LOCAL STRUCTURE PLAN

Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford

Harley Dykstra®

PLANNING & SURVEY SOLUTIONS

DOCUMENT CONTROL

Control Version	DATE	Status	Distribution	Comment
E	14/12/2020	Final	WAPC	Update to reflect WAPC Schedule of Modifications

Prepared for: Goldlight Asset Pty Ltd
Prepared by: CP
Reviewed by: HD
Date: 13th August 2019
Job No: 21396
Ref: 20180720 LSP Report

Harley Dykstra - FORRESTDALE
PO Box 316
Kelmscott WA 6991

Phone: (08) 9495 1947
Email: metro@harleydykstra.com.au

DISCLAIMER

This document has been prepared by HARLEY DYKSTRA PTY LTD (the Consultant) on behalf of the Client. All contents of the document remain the property of the Consultant and the Client except where otherwise noted and is subject to Copyright. The document may only be used for the purpose for which it was commissioned and in accordance with the terms of engagement for the commission.

This document has been exclusively drafted. No express or implied warranties are made by the Consultant regarding the research findings and data contained in this report. All of the information details included in this report are based upon the existent land area conditions and research provided and obtained at the time the Consultant conducted its analysis.

Please note that the information in this report may not be directly applicable towards another client. The Consultant warns against adapting this report's strategies/contents to another land area which has not been researched and analysed by the Consultant. Otherwise, the Consultant accepts no liability whatsoever for a third party's use of, or reliance upon, this specific document.

This structure plan is prepared under the provisions of the Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: **09 FEBRUARY 2021**

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

09 FEBRUARY 2021 Date

09 FEBRUARY 2031 Date of Expiry

TABLE OF AMENDMENT(S)

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

Executive Summary

Proposed Structure Plan
Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford

This report represents an application to the Shire of Serpentine-Jarrahdale to consider a proposed Structure Plan comprising Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford ("the subject land"). The subject land has a total area of approximately 48.67ha and is situated on the corner of Thomas Road and Kargotich Road, approximately 30km southeast of the Perth CBD, and 5km east of the Byford Town Centre.

The proposed Structure Plan will facilitate future subdivision to create Rural Residential lots with a Rural Living A zoning, incorporating a minimum lot size of 4000m^2.

The Structure Plan Summary Table below details the nature and key outcomes of the Structure Plan.

Table 1

ITEM	DATA	STRUCTURE PLAN REF (section no.)
Total area covered by the Structure Plan	48.67ha	Section 1.2
Area of each land use proposed: Rural Residential	48.67ha	Section 5.3

Part One - Implementation

Part One | Implementation

Proposed Structure Plan
Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford

1.0 Structure Plan Area

This Structure Plan shall apply to Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford, being the land contained within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan Map (**Plan 1**).

2.0 Operation

The date the Structure Plan comes into effect is the date the Structure Plan is approved by the WAPC.

3.0 Staging

Staging of the Structure Plan is not dependent upon any infrastructure triggers.

4.0 Subdivision and Development Requirements

4.1 Subdivision within the Structure Plan area is to be generally in accordance with the Rural Living A zoning depicted on the Structure Plan, with minimum lot sizes dependant on Scheme requirements and the provision of reticulated sewer.

4.2 Lots under 1ha in area must be connected to reticulated sewer infrastructure. All other lots must be serviced by an Alternative Treatment Unit that has nutrient stripping abilities.

4.3 Land use permissibility within the Structure Plan area shall be in accordance with the following:

Use classes permitted (P):
- Single Dwellings
- Public Recreation
- Public Utility

Discretionary Uses (AA)
- Ancillary Accommodation
- Home Occupation
- Stable

All other uses are prohibited.

4.4 At the time of subdivision, the following strategies and plans will be required via conditions of subdivision approval:

a) Urban Water Management Plan;
b) Geotechnical Report.

4.5 The Structure Plan has been prepared in respect of the development that is being prepared on the adjacent lot to the south of Lot 4 (Lot 207 Kargotich Road) and in respect of existing development on the lots to the east and south of Lot 2.

4.6 All indicative subdivision layouts shown in this Local Structure Plan and associated appendices are for conceptual purposes only and are subject to further investigation and detailed design at subdivision stage.

4.7 The proposed bund along the northern perimeter of Lot 2 (depicted on the Concept Plan), will be constructed as a condition of any subdivision approval that contemplates lots adjacent to it, to the extent of the proposed lots. The bund will be constructed in accordance with Local Government specifications and its purpose is to ensure compliance with *State Planning Policy 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use Planning*.

4.8 A landscaping and revegetation plan, and its subsequent implementation, will be required in support of any subdivision application. Nutrient stripping vegetation will be required to be planted in proposed swales to assist with nutrient management.

4.9 A street tree master plan shall be prepared, approved, and implemented by the developer as part of the subdivision implementation process.

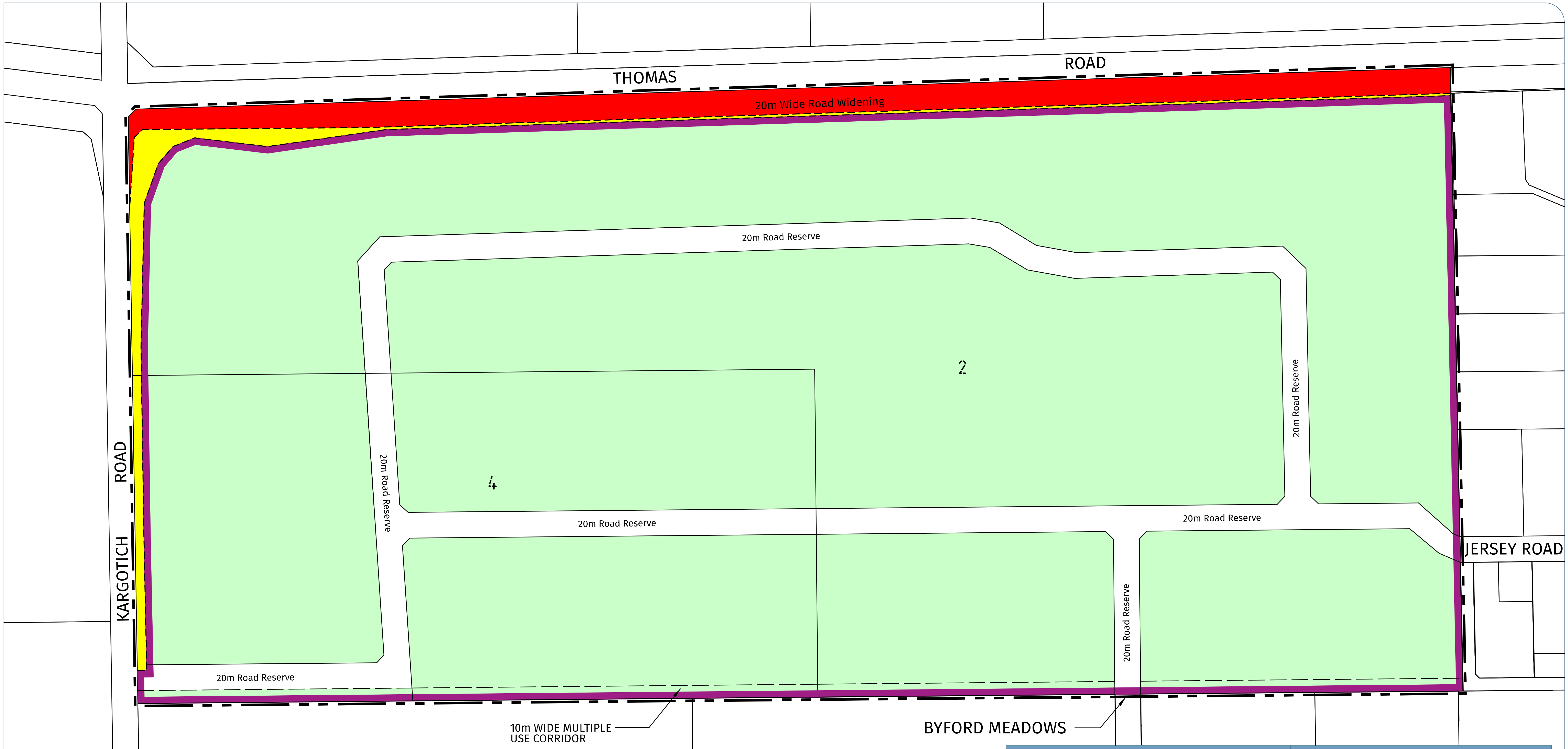
4.10 Stocking rates will be required to be in accordance with the stocking rates set by the Department of Primary Industries and Regional Development.

5.0 Local Development Plans

No Local Development Plans will be required for development within the Structure Plan area.

Plan 1

Structure Plan



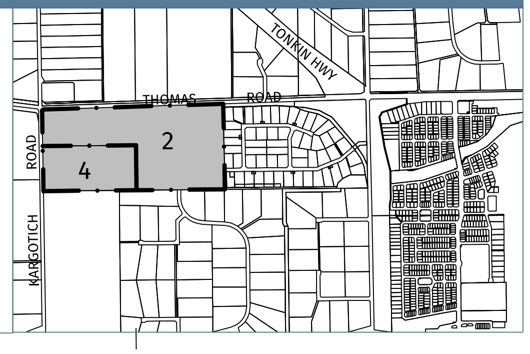
NOTE

1. Planning Control Area 161 has been depicted, in part, to identify land requirements for future road widening along Thomas Road and Kargotich Road and for the proposed intersection design.
2. The full length of Thomas Road abutting the Structure Plan area and the Thomas/Kargotich Road intersection may be subject to further road widening requirements as detailed design progresses, in consultation with MRWA and WAPC.

LEGEND

	Structure Plan Area
A	Rural Living A
	Primary Regional Road
	Planning Control Area 161

LOCATION PLAN



STRUCTURE PLAN

Lot 4 Kargotich Road & Lot 2 Thomas Road OAKFORD

Plan No. | 21396-05
Date | 27/01/21
Drawn | NP
Checked | CP
Revision | J

Scale | 1:3000@A3

0 40m 80m

PERTH & FORRESTDALE:
Lvl 1, 252 Fitzgerald St
PERTH WA 6000
1/2 Hensbrook Loop,
FORRESTDALE WA 6112
T: 08 9495 1947
E: metro@harleydykstra.com.au

ALBANY | BUNBURY | BUSSELTON | FORRESTDALE | PERTH

NOTE: This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey

Harley Dykstra
PLANNING & SURVEY SOLUTIONS

Part Two - Explanatory Report

Harley Dykstra

CONTENTS

APPENDICIES:

1.0 PLANNING BACKGROUND

1.1 Introduction and Purpose

This submission has been prepared by Harley Dykstra on behalf of our client, Goldlight Asset Pty Ltd, and the landowners of Lot 2 (HN 1842) Thomas Road and Lot 4 (HN 331) Kargotich Road, Oakford ("the subject land"). This Structure Plan has been prepared in conjunction with Amendment No.206 to the Shire of Serpentine Jarrahdale Town Planning Scheme No.2 which is progressing simultaneously. Amendment No.206 provides for the subject land to be rezoned from "Rural" to "Rural Living A" and includes the land within Appendix 4A – Rural Living A Zone of TPS2 with related land use controls and provisions.

This Structure Plan provides the associated framework to facilitate the subdivision and development of the land for rural residential land uses in a manner that interacts appropriately with the developing rural residential environment in this locality. The proposed development of this site represents a "rounding off" of rural living development in an area that is bounded by Thomas Road, Tonkin Highway Reserve, Gossage Road and Kargotich Road.

The Structure Plan will facilitate the development of rural residential lots in accordance with the Rural Living A zone of the Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2 (TPS No. 2). It is intended that where possible lots will be serviced by the extension of existing sewer services in the road reserve to the east, thereby allowing potential for lots to be created smaller than 1ha in size, with a minimum lot size of 4000m^2.

This report is accompanied by a Structure Plan (**Plan 1**), which is included at Part One of this Report, prepared in accordance with the Planning and Development (Local Planning Scheme) Regulations and TPS No. 2.

The Explanatory section of this Structure Plan Report includes a detailed description of the proposal, provides an evaluation of the relevant town planning, local water management, bushfire and servicing considerations applicable to the land, and details the rationale supporting the proposed Structure Plan.

The Structure Plan has been formulated by Harley Dykstra in collaboration with specialist consultants, who have provided input in relation to matters as follows:

Porter Consulting	-	Engineering and Servicing Design
Flyt Pty Ltd	-	Traffic Assessment
Lush Fire	-	Bushfire Management Plan
Douglas Partners	-	Geotechnical Investigation
Ecoscape Australia	-	Environmental Assessment
Hdy2o	-	Local Water Management Plan
Lloyd George Acoustics	-	Transportation Noise Assessment

1.2 Site Context

The subject land (see **Figure 1**) is located in Oakford and is situated approximately 30km southeast of the Perth CBD, and 5km east of the Byford Town Centre. It is located on the south eastern corner of Thomas Road and Kargotich Road. Nearby development includes similar rural living estates to the east and south with lot sizes ranging between 4,000m^2 and 2 hectares within those estates. Other estates to the north also comprise rural residential development, but land to the west is used for rural purposes.

Lot 2 Thomas Road is 35.1746ha in area and has frontage to Thomas Road, Kargotich Road, Byford Meadows Drive and Jersey Road. Lot 4 Kargotich Road is 13.4984ha in area and has frontage to Kargotich Road. The total area subject to the proposed Local Structure Plan, is therefore, 48.6748ha.

Figure 1 – Subject Land

The subject land is located within the Shire of Serpentine Jarrahdale, with lots to the west comprising existing rural land and lots to the north, east and south comprising a mixture of rural residential/special rural and rural land. Land to the south of Lot 2, which fronts Kargotich Road (Lot 207), is currently undergoing a scheme amendment to convert the existing rural zoning to “Special Rural” with a minimum lot size of 2ha. The scheme amendment for that site is still in the process of being finalised by the WAPC.

The subject land currently accommodates a dwelling on each lot, a caretakers dwelling on Lot 2 and a number of associated outbuildings on each lot. The rest of the site comprises open pasture and limited vegetation.

1.3 The Subject Site

Table 1 below provides details in respect to the legal ownership of the subject land.

Copies of Certificates of Title and Sketches are included at **Appendix A.**

Lot No.	House No.	Plan / Diagram	Volume	Folio	Registered Proprietor(s)
4	331	64846	1644	900	Asterdell Corporation Pty Ltd
2	1842	63571	1645	575	Tuscanny Management Pty Ltd care of Gilmour Thornett and Jefferies

Both Lot 2 and Lot 4 are affected by an easement noted on the title in favour of the State Energy Commission of Western Australia. The easements reflect the presence of a high voltage power line corridor traversing the lots. The easement and corridor are recognised both in this document and in the concept plan for potential development of the subject lots.

Lot 4 is also affected by a drainage easement in favour of the Shire of Serpentine-Jarrahdale lying immediately adjacent to the Kargotich Road reserve. No change is proposed to this drain as a result of this proposal.

2.0 PLANNING CONTEXT

2.1 State Planning Framework

2.1.1 Metropolitan Region Scheme

Land generally surrounding the site is zoned "Rural", reflecting both the broad acre farming and rural-residential use of the land. Approximately 1km east of the subject site, land is reserved for "Primary Regional Roads" (PRR) for the extension of Tonkin Highway. East of this PRR reservation is the "Urban" zoned Byford residential area.

The majority of the subject land is zoned "Rural" under the Metropolitan Region Scheme (MRS). An "Primary Regional Roads" (PRR) reservation covers a 20m wide portion of the site along the northern boundary of Lot 4 for the future widening of Thomas Road.

A copy of the Clause 42 MRS Certificate that relates to the reservation is included in **Appendix B**. The reservation of a portion of the land for PRR has been accommodated in concept planning for the subject site. Acquisition of the PRR land area is to be considered separately and in parallel to this submission.

This proposed Structure Plan request is entirely consistent with the MRS "Rural" zoning of the land and respects the PRR reservation as outlined.

2.1.2 Perth and Peel@3.5 Million

The Perth and Peel@3.5 Million suite of documents released by the WAPC seek to provide a planning framework for the Perth and Peel Regions as they grow to a population of 3.5 million people by 2050. The strategy is supported by "sub-regional planning frameworks". The subject site lies within the 'South Metropolitan Peel Sub-Regional Planning Framework.

Whilst the land was identified in the South Metropolitan Peel Sub-Regional Planning Framework for "Urban Expansion", it is noted that the final adopted version of the document identifies the subject site for Rural Residential development. This change ensures the site accords with the Shire of Serpentine Rural Strategy that depicts this site for Rural Living development.

Although the sub-regional planning framework indicates that Rural Residential development generally comprises lots between 1 and 4 hectares, in this instance smaller lots sizes, down to 0.4ha can be considered because of the provision of reticulated sewer, the Shire of Serpentine Jarrahdale Rural Strategy (refer to section 2.3.3 below), and proposed Scheme Amendment No. 206 (refer to section 2.3.1 below). In summary, there are specific provisions with the Scheme Amendment document and the Rural Strategy that permit lot sizes at a minimum of 4,000m^2, provided there is a connection to reticulated sewer.

2.2 State Planning Policies

2.2.1 State Planning Policy 2.1 – Peel Harvey Coastal Plain Catchment

The Peel-Harvey Coastal Plain Catchment Policy seeks to ensure that land uses occurring within the Peel-Harvey estuary system are managed to minimise impact and coordinated through planning frameworks. The subject land lies within the policy area. SPP 2.1 includes provisions relating to the development of land for rural-residential purposes (lots over 4,000m²) and identifies requirements for on-site effluent disposal.

2.2.2 State Planning Policy 2.5 – Land Use Planning in Rural Area (SPP2.5)

SPP 2.5 establishes the objectives for the management and protection of rural and rural living land in Western Australia. Under Clause 4.3 of the Policy, the WAPC recognises that there is a market for rural living development, and that it provides for a range of housing and lifestyle opportunities. The policy notes, however, that this type of use can sterilise rural land and should be carefully planned. The policy notes the guidance of SPP 3 with respect to the strategic identification of settlement patterns and guidance on rural living use.

This Structure Plan is consistent with the strategic planning framework endorsed by the WAPC and Shire of Serpentine-Jarrahdale as outlined in Table 2.

Table 2 – Analysis of Proposal under SPP 2.5 Rural Planning (Clause 5.3 – Rural Living)

SPP 2.5 Policy Criteria Measures to apply in decision making for rural living (Clause 5.3)	Analysis of this Scheme Amendment Request
(a) *Rural living proposals shall not be supported where they conflict with the objectives of this policy or do not meet the criteria listed at 5.3 (b) and (c)*	
(b) *The rural living precinct must be part of a settlement hierarchy established in an endorsed planning strategy;*	The subject site is identified within the Shire's Rural Strategy as endorsed by both the Shire and WAPC.
(c) *The planning requirements for rural living precincts are that:* i. *The land be adjacent to, adjoining or close to existing urban areas with access to services, facilities and amenities;*	The proposal represents the final 'round-off' of the identified and well-established rural-residential corridor between Tonkin Highway and Kargotich Road. The land lies immediately west of the planned urban residential area of Byford and has access to the urban services and facilities provided there.
ii. *The proposal will not conflict with the primary production of nearby land, or reduce its potential;*	The land does not impact on or prejudice the continued broad acre rural uses west of the site.
iii. *areas required for priority agricultural land are avoided;*	The subject site is <u>not</u> identified for priority agricultural use.
iv. *the extent of proposed settlement is guided by existing land supply and take-up, dwelling commencements and population projections;*	The Rural Strategy as endorsed identifies the subject site for Rural Living as proposed and notes the demand for this land use. The Strategy notes that the population of the Shire will grow some 128% by 2036, realising a significant demand for new housing. The subject site is the most conveniently accessible remaining land of this use type, with the majority of all nearby rural living

		land already developed. The proposal will create a mix of lot sizes not otherwise provided for in the immediate locality.
v.	*areas required for urban uses are avoided;*	The subject site is not intended for urban use and has been endorsed for rural living use by both the WAPC and Shire within the Shire's Rural Strategy. Finalisation of the Sub-Regional Planning Framework (WAPC March 2018) has identified the land as 'Rural-Residential' consistent with the approved Shire Rural Strategy and surrounding land uses].
vi.	*Water supply shall be as follows – where lots with an individual area of four hectares or less are proposed and a reticulated water supply of sufficient capacity is available in the locality, the precinct will be required to be serviced with reticulated potable water by a licensed service provider. Should an alternative to a licensed supply be proposed it must be demonstrated that a licensed supply is not available; or – where a reticulated supply is demonstrated to not be available, or the individual lots are greater than four hectares, the WAPC may consider a fit-for-purpose domestic potable water supply, which includes water for firefighting. The supply must be demonstrated, sustainable and consistent with the standards for water and health; or – the development cannot proceed if an acceptable supply of potable water cannot be demonstrated;*	An existing reticulated water service to the immediate east of the subject site can be extended to service all proposed lots.
vii.	*electricity supply shall be as follows – – where a network is available the precinct is to be serviced with electricity by a licensed service provider, or – where a network is not available, the precinct is to be serviced by electricity from renewable energy source/s, by a licenced service provider, and this has been demonstrated;*	An existing power supply to the east of the subject site can be extended to service all proposed lots.
viii.	*the precinct has reasonable access to community facilities, particularly education, health and recreation;*	The subject site is relatively close to planned community facilities within

		the established urban area to the east.
ix.	*the land is predominantly cleared of remnant vegetation, or the loss of remnant vegetation through clearing for building envelopes, bushfire protection and fencing is minimal and environmental values are not compromised;*	The subject site is mostly cleared of vegetation, having been long used for grazing purposes. A full feature survey has established the locations of all trees to facilitate tree retention where possible and guide the formulation of a concept plan.
x.	*the proposal demonstrates and will achieve improved environmental and landscape outcomes and a reduction in nutrient export in the context of the soil and total water management cycle, which may include rehabilitation as appropriate;*	Environmental and land capability, together with site specific geotechnical testing demonstrate the land is suitable for development as proposed. There are no environmentally sensitive areas within the subject site. A substantial portion of the development would be serviced by reticulated sewer, thereby minimising the potential nutrient loading from development.
xi.	*the land is capable of supporting the development of dwellings and associated infrastructure (including wastewater disposal and keeping of stock) and is not located in a floodway or an area prone to seasonal inundation;*	A substantial portion of the development would be serviced by reticulated sewer, thereby minimising the potential nutrient loading from development. Those properties not being serviced by sewer have been assessed as suitable for on-site effluent disposal through the use of alternate treatment units (ATU's).
xii.	*the land is not subject to a separation distance or buffer from an adjoining land use, or if it is, that no sensitive land uses be permitted in the area of impact;*	The subject site is not affected by a buffer from an adjoining or nearby land use.
xiii.	*the lots can be serviced by constructed road/s capable of providing access during all weather conditions, including access and egress for emergency purposes; and*	The lots created by this rezoning can be readily connected to the wider road network and be accessible at all times.
xiv.	*bushfire risk and natural hazards can be minimised and managed in accordance with State policy, without adversely affecting the natural environment. Proposals in areas of extreme bushfire risk will not be supported;*	Bushfire risk will be addressed through implementation of the Bush Fire Management Plan completed. Fire risk can be readily managed without any impact on the natural environment.
(d)	*development standards for rural living zones are to be included in local planning schemes;*	Development standards are established in TPS2 and discussed further in this report.
(e)	*further subdivision of existing rural living lots into smaller parcels is not supported, unless*	Not applicable to this proposal.

	provided for in a local planning strategy and/or scheme; and	
(f)	*rural strata proposals with a residential component are considered to be rural living and will be considered in accordance with the criteria listed at clauses 5.3 (a), (b) and (c) of this policy.*	Not applicable to this proposal.

This proposed Structure Plan is demonstrably consistent with SPP 2.5 and the criteria contained therein.

2.2.3 State Planning Policy 3 – Urban Growth and Settlement (SPP 3)

SPP 3 identifies the need for rural residential settlements to be located and designed in a sustainable way which is integrated with the overall pattern of settlement. Specifically, SPP 3 states that planning for rural residential development should:

- *avoid productive agricultural land, important natural resources, areas of high bush fire risk or environmental sensitivity;*
- *avoid future urban areas or areas particularly suitable for urban development in terms of their characteristics and proximity to urban services;*
- *give preference to locations near existing settlements with available services and facilities in order to support the local community and avoid locations where services are not available or costly extensions are necessary;*
- *minimise potential for conflict with incompatible activities associated with productive rural uses or natural resource management;*
- *only include locations which are suitable for this type of development, such as land which is topographically varied, visually attractive and with distinctive environmental attributes or otherwise has potential for lifestyle pursuits; and*
- *take a realistic approach by allocating land based on forecast estimates of demand for rural living not on the speculative development of land.*

This Structure Plan is considered to be consistent with SPP 3. Specifically, the land has been considered to be best suited to rural residential lot sizes, it avoids future urban areas (as confirmed by WAPC support of the RSR) and can be serviced, including the provision of water, power, telecommunications and, to a portion of the site, reticulated sewer.

2.2.4 State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP3.7)

SPP 3.7 requires that any Structure Plan incorporate a Bushfire Hazard Level assessment to consider hazard levels. The policy notes that development should occur only where moderate or low hazard rating can be achieved.

Lush Fire & Planning have completed a Bushfire Management Plan (BMP) for the subject site, in accordance with SPP 3.7 and having regard to the form of development contemplated. The detail within the BMP is discussed further in this report, but nevertheless demonstrates compliance of the proposal with the objectives of SPP 3.7.

2.2.5 State Planning Policy 5.4 – Road and Rail Noise (SPP 5.4)

SPP 5.4 requires that "Sensitive Land Uses" (as defined within SPP 5.4) within 300m of a "Primary Regional Road" be assessed against the noise criteria provided in SPP 5.4. The policy requires that future dwellings will not be subject to noise levels above the assigned maximum noise levels produced by passing traffic. If noise levels do exceed the maximum level notifications are required to be placed on future titles and sensitive uses, such as residential dwellings, are to be constructed to prescribed standards that provide protection against higher noise levels.

In a response to the requirements of this policy an Acoustic Study has been completed by *Lloyd George Acoustics*, is discussed in further detail below and demonstrates compliance with the requirements of the policy.

2.2.6 Government Sewer Policy

The Government Sewer Policy came into effect in 2019 following a period of review after the receipt of numerous submissions. The subject land is to be developed for rural-residential purposes and is expected to provide both lots serviced by reticulated sewer, as well as a limited number of unsewered lots. This is discussed further in the servicing comments contained within this report.

Importantly the identified objectives of the policy are:

- To protect public health and amenity;
- To protect the environment and the State's water and land resources;
- To promote the efficient use of infrastructure and urban land; and
- To minimise costs to the broader community by ensuring an appropriate level and form of sewerage servicing is provided.

In respect of the above, it should be noted that this subdivision and development of the land will occur in accordance with this policy. Lots that are not expected to be serviced by reticulated sewer have been designed to meet the policy's identified 1ha minimum..

2.3 Local Planning Framework

2.3.1 Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2

Existing Zoning

The subject land is identified as "Rural" in the Shire of Serpentine-Jarrahdale's Town Planning Scheme No. 2 (TPS 2), as outlined in **Figure 2**. The MRS Primary Regional Road reservation outlined in above is also reflected. Heritage Item 26 is identified on the Scheme Map and is discussed further in this report.

Land to the south of Lot 2 is zoned Special Rural (SR 20) and land to the east of Lot 2 is zoned Rural Living A (RLA 10). Land to the south of Lot 4 is zoned Special Rural (SR27). Other land surrounding the site is a mixture of Special Rural and Rural.

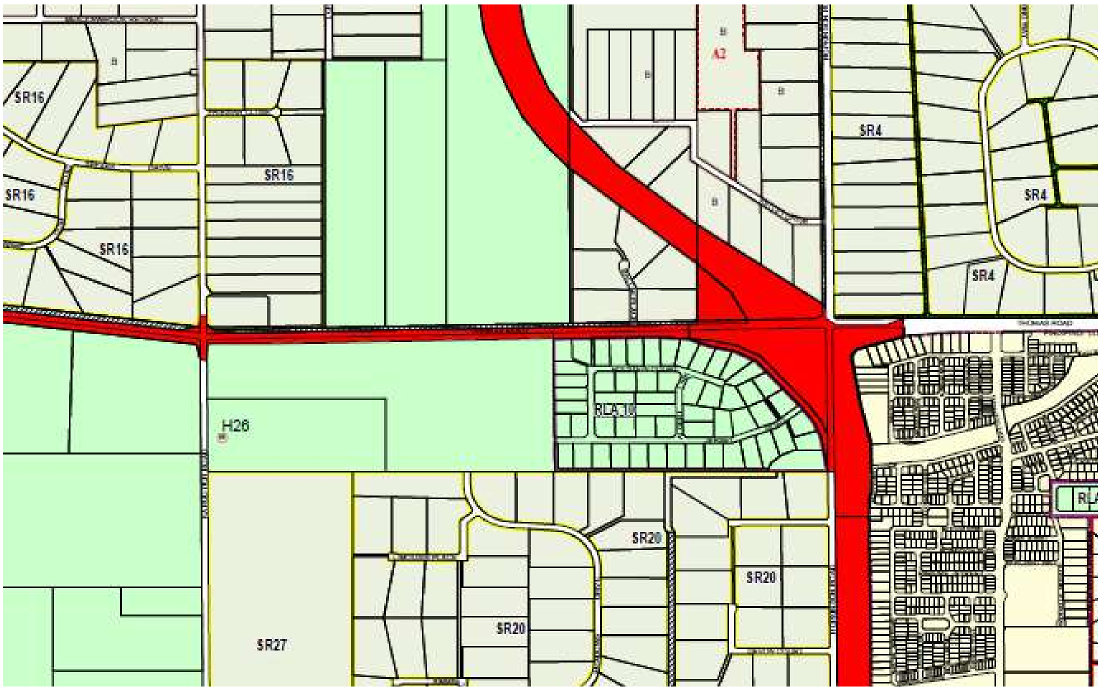


Figure 2: Town Planning Scheme No. 2 – Zoning Extract

<u>Scheme Amendment No. 206</u>

The Shire of Serpentine Jarrahdale has adopted the rezoning of the subject land from "Rural" to "Rural Living A" under Amendment 206 to TPS2. Furthermore, following assessment by the WAPC, the Minister for Planning has requested that the amendment be modified under Section 87 (1) of the *Planning and Development Act 2005*. These amendments have been completed and submitted to the WAPC to enable the imminent gazettal of the amendment.

This Structure Plan directly reflects Amendment No.206 and is submitted in that context.

<u>Town Planning Scheme Provisions</u>

In addition to the zoning of the land under TPS2, a number of scheme provisions are of relevance to this proposal. They are outlined below and have been addressed in the preparation of this submission and the supporting technical information.

Clause 5.12.5 makes reference to the requirement for landowners to prepare a submission in support of a request to rezone land for Rural Living A purposes and make reference to matters outlined in Clause 5.9.3, which are identified in Table 3. These details were addressed as a part of Amendment 206 for the land and are retained in this document:

Table 3 – Analysis of Proposal Under Clause 5.9.3 of TPS 2

Clause 5.9.3 of TPS2 - Measures for Proposals to Rural Living	**Analysis of this Scheme Amendment Request**
Any submission shall include: *(a) the objectives of the proposal;*	These are identified within this report.

(b)	*the reasons for selecting the particular area, and* ***how it relates to the Council's adopted Rural Policy****;*	The land is identified within Council's Rural Strategy for the proposed use. The merit of the proposal is further outlined herein.
(c)	*an* ***analysis of the physical characteristics of the subject land such as geology, soil types, landform, vegetation cover, skylines, vistas, and natural features****;*	The physical characteristics of the land have been assessed in Part 3 of this report and the accompanying technical appendices.
(d)	*a* ***plan showing contours at two metre intervals and any physical features such as existing buildings, rock outcrops, trees or groups of trees, lakes, rivers, creeks, wells and any significant improvements****;*	A full feature survey identifying all features forms part of the documentation within this request.
(e)	*information regarding the* ***method whereby it is proposed to provide a potable water supply*** *to each lot;*	A reticulated water supply is identified as being able to be extended from immediately east of the subject site.
(f)	*the proposed staging of the development and any development provisions which may be required; and*	Anticipated staging of the development is identified in this report.
(g)	*any other information the Council may reasonably require.*	Hydrology, environmental, traffic and fire management reporting are all incorporated.

2.3.2 Proposed Shire of Serpentine-Jarrahdale Local Planning Strategy and LPS NO. 3

It is acknowledged that the Shire has recently forwarded the draft Local Planning Strategy to the WAPC for review and determination.

The current draft strategy indicates that the subject site has been designated as Special Residential development which can provide for lots as small as 4,000m^2. Accordingly, this request is consistent with the draft Local Planning Strategy.

2.3.3 Shire of Serpentine-Jarrahdale Rural Strategy Review 2013

The Shire has recently completed a review of its Rural Strategy (RSR), which was adopted by the WAPC in December 2017 following a number of required modifications.

The Rural Strategy identifies the subject land as "Rural Living 'A' (4000m^2 to 1 ha lots)". Section 4.3 of the RSR provides further guidance regarding the Rural Living Policy Area. The RSR states that:

> *The Rural Living Policy Area provides an opportunity for residential uses in a rural setting. The opportunity for this style of development is becoming harder to find in the metropolitan area and is one of the key characteristics associated with the Shire of Serpentine Jarrahdale. Rural Living development in this instance provides both a mechanism to house a growing population while*

maintaining the rural character and landscape that has been recognised as being of significance to the identity of the Shire.

Furthermore, of particular interest to the subject land, a specific provision in the Strategy (within Section 4.3) notes that a minimum lot size of 1 hectare is applicable to the subject site, unless a connection to reticulated sewer is provided. This is provided in respect of Clause 5.12.4 *of Town Planning Scheme No. 2* that promotes a minimum lot size of 1 hectare for sites where land capability requires a larger lot size. As such, it is implied that a sewer connection resolves the land capability question. Accordingly, Amendment No.206 and this Structure Plan will facilitate subdivision of the site in accordance with this requirement and the broader objectives of the Rural Strategy.

The RSR also outlines a series of key objectives for the Rural Living Policy Area, which are as follows:

- *Provide for additional choice in style and location of residential land not available within the Shire's urban nodes.*
- *Maximise the provision, use and efficiency of infrastructure available in and around the Shire's urban nodes.*
- *Restrict rural land uses that are not generally compatible with maintaining residential amenity.*
- *Provide opportunities for development that maintains rural character and promotes appropriate land management.*
- *Provide for a diversity of lot sizes ranging from 0.4 and 4 hectares.*
- *Provide opportunity for low-key tourism, such as Bed & Breakfast accommodation*
- *Protect Local Natural Areas and encourage revegetation.*

The RSR notes that subdivision in Rural Living Policy Areas should occur in a co-ordinated manner and be pre-empted by an amendment to TPS 2 that includes a Subdivision Guide Plan (this Structure Plan) and associated scheme provisions.

2.3.4 Local Planning Policy 9 – Multiple Use Trails (LPP 9)

LPP 9 sets out the Shire's framework for a network of multiple use trails that provide for walking (including the use of motorised wheelchairs), hiking, cycling, horse riding (including horse drawn vehicles) and other non-motorised recreational uses.

This Structure Plan recognises and extends the adjoining multiple use trail along the southern boundary of the subject site to ensure its continuation and connectivity.

2.3.5 Local Planning Policy 57 – Housing Diversity (LPP 57)

Two of the objectives of LPP 57 are to:

- *Promote and facilitate increased housing diversity and choice to meet the changing housing needs of the Shire community; and*
- *Provide a diverse range of housing types to meet the needs of residents which vary based on income, family types and stages of life, to support the growth of sustainable communities.*

The proposed Structure Plan will facilitate the provision of rural-residential housing, which will contribute to the continued diversity of housing availability within the Shire. More importantly, within the Oakford-Byford area where substantial urban residential development in recent years has significantly outweighed the availability of this lot product, it is expected to be highly sought after.

3.0 SITE ANALYSIS

3.1 Landform & Topography

The site slopes gently from centrally within the subject site, around the existing dwellings, to the west and east with ground surface levels around the dwellings peaking at 26m AHD and falling to levels between 23 and 24m AHD on the eastern boundary and 22mA AHD on the western boundary.

3.2 Historic Land Use

Historic Landgate aerial photography shows that the land has been cleared and grazed since at least 1953 and that no other land uses have occurred on the property since that time. There is no visual or other evidence on site or on aerial photographs of any contentious land uses that might warrant further review.

3.3 Soil & Geology

The subject land is characterised by soils consistent with those identified in the Guildford Formation with sandy/silty clay soils. Drilling at a number of different locations across the subject land found soil profiles that consist of grey-brown, medium grained top soil, with varying amounts of silt and clay that morphs into grey-brown and orange-brown medium grained sand with some silt/clay underneath the topsoil layer. The layer underneath the topsoil was encountered at depths ranging between 0.7m and 2.3m below ground level. Full details are provided in the geotechnical report prepared by Douglas Partners, as attached at **Appendix C**.

3.4 Acid Sulphate Soils

Site specific geotechnical testing completed by Douglas Partners concludes that the site is not subject to acid sulphate levels that may require further management.

Douglas Partners conclude, with further explanation, that testing results are not “strongly indicative of actual acid sulphate soil conditions at the test locations to a depth of 2.5m”. The results from testing produced two “exceedances” of the relevant action criteria, however, these were concluded to be of “low significance”. A full explanation of these findings is provided in the report. Douglas Partners note that no further requirements are necessary regarding this, having regard to the type of development proposed where limited excavation will occur.

3.5 Land Capability

A portion of the site will be serviced by reticulated sewer, though a number of lots will be required to dispose of effluent onsite. The geotechnical report, as attached in **Appendix C**, indicates that lots greater than 2,000m^2 are capable of disposing of effluent onsite provided that they meet the criteria detailed in the report (Criteria include the use of alternative treatment systems including Aerobic Treatment Units, and the proper maintenance of primary effluent treatment systems). All lots disposing of effluent onsite will be greater than 1ha in size, in accordance with the Government Sewerage Policy, and as such, these lots are considered adequate for onsite effluent disposal subject to the implementation of the above criteria.

The keeping of horses and livestock will be limited by the stocking rates provided by the Department of Primary Industries and Regional Development. It is noted that “Stables” is a discretionary use in the zone, which ensures that Development Approval needs to be sought for the keeping of horses on each lot, providing the Local Government with the regulatory power to ensure that stocking rates are adhered too.

3.6 Vegetation – Flora and Fauna

An Environmental Investigation Report has been prepared by Ecoscape Australia in accordance with Environmental Protection Authority (EPA) guidelines and standards (including both desktop and field visit). The investigation also considered matters of national Environmental significance (under the Federal Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)).

The report concludes that the site has "little or no significance" as a general fauna habitat given the completely degraded nature of the site and the lack of an understorey of vegetation to support a diverse fauna assemblage. Furthermore, the degraded nature of the site also indicates that there are no vegetation communities or protected flora at the subject site.

The report adopts a precautionary approach to the management of potential black cockatoo habitats. Six trees have been identified on the site as having the potential to be utilised by black cockatoo species as breeding, foraging or roosting habitat, however, it is important to note that no actual evidence of cockatoo roosting/feeding was observed. The report concludes that when considering the vegetation in the context of the surrounding landscape, the areas of potential habitat on the subject site are considered to be of <u>low significance</u>. Therefore, the potential for the removal of black cockatoo habitat vegetation should only be referred to the Commonwealth if any of the 6 trees in question are proposed to be removed as a part of the development process of the site. All of these trees can be retained, ensuring that no such referral would be necessary.

Further information on the state of existing vegetation is provided in the Environmental Report, as attached at **Appendix D**. Importantly, no findings preclude progression of this Structure Plan as proposed.

In regards to proposed revegetation, this will occur within road verges, on bunds and within proposed swales. Planting in road verges will comprise street trees interspersed at even locations along road frontages, with one generally occurring in front of each lot. Planting on the proposed bund, along the Thomas Road frontage, will comprise a series of shrubs and small trees that would be suitable for planting on the slope of the bund. Planting in swales will occur in accordance with the purpose of the swale (drainage).

A landscaping plan, that will provide comprehensive planting detail, can be required in support of any subdivision application, given that the final detail on lot layout will be known at that stage.

3.7 Wetlands

The Environmental Report, prepared by Ecoscape Australia, has indicated that a review of the DBCA Geomorphic Wetlands dataset indicates the presence of a number of Multiple Use Category Wetlands occurring across the subject site. Importantly, a review of the mapping indicated that there are no RAMSAR Wetlands within a 5km radius of the subject site.

The presence of Multiple Use category wetlands and the lack of any environmentally important wetlands indicate that there is no hindrance to the development of the site. Rather, development should simply be managed so that the existing hydrology of the area is preserved. Further details are provided in the environmental report attached at **Appendix D**.

3.8 Groundwater and Local Water Management

A Local Water Management Strategy has been prepared by Hyd2o utilising Better Urban Water Management principles. The general approach to stormwater management includes the use of roadside swales, maintenance of existing surface water flow paths, proposed swales at the rear of the smaller lots and the use of a drainage corridor in the natural low point of the site.

In regards to groundwater, Hyd2o Groundwater Plan **(Appendix E)** indicates an average depth to groundwater of between 19.37 and 23.96m AHD. Furthermore, onsite testing completed as a part of the geotechnical investigation indicate that groundwater is greater than 1.6m below surface level in all pits, which is generally consistent with existing mapping.

3.9 Heritage

3.9.1 Aboriginal Heritage

The Department of Planning, Lands and Heritage Aboriginal Heritage Inquiry System is managed in accordance with Clause 5.38 of the Aboriginal Heritage Act (1922) and contains details on Registered Aboriginal Sites and other heritage places in Western Australia. A search of the online AHIS enquiry system indicated no registered or other sites of heritage significance in proximity to the subject land.

3.9.2 European Heritage

Lot 4 contains an existing homestead, known as 'Bateman Homestead' which is identified as Item 26 within Appendix 7 of TPS 2 Schedule of Places of Natural Beauty, Historical Buildings and Objects of Historical or Scientific Interest. The homestead is also referred to in the Shire's Municipal Inventory.

A search of the Heritage Council of WA's online portal for heritage places and listings identified the homestead as Place Number 08479. A copy of the listing comprises **Appendix F** to this report. The homestead is significant as one of the earlier homesteads in the Byford district and built be the well-known Bateman family.

While considering a land use approval matter for Lot 4 in 2010, the Shire of Serpentine Jarrahdale noted with respect to the homestead, and the Municipal Heritage Inventory that *"The management category assigned to the homestead under the Municipal Inventory is 'Conservation Highly Recommended'"*. The Council report at that time noted that any approval being granted would *"..not adversely impact upon the heritage homestead in any way"*.

In this instance the Structure Plan merely seeks to facilitate subsequent subdivision approval of the land, with a concept plan that can readily accommodate retention of the homestead. No works to or modification of the homestead are contemplated. The proposal is therefore not going to impact upon the heritage homestead in any way.

3.10 Bushfire Hazard

A Bushfire Management Plan has been prepared by Lush Bushfire Consulting and it concludes that compliance with State Planning Policy 3.7 – Planning for Bushfire Prone Areas, can be achieved.

In particular, the future dwellings/lots will be subject to potential radiant heat levels of less than BAL 29, the site is well connected to the surrounding road network and is connected to a reticulated water supply. The Bushfire Management Plan also requires the ongoing management of the subject site to ensure that bushfire hazards are not produced or intensified by the proposed development. The Bushfire Management Plan has been included at **Appendix G**.

While the Bushfire Management Plan identifies a number of matters including emergency access, building envelopes and the like – and these can be readily addressed – for the purpose of this Local Structure Plan, the BMP adequately demonstrates compliance with SPP3.7 can be achieved, noting that a BMP will also be required in support of any subdivision application.

3.11 Acoustic Impact

A Transportation Noise Assessment has been prepared by Lloyd George Acoustics in response to the requirements of State Planning Policy 5.4 – Road and Rail Transport Noise and Freight Considerations in Land Use Planning (SPP 5.4). The report requires the implementation of a number of measures to ensure that future dwellings would be constructed at an acceptable standard that does not result in the noise levels produced by nearby Thomas Road exceeding the maximum noise levels permitted under the policy. Primarily, these include the establishment of a 3m high earthen bund and/or wall and quiet house design construction packages for selected dwellings. Notifications on the certificates of title for all affected lots are also suggested.

The complete report has been attached at **Appendix H**.

4.0 INFRASTRUCTURE SERVICING

A Servicing Report has been prepared by Porter Engineering. The report indicates that services (power, water, telecommunications and sewer) are available to the site, and importantly, it also confirms those lots less than 1ha, as identified on the Subdivision Concept Plan, are able to be serviced by reticulated sewer. The findings of the report are summarised below and further details can be found in the servicing report, as attached at **Appendix I**.

4.1 Sewer

Porter Consulting Engineers have advised that the existing Wastewater Pumping Station immediately east of the subject site on Jersey Road can be extended via a sewer mains extension into the subject land. This advice has been confirmed with Water Corporation.

The extent of the subject site to be provided with reticulated sewer is influenced by the extent of the serviceable wastewater catchment given minimum pipe grades, required pipe cover and service levels. Generally, the eastern portion of the site is able to be sewered, whilst the western side, because of topographical constraints, is difficult without the substantial placement of Final lot yield will be subject to detailed sewer design whereby all lots below 1 hectare are to be provided with a reticulated sewer connection consistent with the Government Sewer Policy.

Importantly, the sewer serviceability of the land has both been reviewed by Porter Consulting Engineers and discussed with the Water Corporation directly ahead of Structure Plan progression. In regard to lots not serviced by sewer, these will be provided with alternate treatment units as outlined within this report and consistent with the geotechnical review of the site's capability. These lots have been kept to a minimum, having regard to design and sewer service. The following is extracted from the Porter Consulting advice (See **Appendix I**):

"this concept is subject to change but indicated a likely catchment scenario based on realistic site and development constraints. The wastewater catchment is dictated by minimum pipe grades, pipe cover and servicing levels.

The Water Corporation, via email, have confirmed their existing infrastructure has sufficient capacity to cater for these lots and their planning will be formally revised once the land has been rezoned.

The balance of the lots will be serviced via traditional on site disposal."

4.2 Power

There are a number of overhead and underground power lines within close proximity to the site. Furthermore, there is a high voltage overhead power line that runs through the site as well, which is protected by an easement. Proposed development will occur in respect of that easement. The servicing report concludes that underground power can be extended in to the site.

4.3 Water

Existing water mains are located within Jersey Road and can be readily extended in to the site as demonstrated in the servicing report.

4.4 Telecommunications

Existing telecommunications infrastructure is located in the vicinity of site and can also be extended within it in order to service the various lots that will be facilitated by the adoption of this Structure Plan.

4.5 Drainage Infrastructure

The servicing report indicates that drainage can occur utilising a similar approach to the existing development to the east of the site. A series of road side drains and culverts can be proposed that ultimately drain into drainage reserves contained on the eastern portion subject site. The report notes that the western third of the site can be drained through the provision of oversized road side swales.

4.6 Gas

No gas infrastructure exists in the vicinity of the subject land.

4.7 Movement Network

The subject land is well connected by road to the wider metropolitan area. Kargotich Road has a direct connection to Thomas Road, which provides subsequent connections to the nearby Tonkin Highway, approximately 500m east of the site, and Kwinana Freeway to the east. Tonkin Highway is identified to be extended further south towards Mundijong, providing additional locational advantages for the subject site. Jersey Road and Byford Meadows Drive are sealed roads (20m wide reserves) servicing adjacent rural living development and are to be extended in to the subject site.

A traffic impact statement, prepared by Flyt, is attached at **Appendix J**. It provides a review of the existing road network, including intersection standards, and provides analysis on the additional traffic impact that the proposed development will create. The report confirms that the proposed and existing extensions to the road network are capable of accommodating the additional traffic generated by the proposed development.

5.0 LAND USE AND SUBDIVISION REQUIREMENTS

5.1 Overview

This Structure Plan has been prepared in accordance with the requirements of the Planning and Development (Local Planning Schemes) Regulations 2015. The LSP provides a broad framework for subdivision and development and identifies the key land use and movement network considerations.

Key features of the LSP are as follows:

a) **Lot sizes, with an approximate range from 4,000m² to 2ha** – the Structure Plan provides for potential lot sizes that accord with the requirements of TPS 2 and the RSR and will enable a more diverse range of additional housing options to be provided within the Oakford community. The subdivision of lots that are smaller than 1 hectare in size will only be permissible in the instance that they can be connected to reticulated sewer;

b) **Thomas Road Widening** – the LSP recognises for the proposed future widening of Thomas Road, in accordance with the Primary Regional Roads reservation, by recognising a 20m wide strip along the northern perimeter of Lot 2. This has been provided for in accordance with the Clause 42 notice and is the subject of a separate request for acquisition;

c) **New roads** – a series of new 20m road reserves are proposed, providing access and facilitating the proposed drainage of the subject land. The proposed design utilises the existing and proposed road network that surrounds the site, by proposing extensions of Jersey Road, Byford Meadows Drive and the north-south road proposed as a part of the scheme amendment process on Lot 207, to the south. In addition to a proposed connection with Kargotich Road;

d) **Multiple Use Path** – a 10m wide multiple use path has been provided along the southern boundary of the subject site. This multiple use path is an extension of that which is located in the development to the east of the site.

The Structure Plan has been prepared to guide the development of the site for rural living subdivision. The Structure Plan will contribute to the development of a high quality, liveable rural living estate offering a diversity of lot products that is well located in relation to the movement network.

The Concept Plan included at **Appendix K** depicts potential subdivision of the site. In regards to lot layout and design depicted on the Concept Plan, the key influencing factor is the provision of reticulated sewerage. Lots which can be connected to this service are able to have a minimum lot size of 4,000m², whilst lots that are unable to be connected require a minimum lot size of 1 hectare. The sewer strategy for the land has been prepared by Porter Consulting in liaison with the Water Corporation.

5.2 Open Space

The lot sizes are sufficiently large that they reflect a traditional rural residential subdivision, for which public open space is not required in accordance with WAPC Development Control Policy 2.5

We note that, Policy DC2.5 specifically indicates:

"3.2.3 Design and servicing considerations which should be applied to Special Residential zones are as follows:

b) Because of their spacious character and large lot sizes, the Commission does not specify a standard open space contribution for Special Residential zones. Land for public open space will be required, however, when the provision of recreational open space is considered desirable or when it can include an important topographical feature such as a creek, lake or group of trees which is to be retained as a recreational amenity for residents of the subdivision and the district as a whole."

While Liveable Neighbourhoods (LN) acts as a policy tool for the assessment of Structure Plans, we note it is designed to facilitate the orderly and proper development of urban residential neighbourhoods. In that sense, while LN also advocates for the provision of POS this is in an urban context and as neighbourhood planning would warrant.

The Structure Plan as proposed does identify appropriate locations for drainage of the land in accordance with an accompanying LWMS. The Structure Plan also provides for a multi-use corridor on the southern boundary to appropriately extend an existing link.

No POS is proposed under this plan as it is a final 'rounding off' of the corridor of rural residential land use between Thomas Road and Gossage Road to the south. These developments have not previously been subject to POS obligations given the lots created and ample onsite open space. The land's location at the periphery of this corridor indicates POS in this location would in any event be inappropriate.

5.3 Rural Residential

The Local Structure Plan provides opportunity for the creation of rural living lots that are consistent with the Shire's strategic planning and with development in the locality.

The road network has been designed to facilitate the creation of regular shaped lots, capable of accommodating single dwellings and associated outbuildings, which can have direct access to a public street. The design also provides for a range of potential lot sizes at the subdivision stage.

5.4 Movement Networks

The existing subdivisional road network for the locality has been designed to service proposed development over the subject site and is, therefore, capable of accommodating the increased traffic associated with residential development of the subject land. Access to the various proposed lots over the subject land will be derived from the extension of a number of existing roads and two additional subdivisional roads. As such, vehicles will be disbursed across the local road network, thereby minimising the traffic impact.

The anticipated total daily traffic volume associated with the proposed rural living development at the subject land is considered acceptable as has been demonstrated in the preparation of a Traffic Impact Statement that is attached at **Appendix J**. The report investigates the existing road network and intersection in the context of the increased traffic brought about the development of the site. It is concluded that the proposed road network has the capacity to accommodate the anticipated traffic and, accordingly, the Structure Plan will not have an adverse impact on traffic operations.

Access/egress to all lots will be via the 20m wide internal local roads that are proposed in the LSP. No direct access to either Thomas Road or Kargotich Road is contemplated in the LSP or Scheme Amendment proposals for the site.

5.5 Local Water Management

The WAPC's Better Urban Water Management (BUWM) document identifies the requirement to prepare a Local Water Management Strategy (LWMS) to support a proposed Structure Plan. The LWMS (**Appendix E**) has been prepared to support the proposed Structure Plan in accordance with the requirements of the BUWM. The LWMS outlines the key elements required to achieve best practice stormwater management for the site and describes the existing hydrological environment. The LWMS provides for an integrated total water cycle management approach. The LWMS:

- Describes the predevelopment environment, with an assessment of that environment;
- Sets out a Local Water Management Strategy for the precinct, including details relating to:
    a) Water Use and sustainability initiatives;
    b) Surface Water Management; and
    c) Groundwater Management.
- Describes implementation of the LWMS including requirements for subsequent investigations (i.e. Urban Water Management Plan).

The general approach to stormwater management includes a number of catchment swales that are located in road side drains, drainage corridors and at the rear of the smaller properties (protected by an easement or covenant). It also requires the maintenance of existing surface water flow paths, including those within existing drainage swales. This strategy will attenuate the 1, 5 and 100 year ARI post-development flows from the subject land to pre-development rates.

6.0 CONCLUSION

The Structure Plan will facilitate future subdivision of the site into a range of lots between 4,000m^2 and 2 hectares in size that is consistent with the Rural Living zone identified in the Shire of Serpentine Jarrahdale Town Planning Scheme No. 2, with lot sizes being largely dependent on the provision of reticulated sewerage. Rezoning of the land under TPS2 is currently progressing under Amendment 206.

The subdivision and development of this site will represent a rounding off of the existing Rural Living/Special Rural area that is bounded by Thomas Road, Kargotich Road, Gossage Road and Hopkinson Road/Future Tonkin Highway.

Furthermore, the various studies completed in support of this Local Structure Plan, including environmental, bushfire, traffic and servicing demonstrate that the land is physically capable of supporting the proposed development.

On the basis of the above, we respectfully request that the Shire of Serpentine Jarrahdale and the Western Australian Planning Commission consider the proposed Local Structure Plan favourably.

TECHNICAL APPENDICES INDEX

Appendix No.	Nature of Document	Assessment Agency	Approval Status
A	Certificate of Title		
B	Clause 42 MRS Certificate		
C	Geotechnical Investigation		
D	Environmental Assessment		
E	Local Water Management Strategy		
F	Heritage Listing		
G	Bushfire Management Plan		
H	Transportation Noise Assessment		
I	Servicing Report		
J	Traffic Impact Statement		
K	Concept Plan of Subdivision		

APPENDIX A

Certificate of Title

ORIGINAL – NOT TO BE REMOVED FROM OFFICE OF T

LT 37

CT 1644 0900 F

1644 900

Transfer C564848
Application C564849

Volume Folio
1633 23
1633 24

WESTERN AUSTRALIA

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT, 1893" AS AMENDED

I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

Dated 10th June, 1983

REGISTRAR OF TITLES

VOL. 1644 FOL. 900

Page 1 (of 2 pages)

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

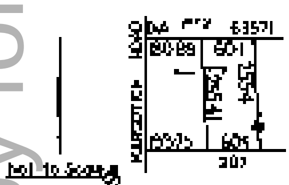
ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Peel Estate Loc 233 and being Lot 4 the subject of Diagram 64846, delineated and coloured green on the map in the Third Schedule hereto, limited however to the natural surface and therefrom to a depth of 60.96 metres.

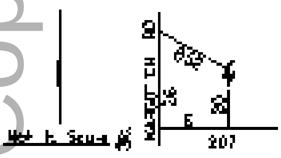
FIRST SCHEDULE (continued overleaf)

Ross Edward Tunstall of 48 Beckenham Street, Beckenham, Cabinetmaker.

SECOND SCHEDULE (continued overleaf)



1. TRANSFER B446286. The right to enter in and upon the portion of the within land coloured blue on the map in the margin for the purpose of erecting and maintaining towers, poles, wires and other necessary apparatus, together also with certain other rights, conditions and restrictions as to buildings as set out in the said Transfer is granted to The State Energy Commission of Western Australia. Registered 14.12.77 at 12.01 o'c.



2. TRANSFER C335263. The right to enter upon the portion of the within land coloured yellow on the map in the margin for the purpose of exercising certain drainage rights as set out in the said Transfer is granted to Shire of Serpentine-Jarrahdale. Registered 5.4.82 at 12.15 o'c.

~~3. MORTGAGE C...051 to Commonwealth Trading Bank of Australia. Registered 10.6.83 10.44 o'c~~

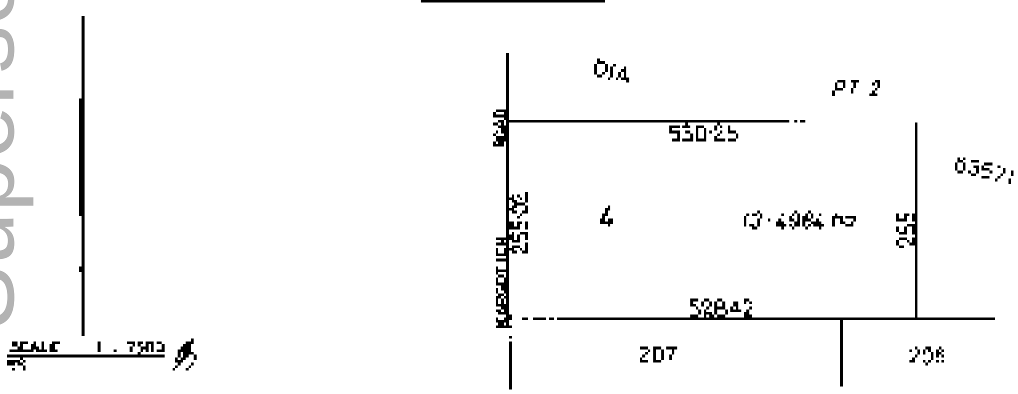
Discharged C8295[illegible] 6.8.84

~~[illegible]~~

[illegible] C82[illegible] 6.8.84

REGISTRAR OF TITLES

THIRD SCHEDULE



NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

FIRST SCHEDULE (continued)

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

REGISTERED PROPRIETOR	INSTRUMENT NATURE	INSTRUMENT NUMBER	REGISTERED	TIME	SEAL	INITIALS

SECOND SCHEDULE (continued)

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

INSTRUMENT NATURE	INSTRUMENT NUMBER	PARTICULARS	REGISTERED	TIME	SEAL	INITIALS	CANCELLATION	NUMBER	REGISTERED OR LODGED	SEAL	INITIALS
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]					
[illegible]	[illegible]	[illegible]				[illegible]					

CERTIFICATE OF TITLE VOL. 1614 900

CT 1645 0575 F

Application C564850

Volume 1633 Folio 24

WESTERN AUSTRALIA

1645 575

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT 1893" AS AMENDED

Page 1 (of 2 pages) VOL. 1645 FOL. 575

I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

Dated 10th June, 1983

REGISTRAR OF TITLES

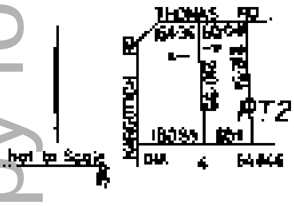
ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Peel Estate Lot 703 and being part of Loc 2 on Diagram 63571, delineated and coloured green on the map in the Third Schedule hereto, limited however to the natural surface and therefrom to a depth of 60.96 metres.

FIRST SCHEDULE (continued overleaf)

~~Murray Frank Donald Holmes of 16 Eighth Avenue, Armadale, [illegible]/Driver.~~

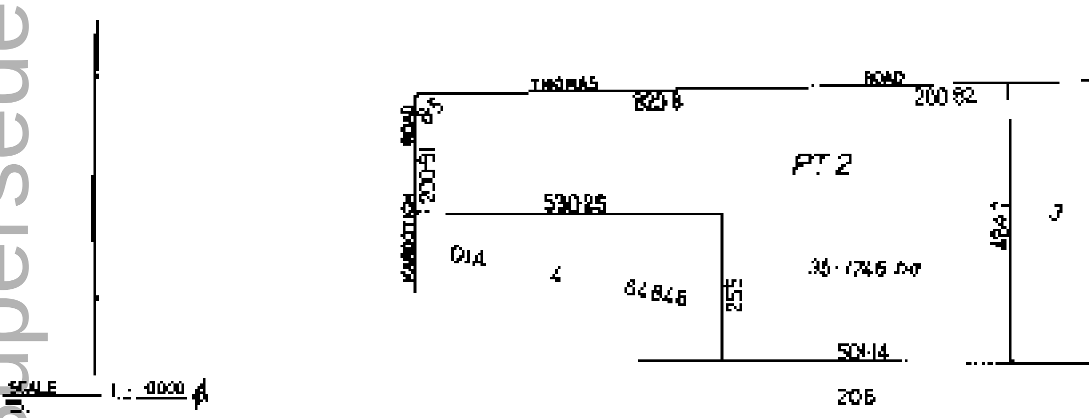
SECOND SCHEDULE (continued overleaf)



1. TRANSFER C446286. The right to enter in and upon the portion of the within land coloured blue on the map in the margin for the purpose of erecting and maintaining towers, poles, wires and other necessary apparatus, together also with certain other rights, conditions and restrictions as to buildings as set out in the said Transfer is granted to The State Energy Commission of Western Australia. Registered 14.12.77 at 12.01 o'c.

REGISTRAR OF TITLES

THIRD SCHEDULE



NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

FIRST SCHEDULE (continued)

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

REGISTERED PROPRIETOR	INSTRUMENT NATURE	INSTRUMENT NUMBER	REGISTERED	TIME	SEAL	INITIALS
Tuscany Management Pty. Ltd. of care of Gilmour Thornell and Jefferies of 25 Prospect Road, Armadale.	Transfer	[illegible]	18.11.86	12.45		

SECOND SCHEDULE (continued)

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

INSTRUMENT NATURE	INSTRUMENT NUMBER	PARTICULARS	REGISTERED	TIME	SEAL	INITIALS	CANCELLATION	NUMBER	REGISTERED OR LODGED	SEAL	INITIALS

CERTIFICATE OF TITLE VOL. 1645 575

REGISTER NUMBER
4/D64846

DUPLICATE EDITION
2

DATE DUPLICATE ISSUED
31/10/2008

WESTERN AUSTRALIA

VOLUME 1644 FOLIO 910

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 4 ON DIAGRAM 64846

REGISTERED PROPRIETOR:

(FIRST SCHEDULE)

ASTERDELL CORPORATION PTY LTD OF LEVEL 2 102 BEAUFORT STREET, PERTH

(T J366656) REGISTERED 11.7.2005

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:

(SECOND SCHEDULE)

1. B446289 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON VOL 1644 FOL 910. REGISTERED 4.12.1975.
2. C532265 EASEMENT TO SHIRE OF SERPENTINE-JARRAHDALE. SEE SKETCH ON VOL 1644 FOL 910. REGISTERED 5.4.1982.
3. M589357 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 4.4.2014.
4. N600945 CAVEAT BY WORMALD CIVIL PTY LTD LODGED 1.8.2017.

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

---END OF CERTIFICATE OF TITLE---

STATEMENTS:

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

SKETCH OF LAND:	1644-910 (4/D64846)
PREVIOUS TITLE:	1633-23, 1633-24
PROPERTY STREET ADDRESS:	33 KARGOTICH RD, OAKFORD.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF SERPENTINE-JARRAHDALE

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING M589357

2/D63571

N/A N/A

WESTERN AUSTRALIA

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

1645 575

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 2 ON DIAGRAM 63571

REGISTERED PROPRIETOR:

(FIRST SCHEDULE)

TUSCANNY MANAGEMENT PTY LTD OF CARE OF GILMOUR THORNETT AND JEFFERIES OF 25 PROSPECT ROAD, ARMADALE

(T D388598) REGISTERED 10.12.1986

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:

(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE. VOL 1645 FOL 575
2. C446286 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON VOL 1645 FOL 575. REGISTERED 14.12.1977.

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

STATEMENTS:

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

SKETCH OF LAND:	1645-575 (2/D63571)
PREVIOUS TITLE:	1633-74
PROPERTY STREET ADDRESS:	1842 THOMAS RD, OAKFORD.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF SERPENTINE-JARRAHDALE

APPENDIX B

Clause 42 MRS Certificate

Western Australian Planning Commission

Enquiries: Trevor Servaas (08) 655 19110
Our Ref: 42/45037371
Your Ref: TOM CARROLL

WESTERN CORPORATE
PO BOX 235
NORTH PERTH WA 6906

Dear Sir/Madam

CERTIFICATE UNDER CLAUSE 42 OF THE METROPOLITAN REGION SCHEME ISSUED BY THE WESTERN AUSTRALIAN PLANNING COMMISSION

In Reply to your request, please find enclosed
Certificate number 45037371.

It is advised that the enclosed Certificate has been prepared to conform with the current Statutory requirements of the Metropolitan Region Scheme as at the date of signature.

The following documents are forwarded for your retention.
PHOTOCOPY OF CERTIFICATE OF TITLE & RECEIPT

Yours faithfully

T. Hillyard

Tim Hillyard
Secretary
Western Australian Planning Commission

15 July 2014

Enc.

Metropolitan Region Scheme

Form 5

Scheme Certificate

[In accordance with the provisions of clause 42 of the Metropolitan Region Scheme text]

Request	45037371
Receipt	82995
Date	15/07/2014

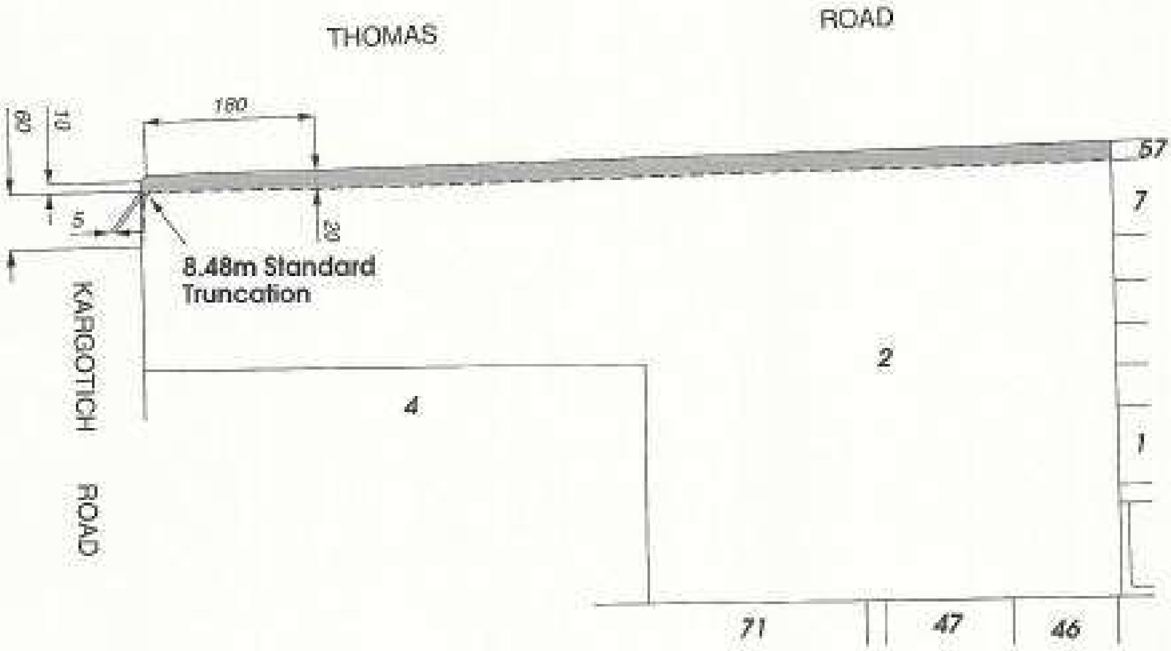
The following information is furnished in respect of:

Lot: 2 Street: Thomas Road

Diagram: 63571 Locality: Oakford

Certificate of title Vol: 1645 Folio: 575

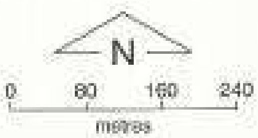
The land shaded on the sketch below is reserved
other regional roads (Thomas Road)
The remainder of the land is zoned **rural**



This certificate relates only to the provisions of the approved Metropolitan Region Scheme and does not purport to indicate the land use allocation under any local government provision.

Produced by:
Mapping & Geospatial Data Branch,
Department of Planning, Perth WA

Base information supplied by:
Western Australian Land Information Authority
LI 430-2009-8



Scale 1:8000
All dimensions are in metres
Subject to survey

T. Hillyard

Tim Hillyard
Secretary
Western Australian Planning Commission

APPENDIX C

Geotechnical Assessment

Prepared by Douglas Partners

Douglas Partners
Geotechnics | Environment | Groundwater

Report on
Preliminary Geotechnical Investigation

Proposed Rural Residential Subdivision
Lot 2 Thomas Road and Lot 4 Kargotich Road,
Oakford, WA

Prepared for
Goldlight Asset Pty Ltd C/- Western Corporate

Project 88862.00
December 2017

Integrated Practical Solutions

Douglas Partners
Geotechnics | Environment | Groundwater

Document History

Document details

Project No.	88862.00	Document No.	R.001.Rev1
Document title	Report on Preliminary Geotechnical Investigation Proposed Rural Residential Subdivision		
Site address	Lot 2 Thomas Road and Lot 4 Kargotich Road, Oakford, WA		
Report prepared for	Goldlight Asset Pty Ltd c/- Western Corporate		
File name	8886200.R.001.Rev1. Proposed Rural Residential Subdivision		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Damian Jagoe-Banks	Fred Verheyde	23 March 2017
Revision 1	Dan Reaveley	Fred Verheyde	12 December 2017

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	1	Goldlight Asset Pty Ltd
Revision 1	1	0	Goldlight Asset Pty Ltd

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	[signature]	12 December 2017
Reviewer	[signature]	12 December 2017

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
36 O'Malley Street
Osborne Park WA 6017
Phone (08) 9204 3511
Fax (08) 9204 3522

Douglas Partners
Geotechnics | Environment | Groundwater

Table of Contents

Page

Report on Preliminary Geotechnical Investigation
Proposed Rural Residential Subdivision
Lot 2 Thomas Road and Lot 4 Kargotich Road, Oakford, WA

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed rural residential subdivision in Oakford, WA. The investigation was commissioned in an purchase order dated 20 February 2017 by Mr James Arthur Richards of Goldlight Asset Pty Ltd C/- Western Corporate, and was undertaken in accordance with Douglas Partners' proposal PER170072 dated 16 February 2017.

It is understood that the proposed development comprises the subdivision of the above mentioned two lots into 58 rural residential lots, generally ranging from 0.4 ha to 1.7 ha in area as well as the construction of access roads and drainage reserves. It is also understood that 15 of the proposed lots in excess of 1 ha in size will be constructed without sewerage connections and as a result these lots will require on-site effluent disposal.

The purpose of this preliminary geotechnical investigation was to determine the subsurface conditions beneath the site and provide preliminary comments on:

- The geotechnical suitability of the site for the proposed development.
- Site classification in accordance with the requirements of AS 2870-2011.
- Site preparation requirements so as to allow the proposed development.
- Suitability of the existing soils for re-use as structural filling.
- Parameters for pavement design, including an indicative design California bearing ratio value based on field observations and laboratory testing.
- The depth to groundwater, if encountered.
- The permeability of the soils within proposed drainage reserves.
- The risk of acid sulphate soils (ASS) beneath the site based upon readily available desktop information and limited laboratory testing.
- The suitability of the site for on-site effluent disposal, and comments regarding appropriate systems for the site conditions.

The investigation included the excavation of 10 test pits, four in situ permeability tests 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.

2. Site Description

The site comprises Lot 2 Thomas Road and Lot 4 Kargotich Road, with a combined area of approximately 48 ha (Refer to Drawing 1, Appendix B). The site is bound by Thomas Road to the north, residential lots to the east, rural properties to the south and Kargotich Road to the west.

At the time of the investigation, the site was generally open and accessible (refer to Figure 1). Residential dwellings and sheds were observed towards the centre of the site, and within the north western corner of the site. Dilapidated vehicles and equipment were observed adjacent to the dwelling in the centre of the site. Stockpiles, observed to be mostly sand, were also observed within this area as well as one stockpile of mulch.

Vegetation was observed to generally comprise pasture grass. Multiple rows of mature trees were observed within the western half of the site, with an isolated group of trees adjacent to the southern boundary in the eastern half of the site. Overhead power lines were observed transecting the site in an easterly direction from Kargotich Road, and in a southerly direction from Thomas Road. Fences divided the site into multiple sections.

An open drain was observed along the western and southern boundary of the site. Three fenced dams were observed towards the southern boundary of the site, and an unfenced dam was observed towards the centre of the site. Gravel hardstands were observed between the roads to the dwellings.

The figures below provide an indication of the conditions at the site.

Figure 1: Lot 2 Thomas Road, looking west from TP03

Figure 2: Lot 4 Kargotich Road, looking south from TP05

Figure 3: Observed Dam, Lot 4 Kargotich Road

The ground surface level falls from a high point of RL 26 m AHD to approximately RL 24 m AHD on the eastern boundary and RL 22 m AHD on the western boundary.

The Armadale 1:50,000 Geology sheet indicates that shallow sub surface conditions beneath the site comprise of thin Bassendean Sand overlying the Guildford Formation with a central zone designated as Bassendean Sand.

Acid sulphate soil mapping indicates that the site is “moderate to low risk” of acid sulphate soils being encountered within 3 m of the surface.

The Perth Groundwater Atlas (2004) indicates that the groundwater level was between 20 m and 21.5 m relative to Australian height datum (AHD) in May 2003, i.e. approximately 1.5 m below the lowest level of the site.

3. Field Work Methods

Field work was carried out between on 23 February 2017 and comprised the excavation of 10 test pits, the drilling of four boreholes, four in situ permeability tests and Dynamic cone penetrometer (DCP) testing, adjacent to each test location.

The test pits (TP01 to TP10) were excavated to a maximum depth of 2.5 m using a backhoe with a 600 mm toothed bucket, and were logged in general accordance with AS1726-1993 by a geotechnical engineer from Douglas Partners. Soil samples were recovered from selected locations for subsequent laboratory testing.

Four hand augered boreholes (Perm11 to Perm14) were drilled for constant head in situ permeability testing. The location, depths of testing, and results are discussed in detail in Section 4.3.

The DCP tests were carried out adjacent to the test pits and boreholes in accordance with AS 1289.6.3.2, to assess the in situ density of the shallow soils.

Soil samples were recovered for the assessment of acid sulphate soils from five test pits (TP01, TP02, TP03, TP07, TP09) at 0.5 m intervals for subsequent laboratory testing. The following sample handling and transport procedures were employed:

- Samples were quickly placed in new air tight snap lock sample bags and hand pressed to exclude air;
- Snap lock bags were labelled with individual and unique identification, including project number and sample number;
- Samples were placed in insulated coolers during field work and subsequently frozen until transported to the analytical laboratory;
- Chain-of-custody documentation was maintained at all times and countersigned by the receiving laboratory on transfer of samples; and
- A National Association of Testing Authorities (NATA), registered laboratory, MPL Envirolab, was engaged to conduct the analysis.

Test locations were determined using GPS with a typical horizontal accuracy of ±3 m and site features, and are marked on Drawing 1 in Appendix B. Surface elevations at each test location were estimated from a plan provided by the client.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing are presented in Appendix B, together with notes defining descriptive terms and classification methods. A summary of the ground conditions encountered at the test locations is given below:

- **Topsoil** (Sand, Silty Sand and Clayey Silty Sand) – grey-brown, fine to medium grained sand topsoil, with varying amounts of silt and clay, with some rootlets, was observed at all locations to depths of between 0.05 m and 0.1 m.
- **Sand –** medium dense, grey-brown and orange-brown, fine to medium grained, sand, with a trace to some silt/clay was encountered underlying the topsoil at TP02, TP05, TP07 and TP08 to a depth of between 0.7 m and 2.3 m.
- **Interbedded Clayey, Silty and Sandy Materials of the Guildford Formation –** The encountered materials were generally clayey with various fractions of silt and sand, and ranged from slightly silty sand to sandy clay. Their density and consistency ranged from loose to medium dense and from soft to hard. In particular, loose and soft materials were encountered at TP01, TP03, TP06, TP07 and TP09 to depths of up to 1.6 m. Ironstone and cemented materials were encountered at TP01, TP03 and TP04.

4.2 Groundwater

Groundwater was observed within two test pits, TP01 and TP10 excavated on 23 February 2017. It is possible that the groundwater encountered at TP10 is water perched above the clayey sand at this location. The test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

Additionally, three existing groundwater wells (installed by others) within the site were dipped. The locations of these wells are shown Drawing 1 in Appendix B.

Groundwater levels are summarised in Table 1 (next page) and are also detailed on the test pit logs in Appendix B.

Table 1: Summary of Observed Groundwater Levels on 23 February 2017

Location	Surface Level [1] (m AHD)	Groundwater Depth (m)	Groundwater Level [2] (RL m AHD)
TP01	22	2.1[3]	19.9[3]
TP10	24	1.6	22.4
MW15	22	2.1	19.9
MW16	22	2.0	20
MW17	24	Dry to 4.0	<20

Notes: [1]: Surface level interpolated from Subdivision Guide Plan provided by Western Corporate.
[2]: Groundwater Level = Interpolated Surface Level – Groundwater Depth.
[3]: Seepage

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

4.3 Permeability

Four in situ permeability tests using the constant head method were undertaken at the locations of proposed drainage basins. The constant head were undertaken in accordance with AS 1547-2012 Appendix 4.1F. Results of the permeability analysis are summarised in Table 2 below.

Table 2: Summary of Permeability Analysis

Test Location	Depth (m)	Measured Permeability		In Situ Conditions of Tested Material
		(m/s)	(m/day)	
PERM11	0.39	7.5×10^{-6}	0.6	Clayey Sand
PERM12	0.24	2.0×10^{-4}	17.5	Sand, trace of silt
PERM13	0.30	2.3×10^{-5}	2.0	Sand with some clay
PERM14	0.44	9.0×10^{-6}	0.7	Clayey Sand

5. Geotechnical Laboratory Testing

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

- The particle size distributions of three samples.
- The Atterberg limits and linear shrinkage of two samples.
- The shrink/swell index of one sample.

- The modified maximum dry density (MMDD), optimum moisture content (OMC) and the California bearing ratio (CBR) values of two samples.
- The Emerson Class testing of two samples.
- pH, phosphorus retention index (PRI), electrical conductivity and cation exchange capacity of two samples.

Detailed test report sheets are given in Appendix C and Appendix D and the results are summarised in Table 3 to Table 5.

Table 3: Results of Laboratory Testing for Soil Identification

Test Location	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	I_{ss} (%)	Material
TP02	0.4-0.5	7	0.11	0.32	-	-	-	-	-	Sand with some silt
TP04	0.3-0.5	59	<0.0135	0.08	50	18	32	4.8	-	Sandy clay, medium plasticity
TP09	0.3-0.6	67	<0.0135	0.02	67	19	48	5.2	3.0	Sandy clay, high plasticity

Where:
- The % fines is the amount of particles smaller than 75 µm.
- A d_{10} of 0.11 mm means that 10% of the sample particles are finer than 0.11 mm.
- A d_{60} of 0.32 mm means that 60% of the sample particles are finer than 0.32 mm.
- I_{ss}: Shrink-Swell Index
- PL: plastic limit.
- LL: liquid limit.
- PI: plasticity Index.
- LS: linear shrinkage
- "-" means 'Not Tested'

The CBR tests were undertaken at a target compaction level of 95% of modified maximum dry density. The samples were tested after soaking for four days with a confining surcharge of 4.5 kg, and the results are presented in Table 4.

Table 4: Results of Laboratory Testing for Pavement Design Parameters

Test Location	Depth (m)	MMDD (t/m^3)	CBR (%)	OMC (%)	Swell (%)	Material
TP04	0.3-0.5	1.87	3.0	16.0	3.5	Sandy clay, medium plasticity
TP09	0.3-0.5	1.74	1.5	17.2	5.5	Sandy clay, high plasticity

Notes:
- MMDD: modified maximum dry density
- CBR: California bearing ratio
- OMC: optimum moisture content

Summarised test results for laboratory analysis to assist with the assessment of the soil suitability of on-site effluent disposal are provided in Table 5 (next page).

Table 5: Results of Laboratory Testing of Assist with Effluent Disposal Assessment

Test Location	Depth (m)	pH	Electrical Cond. (µS/cm)	Cation Exchange Capacity (meq/100g)	Phosphorus Retention Index (PRI) (mL/g)	Material
TP01	0.5	6.8	500	8	7.8	Clayey sand
TP02	0.5	6.0	64	7	1.3	Sand with some silt

6. Acid Sulphate Soil Laboratory Testing

Acid sulphate soil screening tests were undertaken on all soil samples retrieved from five selected test pits (TP01, TP02, TP03, TP07 and TP09.)

Initial acid sulphate soil screening tests were undertaken on selected soil samples by MPL Envirolab in accordance with the method as described in Ahern CR, McElnea AE, Sullivan LA (2004), *Acid Sulphate Soils Laboratory Methods Guidelines*. The screening tests comprised measurement of pH of the soil in water (pH_F) and the pH of the soil after oxidation with a 30% solution of hydrogen peroxide (pH_{FOX}). The results of these tests provide an indication as to the presence of actual and potential acid sulphate soils and should be considered as qualitative only.

Following the screening tests, as required by the Department of Environment Regulation, soil samples were submitted to MPL Laboratories to undergo Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) suite of testing. Soil samples were selected for laboratory analysis with due consideration of the following:

- Screening results, with particular focus on the lowest reported pH_{FOX} within soil strata at each test location.
- Reported reaction strength.
- Visual identification of the soils encountered.

The screening results and laboratory testing (SPOCAS) including the adopted assessment criteria are presented in Table D-1 in Appendix D together with the detailed laboratory reports and associated chain of custody reports. The results are evaluated and discussed in Section 8.6.

7. Proposed Development

It is understood that the proposed development comprises the subdivision of the site into 58 rural residential lots, generally ranging from 0.4 ha to 1.7 ha in area and the construction of access roads and drainage reserves.

It is also understood that 15 of the proposed lots will be constructed without sewerage connections and as a result these lots will require on-site effluent disposal (refer to Drawing 1, Appendix B).

8. Comments

8.1 Suitability of the Site for Development

The results of the investigation indicate that the site is generally underlain by various clayey materials of the Guildford Formation. Sand was encountered up to a depth of 2.3 m and above the clayey materials, in the central part of the site.

Loose sandy soils and soft clayey soils were encountered at several test locations to depths of up to 1.6 m. These materials are currently not suitable for structural foundations and will require compaction prior to any construction.

Based on the results of the investigation, the main geotechnical constraints identified regarding the proposed development of the site include:

- The occurrence of moderately to highly reactive clayey subgrade across parts of the site;
- Soft and loose ground conditions in some areas of the site; and
- The likelihood of groundwater occurring perched on shallow clayey materials, possibly near ground surface in winter.

The main geotechnical opportunity for the development of the site includes the occurrence of shallow sand, forming a possible source of non-reactive filling, in one part of the site.

From a geotechnical standpoint, the land is physically capable of development, provided that the provisions outlined in the subsequent subsections of the report are implemented.

8.2 Preliminary Site Classification Comments

Results of the field work and laboratory testing indicate that the clayey materials encountered across the site are generally moderately to highly reactive. Class S and M will likely apply where reactive material is present within 1.8 m of the surface.

A sufficient depth of non-reactive sand exists above the reactive material within the central area of the site to achieve Class A.

Table 6 (next page) indicates the anticipated site classification at each test location in accordance with AS 2870-2011. Note that due to the preliminary nature of the geotechnical investigation, limited laboratory testing was undertaken. Further testing to assess the reactivity at within proposed building envelopes to confirm site classification is recommended.

Table 6: Anticipated Site Classification at Test Locations

Test Location	Site Classification Based on Current Site Levels[1]	Test Location	Site Classification Based on Current Site Levels[1]
TP01	M	TP06	M
TP02	A	TP07	S
TP03	M	TP08	A
TP04	M	TP09	M
TP05	S	TP10	S

Note [1]: Does not include the effect of trees which can increase the surface movement and alter the site classification.

Improvement of site classification can be achieved with either placement of non-reactive filling above the existing reactive natural material or removal of reactive material (or a combination of both).

8.3 Site Preparation

Site preparation for the semi-rural residential lots will likely occur within proposed building and pavement envelopes within each residential lot. Site preparation will also be required for the construction of the proposed roads to service the lots. As such, the site preparation comments in the following sections do not necessarily pertain to the site as a whole, just within the vicinity of proposed structures and the pavements. Site preparation requirements could be optimised following a more detailed investigation where testing is undertaken within proposed structure and pavement envelopes.

It is recommended that clay earthworks be carried out during the dry period of the year in order to ease handling, placement and compaction.

8.3.1 Site Stripping

All deleterious material, including demolition rubble, debris, topsoil and vegetation should be stripped from the proposed development areas of the site. Tree roots remaining from any clearing operations should be completely removed. Topsoil could be reused for landscape areas or locations where structural filling is not required.

8.3.2 Proof Rolling

Following removal of unsuitable material and prior to any filling, it is recommended that the exposed ground following topsoil stripping be proof rolled with a heavy roller of, say, 16 tonnes minimum deadweight, with smooth drum in vibrating mode to compact the loose sand near the existing surface or sheep’s foot roller directly on a clayey subgrade. A heavy roller is recommended as loose sands and soft clayey materials were encountered in some parts of the site to depths up to 1.6 m below the surface. Care should be taken not to run heavy plant immediately adjacent to existing buildings and services.

Owing to the areas of loose and soft soils encountered at the site, it is recommended that a suitably experienced geotechnical engineer assess the prepared subgrade during proof rolling. For the proposed road pavements, areas with excessive deformation under rolling may require the following treatments:

- Excavation and replacement with suitable structural material;
- Reinforcement with a geogrid; or
- Stabilisation with the addition of lime.

The method of treatment should be determined by the geotechnical engineer, at the time of testing, and depend on the site conditions at the time and the level of improvement that can be achieved during proof compaction.

It is anticipated that for the house envelopes, site preparation including compaction works will be undertaken on a case by case basis, by the individual lot owners. It is recommended that an experienced geotechnical engineer assesses the foundation conditions of each site, at the time of construction.

8.3.3 Re-use of In-Situ Soil

It is anticipated that the topsoil encountered within the sandy central part of the site (where topsoil is predominately a silty sand and sand with some silt with root matter) could be reused for structural filling following screening of the organics and blending with clean sand. A uniform blend is anticipated to be difficult to achieve using the generally clayey topsoil encountered in other parts of the site, and will possibly preclude the suitability of the above approach for clayey topsoil. Further testing of the material stripped at the time of construction would be required to assess a suitable blending ratio of topsoil with clean sand.

The naturally occurring sand encountered in areas within the central area of the site (TP02, TP05, TP07 and TP08) should be suitable for re-use as structural fill, provided it is free from organic material and particles greater than 150 mm in size.

Clayey materials could be reused for filling however their reactivity and lower permeability will impact site classification and drainage. Earthworks plans and construction methodology should be assessed by a geotechnical engineer prior to any reuse of clayey materials for structural filling.

8.3.4 Imported Filling

If required, imported filling should comprise free draining, cohesionless, well graded sand that:

- Contains less than 5% by weight of particles less than 75 microns in size.
- Contains no particles greater than 150 mm in size.
- Is free of organic and other deleterious materials.

Use of imported filling with higher fines content could be considered, provided the fines are non-reactive. This may have some impact on the permeability of the filling, and therefore drainage design, and this limitation should be assessed if such material is used. It is recommended that test certificates are reviewed and approved by the geotechnical engineer prior to importing material to site.

8.3.5 Fill Placement

It is recommended that filing is placed in layers and compacted near optimum moisture content.

8.3.6 Compaction Testing

Compaction control of the natural subgrade within proposed building envelopes following proof rolling, could be carried out with either a Perth sand penetrometer (PSP) (for non-cohesive materials) or a dynamic cone penetrometer (DCP) (for cohesive materials).

Compaction control of the natural subgrade within road pavement areas following proof rolling should be undertaken with a nuclear density meter to confirm suitable subgrade compaction has been achieved. Cohesive pavement subgrades should be compacted to 92% relative to modified maximum dry density (MMDD) and non-cohesive pavement subgrade should be compacted to 96% relative to modified MMDD.

Compaction control of sand filling for building envelopes could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. All areas within the proposed building envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 0.5 m below foundation level.

During construction, some loosening of the surface materials in foundation excavations is expected. Therefore the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings. Confirmation of adequate compaction should be carried out as outlined above.

8.4 Pavement Design Parameters

The shallow soils across the site generally comprise sand, clayey sand and sandy clay. It is anticipated that pavement subgrade is also likely to comprise sand filling where the proposed site surface is raised.

Laboratory testing results detailed in Section 5 indicate CBR values of 1.5% and 3% for soaked samples of sandy clay. Based on observations made in the field, the available laboratory testing results and DP's experience, a subgrade CBR design value of 2% is suggested for the design of pavement on the clay subgrade materials, provided that the subgrade is compacted achieve a dry density ratio of not less than 92% relative to modified compaction and suitably drained.

In the event the subgrade comprises imported sand filling, the pavement should be designed using an appropriate CBR of the material. A presumptive design CBR value of 12% is suggested for clean sand filling, provided there is at least 0.75 m of the material below subgrade level. However, this value should be confirmed prior to pavement construction once the sand filling material is known and its CBR has been assessed.

It is recommended that subgrade be inspected by a suitably experienced geotechnical engineer prior to placement of basecourse to identify unsuitable subgrade materials and to recommend specific drainage measurements required. It is emphasised that particular care should be exercised in implementing a suitable drainage strategy for the proposed roads to prevent water ingress into pavement layers.

8.5 Soil Permeability

In situ permeability tests were undertaken within the surficial materials (at depths less than 0.45 m) in four locations (PERM11 to PERM14) across the site (refer to Drawing 1, Appendix B for test locations). Permeability testing was undertaken within three different material types: sand (PERM12), sand with some clay (PERM13) and clayey sand (PERM11 and PERM14) with results providing the estimated permeability values provided in Table 2 (Section 4.3). The values provided in Table 2 are considered representative for each material type.

The following design soil permeability values are suggested at this site:

- Sand (such as encountered at TP02, TP05, TP07 and TP08): 1.0×10^{-4} m/s (9 m/day)
- Other materials (e.g. silty and clayey materials): 1.0×10^{-6} m/s (0.09 m/day)

A decrease in the above permeability values can be anticipated following compaction of the site during earthworks.

8.6 Groundwater

The Perth Groundwater Atlas (2004) indicates that the groundwater level was between 20 m and 21.5 m relative to Australian height datum (AHD) in May 2003, i.e. approximately 1.5 m below the lowest level of the site.

At the time of the field investigation, in February 2017, groundwater was observed to be at a depth of between 1.6 m and 2.1 m, at a level of between RL19.9 m AHD and RL 22.4 m AHD.

Groundwater is anticipated to perch near or at ground surface on the clayey materials of the Guildford Formation in the winter months, or following heavy rainfall events.

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

8.7 Acid Sulphate Soils

With reference to Table D-1, Appendix D, the reported results indicate the following:

- The results for pH_F are not strongly indicative of actual acid sulphate soils conditions at the test locations to depths of 2.5 m;
- The results for pH_{FOX} are not strongly indicative of potential acid sulphate soil conditions at the test locations to depths of 2.5 m; and

- The calculated net acidity is above the adopted action criterion of 0.03% S for two of four samples submitted for SPOCAS suite testing, TP01 (2.5 m) and TP03 (1.0 m). Net acidities were reported to a maximum of 0.044% S.

It should be noted that the exceedances of the action criteria for net acidity (TP01 [2.5 m] and TP03 [1.0 m]) are attributed to a higher result reported for the titratable actual acidity (TAA) component of the net acidity, which is a measure of the soils existing acidity. It should also be noted that the corresponding results for S_{POS} result were reported as <0.005% S, indicating the general absence of peroxide oxidisable sulphur. In this regard, given the apparent absence of peroxide oxidisable sulphur, the pH of the soil is not expected to decrease as a result of sulphide oxidation following disturbance. The apparent absence of sulphidic material in the samples analysed suggests the higher results for 'existing acidity' are attributed to metal complexes occurring naturally in the soils, and are not necessarily representative of actual acid sulphate soil conditions. This is further supported by the corresponding S_{kCl} results which were reported as <0.03% S, indicating negligible soluble sulphur.

In this regard, DP considers the two exceedences of the action criterion associated with an elevated TAA result to be of low significance. Provided excavations are less than 2.5 m depth and dewatering is not required, DP considers that management of acid sulphate soils is not warranted.

It should be noted, however, that the investigation was a preliminary investigation that was undertaken to provide preliminary advice on the presence or otherwise of acid sulphate soils. In this regard, should a development condition requiring 'clearance' by DER be imposed, we anticipate that the DER would require further detailed investigation to meet DER endorsed guidelines.

9. Evaluation and Recommendations for On-site Wastewater Management

9.1 Site and Soil Effluent Disposal Preliminary Assessment

Based on information provided to Douglas Partners at this time of this report, it is understood that the proposed lots in excess of 1 ha in area, and located within the north-western quadrant and south-western corner of the site will not be serviced with a reticulated sewer connection. Comments on the suitability for on-site effluent disposal contained within this section of the report pertain to the ground conditions within the western part of the site (See Drawing 1, Appendix B).

For this assessment, reference has been made to 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.

The assessment of soil and terrain, including moderate and major limitations for effluent disposal within the site, are discussed below.

9.1.1 Slope, Landform and Upslope Seepage

A high point is located adjacent to the two on-site effluent disposal zones. From the high point, the surface levels gently fall at an estimated angle of less than 2° to the west and north and south at an angle less than 0.5° to the east. The landform generally consists of gentle slope land with the high point of this area being a localised sandy crest and as such, upslope seepage is anticipated to be very low. Therefore, slope, landform and upslope seepage are not considered a limitation for on-site sewage disposal for the north-western quadrant of this site.

9.1.2 Soil Permeability Category and Measured In Situ Soil Permeability

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 sand overlying clayey materials or clayey materials from the surface.

Based on visual assessment and particle size distribution results of laboratory testing, a soil permeability category of Group 1 (reference to AS 1547-2012 Tables 5.1 and E1) is considered suitable for the sandy materials (overlying the clayey materials) and a category of Group 5 to 6 is considered suitable for the clayey materials encountered at the site.

The soil permeability category Group 1 is considered to be a major limitation for absorption trenches and for surface and subsurface irrigation due to excessive run-off and percolation. The soil permeability categories Group 5 and 6 are also considered to be a major limitation for absorption trenches and Group 5 soils present a moderate limitation for surface and subsurface irrigation due to potential waterlogging.

In situ permeability testing undertaken at the site using the constant head method in accordance with AS 1547-2012 indicates a design permeability value of 1.0×10^{-6} m/s (approximately 0.09 m/day) for the sandy clay and a design permeability value of 1.0×10^{-4} m/s (approximately 9 m/day) is suggested for the sand.

9.1.3 Depth to Hardpan

Depth to hardpan materials across the majority of the north-western quadrant is likely to be greater than 1.5 m and as such, presents a minor limitation. Test pit TP03 near the eastern boundary of the quadrant however, encountered cemented materials at a depth of 0.8 m and as such, the land in this portion presents a moderate limitation for surface irrigation systems and a major limitation for absorption systems.

9.1.4 Depth to Groundwater

Where encountered, groundwater in February 2017 was observed to be between 1.6 m and 2.1 m deep across the site. Groundwater at TP01 and MW16 was observed at 2.1 m and 2.0 m deep.

Groundwater is anticipated to perch near or at ground surface on the clayey materials of the Guildford Formation in the winter months, or following heavy rainfall events.

9.1.5 Coarse Fragments

Coarse fragments are defined as particles greater than 2 mm in AS 1547-2012. The abundance of coarse fragments in the clayey sand encountered underlying the site is 'very few' in accordance with Table E2, AS 1547-2012. Consequently, the abundance of coarse fragments is not considered a limitation for sewage disposal at this site.

9.1.6 Soil Dispersion

The Emerson Class result presented in Section 5 indicates that the soils on the site are not dispersive and therefore degradation of soil structure due to dispersion is not considered to be a limitation for sewage disposal at this site.

9.1.7 Chemical Soil Assessment

Assessment of soil pH, electrical conductivity, cation exchange capacity and phosphorus retention index were also undertaken to provide an indication on the soil's suitability for vegetation growth, nutrient retention and salt content. The ratings for against each result are provided in the table below.

Soil Feature	TP01		TP02	
	Surface and subsurface irrigation	Absorption System	Surface and subsurface irrigation	Absorption System
pH	Minor limitation	Minor limitation	Moderate Limitation	Moderate Limitation
Electrical Conductivity	Minor limitation	Minor limitation	Minor limitation	Minor limitation
Cation Exchange Capacity	Moderate Limitation	Moderate Limitation	Moderate Limitation	Moderate Limitation
Phosphorus Retention Index	Moderate Limitation	Moderate Limitation	Moderate Limitation	Moderate Limitation

9.2 On-site Wastewater Management Options

9.2.1 Primary Effluent Treatment System

Owing to the occurrence of soils with the major limitations mentioned above (Sections 9.1.2 and 9.1.3), 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.

The effluent treatment system selected for use should be approved by the WA Department of Health. The type of system adopted for each of the proposed developments should be assessed on a lot by lot basis and is dependent on the key parameters such as house size, location of the application area and water and nutrient reduction fixtures. For a residential subdivision such as proposed for this site, ATU systems are most likely to be chosen by the future landowners.

The ATU selected for use should be approved by the WA Health Department and be able to reduce the nitrogen concentration in the effluent to about 15 mg/L.

9.2.2 Effluent Land Application

Once the effluent has been treated by an approved system, the resulting effluent would be disposed of to the land surface.

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

- treatment system adopted and quality of effluent produced;
- soil and terrain characteristics, as described in Section 9.1;
- climate conditions; and
- effluent loading, as determined by the number of bedrooms within the proposed residence 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. A minimum land application area of 0.2 m^2/l/day of effluent produced is suggested for the surface sands (and sand filling, if the site is filled) and 0.333 m^2/l/day for the underlying sandy clay.

9.3 Additional Comments in Relation to Effluent Disposal

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 the general recommendations contained within this report, the methods detailed in AS/NZS: 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.

9.4 Conclusions on Site Suitability for Effluent Disposal

The site is considered suitable for the disposal of domestic effluent in general accordance with AS/NZS 1547-2012, local government conditions and WA Department of Health, provided that the limitations described in Section 9.1 are addressed. Therefore, a minimum lot size of 2000 m^2 is required for the suitability of the site for on-site wastewater disposal system, in accordance with Government Sewerage Policy – Consultation Draft, Department of Health, December 2011 Table 2 for disposal in the sandy clay, or 1000 m^2 is required if the site is filled with sand filling.

Due to site limitations discussed above, effluent should be pre-treated prior to using surface, subsurface drip or trickle, covered surface or subsurface irrigation or a closed cell amended soil system.

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:NZS 1547:2012, local government authorities, the WA Department of Health and the site characteristics described above.

10. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.2-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Dynamic Cone Penetrometer Test.
3. 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.
4. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
5. Australian Standard AS 2870-2011, Residential Slabs and Footings.
6. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.
7. Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001
8. Environment & Health Protection Guidelines: On-site Sewage Management for Single Households - January 1998.
9. Australian Standard AS/NZS 1547-2012, On-site Domestic-wastewater Management.
10. Government Sewerage Policy – Consultation Draft, Department of Health, December 2011.
11. Code of Practice for Onsite Sewage Management, Consultation Draft, November 2012.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at Lot 2 Thomas Road and Lot 4 Kargotich Road in Oakford, WA in accordance with DP's proposal dated 16 February 2017 and acceptance received from Goldlight Asset Pty Ltd dated 20 February 2017. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Goldlight Asset Pty Ltd 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.

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.

Douglas Partners Pty Ltd

Appendix A

About This Report

Introduction

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.

Copyright

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.

Borehole and Test Pit Logs

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 justify 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.

Groundwater

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.

Reports

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

Site Anomalies

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.

Information for Contractual Purposes

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.

Site Inspection

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

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.

Test Pits

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.

Large Diameter Augers

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.

Continuous Spiral Flight Augers

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.

Non-core Rotary Drilling

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 major 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.

Continuous Core Drilling

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.

Standard Penetration Tests

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.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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.

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, 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

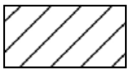
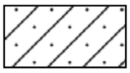
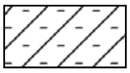
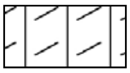
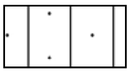
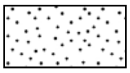
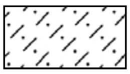
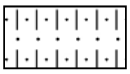
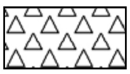
Symbols & Abbreviations

Graphic Symbols for Soil and Rock

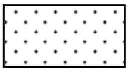
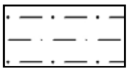
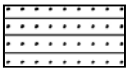
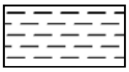
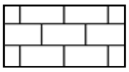
General

	Asphalt
	Road base
	Concrete
	Filling

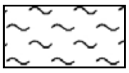
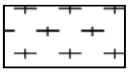
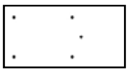
Soils

	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

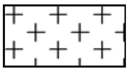
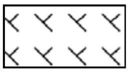
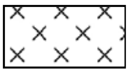
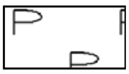
Sedimentary Rocks

	Boulder conglomerate
	Conglomerate
	Conglomeratic sandstone
	Sandstone
	Siltstone
	Laminite
	Mudstone, claystone, shale
	Coal
	Limestone

Metamorphic Rocks

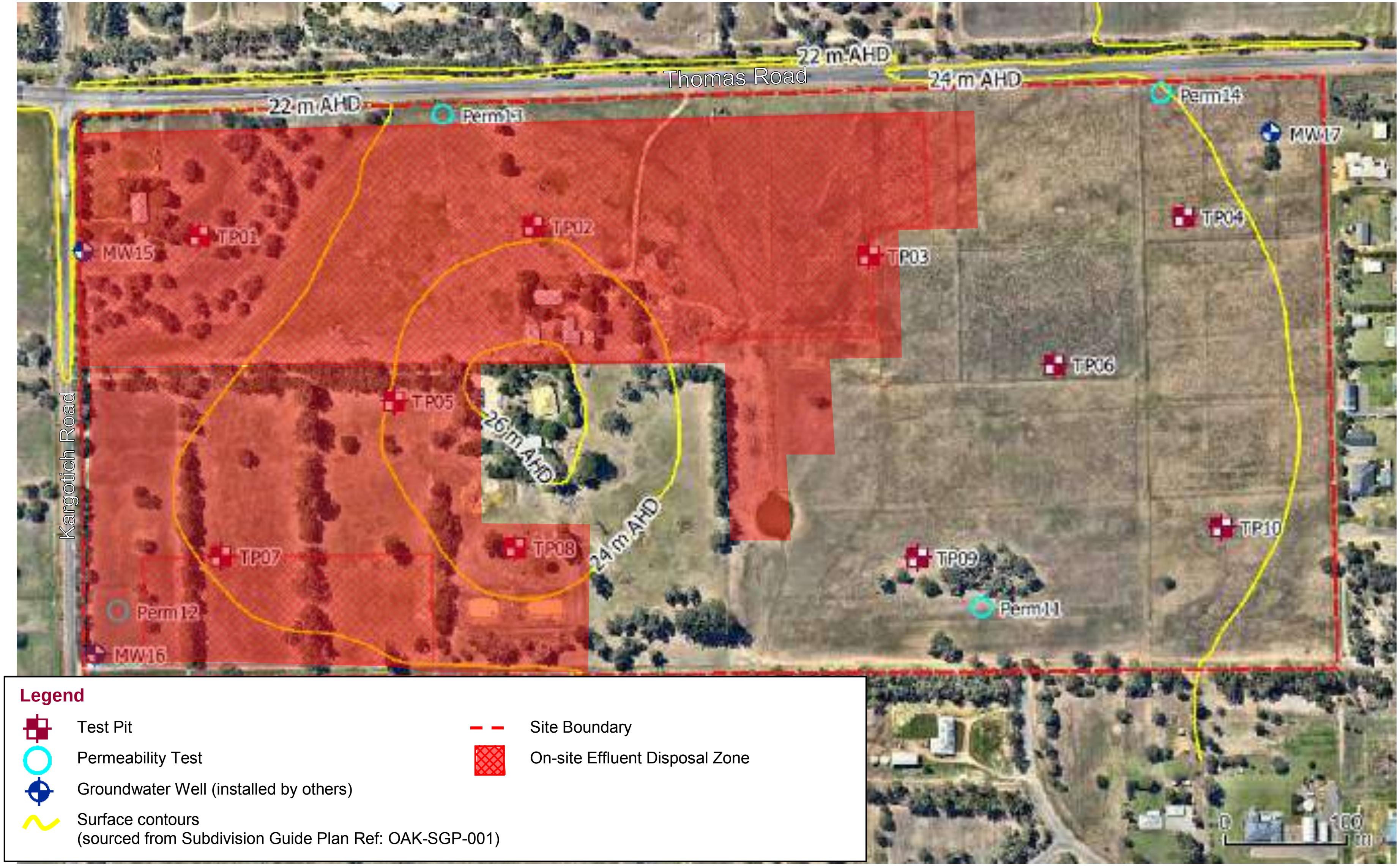
	Slate, phyllite, schist
	Gneiss
	Quartzite

Igneous Rocks

	Granite
	Dolerite, basalt, andesite
	Dacite, epidote
	Tuff, breccia
	Porphyry

Appendix B

Drawing 1
Results of Field Work



Aerial Photography Source: NearMap, flown 27 February 2017.

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT: Goldlight Asset Pty Ltd	**Location of Tests**	PROJECT No:	88862.00
	OFFICE: Perth	**Proposed Rural Residential Development**	DRAWING No:	1
	DATE: 17-03-2017	**Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA**	REVISION:	0

TEST PIT LOG

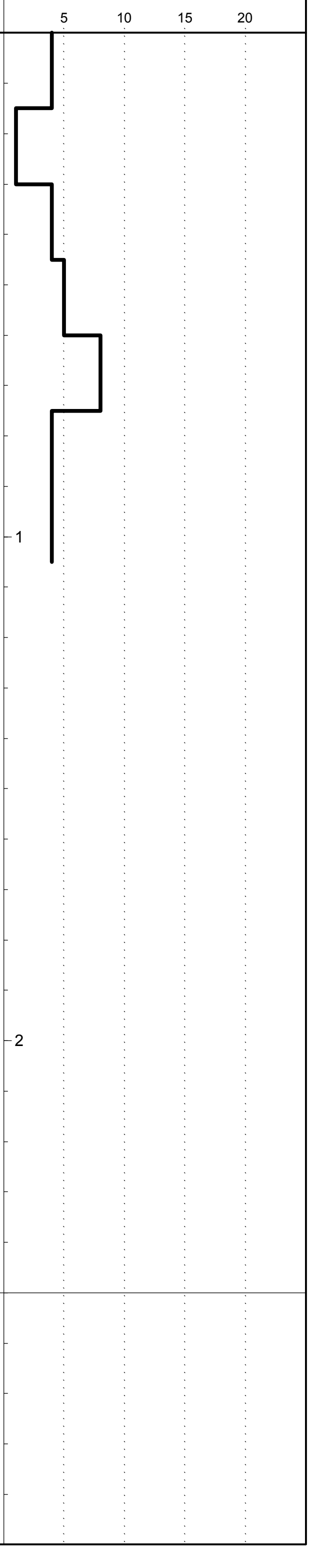
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 22 m AHD*
EASTING: 401445
NORTHING: 6435986

PIT No: TP01
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
22		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.					
	0.1	CLAYEY SAND - loose to medium dense, grey-brown, fine to medium grained, clayey sand, low to medium plasticity clay fines, moist.					
	0.4	SANDY CLAY - stiff to very stiff, grey-brown, sandy clay, medium plasticity, moist. Sand is fine to medium grained.	E	0.5			
				0.6		pp = 280	
	0.9	CLAYEY SAND - orange-brown and grey, fine to medium grained, clayey sand, low to medium plasticity, moist.		0.9		pp = 320	
21	1		E	1.0			
			E	1.5			
		- clay content reducing.					
20	2		E	2.0			
							23-02-17
		- with some ironstone from 2.3 m depth.					
	2.5	Pit discontinued at 2.5m (Target depth)	E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: Groundwater observed at 2.1 m depth.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

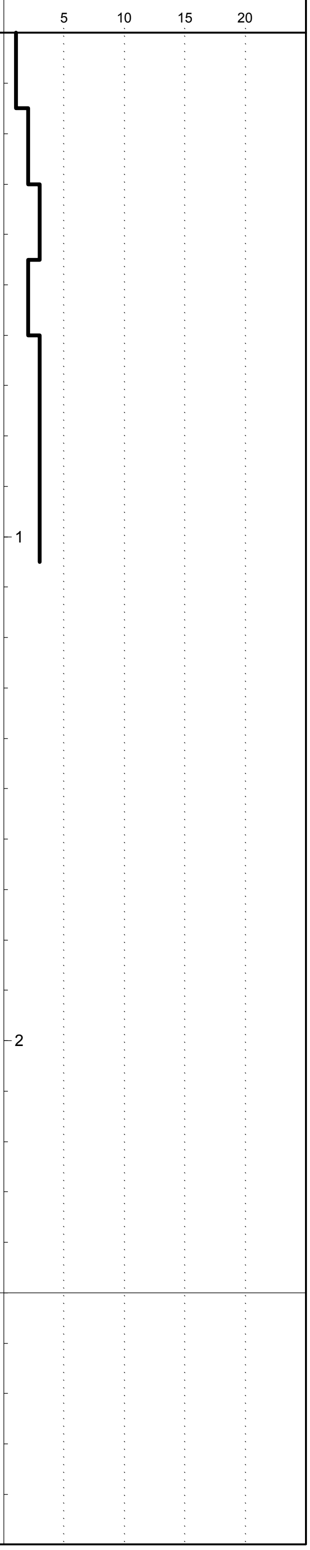
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 401719
NORTHING: 6435994

PIT No: TP02
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24	0.1	TOPSOIL (SAND) - grey-brown, fine to medium grained, sandy topsoil with some silt, dry to moist.						
		SAND - medium dense, grey-brown, fine to medium grained, sand with some silt, moist.						
		- becoming orange-brown from 0.3 m		D	0.4			
				E	0.5			
23	1			E	1.0			
				E	1.5			
		- with some clay from 1.8 m depth.						
22	2							
	2.3	SLIGHTLY CLAYEY SAND - orange-brown, fine to medium grained, slightly clayey sand, moist.						
	2.5	Pit discontinued at 2.5m (Target depth)		E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

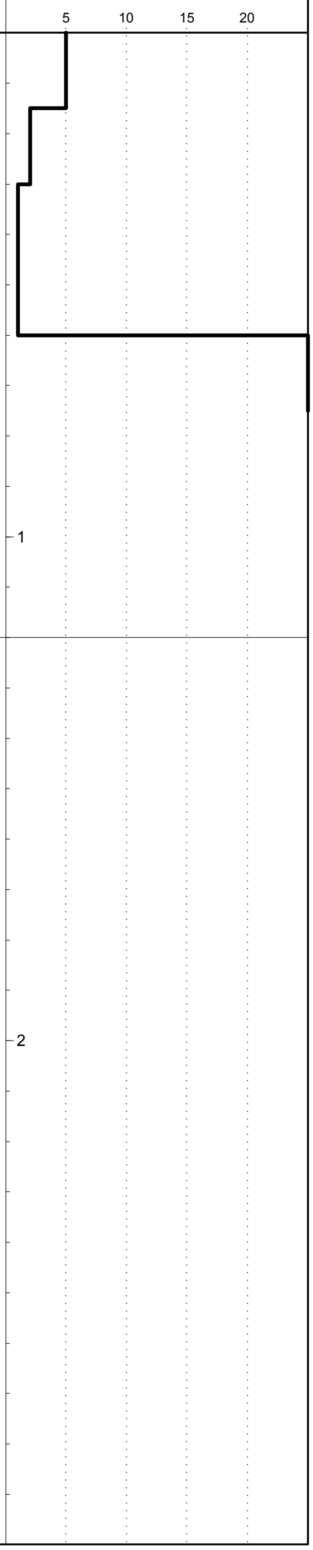
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 401994
NORTHING: 6435970

PIT No: TP03
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.						
	0.15	SANDY CLAY - soft to firm, grey-brown, medium to high plasticity, sandy clay, moist. Sand is fine to medium grained.			0.3		pp = 120	
				B				
				E	0.5	1		
		- becoming hard from 0.6 m depth.						
					0.7		pp = 120	
	0.8	CEMENTED CLAYEY SAND - weakly cemented, light brown, fine to coarse grained, clayey sand, dry to moist.			0.9			
				D				
23	1			E	1.0	2		
	1.2	Pit discontinued at 1.2m (Refusal on strongly cemented material)						
22	2							

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

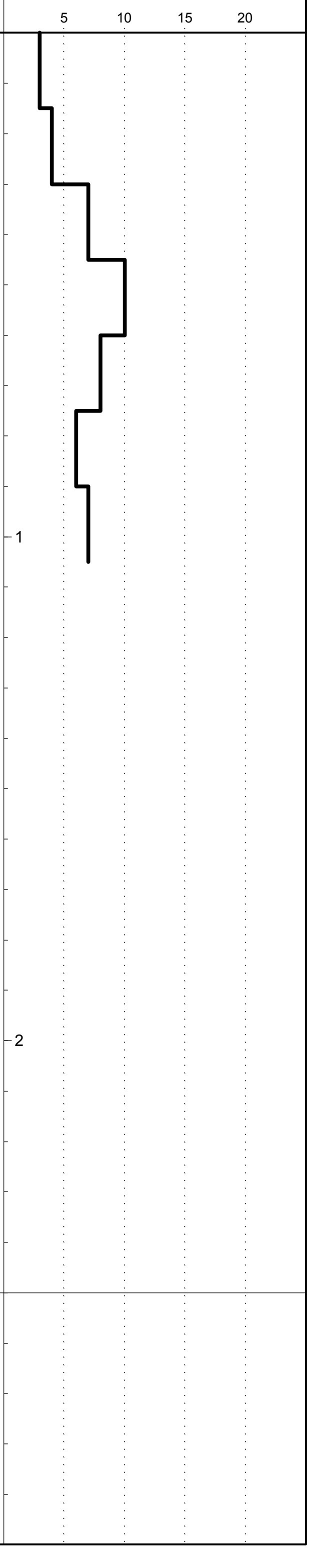
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402252
NORTHING: 6436002

PIT No: TP04
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water
24	0.0	TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.					
	0.1	CLAYEY SILTY SAND - medium dense, brown mottled orange-brown and grey, fine to medium grained, clayey silty sand, low to medium plasticity clay fines, moist.					
	0.2	SANDY CLAY - stiff to very stiff, orange-brown, sandy clay, medium plasticity, moist. Sand is fine to medium grained.	B	0.3–0.5			
		- becoming very stiff, orange-brown and red-brown, low to medium plasticity from 0.9 m depth.	D	0.9–1.0		pp = 510	
23	1						
		- becoming red-brown and grey with some ironstone gravel.	D	1.4			
22	2						
	2.5	Pit discontinued at 2.5m (Target depth)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

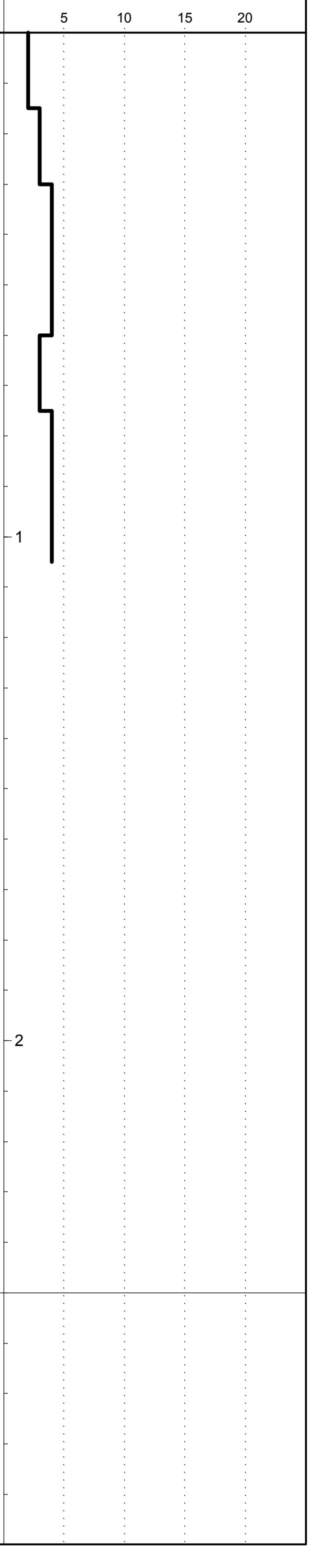
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 401605
NORTHING: 6435851

PIT No: TP05
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24	0.05	TOPSOIL (SAND) - grey-brown, fine to medium grained, sandy topsoil with some silt, dry to moist.					
		SAND - medium dense, grey-brown, fine to medium grained, sand with some silt, moist.					
		- orange-brown with a trace of silt and roots from 0.4 m depth.					
23	1						
	1.7	SLIGHTLY CLAYEY SAND - orange-brown mottled grey and red-brown, fine to medium grained, slightly clayey sand, moist.	D	1.9 – 2.0			
22	2						
	2.1	CLAYEY SAND - orange-brown mottled grey and red-brown, fine to medium grained, clayey sand, low plasticity, moist.					
	2.5	Pit discontinued at 2.5m (Target depth)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

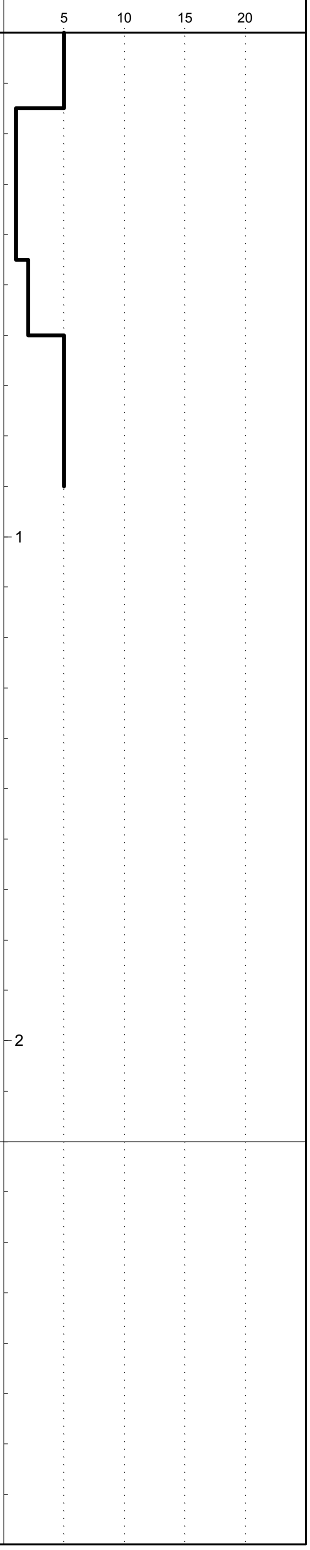
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402146
NORTHING: 6435881

PIT No: TP06
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.						
	0.1	CLAYEY SILTY SAND - loose, brown mottled orange-brown and grey, fine to medium grained, clayey silty sand, low to medium plasticity, moist.						
				U D	0.3 / 0.45			
	0.35	SANDY CLAY - soft, red-brown mottled grey, sandy clay, high plasticity, moist. Sand is fine to medium grained.						
				E	0.5	3	pp = 150	
		- becoming stiff from 0.6 m depth.						
23	1			E	1.0	4	pp = 250	
	1.4	CLAYEY SAND - orange-brown and grey, fine to medium grained, clayey sand, medium plasticity, moist.						
				E	1.5	5		
		- becoming grey mottled orange-brown and red-brown and weakly cemented from 1.7 m depth.						
22	2			E	2.0	6		
	2.2	Pit discontinued at 2.2m (Refusal)						

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

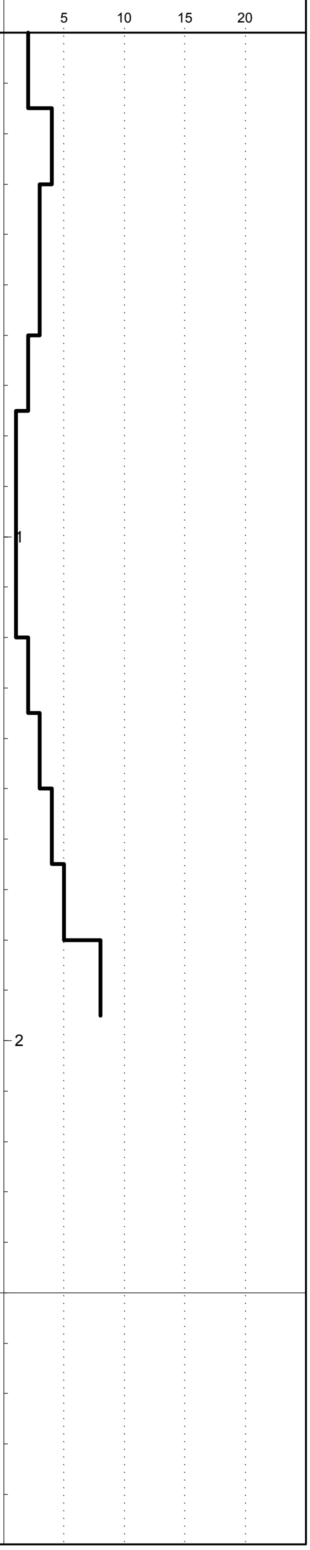
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 22.1 m AHD*
EASTING: 401463
NORTHING: 6435724

PIT No: TP07
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
22	0.1	TOPSOIL (SILTY SAND) - grey, fine to medium grained, silty sandy topsoil, dry to moist.					
	0.7	SAND - medium dense, light brown, fine to medium grained, sand with some silt, moist	D	0.4			
			E	0.5			
	1.0	SLIGHTLY SILTY SAND - loose, light brown, fine to medium grained, slightly silty sand, moist.	E	1.0			
21	1.6	CLAYEY SAND - soft to firm, light brown mottled orange-brown and light grey, fine to medium grained, clayey sand, low plasticity, moist.	U	1.2			
			D	1.3			
			E	1.5			
				1.55			
20	2.5	SANDY CLAY - very stiff, orange-brown and light grey, sandy clay, medium plasticity, moist. Sand is fine to medium grained.	D	1.9			
			E	2.0			
			E	2.5			
		Pit discontinued at 2.5m (Target depth)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

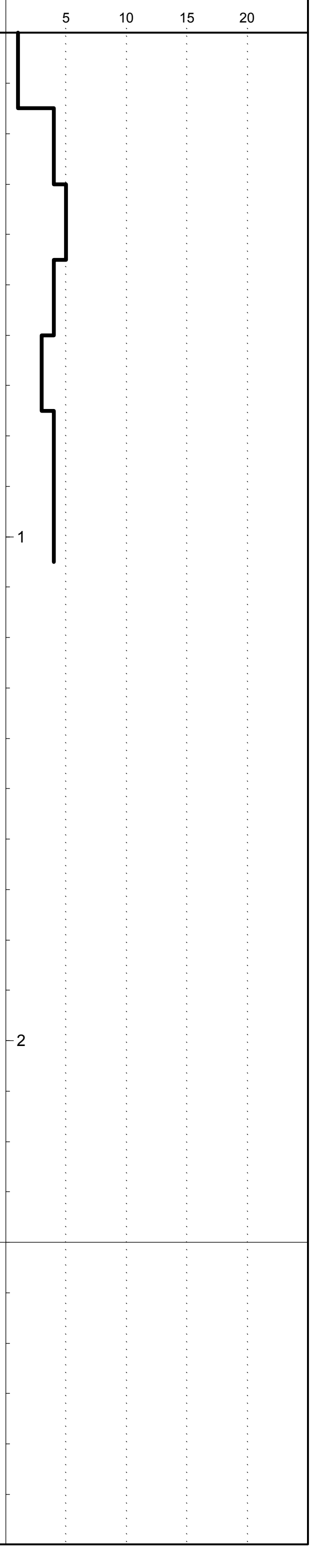
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24.5 m AHD*
EASTING: 401704
NORTHING: 6435731

PIT No: TP08
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
	0.05	TOPSOIL (SAND) - grey-brown, fine to medium grained, sandy topsoil with some silt, dry to moist.						
24		SAND - medium dense, grey-brown, fine to medium grained, sand with some silt, moist. - orange-brown with a trace of silt and roots from 0.4 m depth.						
	1							
23								
	2							
	2.1	SLIGHTLY CLAYEY SAND - orange-brown and light grey, fine to medium grained, slightly clayey sand, low plasticity, moist. - clay content increases from 2.3 m depth.						
	2.4	Pit discontinued at 2.4m (Test pit collapse)						
22								

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

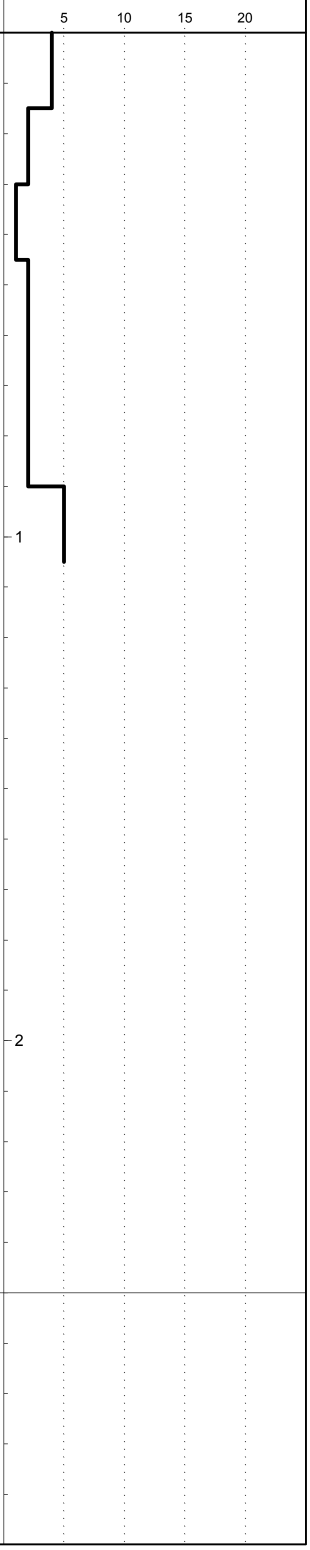
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402034
NORTHING: 6435723

PIT No: TP09
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling Type	Sampling Depth	Sample	Results & Comments	Water
24		TOPSOIL (SILTY SAND) - grey-brown, fine to medium grained, silty sandy topsoil, dry to moist.					
	0.1	SILTY SAND - loose, orange-brown, fine to medium grained, silty sand, moist.					
	0.3	SANDY CLAY - soft to firm, grey-brown, sandy clay, high plasticity, moist. Sand is fine to medium grained.		0.3		pp = 500	
			BU				
			E	0.5		pp = 500	
				0.6			
		- becoming stiff from 0.9 m depth.		0.9		pp = 500	
23	1		E	1.0			
				1.1		pp = 500	
	1.4	CLAYEY SILTY SAND - orange-brown and grey, fine to medium grained, clayey silty sand, low to medium plasticity clay fines, dry to moist.					
			E	1.5			
			D	1.6			
22	2		E	2.0			
	2.5	Pit discontinued at 2.5m (Target depth)	E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

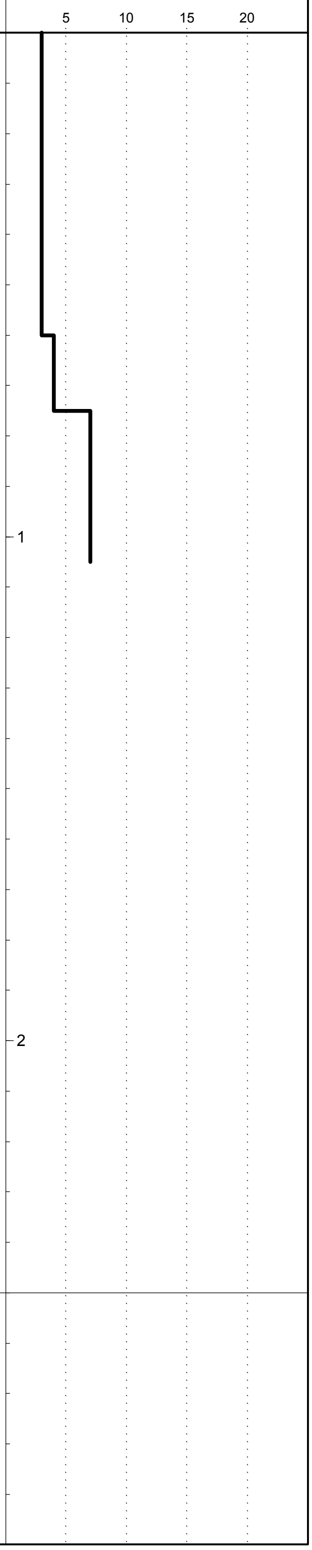
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402283
NORTHING: 6435748

PIT No: TP10
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24	0.0	TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.					
	0.1	CLAYEY SAND - firm to stiff, orange-brown, fine to medium grained, clayey sand, medium plasticity, moist.					
	0.9	SLIGHTLY CLAYEY SAND - medium dense, orange-brown mottled grey, fine to medium grained, slightly clayey sand, low plasticity, moist.					
23	1						
			D	1.4 1.5			
	1.6						▷
	1.7	CLAYEY SAND - orange-brown and grey, fine to medium grained, clayey sand, medium plasticity, moist.					
22	2						
	2.5	Pit discontinued at 2.5m (Target depth)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: Groundwater seepage observed at 1.6 m depth.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

Appendix C

Laboratory Test Results
Geotechnical

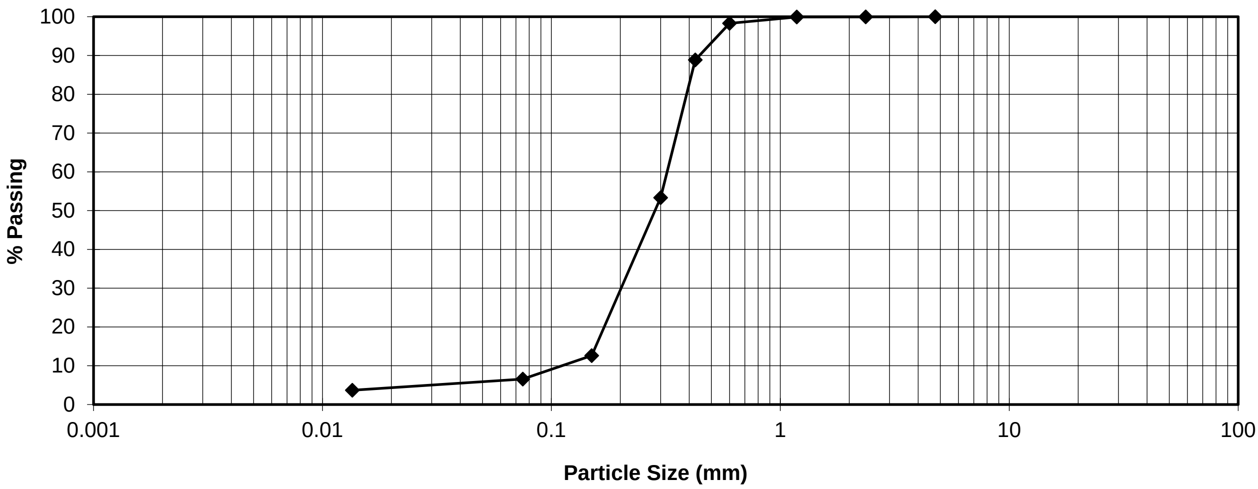
Particle Size Distribution

Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/582**
Sample No:	**P17/582**
Issue Date:	**09-Mar-17**

Client:	Goldlight Asset Pty Ltd	**Sample Details**	TP02
Project:	Proposed Rural Residential Subdivision	**Sample Depth (m)**	0.4-0.5
Location:	Kargotich Rd & Thomas Rd, Oakford		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	98
0.425	89
0.300	53
0.150	13
0.075	7
0.0135	4

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Sampling Procedure: Tested as received

Notes:

Accreditation for compliance with ISO/IEC 17025.
This document may not be reproduced except in full.
Accreditation No 15545.

Approved signature

Craig Hugo

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

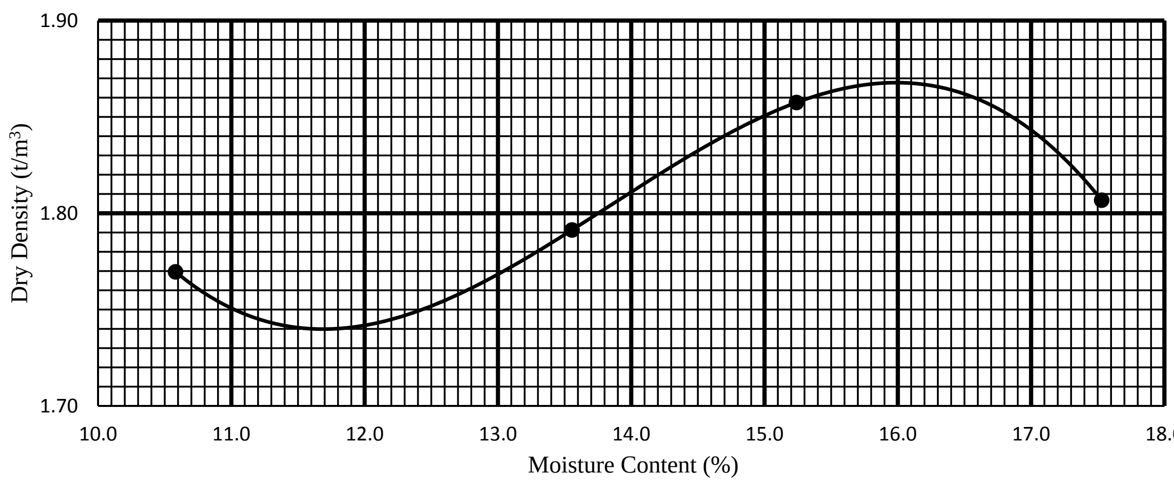
Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email: craig@mcgeotest.com.au

Client:	Goldlight Asset Pty Ltd	**Job No:**	60017
Project:	Proposed Rural Residential Subdivision	**Sample No:**	P17/583
Location:	Kargotich Rd & Thomas Rd, Oakford	**Issued Date:**	08-Mar-17
Sample ID:	TP04 0.3-0.5	**Report No:**	60017-P17/583

Maximum Dry Density t/m3	1.87	**Conditions at Test**	
Optimum Moisture Content %:	16	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	18.9
Compactive Effort		Entire Moisture Ratio %	118.0
Mass of hammer kg	4.9	Top 30mm Moisture Content %	23.4
Number of layers	5	Top 30mm Moisture Ratio %	146.0
Number of blows/layer	20	Swell %	3.5
Conditions after Compaction		C.B.R. at 5.0 mm Penetration %	3
Dry Density t/m3	1.78	**Conditions after Soaking**	
Moisture Content %	15.9	Dry Density t/m3	1.72
Density Ratio %	95.0	Moisture Content %	20.0
Moisture Ratio %	99.0	Dry Density Ratio %	92.0
Soaked / Unsoaked	Soaked	Moisture Ratio %	125.0

Comments:



Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Approved Signature

Craig Hugo

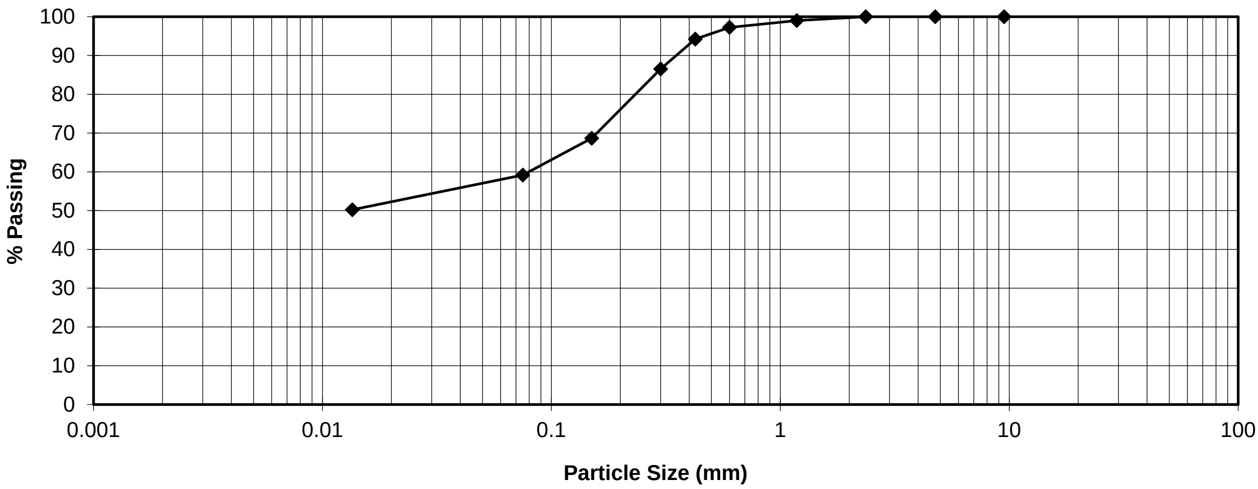
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/583**
Sample No:	**P17/583**
Issue Date:	**10-Mar-17**

Client:	Goldlight Asset Pty Ltd	**Sample Details**	TP04
Project:	Proposed Rural Residential Subdivision	**Sample Depth (m)**	0.3-0.5
Location:	Kargotich Rd & Thomas Rd, Oakford		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	97
0.425	94
0.300	87
0.150	69
0.075	59
0.0135	50

Plasticity index tests
AS 1289

Liquid Limit 3.1.1	50	%
Plastic Limit 3.2.1	18	%
Plasticity Index 3.3.1	32	%
Linear Shrinkage 3.4.1	4.8	%
Cracked	X	
Curled		

Emerson Class Number
AS 1289.3.8.1 6

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Sampling Procedure: Tested as received

Notes:

NATA
WORLD RECOGNISED ACCREDITATION

Accreditation for compliance with ISO/IEC 17025.
This document may not be reproduced except in full.
Accreditation No 15545.

Approved signature

Craig Hugo

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

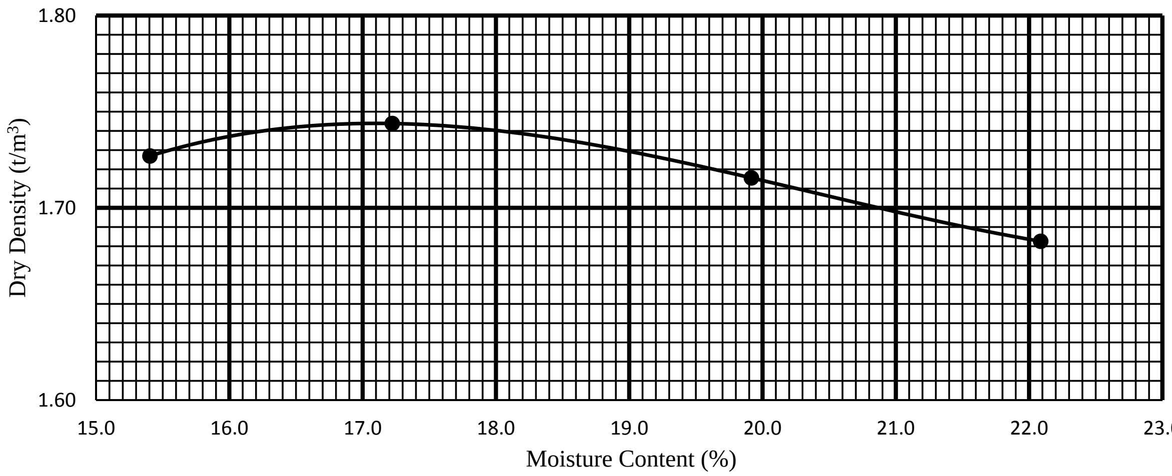
Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email: craig@mcgeotest.com.au

Client:	Goldlight Asset Pty Ltd	**Job No:**	60017
Project:	Proposed Rural Residential Subdivision	**Sample No:**	P17/583
Location:	Kargotich Rd & Thomas Rd, Oakford	**Issued Date:**	08-Mar-17
Sample ID:	TP09 0.3-0.5	**Report No:**	60017-P17/583

Maximum Dry Density t/m3	1.74	**Conditions at Test**	
Optimum Moisture Content %:	17.2	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	24.2
Compactive Effort		Entire Moisture Ratio %	141.0
Mass of hammer kg	4.9	Top 30mm Moisture Content %	36.2
Number of layers	5	Top 30mm Moisture Ratio %	210.5
Number of blows/layer	23	Swell %	5.5
Conditions after Compaction		C.B.R. at 2.5 mm Penetration %	1.5
Dry Density t/m3	1.66	**Conditions after Soaking**	
Moisture Content %	17.3	Dry Density t/m3	1.57
Density Ratio %	95.0	Moisture Content %	24.6
Moisture Ratio %	100.5	Dry Density Ratio %	90.0
Soaked / Unsoaked	Soaked	Moisture Ratio %	143.0

Comments:



Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Approved Signature

Craig Hugo

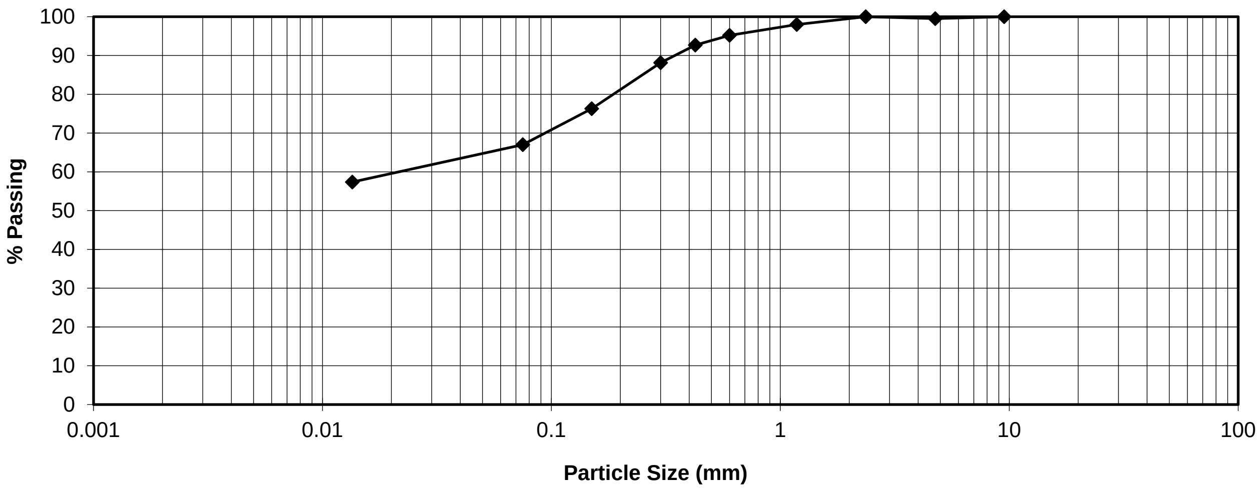
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/584**
Sample No:	**P17/584**
Issue Date:	**10-Mar-17**

Client:	Goldlight Asset Pty Ltd	**Sample Details**	TP09
Project:	Proposed Rural Residential Subdivision	**Sample Depth (m)**	0.3-0.6
Location:	Kargotich Rd & Thomas Rd, Oakford		



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	98
0.600	95
0.425	93
0.300	88
0.150	76
0.075	67
0.0135	57

Plasticity index tests
AS 1289

Liquid Limit 3.1.1	67	%
Plastic Limit 3.2.1	19	%
Plasticity Index 3.3.1	48	%
Linear Shrinkage 3.4.1	5.2	%
Cracked	X	
Curled		

Emerson Class Number
AS 1289.3.8.1 6

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017
Sampling Procedure: Tested as received
Notes:

Approved signature

Craig Hugo

Determination of the Shrinkage Index of a Soil
Shrink Swell Index (AS 1289.7.1.1)

Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/585**
Sample No:	**P17/585**
Issue Date:	**10/03/2017**

Client:	Goldlight Asset Pty Ltd	**Sample Details**	TP09
Project:	Proposed Rural Residential Subdivision	**Sample Depth**	0.3-0.6
Location:	Kargotich Rd & Thomas Rd, Oakford		

Sample Details

Sample Description	Grey brown sandy clay
Sample Type	Tube - U48

Swell Specimen

Dry Density - Initial (t/m^{3})	1.49
Moisture Content - Initial (%)	26.6
Moisture Content - Final (%)	31.7
Overburden Pressure (kPa)	25.0
Inert Inclusions (%)	0.5%

Shrinkage Specimen

Moisture Content Initial (%)	25.4
Length/Diameter Ratio	2.6
Extent of Crumbling	Nil
Extent of Cracking	Nil

Shrink Swell Index

I_{ss} = 3.0 % Vertical strain per pF change in Total suction

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Sampling Procedure: Tested as received

Notes:

Approved signature

Craig Hugo

Appendix D

Laboratory Test Results
Acid Sulphate Soils
Effluent Disposal Suitability

Table D-1: Summary of Soil Laboratory Results

Test Location	Sample ID	Depth (m)	Soil Description	Screening Tests[1]				SPOCAS Suite of Testing								
				pH_F	pH_{FOX}	Reaction[2] Strength	Δ pH[3]	pH_{KCl}	pH_{OX}	TAA[4] (%S)	TPA[5] (%S)	S_{KCl}[6] (%S)	S_{POS}[7] (%S)	N_{RASS}[8] (%S)	ANC[9] (%S)	Net[10] Acidity (%S)
Assessment Criteria				**<4**	**<3**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**-**	**-**	**>0.03**
TP01	TP01 0.5	0.5	CLAYEY SAND / SANDY CLAY - grey-brown.	6.8	5.4	Extreme	1.4	-	-	-	-	-	-	-	-	-
TP01	TP01 1	1	CLAYEY SAND - orange brown.	5.1	4.2	low	0.9	-	-	-	-	-	-	-	-	-
TP01	TP01 1.5	1.5	CLAYEY SAND - orange brown.	4.8	3.9	low	0.9	-	-	-	-	-	-	-	-	-
TP01	TP01 2	2	CLAYEY SAND - orange brown.	4.7	3.6	low	1.1	-	-	-	-	-	-	-	-	-
TP01	TP01 2.5	2.5	CLAYEY SAND - orange brown.	4.7	3.5	low	1.2	5	5.3	0.03	0.018	0.018	<0.005	<0.005	<0.005	**0.032**
TP02	TP02 0.5	0.5	SAND - orange brown.	6.0	4.7	low	1.3	-	-	-	-	-	-	-	-	-
TP02	TP02 1	1	SAND - orange brown.	5.9	4.4	low	1.5	-	-	-	-	-	-	-	-	-
TP02	TP02 1.5	1.5	SAND - orange brown.	6.0	4.6	low	1.4	-	-	-	-	-	-	-	-	-
TP02	TP02 2.5	2.5	SLIGHTLY CLAYEY SAND - orange-brown.	7.5	5.8	low	1.7	-	-	-	-	-	-	-	-	-
TP03	TP03 0.5	0.5	SANDY CLAY - grey-brown.	6.6	5.1	low	1.5	-	-	-	-	-	-	-	-	-
TP03	TP03 1	1	SANDY CLAY - grey-brown.	6.2	5.3	low	0.9	4.8	6.3	0.043	0.021	0.021	<0.005	<0.005	<0.005	**0.044**
TP07	TP07 0.5	0.5	SAND - light brown.	6.1	4.2	Medium	1.9	-	-	-	-	-	-	-	-	-
TP07	TP07 1	1	CLAYEY SAND - light brown mottled orange-brown.	6.6	4.9	Medium	1.7	-	-	-	-	-	-	-	-	-
TP07	TP07 1.5	1.5	CLAYEY SAND - light brown mottled orange-brown.	6.7	5.3	low	1.4	5.6	5.8	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	0.014
TP07	TP07 2	2	CLAYEY SAND / SANDY CLAY - orange-brown.	7.5	6.1	low	1.4	-	-	-	-	-	-	-	-	-
TP07	TP07 2.5	2.5	CLAYEY SAND / SANDY CLAY - orange-brown.	7.4	5.8	low	1.6	-	-	-	-	-	-	-	-	-
TP09	TP09 0.5	0.5	SANDY CLAY - grey-brown.	8.5	6.8	low	1.7	-	-	-	-	-	-	-	-	-
TP09	TP09 1	1	SANDY CLAY - grey-brown.	7.9	6.4	low	1.5	-	-	-	-	-	-	-	-	-
TP09	TP09 1.5	1.5	CLAYEY SILTY SAND - orange-brown and grey.	7.6	6.2	low	1.4	-	-	-	-	-	-	-	-	-
TP09	TP09 2	2	CLAYEY SILTY SAND - orange-brown and grey.	7.5	5.8	low	1.7	-	-	-	-	-	-	-	-	-
TP09	TP09 2.5	2.5	CLAYEY SILTY SAND - orange-brown and grey.	7.7	5.9	low	1.8	5.1	6.9	0.029	<0.01	<0.01	<0.005	<0.005	0.086	0.029

Note:

1. Screening Tests undertaken by MPL Laboratories
2. Low – indicates no or low effervescence in hydrogen peroxide;
   Moderate – indicates moderate effervescence in hydrogen peroxide;
   High – indicates vigorous effervescence in hydrogen peroxide.
3. Δ pH – pHF - pHFOX
4. TAA – titratable actual acidity
5. TPA – titratable peroxide acidity;
6. S_{KCl} – potassium chloride extractable sulphur
7. S_{POS} – peroxide oxidisable sulphur
8. N_{RASS} – retained acidity (reported for pHKCl < 4.5)
9. ANC – acid neutralising capacity (reported for pHKCl > 6.5).
10. Net Acidity = TAA + Spos + NASS. (It should be noted that ANC is excluded as per WA Guidelines)

NT Not Tested

0.04 Exceedance of criteria.

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 192671

Client:
Douglas Partners Perth
36 O'Malley St
Osborne Park
WA 6017

Attention: Rob Shapland

Sample log in details:

Your Reference:	**88862.00**
No. of samples:	21 soils
Date/Time samples received:	28/02/2017 / 15:25
Date completed instructions received:	28/02/2017
Location:	Oakford, lot2 Thomas, lot4 Kargotich rds

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last pages of this report for any comments relating to the results.

Report Details:

Date results requested by:	8/03/17
Date of Preliminary Report:	02/03/2017
Issue Date:	8/03/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

sPOCAS field test						
Our Reference:	UNITS	192671-1	192671-2	192671-3	192671-4	192671-5
Your Reference	-------------	TP01 0.5	TP01 1	TP01 1.5	TP01 2	TP01 2.5
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	6.8	5.1	4.8	4.7	4.6
pHFOX (field peroxide test)*	pH Units	5.4	4.2	3.9	3.6	3.5
Reaction Rate*	-	Extreme	low	low	low	low

sPOCAS field test						
Our Reference:	UNITS	192671-6	192671-7	192671-8	192671-9	192671-10
Your Reference	-------------	TP02 0.5	TP02 1	TP02 1.5	TP02 2.5	TP03 0.5
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	6.0	5.9	6.0	7.5	6.6
pHFOX (field peroxide test)*	pH Units	4.7	4.4	4.6	5.8	5.1
Reaction Rate*	-	low	low	low	low	low

sPOCAS field test						
Our Reference:	UNITS	192671-11	192671-12	192671-13	192671-14	192671-15
Your Reference	-------------	TP03 1	TP07 0.5	TP07 1	TP07 1.5	TP07 2
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	6.2	6.1	6.6	6.7	7.5
pHFOX (field peroxide test)*	pH Units	5.3	4.2	4.9	5.3	6.1
Reaction Rate*	-	low	Medium	Medium	low	low

sPOCAS field test						
Our Reference:	UNITS	192671-16	192671-17	192671-18	192671-19	192671-20
Your Reference	-------------	TP07 2.5	TP09 0.5	TP09 1	TP09 1.5	TP09 2
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	7.4	8.5	7.9	7.6	7.5
pHFOX (field peroxide test)*	pH Units	5.8	6.8	6.4	6.2	5.8
Reaction Rate*	-	low	low	low	low	low

sPOCAS field test		
Our Reference:	UNITS	192671-21
Your Reference	-------------	TP09 2.5
Date Sampled	------------	23/02/2017
Type of sample		Soil
Date prepared	-	01/03/2017
Date analysed	-	02/03/2017
pH_F (field pH test)*	pH Units	7.7
pHFOX (field peroxide test)*	pH Units	5.9
Reaction Rate*	-	low

Miscellaneous Inorg - soil			
Our Reference:	UNITS	192671-1	192671-6
Your Reference	-------------	TP01 0.5	TP02 0.5
Date Sampled	------------	23/02/2017	23/02/2017
Type of sample		Soil	Soil
Date prepared	-	02/03/2017	02/03/2017
Date analysed	-	02/03/2017	02/03/2017
Electrical Conductivity (EC)	µS/cm	500	64

ESP/CEC			
Our Reference:	UNITS	192671-1	192671-6
Your Reference	-------------	TP01 0.5	TP02 0.5
Date Sampled	------------	23/02/2017	23/02/2017
Type of sample		Soil	Soil
Date digested	-	07/03/2017	07/03/2017
Date analysed	-	07/03/2017	07/03/2017
Calcium	mg/kg	110	90
Potassium	mg/kg	<50	<50
Magnesium	mg/kg	720	610
Sodium	mg/kg	440	370
Aluminium	mg/kg	<10	<10
Exchangeable Ca	meq/100g	0.5	0.5
Exchangeable K	meq/100g	<0.1	<0.1
Exchangeable Mg	meq/100g	5.9	5.0
Exchangeable Na	meq/100g	1.9	1.6
Exchangeable Al	meq/100g	<0.07	<0.07
Cation Exchange Capacity	meq/100g	8	7

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
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-020	Metals in soil and water by ICP-OES.
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.

QUALITY CONTROL sPOCAS field test	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD
Date prepared	-			[NT]	192671-1	01/03/2017 || 01/03/2017
Date analysed	-			[NT]	192671-1	02/03/2017 || 02/03/2017
pHF (field pH test)*	pH Units		INORG-063	[NT]	192671-1	6.8 || 6.7 || RPD: 1
pHFOX (field peroxide test)*	pH Units		INORG-063	[NT]	192671-1	5.4 || 5.8 || RPD: 7

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			02/03/2017	[NT]	[NT]	LCS-1	02/03/2017
Date analysed	-			02/03/2017	[NT]	[NT]	LCS-1	02/03/2017
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1.0	[NT]	[NT]	LCS-1	107%

QUALITY CONTROL ESP/CEC	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date digested	-			07/03/2017	[NT]	[NT]	LCS-1	07/03/2017
Date analysed	-			07/03/2017	[NT]	[NT]	LCS-1	07/03/2017
Calcium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	105%
Potassium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	105%
Magnesium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	106%
Sodium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	104%
Aluminium	mg/kg	10	METALS-020	<10	[NT]	[NT]	LCS-1	108%

QUALITY CONTROL sPOCAS field test	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	192671-11	01/03/2017 || 01/03/2017
Date analysed	-	192671-11	02/03/2017 || 02/03/2017
pHF (field pH test)*	pH Units	192671-11	6.2 || 6.2 || RPD: 0
pHFOX (field peroxide test)*	pH Units	192671-11	5.3 || 5.2 || RPD: 2

QUALITY CONTROL sPOCAS field test	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	192671-21	01/03/2017 || 01/03/2017
Date analysed	-	192671-21	02/03/2017 || 02/03/2017
pHF (field pH test)*	pH Units	192671-21	7.7 || 7.0 || RPD: 10
pHFOX (field peroxide test)*	pH Units	192671-21	5.9 || 5.9 || RPD: 0

Report Comments:

Asbestos Signatories:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Airborne fibres were analysed by Approved Counter: Not applicable for this job

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

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.

Douglas Partners
Geotechnics | Environment | Groundwater

CHAIN OF CUSTODY Despatch Sheet

Project Number:	88862.00	**Turn Around Time:**	Standard
Project Name:	OAKFORD, Lot 2 Thomas & Lot 4 Kargotich Roads	**Sample Prior Storage:**	Fridge
Project Manager:	Rob Shapland	**Purchase Order Number:**	128632
Sampler:	Jawad Khandwalla	**Email results to:**	Rob Shapland and Michael Brooker

To: MPL Envirolab
16-18 Hayden Court
Myaree
Ph: 9317 2505

Sample ID	Depth (m)	Sampling Date	Sample Type S - Soil W - Water	Lab ID	Analytes														Notes:
					pH(F)	pH(FOX)	Electrical Conductivity	Cation Exchange Capacity											
TP01	0.5	23/02/2017	Soil (Jar)		x	x	x	x											
TP01	1	23/02/2017	Soil (Bag)		x	x													
TP01	1.5	23/02/2017	Soil (Bag)		x	x													
TP01	2	23/02/2017	Soil (Bag)		x	x													
TP01	2.5	23/02/2017	Soil (Bag)		x	x													
TP02	0.5	23/02/2017	Soil (Jar)		x	x	x	x											
TP02	1	23/02/2017	Soil (Bag)		x	x													
TP02	1.5	23/02/2017	Soil (Bag)		x	x													
TP02	2.5	23/02/2017	Soil (Bag)		x	x													
TP03	0.5	23/02/2017	Soil (Bag)		x	x													
TP03	1	23/02/2017	Soil (Bag)		x	x													
TP07	0.5	23/02/2017	Soil (Bag)		x	x													
TP07	1	23/02/2017	Soil (Bag)		x	x													
TP07	1.5	23/02/2017	Soil (Bag)		x	x													
TP07	2	23/02/2017	Soil (Bag)		x	x													
TP07	2.5	23/02/2017	Soil (Bag)		x	x													
TP09	0.5	23/02/2017	Soil (Bag)		x	x													
TP09	1	23/02/2017	Soil (Bag)		x	x													
TP09	1.5	23/02/2017	Soil (Bag)		x	x													
TP09	2	23/02/2017	Soil (Bag)		x	x													
PQL (S)																			
LOR (W)																			

mpl Laboratories Envirolab
Job No.- 192671
Date Rec- 28-2
Time Rec- 1525
Rec By- MC
TAT Req - SAME 1 / 2 / 3 / STD
Temp- Cool / ambient
Cooling- Ice / Ice pack / None
Security Seal- Yes / No

LOR = Limit of Reporting, PQL = Practical Quantification Limit *As per Laboratory Method Detection Limit

**** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECIEPT OF SAMPLES AND RETURN BY EMAIL****

Relinquished By: Michael Brooker Sign: Date & Time: 28/02/2017

Received By: Meredith Sign: Date & Time: 28-2-17

Send results to: Douglas Partners Pty Ltd, 36 O'Malley Street, OSBORNE PARK 6017 Ph: (08) 9204 3511 Fax: (08) 9204 3522 **Send invoice to:** perth@douglaspartners.com.au

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY Despatch Sheet

Project Number:	88862.00	**Turn Around Time:**	Standard	To: MPL Envirolab
Project Name:	OAKFORD, Lot 2 Thomas & Lot 4 Kargotich Roads	**Sample Prior Storage:**	Fridge	16-18 Hayden Court
Project Manager:	Rob Shapland	**Purchase Order Number:**	128632	Myaree
Sampler:	Jawad Khandwalla	**Email results to:**	Rob Shapland and Michael Brooker	Ph: 9317 2505

Sample ID	Depth (m)	Sampling Date	Sample Type S - Soil W - Water	Lab ID	Analytes														Notes:
					pH(F)	pH(FOX)	Electrical Conductivity	Cation Exchange Capacity											
TP09	2.5	23/02/2017	Soil (Bag)		x	x													
PQL (S)																			
LOR (W)																			

LOR = Limit of Reporting, PQL = Practical Quantification Limit *As per Laboratory Method Detection Limit

**** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECIEPT OF SAMPLES AND RETURN BY EMAIL****

Relinquished By:	Michael Brooker	Sign:		Date & Time:	28/02/2017
Received By:	M. Conroy	Sign:		Date & Time:	28-2-17

Send results to: Douglas Partners Pty Ltd, 36 O'Malley Street, OSBORNE PARK 6017. Ph: (08) 9204 3511 Fax: (08) 9204 3522 **Send invoice to:** perth@douglaspartners.com.au

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 192807

Client:
Douglas Partners Perth
36 O'Malley St
Osborne Park
WA 6017

Attention: Michael Brooker

Sample log in details:

Your Reference:	**88862.00**
No. of samples:	4 dried soils
Date/Time samples received:	28/02/2017 / 15:25
Date completed instructions received:	2/03/2017
Location:	Oakford,Lot2 Thomas & Lot4 kargotich Rds

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last pages of this report for any comments relating to the results.

Report Details:

Date results requested by:	10/03/17
Date of Preliminary Report:	N/A
Issue Date:	9/03/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Stacey Hawkins
Acid Soils/Acid Mine Drainage Supervisor

NATA ACCREDITED FOR TECHNICAL COMPETENCE

sPOCAS Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	192807-1 TP01-2.5m 23/02/2017 Soil	192807-2 TP03-1.0m 23/02/2017 Soil	192807-3 TP07-1.5m 23/02/2017 Soil	192807-4 TP09-205m 23/02/2017 Soil
Date prepared	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017
Date analysed	-	09/03/2017	09/03/2017	09/03/2017	09/03/2017
pH_{kcl}	pH units	5.0	4.8	5.6	5.1
TAA	moles H^+/t	19	27	6.1	18
pH_{Ox}	pH units	5.3	6.3	5.8	6.9
TPA	moles H^+/t	11	13	<5.0	<5.0
S_{KCl}	%w/w S	0.023	0.017	0.012	0.010
Ca_{KCl}	% w / w	0.013	0.025	0.014	0.050
Mg_{KCl}	% w / w	0.049	0.15	0.030	0.22
S_P	% w / w	0.025	0.019	0.016	0.010
Ca_P	% w / w	0.015	0.024	0.014	0.053
Mg_P	% w / w	0.052	0.15	0.030	0.23
a-ANC_E	moles H^+/t	<5	<5	<5	54
SHCl	%w/w S	<0.005	<0.005	<0.005	<0.005
TSA	moles H^+/t	<5.0	<5.0	<5.0	<5.0
s-TAA	%w/w S	0.030	0.043	<0.01	0.029
s-TPA	%w/w S	0.018	0.021	<0.01	<0.01
s-TSA	%w/w S	<0.01	<0.01	<0.01	<0.01
S_{POS}	%w/w S	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+/t	<5.0	<5.0	<5.0	<5.0
Ca_A	%w/w Ca	<0.005	<0.005	<0.005	<0.005
a-Ca_A	moles H^+/t	<5	<5	<5	<5
s-Ca_A	%w/w S	<0.005	<0.005	<0.005	<0.005
Mg_A	%w/w Mg	<0.005	<0.005	<0.005	0.011
a-Mg_A	moles H^+/t	<5.0	<5.0	<5.0	9.2
s-Mg_A	%w/w S	<0.005	<0.005	<0.005	0.015
ANC_E	% $CaCO_3$	<0.01	<0.01	<0.01	0.3
s-ANC_E	%w/w S	<0.005	<0.005	<0.005	0.086
Fineness Factor		1	1	1	1
S_{NAS}	%w/w S	<0.005	<0.005	<0.005	<0.005
a-S_{NAS}	moles H^+/t	<5	<5	<5	<5
s-S_{NAS}	%w/w S	<0.01	<0.01	<0.01	<0.01
s-Net Acidity	%w/w S	0.032	0.044	0.014	0.029
a-Net Acidity	moles H^+/t	20	28	8.5	18
Liming rate	kg $CaCO_3/t$	1.5	2.1	<0.75	1.4
Net Acidity (WA)	%w/w S	0.032	0.044	0.014	0.029
a-Net Acidity without ANCE	moles H^+/t	20	28	8.5	18
Liming rate without ANCE	kg $CaCO_3/t$	1.5	2.1	<0.75	1.4

Method ID	Methodology Summary
INORG-064	Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) using ASSMAC guidelines.

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			[NT]	192807-1	02/03/2017 || 02/03/2017	[NR]	[NR]
Date analysed	-			[NT]	192807-1	09/03/2017 || 09/03/2017	[NR]	[NR]
pH $_{kcl}$	pH units		INORG-064	[NT]	192807-1	5.0 || 5.0 || RPD: 0	LCS	96%
TAA	moles H^+/t	5	INORG-064	[NT]	192807-1	19 || 21 || RPD: 10	LCS	107%
pH $_{Ox}$	pH units		INORG-064	[NT]	192807-1	5.3 || 5.3 || RPD: 0	LCS	98%
TPA	moles H^+/t	5	INORG-064	[NT]	192807-1	11 || 11 || RPD: 0	LCS	96%
S_{KCl}	%w/w S	0.005	INORG-064	[NT]	192807-1	0.023 || 0.022 || RPD: 4	[NR]	[NR]
Ca_{KCl}	%w/w	0.005	INORG-064	[NT]	192807-1	0.013 || 0.013 || RPD: 0	[NR]	[NR]
Mg_{KCl}	%w/w	0.005	INORG-064	[NT]	192807-1	0.049 || 0.047 || RPD: 4	[NR]	[NR]
S_P	%w/w	0.005	INORG-064	[NT]	192807-1	0.025 || 0.026 || RPD: 4	[NR]	[NR]
Ca_P	%w/w	0.005	INORG-064	[NT]	192807-1	0.015 || 0.014 || RPD: 7	[NR]	[NR]
Mg_P	%w/w	0.005	INORG-064	[NT]	192807-1	0.052 || 0.048 || RPD: 8	[NR]	[NR]
a-ANC_E	moles H^+/t	5	INORG-064	[NT]	192807-1	<5 || <5	[NR]	[NR]
SHCl	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
TSA	moles H^+/t	5	INORG-064	[NT]	192807-1	<5.0 || <5.0	[NR]	[NR]
s-TAA	%w/w S	0.01	INORG-064	[NT]	192807-1	0.030 || 0.034 || RPD: 13	[NR]	[NR]
s-TPA	%w/w S	0.01	INORG-064	[NT]	192807-1	0.018 || 0.018 || RPD: 0	[NR]	[NR]
s-TSA	%w/w S	0.01	INORG-064	[NT]	192807-1	<0.01 || <0.01	[NR]	[NR]
S_{POS}	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-S_{POS}	moles H^+/t	5	INORG-064	[NT]	192807-1	<5.0 || <5.0	[NR]	[NR]
Ca_A	%w/w Ca	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-Ca_A	moles H^+/t	5	INORG-064	[NT]	192807-1	<5 || <5	[NR]	[NR]
s-Ca_A	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
Mg_A	%w/w Mg	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-Mg_A	moles H^+/t	5	INORG-064	[NT]	192807-1	<5.0 || <5.0	[NR]	[NR]
s-Mg_A	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
ANC_E	% $CaCO_3$	0.01	INORG-064	[NT]	192807-1	<0.01 || <0.01	[NR]	[NR]
s-ANC_E	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
Fineness Factor			INORG-064	[NT]	192807-1	1 || 1 || RPD: 0	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
SNAS	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-SNAS	moles H^+/t	5	INORG-064	[NT]	192807-1	<5 || <5	[NR]	[NR]
s-SNAS	%w/w S	0.01	INORG-064	[NT]	192807-1	<0.01 || <0.01	[NR]	[NR]
s-Net Acidity	%w/w S	0.01	INORG-064	[NT]	192807-1	0.032 || 0.038 || RPD: 17	[NR]	[NR]
a-Net Acidity	moles H^+/t	5	INORG-064	[NT]	192807-1	20 || 24 || RPD: 18	[NR]	[NR]
Liming rate	kg $CaCO_3$/t	0.75	INORG-064	[NT]	192807-1	1.5 || 1.8 || RPD: 18	[NR]	[NR]
Net Acidity (WA)	%w/w S	0.01	INORG-064	[NT]	192807-1	0.032 || 0.038 || RPD: 17	[NR]	[NR]
a-Net Acidity without ANCE	moles H^+/t	5	INORG-064	[NT]	192807-1	20 || 24 || RPD: 18	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	INORG-064	[NT]	192807-1	1.5 || 1.8 || RPD: 18	[NR]	[NR]

Report Comments:

Asbestos Signatories:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Airborne fibres were analysed by Approved Counter: Not applicable for this job

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

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.

Stacey Hawkins

From: Michael Brooker <Michael.Brooker@douglaspartners.com.au>
Sent: Thursday, 2 March 2017 3:51 PM
To: Stacey Hawkins
Cc: Rob Shapland
Subject: RE: PRELIM Results for Registration 192671 88862.00
Attachments: 192671-[R00].pdf; 192671-COC.PDF; 88862.00.M.001.Rev0.PO for SPOCAS testing.pdf

mpl Laboratories ENVIROLAB
Job No.- 192807
Date Rec- 2.3.17
Time Rec- 15:51
Rec By- St
TAT Req - SAME 1/2/3/STD
Temp - cool/ambient
Cooling - Ice / Ice pack / None
Security Seal - Yes / No

Hi Stacey,

Can you please conduct SPOCAS testing on the following samples:

- TP01 – 2.5 m, (5)
- TP03 – 1.0 m, (11)
- TP07 – 1.5 m, (14)
- TP109 – 2.5 m. (21)

Please find a COC for this testing attached,

Cheers,
Michael

Michael Brooker | Environmental Scientist
Douglas Partners Pty Ltd | ABN 75 053 980 117 | www.douglaspartners.com.au
36 O'Malley Street Osborne Park WA 6017
P: 08 9204 3511 | F: 08 9204 3522 | E: Michael.Brooker@douglaspartners.com.au

From: Stacey Hawkins [mailto:shawkins@mpl.com.au]
Sent: Thursday, 2 March 2017 11:38 AM
To: Michael Brooker; Rob Shapland
Subject: PRELIM Results for Registration 192671 88862.00

Please refer to attached for:
a copy of the Interim Report
a copy of the COC/paperwork received from you
an Excel or .csv file containing the Interim results

Please note that a hard copy will not be posted.

Enquiries should be made directly to:

Joshua Lim on jlim@mpl.com.au
or
Tom Edwards on tedwards@mpl.com.au

THE GOVERNMENT OF WESTERN AUSTRALIA

ChemCentre
Inorganic Chemistry Section
Report of Examination

Chem Centre
EXPERT SOLUTIONS

PO Box 1250, Bentley Delivery Centre
Bentley WA 6983
T +61 8 9422 9800
F +61 8 9422 9801
www.chemcentre.wa.gov.au
ABN 40 991 885 705

Purchase Order: 130101
Your Reference:
ChemCentre Reference: 16S2034 R0

Douglas Partners
36 O'Malley Street
Osborne Park WA 6017

Attention: Jawad Khandwalla

Final Report on 2 samples of soil received on 01/03/2017

LAB ID	Client ID and Description
16S2034 / 001	88862 TP1 0.5m
16S2034 / 002	88862 TP2 0.5m

Analyte		**P**
Method		PRI
Unit		mL/g
Lab ID	**Client ID**	
16S2034/001	88862 TP1 0.5m	7.8
16S2034/002	88862 TP2 0.5m	1.3

Analyte	Method	Description
P	PRI	Phosphorus Retention Index by method S15

The results apply only to samples as received. This report may only be reproduced in full.

Unless otherwise advised, the samples in this job will be disposed of after a holding period of 30 days from the report date shown below.

Phosphorus Retention Index (PRI) is a measure of the ability of soil to retain or leach applied phosphate.

PRI is defined as the ratio P ads : P eq where P ads is the amount of phosphorus adsorbed by soil (µg P/g soil) .

The phosphorus fixation properties of soil may be described by the following PRI values:

PRI

negative	desorbing (P leaching)
0 - 2	weakly adsorbing
2 - 20	moderately adsorbing
20 - 100	strongly adsorbing
>100	very strongly adsorbing

B. Price

Barry Price
Team Leader
Scientific Services Division
9-Mar-2017

APPENDIX D

Environmental Assessment Report

Prepared by Ecoscape

Environmental Investigation

Proposed Rural Residential Subdivision

Lot 2 Thomas Road and Lot 4 Kargotich Road, Oakford WA

Prepared for Goldlight Asset Pty Ltd

ecoscape

VERSION	AUTHOR	QA REVIEWER	APPROVED	DATE
0	Andrew Fry	Bruce Turner Associate Director Environment	Jared Nelson Group Leader Environment	05/12/2017
Final	Bruce Turner	Jared Nelson Group Leader Environment	Jared Nelson Group Leader Environment	13/12/2017

Direct all inquiries to:
Ecoscape (Australia) Pty Ltd
9 Stirling Highway • PO Box 50 NORTH FREMANTLE WA 6159
Ph: (08) 9430 8955 Fax: (08) 9430 8977

TABLE OF CONTENTS

FIGURES

TABLES

MAPS

1 INTRODUCTION

1.1 CONTEXT

Ecoscape was engaged to provide an environmental assessment for Lot 2 Thomas Road and Lot 4 Kargotich Road, Oakford (the study area). The study area is located at the corner of Kargotich and Thomas Roads in the locality of Oakford (**Figure 1**). The environmental information gathered will be used to support a Scheme Amendment Request for zoning to be changed from Rural to Rural Residential.

This proposed zoning change accords with the Shire of Serpentine-Jarrahdale's Rural Strategy Review, which identifies the potential for the subdivision and development of the study area. A draft Structure Plan has been prepared in support to demonstrate how the study area could be subdivided and how the development will integrate the existing and proposed land uses with the movement network in the locality.

Servicing, environmental, geotechnical, water management, bushfire and traffic investigations have been undertaken on site in support of the Scheme Amendment Request to assess the capability of the land for development and to identify specific management measures. Ecoscape provides environmental supporting information in this report.

The study area is 48.6 ha in extent and consists of cleared agricultural land with scattered native and planted exotic tree species with no understorey structure. The site is currently within the boundary of a Multiple Use wetland, as classified by the Department of Biodiversity, Conservation and Attractions (DBCA) Geomorphic Wetland Mapping (DBCA 2017b).

The environmental assessment was undertaken to Environmental Protection Authority (EPA) guidelines and standards and constituted a desktop investigation followed by a field visit to confirm the desktop results. The desktop investigation also considered Matters of National Environmental Significance as administered by the Commonwealth Department of the Environment and Energy (DotEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)..

1.2 PROJECT OBJECTIVES

The objectives of the investigation were to review available data by desktop investigation, and confirm by field investigation, on the following aspects:

- presence of conservation significant wetlands listed under State or Commonwealth legislation
- presence of known environmentally sensitive areas (as administered by the Western Australian Department of Water and Environmental Regulation (DWER) via the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*)
- presence of threatened and priority fauna or fauna habitat
- presence of threatened and priority flora,
- presence of Threatened and Potential Ecological Communities.

Other potential environmental factors including hydrology, acid sulphate soils and landscape capability assessments for receiving wastewater are addressed in the Preliminary Geotechnical Investigation prepared by Douglas Partners in March 2017.

The field visit was undertaken in February of 2017 by an Ecoscape environmental scientist to assess native vegetation and the presence of potential Black Cockatoo habitats.

Figure 1: Study area location

1.3 STATUTORY FRAMEWORK

This environmental assessment was conducted in accordance with Commonwealth and State legislation and guidelines:

- Commonwealth EPBC Act
- Western Australian *Wildlife Conservation Act 1950* (WC Act)
- Western Australian *Environmental Protection Act 1986* (EP Act)
- Western Australian *Biodiversity Conservation Act 2016* (BC Act, partly enacted)
- Department of Environment Water Heritage and the Arts (2009) *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*
- Commonwealth of Australia (2012) *EPBC Act 1999 referral guidelines for three threatened black cockatoo species*: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris, Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii, Forest red-tailed black cockatoo (vulnerable*) *Calyptorhynchus banksii naso*
- Commonwealth of Australia (2017) *Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo*.

In addition, the Minister for the Environment has published lists of fauna and flora species in need of special protection because they are considered rare, likely to become extinct, or are presumed extinct. The current listings published in the *Government Gazette* on 6 January 2017 (Government of Western Australia 2017) were taken into account.

As well as those listed above, the assessment complied with the Environmental Protection Authority requirements for environmental survey and reporting for the purposes of Environmental Impact Assessment in Western Australia, as outlined in:

- EPA (2016a) *Technical Guidance - Terrestrial Fauna Surveys*, known as the *Fauna Technical Guidance*
- EPA (2016b) *Technical Guidance - Sampling Methods for Terrestrial Vertebrate Fauna*.

1.3.1 WESTERN AUSTRALIAN BIODIVERSITY CONSERVATION ACT 2016

The Western Australian BC Act provides for the conservation, protection and ecologically sustainable use of biodiversity and biodiversity components in Western Australia. It will eventually replace the WC Act, however, until relevant Conservation Regulations are in place, provisions under the WC Act still apply. The parts currently in effect are listed on the DBCA website (DBCA 2017a, accessed 17 September 2017).

Threatened species (both flora and fauna) that meet the categories listed within the BC Act are highly protected and require authorisation by the Minister to take or disturb. These are known as Threatened Flora and Threatened Fauna. The conservation categories of critically endangered, endangered and vulnerable have been aligned with those detailed in the EPBC Act, as below.

Flora and fauna species may be listed as being of special conservation interest if they have a naturally low population, restricted natural range, are subject to or recovering from a significant population decline or reduction of range or are of special interest, and the Minister considers that taking may result in depletion of the species. Migratory species and those subject to international agreement are also listed under the Act. These are known as specially protected species in the BC Act.

Threatened Ecological Communities are also protected under the BC Act and are categorised using the same criteria as threatened species.

At the time of writing this report, most provisions within the BC Act have not been yet been proclaimed, including those relating to species of conservation interest (Specially Protected Species) and Threatened Ecological Communities. As these are not included in the WC Act, there is currently no specific legal protection afforded to these within Western Australia beyond the usual protection of unlisted species and native vegetation under the *Native Vegetation Clearing Regulations* (Government of Western Australia 2004), unless they are protected under the Commonwealth EPBC Act. Threatened Flora and Threatened Fauna are protected under the provisions of the WC Act until further sections of the BC Act are enacted.

1.3.2 COMMONWEALTH ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

At a Commonwealth level, Threatened taxa are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependant, Extinct, or Extinct in the Wild.

1.3.3 ENVIRONMENTALLY SENSITIVE AREAS

There are a number of areas around Western Australia identified as being of environmental significance within which the exemptions to the Native Clearing Regulations do not apply. These are referred to as Environmentally Sensitive Areas (ESAs), and are declared under section 51B of the EP Act and described in the Environmental Protection (Environmentally Sensitive Areas) Notice (Government of Western Australia 2005).

2 METHODS

2.1 DESKTOP INVESTIGATION

A desktop investigation used datasets available through government sources and Ecoscape databases to map environmental information onto the study area. Information sourced included the following:

- DBCA NatureMap and wetland mapping
- Heddle Vegetation Complexes and determining current extents to assess the significance of native vegetation
- Environmentally Sensitive Areas mapping
- Commonwealth EPBC Act Protected Matters Search Tool (PMST).

Maps were produced of each of the relevant aspects above in relation to the study area and are displayed in **Appendix One**.

The environmental factors for land capability; groundwater; ASS soils and contamination are provided in the geotechnical report prepared by Douglas Partners, March 2017.

2.2 LEVEL 1 FAUNA SURVEY

2.2.1 GUIDING PRINCIPLES

The following were taken into account when developing the survey methodology:

- EPA (2016a) *Fauna Technical Guidance*
- background information on the study area (i.e. desktop assessment, aerial imagery and other data).

The *Fauna Technical Guidance* recommends the following for a Level 1 fauna survey:

- desktop assessment to gather contextual information on the study area from previous surveys, literature, database searches and map-based information
- site visit to be conducted to verify the accuracy of the desktop study, delineate and characterise the fauna and faunal assemblages present in the study area
- survey to include low intensity sampling of fauna and faunal assemblages.

2.2.2 CONSERVATION SIGNIFICANT FAUNA LIKELIHOOD ASSESSMENT

The likelihood of occurrence of the conservation significant fauna species identified by the NatureMap and PMST searches and literature searches as being known from nearby was assessed using the following criteria:

- suitability of habitats present within the study area
- distance between previous record of conservation significant species and the study area
- frequency and number of records in the region, and
- date of record of conservation significant species (recent or historical).

The sufficiency of information and behavioural and ecological characteristics, such as cryptic behaviours were also taken into account. Using the above criteria, the categories of likelihood of occurrence are shown in **Table 1.**

Table 1: Categories for likelihood of occurrence of conservation significant fauna

Likelihood	Categories
Recorded	Species recorded within the study area within a reasonable timeframe (0-5 years)
High	Species recorded in close proximity to the study area (<5 km) within the past 10 years; suitable habitat occurs within the study area
Medium	Species historically recorded in close proximity (<5 km) to the study area, more than 10 years ago; suitable habitat may exist within the study area
Low	Species not recorded in the proximity of the study area or rarely recorded within 10 km of the study area; suitable habitat unlikely to occur within the study area
Very Low	Species not recorded by multiple surveys/databases within 20 km of the study area and suitable habitat does not occur within the study area, however species or suitable habitat is listed as potentially occurring in the wider region

2.2.3 FAUNA FIELD SURVEY

The fauna field assessment included identifying fauna habitat, with fauna species identified opportunistically based on sightings, calls, remains, diggings and other signs. Potential habitats for conservation significant species were identified and evaluated and their likelihood of occurrence assessed. In addition, potential breeding trees for the three EPBC listed Black Cockatoo species were recorded and photographed where present.

2.2.3.1 Timing of the Field Survey

A field investigation was undertaken on 28 February 2017 for the assessment of native vegetation, terrestrial fauna and potential Black Cockatoo habitats. Potential breeding and foraging habitat was recorded and mapped.

The fauna survey was undertaken outside of the appropriate season as per EPA (2016a) *Fauna Technical Guidance* that states that fauna surveys are optimally conducted in spring (September to November) to ensure sampling during peak activity of reptiles, amphibians and birds. Survey timing for these fauna groups is dependent on warm temperature and/or rainfall events. Mammal activity is not dependant on weather and is therefore not constrained. The degraded nature of the site did not constrain the survey as being adequate and out of season.

2.2.4 BLACK COCKATOO HABITAT SURVEY

The recently released draft revised referral guideline for Black Cockatoo species by DotEE (Commonwealth of Australia 2017) provides guidance on the assessment of habitat for the three listed Black Cockatoo species. Habitat assessment is the primary technique used to inform decisions on significant impact for Black Cockatoos and is aimed at identifying habitat used for foraging, breeding or roosting.

2.2.4.1 Breeding Habitat

The fauna survey for Black Cockatoo habitat followed the DotEE *Black Cockatoo referral guidelines* (Commonwealth of Australia 2012) and *Revised draft referral guideline* (Commonwealth of Australia 2017). In addition to following the guidelines each breeding tree was scored for habitat value using a scoring system developed by Dr Mike Bamford (2016), the score reflects the existing value of the tree characteristics with respect to its potential to be used as a breeding tree and therefore assists in more accurately assessing the real impact of disturbance (**Table 2**).

Table 2: Grading system for the assessment of potential nest trees for Black Cockatoos

Class	Description of Tree and Hollows/Activity
1	Active nest observed; adult (or immature) bird seen entering or emerging from hollow.
2	Hollow of suitable size and angle (i.e. near-vertical) visible with chew marks around entrance.
3	Potentially suitable hollow visible but no chew marks present; or potentially suitable hollow present (as suggested by structure of tree, such as large, vertical trunk broken off at a height of >10m).
4	Tree with large hollows or broken branches that might contain large hollows but hollows or potential hollows are not vertical or near-vertical; thus a tree with or likely to have hollows of sufficient size but not to have hollows of the angle preferred by Black-Cockatoos.
5	Tree lacking large hollows or broken branches that might have large hollows; a tree with more or less intact branches and a spreading crown.

2.2.4.2 Foraging Habitat

A scoring tool has been developed by the Commonwealth to determine if the impact area contains quality foraging habitat (**Table 3**). Habitat surveys must be sufficient to complete the scoring tool and provide a score and justification for foraging habitat quality.

The elements of the scoring tool require surveys to provide information on the following:

- the presence of all plant species that provide foraging, including non-native food sources used by black cockatoos
- the presence of tree species used for breeding
- use as a roosting site
- the vegetation present in the surrounding area i.e. at least 12 km from the impact area, including proximity to any breeding habitat, roosting sites or watering points
- breeding habitat, such as an estimate of the number of trees with a diameter at breast height (1.3 metres from the ground) of 500 mm, or 300 mm if salmon gum or wandoo
- numbers of any known nesting trees
- presence of disease, such as *Phytophthora cinnamomi* or marri canker (*Quambalaria coyrecup*).

Table 3: Commonwealth Foraging Quality Scoring Tool (Commonwealth of Australia 2017)

Starting Score	Foraging habitat for Carnaby's Cockatoo	Foraging habitat for Baudin's Cockatoo	Foraging habitat for Forest Red-tailed Black cockatoo
10 (Very high quality)	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a sore of ≥10	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a sore of ≥10	Foraging habitat that is being managed for black cockatoos such as habitat that is the focus of successful rehabilitation, and/or has some level of protection from clearing, and/or is quality habitat described below with attributes contributing to meet a sore of ≥10
7 (High quality)	Native shrubland, kwongan heathland and woodland dominated by proteaceous plant species such as Banksia spp. (including Dryandra spp.), Hakea spp. and Grevillea spp., as well as native eucalypt woodland and forest that contains foraging species, including along roadsides. Does not include orchards, canola, or areas under a RFA	Native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly marri, including along roadsides. Does not include orchards or areas under a RFA	Jarrah and marri woodlands and forest, and edges of karri forests, including wandoo and blackbutt, within the range of the subspecies, including along roadsides. Does not include areas under a RFA
5 (Quality)	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts	Pine plantation or introduced eucalypts
1 (Low quality)	Individual foraging plants or small stand of foraging plants	Individual foraging plants or small stand of foraging plants	Individual foraging plants or small stand of foraging plants

Additions	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat	Context adjustor - attributes improving functionality of foraging habitat
+3	Is within the Swan Coastal Plain (important foraging area).	Is within the known foraging area (see map).	Jarrah and/or marri show good recruitment (i.e. evidence of young trees).
+3	Contains trees with suitable nest hollows	Contains trees with suitable nest hollows	Contains trees with suitable nest hollows
+2	Primarily contains marri	Primarily contains marri	Primarily contains marri and/or jarrah
+2	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo)	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo)	Contains trees with potential to be used for breeding (dbh ≥ 500 mm or ≥ 300 mm dbh for salmon gum and wandoo)
+1	Is known to be a roosting site	Is known to be a roosting site	Is known to be a roosting site
Subtractions	**Context adjustor - attributes reducing functionality of foraging habitat**	**Context adjustor - attributes reducing functionality of foraging habitat**	**Context adjustor - attributes reducing functionality of foraging habitat**
-2	No clear evidence of feeding debris.	No clear evidence of feeding debris.	No clear evidence of feeding debris.
-2	No other foraging habitat within 6 km.	No other foraging habitat within 6 km.	No other foraging habitat within 6 km.
-1	Is > 12 km from a known breeding location	Is > 12 km from a known breeding location	Is > 12 km from a known breeding location
-1	Is > 12 km from a known roosting site	Is > 12 km from a known roosting site	Is > 12 km from a known roosting site
-1	Is > 2 km from a watering point	Is > 2 km from a watering point	Is > 2 km from a watering point
-1	Disease present (e.g. Phytophthora cinnamomi or marri canker).	Disease present (e.g. Phytophthora cinnamomi or marri canker).	Disease present (e.g. Phytophthora cinnamomi or marri canker).

2.2.4.1 Roosting Habitat

Both large native and introduced Eucalypt trees that provide Black Cockatoo foraging and breeding habitat also provide roosting habitat as it is defined in the Commonwealth guidelines; "*Defined as a suitable tree (generally the tallest) or group of tall trees, native or introduced, usually close to an important water source, and within an area of quality foraging habitat within the range of the species.*"

Roost sites provide shelter during the heat of the day and safe resting places at night. Black cockatoos will favour roost sites that are close to water sources and in proximity to foraging resources (Commonwealth of Australia 2017).

2.2.5 FAUNA SURVEY LIMITATIONS

Table 4: Fauna survey limitations

Possible limitations	Constraints (yes/no):	Comment
Competency/experience of the consultant conducting the survey	No	35+ years' experience in assessing environmental impact and conducting fauna surveys in Western Australia
Scope	No	All items in the scope were investigated
Proportion of fauna identified, recorded and/or collected	Yes	Level 1 opportunistic event does not allow for a full fauna species inventory to be collected
Sources of information	No	Both State and Commonwealth sources readily available
Proportion of the task achieved	No	All tasks achieved
Timing/weather/season/cycle	No	Weather and season were moderate for the detection of most assemblages
Disturbances which affected results of the survey	No	No disturbances to the survey occurred
Intensity of survey (e.g. in retrospect was the intensity adequate?)	No	The size of the study area and the expected level of disturbance warranted a level 1 reconnaissance survey appropriate
Completeness (e.g. was relevant area fully surveyed?)	No	Entire study area was traversed on foot
Remoteness and/or access problems	No	No access problems encountered
Availability of contextual (e.g. bioregional) information for the survey area	No	Adequate contextual material existed for the study area and bioregion

3 RESULTS

3.1 CLIMATE

The South-west of Western Australia experiences a Mediterranean-type climate of mild, wet winters and warm to hot, dry summers (Beard 1990). The climate of the region is strongly influenced by the position of a band of high pressure known as the sub-tropical ridge. For much of the year the ridge is located to the south allowing the east or south easterly winds to prevail. During the cooler months the ridge periodically moves to the north allowing cold fronts to pass over the west coast and deliver much of the annual rainfall. The Swan Coastal Plain typically receives 800-900 mm of annual precipitation and 5-6 nearly dry months per year as shown in **Figure 2.**

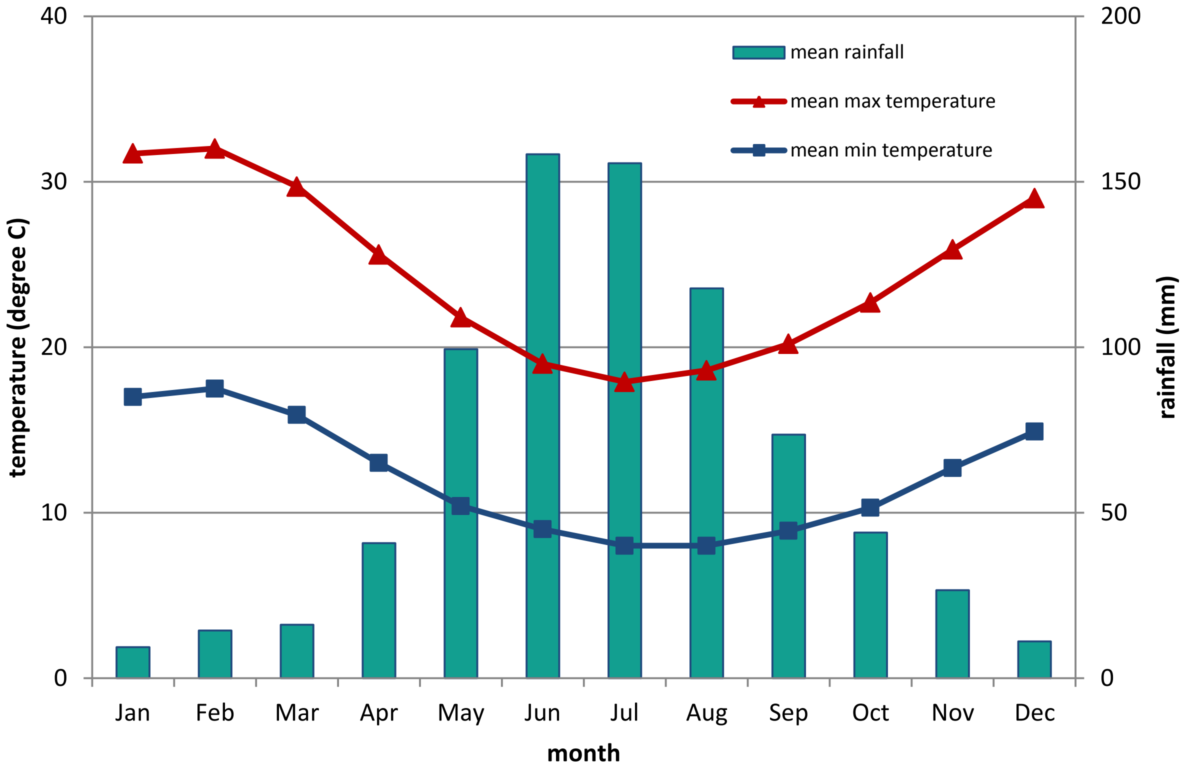


Figure 2: Mean monthly rainfall and temperatures at Perth Airport (Bureau of Meteorology 2017)

3.2 KEY ENVIRONMENTAL FACTORS

3.2.1 WETLANDS

The interaction of the seasonally (winter) wet climate of the Swan Coastal Plain with its undulating topography, variable soil properties, and surface and groundwater flows (now extensively modified by agricultural and urban development, water extraction and active management), creates and maintains temporary and permanent waterways and wetlands (Department of Water 2009).

A review of the DBCA Geomorphic Wetlands Swan Coastal Plain dataset identified a Multiple Use Category Palusplain (Armadale Palusplain UFI 15797) as occurring across the entire study area (DBCA 2017b).

The wetland classification categories provide guidance on the nature of the management and protection the wetland should be awarded. In the case of Multiple Use wetlands the EPA urges that all reasonable measures are taken to retain the wetland's hydrological functions (including on-site water infiltration and flood detention) and, where possible, other wetland functions (Environmental Protection Authority 2008).

The DotEE Protected Matters Search Tool was also used to search for protected areas listed under the EPBC Act (1999). The search identified that no wetlands of importance (RAMSAR Wetlands or Directory of Important Wetlands) occur within a 5 km radius of the study area.

It was identified that the study area is within the *Environmental Protection (Peel Inlet – Harvey Estuary) Policy 1992* boundary and as such restrictions are placed on the export of excess nutrients from land use practices and stormwater flows (Environmental Protection Authority 1992).

3.2.2 VEGETATION

The study area is devoid of any areas of native vegetation with the required structure to be considered extant bushland. Isolated patches of both native and planted exotic tree species are present and exist predominantly around the edges of paddocks used for grazing, access roads, dwellings and outbuildings (**Map 2**). Native Marri trees (*Corymbia calophylla*), Flooded Gums (*Eucalyptus rudis*) and planted non-native Eucalypt species provide some value as Black Cockatoo foraging and roosting habitat. There were also isolated C*asuarina obesa* trees recorded as being present in the study area, however this species is not considered to constitute habitat for Black Cockatoo species. No native understorey species were recorded and as such the entire study area was recorded as being in a Completely Degraded condition according to the Keighery (1994) Bushland Condition scale.

A search of NatureMap indicates the presence of Threatened Flora species *Synaphea* sp. Serpentine, approximately 1000 m to the south east in remnant bushland. This species is known to occur in disturbed infrastructure corridors and road verges, however due to the totally cleared nature of the understory in the study area it is considered that there is no potential for this species to occur.

Due to the field survey recording no extant native vegetation (in Good or better bushland condition), there is no potential of either a Threatened Ecological Community or a Priority Ecological Community occurring.

3.2.3 ENVIRONMENTALLY SENSITIVE AREAS

There were no areas deemed ESA within or directly adjacent to the study area (Department of Environment Regulation 2015).

An ESA boundary that appears to be associated with three Conservation class wetlands and the location of a known Threatened Flora species (*Synaphea* sp. Serpentine) terminates approximately 500 m from the study area boundary to the south east (**Map 1**)(Department of Environment Regulation 2015).

3.2.4 FAUNA SURVEY

The fauna survey was restricted to the assessment of Black Cockatoo habitats as the study area is completely devoid of native understorey vegetation and currently under grazing land use activity and therefore unable to be classified into fauna habitat types other than for avian species. The surrounding areas are also completely degraded and unlikely to provide even minimal habitat for ground dwelling species.

As the field survey recorded no habitat as being within the study area for any of the ground dwelling terrestrial fauna species listed in the NatureMap and PMST search results, other than for Birds, the likelihood of occurrence was assessed as Low. The conservation significant fauna species identified from the NatureMap and PMST searches as likely to occur in the study area are listed in **Table 5** using the likelihood of occurrence criteria as in **Table 1**.

Table 5: Conservation significant fauna species potentially occurring

Common name	Scientific name	Conservation Code			Source	Record	Likelihood of occurrence
		*EPBC ACT**	BC/ WC Act	DBCA status			
Mammals							
Southern Brown Bandicoot	*Isoodon obesulus fusciventer*	-	-	P5	*Nature Map*, DBCA	Recorded <5km	Low
Birds							
Carnaby's Cockatoo	*Calyptorhynchus latirostris*	EN	S2	EN	*Nature Map*, DBCA	Recorded adjacent	High
Forest Red-tailed Black Cockatoo	*Calyptorhynchus banksii* subsp. *naso*	VU	S3	VU	*Nature Map*, DBCA	Recorded adjacent	High
Baudin's Cockatoo (long-billed black-cockatoo)	*Calyptorhynchus baudinii*	VU	S3	VU	*Nature Map*, DBCA	Recorded <5km	Medium
Peregrine Falcon	*Falco peregrinus*	-	S7	-	*Nature Map*	Recorded <5km	Medium
Rainbow Bee-eater	*Merops ornatus*	-	S5	IA	*Nature Map*	Recorded <5km	Medium
Reptiles							
Southern Death Adder	*Acanthophis antarcticus*			P3	*Nature Map*	Recorded <5km	Low

*M = Migratory, S=Schedule, VU=Vulnerable, EN=Endangered; CR=Critically Endangered

3.2.4.1 Black Cockatoo Habitat assessment

The assessment of Black Cockatoo habitat was undertaken in the field by Bruce Turner (Ecoscape Principal Zoologist). The habitat assessment focussed on both potential nesting and foraging habitat present within the study area. Trees were recorded by GPS and assessed for habitat value for breeding, roosting or foraging (**Map 2**).

The study area is outside of the Commonwealth mapped breeding ranges for Carnaby's Cockatoo and Baudin's Cockatoo and therefore it is unknown if the trees recorded are used by the birds for breeding. They have been recorded for their potential to provide breeding habitat only and do not constitute actual breeding habitat.

Breeding Habitat (potential nesting)

The results indicate that six trees out of the 34 trees recorded as breeding habitat have the preferred values for nesting and should be considered for protection (**Table 6**). These six Class 3 trees, three of which are dead standing trunks, could be managed through tree protection measures and suitable placement of building envelopes to avoid their removal.

Table 6: Number of Habitat Trees by Species and Class Value.

Species	Tree Class Value			Total
	3	4	5	
Dead	3	1	0	4
Marri	3	23	0	26
Exotic Eucalypt	0	3	0	3
Flooded Gum	0	0	1	1
Tree Class Value Total	**6**	**27**	**1**	**34**

Foraging Habitat Quality Assessment

Based on the guidelines for the three Black Cockatoo species (Commonwealth of Australia 2012), the study area was assessed as possessing suitable foraging habitat. The Draft Referral Guidelines from the Commonwealth now has a scoring tool for the assessment of foraging habitat quality, as detailed in Section 2.2.4.2, the habitat within the study area was scored as follows.

Foraging habitat quality for Carnaby's Cockatoo and was scored as follows:

- Starting score
  - **+1** (Low Quality) being individual foraging plants or small stand of foraging plants
- Additions –
  - **+3** within the Swan Coastal Plain
  - **+3** Contains trees with suitable nesting hollows
  - **+2** Contains trees with potential to be used for breeding (Diameter at Breast Height (DBH) ≥ 500 mm)
- Subtractions
  - **-2** No clear evidence of feeding debris.

The final score is **7** (of a maximum score of 21), according to the guidelines this indicates high quality habitat. Impacts on high quality foraging habitat are likely to have a significant impact, with a lower acceptability of loss in hectares (Commonwealth of Australia 2017).

Foraging habitat quality for Forest Red-tailed Black Cockatoo and was scored as follows:

- Starting score
  - **+1** (Low Quality) being individual foraging plants or small stand of foraging plants
- Additions –
  - **+3** Contains trees with suitable nesting hollows
  - **+2** Contains trees with potential to be used for breeding (dbh ≥ 500 mm)
- Subtractions
  - **-2** No clear evidence of feeding debris.

The final score is **4** (of a maximum score of 21), according to the guidelines this indicates value habitat. Impacts on value foraging habitat may still require referral, depending upon how much habitat is being impacted (Commonwealth of Australia 2017).

Foraging habitat quality for Baudin's Cockatoo and was scored as follows:

- Starting score
  - **+1** (Low Quality) being individual foraging plants or small stand of foraging plants
- Additions –
  - **+3** Contains trees with suitable nesting hollows
  - **+2** Contains trees with potential to be used for breeding (dbh ≥ 500 mm)
  - **+1** Commonwealth PMST results indicate the study area is a known roosting site (**Appendix Two**)
- Subtractions
  - **-2** No clear evidence of feeding debris.

The final score is **5** (of a maximum score of 21), according to the guidelines this indicates value habitat. Impacts on value foraging habitat may still require referral, depending upon how much habitat is being impacted (Commonwealth of Australia 2017).

A total area of 3.73 ha of foraging habitat was determined from aerial imagery and on-ground confirmation of species present (**Map 2**). Foraging habitat quality is deferred to that for Carnaby's Cockatoo as it scored the higher value.

Roosting Habitat

The extents of both native and introduced trees have the potential to provide roosting habitat as the Commonwealth guidelines state that "*Complete clearance of roost sites that are close to high quality foraging habitat and water resources in non-breeding areas is likely to result in a significant impact*". The study area is within six kilometres of high quality forage habitat in the Jandakot Regional Park to the west and has an open water source approximately 300 m to the north.

It appears from the proposed Structure Plan that there would be little to no requirement to clear the Eucalypt trees existing within the study area to accommodate building envelopes (**Map 3**). Should this not be the case a referral to the Commonwealth for assessment would be recommended.

4 CONCLUSIONS

4.1 FAUNA HABITAT

Considerations for EIA for the factor Terrestrial Fauna (EPA 2016a) include, but are not necessarily limited to:

- application of the mitigation hierarchy to avoid or minimise impacts to terrestrial fauna, where possible
- the terrestrial fauna affected by the proposal
- the potential impacts and the activities that will cause them, including direct and indirect impacts
- the implications of cumulative impacts
- whether surveys and analyses have been undertaken to a standard consistent with EPA technical guidance
- the scale at which impacts to terrestrial fauna are considered
- the significance of the terrestrial fauna and the risk to those fauna
- the current state of knowledge of the affected species/assemblages and the level of confidence underpinning the predicted residual impacts
- whether proposed management approaches are technically and practically feasible.

Terrestrial fauna may be significant for a range of reasons, including:

- being identified as a threatened or priority species
- species with restricted distribution
- degree of historical impact from threatening processes
- providing an important function required to maintain the ecological integrity of a significant ecosystem.

Impacts to significant fauna should be investigated and reported if identified in the survey area. Fauna habitats may be significant if they provide habitat important to the life history of a significant species, i.e. breeding, feeding and roosting or aggregation areas, or where they are unique or isolated habitats, for example wetlands, in the landscape or region.

The results from the fauna survey indicate little to no habitat exists for ground dwelling terrestrial species and the likelihood of ground dwelling terrestrial conservation significant fauna species occurring is assessed as medium to low. The study area has little or no significance as general fauna habitat at either local or regional levels of scale. This is due to the completely degraded nature of the site and the lack of sufficient understorey vegetation of good quality to support a diverse fauna assemblage.

There was 3.73 ha of Black Cockatoo habitat recorded and when considered in context to the surrounding landscape and occurrence of similar habitat this is considered to be of low significance. On review of the proposed structure plan (**Map 3**) there appears that there is little to no requirement to clear the Eucalypt trees existing within the study area, should this not be the case then referral to the Commonwealth is recommended.

No actual breeding, foraging or roosting activity by Black Cockatoo species was recorded.

4.2 FLORA AND VEGETATION

No actions were identified as being required in regards to vegetation communities or protected flora as there was no extant native vegetation in Good or better bushland condition recorded within the study area.

4.3 WETLANDS AND PEEL-HARVEY EPP IMPLICATIONS

The presence of a Multiple Use wetland is not a constraint to development. There are no other classified wetlands that require management in order for the Scheme Amendment to be approved. The development should be managed in such a way as to preserve the existing hydrology of the area.

4.3.1 ENVIRONMENTAL PROTECTION POLICY AREA

As study area is within the Peel-Harvey EPP catchment it is required that the development is undertaken in such a way as to ensure all reasonable measures are taken to retain the wetland's hydrological functions (including on-site water infiltration and flood detention) with a focus on reducing the nutrient input levels to the groundwater table.

4.4 ENVIRONMENTAL APPROVALS

4.4.1 EPA REFERRALS

Ecoscape is of the opinion that any EPA referral will be forthcoming should the Shire of Serpentine-Jarrahdale deem it necessary or if the scheme amendment request is forwarded to the Western Australian Planning Commission for approval who may seek advice from the EPA or DBCA. The Commonwealth have a Memorandum of Understanding with the EPA that referred projects can be assessed by the EPA for the Commonwealth if impacts are to listed conservation significant species common to both State and Federal conservation legislation, Black Cockatoo species will be eligible under this MOU.

4.4.2 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

<u>Flora and Vegetation (Ecological Communities)</u>

There are no Matters of National Environmental Significance (MNES) pertaining to flora or vegetation (ecological communities) associated with the study area, therefore there is no requirement for referral to the Commonwealth for these aspects.

<u>Fauna</u>

The presence of suitable habitat for Black Cockatoo species is the single most relevant environmental factor identified through this investigation. The Breeding, Roosting and Foraging habitat provided by both the native and introduced mature Eucalypt trees can be retained through tree protection management measures and suitable placement of building envelopes thereby avoiding the need for referral to the Commonwealth for assessment. In the event that significant numbers of these habitat trees are required to be removed then referral to the Commonwealth may be required.

REFERENCES

Australian Government. *Environment Protection and Biodiversity Conservation Act 1999.*

Bamford, M. pers. comm. 2016

Beard, J.S. 1990. *Plant life of Western Australia* Kenthurst, N.S.W, Kangaroo Press.

Bureau of Meteorology. 2017. *Climate Data Online*. Available from: http://www.bom.gov.au/climate/data/. [November 2017].

Commonwealth of Australia. 2012. EPBC Act 1999 referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*; Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii*; Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso*. Department of Sustainability Environment Water Population and Communities. Australian Government.

Commonwealth of Australia. 2017. *Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo*. Available from: https://www.environment.gov.au/system/files/consultations/1a21997c-5542-4cd6-ace9-561865bbff29/files/draft-revised-referral-guideline-black-cockatoos.pdf.

Department of Biodiversity Conservation and Attractions. 2017a. *Biodiversity Conservation Act 2016*. Available from: https://www.dpaw.wa.gov.au/plants-and-animals/biodiversity-conservation-act.

Department of Biodiversity Conservation and Attractions. 2017b. *Geomorphic Wetlands, Swan Coastal Plain (DPAW-017)*. Available from: https://catalogue.data.wa.gov.au/dataset/geomorphic-wetlands-swan-coastal-plain.

Department of Environment Regulation. 2015. *Clearing Regulations - Environmentally Sensitive Areas (DER-016)*. Available from:

Department of Environment Water Heritage and the Arts 2009, *Matters of National Environmental Significance. Significant impact guidelines 1.1 - Environment Protection and Biodiversity Conservation Act 1999*, Australian Government.

Department of Water. 2009. *Waterways and wetlands: Perth-Peel regional water plan background paper*. Available from: http://www.water.wa.gov.au/PublicationStore/first/88708.pdf.

Environmental Protection Authority. 1992. Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992. Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority 2008, *Guidance Statement No. 33: Environmental Guidance for Planning and Development*, Environmental Protection Agency, Western Australia.

Environmental Protection Authority. 2016a. *Technical Guidance - Terrestrial Fauna Surveys*. Available from: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Terrestrial%20Fauna%20Surveys-Dec-2016.pdf.

Environmental Protection Authority. 2016b. *Technical Guidance: Sampling methods for terrestrial vertebrate fauna*. Available from: http://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/Tech%20guidance-%20Sampling-TV-fauna-Dec2016.pdf.

Government of Western Australia. *Wildlife Conservation Act 1950.*

Government of Western Australia. *Environmental Protection Act 1986.*

Government of Western Australia. *Environmental Protection (Clearing of Native Vegetation) Regulations 2004.*

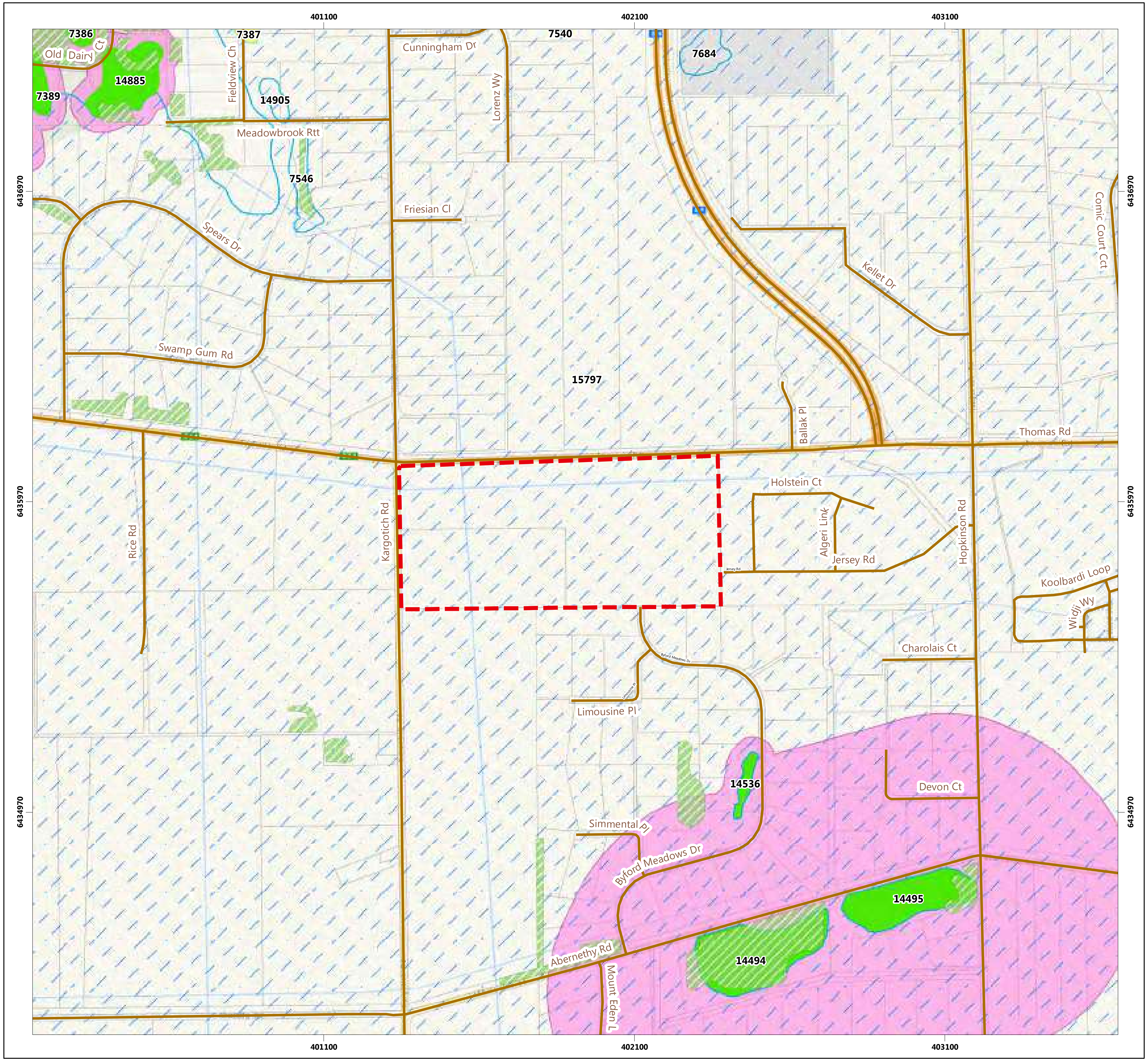
Government of Western Australia. *Environmental Protection (Environmentally Sensitive Areas) Notice 2005.*

Government of Western Australia. *Biodiversity Conservation Act 2016.*

Government of Western Australia. 2017. *Government Gazette No. 4, 6 January 2017*. Available from: https://www.slp.wa.gov.au/gazette/gazette.nsf/searchgazette/7C15F291EA2FAEBC4825809F00146526/$file/TocGg004.pdf.

Keighery, B.J. 1994. *Bushland Plant Survey - A Guide to Plant Community Survey for the Community* Nedlands, Western Australia, Wildflower Society of WA (Inc.).

APPENDIX ONE MAPS



LEGEND

- Roads MRWA
- Study Area
- Lot Boundaries
- Remnant Native Vegetation Extent
- Environmentally Sensitive Area Boundary

Geomorphic Wetlands (DBCA)

Classification

- Conservation
- Resource Enhancement
- Multiple Use

DATA SOURCES :
SOURCE DATA: DBCA, LANDGATE, DPIRD
SERVICE LAYERS: GEOSCIENCE AUSTRALIA

ecoscape

ENVIRONMENTALLY SENSITIVE AREAS, WETLANDS AND REMNANT VEGETATION

LOT 2 AND LOT 4 THOMAS RD ENVIRONMENTAL ASSESSMENT

GOLDLIGHT ASSET PTY LTD

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

SCALE: 1:12,000 @ A3

N

0 100 200 300 400 500 Meters

PROJECT NO: 3885-16

REV	AUTHOR	APPROVED	DATE
01	AF	BT	29/11/2017

MAP

01

LEGEND

Cockatoo Habitat Tree Locations

Species

- Marri (*Corymbia calophylla*)
- Flooded Gum (*Eucalyptus rudis*)
- Introduced Eucalypt
- Dead
- Tree Class Indicator Number

Black Cockatoo Foraging Habitat Extent

Vegetation Clasification

- Indroduced trees (Mixed Eucalypts)
- Native trees (*Corymbia calophylla, Eucalyptus rudis*)
- Study Area

DATA SOURCES :
AERIAL: NEARMAP
SERVICE LAYERS: GEOSCIENCE AUSTRALIA

ecoscape

BLACK COCKATOO FORAGING HABITAT AND HABITAT TREE LOCATIONS

LOT 2 AND LOT 4 THOMAS RD ENVIRONMENTAL ASSESSMENT

GOLDLIGHT ASSET PTY LTD

COORDINATE SYSTEM: GDA 1994 MGA ZONE 50
PROJECTION: TRANSVERSE MERCATOR
DATUM: GDA 1994
UNITS: METER

N

SCALE: 1:4,000 @ A3

0 50 100 150 Meters

PROJECT NO: 3885-16

REV	AUTHOR	APPROVED	DATE
01	AF	BT	29/11/2017

MAP 02

LEGEND

- CONCEPT PLAN AREA
- OVERHEAD TRANSMISSION LINE (AE)
- 60m WIDE EASEMENT
- DRAINAGE SWALE
- INDICATIVE ELEVATED BUILDING PAD
- INDICATIVE BUILDING ENVELOPE (1000m²)
- VEGETATED BUND

NOTE:
ALL LOTS LESS THAN 1 HECTARE ARE TO BE SERVICED BY RETICULATED SEWER

LOT 4 YIELD

Size	No. Lots	% Total Lots
4000m² - 1ha	10	62%
1ha - 2ha	6	38%
Number of Lots	16	
Minimum Lot Size 4015m²	Average Lot Size 7161m²	
Maximum Lot Size 1.06ha	Total Lot Area 11.5ha	

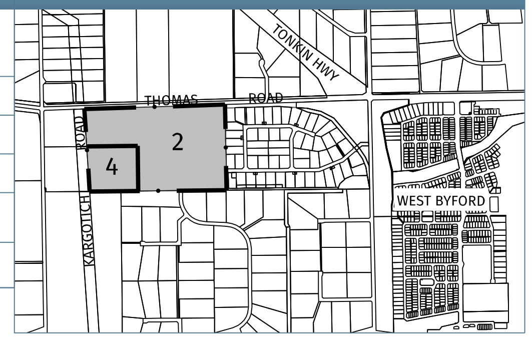
LOT 2 YIELD

Size	No. Lots	% Total Lots
4000m² - 1ha	40	83%
1ha - 3ha	8	17%
Number of Lots	48	
Minimum Lot Size 4001m²	Average Lot Size 6101m²	
Maximum Lot Size 1.96ha	Total Lot Area 29.3ha	

TOTAL YIELD SUMMARY

Size	No. Lots	% Total Lots
4000m² - 1ha	50	78%
1ha - 3ha	14	22%
Number of Lots	64	
Minimum Lot Size 4001m²	Average Lot Size 6366m²	
Maximum Lot Size 1.96ha	Total Lot Area 40.8ha	

LOCATION PLAN



CONCEPT PLAN OF SUBDIVISION

Lot 4 Kargotich Road & Lot 2 Thomas Road
OAKFORD

DRAFT

Plan No. | 21396-01
Date | 12/08/19
Drawn | JW
Checked | CP
Revision | I
Scale | 1:3000 @ A3

PERTH & FORRESTDALE:
Lvl 1, 252 Fitzgerald St, PERTH WA 6000
1/2 Hensbrook Loop, FORRESTDALE WA 6112
T: 08 9495 1947
E: metro@harleydykstra.com.au
ALBANY | BUNBURY | BUSSELTON | FORRESTDALE | PERTH

Harley Dykstra
PLANNING & SURVEY SOLUTIONS

APPENDIX TWO COMMONWEALTH PROTECTECT MATTERS SEARCH RESULTS

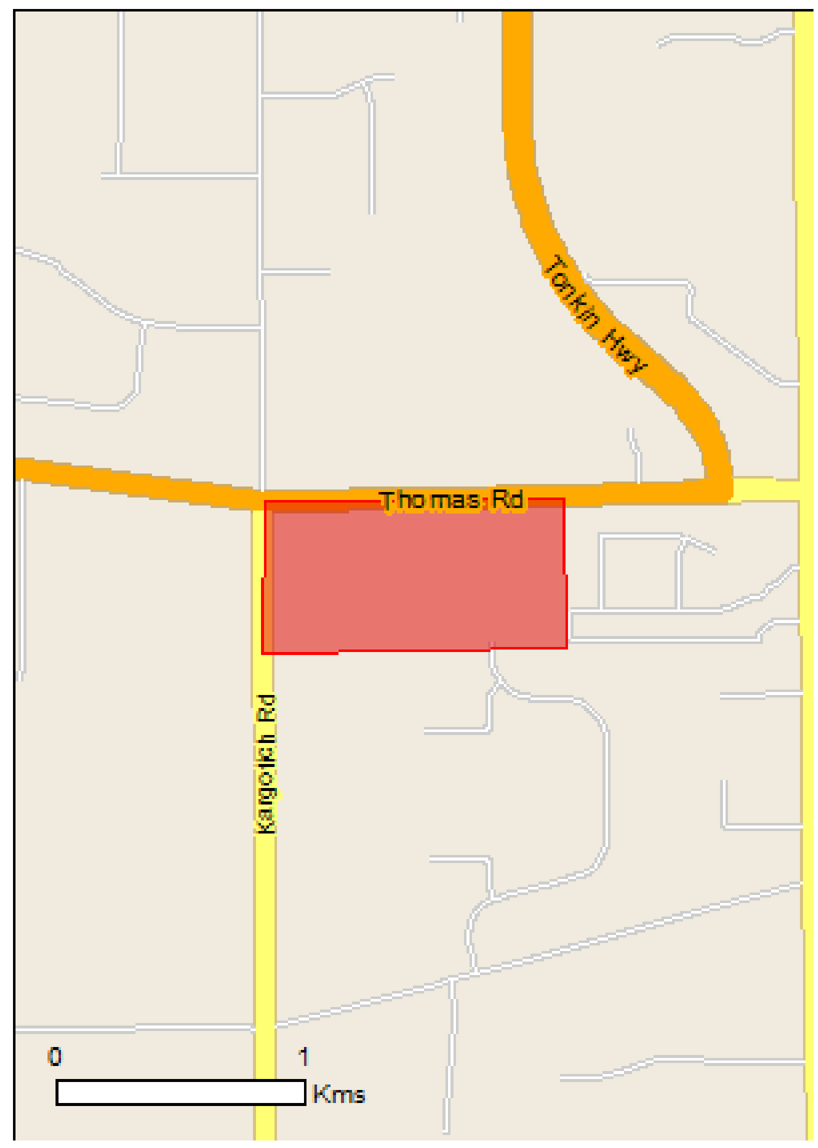
EPBC Act Protected Matters Report

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.

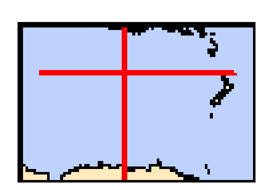
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 04/12/17 12:24:36



Coordinates
Buffer: 5.0Km



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:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	25
Listed Migratory Species:	19

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:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	28
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:	2
Regional Forest Agreements:	None
Invasive Species:	41
Nationally Important Wetlands:	2
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within Ramsar site
Peel-yalgorup system	30 - 40km upstream

Listed Threatened Ecological Communities [Resource Information]

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.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	Community known to occur within area
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	Community known to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to 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, Long-billed Black-Cockatoo [769]	Vulnerable	Roosting known to occur within area
Calyptorhynchus latirostris Carnaby's 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 likely to 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
Insects		

Name	Status	Type of Presence
Leioproctus douglasiellus a short-tongued bee [66756]	Critically Endangered	Species or species habitat known to occur within area
Neopasiphae simplicior A native bee [66821]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Vulnerable	Species or species habitat may occur within area
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat likely to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat may occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Tetraria australiensis Southern Tetraria [10137]	Vulnerable	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		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat likely to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis		
Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta		
Long-toed Stint [861]		Roosting known to occur within area
Charadrius dubius		
Little Ringed Plover [896]		Roosting known to occur within area
Gallinago megala		
Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura		
Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa limosa		
Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus		
Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax		
Ruff (Reeve) [850]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

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		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Roosting known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to 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

Name	Threatened	Type of Presence
		area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Cardup	WA
Forrestdale Lake	WA

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		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
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
Turdus merula Common Blackbird, Eurasian Blackbird [596]		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
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 norvegicus Brown Rat, Norway Rat [83]		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

Name	Status	Type of Presence
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
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
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may 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
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		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
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		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
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		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

Name	Status	Type of Presence
		within area
Solanum elaeagnifolium		
Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to occur within area
Tamarix aphylla		
Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus		
Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
Forrestdale Lake	WA
Gibbs Road Swamp System	WA

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

-32.207386 115.953157,-32.207277 115.963929,-32.207277 115.963929,-32.211853 115.963972,-32.211998 115.953114,-32.207386 115.953157

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.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

APPENDIX E

Local Water Management Strategy

Prepared by Hyd2o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford
Local Water Management Strategy

June 2019

Client: Goldlight Asset Pty Ltd

Contents

Appendices

Figures

Tables

Disclaimer

Executive Summary

Hyd2o was commissioned by Goldlight Asset Pty Ltd to compile this local water management strategy (LWMS) to support the town planning scheme amendment and concept subdivision plan for Lot 2 Thomas Rd and Lot 4 Kargotich Rd in the suburb of Oakford (the site).

The site is approximately 49 ha in size and located approximately 40 km southeast of the Perth central business district within the Shire of Serpentine-Jarrahdale.

The concept subdivision plan for the site has been prepared by Harley Dykstra Planning and Survey Solutions. The proposed rural-residential development consists of 63 rural-residential lots approximately ranging from 4000 m^2 to 2 ha each in size and associated subdivision roads. No broadscale filling is proposed for the site, and building envelopes have been nominated based on appropriate setbacks.

The proposed development of the site has considered the predevelopment environment, and used this information to inform and guide subdivision planning. The site is generally characterised by a mix of sand, clay, and silty sand with the groundwater table within 4m of surface and is subject to 1 in 100 year average recurrence interval flooding from the Birrega/Oakland Drain catchment.

Key elements of the stormwater management system which are reflected in the proposed development include:

- Maintenance of existing surface water flow paths consistent with DoW flood modelling.
- Culverts to be provided at road crossings entering the subdivision.
- Use of roadside swales and swales within lots to manage runoff.

This document has been prepared in accordance with the principles and objectives of Better Urban Water Management (Western Australian Planning Commission, 2008).

Implementation of the strategy will be undertaken in accordance with Better Urban Water Management through the development and implementation of urban water management plans for individual stages of development within the site.

1. Introduction

Hyd2o was commissioned by Goldlight Asset Pty Ltd to compile this local water management strategy (LWMS) to support the town planning scheme amendment and subdivision guide plan for Lot 2 Thomas Rd and Lot 4 Kargotich Rd in the suburb of Oakford (the site).

The site is approximately 49 ha in size and located approximately 40 km southeast of the Perth central business district within the Shire of Serpentine-Jarrahdale (Figure 1).

The concept subdivision plan for the site has been prepared by Harley Dykstra Planning and Survey Solutions. The proposed rural-residential development consists of 63 rural-residential lots approximately ranging from 4000 m^2 to 2 ha each in size and associated subdivision roads.

The proposed development of the site has considered the predevelopment environment and used this information to inform the development of the concept subdivision plan.

This LWMS provides an integrated total water cycle management approach to the development of the subdivision guide plan, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, a groundwater management strategy and a plan for implementation.

A copy of the Better Urban Water Management (WAPC, 2008) LWMS Checklist for Developers is included as Appendix A to assist the Department of Water and Environmental Regulation (DWER) and Shire of Serpentine-Jarrahdale (SoSJ) in review of this document.

1.1 Planning Context

This site is currently zoned ‘Rural’ under the Metropolitan Region Scheme (2007) and zoned earmarked as ‘Rural Living A’ under the Shire of Serpentine-Jarrahdale Rural Strategy Review (Shire of Serpentine-Jarrahdale of Planning, 2013).

This LWMS supports the Local Structure Plan for the site.

Table 1: Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Documents
MRS scheme amendment	No MRS scheme amendment required	No overarching DWMS
Local	Local Structure Plan	Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford, Local Water Management Strategy THIS DOCUMENT
Subdivision	Subdivision application	Urban Water Management Plan FUTURE PREPARATION

1.2 Key Documents

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

- Better Urban Water Management (WAPC, 2008)
- Stormwater Management Manual for WA (DoW, 2007)
- Decision Process for Stormwater Management in WA (DWER, 2017)
- Birrega and Oaklands flood modelling and drainage study: Supporting the Birrega and Oaklands Drainage and Water Management Plan (Hall, 2015)

2. Proposed Development

The proposed concept subdivision plan is shown in Figure 2.

It consists of 63 rural living type lots each ranging between 4000 m^2 and 2.14 ha and subdivisional roads. There are no public open spaces proposed for the development consistent with the requirements of rural living areas. Drainage and public access ways are provided to allow movement of people and drainage across the subdivision.

A Western Power high voltage powerline crosses the site. Adequate setbacks for building envelopes will been considered.

The proposed development is consistent with the exiting surrounding rural residential developments to the east.

3. Design Criteria

Key design criteria for the site are shown in Table 2 and have been established consistent with criteria specified in the key reference documents previously detailed in Section 1.2.

These design criteria are used to formulate the water management strategy for the site within the identified constraints and opportunities of the pre-development environment.

Table 2: Design Criteria

Strategy Elements	LWMS Method & Approach
Water Use Sustainability	
Water Efficiency	• Water wise efficiency consistent with the Building Codes of Australia. • Maximising infiltration of stormwater where possible.
Water Supply	• Rainwater tanks and Water Corporation IWSS for lots.
Wastewater	• ATU units to be installed by landowners consistent with Shire of Serpentine-Jarrahdale requirements. • Part of the site suitable for reticulated sewerage as shown in shaded area in Figure 2.
Stormwater	
Flood Protection	• Provide flood paths for safe conveyance of overland flows within the development area. • Establish minimum habitable floor levels at 0.5m above the 100 year ARI flood levels.
Serviceability	• Roadside swales and drainage areas sized to convey the 1 in 5 year and 1 in 100 year ARI event.
Ecological Protection	• Initial 15mm of rainfall to be retained on site. • Establishment of storage invert levels no lower than seasonal maximum groundwater levels.
Groundwater	
Fill Requirement & Subsoil Drainage	• Habitable floor levels to have clearance to groundwater and flood levels to be achieved by imported fill for building pads. • No broadscale filling proposed as part of the development. • No subsoil drainage proposed.
Acid Sulphate Soils & Contamination	• If required, management of Acid Sulphate Soils to be handled as a separate process to LWMS consistent with DoE(2004) requirements.

4. Pre-Development Environment

4.1 Site Conditions

The 49 ha site is located along Thomas Rd and Kargotich Rd in the suburb of Oakford in the Shire of Serpentine-Jarrahdale. The site is bound to the west by Kargotich Rd, to the north by Thomas Rd, to the east by an existing rural living development and to the south by a rural landholding (Figure 1).

The current land use for the site consists of existing buildings and sheds consistent with use as a rural property. The site is parkland cleared for rural pursuits with some remnant trees and constructed dams. There is a high voltage powerline that traverses down the centre of the site, with the powerline easement shown in Figure 2.

Figure 3 shows an aerial photograph with existing land use and topography.

The topography is generally flat with a rise in the centre of the site at around 26mAHD and falling to 23 mAHD towards the western and eastern boundary (Figure 3).

4.2 Geotechnical

Environmental geology mapping on the Armadale Part Sheet 2033 I and 2133 IV (Jordan, 1986) indicates the site is characterised by:

- Cs – SANDY CLAY –white-grey to brown, fine to coarse grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near the scarp.
- S10- SAND- white to pale grey at surface, yellow at depth, fine to medium-grained, moderately sorted, subangular to subrounded, minor heavy minerals of eolian origin. Over sandy clay to clayey sand of the Guildford Formation.

A Preliminary Geotechnical Investigation was undertaken for the site by Douglas Partners in 2017 to determine the geotechnical suitability of the site for the proposed development (Appendix B). The investigation included the excavation of 10 test pits, four in situ permeability tests and laboratory testing of selected samples. Field work was undertaken on 23 February 2017. Test locations are shown in Figure 4.

All 10 test pits were excavated to a maximum depth of 2.5 m using a backhoe and a 600mm toothed bucket and were logged by a geotechnical engineer. Four hand augered boreholes were drilled for constant head in situ permeability testing. A summary of the ground conditions was provided by Douglas Partners (2017) as follows :

- TOPSOIL (sand, silty sand and clayey silty sand)- grey-brown, fine to medium grained sand topsoil, with varying amounts of silt and clay, with some rootlets, was observed at all locations to depths between 0.05m and 0.1m.
- SAND- medium dense, grey-brown and orange-brown, fine to medium grained, sand with a trace to some silt/clay was encountered underlying the topsoil at TP02, TP05, TP07, and TP08 to a depth of between 0.7m and 2.3m.
- INTERBEDDED CLAY, SILTY SAND SANDY MATERIALS OF THE GUILDFOR FORMATION- the encountered material were generally clayey with various fractions of silt and

sand, and ranged from slightly silty sand to sandy clay. Their density and consistency ranged from loose to medium dense and from soft to hard. In particular, loose and soft materials were encountered at TP01, TP03, TP06, TP07 and TP09 to depths of up to 1.6m. Ironstone and cemented materials were encountered at TP01, TP03, and TP04.

Four permeability tests estimated that permeability ranges from 0.6 m/day to 17.5 m/day. Suggested design permeability for the site ranges from 9 m/day where sandy soils are encountered and 0.09 m/day in other materials. These design ranges account for compaction as part of earthworks (Douglas Partners, 2017).

4.3 Acid Sulphate Soils

Acid Sulphate Soil (ASS) is the common name given to naturally occurring soil and sediment containing iron sulfides. These naturally occurring iron sulfides are generally found in a layer of waterlogged soil or sediment, and are benign in their natural state.

When disturbed and exposed to air, however, they oxidise and produce sulfuric acid, iron precipitates, and concentrations of dissolved heavy metals such as aluminium, iron and arsenic. Release of acid and metals as a result of the disturbance of ASS can cause significant harm to the environment and infrastructure.

The presence of ASS has been a recognised issue of concern in Western Australia since 2003. The Department of Environment and Conservation and the WAPC have released guidance notes on ASS, covering the requirement for assessing sites and the management of sites where ASS are identified. ASS investigations are commonly required as part of the conditions of subdivision or as a requirement for a dewatering license application.

The WAPC's Bulletin 64 (WAPC, 2003) ASS risk mapping for the site indicates that the majority of the site is classified as having a moderate to low ASS disturbance risk less than 3m from surface.

Douglas Partners undertook a preliminary assessment of acid sulphate soils and consider that management of acid sulphate soils is not warranted at this site provided excavation are less than 2.5 m deep and dewatering is not required.

4.4 Contaminated Sites

A search of the Department of Environment and Conservation's (DEC's) Contaminated Sites database indicates no known contaminated sites within the site.

4.5 Wetlands

The site is mapped as a multiple use palusplain according to the Geomorphic Wetlands of the Swan Coastal Plain Database (Landgate, 2017). Multiple use wetlands pose no constraint to the proposed development.

4.6 Surface Water

The topography of the site is generally flat with a rise in the centre of the site at around 26mAHD and a shallow depression immediately to the east and rising to 24 mAHD at the western boundary (Figure 3).

The topography splits the site into two surface water catchments which drain via diffuse overland flow towards the western and southern boundaries of the site (Figure 5).

There are two open drains bordering the site, one along Kargotich Rd which flows south and another along the southern boundary which flows west. Kargotich Rd drain is a shallow roadside drain which conveys flow south and is located within the site boundary and not within the road reserve.

The drain along the southern boundary is a Water Corporation drain within the bridle trail easement. The drain flows west and turns to flow south at Kargotich Rd. The capacity of the southern drain has been estimated by Hyd2o as 1.4 m^3/s using Manning's equation, the dimensions of the drain, and its longitudinal slope (Appendix C).

A culvert (525 mm diameter) is located at the end of the southern drain which conveys flow westward. At the time of the Hyd2o site visit the culvert was mostly obstructed which indicates the preferential pathway for the drain is south along Kargotich Rd.

An existing 300 mm culvert under Thomas Rd conveys flows into the site from a northern catchment.

No surface water quality monitoring was undertaken as part of the development of this LWMS. Surface water drains within the vicinity of the site have a relatively large contributing catchment area to the size of the site. As such, given its proposed land use change, any contribution the site itself would make to water quality is considered to be negligible.

4.6.1 DoW Flood Modelling

The former Department of Water (now DWER) Birrega and Oaklands Flood Modelling and Drainage Study: Supporting the Birrega and Oaklands Drainage and Water Management Plan (Hall, 2015) provides a flood modelling and drainage study for an area of approximately 185 km^2 bound by the Darling Scarp in the east, the Jandakot Mound to the west, the Wungong catchment to the north and the Serpentine River catchment to the south. The study focuses on Birrega Main Drain, the Oaklands Main Drain, and smaller rural drains throughout the catchment.

The site is located within the study boundaries for the flood modelling study and contributes to rural drains within the catchment of the Birrega Main Drain.

DWER provided Hyd2o with floodplain mapping for the site as shown in Figure 6. The depth of flooding in the 1 in 100 year ARI event is of shallow depth estimated as approximately 0.05 m-0.10m. The flood modelling study did not delineate between the floodway and the flood fringe. Flooding is also shown in the neighbouring rural residential developments including to the east and does not appear to have fully considered existing development in this area.

DWER did not model flow within individual rural drains within the study site but modelled only overland flow. As such no flows were estimated for the Kargotich Rd drain or the Southern Drain.

4.7 Groundwater

The former Department of Water (now DWER) Water Monitoring Guidelines for Better Urban Water Management Strategies and Plans (2012) does not provide monitoring guidelines for the development of rural subdivision, as such no long term groundwater monitoring was undertaken for the site.

Groundwater levels were however monitored on a single occasion in four bores within the site by Hyd2o on 29 November 2017 as representative of a winter condition.

An analysis of groundwater level data is provided below.

4.7.1 Groundwater Levels

The second edition of the Perth Groundwater Atlas (Department of Environment, 2004) indicates the superficial aquifer base at the site is approximately 5 mAHD and indicates a saturated thickness of approximately 15 m. Groundwater levels in the Atlas are representative of typical end of summer groundwater levels and estimate groundwater at 20 mAHD -21 mAHD across the site. Groundwater flow is in a southwest direction.

The Lower Serpentine Hydrological Studies: Land Development, Drainage and Climate Scenario report was prepared by the Department of Water in 2015 and included a range of groundwater modelling scenarios (Marillier, Hall and Kretschmer, 2015). The current condition scenario included an analysis of the maximum groundwater levels (1981-2010). Based on this study the maximum groundwater levels for the site were modelled as 22mAHD-24 mAHD (Figure 8).

Hyd2o installed four groundwater monitoring bores on 21 February 2017 and assessed groundwater levels on 29 November 2017. Hyd2o measured groundwater in all four on site bores and in a nearby DWER long-term monitoring bores (T115).

The estimated average annual maximum groundwater level (AAMGL) for the site is shown in Figure 7. Hyd2o have calculated the average annual maximum groundwater level (AAMGL) for the site by adjusting levels at site bores based on the recorded level in DWER bore T115 on 29 November 2017 referenced to its long term historical data (Table 3). Long-term hydrographs for DWER bore T115 are shown in Figure 8. The AAMGL for the site ranges from 22 mAHD to 23.5 mAHD consistent with the maximum groundwater levels provided by the Department of Water.

T115 was selected as the bore to base groundwater level calculations on because of its consistent record over a 30 year period. DWER bores that are closer to the site (such as T170) do not have a consistent record and are suspected to be influenced by other factors.

Depth to groundwater for the site varies from at surface to 5 m below surface in elevated areas. Due to the clay soils noted in the geotechnical report the site is likely to experience some perching during the winter months.

Table 3: Groundwater Levels

Bore	Natural Surface (mAHD)	Water Level 29/11/17 (mAHD)	AAMGL (mAHD)	Depth to AAMGL (m)
MW01	23.67	20.93	22.27	1.40
MW02	24.00	22.42	23.76	0.24
MW03	22.04	20.65	21.99	0.05
MW04	21.70	18.03	19.37	2.33
T115 (DOW)	24.91	22.62	23.96	0.95

5. Water Use Sustainability Initiatives

5.1 Water Efficiency Measures

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

- Promotion of use of waterwise practices including water efficient fixtures and fittings (taps, showerheads, toilets and appliances, rainwater tanks, waterwise landscaping).
- All houses to be built to 5 star building standards.
- Use of groundwater bores for irrigation of residential gardens.
- Maximising on site retention of stormwater.

5.2 Water Supply

Potable water supply to future homes is proposed to be via scheme water provided by the Water Corporation.

The site is located within the Serpentine (Superficial-Swan) Groundwater Management Area (GMA), Byford 2 groundwater sub area. DoW's online Water Register for Licence and Water Availability Information has advised the superficial aquifer is not fully allocated within this sub area indicating water is available. Although no irrigation of POS is required for the development, individual landowners may choose to seek a groundwater abstraction licence for irrigation of their gardens.

There is currently a groundwater license associated with the site according to the Department of Water online Water Register. The allocation is for 10,000 kL/annum under license number 152987. This groundwater is not required for long term irrigation of the proposed development as no Public Open Space (POS) is proposed.

Depending on the period of construction this license may be used for dust suppression or dewatering (if required).

5.3 Wastewater Management

Douglas Partners (2017) details the assessment and site suitability for onsite wastewater management (Appendix B).

Wastewater will managed via Aerobic Treatment Units (ATUs) for lots greater than approximately 1ha in size as specified in the concept subdivision plan in accordance with Shire of Serpentine-Jarrahdale requirements. All ATUs will be positioned on a pad with adequate clearance to groundwater and to local flooding regimes.

The eastern part of the site with smaller lots (approximate size 4000m^2-5000m^2) will be serviced by reticulated sewerage serviced by the Water Corporation. Advice from the Water Corporation is provided in Appendix D.

6. Stormwater Management Strategy

Stormwater management is proposed to be undertaken consistent with water sensitive urban design (WSUD) practices. The system will consist of roadside swales, a drainage/ public access way (PAW) and a drainage pathway within private lots to manage, convey and treat all storm events. There is no proposed use of pit and pipe drainage within roadsides.

Key elements of the system which are reflected in the subdivision guide plan include:

- Maintenance of existing surface water flow paths consistent with DWER flood modelling. Including a drainage corridor to the north to convey flow from under Thomas Rd and utilising and maintaining existing natural topography.
- Use of roadside swales to treat and convey all events. Roadside swales are assumed to be on both sides of the road.
- Roadside swales should be gravel lined to promote infiltration into the natural surface.
- Runoff from smaller lots in the eastern part of the site will be directed towards a swale at the back of the lot to assist in relieving any waterlogging and localised flooding in the wetter months.
- Use of a drainage corridor in the natural low point.
- Culvert sizes at road crossings of the southern drain to be sized to convey the existing estimated maximum drain capacity of 1.4 m^3/s.

6.1 Stormwater Modelling

Stormwater modelling for the site was performed using XP-Storm to determine flood storage requirements and provide an assessment of subdivision guide plan areas required for drainage purposes.

No broadscale filling is proposed that would require piped drainage infrastructure. The following runoff rates have been used in modelling of the 5 and 100 year ARI event:

- 20% for large lots (>5100m^2),
- 30% for smaller lots (<5100m^2), and
- 90% for roads and road reserves.

The drainage infrastructure proposed for the site is to manage drainage associated with the road and lot runoff within the site. Road drainage will be managed through the use of roadside swales built with appropriate capacity to retain the 1 in 100 year ARI to predevelopment flow.

The pre-development discharge rate for the site in the 1 in 100 year ARI event has been calculated using XP-Storm. Using a volumetric run-off coefficient of 20%, peak flows from the site have been calculated as:

- 0.55 m^3/s for the 1 in 100 year ARI

The estimated pre-development flow of 0.55 m^3/s equates to approximately 10 L/s/ha which is typical of rural drainage requirements within the Shire of Serpentine-Jarrahdale.

The design storms modelled by XP-Storm were calculated internally by the model with reference to the methodology in Australian Rainfall & Runoff (AR&R) and the Bureau of Meteorology Computerised Design IFD Rainfall System. The rainfall temporal pattern was assumed to be spatially uniform across the catchment.

Storm durations modelled ranged from 1 hour to 72 hours.

6.2 Flood Protection (5 and 100 year ARI)

Modelled storage volumes, areas, flood rise and inverts are detailed in Table 4 and Figure 9 for the 5 and 100 year ARI flood events.

Stormwater storage is proposed as follows:

- Catchment A will store and attenuate stormwater for all events in roadside swales prior to discharging into the open drain to the south. Runoff in Catchment A is primarily generated by the road surface as the lots are larger size. Inverts of 5 & 100 year storage swales will be established above the 1 in 100 year ARI regional flood height of 22 mAHD.
- Catchment B will use linear swales at the back of lots to direct flow towards either the drainage corridor or the road side swale. Road side swale will act to both detain and convey flows towards the drainage corridor area. Inverts of 5 & 100 year storage areas will be above the 1 in 100 year ARI regional flood height of 23 mAHD.
- Lot swales are proposed to be within a private covenant ownership and have been sized to have a base width of 3m, 1 in 6 side slopes and a depth of approximately 0.3m. The volume required across the subdivision is shown in Table 4 and their locations area shown in Figure 2 and Figure 9.
- Road side swales in Catchment B are assumed to have a base width of 0.5m, 1 in 6 side slopes and depth of 0.3m.

It is recommended that roads are unkerbed or flush kerbed adjacent to the swales to allow movement of drainage water toward the swale. Further refinement of this design will be considered at the UWMP stage.

The proposed development will maintain the flow path of the regional flooding through the use of a drainage reserve to the north and balancing culverts in north/south roads.

The minimum habitable building floor levels will comply with requirements for a 0.5 m clearance above estimated 100 year ARI flood levels as shown in Figure 6.

Table 4: Stormwater Management

Catchment Breakdown	Catchment A Roadside Swale		Catchment B	
Lots (<5100m²) (ha)	0.50		18.38	
Lots (>5100m²) (ha)	13.73		7.74	
Thomas Road Widening (ha)	0.34		1.03	
Subdivisional Road (ha)	2.43		4.45	
Drainage Corridor (ha)	0.00		0.2	
Effective Impervious Area (15mm)	2.19		4.00	
Effective Impervious Area (5 & 100 Yr)	5.08		11.09	
Storage Configuration		Drainage Area	Roadside *Swale	Lot *Swales
Storage Invert (100year) (mAHD)	22.0	22.5	Varies	Varies
Base Area (m²)	385	1300	0.5 m (base width)	3m (base width)
Side Slopes (v:h)	6	6	6	6
Outlet Pipe Diameter (mm)	350	650	-	-
Outlet Pipe Invert (mAHD)	22.0	22.5	-	-
1 Year 1 Hour (15mm)				
Volume (m³)	328		600	
5 year ARI				
TWL Area (ha)	0.29	0.23	-	-
Volume (m³)	626	442	170	874
Flood Rise (m)	0.38	0.33	-	-
Outflow (m³/s)	0.14	0.17	-	-
Critical Storm (hr)	6	6	-	-
100 year ARI				
TWL Area (ha)	0.44	0.29	-	-
Volume (m³)	881	866	623	1564
Flood Rise (m)	0.60	0.44	-	-
Outflow (m³/s)	0.19	0.31	-	-
Critical Storm (hr)	6	6		

*inverts and flood heights of swales vary as they grade back to the low point of the site.

6.3 Ecological Protection (15 mm)

Storm volumes for ecological protection based on the first 15 mm event are provided in Table 4 to provide a guide for storage requirements. Volumes will be refined at UWMP stage on the basis of more detailed modelling in parallel with engineering design.

The first 15 mm is proposed to be retained in roadside swales with volumes retained below the invert of the outlet pipe. The base of the swale should be lined with gravel (or other suitable medium) to promote the infiltration capacity of the swale. Opportunities for landscaping roadside swales with will be undertaken in consultation with the Shire of Serpentine Jarrahdale (SSJ) as part of the subdivision design and reported in a UWMP.

The use of drainage swales at the back of lots to prevent inundation was discussed with the Shire in a meeting on 26 March 2019. As a result of the meeting the Shire recommended that the swales were planted to aid in nutrient stripping and that the swales were nominated as a no fill zone.

Table 5 details a summary from the Stormwater Management Manual for Western Australia (DoW, 2007) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria contained in WAPC (2008).

While DoW (2007) does not provide expected pollutant removal efficiencies for all best management practices (BMPs), application of a treatment train approach using a combination of the non-structural and structural measures will therefore clearly achieve the design objectives for water quality for the site.

Table 5: BMP Water Quality Performance in Relation to Design Criteria

Water Quality Parameter	WAPC (2008) Design Criteria (required removal as compared to a development with no WSUD)	Structural Controls Nutrient Output Reduction [1]	
		Bioretention Systems	Detention/ Retention Storages
Total Suspended Solids	80%	60-80%	65-99%
Total Phosphorus	60%	30-50%	40-80%
Total Nitrogen	45%	25-40%	50-70%
Gross Pollutants	70%	-	>90%

1. Typical Performance Efficiencies via DoW (2007)

7. Groundwater Management Strategy

7.1 Fill and Subsoil Drainage

Broadscale filling of the site is not proposed.

Habitable floor levels and building envelopes and ATU pads (Catchment A on Figure 9) will be filled to provide 500mm clearance to 1 in 100 year ARI flood levels for the site at the dwelling construction stage.

The AAMGL presented in Section 4.7.1 can be considered the 50% average exceedance probability (AEP) groundwater levels to be used for determining separation distance requirements.

As advised by DWER separation distances from the groundwater table should be in accordance with the Institute of Public Works Engineering Australasia's (IPWEA) Specification for Groundwater Controlled Urban Development (2016). The specification recommends compliance with the Building Code of Australia Volume 2- Class 1 and 10 Buildings (2015) to determine performance criteria for building construction to resist moisture.

The specification does not include a guideline for separation distances in private spaces within urban lots greater than 800 m2 in size.

It should be noted that clearance to groundwater may be above the required 500mm required for 1 in 100 year ARI flood levels.

No subsoil drainage is proposed for the site.

7.2 Acid Sulphate Soils

Management of ASS will be addressed by a separate study to this LWMS, if required, depending on excavation depths for engineering services.

While they are considered unlikely to be required, all assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series Identification and Investigation of Acid Sulphate Soils (DoE, 2004).

8. Urban Water Management Plans

Consistent with processes defined in WAPC (2008), an Urban Water Management Plan (UWMP) will be developed and submitted to support subdivision applications for various stages of development within the site. UWMP's will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of SoSJ and DWER.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Detailed stormwater management design including the size, location and design of drainage areas, integrating major and minor flood management capability.
- Management of groundwater levels including proposed building pad levels.
- Additional monitoring of groundwater levels in winter to inform final lot levels.
- Management of subdivision works including development of a strategy for sediment control during construction.
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Specific monitoring and reporting to be undertaken post development.
- Contingency plans (where necessary).

More detail of drainage integration will be provided during the development of the UWMP, including refinement of stormwater modelling and detailed design drawings.

Preparation of the UWMP will be the developers' responsibility.

9. Monitoring

9.1 Pre Development Monitoring

It is proposed to undertake additional groundwater level monitoring during winter prior to the development of any UWMPs to inform engineering design and final floor levels of the development.

9.2 Post Development Monitoring

Post development groundwater monitoring locations and parameters are detailed in Figure 11 and Table 7.

Department of Water (2012) indicates a minimum of 3 years post development monitoring is required, and defines post development as "*from completion of first subdivision to five years after 80 per cent of the development (by land area) has been completed*".

It is proposed to monitor an upstream and downstream location of the drain traversing the southern part of the property when flowing in winter. Locations are shown in Figure

The program is therefore designed to operate over a three year post development period, with the timing for commencement of the program to be negotiated at UWMP stage with DWER and the SSJ with consideration of development staging.

The program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area, or to alter the scope of the program itself. Any modification to the program would be identified through review of the collected data and would require the agreement of all parties (DWER, SSJ, and developer).

All water quality testing will be conducted by a NATA approved laboratory.

Table 7: Post Development Monitoring Program

Monitoring	Parameter	Location	Method	Frequency and Timing
Surface water	pH, EC, TSS Nitrogen Phosphorus	2 location in the drain (upstream & downstream)	Collected grab sample	Nominally 4 times per year when/if water present, typically June to October.

10. Implementation

This LWMS will be implemented by the developer, SoSJ, and DWER based on the roles, responsibilities and funding as detailed in Table 6.

These actions will be further refined, where appropriate, at UWMP stage.

Table 6: Implementation Responsibilities

Implementation Action	Responsibility & Funding		
	Developer	SoSJ	DWER
Urban Water Management Plans			
Preparation of a UWMP for individual development stages	☑		
Review & approval of UWMPs		☑	☑
Stormwater System			
Construction within the site	☑		
Operation & Maintenance			
a) Prior to Handover	☑		
b) Following Handover		☑	

11. References

Australian and New Zealand Environment and Conservation Council (ANZECC) (2000), National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), (2016), Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

Department of Environment (2004a) Acid Sulphate Soil Guideline Series Identification and Investigation of Acid Sulphate Soils, Perth, Western Australia

Department of Environment (2004b) Perth Groundwater Atlas , Second Edition

Department of Environment (2003). General Guidance on Managing Acid Sulphate Soils. Acid Sulphate Soils Guideline Series Department of Environment (DoE), August 2003.

Department of Water (2007), Stormwater Management Manual for Western Australia.

Department of Water and Environmental Regulation (2017). Decision Process for Stormwater Management in WA.

Douglas Partners (2017), Report of Preliminary Geotechnical Investigation, Proposed Rural Residential Subdivision Lot 2 Thomas Rd and Lot 4 Kargotich Rd Oakford WA, December 2017.

Hall, J (2015) Birrega and Oaklands Flood Modelling and Drainage Study, Water Science Technical Series, report no. 71, Department of Water, Western Australia

Institute of Public Works Engineering Australasia (2016) Specification: Separation Distances for Groundwater Controlled Urban Development. Prepared by the Land Development in Groundwater Constrained Landscapes Steering Group.

Institution of Engineers Australia (2006), Australian Rainfall Quality

Institution of Engineers Australia (2003), Australian Rainfall & Runoff

Jordan, J.E. (1986) Armadale Part Sheets 2033 I and 2134 IV, Perth Metropolitan Region Environmental Geology Series. Geological Survey of Western Australia

Marillier, B, Hall, J & Kretschmer, P (2015), Lower Serpentine Hydrological Studies – Land Development, Drainage and Climate Scenario Report, Water Science Technical Series, Report No. 48 Department of Water, Western Australia.

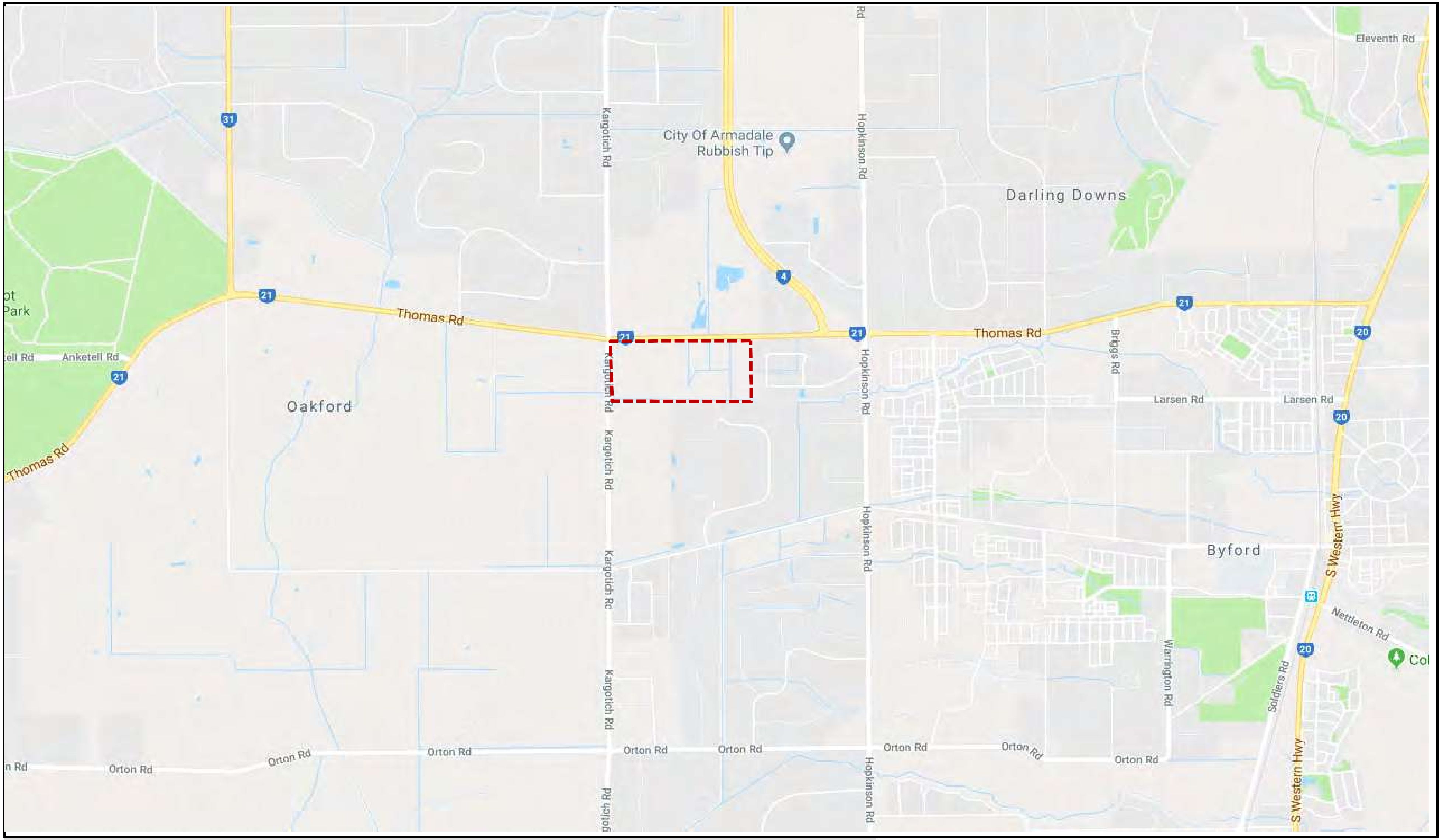
Shire of Serpentine-Jarrahdale. (2013) Rural Strategy Review.

Western Australian Planning Commission, (2003). Planning Bulleting No. 64: Acid Sulphate Soils. Western Australian Planning Commission, November 2003.

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

FIGURES

Date :12/12/2017 Job No H16065



Source: Google Maps, 2017

Site Boundary

hyd$_2$o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd,Oakford: LWMS

Location Plan

Figure 1

Date :12/6/2019 Job No H16065

LEGEND

- CONCEPT PLAN AREA
- OVERHEAD TRANSMISSION LINE
- 60m WIDE EASEMENT
- DRAINAGE SWALE
- INDICATIVE ELEVATED BUILDING PAD
- VEGETATED BUND

NOTE:
ALL LOTS LESS THAN 1 HECTARE ARE TO BE SERVICED BY RETICULATED SEWER

LOT 4 YIELD

Size	No. Lots	% Total Lots
4000m² - 1ha	7	47%
1ha - 2ha	8	53%
Number of Lots	15	
Minimum Lot Size 4340m²	Average Lot Size 7786m²	
Maximum Lot Size 1.23ha	Total Lot Area 11.7ha	

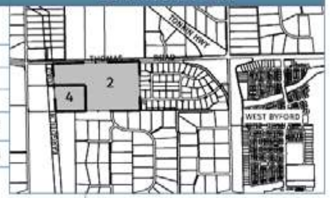
LOT 2 YIELD

Size	No. Lots	% Total Lots
4000m² - 1ha	40	83%
1ha - 3ha	8	17%
Number of Lots	48	
Minimum Lot Size 4001m²	Average Lot Size 6138m²	
Maximum Lot Size 1.77ha	Total Lot Area 29.6ha	

TOTAL YIELD SUMMARY

Size	No. Lots	% Total Lots
4000m² - 1ha	47	75%
1ha - 3ha	16	25%
Number of Lots	63	
Minimum Lot Size 4001m²	Average Lot Size 6556m²	
Maximum Lot Size 1.77ha	Total Lot Area 41.3ha	

LOCATION PLAN



Source: Harley Dykstra Survey and Planning Solutions, 2019

hyd₂o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford: LWMS

Concept Subdivision Plan

Figure 2

Date: 12-12-2017 Job No. H16065

Site

Topography (mAHD) MNG, 2017

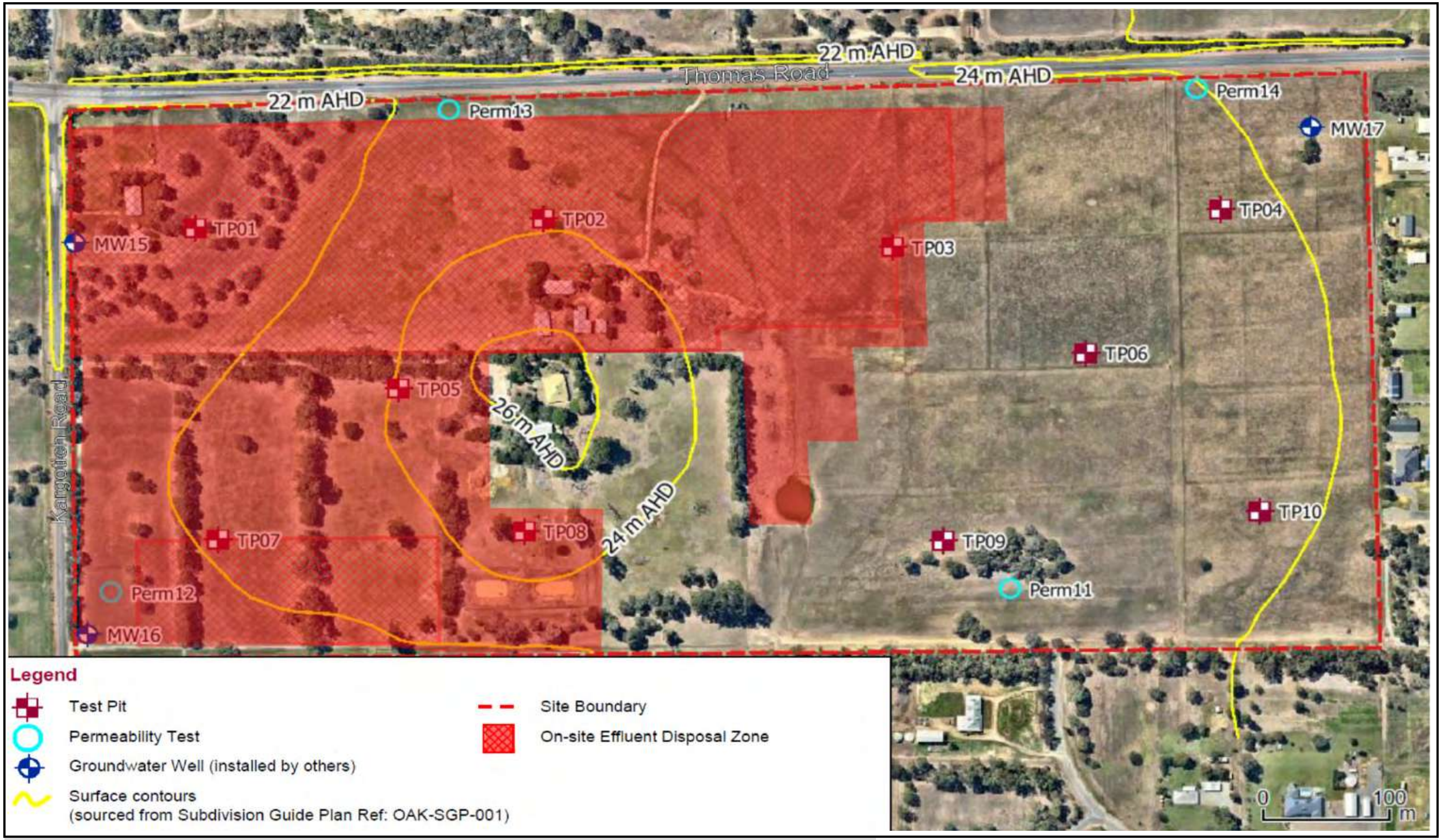
hyd2o

Lot 2 Thomas Rd & Lot 4 Kargotich Rd, Oakford

Site Conditions

Figure 3

Date :2/02/2018 Job No H16065



Source: Douglas Partners, 2017

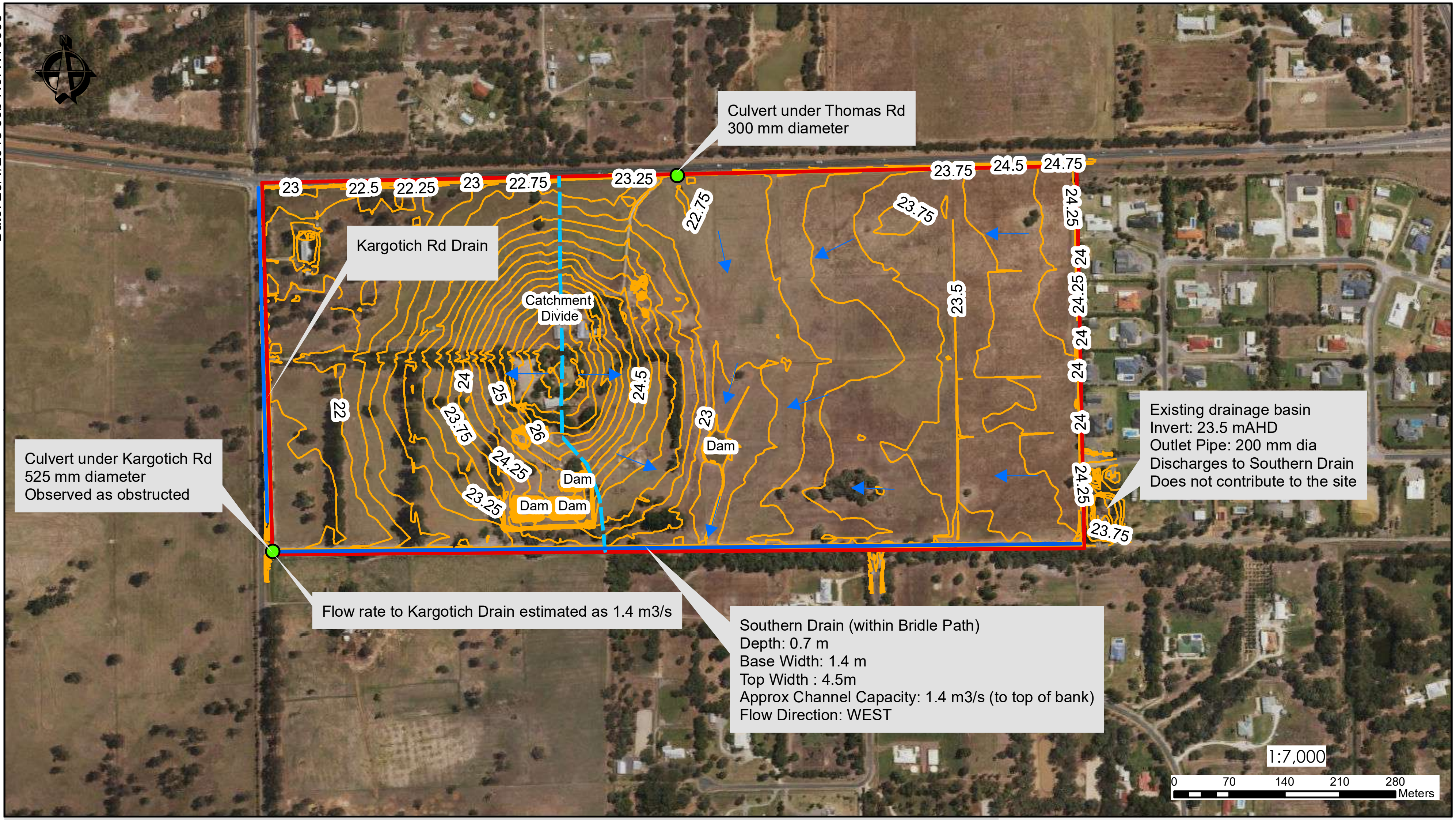
hyd$_2$o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford: LWMS

Geotechnical Plan

Figure 4

Date: 23/1/2018 Job No. H16065



Site

Topography (mAHD) MNG, 2017

Flow Direction

Drain

Catchment Divide

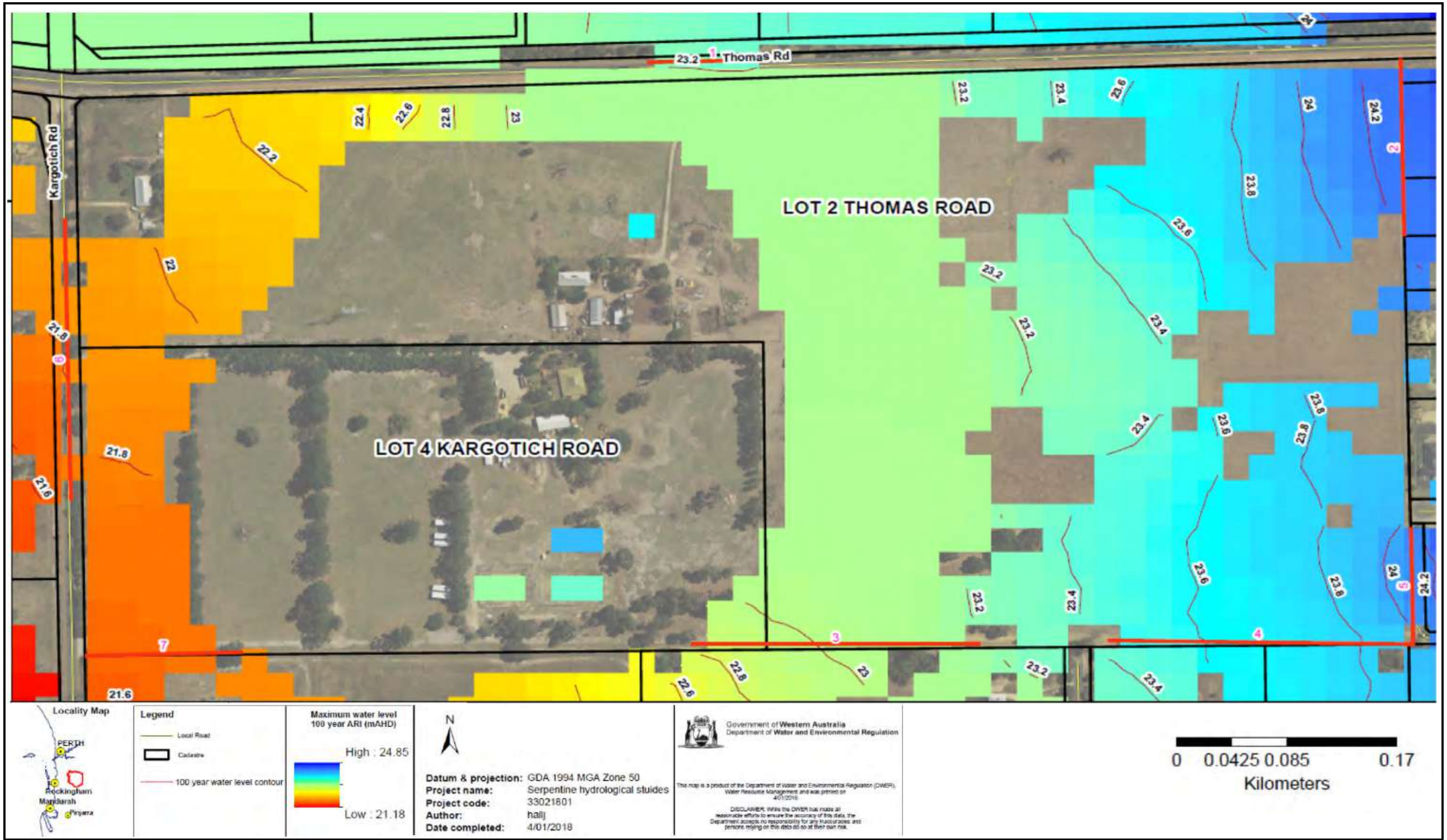
hyd2o

Lot 2 Thomas Rd & Lot 4 Kargotich Rd, Oakford

Surface Water Plan

Figure 5

Date :23/01/2018 Job No H16065



Source: DWER, 2018

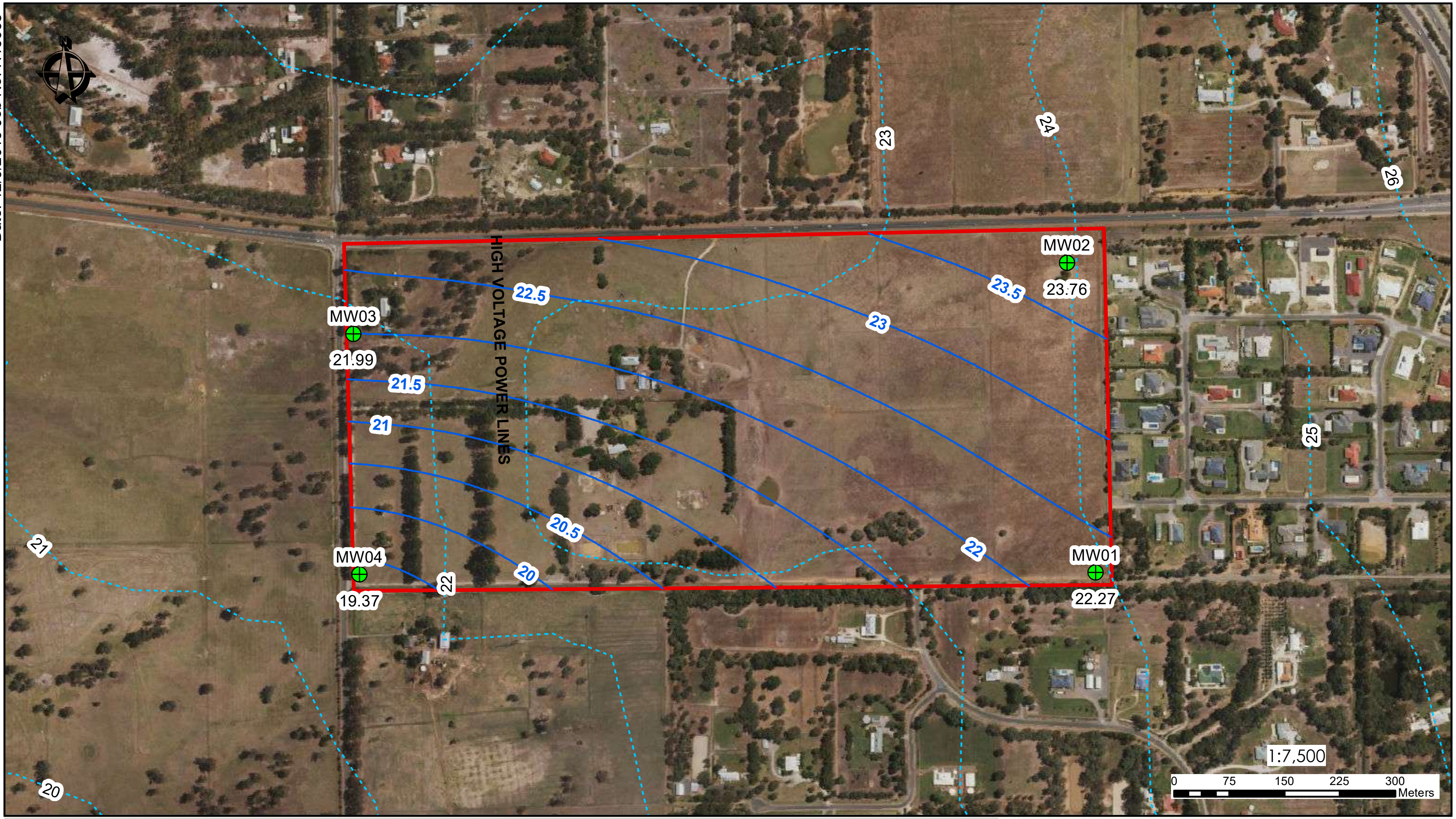
hyd$_2$o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford: LWMS

Serpentine Hydrological Study

Figure 6

Date: 12/6/2019 Job No. H16065



Site

Groundwater Bores

AAMGL (mAHD)

DWER Max Groundwater (mAHD)

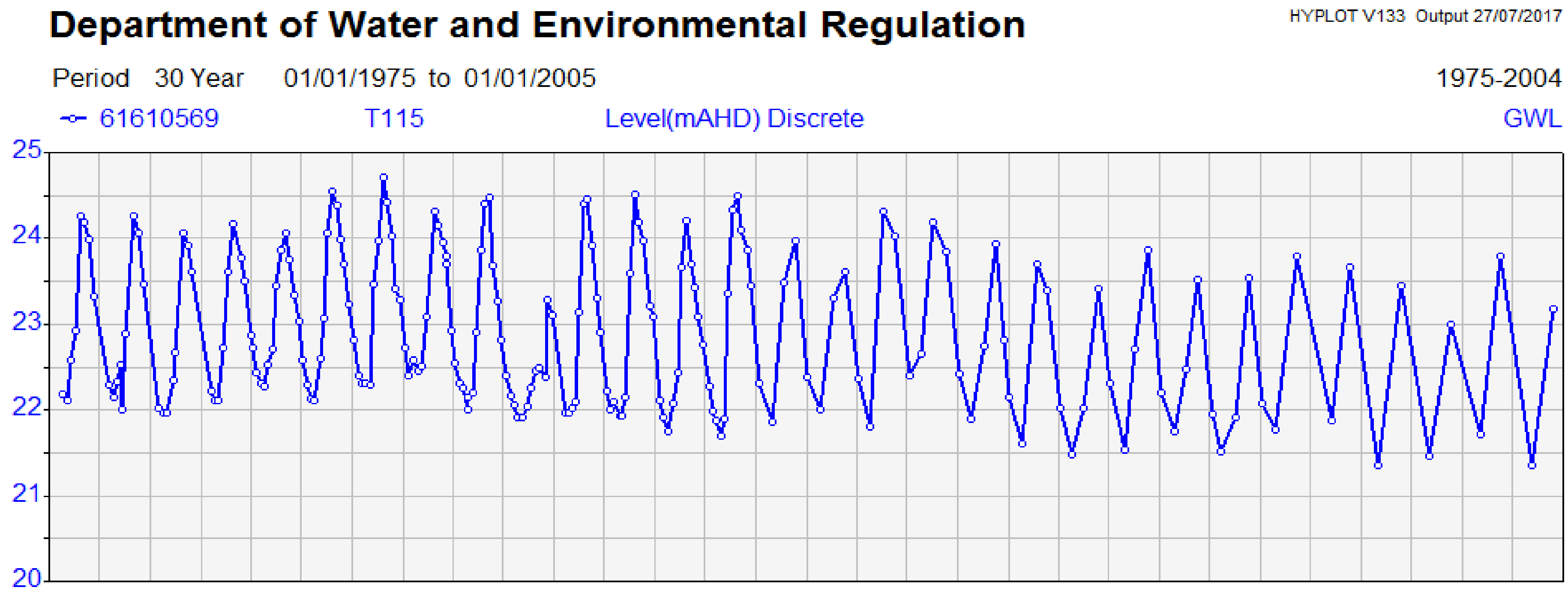
hyd2o

Lot 2 Thomas Rd & Lot 4 Kargotich Rd, Oakford

Groundwater Plan

Figure 7

Date :23/01/2018 Job No H16065



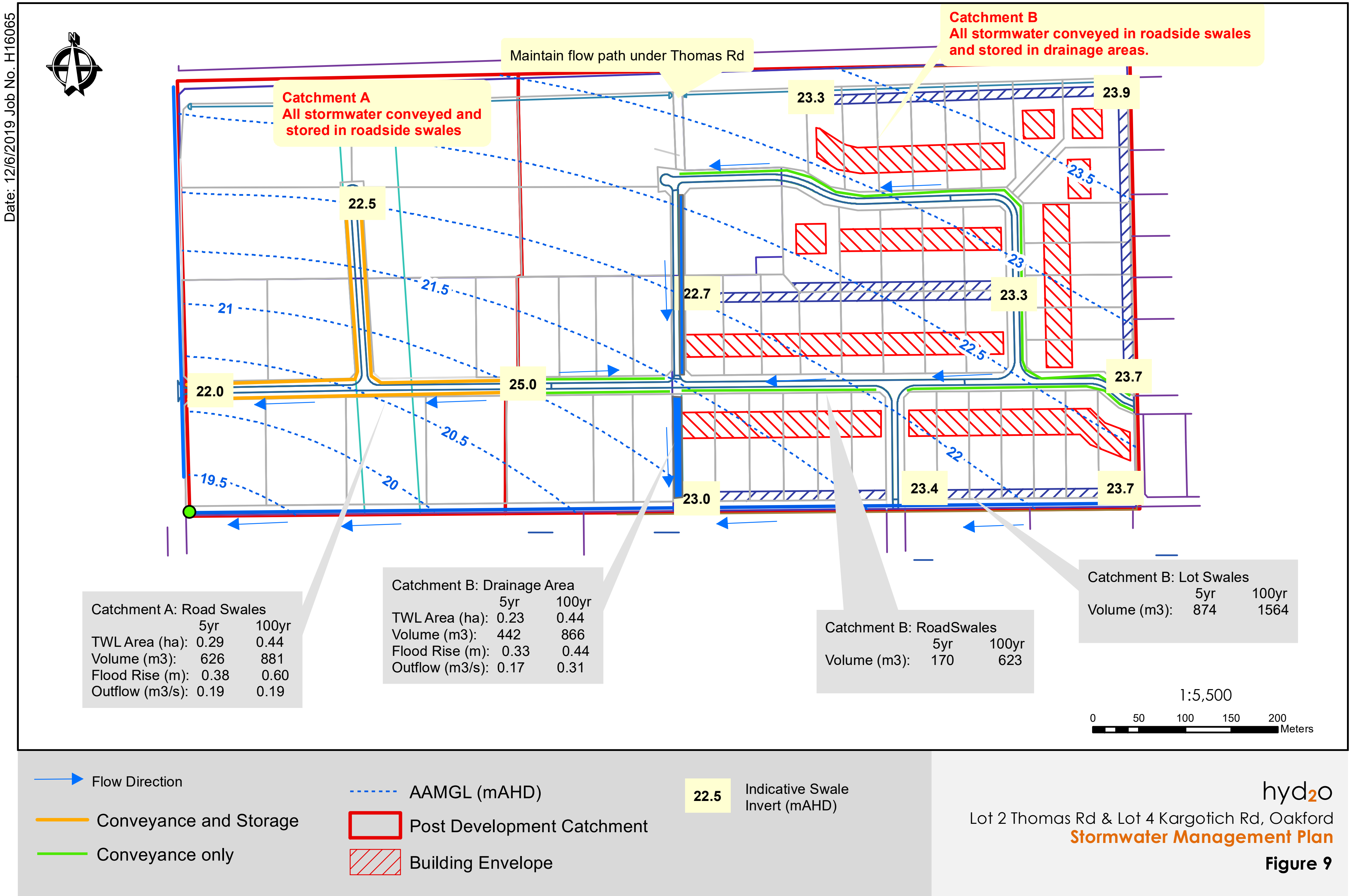
Source: DWER 2018

hyd$_2$o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford: LWMS

T115 Bore Hydrograph

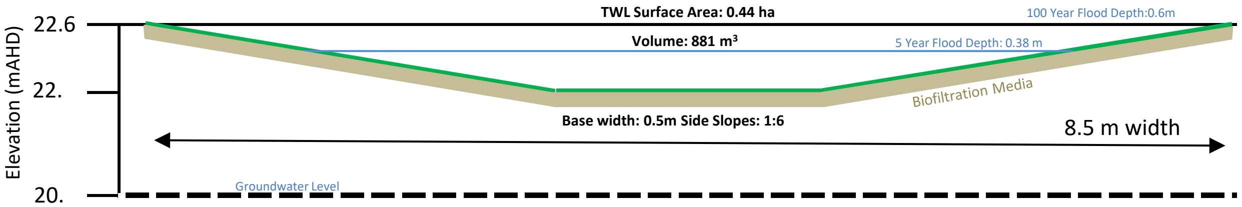
Figure 8



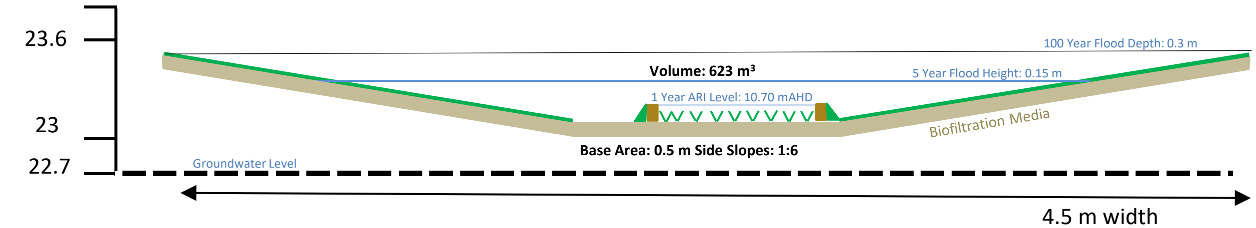
Date: 12/6/2019 Job No. H16065
N
Maintain flow path under Thomas Rd
Catchment A
All stormwater conveyed and stored in roadside swales
Catchment B
All stormwater conveyed in roadside swales and stored in drainage areas.
23.3
23.9
22.5
23.5
23
21.5
22.7
23.3
21
22.5
25.0
23.7
22.0
20.5
22
20
19.5
23.0
23.4
23.7
Catchment A: Road Swales
5yr 100yr
TWL Area (ha): 0.29 0.44
Volume (m3): 626 881
Flood Rise (m): 0.38 0.60
Outflow (m3/s): 0.19 0.19
Catchment B: Drainage Area
5yr 100yr
TWL Area (ha): 0.23 0.44
Volume (m3): 442 866
Flood Rise (m): 0.33 0.44
Outflow (m3/s): 0.17 0.31
Catchment B: RoadSwales
5yr 100yr
Volume (m3): 170 623
Catchment B: Lot Swales
5yr 100yr
Volume (m3): 874 1564
1:5,500
0 50 100 150 200
Meters
Flow Direction
Conveyance and Storage
Conveyance only
AAMGL (mAHD)
Post Development Catchment
Building Envelope
22.5
Indicative Swale Invert (mAHD)
hyd2o
Lot 2 Thomas Rd & Lot 4 Kargotich Rd, Oakford
Stormwater Management Plan
Figure 9

Date: 12/6/2019 Job No. H16065

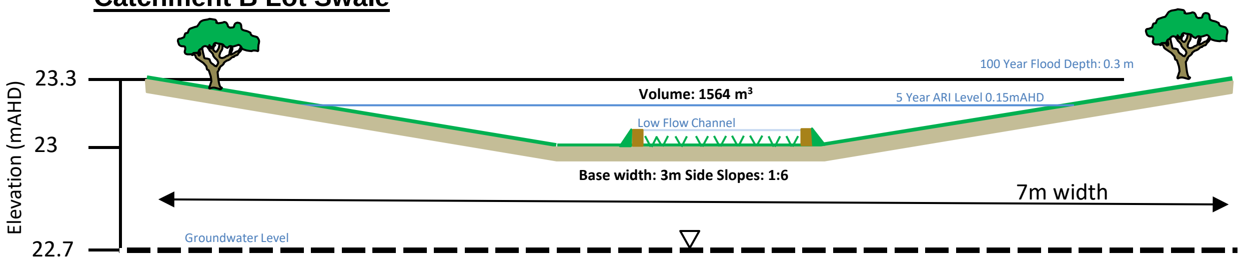
Catchment A Road Swale



Catchment B Road Swale



Catchment B Lot Swale



Note: Cross-sections are not to scale are indicative until further detailed design is undertaken.

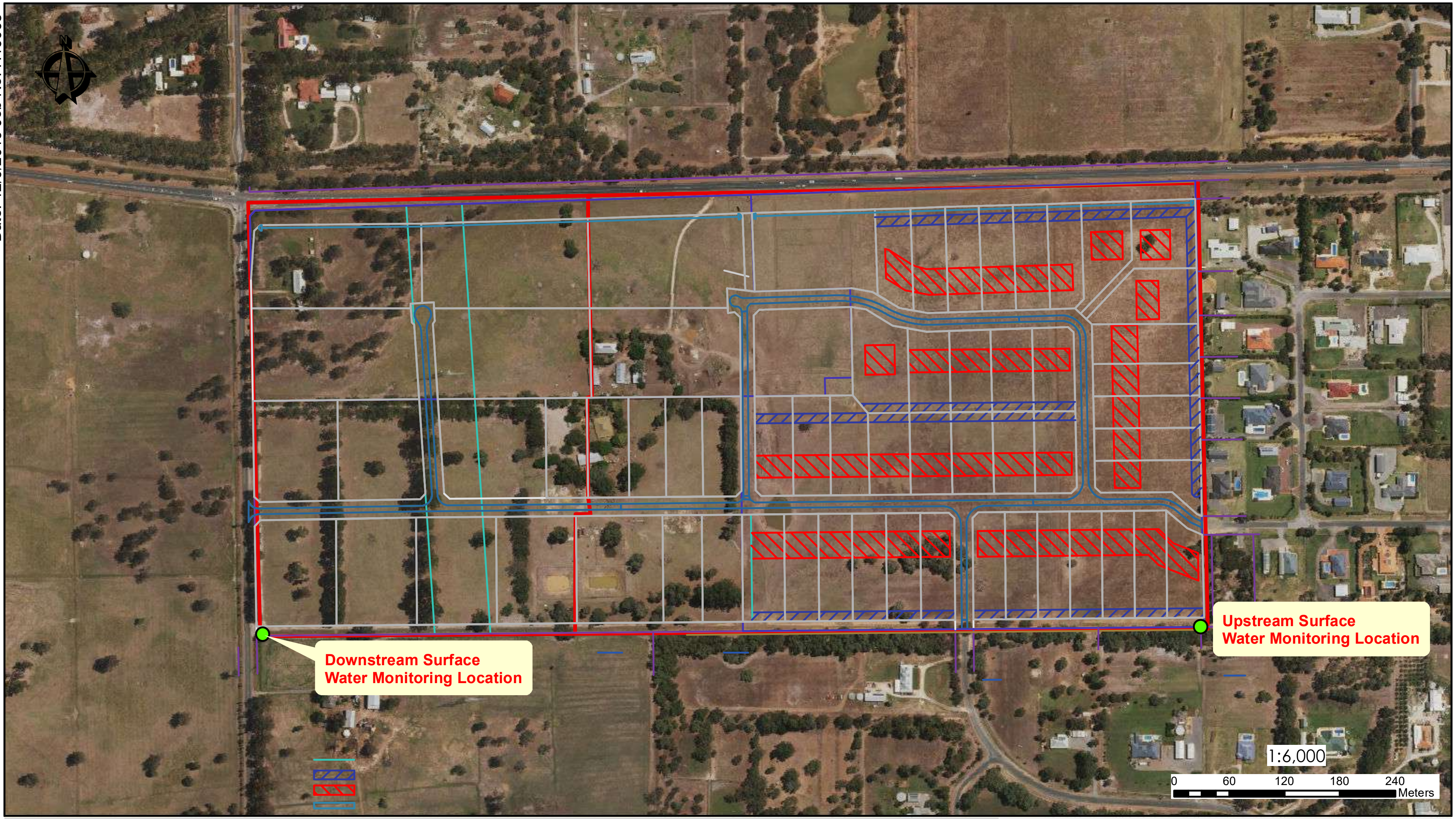
hyd2o

Lot 2 Thomas Rd and Lot 4 Kargotich Rd, Oakford

Conceptual Stormwater Storage Cross-Sections

Figure 10

Date: 12/6/2019 Job No. H16065



Surface Water Monitoring Location

hyd2o

Lot 2 Thomas Rd & Lot 4 Kargotich Rd, Oakford

Post Development Monitoring Plan

Figure 11

APPENDIX A
LWMS Checklist for Developers

Better Urban Water Management LWMS Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 2: Design Criteria	☑	Executive Summary, Table 2
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☑	Section 1.1, 1.2
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Location plan Subdivision plan Site conditions plan	☑	Section 1, 2, 4.1 Figure 1, Figure 2, Figure 3
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☑	No POS proposed in the development.
Design criteria			
Agreed design objective and source of objective		☑	Section 3, Table 2
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 4, Figures 3,4,5,6,7,8
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 4.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Section 4.2, Figure 4
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Section 4.4,4.5
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☑	Section 4.6, Figure 5,6
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☑	Section 4.7, Figure 7
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☑	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Section 5.2
Wastewater management		☑	Section 5.3
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan	☑	Section 6.1, 6.2, Table 4, Figure 9
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☑	Section 6.1, 6.2, Table 4, Figure 9
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan	☑	Section 6.3, Table 4,5 Figure 8

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil Plan	☑	Section 7
Actions to address acid sulphate 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 prior to detailed design		☑	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Section 9
Implementation			
Developer commitments		☑	Section 10, Table 6
Roles, responsibilities, funding for implementation		☑	Section 10, Table 6
Review		☑	Section 10, Table 6

APPENDIX B
Geotechnical Report

Douglas Partners

Geotechnics | Environment | Groundwater

Report on
Preliminary Geotechnical Investigation

Proposed Rural Residential Subdivision
Lot 2 Thomas Road and Lot 4 Kargotich Road,
Oakford, WA

Prepared for
Goldlight Asset Pty Ltd C/- Western Corporate

Project 88862.00
December 2017

Integrated Practical Solutions

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	88862.00	Document No.	R.001.Rev1
Document title	Report on Preliminary Geotechnical Investigation Proposed Rural Residential Subdivision		
Site address	Lot 2 Thomas Road and Lot 4 Kargotich Road, Oakford, WA		
Report prepared for	Goldlight Asset Pty Ltd c/- Western Corporate		
File name	8886200.R.001.Rev1. Proposed Rural Residential Subdivision		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Damian Jagoe-Banks	Fred Verheyde	23 March 2017
Revision 1	Dan Reaveley	Fred Verheyde	12 December 2017

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	1	Goldlight Asset Pty Ltd
Revision 1	1	0	Goldlight Asset Pty Ltd

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	[signature]	12 December 2017
Reviewer	[signature]	12 December 2017

bsi. ISO 9001 Quality Management

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
36 O'Malley Street
Osborne Park WA 6017
Phone (08) 9204 3511
Fax (08) 9204 3522

Table of Contents

Page

Report on Preliminary Geotechnical Investigation
Proposed Rural Residential Subdivision
Lot 2 Thomas Road and Lot 4 Kargotich Road, Oakford, WA

1. Introduction

This report presents the results of a preliminary geotechnical investigation undertaken for a proposed rural residential subdivision in Oakford, WA. The investigation was commissioned in an purchase order dated 20 February 2017 by Mr James Arthur Richards of Goldlight Asset Pty Ltd C/- Western Corporate, and was undertaken in accordance with Douglas Partners' proposal PER170072 dated 16 February 2017.

It is understood that the proposed development comprises the subdivision of the above mentioned two lots into 58 rural residential lots, generally ranging from 0.4 ha to 1.7 ha in area as well as the construction of access roads and drainage reserves. It is also understood that 15 of the proposed lots in excess of 1 ha in size will be constructed without sewerage connections and as a result these lots will require on-site effluent disposal.

The purpose of this preliminary geotechnical investigation was to determine the subsurface conditions beneath the site and provide preliminary comments on:

- The geotechnical suitability of the site for the proposed development.
- Site classification in accordance with the requirements of AS 2870-2011.
- Site preparation requirements so as to allow the proposed development.
- Suitability of the existing soils for re-use as structural filling.
- Parameters for pavement design, including an indicative design California bearing ratio value based on field observations and laboratory testing.
- The depth to groundwater, if encountered.
- The permeability of the soils within proposed drainage reserves.
- The risk of acid sulphate soils (ASS) beneath the site based upon readily available desktop information and limited laboratory testing.
- The suitability of the site for on-site effluent disposal, and comments regarding appropriate systems for the site conditions.

The investigation included the excavation of 10 test pits, four in situ permeability tests 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.

2. Site Description

The site comprises Lot 2 Thomas Road and Lot 4 Kargotich Road, with a combined area of approximately 48 ha (Refer to Drawing 1, Appendix B). The site is bound by Thomas Road to the north, residential lots to the east, rural properties to the south and Kargotich Road to the west.

At the time of the investigation, the site was generally open and accessible (refer to Figure 1). Residential dwellings and sheds were observed towards the centre of the site, and within the north western corner of the site. Dilapidated vehicles and equipment were observed adjacent to the dwelling in the centre of the site. Stockpiles, observed to be mostly sand, were also observed within this area as well as one stockpile of mulch.

Vegetation was observed to generally comprise pasture grass. Multiple rows of mature trees were observed within the western half of the site, with an isolated group of trees adjacent to the southern boundary in the eastern half of the site. Overhead power lines were observed transecting the site in an easterly direction from Kargotich Road, and in a southerly direction from Thomas Road. Fences divided the site into multiple sections.

An open drain was observed along the western and southern boundary of the site. Three fenced dams were observed towards the southern boundary of the site, and an unfenced dam was observed towards the centre of the site. Gravel hardstands were observed between the roads to the dwellings.

The figures below provide an indication of the conditions at the site.

Figure 1: Lot 2 Thomas Road, looking west from TP03

Figure 2: Lot 4 Kargotich Road, looking south from TP05

Figure 3: Observed Dam, Lot 4 Kargotich Road

The ground surface level falls from a high point of RL 26 m AHD to approximately RL 24 m AHD on the eastern boundary and RL 22 m AHD on the western boundary.

The Armadale 1:50,000 Geology sheet indicates that shallow sub surface conditions beneath the site comprise of thin Bassendean Sand overlying the Guildford Formation with a central zone designated as Bassendean Sand.

Acid sulphate soil mapping indicates that the site is “moderate to low risk” of acid sulphate soils being encountered within 3 m of the surface.

The Perth Groundwater Atlas (2004) indicates that the groundwater level was between 20 m and 21.5 m relative to Australian height datum (AHD) in May 2003, i.e. approximately 1.5 m below the lowest level of the site.

3. Field Work Methods

Field work was carried out between on 23 February 2017 and comprised the excavation of 10 test pits, the drilling of four boreholes, four in situ permeability tests and Dynamic cone penetrometer (DCP) testing, adjacent to each test location.

The test pits (TP01 to TP10) were excavated to a maximum depth of 2.5 m using a backhoe with a 600 mm toothed bucket, and were logged in general accordance with AS1726-1993 by a geotechnical engineer from Douglas Partners. Soil samples were recovered from selected locations for subsequent laboratory testing.

Four hand augered boreholes (Perm11 to Perm14) were drilled for constant head in situ permeability testing. The location, depths of testing, and results are discussed in detail in Section 4.3.

The DCP tests were carried out adjacent to the test pits and boreholes in accordance with AS 1289.6.3.2, to assess the in situ density of the shallow soils.

Soil samples were recovered for the assessment of acid sulphate soils from five test pits (TP01, TP02, TP03, TP07, TP09) at 0.5 m intervals for subsequent laboratory testing. The following sample handling and transport procedures were employed:

- Samples were quickly placed in new air tight snap lock sample bags and hand pressed to exclude air;
- Snap lock bags were labelled with individual and unique identification, including project number and sample number;
- Samples were placed in insulated coolers during field work and subsequently frozen until transported to the analytical laboratory;
- Chain-of-custody documentation was maintained at all times and countersigned by the receiving laboratory on transfer of samples; and
- A National Association of Testing Authorities (NATA), registered laboratory, MPL Envirolab, was engaged to conduct the analysis.

Test locations were determined using GPS with a typical horizontal accuracy of ±3 m and site features, and are marked on Drawing 1 in Appendix B. Surface elevations at each test location were estimated from a plan provided by the client.

4. Field Work Results

4.1 Ground Conditions

Detailed logs of the ground conditions and results of the field testing are presented in Appendix B, together with notes defining descriptive terms and classification methods. A summary of the ground conditions encountered at the test locations is given below:

- **Topsoil** (Sand, Silty Sand and Clayey Silty Sand) – grey-brown, fine to medium grained sand topsoil, with varying amounts of silt and clay, with some rootlets, was observed at all locations to depths of between 0.05 m and 0.1 m.
- **Sand –** medium dense, grey-brown and orange-brown, fine to medium grained, sand, with a trace to some silt/clay was encountered underlying the topsoil at TP02, TP05, TP07 and TP08 to a depth of between 0.7 m and 2.3 m.
- **Interbedded Clayey, Silty and Sandy Materials of the Guildford Formation –** The encountered materials were generally clayey with various fractions of silt and sand, and ranged from slightly silty sand to sandy clay. Their density and consistency ranged from loose to medium dense and from soft to hard. In particular, loose and soft materials were encountered at TP01, TP03, TP06, TP07 and TP09 to depths of up to 1.6 m. Ironstone and cemented materials were encountered at TP01, TP03 and TP04.

4.2 Groundwater

Groundwater was observed within two test pits, TP01 and TP10 excavated on 23 February 2017. It is possible that the groundwater encountered at TP10 is water perched above the clayey sand at this location. The test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

Additionally, three existing groundwater wells (installed by others) within the site were dipped. The locations of these wells are shown Drawing 1 in Appendix B.

Groundwater levels are summarised in Table 1 (next page) and are also detailed on the test pit logs in Appendix B.

Table 1: Summary of Observed Groundwater Levels on 23 February 2017

Location	Surface Level [1] (m AHD)	Groundwater Depth (m)	Groundwater Level [2] (RL m AHD)
TP01	22	2.1[3]	19.9[3]
TP10	24	1.6	22.4
MW15	22	2.1	19.9
MW16	22	2.0	20
MW17	24	Dry to 4.0	<20

Notes: [1]: Surface level interpolated from Subdivision Guide Plan provided by Western Corporate.
[2]: Groundwater Level = Interpolated Surface Level – Groundwater Depth.
[3]: Seepage

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

4.3 Permeability

Four in situ permeability tests using the constant head method were undertaken at the locations of proposed drainage basins. The constant head were undertaken in accordance with AS 1547-2012 Appendix 4.1F. Results of the permeability analysis are summarised in Table 2 below.

Table 2: Summary of Permeability Analysis

Test Location	Depth (m)	Measured Permeability		In Situ Conditions of Tested Material
		(m/s)	(m/day)	
PERM11	0.39	7.5×10^{-6}	0.6	Clayey Sand
PERM12	0.24	2.0×10^{-4}	17.5	Sand, trace of silt
PERM13	0.30	2.3×10^{-5}	2.0	Sand with some clay
PERM14	0.44	9.0×10^{-6}	0.7	Clayey Sand

5. Geotechnical Laboratory Testing

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

- The particle size distributions of three samples.
- The Atterberg limits and linear shrinkage of two samples.
- The shrink/swell index of one sample.

- The modified maximum dry density (MMDD), optimum moisture content (OMC) and the California bearing ratio (CBR) values of two samples.
- The Emerson Class testing of two samples.
- pH, phosphorus retention index (PRI), electrical conductivity and cation exchange capacity of two samples.

Detailed test report sheets are given in Appendix C and Appendix D and the results are summarised in Table 3 to Table 5.

Table 3: Results of Laboratory Testing for Soil Identification

Test Location	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	LL (%)	PL (%)	PI (%)	LS (%)	I_{ss} (%)	Material
TP02	0.4-0.5	7	0.11	0.32	-	-	-	-	-	Sand with some silt
TP04	0.3-0.5	59	<0.0135	0.08	50	18	32	4.8	-	Sandy clay, medium plasticity
TP09	0.3-0.6	67	<0.0135	0.02	67	19	48	5.2	3.0	Sandy clay, high plasticity

Where:
- The % fines is the amount of particles smaller than 75 μm.
- A d_{10} of 0.11 mm means that 10% of the sample particles are finer than 0.11 mm.
- A d_{60} of 0.32 mm means that 60% of the sample particles are finer than 0.32 mm.
- I_{ss}: Shrink-Swell Index
- PL: plastic limit.
- LL: liquid limit.
- PI: plasticity Index.
- LS: linear shrinkage
- "-" means 'Not Tested'

The CBR tests were undertaken at a target compaction level of 95% of modified maximum dry density. The samples were tested after soaking for four days with a confining surcharge of 4.5 kg, and the results are presented in Table 4.

Table 4: Results of Laboratory Testing for Pavement Design Parameters

Test Location	Depth (m)	MMDD (t/m^3)	CBR (%)	OMC (%)	Swell (%)	Material
TP04	0.3-0.5	1.87	3.0	16.0	3.5	Sandy clay, medium plasticity
TP09	0.3-0.5	1.74	1.5	17.2	5.5	Sandy clay, high plasticity

Notes:
- MMDD: modified maximum dry density
- CBR: California bearing ratio
- OMC: optimum moisture content

Summarised test results for laboratory analysis to assist with the assessment of the soil suitability of on-site effluent disposal are provided in Table 5 (next page).

Table 5: Results of Laboratory Testing of Assist with Effluent Disposal Assessment

Test Location	Depth (m)	pH	Electrical Cond. (µS/cm)	Cation Exchange Capacity (meq/100g)	Phosphorus Retention Index (PRI) (mL/g)	Material
TP01	0.5	6.8	500	8	7.8	Clayey sand
TP02	0.5	6.0	64	7	1.3	Sand with some silt

6. Acid Sulphate Soil Laboratory Testing

Acid sulphate soil screening tests were undertaken on all soil samples retrieved from five selected test pits (TP01, TP02, TP03, TP07 and TP09.)

Initial acid sulphate soil screening tests were undertaken on selected soil samples by MPL Envirolab in accordance with the method as described in Ahern CR, McElnea AE, Sullivan LA (2004), *Acid Sulphate Soils Laboratory Methods Guidelines*. The screening tests comprised measurement of pH of the soil in water (pH_F) and the pH of the soil after oxidation with a 30% solution of hydrogen peroxide (pH_{FOX}). The results of these tests provide an indication as to the presence of actual and potential acid sulphate soils and should be considered as qualitative only.

Following the screening tests, as required by the Department of Environment Regulation, soil samples were submitted to MPL Laboratories to undergo Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) suite of testing. Soil samples were selected for laboratory analysis with due consideration of the following:

- Screening results, with particular focus on the lowest reported pH_{FOX} within soil strata at each test location.
- Reported reaction strength.
- Visual identification of the soils encountered.

The screening results and laboratory testing (SPOCAS) including the adopted assessment criteria are presented in Table D-1 in Appendix D together with the detailed laboratory reports and associated chain of custody reports. The results are evaluated and discussed in Section 8.6.

7. Proposed Development

It is understood that the proposed development comprises the subdivision of the site into 58 rural residential lots, generally ranging from 0.4 ha to 1.7 ha in area and the construction of access roads and drainage reserves.

It is also understood that 15 of the proposed lots will be constructed without sewerage connections and as a result these lots will require on-site effluent disposal (refer to Drawing 1, Appendix B).

8. Comments

8.1 Suitability of the Site for Development

The results of the investigation indicate that the site is generally underlain by various clayey materials of the Guildford Formation. Sand was encountered up to a depth of 2.3 m and above the clayey materials, in the central part of the site.

Loose sandy soils and soft clayey soils were encountered at several test locations to depths of up to 1.6 m. These materials are currently not suitable for structural foundations and will require compaction prior to any construction.

Based on the results of the investigation, the main geotechnical constraints identified regarding the proposed development of the site include:

- The occurrence of moderately to highly reactive clayey subgrade across parts of the site;
- Soft and loose ground conditions in some areas of the site; and
- The likelihood of groundwater occurring perched on shallow clayey materials, possibly near ground surface in winter.

The main geotechnical opportunity for the development of the site includes the occurrence of shallow sand, forming a possible source of non-reactive filling, in one part of the site.

From a geotechnical standpoint, the land is physically capable of development, provided that the provisions outlined in the subsequent subsections of the report are implemented.

8.2 Preliminary Site Classification Comments

Results of the field work and laboratory testing indicate that the clayey materials encountered across the site are generally moderately to highly reactive. Class S and M will likely apply where reactive material is present within 1.8 m of the surface.

A sufficient depth of non-reactive sand exists above the reactive material within the central area of the site to achieve Class A.

Table 6 (next page) indicates the anticipated site classification at each test location in accordance with AS 2870-2011. Note that due to the preliminary nature of the geotechnical investigation, limited laboratory testing was undertaken. Further testing to assess the reactivity at within proposed building envelopes to confirm site classification is recommended.

Table 6: Anticipated Site Classification at Test Locations

Test Location	Site Classification Based on Current Site Levels[1]	Test Location	Site Classification Based on Current Site Levels[1]
TP01	M	TP06	M
TP02	A	TP07	S
TP03	M	TP08	A
TP04	M	TP09	M
TP05	S	TP10	S

Note [1]: Does not include the effect of trees which can increase the surface movement and alter the site classification.

Improvement of site classification can be achieved with either placement of non-reactive filling above the existing reactive natural material or removal of reactive material (or a combination of both).

8.3 Site Preparation

Site preparation for the semi-rural residential lots will likely occur within proposed building and pavement envelopes within each residential lot. Site preparation will also be required for the construction of the proposed roads to service the lots. As such, the site preparation comments in the following sections do not necessarily pertain to the site as a whole, just within the vicinity of proposed structures and the pavements. Site preparation requirements could be optimised following a more detailed investigation where testing is undertaken within proposed structure and pavement envelopes.

It is recommended that clay earthworks be carried out during the dry period of the year in order to ease handling, placement and compaction.

8.3.1 Site Stripping

All deleterious material, including demolition rubble, debris, topsoil and vegetation should be stripped from the proposed development areas of the site. Tree roots remaining from any clearing operations should be completely removed. Topsoil could be reused for landscape areas or locations where structural filling is not required.

8.3.2 Proof Rolling

Following removal of unsuitable material and prior to any filling, it is recommended that the exposed ground following topsoil stripping be proof rolled with a heavy roller of, say, 16 tonnes minimum deadweight, with smooth drum in vibrating mode to compact the loose sand near the existing surface or sheep’s foot roller directly on a clayey subgrade. A heavy roller is recommended as loose sands and soft clayey materials were encountered in some parts of the site to depths up to 1.6 m below the surface. Care should be taken not to run heavy plant immediately adjacent to existing buildings and services.

Owing to the areas of loose and soft soils encountered at the site, it is recommended that a suitably experienced geotechnical engineer assess the prepared subgrade during proof rolling. For the proposed road pavements, areas with excessive deformation under rolling may require the following treatments:

- Excavation and replacement with suitable structural material;
- Reinforcement with a geogrid; or
- Stabilisation with the addition of lime.

The method of treatment should be determined by the geotechnical engineer, at the time of testing, and depend on the site conditions at the time and the level of improvement that can be achieved during proof compaction.

It is anticipated that for the house envelopes, site preparation including compaction works will be undertaken on a case by case basis, by the individual lot owners. It is recommended that an experienced geotechnical engineer assesses the foundation conditions of each site, at the time of construction.

8.3.3 Re-use of In-Situ Soil

It is anticipated that the topsoil encountered within the sandy central part of the site (where topsoil is predominately a silty sand and sand with some silt with root matter) could be reused for structural filling following screening of the organics and blending with clean sand. A uniform blend is anticipated to be difficult to achieve using the generally clayey topsoil encountered in other parts of the site, and will possibly preclude the suitability of the above approach for clayey topsoil. Further testing of the material stripped at the time of construction would be required to assess a suitable blending ratio of topsoil with clean sand.

The naturally occurring sand encountered in areas within the central area of the site (TP02, TP05, TP07 and TP08) should be suitable for re-use as structural fill, provided it is free from organic material and particles greater than 150 mm in size.

Clayey materials could be reused for filling however their reactivity and lower permeability will impact site classification and drainage. Earthworks plans and construction methodology should be assessed by a geotechnical engineer prior to any reuse of clayey materials for structural filling.

8.3.4 Imported Filling

If required, imported filling should comprise free draining, cohesionless, well graded sand that:

- Contains less than 5% by weight of particles less than 75 microns in size.
- Contains no particles greater than 150 mm in size.
- Is free of organic and other deleterious materials.

Use of imported filling with higher fines content could be considered, provided the fines are non-reactive. This may have some impact on the permeability of the filling, and therefore drainage design, and this limitation should be assessed if such material is used. It is recommended that test certificates are reviewed and approved by the geotechnical engineer prior to importing material to site.

8.3.5 Fill Placement

It is recommended that filing is placed in layers and compacted near optimum moisture content.

8.3.6 Compaction Testing

Compaction control of the natural subgrade within proposed building envelopes following proof rolling, could be carried out with either a Perth sand penetrometer (PSP) (for non-cohesive materials) or a dynamic cone penetrometer (DCP) (for cohesive materials).

Compaction control of the natural subgrade within road pavement areas following proof rolling should be undertaken with a nuclear density meter to confirm suitable subgrade compaction has been achieved. Cohesive pavement subgrades should be compacted to 92% relative to modified maximum dry density (MMDD) and non-cohesive pavement subgrade should be compacted to 96% relative to modified MMDD.

Compaction control of sand filling for building envelopes could be carried out using a Perth sand penetrometer (PSP) test in accordance with test method AS 1289.6.3.3. All areas within the proposed building envelopes should be compacted to achieve a minimum blow count of 8 blows per 300 mm penetration to a depth of not less than 0.5 m below foundation level.

During construction, some loosening of the surface materials in foundation excavations is expected. Therefore the top 300 mm in the base of any excavation should be re-compacted using a vibratory plate compactor prior to construction of any footings. Confirmation of adequate compaction should be carried out as outlined above.

8.4 Pavement Design Parameters

The shallow soils across the site generally comprise sand, clayey sand and sandy clay. It is anticipated that pavement subgrade is also likely to comprise sand filling where the proposed site surface is raised.

Laboratory testing results detailed in Section 5 indicate CBR values of 1.5% and 3% for soaked samples of sandy clay. Based on observations made in the field, the available laboratory testing results and DP's experience, a subgrade CBR design value of 2% is suggested for the design of pavement on the clay subgrade materials, provided that the subgrade is compacted achieve a dry density ratio of not less than 92% relative to modified compaction and suitably drained.

In the event the subgrade comprises imported sand filling, the pavement should be designed using an appropriate CBR of the material. A presumptive design CBR value of 12% is suggested for clean sand filling, provided there is at least 0.75 m of the material below subgrade level. However, this value should be confirmed prior to pavement construction once the sand filling material is known and its CBR has been assessed.

It is recommended that subgrade be inspected by a suitably experienced geotechnical engineer prior to placement of basecourse to identify unsuitable subgrade materials and to recommend specific drainage measurements required. It is emphasised that particular care should be exercised in implementing a suitable drainage strategy for the proposed roads to prevent water ingress into pavement layers.

8.5 Soil Permeability

In situ permeability tests were undertaken within the surficial materials (at depths less than 0.45 m) in four locations (PERM11 to PERM14) across the site (refer to Drawing 1, Appendix B for test locations). Permeability testing was undertaken within three different material types: sand (PERM12), sand with some clay (PERM13) and clayey sand (PERM11 and PERM14) with results providing the estimated permeability values provided in Table 2 (Section 4.3). The values provided in Table 2 are considered representative for each material type.

The following design soil permeability values are suggested at this site:

- Sand (such as encountered at TP02, TP05, TP07 and TP08): 1.0×10^{-4} m/s (9 m/day)
- Other materials (e.g. silty and clayey materials): 1.0×10^{-6} m/s (0.09 m/day)

A decrease in the above permeability values can be anticipated following compaction of the site during earthworks.

8.6 Groundwater

The Perth Groundwater Atlas (2004) indicates that the groundwater level was between 20 m and 21.5 m relative to Australian height datum (AHD) in May 2003, i.e. approximately 1.5 m below the lowest level of the site.

At the time of the field investigation, in February 2017, groundwater was observed to be at a depth of between 1.6 m and 2.1 m, at a level of between RL19.9 m AHD and RL 22.4 m AHD.

Groundwater is anticipated to perch near or at ground surface on the clayey materials of the Guildford Formation in the winter months, or following heavy rainfall events.

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

8.7 Acid Sulphate Soils

With reference to Table D-1, Appendix D, the reported results indicate the following:

- The results for pH_F are not strongly indicative of actual acid sulphate soils conditions at the test locations to depths of 2.5 m;
- The results for pH_{FOX} are not strongly indicative of potential acid sulphate soil conditions at the test locations to depths of 2.5 m; and

- The calculated net acidity is above the adopted action criterion of 0.03% S for two of four samples submitted for SPOCAS suite testing, TP01 (2.5 m) and TP03 (1.0 m). Net acidities were reported to a maximum of 0.044% S.

It should be noted that the exceedances of the action criteria for net acidity (TP01 [2.5 m] and TP03 [1.0 m]) are attributed to a higher result reported for the titratable actual acidity (TAA) component of the net acidity, which is a measure of the soils existing acidity. It should also be noted that the corresponding results for S_{POS} result were reported as <0.005% S, indicating the general absence of peroxide oxidisable sulphur. In this regard, given the apparent absence of peroxide oxidisable sulphur, the pH of the soil is not expected to decrease as a result of sulphide oxidation following disturbance. The apparent absence of sulphidic material in the samples analysed suggests the higher results for 'existing acidity' are attributed to metal complexes occurring naturally in the soils, and are not necessarily representative of actual acid sulphate soil conditions. This is further supported by the corresponding S_{KCl} results which were reported as <0.03% S, indicating negligible soluble sulphur.

In this regard, DP considers the two exceedences of the action criterion associated with an elevated TAA result to be of low significance. Provided excavations are less than 2.5 m depth and dewatering is not required, DP considers that management of acid sulphate soils is not warranted.

It should be noted, however, that the investigation was a preliminary investigation that was undertaken to provide preliminary advice on the presence or otherwise of acid sulphate soils. In this regard, should a development condition requiring 'clearance' by DER be imposed, we anticipate that the DER would require further detailed investigation to meet DER endorsed guidelines.

9. Evaluation and Recommendations for On-site Wastewater Management

9.1 Site and Soil Effluent Disposal Preliminary Assessment

Based on information provided to Douglas Partners at this time of this report, it is understood that the proposed new lots in excess of approximately 1 ha in area, and located within the western part of the site will not be serviced with a reticulated sewer connection. Comments on the suitability for on-site effluent disposal contained within this section of the report pertain to ground conditions within the western part of the site (See Drawing 1, Appendix B).

For this assessment, reference has been made to 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.

The assessment of soil and terrain, including moderate and major limitations for effluent disposal within the site, are discussed below.

9.1.1 Slope, Landform and Upslope Seepage

A high point is located adjacent to the on-site effluent disposal zone. From the high point, the surface levels gently fall at an estimated angle of less than 2° to the west and north and south at an angle less than 0.5° to the east. The landform generally consists of gentle slope land with the high point of this area being a localised sandy crest and as such, upslope seepage is anticipated to be very low. Therefore, slope, landform and upslope seepage are not considered a limitation for on-site sewage disposal in the western part of this site.

9.1.2 Soil Permeability Category and Measured In Situ Soil Permeability

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 sand overlying clayey materials or clayey materials from the surface.

Based on visual assessment and particle size distribution results of laboratory testing, a soil permeability category of Group 1 (reference to AS 1547-2012 Tables 5.1 and E1) is considered suitable for the sandy materials (overlying the clayey materials) and a category of Group 5 to 6 is considered suitable for the clayey materials encountered at the site.

The soil permeability category Group 1 is considered to be a major limitation for absorption trenches and for surface and subsurface irrigation due to excessive run-off and percolation. The soil permeability categories Group 5 and 6 are also considered to be a major limitation for absorption trenches and Group 5 soils present a moderate limitation for surface and subsurface irrigation due to potential waterlogging.

In situ permeability testing undertaken at the site using the constant head method in accordance with AS 1547-2012 indicates a design permeability value of 1.0×10^{-6} m/s (approximately 0.09 m/day) for the sandy clay and a design permeability value of 1.0×10^{-4} m/s (approximately 9 m/day) is suggested for the sand.

9.1.3 Depth to Hardpan

Depth to hardpan material across the majority of the north-western part of site is likely to be greater than 1.5 m and as such, presents a minor limitation. Test pit TP03 near the eastern boundary of the area however, encountered cemented materials at a depth of 0.8 m and as such, the land in this portion presents a moderate limitation for surface irrigation systems and a major limitation for absorption systems.

9.1.4 Depth to Groundwater

Where encountered, groundwater in February 2017 was observed to be between 1.6 m and 2.1 m deep across the site. Groundwater at TP01 and MW16 was observed at 2.1 m and 2.0 m deep.

Groundwater is anticipated to perch near or at ground surface on the clayey materials of the Guildford Formation in the winter months, or following heavy rainfall events.

9.1.5 Coarse Fragments

Coarse fragments are defined as particles greater than 2 mm in AS 1547-2012. The abundance of coarse fragments in the clayey sand encountered underlying the site is 'very few' in accordance with Table E2, AS 1547-2012. Consequently, the abundance of coarse fragments is not considered a limitation for sewage disposal at this site.

9.1.6 Soil Dispersion

The Emerson Class result presented in Section 5 indicates that the soils on the site are not dispersive and therefore degradation of soil structure due to dispersion is not considered to be a limitation for sewage disposal at this site.

9.1.7 Chemical Soil Assessment

Assessment of soil pH, electrical conductivity, cation exchange capacity and phosphorus retention index were also undertaken to provide an indication on the soil's suitability for vegetation growth, nutrient retention and salt content. The ratings for against each result are provided in the table below.

Soil Feature	TP01		TP02	
	Surface and subsurface irrigation	Absorption System	Surface and subsurface irrigation	Absorption System
pH	Minor limitation	Minor limitation	Moderate Limitation	Moderate Limitation
Electrical Conductivity	Minor limitation	Minor limitation	Minor limitation	Minor limitation
Cation Exchange Capacity	Moderate Limitation	Moderate Limitation	Moderate Limitation	Moderate Limitation
Phosphorus Retention Index	Moderate Limitation	Moderate Limitation	Moderate Limitation	Moderate Limitation

9.2 On-site Wastewater Management Options

9.2.1 Primary Effluent Treatment System

Owing to the occurrence of soils with the major limitations mentioned above (Sections 9.1.2 and 9.1.3), 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.

The effluent treatment system selected for use should be approved by the WA Department of Health. The type of system adopted for each of the proposed developments should be assessed on a lot by lot basis and is dependent on the key parameters such as house size, location of the application area and water and nutrient reduction fixtures. For a residential subdivision such as proposed for this site, ATU systems are most likely to be chosen by the future landowners.

The ATU selected for use should be approved by the WA Health Department and be able to reduce the nitrogen concentration in the effluent to about 15 mg/L.

9.2.2 Effluent Land Application

Once the effluent has been treated by an approved system, the resulting effluent would be disposed of to the land surface.

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

- treatment system adopted and quality of effluent produced;
- soil and terrain characteristics, as described in Section 9.1;
- climate conditions; and
- effluent loading, as determined by the number of bedrooms within the proposed residence 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. A minimum land application area of 0.2 m^2/l/day of effluent produced is suggested for the surface sands (and sand filling, if the site is filled) and 0.333 m^2/l/day for the underlying sandy clay.

9.3 Additional Comments in Relation to Effluent Disposal

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 the general recommendations contained within this report, the methods detailed in AS/NZS: 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.

9.4 Conclusions on Site Suitability for Effluent Disposal

The site is considered suitable for the disposal of domestic effluent in general accordance with AS/NZS 1547-2012, local government conditions and WA Department of Health, provided that the limitations described in Section 9.1 are addressed. Therefore, a minimum lot size of 2000 m^2 is required for the suitability of the site for on-site wastewater disposal system, in accordance with Government Sewerage Policy – Consultation Draft, Department of Health, December 2011 Table 2 for disposal in the sandy clay, or 1000 m^2 is required if the site is filled with sand filling.

Due to site limitations discussed above, effluent should be pre-treated prior to using surface, subsurface drip or trickle, covered surface or subsurface irrigation or a closed cell amended soil system.

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:NZS 1547:2012, local government authorities, the WA Department of Health and the site characteristics described above.

10. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.2-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Dynamic Cone Penetrometer Test.
3. 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.
4. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
5. Australian Standard AS 2870-2011, Residential Slabs and Footings.
6. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.
7. Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Unit (ATUs) - November 2001
8. Environment & Health Protection Guidelines: On-site Sewage Management for Single Households - January 1998.
9. Australian Standard AS/NZS 1547-2012, On-site Domestic-wastewater Management.
10. Government Sewerage Policy – Consultation Draft, Department of Health, December 2011.
11. Code of Practice for Onsite Sewage Management, Consultation Draft, November 2012.

11. Limitations

Douglas Partners (DP) has prepared this report for this project at Lot 2 Thomas Road and Lot 4 Kargotich Road in Oakford, WA in accordance with DP's proposal dated 16 February 2017 and acceptance received from Goldlight Asset Pty Ltd dated 20 February 2017. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Goldlight Asset Pty Ltd 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.

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.

Douglas Partners Pty Ltd

Appendix A

About This Report

Introduction

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.

Copyright

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.

Borehole and Test Pit Logs

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 justify 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.

Groundwater

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.

Reports

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

Site Anomalies

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.

Information for Contractual Purposes

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.

Site Inspection

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

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.

Test Pits

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.

Large Diameter Augers

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.

Continuous Spiral Flight Augers

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.

Non-core Rotary Drilling

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 major 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.

Continuous Core Drilling

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.

Standard Penetration Tests

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.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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, 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
$\underline{\nabla}$	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

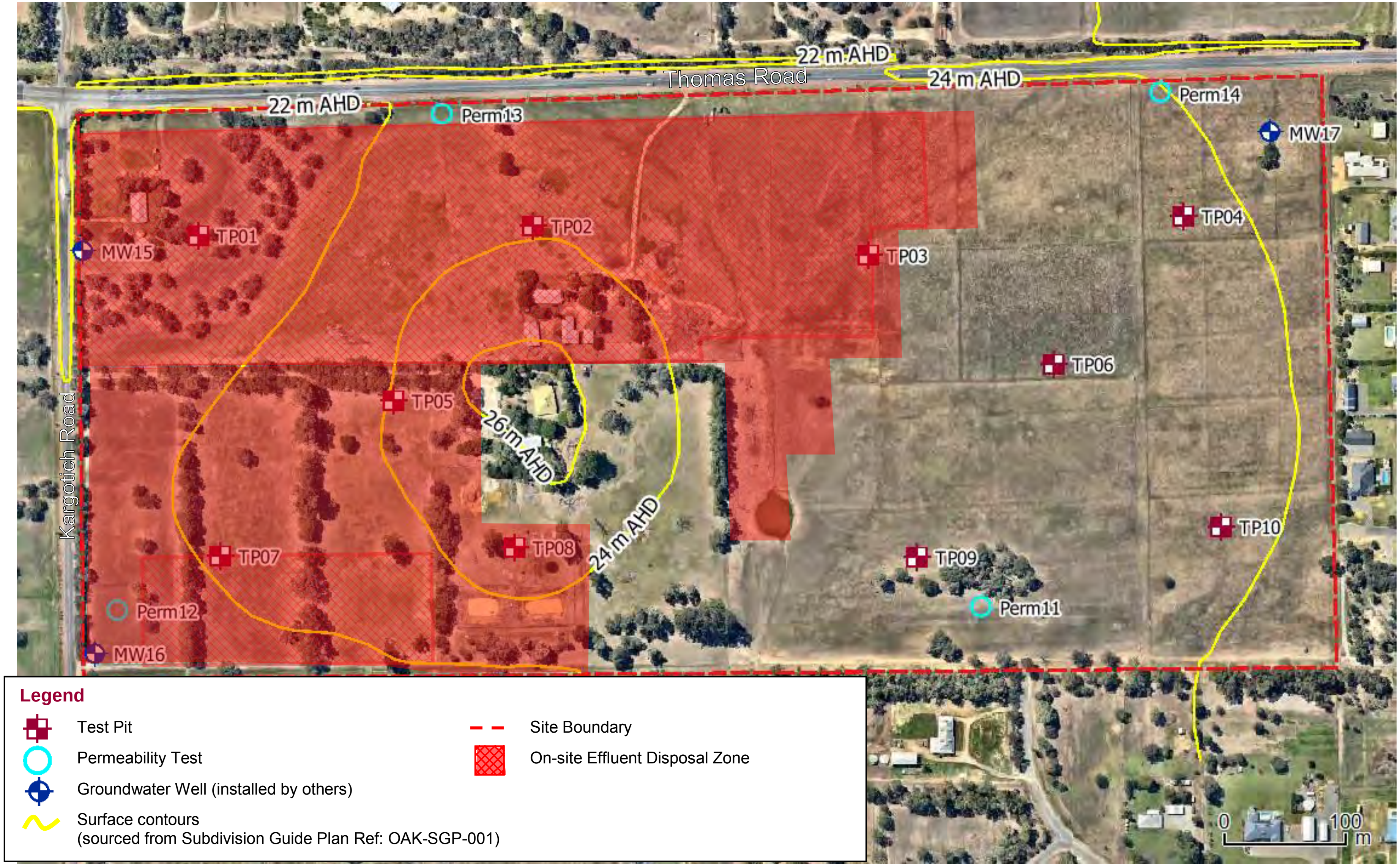
- Slate, phyllite, schist
- Gneiss
- Quartzite

Igneous Rocks

- Granite
- Dolerite, basalt, andesite
- Dacite, epidote
- Tuff, breccia
- Porphyry

Appendix B

Drawing 1
Results of Field Work



Aerial Photography Source: NearMap, flown 27 February 2017.

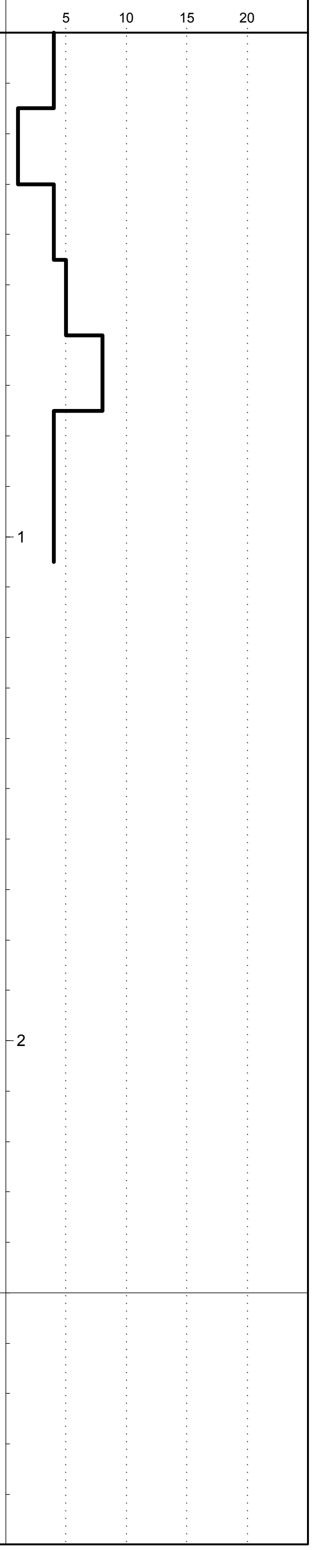
Douglas Partners — Geotechnics / Environment / Groundwater	CLIENT: Goldlight Asset Pty Ltd	**Location of Tests**	PROJECT No: 88862.00
	OFFICE: Perth	**Proposed Rural Residential Development**	DRAWING No: 1
	DATE: 17-03-2017	**Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA**	REVISION: 0

TEST PIT LOG

CLIENT:	Goldlight Asset Pty Ltd	**SURFACE LEVEL:**	22 m AHD*	**PIT No:**	TP01
PROJECT:	Proposed Rural Residential Subdivision	**EASTING:**	401445	**PROJECT No:**	88862.00
LOCATION:	Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA	**NORTHING:**	6435986	**DATE:**	23/2/2017
				SHEET	1 OF 1

RL	Depth (m)	Description of Strata	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
22		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.					
	0.1	CLAYEY SAND - loose to medium dense, grey-brown, fine to medium grained, clayey sand, low to medium plasticity clay fines, moist.					
	0.4	SANDY CLAY - stiff to very stiff, grey-brown, sandy clay, medium plasticity, moist. Sand is fine to medium grained.	E	0.5			
				0.6		pp = 280	
	0.9	CLAYEY SAND - orange-brown and grey, fine to medium grained, clayey sand, low to medium plasticity, moist.		0.9		pp = 320	
21	1		E	1.0			
			E	1.5			
		- clay content reducing.					
20	2		E	2.0			
							23-02-17
		- with some ironstone from 2.3 m depth.					
	2.5	Pit discontinued at 2.5m (Target depth)	E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: Groundwater observed at 2.1 m depth.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

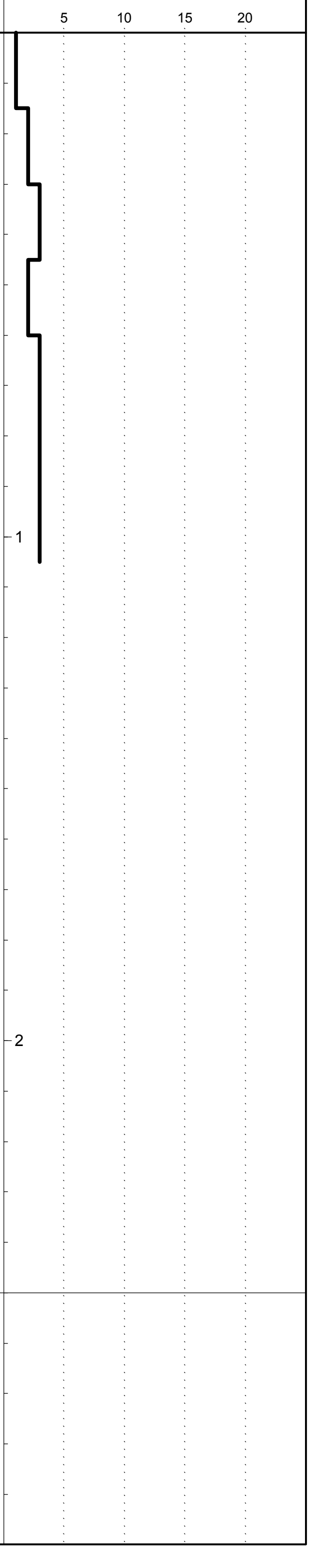
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 401719
NORTHING: 6435994

PIT No: TP02
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (SAND) - grey-brown, fine to medium grained, sandy topsoil with some silt, dry to moist.						
	0.1	SAND - medium dense, grey-brown, fine to medium grained, sand with some silt, moist.						
		- becoming orange-brown from 0.3 m						
				D	0.4			
				E	0.5			
23	1			E	1.0			
				E	1.5			
		- with some clay from 1.8 m depth.						
22	2							
	2.3	SLIGHTLY CLAYEY SAND - orange-brown, fine to medium grained, slightly clayey sand, moist.						
	2.5	Pit discontinued at 2.5m (Target depth)		E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

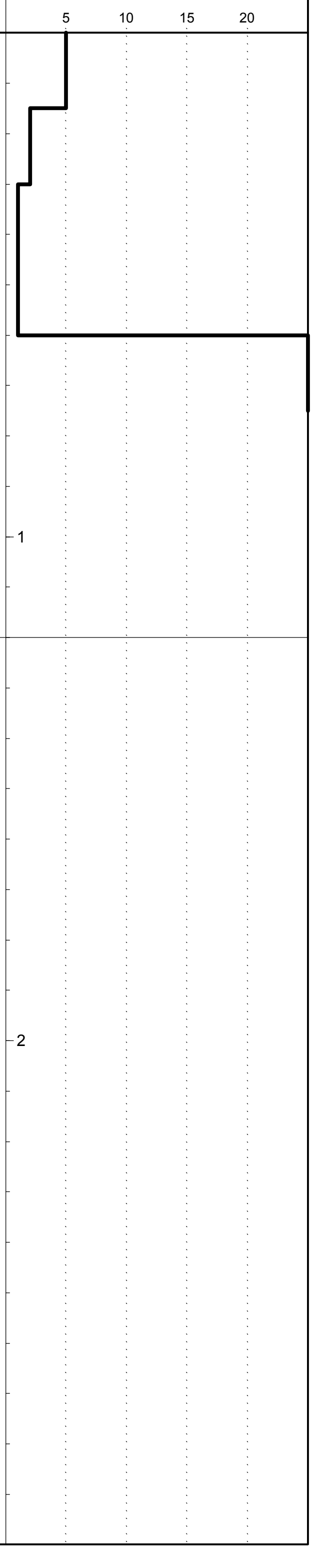
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 401994
NORTHING: 6435970

PIT No: TP03
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.						
	0.15	SANDY CLAY - soft to firm, grey-brown, medium to high plasticity, sandy clay, moist. Sand is fine to medium grained.			0.3		pp = 120	
				B				
				E	0.5	1		
		- becoming hard from 0.6 m depth.			0.7		pp = 120	
	0.8	CEMENTED CLAYEY SAND - weakly cemented, light brown, fine to coarse grained, clayey sand, dry to moist.			0.9			
				D				
23	1			E	1.0	2		
	1.2	Pit discontinued at 1.2m (Refusal on strongly cemented material)						
22	2							

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

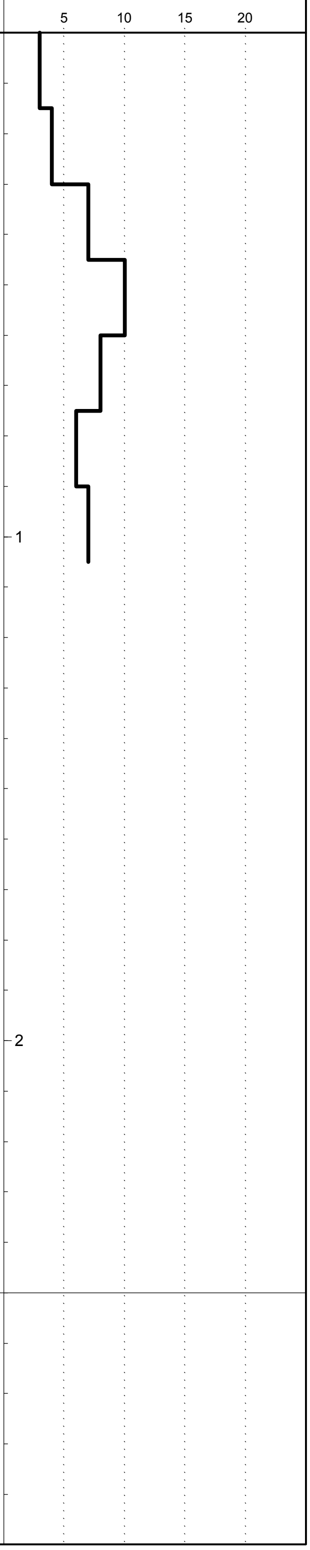
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402252
NORTHING: 6436002

PIT No: TP04
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.					
	0.1	CLAYEY SILTY SAND - medium dense, brown mottled orange-brown and grey, fine to medium grained, clayey silty sand, low to medium plasticity clay fines, moist.					
	0.2	SANDY CLAY - stiff to very stiff, orange-brown, sandy clay, medium plasticity, moist. Sand is fine to medium grained.					
			B	0.3 – 0.5			
		- becoming very stiff, orange-brown and red-brown, low to medium plasticity from 0.9 m depth.	D	0.9 – 1.0		pp = 510	
23	1						
		- becoming red-brown and grey with some ironstone gravel.	D	1.4			
22	2						
	2.5	Pit discontinued at 2.5m (Target depth)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

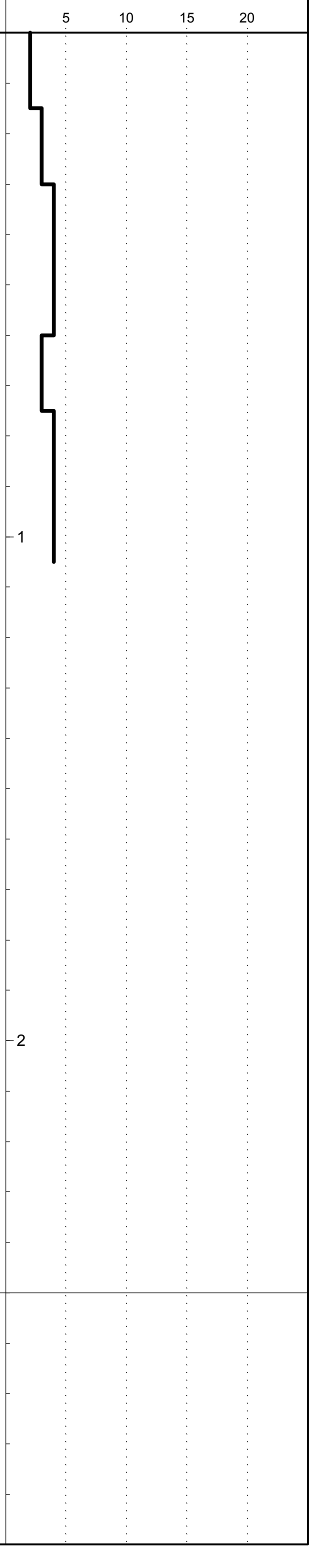
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 401605
NORTHING: 6435851

PIT No: TP05
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24	0.05	TOPSOIL (SAND) - grey-brown, fine to medium grained, sandy topsoil with some silt, dry to moist.						
		SAND - medium dense, grey-brown, fine to medium grained, sand with some silt, moist. - orange-brown with a trace of silt and roots from 0.4 m depth.						
23	1							
	1.7	SLIGHTLY CLAYEY SAND - orange-brown mottled grey and red-brown, fine to medium grained, slightly clayey sand, moist.		D	1.9 2.0			
22	2							
	2.1	CLAYEY SAND - orange-brown mottled grey and red-brown, fine to medium grained, clayey sand, low plasticity, moist.						
	2.5	Pit discontinued at 2.5m (Target depth)						

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

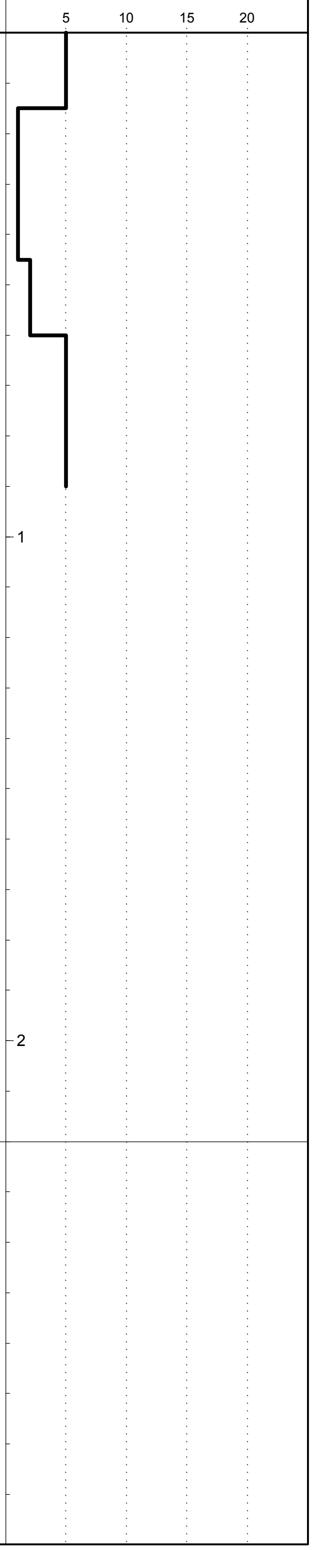
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402146
NORTHING: 6435881

PIT No: TP06
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.					
	0.1	CLAYEY SILTY SAND - loose, brown mottled orange-brown and grey, fine to medium grained, clayey silty sand, low to medium plasticity, moist.					
			U D	0.3 0.45			
	0.35	SANDY CLAY - soft, red-brown mottled grey, sandy clay, high plasticity, moist. Sand is fine to medium grained.					
			E	0.5	3	pp = 150	
		- becoming stiff from 0.6 m depth.					
23	1		E	1.0	4	pp = 250	
	1.4	CLAYEY SAND - orange-brown and grey, fine to medium grained, clayey sand, medium plasticity, moist.					
			E	1.5	5		
		- becoming grey mottled orange-brown and red-brown and weakly cemented from 1.7 m depth.					
22	2		E	2.0	6		
	2.2	Pit discontinued at 2.2m (Refusal)					

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

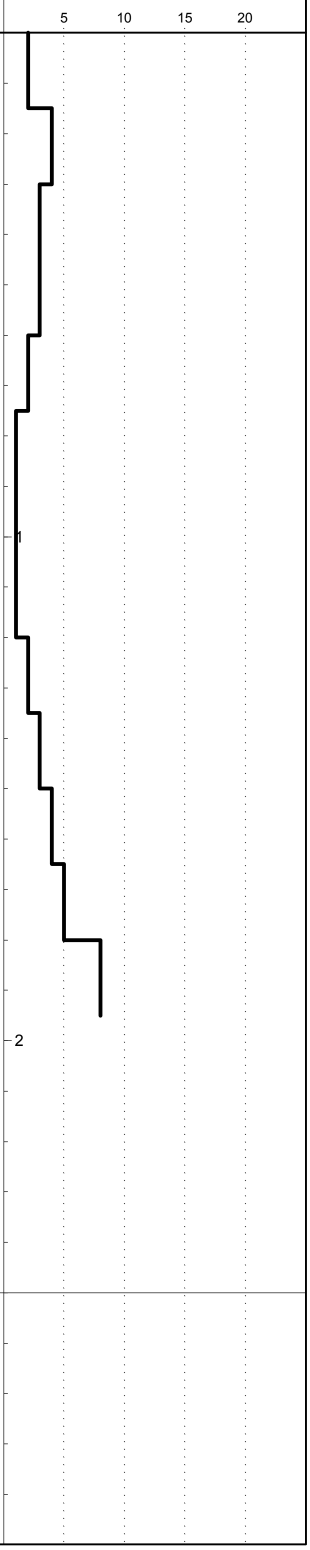
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 22.1 m AHD*
EASTING: 401463
NORTHING: 6435724

PIT No: TP07
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
22		TOPSOIL (SILTY SAND) - grey, fine to medium grained, silty sandy topsoil, dry to moist.						
	0.1	SAND - medium dense, light brown, fine to medium grained, sand with some silt, moist		D	0.4			
				E	0.5			
	0.7	SLIGHTLY SILTY SAND - loose, light brown, fine to medium grained, slightly silty sand, moist.						
21	1.0	CLAYEY SAND - soft to firm, light brown mottled orange-brown and light grey, fine to medium grained, clayey sand, low plasticity, moist.		E	1.0			
				U	1.2			
				D	1.3			
				E	1.5–1.55			
	1.6	SANDY CLAY - very stiff, orange-brown and light grey, sandy clay, medium plasticity, moist. Sand is fine to medium grained.		D	1.9			
20				E	2.0			
	2.5	Pit discontinued at 2.5m (Target depth)		E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

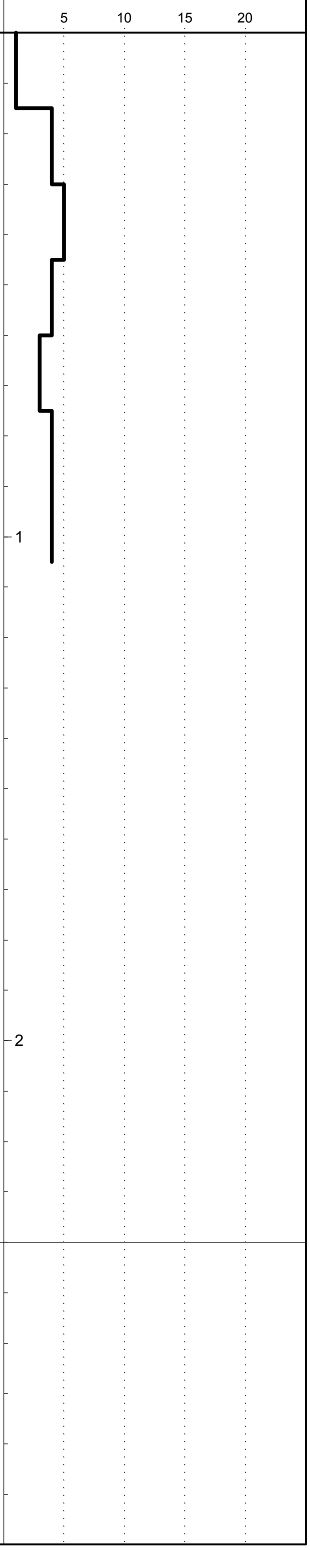
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24.5 m AHD*
EASTING: 401704
NORTHING: 6435731

PIT No: TP08
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Type	Depth	Sample	Results & Comments	Water
	0.05	TOPSOIL (SAND) - grey-brown, fine to medium grained, sandy topsoil with some silt, dry to moist.						
24	1	SAND - medium dense, grey-brown, fine to medium grained, sand with some silt, moist. - orange-brown with a trace of silt and roots from 0.4 m depth.						
23	2							
	2.1	SLIGHTLY CLAYEY SAND - orange-brown and light grey, fine to medium grained, slightly clayey sand, low plasticity, moist. - clay content increases from 2.3 m depth.						
22	2.4	Pit discontinued at 2.4m (Test pit collapse)						

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

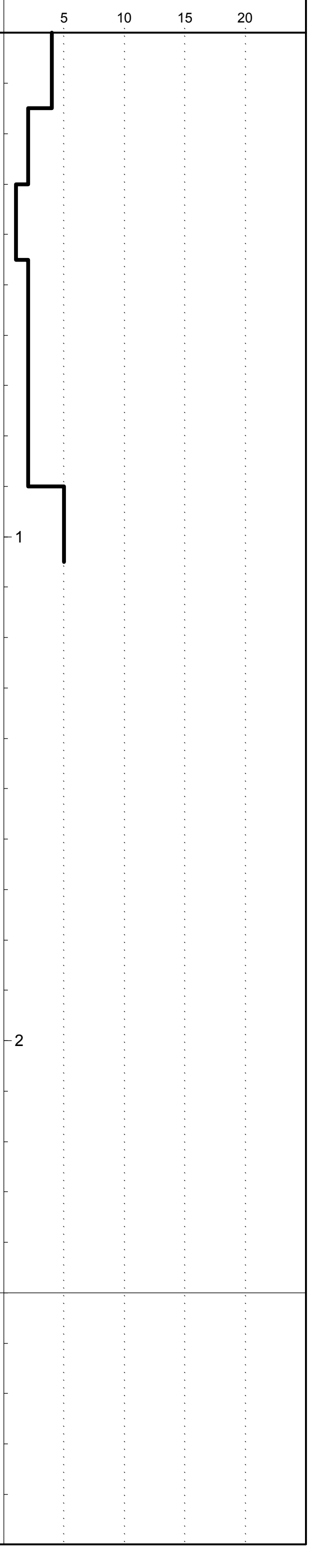
CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402034
NORTHING: 6435723

PIT No: TP09
PROJECT No: 88862.00
DATE: 23/2/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water
24		TOPSOIL (SILTY SAND) - grey-brown, fine to medium grained, silty sandy topsoil, dry to moist.						
	0.1	SILTY SAND - loose, orange-brown, fine to medium grained, silty sand, moist.						
	0.3	SANDY CLAY - soft to firm, grey-brown, sandy clay, high plasticity, moist. Sand is fine to medium grained.			0.3		pp = 500	
				BU				
				E	0.5		pp = 500	
					0.6			
		- becoming stiff from 0.9 m depth.			0.9		pp = 500	
23	1			E	1.0			
					1.1		pp = 500	
	1.4	CLAYEY SILTY SAND - orange-brown and grey, fine to medium grained, clayey silty sand, low to medium plasticity clay fines, dry to moist.						
				E	1.5			
				D				
					1.6			
22	2			E	2.0			
	2.5	Pit discontinued at 2.5m (Target depth)		E	2.5			

Dynamic Penetrometer Test (blows per 150mm)



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket. **LOGGED:** JK **SURVEY DATUM:** MGA94 Zone 50

WATER OBSERVATIONS: No free groundwater observed.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

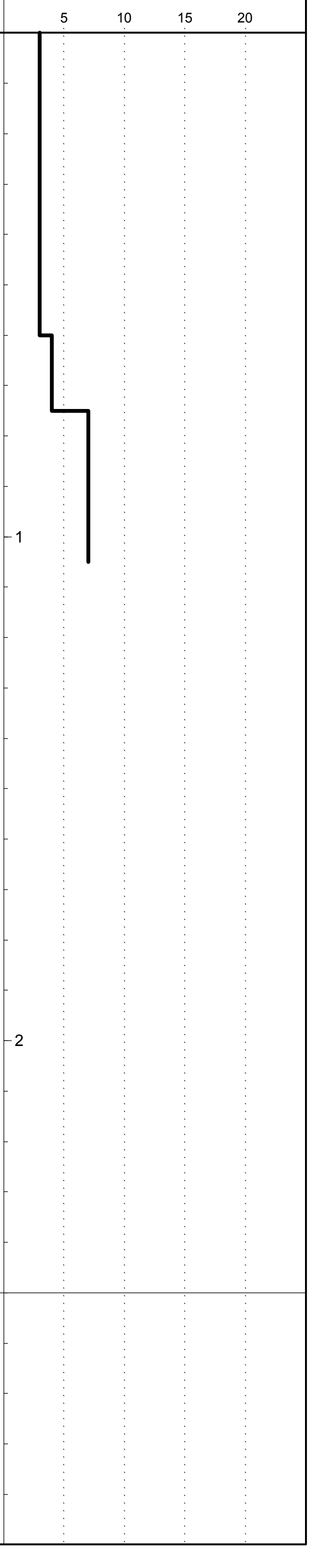
TEST PIT LOG

CLIENT: Goldlight Asset Pty Ltd
PROJECT: Proposed Rural Residential Subdivision
LOCATION: Lot 2 Thomas Road & Lot 4 Kargotich Road, Oakford, WA

SURFACE LEVEL: 24 m AHD*
EASTING: 402283
NORTHING: 6435748

PIT No: TP10
PROJECT No: 88862.00
DATE: 23/2/2017
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)
24		TOPSOIL (CLAYEY SILTY SAND) - grey-brown, fine to medium grained, clayey silty sand with some rootlets, moist.							
	0.1	CLAYEY SAND - firm to stiff, orange-brown, fine to medium grained, clayey sand, medium plasticity, moist.							
	0.9	SLIGHTLY CLAYEY SAND - medium dense, orange-brown mottled grey, fine to medium grained, slightly clayey sand, low plasticity, moist.							
23	1								
				D	1.4 1.5				
								▷	
	1.7	CLAYEY SAND - orange-brown and grey, fine to medium grained, clayey sand, medium plasticity, moist.							
22	2								
	2.5	Pit discontinued at 2.5m (Target depth)							



RIG: JCB 8 tonne backhoe with a 650 mm wide toothed bucket.
LOGGED: JK
SURVEY DATUM: MGA94 Zone 50

WATER OBSERVATIONS: Groundwater seepage observed at 1.6 m depth.

REMARKS: *Surface level interpolated from Plan OAK-SGP-001 provided by the client.

☐ 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

Appendix C

Laboratory Test Results
Geotechnical

Particle Size Distribution

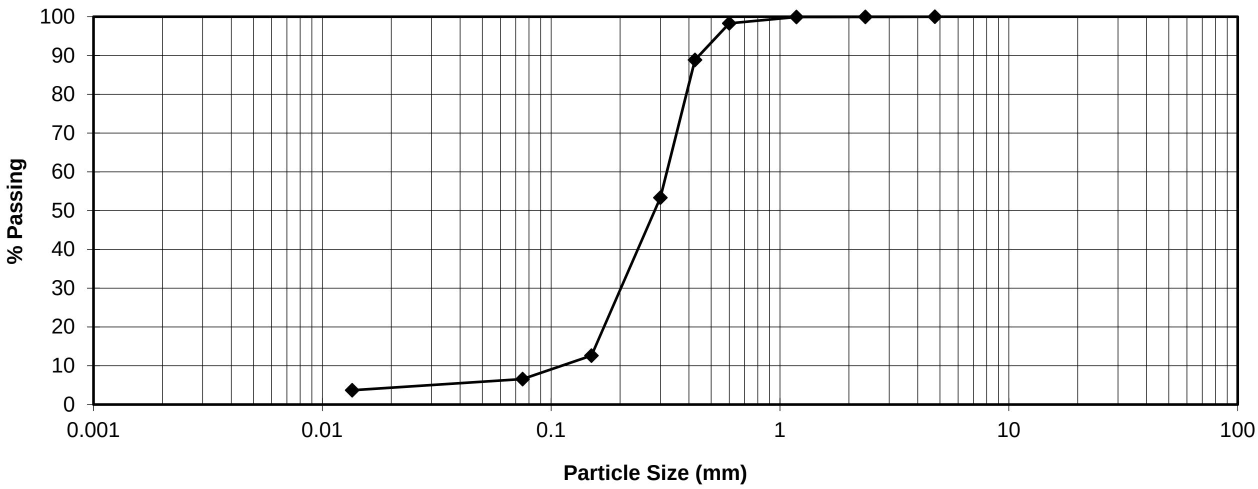
Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No: 60017
Report No: 60017-P17/582
Sample No: P17/582
Issue Date: 09-Mar-17

Client: Goldlight Asset Pty Ltd
Project: Proposed Rural Residential Subdivision
Location: Kargotich Rd & Thomas Rd, Oakford

Sample Details TP02
Sample Depth (m) 0.4-0.5



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	98
0.425	89
0.300	53
0.150	13
0.075	7
0.0135	4

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Sampling Procedure: Tested as received

Notes:

Accreditation for compliance with ISO/IEC 17025.
This document may not be reproduced except in full.
Accreditation No 15545.

Approved signature

Craig Hugo

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

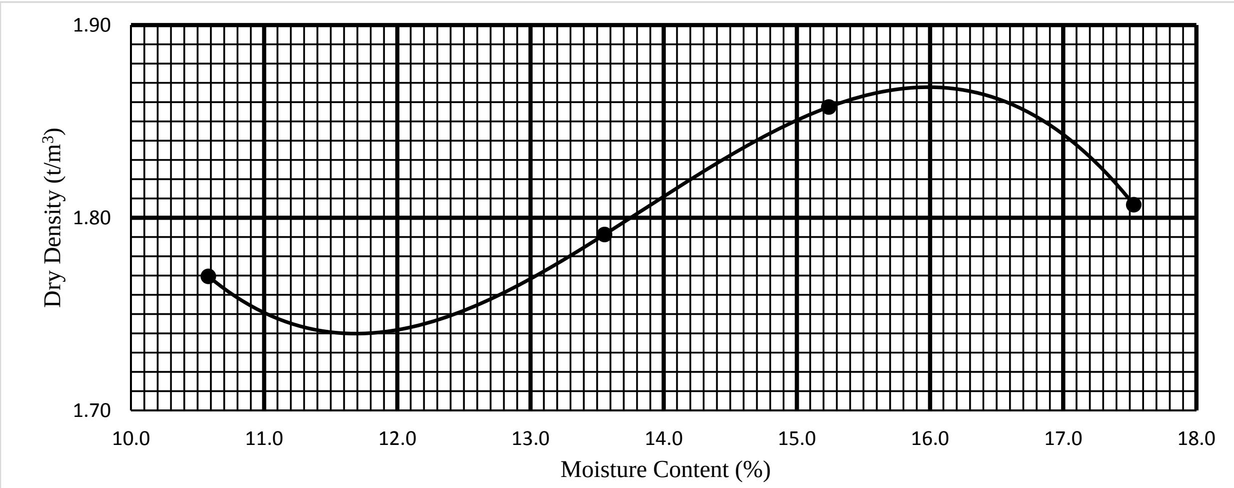
Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873   Mob: 0412 427 245
Email: craig@mcgeotest.com.au

Client:	Goldlight Asset Pty Ltd	**Job No:**	60017
Project:	Proposed Rural Residential Subdivision	**Sample No:**	P17/583
Location:	Kargotich Rd & Thomas Rd, Oakford	**Issued Date:**	08-Mar-17
Sample ID:	TP04 0.3-0.5	**Report No:**	60017-P17/583

Maximum Dry Density t/m3	1.87	**Conditions at Test**	
Optimum Moisture Content %:	16	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	18.9
Compactive Effort		Entire Moisture Ratio %	118.0
Mass of hammer kg	4.9	Top 30mm Moisture Content %	23.4
Number of layers	5	Top 30mm Moisture Ratio %	146.0
Number of blows/layer	20	Swell %	3.5
Conditions after Compaction		C.B.R. at 5.0 mm Penetration %	3
Dry Density t/m3	1.78	**Conditions after Soaking**	
Moisture Content %	15.9	Dry Density t/m3	1.72
Density Ratio %	95.0	Moisture Content %	20.0
Moisture Ratio %	99.0	Dry Density Ratio %	92.0
Soaked / Unsoaked	Soaked	Moisture Ratio %	125.0

Comments:



Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Approved Signature

Craig Hugo

Particle Size Distribution & Plasticity Index tests

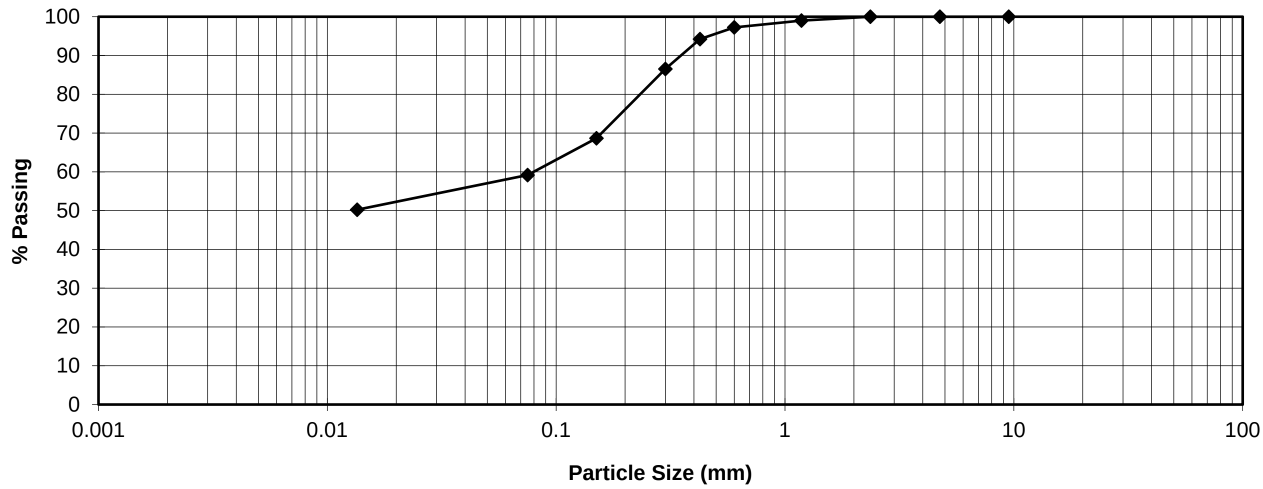
Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873   Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/583**
Sample No:	**P17/583**
Issue Date:	**10-Mar-17**

Client: Goldlight Asset Pty Ltd
Project: Proposed Rural Residential Subdivision
Location: Kargotich Rd & Thomas Rd, Oakford

Sample Details TP04
Sample Depth (m) 0.3-0.5



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	97
0.425	94
0.300	87
0.150	69
0.075	59
0.0135	50

Plasticity index tests
AS 1289

Liquid Limit 3.1.1	50	%
Plastic Limit 3.2.1	18	%
Plasticity Index 3.3.1	32	%
Linear Shrinkage 3.4.1	4.8	%

Cracked X

Curled

Emerson Class Number
AS 1289.3.8.1 6

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017
Sampling Procedure: Tested as received
Notes:

NATA
WORLD RECOGNISED ACCREDITATION

Accreditation for compliance with ISO/IEC 17025.
This document may not be reproduced except in full.
Accreditation No 15545.

Approved signature

Craig Hugo

Maximum Dry Density (AS 1289.5.2.1) & California Bearing Ratio (AS 1289.6.1.1) Test Report

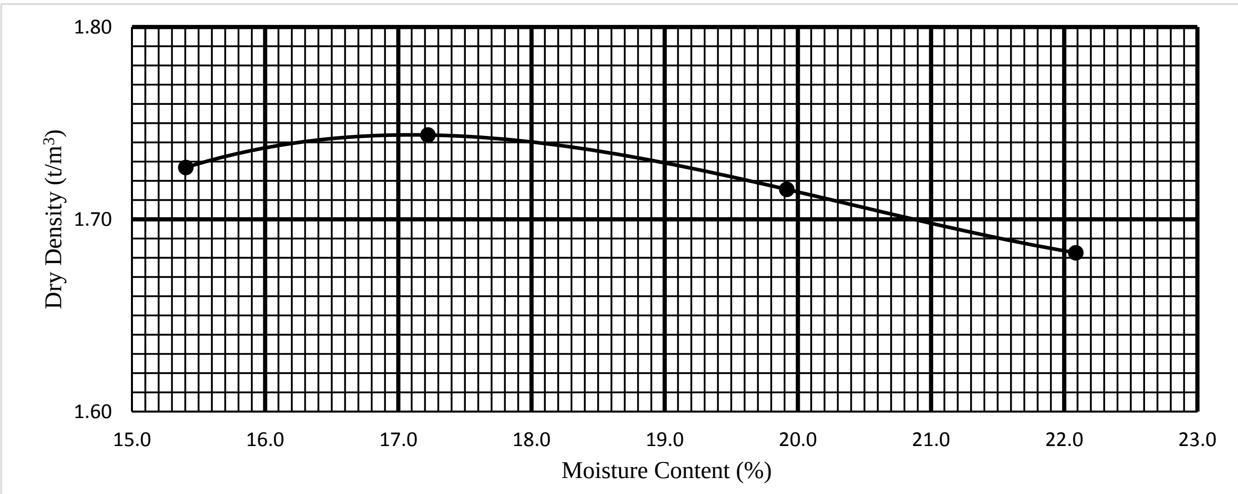
Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email: craig@mcgeotest.com.au

Client:	Goldlight Asset Pty Ltd	**Job No:**	60017
Project:	Proposed Rural Residential Subdivision	**Sample No:**	P17/583
Location:	Kargotich Rd & Thomas Rd, Oakford	**Issued Date:**	08-Mar-17
Sample ID:	TP09 0.3-0.5	**Report No:**	60017-P17/583

Maximum Dry Density t/m3	1.74	**Conditions at Test**	
Optimum Moisture Content %:	17.2	Soaking Period (Days)	4
Desired Conditions: MDD/OMC	95/100	Surcharge (kg)	4.5
Retained on 19.0mm %	0	Entire Moisture Content %	24.2
Compactive Effort		Entire Moisture Ratio %	141.0
Mass of hammer kg	4.9	Top 30mm Moisture Content %	36.2
Number of layers	5	Top 30mm Moisture Ratio %	210.5
Number of blows/layer	23	Swell %	5.5
Conditions after Compaction		C.B.R. at 2.5 mm Penetration %	1.5
Dry Density t/m3	1.66	**Conditions after Soaking**	
Moisture Content %	17.3	Dry Density t/m3	1.57
Density Ratio %	95.0	Moisture Content %	24.6
Moisture Ratio %	100.5	Dry Density Ratio %	90.0
Soaked / Unsoaked	Soaked	Moisture Ratio %	143.0

Comments:



Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Accreditation for compliance with ISO/IEC 17025.
This document may not be reproduced except in full.
Accreditation No 15545.

Approved Signature

Craig Hugo

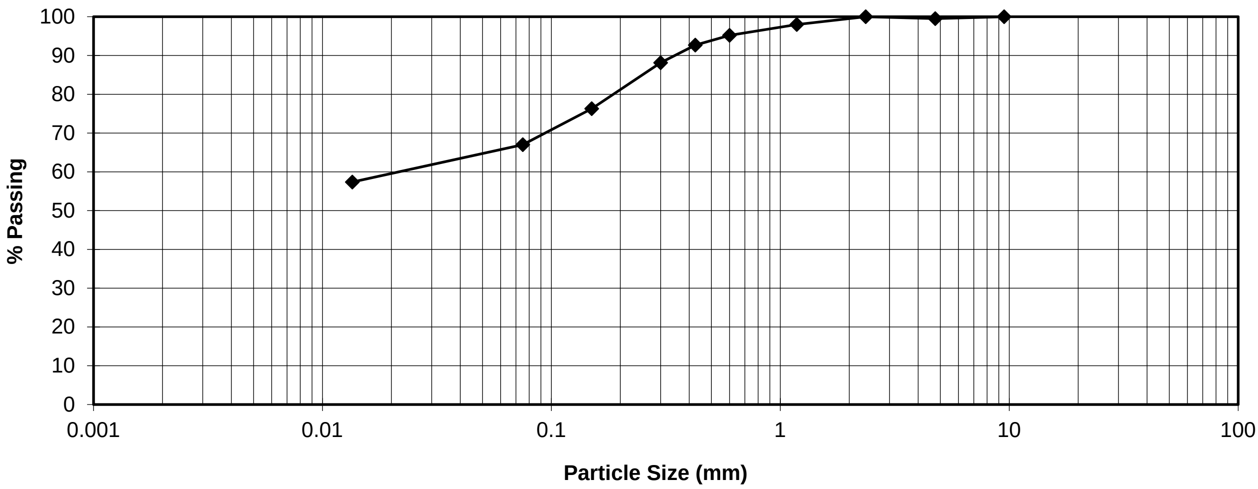
Particle Size Distribution & Plasticity Index tests

Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/584**
Sample No:	**P17/584**
Issue Date:	**10-Mar-17**

Client: Goldlight Asset Pty Ltd
Project: Proposed Rural Residential Subdivision
Location: Kargotich Rd & Thomas Rd, Oakford
Sample Details TP09
Sample Depth (m) 0.3-0.6



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	98
0.600	95
0.425	93
0.300	88
0.150	76
0.075	67
0.0135	57

Plasticity index tests
AS 1289

Liquid Limit 3.1.1	67	%
Plastic Limit 3.2.1	19	%
Plasticity Index 3.3.1	48	%
Linear Shrinkage 3.4.1	5.2	%

Cracked X

Curled

Emerson Class Number
AS 1289.3.8.1 6

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017
Sampling Procedure: Tested as received
Notes:

NATA
WORLD RECOGNISED ACCREDITATION

Approved signature
Craig Hugo

Determination of the Shrinkage Index of a Soil
Shrink Swell Index (AS 1289.7.1.1)

Mining & Civil Geotest Pty Ltd

9 Lerista Court, Bibra Lake WA 6164
Ph: (08) 9418 1873 Mob: 0412 427 245
Email:craig@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P17/585**
Sample No:	**P17/585**
Issue Date:	**10/03/2017**

Client:	Goldlight Asset Pty Ltd	**Sample Details**	TP09
Project:	Proposed Rural Residential Subdivision	**Sample Depth**	0.3-0.6
Location:	Kargotich Rd & Thomas Rd, Oakford		

Sample Details

Sample Description — Grey brown sandy clay

Sample Type — Tube - U48

Swell Specimen		**Shrinkage Specimen**	
Dry Density - Initial (t/m^{3})	1.49	Moisture Content Initial (%)	25.4
Moisture Content - Initial (%)	26.6	Length/Diameter Ratio	2.6
Moisture Content - Final (%)	31.7	Extent of Crumbling	Nil
Overburden Pressure (kPa)	25.0	Extent of Cracking	Nil
Inert Inclusions (%)	0.5%		

Shrink Swell Index

I_{ss} = 3.0 % Vertical strain per pF change in Total suction

Client Address: 36 O'Malley Street, Osborne Park Western Australia 6017

Sampling Procedure: Tested as received

Notes:

Approved signature

Craig Hugo

Appendix D

Laboratory Test Results
Acid Sulphate Soils
Effluent Disposal Suitability

Table D-1: Summary of Soil Laboratory Results

Test Location	Sample ID	Depth (m)	Soil Description	Screening Tests[1]				SPOCAS Suite of Testing								
				pH_F	pH_{FOX}	Reaction[2] Strength	Δ pH[3]	pH_{KCl}	pH_{OX}	TAA[4] (%S)	TPA[5] (%S)	S_{KCl}[6] (%S)	S_{POS}[7] (%S)	N_{RASS}[8] (%S)	ANC[9] (%S)	Net[10] Acidity (%S)
Assessment Criteria				**<4**	**<3**	**-**	**-**	**-**	**-**	**-**	**-**		**-**	**-**	**-**	**>0.03**
TP01	TP01 0.5	0.5	CLAYEY SAND / SANDY CLAY - grey-brown.	6.8	5.4	Extreme	1.4	-	-	-	-	-	-	-	-	-
TP01	TP01 1	1	CLAYEY SAND - orange brown.	5.1	4.2	low	0.9	-	-	-	-	-	-	-	-	-
TP01	TP01 1.5	1.5	CLAYEY SAND - orange brown.	4.8	3.9	low	0.9	-	-	-	-	-	-	-	-	-
TP01	TP01 2	2	CLAYEY SAND - orange brown.	4.7	3.6	low	1.1	-	-	-	-	-	-	-	-	-
TP01	TP01 2.5	2.5	CLAYEY SAND - orange brown.	4.7	3.5	low	1.2	5	5.3	0.03	0.018	0.018	<0.005	<0.005	<0.005	**0.032**
TP02	TP02 0.5	0.5	SAND - orange brown.	6.0	4.7	low	1.3	-	-	-	-	-	-	-	-	-
TP02	TP02 1	1	SAND - orange brown.	5.9	4.4	low	1.5	-	-	-	-	-	-	-	-	-
TP02	TP02 1.5	1.5	SAND - orange brown.	6.0	4.6	low	1.4	-	-	-	-	-	-	-	-	-
TP02	TP02 2.5	2.5	SLIGHTLY CLAYEY SAND - orange-brown.	7.5	5.8	low	1.7	-	-	-	-	-	-	-	-	-
TP03	TP03 0.5	0.5	SANDY CLAY - grey-brown.	6.6	5.1	low	1.5	-	-	-	-	-	-	-	-	-
TP03	TP03 1	1	SANDY CLAY - grey-brown.	6.2	5.3	low	0.9	4.8	6.3	0.043	0.021	0.021	<0.005	<0.005	<0.005	**0.044**
TP07	TP07 0.5	0.5	SAND - light brown.	6.1	4.2	Medium	1.9	-	-	-	-	-	-	-	-	-
TP07	TP07 1	1	CLAYEY SAND - light brown mottled orange-brown.	6.6	4.9	Medium	1.7	-	-	-	-	-	-	-	-	-
TP07	TP07 1.5	1.5	CLAYEY SAND - light brown mottled orange-brown.	6.7	5.3	low	1.4	5.6	5.8	<0.01	<0.01	<0.01	<0.005	<0.005	<0.005	0.014
TP07	TP07 2	2	CLAYEY SAND / SANDY CLAY - orange-brown.	7.5	6.1	low	1.4	-	-	-	-	-	-	-	-	-
TP07	TP07 2.5	2.5	CLAYEY SAND / SANDY CLAY - orange-brown.	7.4	5.8	low	1.6	-	-	-	-	-	-	-	-	-
TP09	TP09 0.5	0.5	SANDY CLAY - grey-brown.	8.5	6.8	low	1.7	-	-	-	-	-	-	-	-	-
TP09	TP09 1	1	SANDY CLAY - grey-brown.	7.9	6.4	low	1.5	-	-	-	-	-	-	-	-	-
TP09	TP09 1.5	1.5	CLAYEY SILTY SAND - orange-brown and grey.	7.6	6.2	low	1.4	-	-	-	-	-	-	-	-	-
TP09	TP09 2	2	CLAYEY SILTY SAND - orange-brown and grey.	7.5	5.8	low	1.7	-	-	-	-	-	-	-	-	-
TP09	TP09 2.5	2.5	CLAYEY SILTY SAND - orange-brown and grey.	7.7	5.9	low	1.8	5.1	6.9	0.029	<0.01	<0.01	<0.005	<0.005	0.086	0.029

Note:

1. Screening Tests undertaken by MPL Laboratories
2. Low – indicates no or low effervescence in hydrogen peroxide;
   Moderate – indicates moderate effervescence in hydrogen peroxide;
   High – indicates vigorous effervescence in hydrogen peroxide.
3. Δ pH – pHF - pHFOX
4. TAA – titratable actual acidity
5. TPA – titratable peroxide acidity;
6. S_{KCl} – potassium chloride extractable sulphur
7. S_{POS} – peroxide oxidisable sulphur
8. N_{RASS} – retained acidity (reported for pHKCl < 4.5)
9. ANC – acid neutralising capacity (reported for pHKCl > 6.5).
10. Net Acidity = TAA + Spos + NASS. (It should be noted that ANC is excluded as per WA Guidelines)

NT Not Tested

0.04 Exceedance of criteria.

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 192671

Client:
Douglas Partners Perth
36 O'Malley St
Osborne Park
WA 6017

Attention: Rob Shapland

Sample log in details:

Your Reference:	**88862.00**
No. of samples:	21 soils
Date/Time samples received:	28/02/2017 / 15:25
Date completed instructions received:	28/02/2017
Location:	Oakford, lot2 Thomas, lot4 Kargotich rds

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last pages of this report for any comments relating to the results.

Report Details:

Date results requested by:	8/03/17
Date of Preliminary Report:	02/03/2017
Issue Date:	8/03/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

sPOCAS field test						
Our Reference:	UNITS	192671-1	192671-2	192671-3	192671-4	192671-5
Your Reference	-------------	TP01 0.5	TP01 1	TP01 1.5	TP01 2	TP01 2.5
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	6.8	5.1	4.8	4.7	4.6
pHFOX (field peroxide test)*	pH Units	5.4	4.2	3.9	3.6	3.5
Reaction Rate*	-	Extreme	low	low	low	low

sPOCAS field test						
Our Reference:	UNITS	192671-6	192671-7	192671-8	192671-9	192671-10
Your Reference	-------------	TP02 0.5	TP02 1	TP02 1.5	TP02 2.5	TP03 0.5
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	6.0	5.9	6.0	7.5	6.6
pHFOX (field peroxide test)*	pH Units	4.7	4.4	4.6	5.8	5.1
Reaction Rate*	-	low	low	low	low	low

sPOCAS field test						
Our Reference:	UNITS	192671-11	192671-12	192671-13	192671-14	192671-15
Your Reference	-------------	TP03 1	TP07 0.5	TP07 1	TP07 1.5	TP07 2
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	6.2	6.1	6.6	6.7	7.5
pHFOX (field peroxide test)*	pH Units	5.3	4.2	4.9	5.3	6.1
Reaction Rate*	-	low	Medium	Medium	low	low

sPOCAS field test						
Our Reference:	UNITS	192671-16	192671-17	192671-18	192671-19	192671-20
Your Reference	-------------	TP07 2.5	TP09 0.5	TP09 1	TP09 1.5	TP09 2
Date Sampled	------------	23/02/2017	23/02/2017	23/02/2017	23/02/2017	23/02/2017
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	01/03/2017	01/03/2017	01/03/2017	01/03/2017	01/03/2017
Date analysed	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017	02/03/2017
pH_F (field pH test)*	pH Units	7.4	8.5	7.9	7.6	7.5
pHFOX (field peroxide test)*	pH Units	5.8	6.8	6.4	6.2	5.8
Reaction Rate*	-	low	low	low	low	low

sPOCAS field test		
Our Reference:	UNITS	192671-21
Your Reference	-------------	TP09 2.5
Date Sampled	------------	23/02/2017
Type of sample		Soil
Date prepared	-	01/03/2017
Date analysed	-	02/03/2017
pHF (field pH test)*	pH Units	7.7
pHFOX (field peroxide test)*	pH Units	5.9
Reaction Rate*	-	low

Miscellaneous Inorg - soil			
Our Reference:	UNITS	192671-1	192671-6
Your Reference	-------------	TP01 0.5	TP02 0.5
Date Sampled	------------	23/02/2017	23/02/2017
Type of sample		Soil	Soil
Date prepared	-	02/03/2017	02/03/2017
Date analysed	-	02/03/2017	02/03/2017
Electrical Conductivity (EC)	µS/cm	500	64

ESP/CEC			
Our Reference:	UNITS	192671-1	192671-6
Your Reference	-------------	TP01 0.5	TP02 0.5
Date Sampled	------------	23/02/2017	23/02/2017
Type of sample		Soil	Soil
Date digested	-	07/03/2017	07/03/2017
Date analysed	-	07/03/2017	07/03/2017
Calcium	mg/kg	110	90
Potassium	mg/kg	<50	<50
Magnesium	mg/kg	720	610
Sodium	mg/kg	440	370
Aluminium	mg/kg	<10	<10
Exchangeable Ca	meq/100g	0.5	0.5
Exchangeable K	meq/100g	<0.1	<0.1
Exchangeable Mg	meq/100g	5.9	5.0
Exchangeable Na	meq/100g	1.9	1.6
Exchangeable Al	meq/100g	<0.07	<0.07
Cation Exchange Capacity	meq/100g	8	7

Method ID	Methodology Summary
INORG-063	pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004.
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-020	Metals in soil and water by ICP-OES.
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.

QUALITY CONTROL sPOCAS field test	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD
Date prepared	-			[NT]	192671-1	01/03/2017 || 01/03/2017
Date analysed	-			[NT]	192671-1	02/03/2017 || 02/03/2017
pHF (field pH test)*	pH Units		INORG-063	[NT]	192671-1	6.8 || 6.7 || RPD: 1
pHFOX (field peroxide test)*	pH Units		INORG-063	[NT]	192671-1	5.4 || 5.8 || RPD: 7

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			02/03/2017	[NT]	[NT]	LCS-1	02/03/2017
Date analysed	-			02/03/2017	[NT]	[NT]	LCS-1	02/03/2017
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1.0	[NT]	[NT]	LCS-1	107%

QUALITY CONTROL ESP/CEC	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date digested	-			07/03/2017	[NT]	[NT]	LCS-1	07/03/2017
Date analysed	-			07/03/2017	[NT]	[NT]	LCS-1	07/03/2017
Calcium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	105%
Potassium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	105%
Magnesium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	106%
Sodium	mg/kg	50	METALS-020	<50	[NT]	[NT]	LCS-1	104%
Aluminium	mg/kg	10	METALS-020	<10	[NT]	[NT]	LCS-1	108%

QUALITY CONTROL sPOCAS field test	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	192671-11	01/03/2017 || 01/03/2017
Date analysed	-	192671-11	02/03/2017 || 02/03/2017
pHF (field pH test)*	pH Units	192671-11	6.2 || 6.2 || RPD: 0
pHFOX (field peroxide test)*	pH Units	192671-11	5.3 || 5.2 || RPD: 2

QUALITY CONTROL sPOCAS field test	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	192671-21	01/03/2017 || 01/03/2017
Date analysed	-	192671-21	02/03/2017 || 02/03/2017
pHF (field pH test)*	pH Units	192671-21	7.7 || 7.0 || RPD: 10
pHFOX (field peroxide test)*	pH Units	192671-21	5.9 || 5.9 || RPD: 0

Report Comments:

Asbestos Signatories:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Airborne fibres were analysed by Approved Counter: Not applicable for this job

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

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.

CHAIN OF CUSTODY Despatch Sheet

Project Number: 88862.00
Project Name: OAKFORD, Lot 2 Thomas & Lot 4 Kargotich Roads
Project Manager: Rob Shapland
Sampler: Jawad Khandwalla

Turn Around Time: Standard
Sample Prior Storage: Fridge
Purchase Order Number: 128632
Email results to: Rob Shapland and Michael Brooker

To: MPL Envirolab
16-18 Hayden Court
Myaree
Ph: 9317 2505

Sample ID	Depth (m)	Sampling Date	Sample Type S - Soil W - Water	Lab ID	Analytes: pH(F)	pH(FOX)	Electrical Conductivity	Cation Exchange Capacity											Notes:
TP01	0.5	23/02/2017	Soil (Jar)		x	x	x	x											
TP01	1	23/02/2017	Soil (Bag)		x	x													
TP01	1.5	23/02/2017	Soil (Bag)		x	x													
TP01	2	23/02/2017	Soil (Bag)		x	x													
TP01	2.5	23/02/2017	Soil (Bag)		x	x													
TP02	0.5	23/02/2017	Soil (Jar)		x	x	x	x											
TP02	1	23/02/2017	Soil (Bag)		x	x													
TP02	1.5	23/02/2017	Soil (Bag)		x	x													
TP02	2.5	23/02/2017	Soil (Bag)		x	x													
TP03	0.5	23/02/2017	Soil (Bag)		x	x													
TP03	1	23/02/2017	Soil (Bag)		x	x													
TP07	0.5	23/02/2017	Soil (Bag)		x	x													
TP07	1	23/02/2017	Soil (Bag)		x	x													
TP07	1.5	23/02/2017	Soil (Bag)		x	x													
TP07	2	23/02/2017	Soil (Bag)		x	x													
TP07	2.5	23/02/2017	Soil (Bag)		x	x													
TP09	0.5	23/02/2017	Soil (Bag)		x	x													
TP09	1	23/02/2017	Soil (Bag)		x	x													
TP09	1.5	23/02/2017	Soil (Bag)		x	x													
TP09	2	23/02/2017	Soil (Bag)		x	x													
PQL (S)																			
LOR (W)																			

mpl Laboratories ENVIROLAB GROUP
Job No.- 192671
Date Rec - 28-2
Time Rec - 1525
Rec By - MC
TAT Req - SAME 1 / 2 / 3 / STD
Temp - Cool / ambient
Cooling - Ice / Ice pack / None
Security Seal - Yes / No

LOR = Limit of Reporting, PQL = Practical Quantification Limit *As per Laboratory Method Detection Limit

** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECIEPT OF SAMPLES AND RETURN BY EMAIL**

Relinquished By: Michael Brooker Sign: Date & Time: 28/02/2017

Received By: Meredith Sign: Date & Time: 28-2-17

Send results to: Douglas Partners Pty Ltd, 36 O'Malley Street, OSBORNE PARK 6017. Ph: (08) 9204 3511 Fax: (08) 9204 3522 **Send invoice to:** perth@douglaspartners.com.au

Douglas Partners
Geotechnics / Environment / Groundwater

CHAIN OF CUSTODY Despatch Sheet

Project Number: 88862.00
Project Name: OAKFORD, Lot 2 Thomas & Lot 4 Kargotich Roads
Project Manager: Rob Shapland
Sampler: Jawad Khandwalla

Turn Around Time: Standard
Sample Prior Storage: Fridge
Purchase Order Number: 128632
Email results to: Rob Shapland and Michael Brooker

To: MPL Envirolab
16-18 Hayden Court
Myaree
Ph: 9317 2505

Sample ID	Depth (m)	Sampling Date	Sample Type S - Soil W - Water	Lab ID	Analytes														Notes:
					pH(F)	pH(FOX)	Electrical Conductivity	Cation Exchange Capacity											
TP09	2.5	23/02/2017	Soil (Bag)		x	x													
PQL (S)																			
LOR (W)																			

LOR = Limit of Reporting, PQL = Practical Quantification Limit *As per Laboratory Method Detection Limit

** IMPORTANT: PLEASE SIGN AND DATE TO ACKNOWLEDGE RECIEPT OF SAMPLES AND RETURN BY EMAIL**

Relinquished By: Michael Brooker Sign: Date & Time: 28/02/2017

Received By: M. CONROY Sign: Date & Time: 28-2-17

Send results to: Douglas Partners Pty Ltd, 36 O'Malley Street, OSBORNE PARK 6017. Ph: (08) 9204 3511 Fax: (08) 9204 3522 **Send invoice to:** perth@douglaspartners.com.au

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 192807

Client:
Douglas Partners Perth
36 O'Malley St
Osborne Park
WA 6017

Attention: Michael Brooker

Sample log in details:

Your Reference:	**88862.00**
No. of samples:	4 dried soils
Date/Time samples received:	28/02/2017 / 15:25
Date completed instructions received:	2/03/2017
Location:	Oakford,Lot2 Thomas & Lot4 kargotich Rds

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last pages of this report for any comments relating to the results.

Report Details:

Date results requested by:	10/03/17
Date of Preliminary Report:	N/A
Issue Date:	9/03/17

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Stacey Hawkins
Acid Soils/Acid Mine Drainage Supervisor

Client Reference: 88862.00

sPOCAS Our Reference: Your Reference Date Sampled Type of sample	UNITS ------------- ------------	192807-1 TP01-2.5m 23/02/2017 Soil	192807-2 TP03-1.0m 23/02/2017 Soil	192807-3 TP07-1.5m 23/02/2017 Soil	192807-4 TP09-205m 23/02/2017 Soil
Date prepared	-	02/03/2017	02/03/2017	02/03/2017	02/03/2017
Date analysed	-	09/03/2017	09/03/2017	09/03/2017	09/03/2017
pH_{kcl}	pH units	5.0	4.8	5.6	5.1
TAA	moles H^+/t	19	27	6.1	18
pH_{Ox}	pH units	5.3	6.3	5.8	6.9
TPA	moles H^+/t	11	13	<5.0	<5.0
S_{KCl}	%w/w S	0.023	0.017	0.012	0.010
Ca_{KCl}	% w / w	0.013	0.025	0.014	0.050
Mg_{KCl}	% w / w	0.049	0.15	0.030	0.22
S_P	% w / w	0.025	0.019	0.016	0.010
Ca_P	% w / w	0.015	0.024	0.014	0.053
Mg_P	% w / w	0.052	0.15	0.030	0.23
a-ANC_E	moles H^+/t	<5	<5	<5	54
SHCl	%w/w S	<0.005	<0.005	<0.005	<0.005
TSA	moles H^+/t	<5.0	<5.0	<5.0	<5.0
s-TAA	%w/w S	0.030	0.043	<0.01	0.029
s-TPA	%w/w S	0.018	0.021	<0.01	<0.01
s-TSA	%w/w S	<0.01	<0.01	<0.01	<0.01
S_{POS}	%w/w S	<0.005	<0.005	<0.005	<0.005
a-S_{POS}	moles H^+/t	<5.0	<5.0	<5.0	<5.0
Ca_A	%w/w Ca	<0.005	<0.005	<0.005	<0.005
a-Ca_A	moles H^+/t	<5	<5	<5	<5
s-Ca_A	%w/w S	<0.005	<0.005	<0.005	<0.005
Mg_A	%w/w Mg	<0.005	<0.005	<0.005	0.011
a-Mg_A	moles H^+/t	<5.0	<5.0	<5.0	9.2
s-Mg_A	%w/w S	<0.005	<0.005	<0.005	0.015
ANC_E	% $CaCO_3$	<0.01	<0.01	<0.01	0.3
s-ANC_E	%w/w S	<0.005	<0.005	<0.005	0.086
Fineness Factor		1	1	1	1
S_{NAS}	%w/w S	<0.005	<0.005	<0.005	<0.005
a-S_{NAS}	moles H^+/t	<5	<5	<5	<5
s-S_{NAS}	%w/w S	<0.01	<0.01	<0.01	<0.01
s-Net Acidity	%w/w S	0.032	0.044	0.014	0.029
a-Net Acidity	moles H^+/t	20	28	8.5	18
Liming rate	kg $CaCO_3$/t	1.5	2.1	<0.75	1.4
Net Acidity (WA)	%w/w S	0.032	0.044	0.014	0.029
a-Net Acidity without ANCE	moles H^+/t	20	28	8.5	18
Liming rate without ANCE	kg $CaCO_3$/t	1.5	2.1	<0.75	1.4

Method ID	Methodology Summary
INORG-064	Suspension Peroxide Oxidation Combined Acidity and Sulphate (SPOCAS) using ASSMAC guidelines.

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			[NT]	192807-1	02/03/2017 || 02/03/2017	[NR]	[NR]
Date analysed	-			[NT]	192807-1	09/03/2017 || 09/03/2017	[NR]	[NR]
pH $_{kcl}$	pH units		INORG-064	[NT]	192807-1	5.0 || 5.0 || RPD: 0	LCS	96%
TAA	moles H^+/t	5	INORG-064	[NT]	192807-1	19 || 21 || RPD: 10	LCS	107%
pH $_{Ox}$	pH units		INORG-064	[NT]	192807-1	5.3 || 5.3 || RPD: 0	LCS	98%
TPA	moles H^+/t	5	INORG-064	[NT]	192807-1	11 || 11 || RPD: 0	LCS	96%
S_{KCl}	%w/w S	0.005	INORG-064	[NT]	192807-1	0.023 || 0.022 || RPD: 4	[NR]	[NR]
Ca_{KCl}	%w/w	0.005	INORG-064	[NT]	192807-1	0.013 || 0.013 || RPD: 0	[NR]	[NR]
Mg_{KCl}	%w/w	0.005	INORG-064	[NT]	192807-1	0.049 || 0.047 || RPD: 4	[NR]	[NR]
S_P	%w/w	0.005	INORG-064	[NT]	192807-1	0.025 || 0.026 || RPD: 4	[NR]	[NR]
Ca_P	%w/w	0.005	INORG-064	[NT]	192807-1	0.015 || 0.014 || RPD: 7	[NR]	[NR]
Mg_P	%w/w	0.005	INORG-064	[NT]	192807-1	0.052 || 0.048 || RPD: 8	[NR]	[NR]
a-ANC_E	moles H^+/t	5	INORG-064	[NT]	192807-1	<5 || <5	[NR]	[NR]
SHCl	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
TSA	moles H^+/t	5	INORG-064	[NT]	192807-1	<5.0 || <5.0	[NR]	[NR]
s-TAA	%w/w S	0.01	INORG-064	[NT]	192807-1	0.030 || 0.034 || RPD: 13	[NR]	[NR]
s-TPA	%w/w S	0.01	INORG-064	[NT]	192807-1	0.018 || 0.018 || RPD: 0	[NR]	[NR]
s-TSA	%w/w S	0.01	INORG-064	[NT]	192807-1	<0.01 || <0.01	[NR]	[NR]
S_{POS}	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-S_{POS}	moles H^+/t	5	INORG-064	[NT]	192807-1	<5.0 || <5.0	[NR]	[NR]
Ca_A	%w/w Ca	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-Ca_A	moles H^+/t	5	INORG-064	[NT]	192807-1	<5 || <5	[NR]	[NR]
s-Ca_A	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
Mg_A	%w/w Mg	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-Mg_A	moles H^+/t	5	INORG-064	[NT]	192807-1	<5.0 || <5.0	[NR]	[NR]
s-Mg_A	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
ANC_E	% $CaCO_3$	0.01	INORG-064	[NT]	192807-1	<0.01 || <0.01	[NR]	[NR]
s-ANC_E	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
Fineness Factor			INORG-064	[NT]	192807-1	1 || 1 || RPD: 0	[NR]	[NR]

QUALITY CONTROL sPOCAS	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
SNAS	%w/w S	0.005	INORG-064	[NT]	192807-1	<0.005 || <0.005	[NR]	[NR]
a-SNAS	moles H^+/t	5	INORG-064	[NT]	192807-1	<5 || <5	[NR]	[NR]
s-SNAS	%w/w S	0.01	INORG-064	[NT]	192807-1	<0.01 || <0.01	[NR]	[NR]
s-Net Acidity	%w/w S	0.01	INORG-064	[NT]	192807-1	0.032 || 0.038 || RPD: 17	[NR]	[NR]
a-Net Acidity	moles H^+/t	5	INORG-064	[NT]	192807-1	20 || 24 || RPD: 18	[NR]	[NR]
Liming rate	kg $CaCO_3$/t	0.75	INORG-064	[NT]	192807-1	1.5 || 1.8 || RPD: 18	[NR]	[NR]
Net Acidity (WA)	%w/w S	0.01	INORG-064	[NT]	192807-1	0.032 || 0.038 || RPD: 17	[NR]	[NR]
a-Net Acidity without ANCE	moles H^+/t	5	INORG-064	[NT]	192807-1	20 || 24 || RPD: 18	[NR]	[NR]
Liming rate without ANCE	kg $CaCO_3$/t	0.75	INORG-064	[NT]	192807-1	1.5 || 1.8 || RPD: 18	[NR]	[NR]

Report Comments:

Asbestos Signatories:

Asbestos was analysed by Approved Identifier: Not applicable for this job
Airborne fibres were analysed by Approved Counter: Not applicable for this job

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

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.

Stacey Hawkins

From: Michael Brooker <Michael.Brooker@douglaspartners.com.au>
Sent: Thursday, 2 March 2017 3:51 PM
To: Stacey Hawkins
Cc: Rob Shapland
Subject: RE: PRELIM Results for Registration 192671 88862.00
Attachments: 192671-[R00].pdf; 192671-COC.PDF; 88862.00.M.001.Rev0.PO for SPOCAS testing.pdf

Hi Stacey,

Can you please conduct SPOCAS testing on the following samples:

- TP01 – 2.5 m, (5)
- TP03 – 1.0 m, (11)
- TP07 – 1.5 m, (14)
- TP109 – 2.5 m. (21)

mpl Laboratories ENVIROLAB GROUP
Job No.- 192807
Date Rec - 2.3.17
Time Rec - 15:51
Rec By - St
TAT Req - SAME 1 / 2 / 3 / STD
Temp - cool / ambient
Cooling - Ice / Ice pack / None
Security Seal - Yes / No

Please find a COC for this testing attached,

Cheers,
Michael

Michael Brooker | Environmental Scientist
Douglas Partners Pty Ltd | ABN 75 053 980 117 | www.douglaspartners.com.au
36 O'Malley Street Osborne Park WA 6017
P: 08 9204 3511 | F: 08 9204 3522 | E: Michael.Brooker@douglaspartners.com.au

From: Stacey Hawkins [mailto:shawkins@mpl.com.au]
Sent: Thursday, 2 March 2017 11:38 AM
To: Michael Brooker; Rob Shapland
Subject: PRELIM Results for Registration 192671 88862.00

Please refer to attached for:
a copy of the Interim Report
a copy of the COC/paperwork received from you
an Excel or .csv file containing the Interim results

Please note that a hard copy will not be posted.

Enquiries should be made directly to:

Joshua Lim on jlim@mpl.com.au
or
Tom Edwards on tedwards@mpl.com.au

ChemCentre
Inorganic Chemistry Section
Report of Examination

PO Box 1250, Bentley Delivery Centre
Bentley WA 6983
T +61 8 9422 9800
F +61 8 9422 9801
www.chemcentre.wa.gov.au
ABN 40 991 885 705

Purchase Order: 130101
Your Reference:
ChemCentre Reference: 16S2034 R0

Douglas Partners
36 O'Malley Street
Osborne Park WA 6017

Attention: Jawad Khandwalla

Final Report on 2 samples of soil received on 01/03/2017

LAB ID	Client ID and Description
16S2034 / 001	88862 TP1 0.5m
16S2034 / 002	88862 TP2 0.5m

Analyte		**P**
Method		PRI
Unit		mL/g
Lab ID	**Client ID**	
16S2034/001	88862 TP1 0.5m	7.8
16S2034/002	88862 TP2 0.5m	1.3

Analyte	Method	Description
P	PRI	Phosphorus Retention Index by method S15

The results apply only to samples as received. This report may only be reproduced in full.

Unless otherwise advised, the samples in this job will be disposed of after a holding period of 30 days from the report date shown below.

Phosphorus Retention Index (PRI) is a measure of the ability of soil to retain or leach applied phosphate.

PRI is defined as the ratio P ads : P eq where P ads is the amount of phosphorus adsorbed by soil (µg P/g soil) .

The phosphorus fixation properties of soil may be described by the following PRI values:

PRI

negative desorbing (P leaching)
0 - 2 weakly adsorbing
2 - 20 moderately adsorbing
20 - 100 strongly adsorbing
>100 very strongly adsorbing

B. Price

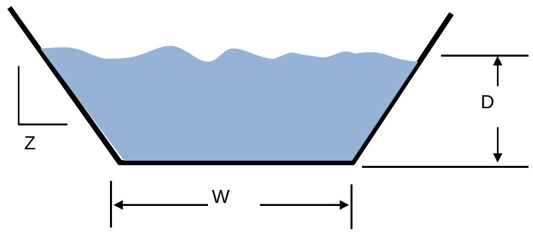
Barry Price
Team Leader
Scientific Services Division
9-Mar-2017

APPENDIX C
Southern Drain Capacity Calculation

25/01/2018

Mannings Calculator

Approx. Base Channel Width (w)	1.4	m
Depth of Water (D)	0.7	m
Mainstream Channel Grade (1 in x)	600.0	m
Side Slope (1 : z)	2.25	m
Mainstream Average Roughness (n)	0.035	
Area (A)	2.083	m^2
Hydraulic Radius (H)	0.430	m
Slope	0.002	m/m
Wettted Perimeter (P)	4.847	m



1.383	Flow (m^3/s)
0.664	Velocity (m/s)

Sensitivity Analysis

		Flow (m^3/s)	Change (%)
Depth (% variation to analyse)	20%		
Lower Bound	0.6	0.88	-37%
	0.7	1.38	0
Upper Bound	0.8	2.03	47%
Width (% variation to analyse)	20%		
Lower Bound	1.1	1.22	-12%
	1.4	1.38	0
Upper Bound	1.7	1.55	12%
Grade (% variation to analyse)	20%		
Lower Bound	480.0	1.55	12%
	600.0	1.38	0
Upper Bound	720.0	1.26	-9%
Manning's n (% variation to analyse)	20%		
Lower Bound	0.042	1.15	-17%
	0.035	1.38	0
Upper Bound	0.028	1.73	25%

Flow Rating Curve

Depth Increment (m) 0.07

Water Depth (m)	Area (m^2)	Perimter (m)	Radius (m)	Flow (m^2/s)
0.00	0.000	1.400	0.000	0.000
0.07	0.109	1.745	0.062	0.020
0.14	0.240	2.089	0.115	0.066
0.21	0.393	2.434	0.162	0.136
0.28	0.568	2.779	0.205	0.230
0.35	0.766	3.124	0.245	0.350
0.42	0.985	3.468	0.284	0.496
0.49	1.226	3.813	0.322	0.671
0.56	1.490	4.158	0.358	0.876
0.63	1.775	4.502	0.394	1.113
0.70	2.083	4.847	0.430	1.383

APPENDIX D
Water Corporation Advice on Sewer

suzanne@hyd2o.com.au

From:	Brett Coombes <Brett.Coombes@watercorporation.com.au>
Sent:	Wednesday, November 29, 2017 3:43 PM
To:	Shane Highman
Subject:	Lots 2 and 4 Kargotich Rd, Oakford

Hi Shane,

Thanks for your query through our on-line portal.

I see on our system that Kevin Purcher provided comments to you regarding the likely servicing of this site in March this year. The issues and the advice remain the same.

The Water Corporation is prepared to accept the additional land gravitating into the Jersey Road Pump Station as the flows from 42 lots appear to be small (<1l/s). I have not reviewed the detail on your draft catchment plan. As previously advised, it appears that the flows from the part of the site shown on your draft plan (dependent on final levels and pipe grades) could be gravitated into the existing Jersey Road Pump Station catchment to the east, provided that the required fill, pipe grades and cover comply with Water Corporation specifications. Some other factors such as the Council's requirements for fill for local drainage purposes, as well as their acceptance of raised building pads vs whole site fill, may alter the final catchment layout.

Water and wastewater planning will be formally revised when the land is rezoned for the intended land use.

Regards

Brett Coombes
Senior Planner, Land Planning
Assets Planning Group
Water Corporation
T: (08) 9420-3165
629 Newcastle Street, Leederville, WA 6007
www.watercorporation.com.au

PROJECT:

LOT 20 KARGOTICH ROAD OAKFORD

No.	DATE	REVISION	BY
A	26-4-2019	ISSUED FOR APPROVAL	MEG

Porter Consulting Engineers

Level 2 Kishorn Court
58 Kishorn Road
Mt Pleasant 6153 WA

PO Box 1036
Canning Bridge 6153 WA

Tel (08) 9315 9955
Email office@portereng.com.au
www.portereng.com.au

TUSNO Pty Ltd ACN 070 097 148 as trustee for the Consulting Engineering Unit Trust trading as Porter Consulting Engineers ABN 78 636 396 385

CLIENT:

GOLDLIGHT ASSET PTY LTD

DRAWING:

WASTEWATER, DRAINAGE AND FILLING STRATEGY PLAN

STATUS: **FOR APPROVAL**

SCALE	1:1000	DRAWING No.	17-2-15/800
DATE	APR 2019	REV No.	A
DESIGN	SCH	ORIGINAL DRAWING SIZE	A1
DRAWN	MEG	FILE NAME	S:\ACTIVE PROJECTS\17-02-015\ACAD\17215-800.dwg
CHECK		APP'D	

APPENDIX F

Heritage Listing

Bateman Homestead

AUTHOR **Shire of Serpentine-Jarrahdale** **PLACE NUMBER** **08479**

LOCATION

Cnr Kargotich & Thomas Rds Byford

LOCATION DETAILS

LOCAL GOVERNMENT Serpentine-Jarrahdale **REGION** Peel

CONSTRUCTION DATE

Constructed from 1894

DEMOLITION YEAR N/A

Statutory Heritage Listings

TYPE	STATUS	DATE	DOCUMENTS
(no listings)			

Other Heritage Listings and Surveys

TYPE	STATUS	DATE	GRADING/MANAGEMENT CATEGORY
Municipal Inventory	Adopted	31 Jul 2000	Category 2

Statement of Significance

Bateman Homestead has historic and social significance as one of the earlier homesteads built in the Byford district by the well-known Bateman family.

Physical Description

Large homestead set in from the roads. The homestead has been renovated but keeps the original structure and lines.

History

Originally part of a much larger estate of 5300 acres purchased by one of the early settlers to the district, Samuel Bateman, in the early 1890's. Bateman was a keen racehorse enthusiast and constructed a racecourse on the property and held picnic races there. Low lying country now used as a hobby farm.

Creation Date 16 Jun 1997 **Last Update** 01 Jan 2017 **Publish place record online (inHerit):** Approved

Disclaimer

APPENDIX G

Bushfire Management Plan

Prepared by Lush Fire Consulting

Bushfire Management Plan
(Subdivision)

Lot 2 Thomas Road & Lot 4 Kargotich Road

Oakford

LUSH FIRE & PLANNING
3 Paterson Rd
Pinjarra WA 6208
0418 954 873
ABN 74 232 678 543

BPAD
Bushfire Planning & Design
Accredited Practitioner
Level 2

Ref 16-076
Ver E
August 2019

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 2 Thomas Road & Lot 4 Kargotich Road				
Suburb:	Oakford	**State:**	WA	**P/code:**	6235
Local government area:	Serpentine Jarrahdale				
Description of the planning proposal:	Rural residential subdivision				
BMP Plan / Reference Number:	16-076	**Version:**	E	**Date of Issue:**	6/08/2019
Client / Business Name:	Goldlight Asset Pty Ltd				

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☒	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development 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.)?

Local structure plan and subdivision

Note: The decision maker (e.g. the 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
Geoffrey Lush	Level 2	BPAD 27682	28/02/2020
Company		**Contact No.**	
Lush Fire & Planning		0418 954 873	

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

Geoffrey Lush

Signature of Practitioner

Date 6/08/2019

This bushfire management plan has been prepared for the proposed rezoning and subdivision of Lot 2 Thomas Road; and Lot 4 Kargotich Road Oakford; Shire of Serpentine Jarrahdale. It defines the responsibilities of relevant stakeholders and the measures required to manage the potential likelihood of fires starting on the proposed lots or the adjoining land.

The subject land has an area of approximately 48 hectares and historically been used for broad acre grazing. There are three existing dwellings and associated outbuildings on the property. A high voltage transmission line bisects the property in a north south direction. The site is flat and has been largely cleared of vegetation with some scattered single trees, windbreaks and some small groups of trees remaining.

It is proposed to rezone the subject land in order to subdivide into 64 rural residential lots with a range of lot sizes being:

- 50 lots between 0.4 and 1.0 hectares in size; and
- 14 lots between 1.0 and 3.0 hectares in size.

The subject land generally has a moderate bushfire hazard rating which reflects the unmanaged grassland on the property. The primary bushland vegetation is around the perimeter of the site being the adjacent road reserves and existing rural residential properties on the boundaries.

The principal objective of SPP3.7 Planning in Bushfire Prone Areas is for land to have a moderate bushfire hazard level rating or a maximum BAL-29 rating when it is developed. The proposed mitigation measures give appropriate regard to the objectives, general principles, guidance statements and performance criteria contained in the Guidelines for Planning in Bushfire Prone Areas and specifically the Bushfire Protection Criteria.

The subject land is located within a bushfire prone area where bushfires occur on a regular basis. Any bushfire can pose a risk to life and property. The proposed development is introducing substantial values (property and people) which must be protected from the risk posed by the potential bushfire hazard.

The management of the risk posed by bushfires is a shared responsibility between landowners, government and industry. While state and local government undertakes bushfire prevention measures (e.g. planned burning), land use planning and emergency response (fire suppression); land owners in bushfire prone areas must take the necessary steps to prepare their property.

The proposed development complies with the objectives of SPP3.7 Planning in Bushfire Prone Areas and the Bushfire Protection Criteria subject to the following requirements:

1. That dwellings be located so as to have a maximum BAL-29 rating.
2. That any application for a building permit for a dwelling is to include an individual BAL assessment to confirm that sufficient land has been cleared to provide for BAL-29 setbacks.
3. That the vegetation within the BAL setback is to be maintained as an asset protection zone / low threat vegetation/low fuel zone as defined in Clause 2.2.3.2 of AS3959.
4. That any new dwelling is to provide a 20m asset protection zone in accordance with Council's firebreak notice.
5. Construct the public roads and cul-de-sac to the standards stated in Table 6 of the Bushfire Protection Criteria.
6. Provision of a temporary turnaround area with a diameter of 17.5m as shown.
7. On the lots shown as "managed land" over all of the lot all grasses and flammable materials are to be maintained below 25mm in height by mowing or slashing or other means.

8. On the lots shown providing and maintaining a 3m wide boundary firebreak with all overhanging branches, trees and limbs trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area.
9. Any new driveway more than 50m in length shall have a minimum 4m wide trafficable surface and any access gate shall be a minimum width of 3.6m.
10. Where a driveway is more than 50m in length a turnaround area suitable to a fire appliance shall be provided within proximity to the dwelling.
11. That the landowners undertake regular maintenance of their property in preparation for the annual fire season.
12. That all fire mitigation measures shall be completed by the date prescribed in Council's Firebreak Notice.
13. In the event of any staging of the subdivision a plan and statement of the proposed interim fire management measures will be submitted and approved by the Shire.
14. A notification be included on the certificate of titles advising that the land is subject to a Bushfire Management Plan.
15. That prospective residents be provided with a summary of this Bushfire Management Plan.

Document Reference

Property Details

Street No	Lot No's	Plan	Street Name		
	2 4	63571 64846	Thomas Road Kargotich Road		
Locality	Oakford		State WA	Postcode	6235
Local Government Area	Serpentine Jarrahdale				
Description of the building or works	Rural residential subdivision 64 lots				

Report Details

Revision	Date	Job No 17-076
A	13/12/2017	Draft for Review
B	18/12/2017	Final
C	07/02/2019	Revised subdivision design
D	11/02/2019	Client comments
E	06/08/2019	Revised subdivision design

Practitioner Details

BPAD	Level 2 Practitioner	Accreditation No	27682

Disclaimer

The measures contained in this report do not guarantee that a building will not be damaged in a bushfire. The ultimate level of protection will be dependent upon the design and construction of the dwelling and the level of fire preparedness and maintenance under taken by the landowner. The severity of a bushfire will depend upon the vegetation fuel loadings; the prevailing weather conditions and the implementation of appropriate fire management measures.

Geoffrey Lush
6 August 2019
geoffrey@lushfire.com.au

BPAD
Bushfire
Planning & Design
Accredited Practitioner
Level 2

LUSHfire
and planning

CONTENTS

FIGURES

TABLES

1.0 PROPOSAL DETAILS

1.1 Introduction

This bushfire management plan is prepared to support the proposed rezoning and subdivision of Lot 2 Thomas Road; and Lot 4 Kargotich Road Oakford.

This report has been prepared to demonstrate that the design of proposed subdivision has given appropriate regard to:

- State Planning Policy 3.7 Planning in Bushfire Prone Areas; and
- Guidelines for Planning in Bushfire Prone Areas (2015)

The aim of this Report is to reduce the threat to the residents in the proposed subdivision in the event of a bushfire within or adjacent to the development. It defines the responsibilities of relevant stakeholders and the measures required to manage the potential likelihood of fires starting on the proposed lots or the adjoining land.

1.2 Existing Conditions

The subject land is located approximately 4kms north west of the Byford town centre as shown in Figure 1. It is situated on the south eastern corner of Thomas and Kargotich Roads, with a frontage of 1020m to Thomas Road and a depth of 460m along Kargotich Road.

The details of the land are documented in Table 1 and the existing conditions are shown in Figure 2.

The subject land contains three dwellings with associated outbuildings and farm infrastructure. Both properties have been developed for broad acre farming/grazing and this includes the development of boundary windbreaks.

The subject land and surrounding area is generally flat with an elevation of 25m AHD. A small ridge is located centrally within the site where two of the dwellings are located.

An open drain is located on southern boundary of the site. A 330KV transmission line and 60m wide easement traverse the western portion of the site.

The land to the east of the site has been developed for special residential purposes with lots generally being 0.4 - 0.5ha in size. The land to the south east along Byford Meadows Drive has been developed for rural residential purposes with lots sizes generally being 2 hectares. Lot 207 immediately south of the subject land is a farming property which is subject to Amendment No 201 which proposes to include the land in a Special Rural zone.

The land to the west of the site is broad acre farming land which is generally being used for grazing. To the north of Thomas Road there is a mixture of rural land and rural residential development.

Table 1 Land Details

Lot	Diagram	Volume	Certificate	Owner	Area
2	63571	1645	575	Tuscanny Management Pty Ltd	35.175ha
4	64846	1644	900	Asterdell Corporation Pty Ltd	13.498ha
					48.673ha

FIGURE 1
LOCATION AND CONTEXT

SUBJECT LAND

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

LEGEND

SUBJECT LAND		EXISTING DWELLING		DRAIN	
ASSESSMENT AREA (150m from site boundary)		DRIVEWAY		DRAINAGE BASIN	
		TRANSMISSION LINE		MULTIPLE USE TRAIL	
		DAM/SOAK			

FIGURE 2
EXISTING CONDITIONS

Job No 16 - 076
Rev A
Description Preliminary
Date 23/11/2017

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

Access to Lot 2 is from Thomas Road which is a major regional road. Secondary access is also available from Jersey Road on the western boundary. Byford Meadows Drive extends to the southern boundary but does not provide access across the open drain.

Access to Lot 4 is from Kargotich Road which is local distributor road.

1.3 Bushfire Prone Land

All of the subject land and the surrounding is shown on the Map of Bush Fire Prone Areas as being bushfire prone (Figure 3). Bushfire prone areas are comprised of (1):

- Bushfire prone vegetation; and
- A 100m wide bushfire prone buffer.

The designation of bushfire prone areas triggers:

- The application of Australian Standard AS3959 Construction of Buildings in Bushfire Prone Areas under the Building Code of Australia;
- The provisions of the Planning and Development (Local Planning Schemes) Amendment Regulations 2015; and
- The application of SPP3.7 Planning in Bushfire Prone Areas.

1.4 Firebreak Notice

Council's Firebreak Notice and Fuel Hazard Reduction Notice 2018 - 2019 requires that:

1. All land 4047m^2 (one acre) or less
   - Cut all grass to less than 25mm in height.
   - Trim all trees and bushes that overhang driveways, access ways and firebreaks to leave a 4 metre wide clearance and a clear vertical axis.

   OR

   Install firebreaks that are:
   - Immediately inside all external boundaries.
   - Immediately surrounding all agricultural buildings, sheds or group of buildings.
   - A minimum of 3 metres wide, but not wider than 5 metres.
   - Trim all trees and bushes that overhang driveways, access ways and firebreaks to leave a 4 metre wide clearance and a clear vertical axis.

   Dwellings are to:
   - Maintain 20m asset protection zones or as per an approved BAL/FMP assessment.
   - Trim back all trees overhanging buildings.

2. All land greater than 4047m^2 (one acre)
   - Keep grasses short.
   - Trim all trees and bushes that overhang driveways, access ways and firebreaks to leave a 4 metre wide clearance and a clear vertical axis.
   - Install firebreaks that are:
     - Immediately inside all external boundaries.
     - Immediately surrounding all agricultural buildings, sheds or group of buildings.

1 DFES (2015) Mapping Standard for Bush Fore Prone Areas.

- A minimum of 3 metres wide, but not wider than 5 metres.

Dwellings are to:

- Maintain 20m asset protection zones or as per an approved BAL/FMP assessment.
- Trim back all trees overhanging buildings.

Compliance with the general provisions of the Firebreak Order is required on or before 30th November and maintained up to and including the 31st May each and every year. Compliance with an approved bushfire management plan is required all year.

1.5 Proposed Development

It is proposed to rezone the subject land in order to subdivide into 64 rural residential lots with a range of lot sizes. The subdivision concept plan is shown in Figure 4 and there are:

- 50 lots between 0.4 and 1.0 hectares in size; and
- 14 lots between 1.0 and 3.0 hectares in size.

The minimum lot size is 0.4ha and the maximum lot size is 1.96ha with the average lot size being 0.6366ha.

All lots will be serviced with reticulated water.

The subdivision has been designed so that the existing dwellings can be retained.

The primary access will be from Kargotich Road on the western boundary with secondary access from Jersey Road on the eastern boundary and Byford Meadows Drive. A additional connection will be created through Lot 207 to the south of the site. This will then connect into Kargotich Road via the proposed subdivision of Lot 207. There is no direct access to Thomas Road as a 20m road widening will be provided along this frontage.

A 10m wide multiple use trail will be provided along the southern boundary.

FIGURE 3
BUSHFIRE PRONE LAND

SUBJECT LAND

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017

LUSHfire and planning

geoffrey@lushfire.com.au
0418 954873

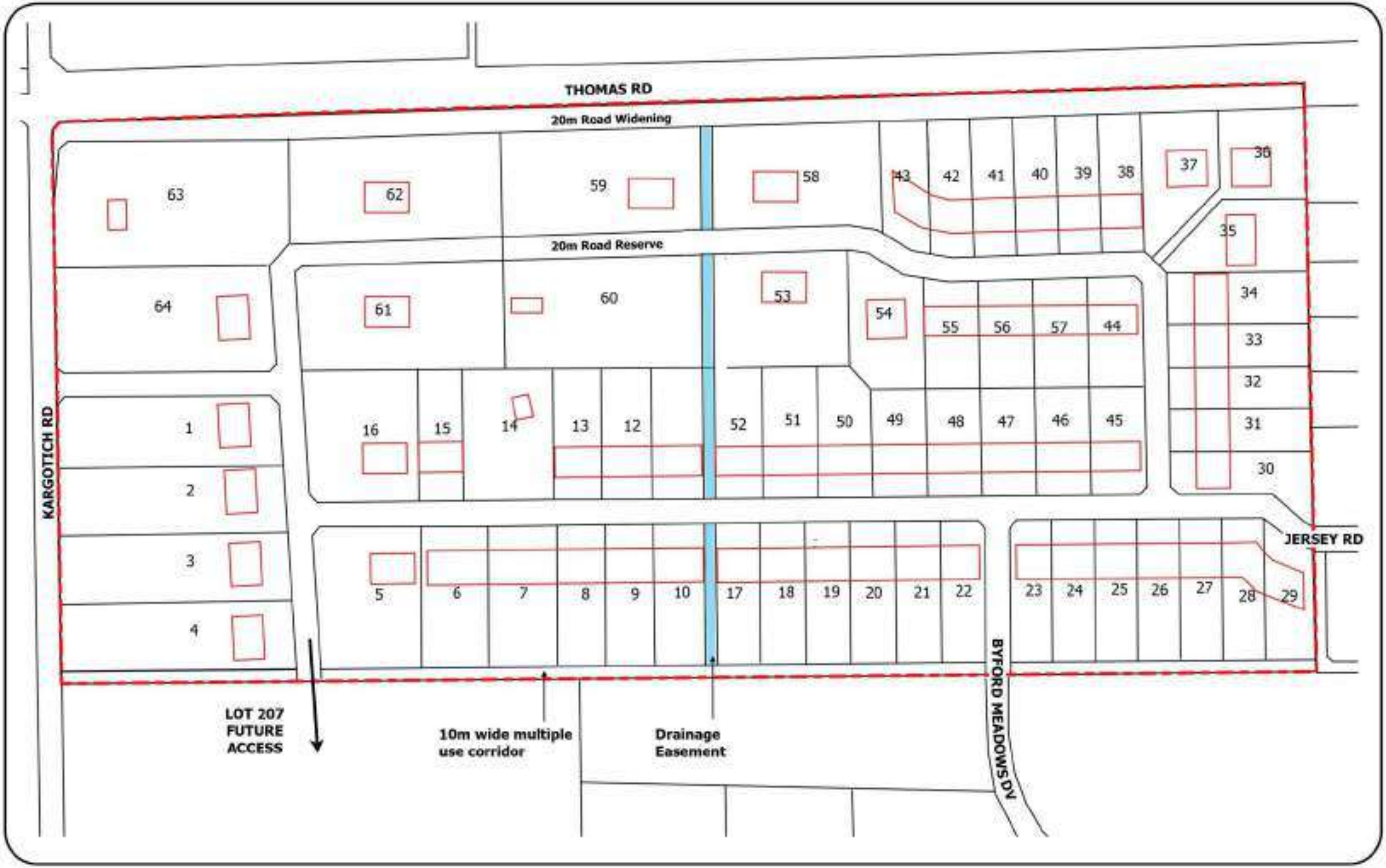


FIGURE 4
PROPOSED SUBDIVISION

BUILDING ENVELOPE

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Subdivision	27/01/2019
C	Rev Design	05/08/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

2.0 ENVIRONMENTAL CONSIDERATIONS

2.1 Native Vegetation Modification and Clearing

The potential clearing of the existing vegetation primarily relates to the existing windbreaks which predominantly contain non local native species. The clearing is likely to be where required for:

- The construction of the subdivision roads;
- Boundary fences and/or firebreaks; or
- The location of the building envelope and any associated asset protection zone.

2.2 Re-vegetation / Landscape Plans

There are no relevant re-vegetation or landscape plans.

Both the potential areas to be cleared and those which may be revegetated are shown in Figure 5.

FIGURE 5

VEGETATION CLEARING & REVEGETATION

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Subdivision	27/01/2019
C	Rev Design	05/08/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

3.0 BUSHFIRE ASSESSMENT RESULTS

3.1 Assessment Inputs

3.1.1 Vegetation Classifications

The classification of the vegetation on and adjacent to the site is shown in Figure 6 and photographs on the following pages.

The classification is based upon AS3959 and also takes into account The Visual Guide for Bushfire Risk Assessment in Western Australia (WAPC 2016) and Fire Protection Australia practice notes. The details of the vegetation plots are summarised in Table 1 below.

Table 2 Vegetation Classification

Plot No	Photo No	Classification	Effective Slope	Comment
1	1 & 2	Forest	Flat	Non-homogeneous vegetation predominantly Sheoaks.
2	3	Woodland	Flat	Sheoaks over pasture
3	4 & 5	Forest	Flat	Multiple rows of Eucalypts.
4	6	Forest	Flat	Sheoaks on road verge.
5	7 & 8	Exempt	Flat	Windbreak single line of trees (1)
6	9	Grassland	Flat	Grazing pasture
7	10	Woodland	Flat	Introduced tall Eucalypts
8	11 & 12	Forest	Flat	Multiple rows of Eucalypts.
9	13	Managed Land	Flat	Existing residential development
10	14 & 15	Scrub	Flat	Drainage basin
11	16 & 17	Grassland	Flat	Pasture on adjacent land.
12	18	Grassland	Flat	Open Woodland
(1) AS3959 (2018) defines a windbreak as low threat vegetation being a single row of planted trees located on a boundary and used as a screen or to reduce the effect of wind on the leeward side of the trees.				

LEGEND

SUBJECT LAND	
ASSESSMENT AREA (150m from site boundary)	
PHOTO POINT	12

VEGETATION CLASS

- A FOREST
- B WOODLAND
- D SCRUB
- G GRASSLAND

LOW THREAT VEGETATION

- MANAGED LAND 2.2.3.2(e) & (f)
- WINDBREAKS 2.2.3.2(f)

Location Details:	Lot 2 Thomas Rd Lot 4 Kargotich Rd
Assessment Date:	10/03/2017
Prepared by:	G Lush
Accreditation Level:	Level 2
Accreditation Number:	BPAD 27682
Accreditation Expiry Date:	February 2020
Date of Aerial Photo:	Feb 2017

FIGURE 6
VEGETATION CLASSIFICATIONS

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Design	30/01/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

Photo No 1 **Plot No 1**

Vegetation Classification

Class A Forest - Low open forest A-04

Description

Non-homogeneous vegetation in adjacent road reserve and rural residential lots. Predominantly Sheoak being less than 10m in height with some Gums, Acacia scrub, and Melaleuca. Typically has grass understorey with some shrubs and moderate to high surface fuel loads greater than 15 tph.

Photo No 2 **Plot No 1**

Vegetation Classification

Class A Forest - Low open forest A-04

Description

Non-homogeneous vegetation in adjacent road reserve and rural residential lots. Predominantly Sheoak being less than 10m in height with some Gums, Acacia scrub, and Melaleuca. Typically has grass understorey with some shrubs and moderate to high surface fuel loads greater than 15 tph.

Photo No 3 **Plot No 2**

Vegetation Classification

Class B Woodland - Low woodland B-07

Description

Sheoak woodland to 10m in height, less than 30% foliage coverage with grassland/pasture understorey. Parkland cleared with low surface fuel loads. Lower branches have been grazed/pruned.

Photo No 4 **Plot No 3**

Vegetation Classification

Class A Forest - Low open forest A-04

Description

Double row of Eucalypts to 10m height. Does not constitute a windbreak. Foliage coverage greater than 50% with understorey comprising of unmanaged grassland with moderate fuel loads.

Photo No 5 **Plot No 3**

Vegetation Classification

Class A Forest - Low open forest A-04

Description

Double row of Eucalypts to 10m height. Does not constitute a windbreak. Foliage coverage greater than 50% with understorey comprising of unmanaged grassland with moderate fuel loads.

Photo No 6 **Plot No 4**

Vegetation Classification

Class A Forest - Low open forest A-04

Description

Predominantly Sheoak being less than 10m in height along roadside. Typically has grass understorey with moderate to high surface fuel loads greater than 15 tph.

Photo No 7 **Plot No 5**

Vegetation Classification

Excludable - 2.2.3.2(f) Low Threat Vegetation

Description

Windbreak being a single line of trees of introduced Eucalypts. Grassland/pasture underneath with low to moderate fuel loads.

Photo No 8 **Plot No 5**

Vegetation Classification

Excludable - 2.2.3.2(f) Low Threat Vegetation

Description

Windbreak being a single line of trees of introduced Eucalypts. Grassland/pasture underneath with low to moderate fuel loads.

Photo No 9 **Plot No 6**

Vegetation Classification

Class G Grassland – Sown pasture G-26

Description

Intensely grazed paddock.

Photo No 10 **Plot No 7**

Vegetation Classification

Class B Woodland - Woodland B-05

Description

Eucalypt Woodland being wider than a windbreak. Introduced Eucalypts to 35m in height with foliage coverage which is potentially more than 30% but surface fuel loads are less than 15 tph.

Photo No 11 **Plot No 8**

Vegetation Classification

Class A Forest - Open forest A-03

Description

Copse of Eucalypts approximately 0.3ha and greater than 10m in height. Grazed understorey with some dead material and moderate surface fuel loads.

Photo No 12 **Plot No 8**

Vegetation Classification

Class A Forest - Low open forest A-04

Description

Multi row planting of Eucalypts greater than 10m in height. Little understorey but more continuous fuel layers with moderate surface fuel loads

Photo No 13 **Plot No 9**

Vegetation Classification

Excludable - 2.2.3.2(f) Low Threat Vegetation

Description

Managed subdivided land in Jersey Road.

Photo No 14 **Plot No 10**

Vegetation Classification

Class D Scrub - Closed scrub D-13

Description

Drainage basin with mixed vegetation but predominantly scrub less than 4m in height with shrub understorey.

Photo No 15 **Plot No 10**

Vegetation Classification

Class D Scrub - Closed scrub D-13

Description

Multiple use path adjacent to the drainage basin extending east from the southern property boundary.

Photo No 16 **Plot No 11**

Vegetation Classification

Class G Grassland – Sown pasture
G-26

Description

Pasture/unmanaged grassland on the adjoining land to the south.

Photo No 17 **Plot No 11**

Vegetation Classification

Class G Grassland – Sown pasture
G-26

Description

Grazed pasture on adjoining land on the western side of Kargotich Road.

Photo No 18 **Plot No 12**

Vegetation Classification

Class B Woodland - Open woodland
B-06

Description

Sheoak woodland to approximately 10m in height with sparse low foliage coverage and grazed pasture. As Open Woodland it I s classified on the basis of the understorey vegetation which is Class G Grassland.

3.2 Assessment Outputs

3.2.1 Bushfire Hazard Level Assessment

A Bushfire Hazard Level assessment provides a 'broadbrush' means of determining the potential intensity of a bushfire for a particular area.

The bush fire hazard primarily relates to the vegetation on the undeveloped site, the type and extent (area) of vegetation and its characteristics. The methodology for determining the bushfire hazard level is contained in the Guidelines for Planning in Bushfire Prone Areas (Section 4.1 and Appendix 2).

This classifies vegetation based on tree height and the percentage of canopy cover and the characteristics of the different hazard categories (2) are:-

Extreme Hazard	• Class A Forest • Class B Woodland (05) • Class D Scrub • Any classified vegetation with a greater than 10 degree slope
Moderate Hazard	• Class B Open Woodland (06), Low Woodland (07) Low Open Woodland (08) Open Shrubland (09) * • Class C Shrubland • Class E Mallee/Mulga • Class G Grassland including sown pasture and crops • Vegetation that has a low hazard level but is within 100 metres of vegetation of vegetation classified as a moderate or extreme hazard.
Low Hazard	• Low threat vegetation, may include the following: areas of maintained lawns, gold courses, public recreation reserves and parklands, vineyards, orchards; cultivated gardens, commercial nurseries, nature strips and windbreaks. • Managed grassland in a minimal fuel condition meaning that there is insufficient fuel available to significantly increase the severity of the bushfire attack, for example short cropped grass to a nominal height of 100mm. • Non vegetated areas including waterways; roads; footpaths; buildings or rock outcrops.

* *As per AS3959 Table 2.3 Note 2 - Overstoreys of open woodland, low open woodland, tall open shrubland should be classified to the vegetation type on the basis of their understoreys; others to be classified on the basis of their overstoreys.*

The bushfire hazard levels for the subject land are shown in Figure 7. The bulk of the land has a moderate hazard rating associated with the existing pasture areas. The existing bushland vegetation has an extreme hazard rating.

2 WAPC (2015) Guidelines for Planning in Bushfire Prone Areas - Proposed modification to Appendix 2

LEGEND

SUBJECT LAND

ASSESSMENT AREA
(150m from site boundary)

HAZARD LEVEL

EXTREME

MODERATE

LOW

Location Details:	Lot 2 Thomas Rd Lot 4 Kargotich Rd
Assessment Date:	10/03/2017
Prepared by:	G Lush
Accreditation Level:	Level 2
Accreditation Number:	BPAD 27682
Accreditation Expiry Date:	February 2020
Date of Aerial Photo:	Feb 2017

FIGURE 7
BUSHFIRE HAZARD LEVELS

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Design	30/01/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

3.2.2 BAL Contour Map

A BAL Contour Map is shown in Figure 8 and the BAL ratings for the proposed lots/building envelopes are shown in Table 3.

A BAL Contour Map is a plan of the subject lot/s illustrating the potential radiant heat impacts and associated indicative BAL ratings in reference to any classified vegetation remaining within 150 metres of the assessment area after the development is completed.

The assumptions for the preparation of the BAL Contour Map are:

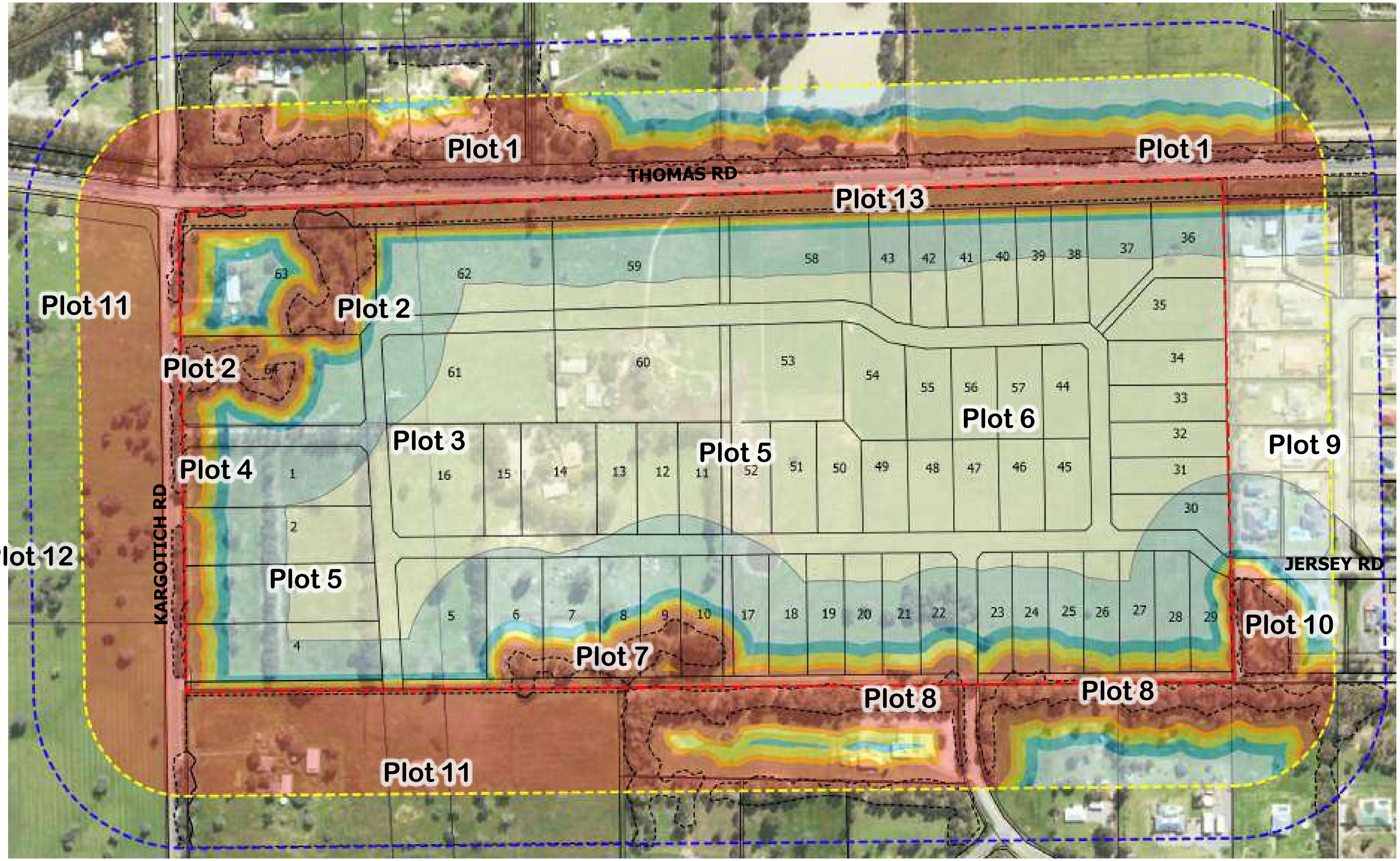
a) The BAL contours have been prepared for all classified vegetation types except Grassland on the subject land. The pasture areas in the adjoining properties have been classified as 'grassland' as the applicant does not have any control over these areas;
b) That the vegetation clearing and revegetation as shown in Figure 5 will occur.
c) Vegetation Plot No 3 will traverse multiple boundaries and can be expected to be modified as part of the development of the subdivision such that it becomes Low Threat Vegetation;
d) Vegetation Plot No 8 will be reduced in size to allow for a building envelope and will be less than 2500sqm and hence excluded vegetation (2.2.3.2(c);
e) Vegetation Plot No 13 is the 20m road widening along Thomas Road which is likely to be left as unmanaged grassland.

The grassland vegetation within the site has been classified and/or noted above that it is to be managed on a low fuel state on the smaller lots. On the larger lots the BASL Contour Map has not included any potential areas of Grassland. This is to allow for meaningful information to be shown on the contour map. Inclusion of the Grassland areas would result in a large portion of the site being mapped as BAL-FZ with a single colour. Grassland and especially pasture is not normally native vegetation. It can be easily managed to a low bushfire threat state and does not require approval for its removal.

A BAL - 29 rating and required asset protection zone for Grassland with a flat slope only requires a setback of 8m from the dwelling.

For the purpose of the BAL Assessments indicative building envelopes have been used. It is noted that the BAL ratings documented in Table 3 apply to the nearest point of the designated building envelope. In many instances where the dwelling is located in other portions of the building envelope a lower BAL rating will apply.

The BAL Contour Map and Table 3 confirm that all of the proposed lots have sufficient areas with a BAL-29 or lower rating.



LEGEND

SUBJECT LAND	red dashed line	MODIFIED VEGETATION PLOT	black dashed line
VEGETATION ASSESSMENT AREA (150m from site boundary)	blue dashed line	BUILDING ENVELOPES	red box
BAL CONTOUR ASSESSMENT AREA (100m from site boundary)	yellow dashed line		

INDICATIVE BUSHFIRE ATTACK LEVELS

BAL - FZ	BAL - 19
BAL - 40	BAL - 12.5
BAL - 29	BAL - Low

Location Details:	Lot 2 Thomas Rd Lot 4 Kargotich Rd
Assessment Date:	10/03/2017
Prepared by:	G Lush
Accreditation Level:	Level 2
Accreditation Number:	BPAD 27682
Accreditation Expiry Date:	February 2020
Date of Aerial Photo:	Feb 2017

FIGURE 8
BAL CONTOUR MAP

BPAD
Bushfire Planning & Design
Accredited Practitioner
Level 2

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Design	30/01/2019
C	Rev Design	05/08/2019

LUSHfire and planning

geoffrey@lushfire.com.au
0418 954873

Table 3 BAL Setbacks

Lot Number	Vegetation Plot (1)	Vegetation Classification	Effective Slope	Separation Distance (2)	BAL Rating
1	2	B Woodland	Flat	60m	BAL-12.5
2	4	A Forest	Flat	138m	BAL-Low
3	7	B Woodland	Flat	38m	BAL-12.5
4	11	G Grassland	Flat	31m	BAL-12.5
5	7	B Woodland	Flat	55m	BAL-12.5
6	7	B Woodland	Flat	40m	BAL-12.5
7	7	B Woodland	Flat	42m	BAL-12.5
8	7	B Woodland	Flat	28m	BAL-19
9	7	B Woodland	Flat	28m	BAL-29
10	7	B Woodland	Flat	28m	BAL-29
11	7	B Woodland	Flat	100m	BAL-Low
12	7	B Woodland	Flat	100m	BAL-Low
13	7	B Woodland	Flat	>100m	BAL-Low
14(3)	7	B Woodland	Flat	>100m	BAL-Low
15	7	B Woodland	Flat	>100m	BAL-Low
16	7	B Woodland	Flat	>100m	BAL-Low
17	8	A Forest	Flat	78m	BAL-12.5
18	8	A Forest	Flat	78m	BAL-12.5
19	8	A Forest	Flat	78m	BAL-12.5
20	8	A Forest	Flat	78m	BAL-12.5
21	8	A Forest	Flat	73m	BAL-12.5
22	8	A Forest	Flat	66m	BAL-12.5
23	8	A Forest	Flat	66m	BAL-12.5
24	8	A Forest	Flat	73m	BAL-12.5
25	8	A Forest	Flat	67m	BAL-12.5
26	8	A Forest	Flat	73m	BAL-12.5
27	8	A Forest	Flat	73m	BAL-12.5
28	8	A Forest	Flat	63m	BAL-12.5
29	10	D Scrub	Flat	13m	BAL-29
30	10	D Scrub	Flat	92	BAL-12.5
31	10	D Scrub	Flat	>100m	BAL-Low
32	10	D Scrub	Flat	>100m	BAL-Low
33	10	D Scrub	Flat	>100m	BAL-Low
34	10	D Scrub	Flat	>100m	BAL-Low
35	13	G Grassland	Flat	84m	BAL-Low
36	13	G Grassland	Flat	30m	BAL-Low
37	13	G Grassland	Flat	30m	BAL-Low
38	13	G Grassland	Flat	65m	BAL-Low
39	13	A Forest	Flat	103m	BAL-Low

Lot Number	Vegetation Plot (1)	Vegetation Classification	Effective Slope	Separation Distance (2)	BAL Rating
40	13	G Grassland	Flat	65m	BAL-Low
41	13	G Grassland	Flat	65m	BAL-Low
42	1	A Forest	Flat	100m	BAL-Low
43	1	A Forest	Flat	82m	BAL-12.5
44	1	A Forest	Flat	>100m	BAL-Low
45	8	A Forest	Flat	>100m	BAL-Low
46	8	A Forest	Flat	>100m	BAL-Low
47	8	A Forest	Flat	>100m	BAL-Low
48	8	A Forest	Flat	>100m	BAL-Low
49	8	A Forest	Flat	>100m	BAL-Low
50	8	A Forest	Flat	>100m	BAL-Low
51	8	A Forest	Flat	>100m	BAL-Low
52	8	A Forest	Flat	>100m	BAL-Low
53	1	A Forest	Flat	>100m	BAL-Low
54	1	A Forest	Flat	>100m	BAL-Low
55	1	A Forest	Flat	>100m	BAL-Low
56	1	A Forest	Flat	>100m	BAL-Low
57	1	A Forest	Flat	>100m	BAL-Low
58	1	A Forest	Flat	82m	BAL-12.5
59	1	A Forest	Flat	82m	BAL-12.5
60(3)	1	A Forest	Flat	>100m	BAL-Low
61	2	B Woodland	Flat	97m	BAL-12.5
62	1	A Forest	Flat	82m	BAL-12.5
63(3)	1	A Forest	Flat	22m	BAL-12.5
64	2	B Woodland	Flat	97m	BAL-12.5
Notes (1) (2) (3)	 The selected vegetation plot is the plot with the highest BAL rating. The separation distance is measured to the nearest point of the proposed building envelope. Existing dwelling - BAL rating / AS3959 construction standards don't apply.				

4.0 IDENTIFICATION OF BUSHFIRE HAZARD ISSUES

The local bushfire management issues and context are shown in Figure 9 while the district context is shown in Figure 1.

The subject land is situated on the north western corner of a partially developed precinct bounded by Abernethy, Hopkins, Thomas and Kargotich Roads. The primary site access is from Kargotich Road and the secondary access is from Jersey Road which extends 840m from Hopkins Road. Byford Meadow Drive extends approximately 1700m from Abernethy Road.

The local road network will be further enhanced and integrated with the development of Lot 207 on the western side of the precinct and south of the subject land. This land is subject to Amendment 201 which has been adopted by Council for final approval.

The local access is supplemented by the system of multiple use corridors which can also function as strategic fire breaks and Fire Service Access Routes.

The land in the eastern half of the site will be developed for residential lots generally being less than 0.5ha in size with a reticulated water supply. These are expected to be developed and maintained as low threat vegetation / managed land. The larger lots to the west will also have a reticulated water supply but can be expected to have some paddock areas with "grassland" vegetation.

The main classified vegetation is located around the boundaries of the site and generally consists of linear "windbreaks" and vegetation strips of various widths. Within the site there are some relatively small areas of woodlands which are parkland cleared with existing pasture.

The main fire threat is expected to be from the land to the west and south west as this is general farming land which will not be subdivided. While the locality is known for the strong "katabatic" easterly breezes winds coming off the escarpment, the land to the east of the site is predominantly urban residential land with a low bushfire hazard.

There are three identified bush fire threats which could impact upon the development of the subject land. These are:-

1. Fire originating from external sources;
2. Fire originating from within the property; and
3. Structural house fires.

In relation to the above types of fire:

a) Type 1 threats would be a fire originating in the adjoining bush, undeveloped farming land and the district road network;
b) Type 2 threats relate to the internal vegetation and how it is being managed. This is expected to be most likely a fast moving grassfire but with a relative short fire run.
c) Type 3 threats relate to structural fires. The provision of fire hydrants is the normal management measure and any response to a structural fire would come from the Fire and Rescue Service.

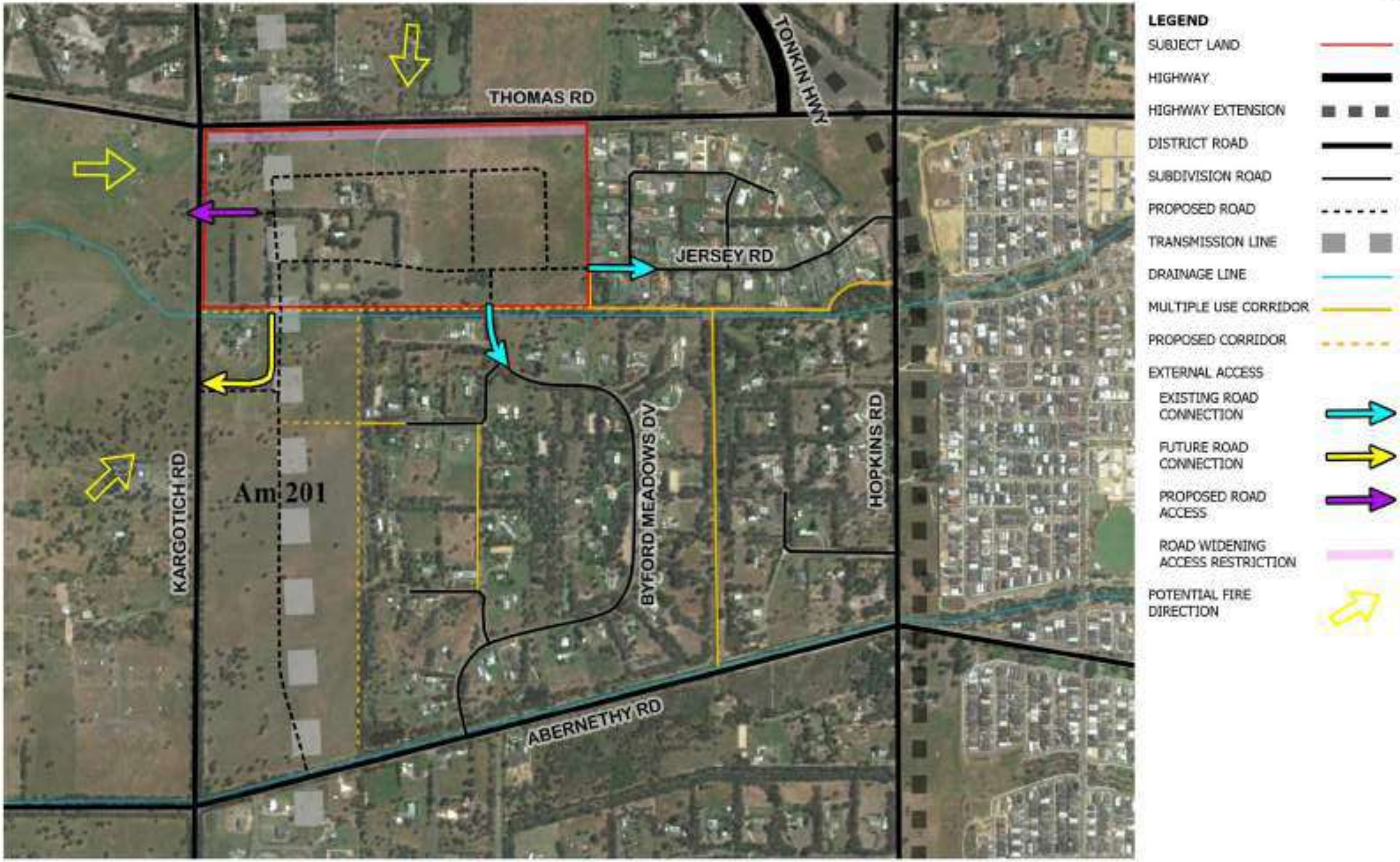


FIGURE 9
LOCAL HAZARD ISSUES

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Design	30/01/2019
C	Rev Design	05/08/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

5.0 ASSESSMENT AGAINST THE BUSHFIRE PROTECTION CRITERIA

5.1 Compliance Table

In formulating the proposed mitigation measures regard has been given to the objectives, general principles, guidance statements and performance criteria contained in the Guidelines for Planning in Bushfire Prone Areas and specifically the Bushfire Protection Criteria. The requirements in the Bushfire Protection Criteria and the proposed mitigation strategies are summarised in Table 4 and shown spatially in Figure 10.

Table 4 Bushfire Protection Criteria

Bushfire protection criteria	Method of Compliance Acceptable solutions / Performance based solution	Compliance	Proposed bushfire management strategies
Element 1: Location	A1.1 Development location	Yes	The developed land will have either a moderate or low bushfire hazard level with all development having a BAL-29 or lower rating. This is because the subject land is predominantly cleared pasture (grassland) with other hazard vegetation being located on the adjoining land.
Element 2: Siting and design	A2.1 Asset protection zone (APZ)	Yes	The 1 ha lots are all large enough to contain the APZ within their own boundaries. The smaller lots in the eastern portion of the site are generally narrow and the APZ may extend over lots boundaries. The APZs are to be the minimum distance required to achieve a BAL-29 rating, it is noted that Council's Firebreak Order requires a 20m APZ around all dwellings.
Element 3: Vehicular access	A3.1 Two access routes	Yes	The site currently will have multiple access routes being: • Kargotich Road to the west; • Jersey Road to the east for 850m and either north or south along Hopkinson Road; • Byford Meadows Drive to the south for 1.6kms and then either east or west along Abernethy Road; and • Through Lot 207 to the south, when that land is developed and either north or south along Kargotich Road.

<table>
<tr><th rowspan="2">Bushfire protection criteria</th><th>Method of Compliance</th><th rowspan="2">Compliance</th><th rowspan="2">Proposed bushfire management strategies</th></tr>
<tr><th>Acceptable solutions / Performance based solution</th></tr>
<tr><td></td><td>A3.2 Public road</td><td>Yes</td><td>The subdivision roads will have a 20m wide road reserve and be constructed in accordance with the standards stated in Table 6 of the Bushfire Protection Criteria as follows:
• A minimum trafficable surface of 6m;
• A horizontal clearance of 20m;
• Maximum grades <50 metres of 1 in 33;
• A minimum weight capacity of 15 tonnes;
• A maximum crossfall of 1 in 33; and
• Curves with a minimum inner radius of 8.5m</td></tr>
<tr><td></td><td>A3.3 Cul-de-sac (including a dead-end-road)</td><td>Yes</td><td>There is one proposed cul-de-sacs, which will be extended through the adjacent Lot 207 when that land is subdivided. It is 120m in length and provides access to two lots.</td></tr>
<tr><td></td><td>A3.4 Battle-axe</td><td>Yes</td><td>There is a single battle axe (Lot 36) which has a 45m access leg with a BAL - 12.5 rating.</td></tr>
<tr><td></td><td>A3.5 Private driveway longer than 50m is to meet detailed requirements contained within the Guidelines.</td><td>Yes</td><td>Driveways are unlikely to be more than 50m in length as the proposed building envelopes are setback 20m from the front boundary. If they are longer than 50m on the larger 1 hectare plus lots, then they must comply with provisions of Table 6 including:
• A minimum trafficable surface of 6m;
• A vehicle turn around area having a minimum diameter of 17.5m in proximity to the dwelling.</td></tr>
<tr><td></td><td>A3.6 Emergency access way (EAW)</td><td>Yes</td><td>Not applicable</td></tr>
<tr><td></td><td>A3.7 Fire service access routes (FSAR)</td><td>Yes</td><td>Not applicable</td></tr>
<tr><td></td><td>A3.8 Firebreak width</td><td>Yes</td><td>All lots larger than 0.4047ha (1 acre) will a 3m boundary firebreak in accordance with the Shire Firebreak Notice.</td></tr>
<tr><td>Element 4: Water</td><td>A4.1 Reticulated areas</td><td>Yes</td><td>All lots will have a reticulated water supply and hydrants.</td></tr>
<tr><td></td><td>A4.2 Non-reticulated areas</td><td>Yes</td><td>Not applicable</td></tr>
<tr><td></td><td>A4.3 Individual lots within non-reticulated areas.</td><td>Yes</td><td>Not applicable</td></tr>
</table>

LEGEND

SUBJECT LAND	SUBDIVISION ROAD	BAL - 29 SETBACK	TEMPORARY 17.5m DIAMETER TURNAROUND PENDING ROAD CONNECTION INTO LOT 2017
HAZARD VEGETATION	3m BOUNDARY FIREBREAK	EXISTING DWELLING	EXTERNAL ROAD CONNECTIONS
FOREST/WOODLAND/SCRUB	10m MULTIPLE USE CORRIDOR	INDICATIVE BUILDING ENVELOPES	
GRASSLAND		20m ASSET PROTECTION ZONE	

FIGURE 10
MITIGATION MEASURES
(SHEET 1 OF 2)

SCALE 0m 100m

BPAD Bushfire Planning & Design Accredited Practitioner Level 2

N

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Subdivision	27/01/2019
C	Rev Design	05/08/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

DEVELOPMENT REQUIREMENTS

1. That dwellings be located so as to have a maximum BAL-29 rating.
2. That any application for a building permit for a dwelling is to include an individual BAL assessment to confirm that sufficient land has been cleared to provide for BAL-29 setbacks.
3. That the vegetation within the BAL setback is to be maintained as an asset protection zone / low threat vegetation/low fuel zone as defined in Clause 2.2.3.2 of AS3959.
4. That any new dwelling is to provide a 20m asset protection zone in accordance with Council's firebreak notice.
5. Construction of subdivision roads in accordance with the Institute of Public Works Engineering Australia WA Division Inc. (2009) Local Government Subdivisional Guidelines as approved by Council.
6. Provision of a temporary turnaround area with a diameter of 17.5m as shown.
7. On the lots shown as "managed land" over all of the lot all grasses and flammable materials are to be maintained below 25mm in height by mowing or slashing or other means.
8. On the lots shown providing and maintaining a 3m wide boundary firebreak with all overhanging branches, trees and limbs trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area.
9. Any new driveway more than 50m in length shall have a minimum 4m wide trafficable surface and any access gate shall be a minimum width of 3.6m.
10. Where a driveway is more than 50m in length a turnaround area suitable to a fire appliance shall be provided within proximity to the dwelling.
11. That the landowners undertake regular maintenance of their property in preparation for the annual fire season.
12. That all fire mitigation measures shall be completed by the date prescribed in Council's Firebreak Notice.
13. In the event of any staging of the subdivision a plan and statement of the proposed interim fire management measures will be submitted and approved by the Shire.
14. A notification be included on the certificate of titles advising that the land is subject to a Bushfire Management Plan.
15. That prospective residents be provided with a summary of this Bushfire Management Plan.

FIGURE 10
MITIGATION MEASURES
(SHEET 2 OF 2)

Job No 16 - 076

Rev	Description	Date
A	Preliminary	23/11/2017
B	Rev Subdivision	27/01/2019
C	Rev Design	05/08/2019

LUSHfire and planning
geoffrey@lushfire.com.au
0418 954873

5.2 Additional Management Strategies

5.2.1 Staging

The development of the estate will have staged construction. In the event that the subdivision is staged then it is necessary to ensure that appropriate interim measures are provided. These may include:

- Interim access or emergency access ways;
- Creation of additional low fuel zones to ensure that the intended BAL ratings can be applied; or
- The provision of boundary firebreaks especially on any balance lot.

5.2.2 Annual Property Maintenance

Annual property maintenance is an important preparation for the annual fire season. This should focus on the area around the proposed dwelling and the following maintenance works should be considered:

Autumn and Winter (May-August)

- Tree pruning and remove lower branches and check that power lines are clear.
- Clear long grass, leaves, twigs and flammable shrubs.
- Overhaul the emergency water pump, fixtures and hoses.

Spring (September-November)

- Prepare boundary firebreaks.
- Carry out maintenance of strategic firebreak.
- Reduce grass levels within the hazard separation and building protection zones.
- Prune the dead material from the shrubs in the building protection zone.
- Clean out gutters, remove debris from roof.

Early summer (December onwards)

- Re-check personal and home protection gear, screens, water supplies and gutters.
- Keep yards as free as possible from combustible materials, fuels and debris.
- Avoid storing any felled trees and rubbish on your property.
- Remove dead shrubs and avoid long grasses, bracken or neglected masses of tall quick-curing annuals.
- Prepare a bushfire survival plan.

5.2.3 Purchaser Advice

All prospective purchasers must be made aware of the fire management issues, measures and responsibilities associated with the subdivision. This can be a notification placed upon the Certificate of Title of all lots pursuant to Section 70A of the Transfer of Land Act advising landowners of this Bushfire Management Plan and BAL requirements.

6.0 RESPONSIBILITIES FOR IMPLEMENTATION AND MANAGEMENT OF THE BUSHFIRE MEASURES

The management of the risk posed by bushfires is a shared responsibility between landowners, government and industry. These responsibilities are summarised in Table 5.

Table 5 Implementation

No	MANAGEMENT ACTION	TIMING
DEVELOPER PRIOR TO ISSUE OF TITLES		
No	**Implementation Action**	**Subdivision Clearance**
1.1	Construction of subdivision roads to standards outlined in the BMP to ensure safe access and egress.	
1.2	Provision of a temporary turnaround area with a diameter of 17.5m as shown.	
1.3	Provision of fire hydrants in accordance with the Water Corporations' No 63 Water Reticulation Standard and submittal of a plan confirming their locations.	
1.4	Removal of vegetation for the creation of the proposed building envelopes	
1.5	Preparing a notification be included on the certificate of titles advising that the land is subject to a Bushfire Management Plan.	
LANDOWNER/DEVELOPER PRIOR TO SALE OR OCCUPANCY		
No	**Implementation Action**	
2.1	Providing prospective residents with a summary of this BMP	
2.2	Siting dwellings so as to have a maximum BAL-29 rating.	
2.3	Ensuring that any application for a building permit for a dwelling is to include an individual BAL assessment to confirm that sufficient land has been cleared to provide for BAL-29 setbacks.	
2.4	Ensuring that any new driveway shall have a minimum 4m wide trafficable surface and any access gate shall be a minimum width of 3.6m.	
2.5	Providing a turnaround area suitable to a fire appliance within proximity to the dwelling, where a driveway is more than 50m in length.	
2.6	On the lots shown as "managed land" over all of the lot all grasses and flammable materials are to be maintained below 25mm in height by mowing or slashing or other means.	
2.7	On the lots shown providing and maintaining a 3m wide boundary firebreak with all overhanging branches, trees and limbs trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area.	
LANDOWNER/OCCUPIER - ONGOING		
No	**Management Action**	
3.1	On the lots shown as managed land over all of the lot all grasses and flammable materials are to be maintained below 25mm in height by mowing or slashing or other means.	
3.2	On the lots shown providing and maintaining a 3m wide boundary firebreak with all overhanging branches, trees and limbs trimmed back four (4) metres wide with a clear vertical axis of not less than five (5) metres over the firebreak area.	
3.3	Undertaking regular maintenance of their property in preparation for the annual fire season. Ongoing	
3.4	Ensuring that all fire mitigation measures shall be completed by the date prescribed in Council's Firebreak Order. Ongoing	
LOCAL GOVERNMENT ONGOING		

No	Management Action
4.1	Ensuring Building Permit Applications and Development Applications are compliant with the building and land use planning provisions
4.2	Enforce compliance with its annual fire break notice.
4.3	Maintenance of the drainage reserve including provisions of boundary firebreaks.

APPENDIX H

Transportation Noise Assessment

Prepared by Lloyd George Acoustics

Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9401 7770
W: www.lgacoustics.com.au

Transportation Noise Assessment

Lot 4 Kargotich Road & Lot 2 Thomas Road, Oakford

Reference: 18104697-01a.docx

Prepared for:
Harley Dykstra

Association of Australasian Acoustical Consultants

Report: 18104697-01a.docx

Lloyd George Acoustics Pty Ltd

ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923

www.lgacoustics.com.au

T: 9401 7770

Contacts	Daniel Lloyd	Terry George	Matt Moyle	Olivier Mallié	Ben Hillion
E:	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	matt@lgacoustics.com.au	olivier@lgacoustics.com.au	ben@lgacoustics.com.au
M:	0439 032 844	0400 414 197	0412 611 330	0439 987 455	0457 095 555

Date:	Rev	Description	Prepared By	Verified
13-Nov-18	0	Issued to Client	Terry George	Matt Moyle
30-Jul-19	A	Updated plan and noise mitigation	Terry George	-

Table of Contents

List of Tables

List of Figures

Appendices

1 INTRODUCTION

This report considers the noise impacts from road traffic on Thomas Road, to the proposed residential development of Lot 4 Kargotich Road and Lot 2 Thomas Road – refer *Figure 1-1*. Thomas Road currently carries around 16,000 vehicles per day (vpd) with 15% heavy vehicles, which is expected to increase to around 19,000 vpd in the future. The noise assessment is undertaken in accordance with and against the criteria of *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning.*

Figure 1-1 Site Locality

Figure 1-2 provides the proposed structure plan with *Figure 1-3* showing the subdivision concept.

Appendix B contains a description of some of the terminology used throughout this report.

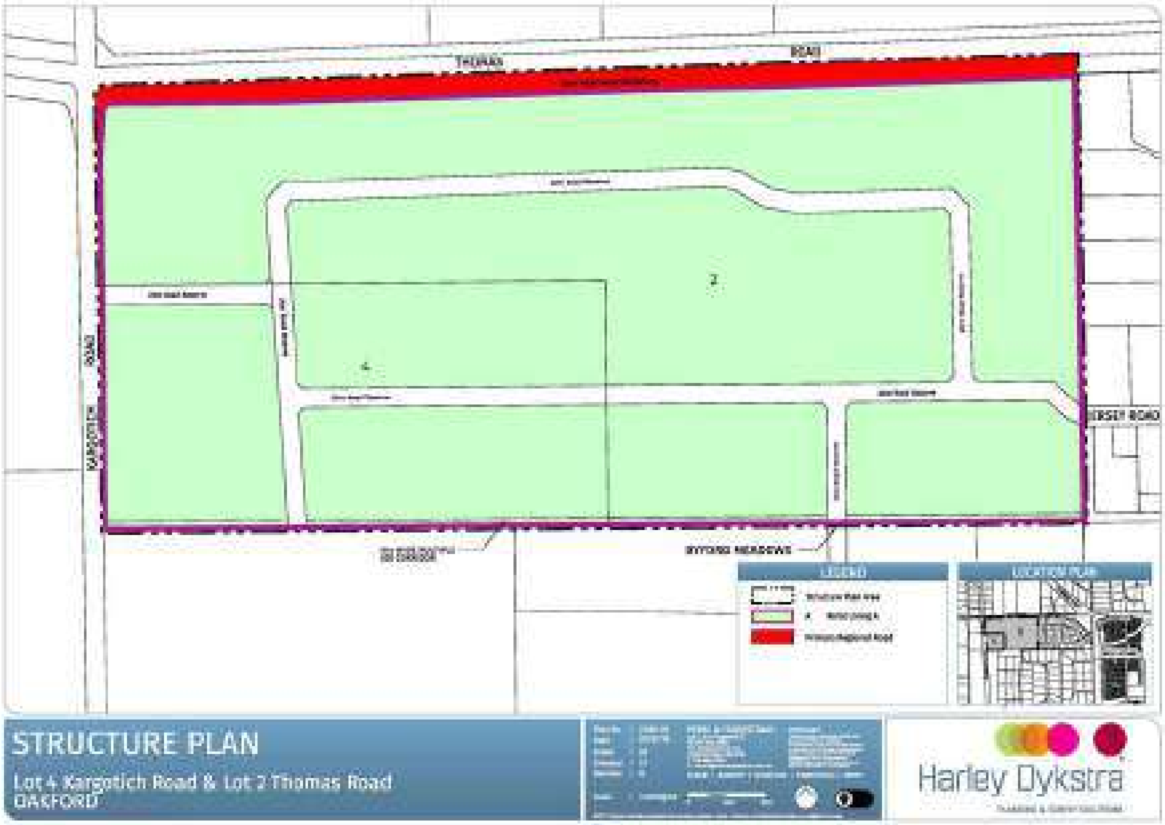


Figure 1-2 Proposed Oakford Structure Plan

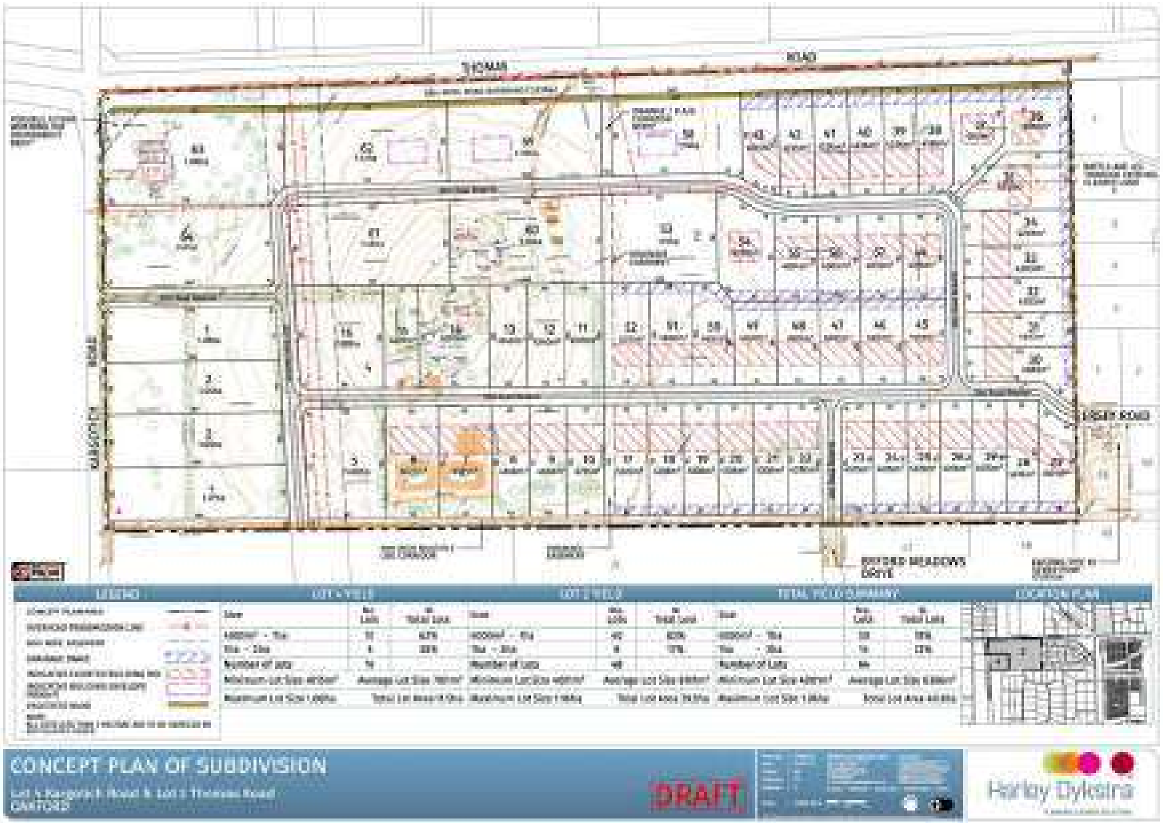


Figure 1-3 Subdivision Concept

2 CRITERIA

The criteria relevant to this assessment is the *State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (hereafter referred to as the Policy) produced by the Western Australian Planning Commission (WAPC). The objectives in the Policy are to:

- Protect people from unreasonable levels of transport noise by establishing a standardised set of criteria to be used in the assessment of proposals;
- Protect major transport corridors and freight operations from incompatible urban encroachment;
- Encourage best practice design and construction standards for new development proposals and new or redevelopment transport infrastructure proposals;
- Facilitate the development and operation of an efficient freight network; and
- Facilitate the strategic co-location of freight handling facilities.

The Policy's outdoor noise criteria are shown below in *Table 2-1*. These criteria apply at any point 1-metre from a habitable façade of a noise sensitive premises and in one outdoor living area.

Table 2-1 Outdoor Noise Criteria

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(Day)}$	60 dB $L_{Aeq(Day)}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

Note: The 5 dB difference between the target and limit is referred to as the margin.

In the application of these outdoor noise criteria to new noise sensitive developments, the objectives of this Policy is to achieve -

- acceptable indoor noise levels in noise-sensitive areas (e.g. bedrooms and living rooms of houses); and
- a 'reasonable' degree of acoustic amenity in at least one outdoor living area on each residential lot.

If a noise sensitive development takes place in an area where outdoor noise levels will meet the *target*, no further measures are required under this policy.

In areas where the *target* is exceeded, customised noise mitigation measures should be implemented with a view to achieving the *target* in at least one outdoor living area on each residential lot, or if this is not practicable, within the *margin*. Where indoor spaces are planned to be facing outdoor areas that are above the *target*, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces.

For residential buildings, "acceptable indoor noise levels" are taken to be 40 dB $L_{Aeq(Day)}$ in living areas and 35 dB $L_{Aeq(Night)}$ in bedrooms.

3 METHODOLOGY

Noise measurements and modelling have been undertaken in accordance with the requirements of the Policy as described below in *Sections 3.1 and 3.2*.

3.1 Site Measurements

Noise monitoring was undertaken at one location from 5 to 9 November 2018 in order to:

- Quantify the existing noise levels;
- Determine the differences between different acoustic parameters ($L_{A10,18hour}$, $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$); and
- Calibrate the noise model for existing conditions.

The instrument used was an ARL Ngara Type noise data logger, located approximately 30 metres from the edge of the road, with the microphone 1.4 metres above ground level. The logger was programmed to record hourly L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels. This instrument complies with the instrumentation requirements of *Australian Standard 2702-1984 Acoustics – Methods for the Measurement of Road Traffic Noise*. The logger was field calibrated before and after the measurement session and found to be accurate to within +/- 1 dB. Lloyd George Acoustics also holds current laboratory calibration certificate for the loggers.

Figure 3-1 Photograph of Noise Data Logger

The noise data collected was verified by inspection and professional judgement. It was determined that the microphone was damaged in the early hours of the 8 November 2018 by livestock and as such, data from the 8 November 2018 was not utilised.

3.2 Noise Modelling

The computer programme *SoundPLAN 8.1* was utilised incorporating the *Calculation of Road Traffic Noise* (CoRTN) algorithms, modified to reflect Australian conditions. The modifications included the following:

- Vehicles were separated into heavy (Austroads Class 3 upwards) and non-heavy (Austroads Classes 1 & 2) with non-heavy vehicles having a source height of 0.5 metres above road level and heavy vehicles having two sources, at heights of 1.5 metres and 3.6 metres above road level, to represent the engine and exhaust respectively. By splitting the noise source into three, allows for less barrier attenuation for high level sources where barriers are to be considered.
- Note that corrections are applied to the exhaust of –8.0 dB (based on Transportation Noise Reference Book, Paul Nelson, 1987) and to the engine source of –0.8 dB, so as to provide consistent results with the CoRTN algorithms for the no barrier scenario;
- Adjustments of -0.8 dB and -1.7 dB have been applied to the predicted $L_{A10,18hour}$ levels for the 'free-field' and 'at facade' cases respectively, based on the findings of *An Evaluation of the U.K. DoE Traffic Noise Prediction*; Australian Road Research Board, Report 122 ARRB – NAASRA Planning Group (March 1983).

Predictions are made at heights of 1.4 metres above ground floor level and at 1.0 metre from an assumed building façade (resulting in a + 2.5 dB correction due to reflected noise).

Various input data are included in the modelling such as ground topography, road design, traffic volumes etc. These model inputs are discussed below.

3.2.1 Ground Topography & Road Design

Topographical and road design data for this project was taken from *GoogleEarth*. At this stage information on subdivision levels are unknown and therefore the modelling uses the existing topography.

Information from Main Roads WA (Lang Fong, Planning Information Manager: Email 1 November 2018) suggests Thomas Road will be widened to the south, with the road consisting of 4 lanes total (2 each way) with a 7 metre median.

Existing buildings have been retained in the model as it is understood these may remain. Future buildings were included on those lots where a designated building pad location has been nominated. Each building is assumed to be single storey, at 3.5 metres high.

A bund and wall combination along the northern boundary has been included. The bund is assumed to be 1.5 metres high with 1:3 batter on each side and 1.0 metre flat section on top of the bund (e.g. 10-metre wide base). A 1.5 metre high wall (e.g. fibre cement fencing) is then assumed on top of the bund.

3.2.2 Traffic Data

Traffic data includes:

- Road Surface – The noise relationship between different road surface types is shown in *Table 3-1*.

Table 3-1 Noise Relationship Between Different Road Surfaces

Road Surfaces						
Chip Seal			Asphalt			
14mm	10mm	5mm	Dense Graded	Novachip	Stone Mastic	Open Graded
+3.5 dB	+2.5 dB	+1.5 dB	0.0 dB	-0.2 dB	-1.5 dB	-2.5 dB

The existing road surface is assumed to be a worn chip seal. There is potential that with the road widening, the road surface will be improved, however this has not been taken into account in the modelling.

- Vehicle Speed – The existing and future posted speeds are 90km/hr.

- Traffic Volumes – Existing (2016) and forecast (2031) traffic volumes were requested from Main Roads WA (Clare Yu, Traffic Modelling Analyst, Reference: 41058). *Table 3-2* provides the traffic volume input data in the model.

Table 3-2 Traffic Information Used in the Modelling for Thomas Road

Parameter	Scenario			
	Existing - 2016[1]		Future - 2031[2]	
	Eastbound	Westbound	Eastbound	Westbound
24 Hour Volume	8,306	7,997	8,300	10,700
18 Hour Volume[1]	7,758	7,341	7,752	9,822
% Heavy[2]	15	15	14	12

Notes:

1. Based on hourly traffic count from Main Roads WA, east of Kargotich Road 2017/18.
2. From Main Roads WA plots, with the exception of.

3.2.3 Ground Attenuation

The ground attenuation has been assumed to be 0.0 (0%) for the road, 0.65 (65%) throughout the subdivision. Note 0.0 represents hard reflective surfaces such as water and 1.00 represents absorptive surfaces such as grass.

3.2.4 Parameter Conversion

The CoRTN algorithms used in the *SoundPLAN* modelling package were originally developed to calculate the $L_{A10,18hour}$ noise level. The WAPC Policy however uses $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$. The relationship between the parameters varies depending on the composition of traffic on the road (volumes in each period and percentage heavy vehicles).

As noise monitoring was undertaken, the relationship between the parameters is based on the results of the monitoring – refer *Section 4.1*.

4 RESULTS

4.1 Noise Monitoring

The results of the noise monitoring are summarised below in *Table 4-1* and shown graphically in *Figure 4-1*.

Table 4-1 Measured Average Noise Level

Date	Average Weekday Noise Level, dB			
	$L_{A10,18hour}$	$L_{Aeq,24hour}$	$L_{Aeq\ (Day)}$	$L_{Aeq\ (Night)}$
6 November 2018	70.5	67.0	68.1	63.3
7 November 2018	70.5	67.1	68.2	63.5
8 November 2018	*66.4*	*63.5*	*64.6*	*59.7*
Average	**70.5**	**67.7**	**68.2**	**63.4**

Note: As discussed in *Section 3.1*, the 8 November 2018 was excluded due to livestock removing the wind sock and knocking the microphone to the ground.

The average differences between the weekday $L_{A10,18hour}$ and $L_{Aeq(Day)}$ is 2.4 dB and this conversion has been used in the modelling. The average differences between the weekday $L_{Aeq(Day)}$ and $L_{Aeq(Night)}$ is 4.8 dB. This same difference has been assumed to exist in future years. As such, there is negligible difference between daytime and night-time compliance. For simplicity, this report provides $L_{Aeq(Day)}$ values throughout.

4.2 Noise Modelling

The noise modelling is provided in *Figure 4-2* as an $L_{Aeq(Day)}$ noise level contour plot being for the future traffic conditions.

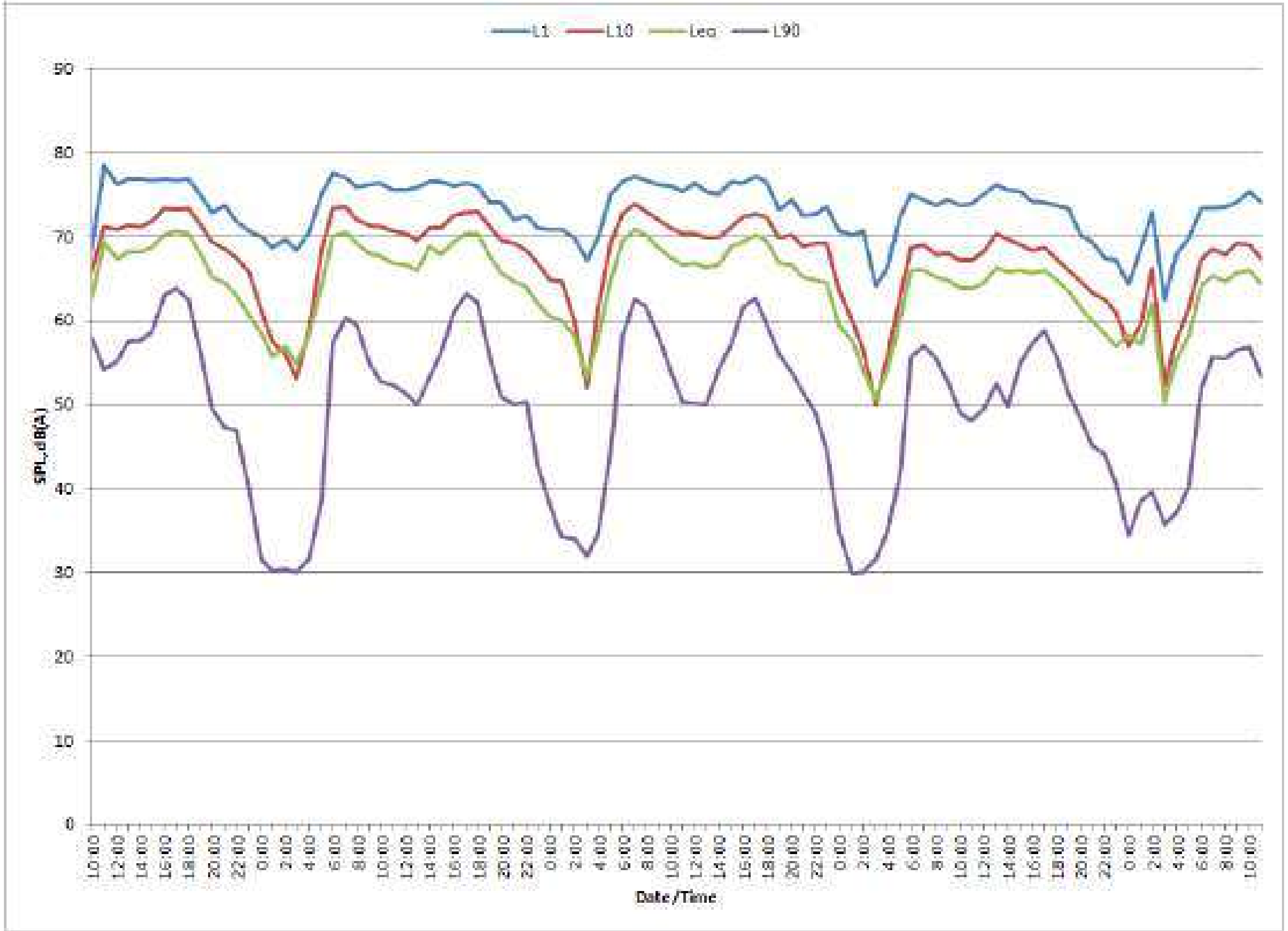
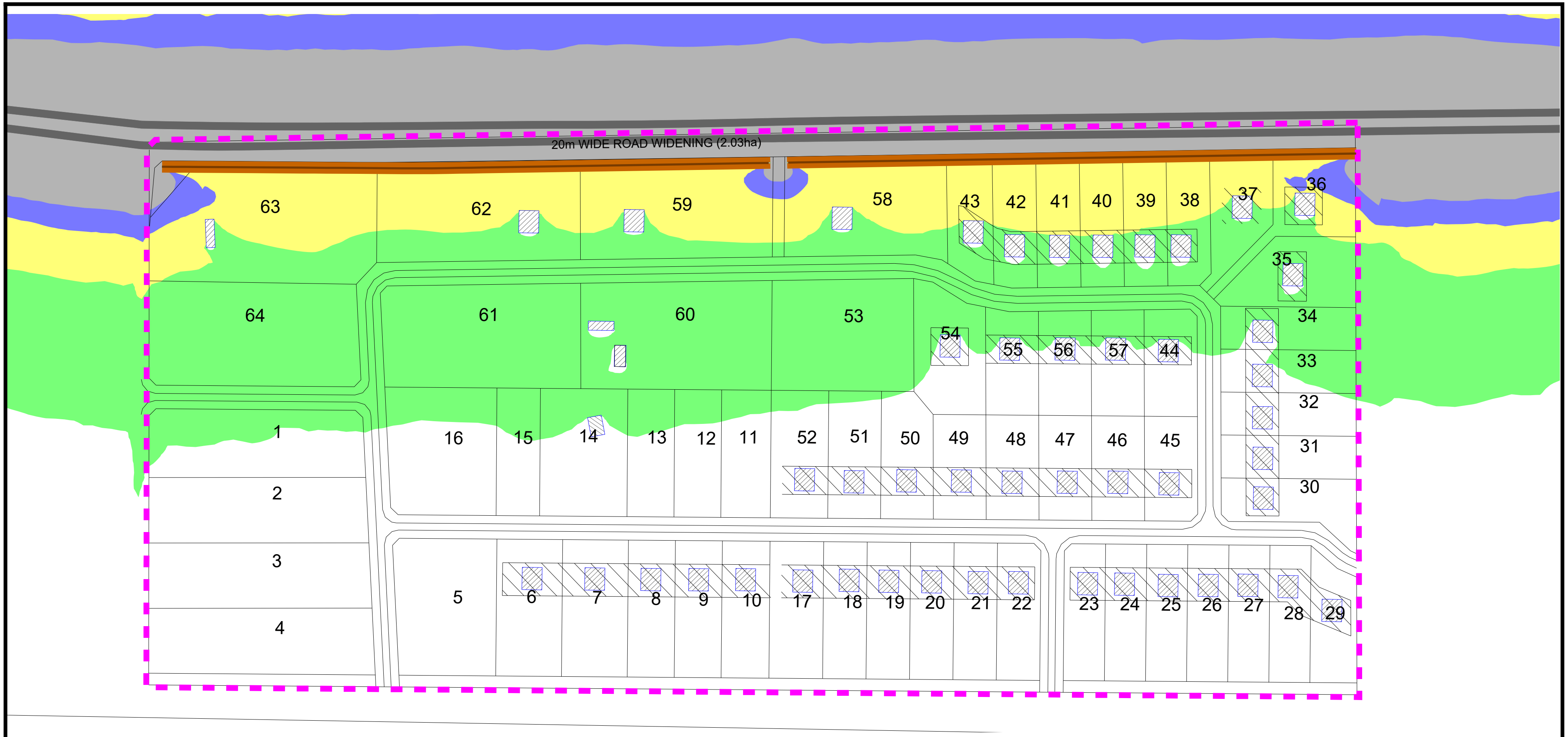


Figure 4-1 Noise Monitoring Results



Oakford Structure Plan

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Traffic Volumes
With 1.5m High Earthen Bund with 1.5m High Wall as Example

SoundPlan v8.1
CoRTN Algorithms

30 July 2019

Lloyd George Acoustics
by Terry George
terry@lgacoustics.com.au
(08) 9401 7770

Length Scale 1:5000

0 25 50 100 150 200 m

Figure 4-2

Signs and symbols

- Road
- Existing / New Building
- Study Area
- Bund
- Wall

N

Noise levels

$L_{Aeq,Day}$ dB

<= 55	
<= 56	Exposure A
<= 57	
<= 58	
<= 59	
<= 60	
<= 61	Exposure B
<= 62	
<= 63	
<= 64	Exposure C
<= 65	
> 65	Exposure D

SPP 5.4 (May 2009)

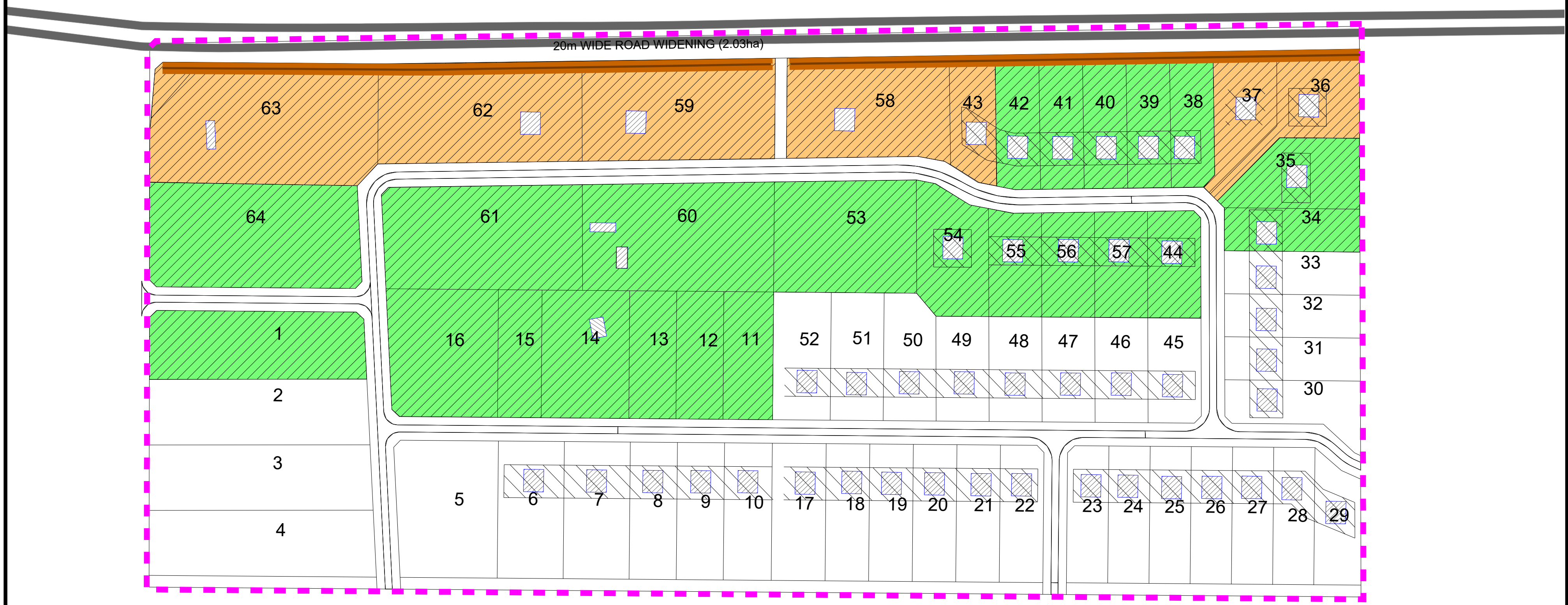
5 ASSESSMENT & CONCLUSION

The objectives of the criteria are for noise at all houses to be no more than the *limit* and preferably no more than the *target*. Where the *target* is achieved, no further controls are required. Where the *target* is exceeded, further controls are necessary.

Figure 5-1 provides the noise mitigation requirements for the project being:

- Construct a bund and wall combination along the northern boundary. For the purposes of the assessment, it is assumed the bund is 1.5 metres high (1:3 batter and 1.0 metre flat top) with 1.5 metre wall on top (e.g. fibre cement sheet), however any combination is acoustically acceptable, provided the 3 metre height is maintained.
- For dwellings requiring Packages A or B, alternative treatment to the deemed to satisfy (refer *Appendix A*) can be accepted if supported by a report by a suitable qualified acoustical engineer (member firm of the Association of Australian Acoustical Consultants);
- All affected lots are to have notifications on lot titles as per the Policy requirements – refer *Appendix A*.
- All affected lots are to provide one outdoor entertaining area where noise levels are below the *limit*. For those dwellings within Package B, one outdoor entertaining area is to be located on the side of the house opposite the transport corridor or within an alcove of the house so that the house itself shields it from the transport corridor.
- Any affected dwelling that is to be double storey construction must have a specific house assessment undertaken to determine suitable noise mitigation.

Note that as the project is at structure plan stage only, the recommendations provided are subject to change. Given the predicted noise contours, it would be possible to minimise the number of affected lots by nominating more building envelope locations such as Lots 1 and 11 to 16 by locating outside the 55 dB $L_{Aeq(Day)}$ contour.



Oakford Structure Plan

$L_{Aeq(Day)}$ Noise Level Contours Based on Future Traffic Volumes
With 1.5m High Earthen Bund with 1.5m High Wall as Example

SoundPlan v8.1
CoRTN Algorithms

30 July 2019

Lloyd George Acoustics
by Terry George
terry@lgacoustics.com.au
(08) 9401 7770

Length Scale 1:5000

0 25 50 100 150 200 m

Figure 5-1

Signs and symbols

- Road
- Existing / New Building
- Study Area
- Bund
- Wall
- Package A & Notification
- Package B & Notification

N

Appendix A

ACCEPTABLE TREATMENT PACKAGES

The packages and information provided on the following pages are taken from *Implementation Guidelines for State Planning Policy 5.4 Road and Rail Transport Noise and freight Considerations in Land Use Planning*; December 2014.

Where outdoor noise levels are above the ***target*** level, excluding the effect of any boundary fences, the Guidelines propose acceptable treatment packages that may be implemented without requiring detailed review. The packages are also intended for residential development only. At higher noise levels or for other building usages, specialist acoustic advice will be needed.

The acceptable treatment packages are intended to simplify compliance with the noise criteria, and the relevant package should be required as a condition of development in lieu of a detailed assessment.

Transition between each package should be made on the basis of the highest incident $L_{Aeq(Day)}$ or $L_{Aeq(Night)}$ value to the nearest whole number determined for the building development under assessment.

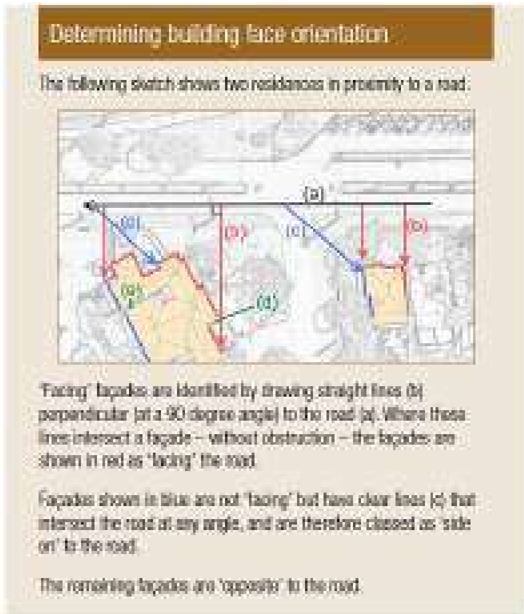
Any departures from the acceptable treatment specifications need to be supported by professional advice from a competent person that the proposal will achieve the requirements of the Policy.

With regards to the packages, the following definitions are provided:

- **Facing** the transport corridor: Any part of a building façade is 'facing' the transport corridor if any straight line drawn perpendicular to its nearest road lane or railway line intersects that part of the façade without obstruction (ignoring any fence).

- **Side-on** to transport corridor: Any part of a building façade that is not 'facing' is 'side-on' to the transport corridor if any straight line can be drawn from it to intersect the nearest road lane or railway line without obstruction (ignoring any fence).

- **Opposite** to transport corridor: Neither 'side on' nor 'facing', as defined above.



Package A

Area	Orientation to Road or Rail Corridor	Package A (up to 60 dB $L_{Aeq(Day)}$ and 55 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum R_w + C_{tr} 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	No requirements
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum R_w + C_{tr} 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to be same performance including brush seals.
	Side	• Windows and external door systems: As above.
	Opposite	No requirements
General	Any	• Walls (minimum R_w + C_{tr} 45) – o Two leaves of 90mm thick brick with minimum 50mm cavity; o One row of 92mm studs at 600mm centres with – ▪ Resilient steel channels fixed to the outside of the studs; and ▪ 9.5mm fibre cement sheet or 11mm fibre cement sheet weatherboards fixed to the outside; ▪ 75mm thick mineral wool insulation with a density of at least 11kgkg/m^3; and ▪ 2 x 16mm fire-rated plasterboard to inside. • Roof and ceiling (minimum R_w + C_{tr} 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor if practicable; or • Locate within alcove area so that the house shields it from corridor if practicable.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Package B

Area	Orientation to Road or Rail Corridor	Package B (up to 63 dB $L_{Aeq(Day)}$ and 58 dB $L_{Aeq(Night)}$)
Bedrooms	Facing	• Windows systems: Glazing up to 40% of floor area (minimum R_w + C_{tr} 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings.
	Side	• Windows systems: As above.
	Opposite	• Windows systems: Glazing up to 40% of floor area (minimum R_w + C_{tr} 25) – 4mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Alternatively, 6mm thick glass (monolithic, toughened or laminated) in sliding frame.
Other Habitable Rooms Including Kitchens	Facing	• Windows and external door systems: Glazing up to 60% of floor area (minimum R_w + C_{tr} 31) – 10mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Sliding glass doors to have laboratory certificate confirming R_w + C_{tr} 31 performance. Alternative, change to hinged door with perimeter acoustic seals and 10mm thick glass.
	Side	• Windows and external door systems: Glazing up to 60% of floor area (minimum R_w + C_{tr} 28) – 6mm thick glass (monolithic, toughened or laminated) in fixed sash, awning or casement opening with seals to openings. Doors to be either 35mm thick solid timber core door with full perimeter acoustic seals. Glazed inserts to match the above. Glass doors to be same performance (R_w + C_{tr} 28) including brush seals.
	Opposite	No requirements
General	Any	• Walls (minimum R_w + C_{tr} 50) – Two leaves of 90mm thick brick with minimum 50mm cavity. Cavity to include 25mm thick, 24kg/m^3 insulation and where wall ties are required, these are to be anti-vibration/resilient type. • Roof and ceiling (minimum R_w + C_{tr} 35) – Standard roof construction with 10mm plasterboard ceiling and minimum R2.5 insulation between ceiling joists. • Eaves to be closed using 4mm thick compressed fibre cement sheet. • Mechanical ventilation – Refer following pages.
Outdoor Living Area		• Locate on the side of the building that is opposite to the corridor; or • Locate within alcove area so that the house shields it from corridor.

Note: Any penetrations in a part of the building envelope must be acoustically treated so as to not downgrade the performance of the building elements affected. Most penetrations in external walls such as pipes, cables or ducts can be sealed through caulking gaps with non-hardening mastic or suitable mortar.

Mechanical Ventilation requirements

It is noted that natural ventilation must be provided in accordance with F4.6 and F4.7 of Volume One and 3.8.5.2 of Volume Two of the National Construction Code. Where the noise *limit* is likely to be exceeded, a mechanical ventilation system is usually required. Mechanical ventilation systems will need to comply with AS 1668.2 – *The use of mechanical ventilation and air-conditioning in buildings*.

In implementing the acceptable treatment packages, the following must be observed:

- Evaporative air conditioning systems will meet the requirements for Packages A and B provided attenuated air vents are provided in the ceiling space and designed so that windows do not need to be opened.
- Refrigerant based air conditioning systems need to be designed to achieve fresh air ventilation requirements.
- External openings (e.g. air inlets, vents) need to be positioned facing away from the transport corridor where practicable.
- Ductwork needs to be provided with adequate silencing to prevent noise intrusion.

Notification

Notifications on certificates of title and advice to prospective purchasers warning of the potential for noise impacts from major transport corridors help with managing expectations.

The area of land for which notification is required should be identified in the noise management plan and contain a description of major noise sources nearby (e.g. 24-hour freight rail).

Notification should be provided to prospective purchasers, and required as a condition of subdivision (including strata subdivision) for the purposes of noise sensitive development or planning approval involving noise sensitive development, where external noise levels are forecast or estimated to exceed the ’target’ criteria as defined by the Policy.

In the case of subdivision and development, conditions of approval should include a requirement for registration of a notice on title, which is provided for under Section 165 of the Planning and Development Act 2005 and Section 70A of the Transfer of Land Act 1893. An example of a suitable notice is:

Notice: This lot is situated in the vicinity of a transport corridor and is currently affected, or may in the future be affected, by transport noise. Transportation noise controls and Quiet House design strategies at potential cost to the owner may be required to achieve an acceptable level of noise reduction. Further information is available on request from the relevant local government offices.

Appendix B

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)

The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

L_1

An L_1 level is the noise level which is exceeded for 1 per cent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{10}

An L_{10} level is the noise level which is exceeded for 10 per cent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{90}

An L_{90} level is the noise level which is exceeded for 90 per cent of the measurement period and is considered to represent the "*background*" noise level.

L_{eq}

The L_{eq} level represents the average noise energy during a measurement period.

$L_{A10,18hour}$

The $L_{A10,18\,hour}$ level is the arithmetic average of the hourly L_{A10} levels between 6.00 am and midnight. The *CoRTN* algorithms were developed to calculate this parameter.

$L_{Aeq,24hour}$

The $L_{Aeq,24\,hour}$ level is the logarithmic average of the hourly L_{Aeq} levels for a full day (from midnight to midnight).

$L_{Aeq,8hour}$ / $L_{Aeq\,(Night)}$

The $L_{Aeq\,(Night)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 10.00 pm to 6.00 am on the same day.

$L_{Aeq,16hour}$ / $L_{Aeq\,(Day)}$

The $L_{Aeq\,(Day)}$ level is the logarithmic average of the hourly L_{Aeq} levels from 6.00 am to 10.00 pm on the same day. This value is typically 1-3 dB less than the $L_{A10,18hour}$.

R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

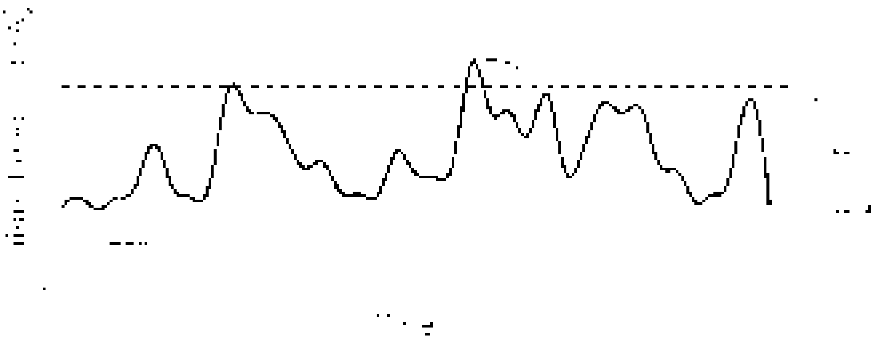
C_{tr}

This is a spectrum adaptation term for airborne noise and provides a correction to the R_w value to suit source sounds with significant low frequency content such as road traffic or home theatre systems. A wall that provides a relatively high level of low frequency attenuation (i.e. masonry) may have a value in the order of –4 dB, whilst a wall with relatively poor attenuation at low frequencies (i.e. stud wall) may have a value in the order of -14 dB.

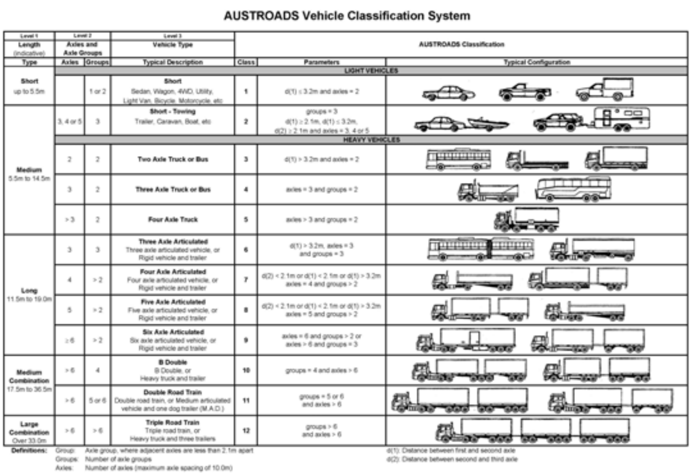
Satisfactory Design Sound Level
The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level
The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Chart of Noise Level Descriptors



Austroads Vehicle Class

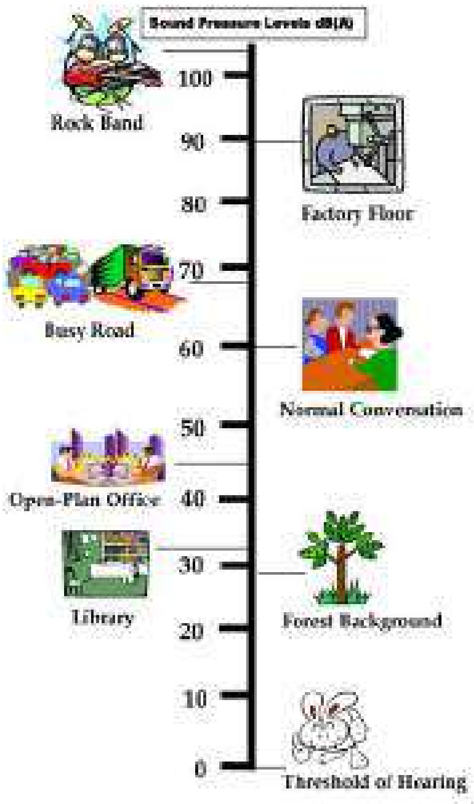


AUSTROADS Vehicle Classification System

Level 1 Length (indicative) Type	Level 2 Axles and Axle Groups Axles	 Groups	Level 3 Vehicle Type Typical Description	AUSTROADS Classification Class	 Parameters	 Typical Configuration
					LIGHT VEHICLES	
Short up to 5.5m		1 or 2	**Short** Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	d(1) ≤ 3.2m and axles = 2	
Medium 5.5m to 14.5m	3, 4 or 5	3	**Short - Towing** Trailer, Caravan, Boat, etc	2	groups = 3 d(1) ≥ 2.1m, d(1) ≤ 3.2m, d(2) ≥ 2.1m and axles = 3, 4 or 5	
					HEAVY VEHICLES	
	2	2	**Two Axle Truck or Bus**	3	d(1) > 3.2m and axles = 2	
	3	2	**Three Axle Truck or Bus**	4	axles = 3 and groups = 2	
	> 3	2	**Four Axle Truck**	5	axles > 3 and groups = 2	
Long 11.5m to 19.0m	3	3	**Three Axle Articulated** Three axle articulated vehicle, or Rigid vehicle and trailer	6	d(1) > 3.2m, axles = 3 and groups = 3	
	4	> 2	**Four Axle Articulated** Four axle articulated vehicle, or Rigid vehicle and trailer	7	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 4 and groups > 2	
	5	> 2	**Five Axle Articulated** Five axle articulated vehicle, or Rigid vehicle and trailer	8	d(2) < 2.1m or d(1) < 2.1m or d(1) > 3.2m axles = 5 and groups > 2	
	≥ 6	> 2	**Six Axle Articulated** Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles > 6 and groups = 3	
Medium Combination 17.5m to 36.5m	> 6	4	**B Double** B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6	
	> 6	5 or 6	**Double Road Train** Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6	
Large Combination Over 33.0m	> 6	> 6	**Triple Road Train** Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6	

Definitions:
Group: Axle group, where adjacent axles are less than 2.1m apart
Groups: Number of axle groups
Axles: Number of axles (maximum axle spacing of 10.0m)
d(1): Distance between first and second axle
d(2): Distance between second and third axle

Typical Noise Levels



APPENDIX I

Servicing Report

Prepared by Porter Consulting Engineers

Porter
Consulting Engineers

Level 2 Kishorn Court
58 Kishorn Road
Mount Pleasant WA 6153

PO Box 1036
Canning Bridge WA 6153

Tel: (08) 9315 9955
Fax: (08) 9315 9959
Email: office@portereng.com.au
www.portereng.com.au

Our Ref: SH/L534C.17
Job No: 17-2-15

13 August 2019

Harley Dykstra
1, 252 Fitzgerald St
Perth WA 6000

Attention: Mr Clayton Plug

Dear Clayton,

LOT 2 THOMAS ROAD AND LOT 4 KARGOTICH ROAD, OAKFORD
DEVELOPMENT SERVICING ADVICE

Porter Consulting Engineers have been engaged to provide civil engineering and servicing advice for the above rural residential development. This letter summaries our investigations to date.

Below is an extract of the development layout as prepared by Harley Dykstra (21396-01I). This shows a mix of lot sizes ranging from 4,000m^2 along the eastern side to 2ha along the west.

Roads
The road network provides frontage to all lots and connects in with existing Jersey Rd (west), Byford Meadows (south) and provides for a future connection via a road parallel to Kargotich. Consistent with the existing development to the east, it is likely the road network will be elevated above the natural surface and will comprise of a sealed pavement with shoulders. It is likely the intersections will be kerbed with appropriate treatment as needed.

Drainage
The eastern half of the site consists of a series of shallow farmland drains leading to a localised low area near lot 17. The western half of the site has a sand mound that rises approximately 3m above the surrounding area with its crest near the rear of lot 14. There is an existing open drain along the southern boundary of the site which flows from the east down to the west. Water Corporation mapping indicates the western half of this southern drain is their asset.

The Water Corporation drain continues south once it reaches Kargotich Road. There is an open drain parallel to Kargotich Road which flows south into the Water Corporation asset.

Consistent with the existing development to the east, there will be a series of road side drains and culverts that direct stormwater to the drainage reserve. There will be lot drains to continue the natural flow of water across the developed area, it is probable easements will be needed to ensure these flow routes are protected.

The western third of the site grades away from the drainage reserve. It is likely oversized road side swales will be provided to manage stormwater quality and quantity, this will be resolved as part of the LWMS process.

Wastewater
There is an existing Water Corporation wastewater pumping station on Jersey Road, approximately 50m east of the site. The Water Corporation have confirmed parts of the site can have a wastewater connection via a sewer mains extension.

The extent of the lots within the Water Corporations wastewater catchment is dictated by minimum pipe grades, pipe cover and servicing levels. It is likely lots 7-15, 17-52 and 54-57 can have a wastewater service with those on the fringe being subject to detailed designs.

The balance of the lots will be serviced via traditional on site disposal.

Water
There is an existing Water Corporation water reticulation network in the development to the east. This main can be extended to service this estate.

Underground Power
There are existing overhead power lines (east-west) across the site, these will be removed. It is likely they will be undergrounded along the southern side of the Thomas Rd road reserve boundary. There is a high voltage transmission line (north-south), this will remain. An easement has been shown on the Harley Dykstra development layout.

Western Power mapping suggests there is a power supply for this estate. Discussions with Western Power will be needed during the detailed design stage to determine the location of the point of connection however it is probable this will be from the existing development to the east. Points of supply will be provided for each lot. The road network will be lit in accordance with the governing standards.

Communications
Telstra has an existing network in the estates to the south and east. It is likely these networks will be extended to service this development.

Gas
There is no gas reticulation in the surrounding area. Discussions can be held with ATCO if a gas supply is required.

Building Areas
Building envelopes will be identified as part of the development process. Consideration to planning setbacks, existing vegetation and bus fire requirements will be made.

Consistent with the surrounding areas, it is likely the houses will be set above the natural surface level. The extent of fill for the houses will be dependent on the following factors and will be determined during the detailed design phase:

- Separation to ground and surface water,
- Wastewater servicing and
- Depth of fill for site classification.

Fencing and Fire Breaks
It is likely the estate will be fenced consistent with rural residential estates. It is likely fire breaks will be established as part of the development process with each lot purchaser then being required to manage their property accordingly.

If you have any further queries, please contact the undersigned.

Yours faithfully

SHANE HIGHMAN
DIRECTOR DEVELOPMENT

APPENDIX J

Traffic Impact Statement

Prepared by Flyt Pty Ltd

flyt

Transport Impact Assessment

LOT 4 KARGOTICH ROAD AND LOT 2 THOMAS ROAD, OAKFORD

email: info@flyt.com.au twitter.com/flytplan web: www.flyt.com.au

PROJECT	81113-250 Transport Assessment for Lot 4 Kargotich Rd and Lot 2 Thomas Rd, Oakford			
Revision	Description	Originator	Review	Date
0	Draft	CXS	MDR	29/05/19
1	Issued	CXS	MDR	30/05/19
2	Revised	CXS	MDR	20/06/2019
3	Revised – change to concept plan	CXS	MDR	15/08/2019

Contents

1. INTRODUCTION AND BACKGROUND

1.1 Transport Assessment

In December 2017 Flyt prepared a Traffic Statement in support of the proposed rezoning of Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford in the Shire of Serpentine Jarrahdale. The Shire of Serpentine Jarrahdale has subsequently asked for a more detailed transport assessment including discussion of the impact of the future southern extension of Tonkin Highway. This report constitutes that assessment.

It is proposed to rezone the subject site from 'Rural' to 'Rural Living A' under the Shire's Town Planning Scheme No.2 (TPS No.2). This proposed zoning change accords with the Shire's Rural Strategy Review, which identifies the potential for the subdivision and development of the subject site.

A draft Local Structure Plan (LSP) has been prepared in support of a Scheme Amendment Request (SAR) to demonstrate how the subject site will be subdivided and how it will integrate the existing and proposed land uses with the movement network in the locality. The location of the site subject to the rezoning application is shown in Figure 1 and Figure 2.

This Transport Impact Assessment has been prepared in accordance with the WA Planning Commission's *Transport Impact Assessment Guidelines (August 2016) Volume 2 – Planning Schemes Structure Plans and Activity Structure Plans*. The Guidelines state that Traffic Impact Assessments are required for a Scheme Amendment where it is expected to generate 500 vehicles in the peak hour, whereas all Structure Plans require supporting Transport Assessments.

Figure 1 Location plan for site subject to potential rezoning in Oakford (map source: Nearmap)

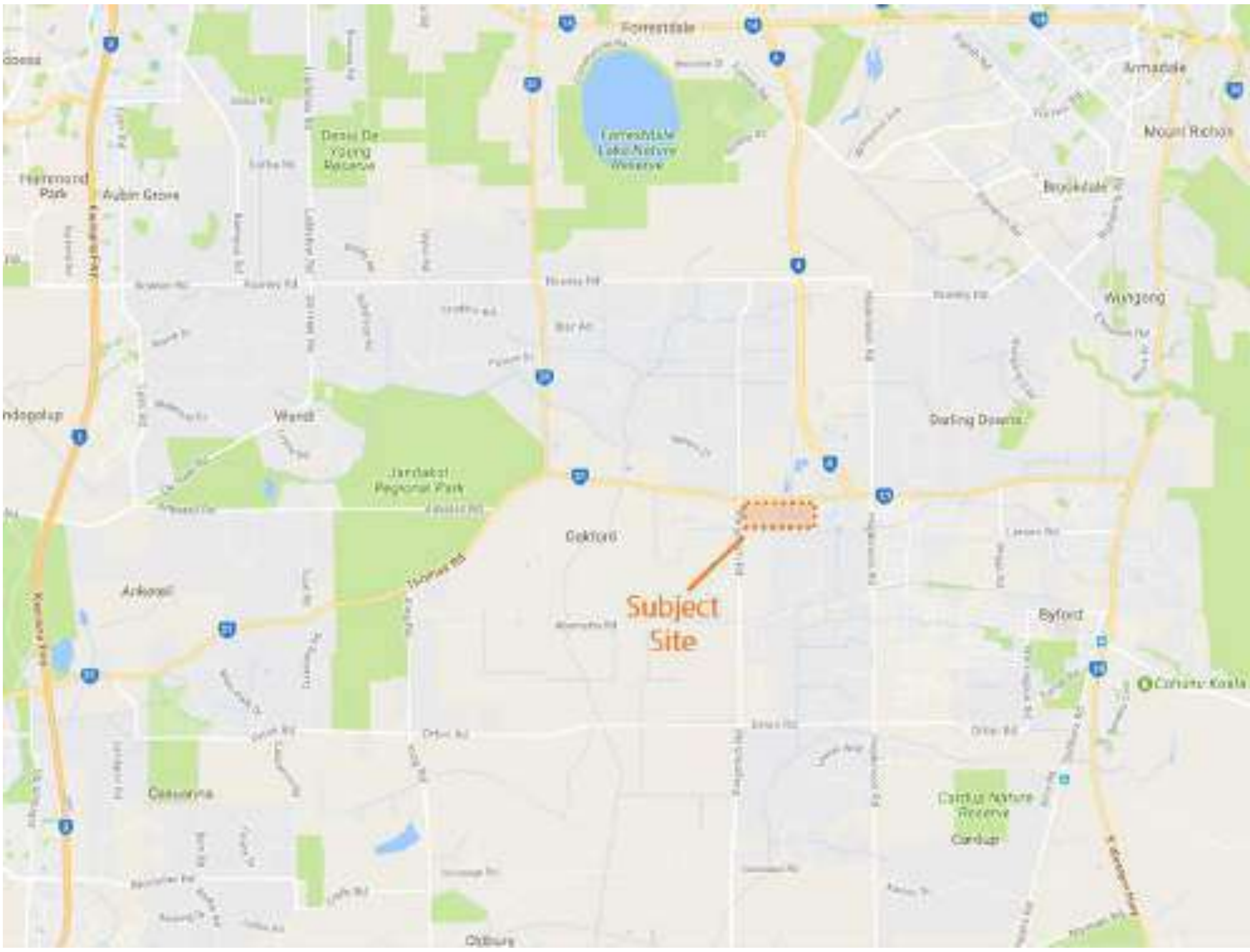


Figure 2 Location plan for site subject to potential rezoning in Oakford (map source: Nearmap)

1.2 Structure of Transport Impact Statement

This introduction forms the first section of the Transport Impact Assessment of which there are a further 11 sections.

- Proposed subdivision;
- Vehicle access and parking;
- Provision for service vehicles;
- Daily traffic volumes and vehicle types;
- Traffic management on frontage streets;
- Public transport use;
- Pedestrian access;
- Cycle access;
- Site specific issues;
- Safety issues; and
- Conclusions.

2. PROPOSED SUBDIVISION

2.1 Existing Land Use

The subject site is located on the south-east corner of the intersection of Thomas Road and Kargotich Road in Oakford. The site is approximately 3km to the south of the Kargotich Road-Rowley Road priority controlled intersection, 2.8km to the east of the Thomas Road-Nicholson Road priority controlled intersection, 500m to the west of the Thomas Road-Tonkin Highway traffic signal controlled intersection and 1.3km to the north of the Kargotich Road-Abernethy Road priority controlled intersection. Figure 3 shows the location of the subject site and surrounding lot boundaries.

The site area is approximately 48.4 hectares, with a frontage of approximately 1,020m to Thomas Road and 460m to Kargotich Road. The site currently contains a single residential dwelling with associated sheds accessed via a crossover on Thomas Road and two residential dwellings with associated sheds accessed via separate crossovers on Kargotich Road. The site is mostly cleared with scattered trees, having historically been used for grazing.

The surrounding area to the south of Thomas Road and east of Kargotich Road has been mostly subdivided and developed as Special Rural or Rural Living A estates. The adjoining land to the east comprises a Rural Living A subdivision with lot sizes in the order of 4,500m^2-5,000m^2. The adjoining land to the southeast comprises a Special Rural subdivision with lot sizes in the order of two hectares. The adjoining land to the southwest has recently been subject to a SAR to rezone the land from Rural to Special Rural – this has been supported by Council with maximum lot sizes of 1.5 hectares. Land west of Kargotich Road is zoned 'Rural' and is not identified for change under the Shire's Rural Strategy 2013 Review.

A 330kV powerline traverses the western portion of the site in a north-south direction, with an easement of approximately 60m in width in favour of the State Energy Commission of Western Australia. Buildings are generally precluded within the easement, unless approved by the State Energy Commission.

Figure 3 Subject site location and surrounding lot boundaries (source: Shire of Serpentine Jarrahdale Intramap)

2.2 Proposed Land Use

The proposal involves the rezoning of Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford, from 'Rural' to 'Rural Living A'.

The rezoning of the subject site would effectively complete the pattern of subdivision in the locality, whereby Kargotich Road is a logical boundary between the larger lots in the Rural zoned land to the west and the smaller, rural residential lots in the adjoining Special Rural/Rural Living A zones to the east.

This approach was confirmed by the Council at its meeting of 9 May 2016, when it passed a resolution on its submission to the draft Perth and Peel Green Growth Plan for 3.5 million, which in part stated, "the Shire is…supportive of Rural Residential uses being identified to extend west to Kargotich Road south of Thomas Road…to consolidate this precinct."

The proposed rezoning will facilitate the creation of 64 Rural Living A lots. The eastern half of the site would accommodate 40 lots of between 4,000m² and 10,000m², and 2 lots of approximately 1 hectare. The western half of the site would accommodate 10 lots of between 4,000m² and 10,000m² and 12 lots of between 1 and 2 hectares.

The proposed road network includes the westerly extension of Jersey Road (which currently services the Rural Living A subdivision to the east) and the northern extension of Byford Meadows Drive which connects to Abernethy Road. The proposed subdivision concept plan is shown in Figure 4.

Figure 4 Proposed concept plan of subdivision (source: Harley Dykstra, August 2019)

2.3 Site Context with Surrounds

The subject site is currently zoned 'Rural' under the Shire's TPS No.2. Under clause 5.10.1 of the TPS No.2 it is stated that:

> *The purpose and intent of the Rural Zone is to allocate land to accommodate the full range of rural pursuits and associated activities conducted in the Scheme Area.*

In respect to minimum lot sizes, clause 5.10.4 of TPS No.2 states:

> *The Council will generally not support subdivision within the Rural zone that will result in the creation of lots less than 40 hectares.*

Land immediately to the east of the site is zoned Rural Living A. Land immediately to the southeast of the site is zoned Special Rural and land immediately to the southwest of the site is zoned Rural but is subject to a recent SAR to change its zoning to Special Rural (which is support by Council).

A number of other Special Rural and Rural Living zones are located within the surrounding area. Figure 5 shows the location of the site in the context of the Shire's TPS No.2.

Figure 5 Shire of Serpentine Jarrahdale Town Planning Scheme No.2 (source: Shire of Serpentine Jarrahdale)

3. ROAD NETWORK AND VEHICULAR ACCESS

3.1 Existing Access Arrangements

The site currently contains three single residential dwellings each with associated sheds but is otherwise undeveloped. The site is mostly cleared with scattered trees, having historically been used for grazing.

One of the residential dwellings is accessed via a crossover on Thomas Road, with a gravel track to the property. Two of the residential dwellings are accessed via separate crossovers on Kargotich Road, with gravel tracks to the properties. In addition to these three crossovers providing vehicular access to residential dwellings, there are two crossovers on Thomas Road that provide gated access to the paddocks.

All points of existing vehicular access to the subject site are shown in Figure 6.

Figure 6 Existing crossovers providing access to the subject site (map source: Nearmap)

The three existing single gravel tracks providing vehicular access to the three residential dwellings on the subject site are shown in Figure 7, Figure 8 and Figure 9.

Figure 7 Existing crossover on Thomas Road providing access to residential dwelling (source: Google Street View)

Figure 8 Existing northern crossover on Kargotich Road providing access to residential dwelling (source: Google Street View)

Figure 9 Existing southern crossover on Kargotich Road providing access to residential dwelling (source: Google Street View)

Kargotich Road – view north with southern crossover to existing residential property on the right

Kargotich Road – view south with southern crossover to existing residential property on the left

3.2 Proposed Internal Road Network

The proposed rezoning of Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford, from 'Rural' to 'Rural Living A', will facilitate the creation of 64 Rural Living A lots.

All of the development lots within the proposed subdivision will be accessed via a new internal road network. All internal roads will be constructed to a width of 7m within a road reserve width of 20m and operate as two lane roads with a single lane in each direction.

The proposed internal road network includes the westerly extension of Jersey Road (which currently services the Rural Living A subdivision to the east) and the northern extension of Byford Meadows Drive which connects to Abernethy Road. A new local road connection to Kargotich Road is proposed, connecting approximately 220m to the south of the intersection with Thomas Road.

The internal road network is shown in the proposed Structure Plan, reproduced in Figure 10.

Figure 10 Proposed internal road network within subdivision concept plan (source: Harley Dykstra, July 2019)

3.3 Proposed Access to External Road Network

It is proposed that the internal road network will have three connections to the external road network. The three proposed connections to the external road network are explained below and shown in Figure 11 and Figure 12.

- Connection of Jersey Road east (existing) – the internal subdivision road network will be connected through to the existing terminus of Jersey Road, which is located along the eastern boundary of the subject site. The Jersey Road corridor provides a connection through to Hopkinson Road, from which Thomas Road can be accessed to the north and Abernethy Road can be access to the south.
- Connection through to Byford Meadows Drive (existing) – the internal subdivision road network will be connected through to the existing terminus of Byford Meadows Drive, which is located along the southern boundary of the subject site. The Byford Meadows Drive corridor provides a connection through to Abernethy Road.
- New local road connection to Kargotich Road (proposed) – the internal subdivision road network will be directly connected to Kargotich Road through a local road connection of approximately 180m in length. This local road will intersect with Kargotich Road approximately 220m to the south of Thomas Road. From Kargotich Road both Thomas Road and Abernethy Road can be accessed.

Figure 11 Proposed access arrangements for the subject site shown on aerial image (map source: Nearmap)

Figure 12 Proposed external access arrangements (source: Harley Dykstra, May 2019)

The proposed local road connection to Kargotich Road will take the form of a priority controlled T-intersection. The Kargotich Road north and south approaches to the intersection with the local road connection will require left and right turning deceleration lanes given its classification as a Regional Distributor road. It is also likely the speed limit of Kargotich Road will reduce to 80km/h between the intersection with Thomas Road and to the south of the intersection with the local road connection.

The existing residential access crossover on Thomas Road and two residential access crossovers on Kargotich Road, along the boundary of the subject site, will be closed and access to the subject site will be only via the three proposed connections outlined above. In addition, the two existing gated access points to the paddocks (on Thomas Road) will also be closed. As such it is proposed that the subject site has no direct access to Thomas Road and a single connection to Kargotich Road.

The Tonkin Highway Stage 3 Extension project will extend Tonkin Highway by 14km from its current terminus with Thomas Road in Byford to the South Western Highway in Mundijong. The road is currently in the planning stages with construction likely to commence by 2023.

It is anticipated that the Tonkin Highway extension within the vicinity of the subject site will run broadly along an alignment close to the existing Hopkinson Road corridor, approximately 1.5km to the east of the subject site. Subject to the form of intersection between any Tonkin Highway extension and Abernethy Road, it would be designed to facilitate the strategic northbound and southbound movements from the subject site.

The extension will impact local east-west road connections which will be severed, including Jersey Road and Abernethy Road. Existing rural residential properties which use these local east-west road connections to access Thomas Road via Hopkinson Road will most likely redirect to Kargotich Road, via either Abernethy Road or the westerly extension of Jersey Road through the proposed Local Structure Plan and the local road connection to Kargotich Road.

4. PROVISION FOR SERVICE VEHICLES

4.1 Site Services and Vehicular Access Requirements

The subdivision is proposed to be serviced as follows (information taken from the servicing advice provided Porter Consulting – letter reference SH/L534.17).

- Water supply: 'there is an existing Water Corporation water reticulation network in the development to the east. This main can be extended to service this estate'.
    - *There are no vehicle movements associated with the proposed method of water supply.*

- Wastewater disposal: 'There is an existing Water Corporation wastewater pumping station on Jersey Road, approximately 50m east of the site. The Water Corporation have confirmed parts of the site can have a wastewater connection via a sewer mains extension. The extent of the lots within the wastewater catchment is dictated by minimum pipe grades, pipe cover and servicing levels. It is likely lots 4-9, 13-42 and 46-51 can have a wastewater service with those on the fringe being subject to detailed designs. The balance of the lots will be serviced via traditional on site disposal'.
    - *As such, it is expected that there will not be any vehicle movements associated with the proposed method of wastewater disposal.*

- Power: 'There are existing overhead power lines (east-west) across the site, these will be removed. It is likely they will be undergrounded along the southern side of the Thomas Rd road reserve boundary. There is a high voltage transmission line (north-south), this will remain. An easement has been shown on the Harley Dykstra development layout. Western Power mapping suggests there is a power supply for this estate. Discussions with Western Power will be needed during the detailed design stage to determine the location of the point of connection however it is probable this will be from the existing development to the east. Points of supply will be provided for each lot. The road network will be lit in accordance with the governing standards'.
    - *Western Power will require access to their infrastructure for maintenance purposes. Access will be facilitated via the new internal road network through the site, which will be designed of sufficient width/standard to safely accommodate all maintenance requirements.*

- Gas: 'There is no gas reticulation in the surrounding area. Discussions can be held with ATCO if a gas supply is required'.
    - *If a gas supply is provided to the estate, ATCO would require access to their infrastructure for maintenance purposes. Access will be facilitated via the new internal road network through the site, which will be designed of sufficient width/standard to safely accommodate all maintenance requirements.*

- Telecommunications: 'Telstra has an existing network in the estates to the south and east. It is likely these networks will be extended to service this development'.
    - *Telstra or other Telco will require access to their infrastructure for maintenance purposes. Access will be facilitated via the new internal road network through the site, which will be designed of sufficient width/standard to safely accommodate all maintenance requirements.*

- Department of Fire and Emergency Services: 'It is likely the estate will be fenced consistent with rural residential estates. It is likely fire breaks will be established as part of the development process with each lot purchaser then being required to manage their property accordingly'.
    - *Access for fire trucks and other emergency service vehicles will be facilitated via the new internal road network through the site, which will be designed of sufficient width/standard to safely accommodate all emergency vehicle requirements.*

4.2 Refuse Collection

Refuse collection will take place along the new internal road network through the site, which will be designed to sufficient width and standard to safely accommodate all of the Shire's refuse collection requirements.

5. TRAFFIC VOLUMES AND VEHICLE TYPES

5.1 Existing Traffic Generated by Development Site

The site currently contains a single residential dwelling with associated sheds accessed via a crossover on Thomas Road and two residential dwellings with associated sheds accessed via separate crossovers on Kargotich Road. As such the site currently generates very minimal daily traffic and has no impact on peak hour traffic carried by the surrounding road network.

In addition to the very minimal residential traffic generated by the site, there would be ad hoc vehicle movements associated with the maintenance of the rural paddocks which currently cover the site.

5.2 Traffic Generated by Development

The WAPC's Transport Impact Assessment Guidelines Volume 5 – Technical Guidance provides residential peak hour trip rates as shown in Table 1. The residential trip rates are based on the Perth and Regions Travel Surveys (PARTS) data averaged over the range of dwelling types.

Table 1 Typical residential vehicle trip rates (source: WAPC TIA Guidelines for Subdivision, August 2016)

Land Use	Unit	AM Peak Hour Trip Rate			PM Peak Hour Trip Rate			Effective Daily Rate
		IN	OUT	TOTAL	IN	OUT	TOTAL	TOTAL
Residential	Dwellings	0.2	0.6	0.8	0.5	0.3	0.8	8

The WAPC trip rates may be considered low for this location as they represent an average of the entire Metropolitan area. As walk trips, cycle trips and public transport trips will play no significant role in access to the site, it is considered prudent to increase the typical vehicle trip rates to reflect the reliance of private vehicle movements to access the site.

Of the proposed 64 Rural Living A lots, 50 lots (representing 78% of the total number of lots) will be between 4,000m² and 10,000m², with 14 lots (22% of the total) between 1 and 2 hectares. While it could be assumed that there will be a difference in traffic generation between the different lot sizes, a uniform trip rate of up to 12 trips per lot has been assumed, which represents an uplift of 50% over the WAPC trip rates.

Table 2 shows the traffic generated from the subject site using the uplifted trip rates.

Table 2 Traffic generated by subdivision concept plan

Approach		AM Peak Hour			PM Peak Hour		
		IN	OUT	TOTAL	IN	OUT	TOTAL
Uplifted Trip Rates	Trip Rate	0.3	0.9	1.2	0.75	0.9	1.2
	Traffic Generated	19	58	77	48	29	77

The development of 64 Rural Living A lots on the subject site would generate up to 77 peak hour vehicle movements, and up to 760 daily trips.

5.3 Traffic Distribution

The proposed access to/from the external road network includes the new local road connection to Kargotich Road, Jersey Road (to the east) and Byford Meadows Drive (to the southeast). With the future extension of Tonkin Highway severing the connection between Jersey Road (east) and Hopkinson Road, it is anticipated that vehicle movements into and out of the site would predominantly use the new local road connection to Kargotich Road. From Kargotich Road most traffic is assumed to head north toward Thomas Road, with the distribution of turning traffic at this intersection based on site observations of existing left, through and right movements.

The proposed external trip distribution is assumed to be:

- 10% to/from Byford Meadows Drive (to Abernethy Road)
- 90% to/from new local road connection (to Kargotich Road);
  - 18% to/from Kargotich Road south;
  - 72% to/from Kargotich Road north;
    - AM Peak hour: To development
      - 41% from Thomas Road west;
      - 28% from Thomas Road east;
      - 3% from Kargotich Road north;
    - AM Peak hour: From development
      - 44% to Thomas Road west;
      - 20% to Thomas Road east;
      - 8% to Kargotich Road north;
    - PM Peak hour: To development
      - 37% from Thomas Road west;
      - 34% from Thomas Road east;
      - 1% from Kargotich Road north;
    - PM Peak hour: From development
      - 44% to Thomas Road west;
      - 16% to Thomas Road east; and
      - 12% to Kargotich Road north.

5.4 Traffic Impact of Subject Site Rezoning

Most roads within the proposed local road network are forecast to carry between 100 and 300 vehicles per day (vpd), with the westward extension of Jersey Street projected to carry up to 600 vpd (traffic generated within the subject site). The local road connection to Kargotich Road is forecast to carry up to 700 vpd.

With the future extension of Tonkin Highway severing the connection between Jersey Road (east) and Hopkinson Road, traffic generated by the Rural Living A development immediately to the east of the subject site may re-route through the subject site. This could add a further 70 vehicles in the peak hour and 700 vpd to Jersey Road within the subject site and to the local road connection to Kargotich Road.

The increase in traffic volumes to existing roads as a result of the rezoning and subsequent development of the subject site is summarised in Table 3.

Table 3 – Traffic volume impact on existing roads of rezoning of subject site

Road	Section	Additional Traffic Volumes		
		AM Peak	PM Peak	Daily
Traffic generated by subject site – no redistribution of external traffic due to Tonkin Hwy extension				
Byford Meadows Drive	South of site	+10	+10	+80
Abernethy Road	West or east of Byford Meadows Dr	+10	+10	+80
Kargotich Road	South of new local road connection	+15	+15	+140
	Thomas Road to new local road connection	+55	+55	+550
	North of Thomas Rd	+6	+4	+50
Thomas Road	West of Kargotich Rd	+35	+30	+320
	East of Kargotich Rd	+17	+20	+190
Traffic generated by subject site and including redistribution of external traffic due to Tonkin Hwy extension				
Byford Meadows Drive	South of site	+15	+15	+160
Abernethy Road	West of Byford Meadows Dr	+15	+15	+160
Kargotich Road	South of new local road connection	+30	+30	+280
	Thomas Road to new local road connection	+110	+110	+1,130
	North of Thomas Rd	+10	+10	+100
Thomas Road	West of Kargotich Rd	+70	+60	+650
	East of Kargotich Rd	+35	+45	+400

The impact of development traffic on the external road network will be discussed in section 6.4. The further impact of traffic generated from areas external to the subject site that may be redirected as a result of the future southerly extension of Tonkin Highway will be discussed in section 6.5.

6. TRAFFIC MANAGEMENT ON FRONTAGE STREETS

6.1 Existing Road Network

The subject site has direct frontage access to Thomas Road along its northern boundary and Kargotich Road along its western boundary.

Figure 13 shows the location of the subject site in relation to the designation of roads within Main Roads WA Road Hierarchy, and Figure 14 shows the posted speed limits on the road network surrounding the site.

Thomas Road is classified as a Primary Distributor and Kargotich Road is classified as a Regional Distributor within the Main Roads WA Road Hierarchy. Main Roads WA provide the following description of these two classifications of road:

- Primary Distributor roads provide for major regional and inter-regional traffic movement and carry large volumes of generally fast-moving traffic. Primary Distributors are managed by Main Roads WA and typically carry above 15,000 vehicles per day; and
- Regional Distributor roads are located in rural areas and link significant destinations and are designed for the efficient movement of people and goods within and beyond regional areas. Regional Distributors are managed by Local Government and typically carry between 8,000-15,000 vehicles per day.

As such, Thomas Road is managed by Main Roads WA and Kargotich Road is managed by the Shire of Serpentine Jarrahdale. The two road corridors have the following features:

- Thomas Road adjacent to the subject site has a posted speed limit of 90km/h and operates as a two lane road (single carriageway in each direction), with a carriageway width of approximately 7.5m and with sealed shoulders. Thomas Road is part of the restricted access vehicle (RAV) network 4, permitted to carry trucks up to 27.5m in length and a mass of up to 87.5 tonnes. Traffic counts, undertaken on Thomas Road at a site east of Kargotich Road in 2018, reveal Thomas Road is carrying 16,300 vpd, with 15.0% heavy vehicles. Thomas Road is approaching capacity for a two lane road and will require duplication to four lane divided standard in the future.
- Kargotich Road has a posted speed limit of 90km/h and operates as a two lane road (single carriageway in each direction), with a carriageway width of approximately 7.5m and sections of unsealed shoulders. Between Thomas Road and Mundijong Road, Kargotich Road is part of the restricted access vehicle (RAV) network 3, permitted to carry trucks up to 27.5m in length and a mass of up to 84 tonnes. The most recent traffic counts for Kargotich Road, at a site south of Thomas Road in 2014, reveal Kargotich Road is carrying 3,500 vpd, with 13.5% heavy vehicles.

Figure 13 Location of subject site within Main Roads WA Road Hierarchy (source: Main Roads WA)

Figure 14 Posted speed limits on road network surrounding the subject site (source: Main Roads WA)

6.2 Intersection and Types of Control

The intersection of Thomas Road and Kargotich Road is within immediate proximity of the subject site. The intersection is four-way with stop sign control. Thomas Road has priority with vehicles travelling along Kargotich Road approaching Thomas Road are required to stop before continuing if it is safe to do so.

Both the Kargotich Road north and south approaches to the intersection with Thomas Road feature blister islands to slow vehicles approaching Thomas Road. A review of historical aerial images of the intersection shows that the blister island on the north approach was remodeled in 2005/2006 and is set back approximately 40m from the stop line with Thomas Road. The blister island on the southern approach was installed in 2013 and is set back approximately 60m from the stop line with Thomas Road.

Thomas Road features a westbound left turn auxiliary lane of approximately 60m, which enables westbound vehicles on Thomas Road turning left to travel southbound on Kargotich Road, to safely deaccelerate outside of the westbound through lane on Thomas Road. Thomas Road also features an eastbound right turn auxiliary lane of approximately 70m, which enables eastbound traffic on Thomas Road turning right to head southbound on Kargotich Road, to safely deaccelerate outside of the eastbound through lane on Thomas Road.

The configuration of the Thomas Road and Kargotich Road intersection is shown in Figure 15 and the two blister island treatments on the Kargotich Road approaches to the intersection are shown in Figure 16.

Figure 15 Crossroads intersection of Thomas Road and Kargotich Road (map source: Nearmap)

Figure 16 Blister island treatments on Kargotich Road approaches to Thomas Road (source: Google Street View)

The proposed connections from the subject site to the surrounding road network would result in additional development related traffic travelling through the following local intersections:

- Jersey Road and Hopkinson Road intersection (existing);
- Byford Meadows Drive and Abernethy Road intersection (existing); and
- New local road connection and Kargotich Road (proposed).

The intersection of Jersey Road and Hopkinson Road is a priority controlled T-intersection with Hopkinson Road having priority and Jersey Road forming the minor arm of the intersection. Vehicles travelling along Jersey Road approaching Hopkinson Road are required to stop before continuing if it is safe to do so.

Hopkinson Road features a northbound left turn auxiliary lane of approximately 75m, which enables northbound vehicles on Hopkinson Road turning left and traveling westbound on Jersey Road, to safely deaccelerate outside of the northbound through lane on Hopkinson Road. The intersection is shown in Figure 17.

Figure 17 Jersey Road and Hopkinson Road intersection (source: Google Street View)

The intersection of Byford Meadows Drive and Abernethy Road is an uncontrolled T-intersection with Abernethy Road having priority and Byford Meadows Drive forming the minor arm of the intersection. Vehicles travelling along Byford Meadows Drive approaching Abernethy Road are required to stop before continuing if it is safe to do so. The intersection is shown in Figure 18.

Figure 18 Byford Meadows Drive and Abernethy Road intersection (source: Google Street View)

The proposed local road connection to Kargotich Road will take the form of a priority controlled T-intersection. The Kargotich Road north and south approaches to the intersection with the local road connection will require left and right turning deceleration lanes given its classification as a Regional Distributor road. It is also likely the speed limit of Kargotich Road will reduce to 80km/h between the intersection with Thomas Road and to the south of the intersection with the local road connection.

6.3 Existing Traffic Volumes

Peak hour traffic counts were undertaken on Wednesday May 15th and Thursday May 16th 2019 at the intersection of Thomas Road and Kargotich Road. Observations were also made of traffic conditions including queue lengths and typical delays for turning vehicles. The traffic counts were undertaken between 7:00 and 8:00 AM and between 4:30 and 5:30 PM, which represent the peak times for Thomas Road and the potential traffic to be generated by the rezoned subject site.

The intersection was observed to be very congested in both peak periods, however the AM peak hour was worse for queues on the Kargotich Road south approach (adjacent to the subject site), which at their worst extended past the blister island. Left turners from Kargotich Road south into Thomas Road are able to find breaks in the traffic stream to enter (possibly due to the close proximity to the signalised intersection of Thomas Road and Tonkin Highway) and do not experience large delays except when they are caught in the queue of through and right turning vehicles.

The existing peak hour traffic volumes are shown in Table 4.

Table 4 – Existing peak hour turning traffic volumes

Approach	Movement	AM Peak	PM Peak
Thomas Road / Kargotich Road			
Thomas Road west	Left	14	10
	Through	592	788
	Right	42	133
Kargotich Road south	Left	134	58
	Through	26	15
	Right	61	20
Thomas Road east	Left	29	124
	Through	766	732
	Right	11	8
Kargotich Road north	Left	12	4
	Through	3	4
	Right	1	9

6.3.1 Existing Intersection Performance

SIDRA Intersection 8.0 has been used to assess the existing peak hour performance of the intersection between Thomas Road and Kargotich Road. The SIDRA model has been calibrated to try to match the queuing and delays observed on-site.

The SIDRA predicted peak hour results are summarised in Table 5. Detailed SIDRA output is provided in Appendix 1.

Table 5 – SIDRA predicted existing intersection performance – AM and PM peak hours

Approach	Turn	AM Peak hour			PM Peak hour		
		Level of Service	Delay (s)	95th % Back of Queue (m)	Level of Service	Delay (s)	95th % Back of Queue (m)
Thomas Road / Kargotich Road							
Thomas Road west	Left	A	5.7	0	A	5.8	0
	Through	A	0	0	A	0.1	0
	Right	B	13.3	2.7	C	16.5	11.3
Kargotich Road south	Left	C	22.5	13.8	C	17.9	4.4
	Through	F	335.6	128.7	F	155.3	21.1
	Right	F	362.8	128.7	F	215.1	21.1
Thomas Road east	Left	A	8.9	0	A	5.7	0
	Through	A	0.1	0	A	0.1	0
	Right	A	5.7	0.4	B	11.2	0.4
Kargotich Road north	Left	B	14.2	1.6	E	37.3	7.8
	Through	D	33.9	1.6	F	77.1	7.8
	Right	F	79.1	1.6	F	133.0	7.8

SIDRA predicts the Kargotich Road approaches to the intersection with Thomas Road are currently operating at a level of service F in the peak hours. Vehicles turning right from Kargotich Road south into Thomas Road are predicted to experience delays of up to 5½ minutes in the AM peak and 3½ minutes in the PM peak.

SIDRA analysis concurs with the on-site observations which concluded the Kargotich Road approach to this intersection has already exceeded its capacity, given its current configuration.

Due to the higher than expected rate of crashes (discussed in section 11.1), the intersection has attracted Black Spot funding. A roundabout controlled intersection has been proposed as a possible solution to address the road safety issues. Traffic analysis of future intersection capacity (including development traffic volumes and any traffic that is redirected as a result of the future Tonkin Highway extension) will be based on roundabout control.

While in its ultimate configuration the roundabout will accommodate a four lane Thomas Road, the roundabout has been assumed to have a single approach and exit lane for Kargotich Road north and south, with two approach and exit lanes for Thomas Road west and east, reducing to a single approach and exit lane 80m from the roundabout.

6.4 Forecast Traffic Volumes

The forecast increase in peak hour traffic volumes through the existing intersection of Thomas Road and Kargotich Road and the proposed intersection of Kargotich Road and the new local road connection as a result of the rezoning and subsequent development of the subject site is summarised in Table 6.

Table 6 – Forecast increase to peak hour turning traffic volumes

Approach	Movement	AM Peak	PM Peak
Thomas Road / Kargotich Road			
Thomas Road west	Left		
	Through		
	Right	+8	+17
Kargotich Road south	Left	+25	+12
	Through	+5	+3
	Right	+11	+4
Thomas Road east	Left	+5	+16
	Through		
	Right		
Kargotich Road north	Left		
	Through	+1	+1
	Right		
Kargotich Road / New local road connection			
Kargotich Road north	Left	+14	+34
	Through		
New local road connection	Left	+10	+5
	Right	+41	+20
Kargotich Road south	Through		
	Right	+3	+8

6.4.1 Forecast Intersection Performance

SIDRA Intersection 8.0 has been used to assess the forecast peak hour performance of the intersection between Thomas Road and Kargotich Road and the proposed intersection of Kargotich Road and the new local road connection.

The SIDRA predicted peak hour results are summarised in Table 7. Detailed SIDRA output is provided in Appendix 2.

Table 7 – SIDRA predicted future intersection performance – AM and PM peak hours

Approach	Turn	AM Peak hour			PM Peak hour		
		Level of Service	Delay (s)	95th % Back of Queue (m)	Level of Service	Delay (s)	95th % Back of Queue (m)
Thomas Road / Kargotich Road							
Thomas Road west	Left	A	6.5	9.6	A	6.0	13.8
	Through	A	6.8	18.5	A	6.5	27.8
	Right	B	12.6	18.5	B	12.0	27.8
Kargotich Road south	Left	B	10.8	17.5	A	5.0	7.2
	Through	B	11.4	17.5	B	9.7	7.2
	Right	B	17.3	17.5	B	10.4	7.2
Thomas Road east	Left	A	6.1	11.5	A	7.0	13.0
	Through	A	6.5	20.0	A	7.2	26.0
	Right	B	12.3	20.0	B	13.1	26.0
Kargotich Road north	Left	A	8.9	0.9	B	10.1	1.0
	Through	A	9.5	0.9	B	10.7	1.0
	Right	A	15.4	0.9	B	16.6	1.0
Kargotich Road / New local road connection							
Kargotich Road north	Left	A	7.0	0.0	A	7.0	0.0
	Through	A	0.0	0.0	A	0.0	0.0
New local road connection	Left	A	5.9	0.3	A	6.7	0.2
	Right	A	8.2	2.2	A	9.0	1.2
Kargotich Road south	Through	A	0.0	0.0	A	0.0	0.0
	Right	A	7.2	0.1	A	8.3	0.3

SIDRA predicts a roundabout controlled intersection of Thomas Road with Kargotich Road would operate at a level of service A in the peak hours. The proposed priority controlled T-intersection of Kargotich Road and the new local road connection is also predicted to operate at a level of service A.

6.5 Impact of Tonkin Highway Extension

With the future extension of Tonkin Highway severing the connection between Jersey Road (east) and Hopkinson Road, traffic generated by the Rural Living A development immediately to the east of the subject site may re-route through the subject site. This could add a further 70 vehicles in the peak hour and 700 vpd to Jersey Road within the subject site and to the local road connection to Kargotich Road.

Table 8 details the forecast increase in peak hour traffic volumes through the existing intersection of Thomas Road and Kargotich Road and the proposed intersection of Kargotich Road and the new local road connection as a result of the:

1. rezoning and subsequent development of the subject site, and
2. redistribution of local traffic as a result of the southerly extension of Tonkin Highway

Table 8 – Forecast peak hour turning traffic volumes with Tonkin Hwy extension

Approach	Movement	AM Peak	PM Peak
Thomas Road / Kargotich Road			
Thomas Road west	Left		
	Through		
	Right	+16	+36
Kargotich Road south	Left	+51	+26
	Through	+10	+7
	Right	+24	+9
Thomas Road east	Left	+11	+34
	Through		
	Right		
Kargotich Road north	Left		
	Through	+1	+1
	Right		
Kargotich Road / New local road connection			
Kargotich Road north	Left	+28	+70
	Through		
New local road connection	Left	+21	+11
	Right	+84	+42
Kargotich Road south	Through		
	Right	+7	+18

SIDRA Intersection 8.0 has been used to assess the peak hour performance of the two intersections with the traffic attributable to the rezoning and development of the subject site, plus the redirected traffic due to the southerly extension of Tonkin Highway.

The SIDRA predicted peak hour results are summarised in Table 9. Detailed SIDRA output is provided in Appendix 3.

Table 9 – SIDRA predicted future intersection performance with Tonkin Hwy extension – AM and PM peak hours

Approach	Turn	AM Peak hour			PM Peak hour		
		Level of Service	Delay (s)	95th % Back of Queue (m)	Level of Service	Delay (s)	95th % Back of Queue (m)
Thomas Road / Kargotich Road							
Thomas Road west	Left	A	6.7	10.2	A	6.1	14.5
	Through	A	7.0	19.6	A	6.5	29.6
	Right	B	12.8	19.6	B	12.4	29.6
Kargotich Road south	Left	B	11.9	24.5	A	9.9	9.5
	Through	B	12.5	24.5	B	10.6	9.5
	Right	B	18.4	24.5	B	16.4	9.5
Thomas Road east	Left	A	6.2	11.9	A	7.2	13.9
	Through	A	6.5	20.9	A	7.4	28.1
	Right	B	12.4	20.9	B	13.3	28.1
Kargotich Road north	Left	A	9.0	1.0	B	10.2	1.1
	Through	A	9.7	1.0	B	10.9	1.1
	Right	A	15.6	1.0	B	16.7	1.1
Kargotich Road / New local road connection							
Kargotich Road north	Left	A	7.0	0.0	A	7.0	0.0
	Through	A	0.0	0.0	A	0.0	0.0
New local road connection	Left	A	5.9	0.6	A	6.8	0.4
	Right	A	8.6	4.8	A	9.5	2.6
Kargotich Road south	Through	A	0.0	0.0	A	0.0	0.0
	Right	A	7.3	0.2	A	8.6	0.7

SIDRA predicts a roundabout controlled intersection of Thomas Road with Kargotich Road would maintain operation at a level of service A in the peak hours. The proposed priority controlled T-intersection of Kargotich Road and the new local road connection is also predicted to operate at a level of service A.

7. PUBLIC TRANSPORT ACCESS

7.1 Access to Public Transport

It is acknowledged that the subject site has limited access to public transport services and the nature of the site location and form of subdivision proposed would see the creation of Rural Living A lots which are traditionally primarily served by private vehicle access.

As such the existing limited access to public transport services does not diminish the desirability of the lots or their suitability for the development of Rural Living A accommodation in the future.

7.2 Existing Public Transport Services

There are limited public transport services accessible from the subject site. To access bus and train services to/from the site, would requires a short drive due to the distance to access the closest bus stop or train station. Due to the interchange required from car to public transport and associated time penalty incurred, it is considered very unlikely that public transport would form part of a journey with an origin or destination within the subject site.

7.2.1 Bus Services

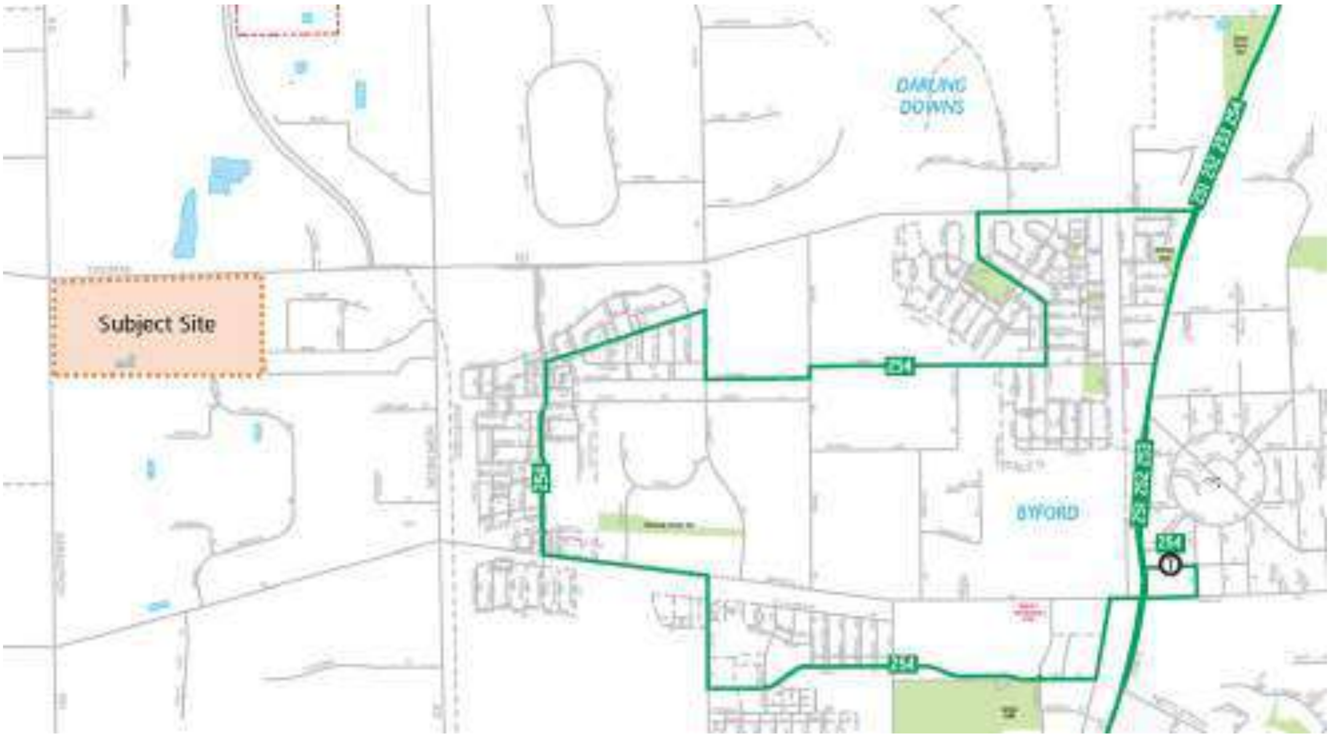
Transperth bus route 254 serves the Byford area and operates a route that gets within approximately 2.5km of the centre of the subject site. The nearest bus stops to the subject site are located within the Redgum Brook Estate. The bus stops at the northern end of the Redgum Brook Estate by Kardan Boulevard/Ballawarra Avenue are 2.5km from the subject site (via Jersey Road-Hopkinson Road-Thomas Road-Kardan Boulevard), and the bus stops at the southern end of the Redgum Brook Estate by Abernethy Road/Kardan Boulevard are 3.5km from the subject site (via Byford Meadows Drive-Abernethy Road-Kardan Boulevard).

There are no footpaths along Jersey Road, Byford Meadows Drive, Hopkinson Road, Thomas Road nor Abernethy Road – therefore it is unlikely that anyone would walk directly between the site and bus stops due to both distance between the two locations (approximately 2.5km-3.5km) and safety concerns. Residents of the subject site would be reliant upon being driven and dropped-off to use the local bus service.

Bus route 254 operates a route between Armadale Station and Byford via Karden Boulevard, with approximately 20 weekday bus services in each direction (towards Armadale and towards Byford) between the hours of 6am-7pm. Bus route 254 provides a 20-30 minute frequency during the morning and afternoon peak hours and hourly at all other times.

Bus route 254 operates in each direction on a 60-minute frequency between 7am-6pm on Saturdays and only five services between 9am-5pm on Sundays. Figure 19 shows the location of the subject site in relation to bus route 254.

Figure 19 Existing bus service in relation to the subject site (source: Transperth)



7.2.2 Train Services

The Transwa Australind train service between Perth and Bunbury serves the station of Byford, which is located approximately 6.5km from the centre of the subject site. The Australind train service provides two daily services to Perth (departing Byford at 7.49am and 4.32pm) and two daily service to Bunbury (departing Byford at 10.07am and 6.36pm).

Due to the limited destinations served and number of services per day it is extremely unlikely that the Australind train service from Byford station would be used regularly by those wishing to access the subject site.

In addition, Armadale Station provides direct train services to Perth with a journey time of 35-45 minutes and a weekday 15-minute frequency. However, Armadale station is approximately 13km from the subject site and is considered unlikely to attract a large number of trips with an origin or destination within the subject site.

8. PEDESTRIAN ACCESS

8.1 Existing Pedestrian Facilities

There are no formal pedestrian facilities within an 800m (10 minute) walk from the subject site, which is typical for a rural location with rural/rural living land uses within proximity of the site.

Figure 20 shows the eastbound and westbound view along Thomas Road from a location adjacent to the subject site, Figure 21 shows the northbound and southbound view along Kargotich Road from a location adjacent to the subject site, Figure 22 shows the eastbound and westbound view along Jersey Road from a location to the east of the tie-in point to the subject sites proposed internal road network, and Figure 23 shows the northbound and southbound view along Byford Meadows Drive from a location to the south of the tie-in point to the subject sites proposed internal road network.

These figures highlight the hostile pedestrian environment along the two road corridors running adjacent to the northern and western boundaries of the site, and the lack of pedestrian infrastructure along the two existing residential road corridors proposed to provide connections into the subject site. As such it is not anticipated that trips to and from the site would be made on foot.

8.2 Proposed Pedestrian Facilities

Due to the location of the subject site and lack of land uses within a reasonable walk distance from the site, it is not proposed to install new pedestrian infrastructure along the Thomas Road or Kargotich Road corridors.

It is also not proposed to install any formal pedestrian infrastructure within the subject site along the new internal road. This is due to the small number of lots created by the proposed subdivision (64 lots) unlikely to generate sufficient local walking trips and the lack of any footpath network surrounding the subject site in which to connect.

Any walk trips between properties within the subject site can be safely made via the new internal road network, which would have low traffic volumes due to the small number of lots being created by the subdivision and low vehicle speeds due to the size of the subdivision site.

Figure 20 Thomas Road corridor adjacent to the subject site (source: Google Street View)

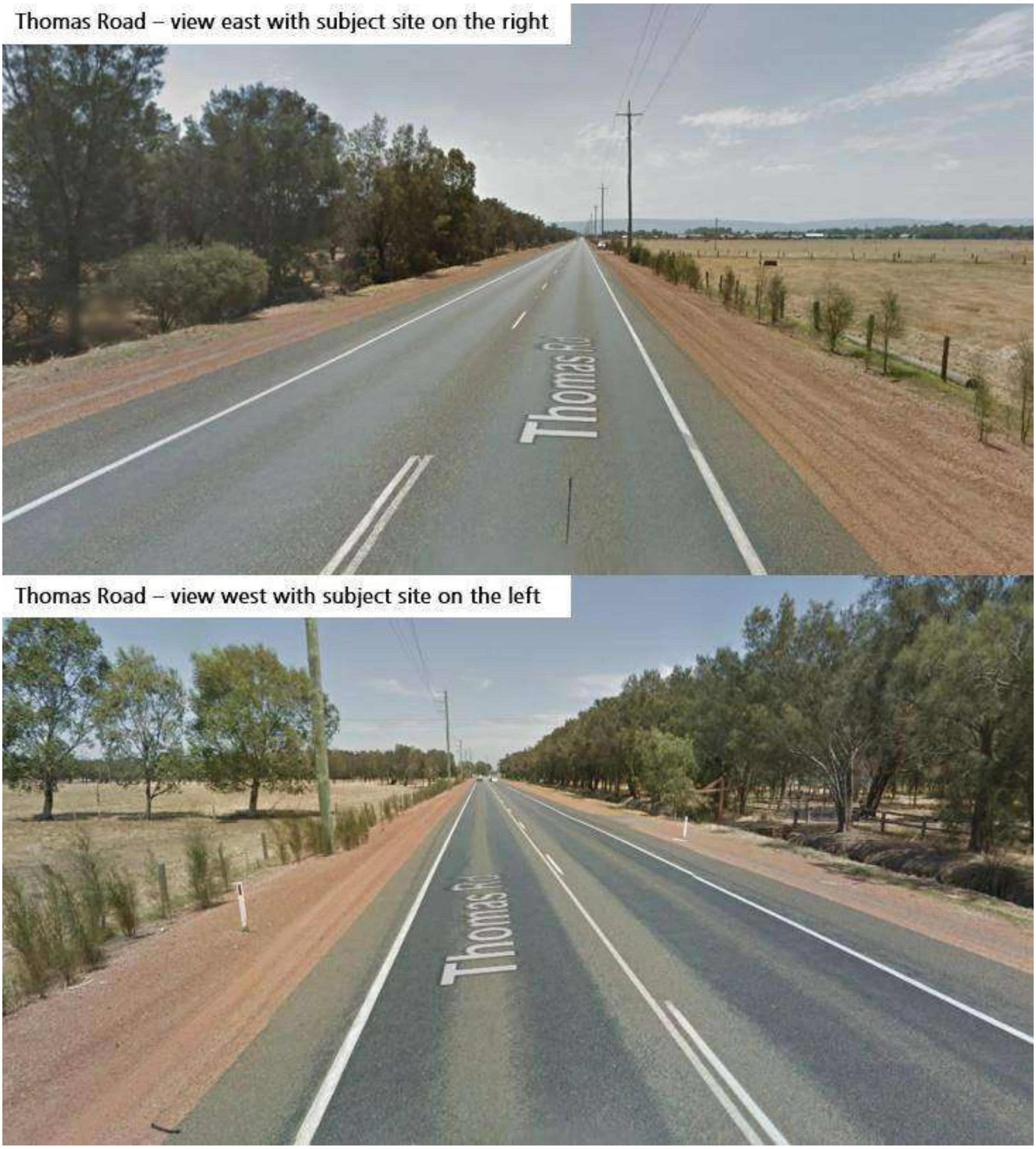


Figure 21 Kargotich Road corridor adjacent to the subject site (source: Google Street View)

Figure 22 Jersey Road corridor adjacent to the subject site (source: Google Street View)

Figure 23 Byford Meadows Drive corridor adjacent to the subject site (source: Google Street View)

9. CYCLE ACCESS

9.1 Existing Cycle Facilities

There are very limited cycle facilities within a reasonable distance from the subject site, which is typical for a rural location with rural/rural living land uses within proximity of the site.

The location of the subject site is not covered by the Department of Transport comprehensive bike map entitled 'Canning and Armadale'. The bike map covers an area as far south as Thomas Road and as far west as Byford South.

The bike map identifies Abernethy Road through Byford South as a 'good road riding environment' and the Hopkinson Road corridor south of Thomas Road as a 'good road riding environment'. However, due to the posted speed limits of these roads (60km/h and 70km/h respectively) and the lack of formal bike infrastructure or sealed shoulder, it is unlikely that all but the most confident road cyclists would use these routes.

All road corridors surrounding the subject site provide for a hostile environment for cyclists, as such it is not anticipated that trips to and from the site would be made by bike.

9.2 Proposed Cycle Facilities

Due to the location of the subject site and lack of land uses within a reasonable cycle from the site, it is not proposed to install new bike infrastructure along the Thomas Road or Kargotich Road corridors.

It is also not proposed to install any formal bike infrastructure within the subject site along the new internal road. This is due to the small number of lots created by the proposed subdivision (64 lots) unlikely to generate sufficient local cycling trips and the lack of any bike network surrounding the subject site in which to connect.

Any cycling trips between properties within the subject site can be safely made via the new internal road network, which would have low traffic volumes due to the small number of lots being created by the subdivision and low vehicle speeds due to the size of the subdivision site.

10. SITE SPECIFIC ISSUES

The Tonkin Highway Stage 3 Extension project will extend Tonkin Highway by 14km from Thomas Road in Byford to the South Western Highway in Mundijong. The road is currently in the planning stages with construction likely to commence by 2023.

The extension will impact local east-west road connections which will be severed, including Jersey Road and Abernethy Road. Existing rural residential properties which use these local east-west road connections to access Thomas Road via Hopkinson Road will most likely redirect to Kargotich Road, via either Abernethy Road or the westerly extension of Jersey Road through the proposed Local Structure Plan and the local road connection to Kargotich Road.

As has been demonstrated in section 6.5, the proposed roundabout controlled intersection of Thomas Road and Kargotich Road would have adequate capacity to accommodate existing traffic volumes, those resulting from the proposed rezoning and those attributable to redirection as a result of the Tonkin Highway extension.

11. SAFETY ISSUES

11.1 Crash History

In the five-year period ending December 31st 2018, there were 26 reported crashes at the intersection of Kargotich Road and Thomas Road, including 9 crashes which required medical treatment. Of the 26 crashes, 15 were right angle crashes (vehicles approaching from adjacent approaches of the intersection), 5 were rear end (a vehicle colliding with the rear of another vehicle), 3 were right turn crashes (a vehicle turning right in front of an oncoming vehicle), 1 was a sideswipe crash (a vehicle colliding with the side of another vehicle) and 2 were other crash type.

The number of right angle crashes, casualty crashes and crashes involving trucks are higher than Main Roads WA would expect for an intersection of this type carrying this level of traffic. The intersection is ranked 4th for crash frequency within the Shire of Serpentine Jarrahdale, behind the first-ranked intersection of Thomas Road with Nicholson Road and the second-ranked intersection of Thomas Road with Hopkinson Road (all intersections within the same 4.6km stretch of Thomas Road).

The intersection has attracted Black Spot funding to address the higher than expected rate of crashes. A roundabout controlled intersection has been proposed as a possible solution to address the road safety issues.

As has been demonstrated in section 6.5, a roundabout controlled intersection would have adequate capacity to accommodate existing traffic volumes, those resulting from the proposed rezoning and those attributable to redirection as a result of the Tonkin Highway extension.

12. CONCLUSIONS

12.1 Transport Impact Statement Conclusions

This Transport Assessment has been prepared to support the proposed rezoning of Lot 4 Kargotich Road and Lot 2 Thomas Road, Oakford, from 'Rural' to 'Rural Living A'. The proposed rezoning will facilitate the creation of 64 Rural Living A lots. The transport assessment considers the impact of the future extension of Tonkin Highway.

The subject site currently contains three single residential dwellings each with associated sheds but is otherwise undeveloped. The site is mostly cleared with scattered trees, having historically been used for grazing.

One of the residential dwellings is accessed via a crossover on Thomas Road, with a gravel track to the property. Two of the residential dwellings are accessed via separate crossovers on Kargotich Road, with gravel tracks to the properties. In addition to these three crossovers providing vehicular access to residential dwellings, there are two crossovers on Thomas Road that provide gated access to the paddocks.

All of the development lots within the proposed subdivision will be accessed via a new internal road network. It is proposed that all new internal roads would have a road reserve width of 20m and operate as two lane roads with a single lane in each direction. It is proposed that the internal road network will have three connections to the external road network. The three proposed connections are:

- Connection through to Jersey Road (east);
- New local road connection to Kargotich Road;
- Connection through to Byford Meadows Drive.

In addition, it is proposed that the existing residential access crossover on Thomas Road, two residential access crossovers on Kargotich Road and two gated access points to paddocks on Thomas Road will all be closed.

The site has limited access to pedestrian, cycling and public transport facilities, therefore it is assumed that all movements to the subject site will be made via private vehicle.

The development of 64 Rural Living A lots on the subject site would generate up to 77 peak hour vehicle movements and 770 vehicle trips per day. Most roads within the proposed local road network are forecast to carry between 100 and 300 vehicles per day (vpd), with the local road connection to Kargotich Road projected to carry up to 700 vpd (traffic generated within the subject site).

With the future extension of Tonkin Highway severing the connection between Jersey Road (east) and Hopkinson Road, traffic generated by the Rural Living A development immediately to the east of the subject site may re-route through the subject site. This could add a further 70 vehicles in the peak hour and 700 vpd to the local road connection to Kargotich Road.

The proposed local road connection to Kargotich Road will take the form of a priority controlled T-intersection. The Kargotich Road north and south approaches to the intersection with the local road connection will require left and right turning deceleration lanes given its classification as a Regional Distributor road. It is also likely the speed limit of Kargotich Road will reduce to 80km/h between the intersection with Thomas Road and to the south of the intersection with the local road connection. This proposed intersection has been assessed using SIDRA and was found to have adequate capacity to accommodate existing traffic volumes, those resulting from the proposed rezoning and those attributable to redirection as a result of the Tonkin Highway extension.

A roundabout at the intersection of Thomas Road and Kargotich Road has been found to have adequate capacity to accommodate existing traffic volumes, those resulting from the proposed rezoning and those attributable to redirection as a result of the Tonkin Highway extension.

12.2 Transport Impact Statement Checklist

The checklist from the WAPC Guidelines for Transport Impact Statements is set out as follows.

Item	Status	Comments/Proposals
Proposed subdivision		
- proposed land uses	Included	Section 2
- existing land uses	Included	Section 2
- context with surrounds	Included	Section 2
Vehicular access and parking		
- access arrangements	Included	Section 3
- public, private, disabled parking set down / pick up	N/A	Not relevant to proposed form of subdivision
Service vehicles		
- access arrangements	Included	Section 4
- on/off-site loading facilities	N/A	Not relevant to proposed form of subdivision
Traffic volumes and vehicle types		
- daily or peak traffic volumes	Included	Section 5
- type of vehicles (e.g. cars, trucks)	Included	Section 5
Traffic management on frontage streets	Included	Section 6
Public transport access		
- nearest bus/train routes	Included	Section 7
- nearest bus stops/train stations	Included	Section 7
- pedestrian/cycle links to bus stops / train station	N/A	Not relevant to proposed form of subdivision
Pedestrian access/facilities		
- existing pedestrian facilities	Included	Section 8
- proposed pedestrian facilities	Included	Section 8
- existing pedestrian facilities on surrounding roads	Included	Section 8
- proposals to improve pedestrian access	Included	Section 8
Cycle access/facilities		
- existing cycle facilities	Included	Section 9
- proposed cycle facilities	Included	Section 9
- existing cycle facilities on surrounding roads	Included	Section 9
- proposals to improve cycle access	Included	Section 9
Site specific issues	Addressed	Section 10
Safety issues		
- identify issues	Addressed	Section 11
- remedial measures	Addressed	Section 11

Proponents Name	Company	Signed/Date
Transport Assessors Name	Company	Signed/Date
Claire Smith	Flyt Pty Ltd	15/08/19

Appendix 1 – SIDRA Output (Existing Intersection Performance

MOVEMENT SUMMARY

Site: 1 [Thomas Kargotich AM existing]

Thomas Rd / Kargotich Rd
Existing traffic volumes
AM Peak
Site Category: (None)
Stop (Two-Way)

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	134	13.0	0.432	23.8	LOS C	1.8	13.8	0.82	1.06	1.12	52.7
2	T1	26	13.0	1.112	336.9	LOS F	16.5	128.7	1.00	1.96	6.53	9.0
3	R2	61	13.0	1.112	364.1	LOS F	16.5	128.7	1.00	1.96	6.53	9.0
Approach		221	13.0	1.112	154.6	LOS F	16.5	128.7	0.89	1.42	3.25	18.1
East: Thomas Road east												
4	L2	29	14.0	0.017	7.7	LOS A	0.0	0.0	0.00	0.65	0.00	65.6
5	T1	766	14.0	0.429	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	89.7
6	R2	11	14.0	0.014	10.6	LOS B	0.1	0.4	0.57	0.72	0.57	61.7
Approach		806	14.0	0.429	0.5	NA	0.1	0.4	0.01	0.03	0.01	88.0
North: Kargotich Road north												
7	L2	12	14.0	0.069	15.5	LOS C	0.2	1.6	0.76	1.00	0.76	52.8
8	T1	3	14.0	0.069	35.2	LOS E	0.2	1.6	0.76	1.00	0.76	52.8
9	R2	1	14.0	0.069	80.4	LOS F	0.2	1.6	0.76	1.00	0.76	52.6
Approach		16	14.0	0.069	23.3	LOS C	0.2	1.6	0.76	1.00	0.76	52.8
West: Thomas Road west												
10	L2	14	14.0	0.342	7.8	LOS A	0.0	0.0	0.00	0.02	0.00	75.3
11	T1	592	14.0	0.342	0.0	LOS A	0.0	0.0	0.00	0.02	0.00	89.4
12	R2	42	14.0	0.102	15.2	LOS C	0.3	2.7	0.71	0.90	0.71	57.6
Approach		648	14.0	0.342	1.2	NA	0.3	2.7	0.05	0.07	0.05	86.0
All Vehicles		1691	13.9	1.112	21.1	NA	16.5	128.7	0.15	0.24	0.45	57.9

MOVEMENT SUMMARY

Site: 1 [Thomas Kargotich PM existing]

Thomas Rd / Kargotich Rd
Existing traffic volumes
AM Peak
Site Category: (None)
Stop (Two-Way)

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	58	13.0	0.172	19.2	LOS C	0.6	4.4	0.74	1.00	0.74	56.3
2	T1	15	13.0	0.795	156.6	LOS F	2.7	21.1	0.99	1.10	1.59	15.5
3	R2	20	13.0	0.795	216.4	LOS F	2.7	21.1	0.99	1.10	1.59	15.5
Approach		93	13.0	0.795	83.7	LOS F	2.7	21.1	0.83	1.04	1.06	28.3
East: Thomas Road east												
4	L2	124	14.0	0.073	7.7	LOS A	0.0	0.0	0.00	0.65	0.00	65.6
5	T1	732	14.0	0.410	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	89.7
6	R2	8	14.0	0.015	12.9	LOS B	0.1	0.4	0.68	0.79	0.68	59.4
Approach		864	14.0	0.410	1.3	NA	0.1	0.4	0.01	0.10	0.01	84.8
North: Kargotich Road north												
7	L2	4	14.0	0.360	38.6	LOS E	1.0	7.8	0.97	1.02	1.08	25.3
8	T1	4	14.0	0.360	79.0	LOS F	1.0	7.8	0.97	1.02	1.08	25.3
9	R2	9	14.0	0.360	134.2	LOS F	1.0	7.8	0.97	1.02	1.08	25.3
Approach		17	14.0	0.360	98.7	LOS F	1.0	7.8	0.97	1.02	1.08	25.3
West: Thomas Road west												
10	L2	10	14.0	0.450	7.8	LOS A	0.0	0.0	0.00	0.01	0.00	75.3
11	T1	788	14.0	0.450	0.1	LOS A	0.0	0.0	0.00	0.01	0.00	89.5
12	R2	133	14.0	0.346	18.4	LOS C	1.4	11.3	0.79	0.97	0.99	54.8
Approach		931	14.0	0.450	2.8	NA	1.4	11.3	0.11	0.15	0.14	81.9
All Vehicles		1905	14.0	0.795	6.9	NA	2.7	21.1	0.11	0.18	0.13	74.7

Appendix 2 – SIDRA Output (Forecast Intersection Performance)

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich AM future]

Thomas Rd / Kargotich Rd
Existing + development traffic volumes
AM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	167	13.0	0.406	10.8	LOS B	2.3	17.5	0.73	0.91	0.81	58.2
2	T1	32	13.0	0.406	11.4	LOS B	2.3	17.5	0.73	0.91	0.81	60.0
3	R2	76	13.0	0.406	17.3	LOS B	2.3	17.5	0.73	0.91	0.81	59.4
Approach		275	13.0	0.406	12.7	LOS B	2.3	17.5	0.73	0.91	0.81	58.7
East: Thomas Road east												
4	L2	36	14.0	0.216	6.1	LOS A	1.5	11.5	0.26	0.46	0.26	62.7
5	T1	766	14.0	0.327	6.5	LOS A	2.5	20.0	0.26	0.46	0.26	64.9
6	R2	11	14.0	0.327	12.3	LOS B	2.5	20.0	0.26	0.46	0.26	64.0
Approach		813	14.0	0.327	6.5	LOS A	2.5	20.0	0.26	0.46	0.26	64.7
North: Kargotich Road north												
7	L2	12	14.0	0.025	8.9	LOS A	0.1	0.9	0.61	0.68	0.61	60.8
8	T1	4	14.0	0.025	9.5	LOS A	0.1	0.9	0.61	0.68	0.61	62.8
9	R2	1	14.0	0.025	15.4	LOS B	0.1	0.9	0.61	0.68	0.61	62.0
Approach		17	14.0	0.025	9.4	LOS A	0.1	0.9	0.61	0.68	0.61	61.3
West: Thomas Road west												
10	L2	14	14.0	0.181	6.5	LOS A	1.2	9.6	0.39	0.50	0.39	61.8
11	T1	592	14.0	0.297	6.8	LOS A	2.4	18.5	0.40	0.51	0.40	63.6
12	R2	52	14.0	0.297	12.6	LOS B	2.4	18.5	0.40	0.51	0.40	62.7
Approach		658	14.0	0.297	7.3	LOS A	2.4	18.5	0.40	0.51	0.40	63.5
All Vehicles		1763	13.8	0.406	7.8	LOS A	2.5	20.0	0.39	0.55	0.40	63.2

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM future]

Thomas Rd / Kargotich Rd
Existing + development traffic volumes
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
1	L2	75	13.0	0.184	9.7	LOS A	0.9	7.2	0.69	0.83	0.69	59.5
2	T1	19	13.0	0.184	10.4	LOS B	0.9	7.2	0.69	0.83	0.69	61.3
3	R2	26	13.0	0.184	16.2	LOS B	0.9	7.2	0.69	0.83	0.69	60.7
Approach		120	13.0	0.184	11.2	LOS B	0.9	7.2	0.69	0.83	0.69	60.0
East: Thomas Road east												
4	L2	146	14.0	0.252	7.0	LOS A	1.7	13.0	0.45	0.56	0.45	61.9
5	T1	732	14.0	0.415	7.2	LOS A	3.3	26.0	0.48	0.54	0.48	63.4
6	R2	8	14.0	0.415	13.1	LOS B	3.3	26.0	0.48	0.53	0.48	62.5
Approach		886	14.0	0.415	7.2	LOS A	3.3	26.0	0.47	0.54	0.47	63.1
North: Kargotich Road north												
7	L2	4	14.0	0.030	10.1	LOS B	0.1	1.0	0.66	0.77	0.66	57.5
8	T1	5	14.0	0.030	10.7	LOS B	0.1	1.0	0.66	0.77	0.66	59.3
9	R2	9	14.0	0.030	16.6	LOS B	0.1	1.0	0.66	0.77	0.66	58.6
Approach		18	14.0	0.030	13.5	LOS B	0.1	1.0	0.66	0.77	0.66	58.6
West: Thomas Road west												
10	L2	10	14.0	0.239	6.0	LOS A	1.8	13.8	0.27	0.45	0.27	62.6
11	T1	788	14.0	0.393	6.5	LOS A	3.5	27.8	0.28	0.48	0.28	64.0
12	R2	156	14.0	0.393	12.3	LOS B	3.5	27.8	0.29	0.50	0.29	62.8
Approach		954	14.0	0.393	7.4	LOS A	3.5	27.8	0.28	0.49	0.28	63.8
All Vehicles		1978	13.9	0.415	7.6	LOS A	3.5	27.8	0.39	0.54	0.39	63.2

MOVEMENT SUMMARY

Site: 2 [Kargotich New local road connection AM future]

Kargotich Rd / New local road connection
Existing + development traffic volumes
AM Peak
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
2	T1	221	13.0	0.123	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
3	R2	5	5.0	0.004	7.2	LOS A	0.0	0.1	0.19	0.58	0.19	62.8
Approach		226	12.8	0.123	0.2	NA	0.0	0.1	0.00	0.01	0.00	79.5
East: New local road connection												
4	L2	14	5.0	0.012	5.9	LOS A	0.0	0.3	0.16	0.54	0.16	52.9
6	R2	54	5.0	0.078	8.2	LOS A	0.3	2.2	0.45	0.67	0.45	51.4
Approach		68	5.0	0.078	7.7	LOS A	0.3	2.2	0.39	0.64	0.39	51.7
North: Kargotich Road north												
7	L2	18	5.0	0.010	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	63.7
8	T1	74	13.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
Approach		92	11.4	0.041	1.4	NA	0.0	0.0	0.00	0.12	0.00	76.2
All Vehicles		386	11.1	0.123	1.8	NA	0.3	2.2	0.07	0.15	0.07	71.9

MOVEMENT SUMMARY

Site: 2 [Kargotich New local road connection PM future]

Kargotich Rd / New local road connection
Existing + development traffic volumes
PM Peak
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
2	T1	93	13.0	0.052	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
3	R2	11	5.0	0.011	8.3	LOS A	0.0	0.3	0.39	0.62	0.39	62.0
Approach		104	12.2	0.052	0.9	NA	0.0	0.3	0.04	0.07	0.04	77.6
East: New local road connection												
4	L2	7	5.0	0.007	6.7	LOS A	0.0	0.2	0.34	0.56	0.34	52.3
6	R2	27	5.0	0.044	9.0	LOS A	0.2	1.2	0.49	0.68	0.49	50.9
Approach		34	5.0	0.044	8.5	LOS A	0.2	1.2	0.46	0.66	0.46	51.2
North: Kargotich Road north												
7	L2	46	5.0	0.026	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	63.7
8	T1	261	13.0	0.145	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		307	11.8	0.145	1.1	NA	0.0	0.0	0.00	0.09	0.00	77.0
All Vehicles		445	11.4	0.145	1.6	NA	0.2	1.2	0.04	0.13	0.04	74.3

Appendix 3 – SIDRA Output (Forecast Intersection Performance with Redistribution)

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich AM future+ redistribution]

Thomas Rd / Kargotich Rd
Existing + development + redistribution traffic volumes
AM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
1	L2	202	13.0	0.495	11.9	LOS B	3.1	24.5	0.77	0.96	0.94	57.3
2	T1	39	13.0	0.495	12.5	LOS B	3.1	24.5	0.77	0.96	0.94	59.0
3	R2	92	13.0	0.495	18.4	LOS B	3.1	24.5	0.77	0.96	0.94	58.4
Approach		333	13.0	0.495	13.7	LOS B	3.1	24.5	0.77	0.96	0.94	57.8
East: Thomas Road east												
4	L2	44	14.0	0.222	6.2	LOS A	1.5	11.9	0.29	0.47	0.29	62.5
5	T1	766	14.0	0.336	6.5	LOS A	2.7	20.9	0.30	0.47	0.30	64.6
6	R2	11	14.0	0.336	12.4	LOS B	2.7	20.9	0.30	0.46	0.30	63.8
Approach		821	14.0	0.336	6.6	LOS A	2.7	20.9	0.30	0.47	0.30	64.5
North: Kargotich Road north												
7	L2	12	14.0	0.027	9.0	LOS A	0.1	1.0	0.62	0.69	0.62	60.6
8	T1	5	14.0	0.027	9.7	LOS A	0.1	1.0	0.62	0.69	0.62	62.6
9	R2	1	14.0	0.027	15.6	LOS B	0.1	1.0	0.62	0.69	0.62	61.9
Approach		18	14.0	0.027	9.6	LOS A	0.1	1.0	0.62	0.69	0.62	61.2
West: Thomas Road west												
10	L2	14	14.0	0.190	6.7	LOS A	1.3	10.2	0.43	0.51	0.43	61.6
11	T1	592	14.0	0.311	7.0	LOS A	2.5	19.6	0.44	0.53	0.44	63.3
12	R2	64	14.0	0.311	12.8	LOS B	2.5	19.6	0.44	0.53	0.44	62.3
Approach		670	14.0	0.311	7.5	LOS A	2.5	19.6	0.44	0.53	0.44	63.1
All Vehicles		1842	13.8	0.495	8.3	LOS A	3.1	24.5	0.44	0.58	0.47	62.6

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM future + redistribution]

Thomas Rd / Kargotich Rd
Existing + development + redistribution traffic volumes
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total	Demand Flows HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	95% Back of Queue Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
1	L2	93	13.0	0.232	9.9	LOS A	1.2	9.5	0.71	0.86	0.71	59.3
2	T1	24	13.0	0.232	10.6	LOS B	1.2	9.5	0.71	0.86	0.71	61.1
3	R2	32	13.0	0.232	16.4	LOS B	1.2	9.5	0.71	0.86	0.71	60.5
Approach		149	13.0	0.232	11.4	LOS B	1.2	9.5	0.71	0.86	0.71	59.8
East: Thomas Road east												
4	L2	169	14.0	0.266	7.2	LOS A	1.8	13.9	0.49	0.58	0.49	61.7
5	T1	732	14.0	0.437	7.4	LOS A	3.6	28.1	0.52	0.56	0.52	63.1
6	R2	8	14.0	0.437	13.3	LOS B	3.6	28.1	0.53	0.56	0.53	62.2
Approach		909	14.0	0.437	7.4	LOS A	3.6	28.1	0.52	0.56	0.52	62.8
North: Kargotich Road north												
7	L2	4	14.0	0.033	10.2	LOS B	0.1	1.1	0.68	0.78	0.68	57.5
8	T1	6	14.0	0.033	10.9	LOS B	0.1	1.1	0.68	0.78	0.68	59.2
9	R2	9	14.0	0.033	16.7	LOS B	0.1	1.1	0.68	0.78	0.68	58.6
Approach		19	14.0	0.033	13.5	LOS B	0.1	1.1	0.68	0.78	0.68	58.5
West: Thomas Road west												
10	L2	10	14.0	0.250	6.1	LOS A	1.9	14.5	0.30	0.46	0.30	62.4
11	T1	788	14.0	0.410	6.5	LOS A	3.8	29.6	0.32	0.49	0.32	63.7
12	R2	181	14.0	0.410	12.4	LOS B	3.8	29.6	0.33	0.51	0.33	62.4
Approach		979	14.0	0.410	7.6	LOS A	3.8	29.6	0.32	0.50	0.32	63.5
All Vehicles		2056	13.9	0.437	7.9	LOS A	3.8	29.6	0.44	0.56	0.44	62.8

MOVEMENT SUMMARY

Site: 2 [Kargotich New local road connection AM future + redistribution]

Kargotich Rd / New local road connection
Existing + development + redistribution traffic volumes
AM Peak
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
2	T1	221	13.0	0.123	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
3	R2	9	5.0	0.007	7.3	LOS A	0.0	0.2	0.22	0.58	0.22	62.7
Approach		230	12.7	0.123	0.3	NA	0.0	0.2	0.01	0.02	0.01	79.1
East: New local road connection												
4	L2	28	5.0	0.023	5.9	LOS A	0.1	0.6	0.17	0.54	0.17	52.9
6	R2	112	5.0	0.165	8.6	LOS A	0.7	4.8	0.49	0.71	0.49	51.2
Approach		140	5.0	0.165	8.0	LOS A	0.7	4.8	0.42	0.67	0.42	51.5
North: Kargotich Road north												
7	L2	38	5.0	0.021	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	63.7
8	T1	74	13.0	0.041	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
Approach		112	10.3	0.041	2.4	NA	0.0	0.0	0.00	0.21	0.00	73.6
All Vehicles		482	9.9	0.165	3.0	NA	0.7	4.8	0.13	0.26	0.13	67.4

MOVEMENT SUMMARY

Site: 2 [Kargotich New local road connection PM future + redistribution]

Kargotich Rd / New local road connection
Existing + development + redistribution traffic volumes
PM Peak
Site Category: (None)
Giveway / Yield (Two-Way)

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total	HV	Deg. Satn	Average Delay	Level of Service	95% Back of Queue Vehicles	Distance	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed
		veh/h	%	v/c	sec		veh	m				km/h
South: Kargotich Road south												
2	T1	93	13.0	0.052	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	80.0
3	R2	23	5.0	0.024	8.6	LOS A	0.1	0.7	0.42	0.65	0.42	61.8
Approach		116	11.4	0.052	1.7	NA	0.1	0.7	0.08	0.13	0.08	75.6
East: New local road connection												
4	L2	14	5.0	0.014	6.8	LOS A	0.0	0.4	0.34	0.58	0.34	52.3
6	R2	56	5.0	0.096	9.5	LOS A	0.4	2.6	0.53	0.74	0.53	50.5
Approach		70	5.0	0.096	9.0	LOS A	0.4	2.6	0.49	0.71	0.49	50.9
North: Kargotich Road north												
7	L2	94	5.0	0.052	7.0	LOS A	0.0	0.0	0.00	0.63	0.00	63.7
8	T1	261	13.0	0.145	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	79.9
Approach		355	10.9	0.145	1.9	NA	0.0	0.0	0.00	0.17	0.00	74.9
All Vehicles		541	10.2	0.145	2.8	NA	0.4	2.6	0.08	0.23	0.08	70.7

Technical Note	81113-250-FLYT-TEN-0008
PROJECT	Lot 4 Kargotich Road & Lot 2 Thomas Road, Oakford
Date	22/01/2020

1. INTRODUCTION

This Technical Note has been prepared to respond to comments received from Main Roads WA regarding the Traffic Impact Statement in support of the Local Structure Plan for Lot 4 Kargotich Road & Lot 2 Thomas Road, Oakford.

MRWA's original comments (provided by the Shire of Serpentine Jarrahdale on October 22nd 2019) and Flyt's responses are shown in the following Table. Flyt's responses include further information provided by MRWA (on December 4th 2019) and from the MRWA's Transport Modelling Section on January 20th 2020.

MRWA Comment	Flyt's Response
Section 5.2- Traffic Generated by Development- Table 2- Traffic Generated by subdivision concept plan • PM peak OUT was incorrectly calculated resulting in 29 trips instead of 58 (64 x 0.9 = 58). Consequently, the total number of trips in PM peak 106 comparing to 77 mentioned in the TIA.	PM Peak OUT was correctly displayed as 29 trips; however, the trip rate should have read 0.45 peak hour trips out trips per dwelling, rather than 0.9 peak hour trips out trips per dwelling. The total trips attributable to the Local Structure Plan area in the PM peak hour is correctly written as 77 trips (48 in, 29 out).
Section 6.4.1 - Forecast intersection performance The analysis of the intersection performance should be undertaken for the year of full development of the structure plan, which is not mentioned in the TIA. The volumes included in the model should consist of full development year volumes on the surrounding road network, extracted from ROM 24, plus the traffic generated by the development.	Intersection analysis is undertaken in Section 3 of this Technical Note, for the year 2031 and 2026. This analysis includes ROM 24 volumes, plus Local Structure Plan traffic and traffic associated with the (approved but not yet constructed) fuel station at Lot 801 Thomas Road. ROM24 link volume plots were provided for 2016, 2021 and 2036 (job #41369) using the Tonkin Hwy Upgrade and Extension land use and network. The ROM24 output is shown in Appendix 1. Turning volume diagrams were

Section 6.4.1 - Forecast intersection performance There is an approved development for a Proposed Fuel Station, rural produce supplies, retail and veterinary for lot 802 at the intersection of Thomas Rd / Kargotich Rd, the potential trip generated by this development should be included in the input volumes.	not able to be provided given the intersection of Thomas Road with Kargotich Road is modelled as a T-intersection in ROM24 and not as it actually exists as a 4-way intersection. Volumes for the proposed fuel station at Lot 801 have been extracted from Shawmac's Traffic Impact Report prepared for the proposed development at Lot 801 Thomas Road. Forecast traffic volumes have had the existing heavy vehicle classifications applied, while it was assumed that traffic associated with the proposed development (Local Structure Plan) and the proposed fuel station, retail and vet at Lot 801 would be light vehicles.
SIDRA • Roundabouts – Geometry - Thomas Rd/Kargotich Rd single lane roundabout is a committed and funded project under the State Black Spot Program. The geometry of the roundabout used in the intersection performance analysis does not reflect the 15% designed developed.	Intersection analysis in Section 3 of this Technical Note has been undertaken using roundabout geometry from drawing 201948-2998/00 provided by Nicole Coaker of MRWA by email on 04/12/2019 (shown in Appendix 2). This is the 15% concept design of the single lane roundabout. The approach speed (for all approaches) was adjusted to 70kph on the basis of the drawing.
• Circulating width for roundabout needs to be adjusted for the east and west, as they are only single lanes. They would not have a width of 10m.	The roundabout circulating width for the east and west have been reduced to 6m to represent single lanes.
• The heavy vehicle traffic modelled has not been calibrated appropriately (in terms of the Austroads vehicle classes). This is to be done in accordance with the ***Operational Modelling Guidelines***	Heavy vehicle traffic in the updated SIDRA modelling (see Section 3 of this Technical Note) has been updated in accordance with MRWA's Operational Modelling Guidelines. Heavy vehicles have been coded as 5 separate Movement Classes, with the classification obtained from site 8375 (Thomas Road east of Kargotich Road for the year 2017/2018), site 8469 (Kargotich Road north of Thomas Road for the year 2014/2015) and site 50525 (Kargotich Road north of Thomas Road for the year 2017/2018).
• Passenger car equivalents and fuel emissions are not in accordance with the ***Operational Modelling Guideline***	Values for mass, maximum power, length and passenger car equivalents have been entered into the Model Parameters and Fuel & Emissions tabs of the Parameter Setting dialog as outlined in MRWA's Operational Modelling Guidelines.
• As previously mentioned at Movement Definition, calibration of HV are not in accordance with the ***Operational Modelling Guideline.***	Gap Acceptance and Opposing Vehicle Factor for all Austroads vehicle classes were added to the calibration tab of Vehicle Movement Data (values obtained from Table 4-5 of MRWA's Operational Modelling Guidelines).

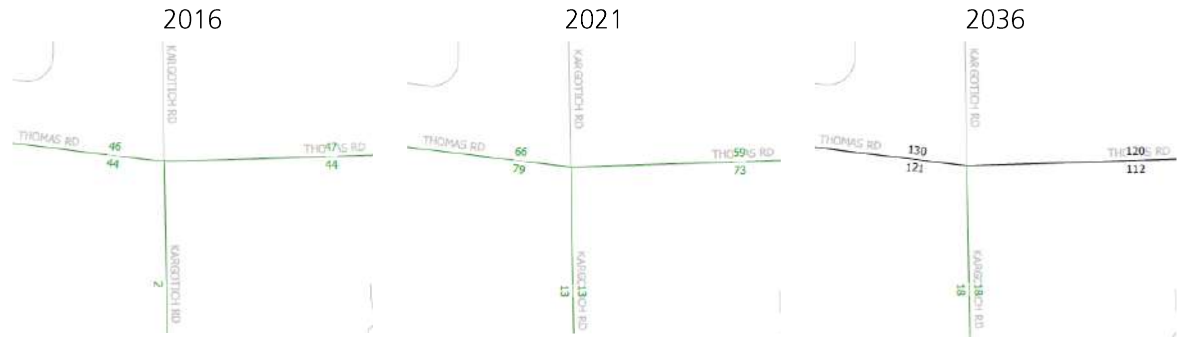
2. FORECAST TRAFFIC VOLUMES

2.1 ROM24 Link Volume Plots

ROM24 link volume plots were provided for 2016, 2021 and 2036 (MRWA Reference job #41369) using the Tonkin Hwy Extension land use and road network. There is no 2031 scenario in the Tonkin Highway extension project.

Excerpts of the ROM24 output are shown in Figure 1 while the full ROM24 output is shown in Appendix 1. MRWA were not able to provide turning volume diagrams for the intersection of Thomas Road with Kargotich Road as the intersection is modelled as a T-intersection in ROM24 and not as a 4-way intersection (the northern Kargotich Road approach is missing from the model).

Figure 1 – ROM24 Link Volume Plots for 2016, 2021 and 2036



As shown in Figure 1, the modelled road network for 2016 and 2021 includes Thomas Road and Kargotich Road (south of Thomas Road) with a single lane in each direction and Tonkin Highway terminates at Thomas Road. The 2036 modelled Road network shows Thomas Road with two lanes in each direction with Tonkin Highway extended south of Thomas Road.

It is therefore not possible to isolate the background traffic growth due to the extension of Tonkin Highway from the traffic growth due to the increased capacity of Thomas Road (increased from a single lane in each direction to two lanes).

It is also important to note that the while the ROM24 2036 link volume plots are based on Thomas Road having two lanes in each direction the intersection being tested is a single lane roundabout.

2.2 Derivation of Background Traffic Volumes

A count of existing peak hour turning traffic volumes was undertaken at the intersection of Thomas Road and Kargotich Road on Wednesday May 15th and Thursday May 16th 2019.

Due to the very traffic low volumes forecast by ROM24 on Kargotich Road in 2016 (200 daily vehicles northbound, no traffic southbound), a modified process has been used for deriving background traffic turning volumes for the intersection of Thomas Road with Kargotich Road for the years 2031 and 2026. While normally the ROM24 percentage growth between 2016 and 2021 and then between 2021 and 2036 (that occurred between 2019 and 2031) would have been applied to the existing (2019) peak hour turning traffic volumes; instead the actual ROM24 forecast growth between 2016 and 2021 and then between 2021 and 2036 was determined, converted from a daily volume into a peak hour volume and then a Furness distribution model (weighted by the existing AM or PM peak period turn counts) was used to determine the additional peak hour traffic growth which was added to the 2019 peak hour volumes.

For traffic movements to and from Kargotich Road north (which is not modelled in ROM24) a compound annual growth rate of 2% was assumed between 2019, 2026 and 2031.

The resulting forecast traffic volumes are shown in Table 1, with 2019 volumes included for comparison.

Table 1 – Forecast 2026 and 2031 turning volumes

Approach	Movement	AM Peak			PM Peak		
		2019	2026 forecast	2031 forecast	2019	2026 forecast	2031 forecast
Thomas Road west	Left	14	16	18	10	11	13
	Through	592	871	1,117	788	1,072	1,321
	Right	42	91	107	133	177	190
Kargotich Road south	Left	134	178	192	58	106	121
	Through	26	30	33	15	17	19
	Right	61	74	80	20	29	34
Thomas Road east	Left	29	43	48	124	144	151
	Through	766	1,007	1,161	732	967	1,119
	Right	11	13	14	8	9	10
Kargotich Road north	Left	12	14	15	4	5	5
	Through	3	3	4	4	5	5
	Right	1	1	1	9	10	11

Heavy vehicle percentages, consistent with the classifications required under MRWA's Operational Modelling Guidelines were taken from site 8375 (Thomas Road east of Kargotich Road for the year 2017/2018), site 8469 (Kargotich Road south of Thomas Road for the year 2014/2015) and site 50525 (Kargotich Road north of Thomas Road for the year 2017/2018), and are summarised in Table 2.

Table 2 – Vehicle classification

Vehicle Class	Thomas Rd eastbound traffic (%)	Thomas Rd westbound traffic (%)	Kargotich Rd northbound traffic (%)	Kargotich Rd southbound traffic (%)
Austroads class 1 - 2	84.5	85.4	84.2	86.3
Austroads class 3 - 5	10.3	10.1	12.8	12.4
Austroads class 6 - 9	3.7	3.0	2.8	1.1
Austroads class 10	0.5	0.4	0.1	0.2
Austroads class 11	1	1	0.1	0
Austroads class 12	0	0	0	0

The classification percentages were applied to the forecast volumes derived for 2031 and 2026.

2.3 Forecast Development Volumes

Forecast peak hour development traffic volumes through the intersection of Thomas Road and Kargotich Road are shown in Table 3 and described as follows:

- peak hour forecasts for the development of Lot 4 Kargotich Road & Lot 2 Thomas Road, for two scenarios; one with a local road connection to Kargotich Road at the southern boundary of development site (volumes taken from Flyt's Traffic Impact Assessment Report dated August 2019) and a second scenario with no direct connection between the development and Kargotich Road.
- peak hour forecasts for the proposed development at Lot 801 Thomas Road (extracted from Shawmac's Traffic Impact Report prepared for the proposed development at Lot 801 Thomas Road).

Table 3 – Forecast development turning traffic volumes through Thomas Road and Kargotich Road intersection

Approach	Turn	AM Peak			PM Peak		
		Lot 801	LSP Scenario 1	LSP Scenario 2	Lot 801	LSP Scenario 1	LSP Scenario 2
Thomas Rd west	Left						
	Through						
	Right	10	7	5	12	15	10
Kargotich Rd south	Left	16	22	14	21	11	7
	Through	2	4	3	2	3	2
	Right	15	10	6	20	4	3
Thomas Rd east	Left	18	5	3	22	14	9
	Through						
	Right						
Kargotich Rd north	Left						
	Through	2	0	0	3	1	0
	Right						
TOTAL		63	48	31	80	48	31

For Scenario 1, the traffic associated with the approved but not yet constructed fuel station at Lot 801 Thomas Road makes up 57% of the AM peak development traffic through the intersection of Thomas Road and Kargotich Road and 62.5% of the PM peak development traffic through the same intersection.

It was assumed that traffic associated with the proposed development (Local Structure Plan) and the proposed fuel station, retail and vet at Lot 801 would be light vehicles.

3. SIDRA INTERSECTION ASSESSMENT

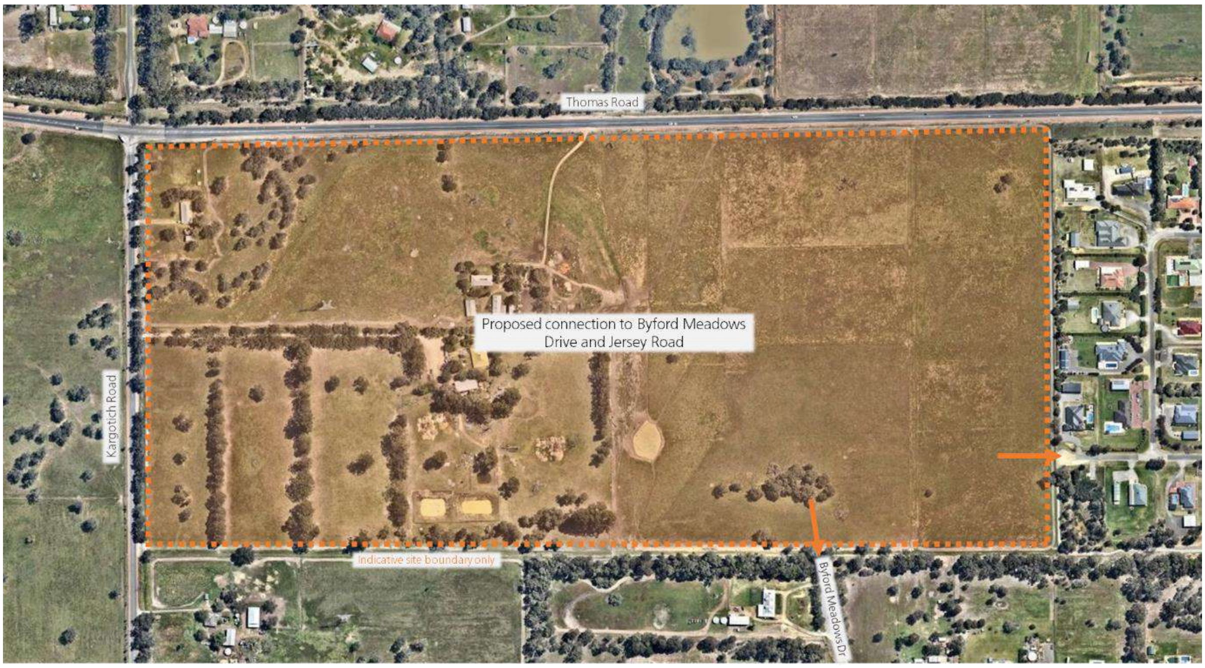
SIDRA Intersection 8.0 has been used to assess the forecast peak hour performance of the intersection between Thomas Road and Kargotich Road, with the roundabout configuration as shown in drawing 201948-2998/00 (shown in Appendix 2). This is the 15% concept design of the single lane roundabout.

Two development scenarios are assessed for the Local Structure Plan, as follows:

- Scenario 1 – 64 Rural Living A lots with 3 connections to external road network including a direct connection to Kargotich Road at the southern boundary of the site, as shown in Figure 2.
- Scenario 2 – 64 Rural Living A lots with 2 connections to external road network as shown in Figure 3. There is no direct connection to Kargotich Road.

Figure 2 – Proposed connections to external road network – Scenario 1

Figure 3 – Proposed connections to external road network – Scenario 2



3.1 2031 Background Volumes

As discussed in Section 2, the ROM24 2036 link volume plots are based on Thomas Road having two lanes in each direction while the intersection being tested is a single lane roundabout. Therefore, derived traffic forecasts along Thomas Road for years after 2021 are most likely overestimated which will impact on the predicted operation of the roundabout.

This is demonstrated by the SIDRA predicted results for the single lane roundabout with base 2031 forecast traffic volumes (without any development traffic). SIDRA predicts the Thomas Road west and east approaches will operate at a level of service (LOS) F in both the AM and PM peak hour, as summarised in Table 4 (AM peak hour) and Table 5 (PM peak hour).

Table 4 – AM Peak hour SIDRA output – 2031 base volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM 2031 base]

Thomas Rd / Kargotich Rd
2031 volumes derived from ROM24
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	121	15.8	0.538	27.0	LOS C	5.6	47.2	1.00	1.09	1.27	43.8
2	T1	18	16.2	0.538	27.0	LOS C	5.6	47.2	1.00	1.09	1.27	45.2
3	R2	34	15.9	0.538	34.9	LOS C	5.6	47.2	1.00	1.09	1.27	45.4
Approach		173	15.8	0.538	28.6	LOS C	5.6	47.2	1.00	1.09	1.27	44.2
East: Thomas Road east												
4	L2	151	14.5	1.062	133.3	LOS F	137.1	1190.1	1.00	3.32	5.66	19.9
5	T1	1118	14.5	1.062	133.4	LOS F	137.1	1190.1	1.00	3.32	5.66	20.3
6	R2	10	14.1	1.062	141.2	LOS F	137.1	1190.1	1.00	3.32	5.66	20.3
Approach		1279	14.5	1.062	133.4	LOS F	137.1	1190.1	1.00	3.32	5.66	20.2
North: Kargotich Road north												
7	L2	5	14.0	0.338	57.5	LOS E	1.5	12.2	0.98	1.02	1.11	32.4
8	T1	5	14.0	0.338	57.5	LOS E	1.5	12.2	0.98	1.02	1.11	33.2
9	R2	11	13.6	0.338	64.8	LOS E	1.5	12.2	0.98	1.02	1.11	33.3
Approach		21	13.8	0.338	61.4	LOS E	1.5	12.2	0.98	1.02	1.11	33.1
West: Thomas Road west												
10	L2	13	15.4	1.032	70.1	LOS F	136.4	1203.7	1.00	1.18	1.99	29.7
11	T1	1321	15.5	1.032	70.2	LOS F	136.4	1203.7	1.00	1.18	1.99	30.4
12	R2	190	15.5	1.032	78.0	LOS F	136.4	1203.7	1.00	1.18	1.99	30.4
Approach		1524	15.5	1.032	71.1	LOS F	136.4	1203.7	1.00	1.18	1.99	30.4
All Vehicles		2997	15.1	1.062	95.2	LOS F	137.1	1203.7	1.00	2.09	3.51	25.4

Table 5 – PM Peak hour SIDRA output 2031 base volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM 2031 base]

Thomas Rd / Kargotich Rd
2031 volumes derived from ROM24
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	121	15.8	0.538	27.0	LOS C	5.6	47.2	1.00	1.09	1.27	43.8
2	T1	18	16.2	0.538	27.0	LOS C	5.6	47.2	1.00	1.09	1.27	45.2
3	R2	34	15.9	0.538	34.9	LOS C	5.6	47.2	1.00	1.09	1.27	45.4
Approach		173	15.8	0.538	28.6	LOS C	5.6	47.2	1.00	1.09	1.27	44.2
East: Thomas Road east												
4	L2	151	14.5	1.062	133.3	LOS F	137.1	1190.1	1.00	3.32	5.66	19.9
5	T1	1118	14.5	1.062	133.4	LOS F	137.1	1190.1	1.00	3.32	5.66	20.3
6	R2	10	14.1	1.062	141.2	LOS F	137.1	1190.1	1.00	3.32	5.66	20.3
Approach		1279	14.5	1.062	133.4	LOS F	137.1	1190.1	1.00	3.32	5.66	20.2
North: Kargotich Road north												
7	L2	5	14.0	0.338	57.5	LOS E	1.5	12.2	0.98	1.02	1.11	32.4
8	T1	5	14.0	0.338	57.5	LOS E	1.5	12.2	0.98	1.02	1.11	33.2
9	R2	11	13.6	0.338	64.8	LOS E	1.5	12.2	0.98	1.02	1.11	33.3
Approach		21	13.8	0.338	61.4	LOS E	1.5	12.2	0.98	1.02	1.11	33.1
West: Thomas Road west												
10	L2	13	15.4	1.032	70.1	LOS F	136.4	1203.7	1.00	1.18	1.99	29.7
11	T1	1321	15.5	1.032	70.2	LOS F	136.4	1203.7	1.00	1.18	1.99	30.4
12	R2	190	15.5	1.032	78.0	LOS F	136.4	1203.7	1.00	1.18	1.99	30.4
Approach		1524	15.5	1.032	71.1	LOS F	136.4	1203.7	1.00	1.18	1.99	30.4
All Vehicles		2997	15.1	1.062	95.2	LOS F	137.1	1203.7	1.00	2.09	3.51	25.4

As the Thomas Road traffic volumes are overestimated (due to the 2 lanes in the ROM24 2036 Tonkin Highway Upgrade and Extension Network), the development traffic volumes will be tested with 2026 forecast background traffic.

3.2 2026 Background Volumes

The SIDRA predicted results for the single lane roundabout with 2026 base forecast traffic volumes (without any development traffic) are summarised in Table 6 (AM peak hour) and Table 7 (PM peak hour).

SIDRA predicts a single lane roundabout controlled intersection of Thomas Road with Kargotich Road would operate at a level of service A in the AM peak hour and B in the PM peak hour. The Kargotich Road approach is predicted to operate at a LOS C in the AM peak with an average delay of 31.7 seconds and at a LOS B in the PM peak with an average delay of 17.1 seconds.

Table 6 – AM Peak hour SIDRA output – 2026 base volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich AM 2026 base]

Thomas Rd / Kargotich Rd
2026 volumes derived from ROM24
AM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	178	15.8	0.654	29.7	LOS C	8.0	68.4	1.00	1.21	1.57	42.3
2	T1	30	15.4	0.654	29.6	LOS C	8.0	68.4	1.00	1.21	1.57	43.7
3	R2	74	15.9	0.654	37.6	LOS D	8.0	68.4	1.00	1.21	1.57	43.8
Approach		282	15.8	0.654	31.7	LOS C	8.0	68.4	1.00	1.21	1.57	42.8
East: Thomas Road east												
4	L2	43	14.5	0.760	5.2	LOS A	11.9	103.2	0.73	0.46	0.73	56.6
5	T1	1006	14.5	0.760	5.2	LOS A	11.9	103.2	0.73	0.46	0.73	59.2
6	R2	13	14.6	0.760	13.1	LOS B	11.9	103.2	0.73	0.46	0.73	59.4
Approach		1062	14.5	0.760	5.3	LOS A	11.9	103.2	0.73	0.46	0.73	59.1
North: Kargotich Road north												
7	L2	14	13.6	0.042	13.9	LOS B	0.3	2.8	1.00	0.76	1.00	52.7
8	T1	3	13.3	0.042	13.8	LOS B	0.3	2.8	1.00	0.76	1.00	54.9
9	R2	1	10.0	0.042	21.4	LOS C	0.3	2.8	1.00	0.76	1.00	56.1
Approach		18	13.3	0.042	14.3	LOS B	0.3	2.8	1.00	0.76	1.00	53.2
West: Thomas Road west												
10	L2	16	15.6	0.735	5.4	LOS A	10.7	94.1	0.76	0.49	0.76	55.9
11	T1	871	15.5	0.735	5.4	LOS A	10.7	94.1	0.76	0.49	0.76	58.5
12	R2	91	15.6	0.735	13.3	LOS B	10.7	94.1	0.76	0.49	0.76	58.6
Approach		978	15.5	0.735	6.1	LOS A	10.7	94.1	0.76	0.49	0.76	58.5
All Vehicles		2340	15.1	0.760	8.9	LOS A	11.9	103.2	0.77	0.56	0.84	56.3

Table 7 – PM Peak hour SIDRA output – 2026 base volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM 2026 base]

Thomas Rd / Kargotich Rd
2026 volumes derived from ROM24
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	106	15.8	0.395	15.6	LOS B	3.6	30.3	1.00	0.96	1.02	50.5
2	T1	17	15.9	0.395	15.6	LOS B	3.6	30.3	1.00	0.96	1.02	52.4
3	R2	29	15.6	0.395	23.4	LOS C	3.6	30.3	1.00	0.96	1.02	52.7
Approach		152	15.8	0.395	17.1	LOS B	3.6	30.3	1.00	0.96	1.02	51.1
East: Thomas Road east												
4	L2	144	14.5	0.912	14.1	LOS B	26.2	227.2	1.00	0.90	1.35	52.7
5	T1	966	14.5	0.912	14.1	LOS B	26.2	227.2	1.00	0.90	1.35	55.0
6	R2	9	14.4	0.912	21.9	LOS C	26.2	227.2	1.00	0.90	1.35	55.2
Approach		1119	14.5	0.912	14.2	LOS B	26.2	227.2	1.00	0.90	1.35	54.7
North: Kargotich Road north												
7	L2	5	14.0	0.081	25.6	LOS C	0.7	5.9	1.00	0.83	1.00	44.1
8	T1	5	14.0	0.081	25.6	LOS C	0.7	5.9	1.00	0.83	1.00	45.5
9	R2	10	13.1	0.081	33.3	LOS C	0.7	5.9	1.00	0.83	1.00	45.9
Approach		20	13.6	0.081	29.4	LOS C	0.7	5.9	1.00	0.83	1.00	45.3
West: Thomas Road west												
10	L2	11	15.5	0.848	5.0	LOS A	20.9	184.6	0.78	0.43	0.78	55.7
11	T1	1072	15.5	0.848	5.0	LOS A	20.9	184.6	0.78	0.43	0.78	58.3
12	R2	177	15.5	0.848	12.9	LOS B	20.9	184.6	0.78	0.43	0.78	58.4
Approach		1260	15.5	0.848	6.1	LOS A	20.9	184.6	0.78	0.43	0.78	58.3
All Vehicles		2551	15.1	0.912	10.5	LOS B	26.2	227.2	0.89	0.67	1.04	56.1

3.3 2026 Background and Development Traffic Scenario 1

The SIDRA predicted results for the single lane roundabout with 2026 forecast traffic volumes (including Scenario 1 development traffic) are summarised in Table 8 (AM peak hour) and Table 9 (PM peak hour).

For Scenario 1, the overall intersection is predicted to operate at a LOS B in the AM peak and at a LOS C in the PM peak. The Kargotich Road approach is predicted to operate at a LOS E in the AM peak with an average delay of 63.7 seconds and at a LOS C in the PM peak with an average delay of 23 seconds.

It is important to note that for Scenario 1, traffic associated with the approved but not yet constructed fuel station at Lot 801 Thomas Road makes up 57% (of AM peak) and 62.5% (of PM peak) development traffic volumes through the intersection of Thomas Road and Kargotich Road. Traffic associated with Lot 801 has been included at MRWA's request.

Table 8 – AM Peak hour SIDRA output – 2026 Scenario 1 development volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich AM 2026 with development Scenario 1]

Thomas Rd / Kargotich Rd
2026 volumes derived from ROM24 plus development Scenario 1
AM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	216	13.0	0.856	61.5	LOS E	16.3	133.4	1.00	1.54	2.47	31.4
2	T1	36	12.8	0.856	61.4	LOS E	16.3	133.4	1.00	1.54	2.47	32.2
3	R2	99	11.9	0.856	69.2	LOS E	16.3	133.4	1.00	1.54	2.47	32.4
Approach		351	12.7	0.856	63.7	LOS E	16.3	133.4	1.00	1.54	2.47	31.8
East: Thomas Road east												
4	L2	66	9.4	0.797	5.4	LOS A	13.2	113.9	0.84	0.49	0.84	57.1
5	T1	1006	14.5	0.797	5.6	LOS A	13.2	113.9	0.84	0.49	0.84	58.5
6	R2	13	14.6	0.797	13.5	LOS B	13.2	113.9	0.84	0.49	0.84	58.7
Approach		1085	14.2	0.797	5.7	LOS A	13.2	113.9	0.84	0.49	0.84	58.4
North: Kargotich Road north												
7	L2	14	13.6	0.052	15.0	LOS B	0.4	3.5	1.00	0.78	1.00	52.0
8	T1	5	8.0	0.052	14.6	LOS B	0.4	3.5	1.00	0.78	1.00	55.2
9	R2	1	10.0	0.052	22.6	LOS C	0.4	3.5	1.00	0.78	1.00	55.3
Approach		20	12.0	0.052	15.3	LOS B	0.4	3.5	1.00	0.78	1.00	52.9
West: Thomas Road west												
10	L2	16	15.6	0.777	5.9	LOS A	11.6	102.0	0.87	0.53	0.87	55.2
11	T1	871	15.5	0.777	5.9	LOS A	11.6	102.0	0.87	0.53	0.87	57.8
12	R2	108	13.1	0.777	13.7	LOS B	11.6	102.0	0.87	0.53	0.87	58.5
Approach		995	15.2	0.777	6.8	LOS A	11.6	102.0	0.87	0.53	0.87	57.8
All Vehicles		2451	14.4	0.856	14.5	LOS B	16.3	133.4	0.88	0.66	1.09	52.0

Table 9 – PM Peak hour SIDRA output – 2026 Scenario 1 development volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM 2026 with development Scenario 1]

Thomas Rd / Kargotich Rd
2026 volumes derived from ROM24 plus development Scenario 1
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles												
Mov ID	Turn	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	138	12.2	0.533	21.1	LOS C	5.6	45.2	1.00	1.06	1.23	47.4
2	T1	22	12.3	0.533	21.1	LOS C	5.6	45.2	1.00	1.06	1.23	49.1
3	R2	53	8.5	0.533	28.6	LOS C	5.6	45.2	1.00	1.06	1.23	50.1
Approach		213	11.3	0.533	23.0	LOS C	5.6	45.2	1.00	1.06	1.23	48.2
East: Thomas Road east												
4	L2	180	11.6	0.984	36.3	LOS D	53.7	463.1	1.00	1.48	2.37	40.6
5	T1	966	14.5	0.984	36.5	LOS D	53.7	463.1	1.00	1.48	2.37	41.6
6	R2	9	14.4	0.984	44.3	LOS D	53.7	463.1	1.00	1.48	2.37	41.7
Approach		1155	14.1	0.984	36.5	LOS D	53.7	463.1	1.00	1.48	2.37	41.5
North: Kargotich Road north												
7	L2	5	14.0	0.138	30.9	LOS C	1.2	9.5	1.00	0.89	1.00	42.1
8	T1	10	7.0	0.138	29.9	LOS C	1.2	9.5	1.00	0.89	1.00	44.3
9	R2	10	13.1	0.138	38.5	LOS D	1.2	9.5	1.00	0.89	1.00	43.7
Approach		25	10.8	0.138	33.5	LOS C	1.2	9.5	1.00	0.89	1.00	43.6
West: Thomas Road west												
10	L2	11	15.5	0.905	5.9	LOS A	24.8	218.3	1.00	0.51	1.00	54.5
11	T1	1072	15.5	0.905	5.9	LOS A	24.8	218.3	1.00	0.51	1.00	57.0
12	R2	204	13.4	0.905	13.7	LOS B	24.8	218.3	1.00	0.51	1.00	57.6
Approach		1287	15.2	0.905	7.1	LOS A	24.8	218.3	1.00	0.51	1.00	57.0
All Vehicles		2680	14.3	0.984	21.3	LOS C	53.7	463.1	1.00	0.98	1.61	48.4

3.4 2026 Background and Development Traffic Scenario 2

The SIDRA predicted results for the single lane roundabout with 2026 forecast traffic volumes (including Scenario 2 development traffic) are summarised in Table 10 (AM peak hour) and Table 11 (PM peak hour).

For Scenario 2, the overall intersection is predicted to operate at a LOS B in both the AM and PM peak. The Kargotich Road approach is predicted to operate at a LOS E in the AM peak with an average delay of 54.5 seconds and at a LOS C in the PM peak with an average delay of 22.4 seconds.

It is important to note that for Scenario 2, traffic associated with the approved but not yet constructed fuel station at Lot 801 Thomas Road makes up 67% (of AM peak) and 72% (of PM peak) development traffic volumes through the intersection of Thomas Road and Kargotich Road. Traffic associated with Lot 801 has been included at MRWA's request.

Table 10 – AM Peak hour SIDRA output – 2026 Scenario 2 development volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich AM 2026 with development Scenario 2]

Thomas Rd / Kargotich Rd
2026 volumes derived from ROM24 plus development Scenario 2
AM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	208	13.6	0.820	52.4	LOS E	14.0	115.5	1.00	1.45	2.21	34.0
2	T1	35	13.2	0.820	52.3	LOS E	14.0	115.5	1.00	1.45	2.21	34.9
3	R2	95	12.4	0.820	60.1	LOS E	14.0	115.5	1.00	1.45	2.21	35.1
Approach		338	13.2	0.820	54.5	LOS E	14.0	115.5	1.00	1.45	2.21	34.4
East: Thomas Road east												
4	L2	64	9.7	0.793	5.4	LOS A	13.0	112.7	0.83	0.49	0.83	57.1
5	T1	1006	14.5	0.793	5.6	LOS A	13.0	112.7	0.83	0.49	0.83	58.6
6	R2	13	14.6	0.793	13.4	LOS B	13.0	112.7	0.83	0.49	0.83	58.7
Approach		1083	14.2	0.793	5.6	LOS A	13.0	112.7	0.83	0.49	0.83	58.5
North: Kargotich Road north												
7	L2	14	13.6	0.051	14.8	LOS B	0.4	3.5	1.00	0.78	1.00	52.1
8	T1	5	8.0	0.051	14.4	LOS B	0.4	3.5	1.00	0.78	1.00	55.3
9	R2	1	10.0	0.051	22.4	LOS C	0.4	3.5	1.00	0.78	1.00	55.4
Approach		20	12.0	0.051	15.1	LOS B	0.4	3.5	1.00	0.78	1.00	53.1
West: Thomas Road west												
10	L2	16	15.6	0.771	5.8	LOS A	11.4	100.6	0.85	0.52	0.85	55.3
11	T1	871	15.5	0.771	5.8	LOS A	11.4	100.6	0.85	0.52	0.85	57.9
12	R2	106	13.4	0.771	13.6	LOS B	11.4	100.6	0.85	0.52	0.85	58.6
Approach		993	15.3	0.771	6.6	LOS A	11.4	100.6	0.85	0.52	0.85	57.9
All Vehicles		2434	14.5	0.820	12.9	LOS B	14.0	115.5	0.86	0.64	1.03	53.1

Table 11 – PM Peak hour SIDRA output – 2026 Scenario 2 development volumes

MOVEMENT SUMMARY

Site: 1v [Thomas Kargotich PM 2026 with development Scenario 2]

Thomas Rd / Kargotich Rd
2026 volumes derived from ROM24 plus development Scenario 2
PM Peak
Site Category: (None)
Roundabout

Movement Performance - Vehicles

Mov ID	Turn	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate	Aver. No. Cycles	Average Speed km/h
South: Kargotich Road south												
1	L2	134	12.5	0.520	20.5	LOS C	5.4	43.6	1.00	1.05	1.21	47.7
2	T1	21	12.9	0.520	20.5	LOS C	5.4	43.6	1.00	1.05	1.21	49.4
3	R2	52	8.7	0.520	28.0	LOS C	5.4	43.6	1.00	1.05	1.21	50.5
Approach		207	11.6	0.520	22.4	LOS C	5.4	43.6	1.00	1.05	1.21	48.5
East: Thomas Road east												
4	L2	175	11.9	0.973	29.5	LOS C	46.9	405.0	1.00	1.32	2.07	43.8
5	T1	966	14.5	0.973	29.7	LOS C	46.9	405.0	1.00	1.32	2.07	44.9
6	R2	9	14.4	0.973	37.5	LOS D	46.9	405.0	1.00	1.32	2.07	45.1
Approach		1150	14.1	0.973	29.7	LOS C	46.9	405.0	1.00	1.32	2.07	44.8
North: Kargotich Road north												
7	L2	5	14.0	0.125	30.7	LOS C	1.1	8.9	1.00	0.88	1.00	42.0
8	T1	8	8.8	0.125	30.0	LOS C	1.1	8.9	1.00	0.88	1.00	44.0
9	R2	10	13.1	0.125	38.3	LOS D	1.1	8.9	1.00	0.88	1.00	43.6
Approach		23	11.8	0.125	33.8	LOS C	1.1	8.9	1.00	0.88	1.00	43.4
West: Thomas Road west												
10	L2	11	15.5	0.899	5.8	LOS A	24.3	213.7	1.00	0.51	1.00	54.5
11	T1	1072	15.5	0.899	5.8	LOS A	24.3	213.7	1.00	0.51	1.00	57.0
12	R2	199	13.8	0.899	13.6	LOS B	24.3	213.7	1.00	0.51	1.00	57.5
Approach		1282	15.2	0.899	7.0	LOS A	24.3	213.7	1.00	0.51	1.00	57.0
All Vehicles		2662	14.4	0.973	18.2	LOS B	46.9	405.0	1.00	0.90	1.48	50.3

APPENDIX 1 – ROM24 LINK VOLUME PLOTS

ROM24 2016 Tonkin Hwy Upgrade and Extension Scenario - Link Volume Plot for Kargotich Rd / Thomas Rd
All Day

MODEL ASSUMPTIONS

NETWORK: 2016 Tonkin Hwy Upgrade and Extension Network
LAND USE: 2016 Tonkin Hwy Upgrade and Extension Land Use
Reference : #41351

ROM24 Multi-Modal Model V4.40
24-Hour Traffic Volumes (Factor X 100)

1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
>=4 Lanes Each Direction

mainroads WESTERN AUSTRALIA

Transport Modelling Section
Enquiries Clare Yu 9323 4967
MRWA Reference Job #41369
Tue 31 Dec 2019
T:\VOYAGER\JOBS_V2019\41369\Reports\Tonkin\LVP\41369_All Day_LVP_Y16_Kargotich_Thomas_Tonkin.VPR

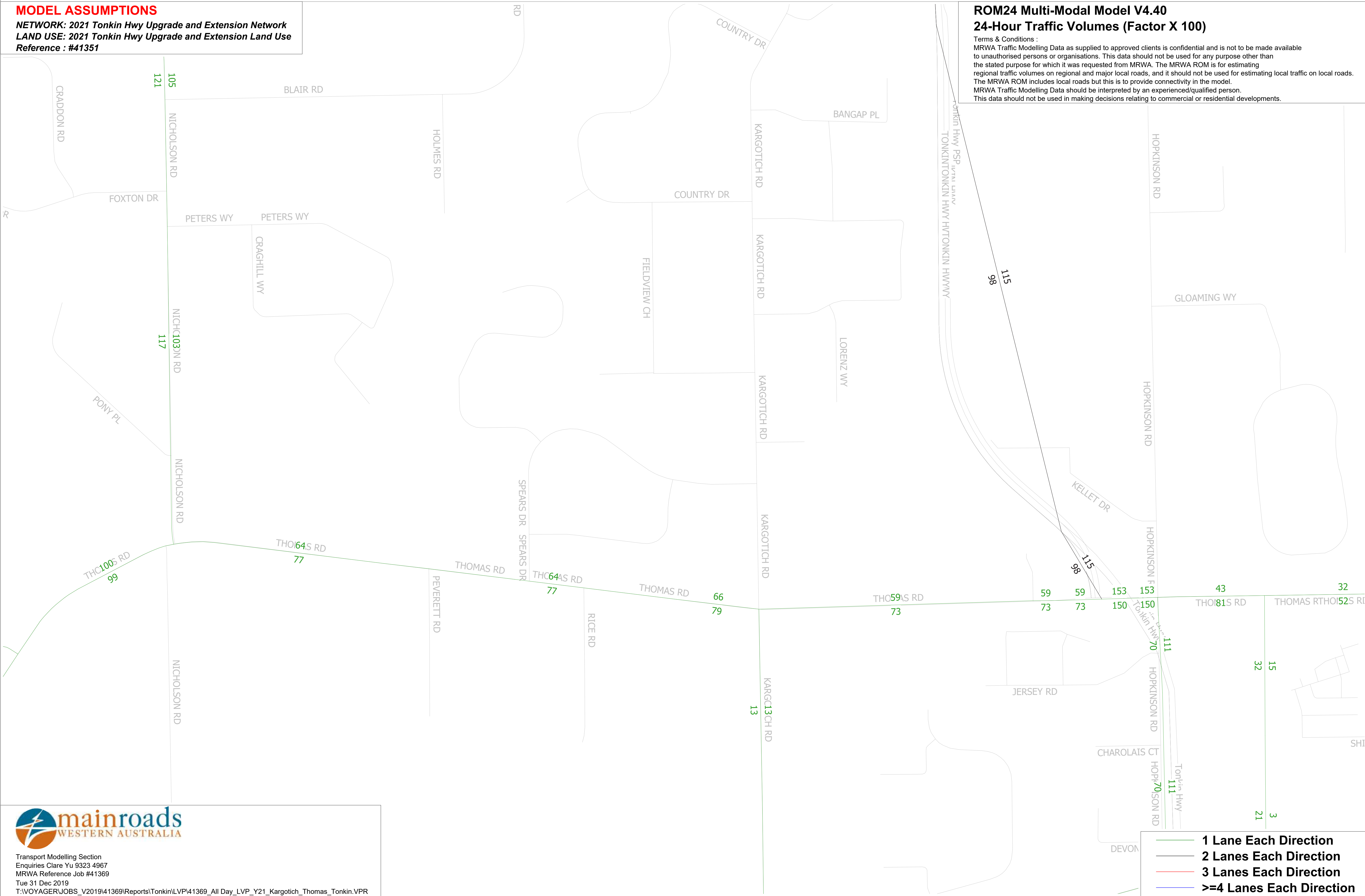
ROM24 2021 Tonkin Hwy Upgrade and Extension Scenario - Link Volume Plot for Kargotich Rd / Thomas Rd
All Day

MODEL ASSUMPTIONS

NETWORK: 2021 Tonkin Hwy Upgrade and Extension Network
LAND USE: 2021 Tonkin Hwy Upgrade and Extension Land Use
Reference : #41351

ROM24 Multi-Modal Model V4.40
24-Hour Traffic Volumes (Factor X 100)

Terms & Conditions :
MRWA Traffic Modelling Data as supplied to approved clients is confidential and is not to be made available to unauthorised persons or organisations. This data should not be used for any purpose other than the stated purpose for which it was requested from MRWA. The MRWA ROM is for estimating regional traffic volumes on regional and major local roads, and it should not be used for estimating local traffic on local roads. The MRWA ROM includes local roads but this is to provide connectivity in the model.
MRWA Traffic Modelling Data should be interpreted by an experienced/qualified person.
This data should not be used in making decisions relating to commercial or residential developments.



1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
>=4 Lanes Each Direction

mainroads WESTERN AUSTRALIA

Transport Modelling Section
Enquiries Clare Yu 9323 4967
MRWA Reference Job #41369
Tue 31 Dec 2019
T:\VOYAGER\JOBS_V2019\41369\Reports\Tonkin\LVP\41369_All Day_LVP_Y21_Kargotich_Thomas_Tonkin.VPR

cube

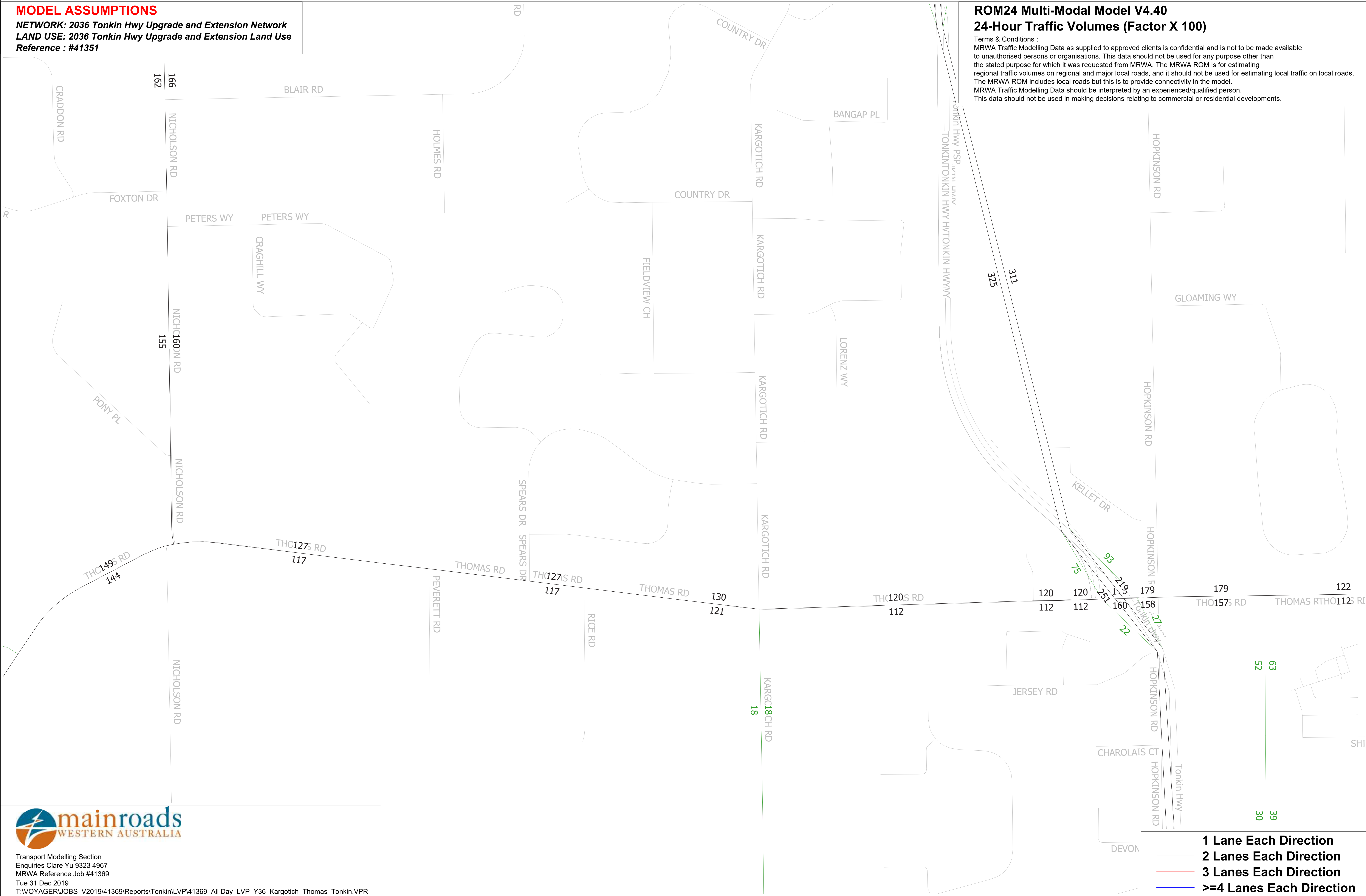
ROM24 2036 Tonkin Hwy Upgrade and Extension Scenario - Link Volume Plot for Kargotich Rd / Thomas Rd
All Day

MODEL ASSUMPTIONS

NETWORK: 2036 Tonkin Hwy Upgrade and Extension Network
LAND USE: 2036 Tonkin Hwy Upgrade and Extension Land Use
Reference : #41351

ROM24 Multi-Modal Model V4.40
24-Hour Traffic Volumes (Factor X 100)

Terms & Conditions :
MRWA Traffic Modelling Data as supplied to approved clients is confidential and is not to be made available to unauthorised persons or organisations. This data should not be used for any purpose other than the stated purpose for which it was requested from MRWA. The MRWA ROM is for estimating regional traffic volumes on regional and major local roads, and it should not be used for estimating local traffic on local roads. The MRWA ROM includes local roads but this is to provide connectivity in the network.
MRWA Traffic Modelling Data should be interpreted by an experienced/qualified person.
This data should not be used in making decisions relating to commercial or residential developments.



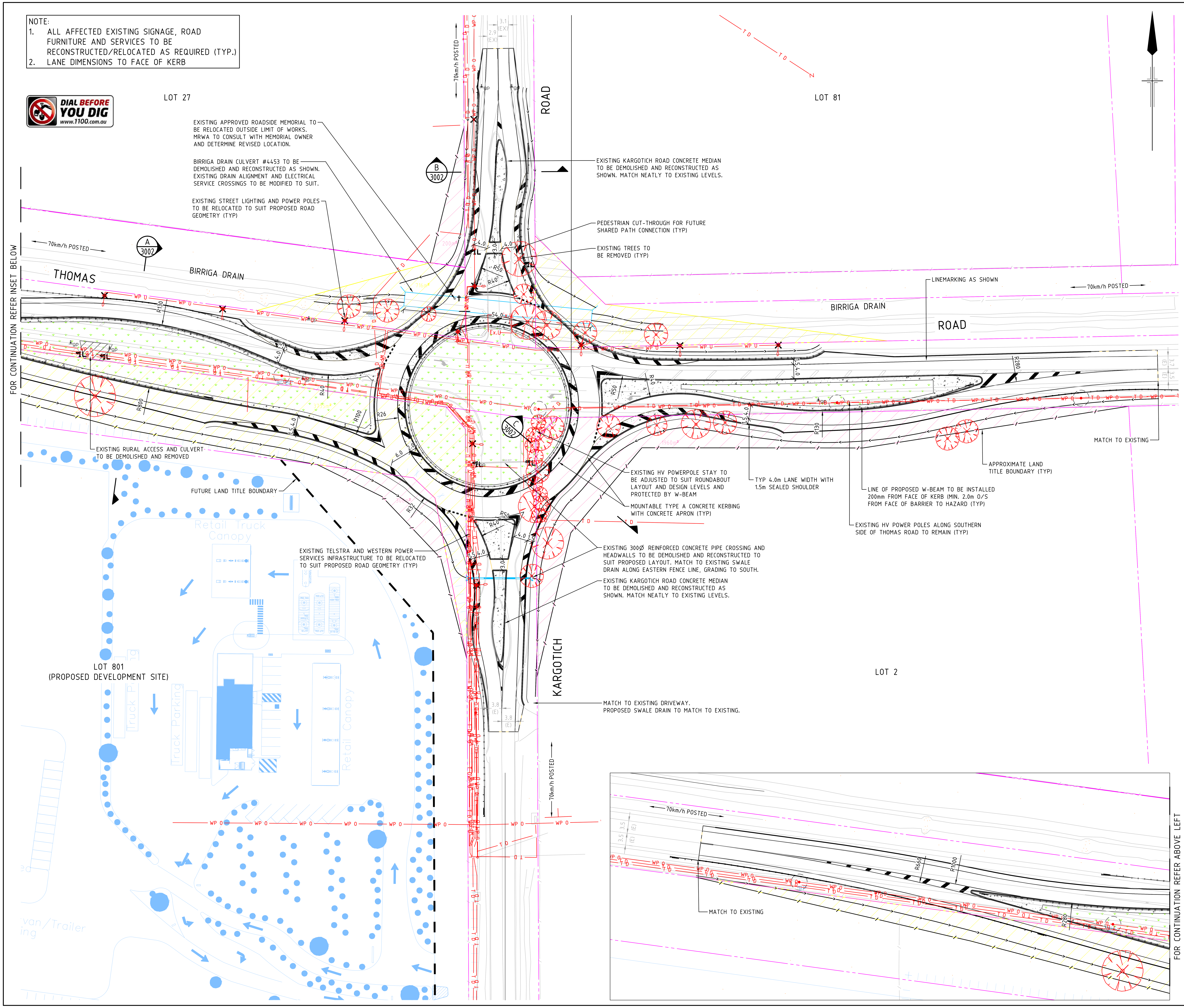
1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
>=4 Lanes Each Direction

mainroads WESTERN AUSTRALIA

Transport Modelling Section
Enquiries Clare Yu 9323 4967
MRWA Reference Job #41369
Tue 31 Dec 2019
T:\VOYAGER\JOBS_V2019\41369\Reports\Tonkin\LVP\41369_All Day_LVP_Y36_Kargotich_Thomas_Tonkin.VPR

flyt

APPENDIX 2 – ROUNDABOUT DRAWING 201948-2998/00



AMENDMENTS

No.	DESCRIPTION	APPROVED & DATE
1	PRELIMINARY ISSUE	17/07/2019
2	AMENDMENTS FOLLOWING REVIEW	22/08/2019
3	MINOR AMENDMENTS	06/09/2019

NOTES

KEY

- PROPERTY ACQUISITION (PUBLIC)
- PROPERTY ACQUISITION (PRIVATE)
- PROPOSED ROAD PAVEMENT
- PROPOSED LANDSCAPING
- PROPOSED CONCRETE WORKS
- EXISTING LIGHT POLE
- EXISTING ELECTRICAL/LIGHT POLES AND ASSOCIATED INFRASTRUCTURE TO BE RELOCATED/MODIFIED AS REQUIRED
- WP U — EXISTING UNDERGROUND ELECTRICITY
- WP O — EXISTING OVERHEAD ELECTRICITY
- T D — EXISTING TELSTRA/OPTUS DISTRIBUTION
- Ex.U — EXISTING UNKNOWN UTILITY
- APPROXIMATE CADASTRAL BOUNDARY
- PROPOSED KERB
- PROPOSED LINE MARKING
- EXISTING / PROPOSED FENCE LINE
- PROPOSED W-BEAM
- PROPOSED UNDERGROUND DRAINAGE
- PROPOSED SWALE DRAIN
- EXISTING TREE TO BE REMOVED
- gp — EXISTING SIGN
- EXISTING STORM WATER

- DESIGN VEHICLE: 19m AUSTROADS SEMI-TRAILER)
- DESIGN VEHICLE: 27.5m AUSTROADS B-DOUBLE)
- DESIGN VEHICLE: 36.5m AUSTROADS B-TRIPLE)

PRELIMINARY PLAN ONLY SUBJECT TO ALTERATION

METADATA

GROUND SURVEY STANDARD:	DIGITAL GROUND SURVEY
DATE OF CAPTURE:	05.07.2019
MAPPING SURVEY STANDARD:	N/A
DATE OF CAPTURE:	N/A
MAIN ROADS PROJECT ZONE:	PCG94
HEIGHT DATUM:	AHD71

GTA consultants
www.gta.com.au
Melbourne 03 9851 9600
Sydney 02 8448 1800
Brisbane 07 3113 5000
Canberra 02 6243 9400
Adelaide 08 8334 3600
Gold Coast 07 5510 4814
Townsville 07 4722 2765
Perth 08 6316 4634

DRAWING NUMBER/DOCUMENT ID W166271-SK01 SK05-P3.DWG

DESIGNED / DRAWN	T.GARDINER 09.07.2019
VERIFIED	T. JUDD 17.07.2019
DIRECTOR	T. JUDD 17.07.2019

THE GOVERNMENT OF WESTERN AUSTRALIA
mainroads WESTERN AUSTRALIA
METROPOLITAN AND SOUTHERN REGIONS
METROPOLITAN REGION (PROJECT DEVELOPMENT)
WATERLOO CRESCENT East Perth 6004
Telephone (08) 9323 4111 Fax (08) 9323 4430

SCALES 1:500

A1

MRWA FILE NUMBER 15/6209

APPROVED (MRWA)

PROPOSED SINGLE-LANE ROUNDABOUT
THOMAS ROAD AND KARGOTICH ROAD INTERSECTION
SLK 16.6 TO SLK 17.1
15% CONCEPT DESIGN

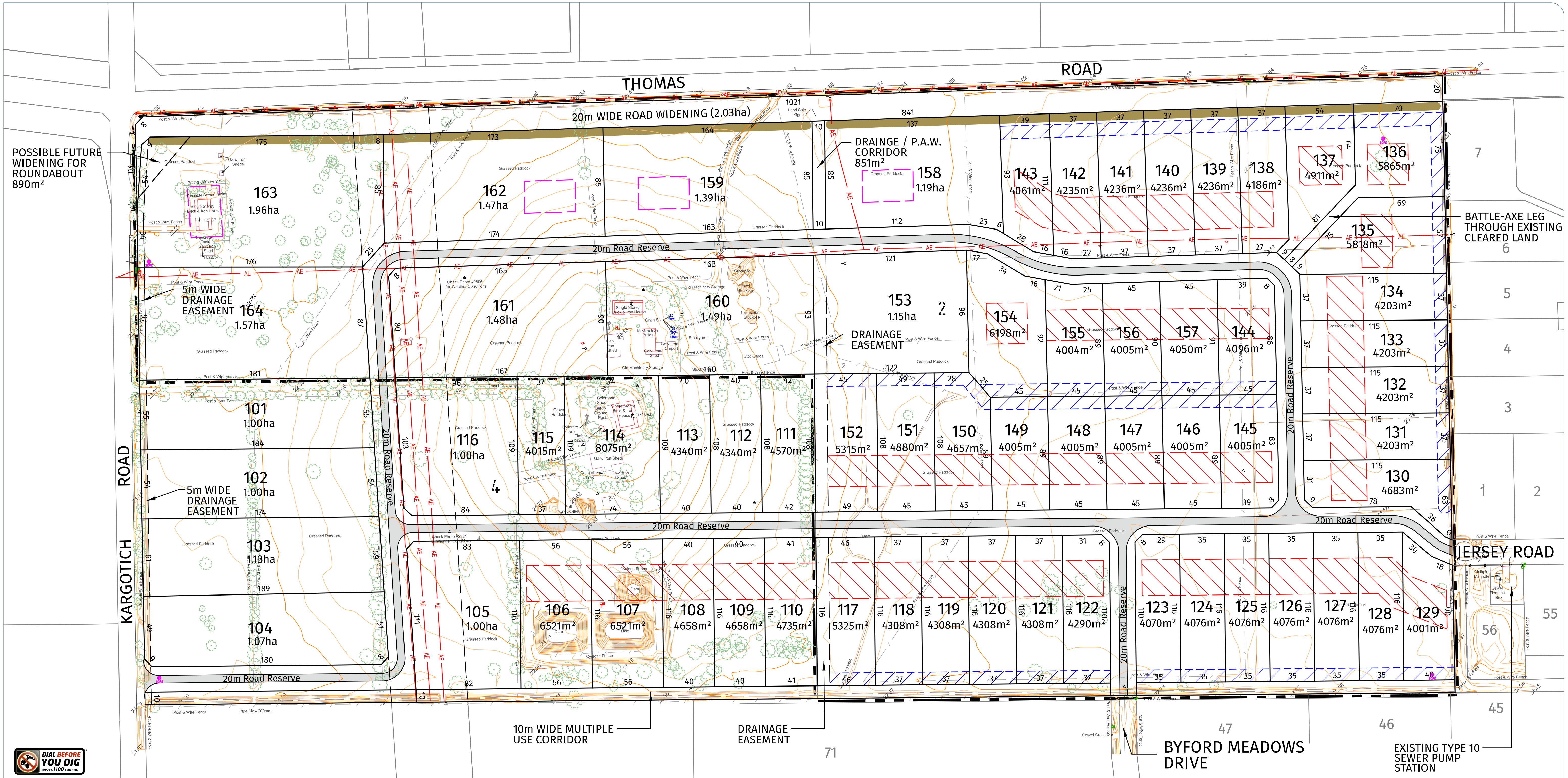
LOCAL AUTHORITY SHIRE OF SERPENTINE JARRAHDALE

MRWA DRAWING NUMBER 201948-2998/00

APPENDIX K

Concept Plan of Subdivision

Prepared by Harley Dykstra



LEGEND

- CONCEPT PLAN AREA
- OVERHEAD TRANSMISSION LINE (AE)
- 60m WIDE EASEMENT
- DRAINAGE SWALE
- INDICATIVE ELEVATED BUILDING PAD
- INDICATIVE BUILDING ENVELOPE (1000m²)
- VEGETATED BUND

NOTE:
ALL LOTS LESS THAN 1 HECTARE ARE TO BE SERVICED BY RETICULATED SEWER

LOT 4 YIELD

Size	No. Lots	% Total Lots
4000m² - 1ha	10	62%
1ha - 2ha	6	38%
Number of Lots	16	
Minimum Lot Size 4015m²	Average Lot Size 7148m²	
Maximum Lot Size 1.13ha	Total Lot Area 11.44ha	

LOT 2 YIELD

Size	No. Lots	% Total Lots
4000m² - 1ha	40	83%
1ha - 3ha	8	17%
Number of Lots	48	
Minimum Lot Size 4001m²	Average Lot Size 6101m²	
Maximum Lot Size 1.96ha	Total Lot Area 29.29ha	

TOTAL YIELD SUMMARY

Size	No. Lots	% Total Lots
4000m² - 1ha	50	78%
1ha - 3ha	14	22%
Number of Lots	64	
Minimum Lot Size 4001m²	Average Lot Size 6365m²	
Maximum Lot Size 1.96ha	Total Lot Area 40.73ha	

LOCATION PLAN

CONCEPT PLAN OF SUBDIVISION OPTION 1

Lot 2 Thomas Road
OAKFORD

DRAFT

Plan No. | 21396-01
Date | 18/02/20
Drawn | NP
Checked | CP
Revision | L
Scale | 1:3000 @ A3 (0 20m 40m)

PERTH & FORRESTDALE:
Lvl 1, 252 Fitzgerald St
PERTH WA 6000
1/2 Hensbrook Loop,
FORRESTDALE WA 6112
T: 08 9495 1947
E: metro@harleydykstra.com.au
ALBANY | BUNBURY | BUSSELTON | FORRESTDALE | PERTH

NOTE: This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey

Harley Dykstra
PLANNING & SURVEY SOLUTIONS