Traffic Impact of Development on Local Area

Based on the above assessment it is concluded that the development will have an acceptable impact on the surrounding roads and intersections with no changes required to either the road network or the geometry of intersections as a result of development alone.

8.3. Road Cross-Sections

The current road cross-sections for Kilburn Road is considered suitable for the expected traffic flows from the structure plan in combination with the current and expected traffic flows on the current road network. This has been shown in Table 8.2 - Kilburn Road is expected to carry approximately 1,000vpd, and the peak hour assessments has shown that the current cross section will be suitable for future traffic flows.

8.4. Intersection Layouts & Controls

From the above assessments, the current formats of intersection layouts and controls are considered appropriate and are not required to be modified. The eastern intersection onto Kilburn Road is expected to be at an angle of less than 90 degrees. This should be aligned as close as possible to 90 degrees to ensure than drivers will be able to have visibility along both directions on Kilburn as near as 90 degrees as possible.

8.5. Sightlines

An assessment of the sight lines found that the central and eastern proposed intersections with Kilburn Road will require assessment in the detailed design stage to take into account the current trees on the northern side of Kilburn Road. This will also require consideration for the 3 lots expected to have direct access onto Kilburn Road.

9. CONCLUSION

As a result of the traffic analysis undertaken for the proposed structure plan, the following findings and recommendations are made:

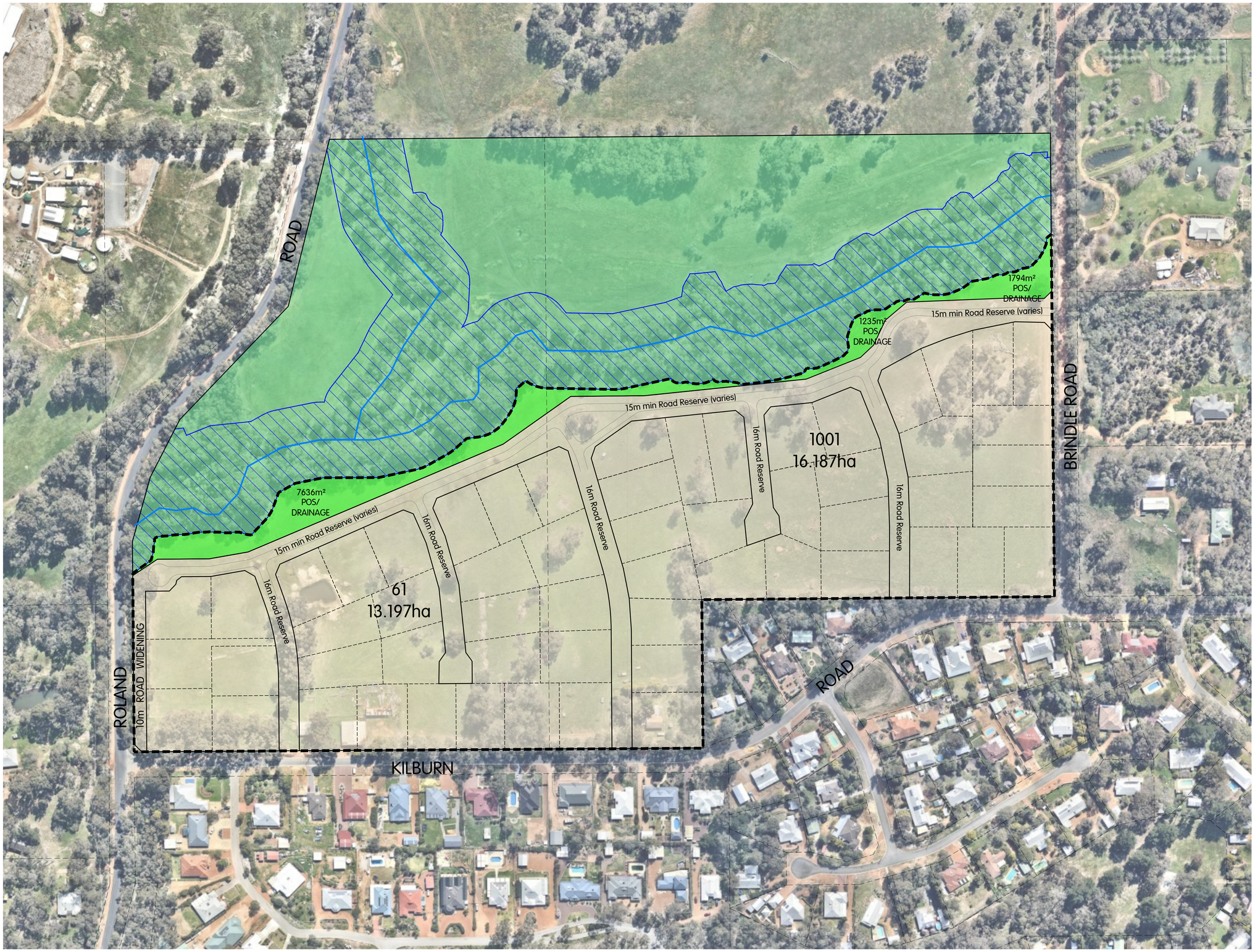
- The ultimate/total development scenario has been assessed on a 2031 traffic flow network assuming future development in the nearby vicinity.
- As a "worst case scenario" the proposed amendment is expected to generate in the order of 460 vehicular trips per day with approximately 35 of these in the AM peak (two-way) and 46 in the PM peak.
- The impacts of the traffic volumes associated with the development on the road network are considered acceptable in the future to 2031.
- All streets proposed within the Structure Plan are lower order Access Streets. These are proposed to be generally of 16m width with the east-west street alongside the southern side of Clutterbuck Creek narrowed to 15m as it is adjacent to the POS to the north.
- There is no requirement for any of the existing road network to be modified as a result of this development alone, with the exception of the new access points to the site in the form of an all movement T-junction intersection on Kilburn Road and Brindle Road.
- Delays and queues at the main entry to the site are expected to be minimal with good levels of service to 2031.
- The following transport network modifications are recommended for consideration:
    - Modify Brindle Road to be a 6.0m wide seal
    - Install a footpath along Kilburn Road along the frontage of the Structure Plan area
    - Align the eastern most Structure Plan intersection onto Kilburn Road at an angle as close as possible to 90 degrees for safety.

The WAPC checklist is included in Appendix C.

A. STRUCTURE PLAN

A

N



LEGEND

- Proposed Site
- Residential R5
- Public Open Space/ Drainage
- Rural Zone
- Foreshore Reserve
- Watercourse (Clutterbuck Creek)

PARKERVILLE CHILDREN AND YOUTH CENTRE(INC)

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SIZE A1

1:1500 0 metres 15 30 45 60 75

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 160904

CADASTRAL INFORMATION
SOURCE: SLIP SERVICE - LANDGATE
YYMMDD:
DWG REF:
PROJECTION: MGA 50

INDICATIVE CONCEPT PLAN
Lot 61 & 1001 Kilburn Road, Parkerville
Shire of Mundaring

REF NO. **PCH PAR** | DRAW NO. **RD1 002** | REV. **O**

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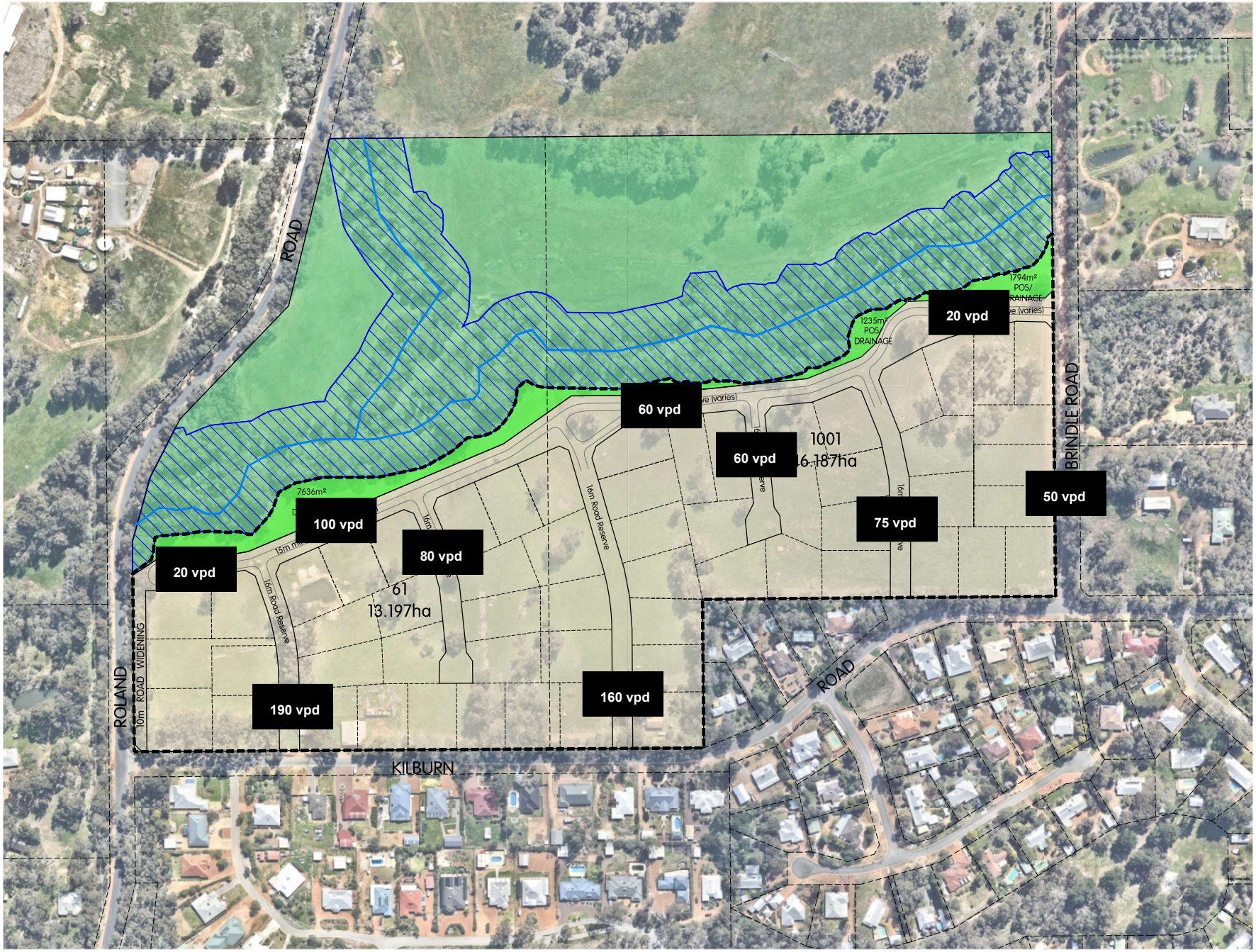
B. TRAFFIC FLOW VOLUMES

B



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CADASTRAL INFORMATION
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C. WAPC GUIDELINES CHECKLIST

C

APPENDIX: WAPC GUIDELINES CHECKLIST

Item	Provided	Comments/Proposals
Summary	Y	
Introduction/Background	Y	
Structure plan proposal		
regional context	Y	
proposed land uses	Y	
table of land uses and quantities	Y	
major attractors/generators	Y	
specific issues	Y	
Existing situation		
existing land uses within structure plan	Y	
existing land uses within 800 metres of structure plan area	Y	
existing road network within structure plan area	Y	
existing pedestrian/cycle networks within structure plan area	Y	
existing public transport services within structure plan area	Y	
existing road network within 2 (or 5) km of structure plan area	Y	
traffic flows on roads within structure plan area (PM and/or AM peak hours)	Y	
traffic flows on roads within 2 (or 5) km of structure plan area (AM and/ or PM peak hours)	Y	
existing pedestrian/cycle networks within 800m of structure plan area	Y	
existing public transport services within 800m of structure plan area	Y	
Proposed internal transport networks		
changes/additions to existing road network or proposed new road network	Y	
road reservation widths	Y	
road cross-sections & speed limits	Y	
intersection controls	Y	
pedestrian/cycle networks and crossing facilities	Y	
public transport routes	Y	
Changes to external transport networks		
road network	Y	
intersection controls	Y	
pedestrian/cycle networks and crossing facilities	Y	
public transport services	Y	
Integration with surrounding area		
trip attractors/generators within 800 metres	Y	

APPENDIX: WAPC GUIDELINES CHECKLIST

proposed changes to land uses within 800 metres	Y	
travel desire lines from structure plan to these attractors/generators	Y	
adequacy of external transport networks	Y	
deficiencies in external transport networks	Y	
remedial measures to address deficiencies	Y	
Analysis of internal transport networks		
assessment year(s) and time period(s)	Y	
structure plan generated traffic	Y	
extraneous (through) traffic	Y	
design traffic flows (that is, total traffic)	Y	
road cross-sections	Y	
intersection controls	Y	
access strategy	Y	
pedestrian/cycle networks	Y	
safe routes to schools	Y	
pedestrian permeability & efficiency	Y	
access to public transport	Y	
Analysis of external transport networks		
extent of analysis	Y	
base flows for assessment year(s)	Y	
total traffic flows	Y	
road cross-sections	Y	
intersection layouts & controls	Y	
pedestrian/cycle networks	Y	
Conclusions	Y	

Proponent's Name: _____

Company: _____ Date: _____

Transport Assessor's Name: Rodney Ding

Company: GTA Consultants Date: 12/05/2020

GTAconsultants

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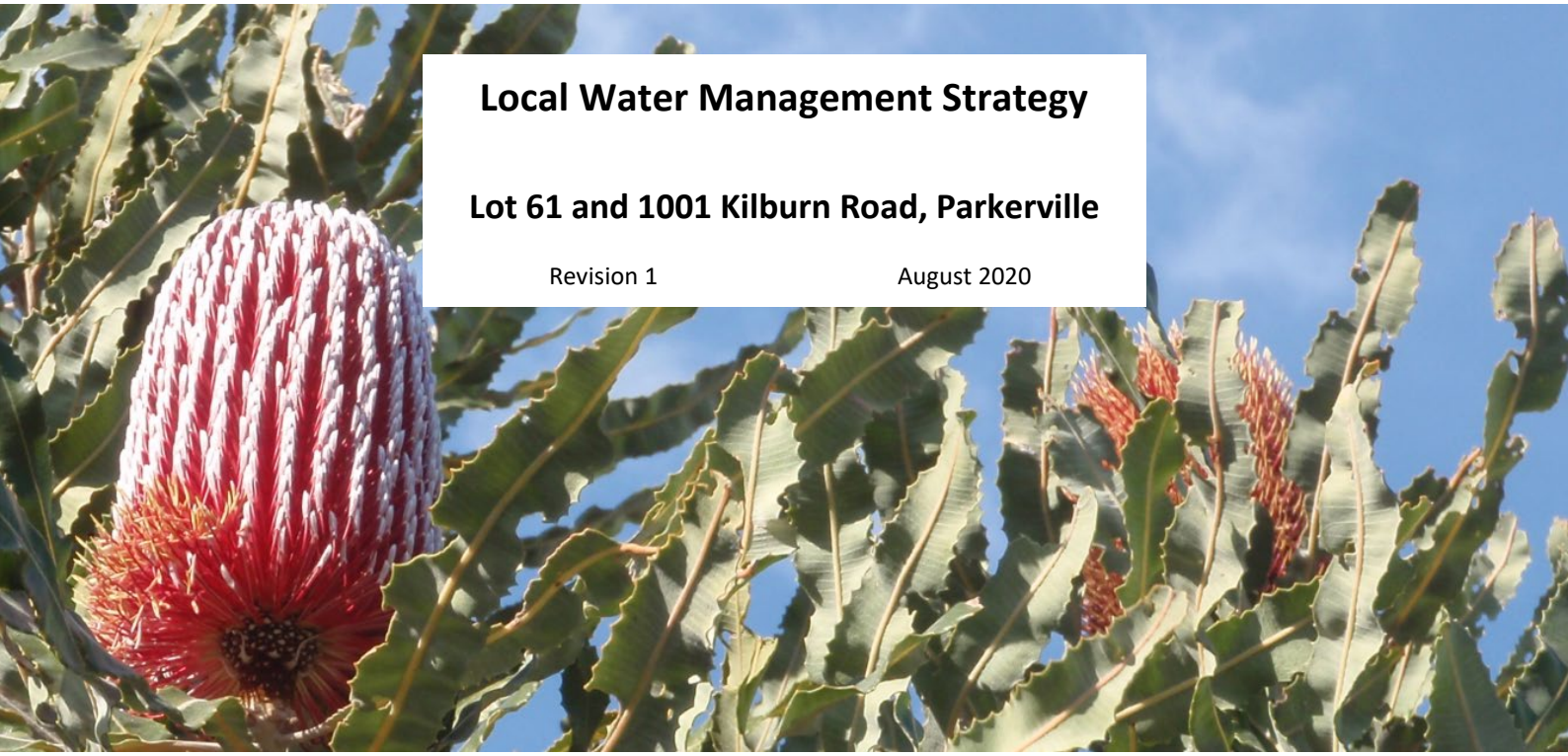
PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX E

LOCAL WATER MANAGEMENT STRATEGY

(COTERRA ENVIRONMENTAL)

COTERRA
ENVIRONMENT



Local Water Management Strategy

Lot 61 and 1001 Kilburn Road, Parkerville

Revision 1 August 2020

CALIBRE | COMMITMENT | COLLABORATION

This report was prepared by: Coterra Pty Ltd trading as COTERRA ENVIRONMENT
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Our Ref: CUTKIL06
Author(s): R Murray / R Epworth
Reviewer: R Epworth
Report Version: Revision 1
Date: August 2020

This report was prepared for:

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Executive Summary

Site Overview	Description
Site Location	Lot 61 and 1001 Kilburn Road, Parkerville located within the Shire of Mundaring. The site is intersected by Clutterbuck Creek and its' tributary.
Size	29.4 ha landholding.
Proposed Change in Land Use	The new development will include: • 58 Residential R5 lots with a minimum 2,000sqm. • 1.0665 ha POS within the Clutterbuck Creek foreshore.
Planning Context	Currently zoned Urban under the MRS and Development under Shire of Mundaring LPS and is within the Perth and Peel @ 3.5 Million North-East Sub-regional Planning Framework.
Hydrological Constraints	• The Clutterbuck Creek and its tributary intersects the site • Clay/ perched groundwater is present onsite which is often poorly draining
Hydrological Opportunities	• Maintain predevelopment flows to Clutterbuck Creek

Key Elements	Key Issues
Site Characteristics	• The Clutterbuck Creek intersects the site along with its' tributary. • The topography slopes towards Clutterbuck Creek from approximately 255 mAHD down to 240mAHD. • Regional soil geology within the site contains Gravel, Laterite, and Clayey Gravely Sand. Geotechnical investigations confirm this. • Permeability rates of 2.0 – 9.0 m/day. • Soil PRI indicates the soils are "very strongly adsorbing". • The site is mapped as having 'Extremely low probability of occurrence' of Acid Sulfate Soils 3 m below the surface. • Surface water flows in Clutterbuck Creek during winter months (ephemeral). Water quality for nutrients is above the ANZECC guidelines for upland rivers. • Groundwater varies spatially and temporally across the site, with shallowest levels occurring in the western portion of the site. • Maximum Groundwater Levels in the predevelopment bores vary from approximately 234 to 242mAHD. • No heritage or contaminated sites are located within site boundaries.
Biophysical Assessment	• A biophysical investigation was carried out onsite. • Vegetation, hydrology, soils, erosion, climate, topography, function, habitat, land use and heritage of Clutterbuck Creek were addressed. • The foreshore reserve was proposed based on this. • The foreshore reserve has a proposed setback from the creek of between 15m and 60m in various locations.
Water Use Strategy	• Water will be supplied by a connection to Water Corporation mains. • No irrigation is required for POS areas as POS will maintain native, existing vegetation which does not require additional water. • Wastewater disposal will be via onsite treatment and disposal • Secondary treatment systems/ATUs will be mandatory for all lots.

Key Elements	Key Issues
	• The proposed wastewater disposal has been assessed against the Government Sewerage Policy and is in compliance, with the exception of a 100m setback from the watercourse for some lots, however mitigation factors have been incorporated.
Stormwater Management	• Lots will infiltrate roof runoff/ building pad area runoff via soakwells. The remainder of the lot area (approx. 75%) will mimic pre development and runoff to the development drainage system. • Five sub catchments will each have a stormwater treatment basin. Treatment basins will treat the first 15mm before eventual discharge to Clutterbuck Creek. • Hydrological modelling (XPSWMM) has been undertaken to maintain predevelopment flows post development in a 5% AEP event (as stipulated in the DWMS). • Basin B has been sized larger to attenuate flows from the development as a whole, in the 5% AEP event to maintain pre development flows post development. • Road runoff will be conveyed to basins in a piped network up to the 20% AEP event and will then be conveyed in the road reserve in larger events. • All lots levels exceed the 0.3m separation distance requirement from the top water level in the basins. • Basins will be planted with nutrient stripping vegetation and will have 300mm of soil amendment beneath the basins to allow water quality treatment to occur prior to discharge.
Groundwater Management	• Building pad envelopes (approx. 25% of the lot area) is required to be filled with clean sand to achieve required separation distances. This will be undertaken by lot owners. • No subsoil drainage is proposed. • All basins achieve the 0.3m separation distance to groundwater/clay layer. Clay contouring and backfill with soil amendment will be undertaken beneath the basins to achieve separation and treatment. • 1.2m separation to groundwater is required for adequate soakwell efficiency and 0.6m for wastewater disposal using secondary treatment systems. • Building pad envelopes within lots will be filled, and clay layers re-contoured/removed when required, to achieve the separation distance requirements between finished floor levels and groundwater. A comprehensive assessment has been undertaken to ensure this is possible.
Monitoring and Reporting	• Pre-development water monitoring has been undertaken for surface water (quality and flows), and groundwater (levels). • Post development monitoring is proposed for three years post development. Quarterly for groundwater and during winter for surface water within the creek. • Annual reporting to be undertaken.

1 Introduction

1.1 Site Description

Lots 61 and 1001 Kilburn Road, Parkerville ('the site') forms a 29.4 ha landholding proposed for residential development. The landholding is currently owned by Parkerville Children and Youth Care Inc.

The site is located approximately 30 km north-east of Perth CBD within the Shire of Mundaring, bound by Roland Road in the west, Kilburn Road to the south, and rural lots to the north and east. The site is intersected by Clutterbuck Creek and its' tributary. The site location is shown in Figure 1.

1.2 Planning Context

The site is currently zoned *Urban* under the Metropolitan Region Scheme (MRS) and *Development* under the Shire of Mundaring Local Planning Scheme No. 4 (LPS4).

The proponent recently rezoned the site from Rural to Urban under the MRS and a District Water Management Strategy (DWMS) was prepared to support the rezoning application (Coterra Environment, 2019).

This LWMS has been prepared to support the Local Structure Plan (LSP) for the site.

1.2.1 Perth and Peel @ 3.5 Million North-East Sub-regional Planning Framework

The site is identified as Urban Investigation under the Perth and Peel @ 3.5 Million North-East Sub-regional Planning Framework (the framework).

The following has been identified as key considerations for the Parkerville Urban Investigation area under the framework:

- Bushfire risk (addressed in the Bushfire Management Plan (Structure Plan), JBS&G, 2020).
- Protection of significant environmental attributes (including Carnaby's Black Cockatoo habitat) (addressed in the Environmental Assessment Report, Coterra Environment, 2020).
- Suitable effluent disposal (addressed and approved in the DWMS, with further information to be provided in the detailed geotechnical report, this LWMS and the future UWMP).
- Availability of reticulated water supply (addressed in the DWMS and this LWMS).

1.3 Proposed Development

The Local Structure Plan has been prepared for the site and is provided in Figure 2. The proposed development includes 58 Residential R5 lots with a minimum 2,000sqm area. The site also includes 1.0665 ha of public open space, located predominately within the foreshore of Clutterbuck Creek and its' tributary which dissect the site.

2 Design and Management Objectives

2.1 Policy and Guidelines

This LWMS has been prepared in accordance with State Planning Policy 2.9 Water Resources (WAPC, 2006), *Better Urban Water Management* (WAPC, 2008), and *Interim: Local Water Management Strategies* (DoW, 2013). The LWMS checklist is provided in Appendix 1.

Additional guidance for the preparation of this LWMS is provided in:

- Liveable Neighbourhoods (WAPC, 2009).
- Local Government Guidelines for Subdivisional Development (IPWEA, 2012).
- WA State Water Strategy (Department of the Premier and Cabinet, 2004).
- WA State Water Plan (Department of the Premier and Cabinet, 2007).
- Water Sensitive Design Policy (EMRC, 2008).
- Operation Policy 4.3: Identifying and establishing waterways foreshore areas (Department of Water, 2012).
- Government Sewerage Policy (Government of Western Australia, 2019).
- Perth and Peel @ 3.5 Million North-East Sub-regional Planning Frameworks (Department of Planning, Lands and Heritage, 2018).

2.2 Design Objectives

The design objectives for the site are presented in Table 2-1 and have been derived from the policy and guidance listed in Section 2.1

Table 2-1 Design Objectives

Element	Principle	Objective
Surface Water Management	Manage catchments to maintain or improve water resources.	Manage and treat stormwater as close to source as much as possible.
		Maintain pre-development surface water discharges from the site.
		Maintain or where possible improve the water quality in the Clutterbuck Creek and other watercourses.
		Maintain surface water quality at pre-development levels.
	Maintain foreshore of Clutterbuck Creek other watercourses	Exclude development from the foreshore of the Clutterbuck Creek and other watercourses where possible.
Groundwater Management	Manage catchments to maintain or improve water resources.	Maintain or improve groundwater quality.
	Manage risks to human life and property.	Provide adequate management of perched groundwater (if present).

Element	Principle	Objective
Flood Risk Management	Manage risks to human life and property.	Protect people and the built environment from flooding and inundation on site.
		No adverse impact in terms of flood risk to communities upstream and downstream of the development.
Nutrient Management	Manage catchments to maintain or improve water resources.	Reduce nitrogen load generated on the site.
		Reduce phosphorous load generated on the site.
Water conservation strategy (potable and wastewater)	Manage catchments to maintain or improve water resources.	Maintain or reduce water usage.
	Ensure the efficient use of water resources	Achieve WA State Water Plan targets of household potable water consumption
		Minimise the external use of potable water.

3 Pre-Development Environment

3.1 Current and Historical Land Use

The site is located within the Darling Ranges and is surrounded by rural or rural-residential land uses on all sides. The site is largely cleared with some pockets of vegetation remaining.

A review of historical aerial photography indicates that the site has been cleared since at least 1965 and is likely to have been used for pastoral grazing.

3.2 Climate and Rainfall

The site experiences a Mediterranean climate, with mild wet winters and hot dry summers. Average annual rainfall at the nearest weather station is 1,086 mm (BoM Station number 9030 - Mundaring). The average monthly rainfall statistics are provided in Table 3-1.

Table 3-1 Average Monthly Rainfall Statistics

Month	Mean rainfall (mm)
January	14.5
February	17.6
March	23.3
April	51.8
May	134.1
June	208
July	212.8
August	171.7
September	111.6
October	69.2
November	32.4
December	17.2
Annual	1069.3

Source: Bureau of Meteorology (2019). Station number 9030 - Mundaring. Record from 1888 – 2019.

3.3 Topography

The site is located within the valley of the Clutterbuck Creek. The valley floor lies at approximately 235 mAHD. On the northern side of the Clutterbuck Creek the site slopes north to south from approximately 240 mAHD to the valley floor. On the southern side of the Clutterbuck Creek the site slopes from south to north from approximately 255 mAHD.

The topography of the site is shown in Figure 3.

3.4 Geology and Soils

Regional geology and soil mapping (Smurthwaite, 1989) is shown in Figure 4 and indicates that the site consists of the following three geological units:

- G2 – GRAVEL – yellow-brown to reddish-brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor recementation; colluvial origin. This geology is associated with the majority of the site area.
- Sgc – CLAYEY GRAVELLY SAND – grey and yellow, kaolinitic, decomposed bedrock, sand and gravel veneer; granitic / gneissic origin. This geology is associated with the creek area on the western side of the site.
- LA1 – LATERITE – massive, hard, cemented, vuggy and pisolitic; up to 1 m thick, overlain by and associated with gravels (G2 and G3) or residual origin. This geology is associated with a small area on the eastern side of the site.

The Department of Agriculture (DoA, 2004) soil landscape mapping indicates that the upland portions of the site lie within the Dwellingup 'DW2' soil-landscape unit on the lateritic uplands of the Darling Plateau. This is shown in Figure 5. These soils are described as:

- DW2 – Very gently to gently undulating terrain (<10%) with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust.

The low-lying portions of the subject area associated with Clutterbuck Creek are largely mapped as Yarragil YG1 and YG4, described as:

- YG4 – Valley floors with poorly drained mottled yellow duplex soils.
- YG1 – Gently to moderately inclined side slopes with moderately well-drained yellow duplex soils, and yellow and brown massive earths.

3.4.1 Preliminary Geotechnical Investigation

A preliminary geotechnical investigation has been undertaken to confirm the site geology, site classifications for lots and suitability for non-sewered effluent disposal.

The geotechnical investigation involved the excavation of twelve test pits, seven in-situ permeability tests, dynamic penetrometer testing adjacent to each test pit location, and laboratory analysis. Test pits were excavated to a maximum depth of 2.0 m using an eight tonne excavator. Refusal occurred prior to the target depth in five locations due to slow or hard digging.

The following soils identified are summarised below:

- **Topsoil (gravelly silty sand)** – generally dark brown-black, fine to medium grained gravelly silty topsoil with some roots.
- **Filling (gravelly sand)** – medium dense, dark brown, fine to medium grained gravelly sand filling (TP9 only).
- **Gravelly clayey sand/clayey sandy gravel** – generally loose, locally medium dense or dense, brown, fine to medium grained gravelly clayey sand or fine to coarse sized clayey sandy gravel. Contained cobbles and boulders of laterite at some test locations.
- **Laterite** – generally high strength laterite.
- **Clayey sand/sandy clay** – generally very dense or hard, light yellow-brown or light grey-brown mottled brown, clayey sand or sandy clay. Sand is medium to coarse grained and clay is of medium plasticity.

The preliminary geotechnical report is provided in Appendix 2.

3.4.2 Onsite Soil Investigation (Pritchard Francis)

In addition to the preliminary geotechnical investigation, in December 2019 Pritchard Francis conducted a more detailed investigation to gather information at 67 test pits. This allowed specific soil information to be gathered for most lots. Appendix 3 shows the test pit locations and findings at each location. In general:

- Clay is present at most locations in the west and along the Clutterbuck Creek from approximately 0.7m to 1.4 m below the surface.
- Rock (laterite) is present in scattered locations in the west, and in properties closest to the Kilburn road and Brindle Road intersection.
- Gravel is present at most locations across the site, agreeing with regional geology mapping.

3.4.3 Soil Permeability

Department of Agriculture and Food land capability mapping indicates that in lowland areas of the site associated with the creek (land unit YG4) site drainage potential is 'very poor to poor' and waterlogging risk is 'moderate to very high'.

In upland areas of the site underlain by gravel (G2) geology soil permeability may be suitable for infiltration depending on the thickness and extent of the gravel horizon. See Section 3.5 for further information.

Site soil permeability testing was undertaken at seven locations as part of the preliminary geotechnical investigation using the constant head method. The test pit locations are shown in Appendix A of the Geotechnical Report (Appendix 2) and Figure 4. The results of the permeability testing indicate permeability rates of 2.0 – 9.0 m/day. The results are summarised in Table 3-2 below.

Table 3-2 Results of Permeability Analysis

Test location	Depth (m)	Measured permeability		In situ conditions of tested material
		m/s	m/day	
BH13	0.25	3.9×10^{-5}	3.5	Gravelly Clayey Sand
BH14	0.25	2.6×10^{-5}	2.0	Clayey Sandy Gravel
BH15	0.25	2.5×10^{-5}	2.0	Clayey Sandy Gravel
BH16	0.25	4.2×10^{-5}	3.5	Gravelly Clayey Sand
BH17	0.25	5.3×10^{-5}	4.5	Gravelly Clayey Sand
BH18	0.25	10.5×10^{-5}	9.0	Clayey Sandy Gravel
BH19	0.25	4.3×10^{-5}	3.5	Clayey Sandy Gravel

Source: Douglas Partners (2018).

3.4.4 Phosphorous Retention Index

Site specific PRI testing was undertaken at three locations as part of the preliminary geotechnical investigation (Douglas Partners, 2018). The results are provided in Table 3-3 below. The results of this testing indicate the site soils are very strongly adsorbing (Table 3-4 below).

Table 3-3 PRI Test Results

Test location	Depth (m)	PRI
TP1	1.1-1.3	418.3
TP6	0.5	188.0

Test location	Depth (m)	PRI
TP11	0.5	177.9

Table 3-4 PRI Fixation Properties

PRI	Description
Negative	desorbing
0–2	weakly adsorbing
2–20	moderately adsorbing
20–100	strongly adsorbing
>100	very strongly adsorbing

Source: Department of Agriculture and Food

3.4.5 Acid Sulphate Soils

The site is mapped by the Australian Soil Resource Information System (ASRIS) as having 'Extremely low probability of occurrence' of Acid Sulfate Soils (ASS) at depths of up to three metres below ground level (ASRIS, 2016).

3.5 Land Capability Summary

Land capability mapping has been prepared as part of the Darling Range Land Capability Study (King and Wells, 1990) and is presented in Department of Agriculture and Food's online mapping. Land capability mapping is used to guide land use planning and development based on soil suitability for various land uses.

As outlined in Section 3.4 the site is made up of three land units, DW2, YG4 and YG1 (shown in Figure 5). The characteristics of these land units are outlined in Table 3-5 below. The land capability assessment is discussed further in Section 5.2.1.

Table 3-5 Land Capability Summary

Land Qualities	DW2 - Dwellingup	YG1 - Yarragil	YG4 - Yarragil
Water erosion risk	Low	Low	Moderate
Wind erosion risk	Low	Low	Low
Microbial purification ability	Low	Moderate	Low
Water pollution risk	N/A	N/A	High (overland flow) Low (subsurface leaching)
Ease of excavation	Moderate	Moderate	Moderate
Waterlogging inundation risk	Low	Low	Moderately high
Flood risk	Nil	Nil	Low
Rural retreat (housing, roads and effluent disposal)	Fair capability (III)	High capability (II)	Very low capability (V)

Land Qualities	DW2 - Dwellingup	YG1 - Yarragil	YG4 - Yarragil
House and road construction	High capability (II)	High capability (II)	Fair capability (III)
Effluent disposal (septic tanks)	Fair capability (III)	High capability (II)	Very low capability (V)

3.6 Surface Water

3.6.1 Watercourses

The site is bisected east to west by the Clutterbuck Creek and north to south (in the northern portion of the site) by a small unnamed tributary (referred to as Clutterbuck tributary in this report).

The Clutterbuck Creek is an ephemeral watercourse with headwaters in Stoneville in the Darling Ranges. The Clutterbuck Creek discharges to the Jane Brook to the west of the site, and ultimately to the Swan River on the Swan Coastal Plain.

The Clutterbuck tributary enters the site from the neighbouring property to the north, creating a confluence with Clutterbuck Creek on the western side of the site. Both the Clutterbuck Creek and tributary are dammed in multiple locations upstream of the site.

The watercourse locations relative to the site are shown in Figure 6.

3.6.1.1 Water Quality

DWER WIN sites 6161125, 6161126, 6161723, 6161724 and 6161725 are located on the Clutterbuck Creek/tributary near to the site. However, no data is available at these sites.

Pre-development surface water monitoring within the Clutterbuck Creek and Clutterbuck Tributary has been undertaken from June 2018 until September 2019 (two winters), at three locations KIL01, KIL02 and KIL03 (Figure 4). Monitoring was only undertaken during the winter months at the site due to the ephemeral nature of the creek. The monitoring locations are summarised as:

- KIL01: Clutterbuck Creek, upstream of the proposed development
- KIL02: Clutterbuck Tributary, upstream of the proposed development
- KIL03: Clutterbuck Creek, downstream of the proposed development

Results of pre-development monitoring are given in Table 3-6 and Table 3-7 below.

Table 3-6 Pre-development Monitoring Results – In-situ Parameters

Bore	Date	Appearance	Colour	Temperature	pH	EC (mS/cm)	TDS (mg/L)	Redox (mV)	DO (%)
ANZECC Guideline					**6.5-8.0**				**min 90%**
KIL01	Jun-18	Clear	Clear	12.8	5.29	640.6	416.65	183.6	60.4
	Jul-18	Clear	Clear	13.5	6.15	292.8	246.05	156.4	75.8
	Aug-18	Clear	Clear	13.7	7.71	262.1	217.1	28.6	84.2
	Sep-18	Clear	Clear	17.5	9.02	379	287.95	71.1	94.8
	Jun-19	Clear	Clear	12.6	6.42	605.3	393.25	84.1	61.3
	Jul-19	Clear	Clear	14	7.52	557.3	362.05	97.2	89.2
	Aug-19	Clear	Clear	14	8.01	307.8	200.2	25.6	91.6
	Sep-19	Clear	Clear	17.5	8.45	416.5	270.4	-21.8	95.4
KIL02	Jun-18	Clear	Clear	12.5	5.23	1262	819.00	195.5	52.3
	Jul-18	Clear	Clear	13.9	6.32	491.1	404.95	184.9	67.9
	Aug-18	Clear	Clear	13	7.07	378.2	319.15	63.4	84.5
	Sep-18	Clear	Clear	15.5	8.23	586	468	114.9	91.1
	Jun-19	DRY							
	Jul-19	Clear	Clear	12.7	7.05	715	461.5	118.8	67.2
	Aug-19	Clear	Clear	12.4	7.45	903	585	72.8	86.7
	Sep-19	Clear	Clear	15.4	8.19	701	455	39.1	85.8
KIL03	Jun-18	Clear	Clear	11.7	5.50	616.2	400.4	183.4	65.4
	Jul-18	Clear	Clear	13.6	6.38	363.2	302.25	163.3	75
	Aug-18	Clear	Clear	13.8	6.76	305.1	252.2	56.1	78.8
	Sep-18	Clear	Clear	19.3	7.95	453	349.7	138.5	93.4

Bore	Date	Appearance	Colour	Temperature	pH	EC (mS/cm)	TDS (mg/L)	Redox (mV)	DO (%)
ANZECC Guideline					**6.5-8.0**				**min 90%**
	Jun-19	Clear	Clear	12.4	7.12	693	448.5	126.6	76.1
	Jul-19	Clear	Clear	12.6	6.99	572.6	372.45	123.1	84.7
	Aug-19	Clear	Clear	12.9	7.22	607.1	394.55	70.4	76.9
	Sep-19	Clear	Clear	17.1	7.34	526	341.9	49.8	81.1
	Not within ANZECC guidelines								

**ANZECC (2000) Guidelines for Aquatic Ecosystems (Upland Rivers) in South-West Australia.*

Table 3-7 Pre-development Monitoring – Laboratory Results

Bore	Date	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	FRP (mg/L)	Ammonia-N (mg/L)	NOx-N (mg/L)	TSS (mg/L)	Turbidity (NTU)	E. Coli (cfu/100 mL)	Thermotolerant coliforms (cfu/100 mL)
ANZECC upland rivers		**0.45**	**0.02**	**0.01**	**0.06**	**0.2**		**10-20**		
KIL01	Jun-18	2.1	0.05	<0.01	<0.02	2.1	<5	1	130	130
	Jul-18	3.2	0.05	<0.01	<0.02	3.2	<5	8.4	810	810
	Aug-18	1.7	0.03	<0.01	0.03	1.6	<5	3.4	120	120
	Sep-18	0.9	0.05	<0.01	<0.02	0.6	<5	1.1	14	44
	Jun-19	2.5	0.06	<0.01	0.05	2.5	<5	2.4	>60	>80
	Jul-19	2.3	0.03	<0.01	<0.02	2.3	<5	1.2	Est[6]	Est [8]
	Aug-19	1.9	0.02	<0.01	0.03	1.6	<5	1.4	73	73
	Sep-19	0.9	0.02	<0.01	<0.02	0.79	<5	0.8	59	59

Bore	Date	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)	FRP (mg/L)	Ammonia-N (mg/L)	NOx-N (mg/L)	TSS (mg/L)	Turbidity (NTU)	E. Coli (cfu/100 mL)	Thermotolerant coliforms (cfu/100 mL)
ANZECC upland rivers		**0.45**	**0.02**	**0.01**	**0.06**	**0.2**		**10-20**		
KIL02	Jun-18	0.2	0.05	<0.01	<0.02	0.02	<5	0.1	Present [4]	Present [4]
	Jul-18	0.9	0.06	<0.01	<0.02	0.78	<5	5.8	20	20
	Aug-18	0.4	0.03	<0.01	<0.02	0.26	<5	2.9	18	22
	Sep-18	0.4	0.06	<0.01	<0.02	0.09	<5	0.9	Present [3]	Est [4]
	Jun-19	DRY								
	Jul-19	0.2	0.04	<0.01	<0.02	0.08	<5	0.3	Est [6]	Est [7]
	Aug-19	0.5	0.05	<0.01	<0.02	0.14	<5	0.4	64	64
	Sep-19	0.7	0.03	<0.01	<0.02	0.07	<5	0.6	12	15
KIL03	Jun-18	1.8	0.05	<0.01	0.02	1.8	<5	0.5	73	73
	Jul-18	2.6	0.05	<0.01	<0.02	2.5	5	7.7	580	580
	Aug-18	1.3	0.03	<0.01	<0.02	1.2	<5	3.4	84	100
	Sep-18	0.7	0.06	<0.01	<0.02	0.42	<5	1.4	Est [9]	21
	Jun-19	1.9	0.07	<0.01	0.04	1.9	10	0.8	>100	>100
	Jul-19	1.7	0.03	<0.01	<0.02	1.5	<5	1	76	83
	Aug-19	1.4	0.03	<0.01	0.02	1	<5	1.5	73	73
	Sep-19	0.8	0.04	<0.01	<0.02	0.54	<5	0.7	16	16

The results indicate that the water in the Clutterbuck Creek ranges in pH from 5.23 – 8.23. A minor trend of increasing pH, decreasing electrical conductivity and increasing dissolved oxygen was observed as the winter progresses from most events (except for KIL02 and KIL03 in 2019). In general readings at KIL03 do not range as high in pH as the upstream quality results, and dissolved oxygen concentration is fairly consistent with upstream readings.

The nutrient concentrations at the site indicated the following trends;

- The total nitrogen (TN) concentrations at the upstream and downstream locations both exceeded ANZECC upland river guidelines of 0.45mg/l.
  - There was a little improvement between the upstream and downstream TN quality overall, indicating that there was some net improvement in general across the site (upstream average TN of 1.9 mg/l and downstream average TN of 1.5 mg/l).
  - The TN water quality coming from the small tributary (catchment to the north of the site) was better than the upstream concentrations (average TN of 0.5 mg/l) so this may have accounted for the improvement in concentration downstream (dilution effect).
- The total phosphorus concentrations at the upstream and downstream locations generally both exceeded ANZECC upland river guidelines of 0.02mg/l slightly.
  - There was no improvement between the upstream and downstream TP quality overall, however both concentrations were generally quite low (upstream average TP of 0.039 mg/l and downstream average TP of 0.045 mg/l).
  - The TP water quality coming from the small tributary (catchment to the north of the site) was similar to the downstream concentration (average TN of 0.046 mg/l), again demonstrating that the tributary inflow is likely impacting the downstream water quality.

3.6.1.2 Water Flows

Flow monitoring during the 2018 and 2019 winter periods demonstrate the ephemeral nature of the Clutterbuck Creek, with low to no flow observed during early winter monitoring, generally in June. The maximum flow rate was recorded during August 2018 with an approximate discharge of 293.88 L/s from KIL03.

The results of the flow monitoring are given in Table 3-8 below.

Table 3-8 Pre-development Flow Monitoring Results

Location	Date	Mean Velocity (m/s)	Discharge (L/s)
KIL01	Jun-18	No flow	0
	Jul-18	0.24	79.94
	Aug-18	0.21	147.91
	Sep-18	0.18	23.42
	Jun-19	0.02	3.52
	Jul-19	0.14	7.27
	Aug-19	-*	-*
	Sep-19	0.02	9.97
KIL02	Jun-18	0.17	3.9
	Jul-18	0.18	19.6

Location	Date	Mean Velocity (m/s)	Discharge (L/s)
KIL02	Aug-18	0.24	32.16
	Sep-18	0.15	8.81
	Jun-19	DRY	DRY
	Jul-19	0.04	0.73
	Aug-19	-*	-*
	Sep-19	0.05	3.11
KIL03	Jun-18	No flow	-
	Jul-18	0.13	103.55
	Aug-18	0.21	293.88
	Sep-18	0.11	24
	Jun-19	0.03	3.38
	Jul-19	0.09	13.88
	Aug-19	-*	-*
	Sep-19	0.07	40.44

* *Faulty equipment gave rise to inaccurate results and have not been included*

3.6.2 Wetlands

There are no mapped wetlands identified on the Geomorphic Wetlands dataset on the SLIP Atlas within or in proximity to the site (Landgate, 2016).

3.7 Groundwater

The site is underlain by a fractured rock aquifer within the (un-proclaimed) Karri Groundwater Area.

The Perth Groundwater Map indicates that the site is outside of the range of DWERs groundwater contour mapping.

3.7.1 WIN Bore Investigations

WIN bore 5466 is located approximately 60 m west of the site (Figure 6) in proximity to the Clutterbuck Creek. Monitoring was undertaken within this bore between February 1983 and September 1990. The maximum groundwater level recorded over this time was 232.515 mAHD.

As no bore construction information is available it is unclear whether this level represents a perched or regional groundwater level. It is noted that the bore is located in the valley of the Clutterbuck Creek near the lowest point of the site.

3.7.2 Site Specific Investigations

Five groundwater bores were installed at the site during August 2018 for the purpose of determining the extent and depth of groundwater at the site. The bore locations and MGL readings are shown in Figure 6.

The bores were monitored for groundwater levels, in August – October 2018, and June - September 2019 to capture two peak periods. The results of this monitoring is provided in Table 3-9 and Table 3-10 below.

Table 3-9 Groundwater Monitoring Results (mbgl)

Date	MBK01	MBK02	MBK03	MBK04	MBK05
Aug-18	2.15	1.80	0.00	0.13	0.85
Sep-18	1.82	0.67	0.73	0.86	1.52
Oct-18	2.40	0.88	0.93	0.96	1.99
Jun-19	DRY	0.77	0.65	0.87	3.04
Jul-19	1.92	0.61	0.58	0.72	1.32
Aug-19	2.25	0.67	0.48	0.59	1.67
Sep-19	1.70	0.63	0.61	0.78	1.31

Table 3-10 Groundwater Monitoring Results (mAHD)

Date	MBK01	MBK02	MBK03	MBK04	MBK05
Aug-18	242.88	243.19	240.01	234.86	244.18
Sep-18	243.21	244.32	239.28	234.13	243.51
Oct-18	242.63	244.11	239.08	234.03	243.04
Jun-19	DRY	244.22	239.36	234.12	241.99
Jul-19	243.11	244.38	239.43	234.27	243.71
Aug-19	242.78	244.32	239.53	234.40	243.36
Sep-19	243.33	244.36	239.40	234.21	243.72
	Annual Maximum				

The results of the monitoring indicate that groundwater varies spatially and temporally across the site, with shallowest levels occurring in the western portion of the site (MBK03 and MBK04).

Maximum groundwater levels over the pre development period varied from 234.36mAHD on the western side of the site, to 242.33mAHD on the eastern side of the site.

Results indicated that groundwater levels reached their peak in August/September each year.

3.8 Contamination

There are no registered contaminated sites located within or adjacent to the site shown on the Department of Environment Regulation (DER) contaminated sites database (DER, 2016).

3.9 Heritage

There are no registered aboriginal heritage sites located within the site boundary.

4 Biophysical Assessment

A biophysical environmental assessment for the site was undertaken in July 2019. This assessment was undertaken at the anticipated peak surface water flow period of the year and was undertaken of Clutterbuck Creek and the tributary to the north which feeds into Clutterbuck Creek on site.

This biophysical assessment has been undertaken in in consideration of the *Operational Policy 4.3: Identifying and establishing waterways foreshore areas* (DoW, 2012). This policy describes the process for identifying and managing foreshore areas whose values are under pressure from land-use changes in the area around them. The proponent is responsible for identifying the foreshore area of waterways as part of land planning and other approval processes.

DWER assesses the risks to waterways and supports proposals that appropriately manage these risks. DWER generally does not support development activities within a foreshore area if they are not consistent with the purpose of the foreshore area, if they may damage the condition of a waterway, or if the risks to waterways are not appropriately managed. This includes development activities that require clearing, altering the watercourse hydrology, changing the landform, discharging wastewater, disturbing ASS and construction. None of these activities are proposed at the site. DWER recommends a flexible approach to identifying foreshore areas, rather than simply adopting 'standard' foreshore widths. Historically, a foreshore area width of 30 metres for waterways and 50 metres for estuaries was generally applied.

The *Identifying the Foreshore Area Policy* (Water and Rivers Commission, 2002) discusses that determining foreshore areas should be based on biological and physical criteria which includes the following:

- Vegetation
- Hydrology
- Soil type
- Erosion
- Geology
- Climate
- Topography
- Function/uses
- Habitat
- Land use
- Heritage

These are discussed further in Table 4-1 and the proposed foreshore reserve for this site presented in Section 4.2. The proposed concept plan drainage areas and foreshore reserve are shown in Figure 2.

4.1 Biophysical Foreshore Assessment

Table 4-1 assesses the Biophysical Criteria identified above. Figure 7 indicates the extent of the Reaches identified in Table 4-1 below and Appendix 4 presents photos of the watercourse.

Table 4-1 Biophysical Criteria Assessment for Clutterbuck Creek

Reach	Reach 1	Reach 2	Reach 3	Reach 4
Location	**See Figure 7– Eastern end of Clutterbuck Creek.**	**See Figure 7– Mid section of Clutterbuck Creek.**	**See Figure 7– Western end of Clutterbuck Creek.**	**See Figure 7– Northern tributary into Clutterbuck Creek.**
Vegetation (Figure 8 and Figure 9)	• Tall Forest to Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Low Open Grass dominated by *Microlaena stipoides*. • Vegetation condition varying between 'Good' to 'Very Good' along most of the Reach, with a small area of 'Very Good Bordering on Excellent'.	• Partly Tall Forest to Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Low Open Grass dominated by *Microlaena stipoides*. • Partly Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species. • Vegetation condition varying between 'Good' and 'Good to Degraded'.	• Partly Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species. • Partly planted corridors of mainly Eastern Australian *Eucalyptus* species. • Vegetation condition varying between 'Good to Degraded' to 'Completely Degraded but trees planted in corridor which should be retained'.	• Partly Open Woodland of *Corymbia calophylla*, *Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species. • Partly Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia*. • Vegetation condition varying between 'Good' and 'Good to Degraded'.
Hydrology - flows	Flat gradient through watercourse long section resulting in near stagnant water along a lot of the reach. Some tree dams creating flatter gradients followed by waterfalls. • Stagnant areas 0 – 0.02m/s. • Post tree dams ~0.2m/s	Flow interrupted by many tree blockages/dams. No evidence of breaking banks due to blockages. • Some stagnant areas. • Velocity 0 - 0.08m/s	• Stagnant to low flow through this reach. • Velocity 0 – 0.05m/s.	Faster velocity but not as much volume of water due to smaller catchment. • Velocity 0.03 – 0.2 m/s

Reach	Reach 1	Reach 2	Reach 3	Reach 4
Location	**See Figure 7– Eastern end of Clutterbuck Creek.**	**See Figure 7– Mid section of Clutterbuck Creek.**	**See Figure 7– Western end of Clutterbuck Creek.**	**See Figure 7– Northern tributary into Clutterbuck Creek.**
Hydrology – high water mark	• High water mark width range 1.5m – 8m, but average ~2-3m. • Average depth at high water mark 0.2m - 0.4m, some pools at ~0.7m depth.	• High water mark width range 2m – 5m, average ~3m. • Average depth at high water mark ~0.1m, some pools at ~0.3m depth.	• High water mark width range 1m – 3m, average ~2.5m. • Average depth at high water mark ~0.1 - 0.2m, some pools at ~0.6m depth.	• High water mark width range 0.5m – 1.3m, average ~0.6m. • Average depth at high water mark ~0.02 - 0.1m. • No significant pooling.
Topography and landform	Sections of wider water with less defined channels than other reaches. Large delta type area (7-8m wide) at photo location 21/22.	Some areas of wider flat delta type areas (~5m wide). A small island has been formed by a diverted flow path. A large tree fell over pulling the root system up with it. The tree was previously in the direct path of the creek and the creek went around the tree, but when the roots ripped up the earth the creek was able to go straight ahead. The original creek route in this location has therefore become redundant and undefined as the majority of the watercourse flow carries on straight ahead in the new flow path created.	More defined, thinner channel than Reaches 1 and 2. No flatter delta type areas.	Slightly steeper long section gradient due to natural topography of the land causing increased velocities. Narrower watercourse, not well defined edges/top water level but at the topographical low point so clearly distinctive.
Soils/Geology	• Gravel (G2) • Silty sediments along the western end of the reach. • Pebbles/gravel at eastern end of the reach creating riffles.	• Clayey Gravelly Sand (Sgc)	• Clayey Gravelly Sand (Sgc) • Pebbles/gravel along a lot of this reach after the confluence with the northern tributary - creating riffles in places.	• Clayey Gravelly Sand (Sgc) • Pebbles/gravel along all of this reach creating riffles

Reach	Reach 1	Reach 2	Reach 3	Reach 4
Location	**See Figure 7– Eastern end of Clutterbuck Creek.**	**See Figure 7– Mid section of Clutterbuck Creek.**	**See Figure 7– Western end of Clutterbuck Creek.**	**See Figure 7– Northern tributary into Clutterbuck Creek.**
Erosion	• Flatter edges to watercourse with no/little signs of erosion. • No signs of surface water runoff from the site creating inlets/erosion into Clutterbuck Creek.	• This reach has a less defined water course and flatter flood plain. • No signs of surface water runoff from the site creating inlets/erosion into Clutterbuck Creek.	• Some local erosion of the steeper sides/ subsidence of soils into the watercourse. • No signs of surface water runoff from the site creating inlets/erosion into Clutterbuck Creek.	• No signs of surface water runoff from the site creating inlets/erosion into Clutterbuck Creek.
Function/uses	Flood conveyance. The creek appears to be primarily a conveyance system for surface water from higher up in the catchment.	Flood conveyance. The creek appears to be primarily a conveyance system for surface water from higher up in the catchment.	Flood conveyance. The creek appears to be primarily a conveyance system for surface water from higher up in the catchment.	Flood conveyance. The creek appears to be primarily a conveyance system for surface water from higher up in the catchment.
Habitat	• Sediment and leaf matter along the length. • Minimal aquatic vegetation. • Riffles at the eastern end.	• A lot of felled trees creating dams/ blockages. • Sediment and leaf matter along the length. • Minimal aquatic vegetation.	• Riffles present. • No aquatic vegetation.	• Numerous riffles. • Some aquatic/ moss vegetation towards the southern end of the reach.
Land-use	Farm to the south and cleared field to the north.	Farm to the south and cleared field to the north.	Farm to the south and cleared field to the north.	Rowley Road to the west and cleared field to the east.
Heritage	No registered aboriginal heritage sites.	No registered aboriginal heritage sites.	No registered aboriginal heritage sites.	No registered aboriginal heritage sites.

4.2 Proposed Foreshore Reserve

As identified in Section 4.1, in the DWMS a generic foreshore reserve with a 30m setback was established. The biophysical assessment undertaken has assessed the watercourse, the hydrology and the vegetation and proposes a new foreshore reserve boundary.

This biophysical assessment has been prepared to support the construction of two drainage basins within the previous foreshore reserve setback line (30m buffer) and receive preliminary confirmation that this design is acceptable. The Biophysical Assessment Report (Coterra, 2019b) was submitted to DWER and liaison was undertaken to determine if the proposed foreshore was acceptable. DWER requested some further information on the management of the foreshore and POS area abutting the foreshore (addressed in Section 4.2.1 below) but otherwise had no objections to the foreshore proposed. The biophysical information was to be included in this LWMS and ultimately assessed as a whole.

Setback and foreshore reserve reduction has been proposed in some areas due to the topography and layout of the expected concept plan (Figure 2). Consideration of how the foreshore area was determined and which areas have been added/removed is shown in Figure 10. The ultimate foreshore boundary line proposed is shown in Figure 11 (derived from the assessment indicated in Figure 10).

Based on the biophysical assessment, and resulting proposed foreshore reserve, the following changes have been proposed regarding the foreshore reserve and setbacks, in comparison to the generic 30m buffer proposed in the DWMS:

- Include an additional 5 ha within the foreshore reserve, including vegetated areas ranging from 'Very good bordering on excellent' to 'good to degraded'.
- Additional tree retention in an area of 'completely degraded' but with some good conditioned gum trees at 10 locations.
- Achieve a minimum setback of approximately 40m to 60m in some locations (Figure 11).
- Exclude 1.4 ha from the generic 30 m buffer at two locations – this is all currently cleared agricultural land with no vegetation. This equates to a minimum setback of approximately 20m in one location and 15m in the other (Figure 11).

The revised setbacks and foreshore areas are expected to provide an additional 3.6 ha of vegetation to total 6.77 ha, which is also to be rehabilitated (in addition to the 2.05 ha POS area provided and shown on the concept plan).

There are two areas within the original generic 30m setback that have been identified as potential drainage areas. These areas are both cleared (no vegetation) and at natural low points in the sub catchments that make them conducive to drainage areas. The basins will be revegetated with water quality treatment vegetation (Section 6.5).

This is considered to be an overall net environmental and ecological benefit to Clutterbuck Creek.

4.2.1 Foreshore Management

The foreshore area will be handed over and managed by the local government following construction. The area will not include any turf, footpaths, boardwalks, or public access ways, and as such there is no requirement for rubbish or erosion control measures. The area will be ceded as a 'Conservation Reserve', in line with correspondence with the Shire of Mundaring (provided in Appendix 5).

5 Water Supply and Disposal

5.1 Water Supply

The site lies adjacent to an area that is serviced by the Water Corporation however there is currently no potable water supply to the site. A connection to the Water Corporation mains will be required to service the site and is available with 100mm extensions to the Roland and Brindell Roads.

Water Corporation have confirmed that there is sufficient capacity within the existing water supply network to service the site, following correspondence for the DWMS (correspondence in Appendix 5).

5.1.1 Irrigation Water Supply

No water is required for POS irrigation supply. Most of the POS areas are associated with the creek foreshore or around retaining existing trees. The native vegetation will be preserved and is well established so will not require additional water (other than rainfall).

5.2 Wastewater Disposal

The site is not located within an area currently serviced by a reticulated sewage system. As such, a non-reticulated effluent disposal method within individual lots are proposed for use at the site. This was proposed as part of the approved DWMS (Coterra, 2019).

Secondary Treatment Systems (STSs) will be mandatory for lots. The requirement for Department of Health (DoH) approved STSs will be mandated through Part 1 of the Local Structure Plan and consequently the subdivision conditions. DoH approved STSs and aerobic treatment units (ATU's) are provided in Appendix 6.

The Shire of Mundaring are supportive of non-sewered effluent disposal subject to land capability assessment (provided in this report) (correspondence provided in Appendix 5), and Department of Health are supportive subject to a Site and Soil Evaluation (expected at subdivision stage).

5.2.1 Land Capability

As outlined in Section 3.5, the Department of Agriculture and Food's land capability mapping indicates that the DW2 and YG1 land units within the site are suitable for non-sewered effluent disposal in the form of septic tanks. The portion of the site within the YG4 land unit (valley floors) is considered likely to be unsuitable for septic tanks (Table 13).

Table 5-1 Land Capability for Effluent Disposal

Land Qualities	DW2 - Dwellingup	YG1 - Yarragil	YG4 - Yarragil
Effluent disposal (septic tanks)	Fair capability (III)	High capability (II)	Very low capability (V)

As land capability mapping is undertaken on a broad scale, more detailed investigations of the sites' suitability for non-sewered effluent disposal from STSs has been undertaken. For lots on land that have been confirmed to be of low capability for effluent disposal, the feasibility of using fill to raise lots in this area has been undertaken and this is discussed in Section 7.

5.2.1.1 Preliminary Geotechnical Investigation

A preliminary assessment of the sites effluent disposal capability was undertaken by Douglas Partners as part of the preliminary geotechnical investigation (Appendix 2). The assessment considered:

- Soil permeability
- Depth to hard pan

- Depth to groundwater
- Abundance of coarse fragments
- Slope
- Dispersivity
- pH
- Electrical conductivity
- Cation exchange capacity
- Phosphorous Retention Index

Douglas Partners (2018) found that the site is generally suitable for on-site effluent disposal in general accordance with AS1547-2012, local government conditions and Department of Health guidance, provided that treatment of primary effluent is undertaken.

Options for primary effluent treatment were identified as including:

- Use of ATUs (or STSs)
- Sand filters
- Closed cell (amended soil) evapotranspiration systems.

Lots will use STSs thereby complying with this requirement.

5.2.2 Setback to Clutterbuck Creek

The Government Sewerage Policy (Government of WA, 2019) specifies a setback requirement of '*100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer. The separation distance should be measured outwards from the outer edge of riparian or wetland vegetation*'.

A 50 m setback was proposed in the approved DWMS and was considered suitable due to:

- The proposed use of secondary treatment units which will treat wastewater to a high standard.
- All STSs will be systems pre-approved by Department of Health and made mandatory.
- The high PRI of the in-situ soils. In-situ soils were found to have a PRI greater than 177 during the geotechnical investigation, indicating that the soils are very strongly adsorbing of phosphorus.
- The geotechnical report identified the site as suitable for non-sewered effluent disposal with secondary treatment. This is proposed.
- All lots will be separated from the Clutterbuck Creek by a road and public open space, interrupting potential runoff pathways to the Clutterbuck Creek.

The majority of lots (67%) will have effluent disposal areas located greater than 100 m from the Clutterbuck Creek. The remaining lots will have effluent disposal areas located between 50 and 100 m from the Clutterbuck Creek. The breakdown of the number of lots and their separation distances are detailed in Table 5-2 below.

Table 5-2 Effluent Disposal Area Setbacks

Location of effluent disposal areas relative to Clutterbuck Creek riparian edge	Number of lots
Within 50 m	0
50-60 m	5
60-70 m	9
70-80 m	3
80-90 m	2
90-100 m	0
Greater than 100 m	38
Total	**57**

Design of wastewater areas will be managed to ensure that there is no inundation of the disposal area, sufficient separation to groundwater and that disposal areas will not discharge to the site drainage network (Sections 6 and 7).

DWER was prepared to accept the reduced waterway setback as stipulated in correspondence in Appendix 5.

5.2.3 Minimum Site Requirements for Use of ATUs

The current Government Sewerage Policy (Government of WA, 2019) (GSP) sets out the requirements for effluent disposal to protect public health. As is the case within the site, the GSP outlines that where connection to reticulated sewerage is not possible (remote or isolated developments, or towns without sewerage), other types of effluent disposal can be used. On-site wastewater disposal was proposed as part of the approved DWMS (Coterra, 2019).

The following criteria for minimum site requirements, are identified in the policy. These are identified in the first column in Table 5-3 below. How this site is meeting those requirements is identified in the second column.

Table 5-3 Government Sewerage Policy Criteria

GSP (2019) Criteria	This Site
5.2.1 Lot sizes	
Outside public drinking water source areas and sewage sensitive areas and: *• Infill residential or commercial subdivision in existing urban areas; or* *• Residential and commercial subdivision in towns outside the Metropolitan and Peel Region Scheme areas without an established reticulated sewerage scheme; or* *• Residential and commercial subdivision in towns outside the Metropolitan and Peel Region Scheme areas with existing sewerage schemes (as listed in Schedule 3) where unsewered subdivision at the density proposed is specifically provided for through the provisions of the local planning scheme or a local structure plan endorsed by the Western Australian Planning Commission.* *• The average lot size is not to be less than 1,000m2, with a minimum individual lot size of 950m2. Does not apply for soil category 6 (medium to heavy clay), where larger lot sizes are required. For soil categories 4 (clay loams) and 5 (light clays), secondary treatment systems will be required (refer to Table 1 in Schedule 2).* *• Urban/Industrial subdivision outside public drinking water source areas and sewage sensitive areas - 2,000m2. For heavy soils, secondary treatment systems will be required to achieve this lot size (refer to Table 1 in Schedule 2).*	• This site is not located within a sewerage sensitive area or PDWSA. • Parts of the site are within clay loams or sandy clays so a larger lot size and/or higher treatment is required. All lots are above 2,000sqm. Secondary treatment systems are proposed for the site. • 2000sqm meet the requirement for disposal on all types of clay (clay loams to heavy clay) as per Schedule 2 of the GSP.
5.2.2 Separation from water resources	
An on-site sewage system is not to be located within: *• a wellhead protection zone or on Crown land within a reservoir protection zone;* *• 100 metres of the high water mark of a reservoir or 100 metres of any bore used for public drinking water supply where: — a wellhead protection zone or reservoir protection zone has not been assigned; or — where existing lots would be rendered undevelopable by the wellhead protection zone;* *• 30 metres of a private bore used for household/ drinking water purposes;* *• 100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer. The separation distance should be measured outwards from the outer edge of riparian or wetland vegetation;* *• 100 metres of a drainage system that discharges directly into a waterway or significant wetland without treatment; or* *• Any area subject to inundation and/or flooding in a 10 per cent Annual Exceedance Probability (AEP) rainfall event. Smaller setbacks may be considered where a proponent demonstrates, to the satisfaction of the responsible*	• The site is not within a wellhead protection zone. • The site is not within 100 metres of the high water mark of a reservoir or 100 metres of any bore used for public drinking water supply. • This site is not within 30 m of a private bore used for household drinking water, and a private bore will not be used on this site. Drinking water will be supplied by scheme water. • Some lots are within 100m of the riparian vegetation of a waterway and this was addressed in Section 5.2.2. • The drainage system proposed onsite undergoes treatment prior to any discharge from site, this is addressed in Section 6 below.

GSP (2019) Criteria	This Site
authority in consultation with the relevant advisory agencies (Department of Water and Environmental Regulation and/or Department of Biodiversity, Conservation and Attractions, *Department of Health and/or Local Government) that the reduced setbacks will not have a significant impact on the environment or public health. In seeking a reduced setback, it is likely that secondary treatment systems with nutrient removal will be required. Smaller setbacks from reservoirs or bores used for public drinking water will not be supported.*	• No wastewater disposal is proposed in areas of inundation or within the foreshore reserve (Section 4). • Secondary treatment systems are proposed.
5.2.3 Separation from groundwater	
The discharge point of the on-site sewage system should be at least the following distances above the highest groundwater level, taking into account the range of seasonal groundwater conditions in the context of long term variability and possible groundwater rise following development: *• two metres in public drinking water source areas;* *• 1.5 metres in sewage sensitive areas; and* *• 0.6 to 1.5 metres in all other areas, depending on soil type and the type of treatment system used (refer to schedule 2).* *Where the use of fill is proposed to achieve separation distances, proponents may be required to provide additional information to demonstrate that solutions are effective, do not impact on other lots through water diversion, are not cost prohibitive and will not compromise amenity or landscape values.*	• This site is not located within a sewerage sensitive area or PDWSA. • Clearance to groundwater must be 0.6 to 1.5 m depending on soil type and type of treatment system.
Schedule 2 identifies: *Where land is not within a public drinking water source area or a sewage sensitive area, the discharge point of the on-site sewage system should be located the following distances above the highest groundwater level:* *• for loams and heavy soils, at least 0.6 metres* *• for gravels, at least one metre* *• For sands, at least 1.5 metres.* *Where a nutrient retentive secondary treatment system is used, at least 0.6 metres.*	• The site is within clay loams and sandy clays which requires 0.6m separation. • Fill management will be occurring on site (discussed in Section 7) in building pad envelopes which will use sand fill, however secondary treatment systems are proposed so in filled building envelopes only 0.6m is required despite the sand nature of the fill. • All lots achieve a separation of 0.6m. This is addressed in Section 0.
5.2.4 Land application area	
Each lot should be of sufficient size to accommodate development and an unencumbered land application area for the disposal of sewage in accordance with Schedule 2 of this policy.	• The land application area for a single house with secondary treatment on a site with sandy loams is 180sqm (Schedule 2).

GSP (2019) Criteria	This Site
	• The 2000sqm lot sizes are able to accommodate this area.
5.2.5 Type of on-site treatment system required	
Secondary treatment systems with nutrient removal will generally be required in public drinking water source areas and sewage sensitive areas. In all other instances, secondary treatment systems should only be required to address site-specific physical or environmental constraints (refer to Schedule 2). In rural and remote areas, determination of the type of treatment system required should consider the availability of maintenance personnel required to service secondary treatment systems in accordance with Department of Health requirements.	• Secondary treatment systems are proposed due to the reduced setback and site conditions.

All non-sewered effluent disposal systems proposed at the site will require approval from Shire of Mundaring.

Proposals for non-sewered effluent will be consistent with Department of Health's *Code of Practice for On-site Sewage Management* and *A/NZ Standard 1547 On-site Domestic Wastewater Management* and DoH approved STSs/ATUs.

5.3 Household Water Efficiency and Conservation

Household water use efficiency will be required through compliance with the 'Energy Use in Houses Code' and the 'Water Use in Houses Code'. These are known as the 5 Star Plus Codes, introduced by the Department of Housing and Works in 2007 (DoH, 2007 a, b).

The following requirements will be mandatory for each dwelling:

- Gas hot water system with a minimum 5 stars WELS rating (or a solar hot water system, or a high energy efficient electric heat pump).
- Water efficient (i.e. 3 star WELS rated) shower heads.
- Water efficient (i.e. 4 star WELS rated) tap fittings in all kitchen sinks, bathroom basins and vanities.
- Water efficient (i.e. 4 star) dual flush toilets.
- Pool blankets for all new pools to reduce the rate of evaporation.
- Hot water outlets must be located close to the hot water system or a recirculating hot water supply to minimise wastage of energy and water.

6 Stormwater Management Strategy

The stormwater management of the site will be in line with the DWMS, *Better Urban Water Management* guidelines (BUWM) (WAPC, 2008) and *Decision Process for Stormwater Management in Western Australia* (DWER, 2017). BUWM promotes Water Sensitive Urban Design (WSUD), a design philosophy that provides a framework for managing water-related issues in urban areas. It incorporates sustainable management and integration of stormwater, wastewater and water supply.

6.1 Principles and Objectives

The site has been divided into five sub catchments, ultimately draining towards five treatment basins located just south of the foreshore reserve associated with Clutterbuck Creek. Post development flows to the creek will be maintained at pre development flow rates. The first flush event will be treated prior to discharge (Figure 13). The following specific WSUD objectives are implemented:

- Protect life and property from flooding events;
- Manage runoff from small rainfall events on-site or as close to the source as possible;
- Protect and enhance sensitive receiving environments by managing the water cycle, water quality, habitat diversity and biodiversity;
- Control stormwater quality through implementation of appropriate non-structural source controls and structural controls;
- Achieve good urban amenity by integrating stormwater management systems within the design of road reserves;
- Maintain runoff volumes, peak flow rates and improve water quality, biodiversity and aesthetics by managing stormwater through the retention and planting of vegetation.

Hydrological and drainage modelling has been undertaken using XPSWMM (by Knobel Engineers). The IFD data and average rainfall intensities used for the modelling are in accordance with the procedures outlined in Geosciences Australia, *Australian Rainfall and Runoff 2019.* The modelling report is presented in Appendix 7.

6.2 Lot Drainage Management

All lots will manage roof runoff at source using infiltration to soakwells. The natural geology of the site is not naturally conducive to soakwells however the building envelopes will be filled with sand to achieve adequate separation distance requirements (this is discussed in Section 7.2) which will allow infiltration of roof runoff in up to the 1 Exceedance per Year (EY) event (previously referred to the 1 in 1-year ARI event).

Given the large size of the lots (approx. 2,000sqm), it is anticipated that only the building pad envelope area would be infiltrated via soakwells (approximately 25% of each lot). The rest of the lot topography is to remain as per pre development topography and the lot geology will remain unaltered (no fill). Therefore the runoff from 75% of the lot areas is anticipated to run off via overland flow and will be managed with the road drainage through the site drainage strategy (Section 6.3).

It has been assumed that lot stormwater from rainfall events greater than 1 EY will all runoff to the road drainage network (i.e. 100% of lot areas). Drainage modelling and basin sizing has included an allowance from lot runoff in rainfall events greater than the 1EY (Appendix 7).

The sub catchment plan is shown in Figure 13.

6.3 Site Drainage Management

6.3.1 Catchment Areas

There are five sub catchment areas which flow in a northerly direction towards Clutterbuck Creek foreshore area. Each sub catchment has a dedicated basin designed the treat and manage stormwater from the development. The sub catchment areas are shown in Figure 13 and presented in Table 6-1 below.

Table 6-1 Catchment Areas

Catchment	Catchment Area (ha)
Catchment A	1.52
Catchment B	5.59
Catchment C	4.96
Catchment D	2.20
Catchment E	1.16

6.3.2 Conveyance System

Road drainage will be piped to basins. The drainage collection and conveyance system will be designed to hold up to the 20% AEP storm runoff (previously referred to as the 1 in 5-year ARI event). The stormwater will enter benched manholes and then the pipe network.

Events greater than 20% AEP will be directed to the basins via overland flow within the road reserves.

6.3.3 1 EY Event Management

Treatment and infiltration of the 1 EY event will occur via infiltration basins. The 1 EY basins primarily have a stormwater treatment function and as such, have been designed for the 15mm of rainfall (first flush event) (DWER, 2017). Modelling adopted a 1EY 45 minute event to provide a rainfall value of 15.1 mm. The water quality treatment in the basins is discussed in more detail in Section 6.4. Further details of the basin sizing using the XPSWMM model is provided in Appendix 7 and in Figure 14.

Modelling assumed a 6mm/hr continuous loss from the basins. Although the natural site geology has variable rates of infiltration across the site, and can have areas of low permeability (Section 3.4), post development there will be some fill management required beneath the basins. The fill will be a free draining sand which will allow for infiltration from the basins. The fill management requirement and earthworks are discussed in more detail in Section 7.

Table 6-2 below provides the volume requirements for the 15mm event. The basin dimensions and detailed design are presented in Section 6.3.4.

Table 6-2 1 EY Volume Requirements

Basin	Volume Requirement (m^3)
Basin A	149
Basin B	269
Basin C	264
Basin D	199
Basin E	113

6.3.4 5% AEP Event Management

The DWMS (Coterra, 2019) identified that the pre-development peak flow rates discharging from the site should be maintained to Clutterbuck Creek. The DWMS assumed that management of up to the 5% AEP event (previously referred to as the 1 in 20 year ARI event) predevelopment flows would occur on site, and DWER confirmed this would be acceptable provided modelling was undertaken.

Modelling was undertaken for the 5% AEP event. The critical storm duration was 120 mins. Pre development modelling indicted a peak flow rate of 0.99 m3/sec as shown in Plate 6-1.

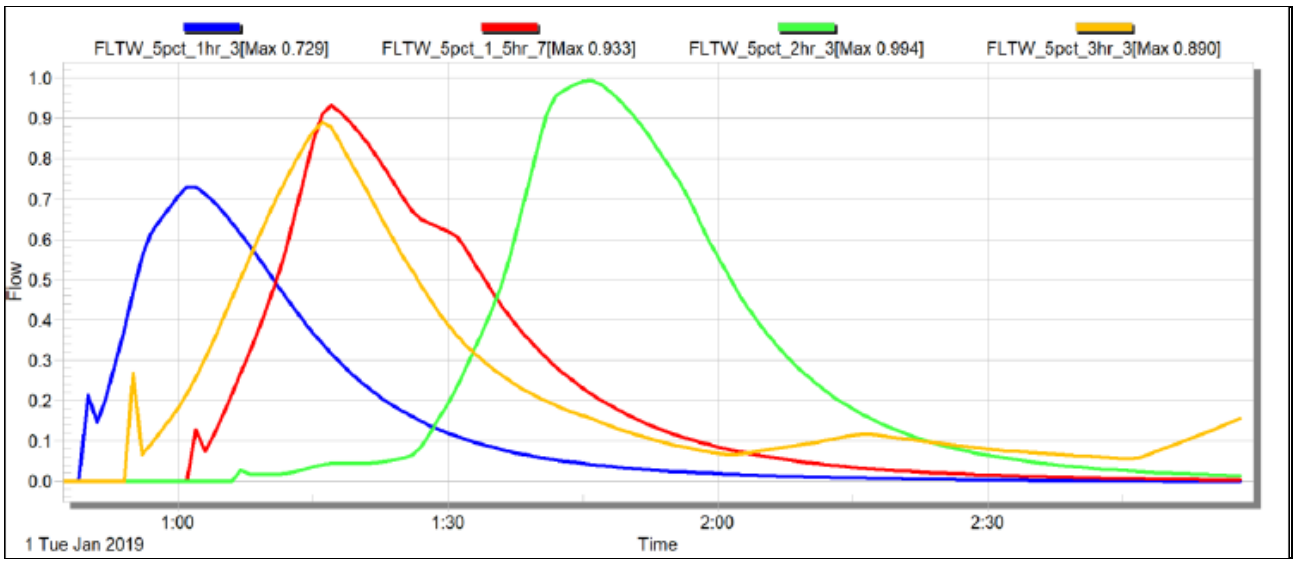

Plate 6-1: Pre Development Hydrographs for 5% AEP Design Event Outflow at Site Discharge Point

Source: XPSWMM, Knobel Engineering, 2020

Initial post development modelling of the 5% AEP event showed the following results;

- Due to the hydrological conditions and the proposed development, post development there was a non-coincidental peak arising with the road runoff occurring first (after approx. 10 mins into the critical 5% AEP storm) and then the lot runoff occurring later (after approx. 2 hours).
    - Both post development peak flows were less than the one pre development peak flow rate (pre development was 0.99 m^3/sec while post development it was 0.67 m^3/sec and 0.72 m^3/sec).
- Initial post development modelling indicated that in four of the five sub catchments, no additional retention basin was required above what was already proposed with the 1 EY treatment basins to ensure the 5% AEP pre development peak flows were maintained.

Liaison was undertaken with DWER in April 2020 following the initial modelling to discuss the drainage strategy and modelling results (Appendix 5). The following strategy was agreed after the results of the initial modelling was discussed, and re-modelling was undertaken;

- Remodelling was undertaken to determine the detention size required in one of the basins to attenuate flows at predevelopment 5% AEP flow rates post development, at the outflow point of the whole site (i.e. Maintain the predevelopment flow for the whole site rather than in individual sub catchments).
- Reduce the retention in the 5% AEP basin so the post development flows are closer to the pre development flows.

Post development modelling was undertaken on this basis for the critical storm duration of 120 mins. Pre development modelling indicted a peak flow rate of 0.99 m^3/sec as shown in Plate 6-1. The post development hydrographs are shown in Plate 6-2 below and indicate a maximum peak flow of 0.84 m^3/sec.

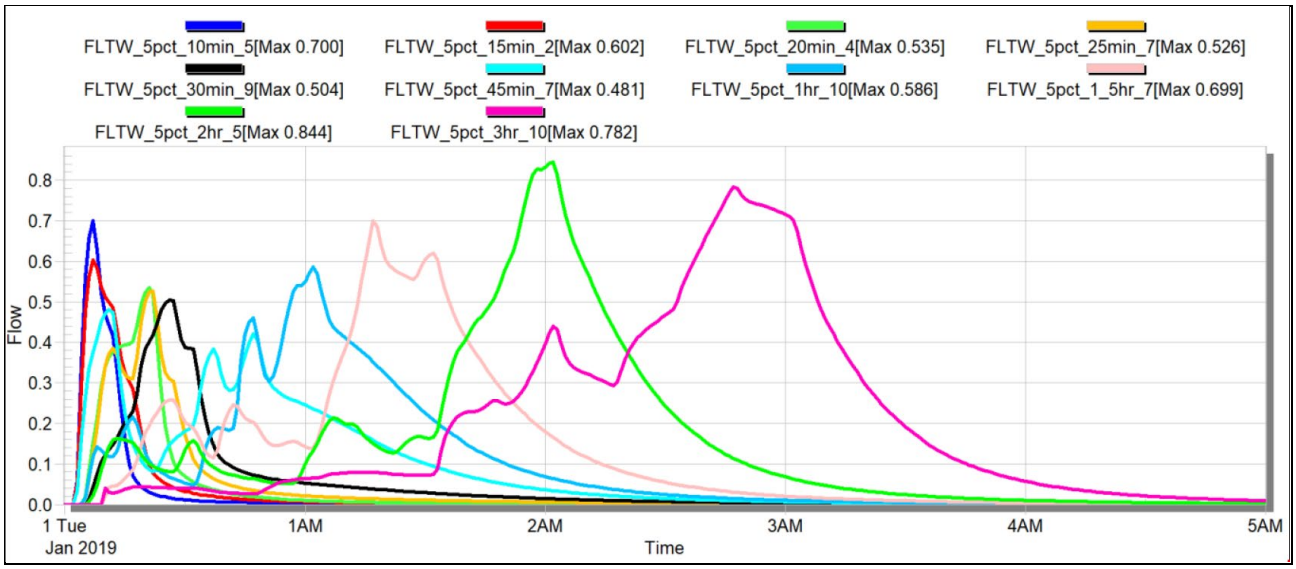

Plate 6-2 Mitigated Post development Hydrographs for 5% AEP Design Event Outflow at Site Discharge Point

Source: XPSWMM, Knobel Engineering, 2020

This modelling included the 1EY basins in each of the five sub catchments, with Basin B having additional capacity to attenuate additional flows to meet the predevelopment 5% AEP flows post development for the catchment as a whole.

Details of the basin sizing is provided in Appendix 7 and Table 6-3 below summarises the basin dimensions and volumes resulting from the modelling for the 1 EY and the 5% AEP event. The basin configuration is displayed in Figure 13, and Figure 14 indicates the location and indicative dimensions of these basins and cross section diagrams.

Table 6-3 1 EY and 5% AEP Indicative Basin Sizing Dimensions

Basin	Event	Capacity Required (m^3)	Volume provided (m^3)	Water Depth in Basin (m)	Basin Invert (mAHD)	Top Water Level (mAHD)	Area at TWL (m^2)	Side Slope (m)
Basin A	1 EY	149	155	0.5	233.0	233.5	433	1:6
	5% AEP							
Basin B	1 EY	269	365	0.6	234.1	234.7	635	1:6
	5% AEP	327		0.7		234.8	720	
Basin C	1 EY	264	275	0.7	236.0	236.7	588	1:6
	5% AEP							
Basin D	1 EY	199	200	1.0	239.0	240.0	378	1:6
	5% AEP							
Basin E	1 EY	113	119	1.0	241.5	242.5	237	1:6
	5% AEP							

6.4 Lot Separation Distances to Basin Top Water Levels

Local Government Guidelines for Subdivisional Development (IPWEA, 2012) identifies that developments need to ensure that the development has a minimum habitable floor level 0.30 metre above the 1% AEP event (previously referred to as the 1 in 100 year ARI) top water level, calculated for the local drainage systems. In this case, this has been compared to the highest TWL in these basins as the basins do not retain up to the 1% AEP event.

All the basins and adjacent lot levels exceed this requirement. This is demonstrated in Table 6-4 below.

Table 6-4 Lot Separation Distances to Basin TWL

Basin	Basin TWL (mAHD)	Lowest Adjacent Lot Level (mAHD)	Clearance (m)
Basin A	233.5	235.2	1.7
Basin B	234.8	237.0	2.2
Basin C	236.7	240.2	3.5
Basin D	240.0	245.8	5.8
Basin E	242.5	248.75	6.25

6.5 Water Quality Treatment

6.5.1 Structural Controls

Stormwater quality will be managed through the treatment basins as discussed in Section 6.3.3. These vegetated areas will filter sediment and pollutants (heavy metals etc.) and provide nutrient removal.

Runoff generated in the 'first flush' event of the year (15mm) generally contains the highest concentration of contaminants. All runoff from this event will be collected and treated prior to infiltration.

Water quality treatment areas will typically comprise of the following profile (see Plate 4-1 below):

- Vegetation: An appropriate mix of high nutrient stripping plant species will be selected from those identified in *Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia* (Monash University, 2014). Remainder to be local, native, ephemeral plants. Typically, 8-12 plants per m^2.
- Stone mulch: 100% stone, 4-13mm in size. 50mm thick. No fines. No wood mulch as it will float under flood conditions.
- Filter media: 300mm amended soil layer. PRI > 10. Saturated K 100-300mm/hr.

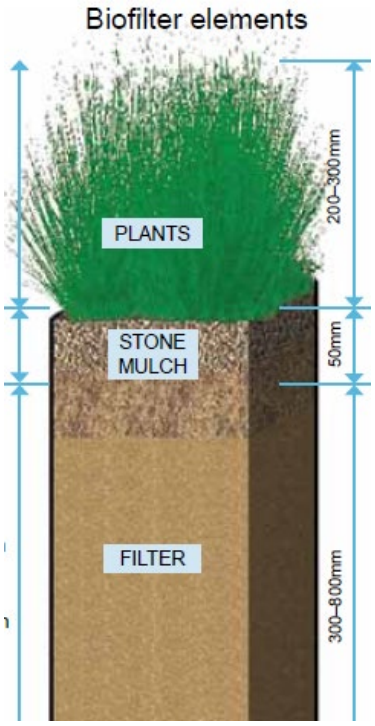

Plate 6-3: Typical vertical profile of water quality treatment areas applicable to the site

Source: DoW, 2011

6.5.2 Non-Structural Controls

In addition to the stormwater management as described above, the following non-structural controls will be employed at the site:

- Ongoing litter management such as street sweeping, and manual litter collections will be included in routine maintenance programs.
- Restrict the use of fertiliser on POS areas given the already established native vegetation being retained in POS areas, to limit the potential addition of nutrients to stormwater runoff
- Local residents will be informed of the need for stormwater quality management and how they can contribute via measures such as community signage and/or information packs included in lot purchase documentation.
- Construction practices such as drainage, erosion, sediment, housekeeping and dust controls will be employed during construction and major landscaping.

7 Groundwater Management

7.1 Fill Management

The earthworks plan is provided in Figure 15. Some cut and fill will be required to achieve this design.

Within lots, fill will be required for the building envelopes (estimated to be approximately 25% of each lot). This is required to achieve the separation distance requirements for treated effluent disposal from the STSs and for infiltration from soakwells. This achievement is demonstrated in the sections below. This will be the responsibility of the lot owners.

Any imported fill will be clean, permeable sand with less than 5% fines.

7.1.1 Subsoil Drainage

Subsoil drainage is not anticipated due to the fill management proposed.

7.2 Clearances to Groundwater

7.2.1 Basin Invert Clearances to Groundwater

The *Urban Water Management Plans: Guidelines for preparing plans and for complying with subdivision conditions* (DoW, 2008) require that the invert of storage areas or swales should be set at least 0.3 metres above the MGL or approved controlled groundwater level.

The basin locations are within areas with a clay geology, however due to the earthworks required on site, some fill management will be required in these areas. The finished earthworks levels beneath the basins will therefore be different to the predevelopment topographical level. Fill management will use an amended soil which will allow infiltration and treatment beneath the basins. The natural clay layers will remain beneath the basins and the separation distances to groundwater have therefore been compared to the in-situ clay layer in each basin location.

Table 7-1 below identifies the separation distance between the inverts of the designed basins for the LSP. Figure 14 shows the cross sectional interaction between the basin inverts and the predevelopment ground levels.

Table 7-1 Basin Clearances to Groundwater/ Clay Layer

Basin Number	Basin Invert (mAHD)	Clay Layer* (mAHD)	Clearance (m)
Basin A	233.0	232.7	0.3
Basin B	234.1	233.7	0.4
Basin C	236.0	235.4	0.6
Basin D	239.0	238.9	0.1
Basin E	241.5	241.1	0.4

**Appendix 3 Soil Investigation - Pritchard Francis, 2019*

All designed basins invert levels have a 0.3m separation distance from the in-situ clay layer to allow for the 300mm soil amendment treatment layer to be applied during construction with the exception is Basin D. The construction of Basin D will therefore require clay contouring (removal of 200m of clay) beneath the basin prior to the backfilling with soil amendment required for the treatment basins.

The cross sections of the basins are shown in Figure 14. The cross sections demonstrate that all the basins will require infill for the bases (above the pre development ground levels) and side walls to achieve;

- The required storage requirements for the basins prior to discharge;
- The treatment requirement through the soil amendment layer. Infill will be with the soil amendment as proposed in Section 6.5.

7.2.2 Lot Levels Clearances to Groundwater

Building pad envelopes will be filled with sand fill to achieve the required separation distances to finished floor levels and effluent disposal. This will be undertaken by lot owners. The houses, soakwells and STSs will all be within the building envelopes.

- A clearance of 1.2m is required between lot levels and MGL or the clay layer (i.e. a perched groundwater level) (WAPC, 2008) for soakwell operation.
- A clearance of 0.6m is required for disposal of ATU treated effluent (Section 5.2) due to the secondary treatment systems proposed and soil types.

A review of the separation distances achieved for each lot was undertaken. Appendix 8 identifies the estimated separation distance between each proposed building envelope pad level (Figure 15) and the corresponding estimated MGL or clay layer (perched groundwater).

The relevant groundwater presence/levels have been predicted based on the following:

- As detailed in Section 3.7, site specific groundwater monitoring has been undertaken at the site. Maximum groundwater levels have been derived from a predicted correlated maximum groundwater level based on the bore readings from pre development. The recorded predevelopment MGLs in mAHD are shown in Figure 6 and the interpreted estimation of MGLs derived from those levels are shown in Appendix 8.
- Where clay is present within a lot, and is recorded higher than the predicted MGL, it is assumed a local perched groundwater may be present and the groundwater level is assumed to be at the clay layer instead. The Geotechnical Investigation and the site soil investigation undertaken by Prichard Francis (Appendix 3) provided information on clay layers present across the site. The presence or absence of a clay layer was derived from these investigations (67 test pit locations dispersed across all/most lots). When present, a clay layer estimate in mAHD was derived from the depth below ground level readings and ground survey levels.

All building pad envelopes achieve the minimum 1.2m separation distance requirement except six lots (discussed below). Figure 15 shows the proposed elevations of lots and identifies those six lots that do not achieve the 1.2m clearance by fill alone. Appendix 8 identifies what clearance is achieved in each lot and the designated lot numbers for the purpose of this exercise are shown in Figure 15.

In lots where the full clearance requirement cannot be achieved with further fill management of the building envelopes, contouring of the clay layer (removal) beneath the building envelope fill is proposed as well. These lots all have a clay layer so clay will be removed before 1.2m of sand fill separation will be added beneath the building pad. This will ultimately achieve the required separation distance.

7.3 Groundwater Quality

Groundwater quality will be maintained throughout the treatment of the first flush stormwater events prior to infiltration. This will be undertaken in the 1 EY basins as described in Section 6.5.

Monitoring of groundwater quality and creek water quality is further discussed in Section 8.

8 Monitoring

8.1 Pre-development Monitoring

8.1.1 Surface Water Monitoring

Pre-development surface water monitoring was undertaken within Clutterbuck Creek and Clutterbuck Creek tributary from June 2018 to September 2019 to capture two winter periods.

The monitoring was undertaken at a minimum of three locations:

- Clutterbuck Creek: at upstream boundary of the site (KIL01)
- Clutterbuck tributary: at upstream boundary of the site (KIL02)
- Clutterbuck Creek: at downstream boundary of the site (below the confluence with the Clutterbuck tributary).

Monitoring were undertaken monthly in winter due to the ephemeral nature of the watercourses. The monitoring included the following parameters:

- Flow
- *In-situ* physical parameters:
  - Temperature, electrical conductivity (EC), pH, Redox Potential (Eh), Dissolved Oxygen (DO).
- Laboratory analysis:
  - Nutrients: Total nitrogen (TN), ammonia-N, total kjeldahl nitrogen (TKN), nitrate/nitrite-N, total phosphorus (TP) and filtered reactive phosphorus (FRP).
  - Microbiological: E.coli, Faecal/Thermotolerant Coliforms

The results for this pre-development monitoring were presented in Section 3.6.

In order to address quality assurance and quality control (QAQC) requirements, two QAQC samples were collected and analysed for each monitoring event.

8.1.2 Groundwater Monitoring

Groundwater monitoring was undertaken monthly from August – October 2018, and June - September 2019 to capture the groundwater levels during two peak periods. These results are discussed in Section 3.7.

8.2 Post-development Monitoring

Post-development monitoring is to be undertaken for three years after construction of the development, for groundwater levels and surface water flows and quality.

8.2.1 Surface Water

Surface water in Clutterbuck Creek will be monitored monthly July to September each year due to the ephemeral nature of the watercourses (and based on when water was present during winter based on pre development monitoring).

Surface water monitoring will follow the same regime as pre-development, including monitoring for:

- Flow
- *In-situ* physical parameters:
  - Temperature, electrical conductivity (EC), pH, Redox Potential (Eh), Dissolved Oxygen (DO).

- Laboratory analysis:
  - Nutrients: Total nitrogen (TN), ammonia-N, total kjeldahl nitrogen (TKN), nitrate/nitrite-N, total phosphorus (TP) and filtered reactive phosphorus (FRP).
  - Microbiological: E.coli, Faecal/Thermotolerant Coliforms

The monitoring is to include two QAQC samples for each event.

8.2.2 Groundwater

Groundwater will be monitored quarterly, expected to be March, June, September (to coincide with the peak period as noted in pre development monitoring), and December each year. Monitoring will be done in the five MB series bores already present. Where a bore is destroyed as a result of the development, it will be replaced as close as possible to the original location for comparability. This is expected to include MB01, MB04 and MB05 which are presently located in future lots.

8.3 Trigger Values

Surface water trigger values are set on the average pre-development quality monitoring results for TN and TP plus 20%. These are presented in Table 8-1.

Table 8-1 Post-development Surface Water Trigger Values

Bore	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)
KIL01	2.33	0.047
KIL02	0.57	0.055
KIL03	1.83	0.054

8.4 Contingency Measures

Where the water quality in the monitoring bores exceeds the trigger values for two consecutive sampling events, investigations will be undertaken to determine the cause and potential impacts of the decreased water quality and instigate mitigation (if required).

Examples of mitigation measures include:

- Reduction in irrigation in key areas or at critical times.
- Audit and reduce fertiliser applications to POS areas.
- Soil amendment in the infiltration areas to reduce leaching.
- Additional planting within treatment areas.
- Educational material provided to residents in the area.

8.5 Reporting

Annual monitoring reporting will be undertaken for three years post development and results presented to the Shire and DWER.

9 Implementation

The effective implementation of the LWMS requires ongoing involvement by the relevant stakeholders. The roles and responsibilities associated with the site are summarised in Table 9-1 below.

Table 9-1 Implementation Schedule

Principal	Commitment	Responsibility	Timescales
Stormwater Management	Design and construction of stormwater infrastructure	Proponent	Following detailed engineering design
	Provision of soakwells for individual lots	Lot owners	During construction, house design and installation
	Maintenance of basins	Proponent	Until handover
Groundwater Management	Cut and fill requirements for roads and basins	Proponent	Following detailed engineering design
	Building pad envelope filling	Lot owners	At construction
Potable Water Supply and Disposal	Confirmation of water supply infrastructure	Proponent	Preparation of UWMP
	Application and provision of STSs / ATUs for individual lot wastewater disposal	Lot owners	During construction, house design and installation
	Provision of educational material for water efficiency and conservation measures	Proponent	At point of sale
	Installation of water efficiency and conservation measures	Lot owner	At lot point of sale, house design and installation
Monitoring	Post-development monitoring programme and installation of any replacement bores damaged during construction phase	Proponent	Groundwater quarterly, surface water over winter, for three years post development. Reporting annually.

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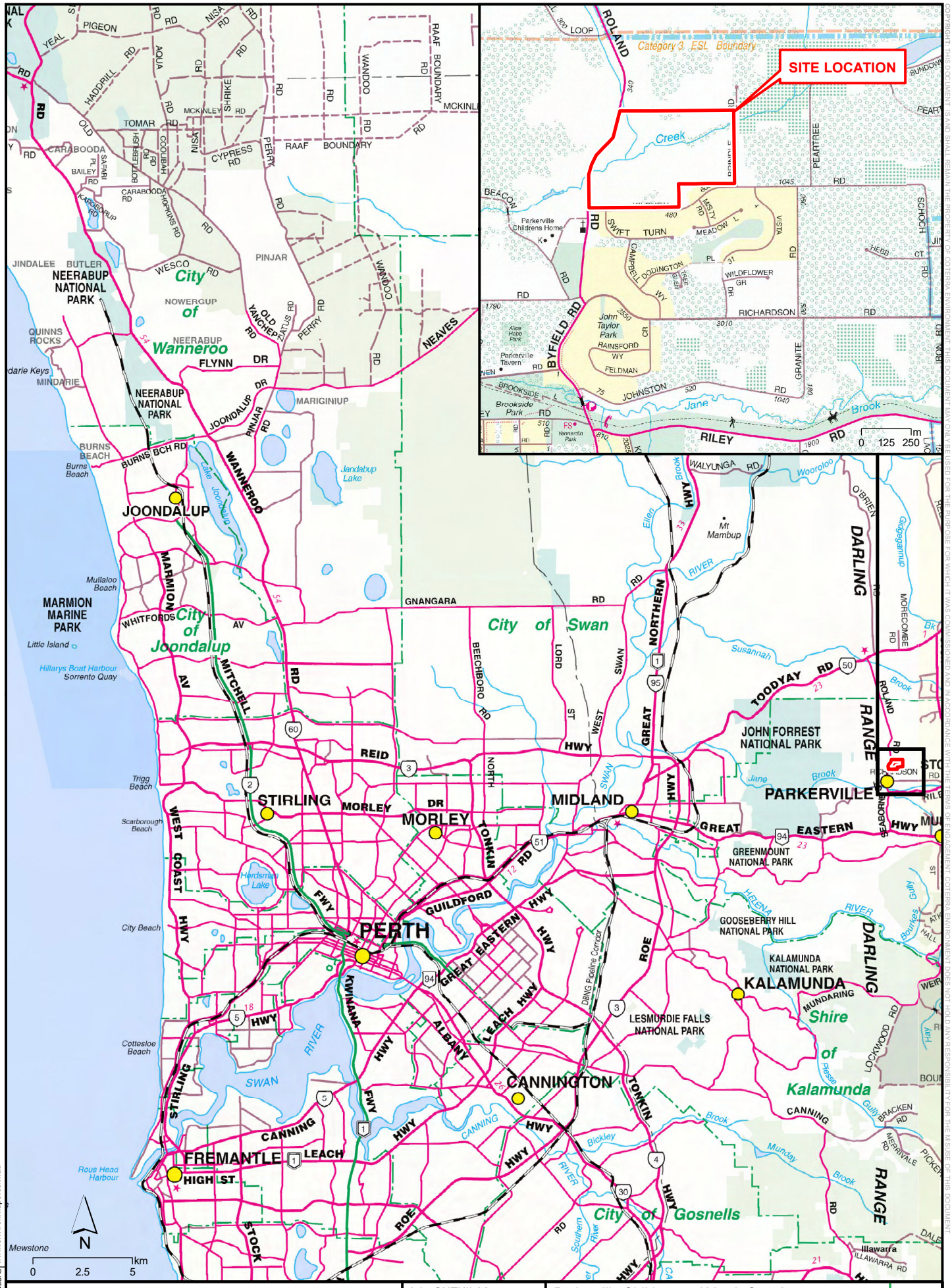
Figures



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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 & 1001 KILBURN ROAD, PARKERVILLE

SITE LOCATION

Figure 1

C:\GIS\Jobs\CoTerra\CUTKIL06 - Lots 61 & 1001 Kilburn Road, Parkerville LWMS\Figures\CUTKIL06_F01 Site Location_190801.mxd

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LEGEND

- Proposed Site
- Residential R5
- Public Open Space/ Drainage
- Rural Zone
- Foreshore Reserve
- Watercourse (Clutterbuck Creek)

N

15 45 60

ROAD

1794m² POS/ DRAINAGE

1235m² POS/ DRAINAGE

15m min Road Reserve (varies)

15m min Road Reserve (varies)

7636m² POS/ DRAINAGE

16m Road Reserve

16m Road Reserve

16m Road Reserve

16m Road Reserve

1001
16.187ha

61
13.197ha

BRINDLE ROAD

ROLAND ROAD WIDENING 10m

ROAD

KILBURN

Source: Roberts Day, PCH PAR - RD1 002

ENVIRONMAPS | t: 0406 590 006
Environmental Mapping Solutions | e: simoncrofts74@me.com

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

FINAL CONCEPT PLAN

Figure 2

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Contour (mAHD)

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

1884 1 148 8 60 61 1001 7 6 1636 1684 9001 1

ROLAND RD

BRINDLE RD

KILBURN RD

CLUTTERBUCK CREEK

255 250 245 240 235 260

SWIFT TURN

MISTY RD

MEADOW LN

101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128

2 3 4 5 1 29 30 31 32 33 34 35 55 28 27 24 23 22 21 36 7 6 8 26 25 20 19 37 38 10

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Topography, Landgate, 2017

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LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

TOPOGRAPHY

Figure 3

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Test Pit Location
- Permeability Test Location

Geology Unit

- Sgc: CLAYEY GRAVELLY SAND - grey and yellow, kaolinitic, decomposed bedrock, sand and gravel veneer; granitic/gneissic origin
- G2: GRAVEL - yellow-brown to reddish brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor recementation; colluvial origin
- LA1: LATERITE - massive hard, cemented, vuggy and pisilitic; up to 4m thick, overlain by and associated with gravels (G2 and G3) of residual origin

N

0 12.5 25 50 75 100 m

Scale: 1:2,513 @ A3
GDA 1994 MGA Zone 50

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Geology - DoIR: Geological Survey of W.A., 1999

ENVIRONMAPS | t: 0406 590 006
Environmental Mapping Solutions | www.environmaps.com.au

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

GEOLOGY

Figure 4

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Dwellingup 2 Phase: Very gently to gently undulating terrain (<10%) with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust.
- Yarragil 1 Phase: Very gentle to moderately inclined concave sideslopes.Moderately well drained yellow duplex soils and yellow and brown massive earths. Woodland of E. wandoo, E. marginata, E. Accedens. Casuarina obesa on salt affected areas.
- Yarragil 4 Phase: Valley floors and gentle lower slopes with poorly drained mottled yellow duplex soils. Slightly prone to salinity. Low woodland of E. wandoo, E. marginata and Acacia spp..

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Soil Landscape Subsustems - DAFWA, 13.06.13

ENVIRONMAPS | t: 0406 590 006 | Environmental Mapping Solutions | www.environmaps.com.au

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LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

SOILS AND LAND CAPABILITY

Figure 5

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Surface Water Location
- WIN Groundwater Bore
- Groundwater Monitor Bore
- (234.01) Maximum Pre development Groundwater Level (mAHD)

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK
Clutterbuck Tributary

KIL01
KIL02
KIL03
5466

MBK01 (242.33 mAHD)
MBK02 (242.38 mAHD)
MBK03 (238.01 mAHD)
MBK04 (234.36 mAHD)
MBK05 (244.18 mAHD)

1884 1 148 8 60 61 1001 7 6 1636 3304 1684

2 3 4 5 1 29 30 31 32 33 34 35 55 36 28 27 22 23 24 21 37 20 19 38 7 6 8 10 25 26 1

101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16

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LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

SURFACE WATER AND GROUNDWATER

Figure 6

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- Contour (mAHD)
- Photograph Location and Orientation
- Proposed Drainage Location Photograph

Watercourse Route

- Reach 1
- Reach 2
- Reach 3
- Reach 4

Watercourse Route Variation

- Reach 1
- Reach 2

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK

P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14 P15 P16
D1 D2 D3 D4

1 61 1001 1636 1684 9001
148 8 7 6
2 3 4 5 1 7 6 8 10 29 30 31 32 33 34 35 55 28 27 24 23 22 21 36 25 26 1 20 19 37 38
101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128

255 250 245 240 235 260

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Topography, Landgate, 2017

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

BIOPHYSICAL ASSESSMENT REFERENCE POINTS

Figure 7

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LEGEND

- Site Boundary
- Cadastre
- Watercourse

Vegetation Units

- Cc
- Fc
- Jp
- Mv
- PT
- Pc
- Tl

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK

SCATTERED / SMALL CLUMPS OF MARRI TREES

SCATTERED / SMALL CLUMPS OF MARRI TREES

SCATTERED / SMALL CLUMPS OF MARRI TREES

1884 1 148 8 60 7 1001 6 1636 61 101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 127 128 1684 2304 10 25 26 1 20 19 37 38

Vegetation Description Abbreviations

Abbreviation	Description
Cc	Tall Forest of *Corymbia calophylla* over Dense Tall Grass
Jp	Open Tall Sedges of *Juncus pallidus* over Dense Herbs of introduced species
Tl	Tall Forest to Woodland of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Open Low Woodland A of *Melaleuca rhaphiophylla* over Thicket of *Taxandria linearifolia* over Low Open Grass dominated by *Microlaena stipoides*
Mv	Open Woodland of *Corymbia calophylla, Eucalyptus patens* and *Eucalyptus rudis* subsp. *rudis* over Scrub of *Melaleuca viminea* subsp. *viminea* over Open Low Scrub A of *Calothamnus quadrifidus* and *Acacia pulchella* var. *pulchella* over Low Grass of mixed species
Fc	Tall Forest of *Eucalyptus rudis* subsp. *rudis* and **Ficus carica* over Open Scrub of *Taxandria linearifolia*
Pc	Planted corridors of mainly Eastern Australian *Eucalyptus* species
PT	Planted trees non-endemic

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Environmental Mapping Solutions | www.environmaps.com.au

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Vegetation Units - Bennett Enviro Consulting, Dec, 2016

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

VEGETATION UNITS

Figure 8

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LEGEND

- Site Boundary
- Cadastre
- Watercourse

Vegetation Condition

- 3(2): Very Good Bordering on Excellence
- 3: Very Good
- 3-4: Good to Very Good
- 4: Good
- 4-5: Good to Degraded
- 5: Degraded
- 5-6: Degraded to Completely Degraded
- 6: Completely Degraded
- 6?: Completely Degraded but trees planted in corridor which should be retained

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
CLUTTERBUCK CREEK
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN

1 148 8 7 6 1636 2304 1684 61 1001

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Vegetation - Bennett Enviro Consulting, Dec, 2016

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LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

VEGETATION CONDITION

Figure 9

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LEGEND

- Site Boundary
- Cadastre
- Contour (mAHD)
- Watercourse
- 30m Watercourse Buffer
- Watercourse Route Variation
- 30m Watercourse Variation Buffer
- Public Open Space

Area proposed to be removed from the original generic 30m foreshore reserve buffer

- Cleared area within 30m setback

Area proposed to be added to the original generic 30m foreshore reserve buffer

- Very Good to Very Good bordering on Excellent vegetation to be added to foreshore reserve
- Good to Very Good vegetation to be added to foreshore reserve
- Good to Degraded vegetation to be added to foreshore reserve
- Completely Degraded but with trees for retention to be added to foreshore reserve

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK

1 61 1001 1636 1684 9001

148 8 7 6

101 102 103 104 105 106 107 108 109 110 111 112
125 126 127 128 124 123 122 121 120

1 2 3 4 5 6 7 8 10 25 26 27 28 29 30 31 32 33 34 35 36 37 38 19 20 21 22 23 24 55

235 240 245 250 255 260

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Topography, Landgate, 2017

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

BIOPHYSICAL ASSESSMENT AND FORESHORE RESERVE DETERMINATION

Figure 10

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LEGEND

- Site Boundary
- Cadastre
- Watercourse
- 30m Watercourse Buffer
- Proposed Foreshore Reserve Buffer
- Public Open Space

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3

GDA 1994 MGA Zone 50

ROLAND RD

BRINDLE RD

KILBURN RD

CLUTTERBUCK CREEK

SWIFT TURN

MISTY RD

MEADOW LN

84 1 148 8 60 7 1001 6 61 1636 5 4 3 2 30 31 32 33 34 35 55 29 1 28 22 23 21 36 27 24 7 6 8 25 26 1 20 37 19 38 10 101 102 103 104 105 106 107 108 109 110 111 112 125 126 124 123 122 121 120 1684 127 128

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Topography, Landgate, 2017

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LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

FORESHORE RESERVE

Figure 11

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LEGEND

- Site Boundary
- Cadastre
- Proposed Cadastre
- Watercourse
- Foreshore Reserve
- Public Open Space
- Public Open Space Drainage
- Indicative Disposal Area Within 100m of the Riparian Vegetation
- Riparian Vegetation Boundary
- 50 m Setback from Riparian Zone
- 100 m Setback from Riparian Zone

N

0 12.5 25 50 75 100 m

Scale: 1:2,500 @ A3
GDA 1994 MGA Zone 50

ROLAND RD
BRINDLE RD
KILBURN RD
SWIFT TURN
MISTY RD
MEADOW LN
CLUTTERBUCK CREEK

1001
61
60
1636
2304
1684

66 m
63 m
60 m
71 m
62 m
65 m
64 m
71 m
61 m
85 m
54 m
67 m
59 m
51 m
84 m
57 m
63 m
64 m
58 m
77 m

ENVIRONMAPS | t: 0406 590 006
Environmental Mapping Solutions | www.environmaps.com.au

Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 04.09.16
Proposed Development - RobertsDay, 13.02.17

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

WASTEWATER SETBACK

Figure 12

Source: Pritchard Francis, March 2020

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Environmental Mapping Solutions

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

STORMWATER CATCHMENT AND BASIN PLAN

Figure 13

NORTH

LEGEND

- EXISTING SURFACE CONTOUR
- PROPOSED SWALE BOTTOM
- EXISTING TREE TO BE REMOVED (U.S.O.)
- EXISTING KERBING
- EXISTING PAVEMENT
- RETAINING WALL
- 6.80 FINISHED PAD LEVEL
- 6.80 EXISTING PAD LEVEL
- EXISTING SPOT LEVEL
- PROPOSED GROUND LEVEL AT LOT BOUNDARY
- PREDEVELOPMENT GROUND LEVEL
- BASIN AREA WHEN AT TWL

TWL / TOP OF SWALE RL 233.5
AREA OF TWL = 433m2
BASE OF SWALE RL 233.0
AREA OF BASE = 191m2
ESTIMATED VOLUME = 155m3

TWL / TOP OF SWALE RL 234.8
AREA OF TWL = 720m2
BASE OF SWALE RL 234.1
AREA OF BASE = 323m2
ESTIMATED VOLUME = 365m3

TWL / TOP OF SWALE RL 236.7
AREA OF TWL = 588m2
BASE OF SWALE RL 236.0
AREA OF BASE = 200m2
ESTIMATED VOLUME = 275m3

TWL / TOP OF SWALE RL 240.0
AREA OF TWL = 378m2
BASE OF SWALE RL 239.0
AREA OF BASE = 22m2
ESTIMATED VOLUME = 200m3

TWL / TOP OF SWALE RL 242.5
AREA OF TWL = 237m2
BASE OF SWALE RL 241.5
AREA OF BASE = 1m2
ESTIMATED VOLUME = 119m3

RESERVE BOUNDARY LINE

61

1001

BASIN A

Datum R.L.232.00

DESIGN CL	235.200		235.200	233.740	233.665	233.637	233.303	233.549	233.500	233.500	233.000	233.000	233.500	232.926
NSL preliminary	234.709		233.748	233.571	233.310	233.300	233.092	232.946	232.889	232.887	232.856	232.846	232.674	232.622	232.596	232.927
CHAINAGE	0.000	13.663	16.359	20.000	21.362	21.662	27.666	27.966	32.969	36.600	37.601	40.000	40.602	47.297	50.317	51.324	54.264

VPI 235.200; VPI 233.740; VPI 233.637; VPI 233.487; VPI 233.303; VPI 233.452; VPI 230.549; VPI 233.500; VPI 233.500; VPI 233.000; VPI 233.000; VPI 233.500; VPI 233.500; RESERVE BOUNDARY LINE

SECTION A-A
SCALE HOR 1:500 VER 1:100

BASIN B

Datum R.L.233.00

DESIGN CL	238.200		238.200	235.309	235.210	235.059	234.880	235.030	235.130	234.800	234.800	234.100		234.100	234.800	234.800	233.798
NSL preliminary	235.652		235.428	235.149	234.973	234.962	234.938	234.751	234.572	234.460	234.430	234.304	234.277	233.938	233.867	233.856	233.850	234.800	233.798
CHAINAGE	0.000	6.121	13.821	19.821	19.121	20.000	25.121	25.421	30.421	33.881	34.881	39.081	40.000	55.134	59.398	60.000	60.410	63.463	63.798

VPI 238.200; VPI 235.309; VPI 235.210; VPI 235.059; VPI 234.880; VPI 235.030; VPI 235.130; VPI 234.800; VPI 234.800; VPI 234.100; VPI 234.100; VPI 234.800; VPI 234.800; RESERVE BOUNDARY LINE

SECTION B-B
SCALE HOR 1:500 VER 1:100

BASIN C

Datum R.L.235.00

DESIGN CL	240.200		240.200	237.164	236.856	236.746	236.613	236.441	236.591	236.698	236.700	236.700	236.000	236.000	236.700	236.700	235.142
NSL preliminary	237.893		237.620	237.175	236.998	236.887	236.706	236.692	236.389	236.374	236.121	236.010	235.967	235.926	235.793	235.480	235.345	235.313	235.241	235.142
CHAINAGE	0.000	5.001	14.110	18.552	20.000	23.670	23.945	30.080	30.389	35.503	38.008	39.029	40.000	43.327	52.087	59.333	60.000	61.134	67.601

VPI 240.200; VPI 237.164; VPI 236.856; VPI 236.746; VPI 236.613; VPI 236.441; VPI 236.591; VPI 236.698; VPI 236.700; VPI 236.700; VPI 236.000; VPI 236.000; VPI 236.700; VPI 236.700; RESERVE BOUNDARY LINE

SECTION C-C
SCALE HOR 1:500 VER 1:100

BASIN D

Datum R.L.238.00

DESIGN CL	244.500		244.499	240.751	240.640	240.515	240.442	240.293	240.405	240.519	240.000	240.000	239.071	239.001	238.714	240.000	240.000	240.000	238.076
NSL preliminary	242.718		242.595	241.378	240.843	240.811	240.600	240.179	240.152	240.519	240.000	239.319	239.071	238.824	238.714	238.430	238.382	240.000	238.075
CHAINAGE	0.000	1.150	12.544	17.667	17.975	20.000	24.165	24.476	29.696	33.088	34.103	40.000	40.451	42.657	48.957	50.001	55.877

VPI 244.499; VPI 240.751; VPI 240.640; VPI 240.515; VPI 240.293; VPI 240.405; VPI 240.519; VPI 240.000; VPI 240.000; VPI 239.001; VPI 239.001; VPI 240.000; VPI 240.000; RESERVE BOUNDARY LINE

SECTION D-D
SCALE HOR 1:500 VER 1:100

BASIN E

Datum R.L.240.00

| | | | | | | | | | | | | | | | | | | |

TWL / TOP OF SWALE RL 242.5
AREA OF TWL = 237m2
BASE OF SWALE RL 241.5
AREA OF BASE = 1m2
ESTIMATED VOLUME = 119m3

TWL / TOP OF SWALE RL 240.0
AREA OF TWL = 378m2
BASE OF SWALE RL 239.0
AREA OF BASE = 22m2
ESTIMATED VOLUME = 200m3

TWL / TOP OF SWALE RL 236.7
AREA OF TWL = 588m2
BASE OF SWALE RL 236.0
AREA OF BASE = 200m2
ESTIMATED VOLUME = 275m3

TWL / TOP OF SWALE RL 234.8
AREA OF TWL = 720m2
BASE OF SWALE RL 234.1
AREA OF BASE = 323m2
ESTIMATED VOLUME = 365m3

TWL / TOP OF SWALE RL 233.5
AREA OF TWL = 433m2
BASE OF SWALE RL 233.0
AREA OF BASE = 191m2
ESTIMATED VOLUME = 155m3

60
61
1001
101

1 235.2
2 237.8
3 240.95
4 237.2
5 238.3
6 241.5
7 237.0
8 238.9
9 240.2
10 242.75
11 243.75
12 245.75
13 242.85
14 240.55
15 238.2
16 238.2
17 239.2
18 240.2
19 240.2
20 243.1
21 244.9
22 246.55
23 249.95
24 248.45
25 246.75
26 244.85
27 243.2
28 241.7
29 251.75
30 249.75
31 247.8
32 246.2
33 244.3
34 242.7
35 241.2
36 243.6
37 244.6
38 246.55
39 249.1
40 250.25
41 247.5
42 244.6
43 245.8
44 247.95
45 250.2
46 251.95
47 253.25
48 250.75
49 248.50
50 245.25
51 246.75
52a 248.75
52b 249.25
53 250.8
54 252.2
55 253.7
56 255.7
57 254.7

SCALE 1:500 0m 10m 20m

N

LEGEND

- EXISTING SURFACE CONTOUR
- PROPOSED SWALE BOTTOM
- EXISTING TREE TO BE REMOVED (U.S.O.)
- EXISTING KERBING
- EXISTING PAVEMENT
- RETAINING WALL
- 6.80 FINISHED PAD LEVEL
- 6.80 EXISTING PAD LEVEL
- EXISTING SPOT LEVEL
- PROPOSED GROUND LEVEL AT LOT BOUNDARY
- SITE CLAY CONTOURING REQUIRED

Source: Pritchard Francis, March 2020

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Parkerville Children and Youth Care Inc.
LOCAL WATER MANAGEMENT STRATEGY
LOTS 61 AND 1001 KILBURN ROAD, PARKERVILLE

EARTHWORKS PLAN

Figure 15

Appendix 1 LWMS Checklist

Department of Water LWMS Guideline Requirements		Coterra Comments
LWMS item	**Deliverable**	
Executive Summary		
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 2-1 Design Objectives	Executive Summary
Introduction		
Total water-cycle management – principles and objectives Planning background Previous studies		Section 1 & Section 2
Proposed development		
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Structure plan	Section 1.2 Figure 2 Section 3.1
Landscape – proposed public open space areas, public open space credits, water source, bore(s), lake details, irrigation areas (if applicable)	Landscape plan and Proposed Bore Locations	Figure 2 and Figure 6
Design Criteria		
Agreed design objectives and source of objectives		Section 2
Pre-development environment		
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		Section 3
Site conditions – existing topography/contours, aerial photo underlay, major physical features	Site condition plan	Section 3.3 and Figure 3
Geotechnical – topography, soils including acid sulfate soils and infiltration capacity, test pit locations		Section 3.3, Section 3.4 Section 3.5 and Figure 4
Environmental – areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	Section3.6, Section 3.8 and Figure 6, Figure 8 and Figure 9
Surface water – topography, 100- year flood ways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface-water plan	Section 3.6
Groundwater – topography, predevelopment groundwater levels and water quality, test bore locations	Groundwater plan plus site investigations	Section 3.7 and Figure 6
Water sustainability initiatives		

Water efficiency measures – private and public open spaces including method of enforcement		Section5.1.1 and Section 5.3
Water supply (fit-for-purpose) strategy, agreed actions and implementation		Section 5.1
Wastewater management		Section 5.2
Stormwater management strategy		
Flood protection – peak flow rates, volumes and top water levels at control points, 100-year flow paths and100-year detention storage areas	100-year-event plan Long section of critical points	Section 6 Figure 14
Manage serviceability – storage and retention required for the critical 5- year ARI storm events. Minor roads should be passable in the 5-year ARI event	5-year event plan	Section 6
Protect ecology – detention areas for the 1-year 1-hour ARI event, areas for water quality treatment and types of agreed structural and non-structural best management practices and treatment trains (including indicative locations). Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1-year-event plan Typical cross sections	Section 6.3.3 and Section 6.5 Figure 11, Figure 12 and Figure 14
Groundwater management strategy		
Post-development groundwater levels, existing and likely final surface levels, outlet controls, and subsoil drain areas/exclusion zones	Groundwater/subsoil plan	Section 7
Actions to address acid sulfate soils or contamination		N/A
The next stage – subdivision and urban water management plans		
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required before detailed design.		Section 9
Monitoring		
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		Section 8
Implementation		
Developer commitments		Section 9
Roles, responsibilities, funding for implementation		
Review		

Appendix 2 Geotechnical Investigation (Douglas Partners, 2018)

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Assessment of Site Suitability for On-Site Sewage Disposal
Lots 61 and 1001 Kilburn Road, Parkerville, WA

Prepared for
Parkerville Children and Youth Care Inc.

Project 89041.00
June 2018

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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Report prepared for	Parkerville Children and Youth Care Inc.		
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Revision 0			Phil Cuttone, Parkerville Children and Youth Care Inc.

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		21 JUNE 2018
Reviewer		21 June 2018

bsi. ISO 9001 Quality Management

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Appendix A: About This Report
Appendix B: Results of Field Work
Appendix C: Laboratory Testing

D

This report presents the results of a geotechnical investigation undertaken for an assessment of site suitability for on-site sewage disposal at Lots 61 and 1001 Kilburn Road, Parkerville, WA. The investigation was commissioned in an email dated 25 May 2018 by Phil Cuttone on behalf of Parkerville Children and Youth Care Inc. and was undertaken in accordance with Douglas Partners' proposal PER180204 dated 24 May 2018.

It is understood that the site is to be rezoned to allow for residential development. The site will not be serviced by the sewerage network. Therefore, in order to progress the rezoning process, an assessment of the suitability of the site for on-site disposal of sewage is required.

The aim of the geotechnical investigation was to assess the soil and groundwater conditions (if encountered) underlying the site and subsequently provide comment on the suitability of soils encountered during investigation for acceptance of domestic on-site effluent disposal in accordance with AS 1547:2012. Additionally, the investigation was to provide an indicative site classification for the site in current condition in accordance with AS2870-2011.

The investigation included the excavation of twelve test pits, dynamic cone penetrometer tests adjacent to each test pit, the performance of seven in situ permeability tests using the constant head method, and laboratory testing of selected samples. The details of the field work are presented in this report, together with comments and recommendations on the issues listed above.

D

The irregular shaped site is identified as Lots 61 and 1001 Kilburn Road in Parkerville, Western Australia (refer to Drawing 1, Appendix A). It is bounded by Kilburn road to the south, by Roland road to the west, by Brindle Road to the east, and by Clutterbuck Creek to the north. The site has a developable area of approximately 15.4 ha.

At the time of the investigation, the site generally comprised grass pasture, with medium to large sized trees located mostly around the perimeter of the site but also occasionally in the pasture area. A residential dwelling and several agricultural buildings were located along the southern boundary of the site. The foundations, ground slab and a wall of a partially demolished structure and adjacent derelict water tank were observed within the centre of the site, with a water dam nearby. Numerous piles of laterite boulders were observed on the surface, which was also generally scattered with laterite cobbles. Several felled trees and timber stockpiles were present. The site falls gently from a high point in the south east corner to a low point in the north western corner.

Some typical views of the site, indicating some of the features described above, are presented in Figures 1 to 6 (below and following pages).

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The ground surface level is estimated to falls from a high point of approximately RL 257 m AHD in the south east corner to a low point of approximately RL 243 m AHD in the north western corner, based on data provided by Google Earth.

The Mundaring 1: 50 000 Environmental Geology sheet indicates that shallow sub surface conditions beneath the most of the site consist of laterite gravel, described as fine to coarse, loose ferruginous pisolites within a sand and silt matrix, of colluvial origin. The eastern part of the site is indicated to be underlain by laterite, described as massive, hard and cemented, and overlain by associated gravels of residual origin. The north western boundary of the site is indicated to be underlain by gravelly clayey sand of colluvial origin.

M

Field work was carried out on 31 May and 1 June 2018 and comprised the excavation of twelve test pits, seven in situ permeability tests and dynamic penetrometer testing adjacent to each test pit location.

The test pits (TP1 to TP12) were excavated to a maximum depth of 2.0 m using an 8 tonne excavator equipped with a 450 mm wide toothed bucket and were logged in general accordance with AS 1726-2017 by a suitably experienced geotechnical engineer from DP. Soil samples were recovered from selected locations for subsequent laboratory testing. Refusal occurred prior to the target depth of 2 m at TP2, TP3, TP7, TP10 and TP11 due to slow or hard digging.

Dynamic cone penetrometer (DCP) tests were carried out adjacent to all test locations in accordance with AS 1289.6.3.2 to assess the in situ density of the shallow soils.

Seven in situ permeability tests were carried out using the constant head method in accordance with AS 1547-2012 at BH13 to BH19 at depths of 0.25 m.

Test locations were determined using hand held GPS coordinates and are marked on Drawing 1 in Appendix A. Surface elevations at each test location were interpolated from data provided by Google Earth.

Detailed logs of the ground conditions and results of the field testing at the test pit locations are presented in Appendix B, with notes defining descriptive terms and classification methods provided in Appendix A.

The encountered ground conditions generally comprised topsoil overlying clayey sandy gravel or gravelly clayey sand. Laterite or clayey sand / sandy clay were generally encountered underlying the gravelly soils.

A summary of the ground conditions encountered or inferred at the test locations is given below:

- **T** – generally dark brown-black, fine to medium grained gravelly silty sandy topsoil with some roots, encountered to a depth of 0.1 m. The topsoil was filling at TP9.
- – medium dense, dark brown, fine to medium grained gravelly sand filling encountered to a depth of 0.4 m at TP9.
- – generally loose, locally medium dense or dense, brown, fine to medium grained gravelly clayey sand or fine to coarse sized clayey sandy gravel encountered underlying the topsoil or filling at all locations to depths of between 0.3 m and 1.3 m, except at TP3 and TP12 where this soil extended to the termination depth of the test pits at depths of 1.7 m and 2.0 m respectively. The gravelly clayey sand contained cobbles and boulders of laterite at some test locations. It behaved as an extremely low strength, extremely weathered rock at TP3 and TP8.
- – generally high strength laterite encountered underlying the gravelly soils described above at TP1, TP2, TP7 and TP10 from depths of approximately 0.25 m and 0.5 m. Refusal occurred within 50 mm to 300 mm of the top of the laterite due to hard digging, except at TP1 where the full depth of the laterite as excavated with the 8 tonne excavator (base of laterite at TP1 approximately 0.9 m). Possible laterite is inferred from test pit refusal due to hard digging at TP3 and TP11 at depths of 1.7 m. The depth to the top of the encountered laterite is summarised in Table 1 below.
- – generally very dense or hard, light yellow-brown or light grey-brown mottled brown, clayey sand or sandy clay, encountered underlying the gravelly soils or laterite at most test locations. The sand is medium to coarse grained and the clay is of medium plasticity. The material was very hard sandy clay at TP1. The material contained some gravel at some locations. The soil behaved as extremely low strength, extremely weathered rock at TP8 and TP11.

T

T	D	D T	T D
TP1	236	0.3	235.7
TP2	241	0.4	240.6
TP3	244	1.7[2]	242.3
TP7	240	0.5	239.5
TP10	248	0.2	247.8
TP11	248	1.7[2]	246.3

Notes: [1]: Interpolated from data provided by Google Earth (estimated accuracy +/- 1 m)
[2]: Laterite inferred due to hard digging

Seepage of groundwater was observed at TP1 and TP4, both located at the north western end of the site, during the field work undertaken on 31 May 2018. A summary of the observed groundwater levels is provided in Table 2 below. A local aquifer was not encountered at any of the test locations.

T

T	D	D	D
TP1	236	0.8[2]	235.2
TP4	238	1.7[2]	235.3

Notes: [1]: Interpolated from data provided by Google Earth (estimated accuracy +/- 1 m)
[2]: Seepage observed from the given depth

BOM records indicate that more than 90 mm of rain fell in Parkerville area in the week preceding the field works.

It should be noted that groundwater levels are affected by climatic conditions and soil permeability, and will therefore vary with time.

Seven in situ permeability tests using the constant head method were carried out in accordance with AS 1547-2012 at depths of 0.25 m at BH13 to BH19. Field permeability values were estimated using the test results in accordance with AS 1547-2012. The results of the in situ permeability test are presented in Table 3 (next page).

T

T	D	M		T M
BH13	0.25	3.9×10^{-5}	3.5	Gravelly Clayey Sand
BH14	0.25	2.6×10^{-5}	2.0	Clayey Sandy Gravel
BH15	0.25	2.5×10^{-5}	2.0	Clayey Sandy Gravel
BH16	0.25	4.2×10^{-5}	3.5	Gravelly Clayey Sand
BH17	0.25	5.3×10^{-5}	4.5	Gravelly Clayey Sand
BH18	0.25	10.5×10^{-5}	9.0	Clayey Sandy Gravel
BH19	0.25	4.3×10^{-5}	3.5	Clayey Sandy Gravel

Notes: [1]: AS1547:2012 Appendix 4.1F.

T

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of:

- the particle size distribution of four samples;
- the Atterberg limits of four samples;
- the Emerson Class of three samples; and
- the pH, electrical conductivity, action exchange capacity and phosphorous retention index on two samples.

The detailed test certificates are given in Appendix C, with the results summarised in Tables 4 and 5 (next page).

T **T**

T	D									M
TP1	1.1-1.3	5	40	55	56	24	32	7.0	0.5	Sandy Clay
TP4	1.0-1.2	11	44	45	55	30	25	6.5	0.9	Sandy Clay
TP6	0.5	75	21	4	-	-	-	-	-	Clayey Sandy Gravel
TP8	1.5	28	45	27	44	29	16	8.0	-	Gravelly Clayey Sand
TP11	0.5	40	45	15	34	21	13	5.5	-	Clayey Gravelly Sand

Where:

- % fines is the amount of particles smaller than 75 µm.
- % gravel is the amount of particles larger than 2.36 mm.
- LL: liquid limit.
- LS: linear shrinkage
- PL: plastic limit
- PI: plasticity Index
- '-' means 'Not Tested'

T **T** **D**

T	D						M
TP1	1.1-1.3	5.4	0.088	2	418.3	6	Sandy Clay
TP4	1.0-1.2	-	-	-	-	6	Sandy Clay
TP6	0.5	6.3	0.004	<1	188.0	5	Clayey Sandy Gravel
TP11	0.5	6.6	0.019	4	177.9	-	Clayey Gravelly Sand

Notes:

- pH and EC tests are carried out in 1:5 (soil:water) solution.
- EC: Electrical conductivity
- CEC: Cation exchange capacity in meq/100g.
- PRI: Phosphorous retention index

D

It is understood that the site is to be rezoned to allow for residential development. The site will not be serviced by the sewerage network. Therefore, in order to progress the rezoning process, an assessment of the suitability of the site for on-site disposal of sewage is required.

The site is generally underlain by mixed clayey soils and laterite. The encountered shallow soils were generally loose. Uncontrolled filling was encountered at one location.

Because of the presence of uncontrolled filling and loose shallow soils, the site should be strictly classified as Class 'P' in current condition. However, the encountered filling should generally form a suitable foundation material and the depth of loose material is less than 1 m and consequently can be compacted to medium dense or denser by conventional earthworks methods and plant.

Therefore, based on the encountered conditions, the majority of the site is suitable to be classified as "Class S" in accordance AS2870-2011, provided the density of the loose soils underlying the site is increased to medium dense or denser.

D

Site characteristics observed during the field work and soil properties determined during subsequent laboratory testing have been assessed in relation to the anticipated limitations that they pose to onsite disposal of domestic effluent.

For this assessment, reference has been made to AS1547-2012, the Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001, Government Sewerage Policy – Consultation Draft, Department of Health, December 2011 and NSW Environment and Health Protection Guidelines. This later guideline evaluates various soil and site characteristics and assigns either a minor, moderate or major limitation depending on the restrictions to the disposal of domestic effluent. Minor limitations are regarded as not posing a constraint to the application of domestic effluent. Site and soil characteristics which are considered to be major limitations will require site or soil improvement measures to allow on-site effluent disposal at the site.

Site and soil characteristics, including, the moderate and major limitations for effluent disposal within the site, are discussed below.

Saturated hydraulic conductivity (permeability) is a measure of the ability of soil to transmit water based on soil properties such as structure, texture and porosity. The soil types noted within the test pits are predominantly gravelly clayey sand / clayey sandy gravel overlying clayey sand / sandy clay. Laterite was encountered close to the ground surface at some locations (see Section 4.1 and Table 1).

A soil permeability category Groups 2 to 5 (reference to AS 1547-2012 Tables 5.1 and E1) are considered suitable for encountered uncemented soils underlying most of the site, with measured permeability ranging between approximately 2.5 x 10^{-5} m/s and 10.5 x 10^{-5} m/s (approximately

2.0 m/day and 9.0 m/day). It is suggested that a preliminary design permeability of 2.5 x 10^{-5} m/s (approximately 2.0 m/day) is adopted for the uncemented soils underlying the site.

The laterite should be regarded as impermeable for drainage or sewage disposal design, as discussed in Section 7.2.2 below.

D

Laterite was encountered at shallow depth at some locations, as summarised in Table 1, Section 4.1. The laterite should be regarded as hardpan and impermeable for drainage or sewage disposal design.

The laterite was not encountered at most test locations, and hard pan material was not generally present within the investigation depth. Therefore, depth to hardpan is not considered a limitation for most of the site.

However, at the depths encountered at TP1, TP2, TP7 and TP10, it is considered a major limitation and will need to be addressed.

Therefore, to allow on-site disposal of sewage where shallow laterite is currently present, either:

- the laterite should be excavated and replaced with soil similar to the uncemented soils encountered at the site; or
- the elevation of the site should be raised to provide sufficient depth of soil above the laterite for drainage to occur.

It may be possible to re-use the laterite following excavation, and crushing of the cemented material. Further investigation, testing and field trials would be required to provide further comment on the reuse of the laterite and appropriate methods of crushing the material.

D

Groundwater seepage was encountered at depths of 0.8 m and 1.7 m at TP1 and TP4 during the field work on 31 June 2018. BOM records indicate that over 90 mm of rainfall fell during the week immediately preceding the field work.

It is possible that perched groundwater will collect on the lower permeability materials such as laterite and sandy clay in the winter period but such phenomenon is likely to be short lived and was not observed during the investigation except at TP1 and TP4. Therefore, the groundwater table is considered a minor limitation for on-site disposal of sewage. Investigation of groundwater levels at the end of winter is suggested to further assess possible impacts of groundwater levels for on-site sewage disposal, particularly the low lying areas of the site. Groundwater levels are affected by climatic conditions and soil permeability and groundwater levels higher than those encountered during the field work may occur.

Coarse fragments are defined as particles greater than 2 mm in AS 1547-2012. The abundance of coarse fragments in the soils encountered underlying the site is generally common to abundant, in accordance with Table E2, AS 1547-2012. Such an abundance of coarse fragments may pose limitations on root growth of surface vegetation and reduce the soil capacity to supply water and nutrients to the vegetation, though there is no evidence of this being the case on the study site. The piles of boulders on the site surface should be removed.

The abundance of coarse fragments may also present difficulty in trench and excavation construction. This is considered to be likely for the massive laterite, which will be hard digging and may require large plant or rock breakers to excavate. The abundance of coarse fragments is considered a moderate limitation.

The site slopes generally slopes gently towards the north western corner, with gradients estimated to be less than 10%. Slopes of this gradient are considered a minor limitation due to the potential rapid runoff of the effluent from surface and subsurface irrigation and absorption systems, possibly resulting in accumulation of runoff and consequent waterlogging where the gradient reduces.

D

Laboratory testing of soil samples taken from the site indicate an Emerson class of 5 or 6. Therefore, the soils generally have a low potential for dispersion and dispersivity does not form a limitation for on-site sewage disposal at the site.

Laboratory testing indicates a pH value of generally above 6, though one result returned a pH of 5.4. Therefore, pH is a minor limitation for on-site sewage disposal at the site.

Laboratory testing indicates that the electrical conductivity of soils underlying the site is less than 0.1 dS/m and therefore electrical conductivity is not a limitation to on-site sewage disposal.

The cation exchange capacity (CEC) is the total number of cations a soil can retain on its absorbent complex at a given pH, and is therefore a good measure of a soil ability to retain specific pollutants. The laboratory tests carried out on the samples collected from test pits TP1, TP6 and TP11, indicate CEC values of less than 5 meq/100g or cmol+/kg. A cation exchange capacity of less than 5 cmol+/kg is considered as a major limitation for on-site effluent disposal and therefore secondary treatment of effluent, using equipment such as aerobic treatment units (ATU) is required.

The laboratory test carried out on samples collected from TP1, TP6 and TP11 indicate a phosphorus retention index (PRI) of between 177.9 mL/g and 418.3 mL/g for the soils underlying the site, indicating the soils are moderately to highly absorbing. PRI is considered a minor limitation for on-site sewage disposal.

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Owing to the occurrence of soils with the major limitations on permeability mentioned above, it is suggested that the treatment of the primary effluent is undertaken to produce secondary quality effluent, prior to on-site disposal over the land surface.

Several treatment options are possible and include the following:

- Aerobic Treatment Unit (ATU);
- sand filters; and
- closed cell (amended soil) evapo-transpiration systems.

It is understood that sequential batch reactor (SBR) units, an advanced form of ATU, are proposed for this site.

The effluent treatment system selected for use should be approved by the WA Department of Health.

Once the effluent has been treated by an approved system, the resulting effluent would be sent to the disposal area.

The disposal area required will be dependent on number of factors, including the following:

- treatment system adopted and quality of effluent produced;
- soil characteristics;
- climate conditions; and

- effluent loading, as determined by the number of people within the proposed workshop and the water reduction fixtures present.

Guidance on the minimum areas for land application of effluent which has been treated by an ATU/SBR system is provided in Table 13 of the "Code of Practice for On-Site Sewage Management, Consultation Draft – November 2012", issued by Department of Health, Government of Western Australia.

D

The performance of an effluent disposal system is dependent on proper maintenance which should incorporate the following:

- regular maintenance of surface vegetation to encourage water and nitrogen uptake.
- maintenance of surface drains to prevent the ponding of water in the vicinity of the disposal area.

Disposal areas should be constructed to comply with AS 1547-2012 and the general recommendations contained within this report, the methods detailed in AS 1547-2012, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001 and the respective local or state authority. Disposal area should also observe the setback distances listed in Table 10 of the "Code of Practice for On-Site Sewage Management, Consultation Draft – November 2012", issued by Department of Health, Government of Western Australia.

D

The site is considered suitable for the disposal of domestic effluent in general accordance with AS1547-2012, local government conditions and WA Department of Health, provided that the limitations described in Section 7.2 are addressed and that treatment of primary effluent is undertaken.

As there are a variety of Department of Health WA approved proprietary systems available, the choice of system is ultimately made by the purchaser of the properties within the guidelines of AS 1547:2012, local government authorities, the WA Department of Health and the site characteristics described above.

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
3. Australian Standard AS 1726-2017, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings.
5. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.

6. Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001.
7. Environment & Health Protection Guidelines: On-site Sewage Management for Single Households - January 1998.
8. Australian Standard AS 1547-2012, On-site Domestic-wastewater Management.
9. Government Sewerage Policy – Consultation Draft, Department of Health, December 2011.
10. Code of Practice for Onsite Sewage Management, Consultation Draft, November 2012.

Douglas Partners (DP) has prepared this report for this project at Lots 61 and 1001, Kilburn road, Parkerville, WA, in accordance with DP's proposal dated 24 May 2018 and acceptance received from Phil Cuttone on behalf of Parkerville Children and Youth Care Inc. dated 25 May 2018. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Parkerville Children and Youth Care Inc. for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition

materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

Asbestos has been detected by observation on the surface of the site near building demolition materials, and these are considered as indicative of the possible presence of hazardous building materials (HBM), including asbestos.

Although the sampling plan adopted for this investigation is considered appropriate to achieve the stated project objectives, there are necessarily parts of the site that have not been sampled and analysed. This is either due to undetected variations in ground conditions or to budget constraints (as discussed above), or to parts of the site being inaccessible and not available for inspection/sampling [where appropriate], or to vegetation preventing visual inspection and reasonable access [where appropriate]. It is therefore considered possible that HBM, including asbestos, may be present in unobserved or untested parts of the site, between and beyond sampling locations, and hence no warranty can be given that asbestos is not present.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

D

About This Report
Drawing

About this Report

Douglas Partners

These notes have been provided to amplify DP s report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP s reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

T

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to ustify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than straight line variations between the test locations.

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open
- A localised, perched water table may lead to an erroneous indication of the true water table
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency
- Changes in policy or interpretations of policy by statutory authorities or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Sampling Methods

Douglas Partners

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

T

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

D

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

D

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only ma or changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

D

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

T

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7

  N = 13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

D T

T

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

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Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Symbols & Abbreviations

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Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

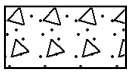
Symbols & Abbreviations

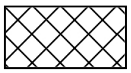
Graphic Symbols for Soil and Rock

General

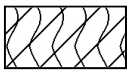
Asphalt

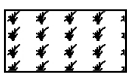
Road base

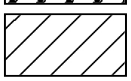

Concrete


Filling

Soils


Topsoil

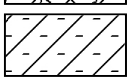

Peat


Clay

Silty clay

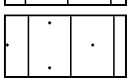
Sandy clay

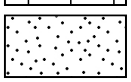
Gravelly clay

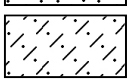

Shaly clay

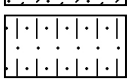
Silt

Clayey silt


Sandy silt

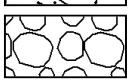

Sand


Clayey sand


Silty sand

Gravel

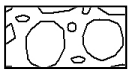
Sandy gravel


Cobbles, boulders

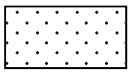
Talus

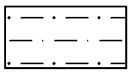
Sedimentary Rocks

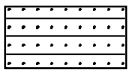
Boulder conglomerate

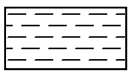

Conglomerate

Conglomeratic sandstone

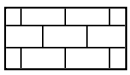

Sandstone


Siltstone

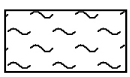

Laminite

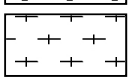

Mudstone, claystone, shale

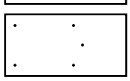
Coal


Limestone

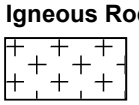
Metamorphic Rocks

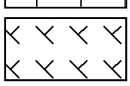

Slate, phyllite, schist

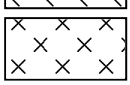

Gneiss

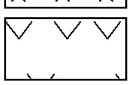

Quartzite

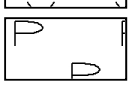
Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

Aerial Photography Source: NearMap, flown April 2018.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Parkerville Children and Youth Care Inc	**Test Location Plan**	PROJECT No:	89041.00
	OFFICE:	Perth	**Proposed On-Site Sewage Disposal**	DRAWING No:	1
	DATE:	14-6-2018	**Lots 61 & 1001 Kilburn Road, Parkerville, WA**	REVISION:	0

Results of Field Work

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 236 m AHD*
EASTING: 418624
NORTHING: 6473668

PIT No: TP01
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
236	0.1	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained, silty sandy topsoil with some gravel to slightly gravelly, some roots, moist.							
	0.3	GRAVELLY CLAYEY SAND - loose, brown, fine to medium grained, gravelly clayey sand, moist. Gravel is laterite.							
		LATERITE - medium to high strength, orange-brown and brown, laterite with some clay seams. Excavated as cobbles and boulders.						▽	
	0.9	SANDY CLAY - very stiff to hard, light grey-brown mottled brown, medium plasticity, sandy clay with some gravel, moist.		D	1.1				
235	1			U	1.2				1
		- becoming light grey and no gravel from 1.4 m depth.			1.35				
234	2 2.0	Pit discontinued at 2.0m (Target depth)							2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Groundwater seepage at 0.8 m depth.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 241 m AHD*
EASTING: 418654
NORTHING: 6473579

PIT No: TP02
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
241	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.		D	0.3				
	0.45			D	0.47				
	0.5	LATERITE - high strength, orange-brown and brown, laterite.							
		Pit discontinued at 0.5m (Hard digging)							
240	1								
239	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 244 m AHD*
EASTING: 418774
NORTHING: 6473596

PIT No: TP03
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
244	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
	0.7	GRAVELLY CLAYEY SAND - light brown and brown, gravelly clayey sand, moist. Behaves as extremely low strength, extremely weathered rock.							
243	1			D	1.0				1
	1.7	Pit discontinued at 1.7m (Slow, hard digging)							
242	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 238 m AHD*
EASTING: 418787
NORTHING: 6473703

PIT No: TP04
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
238	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
	0.8	CLAYEY SAND - very dense, light yellow-brown mottled brown, medium to coarse grained, clayey sand, moist.							
237	1			U	1.0				1
					1.22				
				D	1.3				
		- becoming light grey mottled red-brown from 1.4 m depth.						▽	
236	2 2.0	Pit discontinued at 2.0m (Target depth)							2

5 10 15 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: Groundwater seepage at 1.7 m depth.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 246 m AHD*
EASTING: 418867
NORTHING: 6473646

PIT No: TP05
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
246	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist. PACM observed on surface.		D	0.0 0.05		PACM Sample		
		CLAYEY SANDY GRAVEL - dense, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
245	1								1
	1.3	CLAYEY SAND - light yellow-brown mottled brown, medium to coarse grained, clayey sand, moist.							
244	2 2.0	Pit discontinued at 2.0m (Target depth)							2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 247 m AHD*
EASTING: 418949
NORTHING: 6473664

PIT No: TP06
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
247	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.		D	0.5				
		- becoming dense from 0.6 m depth.							
246	1								1
	1.3	CLAYEY SAND - light yellow-brown mottled brown, medium to coarse grained, clayey sand, moist.							
		- becoming light brown mottled light grey from 1.6 m depth.							
245	2 2.0	Pit discontinued at 2.0m (Target depth)							2

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 240 m AHD*
EASTING: 418902
NORTHING: 6473755

PIT No: TP07
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
240	0.1	TOPSOIL (SILTY SAND) - dark brown, fine to medium grained, silty sandy topsoil with some gravel to slightly gravelly, some roots, moist.							5 10 15 20
		GRAVELLY CLAYEY SAND - loose, brown, fine to medium grained, gravelly clayey sand with some laterite boulders, moist. Gravel is laterite.							
	0.5								
	0.6	LATERITE - high strength, orange-brown and brown, laterite.							
		Pit discontinued at 0.6m (Hard digging)							
239	1								
238	2								

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 245 m AHD*
EASTING: 419042
NORTHING: 6473770

PIT No: TP08
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
245	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
	0.4	CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
		GRAVELLY CLAYEY SAND - dense, light brown, medium to coarse grained, gravelly clayey sand, moist.							
244	1.0	CLAYEY SAND - light yellow-brown mottled brown, medium to coarse grained, clayey sand with some gravel, moist. Behaves as an extremely low strength, extremely weathered rock.		D	1.5				
243	2.0	Pit discontinued at 2.0m (Target depth)							

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 250 m AHD*
EASTING: 419074
NORTHING: 6473711

PIT No: TP09
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
250	0.05	FILLING (TOPSOIL) - dark brown, fine to medium grained, gravelly silty sandy topsoil with some roots, moist.		D	0.1				
	0.4	FILLING (GRAVELLY SAND) - medium dense, dark brown, fine to medium grained, gravelly sand with some silt, moist. Gravel is laterite. - becoming dark grey from 0.2 m depth.							
249	1	GRAVELLY CLAYEY SAND - medium dense, brown, fine to medium grained, gravelly clayey sand with cobbles and boulders of laterite, moist.							1
	1.3	CLAYEY SAND - light yellow-brown and light brown, medium to coarse grained, clayey sand with some gravel to slightly gravelly, moist.							
248	2	2.0 Pit discontinued at 2.0m (Target depth)							2

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 248 m AHD*
EASTING: 419162
NORTHING: 6473797

PIT No: TP10
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
248	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
	0.25	CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
	0.35	LATERITE - high strength, orange-brown mottled red-brown, laterite.							
		Pit discontinued at 0.35m (Hard digging)							
247	1								
246	2								

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 248 m AHD*
EASTING: 419248
NORTHING: 6473857

PIT No: TP11
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
248	0.1	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.		D	0.5				
	0.7	CLAYEY SAND - loose, light yellow-brown and light brown, medium to coarse grained, clayey sand, moist.							
247	1	- behaves as an extremely weathered, extremely low strength rock from 1.1 m depth.							1
	1.7	Pit discontinued at 1.7m (Slow, hard digging)							
246	2								

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Parkerville Children and Youth Care Inc
PROJECT: Proposed On-Site Sewage Disposal
LOCATION: Lots 61 & 1001 Kilburn Road, Parkerville, WA

SURFACE LEVEL: 256 m AHD*
EASTING: 419227
NORTHING: 6473689

PIT No: TP12
PROJECT No: 89041.00
DATE: 31/5/2018
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
256	0.05	TOPSOIL (GRAVELLY SILTY SAND) - dark brown, fine to medium grained, gravelly silty sandy topsoil, some roots, moist.							
		CLAYEY SANDY GRAVEL - loose, brown, fine to coarse sized, clayey sandy gravel, moist. Gravel is laterite.							
255	1			D	1.0				1
254	2	2.0 Pit discontinued at 2.0m (Target depth)							2

RIG: 8 tonne JCB backhoe with a 450 mm wide toothed bucket.

LOGGED: YC

SURVEY DATUM: MGA94

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level obtained from Google Earth.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Laboratory Testing

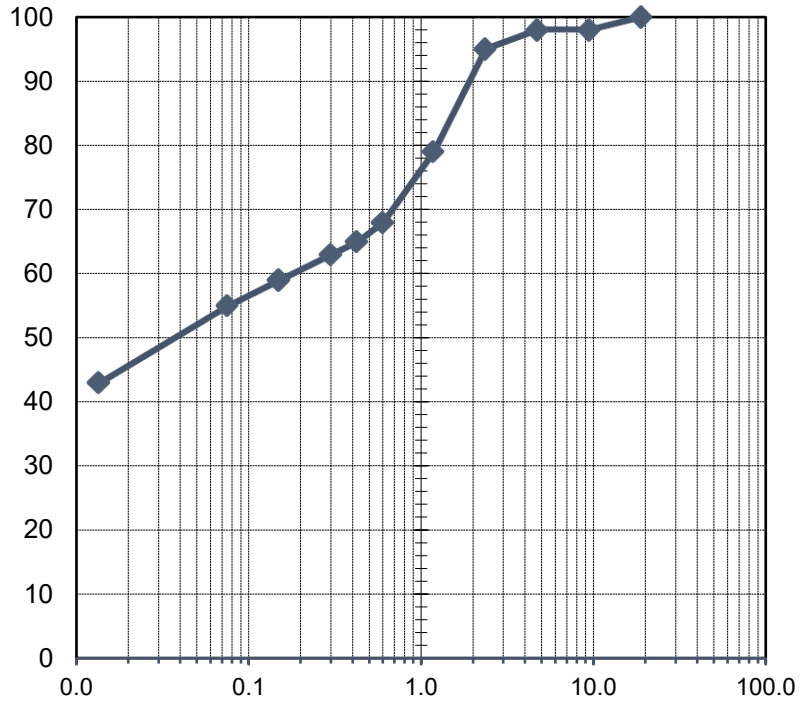
LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

T D T T

WA 115.1



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AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1

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☑	☐	Cracked ☐	Curled ☑

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Laboratory Manager
18- une-2018

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T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

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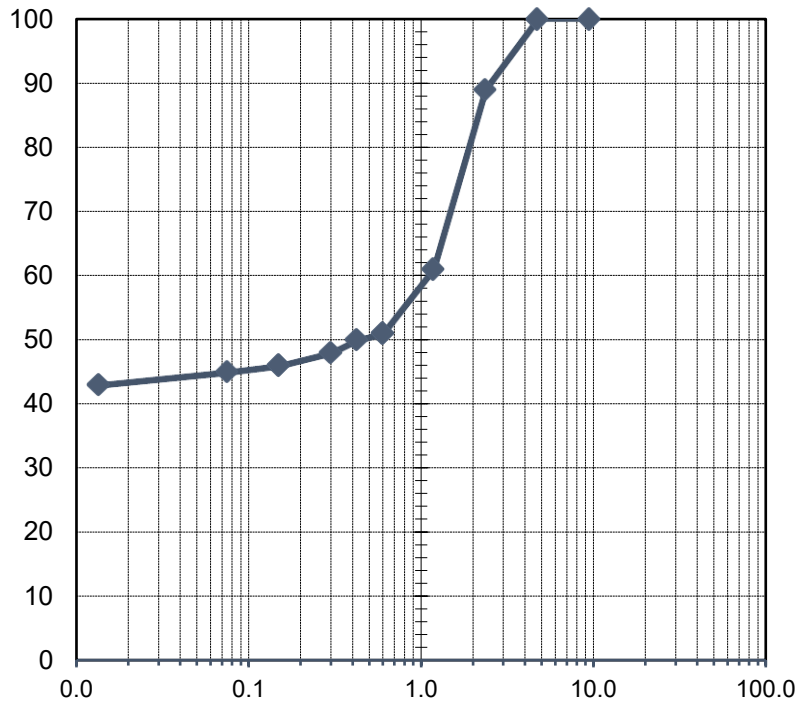

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AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1

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☑	☐	Cracked ☐	Curled ☑

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Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

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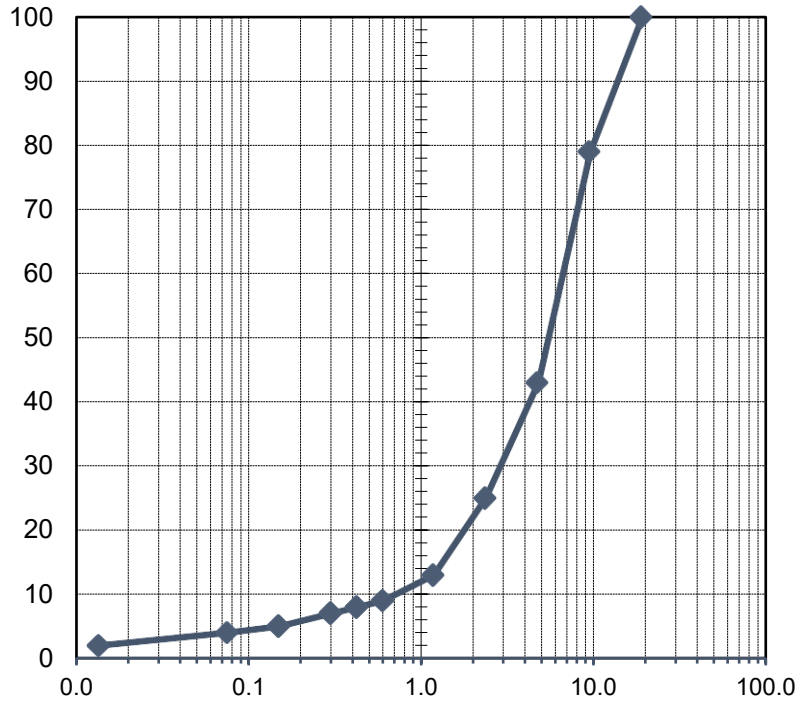
WA 115.1



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T T T T

Client		Ticket No.	
Client Address		Report No.	D
Pro ect	D	Sample No.	
Sampling Location		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D

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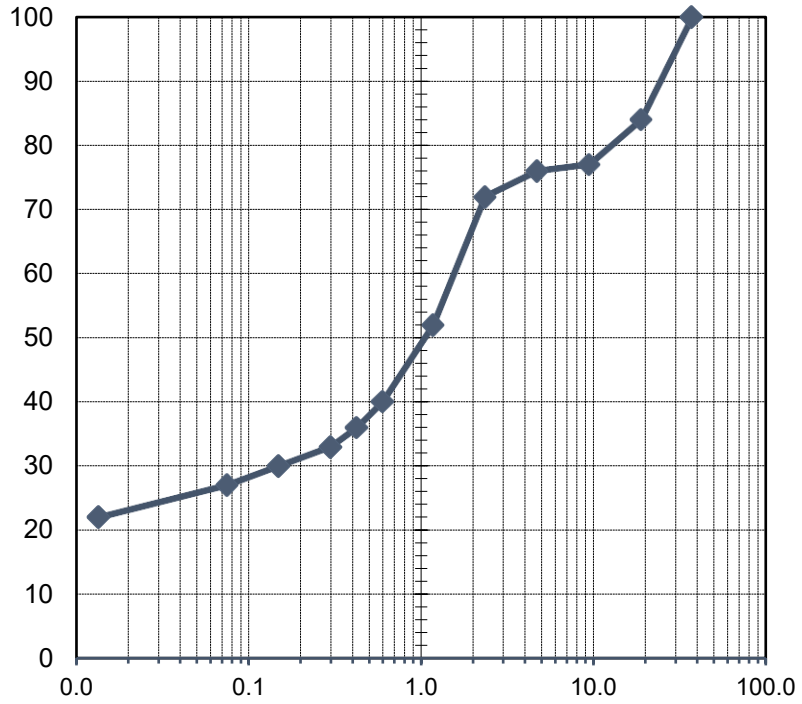

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AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1

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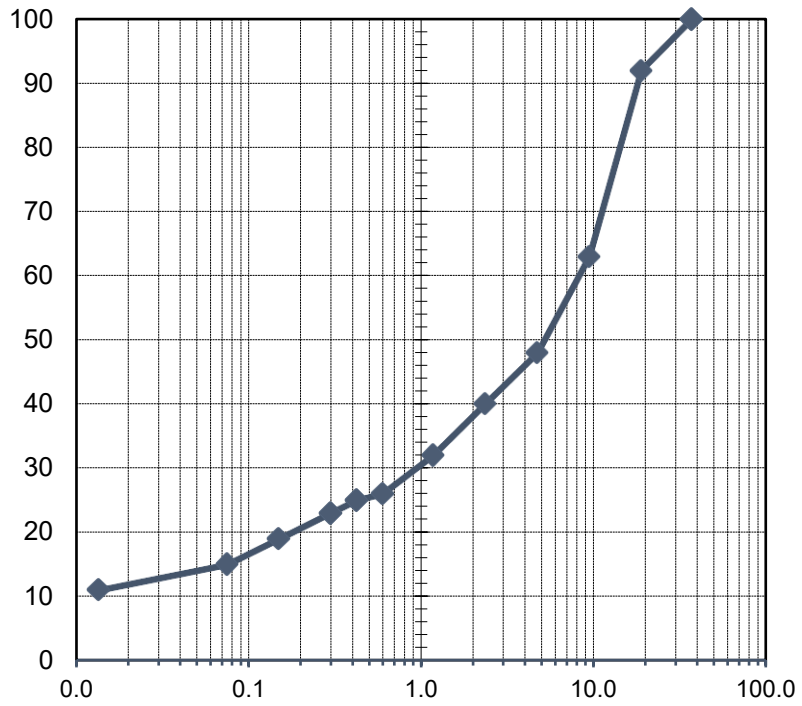
T D T T

WA 115.1



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AS 1289.3.1.1	AS 1289.3.2.1	AS 1289.3.3.1	AS 1289.3.4.1

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Laboratory Manager
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Client		Ticket No.	
Client Address		Report No.	
Pro ect	D	Sample No.	
ob Number		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D
Sample Description			

Moisture Content - Initial ( )	15.8	Moisture Content - Final ( )	17.7
Dry Density - Initail (t/m^3)	1.81	Estimated Inert Inclusions ( )	2

Moisture Content - Initial ( )	16	Length/Diameter Ratio	2.2
Extent of Crumbing	Nil	Extent of Cracking	Nil

Shrinkage Strain ( )	0.8	Shrink Swell Index I $_{ss}$	0.5
Swell Strain ( )	0.0		

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Laboratory Manager
D 18- une-2018

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Client		Ticket No.	
Client Address		Report No.	
Pro ect	D	Sample No.	
ob Number		Sampled By	
Sample Identification	T		
Sampling Method	T	Preparation Method	
Sample History	D	Wet or Dry Sieved	D
Sample Description			

Moisture Content - Initial ( )	17.9	Moisture Content - Final ( )	18.7
Dry Density - Initail (t/m^3)	1.7	Estimated Inert Inclusions ( )	0

Moisture Content - Initial ( )	18.0	Length/Diameter Ratio	2.3
Extent of Crumbing	Nil	Extent of Cracking	Nil

Shrinkage Strain ( )	1.5	Shrink Swell Index I $_{ss}$	0.9
Swell Strain ( )	0.0		

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M. van Herk
Laboratory Manager
D 18- une-2018

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M T T T

n acc dance i

Client		Ticket No.	
Client Address		Report No.	M
Pro ect	D	Sample No.	
Location		Sampled By	
Sample Identification			

Sampling Method: T

M M

D

LLS18/2504	TP01 1.10-1.35m	
LLS18/2505	TP04 1.00-1.22m	
LLS18/2506	TP06 0.5m	

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M. van Herk
Laboratory Manager
18- une-2018

Envirolab Services (WA) Pty Ltd trading as MPL Laboratories
ABN 53 140 099 207
16-18 Hayden Court Myaree WA 6154
ph 08 9317 2505 fax 08 9317 4163
lab@mpl.com.au
www.mpl.com.au

CERTIFICATE OF ANALYSIS 211769

Client Details

Client	Liquid Labs WA
Attention	Matt Van Herk
Address	Unit 4, 96 Briggs Street, WELSHPOOL, WA, 6106

Sample Details

Your Reference	**Proposed On-Site Sewage Disposal**
Number of Samples	3 Soil
Date samples received	08/06/2018
Date completed instructions received	08/06/2018
Location	Lots 61 & 1001 Kilburn Road, Parkerville

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.

Report Details

Date results requested by	14/06/2018
Date of Issue	14/06/2018

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Results Approved By
Todd Lee, Laboratory Manager, Perth

Authorised By

Todd Lee, Laboratory Manager

Miscellaneous Inorg - soil				
Our Reference		211769-1	211769-2	211769-3
Your Reference	UNITS	LLS18/2505 TP04	LLS18/2506 TP06	LLS18/2508 TP11
Depth		1.0-1.22	0.5	0.5
Type of sample		Soil	Soil	Soil
Date prepared	-	13/06/2018	13/06/2018	13/06/2018
Date analysed	-	13/06/2018	13/06/2018	13/06/2018
pH	pH Units	5.4	6.3	6.6
Electrical Conductivity (EC)	µS/cm	88	4.4	19

ESP/CEC				
Our Reference		211769-1	211769-2	211769-3
Your Reference	UNITS	LLS18/2505 TP04	LLS18/2506 TP06	LLS18/2508 TP11
Depth		1.0-1.22	0.5	0.5
Type of sample		Soil	Soil	Soil
Date digested	-	13/06/2018	13/06/2018	13/06/2018
Date analysed	-	14/06/2018	14/06/2018	14/06/2018
Calcium	mg/kg	190	<50	460
Potassium	mg/kg	<50	<50	84
Magnesium	mg/kg	91	<50	120
Sodium	mg/kg	<50	100	94
Aluminium	mg/kg	<10	<10	<10
Exchangeable Ca	meq/100g	0.9	<0.25	2.3
Exchangeable K	meq/100g	<0.13	<0.13	0.2
Exchangeable Mg	meq/100g	0.8	<0.41	1
Exchangeable Na	meq/100g	<0.22	0.4	0.4
Exchangeable Al	meq/100g	<0.07	<0.07	<0.07
Cation Exchange Capacity	meq/100g	2	<1	4

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
METALS-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
METALS-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
METALS-020	Metals in soil and water by ICP-OES.

QUALITY CONTROL: Miscellaneous Inorg - soil						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			13/06/2018	[NT]	[NT]	[NT]	[NT]	13/06/2018	[NT]
Date analysed	-			13/06/2018	[NT]	[NT]	[NT]	[NT]	13/06/2018	[NT]
pH	pH Units		INORG-001	[NT]	[NT]	[NT]	[NT]	[NT]	101	[NT]
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	[NT]	[NT]	[NT]	[NT]	103	[NT]

QUALITY CONTROL: ESP/CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date digested	-			13/06/2018	[NT]	[NT]	[NT]	[NT]	13/06/2018	[NT]
Date analysed	-			14/06/2018	[NT]	[NT]	[NT]	[NT]	14/06/2018	[NT]
Calcium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	105	[NT]
Potassium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	100	[NT]
Magnesium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	100	[NT]
Sodium	mg/kg	50	METALS-020	<50	[NT]	[NT]	[NT]	[NT]	94	[NT]
Aluminium	mg/kg	10	METALS-020	<10	[NT]	[NT]	[NT]	[NT]	104	[NT]

Result 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
NR	Not Reported

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.

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.

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.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

92702
Liquid Labs WA

Soil & Plant Analysis Laboratory

ANALYSIS REPORT

Generated: 15/06/2018 1:56:18 PM

	Lab No	XTS18145	XTS18146	XTS18147
	Name	TP04 0-1.22m	TP06 0.5m	TP11 0.5m
	Code	LLS18/2505	LLS18/2506	LLS18/2508
	Customer	Liquid Labs WA	Liquid Labs WA	Liquid Labs WA
	Depth	0-10	0-10	0-10
Phosphorus Retention Index		418.3	188.0	177.9

Appendix 3 Soil Investigation Plan (Pritchard Francis, 2019)

LEGEND

TESTPIT8 — TESTPIT LOCATION
PROPOSED CADASTRAL
LANDFOCUS CADASTRAL
SCDB CADASTRAL (30/05/2019)

ROAD

BRINDLE ROAD

ROLAND ROAD

KILBURN ROAD

1001
16.187ha

61
13.197ha

Gravel 0 - 0.9m
Clay 0.9 - 1.2m
TESTPIT10
TESTPIT9
Gravel 0 - 0.9m
Clay 0.9 - 1.2m
White Wet Clay
TESTPIT12
TESTPIT11
Gravel 0 - 1.2m
Gravel 0 - 0.9m
Clay 0.9 - 1.2m
TESTPIT8
TESTPIT7
Gravel 0 - 1.2m
Gravel 0 - 0.8m
Clay 0.8 - 1.0m
TESTPIT6
Gravel 0 -1.2m
with Rock Floaters
Gravel 0 - 0.8m
Clay 0.8 - 1.2m
TESTPIT13
Gravel 0 - 0.6m
Clay 0.6 - 1.4m
TESTPIT14
Gravel 0 - 1.0m
with Rock Floaters
TESTPIT15
Rock - 0.3m Below
TESTPIT5
Rock - 0.4m Below
TESTPIT4
Rock - 0.2m Below
TESTPIT3
Sand 0 -1.2m
Gravel 0 - 0.8m
Clay 0.8 - 1.2m
TESTPIT25
TESTPIT24
Gravel 0 - 0.6m
Clay 0.6 - 0.8m
TESTPIT26
Gravel 0 - 0.6m
Clay 0.6 - 1.2m
TESTPIT35
TESTPIT34
Gravel 0 - 0.8m
Clay 0.8 - 1.2m
Rock at Bottom
Gravel 0 - 1.4m
Clay 1.4m
TESTPIT45
TESTPIT44
Gravel 0 - 0.6m
with Floaters
Clay 0.6 - 1.3m
TESTPIT36
Gravel 0 - 1.2m
with Floaters
Clay 1.2 - 1.3m
TESTPIT33
Gravel 0 - 1.2m
Clay 1.2 - 1.4m
TESTPIT27
Gravel 0 - 1.0m
Clay 1.0 - 1.1m
TESTPIT23
Sand 0 - 0.8m
Clay 0.8 - 1.1m
TESTPIT32
Gravel 0 - 1.3m
TESTPIT28
Gravel 0 - 1.2m
TESTPIT22
Gravel 0 - 1.1m
TESTPIT31
Sand 0 - 1.2m
Clay 1.2 - 1.3m
TESTPIT21
Rock - 0.3m below
TESTPIT20
Gravel 0 - 1.1m
TESTPIT19
Rock - 0.1m Below
TESTPIT18
Sand 0 - 1.2m
Rock at 1.2m
TESTPIT16
Rock - 0.1m Below
TESTPIT2B
TESTPIT2A
Sand 0 -0.9m
Rock Floaters 0.9 - 1.2m
Rock at Surface
TESTPIT17
Rock - 0.7m below
TESTPIT1
Sand 0 -1.2m
Gravel 0 - 1.3m
Clay 1.3 - 1.5m
TESTPIT39
Gravel 0 - 1.6m
Clay 1.6m
TESTPIT40
Gravel 0 - 1.5m
TESTPIT41
Gravel 0 - 1.2m
TESTPIT38
Gravel 0 - 1.4m
TESTPIT47
Gravel 0 - 1.4m
Gravel 0 - 1.1m
Clay 1.1 - 1.2m
TESTPIT42
Gravel 0 - 0.8m
Rock at 0.8m
TESTPIT37
Gravel 0 - 1.3m
TESTPIT48
Gravel 0 - 1.5m
with Floaters
TESTPIT49
Gravel 0 - 0.9m
Rock at 0.9m
TESTPIT50
Gravel 0 - 1.2m
TESTPIT55
Gravel 0 - 1.1m
TESTPIT54
Gravel 0 - 1.2m
with Floaters
Clay 1.2m
TESTPIT51
Gravel 0 - 0.8m
Clay 0.8 - 1.2m
Clay Wet
TESTPIT57
Gravel 0 - 1.2m
TESTPIT56
Rock - 0.1m Below
Gravel 0 - 1.2m
TESTPIT61
TESTPIT60
Gravel 0 - 1.2m
Gravel 0 - 1.1m
Clay 1.1 - 1.2m
TESTPIT62
TESTPIT63
Gravel 0 - 1.0m
Clay 1.0m
Gravel 0 - 0.8m
Clay 0.8 - 1.0m
TESTPIT64
TESTPIT65
Gravel 0 - 0.7m
Clay 0.7 - 1.0m
Gravel 0 - 1.2m
with Floaters
Clay 1.2m
TESTPIT66
Gravel 0 - 0.7m
Rock at 0.7m
Gravel 0 - 1.2m
Rock at 1.2m
Gravel 0 - 1.2m
Clay 1.2 - 1.5m
TESTPIT46
TESTPIT43
TESTPIT52
Gravel 0 - 1.3m
Clay 1.3m
Clay Wet
TESTPIT53
Gravel 0 - 0.8m
Clay 0.8 - 1.1m
Clay Wet
TESTPIT58
TESTPIT59
TESTPIT67
Sand 0 - 0.9m
Rock at 0.9m
TESTPIT30
Sand 0 - 1.4m
Clay at Bottom
TESTPIT29
Sand 0 - 0.6m
Cravel 0.6 - 1.2m
Clay at Bottom

Legend

Gravel 0 - 0.7m
Clay 0.7 - 1.0m — Holes with No Rock

Sand 0 - 0.9m
Rock at 0.9m — Holes with Rock

Kilburn Road - Test Holes
Pit Locations and Soil Types
17th December 2019
File No 19-012

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	TKI	20/12/2019	CAY

SCALE 1:1000 @ A1
0 20 40 60 80 100
ALL DISTANCES ARE IN METRES
For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

N

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

Surveyor:- BRB
Survey Date:- 19/12/2019
Precal/Cad:- SUPPLIED

bsi. ISO 9001 Quality Management — AS/NZS 4801:2001 Occupational Health and Safety Management
FS 565311 OSH 591267

MCMULLEN NOLAN GROUP
Level 1, 2 Sabre Crescent
Jandakot, W.A. 6164
PO Box 3526, Success
W.A. 6964, Australia
Offices in: Broome, Bunbury, Kununurra, Newman, Port Hedland
Tel: (08) 6436 1599
Fax: (08) 6436 1500
info@mngsurvey.com.au
www.mngsurvey.com.au
ABN 90 009 363 311

LOT 1854 BEACON ROAD & LOT 1915 KILBURN ROAD, PARKERVILLE
TEST PIT LOCATIONS

CLIENT: CUTTONE PROPERTY GROUP

Project Mngr.	Charlie Younge	Datum	HUG94 / AHD

97909 - DE - 038 - A
Job Number — Type — Plan Number — Revision

Appendix 4 Photos from Biophysical Assessment

Location P 1

Location P 2

Location P 3

Location P 4

Location P 5

Location P 6

Location P 7

Location P 8

Location P 9

Location P 10

Location P 11

Location P 12

Location P 13

Location P 14

Location P 15

Location P 16

Location D 1

Location D 2

Location D 3

Location D 4

Appendix 5 Agency Correspondence

Carrie Hopkirk

From: Philip Patterson <philip.p@pfeng.com.au>
Sent: Tuesday, 11 September 2018 4:27 PM
To: Ryan Darby; Carrie Hopkirk
Cc: 'fcamc@bigpond.net.au'
Subject: [17-313] FW: Water - Planning - Zamia Gravity Zone - Kilburn Rd Development - TA August 2018
Attachments: Kilburn Road Parkerville.pdf

Follow Up Flag: Follow up
Flag Status: Completed

Hi all

Below is some good feedback from the Water Corporation for your info.

Looks like we have a water supply.

Philip Patterson
Pro ect Director - Civil
Pritchard Francis T (08) 9382 5111 D (08) 9382 5154 M 0408 953 545

From: Ross Crockett [mailto:Ross.Crockett@watercorporation.com.au]
Sent: Friday, August 24, 2018 3:22 PM
To: Philip Patterson <philip.p@pfeng.com.au>
Subject: FW: Water - Planning - Zamia Gravity Zone - Kilburn Rd Development - TA August 2018

Hi Phil

Apologies for the delay.

I have just received the advice from our Planning Section that there is sufficient capacity in the system for your proposed development any further development will require an upgrade to system.

Reticulation extensions from the DN100mm Stubs in Roland & Brindell will be required I will forward this advice to our retic planner.

Regards

5 Recommendations

- The existing system should have sufficient capacity Lots 61 & 1001 Kilburn Rd. It is recommended that main upgrade project (CW03072) is completed before
- Pressure monitoring should continue to be underta hydrants outside 900 Kintore Rd and 20 Vista development impacts the actual pressures in the sy recommended to be undertaken at hydrants outs WH029987) and 95 Thornbill Pl (hydrant WH03071(existing pressures in other areas in the Zamia (pressure monitoring locations are shown in Figure 7. will be crucial in providing justification for activating main upgrade project (CW03072).

Ross Crockett
Development Planner
Development Services

E: Ross.Crockett@watercorporation.com.au
T: (08) 9420 2013

WATER CORPORATION

Keep in touch **W:** watercorporation.com.au

From: Dean Crowley
Sent: Friday, 24 August 2018 10:37 AM
To: Ross Crockett
Cc: Tina Zheng
Subject: Water - Planning - Zamia Gravity Zone - Kilburn Rd Development - TA August 2018

Hi Ross,

As requested, please find attached the published Technical Advice regarding the proposed Kilburn Rd Development in the Zamia Gravity Zone.

Regards,
Dean

Dean Crowley
Senior Planner - Customer Networks
Asset Investment Planning Metro

E: Dean.Crowley@watercorporation.com.au
T: (08) 9420 2702

Keep in touch **W:** watercorporation.com.au

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Rebecca Epworth

From: Jim MacKintosh <jim.mackintosh@dwer.wa.gov.au>
Sent: Thursday, 2 May 2019 10:42 AM
To: Rebecca Epworth; Carlie Slodecki
Subject: RE: Kilburn Rd DWMS Rev 2

Dear Bec,

The Department of Water and Environmental Regulation (DWER) has reviewed the 'response to comments' for the above proposal. The DWER is prepared to accept the proposed reduced waterway setback subject to the following:

- Endorsement/support from all other relevant agencies (Shire of Mundaring);
- The DWMS revision to state that all lots within 100m of the waterway will require Department of Health approved aerobic treatment units (ATU's) and this will be mandated.

Once these above have been addressed, and your propose changes made, please submit the revised DWMS to DWER for final endorsement.

Regards

M

D

M

T 08 6250 8043
im.mackintosh@dwer.wa.gov.au
Visit our website www.dwer.wa.gov.au

From: Rebecca Epworth [mailto:rebecca.epworth@coterra.com.au]
Sent: Thursday, 2 May 2019 9:22 AM
To: Jim MacKintosh <jim.mackintosh@dwer.wa.gov.au>; Carlie Slodecki <carlie.slodecki@dwer.wa.gov.au>
Subject: RE: Kilburn Rd DWMS Rev 2

Hi Jim, Carlie – Sorry forgot to ask yesterday when I saw you but just following up on this Kilburn Road DWMS. Any more idea where it is in the queue?

Thanks, Bec

Rebecca Epworth
Director
BSc (Hons), MSc, MSc(Eng)

COTERRA
ENVIRONMENT

Ph: (08) 9381 5513 | M: 0437 707 472
Level 3, 25 Prowse Street, West Perth WA 6005 | www.coterra.com.au | LinkedIn

Coterra would like to congratulate our clients and thank them for the opportunity to be involved with the following projects that have won awards over the last two years:

- 2018 UDIA WA Environmental Excellence Award – Rosehill Waters for Noahs Rosehill Waters
- 2018 UDIA WA Residential Development Award – Trinity at Alkimos for Northern Corridor Developments
- 2018 UDIA EnviroDevelopment Certification 6 leaves – Catalina Beach and Catalina Grove for Tamala Park Regional Council and Satterley Property Group
- 2018 Stormwater Western Australia Excellence in Strategic or Master Planning – Rosehill Waters
- 2018 Australian Water Association Water Sensitive Urban Design (Grahame Heal) Award – Rosehill Waters
- 2017 UDIA National Environmental Excellence Award – Osprey Waters for Mirvac
- 2017 UDIA WA EnviroDevelopment Chairman's Award – Rosehill Waters for Noahs Rosehill Waters
- 2017 UDIA EnviroDevelopment Certification 6 leaves – Rosehill Waters for Noahs Rosehill Waters
- 2017 UDIA WA Urban Water Excellence Award – White Gum Valley for LandCorp.

From: Jim MacKintosh <jim.mackintosh@dwer.wa.gov.au>
Sent: Monday, 25 March 2019 2:30 PM
To: Rebecca Epworth <rebecca.epworth@coterra.com.au>; Carlie Slodecki <carlie.slodecki@dwer.wa.gov.au>
Subject: RE: Kilburn Rd DWMS Rev 2

Hi Bec,

At the moment assessment timeframes are still 10-12 weeks from date of submission.

Regards

M

D

M

T 08 6250 8043
jim.mackintosh@dwer.wa.gov.au
Visit our website www.dwer.wa.gov.au

From: Rebecca Epworth [mailto:rebecca.epworth@coterra.com.au]
Sent: Monday, 25 March 2019 2:24 PM
To: Jim MacKintosh <jim.mackintosh@dwer.wa.gov.au>; Carlie Slodecki <carlie.slodecki@dwer.wa.gov.au>
Subject: Kilburn Rd DWMS Rev 2

Hi Jim, Carlie,

We submitted a report (Kilburn Rd, Parkerville. DWMS, Rev 2) via Water Online on Feb 14th. What are your assessment timeframes like at the moment? Do you know roughly when we might receive a response?

Thanks! Bec

Rebecca Epworth
Director
BSc (Hons), MSc, MSc(Eng)

COTERRA
ENVIRONMENT

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Level 3, 25 Prowse Street, West Perth WA 6005 | www.coterra.com.au | LinkedIn

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- 2018 UDIA WA Residential Development Award – Trinity at Alkimos for Northern Corridor Developments
- 2018 UDIA EnviroDevelopment Certification 6 leaves – Catalina Beach and Catalina Grove for Tamala Park Regional Council and Satterley Property Group
- 2018 Stormwater Western Australia Excellence in Strategic or Master Planning – Rosehill Waters
- 2018 Australian Water Association Water Sensitive Urban Design (Grahame Heal) Award – Rosehill Waters
- 2017 UDIA National Environmental Excellence Award – Osprey Waters for Mirvac
- 2017 UDIA WA EnviroDevelopment Chairman's Award – Rosehill Waters for Noahs Rosehill Waters
- 2017 UDIA EnviroDevelopment Certification 6 leaves – Rosehill Waters for Noahs Rosehill Waters
- 2017 UDIA WA Urban Water Excellence Award – White Gum Valley for LandCorp.

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Rebecca Epworth

From: Ryan Darby <Ryan.Darby@robertsday.com.au>
Sent: Wednesday, 20 June 2018 1:06 PM
To: Phil Cuttone; Carrie Hopkirk; Rebecca Epworth; Philip Patterson
Subject: FW: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Follow Up Flag: Follow up
Flag Status: Flagged

Hi All

Please refer to the email below from the Shire regarding the effluent disposal.

Please contact me if you have any queries.

Regards

D
partner
m 61 408 614 346
t 61 8 9213 7331 (direct)

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442 murray street perth
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perth sydney melbourne brisbane akarta

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From: Angus Money [mailto:AngusMoney@mundaring.wa.gov.au]
Sent: Wednesday, 20 June 2018 11:58 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: Christopher Jennings <ChristopherJennings@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Chris and I have reviewed and note the following.

This seems like the usual issue of competing ob ectives:

- DWER setback is 100 metres to a watercourse for environmental reasons. Shire acknowledges that in this particular instance the foreshore is degraded and could be greatly enhanced (e.g. in POS/Foreshore Reserve) by facilitating subdivision. A balance needs to be struck between making development viable and achieving environmental improvements.

- DoH sets 30 metres setback between a watercourse and dry-type effluent disposal system (septic tank/leach drains) and can be closer if it is an ATU – conflicting with DWER's policy
- LPS4 states the greater setback should apply, but also has ob ectives to accommodate a growing population, increase the viability of centres and so on - plus, the provisions of LPS4 can be varied – which can cuts across agency policies.

Our view is that reason should prevail – which may look like this:

- Foreshore reserve POS road fire setback front of lots a substantial setback between watercourses and effluent disposal systems
- Prescribing ATUs on lots a certain distance from watercourses is an option to mitigate environmental concerns – soil conditions permitting
- If it becomes a sticking point, a common ATU disposal/landscaped area integrated into subdivision design can be considered.

These options have been successfully used elsewhere in the Shire. Any response developed should demonstrate a net' environmental benefit, the obvious offering' in this case is the ceding and rehabilitation of foreshore vegetation.

As you'd appreciate, the WAPC ultimately need to make the call.

thanks

M
M **M**

Please contact me by telephone if your matter is urgent and you need a response within 24 hours

E: angusmoney@mundaring.wa.gov.au
T: 9290 6667 F: 9295 3288
www.mundaring.wa.gov.au
7000 Great Eastern Highway
Mundaring WA 6073

PIA NATIONAL AWARDS FOR PLANNING EXCELLENCE 2017 WINNER

From: Ryan Darby <Ryan.Darby@robertsday.com.au>
Sent: Tuesday, 19 June 2018 2:19 PM
To: Angus Money <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Angus

Can you please provide an update on the query below.

Cheers

D
partner
m 61 408 614 346
t 61 8 9213 7331 (direct)

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planning•design•place

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442 murray street perth
wa australia 6000
t 61 8 9213 7300
robertsday.com.au
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From: Angus Money [mailto:AngusMoney@mundaring.wa.gov.au]
Sent: Tuesday, 12 June 2018 9:47 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: Phil Cuttone <fcamc@bigpond.net.au>; 'Carrie Hopkirk' <carrie.hopkirk@coterra.com.au>; 'Rebecca Epworth' <rebecca.epworth@coterra.com.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

ust so you know, I've received your email and I'm seeking some internal advice. My plate is full at the moment but I intend getting back to you later this week. K

kind regards

M
M **M**

Please contact me by telephone if your matter is urgent and you need a response within 24 hours

E: angusmoney@mundaring.wa.gov.au
T: 9290 6667 F: 9295 3288
www.mundaring.wa.gov.au
7000 Great Eastern Highway
Mundaring WA 6073

From: Ryan Darby <Ryan.Darby@robertsday.com.au>
Sent: Wednesday, 6 June 2018 2:29 PM
To: Angus Money <AngusMoney@mundaring.wa.gov.au>
Cc: Phil Cuttone <fcamc@bigpond.net.au>; 'Carrie Hopkirk' <carrie.hopkirk@coterra.com.au>; 'Rebecca Epworth' <rebecca.epworth@coterra.com.au>
Subject: FW: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Angus

Further to the emails below regarding the MRS amendment, the following is advised.

We are working through DWER's comments in respect to the District Water Management Strategy, including undertaking on-site geotechnical investigations and a land capability assessment. Two issues that have arisen is the use of non-reticulated effluent disposal and associated setbacks. DWER's current position, in accordance with their draft policy, is not to support non-reticulated effluent disposal and if they are provided they need to be setback 100m from the riparian vegetation. Refer to the attached plan showing the 100m setback – this will obviously make the project not viable.

To assist us in our discussions with DWER can you please confirm that the Shire is supportive of the use of non-reticulated effluent disposal subject to suitable land capability?

Please contact me if you have any queries.

Regards

D
partner
m 61 408 614 346
t 61 8 9213 7331 (direct)

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Friday, 18 May 2018 9:42 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

At this stage the suitability of the site for effluent disposal appears to be the only outstanding matter prior to consideration by the WAPC.

I note that the DWMS prepared for the amendment area will need to be finalised, with comments from the Department of Health, Department of Biodiversity, Conservation and Attractions and the Water Corporation prior to any initiated amendment being considered by the WAPC for a final recommendation following public advertising.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
6551 9615 |
www.dplh.wa.gov.au

The department acknowledges the Aboriginal peoples of Western Australia as the traditional custodians of this land and we pay our respects to their Elders, past and present.

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Thursday, 17 May 2018 12:27 PM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

The landowner has engaged a geotechnical consultant to determine the sites suitability for on-site effluent disposal. I will keep you updated on its progress.

Were there any other issues that require addressing prior to the amendment being presented to the SPC?

Regards

D
partner
m 61 408 614 346
t 61 8 9213 7331 (direct)

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Thursday, 10 May 2018 3:49 PM

To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Further to the below I understand that DWER have provided comments in relation to the submitted DWMS back to your consultants. DWER have advised me that they consider the DWMS sufficiently advanced to support the initiation of the amendment, provided that it is finalised prior to a final recommendation being made by the WAPC. DWER does, however, advise that it is unaware as to whether the Shire of Mundaring, Water Corporation or Department of Health are satisfied with the level of detail and investigation provided in the DWMS or amendment report regarding the provision of a reticulated water supply and suitability for waste water disposal.

Whilst the Water Corporation has provided advice in relation to the provision of a reticulated water supply it made no comments regarding the provision of sewer. In this regard I note that the Amendment Report you prepared advises that:

Lots within the site will require private effluent treatment systems. Additional information will need to be sought from septic system suppliers to understand the remediation required to allow for their installation. A geotechnical report is also required to confirm that the use of effluent treatment and disposal on site is acceptable.

Given this, can you please advise how you have addressed the 'suitable effluent disposal' key consideration of the NE Framework? Has a geotechnical report which confirms the suitability of the site been undertaken and reviewed?

Many thanks,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
6551 9615 |
www.dplh.wa.gov.au

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Monday, 30 April 2018 11:42 AM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Have you heard back from DWER yet?

It is acknowledged that the Frameworks t not identify the land north of Clutterbuck Creek and we are OK with this area being removed from the proposed Urban zoning area.

Please contact me if you have any queries.

Regards

Ryan Darby
partner
m +61 408 614 346
t +61 8 9213 7331 (direct)

RobertsDay
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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Wednesday, 4 April 2018 2:08 PM
To: Ryan Darby
Cc: 'Phil Cuttone' ; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

I have emailed the DWER and requested that the DWMS for the Parkerville site is placed in their workflow for assessment, given the release of the final P&P documents. The WAPC would generally require that the DWER had advised that a DWMS was sufficiently advanced to support the initiation of an MRS amendment and as these are complex documents I anticipate that this means we will not meet the 2 May WAPC meeting deadline.

I have asked that DWER provide an estimated ballpark for the initial assessment of the DWMS and will be in further contact following their advice.

I note that the final Framework does not identify land to the north of Clutterbuck Creek (which bisects lots 61 and 1001) as Urban Investigation, in contrast to the current MRS amendment request under consideration.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000

6551 9615 |
www.dplh.wa.gov.au

The department acknowledges the Aboriginal peoples of Western Australia as the traditional custodians of this land and we pay our respects to their Elders, past and present.

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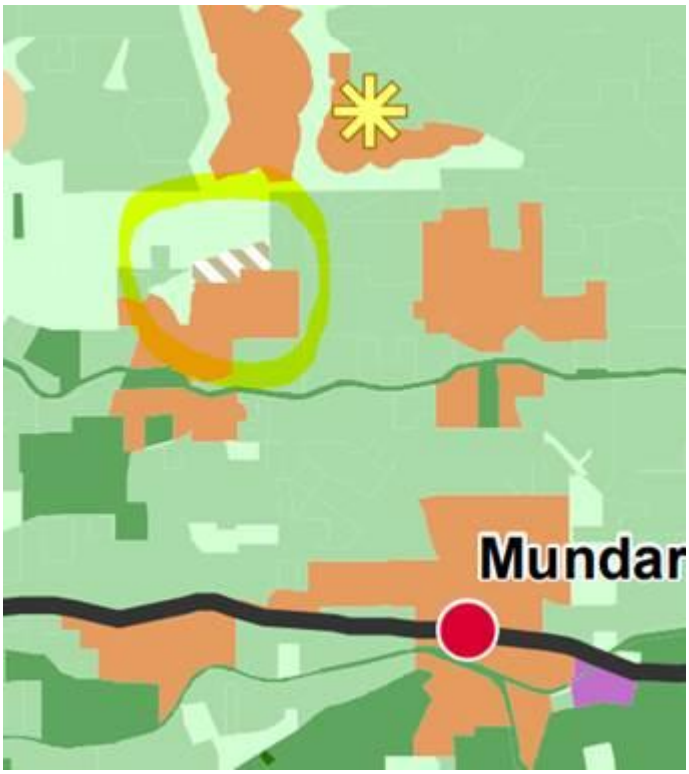
From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Monday, 26 March 2018 4:35 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, it is noted that the subject site has been identified as 'Urban Investigation' in the North-East Framework. Below are excerpts from the Framework the specific requirements for the Parkerville site:



Excerpt from Table 2:

Parkerville	Bushfire risk Protection of significant environmental attributes (including Carnab Suitable effluent disposal Availability of reticulated water supply

We have addressed the matters identified in Table 2 as part of our MRS rezoning submission and discussions with the Shire and State Government agencies.

As the Frameworks have been released, are you able to re-refer the DWMS to DWER for their comments?

In light of the above are we still on track for the 2 May SPC meeting?

Please contact me if you have any queries.

Regards

Ryan Darby
partner
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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Wednesday, 7 February 2018 10:39 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Angus Money' <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

At this stage the earliest the item will be able to be considered is the WAPC's 2 May meeting as there is no April meeting this year.

I note the position of the DWER that it will not review the associated District Water Management Strategy (DWMS) until the WAPC advises that the MRS amendment is likely to be initiated or the final sub-regional planning frameworks are released.

I also note that the amendment area is not identified for Urban expansion or investigation in the draft *North East Sub-regional Planning Framework*, and that both of these factors will be considerations in the WAPC's decision making.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
www.dplh.wa.gov.au

GOVERNMENT OF WESTERN AUSTRALIA
Department of Planning, Lands and Heritage

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 6 February 2018 11:18 AM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Thanks Andrew.

Now that we have got the sign off from DFES, when will you be in a position to present the MRS amendment to the SPC?

Cheers

Ryan Darby
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m +61 408 614 346
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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Thursday, 1 February 2018 3:57 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Angus Money' <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached advice from the Department of Fire and Emergency Services for your records.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
www.dplh.wa.gov.au

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 9 January 2018 5:43 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, please find attached the revised BMP and responses to DFES' comments. The attached has been prepared following discussions with the DPLH Bushfire Advisory Team (Sam Stokes).

Please contact me if you have any queries.

Regards

Ryan Darby
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m +61 408 614 346
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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Wednesday, 27 September 2017 4:34 PM
To: Ryan Darby
Cc: 'Phil Cuttone' ; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Further to the below DWER have reiterated their previous advice. We are still awaiting a response from DFES at this time.

With this in mind the earliest the amendment is likely to be able to be considered by the WAPC will be its November meeting, pending DFES advice.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

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From: Thomas, Andrew
Sent: Wednesday, 27 September 2017 1:40 PM
To: 'Ryan Darby'
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

I am yet to receive a response from either referral agency, I will follow up this week.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

Department of Planning, Lands and Heritage
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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 26 September 2017 3:48 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, can you pleaser provide an update on the progress of the amendment?

Do you have an indicative timeframe for presentation to the WAPC?

Cheers

Ryan Darby
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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Thursday, 17 August 2017 2:06 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Angus Money' <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Thank you for your attached response to referral agency comments, I will pass these on to relevant agencies for their consideration.

Kind regards,

Andrew

Andrew Thomas | Principal Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

GOVERNMENT OF WESTERN AUSTRALIA
Department of **Planning, Lands and Heritage**

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 15 August 2017 3:33 PM

To: Thomas, Andrew
Cc: 'Phil Cuttone'; Angus Money
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to our meeting on 2 August regarding the Kilburn Road MRS amendment, the following is advised.

Attached is a schedule of submissions including our responses to the issues raised by the referral authorities. As can be seen by this schedule there are no major impediments to the amendment progressing. It is therefore requested that the amendment be presented to the WAPC for initiation.

Please contact me if you have any queries.

Regards

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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Monday, 24 July 2017 3:00 PM
To: Ryan Darby
Cc: 'Phil Cuttone'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached a copy of the Shire's pre-referral response.

At the moment Anthony is on leave until late August, I am generally available Thursday – Friday this week and throughout the week next week to discuss the proposal here at 140 William Street.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

Department of **Planning, Lands and Heritage**

GOVERNMENT OF WESTERN AUSTRALIA

The departments of Planning, Lands, State Heritage Office and the Aboriginal heritage and land functions of the Department of Aboriginal Affairs have been amalgamated to form the new Department of Planning, Lands and Heritage.

The department acknowledges the Aboriginal peoples of Western Australia as the traditional custodians of this land and we pay our respects to their Elders, past and present.

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Friday, 21 July 2017 10:58 AM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, have you received comments from the Shire yet?

Following the preliminary referral period we would like to meet with you and Anthony Muscara to discuss the proposal and determine the process for moving forward. I note that the amendment is wholly inconsistent with the draft North-East Sub-regional Planning Framework, however it is wholly consistent with the recently WAPC endorsed Local Planning Strategy. Can you please advise on your availability to meet over the next two weeks.

Please contact me if you have any queries.

Cheers

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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Thursday, 22 June 2017 10:41 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: Phil Cuttone <fcamc@bigpond.net.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached comments from DFES, DoW and DoH. We are still yet to receive comments from the Shire of Mundaring.

Further to the various comments received from agencies, I note that the amendment request is wholly inconsistent with the draft North-East Sub-regional Planning Framework which identifies the amendment area for Rural purposes. This inconsistency will be the subject of consideration should the request be progressed to the WAPC for consideration.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
Department of Planning | 140 William Street | Perth WA 6000
T (08) 6551 9615 | **F** 6551 9001 | **M**
E Andrew.Thomas@planning.wa.gov.au **| W** www.planning.wa.gov.au

---

From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Thursday, 22 June 2017 9:48 AM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, can you please advise if the Departments of Water and Fire and Emergency Services and Health have lodged their submissions yet?

Cheers

Ryan Darby
principal
m +61 408 614 346
t +61 8 9213 7331 (direct)

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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Friday, 26 May 2017 3:49 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: Phil Cuttone <fcamc@bigpond.net.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find Office of the EPA and Water Corporation comments are attached, and additional Water Corporation advice and PTA Comments below.

I can advise that the Departments of Transport, Environment Regulation, Parks and Wildlife and Main Roads WA raised no objections to the amendment.

We are awaiting comments from the Departments of Water, Fire and Emergency Services and Health and the Shire of Mundaring.

Further Water Corporation Comments
Further to our letter of 4 May 2017, our water planners have undertaken some desk-top investigations regarding water supply planning for this area.
Subject to the some minor changes being undertaken further south in the Zamia Water Supply system, the water network in the vicinity of the subject land is likely to have the capacity to be extended further to serve the additional lots proposed on this site, plus a proposed 30 lot subdivision of a site on Richardson Rd, Parkerville.
Any further development in this area in addition to the above subdivisions will trigger the need for the installation of approximately 1km of 500mm diameter water distribution main along Jacoby Street in Mahogany Creek.

PTA Comments
The Public Transport Authority (PTA) has no objection to the proposed rezoning of portions of Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville from 'Rural' to 'Urban'. However, it should be noted that at this point in time Transperth has no plans to introduce bus services within a comfortable walking distance (500m) of the subject site

given the low population density by comparison with most metropolitan suburbs. Based on this fact, there is limited public transport demand which makes running a viable bus service difficult.

Kind Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
Department of Planning | 140 William Street | Perth WA 6000
T (08) 6551 9615 | **F** 6551 9001 | **M**
E Andrew.Thomas@planning.wa.gov.au **| W** www.planning.wa.gov.au

---

From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Wednesday, 24 May 2017 3:31 PM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to our previous discussions regarding the MRS amendment for Lot 61 & 1001 Kilburn Rd, Parkerville, can you please provide an update on its progress through the internal Department sections.

Cheers

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m +61 408 614 346
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From: Ryan Darby
Sent: Monday, 24 April 2017 12:39 PM
To: 'Muscara, Anthony' <Anthony.Muscara@planning.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Anthony

I couriered the additional CD's last week. Can you please confirm that you received them?

Can you also advise on how the amendment will proceed from here?

Please contact me if you have any queries.

Cheers

Ryan Darby
principal
m +61 408 614 346
t +61 8 9213 7331 (direct)

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From: Muscara, Anthony [mailto:Anthony.Muscara@planning.wa.gov.au]
Sent: Thursday, 13 April 2017 11:23 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Subject: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Are you able to send another 5 cds's of the amd request to me.

Thanks,

Anthony Muscara | Principal Planning Officer | Perth and Peel Planning
Department of Planning | 140 William Street | Perth WA 6000
T (08) 6551 9441 | **F** 6551 9001
E Anthony.Muscara@planning.wa.gov.au **| W** www.planning.wa.gov.au

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This notice should not be removed.

Rachel Murray

From: Rachel Murray
Sent: Monday, 20 July 2020 4:26 PM
To: Rachel Murray
Subject: FW: Lot 61 and 1001 Kilburn Road, Parkerville Local Water Management Strategy

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From: Emma van der Linden <Emma.VanDerLinden@robertsday.com.au>
Sent: Monday, 20 July 2020 4:20 PM
To: Rebecca Epworth <rebecca.epworth@coterra.com.au>
Cc: Phil Cuttone <phil@cuttoneproperty.com.au>
Subject: FW: Lot 61 and 1001 Kilburn Road, Parkerville Local Water Management Strategy

Hi Phil/Bec,

The Shire have confirmed they are happy for the land to be ceded as "Conservation Reserve". Bec – do you want to forward this onto DWER to support your updated report?

Thanks,

Emma van der Linden urban planner + designer
d +61 8 9213 7335 **t** +61 8 9213 7300

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From: Adam Olivari <AdamOlivari@mundaring.wa.gov.au>
Sent: Monday, 20 July 2020 3:49 PM
To: Emma van der Linden <Emma.VanDerLinden@robertsday.com.au>
Subject: RE: Lot 61 and 1001 Kilburn Road, Parkerville Local Water Management Strategy

Hi Emma

I have looked into the watercourse downstream and upstream and note that it is extremely unlikely to be utilised for recreational purposes (upstream of the creek is within a conservation reserve). Therefore, the Shire would be supportive of the Foreshore being ceded as 'Conservation Reserve'.

Regards

Adam Olivari
Planning Compliance Officer

Rebecca Epworth

From: Shishkina, Natalia <Natalia.Shishkina@health.wa.gov.au>
Sent: Friday, 24 August 2018 1:46 PM
To: Ryan Darby; Thomas, Andrew
Cc: 'Phil Cuttone'; 'Philip Patterson'; Carrie Hopkirk; Christopher Jennings
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan and Andrew,

The Department of Health has no objection to the above rezoning proposal subject to the site specific Site and Soil Evaluation for Onsite Sewage Management being undertaken and provided for review to this Department in order to support the next stage of the development.

Regards,

Natalia Shishkina
Scientific Officer
Environmental Health Directorate|Public and Aboriginal Health Division
Department of Health
Grace Vaughan House|227 Stubbs Terrace|SHENTON PARK WA 6008
PO Box 8172|Perth Business Centre|WA 6849
Tel: 08 9388 4938 Fax: 08 9388 4910
Email: Natalia.Shishkina@health.wa.gov.au
www.public.health.wa.gov.au

promoting health | preventing disease | managing risk

From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Friday, 24 August 2018 10:13 AM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Philip Patterson'; 'Carrie Hopkirk'; Shishkina, Natalia; Christopher Jennings
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Please find below our response to the Department of Health comments regarding the Site and Soil Evaluation for Onsite Sewage Management (SSE) to support the proposed rezoning at Kilburn Road.

Three technical reports have already been prepared for the site that cover off most of the requirements of a SSE. Two of the three remaining aspects can be readily addressed. However, one aspect cannot be addressed at this time, given the very early stage of planning. We believe that further information can be provided at future planning stages (e.g. as part of the Local Structure Plan and/or Subdivision Application) when the development layout and infrastructure locations are confirmed.

The three reports prepared to date are listed below, and the sections of the report that relate to each SSE requirement are listed in the table below. We have highlighted the requirements which have not been addressed in blue.

- Douglas Partners (2018). Report on Geotechnical Investigation and Assessment of Site Suitability for On-Site Sewage Disposal. Lots 61 & 1001 Kilburn Road, Parkerville, June 2018.
- Coterra Environment (2018). District Water Management Strategy. Lots 61 & 1001 Kilburn Road, Parkerville. Revision 1, July 2018.
- Coterra Environment (2017). Environmental Assessment Report. Lots 61 & 1001 Kilburn Road, Parkerville, Revision 0, March 2017.

SSE Requirement	Information provided	Status relative to stage of planning
Water and nutrient balance	A conceptual water balance is provided in Table 9 of the District Water Management Strategy (DWMS) (Coterra Environment, 2018). A nutrient management strategy is included in Section 8.0 of the DWMS. The nutrient management strategy includes estimated pre and post-development nutrient loading rates.	Complete
Topographical features including slope and aspect	The topography of the site is described in Section 3.3 of the DWMS, and Section 2 of the Douglas Partners (2018) geotechnical investigation. The slope of the site is provided in Section 7.2.5 of the geotechnical report.	Complete
Underlying geology, soil types, rocky outcrops, presence of restrictive soil horizons and bedrock and shallow soils	The geotechnical investigation included an on-site assessment of the underlying soil and geology, including low permeability soil horizons (laterite). The findings are described in Section 4.1, 7.2.2 (depth to hardpan) and 7.2.4 (coarse fragments) of the geotechnical report.	Complete
Potentially poorly drained areas, drainage lines, seepage, watercourses, and flood frequency	Surface water at the site is described in Section 3.6 of the DWMS. Flood risk is described in Section 7.0 of the DWMS. Waterlogging risk is outlined in Table 9.	Complete
Legal and planning information including boundaries and existing and proposed infrastructure and land uses	Legal and planning information is provided in Section 1.2 of the DWMS, and the MRS rezoning application.	Complete
Location, depth, nature and value of aquifers and bores, depth to shallow perched or seasonally high water table	Regional groundwater resources are discussed in Section 3.7 of the DWMS. Perched groundwater is discussed in Sections 4.2 and 7.2.3 of the geotechnical investigation. Further investigation of groundwater at the site during late winter will be undertaken, as recommended by DoH.	Underway. Bores are being installed on Tuesday 28th August. Measurements will be undertaken in August, September and October and the results will be collated, documented and forwarded to the DPLH, Shire and DoH.
Potable water supply catchments, dams and waterways	The site is not located within a Public Drinking Water Supply Area. Waterways are discussed in section 3.6 of the DWMS.	Complete
Risks from stormwater flows and flooding	The stormwater management strategy for the site is provided in Section 5.0 of the DWMS. Stormwater from the site is proposed to be attenuated and treated in bioretention areas prior to discharge to the Clutterbuck Creek. Flood risk management is provided in Section 7.0.	Complete
Rainfall and pan evaporation readings	Rainfall data is included in Section 3.2 of the DWMS. Evaporation data (from Bureau of Meteorology) can be provided.	Available online – can be added to existing reports if required
Vegetation type and density	A flora and vegetation survey was undertaken in November 2016. The results of this survey	Complete

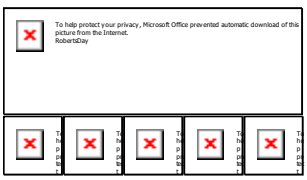
	are discussed in the Coterra Environment (2017) Environmental Assessment Report	
The degree of previous soil disturbance, contamination, compaction and imported fill	Imported fill has been identified in one location and is described in Section 4.1 of the geotechnical report. There are no registered contaminated sites within or adjacent to the site as shown in DWER mapping.	Complete
Risk of erosion and land slippage	Land capability (erosion risk) identified in Section 3.5 of DWMS.	Complete
Distance to surface waters, road cuttings, embankments, retaining walls, fence and buildings	This information can be provided at Local Structure Plan stage, when the development layout and design is confirmed.	Cannot be undertaken at this stage of planning
Soil surface conditions – stoniness, dampness, hardness, soil cracks	Stoniness (coarse fragments) are discussed in Section 7.2.4 of the geotechnical report. Hardness and dampness of soils at the site are described in the test pit logs within the geotechnical report.	Complete
Salinity	Soil electrical conductivity testing undertaken as part of the geotechnical investigation (see Section 7.2.8 of the geotechnical report).	Complete
Sodic and dispersive soils	Dispersity is discussed in Section 7.2.6 of the geotechnical report.	Complete
Soil permeability (constant head) test in accordance with AS/NZS 1547	Results of soil permeability (constant head) testing is provided in Section 4.3.	Complete
Sensitive environments inside and around the lot boundaries	The Clutterbuck Creek passes through the site. The creek is discussed in Section 3.6 of the DWMS.	Complete

Can you please confirm that once the groundwater depths have been measured and are considered satisfactory, that the pending MRS amendment can be presented to the WAPC for initiation and advertising.

Please contact me if you have any queries.

Regards

D partner
61 408 614 346 61 8 9213 7331 61 8 9213 7300



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From: Thomas, Andrew <andrew.thomas@dplh.wa.gov.au>
Sent: Tuesday, 14 August 2018 2:17 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>

Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Philip Patterson' <philip.p@pfeng.com.au>; 'Carrie Hopkirk' <carrie.hopkirk@coterra.com.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Further to the below please find attached the final comments from the Shire and further comments from the Department of Health, provided following the Shire's advice. In summary the Shire is comfortable that the geotechnical report is sufficient to support the urbanisation of the amendment area, however, the Department of Health continues to have concerns. Natalia at the DoH is happy to discuss any queries you may have regarding its position.

At this stage I will await a revised Geotechnical Report consistent with DoH's advice, unless you advise otherwise. Please contact me as below should you wish to discuss the amendment request further.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
6551 9615 |
www.dplh.wa.gov.au

Department of Planning, Lands and Heritage

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From: Thomas, Andrew
Sent: Monday, 30 July 2018 10:30 AM
To: 'Ryan Darby'
Cc: 'Phil Cuttone'; 'Philip Patterson'; 'Carrie Hopkirk'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Further to the below please find attached an email from the Shire of Mundaring providing preliminary comments regarding the Geotechnical Report provided for the Roland & Kilburn Road site.

I note that the Shire has advised it would like to inspect test pits and has noted that the report recommends further groundwater work is done at the end of winter.

I will pass on the Shire's final comments as soon as they are available.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
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From: Thomas, Andrew
Sent: Thursday, 26 July 2018 8:41 AM
To: 'Ryan Darby'
Cc: 'Phil Cuttone'; 'Philip Patterson'; 'Carrie Hopkirk'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

I've spoken with the Shire and been advised we should have their comments by early next week, once those are in hand I'll be in a position to advise if we consider additional work to be required at this stage of the planning process. My preliminary thoughts, pending the Shire's advice, are that at least point one of DoH's advice will need to be addressed as it pertains directly to the suitability of the land for an Urban zoning.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Wednesday, 25 July 2018 3:26 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Philip Patterson'; 'Carrie Hopkirk'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Thanks Andrew

In respect to the DoH comments, can you please clarify as to whether are we required to undertake any additional tasks prior to the amendment being presented to the WAPC for advertising?

As suggested below, these matters can be dealt with during the MRS amendment advertising/assessment process and during the preparation of the local structure plan.

Please contact me if you have any queries.

Regards

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Tuesday, 24 July 2018 2:41 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Philip Patterson' <philip.p@pfeng.com.au>; 'Carrie Hopkirk' <carrie.hopkirk@coterra.com.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached email advice from the Department of Health (DoH) regarding the Geotechnical Report provided. I note that some of the matters raised by the DoH relate to determining if the site is suitable for an Urban zoning (particularly point 1), and that some are probably more appropriately addressed at subsequent more detailed stages of the planning process.

At this stage we are still awaiting a response from the Shire and I have contacted them to follow up on this.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
6551 9615 |

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Department of Planning, Lands and Heritage

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Monday, 23 July 2018 1:39 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Philip Patterson'; 'Carrie Hopkirk'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, have you received a response from the DoH and Shire?

Cheers

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Tuesday, 26 June 2018 2:27 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Philip Patterson' <philip.p@pfeng.com.au>; 'Carrie Hopkirk' <carrie.hopkirk@coterra.com.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Thank you for sending that through, I'll be referring it to the Department of Health and the Shire of Mundaring for consideration and will get back to you with their response in due course. The timing and content of the response from DoH and the Shire will determine the WAPC meeting the item will then be able to be considered at.

Kind regards,

Andrew

Andrew Thomas | Principal Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
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Department of Planning, Lands and Heritage

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Friday, 22 June 2018 12:01 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; Philip Patterson; Carrie Hopkirk
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to emails below , please find attached the geotechnical investigation report for the subject site. The report concludes that on-site effluent disposal is appropriate for the site subject to the use of aerobic treatment units. This requirement will be referred to in the Structure Plan and enforced via a subdivision condition.

7.3 On-site Wastewater Management Options

7.3.1 Primary Effluent Treatment System

Owing to the occurrence of soils with the major limitations on permeability mentioned above, it is suggested that the treatment of the primary effluent is undertaken to produce secondary quality effluent, prior to on-site disposal over the land surface.

Several treatment options are possible and include the following:

- Aerobic Treatment Unit (ATU);
- sand filters; and
- closed cell (amended soil) evapo-transpiration systems.

It is understood that sequential batch reactor (SBR) units, an advanced form of ATU, are proposed for this site.

The effluent treatment system selected for use should be approved by the WA Department of Health.

In respect to the DWMS, the project team is currently liaising with DWER and the Shire with the aim of having it approved prior to final consideration of the MRS amendment.

Can you please advise if there is any further information required prior to presentation to the WAPC for initiation and the likely date of the WAPC/SPC meeting.

Please contact me if you have any queries.

Regards

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Friday, 18 May 2018 9:42 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

At this stage the suitability of the site for effluent disposal appears to be the only outstanding matter prior to consideration by the WAPC.

I note that the DWMS prepared for the amendment area will need to be finalised, with comments from the Department of Health, Department of Biodiversity, Conservation and Attractions and the Water Corporation prior to any initiated amendment being considered by the WAPC for a final recommendation following public advertising.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
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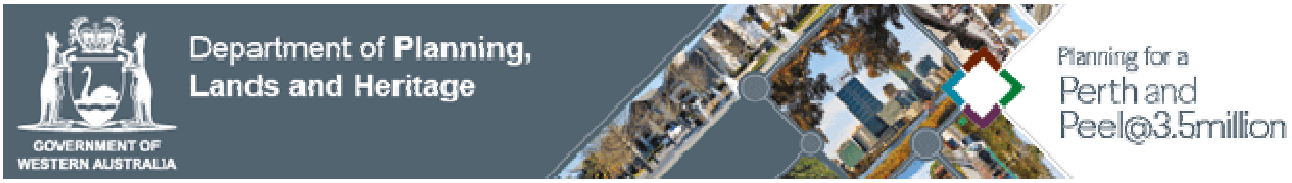

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Thursday, 17 May 2018 12:27 PM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

The landowner has engaged a geotechnical consultant to determine the sites suitability for on-site effluent disposal. I will keep you updated on its progress.

Were there any other issues that require addressing prior to the amendment being presented to the SPC?

Regards

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Thursday, 10 May 2018 3:49 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Further to the below I understand that DWER have provided comments in relation to the submitted DWMS back to your consultants. DWER have advised me that they consider the DWMS sufficiently advanced to support the initiation of the amendment, provided that it is finalised prior to a final recommendation being made by the WAPC. DWER does, however, advise that it is unaware as to whether the Shire of Mundaring, Water Corporation or Department of Health are satisfied with the level of detail and investigation provided in the DWMS or amendment report regarding the provision of a reticulated water supply and suitability for waste water disposal.

Whilst the Water Corporation has provided advice in relation to the provision of a reticulated water supply it made no comments regarding the provision of sewer. In this regard I note that the Amendment Report you prepared advises that:

Lots within the site will require private effluent treatment systems. Additional information will need to be sought from septic system suppliers to understand the remediation required to allow for their installation. A geotechnical report is also required to confirm that the use of effluent treatment and disposal on site is acceptable.

Given this, can you please advise how you have addressed the 'suitable effluent disposal' key consideration of the NE Framework? Has a geotechnical report which confirms the suitability of the site been undertaken and reviewed?

Many thanks,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
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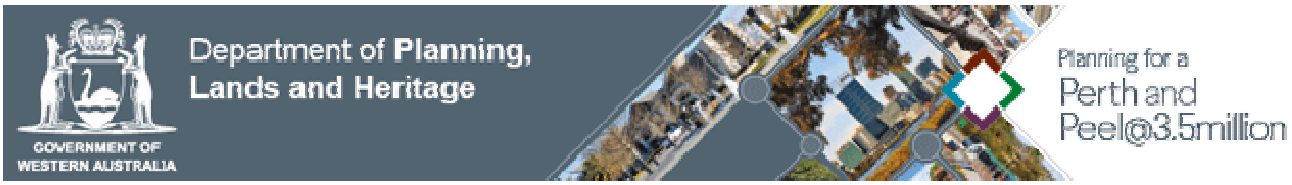

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Monday, 30 April 2018 11:42 AM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Have you heard back from DWER yet?

It is acknowledged that the Frameworks t not identify the land north of Clutterbuck Creek and we are OK with this area being removed from the proposed Urban zoning area.

Please contact me if you have any queries.

Regards

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Wednesday, 4 April 2018 2:08 PM
To: Ryan Darby
Cc: 'Phil Cuttone' ; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

I have emailed the DWER and requested that the DWMS for the Parkerville site is placed in their workflow for assessment, given the release of the final P&P documents. The WAPC would generally require that the DWER had advised that a DWMS was sufficiently advanced to support the initiation of an MRS amendment and as these are complex documents I anticipate that this means we will not meet the 2 May WAPC meeting deadline.

I have asked that DWER provide an estimated ballpark for the initial assessment of the DWMS and will be in further contact following their advice.

I note that the final Framework does not identify land to the north of Clutterbuck Creek (which bisects lots 61 and 1001) as Urban Investigation, in contrast to the current MRS amendment request under consideration.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
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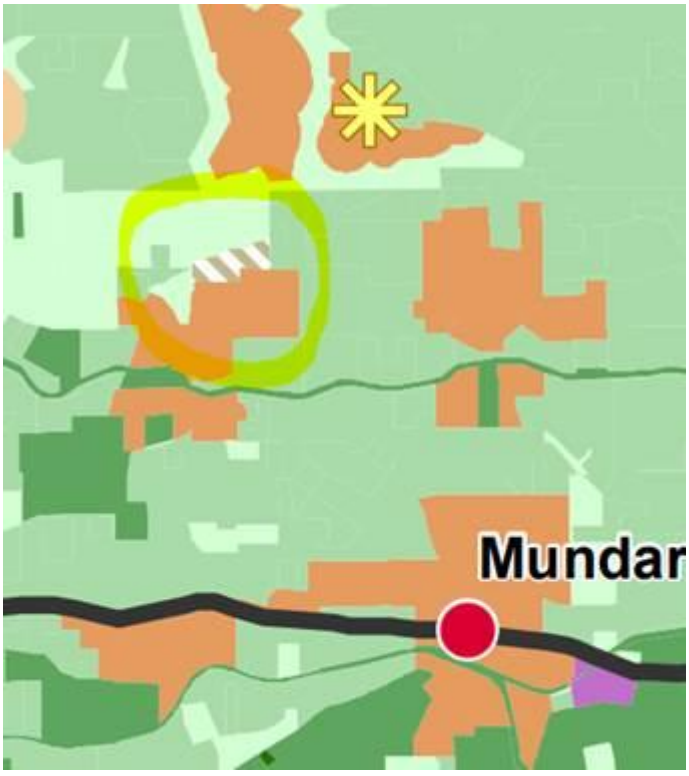
From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Monday, 26 March 2018 4:35 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, it is noted that the subject site has been identified as 'Urban Investigation' in the North-East Framework. Below are excerpts from the Framework the specific requirements for the Parkerville site:



Excerpt from Table 2:

Parkerville	Bushfire risk Protection of significant environmental attributes (including Carnab Suitable effluent disposal Availability of reticulated water supply

We have addressed the matters identified in Table 2 as part of our MRS rezoning submission and discussions with the Shire and State Government agencies.

As the Frameworks have been released, are you able to re-refer the DWMS to DWER for their comments?

In light of the above are we still on track for the 2 May SPC meeting?

Please contact me if you have any queries.

Regards

Ryan Darby
partner
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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Wednesday, 7 February 2018 10:39 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Angus Money' <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

At this stage the earliest the item will be able to be considered is the WAPC's 2 May meeting as there is no April meeting this year.

I note the position of the DWER that it will not review the associated District Water Management Strategy (DWMS) until the WAPC advises that the MRS amendment is likely to be initiated or the final sub-regional planning frameworks are released.

I also note that the amendment area is not identified for Urban expansion or investigation in the draft *North East Sub-regional Planning Framework*, and that both of these factors will be considerations in the WAPC's decision making.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
www.dplh.wa.gov.au

Department of Planning, Lands and Heritage
GOVERNMENT OF WESTERN AUSTRALIA

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 6 February 2018 11:18 AM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Thanks Andrew.

Now that we have got the sign off from DFES, when will you be in a position to present the MRS amendment to the SPC?

Cheers

Ryan Darby
partner
m +61 408 614 346
t +61 8 9213 7331 (direct)

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From: Thomas, Andrew [mailto:andrew.thomas@dplh.wa.gov.au]
Sent: Thursday, 1 February 2018 3:57 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Angus Money' <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached advice from the Department of Fire and Emergency Services for your records.

Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Land Use Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
www.dplh.wa.gov.au

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 9 January 2018 5:43 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, please find attached the revised BMP and responses to DFES' comments. The attached has been prepared following discussions with the DPLH Bushfire Advisory Team (Sam Stokes).

Please contact me if you have any queries.

Regards

Ryan Darby
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m +61 408 614 346
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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Wednesday, 27 September 2017 4:34 PM
To: Ryan Darby
Cc: 'Phil Cuttone' ; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Further to the below DWER have reiterated their previous advice. We are still awaiting a response from DFES at this time.

With this in mind the earliest the amendment is likely to be able to be considered by the WAPC will be its November meeting, pending DFES advice.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

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From: Thomas, Andrew
Sent: Wednesday, 27 September 2017 1:40 PM
To: 'Ryan Darby'
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

I am yet to receive a response from either referral agency, I will follow up this week.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

Department of Planning, Lands and Heritage
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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 26 September 2017 3:48 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; 'Angus Money'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, can you pleaser provide an update on the progress of the amendment?

Do you have an indicative timeframe for presentation to the WAPC?

Cheers

Ryan Darby
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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Thursday, 17 August 2017 2:06 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: 'Phil Cuttone' <fcamc@bigpond.net.au>; 'Angus Money' <AngusMoney@mundaring.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Thank you for your attached response to referral agency comments, I will pass these on to relevant agencies for their consideration.

Kind regards,

Andrew

Andrew Thomas | Principal Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

GOVERNMENT OF WESTERN AUSTRALIA
Department of **Planning, Lands and Heritage**

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Tuesday, 15 August 2017 3:33 PM
To: Thomas, Andrew
Cc: 'Phil Cuttone'; Angus Money
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to our meeting on 2 August regarding the Kilburn Road MRS amendment, the following is advised.

Attached is a schedule of submissions including our responses to the issues raised by the referral authorities. As can be seen by this schedule there are no major impediments to the amendment progressing. It is therefore requested that the amendment be presented to the WAPC for initiation.

Please contact me if you have any queries.

Regards

Ryan Darby
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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Monday, 24 July 2017 3:00 PM
To: Ryan Darby
Cc: 'Phil Cuttone'
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached a copy of the Shire's pre-referral response.

At the moment Anthony is on leave until late August, I am generally available Thursday – Friday this week and throughout the week next week to discuss the proposal here at 140 William Street.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
140 William Street, Perth WA 6000
(08) 6551 9615 |
Andrew.Thomas@planning.wa.gov.au | www.dplh.wa.gov.au

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From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Friday, 21 July 2017 10:58 AM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, have you received comments from the Shire yet?

Following the preliminary referral period we would like to meet with you and Anthony Muscara to discuss the proposal and determine the process for moving forward. I note that the amendment is wholly inconsistent with the draft North-East Sub-regional Planning Framework, however it is wholly consistent with the recently WAPC endorsed Local Planning Strategy. Can you please advise on your availability to meet over the next two weeks.

Please contact me if you have any queries.

Cheers

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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Thursday, 22 June 2017 10:41 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: Phil Cuttone <fcamc@bigpond.net.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find attached comments from DFES, DoW and DoH. We are still yet to receive comments from the Shire of Mundaring.

Further to the various comments received from agencies, I note that the amendment request is wholly inconsistent with the draft North-East Sub-regional Planning Framework which identifies the amendment area for Rural purposes. This inconsistency will be the subject of consideration should the request be progressed to the WAPC for consideration.

Kind regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
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T (08) 6551 9615 | **F** 6551 9001 | **M**
E Andrew.Thomas@planning.wa.gov.au **| W** www.planning.wa.gov.au

---

From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Thursday, 22 June 2017 9:48 AM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to the emails below, can you please advise if the Departments of Water and Fire and Emergency Services and Health have lodged their submissions yet?

Cheers

Ryan Darby
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From: Thomas, Andrew [mailto:Andrew.Thomas@planning.wa.gov.au]
Sent: Friday, 26 May 2017 3:49 PM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Cc: Phil Cuttone <fcamc@bigpond.net.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Please find Office of the EPA and Water Corporation comments are attached, and additional Water Corporation advice and PTA Comments below.

I can advise that the Departments of Transport, Environment Regulation, Parks and Wildlife and Main Roads WA raised no objections to the amendment.

We are awaiting comments from the Departments of Water, Fire and Emergency Services and Health and the Shire of Mundaring.

Further Water Corporation Comments
Further to our letter of 4 May 2017, our water planners have undertaken some desk-top investigations regarding water supply planning for this area.
Subject to the some minor changes being undertaken further south in the Zamia Water Supply system, the water network in the vicinity of the subject land is likely to have the capacity to be extended further to serve the additional lots proposed on this site, plus a proposed 30 lot subdivision of a site on Richardson Rd, Parkerville.
Any further development in this area in addition to the above subdivisions will trigger the need for the installation of approximately 1km of 500mm diameter water distribution main along Jacoby Street in Mahogany Creek.

PTA Comments
The Public Transport Authority (PTA) has no objection to the proposed rezoning of portions of Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville from 'Rural' to 'Urban'. However, it should be noted that at this point in time Transperth has no plans to introduce bus services within a comfortable walking distance (500m) of the subject site given the low population density by comparison with most metropolitan suburbs. Based on this fact, there is limited public transport demand which makes running a viable bus service difficult.

Kind Regards,

Andrew

Andrew Thomas | Senior Planning Officer | Perth and Peel Planning
Department of Planning | 140 William Street | Perth WA 6000
T (08) 6551 9615 | **F** 6551 9001 | **M**
E Andrew.Thomas@planning.wa.gov.au **| W** www.planning.wa.gov.au

From: Ryan Darby [mailto:Ryan.Darby@robertsday.com.au]
Sent: Wednesday, 24 May 2017 3:31 PM
To: Thomas, Andrew
Cc: Phil Cuttone
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Andrew

Further to our previous discussions regarding the MRS amendment for Lot 61 & 1001 Kilburn Rd, Parkerville, can you please provide an update on its progress through the internal Department sections.

Cheers

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From: Ryan Darby
Sent: Monday, 24 April 2017 12:39 PM
To: 'Muscara, Anthony' <Anthony.Muscara@planning.wa.gov.au>
Subject: RE: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Anthony

I couriered the additional CD's last week. Can you please confirm that you received them?

Can you also advise on how the amendment will proceed from here?

Please contact me if you have any queries.

Cheers

Ryan Darby
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From: Muscara, Anthony [mailto:Anthony.Muscara@planning.wa.gov.au]
Sent: Thursday, 13 April 2017 11:23 AM
To: Ryan Darby <Ryan.Darby@robertsday.com.au>
Subject: Proposed MRS Amd - Lot 61 & 1001 Kilburn Rd, Parkerville

Hi Ryan,

Are you able to send another 5 cds's of the amd request to me.

Thanks,

Anthony Muscara | Principal Planning Officer | Perth and Peel Planning
Department of Planning | 140 William Street | Perth WA 6000
T (08) 6551 9441 | **F** 6551 9001
E Anthony.Muscara@planning.wa.gov.au **| W** www.planning.wa.gov.au

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Rebecca Epworth

From: Jim MacKintosh <jim.mackintosh@dwer.wa.gov.au>
Sent: Thursday, 9 April 2020 3:16 PM
To: Rebecca Epworth
Cc: Phil Cuttone; Phil Patterson; Emma van der Linden
Subject: RE: Kilburn Rd - Basin sizing

Dear Bec,

This is an accurate summary of our telephone conversation. I think you proceed with what we have agreed. Once the LWMS is submitted I will get our engineers to check on the peak flow rates proposed versus the pre-development peak flow rates and they will also consider the timing of the peaks.

Regards

M

D

M

T 08 6250 8043
im.mackintosh@dwer.wa.gov.au
Visit our website www.dwer.wa.gov.au

From: Rebecca Epworth [mailto:rebecca.epworth@coterra.com.au]
Sent: Thursday, 9 April 2020 1:07 PM
To: Jim MacKintosh <jim.mackintosh@dwer.wa.gov.au>
Cc: Phil Cuttone <phil@cuttoneproperty.com.au>; Phil Patterson <pp@pflt.com.au>; Emma van der Linden <Emma.VanDerLinden@robertsday.com.au>
Subject: Kilburn Rd - Basin sizing

Hi Jim,

Thanks for the chat today regarding the Kilburn Road stormwater basin sizing. Following on from that, just confirming the outcomes of our conversation and the proposed way forward, detailed below;

- As discussed, due to the hydrological conditions and the proposed development, post development we are seeing a non-coincidental peak arising with the road runoff occurring faster (after approx. 10 mins in the critical 20 year storm) and then the lot runoff occurring later (after approx. 2 hours).
    - Both post development peak flows are less than the one pre development peak flow rate (pre dev: 0.99 vs post dev: 0.67 and 0.72)
- Modelling indicated that in 4 of the 5 sub catchments, no retention basin was therefore required to ensure the 20 year post development peak flows where less than the 20 year pre development peak flow.

Discussion outcomes were:

- It was therefore agreed that 20 year retention basins were not required in the 4 sub catchments discussed (1 year basins to treat stormwater will still be proposed for each of the five sub catchments).
- In the larger sub catchment that modelling indicated required a retention basin in the 20 year event to retain the peak flow;

- It was agreed that it would be more favourable to the decrease this sub catchments' retention basin further.
- The aim being to have the overall post development peak flows from the site closer to sites' pre development flow, rather than looking at it on a sub catchment basis.
- We will therefore re-model the retention basin size for that catchment, to increase the sites' post development peak flows to be closer to the pre development peak flow (ie. 0.99).

As discussed the five 1 year treatment basins will be sized on the 15mm event.

Any issues, let me know. Otherwise we are planning to submit the LWMS in a couple of weeks.

Thanks again, Bec

Rebecca Epworth
Director
BSc (Hons), MSc, MSc(Eng)

COTERRA
ENVIRONMENT

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Level 3, 25 Prowse Street, West Perth WA 6005 | www.coterra.com.au | LinkedIn

Coterra would like to congratulate our clients and thank them for the opportunity to be involved with the following projects that have won awards over the last two years:

- 2018 UDIA WA Environmental Excellence Award – Rosehill Waters for Noahs Rosehill Waters
- 2018 UDIA WA Residential Development Award – Trinity at Alkimos for Northern Corridor Developments
- 2018 UDIA EnviroDevelopment Certification 6 leaves – Catalina Beach and Catalina Grove for Tamala Park Regional Council and Satterley Property Group
- 2018 Stormwater Western Australia Excellence in Strategic or Master Planning – Rosehill Waters
- 2018 Australian Water Association Water Sensitive Urban Design (Grahame Heal) Award – Rosehill Waters
- 2017 UDIA National Environmental Excellence Award – Osprey Waters for Mirvac
- 2017 UDIA WA EnviroDevelopment Chairman's Award – Rosehill Waters for Noahs Rosehill Waters
- 2017 UDIA EnviroDevelopment Certification 6 leaves – Rosehill Waters for Noahs Rosehill Waters
- 2017 UDIA WA Urban Water Excellence Award – White Gum Valley for LandCorp.

Appendix 6 Department of Health ATUs

Government of Western Australia
Department of Health

Approved secondary treatment systems

What are Secondary Treatment Systems (STSs)?

Secondary treatment systems (STS) (previously known as Aerobic Treatment Unit (ATU)) are wastewater treatment systems which produce treated effluent of secondary standard, i.e. 20 mg/L of Biochemical Oxygen Demand (BOD), 30 mg/L of Total suspended solids (TSS) and 10 cfu/100 mL of Escherichia (E) coli. Due to the treatment and disinfection process, the treated wastewater from STS systems may be used for garden irrigation.

The STSs systems listed below have been certified to Australian Standard AS 1546.3 and approved by the Chief Health Officer for domestic installations in Western Australia. They may also be used for commercial installations. AS 1546.3 sets out requirements for the design, commissioning, performance and conformity testing of secondary treatment systems (STS).

STSs are to be installed and operated in accordance with the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974, the Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units Serving Single Dwellings and AS 1547: On-site domestic wastewater management.

As the conditions of approval can vary between designs, persons interested in installing a particular STS should confirm it meets their needs and discuss site requirements with the local government.

STSs have regular service requirements (usually quarterly) and maintenance must be through an authorised person or their staff/subcontractors.

Where nutrient retention is required, the local government should be consulted to determine if the STS's nutrient removal capacity will meet their requirements.

Table 1: Approved STSs

Manufacturer / Distributor	Model	Capacity	Comment / Restrictions	Approval Expiry Date
Allied Pumps (external site) Phone: 9350 1000 / 1800 447 777 Email: sales@alliedpumps.com.au	Everhard Aqua-Nova 2000 Model 80100	1800L/day	Approved for sub-surface or sub-strata or above ground spray irrigation.	Global Certification No. 077 16/02/2022
Aquarius Wastewater Systems Pty Ltd (external site) Phone: 9240 8545 Email:admin@aquariuswastewater.com.au	Aquarius O–3	1800L/day	Aerated Wastewater Treatment System with Ozone disinfection and Alum dosing. Nutrient reduction capability: N reduced to <10mg/L. & P reduced to < 1mg/L as per certification SMKH21519	SMKH21519 25/03/2021
	Aquarius O–2	1800L/day	Aerated Wastewater Treatment System without disinfection and Alum dosing.Sub-surface irrigation only.	
	Aquarius O–2 NR	1800L/day	Aerated Wastewater Treatment System without disinfection, with Alum dosing. Nutrient reduction capability: N reduced to <10mg/L. & P reduced to < 1mg/L as per certification SMKH21519	

Manufacturer / Distributor	Model	Capacity	Comment / Restrictions	Approval Expiry Date
Biolytix Ltd (external site) WA Distributor: Water installations: 9295 6263	BF6 - Mark 2	1600L/day	Aerated Wastewater Treatment System without disinfection	SMK40499 8/12/2020
Biomax Pty Ltd (external site) Phone: 9250 7733 Email: info@biomax.com.au	BioMax C–10 BioMax P10-M	1800L/day	No informstion is available, systems undergo recertification	Interim SAI Global Certificate Number: SMK40530
BioSeptic Pty Ltd (external site) Phone: 9274 6988 Email: sales@bioseptic.com.au	Performa 2000	1500L/day	Aerated Wastewater Treatment System with Chlorine disinfection	SMK02221 18/10/2020
owa Group Pty Ltd (external site) Phone: 8381 9100 Email: admin@biocycle.com.au WA Distributors: Tim Clews: 0429 824 300 Greg Browden: 0401 967 330	Biocycle BIO-7000	1500L/day	Aerated Wastewater Treatment System with Chlorine disinfection	SMKH20266 22/11/2020
Fui Clean Australia Pty Ltd (external site) WA Distributor: Ecowater WA: 0417 098 281 Email: ecowaterwa@bigpond.com	CE1500EX	1500L/day	Aerated Wastewater Treatment System with Chlorine disinfection	SMKH21993 09/05/2021
Global Roto-Moulding Pty Ltd (external site) Phone: (07) 4697 7099 Email: info@globalwater.com.au	UBI Aqua 6000L	1500L/day	Aerated Wastewater Treatment System with Chlorine disinfection	SMK40298 31/12/2020

Manufacturer / Distributor	Model	Capacity	Comment / Restrictions	Approval Expiry Date
Graf Australia Pty Ltd (external site) Phone: 1300 131 971 Email: info@grafaustralia.com.au WA Distributor: Aquarius Wastewater Systems PL (external site) Phone: 9240 8545 Email: mel@aquariuswastewater.com.au	Graf E-Pro 15-1 Graf E-Pro 15-1C Graf E-Pro 15-1 PAC	1500L/day	Approved for sub-surface, sub-strata, above ground spray irrigation and disposal via flatbed drains, leach drains and soakwells. Certification trial results showed system is capable of removing nutrients to the following concentrations: TP (removal): 3 mg/L (54) TN (removal): 24 mg/L (50) Certification trial results showed "PAC" systems are capable of removing nutrients to the following concentrations: TP (removal): 0.3 mg/L (94.5) TN (removal): 24 mg/L (50)	Global certification No. 329 & 188 & 188/1 26/04/2020
	Graf E-Pro 15-2 Graf E-Pro 15-2C Graf E-Pro 15-3O Graf E-Pro 15-2 PAC Graf E-Pro 15-3O PAC	1500L/day	Approved for sub-surface irrigation and disposal via flatbed drains, leach drains and soakwells. Certification trial results showed system is capable of removing nutrients to the following concentrations: TP (removal): 3 mg/L (54) TN (removal): 24 mg/L (50) Certification trial results showed "PAC" systems are capable of removing nutrients to the following concentrations: TP (removal): 0.3 mg/L (94.5) TN (removal): 24 mg/L (50)	

Manufacturer / Distributor	Model	Capacity	Comment / Restrictions	Approval Expiry Date
	Graf E-Pro 15-3 Graf E-Pro 15-3 PAC	1500L/day	Certification trial results showed system is capable of removing nutrients to the following concentrations: TP (removal): 3 mg/L (54) TN (removal): 24 mg/L (50) Certification trial results showed "PAC" systems are capable of removing nutrients to the following concentrations: TP (removal): 0.3 mg/L (94.5), TN (removal): 24 mg/L (50)	
Kingspan Water & Energy Pty Ltd (external site) Phone:1300 736 562 Email: gerry.quinn@kingspan.com	BioFicient Series 1	1500L/day	Aerated Wastewater Treatment System with Chlorine disinfection	SMK40710 22 November 2023
Suncoast Waste Water Management (external site) Phone: 1800 450 767 Email: info@ozzikleen.com	Ozzi Kleen RP-10	2000L/day	Aerated Wastewater Treatment System with Chlorine disinfection	SMK02608 14/08/2021
	Ozzi Kleen RP-10A	2000L/day	Aerated Wastewater Treatment System with Chlorine disinfection and Alum dosing	
Taylex Industries Pty Ltd (external site) Phone: 1300 TAYLEX (1300 829539) Email: info@taylex.com.au	Taylex ABS 10EP (Concrete and plastic)	2000L/day	For dwelling units up to 10 persons. Approved for above ground spray irrigation, sub-surface, sub-strata drip irrigation, leach drains and soakwells. Certification trial results showed that the system is capable of removing nutrients to the following concentrations: TP (removal): 2.5 mg/L (84.67) TN (removal): 24.9 mg/L (53.71)	Global Certification 040/8 & 040/10 11/07/2021

Manufacturer / Distributor	Model	Capacity	Comment / Restrictions	Approval Expiry Date
	Taylex ABS 8EP (Concrete and plastic)	1200L/day	Approved for above ground spray irrigation, sub-surface, sub-strata drip irrigation, leach drains and soakwells. Certification trial results showed that the system is capable of removing nutrients to the following concentrations: TP (removal): 2.5 mg/L (84.67) TN (removal): 24.9 mg/L (53.71)	
Toowomba Tanks Pty Ltd (external site) Phone: (07) 4634 3860 Email: toowoombatanks@gmail.com WA Distributor: TMC Australasia: 0418 267 959 Email: tony@tmcwaterrecycling.com	Barracuda AWTS Super Treat IT	2000L/day	Approved for above ground spray irrigation, sub-surface, sub-strata drip irrigation, leach drains and soakwells.	Global Certification 023/2 23/05/2020

T T

Manufacturer	Model	Reason not approved / Further information
BioSystems 2000 Pty Ltd	Biosystem 2000	Standard Mark certification not provided as of 1 uly 2015.
Earthsafe Environmental Pty Ltd	Earthsafe Environmental	Standard Mark certification SMKH20612 is not available online
Fui Clean Australia Pty Ltd	CE1200	Standard Mark certification not provided as of 1 uly 2015.
Galvin Concrete & Sheetmetal Pty Ltd	Clearwater 90 Compact	Standard Mark certification not provided as of 1 uly 2015.
Icon-Septech Pty Ltd	Septech Turboet 2000	Company liquidated. For further information, visit: Australian Securities and Investments Commission (external site). Systems that have been purchased on or before 27 une 2016 may still be installed.
owa Group Pty Ltd	Biocycle 5800	Standard Mark certification not provided as of 1 uly 2015.
Water Gurus Pty Ltd	Novaclear	Company liquidated. For further information, visit: Australian Securities and Investments Commission (external site)

More information

Environmental Health Directorate
Department of Health
Telephone: 9222 2000
Email: ehinfo@health.wa.gov.au

Government of **Western Australia**
Department of **Health**

Approved alternative treatment systems

The following table details the approved alternative treatment systems that are approved by the Department of Health WA. Where nutrient retention is required, the local government should be consulted to determine if the systems' nutrient removal capacity will meet their requirements.

Manufacture / Supplier	Brand Name	Model	System Capacity	Comments	Expiry Date
Filtrex Innovative Wastewater Solutions (external site) PO Box 5122 BUNBURY WA 6231 Ph: (08) 9726 0118 Fax: (08) 9726 0117 Email: info@filtrex.com.au	Filtrex Alternative Treatment Systems	ATS-2	Up to 564L/day	Certification trial results showed that the system has the following nutrient removal capacities: • TP (% removal): 95% • TN (% removal): 75% Refer to product approval conditions for further information on installation requirements.	26/10/2020
		ATS-4	Up to 829L/day		
		ATS-5	Up to 1099L/day		
		ATS-6	Up to 1369L/day		
		ATS Gen-X	Variable (approved for commercial systems)		
Presby Environmental Inc 143 Airport Road, Whitefield, NH03598 UNITED STATES Supplier: Chankar Environmental PL (external site) 6/62 Rene Street NOOSAVILLE QLD 4566 Ph: (07) 5474 4055 Fax: (07) 5335 1691 Email: info@enviro-septic.com.au	Advanced Enviro-Septic	AES-38	1500L/day	Approved for disposal via subsoil infiltration, mound or evapotranspiration-absorption bed. Land application area to be sized in accordance to AS/NZS1547. Certification trial results showed that the system has the following nutrient removal capacities: • Average TN (% removal): 24.3%	SAI Global License No: SMK40495 9 July 2020
Rootzone Australia PL (external site) PO Box 414 PICTON NSW 2571 Ph: (02) 4632 7566 Fax: (02) 46327344 Email: rootzoneaust@bigpond.com	Rootzone	Model A-5000	1200L/day	Reedbed sand filter system Approved for below ground disposal via sub-surface and sub-strata irrigation. System not certified to remove nutrients.	SAI Global License No: SMKH20690 20/12/2020
Wormsmart Bio-Logical Waste Systems PL				Septic tanks are approved only for	

60 Country Club Drive SAFETY BEACH VIC 3936 WA Supplier: Anthony Smith Ph: 0407247844 or 08 9758 8640 Email: info@ecowastewater.com.au	Wormsmart	AWSP1800PF	1800L/day	below ground installation only as a primary treatment system with underground disposal. System not certified to remove nutrients.	Global certification No: 339 25/08/2021

More information

- **Environmental Health Directorate**
  Department of Health
  Telephone: 92222000
  Email: ehinfo@health.wa.gov.au

Last reviewed: 25-09-2019

Produced by
Public Health

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Appendix 7 XPSWMM Modelling Report (Knobel, 2020)

TECHNICAL MEMORANDUM

To: Pritchard Francis

From: Blake Stephens – Knobel Engineers

Date: 8 May 2020

Re: **PARKERVILLE – PRELIMINARY FLOW ESTIMATION AND BASIN VOLUMES – LOT 61 & 1001 KILBURN ROAD, PARKERVILLE WA**

The following assessment was undertaken in accordance with the following:

- IPWEA Queensland Urban Drainage Manual (QUDM) Fourth Edition (2017);
- Department of Water and Environmental Regulation (external correspondence);
- Shire of Mundaring, *Local Planning Scheme No. 4.*

INTRODUCTION

Knobel Engineers was engaged by Pritchard Francis to prepare a Technical Memorandum for Stormwater Quantity Analysis, for the proposed residential subdivision in Parkerville.

For the preparation of the Technical Memorandum, the following engineering services were conducted:

- Review of existing information and studies for the site;
- Hydrologic and hydraulic assessment of the site and any influencing catchments (for 2 design AEP/ARI events) in accordance with Australian Rainfall & Runoff 2019 procedures;
- Determination of the site's Lawful Point/s of Discharge (LPOD) in accordance with The Shire of Mundaring Guidelines;
- Calculation of pre and post development flow rates utilising XPSWMM software, based off supplied layout by Pritchard Francis (PCH PAR/RD1 002-K);
- Preliminary design and modelling of storage swales (basins) for Stormwater treatment volume requirements and On-Site Detention (OSD);
- Conceptual stormwater management strategies during the construction phase of development; and
- Preparation of association stormwater catchment plans, and Stormwater Quantity Analysis Summary Letter for submission to council.

SITE DESCRIPTION

The current subject site is described as Lots 61 and 1001 on Kilburn Road in Parkerville, Western Australia. The subject site is bounded by Roland Road to the west, Brindle Road to the east, Kilburn road to the south and by Clutterbuck Creek to the north. The total combined area for the subject site is approximately 15.4 ha.

According to aerial imagery, taken on the 8 September 2019, the subject site consists of vacant land with average grass cover and scattered trees. The site grades to Clutterbuck creek to the north, at approximately 6 %, with spot levels on site ranging from RL 256 mAHD along the southern border to RL 232m AHD along the banks of Clutterbuck Creek. The site is located within an overland flow path from a southern catchment consisting of residential lots and Kilburn Road. An aerial image of the site, taken on 8 September 2019, is illustrated in ***Figure 1.***

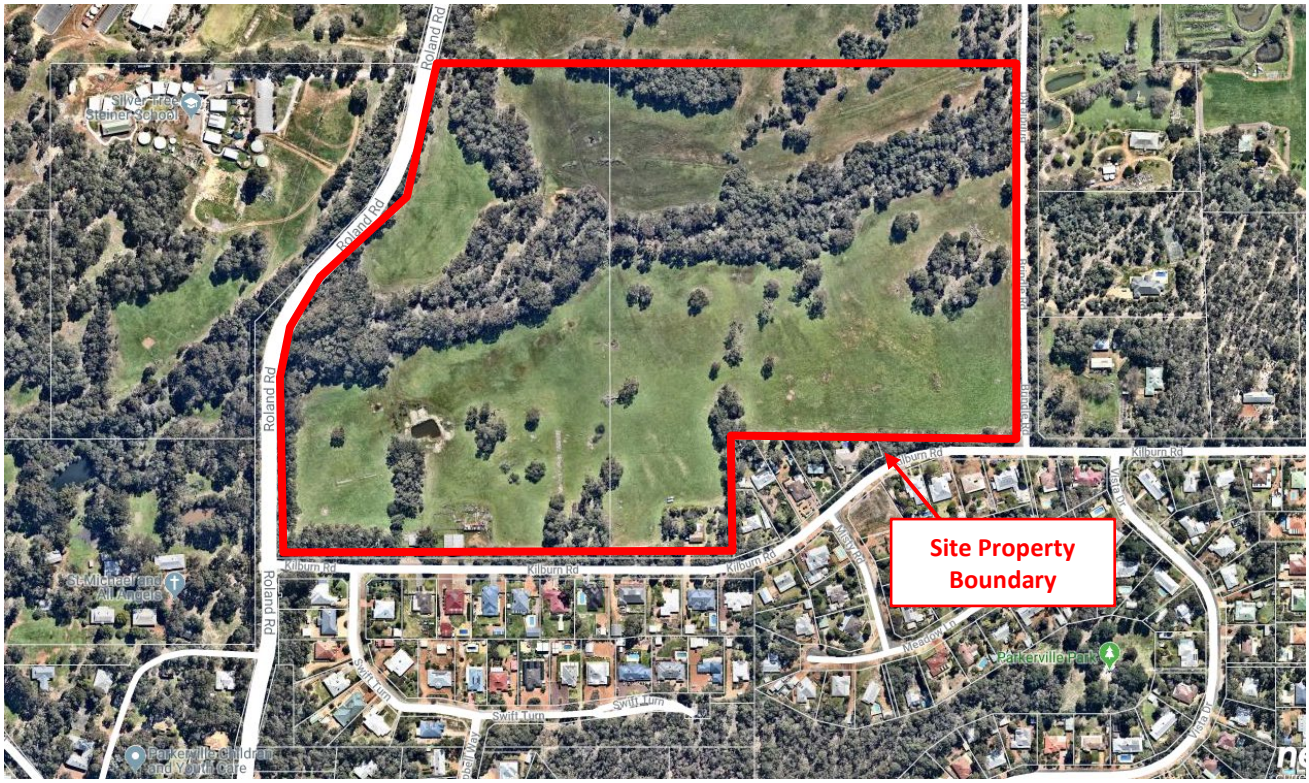


Figure 1: Aerial Image of the site – (Source: Nearmap - Image taken on 8 Sep 2019)

PROPOSED DEVELOPMENT

The proposed development is for the construction of 58 residential allotments, with the majority of lots being approximately 2,000 m^2 in size per lot. There is a proposed road network within the site, which will provide access to Brindle, Kilburn and Roland Road.

ADOPTED RAINFALL DATA

Rainfall intensity data has been obtained from the Australian Bureau of Meteorology's 2016 Design IFD Rainfall System. The data has been extracted for the nearest grid cell at Latitude 31.8625 (S) and Longitude 116.1375 (E). The IFD data and average rainfall intensities used in this Tech Memo are in accordance with the procedures outlined in Geosciences Australia, *Australian Rainfall and Runoff 2019.*

DATA

Data which has been sourced or provided, in order to prepare this report for the site, was gathered from the following sources:

- Proposed Site Layout provided by Pritchard Francis, *Concept Design (*Ref: DPCH PAR/RD1002/K);
- Proposed Road and Basin Layout provided by Pritchard Francis, Drawing Ref: 19012-C9-SK4-A;
- LIDAR data for the subject site sourced from Australian Government Elevation and Depth Foundation Spatial Data (ELVIS), Date Source: 2011, DEM Data;
- Correspondence with Western Australia's Department of Water and Environmental Regulation (DWER); and
- Rainfall and Meteorological 2016 IFD Data by the Australian Bureau of Meteorology.

SITE HYDROLOGY AND HYDRAULICS

The following sections define the method and parameters utilised within the hydrologic and hydraulic modelling of the site, in order to establish a simulation of the anticipated flow regime and peak discharge at the Lawful Point of Discharge (LPOD). The modelling has been undertaken in XPSWMM for both the pre- and post-development scenarios, and a Rational Method calculation has been provided for a comparison (provided as Attachment 5)

The Rational Method (Section 4.3 of the Queensland Urban Drainage Manual - QUDM 2017) is a suitable estimation technique, given its flexibility in its data requirements and is able to produce satisfactory estimates of peak site discharges based on the following data input:

- specific intensity frequency duration (IFD) data;
- length/type of flow path;
- contributing catchment areas; and
- coefficient of discharge.

Note that the hydrologic and hydraulic assessment undertaken, has been for the portion of the site undergoing disturbance as a result of the proposed development, which is approximately 15.5ha. Regions to the south and north of Clutterbuck Creek that is not undergoing development and is not proposed to be disturbed has been excluded as part of this assessment.

STORMWATER QUANTITY ANALYSIS

The combined hydrologic and hydraulic assessment has been divided into two components, to assess the minimum runoff volume storage requirements for a 1yr ARI event, and to assess the detention storage volume and outlet requirements for the peak 20yr ARI event. The industry standard modelling software XPSWMM has been selected for the hydrologic and hydraulic analysis. Details of the model set-up adopted basin design and model results are summarised in the following sections for the consolidated sites LPOD.

Hydrologic Model Set-up

Rainfall data for the subject site has been obtained from the Australian Bureau of Meteorology's 2016 Design IFD Rainfall System. The data has been extracted for the nearest grid cell at Latitude 31.8625 (S) and Longitude 116.1375 (E). The IFD data and average rainfall intensities used in this report are in accordance with the procedures outlined in IEAust, Australian Rainfall and Runoff 2016. Several storm events have been included in the modelling with durations ranging from 10 min to 6 hrs. Adopted catchment areas utilised in the pre-development scenario assessment has been provided below in Table 1.

Table 1: Adopted Pre-Development Catchment Parameters

Catchment ID	Pre A	Pre B	Pre C	Pre D	Pre E
Catchment Area (ha)	1.85	3.58	6.01	2.21	1.78

Hydraulic Model Set-up and Results

1-year ARI Event Runoff Volume Model

In accordance with DWER's requirements, the model has adopted a 63% AEP (1yr ARI) 45 min event, to provide a rainfall value of 15.1mm within the model. 75% of the proposed lot area runoff and 100% of the proposed road area has been diverted to a stormwater swale, which is to be designed to capture the entire 1yr ARI event's runoff volume. All pervious areas have adopted infiltration values of 0mm Initial Loss and 6mm/hr Continuing Loss, in accordance with DWER requirements.

Each Swale (Basin) area is to adopt the minimum volumetric requirements to capture the 1yr ARI event, based off the hydraulic model results, as shown in Table 2 below.

Table 2: Adopted 1yr ARI Event Basin Requirements

Basin ID	Basin A	Basin B	Basin C	Basin D	Basin E
Basin Volume Required	149 m^3	269 m^3	264 m^3	199 m^3	113 m^3

20-year ARI Event Detention Model

An assessment has been undertaken for the 20yr ARI event (5% AEP), to demonstrate no increase in peak flow rates leaving the disturbed regions of the site in the post-development scenario, when compared to the pre-development scenario.

The pre development hydrologic and hydraulic model was development by assigning a singular runoff node for the individual pre development catchments A-E. The runoff nodes from each catchment were connected via a dummy link, to allow the total peak flow rate from the subject site to be calculated at the consolidated LPOD, and also to determine a suitable median temporal pattern to adopt for analysis, in accordance with ARR2016.

For the post development model, each post-development catchment was updated hydrologically, by dividing the areas into proposed road catchment areas, and proposed lot areas (with each region having a pervious and impervious component), and applying appropriate impervious fractions in accordance with the anticipated post-development scenario.

Adopted catchment areas utilised in the post-development scenario assessment has been provided below in Table 3.

Table 3: Adopted Post-Development Catchment Parameters

Catchment ID	Post A	Post B	Post C	Post D	Post E
Catchment Area (ha)	1.52	5.59	4.96	2.20	1.16

Similar to the pre-development model, dummy links were modelled to connect the outlet flows from each post development catchment to the LPOD, allowing the total site runoff to be calculated and compared in the same manner as the pre-development scenario.

A detention swale (basin) has been incorporated within the downstream end of post-development catchment B, to provide adequate mitigation at the site's LPOD outlet from pre to post development scenarios. It is noted that the analysis demonstrated that only one detention basin is required for overall attenuation from the site, as a result of urbanisation of the site, which shifts a portion of the pre-development peak flow rate to a more 'urbanised' hydrologic outcome. The adopted Detention Basin parameters are detailed below.

Detention Basin Parameters

Detention Basin B has been located downstream (north) of post development catchment B. The basin has been adopted to detain up to the 5% AEP (20yr ARI) peak flow rates generated from the subject site, and ensures peak flow levels do not exceed the top of detention basin height in the 5% AEP event.

Basin B contains a volumetric portion below the detention component for the 1yr ARI event volume requirements (as discussed above). The detention component contains a weir which allows discharge of flows as sheet flow towards the LPOD outlet. The detention storage parameters adopted for this basin is provided in Table 4 below.

Table 4: Adopted Detention Basin B Parameters

Basin ID	**Basin B**
Basin Base Area (Detention Component)	1400 m^2
Basin Top Area (Detention Component)	1866 m^2
Adopted Basin Height Modelled (Measured from Basin IL – i.e includes 1y ARI Volume region)	0.7 m (0.2m utilised for 1yr ARI Volume)
High Flow Weir:	5.0m wide @ 0.30m above Basin Invert Level
Approximate Detention Volume:	327 m^3

Preliminary details of Basin B is shown on Knobel Engineers, *Stormwater Management Plan* (Ref: K5077/P003/C), attached to this Technical Memorandum.

Hydraulic Modelling Results

The pre and mitigated post development peak flow rates for the total subject site (at the consolidated LPOD) for the 5% AEP (20yr ARI) critical storm duration is detailed within Table 5. The hydrographs for the pre and post-development scenarios for the critical duration event and adjacent flow rates have been provided below in Figures 2 and 3, respectively.

Table 5: Anticipated Peak Flow Rates at LPOD (m^3/s) – XPSWMM

Scenario	5% AEP (20yr ARI)	Critical Duration Event (mins)
Pre Development	0.99	120
Post Development (mitigated)	0.84	120

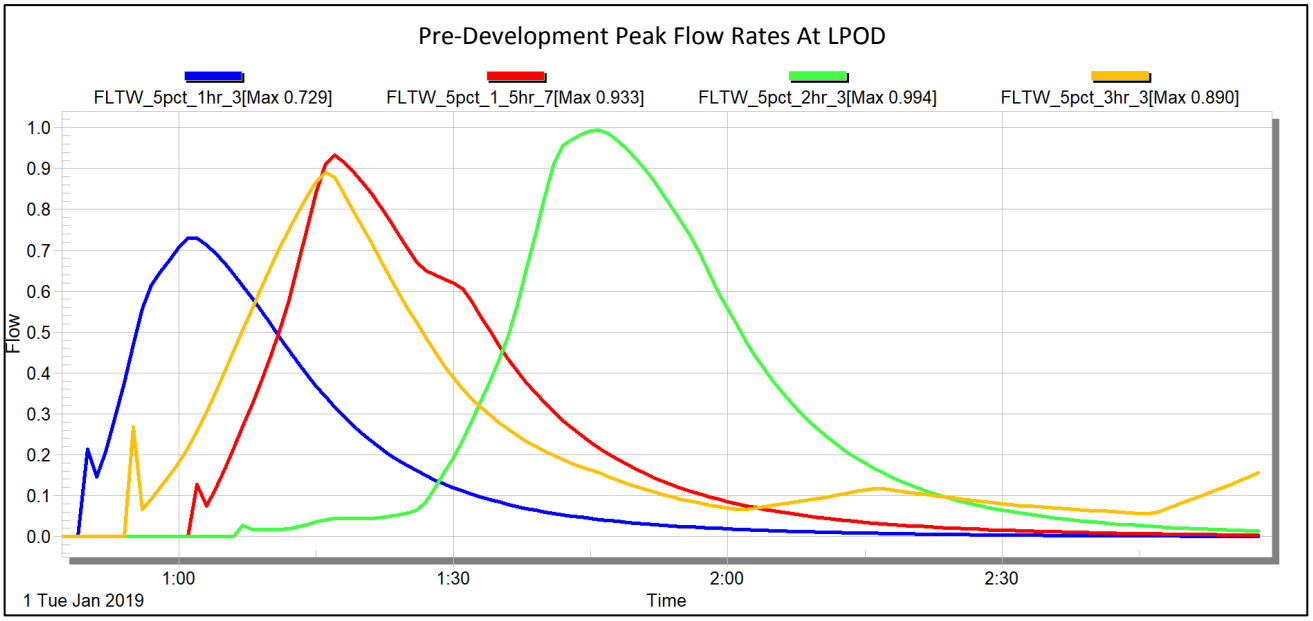


Figure 2: **Pre-Development Hydrographs for 5% AEP Design Event outflows at LPOD (Source: XPSWMM)**

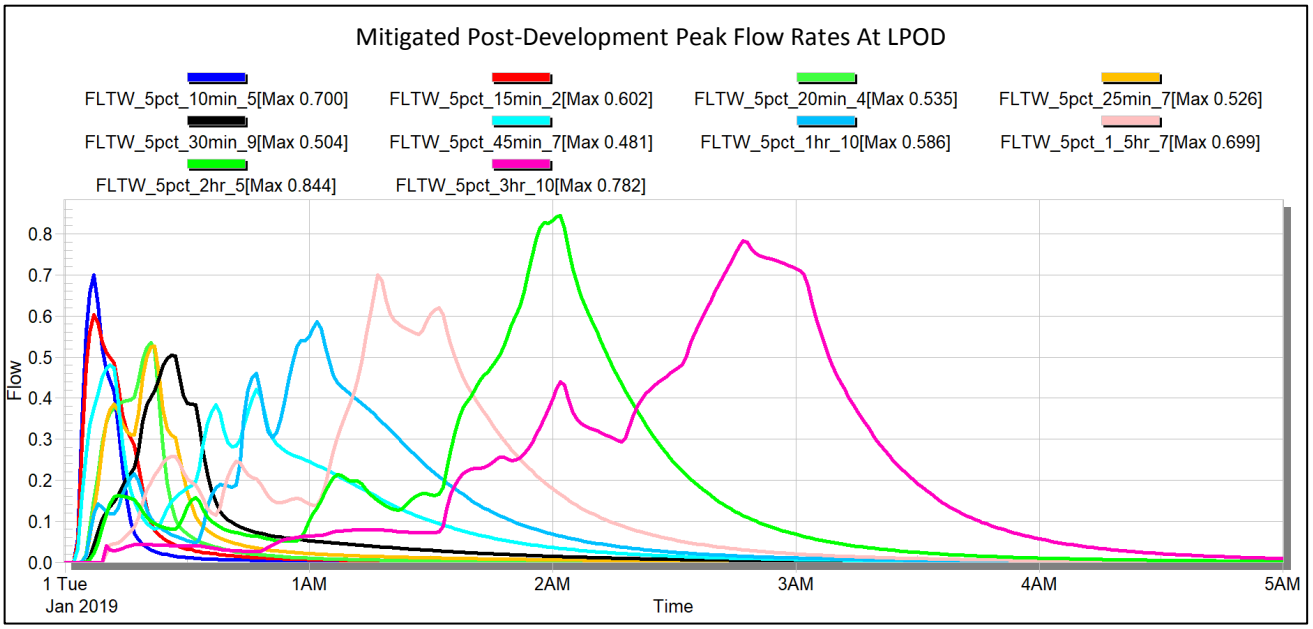


Figure 3: **Mitigated Post-Development Hydrographs for 5% AEP Design Event outflows at LPOD (Source: XPSWMM)**

It is noted that the 5% AEP 3hr pre-development storm event peaks earlier than the 2hr event, however this is deemed to be a result of the adopted median temporal pattern, and therefore has the ability to vary accordingly.

Hydraulic Modelling Summary

In summary, the stormwater quantity analysis has determined that if a detention basin component is adopted within basin/swale B, a reduction in peak flow rates will occur from pre to post-development scenarios in the 5% AEP design event, at the consolidated LPOD, as a result of timing of peak flows, and proposed urbanisation of the site.
The remaining 4 basins (A, C, D and E), are to be utilised for volumetric capture of the 1yr ARI event only, with the remainder of flows beyond the 1yr ARI event, to bypass the basin where possible, and sheet flow is to be promoted where design allows, into Clutterbuck Creek.

CONCLUSION

Knobel Engineers was engaged by Pritchard Francis to prepare a Technical Memorandum for the proposed residential subdivision at Lot 61 and 1001 Kilburn Road, Parkerville. This Technical Memorandum provides a review and analysis of the subject site and influencing catchments, and provides an analysis of the required treatment volume required (for a 1yr ARI event), and size deemed required for on-site detention, to mitigate site flows to the pre development condition. The minimum total swale (basin) volumes required, have been detailed within this Technical Memorandum, with conceptual details of stormwater management during the construction phase of development also being provided.

Yours faithfully

MARTIN ROUSHANI-ZARMEHRI | **SENIOR HYDRAULIC ENGINEER**
Knobel Engineers

Attachment 1

Pritchard Francis
Concept Design Lot 61 & 1001 Kilburn Road, Parkerville
(Ref: PCH PAR/RD1002/K)

LEGEND

Proposed Site	29.40ha
Developable Area (North of Foreshore)	5.00ha
Developable Area (South of Foreshore)	12.19ha
Public Open Space (North of Foreshore)	1.07ha
Public Open Space (South of Foreshore)	0.98ha
Foreshore Reserve	6.77ha
Watercourse (Clutterbuck Creek)	

FAUNA HABITAT TREES

- Jarrah, No Visible Hollow
- Jarrah, Contains Viable Hollow/ Potential Hollow Forming
- Marri, No Visible Hollow
- Marri, Contains Viable Hollow/ Potential Hollow Forming
- Tuart, No Visable Hollow

PARKERVILLE CHILDREN'S AND YOUTH CENTRE

CADASTRAL INFORMATION
SOURCE: COTERRA
YYMMDD: 190521
DWG REF: CUTKIL02_GIS-Datasets
PROJECTION: GDA94

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 190209

RD great places

DRAFT

SIZE A2_ 1:2000

0 metres 20 40 60 80 100

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
K	UPDATED POS/DRAINAGE	190902	HH	RD
J	ADJ ROAD RESERVE TO SAVE TREES	190830	SB	-
I	UPDATED AERIAL & FORESHORE	190827	HH	RD
H	ADD FAUNA & WATERCOURSE	190522	SB	RD
G	NORTH WEST LOTS AMALGAMATED	181001	HH	RD

CONCEPT DESIGN

Lot 61 & 1001 Kilburn Road, Parkerville

Shire of Mundaring

REF NO. **PCH PAR**

DRAW NO. **RD1 002**

REV. **K**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

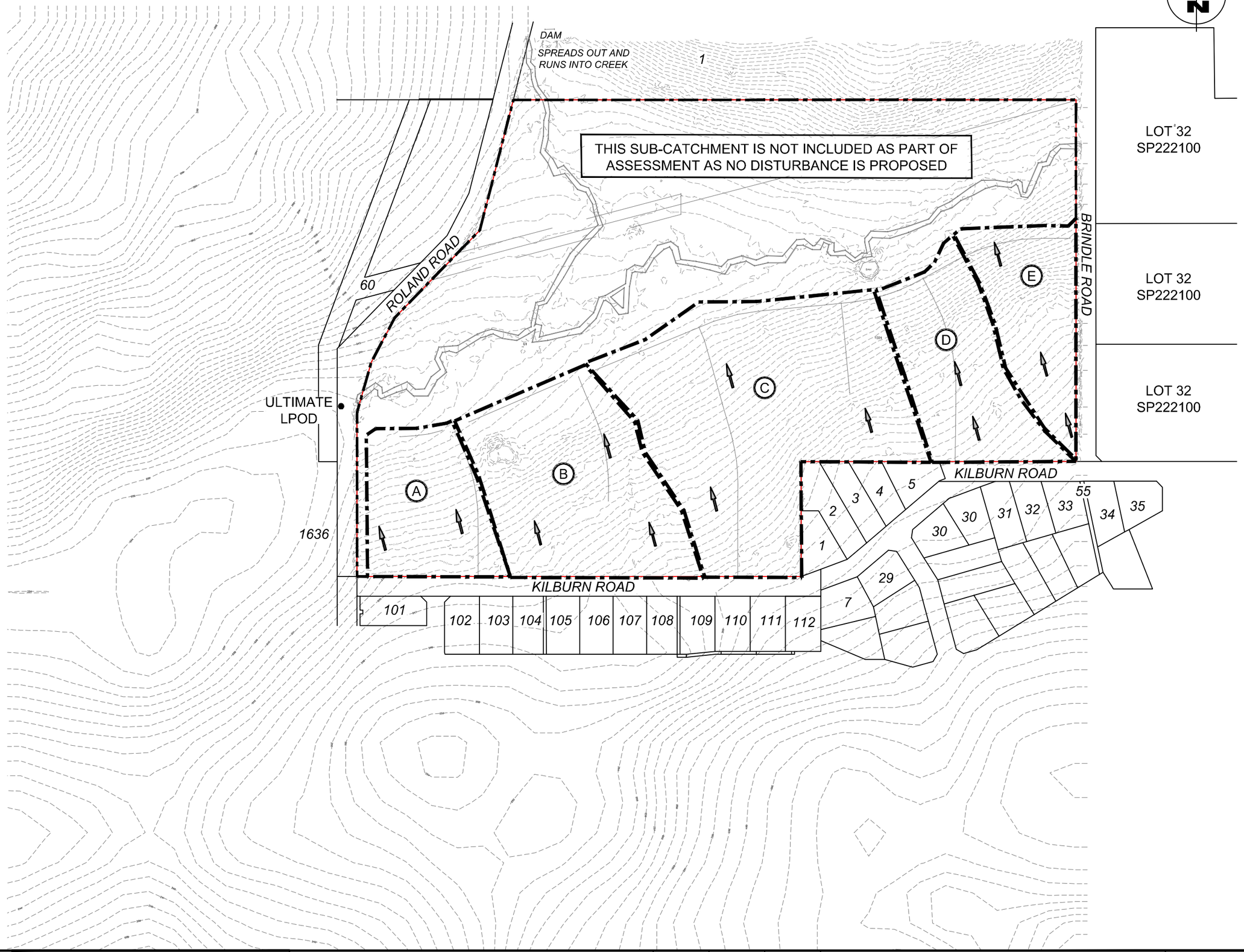
Attachment 2

Knobel Engineers
Pre-Development Stormwater Catchment Plan
(Ref: K5077/P001/C)

LEGEND

- STORMWATER CATCHMENT BOUNDARY
- SITE BOUNDARY
- (A) STORMWATER CATCHMENT I.D.
- 80.0 EXISTING SURFACE CONTOURS
- ● LPOD LAWFUL POINT OF DISCHARGE
- FLOW DIRECTION

STORMWATER CATCHMENT TABLE	
STORMWATER CATCHMENT I.D.	AREA (ha)
A	1.85
B	3.58
C	6.01
D	2.21
E	1.78
TOTAL	15.43



CONTRACTOR TO DETERMINE AND LOCATE ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORKS

REPORT ISSUE
NOT FOR CONSTRUCTION

ISSUE No.	DATE	AMENDMENT
C	08-05-20	ISSUED FOR REPORT
B	22-04-20	ISSUED FOR REPORT
A	05-11-19	ISSUED FOR REPORT

KNOBEL ENGINEERS
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W: knobelengineers.com.au
GOLD COAST | BRISBANE | BALLINA | ROCKHAMPTON

CLIENT: PRITCHARD FRANCIS

PROJECT: CIVIL ENGINEERING CONSULTANCY SERVICES
LOT 61 & 1001 KILBURN ROAD
PARKERVILLE, WA

DESIGN	DRAWN	APPROVED
BS	SA	

TITLE: PRE DEVELOPMENT STORMWATER CATCHMENT PLAN

SCALE: 1:2000 AT A1, 1:4000 AT A3 (0, 50, 100, 150, 200m)

PROJECT NO. K5077

DWG NO. P001

ISSUE C

Attachment 3

Knobel Engineers
Post Development Stormwater Catchment Plan
(Ref: K5077/P002/C)

LEGEND

- SITE BOUNDARY
- STORMWATER CATCHMENT BOUNDARY
- (A) STORMWATER CATCHMENT I.D.
- ● LPOD — LAWFUL POINT OF DISCHARGE
- SWD — EXISTING STORMWATER PIPE
- 80.0 — EXISTING SURFACE CONTOURS
- 80.0 — DESIGN SURFACE CONTOURS

STORMWATER CATCHMENT TABLE	
STORMWATER CATCHMENT I.D.	AREA (ha)
A	1.52
B	5.59
C	4.96
D	2.20
E	1.16
TOTAL	15.43

CONTRACTOR TO DETERMINE AND LOCATE ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORKS

REPORT ISSUE
NOT FOR CONSTRUCTION

ISSUE No.	DATE	AMENDMENT
C	08-05-20	ISSUED FOR REPORT
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GOLD COAST | BRISBANE | BALLINA | ROCKHAMPTON

CLIENT: PRITCHARD FRANCIS

PROJECT: CIVIL ENGINEERING CONSULTANCY SERVICES
LOT 61 & 1001 KILBURN ROAD
PARKERVILLE, WA

DESIGN	DRAWN	APPROVED
BS	SA	

TITLE: POST DEVELOPMENT STORMWATER CATCHMENT PLAN

SCALE: 1:2000 AT A1, 1:4000 AT A3 (0 50 100 150 200m)

PROJECT NO. K5077

DWG NO. P002

ISSUE C

Attachment 4

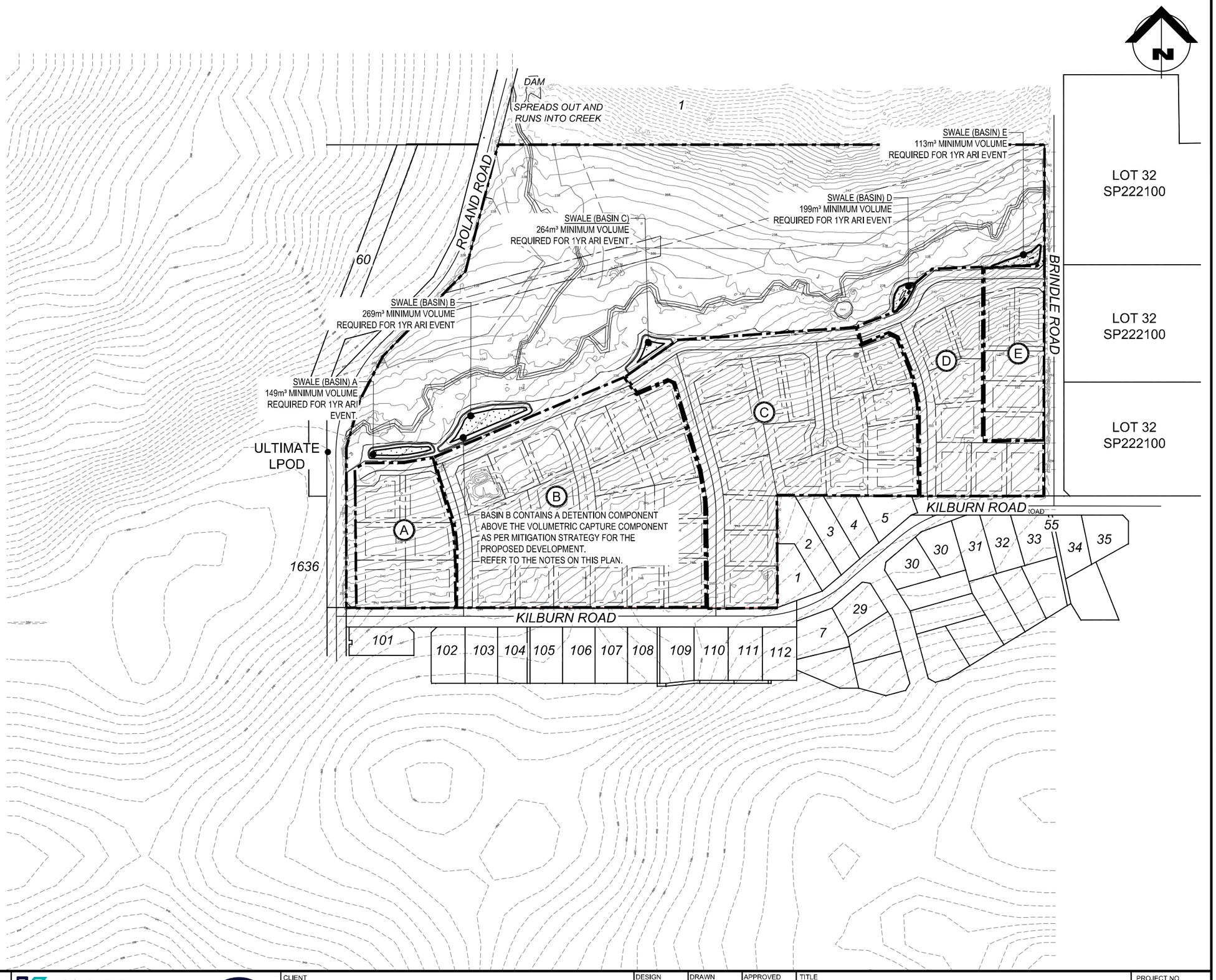
Knobel Engineers
Stormwater Management Plan
(Ref: K5077/P003/C)

LEGEND

- SITE BOUNDARY
- STORMWATER CATCHMENT BOUNDARY
- (A) STORMWATER CATCHMENT I.D.
- ● LPOD — LAWFUL POINT OF DISCHARGE
- PROPOSED FLOW DIRECTION
- PROPOSED DETENTION BASIN
- PROPOSED FIELD INLET PIT
- SWD — PROPOSED STORMWATER PIPE
- SWD — EXISTING STORMWATER PIPE
- 80.0 — EXISTING SURFACE CONTOURS
- 80.0 — DESIGN CONTOURS

NOTE:

- REFER TO PRITCHARD FRANCIS DRAWINGS FOR FURTHER INFORMATION ON BASIN SIZES.
- FOR DETAILS OF HYDROLOGIC AND HYDRAULIC MODELING, REFER TO KNOBEL ENGINEERS TECHNICAL MEMORANDUM (K5077-0002-D).



CONTRACTOR TO DETERMINE AND LOCATE ALL EXISTING SERVICES PRIOR TO COMMENCEMENT OF WORKS

REPORT ISSUE
NOT FOR CONSTRUCTION

ISSUE No.	DATE	AMENDMENT
C	08-05-20	ISSUED FOR REPORT
B	22-04-20	ISSUED FOR REPORT
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KNOBEL ENGINEERS
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W: knobelengineers.com.au
GOLD COAST | BRISBANE | BALLINA | ROCKHAMPTON

CLIENT	PRITCHARD FRANCIS		
PROJECT	CIVIL ENGINEERING CONSULTANCY SERVICES LOT 61 & 1001 KILBURN ROAD PARKERVILLE, WA		
DESIGN	BS	DRAWN	SA
APPROVED			
TITLE	STORMWATER MANAGEMENT PLAN		
SCALE	1:2000 AT A1 1:4000 AT A3	0 50 100 150 200m	
PROJECT NO.	K5077		
DWG NO.	P003	ISSUE	C

Attachment 5

Rational Method Assessment

PRE DEVELOPMENT

The pre development subject site has been analysed and delineated as five (5) internal sub-catchments for the pre development scenario based on the existing flow regime of the site. The Stormwater catchments for the pre development site have been termed Catchments A-E and are detailed on Knobel Engineers, Pre Development Catchment Plan (Ref: K5077/P001/C) included as Attachment 2.

The areas, Times of Concentrations (TOC) and Coefficient of Runoff adopted for each pre-development catchment is detailed in Table 6. It is noted that the calculated parameters for each catchment have been carried out in accordance with Queensland Urban Drainage Manual (QUDM) Fourth Edition (2017).

Table 6: Pre Development Catchments – Adopted Parameters

Catchment ID	Area (ha)	Time of Concentration t_c	Coefficient of Runoff (C_{10})
A	1.85	16	0.32
B	3.58	20	0.32
C	6.01	19	0.32
D	2.21	19	0.32
E	1.78	19	0.32

Design storm flow rates have been calculated for the 1%, 5%, 10% and 39% AEP design storm events for the pre development case using design rainfall intensities from the Bureau of Meteorology. The Rational Method ($Q = 2.78 \times 10^{-3}$ CIA) has been used to estimate the peak flow rates for the subject site. The pre development peak flows for the subject site are presented in Table 7.

Table 7: Pre-Development Estimated Peak Flow Rate – Rational Method

Catchment A				
Annual Exceedance Probability	AEP	39%	10%	5%
Coefficient of Runoff	**C**	0.27	0.32	0.34
Area of Catchment (ha)	**A**	1.85	1.85	1.85
Average Rainfall Intensity (mm/h)	**I**	41	63	72
Peak Flow Rate (m3/s)	**Q**	**0.058**	**0.104**	**0.125**
Catchment B				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.27	0.32	0.34
Area of Catchment (ha)	**A**	3.58	3.58	3.58
Average Rainfall Intensity (mm/h)	**I**	36	55	63
Peak Flow Rate (m^3/s)	**Q**	**0.098**	**0.176**	**0.212**
Catchment C				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.27	0.32	0.34
Area of Catchment (ha)	**A**	6.01	6.01	6.01

Average Rainfall Intensity (mm/h)	**I**	37	57	65
Peak Flow Rate (m^3/s)	**Q**	**0.169**	**0.305**	**0.367**
Catchment D				
Annual Exceedance Probability	AEP	39%	10%	5%
Coefficient of Runoff	**C**	0.27	0.32	0.34
Area of Catchment (ha)	**A**	2.21	2.21	2.21
Average Rainfall Intensity (mm/h)	**I**	37	57	65
Peak Flow Rate (m^3/s)	**Q**	0.062	0.112	0.135
Catchment E				
Annual Exceedance Probability	AEP	39%	10%	5%
Coefficient of Runoff	**C**	0.27	0.32	0.34
Area of Catchment (ha)	**A**	1.78	1.78	1.78
Average Rainfall Intensity (mm/h)	**I**	34	57	65
Peak Flow Rate (m^3/s)	**Q**	0.05	0.090	0.109
TOTAL Peak Flow Rate (m^3/s)	**Q_t**	**0.437**	**0.786**	**0.948**

POST DEVELOPMENT

The post development subject site has been analysed and delineated as five (5) internal sub-catchments based on the preliminary drainage strategy proposed for the site . The Stormwater catchments for the post development site have been termed A-E and are detailed on Knobel Engineers, Post Development Catchment Plans (Ref: K5077/P002/C) included as Attachment 3. Note that as the final developed layout for each lot has not yet been determined, a rural residential category has been assumed for the calculation of catchment parameters.

The areas, Times of Concentrations (TOC) and Coefficient of Runoff adopted for each post development catchment is detailed in Table 8. Note that the calculated parameters for each catchment have been carried out in accordance with QUDM.

Table 8: Post Development Catchments – Adopted Parameters

Catchment ID	Area (ha)	Time of Concentration t_c	Coefficient of Runoff (C_{10})
A	1.52	13	0.55
B	5.59	13	0.55
C	4.96	13	0.55
D	2.20	13	0.55
E	1.16	13	0.55

Design storm flow rates have been calculated for the 1%, 5%, 10% and 39% AEP design storm events for the post development case using design rainfall intensities from the Bureau of Meteorology. The Rational Method ($Q = 2.78 \times 10^{-3}$ CIA) has been used to estimate the peak flow rates for the subject site. The pre development peak flows for the subject site are presented in Table 9.

Table 9: Post Development Estimated Peak Flow Rates – Rational Method

Catchment A				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.47	0.55	0.58
Area of Catchment (ha)	**A**	1.52	1.52	1.52
Average Rainfall Intensity (mm/h)	**I**	46	71	81
Peak Flow Rate (m^3/s)	**Q**	**0.091**	**0.164**	**0.198**
Catchment B				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.47	0.55	0.58
Area of Catchment (ha)	**A**	5.59	5.59	5.59
Average Rainfall Intensity (mm/h)	**I**	46	71	81
Peak Flow Rate (m^3/s)	**Q**	**0.335**	**0.605**	**0.730**
Catchment C				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.47	0.55	0.58
Area of Catchment (ha)	**A**	4.96	4.96	4.96
Average Rainfall Intensity (mm/h)	**I**	46	71	81
Peak Flow Rate (m^3/s)	**Q**	**0.297**	**0.537**	**0.648**
Catchment D				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.47	0.55	0.58
Area of Catchment (ha)	**A**	2.20	2.20	2.20
Average Rainfall Intensity (mm/h)	**I**	46	71	81
Peak Flow Rate (m^3/s)	**Q**	**0.132**	**0.238**	**0.287**
Catchment E				
Annual Exceedance Probability	**AEP**	39%	10%	5%
Coefficient of Runoff	**C**	0.47	0.55	0.58
Area of Catchment (ha)	**A**	1.16	1.16	1.16
Average Rainfall Intensity (mm/h)	**I**	46	71	81
Peak Flow Rate (m^3/s)	**Q**	**0.070**	**0.126**	**0.151**
TOTAL Peak Flow Rate (m^3/s)	**Q_t**	**0.925**	**1.669**	**2.015**

CHANGE IN PEAK FLOW RATES

The difference in peak flow rates calculated from the total pre and post developed site has been analysed via The Rational Method,with the results detailed in Table 10.

Table 10: Change in Peak Flow Rates Estimation – Rational Method

Annual Exceedance Probability	**AEP**	39%	10%	5%	1%
Pre Developed Peak Flow Rate (m^3/s)	**Q**	0.437	0.786	0.948	1.435
Post Developed Peak Flow Rate (m^3/s)	**Q**	0.925	1.669	2.015	3.054
Change in Peak Flow Rate (m^3/s)	**Q**	**0.488**	**0.883**	**1.067**	**1.619**

The proposed development has demonstrated via a Rational Method assessment, that an increase in peak flow rates discharging from the site is anticipated due to the proposed development, therefore on-site detention will be required to mitigate flows to pre development conditions.

EXTERNAL CATCHMENTS

It is to be noted that there is an external catchment to the south of the site (based on 2011 LIDAR) however is it our understanding that development in the early 2000's (and even earlier) has considered this catchment. Advice received from Pritchard Francis relating to this upstream catchment is that that the existing stormwater infrastructure within Kilburn Road and Roland Road can convey flows (up to the 5 year event) away from the site, with Kilburn Road pavement and Roland Road pavement providing a flood route for the heavier events. Therefore, the external catchment is deemed not to require consideration as part of this development.

Appendix 8 Lot Separation Distances to Groundwater and Clay

Lot Number	Lot Level (mAHD)	Estimated Groundwater Level (mAHD)	Estimated Clay Level (mAHD)	Clearance achieved (m)
1	235.2	234.0		1.2
2	237.8	235.0	236.5	1.3
3	240.95	236.0	239.2	1.8
4	237.2	235.0	234.8	2.2
5	238.3	237.0		1.3
6	241.5	238.0		3.5
7	237	236.0	235.2	1.0
8	238.9	238.0	237.7	1.2
9	240.2	239.0		1.2
10	242.75	240.0		2.8
11	243.75	241.0		2.8
12	245.75	243.0		2.8
13	242.85	241.0		1.8
14	240.55	239.0		1.6
15	238.2	237.0		1.2
16	238.2	237.0		1.2
17	239.2	238.0	236.3	1.2
18	240.2	239.0	237.9	1.2
19	240.2	239.0	236.8	1.2
20	243.1	241.5		1.6
21	244.9	244.0	243.2	0.9
22	246.55	245.0	244.9	1.6
23	249.95	247.0	247.4	2.5
24	248.45	245.0		3.4
25	246.75	244.0		2.8
26	244.85	243.0		1.8
27	243.2	242.0		1.2
28	241.7	240.5		1.2
29	251.75	249.0		2.8
30	249.75	248.0	248.3	1.4
31	247.8	246.5	246.6	1.2
32	246.2	245.0		1.2
33	244.3	243.0	242.8	1.3
34	242.7	241.5		1.2

Lot Number	Lot Level (mAHD)	Estimated Groundwater Level (mAHD)	Estimated Clay Level (mAHD)	Clearance achieved (m)
35	241.2	240.0	238.8	1.2
36	243.6	242.0	241.0	1.6
37	244.6	243.0	242.2	1.6
38	246.55	245.0		1.6
39	249.1	247.0		2.1
40	250.25	247.0		3.3
41	247.5	245.0		2.5
42	244.6	243.0	243.4	1.2
43	245.8	243.0	243.9	1.9
44	247.95	245.0		2.9
45	250.2	247.0		3.2
46	251.95	248.0		3.9
47	253.25	249.0		4.3
48	250.75	247.0		3.8
49	248.5	245.0		3.5
50	245.25	242.5	245.2	0.1
51	246.75	242.5	246.6	0.2
52a	248.75	242.5	247.6	1.2
52b	249.25	242.5	247.1	2.2
53	250.8	244.0		6.8
54	252.2	246.0		6.2
55	253.7	247.0		6.7
56	255.7	249.0		6.7
57	254.7	249.0		5.7
	Lots requiring clay contouring to achieve separation distance			

COTERRA
ENVIRONMENT

Level 3, 25 Prowse Street
West Perth WA 6005

T (08) 9381 5513

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info@coterra.com.au

PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX F

BUSHFIRE MANAGEMENT PLAN

(STRATEGEN-JBS&G)

Fire Protection Association Australia
Life. Property. Environment.

BPAD Bushfire Planning & Design

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Lot 61 Roland Road and Lot 1001 Kilburn Road

Suburb: Parkerville **State:** WA **P/code:** 6081

Local government area: Shire of Mundaring

Description of the planning proposal: Subdivision application

BMP Plan / Reference Number: 59572 **Version:** R01 Rev 3 **Date of Issue:** 29/03/2022

Client / Business Name: Cuttone Property Group

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☐	☒
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Louisa Robertson	Level 3	BPAD 36748	28/02/2023
Company		**Contact No.**	
Strategen-JBS&G		08 9792 4797	

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

Signature of Practitioner LMRobertson **Date** 29/03/2022

Cuttone Property Group

Bushfire Management Plan (Structure Plan)

Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville

29 March 2022

59572/125,784 (Rev 3)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

BPAD Bushfire Planning & Design Accredited Practitioner Level 3

www.jbsg.com.au

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Appendix E Vehicular access technical standards of the Guidelines
Appendix F Water technical standards of the Guidelines
Appendix G Shire of Mundaring Firebreak Notice

1. Proposal details

1.1 Background

Hatch RobertsDay, on behalf of Cuttone Property Group, is seeking to lodge a Structure Plan to guide future residential development within Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville (the project area), located in the Shire of Mundaring. The Concept Plan (Figure 1; Hatch RobertsDay 2021) identifies:

- 54 proposed residential lots to the south of Clutterbuck Creek with a minimum lot size of 2,000 m^2
- two balance rural smallholding lots to the north of Clutterbuck Creek of approximately 1 ha and 4 ha
- internal road layout
- emergency access way to Roland Road
- Clutterbuck Creek Foreshore Reserve

areas of Public Open Space (POS) and drainage adjoining the foreshore reserve.

1.2 Site description

The project area comprises approximately 29.39 ha within Lots 61 and 1001. Clutterbuck Creek runs centrally within the project area in an east-west direction and separates the proposed southern residential development cell from the two proposed rural lots to the north. The project area is surrounded by (see Figure 2):

- Kilburn Road and residential lots to the south
- Brindle Road and rural residential lots to the east (Lots 6–8 and 148)
- Roland Road and mixed special use (Lots 9001 and 1636), rural residential (Lot 60, Silver Tree Steiner School) and rural small holdings (Lot 1884, Mundaring Christian College) to the west
- General agriculture (rural small holdings) within Lot 1 to the north.

The project area currently contains property assets in the form of a dwelling on Lot 1001 and sheds on Lot 61.

The project area is designated as bushfire prone on the *Map of Bush Fire Prone Areas* (DFES 2021; see Plate 1).

1.3 Purpose

This Bushfire Management Plan (BMP) has been prepared to address requirements under *Policy Measure 6.3 of State Planning Policy 3.7 Planning in Bushfire-Prone Areas* (SPP 3.7; WAPC 2015) and *Guidelines for Planning in Bushfire-Prone Areas* (the Guidelines; WAPC 2017).

1.4 Other plans/reports

Other reports that have been prepared for the project area include:

- Bushfire Management Plan: Lot 61 Roland Road and Lot 1001 Kilburn Road prepared by Strategen (2017, ref: RDP16601_01 R001 Rev 1) to support the Local Planning Scheme amendments to rezone the project area for future residential development.

This current Structure Plan stage BMP has been prepared in consideration of the abovementioned rezoning stage BMP and has also been updated in October 2021 (Rev 1) in response to an amended Structure Plan area and subdivision design and comments provided by DPLH on the previous version

of this report (Rev 0, dated May 2020). The BMP was further updated in December 2021 (Rev 2) and March 2022 (Rev 3) in response to further agency comments.

Plate 1: Map of Bush Fire Prone Areas (DFES 2021)

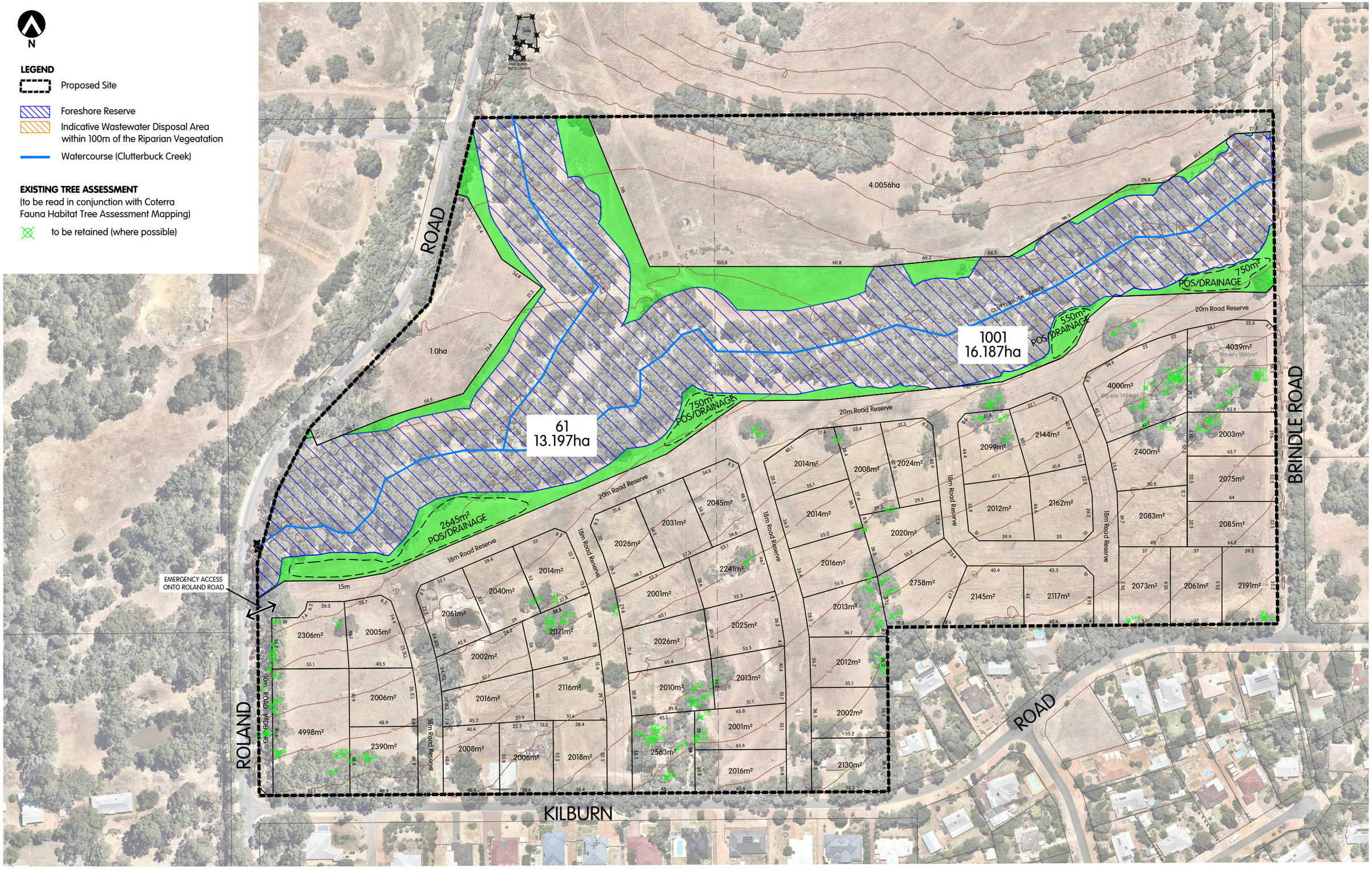
N

LEGEND

- Proposed Site
- Foreshore Reserve
- Indicative Wastewater Disposal Area within 100m of the Riparian Vegeatation
- Watercourse (Clutterbuck Creek)

EXISTING TREE ASSESSMENT
(to be read in conjunction with Coterra Fauna Habitat Tree Assessment Mapping)

- to be retained (where possible)



CADASTRAL INFORMATION
SOURCE: COTERRA
YYMMDD: 190521
DWG REF: CUTKIL02_GIS-Datasets
PROJECTION: GDA94

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 190209

HATCH | RobertsDay

SIZE A3_ 1:1000

0 metres 10 20 30 40 50

FINAL CONCEPT DESIGN

Lot 61 & 1001 Kilburn Road, Parkerville

Shire of Mundaring

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
S	MODS TO LOTS - CNR ROLAND + KILBURN	210915	SB	RDa
R	MODS TO LOTS - ROAD RESERVE	210906	SJ	RDa
Q	PUSH CULDESAC THRU TO KILBURN	210505	SB	RDa
P	ADD EMERGENCY ACCESS ROADS	210204	SB	RDa

REF NO.	DRAW NO.	REV.
PCH PAR	**RD1 002**	**S**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Foreshore reserve buffer
- Proposed lots
- POS/Drainage
- Rural Smallholding
- Indicative 6m wide EAW
- Proposed carriageway
- Watercourse
- Roads (MRWA)

strategen JBS&G

Job No: 57677	
Client: Cuttone Property Group	
Version: 1	Date: 07-Oct-2021
Drawn By: jcrute	Checked By: CT

Scale 1:3,200

0 50 100
metres

Coord. Sys. GDA2020 MGA Zone 50

Lot 61 Roland Rd,
Lot 1001 Kilburn Rd
Parkerville, WA

SITE OVERVIEW

FIGURE 2

File Name: W:\Projects\1)Open\Cuttone Property Group\59572 BMP Kilburn Rd Parkerville LSP (57677)\GIS\Maps\R01 Rev 1\57677_02_A3_SiteOverview.mxd
Image Reference: www.nearmap.com© - Imagery Date: 25. August 2021

2. Environmental considerations

2.1 Native vegetation - modification and clearing

The site is predominantly cleared and currently used for livestock grazing purposes.

All vegetation within the Clutterbuck Creek foreshore reserve will be retained in its current state since the proposal and BMP do not require removal of this vegetation to achieve an appropriate BAL rating for proposed development. In addition, the indicative alignment of the fire service access routes utilises existing cleared tracks within the foreshore reserve and is not expected to require any clearing.

Similarly, the individual and small stands of paddock trees situated north and south of Clutterbuck Creek, which have habitat value for native fauna species, will be retained where possible. The Indicative Tree Retention Plan at Appendix A depicts the trees that are expected to be retained in the southern development area versus those that are expected to be removed as part of the proposed development.

The Roland Road reservation will be widened by 10 m as part of the proposal, to enable retention of the existing trees within this strip for environmental and aesthetic purposes.

Road verge vegetation along the northern side of Kilburn Road and western side of Brindle Road will be impacted by the proposal due to access construction requirements and establishment of private driveways to service the interfacing lots. The remaining vegetation within these road verges will be managed as a nature strip. Any significant/habitat trees located within the Kilburn Road verge will be identified during detailed design stage and retained where possible as part of low threat landscaping.

On this basis, aside from small areas of road verge vegetation on Kilburn Road and Brindle Road, the proposal is not likely to have significant clearing impacts on conservation significant fauna as the majority of potential on-site habitat will be retained. Notwithstanding, all relevant environmental approvals will be sought prior to any vegetation modification or clearing.

A search of publicly available environmental data relating to the project area has been undertaken and is summarised in Table 1.

Table 1: Summary of environmental values

Environmental value	Mapped as occurring within or adjacent to the project area		Description
	Within	Adjacent	
Environmentally Sensitive Area	✗	✗	N/A
Swan Bioplan Regionally Significant Natural Area	✗	✗	N/A
Ecological linkages	✗	✓	An ecological linkage is mapped as occurring 320 m to the east of the project area.
Wetlands	✗		N/A
Waterways	✗	✓	Clutterbuck Creek runs adjacent to the northern boundary of the project area.
Threatened Ecological Communities listed under the EPBC Act	✗		N/A
Threatened and priority flora	✗	✓	The buffer zone for a Threatened Flora species is mapped as occurring 150 m to the southeast of the project area.
Fauna habitat listed under the EPBC Act	✓	✓	With respect to Carnaby's Black Cockatoo, the project area and adjacent areas are mapped as containing:

Environmental value	Mapped as occurring within or adjacent to the project area		Description
	Within	Adjacent	
			• confirmed breeding areas • confirmed roosting areas • potential feeding areas.
Threatened and priority fauna	✓	✓	The buffer zone for a Threatened Fauna species is mapped as occurring across the southeast portion of the project area, with four other Threatened or Priority Fauna species occurring to the south.
Bush Forever Site	✗	✗	N/A
DBCA managed lands and waters (includes legislated lands and waters and lands of interest)	✗	✗	N/A
Conservation covenants	✗	✗	N/A

2.2 Revegetation / Landscape Plans

Any future landscaping/POS will consist of low threat drainage areas, managed gardens and street scaping in accordance with AS 3959 Clause 2.2.3.2 (f) and Schedule 1 of the Guidelines (refer to Appendix C), which will be demonstrated in a future detailed landscaping plan.

No revegetation is proposed within the project area of recreations POS/drainage; however, revegetation may occur within Clutterbuck Creek foreshore reserve at a later time. Details of the extent and composition of revegetation within the foreshore reserve will be identified if applicable at future planning stages through development of detailed landscaping plans as required. Future revegetation of the foreshore reserve will have no bearing on the BAL outcome for proposed development north and south of Clutterbuck Creek since a worst-case Class A Forest classification has already been applied.

The proposed 1 ha rural small holding lot to the north of Clutterbuck Creek contains a portion of Foreshore Reserve which is not currently vegetated (i.e. contains grassland only). The following assumption has been made purposes of the indicative BAL contour assessment at this strategic planning stage and has informed the post-development vegetation classifications as depicted in Figure 6:

- the existing cleared area within the foreshore reserve adjoining the proposed 1 ha lot in the northwest of the project area will not be subject to revegetation and will continue to be managed in a low threat state in accordance with Clause 2.2.3.2 (f).

The above requirement will be reflected in a detailed landscape plan at future planning stages to ensure the outcomes of this BMP are transferred and delivered as part of subdivision design.

3. Bushfire assessment results

3.1 Assessment inputs

3.1.1 Vegetation classification

Strategen-JBS&G assessed classified vegetation and exclusions within 150 m of the project area through on-ground verification on 15 November 2019 in accordance with *AS 3959—2018 Construction of Buildings in Bushfire-Prone Areas* (AS 3959; SA 2018) and the *Visual Guide for Bushfire Risk Assessment in Western Australia* (DoP 2016). Georeferenced site photos and a description of the pre-development vegetation classifications and exclusions are contained in Appendix B and Figure 3. Post-development vegetation classifications and exclusions are depicted in Figure 4.

3.1.2 Effective slope

Strategen-JBS&G assessed effective slope under classified vegetation through on-ground verification on 15 November 2019 in accordance with AS 3959. Results were cross-referenced with DPIRD 2m contour data and are depicted in Table 2, Table 3 and Figure 3.

Site observations confirm that the majority of the project area is flat to gently undulating in association with the Clutterbuck Creek valley floor. The valley periphery in the east grades from undulating to steep; however, these slopes were identified to be up-slope from proposed development. Topographic elevation across the site ranges from approximately 245 m Australian Height Datum (m AHD) in the south and north to approximately 235 m AHD in the west.

Effective slope under post development classified vegetation has been identified as either flat land or upslope from proposed development areas (i.e. effective slope of 0 degrees).

3.1.3 Pre-development inputs

Regional vegetation surveys and mapping of the Swan Coastal Plain indicates the project area and adjacent land is contained within the Yarragil 1 Complex and Dwellingup D2 Complex: Karrakatta Complex – Central and South. These vegetation complexes are described as:

- Yarragil 1: Open forest of jarrah (*Eucalyptus marginata* subsp. *marginata*) – marri (*Corymbia calophylla*) on slopes with mixtures of Swan River blackbutt (*Eucalyptus patens*) and bullich (*Eucalyptus megacarpa*) on the valley floors in humid and subhumid zones.
- Dwellingup D2 Complex: Open forest of jarrah (*Eucalyptus marginata* subsp. *marginata*) – marri (*Corymbia calophylla*) on lateritic uplands in subhumid and semiarid zones.

The indicator species identified from the above vegetation complexes are consistent with the vegetation classifications identified during the site inspection with forest and woodland areas being dominated by overstorey eucalypts. Pre-development vegetation classifications and exclusions are depicted in Figure 3 and listed below:

- the project area consists of:
    - Class A Forest along the southern (Kilburn Road) and western boundaries (Roland Road) and in association with Clutterbuck Creek
    - Class B Woodland within small patches of on-site remnant trees
    - Class G Grassland (grazed pastureland) throughout the majority of the site.
- land adjacent to the project area and within 150 m consists of:
    - Class A Forest within surrounding road reserves and within rural and rural residential land to the west and east of the project area

- Class B Woodland within surrounding road reserves and residential land to the southwest and southeast
- Class G Grassland within the rural land/rural residential land to the north, east and west
- non-vegetated areas (e.g. roads and buildings) and/or low threat managed land excluded from classification under Clause 2.2.3.2 (e) and (f) throughout residential lots to the south and existing constructed road surfaces, buildings and infrastructure.

A summary of the assessed pre-development classified vegetation, exclusions and effective slope are listed in Table 2 and illustrated in Figure 3.

Table 2: Pre-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class A Forest	Flat/upslope (0°)	Dominated by eucalypts with a prominent overstorey, mid-storey and understorey fuel structure.
2	Class B Woodland	Flat/upslope (0°)	Dominated by eucalypts with no mid-storey vegetation and predominantly grassy understorey.
3	Class G Grassland	Flat/upslope (0°)	Grassland dominating the pastural land on-site and throughout adjacent land.
4	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing low threat vegetation (street trees, managed road verges, residential gardens) and non-vegetated areas (i.e. roads, paths, buildings, driveways, water bodies).

3.1.4 Post-development inputs

Proposed development will result in vegetation modification within the Kilburn and Brindle road verges to establish a nature strip at these interfaces and meet the low threat criteria of AS 3959 Clause 2.2.3.2 (f). The current on-site grassland extent will also be converted to a managed low threat/non-vegetated state.

On this basis, post-development vegetation exclusions will consist of:

- vegetation that is currently or will be managed in a low threat, minimal fuel condition excluded from classification under Clause 2.2.3.2 (f) of AS 3959, including:
  - proposed POS and drainage areas associated with Clutterbuck Creek
  - Kilburn Road verge (northern side) and Brindle Road verge (western side), which consist of nature strips.
- any non-vegetated areas occupied by existing and proposed roads, parking, dwellings or other infrastructure excluded from classification under Clause 2.2.3.2 (e) of AS 3959.

Post-development vegetation classifications within the 150 m assessment area will consist of Class A Forest, Class B Woodland and Class G Grassland, with all land outside of the foreshore reserve being modified to and managed in a low threat or non-vegetated state.

A summary of the indicative post-development classified vegetation, exclusions and effective slope within the assessment area are listed in Table 3 and illustrated in Figure 4. If external vegetation is altered prior to future planning stages, the change in vegetation condition is to be captured through a future vegetation assessment.

Table 3: Post-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope
1	Class A Forest	Flat/upslope (0°)
2	Class B Woodland	Flat/upslope (0°)
3	Class G Grassland	Flat/upslope (0°)
4	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A
5	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A

Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary

Vegetation classification

- Class A Forest
- Class B Woodland
- Class G Grassland
- Clauses 2.2.3.2 (e) & (f)

- Watercourse
- Photo point directions
- Topographic contours (mAHD)
- Roads (MRWA)

strategen JBS&G

Job No: 57677	
Client: Cuttone Property Group	
Version: 1	Date: 21-Dec-2021
Drawn By: jcrute	Checked By: CT

Scale 1:3,200

0 50 100
metres

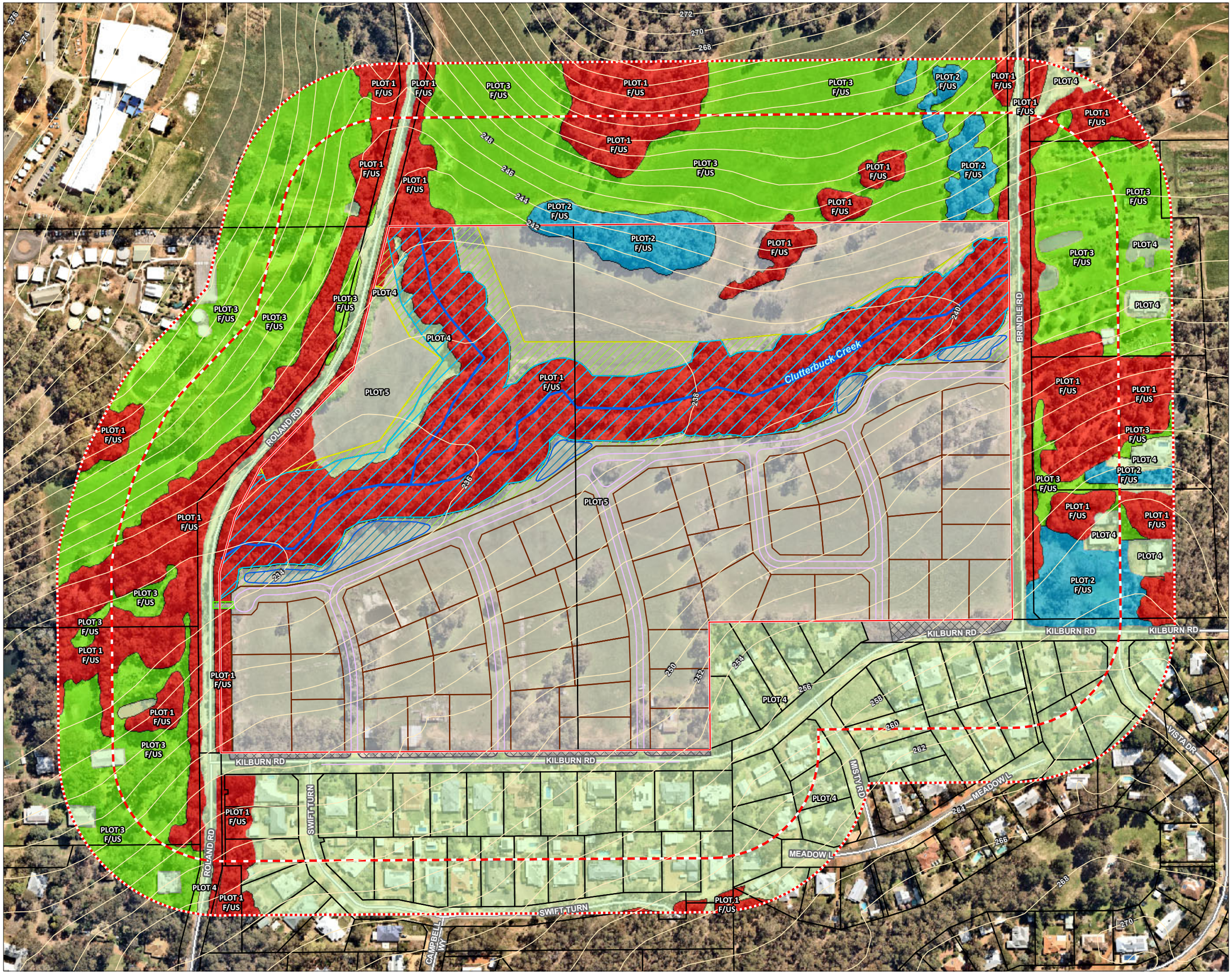
Coord. Sys. GDA2020 MGA Zone 50

Lot 61 Roland Rd,
Lot 1001 Kilburn Rd
Parkerville, WA

PRE-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 3

File Name: W:\Projects\1)Open\Cuttone Property Group\59572 BMP Kilburn Rd Parkerville LSP (57677)\GIS\Maps\R01 Rev 1\57677_03_A3_PreDevVegClass.mxd
Image Reference: www.nearmap.com© - Imagery Date: 25. August 2021



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Foreshore reserve buffer
- Proposed lots
- Existing POS/Drainage
- Proposed POS
- Rural Smallholding
- Indicative 6m wide EAW
- Future nature strips (Clauses 2.2.3.2 [f])

Vegetation classification

- Class A Forest
- Class B Woodland
- Class G Grassland
- Clauses 2.2.3.2 (e) & (f)
- Area to be modified to non-vegetated and low threat state
- Proposed carriageway
- Watercourse
- Topographic contours (mAHD)
- Roads (MRWA)

strategen JBS&G

Job No: 57677	
Client: Cuttone Property Group	
Version: 1	Date: 29-Mar-2022
Drawn By: jcrute	Checked By: CT

Scale 1:3,200

0 50 100
metres

Coord. Sys. GDA2020 MGA Zone 50

Lot 61 Roland Rd,
Lot 1001 Kilburn Rd
Parkerville, WA

POST-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 4

File Name: W:\Projects\1)Open\Cuttone Property Group\59572 BMP Kilburn Rd Parkerville LSP (57677)\GIS\Maps\R01 Rev 1\57677_04_A3_PostDevVegClass.mxd
Image Reference: www.nearmap.com© - Imagery Date: 25. August 2021

3.2 Assessment outputs

3.2.1 Pre-development Bushfire Hazard Level (BHL) assessment

The pre-development vegetation extent has been assigned a Bushfire Hazard Level (BHL) in accordance with the methodology detailed in Appendix Two of the Guidelines as outlined in Table 4.

Table 4: Bushfire hazard levels and characteristics

Bushfire hazard level	Characteristics*
Extreme	• Class A Forest • Class B Woodland (05) • Class D Scrub • Any classified vegetation with a greater than 10° slope.
Moderate	• Class B Low woodland (07) • Class C Shrubland • Class E Mallee/Mulga • Class G Grassland, including sown pasture and crops • Class G Grassland: Open woodland (06), Low open woodland (08), Open shrubland (09) • Vegetation that has a low hazard level but is within 100 metres of vegetation classified as a moderate or extreme hazard, is to adopt a moderate hazard level.
Low	• Low threat vegetation may include areas of maintained lawns, golf courses, public recreation reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks • Managed grassland in a minimal fuel condition (insufficient fuel is available to significantly increase the severity of the bushfire attack). For example, short-cropped grass to a nominal height of 100 millimetre • Non-vegetated areas including waterways, roads, footpaths, buildings and rock outcrops.
*Vegetation classifications from AS 3959-2018 Table 2.3.	

Strategen-JBS&G has mapped the pre-development BHLs within the project area and adjacent 150 m wide assessment area. The bushfire hazard levels have been assessed on the basis of the vegetation discussed in Section 3.1.3 (i.e. the current pre-development extent of vegetation within and surrounding the project area).

The pre-development BHL assessment (refer to Figure 5) shows that based on the existing vegetation, the project area contains land with Moderate and Extreme bushfire hazard levels.

3.2.2 Post-development Bushfire Attack Level (BAL) contour assessment

3.2.2.1 Methodology

The Concept Plan (Figure 1) indicates a proposed lot layout; therefore, Strategen-JBS&G has undertaken an indicative BAL contour assessment in accordance with Method 1 of AS 3959 for the project area (Figure 6). The Method 1 procedure incorporates the following factors:

- state-adopted FDI 80 rating
- vegetation classification
- effective slope
- distance maintained between proposed development areas and the classified vegetation.

The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by proposed development and subsequently informs the standard of building construction and/or setbacks required for proposed habitable development to potentially withstand such impacts.

The BAL contours are based on the vegetation classifications and effective slope observed at the time of inspection as well as consideration of the proposed clearing extent, resultant vegetation exclusions and separation distances achieved in line with the structure plan

3.2.2.2 Results

Results of the BAL contour assessment are detailed for the proposed rural smallholding lots in Table 5 and the proposed residential lots in Table 6. The BAL Contour map is included in Figure 6.

Table 5: Indicative BAL contour assessment results (rural smallholding lots)

Vegetation plot	Vegetation classification	Effective slope	Separation distance (to nearest external lot boundary)	Highest BAL	APZ required to achieve BAL-29	Revised BAL
1	Class A Forest	Flat/upslope	0 m	BAL-FZ	21 m total separation	**BAL-29**
2	Class B Woodland	Flat/upslope	0 m	BAL-FZ	14 m total separation	**BAL-29**
3	Class G Grassland	Flat/upslope	0 m	BAL-FZ	8 m total separation	**BAL-29**
4	Excluded under Clauses 2.2.3.2 (e) and (f)	N/A	N/A	N/A	N/A	N/A
5	Excluded under Clauses 2.2.3.2 (e) and (f)	N/A	N/A	N/A	N/A	N/A

Table 6: Indicative BAL contour assessment results (residential lots)

Vegetation plot	Vegetation classification	Effective slope	Separation distance (to nearest external lot boundary)	Highest BAL	APZ required to achieve BAL-29	Revised BAL
1	Class A Forest	Flat/upslope	0 m	BAL-FZ	21 m total separation	**BAL-29**
2	Class B Woodland	Flat/upslope	13 m	BAL-40	14 m total separation	**BAL-29**
3	Class G Grassland	Flat/upslope	20 m	**BAL-12.5**	N/A	N/A
4	Excluded under Clauses 2.2.3.2 (e) and (f)	N/A	N/A	N/A	N/A	N/A
5	Excluded under Clauses 2.2.3.2 (e) and (f)	N/A	N/A	N/A	N/A	N/A

The highest BAL applicable to the external boundary of the proposed lots is BAL-FZ. This rating applies to:

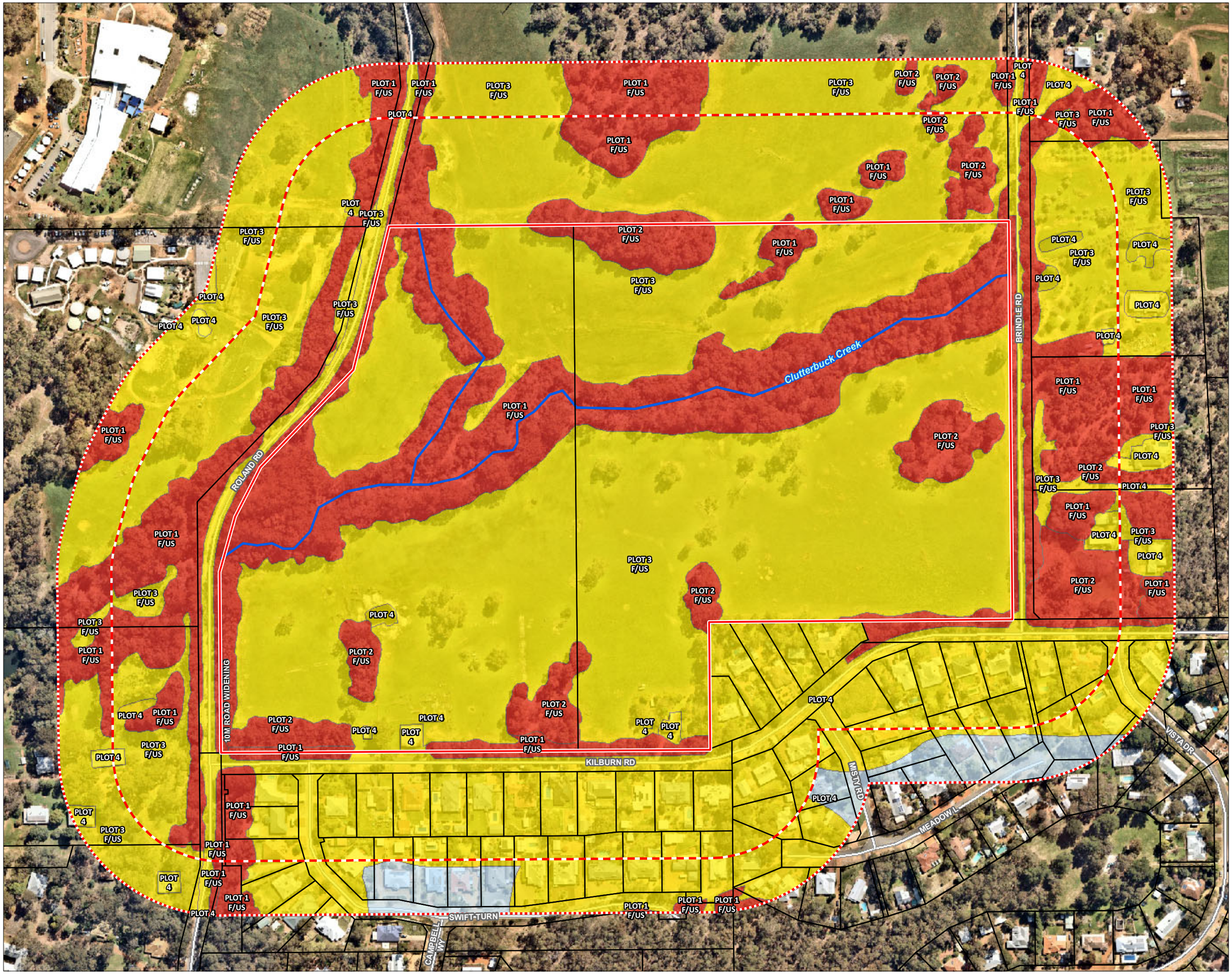
- the two northern rural smallholding lots (Table 5)
- the two residential lots abutting Roland Road (Table 6)
- the five residential lots interfacing Brindle Road (Table 6).

The siting of future habitable development within the two rural smallholding lots within an area of BAL-29 or lower will be addressed at subdivision stage through the nomination of building envelopes and further addressed at DA stage through the preparation of a lot specific BMP. However, the indicative BAL contour assessment demonstrates that there is suitable land subject to BAL-29 for future habitable buildings to be constructed.

In regard to the residential lots bordering Roland Road and Brindle Road which are affected by BAL-40/FZ impacts, APZ setbacks sufficient for habitable development to achieve BAL-29 will be applied at subdivision stage and will be enforced through a restrictive covenant placed on title. The APZ setbacks required for these lots are depicted in Figure 6 and are expected to be 21 m for the lots abutting Roland Road and 9-11 m for lots abutting Brindle Road.

There is one additional residential lot interfacing the foreshore reserve which has a minor BAL-40 incursion. A 1 m APZ setback will be sufficient to achieve BAL-29, which will be enforced via standard R-code provisions at building stage.

In summary, the mandatory APZ setbacks and R-Code building setbacks will ensure that the highest BAL applicable to all future habitable buildings is **BAL–29**. This achieves compliance with Acceptable Solution A1.1 of the Bushfire Protection Criteria of the Guidelines. It should also be noted that the majority of proposed residential lots are subject to BAL-12.5 or BAL-Low.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary

Hazard level

- Extreme
- Moderate
- Low
- Watercourse
- Roads (MRWA)

strategen JBS&G

Job No: 57677	
Client: Cuttone Property Group	
Version: 1	Date: 22-Dec-2021
Drawn By: jcrute	Checked By: CT

Scale 1:3,200

0 50 100
metres

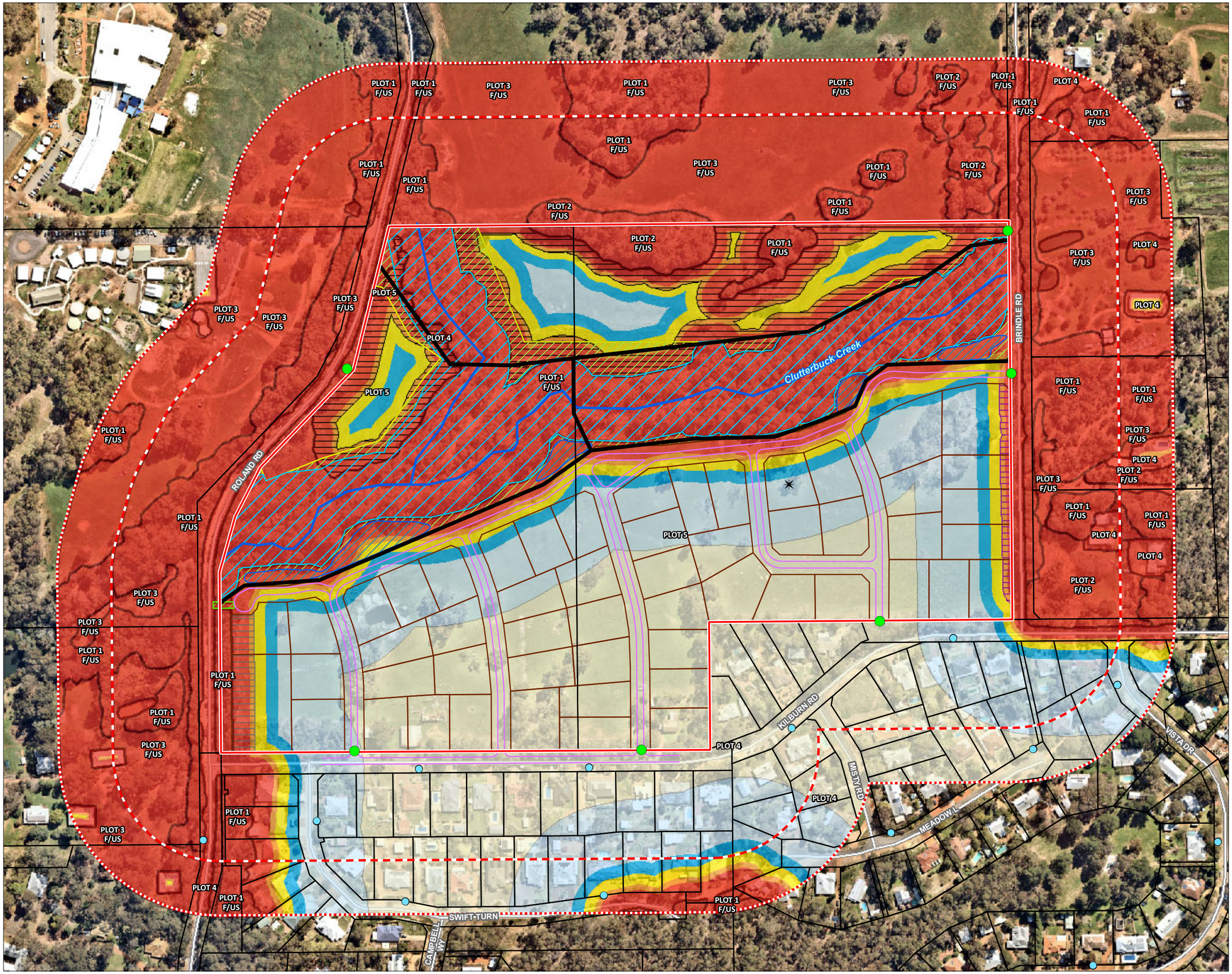
Coord. Sys. GDA2020 MGA Zone 50

Lot 61 Roland Rd,
Lot 1001 Kilburn Rd
Parkerville, WA

PRE-DEVELOPMENT
BHL ASSESSMENT

FIGURE 5

File Name: W:\Projects\1)Open\Cuttone Property Group\59572 BMP Kilburn Rd Parkerville LSP (57677)\GIS\Maps\R01 Rev 1\57677_05_A3_PreDevBHLs.mxd
Image Reference: www.nearmap.com© - Imagery Date: 25. August 2021



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Foreshore reserve buffer
- Proposed lots
- Existing POS/Drainage
- Proposed POS
- Rural Smallholding
- Classified vegetation
- 9m to 11m wide APZ setback
- 14m to 21m wide APZ setback
- 21m wide APZ setback

BAL contours

- BAL FZ
- BAL 40
- BAL 29
- BAL 19
- BAL 12.5
- BAL Low

- Proposed carriageway
- Watercourse
- Indicative FSAR
- Roads (MRWA)
- Lot subject to minor BAL-40 incursion
- Connections to existing road network
- Existing street hydrants

strategen JBS&G

Job No: 57677

Client: Cuttone Property Group

Version: 1	Date: 21-Dec-2021
Drawn By: jcrute	Checked By: CT

Scale 1:3,200

0 50 100
metres

Coord. Sys. GDA2020 MGA Zone 50

Lot 61 Roland Rd,
Lot 1001 Kilburn Rd
Parkerville, WA

POST-DEVELOPMENT BAL CONTOUR ASSESSMENT AND BUSHFIRE MANAGEMENT MEASURES

FIGURE 6

File Name: W:\Projects\1)Open\Cuttone Property Group\59572 BMP Kilburn Rd Parkerville LSP (57677)\GIS\Maps\R01 Rev 1\57677_06_A3_PostDevBALs.mxd
Image Reference: www.nearmap.com© - Imagery Date: 25. August 2021

4. Identification of bushfire hazard issues

4.1 Bushfire context

Landscape scale bushfire risk within or adjacent to the project area is limited due to the significant level of clearing and fragmentation of bushland that has contributed to the establishment of broad rural/pasture areas for livestock grazing, educational institutions and residential/rural-residential living. However, Strategen-JBS&G considers a fire front approaching the project area from the north/northeast, east or west, to be the worst case bushfire scenarios due to the presence of potential bushfire runs in these directions within remnant forest, woodland and grassland contained on surrounding rural and rural-residential land. Post-development conditions will result in a general reduction in the on-site bushfire hazards in consideration of the proposed residential land use; however, Clutterbuck Creek foreshore vegetation may present a vector for fire spread into the site, which will need to be a key consideration for any proposed bushfire management.

Strategen-JBS&G considers the bushfire risks to proposed development can be managed through standard application of acceptable solutions under the Guidelines, including provision for and implementation of APZs, relevant bushfire construction standards under AS 3959, provision of adequate emergency water supply and vehicular access, as well as through a direct bushfire suppression response if required. The bushfire hazard level assessment in Figure 5 and indicative BAL contour assessment in Figure 6 demonstrate that all future development can be located to avoid areas of extreme BHL and achieve a rating of BAL-29 or lower. This reiterates the findings of the rezoning stage BMP.

4.2 Bushfire hazard issues

Based on the above, Strategen-JBS&G considers the bushfire hazards within and adjacent to project area and the associated bushfire risks are readily manageable through standard management responses outlined in the Guidelines and AS 3959. These responses are being factored into proposed development at all stages of the planning process to ensure a suitable, compliant and effective bushfire management outcome is achieved for protection of future life, property and environmental assets. The following sub-sections include a discussion on the management measures that will need to be considered through preparation of a BMP at the subdivision stage.

4.2.1 Asset Protection Zones (APZs)

The indicative BAL contours identified in Figure 6 demonstrate that all proposed rural smallholding and residential lots have capacity for habitable development to be located within areas of BAL-29 or lower. This will be achieved via provision of APZs at all interfaces where proposed dwellings abut post development classified vegetation to achieve minimum separation distances outlined in Table 5 and Table 6.

APZs will comprise of one or a combination of:

- managed areas of POS and/or foreshore reserve
- road reserves (existing and proposed)
- APZ building setbacks for proposed residential lots identified in Figure 6, enforced via:
    - standard R-code setback provisions at building stage
    - restrictive covenants on title at subdivision stage.

Building envelopes for the rural smallholding lots will be nominated at subdivision stage, along with the determination of APZs sufficient to achieve BAL-29. APZs will be further nominated and enforced at DA stage through the preparation of lot specific BMPs based on final building location.

APZs are to be implemented and maintained in accordance with Schedule 1 of the Guidelines (refer to Appendix C).

4.2.2 Public Open Space

POS will need to be maintained on a regular and ongoing basis through slashing, weed control and manual fuel removal to ensure the understorey and surface fuels are kept in a low threat, minimal fuel condition in accordance with Clause 2.2.3.2 (f) of AS 3959. Individual trees throughout on-site POS areas can be retained for visual/aesthetic/screening purposes. POS management will be the responsibility of the developer until such time that these management responsibilities are transferred to the Shire.

4.2.3 Road verge vegetation

4.2.3.1 Internal road verges

Proposed internal road verges will be established in a low-threat/non-vegetated state and maintained in accordance with Clauses 2.2.3.2 (e) and (f) by the Shire.

4.2.3.2 Surrounding road verges

In terms of external road verges, the northern side of Kilburn Road and the western side of Brindle Road will be subject to vegetation modification as part of subdivision works which will result in removal and modification of vegetation for construction of driveways and public road connections. These works will result in fragmentation and thinning of the existing verge fuels and limit post-development vegetation to a series of distinct street-scaped nature-strips extending between the public roads and driveways. The post-development vegetation is expected to comprise one-two rows of trees on Kilburn Road and a fully landscaped verge on Brindle Road. Clearing of on-site vegetation (especially within lots fronting Kilburn Road), will further act to fragment the nature-strips from any adjoining vegetation hazards.

The developers will attend to a general tidy up and landscaping of the remaining verge vegetation as part of construction works, including the removal of understorey scrub vegetation and unhealthy trees and the lifting of low hanging branches to at least 2 m from the ground. Thereafter the Shire (in conjunction with the immediate landowners) will carry out general maintenance and tidying of the nature-strips as part of Shire's routine maintenance schedule for the area which is considered to be minimal once the initial landscaping treatments have been applied.

Nature strips are considered low threat vegetation under Clause 2.2.3.2 (f) due to the limited potential to increase the severity of bushfire attack. Similarly, windbreaks (a single row of trees used as a screen) are excludable under Clauses 2.2.3.2 (f) and this exclusion would also be applicable to the remaining row of trees within the nature strips on the western end of Kilburn Road.

Exclusion under Clause (f) is considered to be an appropriate outcome for the streetscaped verges given the fragmentated nature and narrow width of the remaining vegetation; the minimal ongoing management required following the initial landscaping treatments; and the limited fire behaviour potential within this vegetation due to the abovementioned factors. The extent of roadside vegetation excluded as a nature strip is depicted on Figure 4.

The BMP prepared to support the subdivision application for future development is to make provisions regarding how the developers will specifically establish the low threat/excluded road verges. These specifications are to be set out in the responsibilities table and will include the following measures to be carried out by the developer prior to subdivision approval:

- removal of weeds and dead plant debris such as branches, logs and leaves (where applicable),
- removal of ground and ladder fuels, including shrubs/scrub and any trees not identified for retention,

- retention of significant trees and under pruning of branches to at least 2 m from the ground, and
- treatment of the verge comprising fuel reducing features such as mulch, landscape boulders and strategic planting of low flammability ground covers.

Compliance with these initial landscaping treatments will be determined through preparation of a BMP condition clearance report which demonstrates that the management commitments of the BMP have been implemented satisfactorily.

The subdivision stage BMP will also outline ongoing responsibilities of individual landowners to maintain the road verge abutting their lot in a low threat state in perpetuity.

4.2.4 On-site fuel management

Further to the APZ requirements outlined in Section 4.2.1, current grassland areas within the northern and southern development zones will need to be converted to a low threat state and maintained by the developer until such time that the land is transferred or sold. In addition, following subdivision approval, the developer will be responsible for the management of any vacant lots through regular slashing and weed control to ensure the understorey and surface fuels are kept in a low threat, minimal fuel condition in accordance with Clause 2.2.3.2 (f) until such time that the lots are sold, after which the fuel management responsibility will be transferred to the respective landowners.

This is consistent with the Shire of Mundaring annual firebreak notice (Appendix F), which requires all grass located outside of APZs to be maintained at a height no greater than 5 cm on all lots less than 5 ha in size.

4.2.5 On-site staging buffers

The indicative BAL contours depicted in Figure 6 are based on all proposed vegetation clearing being completed within the project area.

If development (and therefore clearing) is to occur on a staged basis, clearing in advance will need to occur to ensure building construction is not inhibited by a temporary vegetation extent located within adjacent development stages yet to be cleared. This can be achieved by ensuring that each approved stage subject to construction is surrounded by a 100 m wide, on-site cleared or low threat buffer prior to development (not including vegetation proposed to be retained). Once the buffers are created, they will need to be maintained on a regular and ongoing basis at a fuel load less than 2 t/ha to achieve a low threat minimal fuel condition all year round until such time that the buffer area is developed as part of the next development stage.

4.2.6 Increased building construction standards

Strategen-JBS&G has undertaken an indicative BAL contour assessment across the project area and determined that some lots have potential to require implementation of building construction standards under AS 3959, due to being located within a bushfire prone area within BAL-12.5 or higher (see Figure 6). The BAL contours are based on proposed structure plan design and implementation of the bushfire management measures documented in this BMP, which will need to be revalidated at the subdivision application stage.

The indicative BAL contour assessment indicates that all proposed lots have the capacity to achieve minimum separation distances that deliver a rating of BAL–29 or lower.

4.2.7 Public and internal access

4.2.7.1 Residential development

The proposed internal road network will provide four linkages with Kilburn Road in the south and one linkage to Brindle Road in the east. This will ensure that at least two different vehicular access routes which connect to the surrounding public road network are provided to allow safe access and egress to at least two different destinations.

One cul-de-sac of 80 m length is proposed in the southwest of the project area to provide public road access to one of the lots abutting Roland Road, thereby avoiding creation of a battle-axe lot. Cul-de-sacs have been avoided where possible for the remaining development design. The proposed cul-de-sac will comply with the Guidelines vehicular access requirements (refer to Appendix D) in that it will be less than 200 m in length and will have minimum 17.5 m diameter cul-de-sac head. An emergency access way will be provided to connect the cul-de-sac head with Roland Road, to enable alternative egress to Roland Road in the event that the dead-end road is not trafficable during a bushfire emergency.

A network fire service access routes (FSAR) has been requested by DFES within the perimeter of the foreshore reserve to enable a fire suppression response to be carried out directly at the bushland interface. An east-west FSAR is therefore proposed along the southern boundary of the foreshore reserve in combination with pedestrian paths which will also act to provide access for Shire maintenance purposes. An indicative alignment is depicted in Figure 6. The final alignment will be identified in the future Foreshore Management Plan.

The proposed public road, cul-de-sac, fire service access route and emergency access ways are to comply with technical requirements of the Guidelines (refer to Appendix D). Any temporary cul-de-sacs or emergency access ways required to address access compliance during staging will also need to comply.

4.2.7.2 Rural smallholding lots

The northwest rural small holding lot will be accessed directly from Roland Road, which will provide to required two access routes (north and south).

The northeast rural small holding lot will be serviced by Brindle Road, which is an existing non-compliant dead-end road (i.e. >200 m length). Construction of the proposed east-west aligned road to the south of Clutterbuck Creek will reduce the length of the dead-end portion of road to approximately 130 m by creating four alternative access options to Kilburn Road (five including the EAW to Roland Road). In this regard, the northeast lot will be serviced by a compliant public access arrangement.

The FSAR network is proposed to be extended around the northern portion of foreshore reserve vegetation to enable firefighters to achieve access at the perimeter of the rural smallholding lots. The alignment of the FSAR is subject to detailed design through development of a Foreshore Management Plan, as discussed above.

4.2.8 Reticulated water supply

All lots within the project area will be provided a reticulated water supply through extension of existing services from surrounding residential areas to the south. The reticulated system will ensure a year round supply of water for each lot to meet minimum domestic and emergency water supply requirements to comply with Guidelines Acceptable Solution A4.1 (refer to Appendix E).

A network of hydrants will also be provided along the internal road network at locations which meet relevant water supply authority and DFES requirements, in particular the Water Corporation Design Standard DS 63 'Water Reticulation Standard Design and Construction Requirements for Water Reticulation Systems up to DN250'. This standard will guide construction of the internal reticulated

water supply system and fire hydrant network, including spacing and positioning of fire hydrants so that the maximum distance between a hydrant and the rear of a building envelope (or in the absence of a building envelope, the rear of the lot) shall be 120 m and the hydrants shall be no more than 200 m apart.

4.2.9 Notification on title

Notification will be required to be placed on the Title of all proposed lots located within a designated bushfire prone area as a condition of subdivision to ensure all landowners/proponents and prospective purchasers are aware that a BMP has been prepared over the site and that increased building construction standards may apply to future buildings in accordance with the approved BMP or future BAL assessment at the building permit stage.

4.2.10 Restrictive covenant on lots with areas of BAL-40 and/or BAL-FZ

Development of habitable buildings within residential lots impacted by areas of BAL-40 and/or BAL-FZ will be restricted via application of the following subdivision condition:

A restrictive covenant to the benefit of the local government, pursuant to section 129BA of the Transfer of Land Act 1893, is to be placed on the certificate(s) of title of the proposed lot(s) advising of the existence of a restriction on the use of the land within areas that have been assessed as BAL-40 or BAL-Flame Zone. Notice of this restriction is to be included on the diagram or plan of survey (deposited plan). The restrictive covenant is to state as follows: 'No habitable buildings are to be built within areas identified as BAL-40 or BAL-Flame Zone.'

4.2.11 Compliance with annual firebreak notice

All parties will be required to comply with relevant provisions of the current Shire of Mundaring annual firebreak notice as amended (refer to Appendix F). The firebreak notice requires installation of 3 m wide (4 m vertical clearance) firebreaks around all structures and immediately inside all external boundaries for lots 5,000 m² or greater.

These firebreak requirements may be applicable during staging of development in regard to balance land.

5. Assessment against the bushfire protection criteria

5.1 Compliance table

An acceptable solutions assessment against the bushfire protection criteria is provided in Table 7.

Table 7: Compliance with the bushfire protection criteria of the Guidelines

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance can be met at future planning stages
Element 1: Location	A1.1 Development location	The post-development BAL contour assessment (Figure 6) indicates that all future habitable buildings have the ability to achieve BAL-29 or lower with appropriately sized APZs and building setbacks at the subdivision and building stages.	✓
Element 2: Siting and design	A2.1 Asset Protection Zone	Minimum separation distances for a BAL–29 rating or lower can be achieved for all proposed development areas through the application of APZs/setbacks. This equates to a minimum separation distance of: • 21 m adjacent to Class A Forest on flat/upsloping land • 14 m adjacent to Class B Woodland on flat/upsloping land • 8 m adjacent to Class G Grassland on flat/upsloping land. The required separation distances will be achieved in the form of APZs comprising existing/proposed road reserves, managed POS or foreshore reserve and/or building setbacks, which will achieve a BAL–29 rating or lower. Final separation distances between classified vegetation and proposed buildings will need to be confirmed at future planning/building stages. APZs are to be implemented and maintained in accordance with Schedule 1 of the Guidelines (Appendix C) and the Shire's Firebreak and Fuel Hazard Reduction Notice as amended (see Appendix F).	✓
Element 3: Vehicular access	A3.1 Two access routes	On completion of development, the existing public road network and proposed internal public roads will provide all occupants with the option of travelling to more than two different destinations (refer to Figure 6 and Section 4.2).	✓
	A3.2 Public road	All proposed public roads are to be constructed to relevant technical requirements under the Guidelines (see Appendix D). Brindle Road being constructed and sealed by the applicant to the extent necessary to provide access to Urban zone land.	✓
	A3.3 Cul-de-sac (including a dead-end-road)	• Brindle Road is an existing non-compliant (i.e. >200 m) dead-end road which services the eastern interfacing lots and northeast rural smallholding lot. The proposed development will result in additional access options from Brindle Road to Kilburn Road due to the construction of the internal road network and connection adjacent to the foreshore reserve. This will ensure that all proposed lots serviced by Brindle Road will be located within 200 m of a road providing two access options (i.e. no more than 200m along a dead-end road) which achieves compliance with A3.3. • Section 3.1.1 outlines that a single cul-de-sac is required to provide public road access to one of the lots abutting Roland Road. The proposed cul-de-sac is compliant with requirements of the Guidelines is not considered to add unacceptable bushfire risk to the proposal. In addition, an EAW will be provided from the cul-de-sac heard as an alternative means of egress to Roland Road.	✓

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance can be met at future planning stages
		• The proposed cul-de-sacs and any temporary cul-de-sacs required as part of internal staging will be less than 200 m in length, will include minimum 17.5 m diameter turn-around heads and are to be constructed to the relevant technical requirements of the Guidelines (see Appendix D).	
	A3.4 Battle-axe	No battle-axe lots are proposed.	**N/A**
	A3.5 Private driveway longer than 50 m	The proposed residential lots are of size where all future habitable development will be located within 50 m of a public road; in this regard the southern portion of the proposed development will not be required to comply with A3.5. Future habitable development within the rural smallholding lots may require driveways longer than 50 m and will need to address the requirements of A3.5 at DA stage (see Appendix D).	✓
	A3.6 Emergency access way	A compliant EAW is proposed to connect the compliant cul-de-sac head with Roland Road. The proposed EAW and any temporary EAWs required as a result of staged subdivision are to be constructed to the relevant technical requirements of the Guidelines as detailed in (see Appendix D).	✓
	A3.7 Fire service access routes (perimeter roads)	Fire service access routes will be provided around the perimeter of the foreshore reserve at the request of DFES to enable firefighter access to the on-site vegetation hazards. An indicative alignment for the FSARs is depicted in Figure 6 and will be finalised during detailed design and preparation of a Foreshore Management Plan. The FSARs are to meet the relevant technical requirements of the Guidelines, as detailed in (see Appendix D).	✓
	A3.8 Firebreak width	The Shire of Mundaring annual firebreak notice (Appendix F) requires installation of 3 m wide (4 m vertical clearance) mineral earth firebreaks immediately inside all external boundaries for lots 5,000 m² or greater. Each stage of development is required to comply with the requirements of the annual Shire Firebreak Notice as amended (refer to Appendix F).	✓
Element 4: Water	A4.1 Reticulated areas	The proposed development will be connected to a reticulated water supply via extension from surrounding development in accordance with Water Corporations Design Standard 63 requirements (refer to Appendix E). Existing water hydrants are located at 200 m intervals in the surrounding residential development.	✓
	A4.2 Non-reticulated areas	The proposed subdivision will be provided with a reticulated water supply.	**N/A**
	A4.3 Individual lots within non-reticulated areas (Only for use if creating 1 additional lot and cannot be applied cumulatively)	The proposed subdivision will be provided with a reticulated water supply.	**N/A**

6. Responsibilities for implementation and management of the bushfire measures

This BMP has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs to accompany future subdivision and development applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs prepared for subsequent subdivision and development applications are to meet the relevant commitments outlined in this strategic level BMP, address the relevant requirements of SPP 3.7 (i.e. Policy Measures 6.4 and 6.5 respectively) and demonstrate in detail how the proposed development will incorporate the relevant acceptable solutions or meet the performance requirements of the Guidelines. Future BMPs are to include the following detailed information:

- confirmed lot layout, including any public open space (POS) and drainage areas
- detailed landscaping design/plans in regard to POS, foreshore reserve and drainage areas, consistent with the provisions of this BMP (i.e. to achieve exclusion under Clause 2.2.3.2 (f))
- tree retention plan for the Kilburn Road to identify which trees will be retained as part of low threat landscaping
- confirmed post-development classified vegetation extent and effective slope
- updated BAL contour map demonstrating that proposed development areas will achieve BAL–29 or lower (including designation of APZs/building envelopes)
- width and alignment of compliant APZs/setbacks
- confirmation of how bushfire management will be addressed during development staging (i.e. staging of vehicular access, low threat staging buffers)
- proposed approach to fuel management or alternatively, application of AS 3959 in response to retained on-site classified vegetation
- vehicular access provisions, including demonstration that a minimum of two access routes will be achieved for each stage of development in accordance with Acceptable Solution A3.1 and provision of emergency access ways and fire service access routes
- water supply provisions with regards to reticulated water
- provisions for notification on Title for any future lots with a rating of BAL–12.5 or greater as a condition of subdivision
- compliance requirements with the Shire's annual firebreak notice as amended
- construction of Class 1, 2, 3 or associated 10a buildings in accordance with AS 3959 to the assessed BAL rating
- requirements for BMP/BAL compliance reports as conditions of subdivision to ensure the subdivision stage BMP is implemented satisfactorily prior to clearance
- compliance with performance principles of the bushfire protection criteria
- proposed implementation and audit program outlining all measures requiring implementation and the appropriate timing and responsibilities for implementation.

On the basis of the information contained in this BMP, Strategen-JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks are readily

manageable through standard management responses outlined in the Guidelines and AS 3959. Strategen-JBS&G considers that on implementation of the proposed management measures, the project area will be able to be developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines and AS 3959.

7. References

Department of Fire and Emergency Services (DFES) 2021, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: https://maps.slip.wa.gov.au/landgate/bushfireprone/, [22/03/2022].

Department of Planning (DoP) 2016, *Visual guide for bushfire risk assessment in Western Australia*, Department of Planning, Perth.

Roberts Day 2020, *Indicative Tree Retention Plan, Lot 61 &1001 Kilburn Road Parkerville*, Roberts Day, Perth.

Hatch RobertsDay 2021, *Concept Plan (Rev S), Lot 61 &1001 Kilburn Road Parkerville*, Hatch RobertsDay, Perth.

Standards Australia (SA) 2018, Australian Standard *AS 3959–2018 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.

Strategen Environmental (Strategen) 2017*, Bushfire Management Plan: Lot 61 Roland Road and Lot 1001 Kilburn Road, Parkerville*, Strategen, Bunbury.

Western Australian Planning Commission (WAPC) 2015, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2017, *Guidelines for Planning in Bushfire Prone Areas*, Version 1.3 August 2017, Western Australian Planning Commission, Perth.

8. Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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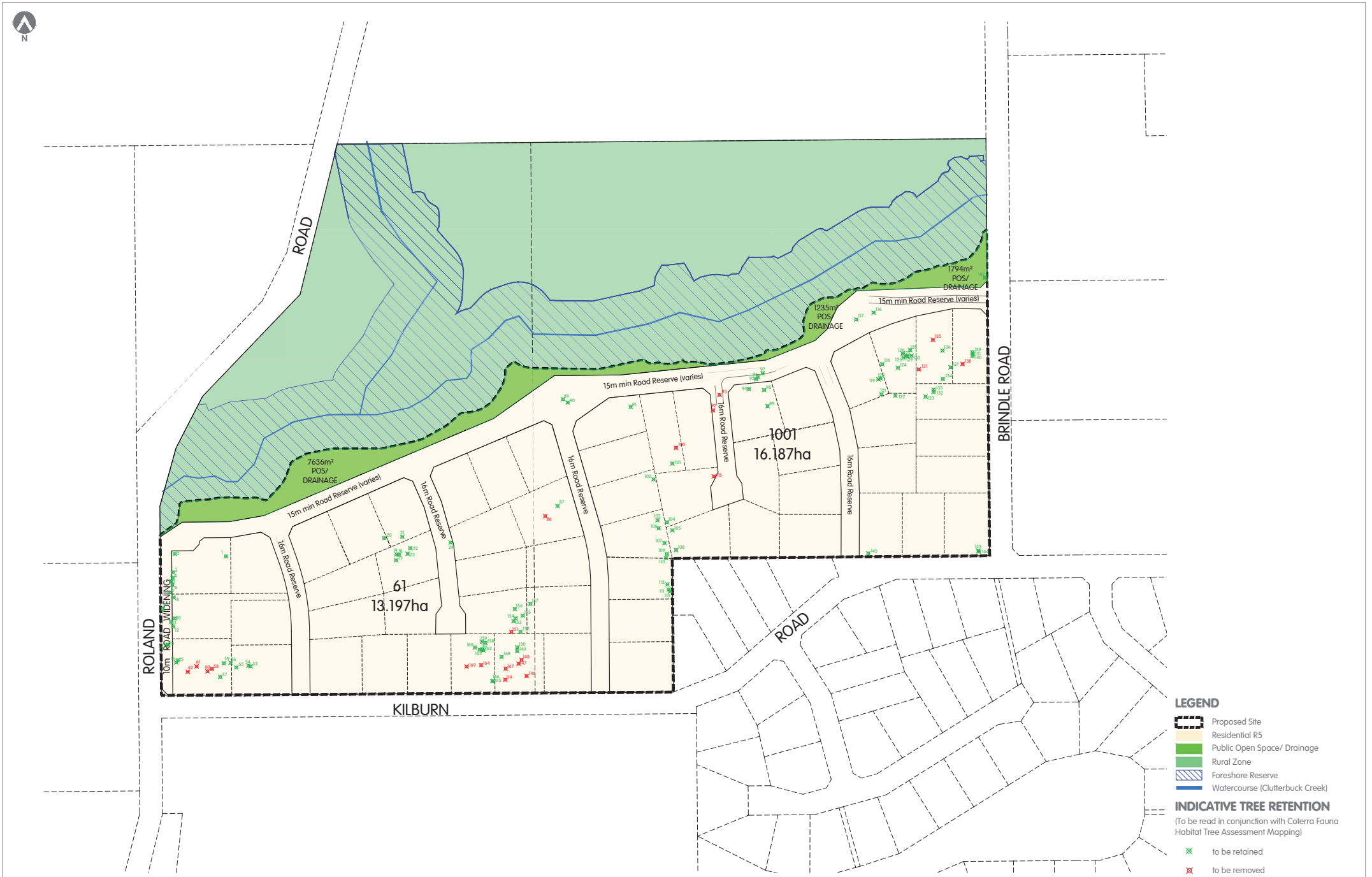
Appendix A Tree Retention Plan (Roberts Day 2020)



robertsday.com.au *planning·design·place*

1:1500 SIZE A1

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 160904

CADASTRAL INFORMATION
SOURCE: SLIP SERVICE - LANDGATE
YYMMDD:
DWG REF:
PROJECTION: MGA 50

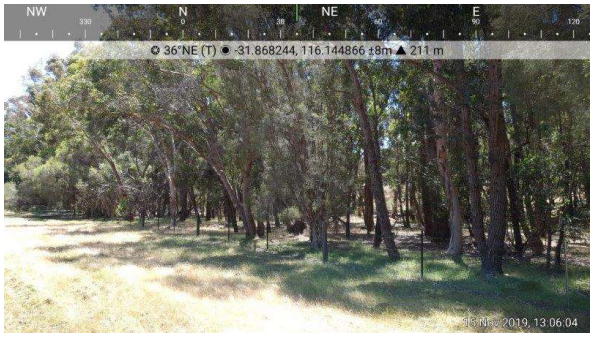
INDICATIVE CONCEPT PLAN
Lot 61 & 1001 Kilburn Road, Parkerville
Shire of Mundaring

REF NO. **PCH PAR** DRAW NO. **RD1 002** REV. **O**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

Appendix B Vegetation plot photos and description

Photo ID: 1a



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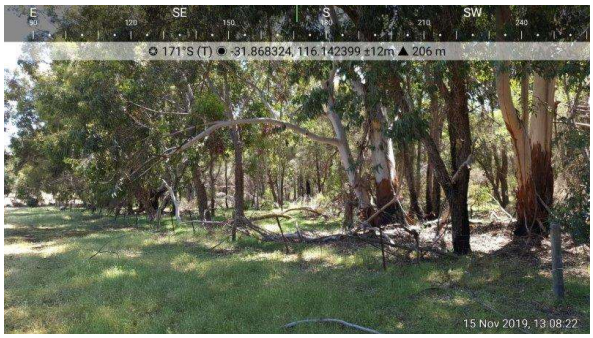


Photo ID: 1c

Photo ID: 1d

Photo ID: 1e

Photo ID: 1f

Photo ID: 1g

Photo ID: 1h

Plot 1 continued over page

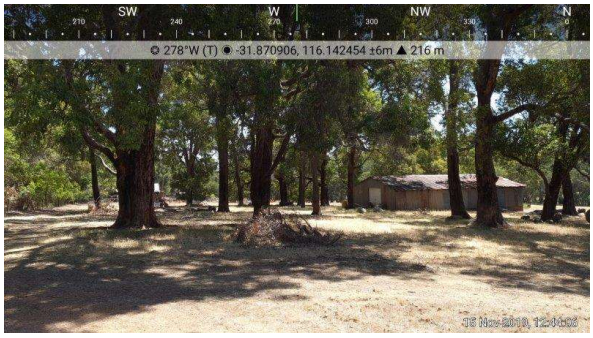
Photo ID: 1i

Photo ID: 1j

Photo ID: 1k

Photo ID: 1l

Plot number		Plot 1
Vegetation classification	**Pre-development**	Class A Forest
	Post-development	Class A Forest
Description / justification		Dominated by eucalypts with a prominent overstorey, mid-storey and understorey fuel structure.



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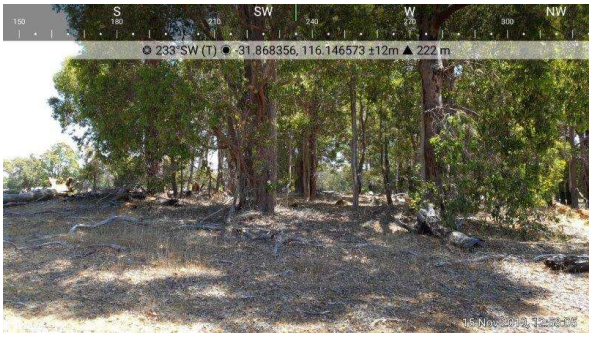


Photo ID: 2b

Photo ID: 2c

Photo ID: 2d

Photo ID: 2e

Plot number		Plot 2
Vegetation classification	**Pre-development**	Class B Woodland
	Post-development	Class B Woodland
Description / justification		Dominated by eucalypts with no mid-storey vegetation and predominantly grassy understorey.

Photo ID: 3a

Photo ID: 3b

Photo ID: 3c

Photo ID: 3d

Photo ID: 3e

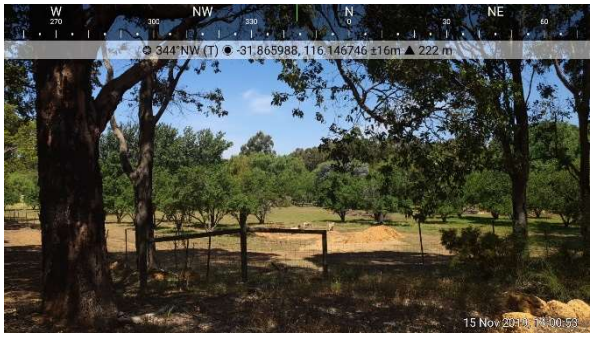


Photo ID: 3f

Photo ID: 3g

Plot number		Plot 3
Vegetation classification	**Pre-development**	Class G Grassland
	Post-development	Class G Grassland
Description / justification		Grassland dominating the pastural land on-site and throughout adjacent land.

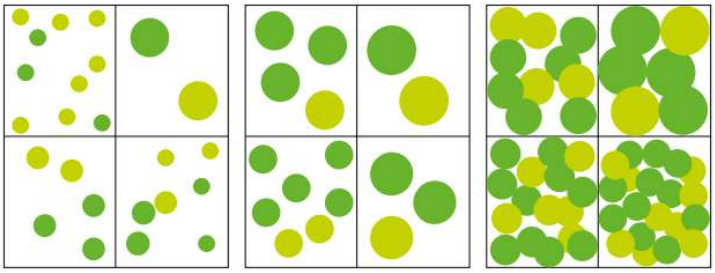
Photo ID: 4

Plot number		Plot 4
Vegetation classification	**Pre-development**	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])
	Post-development	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])
Description / justification		Existing low threat vegetation (street trees, managed road verges, residential gardens) and non-vegetated areas (i.e. roads, paths, buildings, driveways, water bodies).

Appendix C APZ standards (Schedule 1 of the Guidelines)

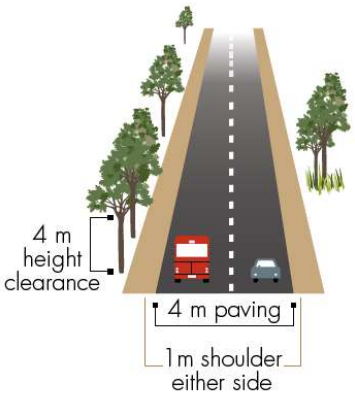
Schedule 1: Standards for Asset Protection Zones

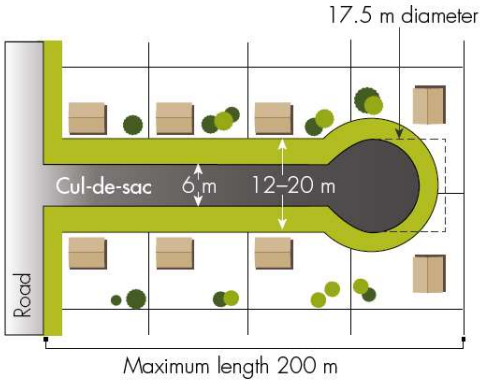
- **Fences:** within the APZ are constructed from non-combustible materials (e.g. iron, brick, limestone, metal post and wire). It is recommended that solid or slatted non-combustible perimeter fences are used.
- **Objects:** within 10 metres of a building, combustible objects must not be located close to the vulnerable parts of the building i.e. windows and doors.
- **Fine Fuel load:** combustible dead vegetation matter less than 6 millimetres in thickness reduced to and maintained at an average of two tonnes per hectare.
- **Trees (> 5 metres in height):** trunks at maturity should be a minimum distance of 6 metres from all elevations of the building, branches at maturity should not touch or overhang the building, lower branches should be removed to a height of 2 metres above the ground and or surface vegetation, canopy cover should be less than 15% with tree canopies at maturity well spread to at least 5 metres apart as to not form a continuous canopy.

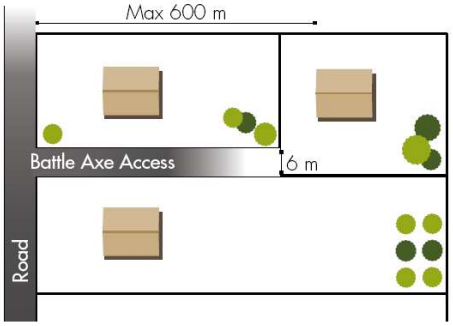


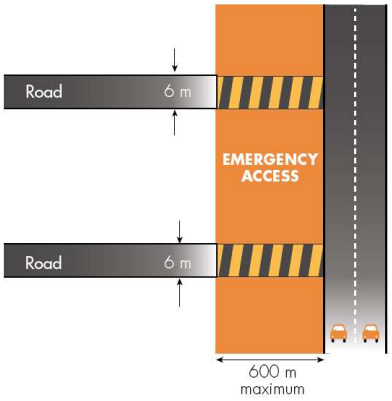
- **Shrubs (0.5 metres to 5 metres in height):** should not be located under trees or within 3 metres of buildings, should not be planted in clumps greater than 5m2 in area, clumps of shrubs should be separated from each other and any exposed window or door by at least 10 metres. Shrubs greater than 5 metres in height are to be treated as trees.
- **Ground covers (<0.5 metres in height):** can be planted under trees but must be properly maintained to remove dead plant material and any parts within 2 metres of a structure, but 3 metres from windows or doors if greater than 100 millimetres in height. Ground covers greater than 0.5 metres in height are to be treated as shrubs.
- **Grass:** should be managed to maintain a height of 100 millimetres or less.

Appendix D Vehicular access technical standards of the Guidelines

Public roads	
Acceptable solution A3.2	A public road is to meet the requirements in Table 1, Column 1.
Explanatory note E3.2	Trafficable surface: Widths quoted for access routes refer to the width of the trafficable surface. A six metre trafficable surface does not necessarily mean paving width. It could, for example, include four metre wide paving one metre wide constructed road shoulders. In special circumstances, where eight lots or less are being serviced, a public road with a minimum trafficable surface of four metres for a maximum distance of 90 metres may be provided subject to the approval of both the local government and Department of Fire and Emergency Services. Public road design: All roads should allow for two-way traffic to allow conventional two-wheel drive vehicles and fire appliances to travel safely on them. 

Cul-de-sac (including a dead-end road)	
Acceptable solution A3.3	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: • Requirements in Table 1, Column 2 • 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) • Turn-around area requirements, including a minimum 17.5 metre diameter head.
Explanatory note E3.3	In bushfire prone areas, a cul-de-sac subdivision layout is not favoured because they do not provide access in different directions for residents. In some instances it may be possible to provide an emergency access way between cul-de-sac heads to a maximum distance of 600 metres, so as to achieve two-way access. Such links must be provided as right of ways or public access easements in gross to ensure accessibility to the public and fire services during an emergency. A cul-de-sac in a bushfire prone area is to connect to a public road that allows for travel in two directions in order to address Acceptable Solution A3.1. 

Battle-axe	
Acceptable solution A3.4	Battle-axe access leg 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: • Requirements in Table 1, Column 3 • Maximum length: 600 metres • Minimum width: six metres.
Explanatory note E3.4	In bushfire prone areas, lots with battle-axe access legs should be avoided because they often do not provide two-way access and egress for residents and may be easily blocked by falling trees or debris. In some instances, however; it may be appropriate for battle-axe access to be used to overcome specific site constraints. Where used, they should comply with the minimum standards for private driveways. Passing bays should be provided at 200 metre intervals along battle-axe access legs to allow two-way traffic. The passing bays should be a minimum length of 20 metres, with the combined width of the passing bay and the access being a minimum of six metres. Turn-around areas should allow type 3.4 fire appliances to turn around safely (i.e. kerb to kerb 17.5 metres) and should be available at house sites and at 500 metre intervals along the access leg. 

Emergency access way	
Acceptable solution A3.6	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: • Requirements in Table 1, Column 4 • No further than 600 metres from a public road • Provided as right of way or public access easement in gross to ensure accessibility to the public and fire services during an emergency • Must be signposted.
Explanatory note E3.6	An emergency access way is not a preferred option however may be used to link up with roads to allow alternative access and egress during emergencies where traffic flow designs do not allow for two-way access. Such access should be provided as a right-of-way or easement in gross to ensure accessibility to the public and fire emergency services during an emergency. The access should comply with minimum standards for a public road and should be signposted. Where gates are used to control traffic flow during non-emergency periods, these must not be locked. Emergency access ways are to be no longer than 600 metres and must be adequately signposted where they adjoin public roads. Where an emergency access way is constructed on private land, a right of way or easement in gross is to be established. 

Technical requirement	1	2	3	4	5
	Public road	Cul-de-sac	Private driveway longer than 50 m	Emergency access way	Fire service access routes
Minimum trafficable surface (m)	6*	6	4	6*	6*
Horizontal distance (m)	6	6	6	6	6
Vertical clearance (m)	4.5	N/A	4.5	4.5	4.5
Maximum grade <50 m	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	8.5	8.5	8.5	8.5	8.5
* Refer to E3.2 Public roads: Trafficable surface					

Appendix E Water technical standards of the Guidelines

Reticulated areas	
Acceptable solution A4.1	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.
Explanatory note E4.1	Water supply authorities in Western Australia include the Water Corporation, Aqwest and the Busselton Water Board. The Water Corporation's 'No. 63 Water Reticulation Standard' is deemed to be the baseline criterion for developments and should be applied unless local water supply authorities' conditions apply.

Appendix F Shire of Mundaring Firebreak Notice

FIREBREAK AND FUEL LOAD NOTICE

Bush Fires Act 1954

Section 33

Notice to all owners and/or occupiers of land situated within Shire of Mundaring

As a measure to assist in the control of bush fires, or preventing the spread or extension of a bush fire which may occur, notice is hereby given to all owners and/or occupiers of land within the Shire of Mundaring that pursuant to the powers conferred in Section 33 of the *Bush Fires Act 1954*, works in accordance with the requisitions of this notice must be carried out before the 1st day of November in each year, or within 14 days of becoming the owner or occupier of land if after that date. All work specified in this Notice is to be maintained up to and including the 31st day of March in the following calendar year.

DEFINITIONS

For the purpose of this Notice the following definitions apply:

Alternative Fire Management Arrangement includes a variation as defined in Section 6 of this Notice and, a Bushfire Management Plan, Bushfire Management Statement, or Fuel Load Management Plan, approved by the Shire of Mundaring to reduce and mitigate fire hazards within a particular subdivision, lot or other area of land anywhere in the district.

Authorised Officer means an employee of the Shire of Mundaring appointed as a Bush Fire Control Officer pursuant to the powers conferred in Section 38 of the *Bush Fires Act 1954*.

Firebreak means a strip or area of ground, not less than 3 metres in width, and 4 metres in height, immediately inside all external boundaries of any lot owned and/or occupied by you and situated within Shire of Mundaring, constructed to a trafficable surface that is kept and maintained totally clear of all flammable material and includes the pruning and removal of any living or dead trees, scrub or any other material encroaching into the vertical axis of the firebreak area. Such firebreaks may be constructed by one or more of the following methods: PLOUGHING, CULTIVATING, SCARIFYING, RAKING, BURNING, CHEMICAL SPRAYING OR OTHER METHOD as approved by an Authorised Officer.

Flammable Material means any plant, tree, grass, substance, object, thing or material that may or is likely to catch fire and burn or any other thing deemed by an Authorised Officer to be capable of combustion.

Fuel Depot / Fuel Storage Area means an area of land, a building or structure where fuel, (ie petrol, diesel, kerosene, liquid gas or any other fossil fuel) is kept in any container or manner.

Fuel Load is the leaf litter on the ground inclusive of leaves, twigs (up to 6mm in diameter) and bark. A litter depth of 5mm from the top of the layer to the mineral earth beneath is indicative of approximately 2.5 tonnes per hectare. A litter depth of 15mm from the top of the layer to the mineral earth beneath is indicative of approximately 8 tonnes per hectare. The Shire of Mundaring can provide advice on determining fuel load levels and provides a fuel load measurement guide for your use on request.

Habitable Buildings means a dwelling, workplace, place of gathering or assembly, a building used for the storage or display of goods or produce for sale by wholesale in accordance with classes 1-9 of the Building Code of Australia. The term habitable building includes attached and adjacent structures like garages, carports, verandas or similar roofed structure(s) that are attached to, or within 6 metres of the dwelling or primary building.

Maintaining Fuel Loads relates to the management of leaf litter as described in this Notice. Reducing fuel load levels does not necessarily require the removal of existing natural vegetation. A combination of methods can be utilised inclusive of safe burning, raking, weed removal, pruning and/or the removal of dead plant material.

Managed Vegetation includes vegetation that is pruned away from buildings, under pruned to minimise contact with ground fuels and that is kept free of dead suspended matter such as twigs, leaves and bark.

Trafficable means to be able to travel from one point to another in a four-wheel drive fire appliance on a clear surface, unhindered without any obstruction that may endanger such fire appliances. A firebreak is not to terminate, or lead to a dead end, without provision for egress to a safe place or a cleared turn around area of not less than a 19 metre diameter.

Vertical Axis means a continuous vertical uninterrupted line at a right angle to the horizontal line of the firebreak to a minimum height of 4 metres from the ground.

LAND CATEGORIES

The specific requirements below relating to land categories within the Shire are to be implemented and maintained to the satisfaction of an Authorised Officer.

1. All land with an area of less than 5000sqm with a building on it

Maintain an Asset Protection Zone in line with the requirements of Section 5 of this Notice.
For the remainder of the land on the lot outside of the Asset Protection Zone:

- Maintain all grass on the land to a height no greater than 5cm.
- Ensure no tree crowns overhang a building.
- Prune trees and shrubs, and remove dead flammable material within 1.5 metres around all buildings.
- Ensure the roofs, gutters and walls of all buildings on the land are free of flammable matter.
- Maintain fuel loadings in natural bush areas at less than 8 tonnes per hectare across the land.

2. All land with an area of 5000sqm or greater, with a building on it

Maintain an Asset Protection Zone in line with the requirements of Section 5 of this Notice.

For the remainder of the land on the lot outside of the Asset Protection Zone:

- If the land is an area of less than 50,000sqm (5 Hectares) all grass must be maintained on the land to a height no greater than 5cm.
- If the land is an area of 50,000sqm (5 Hectares) or greater, the grass must be maintained on the land to a height no greater than 5cm for a distance of 10m from any firebreak.
- Install a firebreak around all structures and immediately inside all external boundaries of the land.

- Prune trees and shrubs, and remove dead flammable material around all structures.
- Ensure the roofs, gutters and walls of all buildings on the land are free of flammable matter.
- Maintain fuel loadings in natural bush areas at less than 8 tonnes per hectare across the land.

3. All vacant land

- Install a firebreak immediately inside all external boundaries of the land.
- If the land is an area of less than 50,000sqm (5 Hectares) all grass must be maintained on the land to a height no greater than 5cm.
- If the land is an area of 50,000sqm (5 Hectares) or greater, the grass must be maintained on the land to a height no greater than 5cm for a distance of 10m from any firebreak.
- Maintain fuel loadings in natural bush areas to less than 8 tonnes per hectare across the land.

4. Fuel Depot / Fuel Storage Area / Haystacks / Stockpiled Flammable Material

- Remove all inflammable matter within 10 metres of where fuel drums, fuel ramps or fuel dumps are located, and where fuel drums, whether containing fuel or not, are stored.
- Install a firebreak immediately adjacent to any haystacks or stockpiled flammable material.

5. Asset (Building) Protection Zone Specification

The Asset Protection Zone (APZ) for habitable buildings and related structures, as defined within this Notice, must meet the following requirements, unless varied under an approved 'Alternative Fire Management Arrangement' as defined within this Notice, and applies only within the boundaries of the lot on which the habitable building is situated:

- APZs for habitable buildings must extend a minimum of 20 metres out from any external walls of the building, attached structures, or adjacent structures within 6 metres of the habitable building.
- On sloping ground the APZ distance shall increase at least 1 metre for every degree in slope on the sides of the habitable building that are exposed to down slope natural vegetation.
- APZs predominantly consist of managed vegetation, reticulated lawns and gardens and other non-flammable features.
- All grass is maintained to or under 5cm.
- Fuel loads must be maintained at 2 tonnes per hectare or lower.
- Clear separation distance between adjoining or nearby tree crowns.
- 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.
- Trees are to be low pruned (or under pruned) to at least a height of 2 metres from ground.
- No tree, or shrub over 2 metres high are to be within 2 metres of a habitable building.
- Tall shrubs over 2 metres high are not planted in groups close to the habitable building and ensure there is a gap of at least three times the height (at maturity) of the shrub away from the habitable building.
- There are no tree crowns or branches hanging over habitable buildings.
- Ensure the roofs, gutters and walls of all buildings on the land are free of flammable matter.
- Install paths and non-flammable features immediately adjacent to the habitable building.
- Wood piles and flammable materials stored a safe distance from habitable buildings.

6. Application to vary the above requirements

If it is considered impracticable for any reason whatsoever to implement any of the requirements of this Notice, you may apply in writing to the Shire of Mundaring by **no later than the 15th day of September** each year for permission to implement alternative measures to assist in the control of bush fires, or preventing the spread or extension of a bush fire which may occur. If permission is not granted in writing by the Shire of Mundaring you must comply with the requirements of this Notice.

7. Additional Works

In addition to the requirements of this Notice, you may be required to carry out further works which are considered necessary by an Authorised Officer and specified by way of a separate written notice forwarded to the address of the owner/s as shown on the Shire of Mundaring rates record for the relevant land.

TAKE NOTICE that pursuant to Section 33(4) of the *Bush Fires Act 1954*, where the owner and/or occupier of land fails or neglects to comply with the requisitions of this Notice within the times specified, the Shire of Mundaring may, by its officers and with such servants, workmen and contractors, vehicles and machinery as the officers deem fit, enter upon the land and carry out the requisitions of this Notice which have not been complied with and pursuant to Section 33(5) of the *Bush Fires Act 1954*, the amount of any costs and expenses incurred may be recovered from you as the owner and/or occupier of the land.

Section 24F and 24G (Restricted Burning)

BURNING OF GARDEN REFUSE

- 1sqm piles of garden refuse may be burnt without a permit between 6pm and 11pm and must be fully extinguished before midnight. Fully extinguished means no heat, smoke or steam and no white ash present where the fire was situated.
- No more than ONE pile of garden refuse is to be burnt at any one time.
- You must obtain a permit to burn before 6pm, and follow all permit conditions.
- There must be one adult person/s in attendance at all times or as specified on your permit.

If the requirements of this Notice are carried out by burning, such burning must be in accordance with the relevant provisions of the *Bush Fires Act 1954*.

The PENALTY FOR FAILING TO COMPLY with this Notice is a fine not exceeding $5000 and a person in default is also liable, whether prosecuted or not, to pay the costs of performing the work directed by this Notice if it is not carried out by the owner and/or occupier by the date required by this Notice.

By order of the Council.

Jonathan Throssell
CHIEF EXECUTIVE OFFICER

Please be advised that the Fire and Burning Information booklet is now issued once every three years. If you would like a copy mailed to you, please call 9290 6666 or visit the Shire website to download the booklet.

Shire of Mundaring
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Document Status

Report version	Rev No.	Purpose	Author	Reviewed and Approved for Issue	
				Name	Date
Draft Report	Rev A	For review by client	Brodie Mastrangelo (BPAD 45985, Level 1)	Zac Cockerill (BPAD 37803, Level 2)	18 December 2019
Final Report	Rev 0	For client use, to accompany Structure Plan submission	Louisa Robertson (BPAD 36748, Level 1)	Zac Cockerill (BPAD 37803, Level 2)	19 May 2020
Final Report	Rev 1	Revised in response to DPLH comments; issued for client review	Louisa Robertson (BPAD 36748, Level 3)	Louisa Robertson (BPAD 36748, Level 3)	5 October 2021
Final Report	Rev 2	Revised in response to further agency comments	Louisa Robertson (BPAD 36748, Level 3)	Louisa Robertson (BPAD 36748, Level 3)	22 December 2021
Final Report	**Rev 3**	**Revised in response to further agency comments**	**Louisa Robertson (BPAD 36748, Level 3)**	**Louisa Robertson (BPAD 36748, Level 3)**	**29 March 2022**

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PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX G

SERVICING AND INFRASTRUCTURE REPORT

(PRITCHARD FRANCIS)

Lots 61 & 1001 Kilburn Road, Parkerville

Engineering Report

Project No: 19-012

pritchard francis lite
civil engineering consultants

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Appendix One: Site Plan

Appendix Two: Geotechnical Mapping

Appendix Three: Existing Water Reticulation Network

Appendix Four: NBNCo Existing Network Plans

Appendix Five Telstra Existing Network Plan

Revision	Description	Author	Date
0	Issued for Inclusion in Planning Report	Philip Patterson	5 March 2020

1	Issued for Inclusion in Planning Report	Philip Patterson	14 May 2020

1 Introduction

This report has been commissioned by Parkerville Children and Youth Care with the view of developing the land north of Kilburn Road bounded by Roland Road to the west and Brindle Road to the east into 2,000m^2 residential lots.

In order to determine servicing of the lots, information has been obtained from authorities and online web pages. The report covers infrastructure requirements and site conditions.

2 Site Description

This site is located about 40km east of Perth CBD in the suburb of Parkerville and has been used as pastural land.

The site covers an area of 29.4ha and is bisected by Clutterbuck Creek which runs from east to west across the site. (See Appendix 1)

The southern section of the site between Clutterbuck Creek and Kilburn Road covers an area of approximately 15.4ha and is where the proposed creation of 2ha lots is proposed.

The site is sparsely vegetated and grades from Kilburn Road to Clutterbuck Creek with about 16m fall across the proposed site from Kliburn Road to the creek which equals to about 6% grading from North to South.

3 Local Government

This land is located in the Shire of Mundaring, who are aware of the proposed development. Previous correspondence with the Shire indicate the following requirements:

- Attenuation of a 1 in 20 year ARI storm event will need to be stored. Storage of this stormwater can be catered for in swales adjacent to the foreshore reserve in the POS.
- Kerbed roads with piped drainage to take in up to 1 in 5 year storm event are to be constructed.
- Lots are to dispose of their own stormwater runoff on site.
- Road pavement widths are to comply with the findings of the traffic report.

4 Aboriginal Heritage

A search of the Native Title / Heritage register has been undertaken and there are no Native Title sites over the development area, however, there is a #3188 large heritage area mentioned which is not specific to the site.

5 Acid Sulphate Soils

WA Acid Sulphate Soil mapping does not exist for this area.

6 Topography

Based on mapping provided by MAPS and on-site inspection, the southern section of land being developed, grades gently from RL 257m AHD in the southeast corner to a low of approximately 234m AHD in the northwest corner. As mentioned before, the site is sparsely vegetated with the majority of the vegetation existing along the creek line which will not be affected by the development and in abutting road reserves along Kilburn and Ronald Roads.

7 Geotechnical

Geotechnical mapping and on-site investigation indicate the site is underlain by clay, with clayey gravelly sand, gravel and laterite above. (See Appendix 2)

It is evident that out crops of laterite are on site in different locations. These out crops are more predominant in the eastern area of the site but laterite out crops were evidenced across the site. The laterite ground / hardpan is usually underlain by clayey soil which then trends to rock which was evidenced when test holes were dug.

8 Lots

As part of the development work for this site, it is proposed to carry out earthworks on lots to create relatively flat blocks with a maximum grade of about 3% fall across lots.

It is proposed that the flatter area will cover about 900m² with the pad areas being set back 10m from front and rear boundaries and 5m from side boundaries to preserve trees and allow battering of the pad areas.

Final levelling, filling and grading of the building areas will be carried out by builders / lot owners as required to suit building footprints.

Levelling of the lots this way will minimise site work required by lot owners and minimise future work required on lot boundaries.

9 Roadworks

It is proposed that the road system for the development is to be of subdivision standard which means roads are to be kerbed and asphalted.

As Kilburn Road is an existing sealed and kerbed road on one side, the intention would be to bring the road up to urban standard by kerbing the northern side of the road and incorporating intersections for the future development.

Roads will be deviated around trees where achievable to save existing vegetation to create a more environmentally friendly development.

10 Stormwater Drainage

With roads being kerbed, a piped drainage system is to be installed to pick up and carry the 1 in 5 year storm event that will discharge into several specifically built swales located between the southern edge of Clutterbuck Creek and northern boundary of the east west road reserve.

These swales will be designed to cater for first flush events and water from post 1 in 20 year storm events.

11 Waste Water Disposal

There is no piped waste water disposal system available in the area to service these lots, so it is intended that waste water will be disposed of on site.

An independent assessment has been carried out by Douglas Partners which confirms disposal of domestic effluent is considered suitable for on site disposal via approved priority system, the type of system will ultimately be the choice of the property owners.

12 Water Supply

There is an existing Ø150mm PVC water main running along Kilburn Road that will be extended north up Brindle and into the future roads so as to service new lots with a potable water supply. Negotiation will need to be had with Water Corporation to ascertain any upgrades required, but until the subdivision is approved, Water Corporation are not prepared to carry out any further review on their infrastructure.

13 Gas Supply

There is no natural gas network in the area and no gas supply will be available for this development.

14 Power Supply

14.1 Existing Power Distribution Network

The existing Western Power (WP) distribution infrastructure in the vicinity of the site primarily comprises of a 22kV three phase aerial High Voltage (HV) and aerial three phase Low Voltage (LV) network. The WP distribution network emanates from the Darlington Zone substation and currently services the proposed development area.

Information on the capacity of the local zone substations can be determined from Western Power's public Network Capacity Mapping Tool (NCMT). Currently there is an excess of 25MVA capacity in the Darlington Zone Substation. Within the next ten years, this has been forecasted not to change significantly, suggesting that growth in power demand has stabilised in the area. The spare capacity in the distribution network however can only be confirmed via an official application to Western Power such as the Design Information Package or feasibility study request. Load and network upgrades requirements will need to be assessed/determined by Western Power based on development densities, type and timing at the time of application.

Currently no transmission lines run through the proposed development area and therefore there are no transmission easements restricting the development.

14.2 Site Supply Distribution Infrastructure

WP requires that all new developments are to be serviced by underground three phase power. WP also require any existing HV and LV aerials adjacent to the land being subdivided to be undergrounded and any existing consumers affected will have to have their consumer mains reconnected to the network.

In a Rural residential development, this is implemented by WP owned and maintained Underground Residential Distribution (URD) 3-phase direct buried underground cabling from a spare way at the transformer LV frame to uni-pillars serving each site on the general basis with a pillar per lot. In the freehold residential development scenario this would be by traditional WP owned and maintained URD 3-phase direct buried underground cabling from new transformer(s) to pillars servicing each freehold lot on the general basis of one pillar serving two adjacent lots. All electrical infrastructures are to be gifted to Western Power as WP will own & maintain these assets.

Typically, HV substations are placed on Public Open Space (POS) lots to avoid affecting one of the newly created lots. This cannot always be achieved as POS lots may not be available or due to the need to meet technical requirements. Typical land requirements for HV substations are as follows:

Residential Developments:

- Transformer only 3.7m (W) x 4m (D)
- Switchgear only 4.5m (W) x 3m (D)
- HV Switchgear and transformer 6.2m (W) x 4m (D)

The above land requirements are to be created as an extension of road reserve as per WP's requirements and a general condition of the subdivision by the Western Australian Planning Commission (WAPC).

14.3 Power Supply Requirements

Power load requirements for the development are subject to lot yield creation, zoning of the area, Residential design codes and ultimate lot use. The load requirements can however be estimated by applying typical WP load allocations where the only the minimum requirements are to be satisfied to achieve clearances only. Typical load allocations as follows:

- Freehold Residential Development (Great than 1000sqm)
  - 5kVA per lot allocation

Thus, this development will require an overall load allocation of 285kVA. Which can serviced by the existing network around the area.

14.4 Lighting for New Roadways

All newly created roadways will require new lighting to satisfy the requirements of AS1158 and the Local Government Authority. The lighting could consist of standard or decorative Western Power lighting poles, or if the Local Government preferred, “privately” (Local Government) owned lighting, where any range of suitable lighting products could be utilised, opening up the opportunity to use broader technologies and strategies, including:

- Architectural lighting poles and luminaires.
- High efficiency and low glare LED luminaires.
- Multi-technology poles, including banner mounts, CCTV cameras and power outlets.

Time based, light level and motion detection-controlled lighting operation and output levels can be determined if required.

For remote areas such as this, the Local Shire may opt to light the roads with flag style lighting, which focuses on intersections and sections of roadway that change direction, due to the low vehicle count on the roads.

14.5 Relocation/Removal of Existing Assets

The existing aerial line that cuts through the northern portion of the project can be removed if required by the WAPC or if the lots are to be left as balance of title for future development works, then left for future removal.

If the aerials are to be removed, power can be sourced off Brindle Road. Any change in alignments of Brindle Rd, which will place the existing aerial lines off the 2.7m alignment. Will require either the undergrounding or re-alignment of those aerials.

14.6 Power Supply Timelines

Western Power will neither reserve capacity nor guarantee supply to this development without a formal request being lodged. For developments consisting of 5 or greater freehold lots, a subdivision Design Information Package (DIP) request must be prepared and submitted to Western Power for the design and construction of the proposed development to commence.

From the date of DIP request submission DIP is typically provided between eight to twelve weeks. Soon after, a design can be lodged with WP for conformance and quoting. From the date of the design being lodged with WP, the design acceptance and works quote is typically provided within eight to twelve weeks. Once the quote is paid, typically within two to four weeks a Construction QA Manager is appointed, and the pre-start meeting can occur. One the pre-start is complete, construction can commence.

To avoid any project delays, it is highly advised that a DIP request is prepared and submitted to Western Power as soon as possible.

14.7 Likely Power Scenario

For servicing the development with power, we would expect that the site is serviced by either 2 x 315kVA transformers (with HV switchgear) or 5 x 63kVA transformers fed by an isolation transformer. We would need to discuss options with Western power for final servicing.

- District transformers and switchgears strategically placed within the development area to service newly created lots
  - Locations subject to EPR/LFI study due to potential risks on metallic pipeline infrastructure
- Existing HV network servicing lots outside of development area to be maintained.

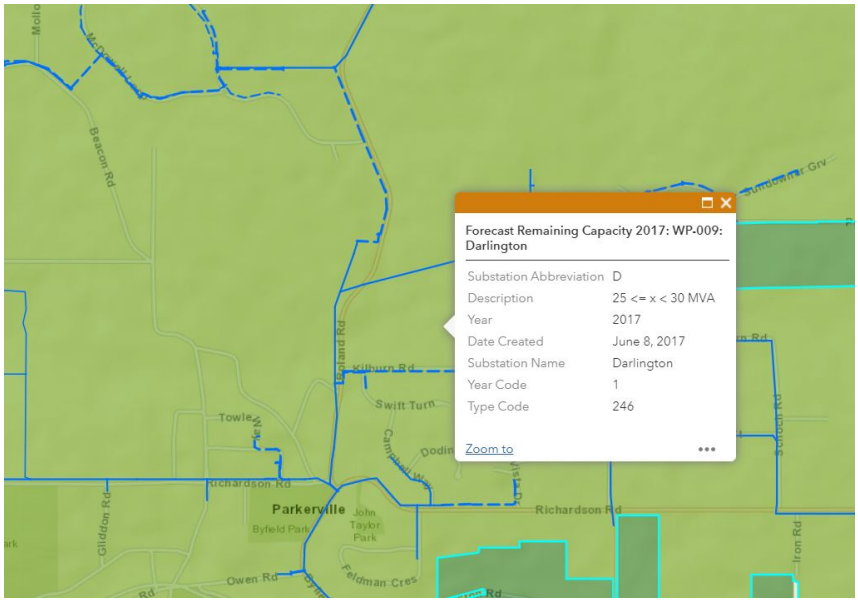


Figure 1. Existing Western Power Electrical Network

15 Communications

15.1 Existing Telecommunications Network

The area around the proposed development is serviced from the Telstra Parkerville Exchange, approximately 800m route length minimum to the south, on Byfield Rd. The location of NBN Co's Fibre Access Node (FAN) is unknown but probably not in the Parkerville exchange. Existing Telstra network is located near the eastern side of Roland and on the southern side of Kilburn Roads but pipe sizes (P80 and P50 respectively) are not regarded as Fibre Ready. NBN Co would have taken ownership of Telstra's distribution cable network under the Brownfields Rollout but there would be limited pipe capacity for expansion of the NBN Co cable network. Likewise, for cable, DBYD (see attached) suggests that there are limited dead pairs on Roland Rd, indicating that spare capacity would be limited and probably insufficient to service the new development – see attached. NBN Co do not divulge utilisation of cable ranges, making it impossible for us to assess the real extent of spare capacity. It would appear that NBN Co's FTTN node is located near no 440 Kilburn Rd. DBYD indicates that the Telstra/NBN Co network may be installed on private property adjacent to the eastern side Roland Rd, which would affect the proposed development. On Kilburn Rd the Telstra/NBN Co network is installed on road reserve and on Brindle Rd, on private property to the east of the road reserve, and thus not affecting the proposed development.

15.2 Developer Responsibilities

Developers have two obligations in relation to the provision of telecommunctions infrastructure. Under the Telecommuncations Act 1997, Developers are obliged to provide fibre ready pit and pipe to new developments and under the Federal Governments Telecommunications in New Developments policy (TIND), Developers are required to provide telecommunications infrastructure as they do for other utilities. To ensure that telecommunications can always be provided the federal government has specified the NBN Co and Telstra shall be Infrastructure Providers of Last Resort (IPOLR), in certain portions of the network. Further details of these responsibilities are detailed below.

15.3 Proposed Telstra Network

Telstra would not be regarded the IPOLR for voice infrastructure, unless NBN Co decided classify lot 61 as falling within the Fixed Wireless Footprint. In the unlikely scenario that NBN Co did extend its Fixed Wireless Footprint, then the Fixed Wireless Footprint portion would need to be serviced with Telstra pit, pipe and cable, since Telstra would be IPOLR for voice infrastructure. Therefore, a Telstra pit and pipe design would be required, for the Telstra portion.

Telstra would quote, design and install their own communications cable infrastructure, usually undertaken via their partner, Tandem Corp. Telstra infrastructure costs for ½ acre lots is substantially higher than the average urban lot, given the much longer frontage.

15.4 Proposed NBN Co Network

The proposed development falls in an area that has already been partly converted to NBN Co broadband under the Brownfields Rollout with lot 1001 classified within the Fixed Line Footprint, the southern portion of lot 61 not classified and the northern portion falling within the Fixed Wireless Footprint – see NBN Co Rollout Map below. NBN Co would be the IPoLR for broadband infrastructure, in both the Fixed Wireless and Fixed Line Footprint areas, of the which the Fixed Wireless is currently being provided free of charge to Developers, whilst the Fixed Line Footprint area is subject to Deployment Charges of $600/lot. We understand that the TIND policy is currently being reviewed and it is possible that Fixed Wireless infrastructure charges specified in the TIND policy or revised TIND policy could be applied. Lodgement of an NBN Co development and stage infrastructure applications ASAP is recommend, if the development is to proceed.

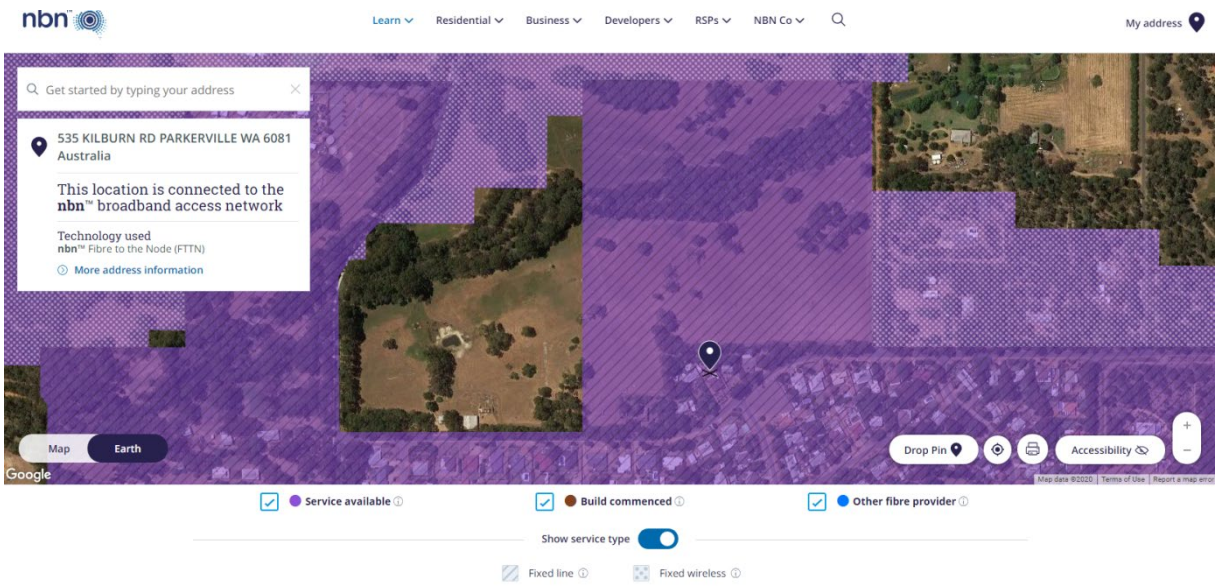
Existing Fixed Line Footprint homes have been serviced with FTTN technology. Therefore, NBN Co must accept IPoLR responsibility and service lot 1001, if the Developer wished to engage them. Given the yield, it is likely that NBN Co would reclassify super lot 61 as falling within the Fixed Line Footprint and would possibly consider delivering FTTP technology to both, which would be the preferred technology. Assuming NBN Co accept IPOLR responsibility now, we recommend an allowance for infrastructure of $600/lot Deployment Charge be made. Given the proximity of the FTTN Node it should not be necessary to make any allowance for Backhaul pit, pipe or fibre. If NBN Co elected to service in FTTN, then there is ready access to the node on Kilburn Rd and home owners would receive medium to good speeds, depending on their distance from the node. If serviced with FTTP, then excellent broadband speeds would be available. The costing below assumes a fully serviced NBN Co development ie not part Telstra infrastructure.

The limited availability of road reserves, due to trees and vegetation, would affect the proposed pit and pipe design, with use of the southern side of Kilburn Rd recommended for a new route, preferably on 3m –> 4.2m alignment. Brindle Rd reserve could probably be open trenched, given that the scrub is light. Roland Rd reserve would be best installed on the new alignment, so avoid as much vegetation as possible and future relocation costs.

15.5 Network Relocations

Since the 10m road reserve widening of Roland Rd is occurring with the subdivision, the Telstra and NBN Co assets affected would require relocation. However, since Telstra's P80 on private property adjacent to the eastern side of Roland Rd, may fall on the ultimate alignment, there may not be a need to relocate. If not, then the P80, 60 fibre SMOF cable and a 100/0.40 CPFUT copper cable would have to be relocated, if it fell within road reserve. If the route happened to remain in private property and was not restrictive of lot development, then it could be left on private property. The balance of the network, P35, 100/0.40 PEIUT and 30/0.64 direct buried assets on Roland Rd reserve, at the southern end, would require relocation regardless. It would appear that the 100 pair is Telstra owned and 30 pair NBN Co owned. A Type A location of the assets on Roland Rd and adjacent private property should be undertaken, to provide certainty over which assets are affected and to avoid the costs that could arise if the existing assets were damaged. Telstra would prefer that assets were not located on private property. If required, the relocations could cost would be substantial. Communications relocations costs would be minimised if the road widening occurred on the western side of Roland Rd. In that instance only a 25 pair cable would be affected and a relocation cost under $50K could be expected. Widening to western side would be affected by the presence of an HV aerial route within private property, on approximately the 7.5m alignment.

15.6 NBN Co Rollout Map



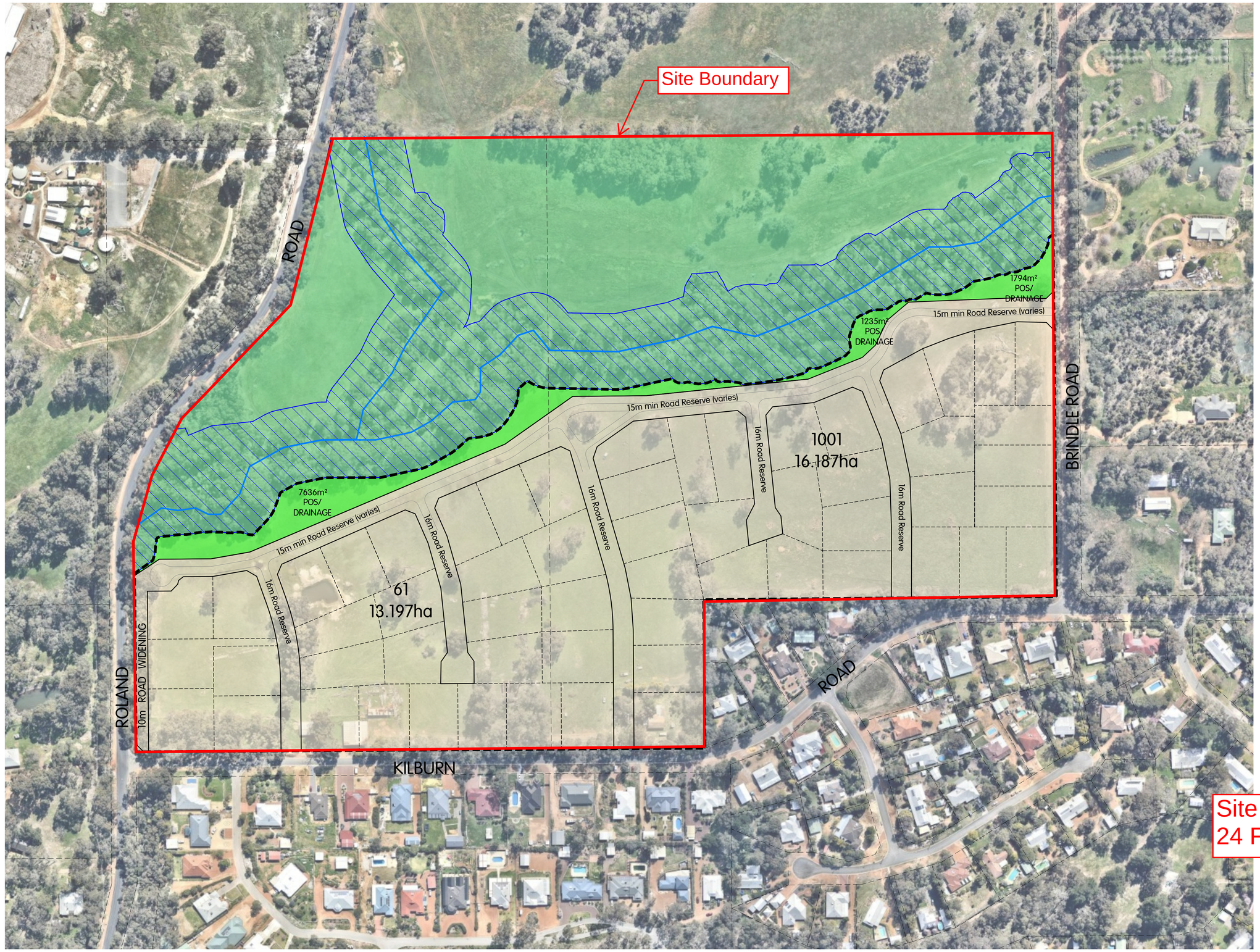
16 Conclusion

This report and supporting information confirms that this site is suitable and able to be fully serviced as a residential subdivision.

Appendices

Appendix One:	Site Plan
Appendix Two:	Geotechnical Mapping
Appendix Three:	Existing Water Reticulation Network
Appendix Four:	NBNCo Existing Network Plans
Appendix Five	Telstra Existing Network Plan

Appendix One: Site Plan



Site Location Plan
24 February 2020

LEGEND

- Proposed Site
- Residential R5
- Public Open Space/ Drainage
- Rural Zone
- Foreshore Reserve
- Watercourse (Clutterbuck Creek)

PARKERVILLE CHILDREN AND YOUTH CENTRE(INC)

robertsday.com.au *planning·design·place*

SIZE A1

1:1500 0 metres 15 30 45 60 75 90

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 160904

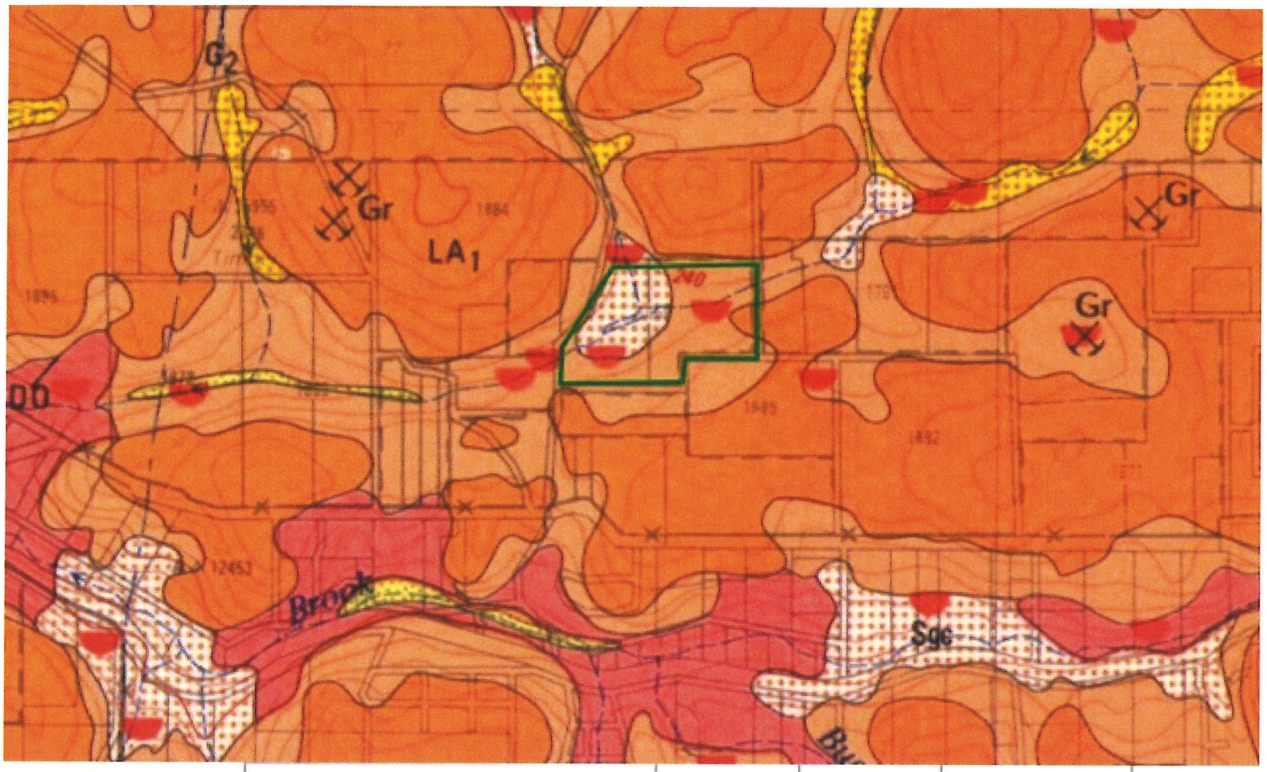
CADASTRAL INFORMATION
SOURCE: SLIP SERVICE - LANDGATE
YYMMDD:
DWG REF:
PROJECTION: MGA 50

INDICATIVE CONCEPT PLAN
Lot 61 & 1001 Kilburn Road, Parkerville
Shire of Mundaring

REF NO.	DRAW NO.	REV.
PCH PAR	**RD1 002**	**O**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

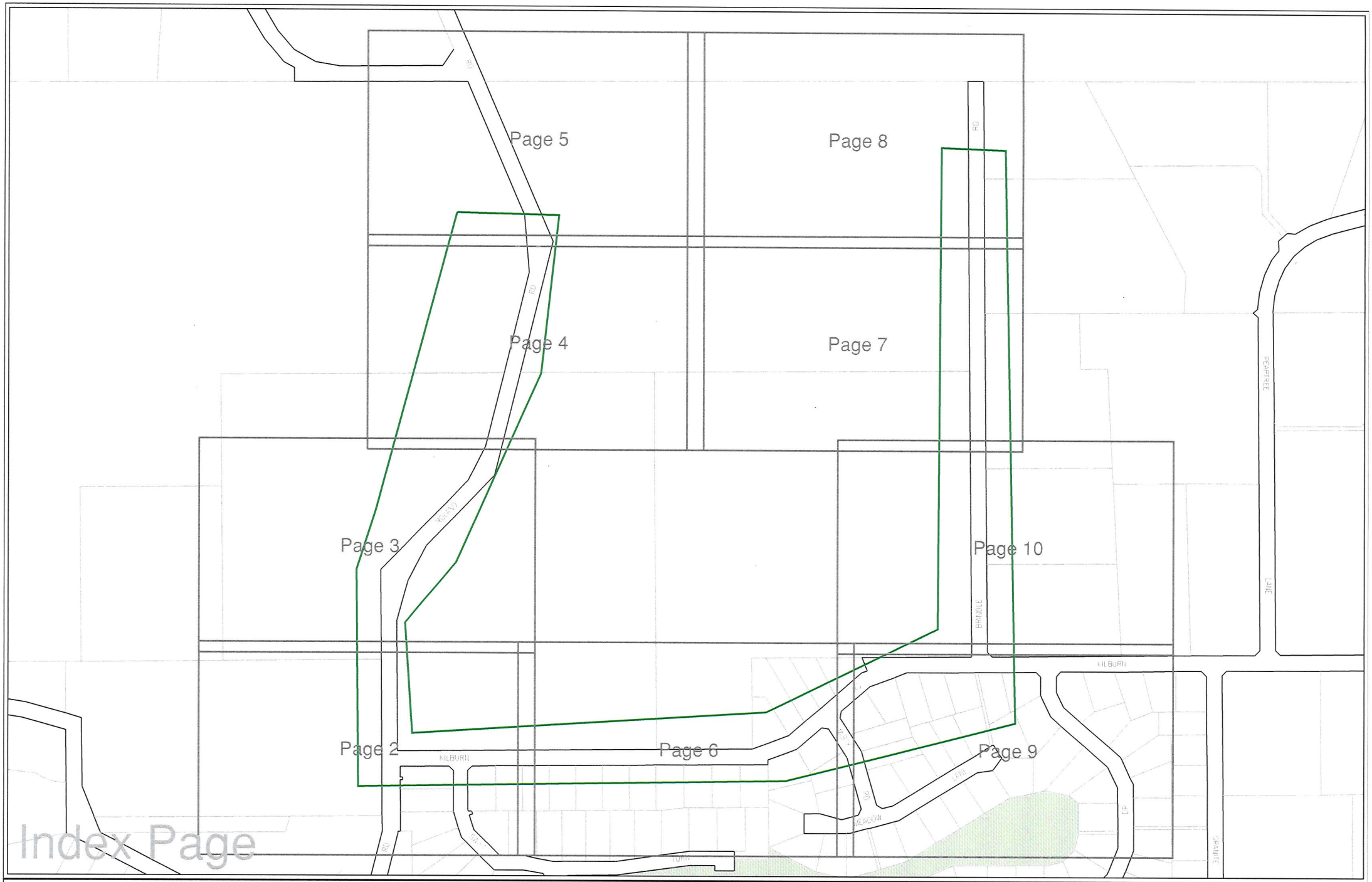
Appendix Two: Geotechnical Mapping



Sgc	CLAYEY GRAVELLY SAND – grey and yellow, kaolinitic, decomposed bedrock, sand and gravel veneer; granitic/gneissic origin	Colluvium (Qrc, Qrt)	150–250m; G–M	Gravel, sand
Scg	GRAVELLY CLAYEY SAND – grey, brown, closely associated with Sgc and G_2; doleritic origin	Colluvium (Qrt)	175–225m; M	
S_S	SAND – light grey, white and yellow, angular to sub-rounded quartz some feldspar, moderately sorted; colluvial origin	Colluvium (Qs)	220–295m; F	Construction sand
G_2	GRAVEL – yellow-brown to reddish brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor recementation; colluvial origin	Laterite (Czl)	200–300m; F–G	Gravel
G_3	GRAVEL – as for G_2 but pisolites predominately maghemite-goethite, ferruginous black coating; colluvial origin		240–300m; G	
LA_1	LATERITE – massive, hard, cemented, vuggy and pisolitic; up to 4 m thick, overlain by and associated with gravels (G_2 and G_3) of residual origin		270–390m; F–G	Bauxite, gravel, building stone

Geotechnical Mapping
- Kilburn Road Parkerville
- 25th February 20

Appendix Three: Existing Water Reticulation Network



WATER CORPORATION

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Sequence No: **58979151**

Print Date: 16/02/2017 Page: 1 of 10

N

Water

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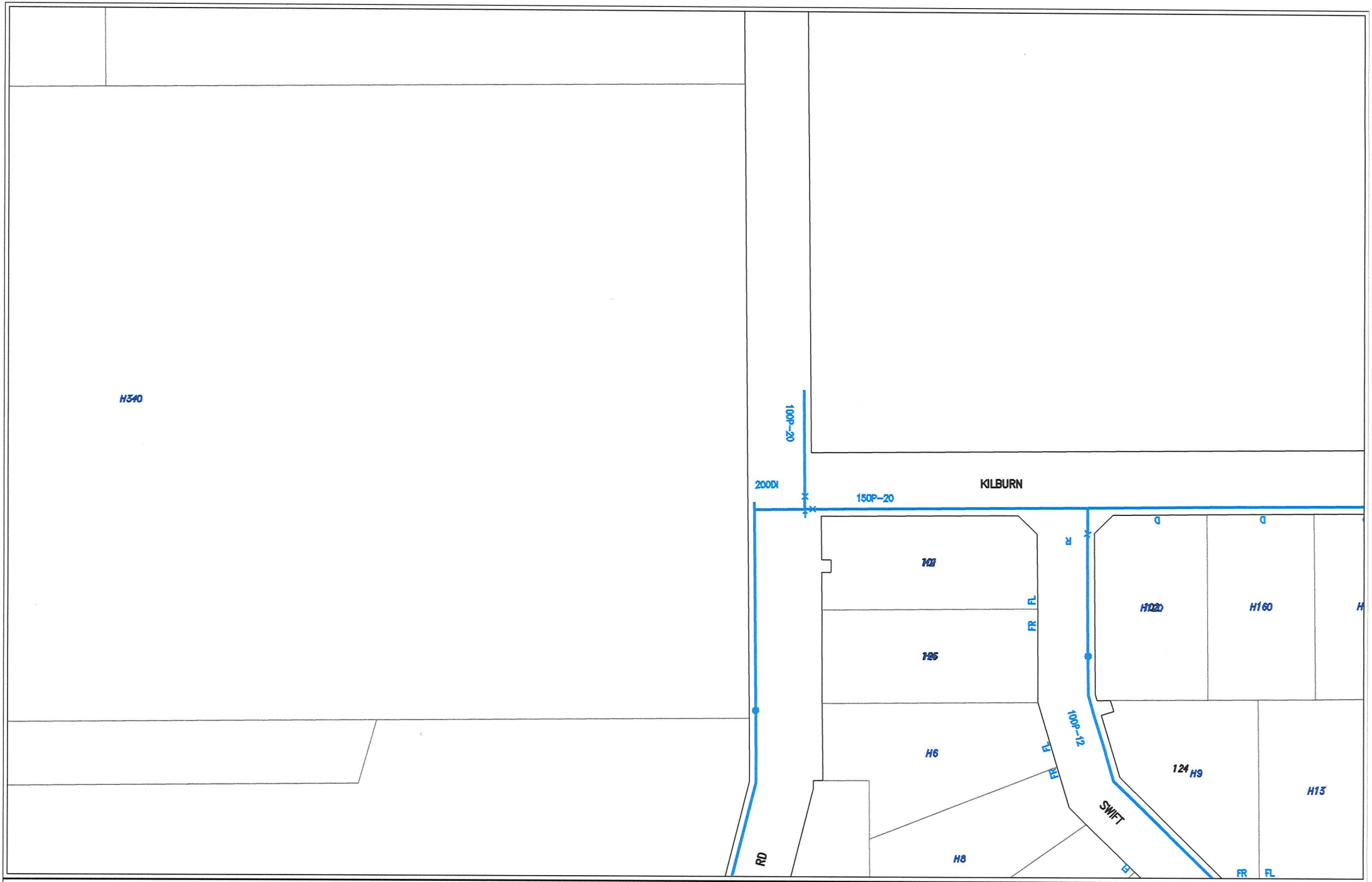

WATER CORPORATION

Scale: 1:1500 Centre Point: 116.138°, -31.871°

Sequence No: 58979151

Print Date: 16/02/2017 Page: 2 of 10

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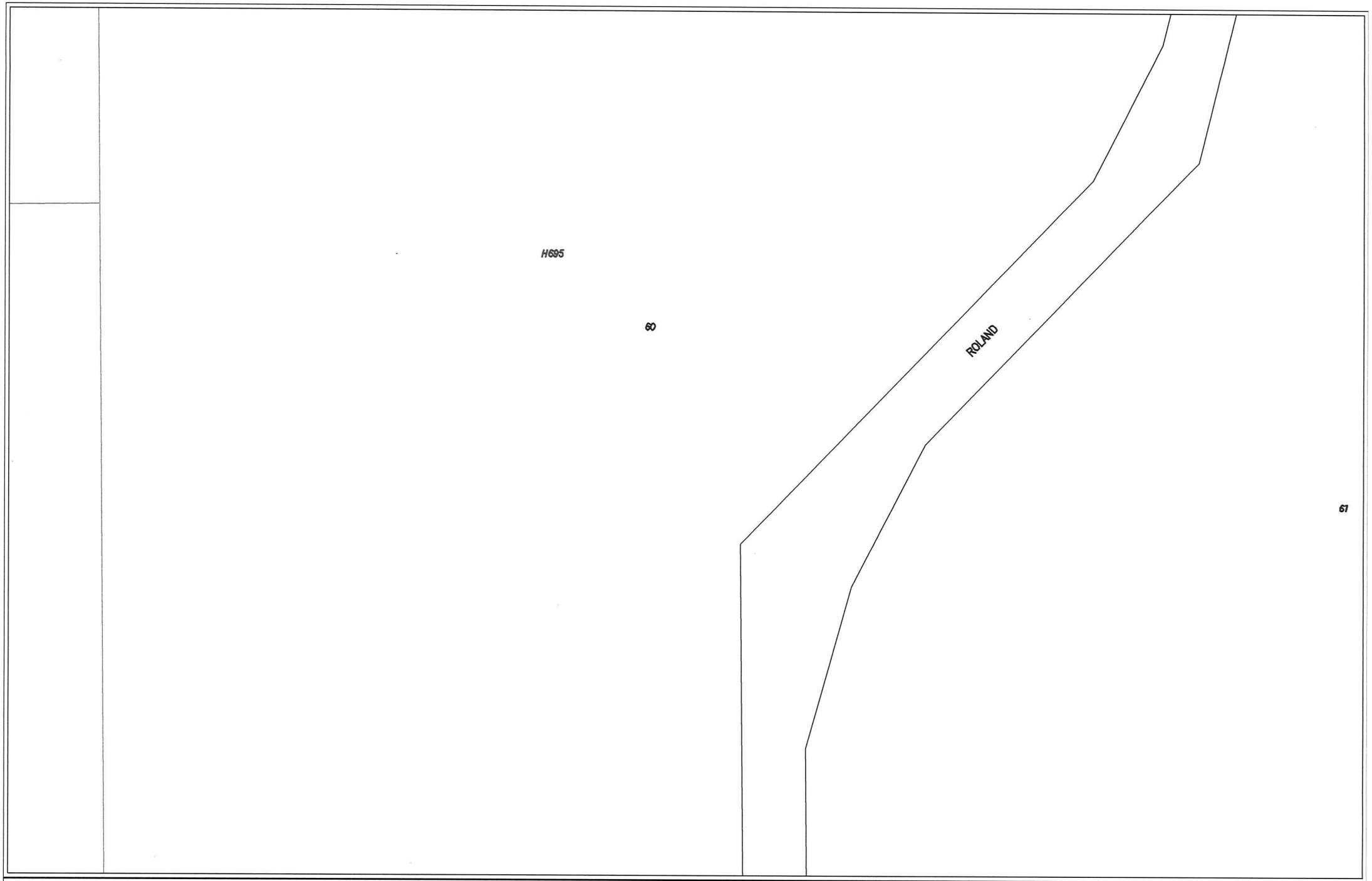

WATER CORPORATION

Scale: 1:1500 Centre Point: 116.138°, -31.869°

Sequence No: 58979151

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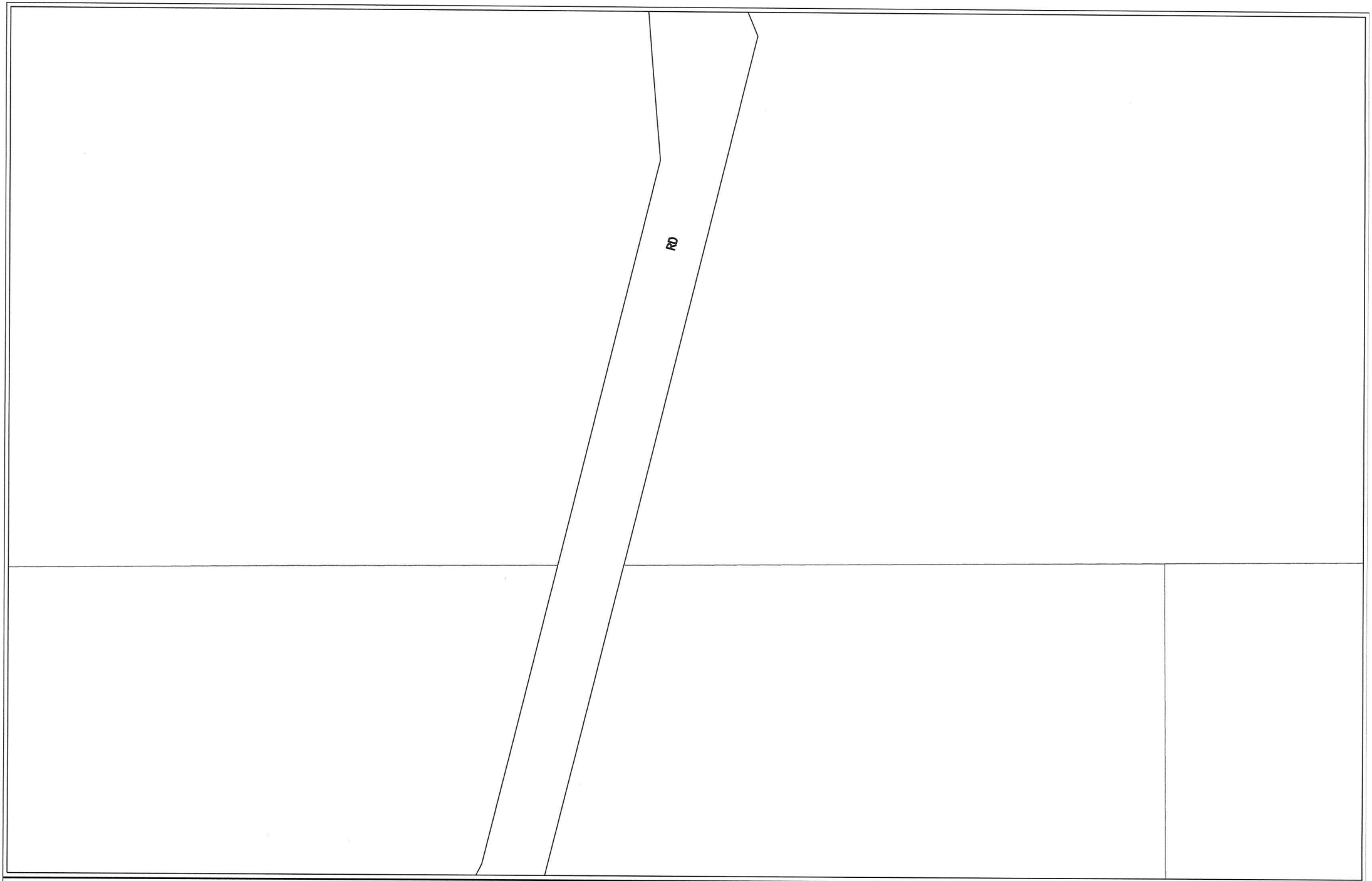

WATER CORPORATION

Scale: 1:1500 Centre Point: 116.141°, -31.866°

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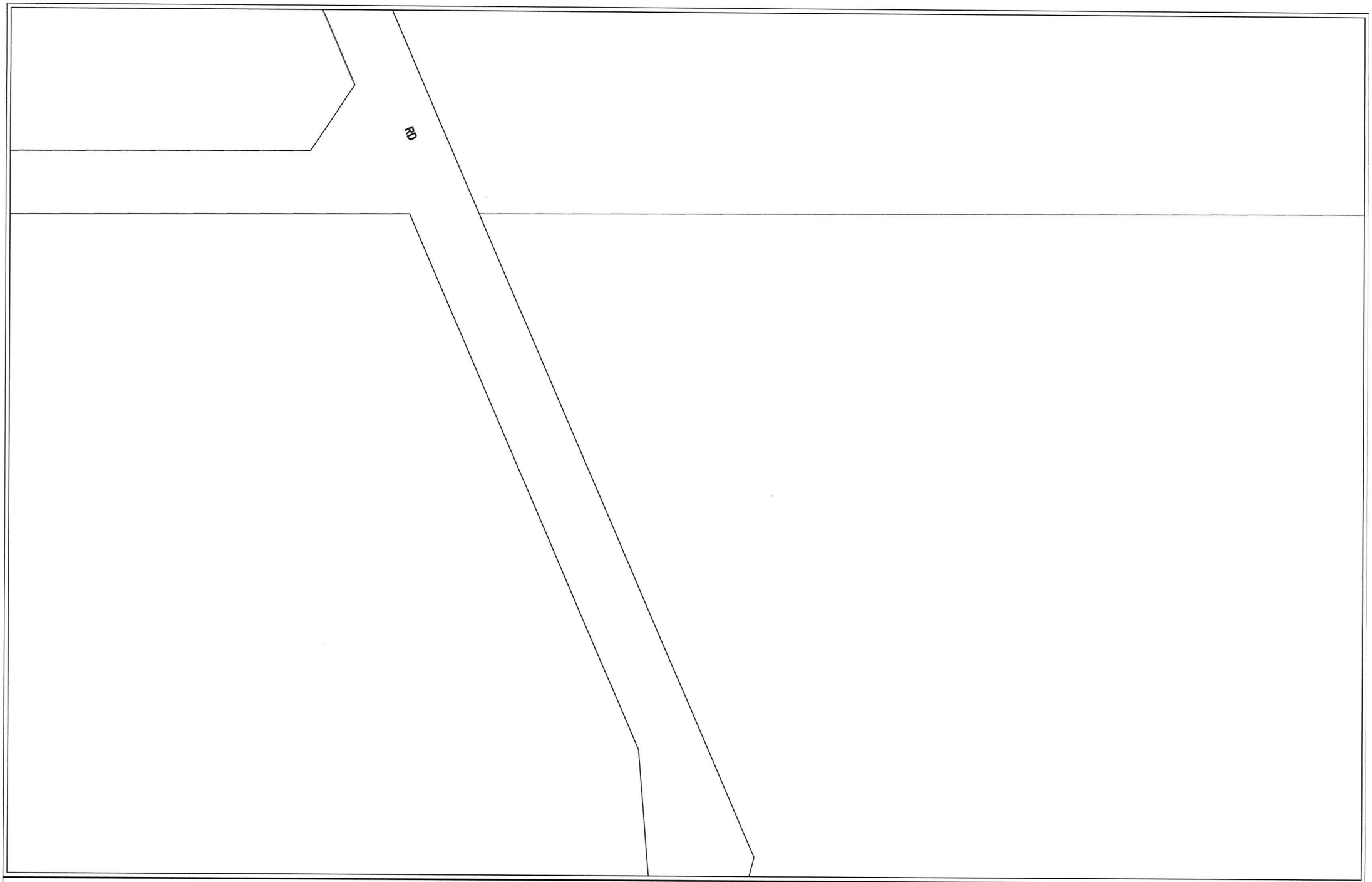

WATER CORPORATION

Scale: 1:1500 Centre Point: 116.141°, -31.864°

Sequence No: 58979151

Print Date: 16/02/2017 Page: 5 **of 10**

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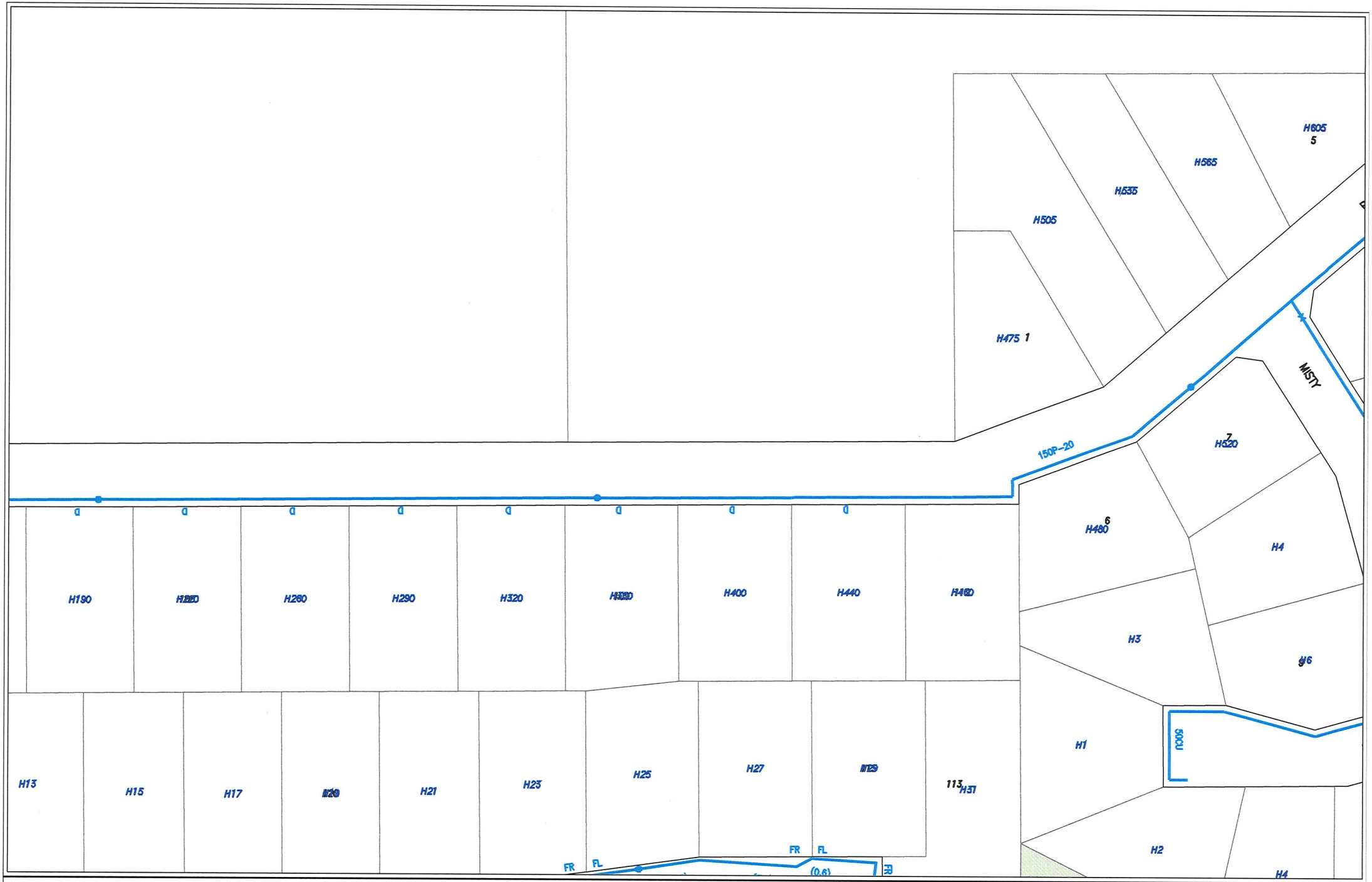

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Sequence No: 58979151

Print Date: 16/02/2017 Page: 6 of 10

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WATER CORPORATION

Scale: 1:1500 Centre Point: 116.145°, -31.866°

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WATER CORPORATION

Scale: 1:1500 Centre Point: 116.145°, -31.864°

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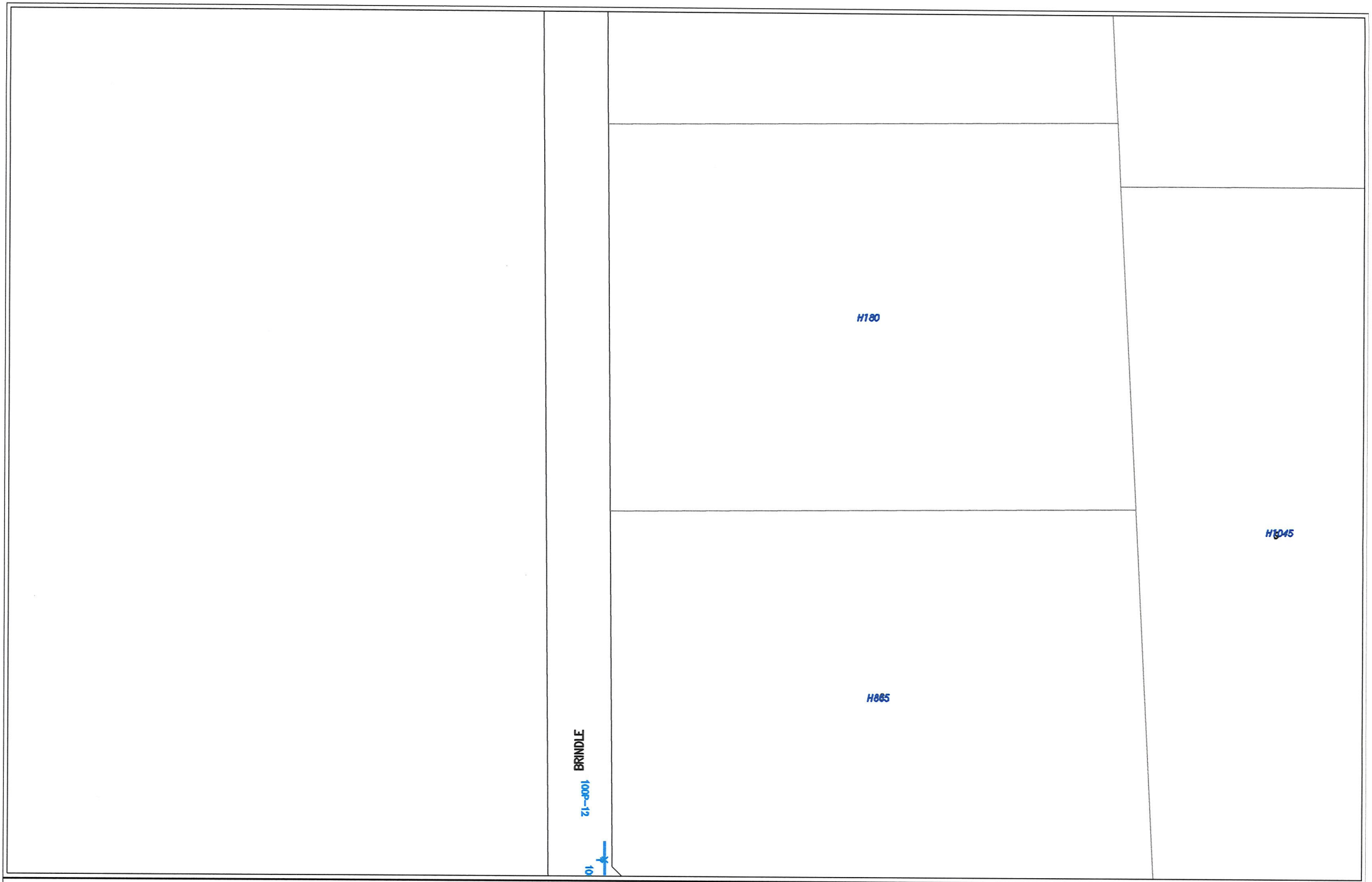

WATER CORPORATION

Scale: 1:1500 Centre Point: 116.147°, -31.869°

Sequence No: 58979151

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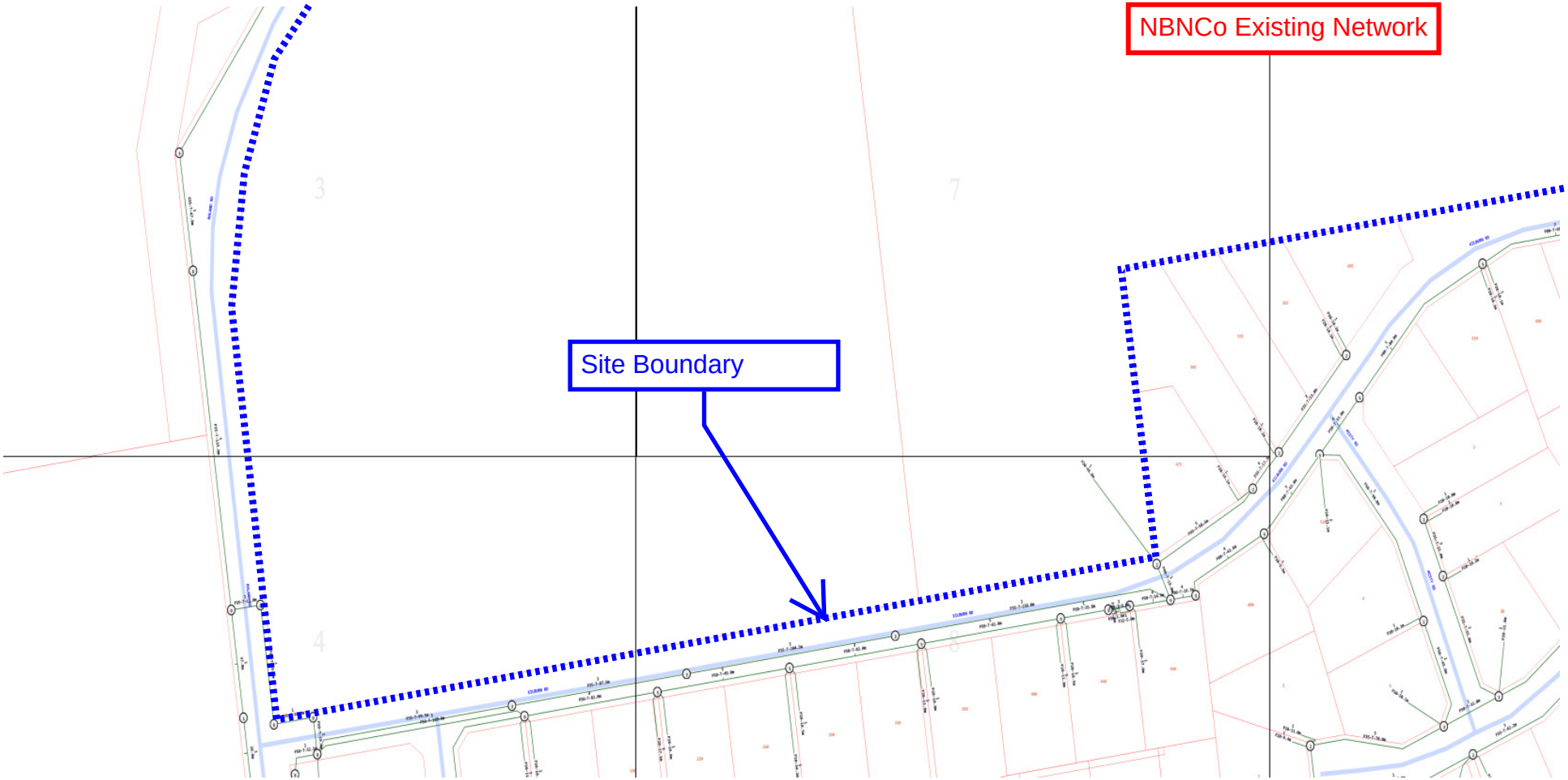
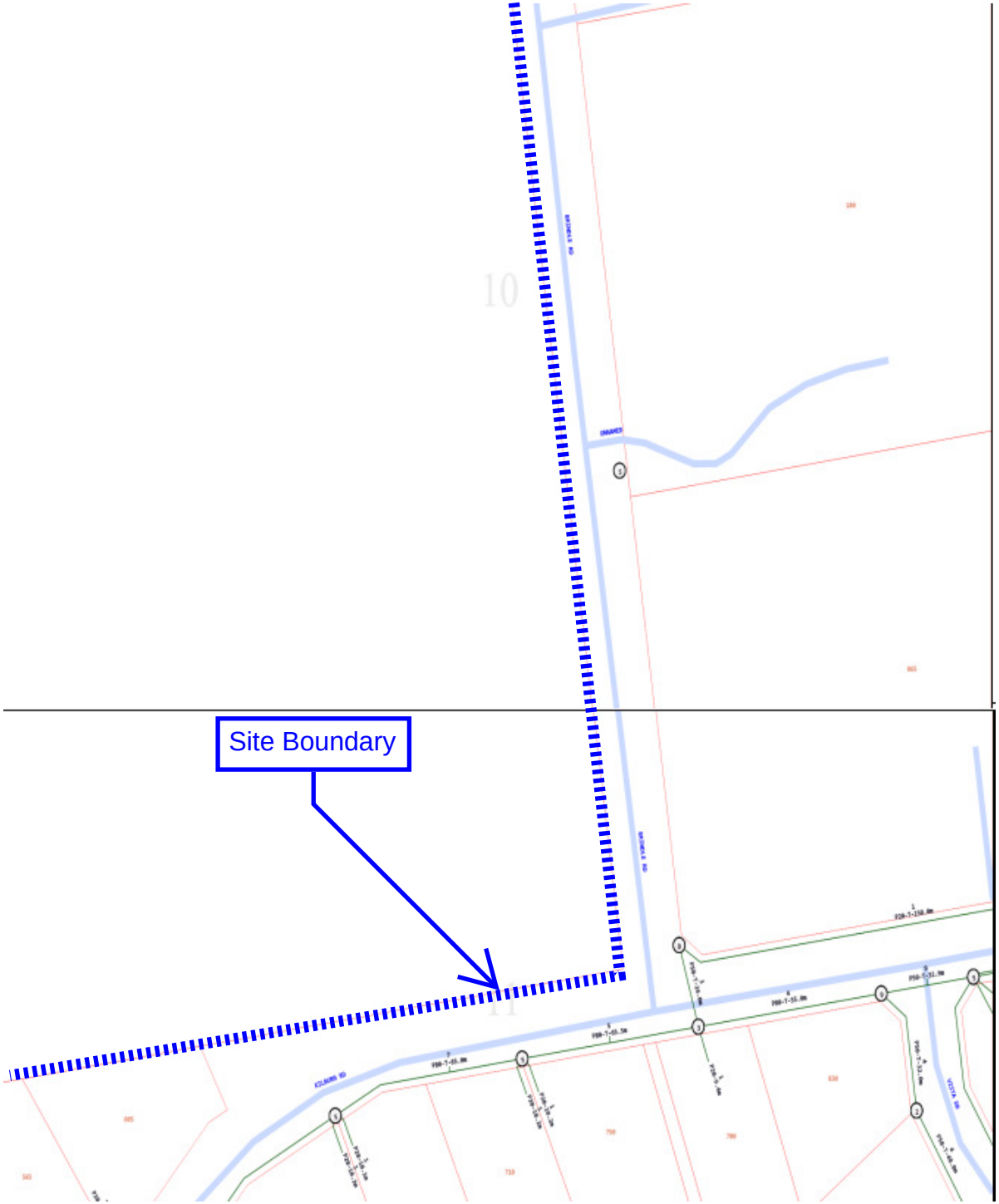
Appendix Four: NBNCo Existing Network Plans


NBNCo Existing Network
Site Boundary

NBNCo Existing Network
Sheet 2 of 2



Appendix Five Telstra Existing Network Plan

Site Boundary

Existing Telstra Network Plan

M LOOP F PVIL 3002

RD/LAND

KILBURN

SWIFT

MISTY

MEADOW

RAM Phase2

CLP

NOTES
1. ALL CABLI

PARKERVILLE LOCAL STRUCTURE PLAN
LOT 61 ROLAND ROAD & LOT 1001 KILBURN ROAD, PARKERVILLE . MAY 2020

APPENDIX H

STRUCTURE PLAN MAP

(ROBERTSDAY)

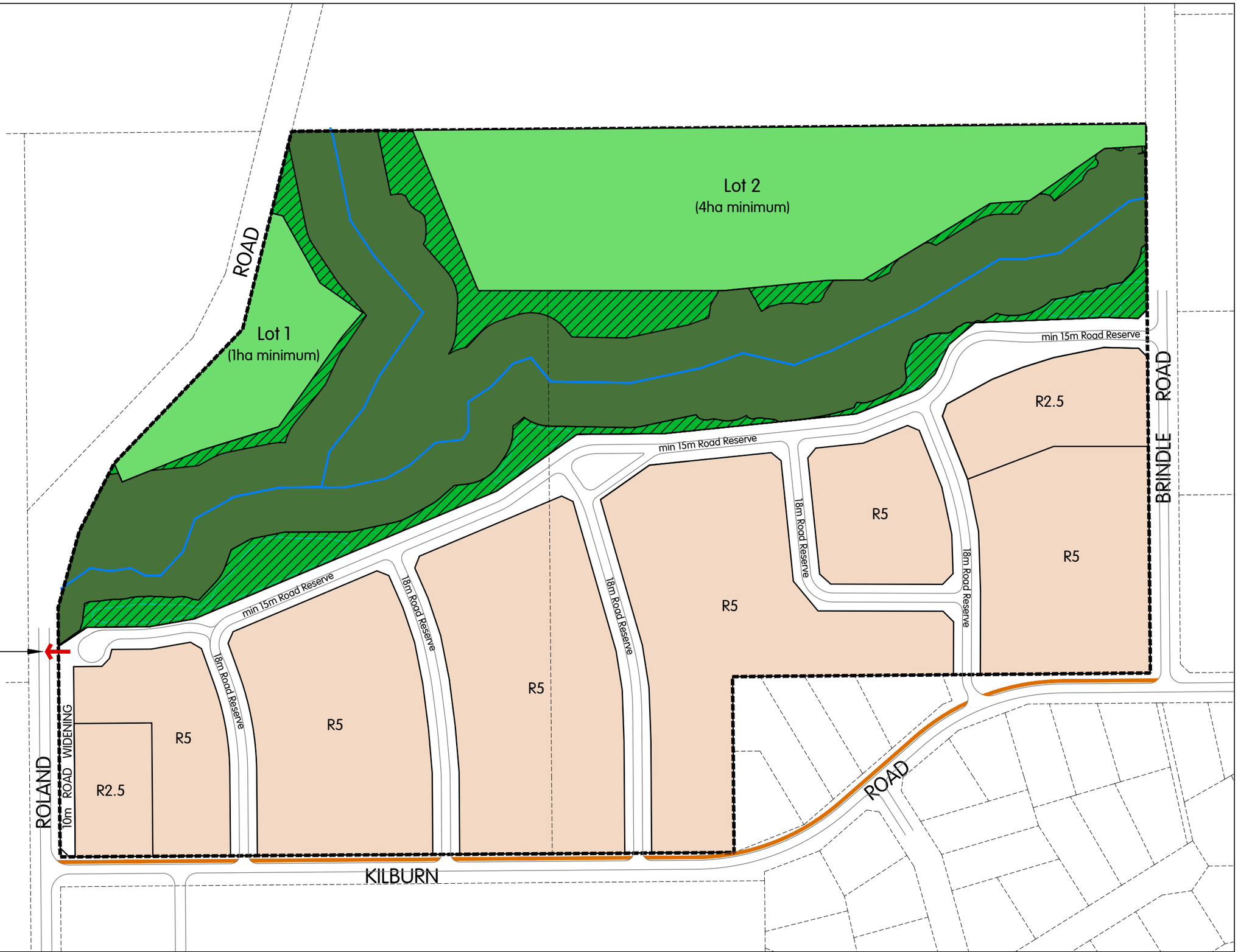
N

LEGEND

- Structure Plan Boundary
- Residential
- R2.5 R Code R2.5
- R5 R Code R5
- Rual Smallholding
- Recreation
- Conservation
- Watercourse (Clutterbuck Creek)
- Footpath (to be constructed)

NOTES

1. Subdivision applications proposing the creation of battleaxe lots will not be supported.
2. Road connections to Kilburn Road to be designed to retain trees within the road reserve as much as practicable.



CADASTRAL INFORMATION
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DWG REF: CUTKIL02_GIS-Datasets
PROJECTION: GDA94

AERIAL PHOTOGRAPHY
SOURCE: NEARMAPS
YYMMDD: 190209

HATCH | RobertsDay

SIZE A3_ 1:1000

0 metres 10 20 30 40 50

REV	DESCRIPTION	YYMMDD	DRAWN	APPR'D
C	FOOTPATH, EAW, NOTES	211123	SJ	RD

STRUCTURE PLAN
Lot 61 & 1001 Kilburn Road, Parkerville
Shire of Mundaring

REF NO.	DRAW NO.	REV.
PCH PAR	**RD1 003**	**C**

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