PROPOSED METROPOLITAN REGION SCHEME AMENDMENT

PICKERING BROOK TOWNSITE EXPANSION

JUNE 2016

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Executive Summary

The Metropolitan Region Scheme (MRS) amendment request for the proposed expansion of the Pickering Brook townsite is a direct response to the recommendations contained in the endorsed Shire of Kalamunda Local Planning Strategy. The Strategy identifies as a priority the undertaking of a comprehensive analysis of the townsite and surrounds to investigate future lot creation. The amendment request seeks the rezoning of the project area from 'Rural' to 'Urban' under the MRS and aligns with Strategy recommendations.

The future sustainability of the Pickering Brook townsite is contingent upon the expansion and consolidation of the existing townsite to a more viable level that can support required goods and services at a level commensurate with contemporary needs and expectations.

Relatively large lot subdivision potential in serviceable locations that reinforce the existing townsite and that are able to respond to bushfire risk and other relevant environmental and strategic planning considerations are considered an appropriate response to emerging economic, social and environmental trends and issues at Pickering Brook and in the broader Perth Metropolitan North-East Sub-region, and will be flexible enough to meet the needs of a range of suitable future urban and peri-urban uses.

The planning process to support the MRS amendment process has included the following:

- Technical studies for bushfire risk, water management, environmental values, servicing requirements and transport issues;
- Meetings with key State Government agencies and other private and institutional stakeholders; and
- Community information sessions.

The approximately 90-hectare project area forming the MRS amendment request for the townsite expansion was derived from a broader study area based on the following key factors as identified via a comprehensive opportunities and constraints analysis:

- The ability to be serviced with a reticulated water supply by the Water Corporation;
- The capacity to manage bushfire risk through adequate separation from high risk fire areas and road connectivity opportunities;
- The opportunity to reinforce the existing townsite and recreational facilities with the inclusion of a potential local centre in the most suitable location; and
- The ability to mitigate water and environmental factor risks by avoiding areas of high environmental value and improving the quality of the water receiving environment where practical to do so.

In order to guide the preparation of the technical reports to support the MRS amendment request, an Indicative Development Precinct Plan was prepared to illustrate future development intentions for the project area consistent with the Shire's Strategy. A preliminary yield assessment prepared for the proposed townsite expansion based on the precincts identified in the plan indicates an approximate lot yield for the project area of 300-350 lots and a local centre, contingent on final lot size. A more detailed analysis will be developed at the local structure planning stage to the areas opportunities and constraints at which time a more accurate yield can be determined.

An Environmental Assessment Report (EAR) prepared by Coterra Environment outlines the relevant environmental characteristics of the project area, assesses the environmental impacts associated with the proposed scheme amendment, and identifies management strategies that aim to minimise or manage these impacts.

A District Water Management Strategy (DWMS) prepared by Strategen Environmental Consultants sets out a series of principles, objectives and proposed implementation measures in relation to water use, groundwater levels and surface water flows, groundwater and surface water quality and disease vector and nuisance insect management. The DWMS also addresses the

consideration that the project area is currently a Priority 2 Public Drinking Water Source Area (PDWSA) and that in order to achieve the lot size desired by the Shire, the area will need to be reclassified to a Priority 3 PDWSA consistent with the existing Pickering Brook townsite to the east. It is considered that with the implementation of the measures outlined in the DWMS that drinking water quality will be maintained.

The project area is also surrounded by dense vegetated areas with a Bushfire Hazard Assessment prepared by FirePlan WA identifying that a Fire Management Plan will be required during subsequent more detailed planning stages. Transport Impact Assessment and Infrastructure Servicing Reports prepared by KCTT conclude that there are no transport or servicing considerations that would preclude the development of the project area in the form envisaged.

More detailed investigations of the project area will be addressed at the local structure planning or subdivision stage, incorporating additional actions to assist in the retention of environmental values, detailed water management, bushfire risk management and specific servicing and transport requirements.

In conclusion, the MRS amendment for the proposed townsite expansion is demonstrated to comprise an orderly and proper planning outcome in terms of the statutory requirements for MRS amendments as outlined in the Western Australian Planning Commissions Development Control Policy 1.9 Amendments to Regions Schemes (March 2010), relevant State and local planning framework requirements including the draft Perth and Peel@3.5 million suite of strategic planning documents and applicable State Planning Policies, the Shire's Local Planning Scheme No. 3 and Local Planning Strategy and the Hills Rural Study

Contents

Introduction

The future sustainability of the Pickering Brook community is contingent upon the expansion and consolidation of the existing townsite to a more viable level that can support required goods and services at a level commensurate with contemporary local needs and expectations.

The changing composition of the local population over recent decades in conjunction with the general intrusion of urban uses including quasi-industrial uses has resulted in a transition from orchards and other intensive and extensive agricultural uses to more urban and lifestyle based land use opportunities, including tourism based activities.

Relatively large lot subdivision potential (2000-4000m^2+) in serviceable locations that are able to respond to bushfire risk and other relevant environmental and strategic planning considerations are considered to be an appropriate response to emerging economic, social and environmental trends and issues at Pickering Brook and in the broader Perth Metropolitan North-East Sub-region, and will be flexible enough to meet the needs of a range of suitable future urban and peri-urban uses.

On balance, the strategic planning benefits for the expansion of the Pickering Brook townsite as reflected in the Shire of Kalamunda (the Shire's) endorsed Local Planning Strategy (the Strategy) are considered to out-weigh the value of the area as a relatively compromised surface water catchment area.

To date, the planning process to support the required Metropolitan Region Scheme (MRS) amendment process for the proposed townsite expansion has included:

- the finalisation of the Shire's Strategy, including endorsement by the Western Australian Planning Commission (WAPC) in February 2013;
- technical studies for bushfire risk, water management, environmental values, servicing requirements and transport issues;
- meetings with key government agencies and other private and institutional stakeholders; and
- community information sessions.

To date there have been no critical constraints identified that would prevent the MRS amendment proceeding as currently proposed.

A summary of stakeholder consultation outcomes is provided at Appendix 1.

Refer to Appendix 1 - Stakeholder Consultation Outcome Summary (January 2014)

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Proposed MRS Amendment

It is proposed to rezone the project area from 'Rural' to 'Urban' under the MRS. Approval of the proposed MRS amendment will provide the necessary overarching statutory planning framework for the project area to be rezoned to 'Development' under the Shire's Local Planning Scheme No. 3 (LPS3), with a local structure plan then being prepared to guide future subdivision and development.

Indicative Development Precinct Plan

In order to guide the preparation of technical reports to support the MRS amendment request, an Indicative Development Precinct Plan (IDPP) was prepared to inform the sub-consultants as to the probable future development intentions for the project area consistent with the Shire's endorsed Strategy. A copy of the IDPP is provided at Figure 1.

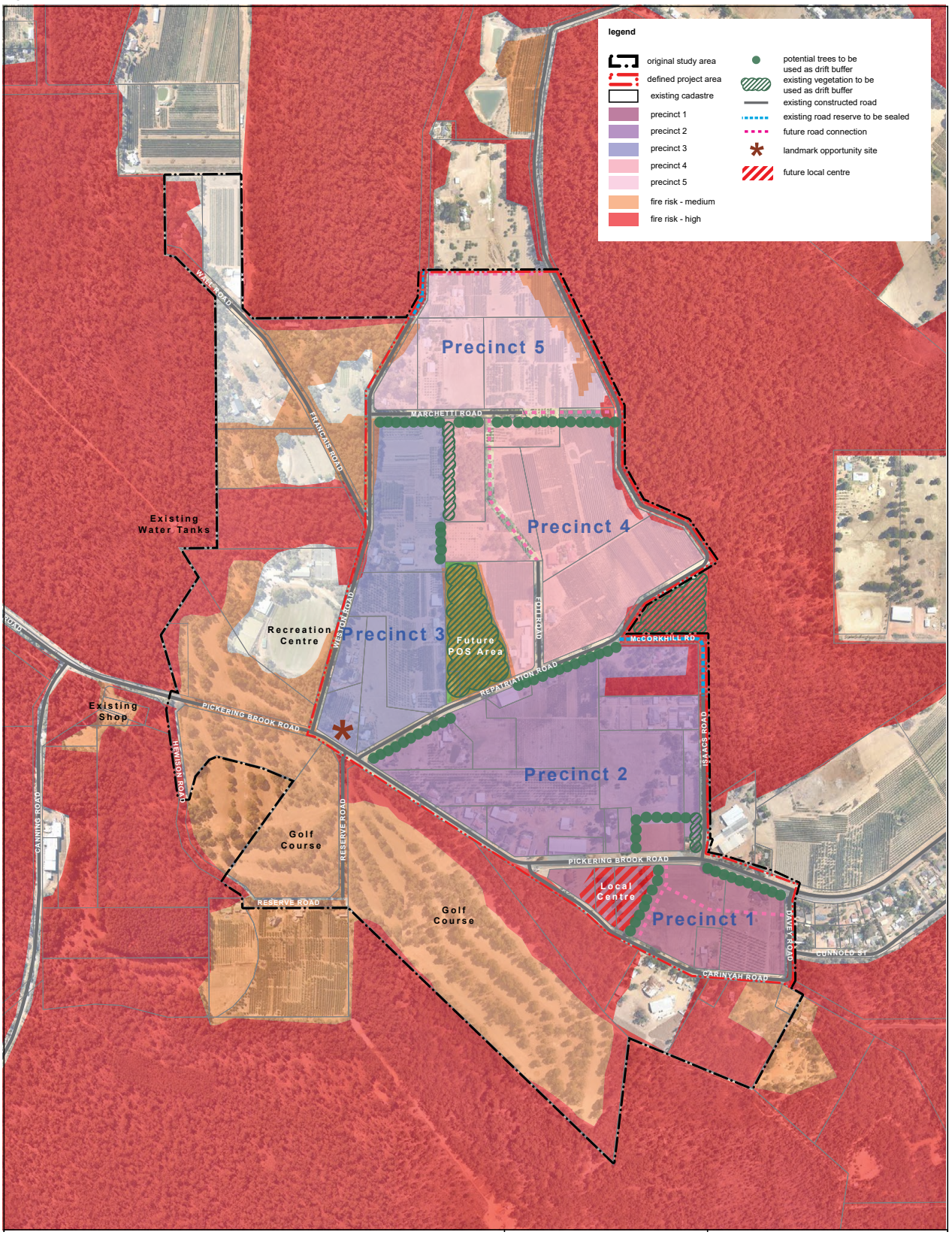
Refer to Figure 1 – Indicative Development Precinct Plan

The project area forming the MRS amendment request for the proposed Pickering Brook townsite expansion was derived from a broader study area based on the following key factors as identified via a comprehensive opportunities and constraints analysis:

- The ability to be serviced with a reticulated water supply by the Water Corporation.
- The capacity to manage bushfire risk through adequate separation from high risk areas and road connectivity opportunities.
- The opportunity to reinforce the existing townsite and recreational facilities with the inclusion of a potential local centre in the most suitable location.
- The ability to mitigate water and environmental factor risks by avoiding areas of high environmental value and improving the quality of the water receiving environment where practical to do so.

A preliminary yield assessment prepared by TPG for the proposed townsite expansion based on the precincts identified in the IDPP at Figure 1 indicates an approximate lot yield for the project area of 300-350 lots and a local centre, contingent on final lot size. A more detailed response will be developed at the local structure planning stage to the areas opportunities and constraints, at which time a more accurate yield can be determined.

Figure 1 – Indicative Development Precinct Plan



Subject Land

The Project Area

The project area covers an area of approximately 90 hectares and is generally bound by:

1. Davey Road, Isaacs Road, McCorkhill Road and Repatriation Road to the east.
2. Western Road and Isaacs Road to the north.
3. Carinyah Road and Pickering Brook Road to the south.
4. Weston Road to the west.

The project area is situated entirely within the municipality of the Shire of Kalamunda and is situated in the locality of Pickering Brook.

Pickering Brook is located on the outskirts of Perth, approximately 26 kilometres (32 kilometres by road) east of the Perth CBD and 9.5 kilometres south east of Kalamunda.

Lots included within the project area are set out in Table 1 below.

Refer to Figure 2 – Project Area Plan

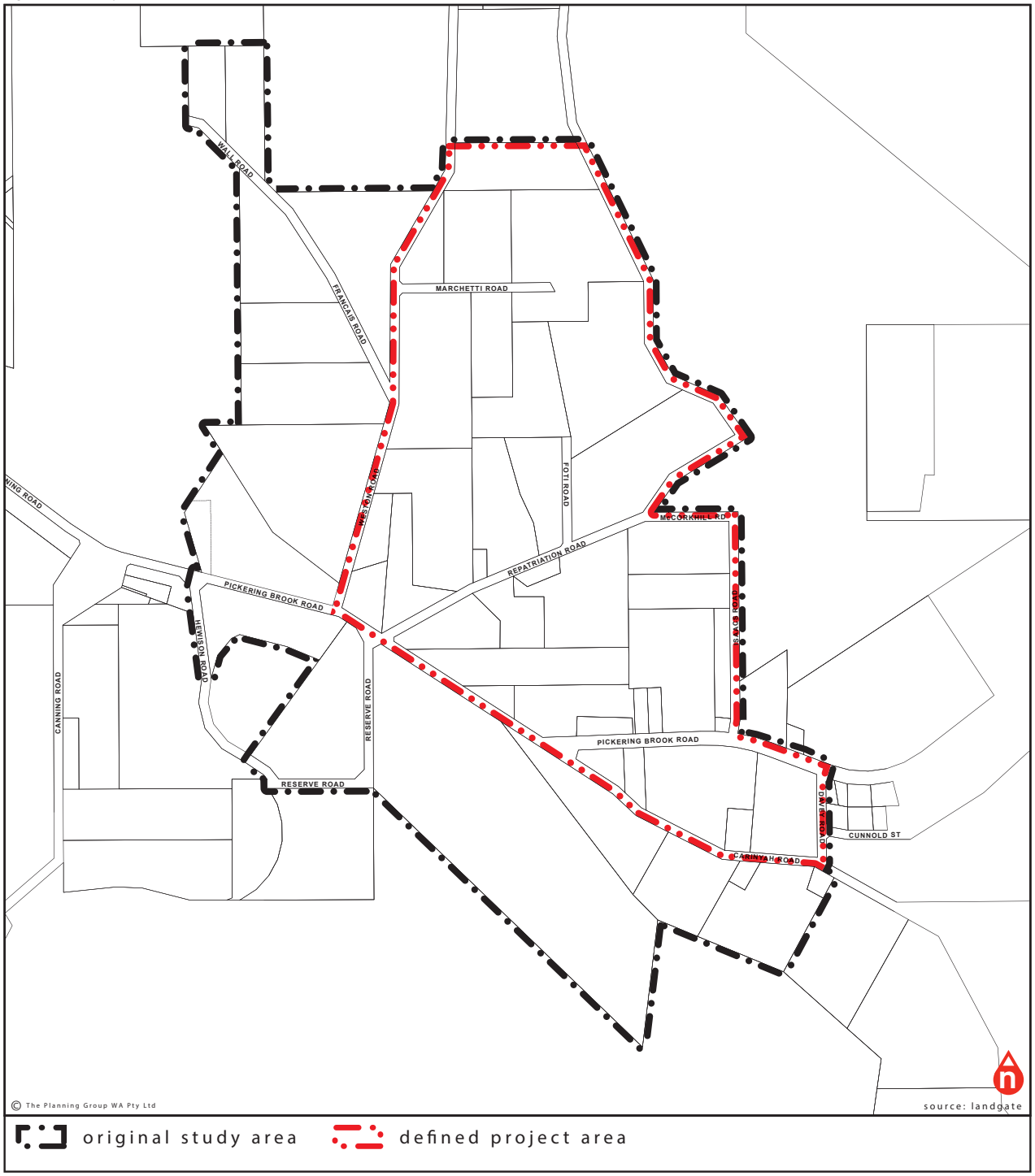
Table 1 - Land in Project Area

Lot	Street Address	Certificate of Title	Plan/Diagram	Landowner
500	37 Carinyah Road, Pockering Brook	1515/259	54578	FORSYTH, DAVID AARRON FORSYTH, PETA TRACEY
12	30 Foti Road, Pickering Brook	1536/374	056916	O'MEAGHER, LINETTA O'MEAGHER, GRAHAM STANLEY
13	16 Isaacs Road, Pickering Brook	1808/972	074196	CASKEY, WARREN JOHN SPRIGGS, GEORGE CHARLES SPRIGGS, DAPHNE SPRIGGS, KERRY ANN
2	20 Isaacs Road, Pickering Brook	1930/762	007936	BRESCACIN, JO-ANNE MAREE BRESCACIN, GIAN PIETRO NILO
5	21 Marchetti Road, Pickering Brook	1636/223	019828	MCGEOUGH, TERRI ANNE MCGEOUGH, DAVID
9	24 Marchetti Road, Pickering Brook	1248/268	026584	MOORE, GERALD PHILLIP MOORE, GLENYS PAM
501	31 Marchetti Road, Pickering Brook	2805/376	043813	FRY, RONALD WILLIAM
150	47 Pickering Brook Road, Pickering Brook	2668/421	053702	O'TOOLE, PASCHAL WILLIAM O'TOOLE, PATRICIA ANN
CA814	71 Pickering Brook Road, Pickering Brook	822/133	202178	GIGLIA, MARIA ANGELA
3	85 Pickering Brook Road, Pickering Brook	1002/245	007935	VINCI, ROBERT PHILLIP
105	91 Pickering Brook Road, Pickering Brook	2536/742	029400	VINCI, ROBERT PHILLIP
104	95 Pickering Brook Road, Pickering Brook	2536/741	029400	ERCEG HOLDINGS PTY LTD
106	98 Pickering Brook Road, Pickering Brook	2604/537	43776	STERVAGGI, MARIA
100	99 Pickering Brook Road, Pickering Brook	2068/494	090613	MCGRATH, TREVOR

Lot	Street Address	Certificate of Title	Plan/Diagram	Landowner
101	101 Pickering Brook Road, Pickering Brook	2068/495	090613	JOHNSON, KIM LEANNE JOHNSON, DONALD ANDREW JOHNSON, BRIAN RAYMOND
107	104 Pickering Brook Road, Pickering Brook	2604/537	43776	VINCI, MICHAEL ANGELO
11	109 Pickering Brook Road, Pickering Brook	1324/624	041604	VINCI, MARIO DENNIS
2	112 Pickering Brook Road, Pickering Brook	1515/260	14933	MARCHESANO, LUIGI
CA1843	115 Pickering Brook Road, Pickering Brook	1317/622	208872	EELES, NANETTE HAZEL EELES, ERIC ERNEST
3	140 Pickering Brook Road, Pickering Brook	1801/185	14933	DELLA FRANCA, JOHN CHARLES
2	6 Repatriation Road, Pickering Brook	1153/413	014171	RANDO, COSIMO TONY RANDO, PATRICK MICHAEL RANDO, NICHOLAS TONY RANDO, MITCHELL FRANK
50	19 Repatriation Road, Pickering Brook Road	2666/296	057168	LAWRENCE, KERRYN LEE MORFITT, CHANTELLE LEE LAWRENCE, RUSSELL CLINTON MORFITT, BRADLEY GORDON
6	26 Repatriation Road, Pickering Brook	1226/176	024455	LAMONT, STEPHEN FRANCIS KENNETH LAMONT, REBECCA MAREE
10	30 Repatriation Road, Pickering Brook	2674/800	054306	MILLAR, BEVERLEY DAWN
7	31 Repatriation Road, Pickering Brook	1290/193	027251	O'MEAGHER, LINETTA O'MEAGHER, GRAHAM STANLEY
11	40 Repatriation Road, Pickering Brook	2674/799	054305	G & L O'MEAGHER NOMINEES PTY LTD O'MEAGHER, GLEN STANLEY
CA964	55 Repatriation Road, Pickering Brook	1808/973	156711	MARTIN, ROSALIE ANNE
6	60 Repatriation Road, Pickering Brook	1814/794	024633	O'MEAGHER, LINETTA O'MEAGHER, GRAHAM STANLEY
13	120 Repatriation Road, Pickering Brook	1536/375	056916	O'MEAGHER, LINETTA O'MEAGHER, GRAHAM STANLEY
200	200 Repatriation Road, Pickering Brook	2740/288	065619	O'MEAGHER, LINETTA O'MEAGHER, GRAHAM STANLEY
201	201 Repatriation Road, Pickering Brook	2740/289	065619	FURFARO, MARIA ANNUZIATA
1	16 Weston Road, Pickering Brook	2133/206	014171	ROSS, CAREN YVONNE ROSS, ALAN GRENVILLE
5	30 Weston Road, Pickering Brook	39/400A	022785	SPICCIA, ROMA SPICCIA, ANGELO
4	50 Weston Road, Pickering Brook	1479/593	022785	MCKENZIE, BARBARA JEAN MCKENZIE, KENNETH JAMES FRANCIS
6	80 Weston Road, Pickering Brook	378/17A	019828	STEUART, KATHERINE ELIZABETH STEUART, ROBERT FRANCIS LASCELLES
1	100 Weston Road, Pickering Brook	1196-972	019535	GENETTI, IDA

The lots outlined above will generally be referred to as 'the project area' for the purpose of this report.

Figure 2 – Project Area Plan



Site Characteristics

Pickering Brook is a locality with a small townsite situated in the Darling Ranges east of Perth, Western Australia. The project area is predominantly comprised of orchards that are scattered throughout the undulating topography. Meandering valleys and streams traverse through the project area, which is surrounded by mainly State Forest Reserves that are dominated by tall and mature Marri and Karri trees.

The project area itself is predominantly cleared of existing native vegetation and now contains a number of orchards, houses and associated farming infrastructure that support the existing orcharding activities. A valley dissects the project area generally in a north south direction, where a number of dams have been constructed both on and off the main creek line that passes through the project area, towards an unnamed tributary of Piesse Brook.

A series of investigations were undertaken over a wider study area before the project area that would form the MRS amendment request was finalised. The two areas can be seen relative to each other in Figures 1 - 5.

Refer to Figure 3 – Study Area Opportunities and Constraints

Refer to Figure 4 - Study Area Topography

Refer to Figure 5 - Study Area Aerial Photograph

Local Context

Pickering Brook is located on the outskirts of the Perth Metropolitan Region. The project area that is defined by this MRS amendment will facilitate the expansion of the Pickering Brook townsite, where the existing residential development has historically formed along the southern side of Pickering Brook Road. Apart from these existing residential dwellings along Pickering Brook Road and associated community facilities including a primary school, the immediate surrounding area is characterised by areas of native forest that separate areas of dispersed orchards.

Within the immediate vicinity of the project area is the Pickering Brook Golf Course and the Pickering Brook Sports Club, located at the George Spriggs Reserve. There are a limited number of commercial activities within the project area that are not directly associated with the orcharding industry, which includes a truck sales business, bed and breakfast and building supplies company.

Refer to Figure 6 – Location Plan

Regional Context

As noted above, Pickering Brook is located approximately 26km east of the Perth CBD, approximately 9.5km south east of Kalamunda and approximately 15km south of Mundaring.

Pickering Brook is within an area that is largely dominated by rural land uses. The project area is situated within the Darling Scarp by approximately the same distance as Mundaring, although a notable difference between Mundaring and Pickering Brook is the major arterial road connection of Great Eastern Highway that traverses through Mundaring, connecting Perth to the Wheatbelt Region and beyond. Presumably this road connection has influenced the greater urban intensification found at Mundaring, compared to Pickering Brook, which is not serviced by a major arterial road connection and as such, has been historically limited in its growth potential.

Current Metropolitan Region Scheme and Local Planning Scheme Zonings

Metropolitan Region Scheme

The project area is currently zoned 'rural' under the MRS. The existing 'Urban' zoned land in Pickering Brook (does not form part of this amendment request) abuts the south eastern portion of the project area along Pickering Brook Road, to the east of Davey Road.

Refer to Figure 7 – Metropolitan Region Scheme Extract

Shire of Kalamunda Local Planning Scheme No.3

The project area is zoned 'Rural Agricultural' under the Shire's LPS3 with a significant portion shown as 'Bushfire Prone' on the Shire's Scheme Map in Figure 8. To the north west of the project area land is zoned 'Rural Landscape Interest', to the south is predominantly zoned 'Rural Conservation' with an area reserved for 'Local Open Space' west of the project area accommodating the George Spriggs Reserve. The area to the east of the project area is predominantly reserved as 'Parks and Recreation' under the MRS.

Refer to Figure 8 – Shire of Kalamunda Local Planning Scheme No. 3 Extract

Figure 3 – Study Area Opportunities and Constraints

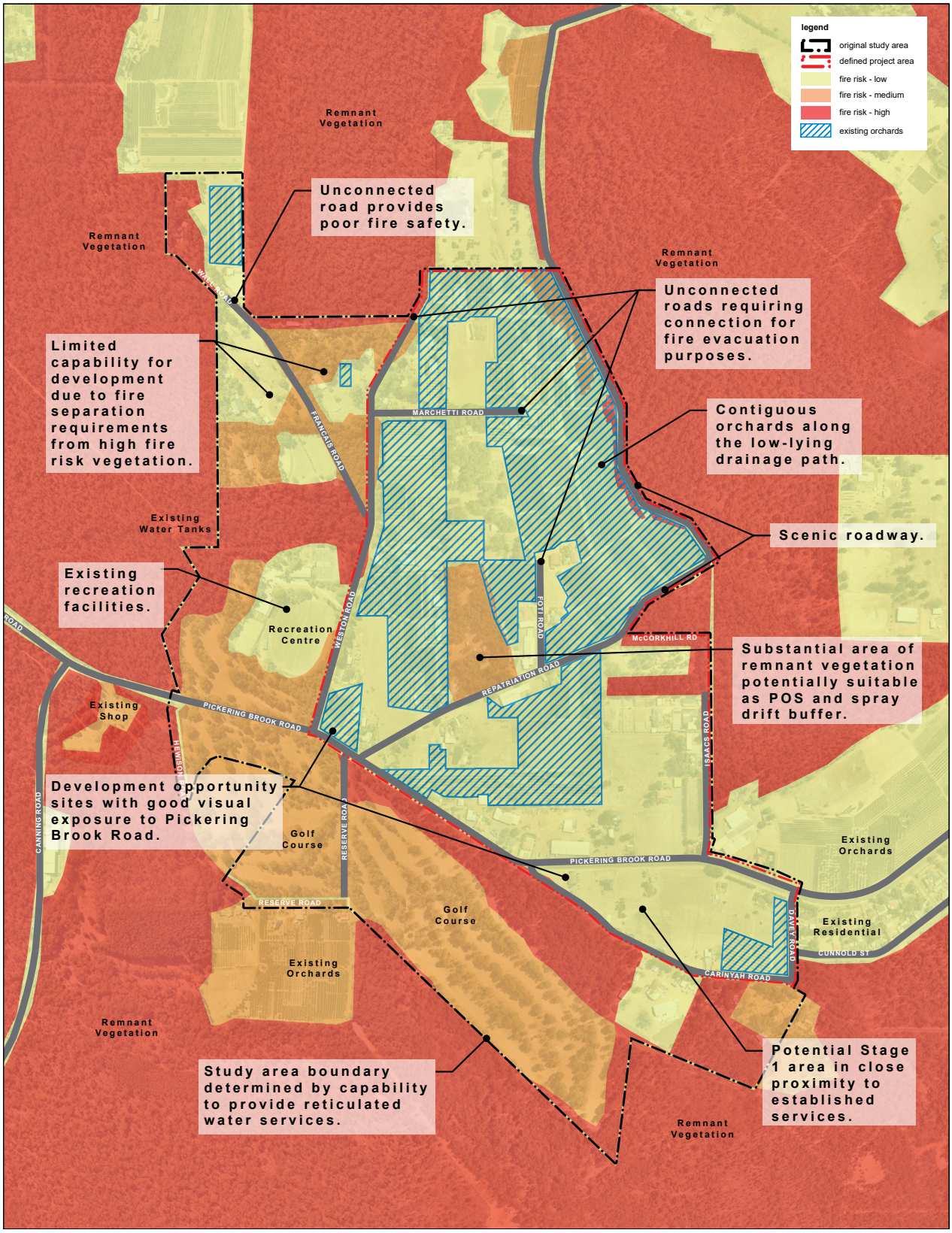


Figure 4 - Study Area Topography

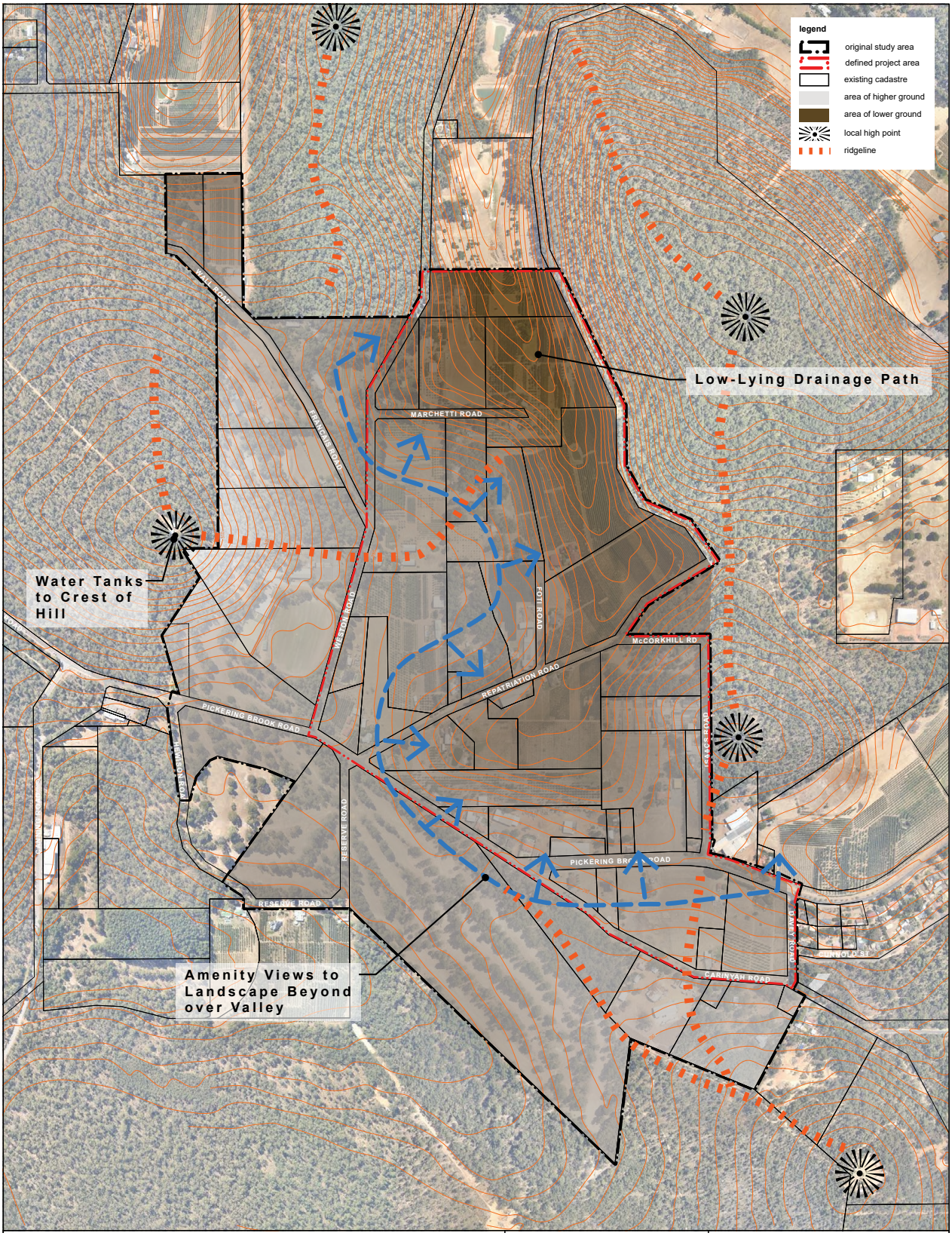


Figure 5 - Study Area Aerial Photograph

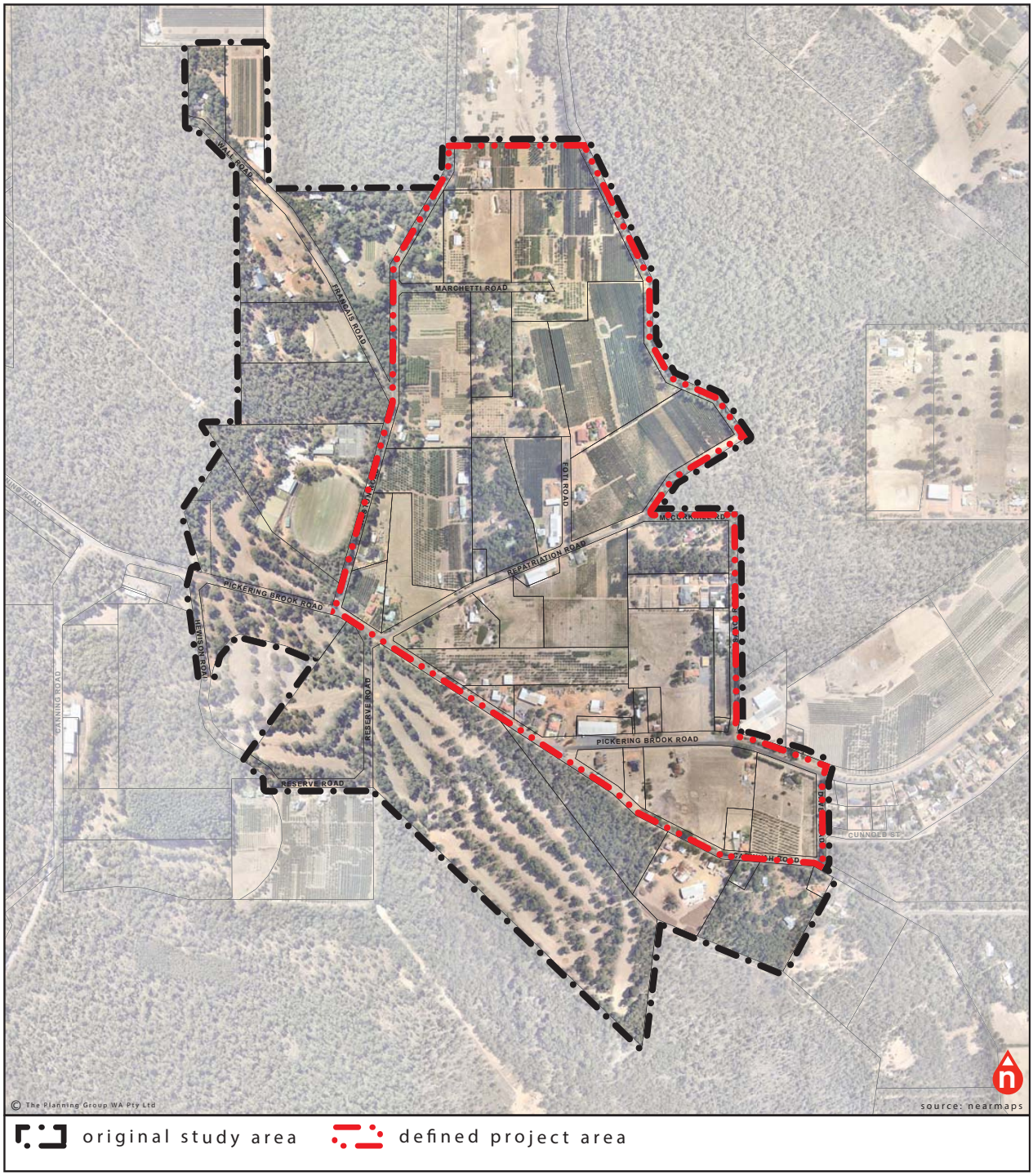


Figure 6 – Location Plan

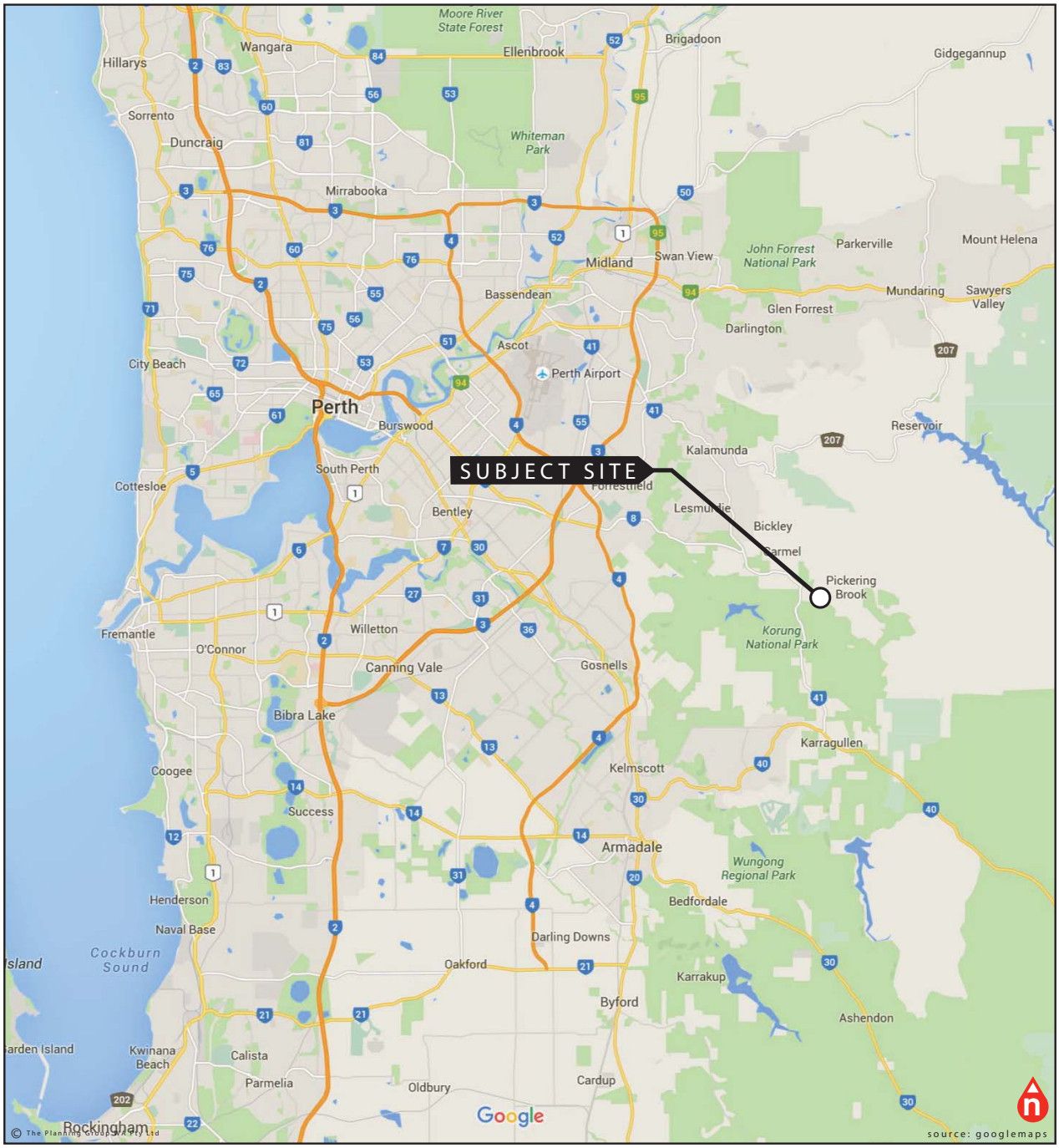


Figure 7 – Metropolitan Region Scheme Extract

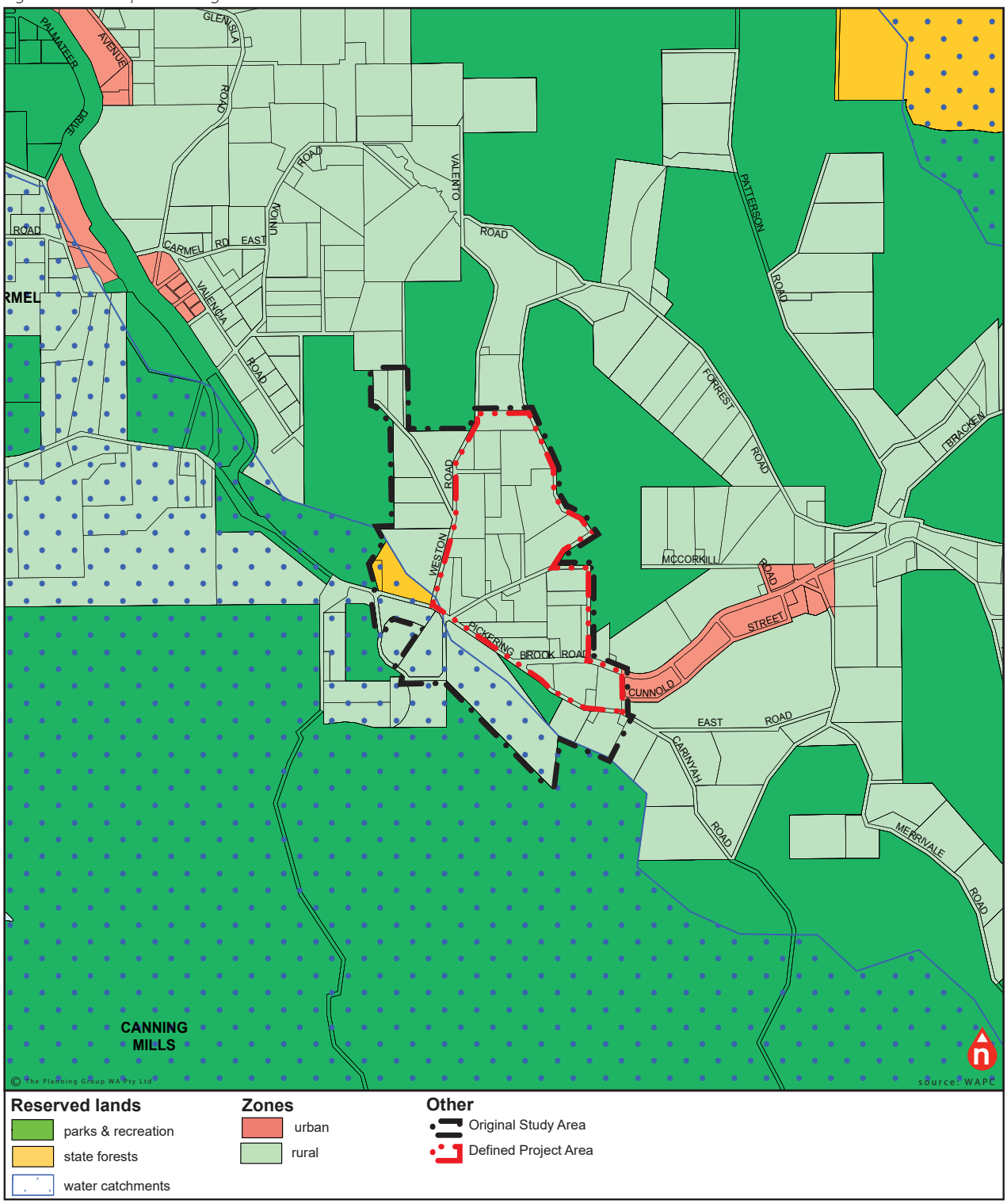
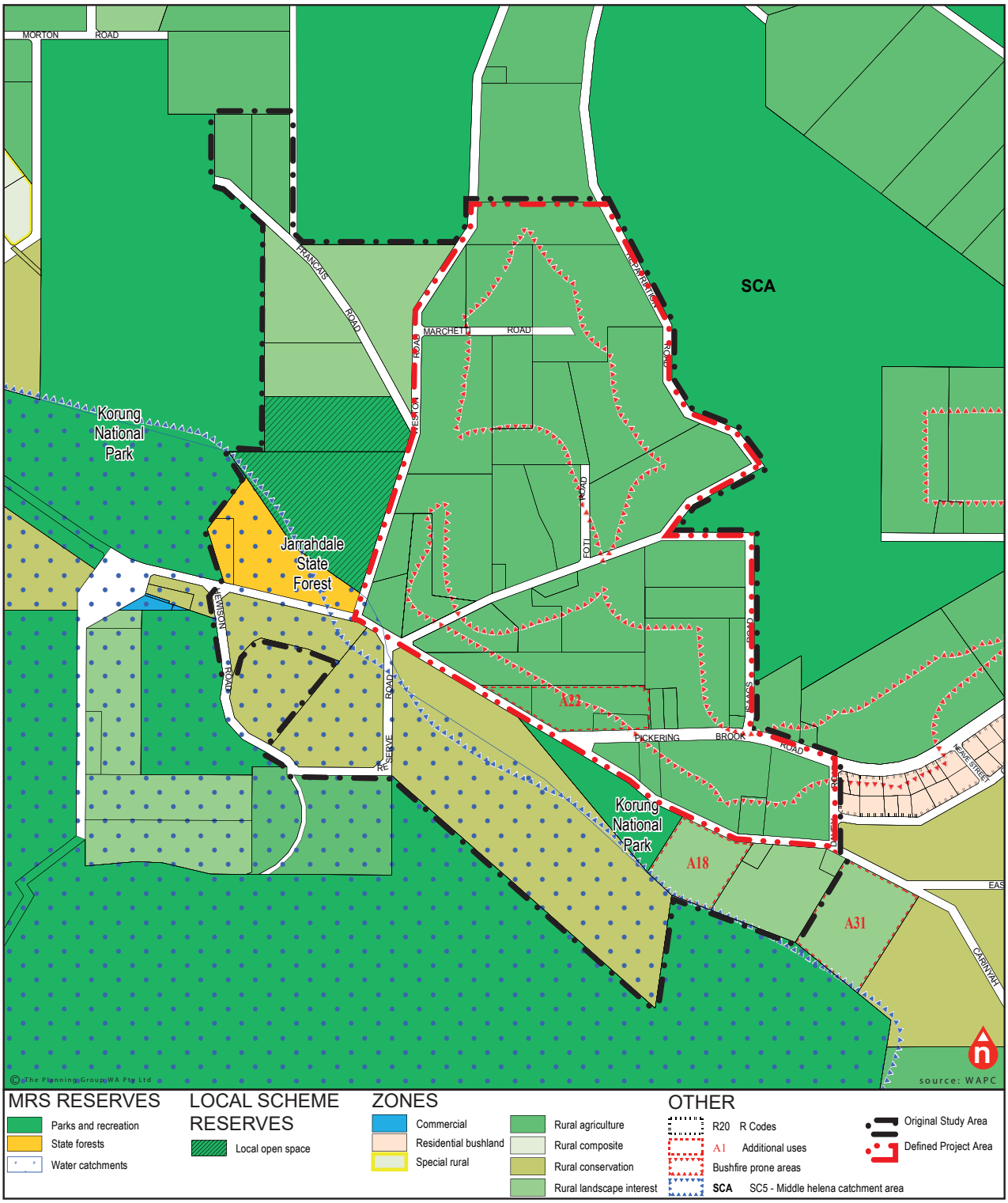


Figure 8 – Shire of Kalamunda Local Planning Scheme No. 3 Extract



Site History

The Pickering Brook townsite was only formally gazetted on January 12, 1973. Prior to this, the townsite began to form around the Pickering Brook Junction, located on the Upper Darling Railway that was built in 1891 for the purpose of supplying railway sleepers to Perth's growing railway system. The Upper Darling Railway traversed through to the Darling Ranges, connecting Pickering Brook and Kalamunda to Midland Junction via the Zig Zag section of the Darling Scarp.

Ultimately, market forces and transport issues forced the timber industry to a close and settlement was not encouraged around Pickering Brook due to its proximity to a water catchment. A new townsite was formed east of Pickering Brook Junction in 1923 called Carilla. The new townsite location was later cancelled and Pickering Brook formally then encompassed the whole area.

In 1918, a Soldiers' Settlement Act was passed in an effort to re-settle soldiers returning from World War One. Of the numerous locations selected across the State, one was an area along Piesse Brook, from Pickering Brook to where it crossed Mundaring Weir Road. A significant constraint to the development of Pickering Brook was that soldiers often had no previous knowledge of the land and relied heavily upon loans from the State's Agricultural Bank. Areas of land were cleared and fruit trees were planted, however, because the trees took years to produce fruit, many soldiers could not meet loan repayment deadlines and forfeited their land. Some of these properties were later purchased by Italian migrants and others who helped establish the area and contribute to the areas fruit growing industry.

PICKERING BROOK JUNCTION. NOTE: THE PASSENGER LUGGAGE, THE PLATFORM SCALES FOR WEIGHING FREIGHT AND THE BASKET ON WHICH THE WOMAN IS SITTING, WHICH WAS USED TO CARRY BREAD ON THE TRAINS #16

Figure 9 – Pickering Brook Junction (source: Pickering Brook Heritage Group Inc. 2008 – 2014)

Today, it is evident that the profitability of agricultural/ horticultural production in the Pickering Brook area has declined significantly, which has made it difficult for landowners to maintain agriculture/horticulture as a sole source of income. A significant amount of background research was undertaken by the Shire in preparing the Hills Rural Study, which identified the following primary issues facing growers in the area:

- *'The availability of water has steadily reduced and it is likely that this trend will continue;*
- *The loss of markets - most growers are not of a large enough scale to cater to the large food providers, and local markets are too small to accommodate all the growers. The international market has become too competitive because of the inclusion of countries with cheaper labour costs;*
- *Younger generations have increasingly chosen to work in other industries, resulting in a increasing number of ageing landowners who are struggling to cope with the demands of 'growing' work on their own;*
- *The inability to subdivide large rural landholdings results in the fragmentation of the traditional horticultural family units as young people are forced to move out of the area in order to be able to purchase their own property; and*
- *Some pest controlling chemicals are being banned from use, making pest control management considerably harder and less cost effective. '*

The above outlines the current issues facing Pickering Brook and the likely inevitable decline of the orcharding industry as a contemporary parallel to the decline and ultimate closure of the historic timber industry due to transport difficulties and market forces.

The proposed MRS amendment to facilitate the townsite expansion as envisaged under the Shire's endorsed Strategy will act as a catalyst to revitalise the Pickering Brook area and to address the issues raised by the growers in the preparation of the Hills Rural Study.

Importantly, the proposed amendment will align with the overall framework and strategic vision that is shaping the Perth Metropolitan Region, which will ensure that the Pickering Brook area can continue to prosper through appropriately locating specific land uses in response to the various constraints and market forces that shape the area.

European Heritage

The Heritage Council State Heritage Office Inherit Database indicates that one registered heritage place occurs within the project area, being Temby's home (fmr) (Heritage Place No. 10407) located at 30 Foti Road, Pickering Brook. It is noted that this heritage place is also identified on the Pickering Brook Heritage Group Inc. website.

The retention of the cultural heritage values of this place will be considered in detail as part of the local structure planning process for the project area.

Aboriginal Heritage

A search of the Department of Aboriginal Affairs (DAA) database indicates that there are no listed Aboriginal heritage sites within or in close proximity to the project area.

On the basis that no identified sites of Aboriginal Heritage were found within the project area, there are no required management measures.

Environmental Site Analysis

A summary of the environmental investigations undertaken for the project area is provided below. A full copy of the Environmental Assessment Review (EAR) as prepared by Coterra Environment is contained at Appendix 2 and the District Water Management Strategy (DWMS) as prepared by Strategen Environmental Consultants is contained at Appendix 3 of this report.

Refer to Appendix 2 - Environmental Assessment Review (Coterra Environment)

Refer to Appendix 3 – District Water Management Strategy (Strategen Environmental Consultants)

Geology, Soils and Topography

The project area is located within the Darling Plateau and is characterised by strong changes in topography and lateritic uplands with major valleys along the scarp.

Two soil associations have been identified as extending across the project area:

- Dwellingup soil association - The crests and upper slopes are common landform features dominated by lateritic duricrust and shallow gravelly sands.
- Yarragil soil association - The soils range from yellow duplex soils to sands over mottled clay on sideslopes and headwaters to poorly drained uniform clays on valley floors.

Acid Sulfate Soil (ASS) risk mapping identifies that there is a low to nil risk of acid or potentially acid sulphate soils occurring greater than three metres below the ground surface. As such, no further ASS investigations are required.

The existing landholdings used for agricultural purposes have generally been cleared, with existing road reservations, boundaries and areas external to agricultural landholdings featuring varying degrees of remnant vegetation. The project area features up to 60% of the total land area as containing existing orchards, with the majority of these located on the northern side of Pickering Brook Road and Repatriation Road.

Hydrology

Surface Water

The project area drains towards an unnamed tributary of Piesse Brook, which drains in a northwards direction into Piesse Gully and the Helena River, which is ephemeral and usually flows between June and January and the tributary may flow for part or all of this period.

The ephemeral creek is poorly defined within the project area, except near the northern boundary. The creek traverses through a series of orchards and farm dams are present both on and off the main creekline.

There are no mapped geomorphic wetlands or *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP)1 wetlands located within or immediately adjacent to the project area. However, the project area is currently a Priority 2 Public Drinking Water Source Area (PDWSA) and forms part of the catchment of the Helena Pumpback Dam, generally referred to as the Middle Helena Catchment .

This categorisation requires a minimum lot size of 2 hectares (DoW 2004). In order to achieve the lot size desired by the Shire, the project area will need to be reclassified to a Priority 3 PDWSA, consistent with the existing Pickering Brook townsite to the east. This issue is addressed in depth through the DWMS, as discussed later in this report and contained in Appendix 3.

Refer to Appendix 3 - District Water Management Strategy (Strategen Environmental Consultants).

Groundwater

The project area is not located within a groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914*; as such bores within the superficial aquifer do not require licensing. A search of the Department of Water's Water Register indicates that no groundwater licences have been issued in this area. Groundwater in the area is considered likely to provide baseflow to the creek, which allows the creek to flow between winter rainfall events and into late spring or early summer and the boundary of the groundwater catchment is not expected to extend beyond the boundary of the surface water catchment.

Refer to Appendix 3 - District Water Management Strategy (Strategen Environmental Consultants)

Vegetation and Flora

The project area is located on the western edge of the Darling Plateau, directly east of the Darling Scarp. A biological survey was undertaken of the project area on 14 November 2014 (Del Botanics, 2014). This survey identified one vegetation type within the remnant vegetated areas consisting of Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) woodland over shrubland of Grass trees (*Xanthorrhoea preissii*) and Zamia (*Macrozamia riedlei*).

Vegetation condition across the majority of the project area is considered to be completely degraded due to historical clearing for agricultural activities. Remaining remnant vegetation is primarily located within the centre and east of the project area, as well as along the road verge of Weston Road and is rated as follows:

- 30 Repatriation Road and 30 Foti Road vegetation rated in a Degraded condition;
- 24 Marchetti Road and 55 Repatriation Road vegetation rated in a Good condition; and
- a linear strip of large old native trees extending along Weston Road vegetation rated in a Good condition.

A search of the Department Parks and Wildlife (DPaW) Threatened (Declared Rare) and Priority Flora Database identified four listed flora species in close proximity to the project area although none of these species were located during the flora and vegetation survey, nor were any Threatened Ecological Communities identified.

A search of the Commonwealth Department of the Environment (DoTE) Protected Matters database identified six flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as having the potential to occur within the project area. None of these species were identified during the flora and vegetation survey (Del Botanics, 2014).

Refer to Appendix 2 - Environmental Assessment Review (Coterra Environment)

Fauna

While a large number of species of significance have been recorded or are expected to occur within two kilometres of the project area, a review of the habitat types required by the identified species indicates that only six fauna species of conservation significance are likely to visit/utilise the project area: Forest Red- tailed, Baudin's and Carnaby's Black-Cockatoos, Quenda, Chuditch and Southern Death Adder.

Given the lack of remnant vegetation located within the project area due to historical clearing activities, as well as the substantial areas of habitat in the surrounding Korung National Park, it is unlikely that the project area is significant to these species.

Refer to Appendix 2 - Environmental Assessment Review (Coterra Environment)

Contamination

A search of the Department of Environment Regulation (DER) database revealed that there are no known contaminated sites within or adjacent the project area. No registered sites were found within or in close proximity to the project area.

Refer to Appendix 2 - Environmental Assessment Review (Coterra Environment)

Environmental Management

Environmental Review Outcomes

The EAR outlines the relevant environmental characteristics of the project area, assesses the potential environmental impacts associated with the proposed scheme amendment, and identifies management strategies, which aim to minimise or manage these impacts.

The following summarises the implications for development and recommendations for future investigations/management measures to be considered subsequent to the MRS amendment for the project area:

- That remnant vegetation rated in 'Good' condition is retained where possible in the development design.
- Additional studies will need to be undertaken including a Level 2 flora/vegetation assessment and a significant tree assessment focusing on particular areas of land and the linear strip of large old native trees extending along the verges of Weston Road and Repatriation Road.
- Vegetated buffer areas are proposed across the project area to facilitate staged rural residential development in close proximity to existing orchards.
- A Preliminary Site Investigation to be undertaken prior to the subdivision or development stage to ensure that agricultural activities have not resulted in any contamination issues which are required to be addressed.
- The project area is currently a Priority 2 PDWSA and will need to be reclassified to a Priority 3 PDWSA prior to any rural residential development being permitted.

The EAR outlines that the MRS amendment and subsequent development of the project area for rural residential purposes are viewed to have minimal potential environmental impacts provided that the above issues are addressed prior to any development.

The required more detailed investigations of the project area will be undertaken at the local structure plan or subdivision stage, incorporating additional environmental management actions to assist in the retention of environmental values.

Refer to Appendix 2 - Environmental Assessment Review (Coterra Environment)

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District Water Management Strategy

Summary

A DWMS has been prepared by Strategen Environmental Consultants to inform the MRS amendment proposal. In this regard it is noted that the project area will be subject to further, more detailed planning subsequent to this amendment and will require a local planning scheme amendment and a structure plan to address varying matters at both a large and small scale.

A summary of the DWMS prepared for the project area is provided below. A full copy of the DWMS as prepared by Strategen Environmental Consultants is contained with Appendix 3 of this report.

Refer to Appendix 3 - District Water Management Strategy (Strategen Environmental Consultants)

Currently the project area is proclaimed under the *Country Areas Water Supply Act 1947* as part of the Middle Helena Catchment (MHC) PDWSA. As indicated previously the project area is currently a Priority 2 PDWSA. Priority 2 PDWSA, are to be managed to 'ensure there is no increased risk of pollution to the water source' (WAPC and DoP 2010). This categorisation requires a minimum lot size of two hectares (DoW 2004). In order to achieve the lot size desired by the Shire, the area will need to be reclassified to a Priority 3 PDWSA, consistent with the existing Pickering Brook townsite to the east.

Local structure planning will be undertaken in a manner that implements the principles and objectives of the DWMS as outlined in Table 2 (Table ES 1-1 as taken from the DWMS). It is considered that with the implementation of these measures, the principles and objectives of the DWMS will be met and drinking water quality will be maintained.

Refer to Appendix 3 - District Water Management Strategy (Strategen Environmental Consultants)

Table 2 - Summary of DWMS principles, objectives and proposed implementation measures (Table ES 1-1 from DWMS, Strategen Environmental Consultants)

Category	Principles	Objectives	Proposed Implementation Measures
Water Use	The development shall: • Consider all potential water sources in water supply planning. • Integrate water and land use planning. • Ensure sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	The objectives of these measures will be to: • Minimise the use of potable water where drinking water quality is not essential. • Limit water consumption to less than 100 kL/person/year based on the State Water Plan target.	Future land owners shall be encouraged to: • reduce landscaped areas and associated irrigation rates • retain native vegetation and utilise native landscaping where possible • treat wastewater to a high standard for on-lot irrigation purposes • consider the use of rainwater tanks for in-house and ex-house water use.
Groundwater levels and surface water flows	The development shall: • Aim to retain natural drainage systems and protect ecosystem health. • Protect dwellings and infrastructure from flooding and waterlogging. • Implement economically viable stormwater systems. • Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	The objectives of these measures will be to: • Maintain or restore desirable environmental flows and/or hydrological cycles where there are identified impacts on significant ecosystems. • Manage up to the 1 in 100-year ARI event within the development area to predevelopment flows.	• Include a 30 m vegetated buffer around the foreshore of The Creek, including swales and biofiltration structures to manage stormwater quality. • Lots shall manage and treat stormwater from buildings and hardstand in events up to the 1 in 1- year ARI, 1-hour event through the use of rainwater tanks, soakwells and vegetated structures. • The development shall maintain pre-development flows off the project area in the 1 in 100 year ARI event through swales and infiltration/ detention basins in the road reserve and foreshore buffer.
Groundwater and surface water quality	The development shall: • Maintain or improve groundwater and surface water quality. • Minimise discharge of pollutants to receiving waterways and maintain water quality in the specified environment. • Manage impacts to water quality within the context of a Priority 3 PDWSA.	The objectives of these measures will be to: • Maintain surface water and groundwater quality. • Ensure that all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007) to remove contaminants. • Ensure that development, including onsite effluent disposal does not negatively impact upon surface water quality.	• Stormwater shall be treated prior to discharge through swales and infiltration/detention basins in the road reserve and foreshore buffer. • Nutrient and pathogen reducing ATUs will be used for effluent treatment on the Project area. • Land capability assessment will be undertaken at a LWMS stage to confirm capability for effluent disposal.
Disease vector and nuisance insect management	To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.	New permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of Departments of Water and Health.	New permanent water bodies are not proposed on the Project area.

Key Guiding Principles

The key guiding principles of the DWMS are to:

- facilitate implementation of sustainable best practice in urban water management;
- encourage environmentally responsible development;
- provide integration with planning processes and clarity for agencies involved with implementation;
- facilitate adaptive management responses to the monitored outcomes of development;
- minimise public risk; and
- maintain the total water cycle of the project area.

The DWMS has been prepared to guide water management actions for future development with particular emphasis on demonstrating that the impacts of development to water quality are manageable within the context of a Priority 3 PDWSA.

Pre-Development Environment

The pre-development environment is summarised as follows:

- The project area has a Mediterranean climate with hot dry summers and cool wet winters with an average annual rainfall of 1093mm.
- The project area varies in height from approximately 287m AHD in the southeast to approximately 234m AHD along the streamline in the north.
- Gradients vary from less than 2% along the creekline near Repatriation Road to greater than 10% in the steeper areas in the far north of the project area.

Water Sustainability Strategy

Potable Water

New development will be connected to the Water Corporation reticulated water supply system. The project area currently has access to this system. Water Corporation advises that hydraulic modelling has recently been undertaken for the reticulated water supply for Pickering Brook and there are minimal constraints to developing the entire area. Some minor upgrades to reticulation pipes may be required; and will be monitored by Water Corporation.

Non-potable Water

Because of the size and location of the project area, it is anticipated that not all residents will intensively landscape and irrigate the full area of their lot. However, residents will require water for ex-house water use. Future land owners shall be encouraged to:

- reduce landscaped areas and associated irrigation rates;
- retain native vegetation and utilise native landscaping where possible;
- treat wastewater to a high standard for on-lot irrigation purposes; and
- consider the use of rainwater tanks for in-house and ex-house water use.

The project area consists of a relatively thin layer of alluvial sediments over rock of the Yilgarn Craton. As such, the availability of groundwater in the area is anticipated to be limited to small volumes within the alluvial sediments and very limited volumes within rock fractures.

The project area is not located within a groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914*, bores within the superficial aquifer do not require licensing and no groundwater licences have been issued in this area. Landowners in the area could conceivably use groundwater as a water source.

As indicated previously, the project area is located in a proclaimed surface water area under the *Rights in Water and Irrigation Act 1914* (RiWI Act). The taking of surface water in proclaimed areas is licensed. A search of the Water Register (DoW undated b) indicates that no surface water licences have been issued in this area.

Wastewater Management

There is no reticulated wastewater system in the vicinity of the project area. The cost of connecting the project area to reticulated sewerage for rural residential development is considered prohibitive, and as such wastewater will be treated and disposed of onsite. As such, aerobic treatment units (ATUs) and on-lot disposal of wastewater will be utilised. ATUs are electrically driven wastewater treatment units that rely on aerobic microbes to degrade

sewage in the presence of excess air (DoW 2010). Treated wastewater may be disposed of by irrigation (if adequately disinfected) or otherwise via an underground soakage system (DoW 2010). These systems reduce degradable organic matter, nutrient, suspended solids and grease to concentrations significantly less than conventional septic tank treatment systems (DoW 2010).

ATU treated wastewater may still contain elevated concentrations of nitrogen (in various forms), phosphorus and pathogens. In order to be certified for domestic use in Western Australia, an ATU must meet Department of Health (DoH) standards related to effluent concentrations of:

- suspended solids
- biochemical oxygen demand
- coliform concentration (DoH 2001).

Nutrient removing ATUs can achieve total nitrogen concentrations of less than 10 mg/L (>97% removal) and total phosphorus concentrations less than 1 mg/L (>98% removal) (DoH 2016). To be approved for use in WA, an ATU must on average achieve a median coliform count of 10 cfu/100 mL or less (DoH 2001), which generally requires disinfection. This compares to hundreds of thousands to millions of cfu/100 mL of septic tank effluent (EPA Victoria 2013). For these reasons, the use of ATUs is recommended for the project area.

Land Capability for Effluent Disposal

In PDWSA, DoW policy states that lots should only be created where land capability assessment shows that effective on-site soakage of treated wastewater can be achieved (DoW 2006). In order for effective and safe wastewater disposal, effluent disposal areas must be located in areas of suitable conditions, as outlined in Table 3 (Table ES4-1 as taken from the DWMS). To prevent contamination of surface waters, ATUs and effluent disposal areas within a Priority 3 PDWSA are required to have a minimum setback to ephemeral flow waterways of 30 metres (DoW 2010). Generally, a minimum disposal area of 150m^2 is required on each lot (DoH 2001).

Table 3 - Onsite effluent disposal criteria (Table 4-1 from DWMS, Strategen Environmental Consultants)

Parameter	Criteria
Slope	The natural land slope on which effluent disposal is to occur shall not exceed a one in five gradient. Proposals should demonstrate that the intended wastewater disposal design prevents the risk of wastewater run-off (DoH undated).
Distance to drainage channel	No wastewater system shall be discharged into the ground within 6 m of any subsoil drainage system or open drainage channel (DoH 2001).
Distance to watercourses	Minimum setback to ephemeral flow waterways of 30 m in PDWSA (DoW 2010).
Infiltration ability	The disposal area shall maintain at least 1.2 m of soil above bedrock or impervious clay soils layer (DoH undated).
Separation to groundwater	In the case of a surface irrigation system, 0.5 m is required from distance being from the upper surface of the irrigation area to the highest known water table level to allow for microbiological purification (DoH 2001).

Source: King and Wells 1990

Land capability refers to the ability of a site to support a land use without impacts to the land use itself or the environment. In order to assess the suitability of sites in the Perth Hills for unsewered rural residential development, a study was undertaken by King and Wells (1990) based on DAFWA soil mapping and the land capability class definitions outlined in Table 4 (Table 4-2 as taken from the DWMS)

Table 4 - Land use capability classes (Table 4-2 from DWMS, Strategen Environmental Consultants)

Capability class	General description
I – very high	Very few physical limitations present which are easily overcome. Risk of land degradation is negligible.
II - high	Some physical limitations affecting either productive land use or risk of land degradation. Limitations overcome by careful planning.
III - fair	Moderate physical limitations significantly affecting productive land use or risk of land degradation. Careful planning and conservation measures required.
IV – low	High degree of physical limitations not easily overcome by standard development techniques and/or resulting in a high risk of land degradation. Extensive conservation requirements.
V– very low	Severity of physical limitations is such that its' use is usually prohibitive in terms of either development costs or the associated risk of land degradation.

Source: King and Wells 1990

King and Wells (1990) considered that the land units present within the project area (see Figure 3-3 of DWMS) have the following capabilities for unsewered rural residential development:

- Murray Phase 2: Fair (Class III)
- Dwellingup Phase 2: Fair (Class III)
- Yarragil Phase 1: High (Class II)
- Yarragil Phase 4: Very low (Class V).

Land units with a high capability are considered highly suitable for rural residential development, including effluent disposal. Land units with a fair land capability may be used for rural residential purposes with management, including siting of effluent disposal areas to avoid rock outcrops and/or seasonally wet areas (King and Wells 1990).

The very low capability Yarragil Phase 4 is associated with creeklines and seasonally wet areas, where waterlogging is likely to occur and treated wastewater may enter watercourses. Areas with these characteristics are not considered appropriate for onsite effluent disposal. These areas need to be appropriately delineated as part of the planning process.

The King and Wells (1990) study was undertaken using mapping at a scale of 1:25,000. Mapping at this scale has an approximate resolution of 1-25 ha (van Gool et al 2005). This scale is recommended by DAFWA for general suitability for various forms of land use and strategic planning for intensive land use developments including urban and horticulture (van Gool et al 2005).

It is possible that the DAFWA mapping and King and Wells (1990) Study underestimates the land capability of the project area for rural residential development. Inspections by Strategen indicates that the southern, more upland areas mapped as Yarragil Phase 4 appeared to be relatively dry and may not be subject to seasonal inundation. It is consequently recommended that this land capability assessment is refined through onsite investigations at the Local Water Management Strategy (LWMS) and Urban Water Management Plan (UWMP) stages. This process may result in areas considered to have a low capability for a land use being upgraded to an improved capability class.

Land Capability Assessment

In order to ensure that land is suitable for effluent disposal, a Land Capability Assessment (LCA) should be undertaken in a manner consistent with DoH guidance (*Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units [ATUs*], DoH 2001) and Australian/New Zealand Standard AS/NZS 1547:2012 *On-site Domestic Wastewater Management* (Standards Australia 2012). At the LWMS stage, it is recommended that a Site and Soil Evaluation be undertaken to a standard suitable for rezoning and subdivision of land as outlined in Appendix C of AS/NZS 1547:2012. These studies will inform land use and the density of development on a site.

At the UWMP stage, a more detailed land capability assessment may be required to designate effluent disposal areas on each lot in a manner consistent with Appendix D of AS/NZS 1547:2012. This level of investigation may not be required in all locations. The areas in need of such studies will be identified at the LWMS stage.

Water Management Strategy

Surface Water Management Strategy

Surface water management in the Pickering Brook area includes:

- delineation and management of the foreshore as a measure to protect the creek and control water quality risks;
- management of risks to drinking water quality; and
- stormwater and flood management.

Stormwater and Flood Management

The stormwater management system will be designed to maintain pre-development flows off the project area in the 1-in-100 year ARI event. This will be undertaken through the following measures:

1. Runoff from buildings and hardstand will be managed within the lot through either infiltration on site or storage in rainwater tanks. All lots will be expected to maintain pre-development flows off the project area in the 1-in-1 year ARI event.

2. The critical 1-in-1 year ARI event will be treated as close to source as possible through swales and biofiltration systems within the road reserve and foreshore. Because of the rural nature of the project area, wider road reserves are anticipated. Where practical, these will contain the 1 in 5-year ARI event. The use of pipework within the project area will be minimised.
3. The potential for infiltration may be limited by the presence of lateritic hardpans and/or clay soils. As such, the focus of stormwater management will be on detention and treatment, although infiltration will occur where practical.
4. Road reserve widths should consider the need to provide adequate stormwater retention and maintain existing vegetation and potentially accommodate additional vegetation for spray drift protection. Conceptual design for this will be addressed at the LWMS stage.
5. Larger events will be allowed to flow into the creek via overland pathways. Allowance will be made for detention of events up to the 1-in-100 year ARI event within Public Open Space (POS), including within the foreshore POS.
6. As part of the LWMS and LCA, hydraulic conductivity testing will be undertaken within the proposed foreshore reserve and in selected locations around the project area. This hydraulic conductivity testing will be used to inform the design of drainage systems.

Foreshore Area Management

The Creek is currently in very poor condition and is not observable at the surface at some locations within the project area. As such, the key objective of foreshore management is considered to be water quality risk management. The foreshore is intended to be revegetated and reserved as POS to minimise the risks of development intensification on water quality and to provide an additional, natural opportunity for the treatment of surface water flows. The foreshore will be ceded to the Shire during the subdivision of each lot.

There are no specific guidelines for the setback from rural residential property boundaries to creek lines in surface water PDWSA. To prevent contamination of surface waters, ATUs and effluent disposal areas within a Priority 3 PDWSA are required to have a minimum setback to ephemeral flow waterways of 30 metres (DoW 2010). If pathogens and nutrients from effluent are considered a risk to water quality at this distance, risks from other residential land use activities such as the keeping of poultry and use of manure as fertiliser, which also cause elevated nutrient and pathogen loads, are also likely to pose a risk to surface water quality. A minimum buffer distance of 30 metres from the creekline to property boundaries is consequently proposed, see Figure 3-2 of DWMS. This buffer area will be rehabilitated and revegetated.

A Foreshore Assessment consistent with *Operational Policy 4.3: Identifying and Establishing Waterways Foreshore Areas* (DoW 2012) will be undertaken as part of the preparation of the LWMS. This will be used to refine creekline location. Where possible, the foreshore assessment will identify where the creekline has been piped through orchards and/or where subsoil drainage may have been installed. The Foreshore Assessment will also provide guidance on measures to be undertaken to rehabilitate the foreshore. Detailed design of the foreshore area will be undertaken through the UWMP process.

The foreshore boundary will be fenced to control access, although gates may be provided to allow pedestrian (but not vehicle) access to the foreshore from adjacent lots.

Surface Water Quality Management and Risk Assessment

The change in land use on the project area may potentially result in an increased risk to drinking water quality. To assess the risk of the development to drinking water quality and determine appropriate management measures, Strategen has undertaken a qualitative risk assessment for water quality, based on Water *Quality Protection Note No. 77 – Risk Assessment of Public Drinking Water Source Areas* (DoE 2005), which refers to the *Australian Drinking Water Guidelines* (ADWG, NHMRC and NRMMC 2004, subsequently updated in 2011). The focus of this risk assessment is the change in risk associated with the change in land use from orchards and rural lifestyle lots to a rural residential development. Parameters to be assessed were agreed with DoW to be:

- pesticides (includes herbicides)
- hydrocarbons
- heavy metals
- nitrogenous compounds (including nitrate, nitrite and ammonia)
- phosphorus and phosphate
- pathogens.

Groundwater Management Strategy

Groundwater resources are present in the area but are likely to be limited. Future landowners may not be able to obtain adequate groundwater for irrigation - therefore waste water recycling of dry lots will be encouraged.

Implementation Framework

Future Planning Process

After the MRS amendment has occurred, LPS3 will be amended. It is anticipated that the area will be rezoned under the Shire's LPS3 as an 'Urban Development' zone or equivalent allowing for the preparation of a local structure plan to guide development in the project area.

The preparation of local structure plans will be undertaken in a manner that implements the principles and objectives of the DWMS. It is considered that with the implementation of these measures, the principles and objectives of the DWMS will be met and drinking water quality will be maintained.

The local structure plan and LWMS will be developed to provide more planning certainty. Landowners in the area will then be able to subdivide their land through preparation of subdivision applications and UWMPs.

Monitoring

Pre-development monitoring has been undertaken at the project area as part of the preparation of the DWMS.

Post-development monitoring would not normally be anticipated for rural residential developments. However, given the location of the project area within a PDWSA, some post-development monitoring should be undertaken. Post-development monitoring will be undertaken in line with the *Water Monitoring Guidelines for Better Urban Water Management Strategies/Plans* (DoW 2011); or the final guidelines when these are developed. Post-development monitoring will occur from the completion of first subdivision stages until two years following the completion of construction.

Any change in the water quality parameters during this period will be investigated. A post-development monitoring plan will be included as part of the LWMS and will contain:

- details of monitoring required;
- design criteria;
- methods to determine whether the development's design criteria are being met; and
- contingency plans and management responses should variation occur between pre and post-development monitoring results.

Responsibilities for monitoring will be determined at a LWMS stage, when the funding model (e.g. whether a developer contribution scheme will be put in place) will be determined.

The risk assessment indicates that the change in land use will not result in a significant change in risk to drinking water quality. The key risk changes and management measures are:

1. Providing a 30 metre foreshore buffer to prevent the current situation where fertiliser and pesticides are used immediately adjacent to and possibly even on the creek.
2. Treating runoff prior to entering the creek in swales and/or detention areas to reduce pollutant loads entering the creek.
3. Use of nutrient reducing ATU's to reduce nutrients and pathogen loads.

Technical Review

A review of the assessment and advice presented in the DWMS will occur at the LWMS stage.

Funding and Ongoing Maintenance

Stormwater management infrastructure will be constructed by developers with funding through a developer contributions scheme. The developer will be responsible for maintenance of stormwater infrastructure for two years prior to handover to the Shire.

Considerations and Requirements for Local Structure Plan Stage

The LWMS prepared at the local structure plan stage in order to allow subdivision and development should include:

- confirmation of predevelopment hydrology including surface water flow direction, catchment areas, in 1-year ARI, 1 in 10 year ARI and 1 in 100-year ARI flows;
- drainage strategies based on the refined modelling, including:
- design assumptions including runoff coefficients, catchment boundaries, flow rates and volumes;
- figures showing post-development stormwater systems including flow paths and drainage structures (swales, rain gardens, infiltration areas and underground storage structures) for the 1 in 1-year ARI, 1 in 10 year ARI and 1 in 100-year ARI flood events; and
- conceptual cross sections for road and swale arrangements for the 1 in 1-year ARI, 1 in 10 year ARI and 1 in 100-year ARI flood events.
- Foreshore Area Assessment in accordance with Operational Policy 4.3: Identifying and Establishing Waterways Foreshore Areas (DoW 2012);
- measures to address foreshore management issues;
- land capability assessment including field investigations as outlined in Section 4.3.2 of the DWMS; and
- clarification of responsibilities for preparation of UWMP documents, design guidelines and post-development monitoring.

Bushfire Risk

The project area is surrounded by dense vegetated areas, including Korung National Park. Given the level of vegetation within close proximity to the project area, it is crucial that fire risks are accounted for. Preliminary fire management advice has been provided by a qualified specialist to the Shire, informing the preparation of the MRS amendment request. A fire management plan will be required during subsequent more detailed planning stages.

Refer to Appendix 4 – Bush Fire Hazard Assessment (FirePlan WA)

Development Setbacks from Open Jarrah/ Marri Forest

The boundaries of the project area adjoin areas of Jarrah/ Marri (Classified as Open Forest Class A) and the majority of the project area is located in a Bush Fire Prone Area, as shown on the Shire's LPS3. Given this, the actual developable area of the project area is limited by the application of required setback distances to the specific vegetation class.

As detailed in the Planning for Bush Fire Protection (Edition 2 2010), the minimum distance of 100 metres (from vegetation rated 'Moderate' or 'Extreme') may be reduced in compliance with AS 3959 Construction of Buildings in Bush Fire Prone Areas. Where the construction standard is increased in accordance with AS 3959, the setback distance may be reduced as outlined in Table 2.4.3 of AS 3959, which sets out this relationship and Section 2 of AS 3959, which details the methodology of determining the Bushfire Attack Level (BAL).

Access

The Performance Criteria P2 (Appendix 2) of the Planning for Bush Fire Protection guidelines requires the internal layout, design and construction of public and private vehicle access in a subdivision/development to allow for emergency and other vehicles to move through it easily and safely at all times.

The Acceptable Solution A2.1 requires two different vehicular access routes, both of which connect to the public road network and are available to all residents and the public at all times.

The existing Francais Road, Weston Road, Marchetti Road, Foti Road and Isaacs Street are currently all no through roads and will be required to be linked into the proposed road system to improve access and egress in the case of an emergency. Each stage of future development would need to comply with these standards.

The local structure planning stage will need to ensure that the internal road system improves the existing configuration through minimsing cul de sac heads, battle axe configurations, emergency access ways and fire service access through appropriate road design.

Water Supplies for Fire Fighting

Fire Hydrants will need to be installed in accordance with the Water Corporation's No 63 Water Reticulation Standard. If no reticulated water supply is available water tanks specifically for fire fighting will be required to be provided at a ratio of 50,000 litres per 25 Lots (or part thereof). If water tanks are provided then they are provided by the developer and maintained in perpetuity by Local Government.

Bushfire Hazard Level Assessment

The Bushfire Hazard Level Assessment has been prepared to inform the suitability of the area for the proposed MRS amendment.

The WAPC's State Planning Policy 3.7 - Planning in Bushfire Prone Areas outlines a number of objectives and policy measures that are to be addressed though planning, designing and assessing a planning proposal within bushfire prone areas, which is further detailed in the Guidelines for Planning in Bushfire Prone Areas (the Guidelines)

Importantly, the Guidelines outline that a Bush Fire Hazard Level assessment allows for the early strategic consideration of bush fire risk which can then be used to inform the more detailed stages that follow to ensure that all issues are considered, identified and properly addressed at the initial stages.

Transport

Transport Assessment Overview

KCTT have prepared a Transport Impact Assessment (TIA) to support the proposed MRS amendment and future townsite expansion. The TIA provides detailed commentary and analysis on the potential traffic and transport impacts that the proposed townsite expansion may have on surrounding road and transportation networks.

The analysis supports the proposed MRS amendment and any subsequent amendment of the Shire's LPS3 to allow for a range of land uses to occur within the project area. Whilst the final site yields and land-uses are subject to change prior to the finalisation of any subsequent future structure planning, the traffic and transportation requirements are based on the preliminary yield as generated through the IDPP prepared by TPG.

Refer to Figure 1 – Indicative Development Precinct Plan

The key transport issues identified and addressed by the TIA include the following:

- The capacity of the local road network to accommodate the additional traffic generated by the proposal and vehicle parking requirements.
- The hours of operation to determine the likely peak periods and the extent to which the additional traffic generated can be safely managed on the adjacent current and future road network.
- The efficiency of the project area's existing road network, including existing pedestrian and cyclist infrastructure and public transportation services available within an 800 metre radius of the project area and the possible extension of these services.

Analysis of the available data shows that Pickering Brook Road is currently the major traffic carrying route to and from the area, with approximately 1,000 vehicles per day. Repatriation Road, has the same Urban Local Road classification as Pickering Brook Road , although it carries only approximately 77 vehicles per day. It is expected that there will be several new roads within the project area, however, the location of these are yet to be determined as this will occur at the local structure planning stage.

The total project area development scenario is expected to generate approximately 1,998 vehicular movements per day with a forecasted impact of around 176 vehicles per hour in the peak hour for Precincts 1-3. If all five precincts are developed, it is expected to generate in total approximately 3,150 vehicular movements per day with a forecasted impact of around 278 vehicles per hour in the peak hour.

It has been assumed that the Local Centre's attractions will comprise of 60% from the proposed townsite expansion and 40% from the surrounding community and it is therefore assumed that the additional traffic generation is 48 vehicles per day and four vehicles per hour. It is anticipated that approximately 78% of traffic will be distributed to the adjacent road network via Pickering Brook Road.

The TIA identifies no issues with the proposed MRS amendment and townsite expansion primarily due to the existing low traffic volumes in the locality. The TIA and associated recommendations is provided in Appendix 5.

Refer to Appendix 5 - Transport Impact Assessment (KCTT)

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Servicing Information

KCTT have prepared an Infrastructure Servicing Report (ISR) that addresses the civil engineering aspects of potential residential and local centre development within the project area through providing an assessment of the potential infrastructure requirements and assessing the availability of existing infrastructure in proximity to the project area.

Refer to Appendix 6 – Infrastructure Servicing Report (KCTT)

Site Works

The development of rural-residential and large lot residential landholdings generally does not require the importation of substantial volumes of fill material. This should be strongly considered by the Shire when formulating the evolving framework for the project area.

Earthworks in the project area should be confined to:

- Replacement of local materials which are not suitable as sub-grades in road construction;
- Removal of material for the construction of stormwater drainage infrastructure;
- Importation of fill for areas of road construction which sit directly above hard rock, bed rock or similar;
- Replacement of existing material in trenches for water, power, gas and telco services (import select fill).

Lots greater than 2,000m^2 should have earthworks undertaken by the end purchaser to ensure that the work is carried out to specifically suit the building requirements of each landowner.

Roads

Internal roads will be required for the townsite expansion in order to service the future development layout. Only general requirements for road upgrades to the existing road network are considered as part of the proposed MRS amendment, with further more detailed consideration at the local structure planning stage.

Preliminary road and stormwater drainage considerations are set out in the ISR.

Water Reticulation

The Water Corporation has provided general information relating to major asset requirements for the distribution of water through Pickering Brook. The Water Corporation desk top assessment of the capacity of the system concluded that initial stages of subdivision and development are unlikely to trigger the need for any upgrades to the existing system.

The 150mm outlet and distribution main from existing elevated tanks at the western edge of the project area may need to be duplicated as development proceeds and after approximately 100 new services are connected to the existing scheme.

The ultimate development outcome may require the construction of an additional storage tank (nominally 225KL) in order to maintain adequate emergency storage for the scheme.

Sewer

The extension of wastewater (sewer) assets is not applicable in the project area as there are no wastewater assets in proximity to Pickering Brook, therefore this has not been considered in the ISR. It is assumed that the proposed developments will be required to install ATUs.

Gas Reticulation

There are currently no gas services located in proximity to the project area.

Telecommunications Infrastructure and Electricity

The provision of telecommunications infrastructure and electricity provision will be a requirement for all future developers in the project area.

Western Power requires that all existing overhead power assets are undergrounded where they are located on the development side of any road reserve. Western Power has an online management tool known as the Network Capacity Mapping Tool, or NCMT. Using this tool, it has been found that the 'forecast remaining capacity' in the area has between 20 and 25 MVA of available network capacity over the project area through to 2034.

High Voltage overhead 3 phase power infrastructure is currently available through most of the project area as follows: -

- Pickering Brook Road, between Marchetti Road and Isaacs Street;
- Marchetti Road, to a location north of Francais Road;
- Repatriation Road, to a location southwest of the intersection with Foti Road; and
- Carinyah Road, to a location east southeast of the intersection of Pickering Brook Road.

The Pickering Brook townsite expansion area has existing telecommunications assets which are suitable for general telephony. NBN Co are also currently seeking to locate a tower in the area to provide improved telephony and internet services. The status of the tower approval is unknown at the time of writing this report.

Conclusion

The Pickering Brook townsite expansion project area offers a series of opportunities and challenges in terms of infrastructure provision. The key items for consideration in the development of a suitable residential layout include:

- Shaping the road layout and stormwater drainage infrastructure to suit the topography and therefore to minimize the volume of imported fill required.
- Designing roads and drainage systems that maintain the overall aesthetics and feel that make Pickering Brook the place it is today. This requires design that is sympathetic to the overall topography and not 'over-engineering' the new proposed infrastructure so that it looks obviously different to that already existing.
- Partnering with the various regulatory authorities to examine the requirements for power, water and telecommunications to make the future development of the Pickering Brook townsite expansion area robust and vibrant.
- Providing effective measures to limit damage to roadways, sub-grades and drainage infrastructures from storm damage and erosion.
- Developing an effective strategy to mitigate excessive construction costs in rock excavation.

These are the key infrastructure opportunities and challenges in relation to the future development of the project area.

Statutory Requirements for an MRS Amendment

Development Control Policy 1.9 Amendments to Region Schemes (March, 2010)

The *Planning and Development Act 2005 (PD Act)* provides two procedures by which region schemes may be amended (part 4). The determination of whether an amendment will proceed down either path is at the discretion of the WAPC, who form an opinion as to whether an amendment constitutes a substantial or non-substantial alteration to a region scheme. The policy provides the WAPC with those matters that should be taken into account when forming an opinion to reflect the impact an amendment will have on the region as a whole. Development Control Policy 1.9 - Amendments to region schemes (DC1.9) provides a number of principal considerations to be taken into account when determining substantiality, which includes but is not limited to the following:

- *The area of land involved in the rezoning and the scale and purpose of the proposal and its impact on the region scheme.*
- *The likely impact of the proposal on the environment of the affected land and its surroundings.*
- *The history of the land in its setting, the factors which determined the present zoning or reservation of the land and its environs, and the reasons justifying the proposed change to be made.*
- *The future planning needs of the region and the factors justifying changes in the use of land generally and the subject land in particular.*
- *The complexity of the proposal.*
- *The degree to which the proposal reflects any significant changes to the planning strategy for the region.*
- *The relationship of the proposal to any current or proposed strategic plans or policies for the region or sub- regions within that region.*
- *Any other land use, transport, environmental or planning implications associated with the proposal.*

Dependent upon the substantiality determined, the procedures for processing an amendment vary considerably.

It is anticipated that the proposed MRS amendment will be determined as being a minor amendment as it is relatively simple, environmental values are manageable and it is consistent with the Shire's WAPC endorsed Strategy.

State and Regional Planning Context

Metropolitan Region Scheme

The MRS is the overriding statutory land use planning scheme for the Perth Metropolitan Region. The MRS provides the statutory basis for land use and development and identifies land use patterns based on broad zones and reservations. The MRS reflects the agreed strategic direction for land within the Perth Metropolitan Region with all local planning schemes being required to be aligned to it in terms of planning controls at the local level, including local area planning and development processes.

Under the MRS, Pickering Brook is predominantly zoned 'Rural' whilst a small concentrated area of land that reflects the existing residential development in the established townsite is zoned 'Urban'. Pickering Brook is also contained within the MRS 'Water Catchment' reserve which forms part of the Upper and Lower Bickley Catchments.

Directions 2031 and Beyond (August, 2010)

Directions 2031 recognises that the outer areas of the Perth Metropolitan Region are generally less developed and exhibit a patchwork of urban areas interspersed with rural and semi-rural areas. This has lead to the creation of a number of individual and uniquely different sub-regions.

The planning, management and staging of urban growth are reinforced through associated sub-regional strategies, which are outlined to inform:

- the preparation of strategic and statutory plans and policies, by landowners, land and infrastructure developers and government; and
- the consideration and approval of local planning scheme amendments and structure plans by State Government agencies, local governments, the WAPC and the Minister for Planning.

Draft Outer Metropolitan Perth and Peel Sub-regional Strategy (Draft August, 2010)

The Draft Outer Metropolitan Perth and Peel Sub-Regional Strategy is intended to provide guidance to assist with the application of Directions 2031 at the local level. It addresses issues that extend beyond local government boundaries and that require a regional response, as well as commonly shared issues such as the provision of housing choice, affordability and employment.

It identifies a strategic plan of actions, agency responsibilities and delivery timeframes and links State and local government strategic planning to guide the preparation and review of local planning strategies. The draft strategy informed the preparation of the Shire's Strategy and will ultimately inform a new local planning scheme as outlined in the key planning actions required for the North-East Sub-region.

The proposed MRS amendment will support and acknowledge the numerous complex issues and interests facing the Pickering Brook area that are a result of changing demographics, individual interests and market forces that have impacted and will continue to impact the nature, character and use of the Pickering Brook area.

Perth and Peel@3.5 Million

The draft *Perth and Peel@3.5million* suite of strategic land use planning documents aim to accommodate 3.5 million people by 2050. The population growth is expected to place pressure on resources, social and physical infrastructure, services and the natural environment. The Perth and Peel@3.5 million report provides a snapshot of the current state and the potential future state of Perth and Peel and outlines:

- where future homes and jobs should be located;
- how we can protect important environmental assets;

- how we can best utilise existing and proposed infrastructure; and
- appropriate areas for greater infill development and residential density.

The suite of documents includes four draft sub-regional planning frameworks, including a framework for the North-East Sub-region. Once finalised, the frameworks will become sub-regional structure plans and will be used to guide residential and industrial development, and supporting infrastructure.

An analysis of the 1,100 submissions received during the public comment period for the suite of documents in May 2015 has now been completed by the Department of Planning and a report will be considered by the WAPC, after which the draft frameworks will be finalised in the second half of 2016.

North-East Sub-regional Planning Framework (Draft, May 2015)

The North-East Sub-regional Planning Framework sets out proposals to guide the staging and sequencing of future urban development. The proposed amendment to allow the Pickering Brook townsite expansion is consistent with key planning framework principles in that it will support a consolidated and logical extension to the urban form of the existing townsite.

It is noted that the advertised version of the draft framework did not reflect the Shire's Strategy, which identifies Pickering Brook as an investigation area, as discussed in more detail below. Importantly, it should be noted that the Shire worked closely with the Department of Planning in preparing the Strategy, which was endorsed by the WAPC in 2013. This particular inconsistency was outlined through a formal written submission lodged by the Shire during the public comment period in May 2015.

It is anticipated that the final framework will be amended by the WAPC to be consistent with the Strategy and this MRS amendment request.

Refer to Appendix 7 – Extract from Shire of Kalamunda Submission on Perth and Peel@3.5 million

Perth and Peel Growth Plan for 3.5 Million (Draft, December, 2015)

The Perth and Peel regions are projected to grow to 3.5 million people by 2050 – an increase of almost 70 per cent on current population. Supporting this growth and delivering an efficient and liveable city while protecting the unique natural environment is a significant challenge.

The State Government has prepared the draft *Perth and Peel Green Growth Plan for 3.5 million (Green Growth Plan)* to meet this challenge.

The Green Growth Plan delivers a comprehensive environmental program for the protection of both Commonwealth matters of national environmental significance and State environmental values. This includes:

- 170,000 ha of new and expanded conservation reserves in the Perth and Peel regions and immediate surrounds, including improved protection and management of Bush Forever sites and the establishment of a Peel Regional Park;
- Implementation of critical steps to cut nutrient run-off into the Swan Canning and Peel Harvey estuaries and ensure the health of these systems over the long-term; and
- Implementation of a program of on-ground management to improve protection and management of threatened species, wetlands of international significance and threatened ecological communities.

The suite of draft Green Growth Plan documents provides a comprehensive approach to the avoidance and mitigation of environmental impacts and a committed conservation program that will deliver significant improvements to the protection and management of the environment as the Perth and Peel regions grow to a population of 3.5 million people.

As demonstrated in the technical reports supporting the MRS amendment request, it is considered that an appropriate environmental response for the project area can be established through a comprehensive local structure planning process particularly as the ecological values of the project area are known and appropriate detailed responses can be determined through additional

technical studies and implementation of associated recommendations.

State Planning Policy No. 2.5 – Land Use Planning in Rural Areas (May, 2012)

The WAPC's *State Planning Policy No. 2.5 – Land Use Planning in Rural Areas* (SPP 2.5) is one of the key planning policies that guide decision-making on rural land and for rural living purposes.

SPP 2.5 acknowledges that demand pressures associated with economic and population growth are occurring in an environment where the quality and availability of rural land has declined, largely due to settlement pressure, natural resource degradation and climate change.

Population increase and the economic climate has placed pressure on rural land for a wide variety of purposes, including urban settlement expansion. SPP 2.5 aims to support both rural and rural living land uses to cater for both anticipated and unexpected future needs, whilst protecting rural land from incompatible uses through requiring comprehensive planning.

The WAPC have sought public comment on proposed amendments to SPP 2.5. The new draft of SPP 2.5 provides more detailed policy guidance for development issues on rural land and has absorbed the intent of State Planning Policy 4.3 - Poultry Farms.

SPP 2.5 recognises that there is a market for rural living developments, although, they must be carefully planned as they are an inefficient way of accommodating people. The draft SPP 2.5 outlines a series of policy measures that apply to decision making for rural living proposals including but not limited to the following criteria:

(b) the rural living precinct must be part of a settlement hierarchy established in an endorsed planning strategy;

(ix) the land is predominantly cleared of remnant vegetation, or the loss of remnant vegetation through clearing for building envelopes, bush fire protection and fencing is minimal and environmental values are not compromised;

(xi) the land is capable of supporting the development of dwellings and associated infrastructure and is not located in a floodway;

(xiv) bush fire risk can be minimised and managed in accordance with State policy, without adversely affecting the natural environment. Proposals in areas of extreme bush fire risk cannot proceed.

The project area has been recognised as a proposed future rural residential area in the Shire's endorsed Strategy, bush fire risk is manageable, loss of remnant vegetation will be minimal and environmental values can be maintained as demonstrated by the technical reports prepared in support of the MRS amendment request.

State Planning Policy No. 3 – Urban Growth and Settlement (March, 2006)

The WAPC's *State Planning Policy 3 – Urban Growth and Settlement* (SPP 3) applies throughout Western Australia and seeks to promote a sustainable and well planned pattern of settlement across the State, with sufficient and suitable land to provide for a wide variety of housing, employment, recreation facilities and open space.

The proposed amendment will allow Pickering Brook to expand upon the existing residential development to the east of the project area and facilitate the creation of a variety of housing opportunities, representing an appropriate response to SPP 3 objectives.

State Planning Policy No. 2.7 – Public Drinking Water Source Protection (June, 2003)

State Planning Policy 2.7 – Public Drinking Water Source Protection (SPP 2.7) addresses the protection and management of public drinking water sources from incompatible land uses and pollution in order to maintain the quality and quantity of potable water supply.

SPP 2.7 ensures that priority is given to the protection of the highest quality drinking water through provisions in the MRS and local government town planning schemes. Where land uses may be detrimental to the quality of the water supply, such uses are not permitted unless it can be demonstrated that the impact can be managed.

The impact of the MRS amendment and proposed townsite expansion on the Priority 2 PDWSA over the projected area have been addressed in detail in the DWMS prepared by Strategen Environmental Consultants. The

risk assessment indicates that the changes in the land use will not result in a significant change in risk to drinking water quality. Key risk changes and management measures are also provided.

State Planning Policy No. 3.7 – Planning in Bushfire Prone Areas (December, 2015)

State Planning Policy 3.7 - Planning in Bushfire Prone Areas (SPP 3.7) applies to all land that has been designated as bushfire prone by the Fire and Emergency Services Commissioner as highlighted on the map of Bush Fire Prone Areas. Importantly, SPP 3.7 guides the implementation of risk-based land use planning and development to protect lives, properties and infrastructure from bush fire and applies to all higher order strategic planning proposals such as this amendment, as well as in relation to subdivision and development applications where located in designated bush fire prone areas.

The WAPC's *Guidelines for Planning in Bushfire Prone Areas* provides explanatory supporting information to assist with the interpretation of the objectives and policy measures contained in SPP 3.7, including how bushfire risk is addressed though planning, designing and assessing a planning proposal within bushfire prone areas.

Whilst the majority of the project area is identified as bushfire prone, it is also largely cleared of native vegetation and presents a manageable fire risk. A small portion within the middle of the project area has a moderate fire hazard associated with remnant vegetation that is likely to be retained within POS . The area surrounding the project area is dominated by a high fire hazard area as it comprises predominantly existing native vegetation.

A bush fire hazard assessment has been prepared to determine the specific nature and risk associated with the level of vegetation that exists, to highlight critical access requirements and to clarify water supply needs for fire fighting purposes.

The assessment includes that bushfire risk is manageable in relation to the project area and that a Fire Management Plan will be required to be prepared during subsequent more detailed planning stages.

Local Planning Context

Shire of Kalamunda Local Planning Scheme No. 3

The Shire's LPS3 is a statutory document that forms the basis for assessing and determining proposals for the use and development of land within the Shire.

Under the Shire's LPS3 the land within the project area is zoned 'Rural Agricultural' with a significant portion shown as 'Bushfire Prone'.

The implementation and application of LPS3 is supported by a number of local planning policies prepared and adopted as required under local planning scheme requirements.

Upon finalisation of the proposed MRS amendment the Shire's LPS3 will also be amended, probably to include the project area in a 'Development' zone, allowing for a local structure planning process for the townsite expansion, supported by appropriate detailed technical investigations.

Refer to Figure 8 – Local Planning Scheme 3 Map Extract

Shire of Kalamunda Local Planning Strategy (2010)

The Shire has developed a comprehensive local planning strategy to guide the future evolution of the district. The Strategy was endorsed by the WAPC in February 2013.

The purpose of the Strategy is to enable Council to determine the vision and strategic planning direction for the Shire for the next 20 years, to coincide with Directions 2031. Importantly, the Strategy identified the review of the Pickering Brook townsite as a priority with a recommendation to undertake a comprehensive planning analysis of the townsite and surrounds to investigate potential for future lot creation.

The LPS specifically states :

> *'Some scope exists for further subdivision of the land in the townsite of Pickering Brook to a minimum of 2,000sqm and the expansion of the Residential Bushland (4,000sqm lots) zone to land immediately abutting the townsite to allow for the creation of additional lots. There is also potential for a small commercial activity centre at the centre of Pickering Brook to cater for neighbourhood services and to create a focus for the settlement. Consideration should therefore be given to the preparation of a structure plan for the Pickering Brook townsite to guide further subdivision in the townsite area.*

and...

> *'Pickering Brook is relatively isolated from Kalamunda and most of the Town Centre uses. In addition, there has been a demand expressed that a greater variety of housing is needed in the Pickering Brook locality to cater for the existing demographic profile. As a result it is proposed that land should be identified in the centre of the Pickering Brook settlement for closer subdivision to 4,000sqm lots to provide housing for the ageing local community. In addition, a focal area for a small neighbourhood activity centre should be identified to serve the local community. '*

Refer Figure 11 - Local Planning Strategy – Pickering Brook Townsite Structure Plan Area

The proposed MRS amendment is a direct response to Strategy recommendations in relation to Pickering Brook.

Hills Rural Study (2014)

A significant amount of background research was undertaken by the Shire in preparing the Hills Rural Study (the Study), which was initiated in order to examine a number of complex issues and often competing interests facing the Kalamunda Hills Rural Area. Whilst the Study did not focus on the project area specifically, the Study identified a number of issues facing growers in the Hills Rural Area.

Figure 11 - Local Planning Strategy – Pickering Brook Townsite Structure Plan Area

This includes that land owners in the Kalamunda Hills Rural area have historically been producers of vegetables, citrus fruit, and more recently stone and pome fruit. In the past few decades the region has experienced a decline in productivity based on changes in climate, economic factors and changes in family structures.

Some of the challenges facing traditional orchardists in the Study area relate to the increasing costs of production, including start-up costs, labour, machinery, petrol, electricity, and other inputs into the growing industry. Availability of water has also been reduced and chemicals to alleviate risk to crops are becoming unavailable to the horticulturalists. Furthermore, the market prices for stone fruit, apples, pears, and other produce have decreased and tend to be very sensitive to fluctuations of the market.

As a result of these increasing challenges, there has been a steady flow of requests from landowners to the Shire for land use planning changes in the area. As a consequence, the Shire prepared the Hills Rural Study for the purpose of addressing these requests by thoroughly understanding land use, agricultural, environmental, economic and social trends relating to the study area, so that opportunities can be identified and informed decisions made regarding land use planning in the Hills Rural area.

The Study incorporates a comprehensive review of strategic and statutory planning documents relating to the Study area; a comprehensive contextual investigation relating to the land uses, demographics, environment and infrastructure of the Study area; the findings of an economic development discussion paper relating to the Study area; and an analysis of over 300 submissions on the draft Hills Rural Study from both the public and State Government Agencies.

The opportunities and constraints identified in the Study informed three recommendations, which included potential responses to those primary issues as outlined above such as economic diversification and improving the viability of agriculture/horticulture activities, amendments to LSP3 to implement zone rationalisation, greater land use flexibility and a request that relevant State planning agencies further investigate the agricultural productivity of the area to inform amendments to LPS3

The proposed MRS amendment for the project area is consistent with the intent of rationalising rural zones in the Study and is a direct response to Strategy recommendations.

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Planning Merit

The future sustainability of the Pickering Brook community is contingent upon the expansion and consolidation of the existing townsite to a more viable level that can support required goods and services at a level commensurate with contemporary local needs and expectations.

The changing composition of the local population over recent decades in conjunction with the general intrusion of urban uses including quasi-industrial uses has resulted in a transition from orchards and other intensive and extensive agricultural uses to more urban and lifestyle based land use opportunities, including tourism based activities.

Relatively large lot subdivision potential (2000- 4000 m2+) in serviceable locations that are able to respond to bushfire risk and other relevant environmental and strategic planning considerations are considered to be an appropriate response to emerging economic, social and environmental trends and issues at Pickering Brook and in the broader North-East Sub-region, and will be flexible enough to meet the needs of a range of suitable future urban and peri-urban uses.

On balance, the strategic planning benefits for the expansion of the Pickering Brook townsite as reflected in the Shire's Strategy are considered to outweigh the risks to the surface water catchment associated with land use change. The Strategy was endorsed by the WAPC in February 2013. The specific area to the west of the existing townsite was selected for the townsite expansion because the study area is largely cleared and reticulated potable water is available to the area.

An IDPP has been prepared and is presented in Figure 1. To develop this plan, the Shire has undertaken consultation with key government agencies and other private and institutional stakeholders. A summary of this consultation is presented in Appendix 1.

Refer to Appendix 1 - Stakeholder Consultation Outcome Summary (January 2014).

The MRS amendment request for the project area is supported by appropriate technical studies, including bush fire risk, water management, environmental values, servicing requirements and transport issues.

The proposed townsite expansion is demonstrated to comprise an orderly and proper planning outcome in terms of:

- Environmental Values Management – including a series of recommendations for future investigations and management measures.
- Water Management – including a series of implementation measures for water use, groundwater and surface water management and disease vector and nuisance insect management.
- Bushfire Risk – the area being identified as being suitable for development subject to the preparation of a more detailed Fire Management Plan.
- Servicing and Transport – existing infrastructure modifications and future requirements have been identified.

All of the above technical studies will be augmented at the subsequent more detailed local structure planning stage for the project area.

On the basis of the above, it is considered that the planning merits of the proposal have been demonstrated within the context of the applicable statutory requirements for an MRS amendment, the strategic planning intent of the State and regional planning framework and the aspirations of the Shire's local planning framework.

Appendix 1

Stakeholder Consultation Outcome Summary (January 2014)

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Pickering Brook Townsite Expansion – Outcomes of Preliminary Consultation in November/December 2013

January 2014

Organisation	Consultation Type	Comments
Pickering Brook Primary School	Phone conversation	• The school would prefer workshop style consultation and would prefer evenings from a timing perspective. • The school contact indicated that there were no local orcharding industry groups as far as they knew.
Pickering Brook Heritage Group	Phone conversation	• The heritage group would prefer to be consulted in a small group setting (focus group) but would also be happy to be included with the school if we consulted with them separately. • There may be an opportunity to tie in engagement with any scheduled group meeting if possible and also a display at a local scheduled community event if possible. • The heritage group contact indicated that there were no local orcharding industry groups as far as they knew.
Department of Water	Face-to-face meeting - 29 November 2013 Plan provided showing priority protection areas	• Middle Helena Catchment Area – Land Use and Water Management Strategy (June 2010) is actually much older than that (early 2000's). • WAPC need to sign off on amendment to Local Planning Scheme No. 3 (LPS3), which introduces water catchment areas into the scheme. • Process to change from Priority P1, P2 or P3 source protection areas is triggered by zoning changes, as the priority areas are a 'snapshot' of the current situation. • The Department of Water (DoW) would need a preliminary investigation into the water issues for the area that would ultimately inform a District Water Management Strategy (DWMS). • The preliminary investigation (assessment) would be required at the Metropolitan Region Scheme (MRS) amendment stage with an actual DWMS being prepared post initiation of the MRS amendment but prior to advertising. • The preliminary investigation would need to weigh up 'land factors' (cleared land, community benefit value etc.) versus 'water factors' (source protection value), with the final outcome constituting a strategic decision and with the DWMS being a management document. • Banjup and Wandi MRS amendments in Jandakot are examples of where this weighing up has occurred with the outcomes being based on land factors associated with the provision of a train station for Wandi and changing land factors in Banjup. In these cases the MRS amendments occurred prior to changes to the priority source protections areas (P2 to P3).

		• DoW also suggested that the Department of Health be consulted.
Department of Planning	Face-to-face meeting - 27 November 2013	• Any MRS amendment will need to consider buffering issues from existing orchards • Consultation with the community will be required as part of any MRS amendment proposal. • Justification based around consolidation of the Pickering Brook Townsite would likely need to form part of any proposal. • Bushfire management is a key issue and would need to be addressed up front as part of any MRS amendment proposal. • Appropriate separation to agricultural uses will need to be addressed. • Department of Planning (DoP) suggested that consultation with the Department of Fire and Emergency Services (DFES) and Department of Parks and Wildlife (DPaW). • A residential density of R5 was discussed supported by a development area and associated structure plan. • In terms of fire management, hazard separation needs to be considered and it was noted that the Shire has appointed Bill Harris to look at fire risk assessment across the whole local government area. • Appropriate area access will also need to be considered and confirmed as part of fire risk management. • DOP suggested consultation take place with the Department of Health regarding effluent disposal due to the unavailability of sewer to the area. • DoP also confirmed the need for reclassification of source protection Priority P2 to P3 and that the DoW may do this after the MRS amendment process has been finalised.
Water Corporation	E-mail - 20 November 2013 Face-to-face meeting - 21 November 2013 Plan provided of area showing where levels restrict the capacity to supply reticulated water	• Water Corporation (WC) confirmed that there is only water reticulation in this area (no wastewater system or any plans/capital to build wastewater infrastructure) so their advice and comments are limited to water planning. • Suggest that the Shire look towards getting an engineering consultant on board at some stage to do desk-top water investigations and planning, as the WC's IBP is often limited in its ability to do new small jobs that are not scheduled on the CWC's State Wide Planning Program. • The water scheme serving this area is a High Level Scheme (Pickering Brook High Level Zone). The zone is served via a single-feed 150AC water main heading east out of two small summit tanks to the west (Weston Rd Summit Tanks). Each tank has a maximum capacity of 225m^3. The smaller water reticulation pipes branching off the 150mm outlet main to serve customers in the HL zone are typically 100mmAC. The ability to serve additional houses/customers off the existing system will be limited among other things by the Top Water Level of the existing tanks (319.5mAHD), the need to achieve at least 17m residual head at each lot boundary, and the reserve storage capacity in the tanks.

		• Most of the water for the area comes from the Victoria Reservoir. • Suggested that soils suitable for on-site effluent disposal should be mapped to inform the MRS amendment process. • Single feed 150mm AC pipe as a rule of thumb can provide 120 services. There are approximately 100 existing services. • Depending on what additional level of development might be proposed there may need to be consideration for an additional water tank. • May need to be consideration of a contribution scheme component for reticulation. • Any appointed engineer would need to look at reticulation design to service subdivision/development. • WC would need to consider headworks modifications (more storage, pump capacity from destination and main size increase). • Any additional subdivision/development would probably need to be considered as part of a staged approach. • WC were going to provide some feedback on an informal basis on how many additional services might be able to be provided (guesstimate only).
Department of Parks and Wildlife (DPaW) Department of Environmental Regulation (DER)	Phone conversations E-mail - 15 November 2013	• On July 1 the former Department of Environment and Conservation (DEC) separated into the Department of Environment Regulation (DER) and the Department of Parks and Wildlife (DPaW). Previously DEC had provided advice on land use planning (LUP) matters relating to the following legislation; 1. *Environmental Protection Act 1986* (EP Act) 2. *Conservation and Land Management Act 1984* (CALM Act) 3. *Wildlife Conservation Act 1959* (WC Act) 4. *Contaminated Sites Act 2003* (CS Act) • The separation of DEC has resulted in DER now being responsible for LUP matters relating to Part V of the EP Act and the CS Act, with DPaW responsible for LUP matters relating to the CALM Act and WC Act. • In general terms: 1. DER deals with buffer issues i.e. noise, dust, odour, vibration. Also, contamination, acid sulfate soils, clearing permits and prescribed premises/licensing. 2. DPaW deal with issues relating to Flora/Fauna, wetlands, Bush Forever, impacts on regional parks and the conservation estate. • The likely range of land use buffer impacts/implications for the Pickering Brook project was discussed over the phone where is was confirmed that the primary issues that would need to be considered as part of any MRS amendment would be buffers and any potential contamination.

		• DPaW indicated that they would be happy to meet at a later date to go over any issues as the project advances.
Department of Agriculture and Food (DFWA)	Phone conversations	• DFWA Indicated that any proposal should work off mapping in relation to any high quality agricultural areas and take into consideration 500m buffers for urban areas from agricultural areas.

Appendix 2

Environmental Assessment Report – Pickering Brook Townsite Expansion (Coterra Environment)

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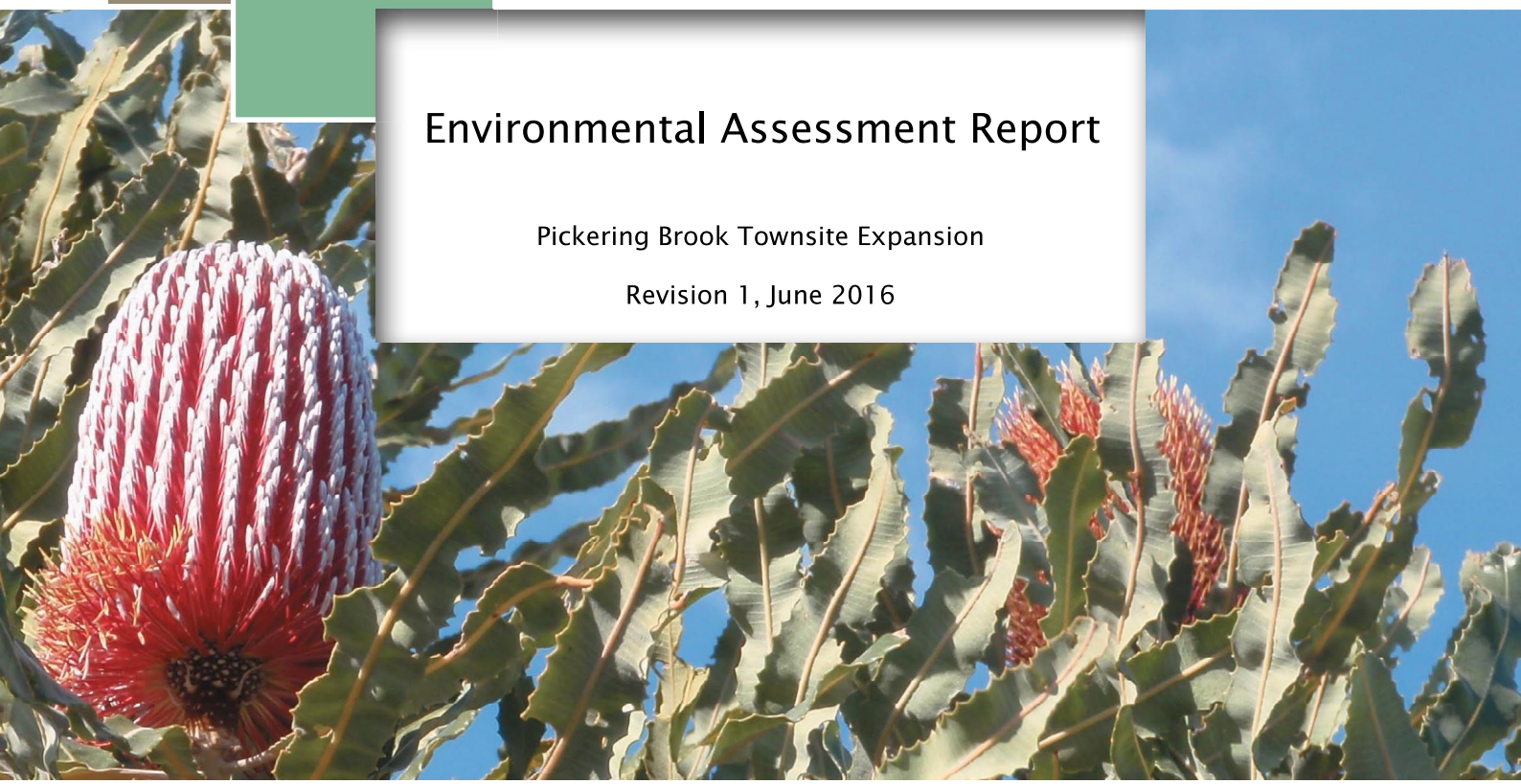
COTERRA ENVIRONMENT

Environmental Assessment Report

Pickering Brook Townsite Expansion

Revision 1, June 2016



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ENVIRONMENT

Environmental Assessment Report
Pickering Brook Townsite Expansion

Revision 1, June 2016

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Notice

EXECUTIVE SUMMARY

Pickering Brook is a small, relatively isolated district within the Shire of Kalamunda municipality, located approximately 30 km south-east of Perth CBD. This Environmental Assessment Report (EAR) has been prepared to accompany an Amendment Report to the West Australian Planning Commission (WAPC) supporting the rezoning of the Pickering Brook townsite expansion area (the Site) from 'Rural' to 'Urban' under the Metropolitan Region Scheme (MRS).

The EAR outlines the relevant environmental characteristics of the Site, assesses the potential environmental impacts associated with the proposed scheme amendment, and identifies management strategies which aim to minimise or manage these impacts.

A review of the following environmental factors concludes that there are no significant impediments to rural residential development:

Key Elements	Summary
Geology, Soil and Topography	The Site is located within the Darling Plateau, characterised by undulating hilly landscapes and lateritic uplands with major valleys along the scarp. Two soil associations have been identified as extending across the Site: ▪ Dwellingup soil association - The crests and upper slopes are common landform features dominated by lateritic duricrust and shallow gravelly sands. ▪ Yarragil soil association - The soils range from yellow duplex soils to sands over mottled clay on sideslopes and headwaters to poorly drained uniform clays on valley floors. Acid Sulfate Soil (ASS) risk mapping for the Site shows that there is a 'Low to nil risk of acid or potentially acid sulphate soils >3m below the ground surface'. No further investigations are required.
Existing Land Uses	A large majority of the Site is currently utilised for agricultural purposes, primarily citrus, stone or pome fruit orchards. It is anticipated that over time these operations will be removed to allow for the subdivision of the land to facilitate the expansion of the Pickering Brook townsite. As it is likely this change in landuse will occur over an extended time period, it is important that appropriate mitigation measures are implemented to avoid conflicts arising from the proposed rural residential development stages near existing agricultural land, in particularly health and nuisance impacts from chemical use, noise and dust. A number of vegetative buffers are proposed across the Site to facilitate staged rural residential development in close proximity to existing orchards. These buffers are proposed to be designed in accordance with the criteria set in Department of Health guidelines. Approximate locations for the vegetative buffers have been identified, however further detailed design will be required at the Local Structure Plan or subdivision level, dependent on development timings.
Surface Water	The Site drains towards an unnamed tributary of Piesse Brook which drains in a northwards direction into Piesse Gully and the Helena River. Helena River is ephemeral and usually flows between June and January, the tributary may flow for part or all of this period. The Site is currently a Priority 2 Public Drinking Water Source Area (PDWSA) and forms part of the catchment of the Helena Pumpback Dam, generally referred to as the 'Middle Helena Catchment'. Priority 2 PDWSA, are to be managed to *'ensure there is no increased risk of pollution to the water source'*. This categorisation requires a minimum lot size of 2 ha. In order to achieve the lot size desired by the Shire, the area will need to be reclassified to a Priority 3 PDWSA, consistent with the existing Pickering Brook townsite to the east. This issue is addressed in depth through the

Key Elements	Summary
	District Water Management Strategy (Strategen, 2016).
Groundwater	The Site is not located within a groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914*; as such bores within the superficial aquifer do not require licensing. Groundwater in the area is considered likely to provide baseflow to the creek, allowing the creek to flow between winter rainfall events and into late spring or early summer. The boundary of the groundwater catchment is not expected to extend beyond the boundary of the surface water catchment (Strategen, 2016:19).
Flora and Vegetation	The Site is located on the western edge of the Darling Plateau, directly east of the Darling Scarp. A biological survey was undertaken of the Site on 14 November 2014 (Del Botanics, 2014, Appendix A). This survey identified one vegetation type within the remnant vegetated areas consisting of Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) woodland over shrubland of Grass trees (*Xanthorrhoea preissii*) and Zamia (*Macrozamia riedlei*). Vegetation condition across the majority of the Site has been rated as 'Completely Degraded' due to historical clearing for agricultural activities. Remaining remnant vegetation is primarily located within the centre and east of the Site, as well as along the road verge of Weston Road and is rated as follows: ▪ 30 Repatriation Road and 30 Foti Road – vegetation rated in a 'Degraded' condition; and ▪ 24 Marchetti Road and 55 Repatriation Road – vegetation rated in a 'Good' condition; and ▪ a linear strip of large old native trees extending along Weston Road – vegetation rated in a 'Good' condition. No flora species of conservation significance were recorded across the Site in the survey (Del Botanics, 2014).
Fauna and Habitats	While a large number of species of significance have been recorded or are expected to occur within 2km of the Site, a review of the habitat types required by the identified species indicates that only six fauna species of conservation significance are likely to visit/utilise the Site: Forest Red-tailed, Baudin's and Carnaby's Black-Cockatoos, Quenda, Chuditch and Southern Death Adder. Given the lack of remnant vegetation located within the Site (having previously been cleared for historical agricultural activities), as well as the substantial areas of habitat in the surrounding Korung National Park, it is unlikely that the Site is significant to these species.
Fire Risk	The Site is surrounded by dense vegetated areas, including Korung National Park. Given the level of vegetation within close proximity to the Site it is crucial that fire risks are accounted for during design of the proposed expansion. Preliminary fire management advice has been provided by a qualified specialist to the Shire informing the development of the MRS Amendment request. A Fire Management Plan will be required at the Local Structure Plan stage.
Contaminated Sites	The DER Contaminated Sites database was searched for known contaminated sites within or adjacent the site (DER, 2013). No registered sites were found within or in close proximity to the Site.
Heritage	No listed Aboriginal heritage places occur within or in close proximity to the Site (DAA, 2015). However, one registered non-Aboriginal heritage place occurs within the Site: ▪ Heritage Place No. 10407 'Temby's home (fmr)' located at 30 Foti Road, Pickering Brook.

The following summarises the implications for development and recommendations for future investigations/management measures to be considered during development of a final concept design for the site:

Significant Native Vegetation

It is recommended that remnant vegetation rated in 'Good' condition is retained where possible in the development design. To assist with determining the location of vegetation and significant trees for retention, the following additional studies will need to be undertaken:

- Level 2 flora and vegetation assessment of 24 Marchetti Road, 55 Repatriation Road; and
- Significant tree assessment focusing on 24 Marchetti Road, 30 and 55 Repatriation Road, 30 Foti Road and the linear strip of large old native trees extending along the verges of Weston Road and Repatriation Road.

Vegetated Buffer Areas from Spray Drift

- A number of vegetated buffer areas are proposed across the Site to facilitate probable staged rural residential development in close proximity to existing orchards. These buffers are proposed to be designed in accordance with the criteria set in the DoH guidelines and located to respond to a staged development process in relation to existing orchards nearby.

Contamination

- No issues have been raised through the desktop database searches; however it is recommended that a Preliminary Site Investigation is undertaken for each development stage prior to subdivision, to ensure that agricultural activities have not resulted in any contamination issues which are required to be addressed.

Public Drinking Water Source Area

- The Site is currently a Priority 2 Public Drinking Water Source Area (PDWSA) and will need to be reclassified to a Priority 3 PDWSA prior to any rural residential development being permitted. This issue is addressed in depth through the District Water Management Strategy (Strategen, 2016).

In conclusion, the proposed scheme amendment and subsequent development of the Site for rural residential purposes are viewed to have minimal potential environmental impacts provided the above issues are addressed prior to development. Final design for the development will be addressed at the Local Structure Plan or subdivision stage and will incorporate additional environmental management actions to assist in the retention of environmental values at the Site.

TABLE OF CONTENTS Page

TABLES (Compiled within the report)

FIGURES (Compiled at the end of the report)

APPENDICES

1.0 INTRODUCTION

1.1 Background

Pickering Brook is a small, relatively isolated district within the Shire of Kalamunda municipality, located approximately 30 km south-east of Perth CBD (Figure 1). Predominately consisting of a small town site and rural residential housing scattered amongst agricultural orchards and surrounded by Korung National Park, over a number of years the local community has expressed a desire to establish a dedicated town centre and a greater variety of housing to cater for the existing and emerging demographic profile in the Pickering Brook locality.

As a result, the Shire of Kalamunda's Local Planning Strategy (LPS) proposed that land should be identified near the centre of the Pickering Brook settlement to allow for subdivision of 4,000/2,000 m² lots, as well as the creation of a small local centre as a focal area.

Following on from the endorsement of this LPS by the Western Australian Planning Commission (WAPC), preliminary investigations have been undertaken and initial consultation held with State Government agencies and other stakeholders in relation to potential future zoning changes to facilitate land use in accordance with the LPS. Currently land within the proposed Pickering Brook townsite expansion area (the Site) is zoned 'Rural' under the Metropolitan Region Scheme (MRS) and 'Rural Agriculture' under LPS 3. A MRS Amendment request is therefore being lodged seeking a rezoning of the Site accompanied by a report outlining the constraints and opportunities of the area.

Figure 2 provides an aerial photograph and outline of the proposed development precincts within the Site for the expansion of Pickering Brook townsite.

1.2 Scope of Report

This Environmental Assessment Report (EAR) has been prepared to accompany an Amendment Report to the West Australian Planning Commission (WAPC) supporting the rezoning of the Site from 'Rural' to 'Urban' under the Metropolitan Region Scheme (MRS).

The EAR outlines the relevant environmental characteristics of the Site, assesses the potential environmental impacts associated with the proposed scheme amendment, and identifies management strategies which aim to minimise or manage these impacts.

2.0 EXISTING ENVIRONMENT

2.1 Climate

The climate of this region is described as Mediterranean, with hot dry summers and mild wet winters. The closest official meteorological station is at Bickley, located approximately 4 km north-west of the Site. Average temperatures at this station generally range between 11 - 22˚C, with annual average rainfall measured as approximately 1093 mm (BoM, 2015).

2.2 Geology, Soils and Topography

The Site is located within the Darling Plateau geomorphological province, which covers the majority of the Shire of Kalamunda. The Darling Plateau lies to the east of the Swan Coastal Plain and is characterised by undulated hilly landscapes and lateritic uplands with major valleys along the scarp (Churchward and McArthur, 1978). Large rock outcrops are a dominant feature along slopes and crests.

Topography of the Site is undulating, sloping down towards the streamline which runs around the eastern side of the Site (Figure 3).

The following soil associations have been identified as extending across the Site:

- Dwellingup soil association - comprises almost half the total area of the Shire and encapsulates the lateritic uplands of the Darling Plateau. The crests and upper slopes are common landform features dominated by lateritic duricrust and shallow gravelly sands.
- Yarragil soil association – occurs on the minor upland valleys in the western part of the Darling Plateau and encompasses the valley sideslopes, headwaters and floor. The soils range from yellow duplex soils to sands over mottled clay on sideslopes and headwaters to poorly drained uniform clays on valley floors. The Yarragil soil association is commonly adjacent to the Dwellingup soil association associated with the major valleys.

Acid Sulfate Soil (ASS) risk mapping (Landgate, 2015) for the Site indicates that there is a 'low to nil risk of acid or potentially acid sulphate soils occurring >3 m below the ground surface'. As such, no further investigations are considered necessary.

2.3 Existing Land Uses

A large majority of the Site is currently utilised for agricultural purposes, primarily citrus, stone or pome fruit orchards. However, in the past few decades the region has experienced a decline in productivity based on changes in climate, economic factors and changes in family structure (Shire of Kalamunda, 2014). On this basis, while the majority of the Site currently consists of existing orchards, it is anticipated that over time these operations will be removed to allow for the subdivision of the land to facilitate the expansion of the Pickering Brook townsite.

As it is likely this change in landuse will occur over an extended time period, it is important that appropriate mitigation measures are implemented to avoid conflicts

arising from the proposed rural residential development stages near existing agricultural land, in particularly health and nuisance impacts from chemical use and dust. This is addressed in further detail in Section 3.0.

2.4 Hydrology

The following section is an extract from the draft District Water Management Strategy (Strategen, 2016), being prepared concurrently to this EAR.

2.4.1 Surface Water

The Site drains towards an unnamed tributary of Piesse Brook which drains in a northwards direction into Piesse Gully and the Helena River (the creek). The Helena River is ephemeral and usually flows between June and January. The tributary may flow for part or all of this period.

The ephemeral creek is poorly defined within the Site, except near the northern boundary. The creek runs through a series of orchards and farm dams are present both on and off the main creekline (Strategen, 2016:12).

There are no mapped DER geomorphic wetlands or *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (EPP)[1] wetlands located within or immediately adjacent to the Site. However, the Site is currently a Priority 2 Public Drinking Water Source Area (PDWSA) and forms part of the catchment of the Helena Pumpback Dam, generally referred to as the 'Middle Helena Catchment'.

Priority 2 PDWSA, are to be managed to *'ensure there is no increased risk of pollution to the water source'* (WAPC and DoP 2010). This categorisation requires a minimum lot size of 2 ha (DoW 2004). In order to achieve the lot size desired by the Shire, the area will need to be reclassified to a Priority 3 PDWSA, consistent with the existing Pickering Brook townsite to the east. This issue is addressed in depth through the draft District Water Management Strategy (Strategen, 2016).

As part of the DWMS surface water monitoring to obtain baseline data was undertaken on site. For further information refer to the DWMS (Strategen, 2016).

2.4.2 Groundwater

The Site is not located within a groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914*; as such bores within the superficial aquifer do not require licensing. A search of the DoW Water Register indicates that no groundwater licences have been issued in this area.

Groundwater in the area is considered likely to provide baseflow to the creek, allowing the creek to flow between winter rainfall events and into late spring or early summer. The boundary of the groundwater catchment is not expected to extend beyond the boundary of the surface water catchment (Strategen, 2015).

[1] Note that the EPP was revoked in November 2015.

2.5 Flora and Vegetation

2.5.1 Vegetation Complexes

The Site is located on the western edge of the Darling Plateau, directly east of the Darling Scarp. The Darling Scarp rises to a height of approximately 300 m above sea level over the coastal plain and runs in a north-south direction parallel to the coast. Mapping undertaken by Heddle (1980) indicates vegetation of the project area is considered to be representative of two vegetation communities:

- Dwellingup Complex in Medium to High Rainfall – dominated by open forests of Jarrah (*Eucalyptus marginata*) – Marri (*Corymbia calophylla*) on the uplands.
- Yarragil Complex (Maximum Development of Swamps) in Medium to High Rainfall – predominantly consists of a mixture of open-forest of Jarrah (*Eucalyptus marginata*) – Marri (*Corymbia calophylla*) with admixtures of Yarri (*Eucalyptus patens*). On sandier soils a well-defined second storey of *Banksia* species is distinguishable.

2.5.2 Vegetation Types

A biological survey was undertaken of the Site on 14 November 2014 (Del Botanics, 2014, Appendix A). This survey identified one vegetation type within the remnant vegetated areas consisting of Marri (*Corymbia calophylla*) and Jarrah (*Eucalyptus marginata*) woodland over shrubland of Grass trees (*Xanthorrhoea preissii*) and Zamia (*Macrozamia riedlei*).

2.5.3 Vegetation Condition

Vegetation condition across the majority of the Site has been rated as 'Completely Degraded' due to historical clearing for agricultural activities. Remaining remnant vegetation is primarily located within the centre and east of the Site, as well as along the road verge on the western side of the Site and is rated as follows (Figure 4):

- 30 Repatriation Road and 30 Foti Road – vegetation rated in a 'Degraded' condition; and
- 24 Marchetti Road and 55 Repatriation Road – vegetation rated in a 'Good' condition; and
- A linear strip of large old native trees extending along Weston Road – vegetation rated in a 'Good' condition.

2.5.4 Conservation Significant Flora Species

The Department of Parks and Wildlife (DPaW) enforces regulations under the *Wildlife Conservation Act 1950* (WC Act) to conserve Threatened species and protect significant populations.

A search of the DPaW Threatened (Declared Rare) and Priority flora database identified four listed flora species in close proximity to the Site (Table 1). None of these species were located during the flora and vegetation survey, nor were any Threatened Ecological Communities identified (Del Botanics, 2014).

Table 1 State listed Threatened and Priority flora species identified in close proximity to the Site

Species Name	Common Name	Conservation Rating
Acacia anomala	Grass Wattle	Threatened Flora (Declared Rare Flora – Extant)
Hemigenia rigida	-	Priority 1 – poorly known species
Pimelea rara	Summer Pimelea	Priority 4 – rare, near threatened and other species in need of monitoring
Stylidium striatum	Fan-leaved Triggerplant	Priority 4 – rare, near threatened and other species in need of monitoring

Source: Florabase (DPaW, 2015)

A search of the Commonwealth Department of the Environment (DoTE) Protected Matters database identified six flora species listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as having the potential to occur within the Site (Table 2 and Appendix B). None of these species were identified during the flora and vegetation survey (Del Botanics, 2014).

Table 2 EPBC listed flora species identified as having the potential to occur within the Site

Species Name	Common Name	Conservation Code
Acacia anomala	Grass Wattle, Chittering Grass Wattle	Vulnerable
Caladenia huegelii	King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid	Endangered
Diuris micrantha	Dwarf Bee-orchid	Vulnerable
Diuris purdiei	Purdie's Donkey-orchid	Endangered
Thelymitra manginiorum	-	Endangered
Thelymitra sellata	Star Sun-orchid	Endangered

Source: EPBC Protected Matters Search (DoTE, 2015)

2.6 Fauna and Habitats

The conservation status of fauna species is assessed at a Commonwealth level under the EPBC Act, and at a State level under the WC Act.

A search of the DPaW NatureMap database (NatureMap, 2015) was undertaken in March 2015 for potential threatened fauna occurrences within 2km of the Site. In addition a search of the Department of the Environment (DoTE) database was also undertaken for matters of national environmental significance and other matters protected by the EPBC Act within the Site (DoTE, 2015; Appendix B).

While a large number of species of significance have been recorded or are expected to occur within 2km of the Site, a review of the habitat types required by the identified species indicates that only six fauna species of conservation significance are likely to visit/utilise the Site (Table 3). However, given the lack of remnant

vegetation located within the Site (having previously been cleared for historical agricultural activities), as well as the substantial areas of habitat in the surrounding Korung National Park, it is unlikely that the Site is significant to these species.

Table 3 Conservation significant fauna species identified as having the potential to occur within the Site

Species	Conservation Code	Habitat
Birds		
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak	Vulnerable	Inhabits dense Jarrah, Karri (*Eucalyptus diversicolor*) and Marri forests receiving more than 600 mm average rainfall annually, mainly in the hilly interior of Western Australia. **Suitable habitat present within the Site**.
Calyptorhynchus baudinii Baudin's Black-Cockatoo, Long-billed Black- Cockatoo	Vulnerable	Occurs in heavily forested areas, generally associated with large gums such as marri, karri and jarrah trees. Forages in marri trees and other trees/shrubs, occasionally sourcing seeds and grubs from the ground. **Suitable habitat present within the Site**.
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo	Endangered	Inhabits remnant native eucalypt woodlands, primarily in the semi-arid region and southern jarrah-marri forests. Feeds on seeds, nectar and fruit of Banksia, Dryandra, Pinus, Eucalyptus and *Corymbia calophylla*. **Suitable habitat present within the Site**.
Leipoa ocellata Malleefowl	Vulnerable	Occurs in semi-arid and arid zones of temperate Australia, where it occupies shrublands and low woodlands that are dominated by mallee vegetation. It also occurs in other habitat types including eucalypt or native pine *Callitris* woodlands, acacia shrublands, Broombush *Melaleuca uncinata* vegetation or coastal heathlands. Suitable habitat not present onsite.
Rostratula australis Australian Painted Snipe	Endangered	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire; often with scattered clumps of lignum *Muehlenbeckia* or canegrass or sometimes tea-tree (*Melaleuca*). Suitable habitat not present onsite.
Mammals		
Isodon obesulus subsp. fusciventer Quenda	Priority 5 – conservation dependent species	Found in wet or dry schlerophyll forest through to open woodland and scrubby vegetation on sandy soils. Dense undergrowth and low ground cover are important in providing cover. **Suitable habitat present within the Site**.
Bettongia penicillata ogilbyi Woylie	Endangered	In Western Australia, scattered Woylie populations may be found throughout the jarrah forest in the south-west corner of the state. Isolated populations also occur at Francois Peron National Park (NP), Kalbarri NP, Nambung NP, Julimar Forest, Avon Valley NP, Dryandra Woodland, Boyagin Nature Reserve (NR), Tutanning NR and North Karlgarin NR. Site is located outside of expected range.

Species	Conservation Code	Habitat
Dasyurus geoffroii Chuditch, Western Quoll	Vulnerable	Inhabit most kinds of wooded habitat within its current range including eucalypt forest (especially Jarrah, *Eucalyptus marginata*), dry woodland and mallee shrublands. In Jarrah forest, Chuditch populations occur in both moist, densely vegetated, steeply sloping forest and drier, open, gently sloping forest. The densest populations of Chuditch have been found in riparian forest. **Suitable habitat present onsite**.
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir	Vulnerable	Restricted in the south-west corner of WA, mainly in coastal forests and woodlands containing peppermint (*Agonis flexuosa*). They shelter in tree hollows or in leaf nests in tree canopy. Site is located outside of expected range.
Setonix brachyurus Quokka	Vulnerable	A habitat specialist, preferring early seral (young) vegetation stages that have been burned within the previous ten years. The main habitat for mainland populations of the Quokka is dense riparian vegetation. Site is located outside of expected range.
Migratory Species		
Apus pacificus Fork-tailed Swift	Migratory Marine Bird	Almost exclusively aerial, in Australia, they mostly occur over inland plains but sometimes above foothills or in coastal areas. May fly over the Site but unlikely to visit.
Haliaeetus leucogaster White-bellied Sea Eagle	Migratory Terrestrial Species	Found in coastal habitats and tends to occupy dunes, tidal flats, woodlands, forests and grasslands (generally in areas associated with large bodies of water). Often occupies urban areas. Nests constructed in large trees, cliffs, rocky outcrops, mangroves, caves or on artificial structures, usually coastal but sometimes terrestrial. Unlikely to utilise the Site.
Merops ornatus Rainbow Bee-eater	Migratory Terrestrial Species	Migrates between Australia, Eastern Indonesia and Japan, and has formed a colony on Rottnest Island. Tends to occupy open forests and woodlands, cleared or semi-cleared areas and farmland, in usually timbered landscapes, often in close proximity to water. Unlikely to utilise the Site.
Ardea alba Great Egret, White Egret	Migratory Wetland Species	Has been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). May potentially occur at wetlands that also support a range of other waterbirds or shorebirds. Suitable wetland habitat not available onsite.
Ardea ibis Cattle Egret	Migratory Wetland Species	Wide range of wetland habitats (fresh/saline, inland/coastal, open/vegetated, permanent/ ephemeral). Commonly found in cattle fields and other farm areas that contain livestock. Suitable wetland habitat not available onsite.
Rostratula benghalensis (sensu lato) Painted Snipe	Endangered Migratory Wetland	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Suitable wetland habitat not available onsite.

Species	Conservation Code	Habitat
	Species	
Acanthophis antarcticus Southern Death Adder	Priority 3 – poorly-known species	Inhabit a range of habitats, including rainforest, scrubland, semi-arid zones and rocky outcrops. Occurs over much of eastern and coastal southern Australia – Queensland, New South Wales, Victoria and South Australia. It may also be found more scarcely in the Northern Territory, Western Australia and the west parts of South Australia. **Suitable habitat present within the Site**.
Phascogale tapoatafa subsp. tapoatafa (Brush-tailed Phascogale)	Threatened species listed under the WC Act as Vulnerable	Observed in dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover. Suitable habitat not present onsite.

Source: NatureMap (DPaW, 2015); EPBC Protect Matters Search (DoTE, 2015)

2.7 Fire Risk

The proposed Pickering Brook townsite expansion area is surrounded by dense vegetated areas, including Korung National Park, a popular location for bushwalking and mountain biking. Given the level of vegetation within close proximity to the Site it is crucial that fire risks are accounted for during design of the proposed expansion.

The State government has recently enacted the bushfire planning reforms. Part of the reform package is the production of bushfire prone area maps. This mapping indicates that in its current state the site, that a significant portion of the site is considered to be in a Bushfire Prone Area (DFES, 2016).

It is understood that preliminary fire management advice has been provided by a qualified specialist to the Shire of Kalamunda to inform the development of the MRS Amendment request. A Fire Management Plan will be required/ prepared at the LSP stage.

2.8 Contaminated Sites

The DER contaminated sites database was searched for known contaminated sites within or adjacent the Site (DER, 2015). No registered sites were found within or in close proximity to the Site.

2.9 Heritage

2.9.1 Aboriginal Heritage

The Department of Aboriginal Affairs (DAA) database indicates no listed Aboriginal heritage sites occur within or in close proximity to the Site (DAA, 2015).

2.9.2 Non-Aboriginal Heritage

The Heritage Council State Heritage Office's inherit database indicates that one registered heritage place occurs within the Site (Heritage Council State Heritage Office, 2015):

- Heritage Place No. 10407 'Temby's home (fmr)' located at 30 Foti Road, Pickering Brook (Figure 5).

It is noted that this heritage place is also identified on the Pickering Brook Heritage Group Inc. website and will therefore likely require further consultation.

3.0 IMPLICATIONS FOR DEVELOPMENT AND PROPOSED MANAGEMENT

3.1 Significant Native Vegetation

Given the limited extent of remnant vegetation that exists within the Site, it is recommended that remnant vegetation rated in 'Good' condition is retained where possible in the development design. Not only will this ensure the protection and enhancement of habitat, the location of the vegetation may also assist with providing vegetated buffers for spray drift, as addressed further in Section 3.2.

To assist with the detailed design of the development it is recommended that the following additional studies are undertaken:

- Level 2 flora and vegetation assessment of 24 Marchetti Road, 55 Repatriation Road; and
- Significant tree assessment focusing on 24 Marchetti Road, 30 and 55 Repatriation Road, 30 Foti Road and the linear strip of large old native trees extending along the verges of Weston Road and Repatriation Road.

3.2 Vegetated Buffer Areas

The proposed Pickering Brook townsite expansion is likely to be undertaken in stages across a number of years. As detailed in Section 2.3, the majority of the Site is currently utilised for agricultural purposes (orchards). Initial consultation with local community members/landholders has indicated to the Shire that this landuse will likely change over time as the Pickering Brook townsite development progresses. Consequently, it is important that appropriate mitigation measures are designed and implemented early in the development process to avoid conflicts arising from proposed rural residential development stages gradually being constructed near existing agricultural operations.

Key conflicts that commonly occur between agricultural operations and nearby residential uses ('sensitive uses') revolve around health and nuisance impacts from chemical use, noise and dust. As such the Department of Health have released a guidance document entitled '*Guidelines for Separation of Agricultural and Residential Land Uses: Establishment of Buffer Areas'* (DoH, 2012). This guidance document specifically addresses the establishment of separation buffer distances and/or vegetative or constructed temporary buffers. Of particular relevance to this proposal is Recommendation No.3 which states:

> *'applications for a site being developed for residential purposes are to include buffer areas that are planned and funded by the proponent of that development, unless otherwise determined by mutual agreement with existing landowners'* (DoH, 2012 page 3)

On this basis a number of vegetative buffers are proposed across the Site to facilitate staged rural residential development in close proximity to existing orchards. These buffers are proposed to be designed in accordance with the criteria set in the DoH guidelines (DoH, 2012) in that they will:

- be located as close as practicable to the point of release of the spray;
- consist of a minimum total width of 40 m made up of 10 m cleared fire break area either side of a 20 m wide planted area;
- contain random plantings of a variety of tree and shrub species of differing growth habitats, at spacings of 4-5 m;
- include species with long, thin (needle-like) and rough (furry/hairy) foliage which facilitates the more efficient capture of spray droplets and which are fast growing and hardy;
- contain foliage from the base to the crown; mixed plantings of trees may be required to ensure there are no gaps in the lower canopy;
- provide a permeable barrier which allows air to pass through the buffer. A porosity of 0.5 is acceptable (that is, approximately 50% of the screen should be air space);
- have a mature tree height twice the height of the spray release height;
- have mature height and width dimensions which do not detrimentally impact upon adjacent crop land.

Figure 6 illustrates the approximate locations for the vegetative buffers, based on the precinct boundaries identified in Figure 2. This is a high-level assessment and will require further detailed design at the Local Structure Plan or subdivision level, dependent on development timings.

3.3 Potential Risks Associated with Soil Types/Contamination

Acid Sulfate Soil (ASS) risk mapping and the DER contaminated sites database have not identified any registered sites or risks associated with soil types. Nevertheless, due to the extent of the existing agricultural activities located within the proposed Site, it is recommended that a Preliminary Site Investigation is carried out for each development stage prior to subdivision to ensure that no activities have occurred which could potentially result in contamination issues for future redevelopment.

4.0 CONCLUSION

This EAR has been developed as a supporting document for the MRS Amendment request being submitted for the proposed expansion of the Pickering Brook Townsite. It has discussed the relevant environmental characteristics of the Site, assessed the potential environmental impacts associated with the proposed scheme amendment, and identified management strategies which aim to minimise or manage these impacts.

The following summarises the implications for development and recommendations for future investigations/management measures to be considered during development of a final concept design for the Site:

Significant Native Vegetation

It is recommended that remnant vegetation rated in 'Good' condition is retained where possible in the development design. To assist with determining the location of vegetation and significant trees for retention, the following additional studies will need to be undertaken:

- Level 2 flora and vegetation assessment of 24 Marchetti Road, 55 Repatriation Road; and
- Significant tree assessment focusing on 24 Marchetti Road, 30 and 55 Repatriation Road, 30 Foti Road and the linear strip of large old native trees extending along the verges of Weston Road and Repatriation Road.

Vegetated Buffer Areas from Spray Drift

- A number of vegetated buffer areas are proposed across the Site to facilitate staged rural residential development in close proximity to existing orchards. These buffers are proposed to be designed in accordance with the criteria set in the DoH guidelines (DoH, 2012) and located appropriately in accordance with the finally determined staged development process in relation to existing orchards nearby.

Contamination

- No issues have been raised through the desktop database searches; however it is recommended that a Preliminary Site Investigation is undertaken for each development stage prior to subdivision to ensure that agricultural activities have not resulted in any contamination issues which are required to be addressed.

Public Drinking Water Source Area

- The Site is currently a Priority 2 Public Drinking Water Source Area (PDWSA) and will need to be reclassified to a Priority 3 PDWSA prior to any rural residential development being permitted. This issue is addressed in depth through the District Water Management Strategy (Strategen, 2016).

In conclusion, the proposed scheme amendment and subsequent development of the Site for rural residential purposes are viewed to have minimal potential

environmental impacts provided the above issues are addressed prior to development. Final design for the development will be addressed at the LSP or subdivision stage and will incorporate additional environmental management actions to assist in the retention of environmental values at the Site.

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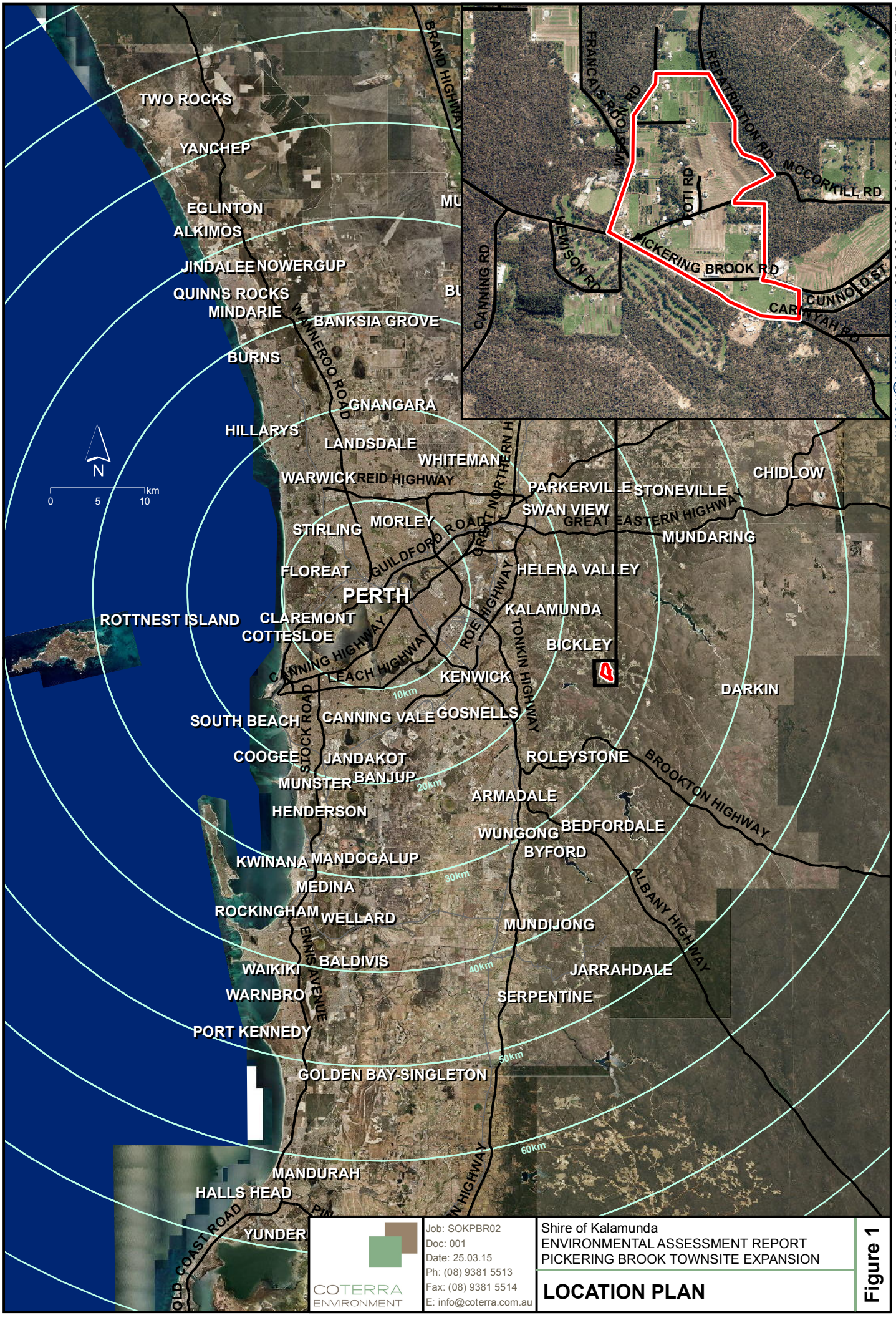
FIGURES



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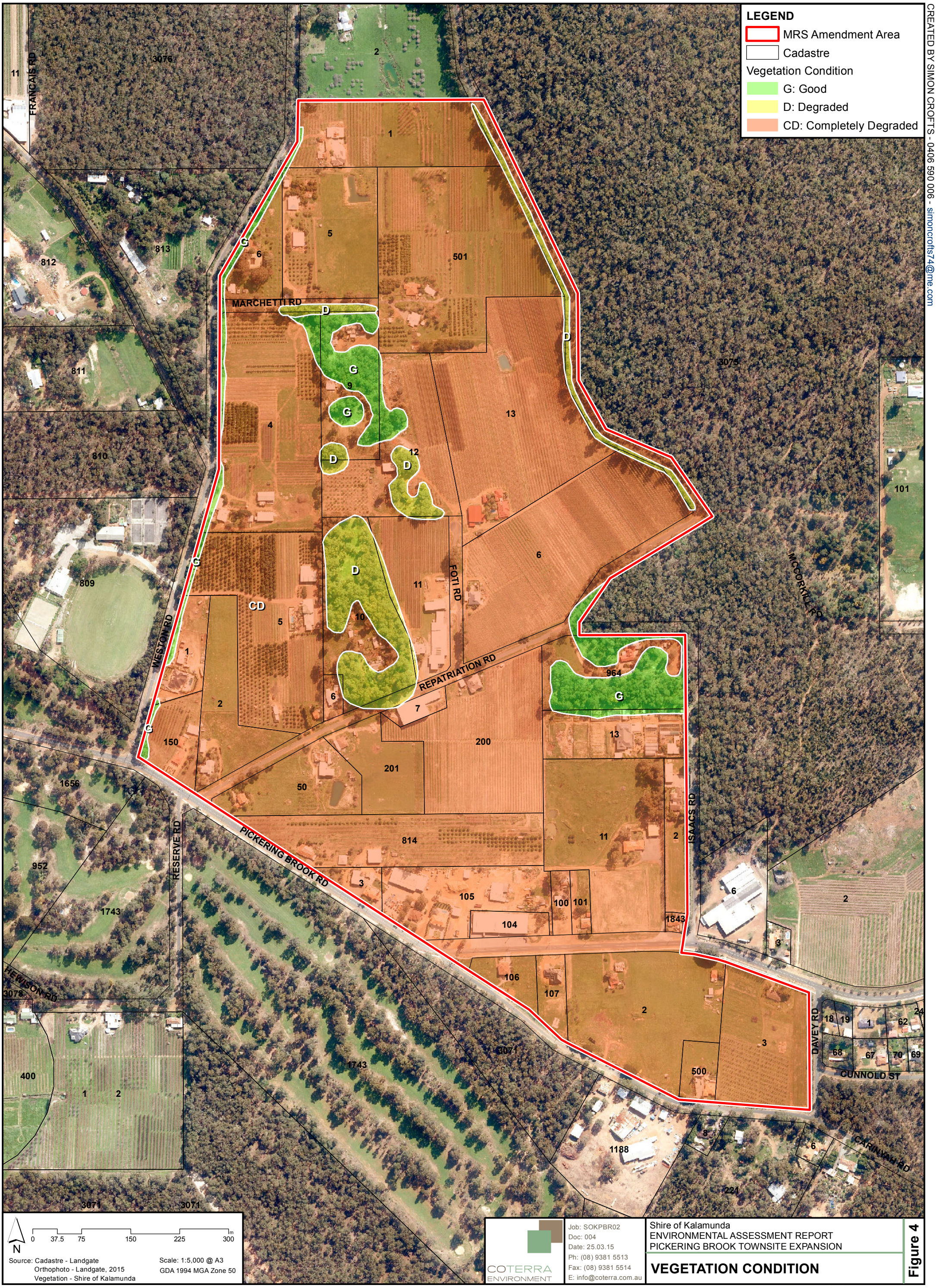
Shire of Kalamunda
ENVIRONMENTAL ASSESSMENT REPORT
PICKERING BROOK TOWNSITE EXPANSION

LOCATION PLAN

Figure 1



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VEGETATION CONDITION

Figure 4

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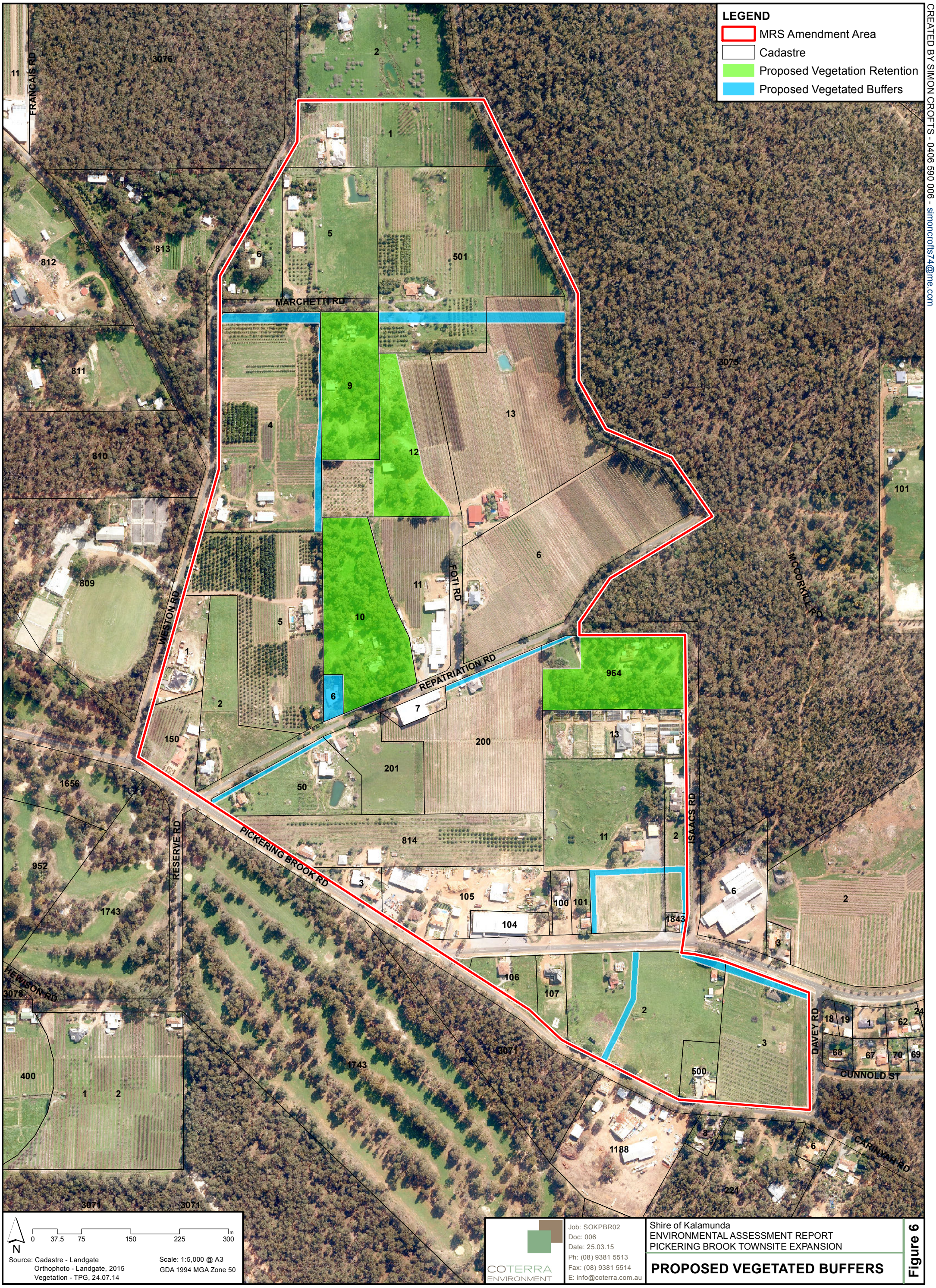
REGISTERED HERITAGE SITES

Figure 5



APPENDIX A – FLORA AND VEGETATION ASSESSMENT PICKERING BROOK TOWNSITE

Flora and Vegetation Assessment
Pickering Brook Townsite

Prepared for: Shire of Kalamunda

Prepared by: **Del Botanics**
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December 2014

EXECUTIVE SUMMARY

This report has been prepared by Del Botanics on behalf of the Shire of Kalamunda to undertake a Level 1 Flora Survey within the proposed area for rezoning, adjacent to the Pickering Brook Townsite and a Level 2 Flora Survey on Lot 10 Repatriation Road, the location of the site is shown on **Figure 1**. The Level 1 Flora survey is outlined in blue, and the Level 2 Flora Survey is shown as Future POS Area on shown on **Figure 2**.

One Vegetation Type at a local level was recorded during the survey. No species of Threatened (T), Priority Flora or Threatened Ecological Communities (TEC's) pursuant to subsection 2 of section 23F of the *Wildlife Conservation Act* 1950 and listed by Department of Parks and Wildlife (DPaW) were located during the time of the survey. The vegetation is in "Good - Degraded" condition

Based on the results of this survey, Del Botanics is of the opinion that development of the site would not pose significant or unacceptable impacts on flora or vegetation with consideration to the following recommendations:

- Undertake a Level 2 Flora assessment at 24 Marchetti Road;
- Assess the existing road verges and retain vegetation where possible; and
- Undertake a significant tree assessment and retain large trees where possible for fauna habitat.

STATEMENT OF LIMITATIONS

This environmental report has been prepared in accordance with the scope of services set out in the original quotation. In preparing the report, Del Botanics has relied on data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report. Del Botanics has not verified the accuracy or completeness of the data to the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report are based in whole or in part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Del Botanics will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, unavailable, misrepresented or otherwise not fully disclosed.

In accordance with the scope of services, Del Botanics has relied on the data and has conducted environmental field monitoring in the preparation of the report. The nature and extent of monitoring conducted is described in the report. Within the limitations imposed by the scope of services, the monitoring, and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care. No other warranty, express or implied, is made.

The report has been prepared for the benefit of the Client and for no other party. Del Botanics assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report. Other parties should not rely upon the report or the accuracy or completeness of any conclusions, and should make their own enquiries and obtain independent advice in relation to such matters.

TABLE OF CONTENTS

PAGE

TABLES

FIGURES

PHOTOGRAPHIC PLATES

APPENDICES

1. INTRODUCTION

1.1 BACKGROUND

This report has been prepared by Del Botanics on behalf of the Shire of Kalamunda to undertake a Level 1 Flora Survey within the proposed area for rezoning, adjacent to the Pickering Brook Townsite and a Level 2 Flora Survey on Lot 10 Repatriation Road, the location of the site is shown on **Figure 1**. The Level 1 Flora survey is outlined in blue, and the Level 2 Flora Survey is shown as Future POS Area on **Figure 2** and is outlined on **Figure 3**.

1.2 PURPOSE OF THIS REPORT

This report was prepared to document the flora and vegetation that occurs on site. The flora species and vegetation were used to determine the significance of the site in regards to Threatened and Priority Flora and Threatened Ecological Communities.
In summary this report provides:

- A Threatened Flora (T) and Threatened Ecological Communities (TEC's) DPaW Database search;
- A spring botanical survey; and
- An assessment of vegetation types and conditions.

1.3 LEVEL 1 FLORA AND VEGETATION SURVEY

A desktop assessment was undertaken on the target area to provide background information for a Level 1 Flora and Vegetation Survey. A reconnaissance survey is undertaken to verify the accuracy of the desktop assessment and to further delineate and characterise the flora and the range of vegetation units present in the target area and to identify potential impacts.

1.4 LEVEL 2 FLORA AND VEGETATION SURVEY

A Level 2 Flora and Vegetation Survey incorporates the desktop assessment and reconnaissance survey as preparation for more intensive survey that may range between a detailed and comprehensive survey. A Comprehensive survey was undertaken on Lot 10 Repatriation Road to collect further information of the site.

2. EXISTING ENVIRONMENT

2.1 SOILS AND LANDFORMS

The site is within what is commonly known as the Darling Plateau. The Darling Plateau lies to the east of the Swan Coastal Plain. It is characterised by an undulating hilly landscape and lateritic uplands with major valleys along the scarp. Large rock outcrops are a dominant feature along slopes and crests. The soil types associated with the Darling Plateau are:

- Darling Scarp – shallow red and yellow earths with large granite outcrops a common feature;
- Dwellingup – consists of duri-crust on ridges and sands and gravels in shallow depressions;
- Helena – yellow duplex soils and some shallow gradational earths with granite outcrops a common feature;
- Murray – red and yellow earths on side slopes of valleys and narrow alluvial terraces;
- Yarragil – sandy gravels on the slopes with orange earths in swampy floors;
- Yalanbee – dominated by fine gravel with some duri-crust on ridges;
- Cooke – dominated by granite outcrops and shallow duplex soils;
- Pindalup – contains gravely duplex soils on the slopes with some rocky outcrops, while the valley floors are dominated by grey sands with yellow duplex soils and orange earths; and
- A minor occurrence of Coolakin to the north – slopes dominated by sandy and gravely duplex soils with some rock outcrops.

2.2 CLIMATE

The Darling Scarp generally has a warm Mediterranean climate with hot dry summers and mild wet winters with rainfall ranges between 1000 and 600mm annually. The annual rainfall of Pickering Brook is approximately 1113 mm

3. FLORA AND VEGETATION

The survey area lies in the Drummond Botanical Subdistrict within the Southwest Botanical Province as described by Beard (1990). Flora composition has been described by Beard (1990) as predominantly consisting of *Banksia* Low Woodlands on leached sands with *Melaleuca* swamps where ill drained and Woodlands of *Eucalyptus* spp. on less leached soils.

The vegetation assessed is known as Darling Plateau Vegetation which is characterised by Marri woodlands with heath on the shallow soils. Jarrah forest occurs on the uplands, grading to Jarrah and Marri woodlands on the slopes with scrub along the creeklines. Where granite outcrops occur, at or near the surface, woodland of rock Sheoak and Wandoo are present with herbland on the shallowest soils.

3.1 HEDDLE VEGETATION COMPLEX

Two Heddle vegetation communities have been recorded within close proximity to the subject area. They are described below.

- **2. Dwellingup Complex in Medium to High Rainfall**. Dominated by open forests of Jarrah (*Eucalyptus marginata)*-Marri (*Corymbia calophylla)* on the uplands.

- **Yarragil Complex (Maximum development of Swamps) in Medium to High Rainfall**. Predominately consists of a mixture of open-forest of Jarrah (*Eucalyptus marginata)*-Marri (*Corymbia calophylla)* with admixtures of Yarri (*Eucalyptus patens*). On sandier soils a well-defined second storey of *Banksia* spp is distinguishable.

3.2 VEGETATION METHODS

A botanical survey was undertaken on the 14th November 2014. The site was surveyed for flora, vegetation communities and condition, Threatened Flora (T), Priority Flora (PF) and potential areas of Threatened Ecological Communities (TEC's). The vegetation on Lot 10 Repatriation Road was recorded with a 10 metre by 10 metre quadrat. Data was recorded to statistically determine vegetation types and condition. Quadrat data is available in **Appendix B.**

The survey methodology was undertaken in accordance with EPA Position Statement No.3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* and EPA Guidance Statement

No. 51: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia.*

3.3 DECLARED RARE AND PRIORITY FLORA

Species of Flora acquire "Threatened" "Presumed Extinct" or "Priority" conservation status where populations are restricted geographically or threatened by local processes. The Department of Parks and Wildlife (DPaW) recognise these threats and subsequently applies regulations towards population protection and species conservation. The DPaW enforces regulations under the *Wildlife Conservation Act* 1950 to conserve Threatened species and protect significant populations. Priority Flora species are potentially rare or threatened and are classified in order of threat. Threatened and Priority Flora category definitions are listed in **Table 1**.

Threatened Flora species are gazetted under subsection 2 of section 23F of the *Wildlife Conservation Act* 1950 and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the Act defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora to cause or permit the same to be done by any means".

Table 1: Definition of Rare and Priority Flora Species (DEC 2012)

Conservation Code	Category
T	**Threatened Flora (Declared Rare Flora – Extant)**. Schedule 1 under the Wildlife Conservation Act 1950 Rare Flora Notice Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such **Threatened Flora (Schedule 1)are further ranked by the Department according to their level of threat using IUCN Red List criteria:** **CR**: Critically Endangered - considered to be facing an extremely high risk of extinction in the wild. **EN**: Endangered –considered to be facing a very high risk of extinction in the wild. **VU**: Vulnerable - considered to be facing a high risk of extinction in the wild
X	**Presumed Extinct Flora (Declared Rare Flora – Extinct)** Schedule 2 under the Wildlife Conservation Act 1950 Rare Flora Notice Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
P1	**Priority One: Poorly-known species** pecies that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes
P2	**Priority Two: Poorly-known species** Species that are known from one or a few collections or sight records, some of which are on landsnot under imminent threat of habitat destruction or degradation, e.g. national parks, conservationparks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	**Priority Three: Poorly-known species** Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them..
P4	**Priority Four: Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	**Priority Five: Conservation Dependent species** Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years

A search of the Department of Parks and Wildlife (DPaW) Threatened (Declared Rare) and Priority flora database identified one Threatened Flora (T), one Priority 1 (P1) and two Priority 4 (P4) species in close proximity to the site. The results from the database search identified species within a 2 km buffer of the subject area. The species are listed in **Table 2** below: No Threatened or Priority Flora species listed below were located during the time of the survey.

Table 2: Threatened and Priority species in close proximity to the site

Species Name	Common Name	Conservation Code
Acacia anomala	Grass Wattle	T
Hemigenia rigida		P1
Pimelea rara	Summer Pimelea	P4
Stylidium striatum	Fan-leaved Triggerplant	P4

3.4 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT (1999) – SPECIES LEVEL SIGNIFICANCE

The *Environment Protection and Biodiversity Conservation* (EPBC) Act promotes the conservation of biodiversity by providing strong protection for plants at a species level. Section 178 and 179 provides the lists and categories of threatened species under the Act and is presented in **Table 3** below.

Table 3: Categories of Threatened Species (EPBC Act, Section 179, 1999)

1	**Extinct** A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
2	**Extinct in the Wild** A native species is eligible to be included in the **extinct in the wild** category at a particular time if, at that time:(a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
3	**Critically Endangered** A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
4	**Endangered** A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
5	**Vulnerable** A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria..
6	**Conservation Dependant** A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

A search of the EPBC Protected Matters website was undertaken within a 2km radius of the site. The results noted six significant flora species likely to occur in the area. Four species have been listed as Endangered and two have been listed as Vulnerable. These species are listed in **Table 4** below. These species were not located during the time of the survey.

Table 4: EPBC listed flora species

Species Name	Common Name	Conservation Code
Acacia anomala	Grass Wattle	Vulnerable
Caladenia huegelii	Grand Spider Orchid	Endangered
Diuris micrantha	Dwarf Bee-orchid	Vulnerable
Diuris purdiei	Purdie's Donkey-orchid	Endangered
Thelymitra manginii K.Dixon & Batty ms.		Endangered
Thelymitra stellata	Star Sun-orchid	Endangered

4. FIELD ASSESSMENT

A survey was undertaken on 14th November 2014. The site was surveyed for flora, vegetation communities and condition, Threatened Flora (T), Priority Flora (PF) and potential areas of Threatened Ecological Communities (TEC's). A flora species list is available in **Appendix A.**

The site assessment was undertaken by transvering the proposed area for rezoning, and assessing the quadrat data within Lot 10 Repatriation Road. Flora species and vegetation types and conditions were noted during the survey.

4.1 FLORA AND VEGETATION ASSESSMENT RESULTS

A total of 17 taxa, comprising 13 families were recorded on site and are shown in **Appendix A**. Species representation was greatest among the Poaceae (Grasses) Family. There is a high presence of weeds, making up 53% of the flora species recorded.

4.2 VEGETATION TYPE

One vegetation type was recorded at a local scale during the survey. The vegetation is best described as Marri/Jarrah Woodland. The dominant species consists of *Corymbia calophylla* and *Eucalyptus marginata* over shrubland of *Xanthorrhoea preissii* and *Macrozamia riedlei.*

4.3 VEGETATION CONDITION

The Vegetation Condition was rated according to the Vegetation Condition Scale commonly used in the Perth Metropolitan Region (Government of WA 2000). The definitions are described in **Table 5** below. In general, the vegetation condition ranged from "Good" to "Degraded".

Table 5: Vegetation Condition Scale (Taken from Bush Forever (Government of WA 2000))

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

4.4 SIGNIFICANT AREAS

During the survey a number of large old native trees were observed on site. In order to retain and protect these trees it would be beneficial to undertake a significant tree assessment. There are a number of trees on Foti Road, Repatriation Road, Weston Road and Marchetti Road.

There are also a number of areas along the road verges that have significant trees and an intact understorey which provides important ecological linkages to the adjacent bushland. There are three areas within the site that have been noted as significant. At the end of Isaacs Road there is a patch of significant vegetation, there are also patches of roadside vegetation along Weston Road and Marchetti in good condition.

During the survey number 24 Marchetti Road has been noted as significant as a large proportion of this property appears to be in good condition, providing a good example of remnant vegetation with a dominant over and understorey of native vegetation. This property provides a better example of native vegetation than the vegetation assessed on Lot 10 Repatriation Road. It is recommended that the vegetation on this property is assessed and retained where possible.

5. CONCLUSIONS AND RECOMMENDATIONS

One Vegetation Type at a local level was recorded during the survey. No species of Threatened (T), Priority Flora or Threatened Ecological Communities (TEC's) pursuant to subsection 2 of section 23F of the *Wildlife Conservation Act* 1950 and listed by Department of Parks and Wildlife (DPaW) were located during the time of the survey. The vegetation is generally in a "Good" to "Degraded" condition, with many road verges in "Good" condition.

Based on the results of this survey, Del Botanics is of the opinion that development of the site would not pose significant or unacceptable impacts on flora and vegetation with consideration to the following recommendations:

- Undertake a Level 2 Flora assessment at 24 Marchetti Road;
- Assess the existing road verges and retain vegetation where possible; and
- Undertake a significant tree assessment and retain large trees where possible for fauna habitat.

6. REFERENCES

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FIGURES

FIGURE 1: LOCATION OF SUBJECT SITE

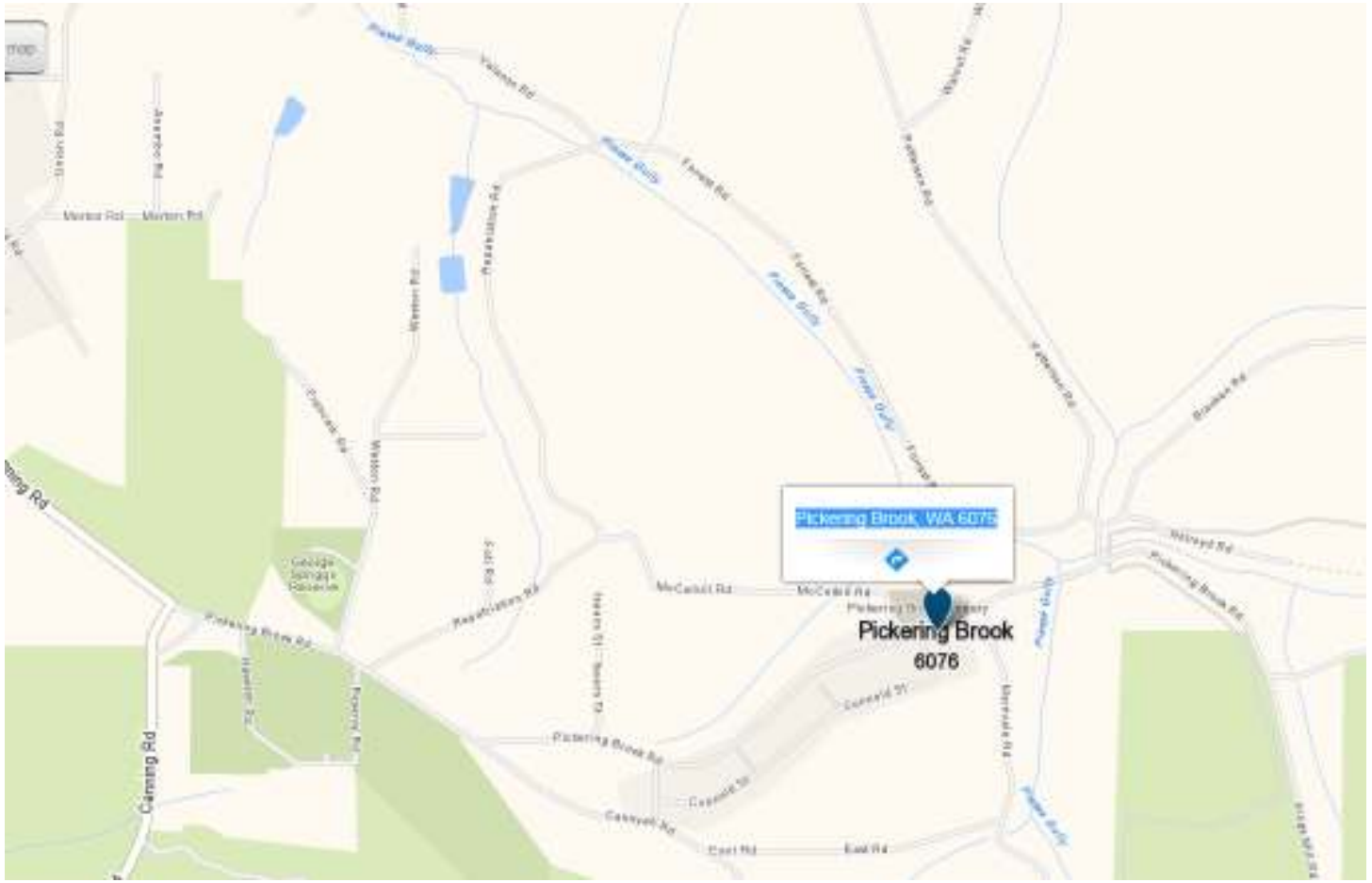

FIGURE 2 EXTENT OF SUBJECT SITE

FIGURE 3 SIGNIFICANT VEGETATION

FIGURE 4 LEVEL 2 SURVEY AREA

PHOTOGRAPHIC PLATES

Plate 1: Significant vegetation at 24 Marchetti Road

Plate 2: Significant tree in roadside vegetation

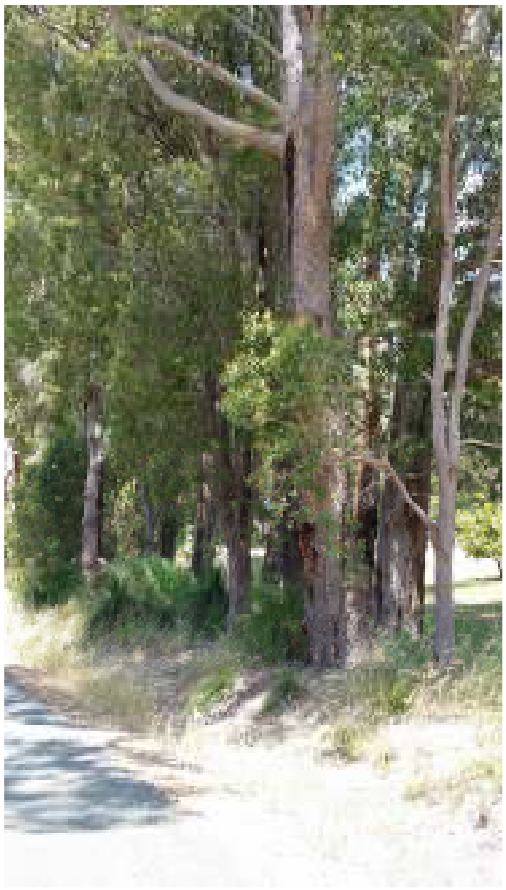

Plate 3: Significant roadside vegetation

Plate 4: Significant tree

APPENDIX A
VASCULAR PLANT SPECIES RECORDED

APPENDIX A: VASCULAR PLANT SPECIES RECORDED AT LOT 10 REPATRIATION ROAD, PICKERING BROOK, NOVEMBER 2014 (*DENOTES A WEED SPECIES)

Family	**** Genus***	***Species***
Asteracaea	**Hypochaeris glabra*	
Colchicaceae	*Burchardia congesta*	
Cyperaceae	*Lepidosperma sp*	
Euphorbiaceae	*Euphorbia ?terracina*	
Iridaceae	**Romulea rosea*	
Myrtaceae	*Corymbis calophylla*	
Myrtaceae	*Eucalyptus marginata*	
Oleaceae	**Olea europaea*	
Orchidaceae	*Prasophyllum parvifolium*	
Oxalidaceae	**Oxalis?corniculata*	
Poaceae	**Avena barata*	
Poaceae	**Briza maxima*	
Poaceae	**Erhrarta calycina*	
Poaceae	**Fescue sp*	
Rosaceae	**Prunus persica var. nectarina*	
Thymelaeaceae	*Pimelea sp*	
Zamiaceae	*Macrozamia riedlei*	

APPENDIX B
QUADRAT DATA

Del Botanics

FIELD SHEET – FLORA AND VEGETATION SURVEY

Job Code Lot 10 Repatriation Road, Pickering Brook	**Date:**14/11/14	**Site:** Q1
GPS Datum: 50 416374 6453482	**Topography:** Mid slope	**Litter cover:** 10 % twigs, 90 % leaves
Age since fire: **>10** yrs	**Disturbance:** **Hi** Med Lo	**Soils:** Grey/brown sand/loam
Vegetation Description: Parkland cleared Marr/Jarrah Woodland		
Vegetation Condition: Degraded		
Observations: Good stand of old native trees, however there no to a very limited understorey		

Coll No.	Taxon	Ht (cm)	% Alive	% Dead	% Cover
	Eucalyptus marginata	1500	100		40
	Corymbis calophylla	2000	100		80
	Macrozamia reidleii	60	100		3
	**Briza maxima*	20	100		5
	**Avena barata*	40	100		25
	Pimelea sp	120	100		2
	Euphorbia ?terracina	15	100		5
	Lepidosperma sp	40	100		5
	**Oxalis?corniculata*	10	100		<1
	Burchardia umbellata	50	100		2
	**Olea europaea*	10	100		<1
	**Erhrarta calycina*	15	100		2
	Prasophyllum parvifolium	15	100		<1
	**Fescue sp*	10	100		2
	**Romulea rosea*	10	100		2
	**Hypochaeris glabra*	5	100		<1
	Prunus **persica var. nectarina*	10	100		<1

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APPENDIX B – PROTECTED MATTERS SEARCH REPORT (EPBC)

Australian Government

Department of the Environment

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.

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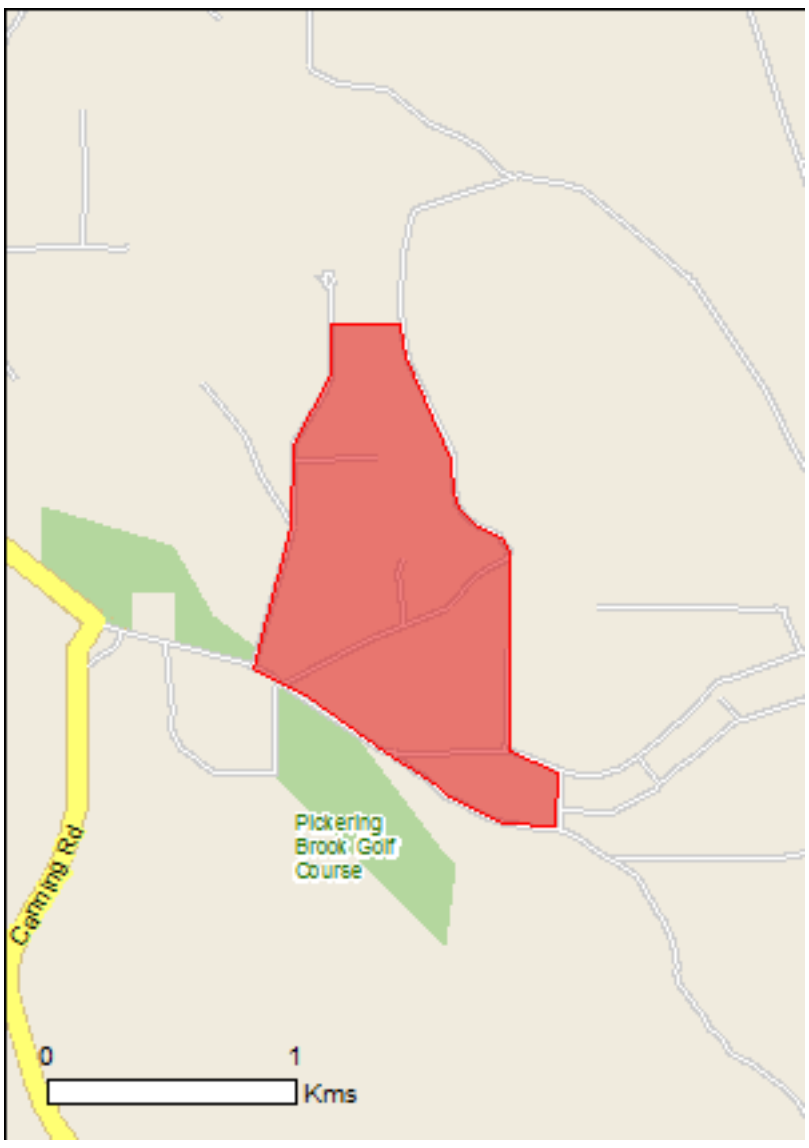

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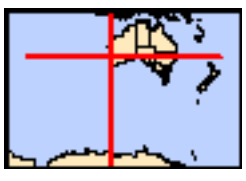

Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	15
Listed Migratory Species:	6

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

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.

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:	7
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.

Place on the RNE:	None
State and Territory Reserves:	1
Regional Forest Agreements:	1
Invasive Species:	29
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calyptorhynchus banksii naso		
Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat may occur within area
Calyptorhynchus baudinii		
Baudin's Black-Cockatoo, Long-billed Black-Cockatoo [769]	Vulnerable	Roosting known to occur within area
Calyptorhynchus latirostris		
Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Breeding likely to occur within area
Leipoa ocellata		
Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Bettongia penicillata ogilbyi		
Woylie [66844]	Endangered	Species or species habitat may occur within area
Dasyurus geoffroii		
Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis		
Western Ringtail Possum, Ngwayir [25911]	Vulnerable	Species or species habitat may occur within area
Setonix brachyurus		
Quokka [229]	Vulnerable	Species or species habitat may occur within area
Plants		

Name	Status	Type of Presence
Acacia anomala		
Grass Wattle, Chittering Grass Wattle [8153]	Vulnerable	Species or species habitat likely to occur within area
Caladenia huegelii		
King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
Diuris micrantha		
Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei		
Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Thelymitra manginii K.Dixon & Batty ms.		
[67443]	Endangered	Species or species habitat may 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		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may 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		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Korung	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
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

Name	Status	Type of Presence
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
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 rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
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		Species or species habitat likely to occur

Name	Status	Type of Presence
[20126]		within area
Genista sp. X Genista monspessulana		
Broom [67538]		Species or species habitat may occur within area
Lantana camara		
Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum		
African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Pinus radiata		
Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate		
Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
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 within area

Coordinates

-32.040884 116.121555,-32.040921 116.121555,-32.040921 116.121555,-32.040848 116.119581,-32.040011 116.117607,-32.03972 116.117264,-32.038665 116.115289, -32.037028 116.112629,-32.036119 116.110612,-32.031789 116.111985,-32.029242 116.112071,-32.027059 116.113401,-32.025531 116.113401,-32.025531 116.115933, -32.026477 116.116148,-32.029679 116.117779,-32.030698 116.117821,-32.031171 116.118036, 32.031716 116.118723,-32.032153 116.119667, 32.032553 116.119838, -32.038629 116.119838,-32.03932 116.121598,-32.040884 116.121555

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 Heritage and Register of National Estate properties, Wetlands of International 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.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

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.

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:

-Department of Environment, Climate Change and Water, New South Wales
-Department of Sustainability and Environment, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment and Natural Resources, South Australia
-Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
-Environmental and Resource Management, Queensland
-Department of Environment and Conservation, Western Australia
-Department of the Environment, Climate Change, Energy and Water
-Birds Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-SA 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, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
-State Forests of NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

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

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

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Appendix 3

District Water Management Strategy (Strategen Environmental Consultants)

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Pickering Brook

District Water Management Strategy

FINAL DRAFT

Prepared for
Shire of Kalamunda
by Strategen

June 2016

STRATEGEN
environmental consultants

Pickering Brook

District Water Management Strategy

FINAL DRAFT

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

June 2016

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consulting Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: Shire of Kalamunda

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Preliminary Draft Report	A	Client review	M Dunlop/ D Newsome	Electronic	19/02/2016
Final Draft Report	0	For agency review	M Dunlop/ D Newsome	Electronic	13/06/2016
Final Report					

Filename: SKA15019_01 R001 Rev 0 - 13 June 2016

Executive Summary

The Shire of Kalamunda (the Shire) wishes to rezone a portion of Pickering Brook (the Site) from 'rural' to 'urban' under the Metropolitan Region Scheme (MRS), with the aim of supporting subdivision to 2000 to 4000 m^2 lifestyle lots and a local centre, with a total lot yield of 300 to 350 lots. The Site is approximately 32 km east of the Perth Central Business District (CBD) and has a total area of 89.5 ha (Figure 1-1).

This rezoning is consistent with the Shire Local Planning Strategy (LPS), which proposed that land should be identified, near the Pickering Brook settlement, to allow for subdivision for 2000-4000 m^2 lots to provide housing for the local community. The Shire is now seeking to amend the MRS to be consistent with the LPS. This District Water Management Strategy (DWMS) has been prepared to support the MRS amendment.

Currently the area is proclaimed under the *Country Areas Water Supply Act 1947* as part of the Middle Helena Catchment (MHC) Public Drinking Water Source Area (PDWSA). The Site is currently a Priority 2 PDWSA. Priority 2 PDWSA, are to be managed to 'ensure there is no increased risk of pollution to the water source' (WAPC and DoP 2010). This categorisation requires a minimum lot size of 2 ha (DoW 2004). In order to achieve the lot size desired by the Shire, the area will need to be reclassified to a Priority 3 PDWSA, consistent with the existing Pickering Brook townsite to the east of the Site.

Local Structure Planning will be undertaken in a manner that implements the principles and objectives of this DWMS as outlined in. Table ES 1-1. It is considered that with the implementation of these measures, the principles and objectives of the DWMS will be met and drinking water quality will be maintained.

Table ES 1-1: Summary of DWMS principles, objectives and proposed implementation measures

Category	Principles	Objectives	Proposed implementation measures
Water use	The development shall: 1. Consider all potential water sources in water supply planning. 2. Integrate water and land use planning. 3. Ensure sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	The objectives of these measures will be to: 1. Minimise the use of potable water where drinking water quality is not essential. 2. Limit water consumption to less than 100 kL/person/year based on the State Water Plan target.	Future land owners shall be encouraged to: • reduce landscaped areas and associated irrigation rates • retain native vegetation and utilise native landscaping where possible • treat wastewater to a high standard for on-lot irrigation purposes • consider the use of rainwater tanks for in-house and ex-house water use.

Category	Principles	Objectives	Proposed implementation measures
Groundwater levels and surface water flows	The development shall: 1. Aim to retain natural drainage systems and protect ecosystem health. 2. Protect dwellings and infrastructure from flooding and waterlogging. 3. Implement economically viable stormwater systems. 4. Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	The objectives of these measures will be to: 1. Maintain or restore desirable environmental flows and/or hydrological cycles where there are identified impacts on significant ecosystems. 2. Manage up to the 1 in 100-year ARI event within the development area to predevelopment flows.	1. Include a 30 m vegetated buffer around the foreshore of The Creek, including swales and biofiltration structures to manage stormwater quality. 2. Lots shall manage and treat stormwater from buildings and hardstand in events up to the 1 in 1-year ARI, 1-hour event through the use of rainwater tanks, soakwells and vegetated structures. 3. The development shall maintain pre-development flows off the site in the 1 in 100 year ARI event through swales and infiltration/detention basins in the road reserve and foreshore buffer.
Groundwater and surface water quality	The development shall: 1. Maintain or improve groundwater and surface water quality. 2. Minimise discharge of pollutants to receiving waterways and maintain water quality in the specified environment. 3. Manage impacts to water quality within the context of a Priority 3 PDWSA.	The objectives of these measures will be to: 1. Maintain surface water and groundwater quality. 2. Ensure that all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007) to remove contaminants. 3. Ensure that development, including onsite effluent disposal does not negatively impact upon surface water quality.	1. Stormwater shall be treated prior to discharge through swales and infiltration/detention basins in the road reserve and foreshore buffer. 2. Nutrient and pathogen reducing ATUs will be used for effluent treatment on the Site. 3. Land capability assessment will be undertaken at a LWMS stage to confirm capability for effluent disposal.
Disease vector and nuisance insect management	1. To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.	1. New permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of Departments of Water and Health.	1. New permanent water bodies are not proposed on the Site.

Table of contents

List of tables

List of figures

List of plates

List of appendices

1. Introduction

1.1 Planning background

The Shire of Kalamunda (the Shire) wishes to rezone a portion of Pickering Brook (the Site) from 'rural' to 'urban' under the Metropolitan Region Scheme (MRS), with the aim of supporting subdivision to 2000 to 4000 m^2 lifestyle lots and a local centre, with a total lot yield of 300 to 350 lots. The Site is approximately 32 km east of the Perth Central Business District (CBD) and has a total area of 89.5 ha (Figure 1-1).

This rezoning is consistent with the Shire Local Planning Strategy (LPS), which proposed that land should be identified, near the Pickering Brook settlement, to allow for subdivision for 2000-4000 m^2 lots to provide housing for the local community. The Shire is now seeking to amend the MRS to be consistent with the LPS. This District Water Management Strategy (DWMS) has been prepared to support the MRS amendment.

Currently the area is proclaimed under the *Country Areas Water Supply Act 1947* as part of the Middle Helena Catchment (MHC) Public Drinking Water Source Area (PDWSA).

1.2 Current land use

The area to be rezoned is private land and predominantly consists of fruit orchards and some rural lifestyle blocks (Figure 1-2). This area was identified within a broader study area through an opportunities and constraints process that took into account environmental, social and servicing factors.

Land use context

The Site is currently a Priority 2 PDWSA (Figure 1-3). Priority 2 PDWSA, are to be managed to ensure there is no increased risk of pollution to the water source (State Planning Policy 2.7 [SPP 2.7], WAPC 2003). This categorisation requires a minimum lot size of 2 ha (DoW 2004). In order to achieve the lot size desired by the Shire, the area will need to be reclassified to a Priority 3 PDWSA, consistent with the existing Pickering Brook townsite to the east (Figure 1-3).

The MHC forms the catchment of the Helena Pumpback Dam (HPD). Water from the HPD is pumped into Lake CY O'Connor, which supplies water to the Water Corporation Goldfields and Agricultural Water Supply Scheme and also supplies part of the Integrated Water Supply System, which serves the Perth Metropolitan Area (WAPC and DoP 2010). The HPD can contribute 25 to 40% of the flow to Lake CY O'Connor (WAPC and DoP 2010).

The MHC covers approximately 11 260 hectares, of which approximately 80% is native vegetation (WAPC and DoP 2010). The ownership of the catchment can be broken down as:

- 35% state forest managed by the Department of Parks and Wildlife (DPaW)
- 33% Crown Reserve and State Government land
- 27% is privately held (WAPC and DoP 2010).

Based on a land use survey undertaken in 2003:

- 79% of the MHC is native vegetation
- 7.3% is paddocks or fields
- 5.9% is orchards and vineyards
- 3.4% is 'house and garden' (WAPC and DoP 2010).

The Site represents less than 1% of the MHC. As the Site is a very small portion of the MHC, development of the Site for rural residential purposes will not significantly alter the land use profile of the MHC.

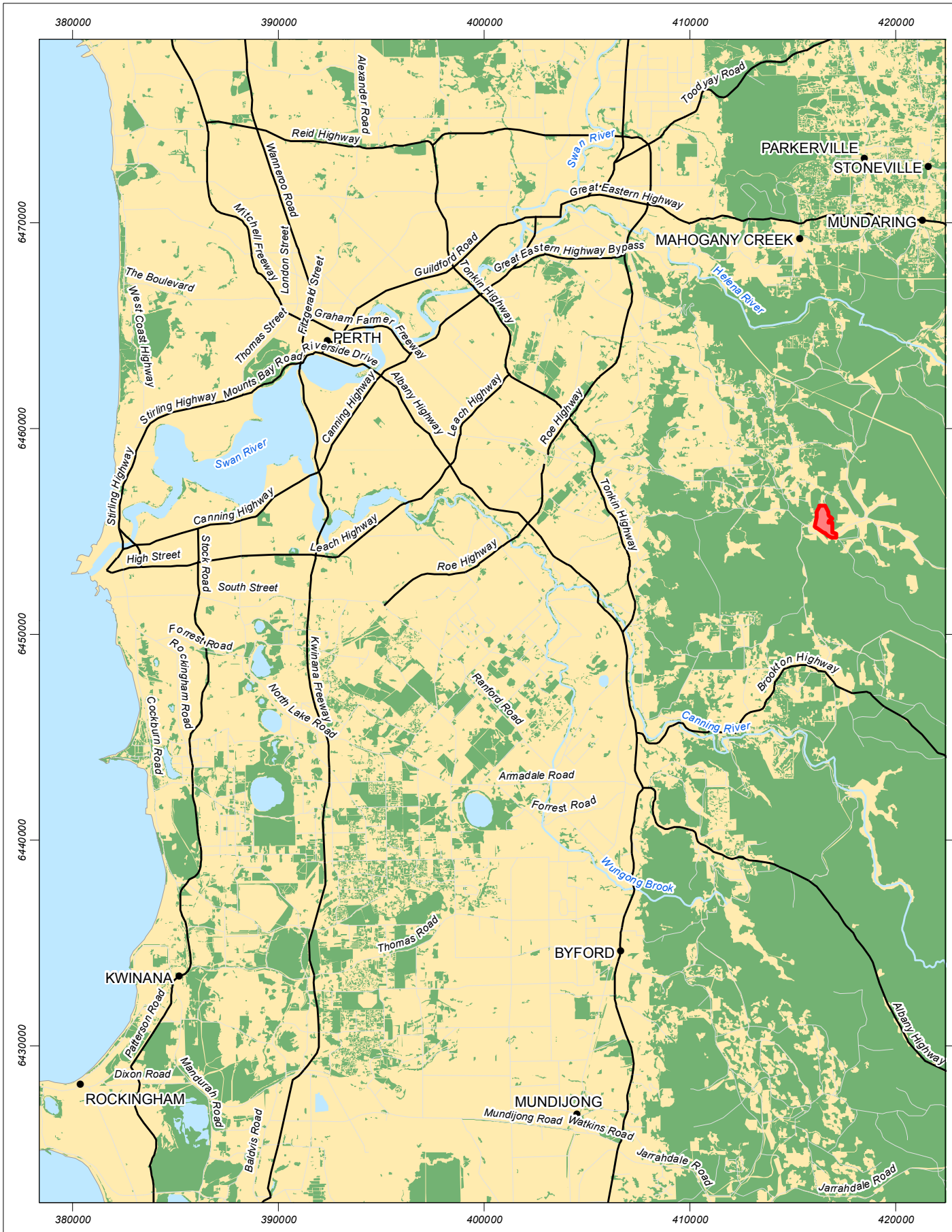

Figure 1-1: Site location plan

Scale 1:250,000 at A4

0 1 2 3 4 5 km

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 25/03/2015

Author: JCrute

Source: Topography: Geoscience Australia 2011.

Legend

- Town
- Major road
- Minor road
- Major river
- Lakes
- Native vegetation
- Site boundary

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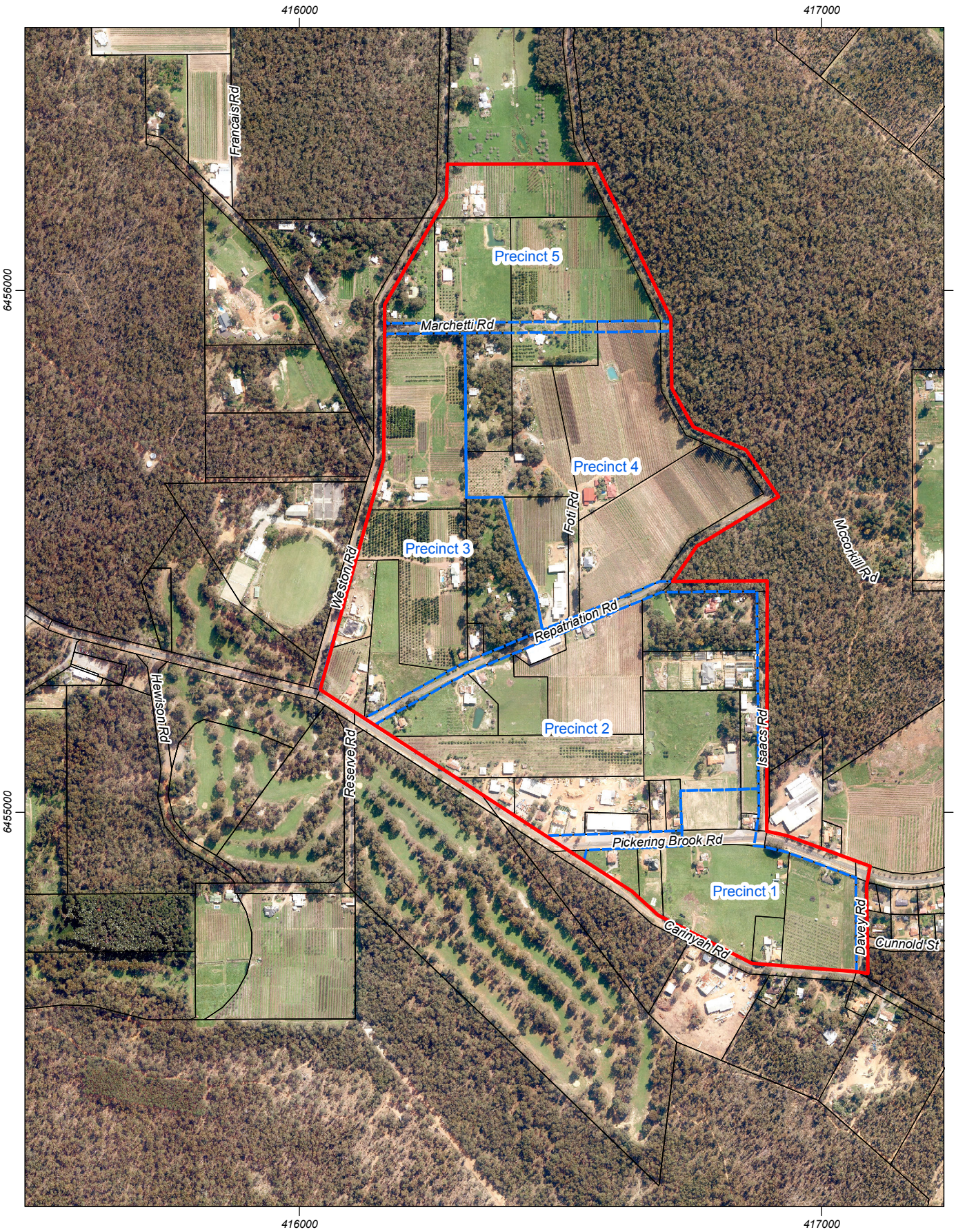

Figure 1-2: Context plan

Scale 1:10,000 at A4

0 100 200 300 400 m

N

Legend

- Site boundary
- Precinct boundaries
- Cadastral boundaries

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 16/02/2016
Author: DWhite
Source: Aerial image, cadastre & project boundary: Client 2015. Roads: Main Roads WA 2012.

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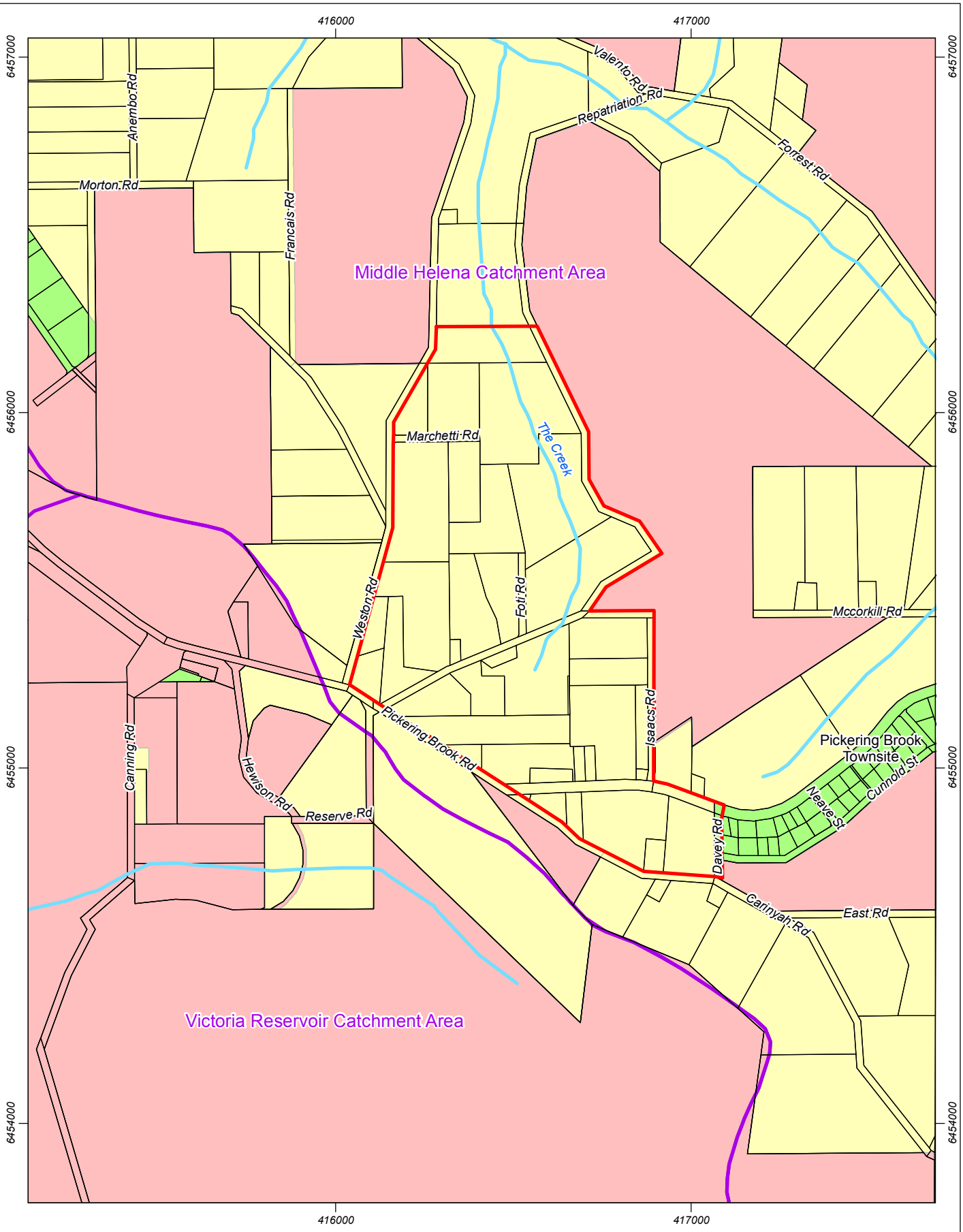

Figure 1-3: Public Drinking Water Source Area Plan

Scale 1:14,500 at A4

0 100 200 300 400 m

N

Legend

- Watercourse
- Site boundary
- Cadastral boundaries
- Catchment boundary

Priority

- P1
- P2
- P3

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 16/02/2016
Author: DWhite
Source: Aerial image, cadastre & project boundary: Client 2015. Roads: Main Roads WA 2012. Watercourse: SLIP online, Landgate 2015. PDWSAs: DoW 2013.

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1.3 Planning process and justification

The future sustainability of the Pickering Brook community is contingent upon the expansion and consolidation of the existing townsite to a more viable level that can support required goods and services at a level commensurate with contemporary local needs and expectations. The changing composition of the local population over recent decades in conjunction with the general intrusion of urban uses including quasi-industrial uses has resulted in a transition from orchards and other intensive and extensive agricultural uses to more urban and lifestyle based land use opportunities, including tourism based activities. Relatively large lot subdivision potential (2000- 4000 m^2+) in serviceable locations that are able to respond to bushfire risk and other relevant strategic planning considerations are considered to be an appropriate response to emerging economic, social and environmental trends and issues at Pickering Brook and in the broader North-East Sub-region, and will be flexible enough to meet the needs of a range of suitable future urban and peri-urban uses. On balance, the strategic planning benefits for the expansion of the Pickering Brook townsite as reflected in the Shire's endorsed LPS are considered to outweigh the risks to the surface water catchment associated with land use change. The LPS was endorsed by the West Australian Planning Commission (WAPC) in 2012. This Site to the west of the existing townsite was selected for expansion because the site is largely cleared and reticulated potable water is available in the area.

An Indicative Development Precinct Plan is presented in Figure 1-4. To develop this plan, the Shire has undertaken an extensive consultation process including consultation with the Department of Planning (DoP), Department of Water (DoW), Department of Parks and Wildlife, Department of Environment Regulation, Department of Agriculture and Food, Water Corporation, the Pickering Brook Heritage Group and Pickering Brook Primary School. A summary of this consultation is presented in Appendix 2.

The planning process subsequent to the MRS amendment is discussed in Section 6.1.

1.4 Total water cycle management principles and objectives

This DWMS identifies and describes a range of design elements and management measures that are being considered for the Site. The principal objective of this DWMS is to achieve better urban water management outcomes by designing a development that manages the total water cycle in a sustainable manner and meets objectives for water sensitive urban design. This includes consideration of water conservation and efficiency (water use), water quantity management (groundwater levels and surface water flows), water quality management (groundwater and surface water quality) and disease vector and nuisance insect management.

This DWMS has been prepared in accordance with *Better Urban Water Management* (BUWM) guidelines (DoW 2008) on advice from DoW. The document is consistent with the relevant State and local guidance on water management including the *State Water Plan* (DPC 2007) and the *State Planning Policy 2.9 Water Resources* (WAPC 2006). The document aims to meet the principles and objectives of stormwater management in Western Australia, as detailed in the *Stormwater Management Manual for Western Australia* (DoW 2007).

The BUWM guidelines (WAPC and DPI 2008) also outline the principles of stormwater management as a component of water sensitive urban design (WSUD), which are:

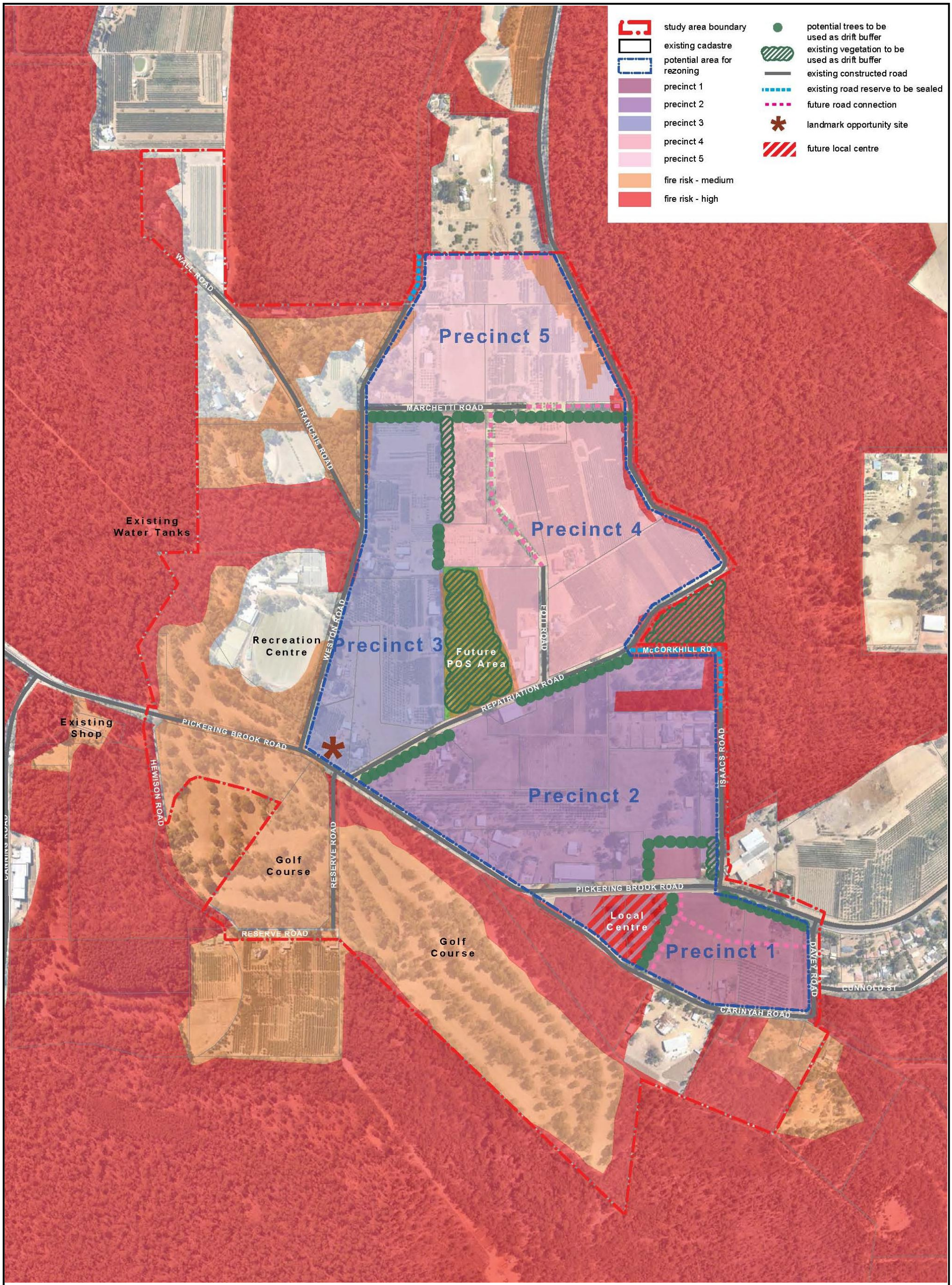
- protect natural systems – protect and enhance natural water systems and their hydrological regimes in urban developments
- integrate stormwater treatment into the landscape – use stormwater in the landscape by incorporating multi-use corridors that maximise the visual and recreational amenity of developments
- protect water quality – protect from draining from urban development and minimise outputs of phosphorous, nitrogen and other pollutants
- manage run-off and peak flows – reduce peak flows from urban development by using local detention measures and minimising impervious areas
- add value while minimising development costs – minimise the drainage infrastructure cost of development.

A copy of the DWMS checklist has been attached to assist in the review of this document (Appendix 1).

1.5 Previous studies and recommendations

Previous studies relevant to the Site include:

- *Middle Helena Catchment Area Land Use and Water Management Strategy,* WAPC and DoP 2010 (the LUWMS, discussed further in Section 2.1.3)
- *Hills Rural Study* (Shire of Kalamunda 2014)
- *Flora and Vegetation Assessment: Pickering Brook Townsite*, Del Botanics 2014.



Source: TPG

Figure 1-4: Indicative Development Precincts Plan

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2. Design and management objectives

2.1 Key principles and objectives

The DWMS uses the following documents to define its key principles and objectives:

- *Water Resources: Statement of Planning Policy 2.9* (WAPC 2004)
- *Stormwater Management Manual for WA* (DoW 2004 – 2007)
- *Decision Process for Stormwater Management in WA* (DoE & SRT 2005)
- *Better Urban Water Management* (WAPC 2008)
- *Public Drinking Water Source Areas: Statement of Planning Policy 2.7* (WAPC 2003)
- LUWMS (WAPC and DoP 2010).

The Site is not covered by a Drainage and Water Management Plan.

The key guiding principles of the DWMS are to:

- facilitate implementation of sustainable best practice in urban water management
- encourage environmentally responsible development
- provide integration with planning processes and clarity for agencies involved with implementation
- facilitate adaptive management responses to the monitored outcomes of development
- minimise public risk, including the risk to public drinking water supplies
- maintain the total water cycle of the site.

The DWMS has been prepared to guide water management actions for future development with particular emphasis on demonstrating that the impacts of development to water quality are manageable within the context of a Priority 3 PDWSA.

Summaries of principles and objectives applicable to the DWMS for the Site based have been based on the documents outlined above and are summarised in Sections 2.1.2 to 2.1.5.

Table 2-1: Summary of DWMS principles and objectives

Category	Principles	Objectives
Water use	The development shall: 1. Consider all potential water sources in water supply planning. 2. Integrate water and land use planning. 3. Ensure sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	The objectives of these measures will be to: 1. Minimise the use of potable water where drinking water quality is not essential. 2. Limit water consumption to less than 100 kL/person/year based on the State Water Plan target.
Groundwater levels and surface water flows	The development shall: 1. Aim to retain natural drainage systems and protect ecosystem health. 2. Protect dwellings and infrastructure from flooding and waterlogging. 3. Implement economically viable stormwater systems. 4. Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	The objectives of these measures will be to: 1. Maintain or restore desirable environmental flows and/or hydrological cycles where there are identified impacts on significant ecosystems. 2. Manage up to the 1 in 100-year ARI event within the development area to predevelopment flows.

Category	Principles	Objectives
Groundwater and surface water quality	The development shall: 1. Maintain or improve groundwater and surface water quality. 2. Minimise discharge of pollutants to receiving waterways and maintain water quality in the specified environment. 3. Manage impacts to water quality within the context of a Priority 3 PDWSA.	The objectives of these measures will be to: 1. Maintain surface water and groundwater quality. 2. Ensure that all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007) to remove contaminants. 3. Ensure that development, including onsite effluent disposal does not negatively impact upon surface water quality.
Disease vector and nuisance insect management	1. To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.	1. New permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of Departments of Water and Health.

2.1.1 Public Drinking Water Source Areas: Statement of Planning Policy 2.7

SPP 2.7 (WAPC 2003) acknowledges the DoW three-level catchment protection prioritisation and wellhead protection zone approach and introduction of *Water Catchment* and *Rural Water Protection* zones into the Metropolitan Region Scheme (MRS) to identify surface and groundwater catchments (respectively) to ensure local government town planning schemes give effect to public water supply source protection strategies.

2.1.2 Water Resources Statement of Planning Policy 2.9 and Liveable Neighbourhoods

The DWMS has been developed in accordance with regional and local principles and objectives of Integrated Urban Water Management (IUWM).

WAPC (2004) defines IUWM (also known as total water cycle management) as promoting *'management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality, waterways, estuaries and coastal waters is recognised'*.

IUWM should also promote water conservation measures, reuse and recycling of water and best practice in stormwater management (WAPC 2004). These objectives are consistent with Liveable Neighbourhoods (WAPC & DPI 2007).

2.1.3 Middle Helena Land Use and Water Management Strategy

The LUWMS was prepared to improve water quality management and management of natural resources in the MHC (WAPC and DoP 2010). The LUWMS outlined the process for determining the Priority classification of land within the MHC (WAPC and DoP 2010). All land within the MHC was categorised into one of three categories, being:

1. Priority 1 Public Drinking Water Source Areas (PDWSA), which are to be managed to 'ensure that there is no degradation of the water source'. Acceptable land uses in Priority 1 areas are limited to bushland parks and forestry (DoW 2004).
1. Priority 2 PDWSA, which are to be managed to 'ensure there is no increased risk of pollution to the water source' (WAPC and DoP 2010). Acceptable land uses in Priority 2 include broadscale agriculture, orchards and rural residential lots with an area of 2 ha or greater (DoW 2004).
2. Priority 3 PDSA are designed to manage to the risk of pollution to the water source. Acceptable land uses include residential, commercial and light industrial developments, although polluting heavy industry is not allowed (DoW 2004).

The process for classifying sites was based on the MRS zoning and land use at the time at which the LUWMS was developed (WAPC and DPI 2010). As a consequence, all three Priority categories exist within the broader Pickering Brook area (Figure 1-3). The LUWMS does not address criteria for changing Priority classifications within the MHC.

2.1.4 Stormwater Management Manual for WA

DoW's current position on Urban Stormwater Management in Western Australia is outlined in Chapter 2: Understanding the Context of the Stormwater Management Manual for Western Australia (DoW 2004-2007), which details the management objectives, principles, and a stormwater delivery approach for WA. Principal objectives for managing urban water in WA are stated as:

- Water Quality: to maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions
- Water Quantity: to maintain the total water cycle balance within development areas relative to the pre-development conditions
- Water Conservation: to maximise the reuse of stormwater
- Ecosystem Health: to retain natural drainage systems and protect ecosystem health
- Economic Viability: to implement stormwater systems that are economically viable in the long term
- Public Health: to minimise the public risk, including risk of injury or loss of life to the community
- Protection of Property: to protect the built environment from flooding and water-logging
- Social Values: to ensure that social, aesthetic and cultural values are recognised and maintained when managing stormwater
- Development: to ensure the delivery of best practice stormwater management through planning and development of high quality developed areas in accordance with sustainability and precautionary principles.

2.1.5 Better Urban Water Management

This DWMS has been developed to be consistent with the framework and process detailed in the guideline document *Better Urban Water Management* (BUWM) (WAPC 2008).

This DWMS has been prepared to an appropriate level of detail to support the Metropolitan Region Scheme amendment for the future development of the Site. A Local Water Management Strategy (LWMS) will be prepared to support a future Local Structure Plan.

3. Pre-development environment

3.1 Climate

The Site has a Mediterranean climate with hot dry summers and cool wet winters (Figure 3-1). Rainfall at the nearest Bureau of Meteorology site in Bickley (approximately 4 km north of the Site), indicates an average annual rainfall of 1093 mm, with the majority of rain falling between April and October (Figure 3-1).

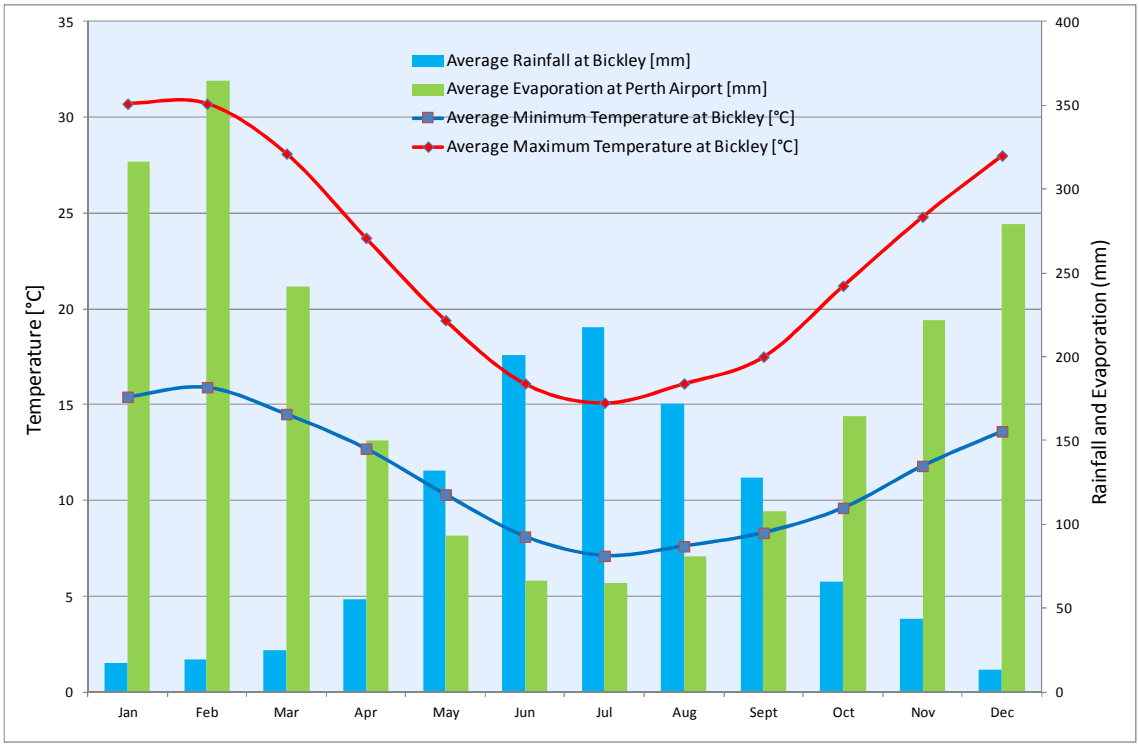

Figure 3-1: Climate
Source: BoM 2015

3.2 Topography

The Site consists of a valley structure within the Darling Range. The Darling Range is an undulating lateritic upland dissected by a series of valleys (WAPC and DoP 2010). The site varies in height from approximately 287 metres Australian Height Datum (m AHD) in the southeast, near the corner of Carinyah Road and Davey Road, to approximately 234 mAHD along the streamline in the north (Figure 3-2). Gradients on the site vary from less than 2% along the creekline near Repatriation Road to greater than 10% in the steeper areas in the far north of the Site.

3.3 Geology and soils

The soil types within the Site fall into the following broad soil groups:

- Dwellingup: lateritic duricrust (hardpan) on ridges and sands and gravels in shallow depressions
- Murray: red and yellow earths on side slopes of valleys and narrow alluvial terraces
- Yarragil: sandy gravels on the slopes with orange earths in swampy floors (Del Botanics 2014).

These land units are underlain by the granites, gniesses and migmatites of the Darling Plateau, which represents the western boundary of the Yilgarn Craton (WAPC and DoP 2010).

The Department of Agriculture and Food (DAFWA) has mapped the following soil types as occurring within and adjacent to the Site:

- Murray Phase 2: variable duplex (soils with a sand layer over a clayey layer) and gradational soils (soils that become more clayey with depth)
- Dwellingup Phase 2: shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust (hardpan)
- Yarragil Phase 1:yellow duplex soils and brown massive earths (unconsolidated soils)
- Yarragil Phase 4: mottled yellow duplex soils adjacent to creeklines (Figure 3-3).

The duplex soils and sandy soils overlying duricrusts are anticipated to have a comparatively high hydraulic conductivity within the top soils (i.e. greater than 0.1 m/day), and thus some capacity for infiltration. However, the clayey materials and duricrusts below this are relatively impermeable and will not allow for significant infiltration to occur. Small rainfall events may infiltrate well into the topsoil, but once the top layer of soil is saturated, infiltration rates will drop significantly. Based on the DAFWA mapping, this situation is anticipated to occur in the majority of soil types on the site.

The soils described above are anticipated to have a phosphorus retention index of at least 20, based on the classification system of Allen and Jeffrey (1990).

3.4 Surface water

3.4.1 Hydrology

The Site drains towards an unnamed tributary of Piesse Brook which drains in a northwards direction into Piesse Gully and the Helena River (the creek) and eventually into Lake CY O'Connor (Section 1.2, Figure 3-2). The Helena River is ephemeral and usually flows between June and January (DoW and SRT 2012). Flows in the creek have not been documented, so the creek may flow for part or all of this period.

The ephemeral creek is poorly defined within the Site and the creekline could not be identified on 12 March 2015, except near the northern boundary of the Site. The creek runs through a series of orchards (Plate 3-1). Farm dams are present both on and off the main creekline (Figure 3-2).

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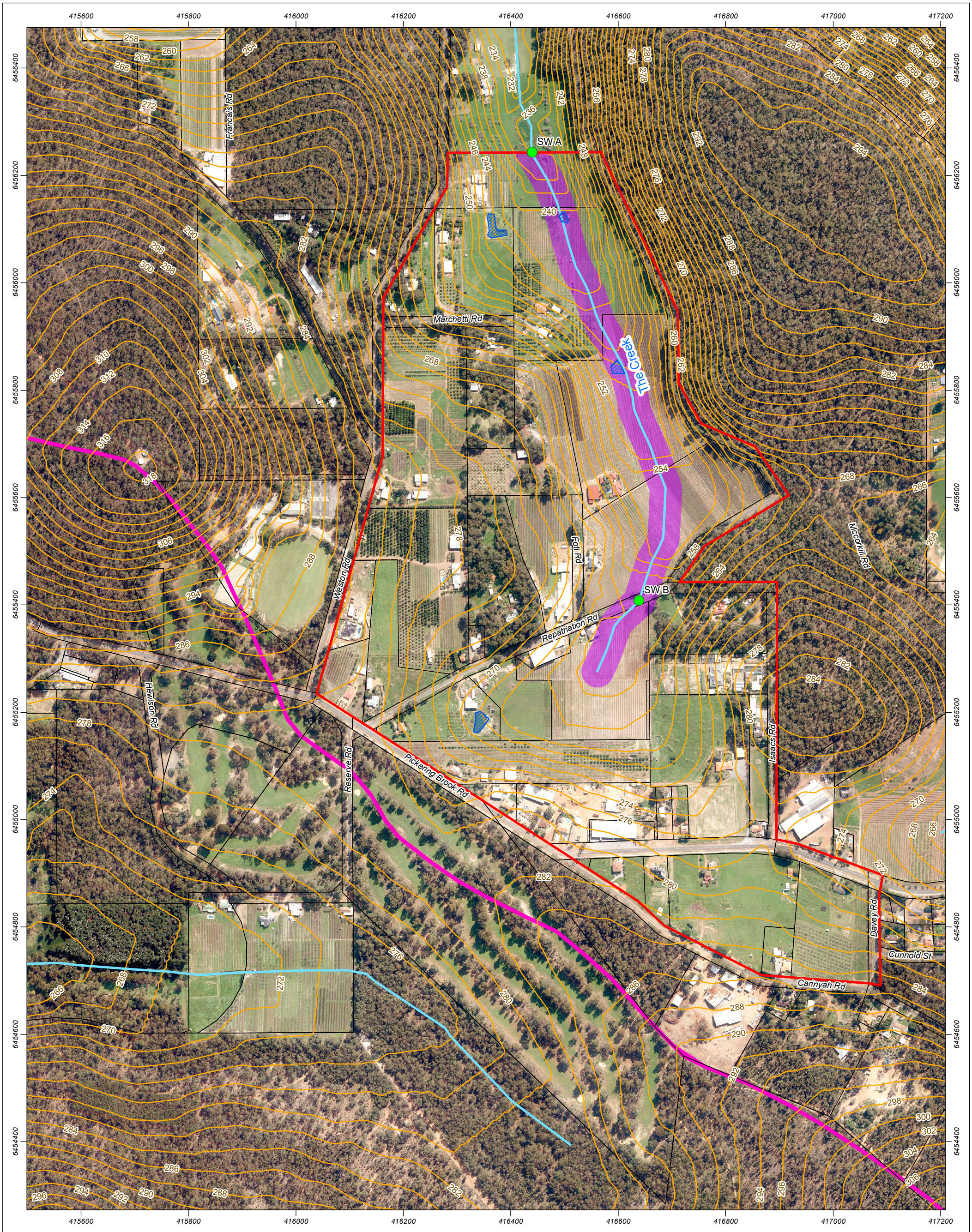

Figure 3-2: Surface water plan

Scale 1:6,500 at A3

Meters
0 50 100 150 200 250

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 16/02/2016
Author: DWhite
Source: Aerial image, cadastre & project boundary: Client 2015. Roads: Main Roads WA 2012. Watercourse: SLIP online, Landgate 2015.

Legend

- Monitoring locations
- Site boundary
- Farm dam
- Watercourse
- Surface elevation (mAHD)
- Cadastral boundaries
- Catchment boundary
- Foreshore 30m buffer

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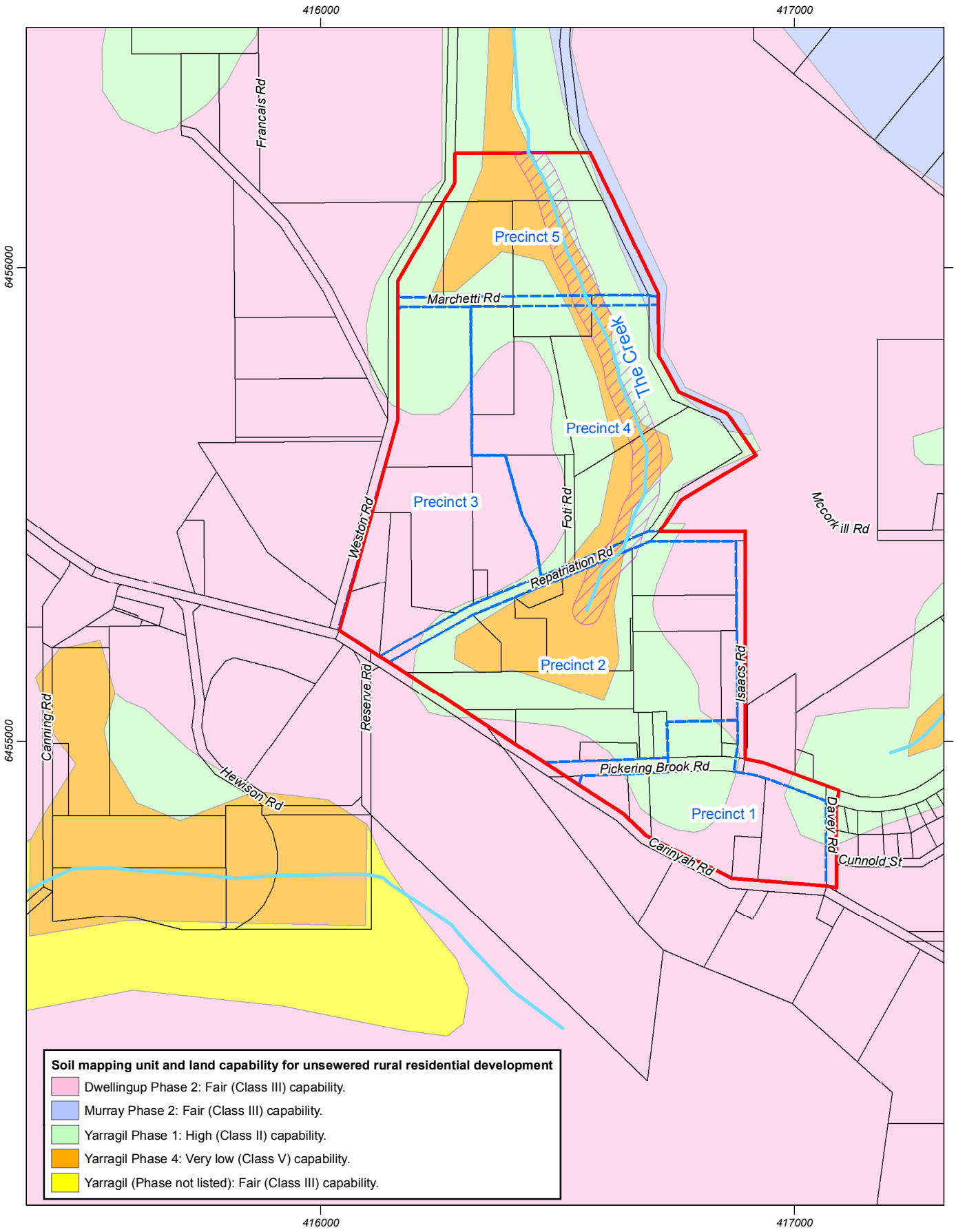

Figure 3-3: Geological plan

Scale 1:11,000 at A4

0 100 200 300 400 m

N

Legend

- Watercourse
- Foreshore 30m buffer
- Site boundary
- Precinct boundaries
- Cadastral boundaries

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 16/02/2016
Author: DWhite
Source: Aerial image, cadastre & project boundary: Client 2015. Roads: Main Roads WA 2012. Watercourse: SLIP online, Landgate 2015. Soils: DAFWA 2005.

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Plate 3-1: Reported location of the creek near Marchetti Road, March 2015

Most of the larger roads within the Site have some form of road drainage (Plate 3-2). This drainage generally consists of gullies excavated on one side of the road that accept runoff from the road and upgradient areas. These drains do not appear to have formal connections to the creek, but appear to flow via overland flow through the existing farmlands.

The Site is a surface water catchment and runoff is anticipated to occur off the site during the winter months as a result of rainfall events.

Plate 3-2: Road drainage on Marchetti Road

3.4.2 Middle Helena Catchment water quality

Water treatment undertaken by Water Corporation at Lake CY O'Connor for water from the MHC includes filtration to remove particulate matter and dissolved organic carbon and disinfection to remove pathogens (Water Corporation 2014). In 2013/14, Water Corporation met 100% of the water quality health standards set by Department of Health (Water Corporation 2014).

A review of raw (untreated) water quality in the MHC and HPD was undertaken as part of the LUWMS (WAPC and DoP 2010). In the absence of specific guidelines for raw water quality, the results have been compared with Australian Drinking Water Guidelines (ADWG) values set for drinking water, which defines the quality requirements at the customer's tap. The LUWMS summarises water quality results from 2000 to 2009 which showed:

1. Positive results of *Escherichia coli* (*E. coli*), in the MHC and HPD in 100% of samples tested, indicating "a high and consistent degree of faecal contamination". *E coli* are one form of thermotolerant coliforms used as an indicator of pathogen presence and is generally not harmful to humans (NHMRC and NRMMC 2011). *E. coli* is commonly encountered in samples from other hills water catchments, but generally at lower levels than in the MHC (WAPC and DoP 2010). *E. coli* and other thermotolerant coliforms are found in the gut and excreta of warm blooded animals, including humans, birds and livestock.

2. Water quality guidelines for all health related chemicals were met in the MHC and HPD (WAPC and DoP 2010). Dieldrin and chlorpyrifos have been detected once each in the MHC. Nitrate, nitrite and ammonia met health guideline values for drinking water. Health guideline values are not set for phosphorus compounds or total nitrogen (NHMRC and NRMMC 2011). Total nitrogen concentrations are not reported in the LUWMS, but total phosphorus concentrations ranged from <0.002 to 0.09 mg/L (WAPC and DoP 2010).
3. Raw water quality in HPD met all ADWG aesthetic criteria, with occasional exceedences of unfiltered iron, unfiltered aluminium, turbidity and colour guidelines (WAPC and DoP 2010). Elevated results for unfiltered iron and aluminium may be due to the presence of natural sediment in the samples, as soils in the area naturally contain high concentrations of iron and aluminium.

Since the LUWMS was completed, the Water Corporation has installed a new water treatment plant at Lake CY O'Connor, which improves the removal of particulate matter and dissolved organic carbon components that cause turbidity and colour issues (Water Corporation 2014).

Based on the LUWMS, the current land uses in the MHC do not appear to be negatively impacting upon drinking water quality from an aesthetic or health related chemical perspective. The "high and consistent" degree of faecal matter is the most significant water quality issue in the catchment.

3.4.3 Risks to surface water quality from the current land use

Existing risks to surface water quality present on the site include:

1. The use of pesticides, herbicides and fertilisers within orchards. The creekline is not well defined and in places runs between rows of fruit trees, so these chemicals may be applied directly to the creek itself.
2. Disposal of wastewater from existing houses and businesses, including extensive fruit packing buildings. As reticulated sewerage is not available, these buildings will be connected to either septic tanks or Aerobic Treatment Units (ATUs) with treated effluent being disposed of to land. Disposal of wastewater is a potential source for contaminants including nutrients and pathogens.
3. Animals within the catchment, including livestock, poultry and native animals will contribute pathogens to the catchment through their waste.
4. Storage of rubbish and vehicles outside of hardstand areas on orchard and rural residential lots (Plate 3-3).
5. Truck and heavy machinery saleyard located on the corner of Pickering Brook and Carinyah Roads.

Plate 3-3: Miscellaneous rubbish on an orchard lot

3.4.4 Surface water monitoring results

Strategen undertook surface water monitoring on the Site to provide baseline information for comparison with post-development contaminant concentrations. Monitoring was undertaken at the unnamed tributary of Piesse Brook (The Creek) which drains in a northwards direction into Piesse Gully and the Helena River. Samples were taken monthly between September and November 2015 at two locations (Figure 3-2). Prior to monitoring occurring, this approach was endorsed by DoW (Slodecki C [DoW] 2015, pers. comm. 20 August). A copy of the monitoring report, including full results, id provided in Appendix 3.

All samples contained thermotolerant coliforms, consistent with the results from the broader MHC discussed in Section 3.4.2. Nutrient and Benomyl (fungicide) concentrations indicate that water quality in the catchment has been impacted by horticultural activities.

3.5 Groundwater

During the site inspection, one local orchardist reported using a bore as a source of water over the summer months. The bore is located within 50 m of The Creek and is reportedly less than 15 m deep, indicating that groundwater from superficial sediments is being accessed. Shire of Kalamunda advises that the oval located on Weston Road is irrigated through the use of two bores (Koroveshi J [The Shire] 2015 pers. comm. 24 March).

Given that The Creek was flowing in November2015, after a particularly dry spring, it is likely that groundwater provides some baseflow to The Creek, allowing the creek to flow between winter rainfall events and into late spring. The boundary of the groundwater catchment is not expected to extend beyond the boundary of the surface water catchment.

3.6 Vegetation and flora

The Site has predominantly been cleared for farming purposes (Figure 3-4).

Mapping undertaken by Heddle (1980) indicates vegetation of the project area is considered to be representative of two vegetation communities:

1. Dwellingup Complex in Medium to High Rainfall – dominated by open forests of Jarrah (*Eucalyptus marginata*) – Marri (*Corymbia calophylla*) on the uplands.
2. Yarragil Complex (Maximum Development of Swamps) in Medium to High Rainfall – predominantly consists of a mixture of open-forest of Jarrah– Marri with admixtures of Blackbutt (*E. patens*). On sandier soils a well-defined second storey of *Banksia* species is distinguishable.

A biological survey was undertaken of the Site on 14 November 2014 (Del Botanics 2014). This survey identified one vegetation type within the remnant vegetated areas consisting of Marri and Jarrah woodland over shrubland of Grass trees (*Xanthorrhoea preissii*) and Zamia (*Macrozamia riedlei*). Vegetation condition across the majority of the Site has been rated as 'Completely Degraded' due to historical clearing for agricultural activities (Del Botanics, 2014).

No priority or threatened flora species or EPBC-listed flora species were observed during the survey (Del Botanics 2014).

3.6.1 Wetlands

The Landgate mapping shows no wetlands within Site boundary.

3.7 Fauna

A search of the DPaW NatureMap database (NatureMap, 2015) was undertaken by Coterra (2015) for potential threatened fauna occurrences within 2 km of the Site.

Coterra (2015) considered that while a large number of species of significance have been recorded or are expected to occur within 2 km of the Site, a review of the habitat types required by the identified species indicates that only six fauna species of conservation significance are likely to visit/utilise the Site. Given the lack of remnant vegetation located within the Site, as well as the substantial areas of habitat in the surrounding Korung National Park, it was considered unlikely that the Site is significant to these species (Coterra 2015).

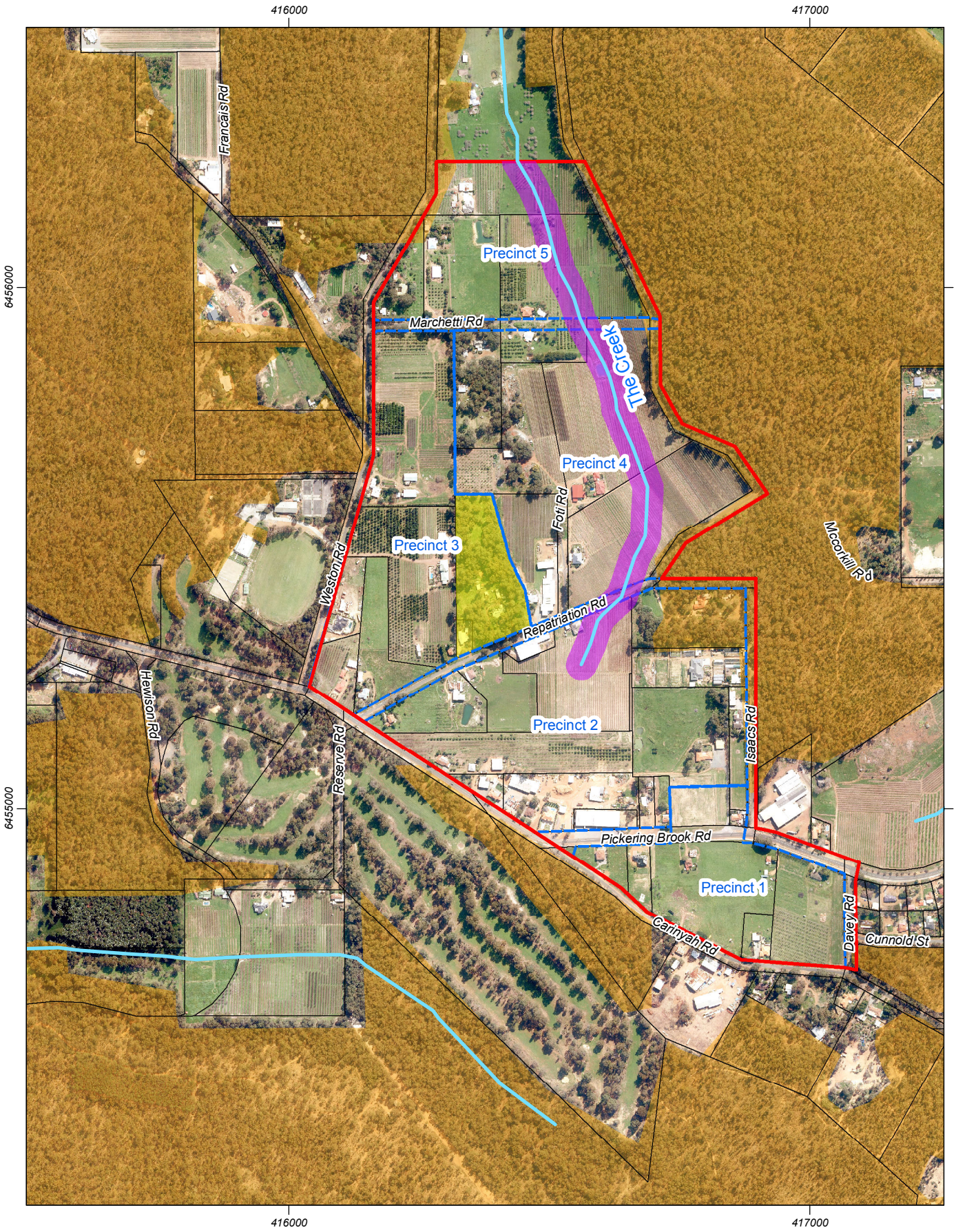

Figure 3-4: Environmental plan

Scale 1:10,000 at A4

0 100 200 300 400 m

N

Legend

- Watercourse
- Foreshore 30m buffer
- Site boundary
- Precinct boundaries
- Future POS area
- Cadastral boundaries
- Native vegetation

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 16/02/2016
Author: DWhite
Source: Aerial image, cadastre & project boundary: Client 2015. Roads: Main Roads WA 2012. Watercourse: SLIP online, Landgate 2015. Vegetation: DAFWA 2014. Wetland: DPAW 2014.

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4. Water sustainability strategy

4.1 Potable water

New development will be connected to the Water Corporation reticulated water supply system. The Site currently has access to this system. Water Corporation advises that hydraulic modeling has recently been undertaken for the reticulated water supply for Pickering Brook. Water Corporation advises that minimal constraints are present to developing the entire area that we have identified. Some minor upgrades to reticulation pipes may be required; this requirement will be monitored by Water Corporation.

4.2 Non-potable water

Because of the size and location of the Site, it is anticipated that not all residents will intensively landscape and irrigate the full area of their lot. However, residents will require water for ex-house water use. Future land owners shall be encouraged to:

- reduce landscaped areas and associated irrigation rates
- retain native vegetation and utilise native landscaping where possible
- treat wastewater to a high standard for on-lot irrigation purposes
- consider the use of rainwater tanks for in-house and ex-house water use.

The Site consists of a relatively thin layer of alluvial sediments over rock of the Yilgarn Craton. As such, the availability of groundwater in the area is anticipated to be limited to small volumes within the alluvial sediments and very limited volumes within rock fractures. The Site is not located within a groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914*, bores within the superficial aquifer do not require licensing (DoW undated a). A search of the Water Register (DoW undated b) indicates that no groundwater licences have been issued in this area. Landowners in the area could conceivably use groundwater as a water source.

The Site is located in a proclaimed surface water area under the *Rights in Water and Irrigation Act 1914* (RiWI Act). The taking of surface water in proclaimed areas is licensed. A search of the Water Register (DoW undated b) indicates that no surface water licences have been issued in this area.

New Public Open Space within the area is anticipated to be revegetated without the need for long-term irrigation.

4.3 Wastewater management

There is no reticulated wastewater system in the vicinity of the Site. The cost of connecting the Site to reticulated sewerage for rural residential development is considered prohibitive, and as such wastewater will be treated and disposed of onsite. As such, aerobic treatment units (ATUs) and on-lot disposal of wastewater will be utilised. ATUs are electrically driven wastewater treatment units that rely on aerobic microbes to degrade sewage in the presence of excess air (DoW 2010). Treated wastewater may be disposed of by irrigation (if adequately disinfected) or otherwise via an underground soakage system (DoW 2010). These systems reduce degradable organic matter, nutrient, suspended solids and grease to concentrations significantly less than conventional septic tank treatment systems (DoW 2010).

ATU treated wastewater may still contain elevated concentrations of nitrogen (in various forms), phosphorus and pathogens. In order to be certified for domestic use in Western Australia, an ATU must meet Department of Health (DoH) standards related to effluent concentrations of:

- suspended solids
- biochemical oxygen demand
- coliform concentration (DoH 2001).

Nutrient removing ATUs can achieve total nitrogen concentrations of less than 10 mg/L (>97% removal) and total phosphorus concentrations less than 1 mg/L (>98% removal) (DoH 2016). To be approved for use in WA, an ATU must on average achieve a median coliform count of 10 cfu/100 mL or less (DoH 2001), which generally requires disinfection. This compares to hundreds of thousands to millions of cfu/100 mL of septic tank effluent (EPA Victoria 2013). For these reasons, the use of ATUs is recommended on this Site.

4.3.1 Land capability for effluent disposal

In PDWSA, DoW policy states that lots should only be created where land capability assessment shows that effective on-site soakage of treated wastewater can be achieved (DoW 2006). In order for effective and safe wastewater disposal, effluent disposal areas must be located in areas of suitable conditions, as outlined in Table 4-1. To prevent contamination of surface waters, ATUs and effluent disposal areas that are within a Priority 3 PDWSA are required to have a minimum setback to ephemeral flow waterways of 30 m (DoW 2010). Generally, a minimum disposal area of 150 m^2 is required on each lot (DoH 2001).

Table 4-1: Onsite effluent disposal criteria

Parameter	Criteria
Slope	The natural land slope on which effluent disposal is to occur shall not exceed a one in five gradient. Proposals should demonstrate that the intended wastewater disposal design prevents the risk of wastewater run-off (DoH undated).
Distance to drainage channel	No wastewater system shall be discharged into the ground within 6 m of any subsoil drainage system or open drainage channel (DoH 2001).
Distance to watercourses	Minimum setback to ephemeral flow waterways of 30 m in PDWSA (DoW 2010).
Infiltration ability	The disposal area shall maintain at least 1.2 m of soil above bedrock or impervious clay soils layer (DoH undated).
Separation to groundwater	In the case of a surface irrigation system, 0.5 m is required from distance being from the upper surface of the irrigation area to the highest known water table level to allow for microbiological purification (DoH 2001).

Land capability refers to the ability of a site to support a land use without impacts to the land use itself or the environment. In order to assess the suitability of sites in the Perth Hills for unsewered rural residential development, a study was undertaken by King and Wells (1990) based on DAFWA soil mapping and the land capability class definitions outlined in Table 4-2.

Table 4-2: land use capability classes

Capability class	General description
I– very high	Very few physical limitations present which are easily overcome. Risk of land degradation is negligible.
II - high	Some physical limitations affecting either productive land use or risk of land degradation. Limitations overcome by careful planning.
III - fair	Moderate physical limitations significantly affecting productive land use or risk of land degradation. Careful planning and conservation measures required.
IV – low	High degree of physical limitations not easily overcome by standard development techniques and/or resulting in a high risk of land degradation. Extensive conservation requirements.
V– very low	Severity of physical limitations is such that its' use is usually prohibitive in terms of either development costs or the associated risk of land degradation.

Source: King and Wells 1990

King and Wells (1990) considered that the land units present within the Site (Figure 3-3) have the following capabilities for unsewered rural residential development:

- Murray Phase 2: Fair (Class III)
- Dwellingup Phase 2: Fair (Class III)
- Yarragil Phase 1: High (Class II)
- Yarragil Phase 4: Very low (Class V).

Land units with a high capability are considered highly suitable for rural residential development, including effluent disposal. Land units with a fair land capability may be used for rural residential purposes with management, including siting of effluent disposal areas to avoid rock outcrops and/or seasonally wet areas (King and Wells 1990).

The very low capability Yarragil Phase 4 is associated with creeklines and seasonally wet areas, where waterlogging is likely to occur and treated wastewater may enter watercourses. Areas with these characteristics are not considered appropriate for onsite effluent disposal. These areas need to be appropriately delineated as part of the planning process.

The King and Wells (1990) study was undertaken using mapping at a scale of 1:25,000. Mapping at this scale has an approximate resolution of 1-25 ha (van Gool et al 2005). This scale is recommended by DAFWA for general suitability for various forms of land use and strategic planning for intensive land use developments including urban and horticulture (van Gool et al 2005).

It is possible that the DAFWA mapping and King and Wells (1990) Study underestimates the land capability of the Site for rural residential development. Site inspection by Strategen indicates that the southern, more upland areas mapped as Yarragil Phase 4 appeared to be relatively dry and may not be subject to seasonal inundation. It is consequently recommended that this land capability assessment is refined through onsite investigations at the LWMS and UWMP stages. This process may result in areas considered to have a low capability for a land use being upgraded to an improved capability class.

4.3.2 Land capability assessment

In order to ensure that land is suitable for effluent disposal, a land capability assessment (LCA) should be undertaken in a manner consistent with DoH guidance (*Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units [ATUs],* DoH 2001) and Australian/New Zealand Standard AS/NZS 1547:2012 *On-site Domestic Wastewater Management* (Standards Australia 2012). At a LWMS stage, it is recommended that a Site and Soil Evaluation be undertaken to a standard suitable for rezoning and subdivision of land as outlined in Appendix C of AS/NZS 1547:2012. These studies will inform land use and the density of development on a site.

At a UWMP stage, more detailed land capability assessment may be required to designate effluent disposal areas on each lot in a manner consistent with Appendix D of AS/NZS 1547:2012. This level of investigation may not be required in all locations. The areas in need of such studies will be identified at the LWMS stage.

5. Water management strategy

5.1 Surface water management strategy

Surface water management in the Pickering Brook area includes:

- delineation and management of the foreshore as a measure to protect the creek and control water quality risks
- management of risks to drinking water quality
- stormwater and flood management.

5.1.1 Stormwater and flood management

The stormwater management system will be designed to maintain pre-development flows off the Site in the 1-in-100 year ARI event. This will be undertaken through the following measures

1. Runoff from buildings and hardstand will be managed within the lot through either infiltration on site or storage in rainwater tanks. All lots will be expected to maintain pre-development flows off the site in the 1-in-1 year ARI event.
2. The critical 1-in-1 year ARI event will be treated as close to source as possible through swales and biofiltration systems within the road reserve and foreshore. Because of the rural nature of the site, wider road reserves are anticipated. Where practical, these will contain the 1 in 5-year ARI event. The use of pipework on the site will be minimised.
3. The potential for infiltration on Site may be limited by the presence of lateritic hardpans and/or clay soils. As such, the focus of stormwater management will be on detention and treatment, although infiltration will occur where practical.
4. Road reserve widths should consider the need to provide adequate stormwater retention and maintain existing vegetation and potentially accommodate additional vegetation for spray drift protection. Conceptual design for this will be addressed at the LWMS stage.
5. Larger events will be allowed to flow into the creek via overland pathways. Allowance will be made for detention of events up to the 1-in-100 year ARI event within POS, including within the foreshore POS.
6. As part of the LWMS and LCA, hydraulic conductivity testing will be undertaken within the proposed foreshore reserve and in selected locations around the site. This hydraulic conductivity testing will be used to inform the design of drainage systems.

5.1.2 Foreshore area management

The Creek is currently in very poor condition and is not observable at the surface at some locations within the Site. As such, the key objective of foreshore management is considered to be water quality risk management. The foreshore is intended to be revegetated and reserved as Public Open Space to minimise the risks of development intensification on water quality and to provide an additional, natural opportunity for the treatment of surface water flows. The foreshore will be ceded to the Shire during the subdivision of each lot.

There are no specific guidelines for the setback from rural residential property boundaries to creek lines in surface water PDWSA. To prevent contamination of surface waters, ATUs and effluent disposal areas within a Priority 3 PDWSA are required to have a minimum setback to ephemeral flow waterways of 30 m (DoW 2010). If pathogens and nutrients from effluent are considered a risk to water quality at this distance, risks from other residential land use activities such as the keeping of poultry and use of manure as fertiliser, which also cause elevated nutrient and pathogen loads, are also likely to pose a risk to surface water quality. A minimum buffer distance of 30 m from the creekline to property boundaries is consequently proposed, as indicatively shown in Figure 3-2. This buffer area will be rehabilitated and revegetated.

A Foreshore Assessment consistent with *Operational Policy 4.3: Identifying and Establishing Waterways Foreshore Areas* (DoW 2012) will be undertaken as part of the preparation of the LWMS. This will be used to refine creekline location. Where possible, the foreshore assessment will identify where the creekline has been piped through orchards and/or where subsoil drainage may have been installed. The Foreshore Assessment will also provide guidance on measures to be undertaken to rehabilitate the foreshore. Detailed design of the foreshore area will be undertaken through the Urban Water Management Plan process.

The foreshore boundary will be fenced to control access, although gates may be provided to allow pedestrian (but not vehicle) access to the foreshore from adjacent lots.

New permanent water bodies are not proposed on the Site.

5.1.3 Surface water quality management and risk assessment

The change in land use on the Site may potentially result in an increased risk of drinking water quality. To assess the risk of the development to drinking water quality and determine appropriate management measures, Strategen has undertaken a qualitative risk assessment for water quality, based on Water *Quality Protection Note No. 77 – Risk Assessment of Public Drinking Water Source Areas* (DoE 2005), which refers to the *Australian Drinking Water Guidelines* (ADWG, NHMRC and NRMMC 2004, subsequently updated in 2011). The focus of this risk assessment is the change in risk associated with the change in land use from orchards and rural lifestyle lots to a rural residential development. Parameters to be assessed were agreed with DoW to be:

- pesticides (includes herbicides)
- hydrocarbons
- heavy metals
- nitrogenous compounds (including nitrate, nitrite and ammonia)
- phosphorus and phosphate
- pathogens.

The methodology for the risk assessment is discussed below.

Methodology

Risk is a function of both the likelihood of an event occurring and the potential consequences that may arise (NMRHMC and NRMMC 2011). Qualitative measures of likelihood and consequence or impact have been developed as part of the ADWG for use in catchment management, design of treatment plants and distribution systems (Table 5-1, Table 5-2). The risk assessment is presented in Table 5-4.

Table 5-1 Qualitative measures of likelihood

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might or should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Source: ADWG (NHMRC and NRMMC 2011)

Table 5-2 Qualitative measures of consequence or impact

Level	Descriptor	Description
1	Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operation costs
2	Minor	Minor impact for small population, some manageable operation disruption, some increase in operating costs
3	Moderate	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
4	Major	Major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
5	Catastrophic	Major impact for large population, complete failure of systems

Source: ADWG (NHMRC and NRMMC 2011)

Table 5-3 Qualitative risk analysis matrix – level of risk

Likelihood	Consequence				
	1 Insignificant	2 Minor	3 Moderate	4 Major	5 Catastrophic
A (Almost certain)	Moderate	High	Very high	Very high	Very high
B (likely)	Moderate	High	High	Very high	Very high
C (possible)	Low	Moderate	High	Very high	Very high
D (unlikely)	Low	Low	Moderate	High	Very high
E (rare)	Low	Low	Moderate	High	High

Source: ADWG (NHMRC and NRMMC 2011)

Table 5-4: Risk assessment

Parameter of concern (hazard)	Current activities		Proposed activities			Comment
	Practices and potential impacts	Level of risk (Likelihood x consequence)	Practices and potential impacts	Proposed management measures	Level of Risk (Likelihood x consequence)	
Pesticides (includes herbicides)	Uncontrolled commercial use of pesticides in orchards, including orchards on and adjacent to streamline, potentially causing spray drift and emissions of pesticides to creek. Spills and over application causing emissions to creek.	Likelihood – A (Almost certain) Consequences – 2 (minor). Risk - high	Limited use of pesticides on rural residential properties, with a vegetated buffer between the creekline and any pesticide use. The total amount of pesticide used in the catchment is anticipated to decrease as orchards, which intensively use pesticides, will be removed to form rural residential lots. As the volume and frequency of pesticide use will be reduced, any spills are likely to be smaller, reducing the potential consequences of any spill.	1. A vegetated 30 metre buffer will be placed between streamline and rural residential properties to reduce the risk of pesticide drift. The buffer will be managed by the Shire with use of only pesticides considered appropriate to riparian zones, in accordance with best practice guidance. 2. Treatment of 1 in 1-year ARI event prior to entering the creek. 3. The Shire to consider provision of information to residents on reducing chemical use with rates notices.	Likelihood – C (possible) Consequences – 1 (insignificant). Risk – low	Total pesticide use and risk in catchment anticipated to decrease as land use changes from rural to urban. Pesticide use will still occur in the area.
Hydrocarbons	Use, storage and maintenance of vehicles (including farm machinery and trucks) and associated hydrocarbons may lead to hydrocarbon spills and leaks, which may enter into soil and groundwater. These hydrocarbons may then be transported into the creek. Road runoff is also a source of hydrocarbons. There is currently no treatment of road runoff prior to discharge to the creek.	Likelihood – A (Almost certain) Consequences – 1 (insignificant). Risk - moderate	Use, storage and maintenance of vehicles and associated hydrocarbons may lead to hydrocarbon spills and leaks, which may enter into soil and groundwater. These hydrocarbons may then be transported into the creek. Road runoff is a source of hydrocarbons. Increases in vehicle movements are anticipated to lead to a small increase in hydrocarbon deposition on roads.	1. Treatment of 1 in 1-year ARI event to remove contaminants from roads and lots prior to entering the creek. 2. A vegetated 30 metre buffer will be placed between streamline and rural residential properties to reduce hydrocarbon use in the vicinity of the Creek. 3. The Shire to consider provision information to residents on best management to reduce water quality risks with rates notices.	Likelihood – A (Almost certain) Consequences – 1 (insignificant). Risk - moderate	While the number of vehicles and vehicle movements is anticipated to increase, hydrocarbon storage volumes are anticipated to decrease as private vehicles are less likely to be refuelled or serviced on site than farm machinery.

Parameter of concern (hazard)	Current activities		Proposed activities			Comment
	Practices and potential impacts	Level of risk (Likelihood x consequence)	Practices and potential impacts	Proposed management measures	Level of Risk (Likelihood x consequence)	
Heavy metals (e.g. copper, arsenic, chromium, lead, zinc)	Current potential sources of heavy metals include: • copper chemicals used as fungicides and pesticides • road runoff, which contains small amounts of metals due to vehicle wear and tear • runoff from metal roofs • wood treated with Copper Chrome Arsenate (CCA). There is currently no treatment of runoff prior to discharge to the creek.	Likelihood – A (Almost certain) Consequences – 2 (minor). Risk - high	Limited use of pesticides on rural residential properties, with a vegetated buffer between the creekline and properties. Road runoff is a source of metals. Increases in vehicle movements are anticipated to lead to a small increase in metals deposition on roads. The number of metal rooves and amount of CCA in the catchment is anticipated to increase. Roof water will be infiltrated on site or collected for reuse by residents.	1. A vegetated 30 metre buffer proposed between streamline and rural residential properties to avoid pesticide spray drift. The buffer will be managed by the Shire with use of only pesticides considered appropriate to riparian zones, in accordance with best practice guidance. 2. Treatment of 1 in 1-year ARI event to remove contaminants prior to entering the Creek.	Likelihood – A (Almost certain) Consequences – 2 (minor). Risk - high	While there is a decrease in the likelihood of excess copper based pesticide application, this is considered likely to be offset by an increase in the concentrations of metals from road runoff.
Phosphorus (includes phosphate)	Phosphorus and phosphate are chemicals are a potential concern because elevated nutrient concentrations can result in algal blooms in dams, leading to issues with taste, odour and potentially toxins (some forms of blue green algae). There are no ADWG guidelines for phosphorus or phosphate, indicating that NHMRC and NRMMC (2011) to pose a direct risk to drinking water quality. Current potential sources of phosphorus are: • fertiliser use on orchards, paddocks and gardens • ATUs and septic tanks. Given the age of houses on the Site, it is likely that many use septic tanks. There is currently no treatment of runoff prior to discharge to the creek. Phosphorus inputs for orchard areas in Western Australia are estimated at 100 kg/ha/yr and pasture areas at 20 kg/ha/yr (Gerritse 2002).	Likelihood – A (Almost certain) Consequences – 2 (likely) Risk - moderate	An additional 300 to 350 dwellings will be created, each with an ATU. Phosphorus inputs for unsewered rural residential developments at an average lot size of 2000 m^2 is approximately 25 kg/ha/yr (Gerritse 2002), well below that for orchards and similar to that of pasture.	1. Requirement for the use of phosphorus removing ATUs will be put in place. 2. LCA will be required to demonstrate that each lot contains an area suitable for effluent disposal prior to subdivision. 3. Use of vegetated buffer and treatment of stormwater prior to entering the creek to reduce nutrient loads. 4. The Shire to consider provision of information to residents on best management to reduce water quality risks with rates notices.	Likelihood – A (Almost certain) Consequences – 2 (likely) Risk - moderate	No additional comments.

Parameter of concern (hazard)	Current activities		Proposed activities			Comment
	Practices and potential impacts	Level of risk (Likelihood x consequence)	Practices and potential impacts	Proposed management measures	Level of Risk (Likelihood x consequence)	
Nitrogenous compounds (including nitrate, nitrite and ammonia)	Nitrogenous chemicals are a potential concern because elevated nutrient concentrations can result in algal blooms in dams, leading to issues with taste, odour and potentially toxins (some forms of blue green algae). Nitrate is the only nitrogenous nutrient with a health related ADWG guideline (NHMRC and NRMMC 2011). Ammonia is considered of concern from an aesthetic perspective Other nitrogenous nutrients are not considered by NHMRC and NMMRC to pose a direct risk to drinking water quality. Current potential sources of nitrogen are: • fertiliser use on orchards, paddocks and gardens • ATUs and septic tanks. Given the age of houses on the Site, it is likely that many use septic tanks. Nitrogen inputs for orchard areas in Western Australia are estimated at 200 kg/ha/yr and pasture areas at 20-70 kg/ha/yr (Gerritse 2002).	Likelihood – A (Almost certain) Consequences – 2 (minor) Risk - high	An additional 300 to 350 lots will be created, each with an ATU. Nitrogen inputs for unsewered rural residential developments at an average lot size of 2000 m^2 is approximately 125 kg/ha/yr (Gerritse 2002), well below that for orchards and similar to that of pasture.	1. Requirement for the use of nutrient removing ATUs will be put in place. 2. LCA will be required to demonstrate that each lot contains an area suitable for effluent disposal prior to subdivision. 3. Use of vegetated buffer and treatment of stormwater prior to entering the creek to reduce nutrient loads. 4. The Shire to consider provision of information to residents on best management to reduce water quality risks with rates notices.	Likelihood – A (Almost certain) Consequences – 2 (minor) Risk - high	No additional comments.

Parameter of concern (hazard)	Current activities		Proposed activities			Comment
	Practices and potential impacts	Level of risk (Likelihood x consequence)	Practices and potential impacts	Proposed management measures	Level of Risk (Likelihood x consequence)	
Pathogens	Pathogens can potentially result in sickness in humans and animals if ingested. As discussed in Section 3.4.2, water treatment for the MHC includes disinfection as a barrier to pathogens entering the potable water supply. Current potential sources of pathogens are: • warm blooded animals, including livestock, poultry and kangaroos • ATUs and septic tanks • use of manure as a fertiliser. Given the age of houses on the Site, it is likely that many use septic tanks.	Likelihood – A (Almost certain) Consequences – 3 (moderate) Risk – very high	An additional 300 to 350 lots will be created, each with an ATU. Numbers of grazing animals and poultry are anticipated to be reduced. Manure will continue to be used as a fertiliser.	1. ATUs approved in WA are required to reduce pathogen loads to a maximum of 10 cfu/100 mL, compared to septic tanks, which can produce millions of cfu/100 mL (Section 4.3). 2. LCA will be required to demonstrate that each lot contains an area suitable for effluent disposal prior to subdivision.	Likelihood – A (Almost certain) Consequences – 3 (moderate) Risk – very high	No additional comments.

The risk assessment indicates that the change in land use will not result in a significant change in risk to drinking water quality (Table 5-4). The key risk changes and management measures are:

1. Providing a 30 m foreshore buffer to prevent the current situation where fertiliser and pesticides are used immediately adjacent to and possibly even on the creek as shown in Plate 3-1.
2. Treating runoff prior to entering the creek in swales and/or detention areas to reduce pollutant loads entering the creek.
3. Use of nutrient reducing ATUs to reduce nutrients and pathogen loads (Table 5-4).

5.2 Groundwater management strategy

As outlined in Section 4.2, groundwater resources are present in the area but are likely to be limited. Future land owners may not be able to obtain adequate groundwater for irrigation – therefore wastewater recycling or dry lots will be encouraged. The area is not a proclaimed groundwater area, groundwater use in the area is not licensed.

6. Implementation framework

6.1 Future planning process

After the MRS amendment has occurred, the Local Planning Scheme (LPS) will be amended. It is anticipated that the area will be rezoned under the LPS as an 'urban development' zone or equivalent. This zone and an associated development area overlay in the form of a special control area under the planning scheme will require the preparation of a local structure plan to guide future subdivision and development.

Local Structure Planning will be undertaken in a manner that implements the principles and objectives of this DWMS as outlined in Table 6-1. It is considered that with the implementation of these measures, the principles and objectives of the DWMS will be met and drinking water quality will be maintained.

Table 6-1: Summary of DWMS principles, objectives and proposed implementation measures

Category	Principles	Objectives	Proposed implementation measures
Water use	The development shall: 1. Consider all potential water sources in water supply planning. 2. Integrate water and land use planning. 3. Ensure sustainable and equitable use of all water sources having consideration for the needs of all users, including community, industry and the environment.	The objectives of these measures will be to: 1. Minimise the use of potable water where drinking water quality is not essential. 2. Limit water consumption to less than 100 kL/person/year based on the State Water Plan target.	Future land owners shall be encouraged to: • reduce landscaped areas and associated irrigation rates • retain native vegetation and utilise native landscaping where possible • treat wastewater to a high standard for on-lot irrigation purposes • consider the use of rainwater tanks for in-house and ex-house water use.
Groundwater levels and surface water flows	The development shall: 1. Aim to retain natural drainage systems and protect ecosystem health. 2. Protect dwellings and infrastructure from flooding and waterlogging. 3. Implement economically viable stormwater systems. 4. Post development annual discharge volume and peak flow rates to remain at pre-development levels or defined environmental water requirements.	The objectives of these measures will be to: 1. Maintain or restore desirable environmental flows and/or hydrological cycles where there are identified impacts on significant ecosystems. 2. Manage up to the 1 in 100-year ARI event within the development area to predevelopment flows.	1. Include a 30 m vegetated buffer around the foreshore of The Creek, including swales and biofiltration structures to manage stormwater quality. 2. Lots shall manage and treat stormwater from buildings and hardstand in events up to the 1 in 1-year ARI, 1-hour event through the use of rainwater tanks, soakwells and vegetated structures. 3. The development shall maintain pre-development flows off the site in the 1 in 100 year ARI event through swales and infiltration/detention basins in the road reserve and foreshore buffer.

Category	Principles	Objectives	Proposed implementation measures
Groundwater and surface water quality	The development shall: 1. Maintain or improve groundwater and surface water quality. 2. Minimise discharge of pollutants to receiving waterways and maintain water quality in the specified environment. 3. Manage impacts to water quality within the context of a Priority 3 PDWSA.	The objectives of these measures will be to: 1. Maintain surface water and groundwater quality. 2. Ensure that all runoff contained in the drainage infrastructure network receives treatment prior to discharge to a receiving environment consistent with the Stormwater Management Manual for Western Australia (DoW 2007) to remove contaminants. 3. Ensure that development, including onsite effluent disposal does not negatively impact upon surface water quality.	1. Stormwater shall be treated prior to discharge through swales and infiltration/detention basins in the road reserve and foreshore buffer. 2. Nutrient and pathogen reducing ATUs will be used for effluent treatment on the Site. 3. Land capability assessment will be undertaken at a LWMS stage to confirm capability for effluent disposal.
Disease vector and nuisance insect management	1. To reduce the health risk from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated within a time period not exceeding 96 hours.	1. New permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of Departments of Water and Health.	1. New permanent water bodies are not proposed on the Site.

The Local Structure Plan and Local Water Management Strategy (LWMS) will be developed to provide more detailed planning. Land owners in the area will then be able to subdivide their land through preparation of subdivision applications and Urban Water Management Plans (UWMPs).

6.2 Monitoring

Pre-development monitoring has been undertaken on the Site as discussed in Section 3.4.3.

Post-development monitoring would not normally be anticipated for rural residential developments. However, given the location of the site within a PDWSA, some post-development monitoring should be undertaken. Post-development monitoring will be undertaken in line with the *Water Monitoring Guidelines for Better Urban Water Management Strategies/Plans* (DoW 2011); or the final guidelines when these are developed. Post-development monitoring will occur from the completion of first subdivision stages until two years following the completion of construction.

Any change in the water quality parameters during this period will be investigated. A Post-development Monitoring Plan will be included as part of the LWMS and will contain:

- details of monitoring required
- design criteria
- methods to determine whether the development's design criteria are being met
- contingency plans and management responses should variation occur between pre and post-development monitoring results.

Responsibilities for monitoring will be determined at a LWMS stage, when the funding model (e.g. whether a developer contribution scheme will be put in place) will be determined.

6.3 Technical review

A review of the assessment and advice presented in the DWMS will occur at the LWMS stage.

6.4 Funding and ongoing maintenance requirements

Local structure planning will be undertaken by The Shire. No outside funding is being sought for this development.

Stormwater management infrastructure will be constructed by the developers with funding through a developer contributions scheme. The developer will be responsible for maintenance of stormwater infrastructure for two years prior to handover to The Shire.

6.5 Considerations and requirements for local structure plan stage

The LWMS prepared at the LSP stage should include:

- confirmation of predevelopment hydrology including surface water flow direction, catchment areas, in 1-year ARI, 1 in 10 year ARI and 1 in 100-year ARI flows
- drainage strategies based on the refined modelling, including:
  - design assumptions including runoff coefficients, catchment boundaries, flow rates and volumes
  - figures showing post-development stormwater systems including flow paths and drainage structures (swales, rain gardens, infiltration areas and underground storage structures) for the 1 in 1-year ARI, 1 in 10 year ARI and 1 in 100-year ARI flood events
  - conceptual cross sections for road and swale arrangements for the 1 in 1-year ARI, 1 in 10 year ARI and 1 in 100-year ARI flood events
- Foreshore Area Assessment in accordance with Operational Policy 4.3: Identifying and Establishing Waterways Foreshore Areas (DoW 2012)
- measures to address foreshore management issues
- land capability assessment including field investigations as outlined in Section 4.3.2
- clarification of responsibilities for preparation of UWMP documents, design guidelines and post-development monitoring.

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Appendix 1
DWMS checklist

Appendix 1 – District water management strategy guide

Use the guide below to assist with the completion of the DWMS. Tick the box where items have been met. If the item is not applicable to the DWMS, include N/A with explanation in the notes column. Provide any other relevant comments briefly in the notes column.

District water management strategy item	☒	Notes
Executive summary		
Describe proposed water management objectives and how the objectives will be met.	☒	Executive summary; Table ES1-1
Planning background and previous studies		
Map the location of the site.	☒	Figure 1-1; Figure 1.2
State which planning document the strategy is supporting.	☒	Section 1.1
Provide references to the key state and/or local policies, guidelines, strategies and their relevance.	☒	Section 2.1
Design criteria		
Provide references to the key state and/or local policies, guidelines, strategies and their relevance.	☒	Section 2.2
Design objectives from previous water strategies and/or plans.	☐	N/A
Pre-development environment (identification of assets, risks and constraints)		
Describe site characteristics: provide preliminary desktop assessments and/or field investigations (if required)	☒	Section 3
Describe climate.	☒	Section 3.1; Figure 3.1
Describe and map topography, landform and geotechnical conditions.	☒	Section 3.2; Section 3.3; Figure 3.2; Figure 3.3
Describe the existing land use.	☒	Section 1.2
Identify environmental assets and their significance.	☒	Section 3.6; Section 3.7
Detail the social, cultural and heritage considerations.	☒	Section 1.3
Describe the hydrology and hydrogeology of the area: • surface water • groundwater • water-dependent ecosystems • water resource issues.	☒	Section 3.4; Figure 1.3; Figure 3.2
Describe existing drainage infrastructure and other infrastructure likely to affect management of water resources.	☒	Section 3.4; Figure 3.2
Post-development water management		
Identify the proposed broad scale management strategies that will address water resource issues and meet the objectives and design criteria.	☒	Section 4; Section 5
Calculate an indicative water balance.	☒	N/A
Describe the impacts to water resources and/or impacts to proposed change in land use from water issues.	☒	Section 5.1
Surface water – Estimate land requirements for water management. – Identify water quality issues and scope for improvement. – Describe proposed strategy for management of small, minor and major surface flows.	☒	Section 5.1
Describe groundwater levels, use, management and maintenance.	☒	Section 5.2
Identify water-dependent ecosystems	☐	N/A
Identify contamination issues – high risk acid sulfate soils, contaminated sites or areas with historical high nutrient and/or non-nutrient contaminants.	☒	Section 5.1

District water management strategy item	☒	Notes
Water services and efficiency initiatives		
Describe potable water supply – options including details of technical, environmental and regulatory feasibility – regulatory approvals, technical investigations and any obtained written approvals – recommendations for water efficiency and conservation	☒	Section 4.1
Identify wastewater servicing – options including preferred option, location, treatment process, level of treatment, disposal, buffers and infrastructure – approvals and investigations required and any obtained written approvals – recommendations for water efficiency and conservation	☒	Section 4.3
Identify non-potable (fit-for-purpose) water supply – non-potable water source options. Highlight preferred option with consideration of pre and post development water balance – approvals and investigations required and any obtained written approvals – recommendations for water efficiency and conservation	☒	Section 4.2
Implementation framework		
Describe commitments and obligations for the next stage of the planning process (e.g. LWMS). Identify issues that need specialised investigation and management for the subsequent LWMS. Make recommendations for implementing the DWMS.	☒	Section 6

Appendix 2
Consultation summary

Pickering Brook Townsite Expansion – Outcomes of Preliminary Consultation in November/December 2013

January 2014

Organisation	Contact	Consultation Type	Comments
Pickering Brook Primary School	Derrick Ernst Headmaster Ph. (08) 9293 8256	Phone conversation	• The school would prefer workshop style consultation and would prefer evenings from a timing perspective. • The school contact indicated that there were no local orcharding industry groups as far as they knew.
Pickering Brook Heritage Group	Helen Ross Ph. 0418 923 970	Phone conversation	• The heritage group would prefer to be consulted in a small group setting (focus group) but would also be happy to be included with the school if we consulted with them separately. • There may be an opportunity to tie in engagement with any scheduled group meeting if possible and also a display at a local scheduled community event if possible. • The heritage group contact indicated that there were no local orcharding industry groups as far as they knew.
Department of Water	James Mackintosh Program Manager, Land Use Planning, Swan Avon Region Ph. (08) 6250 8043 Stephen Watson Branch Manager, Water Source Protection Ph. (08) 6364 6881	Face-to-face meeting - 29 November 2013 Plan provided showing priority protection areas	• Middle Helena Catchment Area – Land Use and Water Management Strategy (June 2010) is actually much older than that (early 2000's). • WAPC need to sign off on amendment to Local Planning Scheme No. 3 (LPS3), which introduces water catchment areas into the scheme. • Process to change from Priority P1, P2 or P3 source protection areas is triggered by zoning changes, as the priority areas are a 'snapshot' of the current situation. • The Department of Water (DoW) would need a preliminary investigation into the water issues for the area that would ultimately inform a District Water Management Strategy (DWMS). • The preliminary investigation (assessment) would be required at the Metropolitan Region Scheme (MRS) amendment stage with an actual DWMS being prepared post initiation of the MRS amendment but prior to advertising. • The preliminary investigation would need to weigh up 'land factors' (cleared land, community benefit value etc.) versus 'water factors' (source protection value), with the final outcome constituting a strategic decision and with the DWMS being a management document.

			• Banjup and Wandi MRS amendments in Jandakot are examples of where this weighing up has occurred with the outcomes being based on land factors associated with the provision of a train station for Wandi and changing land factors in Banjup. In these cases the MRS amendments occurred prior to changes to the priority source protections areas (P2 to P3). • DoW also suggested that the Department of Health be consulted.
Department of Planning	Sarah Cosstick Planning Manager Metropolitan Planning North East Ph. (08) 6551 9234 Natalie Cox Planning Manager Schemes and Amendments Ph. (08) 6551 9442 Anthony Muscara Senior Planning Officer Schemes, Strategies and Amendments Ph. (08) 6551 9441	Face-to-face meeting - 27 November 2013	• Any MRS amendment will need to consider buffering issues from existing orchards • Consultation with the community will be required as part of any MRS amendment proposal. • Justification based around consolidation of the Pickering Brook Townsite would likely need to form part of any proposal. • Bushfire management is a key issue and would need to be addressed up front as part of any MRS amendment proposal. • Appropriate separation to agricultural uses will need to be addressed. • Department of Planning (DoP) suggested that consultation with the Department of Fire and Emergency Services (DFES) and Department of Parks and Wildlife (DPaW). • A residential density of R5 was discussed supported by a development area and associated structure plan. • In terms of fire management, hazard separation needs to be considered and it was noted that the Shire has appointed Bill Harris to look at fire risk assessment across the whole local government area. • Appropriate area access will also need to be considered and confirmed as part of fire risk management. • DOP suggested consultation take place with the Department of Health regarding effluent disposal due to the unavailability of sewer to the area. • DoP also confirmed the need for reclassification of source protection Priority P2 to P3 and that the DoW may do this after the MRS amendment process has been finalised.
Water Corporation	Brett Coombes Senior Town Planner Land Planning Development Services Planning and	E-mail - 20 November 2013 Face-to-face meeting - 21 November 2013	• Water Corporation (WC) confirmed that there is only water reticulation in this area (no wastewater system or any plans/capital to build wastewater infrastructure) so their advice and comments are limited to water planning. • Suggest that the Shire look towards getting an engineering consultant on board at some stage to do desk-top water investigations and planning, as the WC's IBP is often limited in its ability to do new small jobs that are not scheduled on the CWC's State

	Capability Group Ph. (08) 9420 3165	Plan provided of area showing where levels restrict the capacity to supply reticulated water	Wide Planning Program. • The water scheme serving this area is a High Level Scheme (Pickering Brook High Level Zone). The zone is served via a single-feed 150AC water main heading east out of two small summit tanks to the west (Weston Rd Summit Tanks). Each tank has a maximum capacity of 225m^3. The smaller water reticulation pipes branching off the 150mm outlet main to serve customers in the HL zone are typically 100mmAC. The ability to serve additional houses/customers off the existing system will be limited among other things by the Top Water Level of the existing tanks (319.5mAHD), the need to achieve at least 17m residual head at each lot boundary, and the reserve storage capacity in the tanks. • Most of the water for the area comes from the Victoria Reservoir. • Suggested that soils suitable for on-site effluent disposal should be mapped to inform the MRS amendment process. • Single feed 150mm AC pipe as a rule of thumb can provide 120 services. There are approximately 100 existing services. • Depending on what additional level of development might be proposed there may need to be consideration for an additional water tank. • May need to be consideration of a contribution scheme component for reticulation. • Any appointed engineer would need to look at reticulation design to service subdivision/development. • WC would need to consider headworks modifications (more storage, pump capacity from destination and main size increase). • Any additional subdivision/development would probably need to be considered as part of a staged approach. • WC were going to provide some feedback on an informal basis on how many additional services might be able to be provided (guesstimate only).
Department of Parks and Wildlife (DPaW) Department of Environmental Regulation (DER)	<u>DPaW</u> David Lodwick Regional Leader Land Use Planning Ph. (08) 9442 0336 <u>DER</u> Adrian Blockley	Phone conversations E-mail - 15 November 2013	• On July 1 the former Department of Environment and Conservation (DEC) separated into the Department of Environment Regulation (DER) and the Department of Parks and Wildlife (DPaW). Previously DEC had provided advice on land use planning (LUP) matters relating to the following legislation; 1. *Environmental Protection Act 1986* (EP Act) 2. *Conservation and Land Management Act 1984* (CALM Act) 3. *Wildlife Conservation Act 1959* (WC Act) 4. *Contaminated Sites Act 2003* (CS Act)

	Section Manager Studies and Investigations Ph. (08) 9333 7420		• The separation of DEC has resulted in DER now being responsible for LUP matters relating to Part V of the EP Act and the CS Act, with DPaW responsible for LUP matters relating to the CALM Act and WC Act. • In general terms: 1. DER deals with buffer issues i.e. noise, dust, odour, vibration. Also, contamination, acid sulfate soils, clearing permits and prescribed premises/licensing. 2. DPaW deal with issues relating to Flora/Fauna, wetlands, Bush Forever, impacts on regional parks and the conservation estate. • The likely range of land use buffer impacts/implications for the Pickering Brook project was discussed over the phone where is was confirmed that the primary issues that would need to be considered as part of any MRS amendment would be buffers and any potential contamination. • DPaW indicated that they would be happy to meet at a later date to go over any issues as the project advances.
Department of Agriculture and Food (DFWA)	Rod Safstrom Senior Development Officer Ph. (08) 9368 3169	Phone conversations	• DFWA Indicated that any proposal should work off mapping in relation to any high quality agricultural areas and take into consideration 500m buffers for urban areas from agricultural areas.

Appendix 3
Water monitoring

Jordan Koroveshi
Senior Strategic Planning Officer
Shire of Kalamunda
PO Box 42
KALAMUNDA WA 6926

Our reference: SKA15285.01

Dear Jordan,

PICKERING BROOK TOWNSITE SURFACE WATER MONITORING

Strategen has undertaken surface water monitoring in the Pickering Brook Townsite in the Middle Helena Catchment (MHC) to support the preparation of a future Local Water Management Strategy (LWMS). Prior to monitoring commencing, the proposed approach was discussed with Department of Water (DoW), who endorsed the approach (Slodecki C [DoW] 2015, pers. comm. 20 August). The intention is for these results to provide baseline information for comparison with post-development contaminant concentrations.

Monitoring was undertaken at the unnamed tributary (the creek) of Piesse Brook which drains in a northwards direction into Piesse Gully and the Helena River. Samples were taken monthly between September and November 2015. Monitoring occurred at two locations along the creekline for water levels and quality (Figure 1).

The sections below discuss the results of the water quality monitoring. Copies of all laboratory analysis documentation are provided in Attachment 1.

Levels and flows

Surface water flow was present at both locations on all three occasions despite the comparatively low rainfall in 2015 (604.8 mm to November 30, compared to 826.8 mm to November 30 for an average year in Perth). Surface water levels were highest in September and decreased later in the monitoring period. This decrease was most noticeable at SWA where levels decreased from 0.462 m to 0.158 m (Table 1).

Physicochemical water quality on the site was generally very good. Water was fresh, with total dissolved salts varying from 162 to 312 mg/L (Table 2). The pH was slightly acidic, and varied between 6.19 and 6.79 (Table 2). Physicochemical parameters were not recorded on the first sampling event due to instrument failure.

Nutrients

Total nitrogen concentrations exceeded ANZECC and ARMCANZ (2000) freshwater guidelines for slightly disturbed ecosystems (FWG) of 0.45 mg/L in five out of six samples (Table 3). The maximum concentration recorded was 6.6 mg/L, which also exceed the ANZECC and ARMCANZ (2000) long term irrigation guideline (LIWG) of 5 mg/L. Five out of six samples also exceeded the FWG for nitrate/nitrite of 0.2 mg/L, with concentrations of up to 4.74 mg/L.

Samples taken at SWB (upstream location) all exceeded the FWG for ammonia with concentrations between 0.11 and 1.25 mg/L. None of the samples from SWA exceeded this guideline.

The Australian Drinking Water Guidelines (DWG) for nutrients was not exceeded.

Five out of six samples exceeded the FWG for total phosphorus of 0.02 mg/L, with two exceeding the LIWG of 0.05 mg/L and a maximum concentration of 0.27 mg/L. One sample exceeded the FWG for phosphate of 0.01 mg/L, with a concentration of 0.18 mg/L.

In general, water quality at SWA was better than at SWB, indicating that a minor source of pollutants may be present between the two monitoring locations.

Coliforms

All samples contained thermotolerant coliforms, with concentrations varying from approximately 9 to approximately 840 colony forming units per 100 mL (cfu/100 mL) (Table 3). Coliforms are used as an indicator of pathogen presence and are generally not harmful to humans (NHMRC and NRMMC 2011). Coliforms are found in the gut and excreta of warm blooded animals, including humans, birds and livestock.

This is consistent with previous sampling undertaken in the MHC (WAPC and DoP 2010). MHC identified positive results for *Escherichia coli* (*E. coli*, a type of thermotolerant coliform), in 100% of samples they tested, which indicated "a high and consistent degree of faecal contamination". *E. coli* is commonly encountered in samples from other hills water catchments, but generally at lower counts than in the MHC (WAPC and DoP 2010).

Metals

Heavy metals tested were at or below the detection limit, with the exception of copper and zinc. Copper exceeded the FWG of 0.0014 mg/L in five of the six samples taken and the long term irrigation guideline of 0.2 mg/L on one occasion (Table 4). The maximum concentration recorded was 0.061 mg/L. The source of this copper may be natural or anthropogenic. Copper is mined on the Darling Scarp at Boddington, indicating that high soil copper concentrations may occur in the area. Copper salts were historically used as pesticides, so the orchards in the catchment may also be a source of copper.

Zinc exceeded the FWG of 0.008 mg/L in five out of six samples (Table 4). The highest zinc concentration recorded was 0.015 mg/L. Recent work undertaken by Strategen in the foothills in Kelmscott indicated similar elevated zinc concentrations in groundwater. It is common for elevated zinc concentrations across the broader landscape of the Swan Coastal Plain and Darling Scarp.

Trace metal concentrations did not exceed the DWG.

Monocyclic aromatic hydrocarbons and total recoverable hydrocarbons

Monocyclic aromatic hydrocarbons (MAH) and total recoverable hydrocarbons (TRH) are organic compounds commonly sourced from fuel, oils and vehicle emissions.

As agreed with DoW, organic compounds not detected in the first round were not required to be tested in subsequent rounds (Slodecki C [DoW] 2015, pers. comm. 13 October). As no MAH or TRH were detected in the first round of sampling, analysis for these compounds was discontinued.

Pesticides and herbicides

The only pesticide detected was Benomyl, from the thiocarbamates and carbomates group. Benomyl is a broad-spectrum fungicide used on fruit trees, nuts, vegetables, cereals ornamentals and turf (NHMRC and NRMMC 2011). There are no registered products containing benomyl in Australia, as the active ingredient was withdrawn due to health concerns in 2006 (NHMRC and NRMMC 2011). However, withdrawn compounds can still be detected in water (NHMRC and NRMMC 2011). Concentrations of Benomyl ranged from 0.02 µg/L to 0.03 µg/L over the sampling period (Table 7). Benomyl concentrations did not exceed the relevant guidelines.

No organochlorine (OC) pesticides, organophosphorus (OP) pesticides, synthetic pyrethroids, acidic herbicides triazine herbicides or organic pesticides were detected during the first round of monitoring (Tables 6 to 8).

Summary

Nutrient and Benomyl concentrations indicate that water quality in the catchment has been marginally impacted by horticultural activities. However, in general the water quality at both locations is still relatively good and there does not appear to be any significant human health or environmental concerns associated with measured concentrations.

We trust the monitoring program and associated letter report (herein) is to your satisfaction. Please contact me if you have any questions.

Yours sincerely

Margaret Dunlop
SENIOR CONSULTANT

1 December 2015

References

National Health and Medical Research Council and National Resource Management Ministerial Council 2011, *Australian Drinking Water Guidelines 6,* Australian Government, Canberra.

Western Australian Planning Commission and Department of Planning (WAPC and DoP) 2010, *Middle Helena Land Use and Water Management Strategy*, Government of Western Australia, Perth.

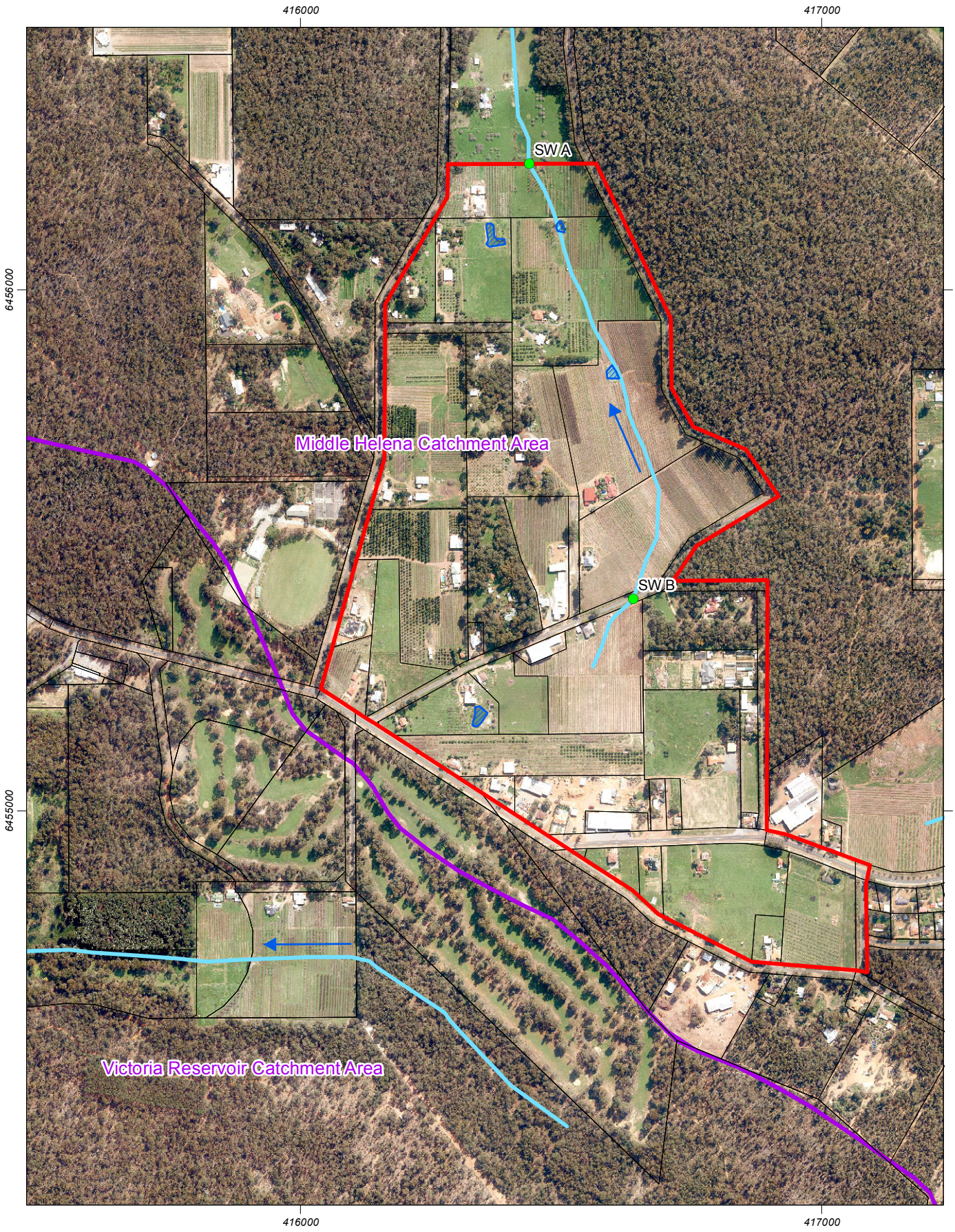

Figure 1: Monitoring plan

Scale 1:10,000 at A4

0 100 200 300 400 m

N

Legend

- Monitoring locations
- Site boundary
- Surface water flow direction
- Farm dam
- Watercourse
- Cadastral boundaries
- Catchment boundary

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 30/11/2015

Author: DWhite

Source: Aerial image, cadastre & project boundary: Client 2015. Roads: Main Roads WA 2012. Watercourse: SLIP online, Landgate 2015.

strategen ENVIRONMENTAL
info@strategen.com.au
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Path: Q:\Consult\2015\SKA\SKA15285\ArcMap_documents\L001\SKA15285_01_L001_RevA_F001.mxd

Appendix 1
Laboratory analysis documentation

CHAIN OF CUSTODY DOCUMENTATION

strategen ENVIRONMENTAL

Level 1,
50 Subiaco Square Road
Subiaco WA 6008
PO Box 243
Subiaco WA 6904
Ph: (08) 9380 3100

Client: STRATEGEN	**Project No.:** SKA 15019.01	**Page:** 1 of 1	
Site: PICKERING BROOK	**Report To:** p.molinari@strategen.com.au m.dunlop@strategen.com.au	**Phone:** 9380 3100	
Project Manager: MARGARET DUNLOP	**Sampled By:** PAT MOLINARI	**Quote No.:** EP/593/15	

Send invoice to accounts@strategen.com.au

LAB No.	SAMPLE ID.	DATE	SOIL/WATER (S/W)	NO. SAMPLE CONTAINERS	pH	EC	TDS	NUTRIENTS: TP, PHOSPHATE, TOTAL N, NITROGEN, NITRATE, TKN, AMMONIA	HEAVY METALS: As, Cd, Cr, Cu, Hg, Ni, Pb, Zn	HERBICIDES	OC/OP PESTICIDES	TPH	TOTAL THERMOTOLERANT COLIFORMS	COMMENTS
	SWA	18/9/15	S	12	X	X	X	X	X	X	X	X	X	
	SW B	"	S	12	X	X	X	X	X	X	X	X	X	

Environmental Division
Perth
Work Order Reference
EP1514036

Telephone : +61-8-9209 7655

Strategen Environmental			Laboratory		
RELINQUISHED BY	Date:	Time:	RECEIVED BY	Date:	Time:
Name: PAT MOLINARI	18/9/15	2-00pm	Name	18/9/15	1520
Signature:			Signature:		

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1514036**	Page	: 1 of 8
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Contact	: Customer Services EP
Address	: LEVEL 2 322 HAY STREET SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
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Facsimile	: +61 08 9380 4606	Facsimile	: +61-8-9209 7600
Project	: SKA15019.01	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 18-Sep-2015 15:20
C-O-C number	: ----	Date Analysis Commenced	: 18-Sep-2015
Sampler	: PAT MOLINARI	Issue Date	: 02-Oct-2015 11:12
Site	: Pickering Brook		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Alini Goundar	Senior Analyst	Perth Microbiology
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
Efua Wilson	Metals Chemist	Perth Inorganics
Jeremy Truong	Laboratory Supervisor	Perth Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Rassem Ayoubi	Senior Organic Chemist	Perth Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- Synthetic Pyrethoids conducted by ALS Brisbane, NATA Site No. 818.
- Diquat/Paraquat, Glyphosate/AMPA, Thiocarbamates/Carbamates, Phenoxyacid Herbicides conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- Poor spike recovery for (EP205) due to matrix interferences.
- MW006,estimate (~) is reported where the growth of presumptive bacteria on the filtered membrane is counted <10 cfu and/or >100 cfu.
- MW006 is ALS's internal code and is equivalent to AS4276.7.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SWA	SWB	----	----	----
			Client sampling date / time	[18-Sep-2015]	[18-Sep-2015]	----	----	----
Compound	CAS Number	LOR	Unit	EP1514036-001	EP1514036-002	--------	--------	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.64**	**6.19**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**479**	**307**	----	----	----
EA015: Total Dissolved Solids								
^ **Total Dissolved Solids @180°C**	----	10	mg/L	**271**	**186**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	**0.0001**	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.061**	**0.002**	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.013**	**0.015**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**0.11**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
^ **Nitrate as N**	14797-55-8	0.01	mg/L	**1.31**	**0.98**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.31**	**0.98**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	**0.2**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.4**	**1.2**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.05**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[18-Sep-2015]	[18-Sep-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1514036-001	EP1514036-002	--------	--------	--------
					Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued									
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	----	----	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	----	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	2	µg/L		<2.0	<2.0	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	----	----	----
Methoxychlor	72-43-5	2	µg/L		<2.0	<2.0	----	----	----
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	----	----	----
^ Sum of DDD + DDE + DDT	----	0.5	µg/L		<0.5	<0.5	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Monocrotophos	6923-22-4	2	µg/L		<2.0	<2.0	----	----	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion-methyl	298-00-0	2	µg/L		<2.0	<2.0	----	----	----
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion	56-38-2	2	µg/L		<2.0	<2.0	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[18-Sep-2015]	[18-Sep-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1514036-001	EP1514036-002	--------	--------	--------
					Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued									
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	----	----	----
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	----	----	----
EP068C: Triazines									
Atrazine	1912-24-9	0.5	µg/L		<0.5	<0.5	----	----	----
Simazine	122-34-9	0.5	µg/L		<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	>C10_C16	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[18-Sep-2015]	[18-Sep-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1514036-001	EP1514036-002	--------	--------	--------
					Result	Result	Result	Result	Result
EP080: BTEXN - Continued									
^ **Sum of BTEX**	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP094A: Synthetic Pyrethroids									
Bioresmethrin	28434-01-07	0.5	µg/L		<0.5	<0.5	----	----	----
Bifenthrin	82657-04-3	0.5	µg/L		<0.5	<0.5	----	----	----
Phenothrin	26002-80-2	0.5	µg/L		<0.5	<0.5	----	----	----
Lambda-cyhalothrin	68085-85-8	0.5	µg/L		<0.5	<0.5	----	----	----
Permethrin	52645-53-1	0.5	µg/L		<0.5	<0.5	----	----	----
Cyfluthrin	68359-37-5	0.5	µg/L		<0.5	<0.5	----	----	----
Cypermethrin	52315-07-8	0.5	µg/L		<0.5	<0.5	----	----	----
Fenvalverate & Esfenvalerate	51630-58-1/66230-04-	0.5	µg/L		<0.5	<0.5	----	----	----
Deltamethrin & Tralomethrin	62229-77-0/66841-25-	0.5	µg/L		<0.5	<0.5	----	----	----
Allethrin	----	0.5	µg/L		<0.5	<0.5	----	----	----
Transfluthrin	118712-89-3	0.5	µg/L		<0.5	<0.5	----	----	----
Tau-fluvalinate	----	0.5	µg/L		<0.5	<0.5	----	----	----
Tetramethrin	----	0.5	µg/L		<0.5	<0.5	----	----	----
EP094B: Synergist									
Piperonyl Butoxide	63993-73-7	0.5	µg/L		<0.5	<0.5	----	----	----
EP202A: Phenoxyacetic Acid Herbicides by LCMS									
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L		<10	<10	----	----	----
2.4-DB	94-82-6	10	µg/L		<10	<10	----	----	----
Dicamba	1918-00-9	10	µg/L		<10	<10	----	----	----
Mecoprop	93-65-2	10	µg/L		<10	<10	----	----	----
MCPA	94-74-6	10	µg/L		<10	<10	----	----	----
2.4-DP	120-36-5	10	µg/L		<10	<10	----	----	----
2.4-D	94-75-7	10	µg/L		<10	<10	----	----	----
Triclopyr	55335-06-3	10	µg/L		<10	<10	----	----	----
2.4.5-TP (Silvex)	93-72-1	10	µg/L		<10	<10	----	----	----
2.4.5-T	93-76-5	10	µg/L		<10	<10	----	----	----
MCPB	94-81-5	10	µg/L		<10	<10	----	----	----
Picloram	1918-02-1	10	µg/L		<10	<10	----	----	----
Clopyralid	1702-17-6	10	µg/L		<10	<10	----	----	----
Fluroxypyr	69377-81-7	10	µg/L		<10	<10	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SWA	SWB	----	----	----
			Client sampling date / time	[18-Sep-2015]	[18-Sep-2015]	----	----	----
Compound	CAS Number	LOR	Unit	EP1514036-001	EP1514036-002	--------	--------	--------
				Result	Result	Result	Result	Result
EP202A: Phenoxyacetic Acid Herbicides by LCMS - Continued								
2.6-D	575-90-6	10	µg/L	<10	<10	----	----	----
2.4.6-T	575-89-3	10	µg/L	<10	<10	----	----	----
EP205: Quaternary Ammonium Herbicides								
Paraquat	4685-14-7	0.1	µg/L	<0.10	<0.10	----	----	----
Diquat	231-36-7	0.05	µg/L	<0.05	<0.05	----	----	----
EP234B: Thiocarbamates and Carbamates								
Aldicarb	116-06-3	0.05	µg/L	<0.05	<0.05	----	----	----
Bendiocarb	22781-23-3	0.1	µg/L	<0.10	<0.10	----	----	----
Benomyl	17804-35-2	0.01	µg/L	**0.02**	**0.02**	----	----	----
Carbaryl	63-25-2	0.01	µg/L	<0.01	<0.01	----	----	----
Carbofuran	1563-66-2	0.01	µg/L	<0.01	<0.01	----	----	----
3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	<0.02	----	----	----
Methiocarb	2032-65-7	0.01	µg/L	<0.01	<0.01	----	----	----
Methomyl	16752-77-5	0.01	µg/L	<0.01	<0.01	----	----	----
Molinate	2212-67-1	0.1	µg/L	<0.1	<0.1	----	----	----
Oxamyl	23135-22-0	0.01	µg/L	<0.01	<0.01	----	----	----
Thiobencarb	28249-77-6	0.01	µg/L	<0.01	<0.01	----	----	----
Thiodicarb	59669-26-0	0.01	µg/L	<0.01	<0.01	----	----	----
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	**37**	**~9**	----	----	----
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**84.5**	**81.2**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**78.8**	**75.7**	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**80.6**	**87.7**	----	----	----
Toluene-D8	2037-26-5	2	%	**103**	**99.9**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%	**104**	**103**	----	----	----
EP094S: Pesticide Surrogate								
DEF	78-48-8	0.5	%	**90.6**	**70.8**	----	----	----
EP202S: Phenoxyacetic Acid Herbicide Surrogate								
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%	**110**	**102**	----	----	----

ALS Environmental

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EP1514036**	Page	: 1 of 8
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Telephone	: +61-8-9209 7655
Project	: SKA15019.01	Date Samples Received	: 18-Sep-2015
Site	: Pickering Brook	Issue Date	: 02-Oct-2015
Sampler	: PAT MOLINARI	No. of samples received	: 2
Order number	: ----	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EP205: Quaternary Ammonium Herbicides	EP1514036--001	SWA	**Diquat**	231-36-7	25.6 %	59-151%	**Recovery less than lower data quality objective**
EP205: Quaternary Ammonium Herbicides	EP1514036--001	SWA	**Paraquat**	4685-14-7	22.4 %	54-144%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
SWA, SWB	----	----	----	21-Sep-2015	18-Sep-2015	**3**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Pesticides by GCMS	0	2	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Synthetic Pyrethroids by GCMS	0	2	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	0	19	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)					
Pesticides by GCMS	0	2	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Synthetic Pyrethroids by GCMS	0	2	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	0	19	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**21-Sep-2015**	18-Sep-2015	×
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**21-Sep-2015**	16-Oct-2015	✓
EA015: Total Dissolved Solids								
Clear Plastic Bottle - Natural (EA015H)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**22-Sep-2015**	25-Sep-2015	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**23-Sep-2015**	16-Mar-2016	✓
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**23-Sep-2015**	16-Oct-2015	✓
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**18-Sep-2015**	16-Oct-2015	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**18-Sep-2015**	20-Sep-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**18-Sep-2015**	16-Oct-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK061G)								
SWA,	SWB	**18-Sep-2015**	**23-Sep-2015**	16-Oct-2015	✓	**23-Sep-2015**	16-Oct-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G)								
SWA,	SWB	**18-Sep-2015**	**23-Sep-2015**	16-Oct-2015	✓	**23-Sep-2015**	16-Oct-2015	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**18-Sep-2015**	20-Sep-2015	✓
EP068A: Organochlorine Pesticides (OC)								
Amber Glass Bottle - Unpreserved (EP068)								
SWA,	SWB	**18-Sep-2015**	**24-Sep-2015**	25-Sep-2015	✓	**24-Sep-2015**	03-Nov-2015	✓
EP080/071: Total Petroleum Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP071)								
SWA,	SWB	**18-Sep-2015**	**24-Sep-2015**	25-Sep-2015	✓	**24-Sep-2015**	03-Nov-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080S: TPH(V)/BTEX Surrogates								
Amber VOC Vial - Sulfuric Acid (EP080)								
SWA,	SWB	**18-Sep-2015**	**23-Sep-2015**	02-Oct-2015	✓	**23-Sep-2015**	02-Oct-2015	✓
EP094A: Synthetic Pyrethroids								
Amber Glass Bottle - Unpreserved (EP094)								
SWA,	SWB	**18-Sep-2015**	**24-Sep-2015**	25-Sep-2015	✓	**26-Sep-2015**	03-Nov-2015	✓
EP202A: Phenoxyacetic Acid Herbicides by LCMS								
Amber Glass Bottle - Unpreserved (EP202-SL)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**23-Sep-2015**	25-Sep-2015	✓
EP205: Quaternary Ammonium Herbicides								
HDPE (no PTFE) (EP205)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**25-Sep-2015**	25-Sep-2015	✓
EP234B: Thiocarbamates and Carbamates								
Amber Glass Bottle - Unpreserved (EP234-1)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**23-Sep-2015**	25-Sep-2015	✓
MW006: Faecal Coliforms & E.coli by MF								
Sterile Plastic Bottle - Sodium Thiosulfate (MW006)								
SWA,	SWB	**18-Sep-2015**	**----**	----	----	**18-Sep-2015**	19-Sep-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	2	**100.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	2	14	**14.29**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	17	**11.76**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	13	**15.38**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	2	13	**15.38**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	0	2	**0.00**	**10.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	3	**33.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Quaternary Ammonium Herbicides	EP205	1	3	**33.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Synthetic Pyrethroids by GCMS	EP094	0	2	**0.00**	**10.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	0	19	**0.00**	**10.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	2	17	**11.76**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Quaternary Ammonium Herbicides	EP205	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Synthetic Pyrethroids by GCMS	EP094	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Quaternary Ammonium Herbicides	EP205	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Synthetic Pyrethroids by GCMS	EP094	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	0	2	**0.00**	**5.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Quaternary Ammonium Herbicides	EP205	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Synthetic Pyrethroids by GCMS	EP094	0	2	**0.00**	**5.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	0	19	**0.00**	**5.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Synthetic Pyrethroids by GCMS	EP094	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	WATER	In-House, LCMS (Electrospray in negative mode). After adding surrogate and acetic acid, water samples are injected on a C18 column for LC/MS determination.
Quaternary Ammonium Herbicides	EP205	WATER	In-House, large volume direct injection, HPLC ion-paired reverse phase, MS detection (Electrospray in positive mode).
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	WATER	In-House, LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Analysis is by LC/MSMS, ESI Positive Mode.
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EP1514036**	Page	: 1 of 11
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Contact	: Customer Services EP
Address	: LEVEL 2 322 HAY STREET SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: M.Dunlop@strategen.com.au	E-mail	: ALSEnviro.Perth@alsglobal.com
Telephone	: +61 08 9380 3100	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9380 4606	Facsimile	: +61-8-9209 7600
Project	: SKA15019.01	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 18-Sep-2015
C-O-C number	: ----	Date Analysis Commenced	: 18-Sep-2015
Sampler	: PAT MOLINARI	Issue Date	: 02-Oct-2015
Site	: Pickering Brook	No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Alini Goundar	Senior Analyst	Perth Microbiology
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
Efua Wilson	Metals Chemist	Perth Inorganics
Jeremy Truong	Laboratory Supervisor	Perth Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Rassem Ayoubi	Senior Organic Chemist	Perth Organics

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005P: pH by PC Titrator (QC Lot: 219764)									
EP1514034-002	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	7.69	7.72	0.389	0% - 20%
EP1514035-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	8.00	7.93	0.879	0% - 20%
EA005P: pH by PC Titrator (QC Lot: 219767)									
EP1514037-014	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	4.13	4.14	0.242	0% - 20%
EP1514037-010	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	5.82	5.77	0.863	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 219766)									
EP1514035-003	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	514	512	0.392	0% - 20%
EP1514037-010	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	593	590	0.511	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 220721)									
EP1514036-001	SWA	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	271	264	2.43	0% - 20%
EP1514063-007	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	2360	2440	3.63	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 222200)									
EP1514030-005	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.035	0.036	0.00	0% - 20%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.030	0.029	0.00	No Limit
EP1514010-011	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	0.049	0.049	0.00	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.018	0.018	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 222201)									
EP1514010-013	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP1514064-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 220215)									
EP1514036-001	SWA	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.03	0.00	No Limit
EP1514037-023	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	1.38	1.29	6.46	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 219807)									
EP1514036-001	SWA	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 219807) - continued									
EP1514037-011	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 220216)									
EP1514036-001	SWA	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.31	1.31	0.00	0% - 20%
EP1514037-023	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.02	61.3	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 220799)									
EP1514038-005	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.4	4.0	14.2	0% - 20%
EP1514001-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.0	1.7	15.4	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 220798)									
EP1514037-009	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.01	80.1	No Limit
EP1514001-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.31	0.31	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 219806)									
EP1514036-001	SWA	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 221229)									
EP1514050-004	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP1514063-008	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 221229)									
EP1514050-004	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP1514063-008	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 221229)									
EP1514050-004	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP1514063-008	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QC Lot: 221885)									
EP1514036-001	SWA	EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4.5-TP (Silvex)	93-72-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	<10	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QC Lot: 221885) - continued									
EP1514036-001	SWA	EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPA	94-74-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPB	94-81-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Picloram	1918-02-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	<10	0.00	No Limit
EP205: Quaternary Ammonium Herbicides (QC Lot: 226607)									
EP1514036-001	SWA	EP205: Diquat	231-36-7	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP205: Paraquat	4685-14-7	0.1	µg/L	<0.10	<0.10	0.00	No Limit
EP234B: Thiocarbamates and Carbamates (QC Lot: 221880)									
EB1529219-001	Anonymous	EP234-1: Benomyl	17804-35-2	0.01	µg/L	0.03	0.03	0.00	No Limit
		EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 219764)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	101	99	102
				----	7 pH Unit	101	99	102
EA005P: pH by PC Titrator (QCLot: 219767)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	99.0	99	102
				----	7 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 219766)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	97.7	95	105
EA015: Total Dissolved Solids (QCLot: 220721)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	94.7	83	111
				<10	293 mg/L	105	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 222200)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	95.8	84	108
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	94.6	86	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	89.4	85	109
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	106	84	110
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	93.7	85	107
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	107	84	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	109	89	115
EG035F: Dissolved Mercury by FIMS (QCLot: 222201)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	103	92	116
EK055G: Ammonia as N by Discrete Analyser (QCLot: 220215)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	105	87	115
EK057G: Nitrite as N by Discrete Analyser (QCLot: 219807)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.4	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 220216)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	104	92	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 220799)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	91.6	82	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 220798)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	89.8	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 219806)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	102	87	115
EP068A: Organochlorine Pesticides (OC) (QCLot: 222317)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 222317) - continued								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	80.8	39	117
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	77.2	40	116
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	76.8	26	106
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	74.7	40	110
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	70.5	40	104
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	77.6	36	124
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	76.9	39	109
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	77.3	40	122
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	76.8	40	112
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	76.7	42	110
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	73.4	39	119
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	76.2	40	106
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	45.9	35	119
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	75.4	39	105
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	83.7	36	108
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	76.1	42	112
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	70.6	39	105
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	75.2	40	112
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	69.4	37	99
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	71.7	26	104
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	77.9	41	111
EP068B: Organophosphorus Pesticides (OP) (QCLot: 222317)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	59.8	19	133
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	78.5	36	112
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	78.7	39	111
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	75.8	39	115
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	64.2	44	112
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	71.4	43	111
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	72.2	35	105
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	80.0	43	111
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	73.9	38	102
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	59.2	33	93
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	81.6	38	116
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	46.6	33	107
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	78.0	42	110
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	58.0	38	110
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	5.04	2	20
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	75.9	37	107
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	75.6	32	100

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP068B: Organophosphorus Pesticides (OP) (QCLot: 222317) - continued								
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	78.4	37	117
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	80.5	37	119
EP068C: Triazines (QCLot: 222317)								
EP068: Atrazine	1912-24-9	0.5	µg/L	<0.5	5 µg/L	75.8	42	108
EP068: Simazine	122-34-9	0.5	µg/L	<0.5	5 µg/L	79.5	35	121
EP080/071: Total Petroleum Hydrocarbons (QCLot: 221229)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	320 µg/L	106	69	125
EP080/071: Total Petroleum Hydrocarbons (QCLot: 222318)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	400 µg/L	46.1	29	109
EP071: C15 - C28 Fraction	----	100	µg/L	<100	400 µg/L	66.2	36	124
EP071: C29 - C36 Fraction	----	50	µg/L	<50	400 µg/L	63.7	35	125
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 221229)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	370 µg/L	90.1	72	120
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 222318)								
EP071: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	400 µg/L	51.0	34	112
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	600 µg/L	67.5	38	124
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	200 µg/L	46.3	18	136
EP080: BTEXN (QCLot: 221229)								
EP080: Benzene	71-43-2	1	µg/L	<1	20 µg/L	99.8	78	120
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	20 µg/L	109	78	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	40 µg/L	106	78	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	20 µg/L	106	71	125
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	20 µg/L	108	81	119
EP080: Toluene	108-88-3	2	µg/L	<2	20 µg/L	106	78	120
EP094A: Synthetic Pyrethroids (QCLot: 223380)								
EP094: Allethrin	----	0.5	µg/L	<0.5	0.5 µg/L	62.7	46	127
EP094: Bifenthrin	82657-04-3	0.5	µg/L	<0.5	0.5 µg/L	70.5	47	122
EP094: Bioresmethrin	28434-01-07	0.5	µg/L	<0.5	0.5 µg/L	89.3	39	133
EP094: Cyfluthrin	68359-37-5	0.5	µg/L	<0.5	0.5 µg/L	79.5	41	119
EP094: Cypermethrin	52315-07-8	0.5	µg/L	<0.5	0.5 µg/L	66.0	36	138
EP094: Deltamethrin & Tralomethrin	62229-77-0/ 66841-25-	0.5	µg/L	<0.5	0.5 µg/L	73.0	42	126
EP094: Fenvalverate & Esfenvalerate	51630-58-1/ 66230-04-	0.5	µg/L	<0.5	0.5 µg/L	70.9	47	129
EP094: Lambda-cyhalothrin	68085-85-8	0.5	µg/L	<0.5	0.5 µg/L	69.1	47	127
EP094: Permethrin	52645-53-1	0.5	µg/L	<0.5	0.5 µg/L	69.5	56	122
EP094: Phenothrin	26002-80-2	0.5	µg/L	<0.5	0.5 µg/L	64.9	51	119

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP094A: Synthetic Pyrethroids (QCLot: 223380) - continued								
EP094: Tau-fluvalinate	----	0.5	µg/L	<0.5	0.5 µg/L	87.2	27	140
EP094: Tetramethrin	----	0.5	µg/L	<0.5	0.5 µg/L	74.5	42	117
EP094: Transfluthrin	118712-89-3	0.5	µg/L	<0.5	0.5 µg/L	61.7	58	125
EP094B: Synergist (QCLot: 223380)								
EP094: Piperonyl Butoxide	63993-73-7	0.5	µg/L	<0.5	0.5 µg/L	72.8	47	128
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 221885)								
EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	100 µg/L	91.0	78	140
EP202-SL: 2.4.5-TP (Silvex)	93-72-1	10	µg/L	<10	100 µg/L	92.8	75	143
EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	100 µg/L	94.9	77	139
EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	100 µg/L	98.5	65	147
EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	100 µg/L	94.0	76	144
EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	100 µg/L	95.1	82	136
EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	100 µg/L	99.6	70	145
EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	100 µg/L	96.1	83	137
EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	100 µg/L	95.6	77	145
EP202-SL: MCPA	94-74-6	10	µg/L	<10	100 µg/L	95.1	76	140
EP202-SL: MCPB	94-81-5	10	µg/L	<10	100 µg/L	98.1	69	139
EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	100 µg/L	95.0	75	143
EP202-SL: Picloram	1918-02-1	10	µg/L	<10	100 µg/L	103	70	144
EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	100 µg/L	93.1	77	141
EP205: Quaternary Ammonium Herbicides (QCLot: 226607)								
EP205: Diquat	231-36-7	0.05	µg/L	<0.05	0.5 µg/L	121	55	135
EP205: Paraquat	4685-14-7	0.1	µg/L	<0.10	1 µg/L	117	53	133
EP234B: Thiocarbamates and Carbamates (QCLot: 221880)								
EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	0.2 µg/L	108	68	134
EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	0.5 µg/L	96.2	80	122
EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	1 µg/L	96.5	70	130
EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	0.1 µg/L	105	70	132
EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	0.1 µg/L	84.0	68	134
EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	0.1 µg/L	90.0	77	127
EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	0.1 µg/L	85.0	70	130
EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	0.1 µg/L	116	79	127
EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	1 µg/L	109	75	127
EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	0.1 µg/L	107	70	130
EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	0.1 µg/L	121	79	131
EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	0.1 µg/L	108	74	132

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 222200)							
EP1514010-012	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	125	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	112	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	98.2	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	118	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	105	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	116	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	124	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 222201)							
EP1514010-014	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	104	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 220215)							
EP1514036-001	SWA	EK055G: Ammonia as N	7664-41-7	1 mg/L	116	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 219807)							
EP1514036-001	SWA	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	114	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 220216)							
EP1514036-001	SWA	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	95.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 220799)							
EP1514001-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	98.9	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 220798)							
EP1514001-001	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	93.8	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 219806)							
EP1514036-001	SWA	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	108	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 221229)							
EP1514050-005	Anonymous	EP080: C6 - C9 Fraction	----	240 µg/L	104	77	137
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 221229)							
EP1514050-005	Anonymous	EP080: C6 - C10 Fraction	C6_C10	290 µg/L	87.9	77	137
EP080: BTEXN (QCLot: 221229)							
EP1514050-005	Anonymous	EP080: Benzene	71-43-2	20 µg/L	99.9	77	122
		EP080: Toluene	108-88-3	20 µg/L	104	74	126
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 221885)							
EP1514036-001	SWA	EP202-SL: 2.4.5-T	93-76-5	100 µg/L	96.4	78	140
		EP202-SL: 2.4-D	94-75-7	100 µg/L	100.0	77	139
		EP202-SL: Clopyralid	1702-17-6	100 µg/L	81.7	70	145

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 221885) - continued							
EP1514036-001	SWA	EP202-SL: MCPA	94-74-6	100 µg/L	97.9	76	140
		EP202-SL: Mecoprop	93-65-2	100 µg/L	98.4	75	143
		EP202-SL: Picloram	1918-02-1	100 µg/L	97.2	70	144
		EP202-SL: Triclopyr	55335-06-3	100 µg/L	97.3	77	141
EP205: Quaternary Ammonium Herbicides (QCLot: 226607)							
EP1514036-001	SWA	EP205: Diquat	231-36-7	0.5 µg/L	# 25.6	59	151
		EP205: Paraquat	4685-14-7	1 µg/L	# 22.4	54	144
EP234B: Thiocarbamates and Carbamates (QCLot: 221880)							
EB1529219-001	Anonymous	EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.2 µg/L	100	70	130
		EP234-1: Aldicarb	116-06-3	0.5 µg/L	95.0	70	130
		EP234-1: Bendiocarb	22781-23-3	1 µg/L	82.6	70	130
		EP234-1: Benomyl	17804-35-2	0.1 µg/L	102	62	136
		EP234-1: Carbaryl	63-25-2	0.1 µg/L	89.0	70	130
		EP234-1: Carbofuran	1563-66-2	0.1 µg/L	108	70	130
		EP234-1: Methiocarb	2032-65-7	0.1 µg/L	85.0	70	130
		EP234-1: Methomyl	16752-77-5	0.1 µg/L	105	70	130
		EP234-1: Molinate	2212-67-1	1 µg/L	92.9	66	128
		EP234-1: Oxamyl	23135-22-0	0.1 µg/L	117	70	130
		EP234-1: Thiobencarb	28249-77-6	0.1 µg/L	116	70	130
		EP234-1: Thiodicarb	59669-26-0	0.1 µg/L	127	70	130

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1514852**	Page	: 1 of 4
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Contact	: Customer Services EP
Address	: LEVEL 2 322 HAY STREET SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: M.Dunlop@strategen.com.au	E-mail	: ALSEnviro.Perth@alsglobal.com
Telephone	: +61 08 9380 3100	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9380 4606	Facsimile	: +61-8-9209 7600
Project	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 15-Oct-2015 15:25
C-O-C number	: ----	Date Analysis Commenced	: 15-Oct-2015
Sampler	: D WHITE	Issue Date	: 29-Oct-2015 14:16
Site	: Pickering Brook		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
Jeremy Truong	Laboratory Supervisor	Perth Inorganics
Lana Nguyen	Senior LCMS Chemist	Sydney Organics
Scott James	Laboratory Manager	Perth Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- MW006,estimate (~) is reported where there are many non-target colonies; the typical colonies may be masked by overgrowth of non-target organisms.
- MW006 is ALS's internal code and is equivalent to AS4276.7.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[15-Oct-2015]	[15-Oct-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1514852-001	EP1514852-002	--------	--------	--------
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.79**	**6.62**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**462**	**285**	----	----	----
EA015: Total Dissolved Solids									
^ **Total Dissolved Solids @180°C**	----	10	mg/L		**244**	**162**	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.001**	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.007**	**0.009**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.11**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
^ **Nitrate as N**	14797-55-8	0.01	mg/L		**1.16**	**0.90**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**1.16**	**0.90**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**0.3**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.4**	**1.2**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	**0.03**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EP234B: Thiocarbamates and Carbamates									
Aldicarb	116-06-3	0.05	µg/L		<0.05	<0.05	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[15-Oct-2015]	[15-Oct-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1514852-001	EP1514852-002	--------	--------	--------
					Result	Result	Result	Result	Result
EP234B: Thiocarbamates and Carbamates - Continued									
Bendiocarb	22781-23-3	0.1	µg/L		<0.10	<0.10	----	----	----
Benomyl	17804-35-2	0.01	µg/L		**0.02**	**0.02**	----	----	----
Carbaryl	63-25-2	0.01	µg/L		<0.01	<0.01	----	----	----
Carbofuran	1563-66-2	0.01	µg/L		<0.01	<0.01	----	----	----
3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L		<0.02	<0.02	----	----	----
Methiocarb	2032-65-7	0.01	µg/L		<0.01	<0.01	----	----	----
Methomyl	16752-77-5	0.01	µg/L		<0.01	<0.01	----	----	----
Molinate	2212-67-1	0.1	µg/L		<0.1	<0.1	----	----	----
Oxamyl	23135-22-0	0.01	µg/L		<0.01	<0.01	----	----	----
Thiobencarb	28249-77-6	0.01	µg/L		<0.01	<0.01	----	----	----
Thiodicarb	59669-26-0	0.01	µg/L		<0.01	<0.01	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~69**	**~840**	----	----	----

ALS Environmental

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EP1514852**	Page	: 1 of 7
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Telephone	: +61-8-9209 7655
Project	: ----	Date Samples Received	: 15-Oct-2015
Site	: Pickering Brook	Issue Date	: 29-Oct-2015
Sampler	: D WHITE	No. of samples received	: 2
Order number	: ----	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK055G: Ammonia as N by Discrete Analyser	EP1514840--001	Anonymous	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Days overdue	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
SWA, SWB	----	----	----	19-Oct-2015	15-Oct-2015	**4**

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Extraction / Preparation: Due for extraction	Extraction / Preparation: Evaluation	Analysis: Date analysed	Analysis: Due for analysis	Analysis: Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**19-Oct-2015**	15-Oct-2015	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**19-Oct-2015**	12-Nov-2015	✓
EA015: Total Dissolved Solids							
Clear Plastic Bottle - Natural (EA015H)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**16-Oct-2015**	22-Oct-2015	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**26-Oct-2015**	12-Apr-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**26-Oct-2015**	12-Nov-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**15-Oct-2015**	12-Nov-2015	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**15-Oct-2015**	17-Oct-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**15-Oct-2015**	12-Nov-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
SWA, SWB	**15-Oct-2015**	**21-Oct-2015**	12-Nov-2015	✓	**21-Oct-2015**	12-Nov-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
SWA, SWB	**15-Oct-2015**	**21-Oct-2015**	12-Nov-2015	✓	**21-Oct-2015**	12-Nov-2015	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**15-Oct-2015**	17-Oct-2015	✓
EP234B: Thiocarbamates and Carbamates							
Amber Glass Bottle - Unpreserved (EP234-1)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**21-Oct-2015**	22-Oct-2015	✓
MW006: Faecal Coliforms & E.coli by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW006)							
SWA, SWB	**15-Oct-2015**	**----**	----	----	**15-Oct-2015**	16-Oct-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	15	**13.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	15	**13.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	5	**20.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	1	6	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	5	**20.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	6	**33.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	5	**20.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite as N by Discrete Analyser	EK057G	1	5	**20.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	WATER	In-House, LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Analysis is by LC/MSMS, ESI Positive Mode.
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EP1514852**	Page	: 1 of 7
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Contact	: Customer Services EP
Address	: LEVEL 2 322 HAY STREET SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: M.Dunlop@strategen.com.au	E-mail	: ALSEnviro.Perth@alsglobal.com
Telephone	: +61 08 9380 3100	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9380 4606	Facsimile	: +61-8-9209 7600
Project	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 15-Oct-2015
C-O-C number	: ----	Date Analysis Commenced	: 15-Oct-2015
Sampler	: D WHITE	Issue Date	: 29-Oct-2015
Site	: Pickering Brook	No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out ir compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
Jeremy Truong	Laboratory Supervisor	Perth Inorganics
Lana Nguyen	Senior LCMS Chemist	Sydney Organics
Scott James	Laboratory Manager	Perth Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005P: pH by PC Titrator (QC Lot: 248050)									
EP1514849-001	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.63	6.67	0.602	0% - 20%
EP1514864-002	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	8.61	8.66	0.579	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 248048)									
EP1514849-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	477	474	0.638	0% - 20%
EP1514864-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	838	839	0.120	0% - 20%
EA015: Total Dissolved Solids (QC Lot: 245394)									
EP1514849-006	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	996	1060	6.04	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 254826)									
EP1514852-001	SWA	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.007	0.035	132	No Limit
EP1514977-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0017	0.0016	0.00	0% - 50%
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.037	0.037	0.00	0% - 20%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.024	0.024	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 254827)									
EP1514852-001	SWA	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP1514977-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 245059)									
EP1514840-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	241	239	0.849	0% - 20%
EP1514852-001	SWA	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.04	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 245052)									
EP1514852-001	SWA	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 245060)									
EP1514840-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.03	0.03	0.00	No Limit
EP1514852-001	SWA	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.16	1.10	5.37	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 246008)									

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 246008) - continued									
EP1514816-012	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	0.4	0.00	No Limit
EP1514840-009	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.2	1.1	0.00	0% - 50%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 246007)									
EP1514816-012	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.01	<0.01	0.00	No Limit
EP1514840-009	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.02	0.00	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 245051)									
EP1514852-001	SWA	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP234B: Thiocarbamates and Carbamates (QC Lot: 249864)									
EB1531445-013	Anonymous	EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 248050)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	99	102
				----	7 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 248048)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	97.2	95	105
EA015: Total Dissolved Solids (QCLot: 245394)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	99.8	83	111
				<10	293 mg/L	110	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 254826)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	97.0	84	108
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	101	86	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	96.0	85	109
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.9	84	110
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.6	85	107
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	101	84	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	104	89	115
EG035F: Dissolved Mercury by FIMS (QCLot: 254827)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	102	92	116
EK055G: Ammonia as N by Discrete Analyser (QCLot: 245059)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	105	87	115
EK057G: Nitrite as N by Discrete Analyser (QCLot: 245052)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	101	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 245060)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	105	92	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 246008)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	92.6	82	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 246007)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	84.8	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 245051)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	95.6	87	115
EP234B: Thiocarbamates and Carbamates (QCLot: 249864)								
EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	0.2 µg/L	111	68	134
EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	0.5 µg/L	96.8	80	122
EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	1 µg/L	98.7	70	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP234B: Thiocarbamates and Carbamates (QCLot: 249864) - continued								
EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	0.1 µg/L	100	70	132
EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	0.1 µg/L	114	68	134
EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	0.1 µg/L	103	77	127
EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	0.1 µg/L	111	70	130
EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	0.1 µg/L	86.0	79	127
EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	1 µg/L	97.0	75	127
EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	0.1 µg/L	92.0	70	130
EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	0.1 µg/L	89.0	79	131
EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	0.1 µg/L	105	74	132

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EG020F: Dissolved Metals by ICP-MS (QCLot: 254826)							
EP1514941-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	88.0	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	88.4	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	81.6	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	84.3	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	81.3	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	85.6	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	88.7	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 254827)							
EP1514852-002	SWB	EG035F: Mercury	7439-97-6	0.01 mg/L	97.9	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 245059)							
EP1514840-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	# Not Determined	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 245052)							
EP1514852-001	SWA	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	113	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 245060)							
EP1514840-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	96.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 246008)							
EP1514816-015	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	91.2	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 246007)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 246007) - continued							
EP1514816-015	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	82.4	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 245051)							
EP1514852-001	SWA	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	104	70	130
EP234B: Thiocarbamates and Carbamates (QCLot: 249864)							
EB1531445-013	Anonymous	EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.2 µg/L	121	70	130
		EP234-1: Aldicarb	116-06-3	0.5 µg/L	99.8	70	130
		EP234-1: Bendiocarb	22781-23-3	1 µg/L	102	70	130
		EP234-1: Benomyl	17804-35-2	0.1 µg/L	107	62	136
		EP234-1: Carbaryl	63-25-2	0.1 µg/L	101	70	130
		EP234-1: Carbofuran	1563-66-2	0.1 µg/L	86.0	70	130
		EP234-1: Methiocarb	2032-65-7	0.1 µg/L	102	70	130
		EP234-1: Methomyl	16752-77-5	0.1 µg/L	96.0	70	130
		EP234-1: Molinate	2212-67-1	1 µg/L	87.7	66	128
		EP234-1: Oxamyl	23135-22-0	0.1 µg/L	104	70	130
		EP234-1: Thiobencarb	28249-77-6	0.1 µg/L	94.0	70	130
		EP234-1: Thiodicarb	59669-26-0	0.1 µg/L	83.0	70	130

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1515825**	Page	: 1 of 5
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Contact	: Customer Services EP
Address	: LEVEL 2 322 HAY STREET SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: M.Dunlop@strategen.com.au	E-mail	: ALSEnviro.Perth@alsglobal.com
Telephone	: +61 08 9380 3100	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9380 4606	Facsimile	: +61-8-9209 7600
Project	: SKA15285	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 11-Nov-2015 15:35
C-O-C number	: ----	Date Analysis Commenced	: 11-Nov-2015
Sampler	: D WHITE	Issue Date	: 23-Nov-2015 16:08
Site	: PICKERIN BROOK		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Jeremy Truong	Laboratory Supervisor	Perth Inorganics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Rassem Ayoubi	Senior Organic Chemist	Perth Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- Glyphosate/AMPA, Phenoxyacid Herbicides and metals conducted by ALS Sydney, NATA accreditation no. 825, site no 10911.
- EP202: Poor matrix spike recoveries for Clopyralid due to matrix effects.
- MW006,there are many non-target colonies; the typical colonies may be masked by overgrowth of non-target organisms.
- MW006 is ALS's internal code and is equivalent to AS4276.7.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SWA	SWB	----	----	----
			Client sampling date / time	[11-Nov-2015]	[11-Nov-2015]	----	----	----
Compound	CAS Number	LOR	Unit	EP1515825-001	EP1515825-002	--------	--------	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.69**	**6.64**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**515**	**500**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**287**	**312**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.006**	**0.004**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.008**	**0.012**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**1.25**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	**0.01**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.16**	**4.73**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.16**	**4.74**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**1.9**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**0.4**	**6.6**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.27**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.18**	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[11-Nov-2015]	[11-Nov-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1515825-001	EP1515825-002	--------	--------	--------
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP202A: Phenoxyacetic Acid Herbicides by LCMS									
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L		<10	<10	----	----	----
2.4-DB	94-82-6	10	µg/L		<10	<10	----	----	----
Dicamba	1918-00-9	10	µg/L		<10	<10	----	----	----
Mecoprop	93-65-2	10	µg/L		<10	<10	----	----	----
MCPA	94-74-6	10	µg/L		<10	<10	----	----	----
2.4-DP	120-36-5	10	µg/L		<10	<10	----	----	----
2.4-D	94-75-7	10	µg/L		<10	<10	----	----	----
Triclopyr	55335-06-3	10	µg/L		<10	<10	----	----	----
2.4.5-TP (Silvex)	93-72-1	10	µg/L		<10	<10	----	----	----
2.4.5-T	93-76-5	10	µg/L		<10	<10	----	----	----
MCPB	94-81-5	10	µg/L		<10	<10	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SWA	SWB	----	----	----
				Client sampling date / time	[11-Nov-2015]	[11-Nov-2015]	----	----	----
Compound	CAS Number	LOR	Unit		EP1515825-001	EP1515825-002	--------	--------	--------
					Result	Result	Result	Result	Result
EP202A: Phenoxyacetic Acid Herbicides by LCMS - Continued									
Picloram	1918-02-1	10	µg/L		<10	<10	----	----	----
Clopyralid	1702-17-6	10	µg/L		<10	<10	----	----	----
Fluroxypyr	69377-81-7	10	µg/L		<10	<10	----	----	----
2.6-D	575-90-6	10	µg/L		<10	<10	----	----	----
2.4.6-T	575-89-3	10	µg/L		<10	<10	----	----	----
EP204: Glyphosate and AMPA									
Glyphosate	1071-83-6	10	µg/L		<10	<10	----	----	----
AMPA	1066-51-9	10	µg/L		<10	<10	----	----	----
EP234B: Thiocarbamates and Carbamates									
Aldicarb	116-06-3	0.05	µg/L		<0.05	<0.05	----	----	----
Bendiocarb	22781-23-3	0.1	µg/L		<0.10	<0.10	----	----	----
Benomyl	17804-35-2	0.01	µg/L		**0.02**	**0.03**	----	----	----
Carbaryl	63-25-2	0.01	µg/L		<0.01	<0.01	----	----	----
Carbofuran	1563-66-2	0.01	µg/L		<0.01	<0.01	----	----	----
3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L		<0.02	<0.02	----	----	----
Methiocarb	2032-65-7	0.01	µg/L		<0.01	<0.01	----	----	----
Methomyl	16752-77-5	0.01	µg/L		<0.01	<0.01	----	----	----
Molinate	2212-67-1	0.1	µg/L		<0.1	<0.1	----	----	----
Oxamyl	23135-22-0	0.01	µg/L		<0.01	<0.01	----	----	----
Thiobencarb	28249-77-6	0.01	µg/L		<0.01	<0.01	----	----	----
Thiodicarb	59669-26-0	0.01	µg/L		<0.01	<0.01	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~54**	**~59**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**111**	**116**	----	----	----
Toluene-D8	2037-26-5	2	%		**94.8**	**97.6**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**86.5**	**88.9**	----	----	----
EP202S: Phenoxyacetic Acid Herbicide Surrogate									
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%		**103**	**103**	----	----	----

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1515825**	Page	: 1 of 8
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Telephone	: +61-8-9209 7655
Project	: SKA15285	Date Samples Received	: 11-Nov-2015
Site	: PICKERIN BROOK	Issue Date	: 23-Nov-2015
Sampler	: D WHITE	No. of samples received	: 2
Order number	: ----	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EP202A: Phenoxyacetic Acid Herbicides by LCMS	EB1534277--001	Anonymous	**Clopyralid**	1702-17-6	36.1 %	70-145%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
SWA, SWB	----	----	----	12-Nov-2015	11-Nov-2015	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	0	9	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	9	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
SWA, SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	11-Nov-2015	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
SWA, SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**18-Nov-2015**	09-May-2016	✓
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**20-Nov-2015**	09-Dec-2015	✓
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	13-Nov-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK061G)								
SWA,	SWB	**11-Nov-2015**	**20-Nov-2015**	09-Dec-2015	✓	**20-Nov-2015**	09-Dec-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G)								
SWA,	SWB	**11-Nov-2015**	**20-Nov-2015**	09-Dec-2015	✓	**20-Nov-2015**	09-Dec-2015	✓
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	13-Nov-2015	✓
EP080/071: Total Petroleum Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP071)								
SWA,	SWB	**11-Nov-2015**	**18-Nov-2015**	18-Nov-2015	✓	**18-Nov-2015**	28-Dec-2015	✓
EP080/071: Total Petroleum Hydrocarbons								
Amber VOC Vial - Sulfuric Acid (EP080)								
SWA,	SWB	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
EP202A: Phenoxyacetic Acid Herbicides by LCMS								
Amber Glass Bottle - Unpreserved (EP202-SL)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EP204: Glyphosate and AMPA								
Amber Glass Bottle - Unpreserved (EP204)								
SWA,	SWB	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	25-Nov-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP234B: Thiocarbamates and Carbamates							
Amber Glass Bottle - Unpreserved (EP234-1)							
SWA, SWB	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
MW006: Faecal Coliforms & E.coli by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW006)							
SWA, SWB	**11-Nov-2015**	**----**	----	----	**11-Nov-2015**	12-Nov-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Glyphosate and AMPA	EP204	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	9	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Glyphosate and AMPA	EP204	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Dissolved Mercury by FIMS	EG035F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Glyphosate and AMPA	EP204	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Glyphosate and AMPA	EP204	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	9	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	WATER	In-House, LCMS (Electrospray in negative mode). After adding surrogate and acetic acid, water samples are injected on a C18 column for LC/MS determination.
Glyphosate and AMPA	EP204	WATER	In-House, Pre-column derivatisation LCMS (ES in negative mode). Water samples are derivatised with 9-fluorenyl methoxycarbonyl chloroformate (FMOC) in alkaline condition. The derivatives of glyphosate and AMPA are separated by a C8 column and determined by MS.
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	WATER	In-House, LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Analysis is by LC/MSMS, ESI Positive Mode.
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EP1515825**	Page	: 1 of 9
Client	: **STRATEGEN ENVIRONMENTAL CONSULTANT**	Laboratory	: Environmental Division Perth
Contact	: MARGARET DUNLOP	Contact	: Customer Services EP
Address	: LEVEL 2 322 HAY STREET SUBIACO WESTERN AUSTRALIA 6008	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: M.Dunlop@strategen.com.au	E-mail	: ALSEnviro.Perth@alsglobal.com
Telephone	: +61 08 9380 3100	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 9380 4606	Facsimile	: +61-8-9209 7600
Project	: SKA15285	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 11-Nov-2015
C-O-C number	: ----	Date Analysis Commenced	: 11-Nov-2015
Sampler	: D WHITE	Issue Date	: 23-Nov-2015
Site	: PICKERIN BROOK	No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out ir compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Jeremy Truong	Laboratory Supervisor	Perth Inorganics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Rassem Ayoubi	Senior Organic Chemist	Perth Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005P: pH by PC Titrator (QC Lot: 275610)									
EP1515815-003	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	3.31	3.28	0.910	0% - 20%
EP1515821-002	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	5.45	5.36	1.66	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 275612)									
EP1515821-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	380	376	1.08	0% - 20%
EP1515829-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	936	952	1.72	0% - 20%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 275313)									
EP1515776-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1450	1470	1.16	0% - 20%
EP1515825-001	SWA	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	287	291	1.38	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 282362)									
EP1515825-001	SWA	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.006	0.007	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.008	0.009	0.00	No Limit
EP1515920-005	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 282363)									
EP1515825-002	SWB	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 275661)									
EP1515825-001	SWA	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.02	0.00	No Limit
EP1515830-006	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	1.43	1.44	1.14	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 275573)									
EP1515830-004	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1515820-021	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 275662)									
EP1515825-001	SWA	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.16	0.16	0.00	0% - 50%
EP1515830-006	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.03	<0.01	91.9	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 282863)									
EP1515825-001	SWA	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.2	0.00	No Limit
EP1515919-005	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.6	3.6	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 282862)									
EP1515825-001	SWA	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.04	0.03	44.4	No Limit
EP1515919-005	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.30	0.56	60.7	No Limit
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 275574)									
EP1515830-004	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1515820-021	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 275306)									
EP1515840-016	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP1515840-017	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 275306)									
EP1515840-016	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP1515840-017	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 275306)									
EP1515840-016	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP1515840-017	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QC Lot: 277738)									
EB1534277-001	Anonymous	EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPA	94-74-6	10	µg/L	<10	<10	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QC Lot: 277738) - continued									
EB1534277-001	Anonymous	EP202-SL: MCPB	94-81-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Picloram	1918-02-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	<10	0.00	No Limit
EP204: Glyphosate and AMPA (QC Lot: 277739)									
EP1515825-001	SWA	EP204: AMPA	1066-51-9	10	µg/L	<10	<10	0.00	No Limit
		EP204: Glyphosate	1071-83-6	10	µg/L	<10	<10	0.00	No Limit
EP234B: Thiocarbamates and Carbamates (QC Lot: 277735)									
EB1534356-001	Anonymous	EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA005P: pH by PC Titrator (QCLot: 275610)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	100	99	102
				----	7 pH Unit	100	99	102
EA010P: Conductivity by PC Titrator (QCLot: 275612)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	24800 µS/cm	100	95	105
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 275313)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	96.7	83	111
				<10	293 mg/L	102	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 282362)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	98.9	85	114
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	93.9	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	92.4	85	111
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.5	81	111
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	95.0	83	111
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	91.4	82	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	103	81	117
EG035F: Dissolved Mercury by FIMS (QCLot: 282363)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	95.8	83	105
EK055G: Ammonia as N by Discrete Analyser (QCLot: 275661)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	107	87	115
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275573)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	94.2	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 275662)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	97.5	92	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 282863)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	97.0	82	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 282862)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	93.8	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 275574)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	93.3	87	115
EP080/071: Total Petroleum Hydrocarbons (QCLot: 275306)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	320 µg/L	89.2	69	125
EP080/071: Total Petroleum Hydrocarbons (QCLot: 276558)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	400 µg/L	71.8	29	109

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 276558) - continued								
EP071: C15 - C28 Fraction	----	100	µg/L	<100	400 µg/L	73.1	36	124
EP071: C29 - C36 Fraction	----	50	µg/L	<50	400 µg/L	81.5	35	125
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 275306)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	370 µg/L	89.2	72	120
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 276558)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	400 µg/L	73.2	34	112
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	600 µg/L	77.1	38	124
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	200 µg/L	86.7	18	136
EP080: BTEXN (QCLot: 275306)								
EP080: Benzene	71-43-2	1	µg/L	<1	20 µg/L	95.6	78	120
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	20 µg/L	94.6	78	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	40 µg/L	91.1	78	122
EP080: Naphthalene	91-20-3	5	µg/L	<5	20 µg/L	92.4	71	125
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	20 µg/L	88.0	81	119
EP080: Toluene	108-88-3	2	µg/L	<2	20 µg/L	84.2	78	120
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 277738)								
EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	100 µg/L	97.6	78	140
EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	100 µg/L	99.5	77	139
EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	100 µg/L	101	65	147
EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	100 µg/L	99.7	76	144
EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	100 µg/L	102	82	136
EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	100 µg/L	85.5	70	145
EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	100 µg/L	106	83	137
EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	100 µg/L	99.8	77	145
EP202-SL: MCPA	94-74-6	10	µg/L	<10	100 µg/L	95.6	76	140
EP202-SL: MCPB	94-81-5	10	µg/L	<10	100 µg/L	107	69	139
EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	100 µg/L	97.3	75	143
EP202-SL: Picloram	1918-02-1	10	µg/L	<10	100 µg/L	103	70	144
EP202-SL: Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	100 µg/L	102	75	143
EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	100 µg/L	99.4	77	141
EP204: Glyphosate and AMPA (QCLot: 277739)								
EP204: AMPA	1066-51-9	10	µg/L	<10	50 µg/L	98.1	68	134
EP204: Glyphosate	1071-83-6	10	µg/L	<10	50 µg/L	90.3	70	134
EP234B: Thiocarbamates and Carbamates (QCLot: 277735)								
EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	0.2 µg/L	104	68	134
EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	0.5 µg/L	106	75	123
EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	1 µg/L	79.9	70	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EP234B: Thiocarbamates and Carbamates (QCLot: 277735) - continued								
EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	0.1 µg/L	111	73	129
EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	0.1 µg/L	81.0	68	134
EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	0.1 µg/L	83.0	77	127
EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	0.1 µg/L	95.0	70	130
EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	0.1 µg/L	110	79	127
EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	1 µg/L	97.9	75	127
EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	0.1 µg/L	107	70	130
EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	0.1 µg/L	100	79	131
EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	0.1 µg/L	83.0	74	132

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EG020F: Dissolved Metals by ICP-MS (QCLot: 282362)							
EP1515825-002	SWB	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	113	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	102	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	106	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	106	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	95.6	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	104	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	108	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 282363)							
EP1515825-001	SWA	EG035F: Mercury	7439-97-6	0.01 mg/L	99.4	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 275661)							
EP1515825-001	SWA	EK055G: Ammonia as N	7664-41-7	1 mg/L	112	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275573)							
EP1515820-021	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	102	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 275662)							
EP1515825-001	SWA	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	103	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 282863)							
EP1515825-002	SWB	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	104	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 282862)							
EP1515825-002	SWB	EK067G: Total Phosphorus as P	----	1 mg/L	102	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 275574)							
EP1515820-021	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	104	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 275306)							
EP1515787-002	Anonymous	EP080: C6 - C9 Fraction	----	240 µg/L	94.1	77	137
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 275306)							
EP1515787-002	Anonymous	EP080: C6 - C10 Fraction	C6_C10	290 µg/L	92.7	77	137
EP080: BTEXN (QCLot: 275306)							
EP1515787-002	Anonymous	EP080: Benzene	71-43-2	20 µg/L	95.6	77	122
		EP080: Toluene	108-88-3	20 µg/L	87.1	74	126
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 277738)							
EB1534277-001	Anonymous	EP202-SL: 2.4.5-T	93-76-5	100 µg/L	98.2	78	140
		EP202-SL: 2.4-D	94-75-7	100 µg/L	117	77	139
		EP202-SL: Clopyralid	1702-17-6	100 µg/L	# 36.1	70	145
		EP202-SL: MCPA	94-74-6	100 µg/L	106	76	140
		EP202-SL: Mecoprop	93-65-2	100 µg/L	106	75	143
		EP202-SL: Picloram	1918-02-1	100 µg/L	81.0	70	144
		EP202-SL: Triclopyr	55335-06-3	100 µg/L	119	77	141
EP204: Glyphosate and AMPA (QCLot: 277739)							
EP1515825-001	SWA	EP204: AMPA	1066-51-9	50 µg/L	113	60	129
		EP204: Glyphosate	1071-83-6	50 µg/L	94.9	57	125
EP234B: Thiocarbamates and Carbamates (QCLot: 277735)							
EB1534356-001	Anonymous	EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.2 µg/L	109	70	130
		EP234-1: Aldicarb	116-06-3	0.5 µg/L	106	70	130
		EP234-1: Bendiocarb	22781-23-3	1 µg/L	86.1	70	130
		EP234-1: Benomyl	17804-35-2	0.1 µg/L	105	62	136
		EP234-1: Carbaryl	63-25-2	0.1 µg/L	82.0	70	130
		EP234-1: Carbofuran	1563-66-2	0.1 µg/L	81.0	70	130
		EP234-1: Methiocarb	2032-65-7	0.1 µg/L	89.0	70	130
		EP234-1: Methomyl	16752-77-5	0.1 µg/L	109	70	130
		EP234-1: Molinate	2212-67-1	1 µg/L	93.2	66	128
		EP234-1: Oxamyl	23135-22-0	0.1 µg/L	113	70	130
		EP234-1: Thiobencarb	28249-77-6	0.1 µg/L	99.0	70	130
		EP234-1: Thiodicarb	59669-26-0	0.1 µg/L	84.0	70	130

Appendix 4

Bush Fire Hazard Assessment (FirePlan WA)

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FirePlan WA

Bill Harris
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Thornlie WA 6108

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ABN 44 116 937 762

30th April 2014

Shire of Kalamunda
PO Box 42
Kalamunda WA 6076

Attention: Nina Linton

Dear Nina,

RE: FMP 2025 - Bush Fire Hazard Assessment – Pickering Brook Concept Plan Area

I carried out a site inspection of the Site on the 30th April 2014

The Site

The site generally is surrounded to the west, south (Golf Course), east and to the north by reserves with a valley running north –south approximately along the eastern boundary of the project area,

The areas to the west, north and east consist of the Pickering Brook Oval (SW corner), Jarrah/Marri Forest Class A around the remainder of the western boundary, to the north and the east. See *Attachment 1*.

The private property area is generally used as Orchards for fruit growing with some smaller Lots containing commercial businesses and rural living Lots.

The slope analysis of the site is shown in *Attachment 2* with slopes within the project area generally between 0°-10°within an area of 10°-20° in the NE Corner (which is mainly located in the Reserve outside the project area).

Bush Fire Hazard Assessment

In Planning for Bush Fire Protection Edition 2 2010 Appendix 1, the methodology for classifying bush fire hazard levels is detailed.

The methodology rates bush fire hazard using vegetation type. The methodology is also based on the underlying assumption that land in Western Australia is predominantly undulating. The methodology specifies three bush fire hazard levels, "Low", "Moderate", and "Extreme".

The bush fire hazard for this site is shown in *Attachment 3*.

Development setback from Open Jarrah/Marri Forest.

As the boundaries of the project area adjoin Jarrah/ Marri (Classified as Open Forest Class A) and the majority of the project area being located in a Bush Fire Prone Area the developable area of the site is reduced by setbacks from Vegetation. See Attachment 4 excerpt from Shire of Kalamunda Bush Fire Prone Area mapping.

As detailed in Planning for Bush Fire Protection (Edition 2 2010) the minimum distance of 100 metres (from vegetation rated 'Moderate' or 'Extreme') may be reduced in compliance with AS 3959 *Construction of Buildings in Bush Fire Prone Areas* . Under AS 3959 as the distance from the vegetation is reduced, the construction standard must be increased. Table 2.4.3 AS 3959 sets out this relationship and Section 2 of AS 3959 details the methodology of determining the Bushfire Attack Level (BAL).

As most of the vegetation is upslope from the potential development the minimum setback from a habitable building to vegetation and the appropriate Construction Standard (BAL) is shown in the Table below.

TABLE 2.4.3

DETERMINATION OF BUSHFIRE ATTACK LEVEL (BAL)—FDI 80 (1090 K)

Vegetation classification	Bushfire Attack Levels (BALs)				
	BAL—FZ	BAL—40	BAL—29	BAL—19	BAL—12.5
	Distance (m) of the site from the predominant vegetation class				
	All upslopes and flat land (0 degrees)				
A. Forest	<16	16–<21	21–<31	31–<42	42–<100
B. Woodland	<10	10–<14	14–<20	20–<29	29–<100
C. Shrubland	<7	7–<9	9–<13	13–<19	19–<100
D. Scrub	<10	10–<13	13–<19	19–<27	27–<100
E. Mallee/Mulga	<6	6–<8	8–<12	12–<17	17–<100
F. Rainforest	<6	6–<9	9–<13	13–<19	19–<100
G. Grassland	<6	6–<8	8–<12	12–<17	17–<50
	Downslope >0 to 5 degrees				
A. Forest	<20	20–<27	27–<37	37–<50	50–<100
B. Woodland	<13	13–<17	17–<25	25–<35	35–<100
C. Shrubland	<7	7–<10	10–<15	15–<22	22–<100
D. Scrub	<11	11–<15	15–<22	22–<31	31–<100
E. Mallee/Mulga	<7	7–<9	9–<13	13–<20	20–<100
F. Rainforest	<8	8–<11	11–<17	17–<24	24–<100
G. Grassland	<7	7–<9	9–<14	14–<20	20–<50
	Downslope >5 to 10 degrees				

The Bush Fire Attack Level (BAL) Descriptions are shown below

Bushfire Attack Level	Description of risk and levels of exposure
BAL – LOW	*There is insufficient risk to warrant specific construction requirements.*
BAL – 12.5	*Risk of radiant heat is considered low. Primarily risk of ember attack.* *AS 3959 Construction Standards Sections 3 & 5.*
BAL – 19	*Risk is considered moderate. Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux between 12.5 and 19kW m².* *AS 3959 Construction Standards Sections 3 & 6.*
BAL – 29	*Risk is considered high. Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux between 19 and 29 kW m².* *AS 3959 Construction Standards Sections 3 & 7.*
BAL – 40	*Risk is considered very high. Increasing levels of ember attack and burning debris ignited by windborne embers together with increasing heat flux with the increased likelihood of direct exposure to flames. The construction elements are expected to be exposed to a heat flux not greater than 40kW m².* *AS 3959 Construction Standards Sections 3 & 8.*
BAL – FZ	*Risk is considered extreme. Direct exposure to flames from fire front in addition to heat flux and ember attack. The construction elements are expected to be exposed to a heat flux greater than 40kW m².* *AS 3959 Construction Standards Sections 3 & 9.*

The relevant AS 3959 Construction Standards detail the requirements for but not limited to:

- Subfloor framing and supports;
- Floor construction where elevated;
- External wall cladding;
- External doors, windows and other glazed treatments;
- Roofs, including verandas, garages and carports;
- Decks, steps, ramps and landings; and
- Water and gas supply.

Note: In Planning for Bush Fire Protection Edition 2 Principle 3 states: - *Subdivision and development in areas with an extreme bush fire hazard level or a Bushfire Attack Level between BAL- 40 and BAL-FZ is to be avoided unless certain fire protection requirements can be implemented to the satisfaction of the WAPC, DFES and /or the local Government.*

The setback from the walls of habitable buildings and vegetation may consist of a road reserve, footpaths, low fuel areas (turfed) within areas of Public Open Space and the front setbacks within Lots. The setback is to be managed by the landowner(s) to the Building Protection Zone standard. See *Attachment 5*.

Access

In Performance Criteria P2 (Appendix 2) of *Planning for Bush Fire Protection* it states:- *The internal layout , design and construction of public and private vehicle access in the subdivision /development allows for emergency and other vehicles to move through it easily and safely at all times.*

Acceptable Solution A2.1 states*: - Two different vehicular access routes, both of which connect to the public Road network are available to all residents/the public at all times.*

Within the project area Francais Road, Weston Road, Marchetti Road, Foti Road and Isaacs Street are currently dead end roads. These roads would need to be linked into the proposed road system of any subdivision within the project area to improve access and egress. Each stage of development would need to comply with these standards.

Through good design of the internal road system cul de sacs, Battle axe access, emergency access ways and fire service access can be kept to a minimum.

Water Supplies for Fire Fighting

Fire Hydrants will need to be installed in accordance with the *Water Corporation's No 63 Water Reticulation Standard.* If no reticulated water supply is available water tanks specifically for fire fighting are to be provided at a ratio of 50,000 litres per 25 Lots (or part thereof*)*.If water tanks are provided then they are provided by the developer and maintained in perpetuity by Local Government.

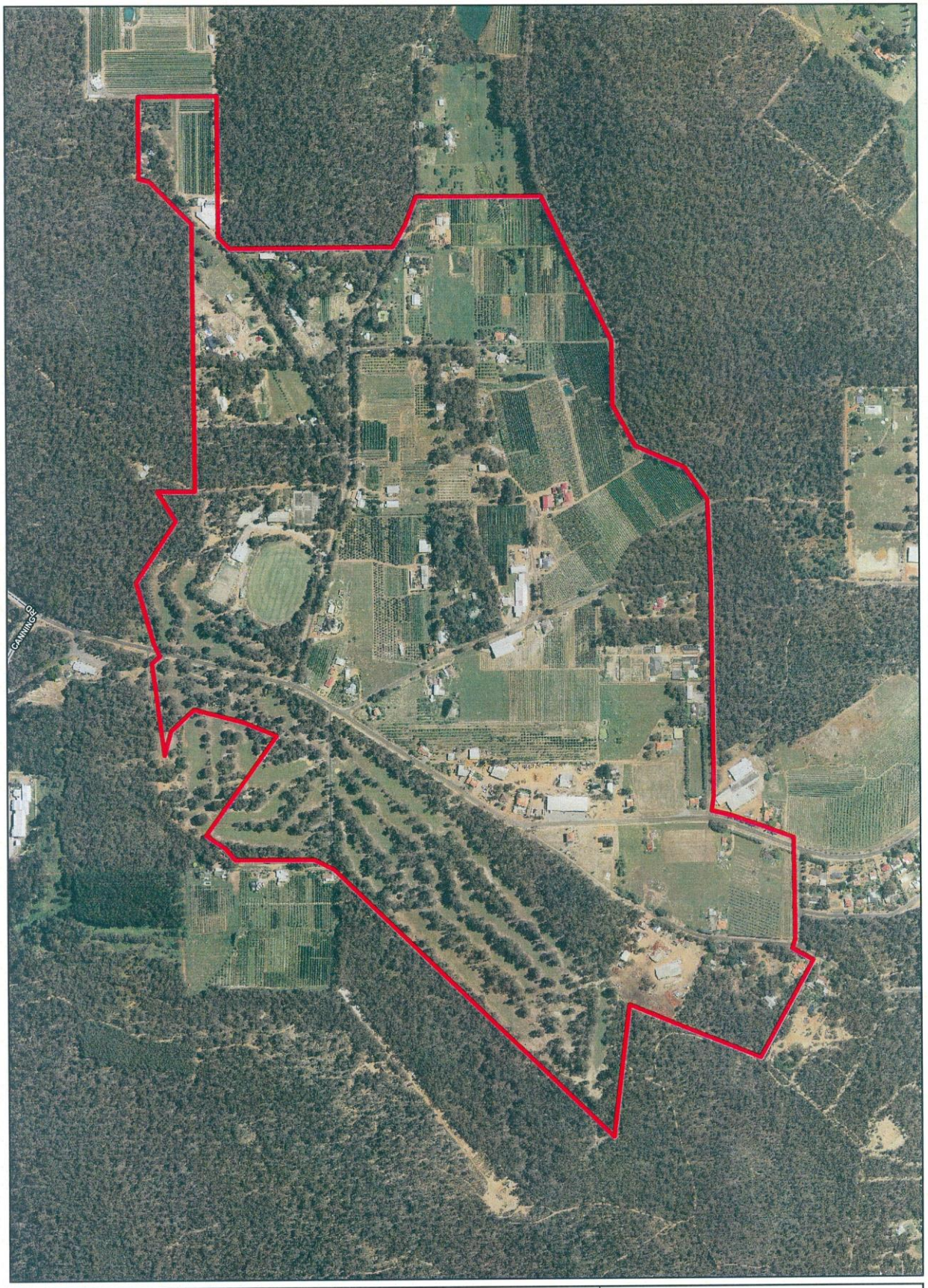
Yours faithfully

B.W. Harris

B.W. Harris. AFSM. ACM.
FirePlan WA.

Attachment 1 Pickering Brook Concept Plan
2 Slope Analysis.
3 Bush Fire Hazard Assessment.
4 Bush Fire Prone Areas.
5 Building Protection Zone standard.

Attachment 1 Pickering Brook Concept Area



PICKERING BROOK

1:8,000

200 100 0 200 Metres

Map Produced: 30/04/2014 Author: K. Ito

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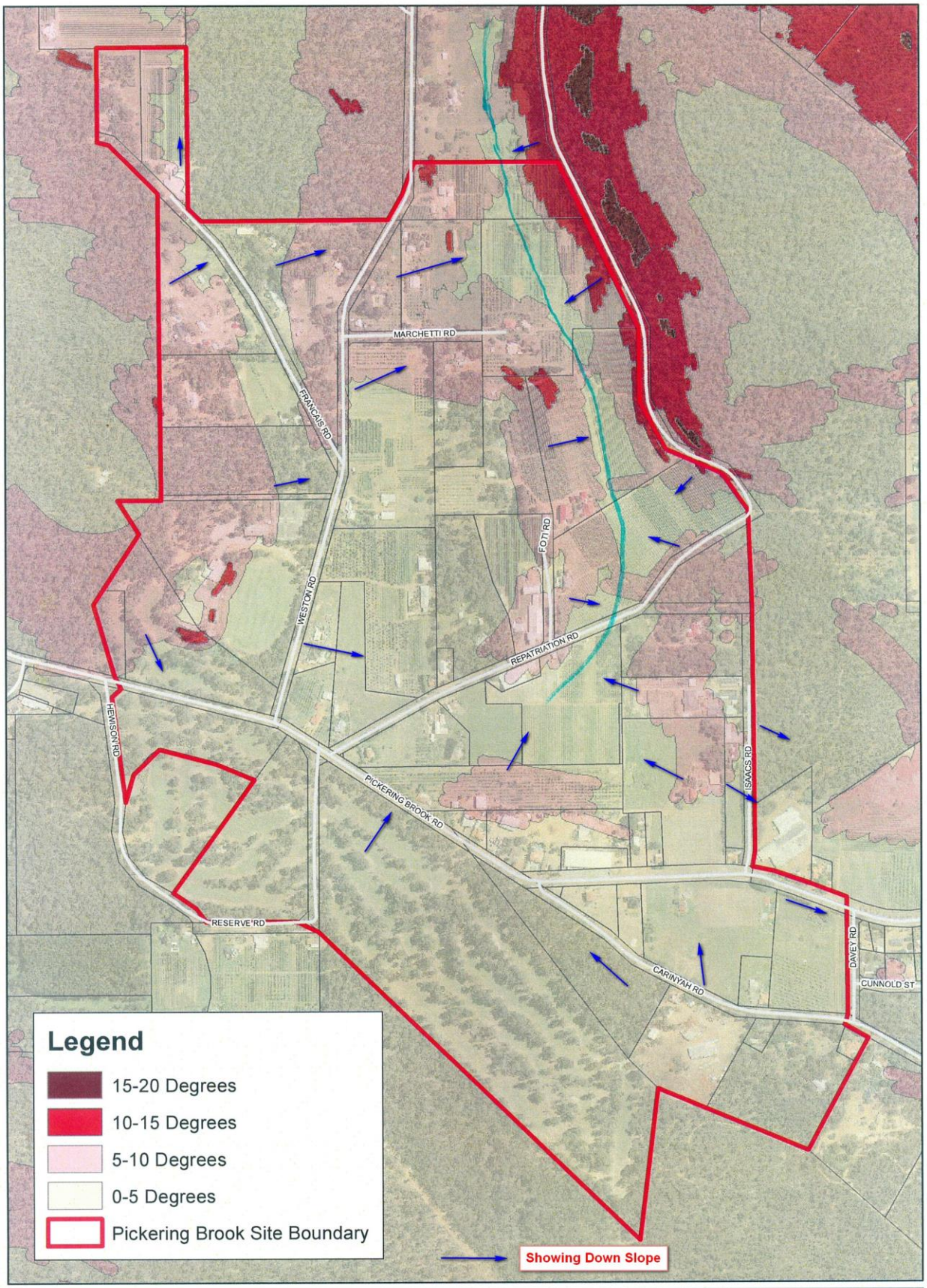
Attachment 2 Slope Analysis.



PICKERING BROOK - SLOPE ANALYSIS

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Attachment 3 Bush Fire Hazard Assessment

Attachment 4 Bush Fire Prone Areas

Attachment 5 Building Protection Zone Standards

- fuel load: reduced to and maintained at 2 tonnes per hectare
- trees (crowns) are a minimum of 10 metres apart
- trees are low pruned at least to a height of 2 metres
- no tall shrub or tree is located within 2 metres of a building (including windows)
- there are no tree crowns overhanging the building
- fences and sheds within the building protection zone are constructed using non-combustible materials (e.g. colour bond iron, brick, and limestone)
- shrubs in the building protection zone have no dead material within the plant
- tall shrubs in the building protection zone are not planted in clumps close to the building i.e. within3 metres
- trees in the building protection zone have no dead material within the plant's crown or on the bole(trunk).

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Appendix 5

Transport Impact Assessment (KCTT)

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TRANSPORT IMPACT ASSESSMENT

Pickering Brook Townsite Expansion,

Pickering Brook

June 2016,

Rev B

kctt

HISTORY AND STATUS OF THE DOCUMENT

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Rev A	20.03.2015	C Kleyweg	C Kleyweg	20.03.2015	Issued for Review
Rev B	13.06.2016	C Kleyweg	C Kleyweg	13.06.2016	Revised in accordance with the comments received from the client

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Revision	Date of issue	Quantity	Issued to
Rev A	20.03.2015	1 (PDF)	Mrs Nina Lytton and Mr Jordan Koroveshi (Shire of Kalamunda)
Rev B	13.06.2016	1 (PDF)	Mr Murray Casselton (TPG), Mrs Nina Lytton and Mr Jordan Koroveshi (Shire of Kalamunda)

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Project Manager	Colin Kleyweg
Name of the Project	Pickering Brook Townsite Expansion
Name of the Document	Pickering Brook Townsite Expansion - Transport Impact Assessment
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Table of Contents

Tables

Appendix

Appendix 1 - The layout of the Indicative Development Precinct Plan

Appendix 2 - Transport Planning and Traffic Plans

KC00315.000_S01 Pickering Brook Townsite Expansion - Shire of Kalamunda LPS No 3 (Map 8)
KC00315.000_S02 Pickering Brook Townsite Expansion - PBN Plan
KC00315.000_S05 Pickering Brook Townsite Expansion - Existing Traffic Counts

Appendix 3 - Typical Road Cross Sections

1. Introduction

1.1 Transport Impact Assessment Layout

KCTT have been requested to provide a Transport Impact Assessment for the development of the Pickering Brook Townsite Expansion. The purpose of this document is to provide detailed commentary and analysis on the potential traffic and transport impacts that the proposed development of this project area may have on both the surrounding road and transportation networks in order to support MRS amendment request. The scope of this report is, therefore, to provide a detailed assessment of the following: -

Undertake an analysis to support an MRS amendment to rezone the land from Rural to Urban: -

- An analysis of the road network within and surrounding the Pickering Brook Townsite: -
    - Determine the expected future traffic volumes accessing Pickering Brook Road via the Repatriation Road/Hewson Road intersection, Carinyah Road/Davey Road intersection, Cunnold Street and Merrivale Road, taking into consideration the planned residential densities;
    - Assess Pickering Brook Road and Carinyah Road between Davey Road Merrivale Road in terms of capacity, turning movements and safety.

  The assumptions in the models will include: -
    - Increased residential densities;
    - Additional road connections required for fire safety as per the Indicative Development Staging Plan's "Future Road Connections"; and
    - Upgraded road reserve widths (min. 20m) to accommodate the movement of agricultural vehicles and trucks. KCTT will provide confirmation of road width requirements based on vehicular requirements, safety requirements and vehicle volumes.
- Collate all available traffic volumes from Main Roads WA and the Shire of Kalamunda within the development as described above.
- Collate all updated crash data for roadways and intersections within a 400 metre radius of the development and provide comments on the safety of the area in terms of its crash rates.
- Estimate the development's trip generation / attraction on the basis of the proposed land-use quantities and areas.
- Provide colour graphics showing existing and future traffic volumes and traffic flows.

This Transport Impact Assessment is presented in the following logical sequence: -

- Section 1 – Introduction

This section provides a brief description on the role of this report in the MRS amendment process, the general layout of the report and a list of the guideline and reference documents used in its composition.

- Section 2 – Transport Impact Assessment

This section provides research and analysis of the key items required for submission of a Transport Impact Assessment in accordance with the Transport Assessment Guidelines nominated above. In this section, KCTT have examined the following: -

- Section 2.1 – Project Outline

In consultation with TPG, we will provide a brief description of the project area and its proposed land uses.

- Section 2.2 – Existing Situation and External Traffic Networks

This section provides a description of the existing land uses within the project area and collates all available traffic data from both within, and external to the project area.

- Section 2.3 – Traffic Modelling for the Proposed Development

This section describes KCTT's 4-step model which is used to determine the future traffic generation / attraction to and from the proposed development.

- Section 2.4 – Vehicle Access and Parking Requirements

This section generically describes vehicle access and parking requirements for individual land uses within the project area. Each development proposal will be required to address on-site vehicular access and parking requirements in detail. This section will discuss a broad framework for the consideration of these issues.

- Section 2.5 – Provision for Service Vehicles

This section provides generic descriptions for service vehicle requirements throughout the project area. Each of the proposed land uses will be required to examine requirements for service vehicles, pending confirmation of the land uses proposed.

- Section 2.6 – Hours of Operation

This section describes the general operating times for the land uses as they are proposed in the project area. This information assists in determining the likely timing of the AM and PM peaks, and therefore the peak impact on the existing and surrounding transportation network. The peak vehicle generation is the key for determining intersection capacities within a road network.

- Section 2.7 – Public Transport Access

This section provides a summary of the existing public transportation services available within an 800 metre radius of the development's boundaries and provides commentary on whether any services are likely to be extended into the development.

- Section 2.8 – Pedestrian and Cyclist Access

This section provides a summary of the existing pedestrian and cyclist infrastructure available within an 800 metre radius of the development's boundaries and provides commentary on the infrastructure likely to be extended into the development.

- Section 3 – Transport Impact Assessment Checklist

This section provides a concise, tabulated summary and review of the detailed information presented in Section 2 of this report. The intention of this checklist is to document the findings of this report, and / or any of the likely transportation / safety issues which should be considered as part of the submission. This checklist has been developed in accordance with the requirements of the Transport Assessment Guidelines for Developments: Structure Plan Submissions.

1.2 Notes Pertaining to This Report

The purpose of this document is to undertake the following analysis to support a Metropolitan Region Scheme and Local Planning Scheme amendment to rezone the land from rural to urban. Whilst the final site yields and land-uses are subject to change, the traffic and transportation requirements discussed in this report are based on the land uses and yields proposed in accordance with the Indicative Development Concept Plan. The yields have been nominated by TPG Town Planning, Urban Design and Heritage dated July, 2014.

1.3 Available Information and Technical Literature

This section provides a brief description of the inputs used in the compilation of this report:

- WAPC Transport Impact Assessment Guidelines – Volume 2 Structure Plans;
- WAPC Transport Impact Assessment Guidelines – Volume 5 (referenced for PM peak hour and traffic splits);
- RTA NSW Guide to Traffic Generating Developments Version 2.2 October 2002 (referenced to determine trip generation / attraction rates for various land uses);
- Guide to Traffic Management – Part 3: Traffic Studies and Analysis, Austroads, 2008 (referenced to discuss requirements for provision of car parking for various land use types, and how trip attraction / generation rates can be cross-checked in this report to provide a robust and consistent transportation model);
- Guide to Traffic Management – Part 11: Parking, Austroads, 2008 (referenced to discuss requirements for provision of car parking for various land use types, and how trip attraction / generation rates can be cross-checked in this report to provide a robust and consistent transportation model);
- Guide to Traffic Management – Part 12: Traffic Impacts of Developments, Austroads, 2008 (referenced to discuss requirements for provision of car parking for various land use types, and how trip attraction / generation rates can be cross-checked in this report to provide a robust and consistent transportation model);
- Shire of Kalamunda Local Planning Scheme No 3, Updated to include AMD 70 GG 08/04/16, Original Town Planning Scheme Gazettal Date: 22 March 2007
- Shire of Kalamunda Local Planning Strategy, 2010.

2. Transport Impact Assessment

2.1 Project Outline

Pickering Brook is a rural area locality situated within the Shire of Kalamunda, characterised by low-density housing, agricultural activities and a rural lifestyle. Pickering Brook is primarily made up of various orchards, surrounded by state forest reserves.

An Indicative Development Concept Plan for the Pickering Brook Townsite Expansion has been utilised for the purpose of this analysis in order to identify the potential land-use and transportation issues. The development yields utilised in this report are conceptual in nature and as a result, full plans of this Indicative Development Concept Plan will not be provided with this report.

The Indicative Development Precinct Plan comprises of subdividing the existing landholdings in the Pickering Brook Townsite into a new layout containing 302 lots, a local centre and a POS. The proposed subdivision will consider increased residential densities (R2.5 and R5) and most likely additional road connections. The Recreational Centre and Golf Course will keep their existing land use.

Table 1 - Quantities of Proposed Land Uses

Precinct	Block	Proposed Land Use	Yield
1	1A	Residential	7
	1B	Residential	16
	1C	Local Centre	app. 1,500m^2
	1D	Residential	4
Subtotal			**27 + Local Centre**
2	2A	Residential	7
	2B	Residential	32
	2C	Residential	21
	2D	Residential	13
	2E	Residential	19
Subtotal			**92**
3	3A	Residential	9
	3B	Residential	24
	3C	Residential	22
	3D*	POS	app. 30,000m^2
Subtotal			**55 + POS**
4	4A	Residential	12
	4B	Residential	20
	4C	Residential	48
Subtotal			**80**
5	5A	Residential	48
Subtotal			**48**
Total Yield - All Precincts			**302 Lots + Local Centre + POS**

*Note: * This land use will not be taken into consideration when calculating both the parking provision and the traffic generated from the proposed development.*

The Shire of Kalamunda's Local Planning Strategy states the following:

Some scope exists for further subdivision of the land in the town site of Pickering Brook to a minimum of 2,000sqm and the expansion of the Residential Bushland (4,000sqm lots) zone to land immediately abutting the town site to allow for the creation of additional lots. There is also potential for a small commercial activity centre at the centre of Pickering Brook to cater for neighbourhood services and to create a focus for the settlement. Consideration should therefore be given to the preparation of a structure plan for the Pickering Brook Town Site to guide further subdivision in the town site area. (pages 89, 90)

Key Issue: Future of Pickering Brook

Pickering Brook is relatively isolated from Kalamunda and most of the Town Centre uses. In addition, there has been a demand expressed that a greater variety of housing is needed in the Pickering Brook locality to cater for the existing demographic profile. As a result it is proposed that land should be identified in the centre of the Pickering Brook settlement for closed subdivision to 4,000sqm lots to provide housing for the ageing local community. In addition, a focal area for a small neighbourhood activity centre should be identified to serve the local community. (page 123)

Plan showing the proposed development has been provided in Appendix 1 of this report.

2.2 Existing Situation and External Traffic Networks

The existing road network surrounding and within the project area includes Pickering Brook Road and Carinyah Road to the south, Weston Road to the west, Francais Road to the northwest, Marchetti Road to the north, McCorkill Road, Repatriation Road, Foti Road, Isaacs Street and Davey Road to the east and Reserve Road and Hewison Road to the southwest. A plan showing the existing network and distribution of the existing traffic volumes is provided in Appendix 2.

Pickering Brook Road is a two-way, two-lane undivided road, classified as a Rural Local Road / Local Distributor (between Canning Road and Davey Road) and a Significant Urban Local Road / Local Distributor (between Davey Road and Merrivale Road). The road pavement is approximately 8.0 metres wide with a road reserve width of 20.0m. There are no bus services running along this road; however, a cyclist path of 2.0 metres width is provided on the southern side of the road reservation. Pickering Brook Road has a speed limit of 70kph (west of Woodbine Road).

In the vicinity of the project area, **Carinyah Road**, **Weston Road, Francais Road, Marchetti Road, McCorkill Road, Foti Road, Isaacs Street, Davey Road, Reserve Road and Hewison Road** (road reserve width 20.0m) are two-way, two-lane undivided roads classified as Urban Local Roads / Access Roads by Main Roads WA. The legal speed limit on these roads is 50kph. There are no bus services running along these roads.

Repatriation Road is a two-way, two-lane undivided road, with each lane being approximately 3.0 metres wide and a road reserve width of 20.0 metres. Repatriation Road is classified as an Urban Local Road / Access Road with a sign-posted speed limit of 70kph.

It is expected that that there will be several new roads within the proposed development; however, the location of these roads is still yet to be determined.

The following existing traffic volume information has been sourced from MRWA and the Shire of Kalamunda.

Table 2 - Traffic Volumes for the Surrounding Road Network

Road Name	Functional Classification / Road Hierarchy	Location of Traffic Count	Vehicles Per Day (VPD)	Vehicles per Peak Hour (VPH)	Heavy Vehicle %	Year	Legal Speed Limit
Pickering Brook Road	Significant Urban Local Road / Local Distributor	West of Merrivale Road	919	AM 0800 - 122 PM 1445 - 112	11.6	Feb 2011	70kph
		300m East of Neave Street	1,081	AM 0800 - 153 PM 1500 - 134	n.a.	Aug 2013	
Repatriation Road	Urban Local Road / Access Road	450m North of McCorkill Road	77	AM 1100 - 6 PM 1600 - 7	n.a.	Sept 2013	70kph

Formal peak hour data has been recorded and is shown in Table 2. An analysis of available traffic data within 600 metres of the development suggests: -

Pickering Brook Road (300m east of Neave Street):

- AM peak occurs in the period between 08:00-09:00. Traffic volumes in the AM peak are approximately 14.15% of total daily volumes; and
- PM peak occurs in the period between 15:00-16:00. Traffic volumes in the PM peak are approximately 12.4% of total daily volumes.

Repatriation Road (450m north of McCorkill Road):

- AM peak occurs in the period between 11:00-12:00. Traffic volumes in the AM peak are approximately 7.79% of total daily volumes; and
- PM peak occurs in the period between 16:00-17:00. Traffic volumes in the PM peak are approximately 9.09% of total daily volumes.

2.2.1 Crash Data

The following table shows a collation of crash data from the Main Roads WA database for crashes and incidents for roads adjacent to the project area between the 1st January 2011 and 31st December 2015.

Table 3 - Crash Data

Road Name	Road Hierarchy	Functional Classification	Speed Limit	Crash Statistics	
Pickering Brook Road & Repatriation Road	Rural Local Road / Urban Local Road	Local Distributor / Access Road	70kph / 70kph	Total of 1 incident: • 1 Hospital MR Type: • 1 Other / Unknown	MR Nature: • 1 Right Angle
Pickering Brook Road & Canning Road	Rural Local Road / Rural Local Road	Local Distributor/ Regional Distributor	70kph / 70kph	Total of 9 incidents: • 1 Medical • 6 PDO Major • 2 PDO Minor MR Type: • 9 Other / Unknown	MR Nature: • 6 Rear End • 2 Right Angle • 1 Right Turn Thru

Pickering Brook Road (0.00 - 7.43)	0.00 - 1.71 - Rural Local Road 1.71 - 2.90 - Significant Urban Local Road 2.90 - 3.36 - Rural Local Road	0.00 - 3.36 - Local Distributor 3.36 - 7.43 - Access Road	0.00 - 5.56 70kph 5.56 - 7.43 50kph	Total of 7 incidents: • 3 Hospital • 3 PDO Major • 1 PDO Minor MR Type: • 7 Other / Unknown	MR Nature: • 1 Head On • 4 Hit Object • 2 Non Collision
Canning Road (8.99 to 14.16)	Rural Local Road	Regional Distributor	8.99 - 10.21 70kph 10.21 - 14.16 90kph	Total of 11 incidents: • 2 Hospital • 2 Medical • 6 PDO Major • 1 PDO Minor MR Type: • 2 Involving Animal • 9 Other / Unknown	MR Nature: • 1 Rear End • 1 Right Angle • 6 Hit Object • 2 Non Collision • 1 Other / Unknown
Repatriation Road (0.00 to 2.66)	Urban Local Road	Access Road	70kph	Total of 2 incidents: • 1 Medical • 1 PDO Major MR Type: • 2 Other / Unknown	MR Nature: • 2 Hit Object
Carinyah Road (0.00 – 6.77)	Urban Local Road	Access Road	50kph	Total of 1 incident: • 1 PDO Major MR Type: • 1 Involving Animal	MR Nature: • 1 Hit Object

2.3 Traffic Modelling for the Proposed Development

This section provides a detailed description of how traffic volumes are calculated for the proposed development. Our traffic model uses a 4-step approach for the estimation of transportation demand into and out of the project area:

- Step 1 - Confirm the size and quantum of the proposed land uses;
- Step 2 - Confirm how these land uses impact travel patterns and the generation / attraction of transportation trips;
- Step 3 - Confirm where the likely origins of travel external to the development are located and confirm the likely destinations for travel from the subject landholdings; and
- Step 4 - Distribute the traffic through the network.

2.3.1 Step 1 - Quantum of Proposed Land Uses

The Indicative Development Concept Plan proposes usage of the landholdings for residential purposes together with a Local Centre and a POS.

The WAPC Transport Assessment Guidelines for Developments (Volume 5) offers the following vehicle trip generation rates for the land uses proposed within the development: -

- **Residential** - 0.8 vehicle trips per dwelling for the AM and PM peak hours. A 25% IN / 75% OUT split has been adopted for the AM peak and a 67% IN / 33% OUT split for the PM peak hour;
- **Retail / Shopping Centres (with significant food retail component)** - 10 vehicular trips per 100m^2 of NLA for PM Peak and 2.5 trips per 100m^2 for the AM peak hour. A 50%IN / 50%OUT split has been adopted for the PM peak and an 80%IN / 20%OUT split for the AM peak hour;

Given that the WAPC does not offer daily vehicle trip generation rates for the land uses proposed within the development, the following rates are provided in the NSW RTA Guide to Traffic Generating Developments:

- **Residential** (dwelling houses) - 9 vehicular trips per dwelling (between 16:00 & 17:00);
- **Retail** (less than 10,000m^2) - 121 vehicular trips per 100m^2 of NLA.

KCTT believe that a rate of 9 vehicular trips per dwelling is suitable for this development as it is located in an outer lying metropolitan area with no available public transport.

It has been assumed that the Local Centre's attractions will comprise of 60% from the development and 40% from the surrounding community. Therefore, it is assumed that the additional traffic generation from the Local Centre is 48 VPD and 4 VPH.

The following table outlines the traffic generation of the proposed development based on the above rates.

Table 4 - Traffic Generation of the Proposed Development

Precinct	Yield	WAPC Transport Assessment Guidelines for Developments / NSW RTA Guide to Traffic Generating Developments Requirement	Total VPD	Total VPH (Peak)
1A	7	9 vehicle trips per lot (daily traffic); 0.8 vehicle trips per lot (AM / PM Peak)	63 VPD	6 VPH
1B	16		144 VPD	13 VPH
1C	app. 1,200m^2* NLA	48 VPD per 100m^2 of NLA (daily traffic); 4 VPH per 100m^2 of NLA (AM / PM Peak)	576 VPD	48 VPH
1D	4	9 vehicle trips per lot (daily traffic); 0.8 vehicle trips per lot (AM / PM Peak)	36 VPD	3 VPH
Subtotal - Precinct 1			**819 VPD**	**70 VPH**
2A	7	9 vehicle trips per lot (daily traffic); 0.8 vehicle trips per lot (AM / PM Peak)	63 VPD	6 VPH
2B	32		288 VPD	26 VPH
2C	21		189 VPD	17 VPH
2D	13		117 VPD	10 VPH
2E	19		171 VPD	15 VPH
Subtotal - Precinct 2			**828 VPD**	**74 VPH**
3A	9	9 vehicle trips per lot (daily traffic); 0.8 vehicle trips per lot (AM / PM Peak)	81 VPD	7 VPH
3B	24		216 VPD	19 VPH

3C	22		198 VPD	18 VPH
3D	/	/	/	/
Subtotal - Precinct 3			**495 VPD**	**44 VPH**
4A	12	9 vehicle trips per lot (daily traffic); 0.8 vehicle trips per lot (AM / PM Peak)	108 VPD	10 VPH
4B	20		180 VPD	16 VPH
4C	48		432 VPD	38 VPH
Subtotal - Precinct 4			**720 VPD**	**64 VPH**
5A	48	9 vehicle trips per lot (daily traffic); 0.8 vehicle trips per lot (AM / PM Peak)	432 VPD	38 VPH
Subtotal - Precinct 5			**432 VPD**	**38 VPH**
Total			**3,294 VPD**	**290 VPH**

Note The Net Lettable Area (NLA) of the Local Centre has been taken as 80% of the Gross Floor Area (GFA) due to the likely inclusions of verandahs, storage and loading bays in the Local Centre's design.*

2.3.2 Step 2 - Trip Purposes

To understand the likely demand for alternative transportation modes including public transportation trips; cyclist and pedestrian trips; and the impact of the vehicular traffic on the adjacent road network, it is important to understand why people are travelling into and out of the project area. These general trip purposes include employment, shopping, social, education and other general purposes. Each land usage will generate / attract a unique matrix of trip purposes. For example, the following table shows the likely percentage share for different trip purposes based on the land usage: -

Table 5 - Trip Purposes by Land Use

Land Use Type	Employment	Shopping	Education	Social / Recreational
Residential	40%	25%	17.5%	17.5%
Local Centre	20%	60%	n.a.	20%

2.3.3 Step 3 - Expected Origin / Destination

The expected origin / destination matrix is important to determine the likely route of vehicular and other travel. Table 6 (below) describes the expected trip purposes for trips generated by the proposed land uses within the development and the likely destinations.

Table 6 - Table of Trip Purposes and Likely Destinations

Land Use Type	Trip Purpose	Likely Destination
Residential	• Employment	The economic profile in the Shire of Kalamunda shows that according to the latest census, 35.2% of people employed also live in the area and 64.8% live in the area but work outside. Therefore, the majority of employment trips will be external to the proposed development. The Kalamunda i.d. website on the Shire of Kalamunda's webpage suggests the following breakdown for employment destinations for residents of the Shire of Kalamunda: • Kalamunda - 23.7% • Canning - 9.7% • Swan - 9.2%

		• Belmont - 8.2% • Perth (Inner) - 5.0% • POW No Fixed Address (WA) - 4.2% • Perth (Remainder) - 4.0% • POW (State)/Territory Unidentified (WA) - 3.9% • Victoria Park - 3.7% • Gosnells - 3.5%. • Other - 24.9% (http://profile.id.com.au/kalamunda/residents) We, therefore, believe that the following roads will be used for access / egress to the site: - • Pickering Brook Road; • Repatriation Road; • Cunnold Street; • Carinyah Road. Excluding work from home, the other sources of employment in this area are the proposed Local Centre and agriculture and ancillary support services such as truck sales / servicing. Tourism will also provide employment as it plays an important role in the area.
		Journey to work data: • Car as Driver - 67.6% • Car as Passenger - 4.9% • Bus - 3.4% • Train - 2% • Bicycle - 0.5% • Walked only - 1.5% • Working from home - 4.2% • Other - 15.9%
	• Shopping	• Lesmurdie Village Shopping Centre is located approximately 6.7km to the northwest of the project area. • Kalamunda Central Shopping Centre is located approximately 8.4km to the northwest of the project area. • Roleystone Shopping Centre is located approximately 9.1km to the southwest of the project area.
	• Education	• Pickering Brook Primary School is located approximately 1.2km to the east of the project area.
	• Social / Recreational	• George Spriggs Reserve is located within the project area north of Pickering Brook Road / west of Weston Road. • Pickering Brook Golf Club is located within the project area south of Pickering Brook Road / Carinyah Road and north of Pickering Brook Road / west of Weston Road. • Carilla Camping Ground is located immediately to the east of Pickering Brook Primary School. • Korrung National Park surrounds the project area.
Local Centre	• Employment	• The local centre is not expected to be a large attractor for employment purposes.

	• Shopping / Social	• At this point the full range of uses that will be located within the local centre have not been determined. Therefore, the local centre is treated as commercial premises for the purposes of this report.

2.3.4 Step 4 - Destination Matrix and Distribution of Traffic / Transport

Land uses can be generally classified as trip generators and / or trip attractors. Given the nature of the development, the project area will generate almost 100% of its trips from internal sources. The project area will be accessed via Pickering Brook Road, Repatriation Road, Cunnold Street and Carinyah Road.

The subject site offers direct vehicular access via Pickering Brook Road. This road provides connectivity to Canning Road to the west and Pickering Brook settlement to the east. All proposed and existing intersections will be designed to have full unrestricted movement of vehicles.

In summary, the total site development scenario is expected to generate approximately **3,294 vehicular movements per day** with a forecasted impact of around **290 vehicles per hour in the peak hour.**

Taking into consideration the breakdown for the typical residents' locations of work in the Shire of Kalamunda (refer the Shire of Kalamunda ID profile above), KCTT believe that the traffic from the development will be distributed into the adjacent road network as follows: -

- 78% to / from the west via Pickering Brook Road - 0.78*3,294 = 2,569 VPD;
    - 58% to / from the west via Canning Road - 0.58*3,294 = 1,911 VPD;
    - 20% to / from the south via Canning Road - 0.20*3,294 = 659 VPD;
- 14% to / from the east via Pickering Brook Road - 0.14*3,294 = 461 VPD;
- 2% to / from the east via Cunnold Street - 0.02*3,294 = 66 VPD;
- 3% to / from the north via Repatriation Road - 0.03*3,294 = 99 VPD;
- 3% to / from the south via Carinyah Road - 0.03*3,294 = 99 VPD.

Table 7, below, considers the traffic generation from the proposed development of the Pickering Brook Townsite Expansion and its impact upon the road network adjacent to the proposed development.

Table 7 - Forecasted Traffic Volumes on the Surrounding Road Network

Road Name	Functional Class / Road Hierarchy	Location of Traffic Count	Existing Traffic Volumes (VPD)	Estimated traffic growth at the rate of 3% per annum - 2026 (VPD)	Traffic generated / attracted by the development site (VPD)	Total VPD (2026)
Pickering Brook Road	Significant Urban Local Road / Local Distributor	West of Merrivale Road	919 (Feb 2011)	1,518	527	2,045
		300m East of Neave Street	1,081 (Aug 2013)	1,684	461	2,145
		West of LSP	N/A	1,684*	2,569	4,253
Repatriation Road	Urban Local Road / Access Road	450m North of McCorkill Road	77 (Sept 2013)	120	99	219

Note There was no existing traffic data for Pickering Brook Road West of the development and therefore the quantity of existing traffic has been assumed to be equal to the traffic count 300 metres East of Neave Street.*

2.4 Vehicular Access and Parking Requirements

Vehicular access / egress for the proposed development will mainly be from Pickering Brook Road.

The parking requirements and vehicular access requirements for the proposed landholdings within the project area will be examined in detail as specific Development Applications are provided for each of the proposed allotments within the development.

2.4.1 Vehicle Parking Requirements

The Shire of Kalamunda's Local Planning Scheme No 3 stipulates that parking provisions should be made in accordance with the following ratios and rates (Table 3 - Parking Requirements):

- **Community Purpose** - 1 bay for every 5 persons the facility is designed to accommodate.
- **Office** - 4 bays per 100m^2 of NLA.
- **Retail (Shop)** - 5 bays per 100m^2 of NLA.

The vehicle parking requirements will be reviewed as part of any Development Application for land uses other than residential.

2.4.2 Bicycle Parking

The Shire of Kalamunda does not provide requirements for the provision of bicycle parking.

It is most likely that with the local centre and the expansion of the Townsite, the utilisation of bicycles within Pickering Brook will be more viable and attractive to residents. This will be supported by dual use footpaths, providing safe connectivity to the residential land usages. There are also numerous attractions in and surrounding Pickering Brook, with it being possible that more attractions may occur as a result of the Townsite expansion. This includes the Core Cidery; the Hidden Valley Eco Spa Lodges and Day Spa; and the Due Jolly Winery. This expansion allows for a vibrant and effective community that utilises cycling as a means of transport, recreation and fitness.

To support cycle planning, effective bicycle parking facilities would be required at all end of trip destinations. This would include both the local centre and places of attractions. Sufficient bicycle parking facilities will need to be discussed with the Shire of Kalamunda in order to cater for the proposed community.

2.4.3 ACROD Parking

The commercial component of the development can be classified as Classes 5, 6 and 9b according to the Australian Building Code and requires provision for the minimum number of ACROD bays as follows:-

Class 5 - *(An office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9)*:

- 1 ACROD bay for every 100 carparking spaces or part thereof.

Class 6 - (*A shop or other building for the sale of goods by retail or the supply of services direct to the public. Example: café, restaurant, kiosk, hairdressers, showroom or service station)*:

- Up to 1,000 carparking spaces - 1 ACROD bay for every 50 carparking spaces and 1 ACROD bay for each additional 100 carparking spaces or part thereof in excess of 1,000 carparking spaces.

Class 9b - *(An assembly building, including a trade workshop, laboratory or the like, in a primary or secondary school, but excluding any other parts of the building that are of another class)*:

- School - 1 ACROD bay for every 100 carparking spaces or part thereof.
- Other assembly building -
  - Up to 1,000 carparking spaces - 1 ACROD bay for every 50 carparking spaces or part thereof and 1 ACROD bay for each additional 100 carparking spaces or part thereof in excess of 1,000 carparking spaces.

These requirements will be reviewed as part of the respective Development Applications for each of the sites.

2.5 Management of Traffic Attracted to the Development

2.5.1 Hours of Operation

The majority of land uses within the development is residential; however, some future landholdings to the south of the development are likely to influence morning and afternoon peaks into the future.

In the short-term it is likely that AM and PM peaks will coincide with journey to / from work times. As such, morning and afternoon peaks are likely to be around 08:00 to 09:00 and 15:30 to 16:30 during work days.

The exact hours of operation for the Local Centre will be determined once the range of uses within the Local Centre becomes known. However, it is reasonable to expect that the Local Centre will be operational between 8:00 to 20:00 with peak usage in weekday evenings and on Saturdays.

It is therefore likely that the AM and PM Peak will coincide with the peak AM and PM hour period on Pickering Brook Road.

2.5.2 Public Transport Access

Public transportation service (Route No 281) serviced the Pickering Brook region along Pickering Brook Road up until December, 2014; however, this service is no longer available.

KCTT has discussed the prospects of future public transport for the proposed project area with the Public Transport Authority (PTA), who have expressed that even with consideration to the development, a bus service to the Pickering Brook area would be low-priority for the PTA. However, they did propose that a service could potentially be reinstated to the site if it was fully funded by either a local developer or the Shire of Kalamunda on a long term funding arrangement.

2.5.3 Pedestrian and Cyclist Access

The following is a list of the major cyclist infrastructure within an 800 metre radius of the project area: -

- Pickering Brook Road (east of Canning Road), Repatriation Road and Forrest Road are classified as PBN "Good Road Riding Environment" routes.

The Munda Biddi cyclist trail runs through parts of Korung National Park as well as several other walk trails.

Carmel Walk Trail is located immediately to the north of the project area.

There is initiative to improve the link from Kalamunda to Bickley to Pickering Brook for walkers and cyclists (Perth Hills Trails Master Plan, May 2013).

Cyclist routes in the area are shown in Appendix 2 on KC00315.000_S02 PBN Plan.

3. Transport Impact Assessment Checklist

The following is the summary / checklist for a Transport Impact Assessment as shown in the Department for Planning and Infrastructure's Transport Assessment Guidelines – Part 2: Structure Plans.

Item	Status	Comments / Proposals
Summary	Y	The Indicative Development Precinct Plan comprises of subdividing the existing landholdings in the Pickering Brook Townsite into a new layout containing 302 lots, a local centre and a POS. The proposed subdivision will consider increased residential densities (R2.5 and R5) and most likely additional road connections. The Recreational Centre and Golf Course will keep their existing use. The purpose of this document is to undertake the following analysis to support a Metropolitan Region Scheme and Local Planning Scheme amendment to rezone the land from rural to urban.
Introduction / Background	Y	KCTT have completed a Transport Impact Assessment using the data from the Indicative Development Concept Plan. We have completed this report and all supporting graphics in accordance with the full requirements of the WAPC Guidelines for the preparation of a Transport Impact Assessment - Part 2 (Structure Plans).
Development Proposal		
Regional Context	Y	The proposed project area fits within the general regional context. It is in accordance with the Shire of Kalamunda's Local Planning Strategy.
Proposed Land Uses	Y	The Indicative Development Precinct Plan proposes usage of the landholdings for residential purposes together with a Local Centre and a POS.
Table of Land Uses and Quantities	Y	Refer to Appendix 1 of this report for a plan of the proposed development. Refer to Section 2.1 of this report for a summary of the quantities of the proposed uses.
Major Attractors / Generators	Y	The major trip generators in this locality will be: • Residential - likely peaks from 08:00 to 09:00 and from 15:30 to 16:30 Mondays to Fridays. The major trip attractors in this locality will be: • Local Centre - likely peaks from 11:00 to 12:00 and from 18:00 to 19:00 Mondays to Fridays.
Specific Issues	Y	An Indicative Development Concept Plan for Pickering Brook Townsite Expansion has been utilised for the purpose of this analysis in order to identify the potential future development scenario and its potential issues. The purpose of this document is to undertake the analysis to support a potential future Metropolitan Region Scheme and Local Planning Scheme amendment to rezone the land from rural to urban.
Existing Situation		

Existing Land Uses Within The Project Area	Y	The existing land zoning is rural agricultural, with the recreational centre and golf course to the west and south of the proposed development.
Existing Land Uses Within 800 metres of the Project Area	Y	Residential and rural agricultural land use, parks and recreation.
Existing Road Network Within the Project Area	Y	The project area includes the following existing roads: - • Pickering Brook Road and Carinyah Road to the south, • Weston Road to the west, • Francais Road to the northwest, • Marchetti Road to the north, • McCorkill Road, Repatriation Road, Foti Road, Isaacs Street and Davey Road and to the east, and • Reserve Road and Hewison Road to the southwest.
Existing Pedestrian / Cyclist Network Within the Project Area	Y	• PBN "Good Road Riding Environment" route along Pickering Brook Road and Repatriation Road.
Existing Public Transport Services Within the Project Area	N/A	Refer to Section 2.5.2.
Existing Road Network Within 2 (or 5) km of Project Area	Y	Key desire lines: - • Canning Road / Pickering Brook Road; • Pickering Brook Road / Weston Road; • Pickering Brook Road / Repatriation Road; • Pickering Brook Road / Cunnold Street; • Pickering Brook Road / Carinyah Road.
Traffic Flows on Roads Within the Project Area (PM and/or AM Peak Hours)	Y	Refer to Section 2.2 for the existing traffic flows on the roads within the project area.
Traffic Flows on Roads within 2 (or 5) km of Project Area (AM and/or PM Peak Hours)	Y	Refer to Section 2.2 for the existing traffic flows on the adjacent road network.
Existing Pedestrian / Cycle Networks Within 800 metres of the Project Area	Y	The following is a list of the major cyclist infrastructure within an 800 metre radius of the project area: - • Pickering Brook Road (east of Canning Road), Repatriation Road and Forrest Road are classified as PBN "Good Road Riding Environment" route. Refer to KC00315.000_S02 PBN Plan in Appendix 2.

Existing Public Transport Services Within 800 metres of the Project Area	N/A	Refer to Section 2.5.2.
Proposed Internal Transport Networks		
Changes / Additions to Existing Road Network or Proposed Road Network	Y	It is expected that that there will be several new roads within the proposed project area, and that there would be potential changes to the existing roads (potential extension of Marchetti Road, McCorkill Road and Isaacs Street; potential closure of Foti Road).
Road Reservation Widths	Y	The existing Pickering Brook Road is classified as a Significant Urban Local Road / Local Distributor with: • 8.0m wide pavement; • Cyclist path = 2.0m southern side of the road; • Total reservation width = 20m. All other roads within the project area are classified as Urban Local Roads / Access Roads with: • 6.0m wide pavement; • Total reservation width = 20m. All internal roads shall be 20.0 metre width road reserves with each lane being 3.5 metres wide. Typical road cross-section for the Existing and Proposed Roads will be as follows: • Pavement width = 7.0m; • Dual use path / footpath = 2.0m on one side of the road; • Sealed Shoulder = 1.2m on each side of the road; • Typical V-neck drain = 3.3m and 5.3m on each side of the road; • Total = 20m width. Refer to Appendix 3.
Road Cross-Sections and Speed Limits	Y	Pickering Brook Road (west of Woodbine Road) and Repatriation Road have a speed limit of 70kph. Speed limit on all other roads to be 50kph. For cross sections refer to Appendix 3.
Intersection Controls	Y	All the intersections are designed to have full unrestricted movement of vehicles.
Pedestrian / Cycle Networks and Crossing Facilities	Y	Internal pedestrian and cyclist networks should be considered along internal roads within the project area.
Public Transport Routes	N/A	N/A
Changes to External Transport Networks		
Road Network	N	No proposed changes.

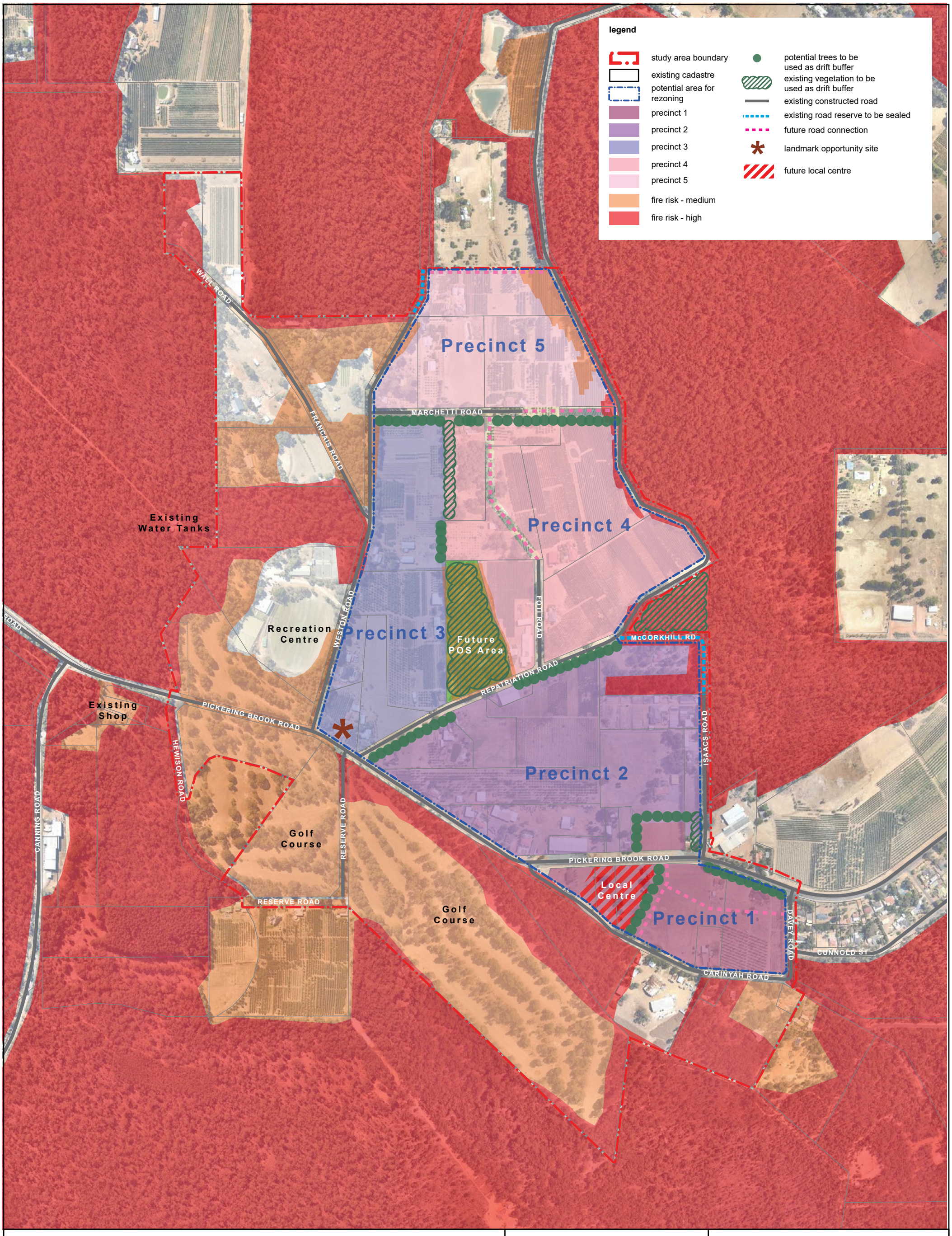
Intersection Controls	N	No proposed changes.
Pedestrian Cycle Networks and Crossing Facilities	Y	Existing cycle networks have been noted.
Public Transport Services	N/A	N/A
Integration with Surrounding Area		
Trip Attractors / Generators Within 800 metres of the Project Area	Y	Residential (generator) and rural agricultural land use (attractor), parks and recreation (attractor).
Proposed Changes to Land Uses Within 800 metres of the Project Area	N/A	N/A
Travel Desire Lines from the Project Area to Trip Attractors / Generators Within 800 metres of the Project Area	Y	• Pickering Brook Road / Canning Road for travel to the west and northwest; • Pickering Brook Road / Canning Road for travel to the west and southwest; • Pickering Brook Road / Repatriation Road for travel to the north; • Pickering Brook Road / Carinyah Road for travel to the south; • Pickering Brook Road for travel to the east.
Adequacy of External Transport Networks	Y	The existing external transport networks are likely to be suitable for the proposed development.
Deficiencies in External Transport Networks	N/A	None identified.
Remedial Measures to Address These Deficiencies	N/A	Not applicable.
Analysis of Internal Transport Networks		
Assessment Year(s) and Time Period(s)	Y	The proposed project area was observed as fully constructed.
Project Area Generated Traffic	Y	Refer to Table 4 - Section 2.3.
Extraneous (Through) Traffic	Y	Refer to Table 7 - Section 2.3.
Design Traffic Flows (i.e. Total Traffic)	Y	Proposed development traffic flows + existing Main Roads WA data provides the likely total vehicular flows for the current project area assessment. Refer to Section 2.3.

Road Cross-Sections	Y	Refer to Appendix 3.
Intersection Controls	Y	All the intersections are designed to have full unrestricted movement of vehicles to and from the project area.
Access Strategy	Y	The project area will be accessed via Pickering Brook Road, Repatriation Road, Cunnold Street and Carinyah Road.
Pedestrian / Cycle Networks	Y	Internal pedestrian and cyclist networks should be considered along internal roads within the development.
Safe Routes to Schools	Y	Pedestrian / Cyclist Networks along Pickering Brook Road are important to provide direct connection to and from the Pickering Brook Primary School to the east of the project area.
Pedestrian Permeability and Efficiency	Y	The proposed improvements and additions to the pedestrian path network promote connectivity, permeability and efficiency.
Access to Public Transport	N/A	N/A
Analysis of External Transport Networks		
Extent of Analysis	Y	Review of road and transportation networks undertaken to within an 800m radius of the project area.
Base Flows for Assessment Year(s)	Y	Traffic assessed as a base case, based on 2011 and 2013 traffic volumes from MRWA and the Shire of Kalamunda. KCTT have used a traffic growth rate of 3% per annum for all existing roads adjacent to / within the project area. The traffic impact of the development has been calculated for the year 2026.
Total Traffic Flows	Y	Refer to Table 7 - Section 2.3.
Road Cross-Sections	N/A	Not applicable.
Intersection Layouts and Controls	Y	All the intersections are designed to have full unrestricted movement of vehicles to and from the project area.
Pedestrian/Cycle Networks	N/A	Not applicable.
Conclusions		
Conclusions	Y	KCTT believe that the suitable pavement width for the existing and proposed internal road network is 7.0 metre width roadways plus minimum 1.2 metre width shoulders within a 20.0m wide road reserve. Considerations have also been given to providing cyclist and pedestrian paths and drainage infrastructure on the roads within the project area. Based on vehicular requirements, safety requirements and vehicle volumes, we believe this road reserve width is adequate for the proposed development allowing movements of agricultural vehicles and trucks. The findings of this report regarding the potential traffic and transportation requirements based on the land uses and yields proposed in accordance

		with the Indicative Development Concept Plan, support a Metropolitan Region Scheme and Local Planning Scheme amendment to rezone the land from rural to urban.

Appendix 1

The layout of the Indicative Development Precinct Plan



PLAN 3
Indicative Development Precincts
Pickering Brook

0 | 75 | 150m

Project Manager: MC
Drawn: GW
Checked: OP
Date: 3 March 2016
Scale: 1:7,500 @ A3
Drawing No. 713-432 CP 3 A

tpg
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The Planning Group WA Pty Ltd
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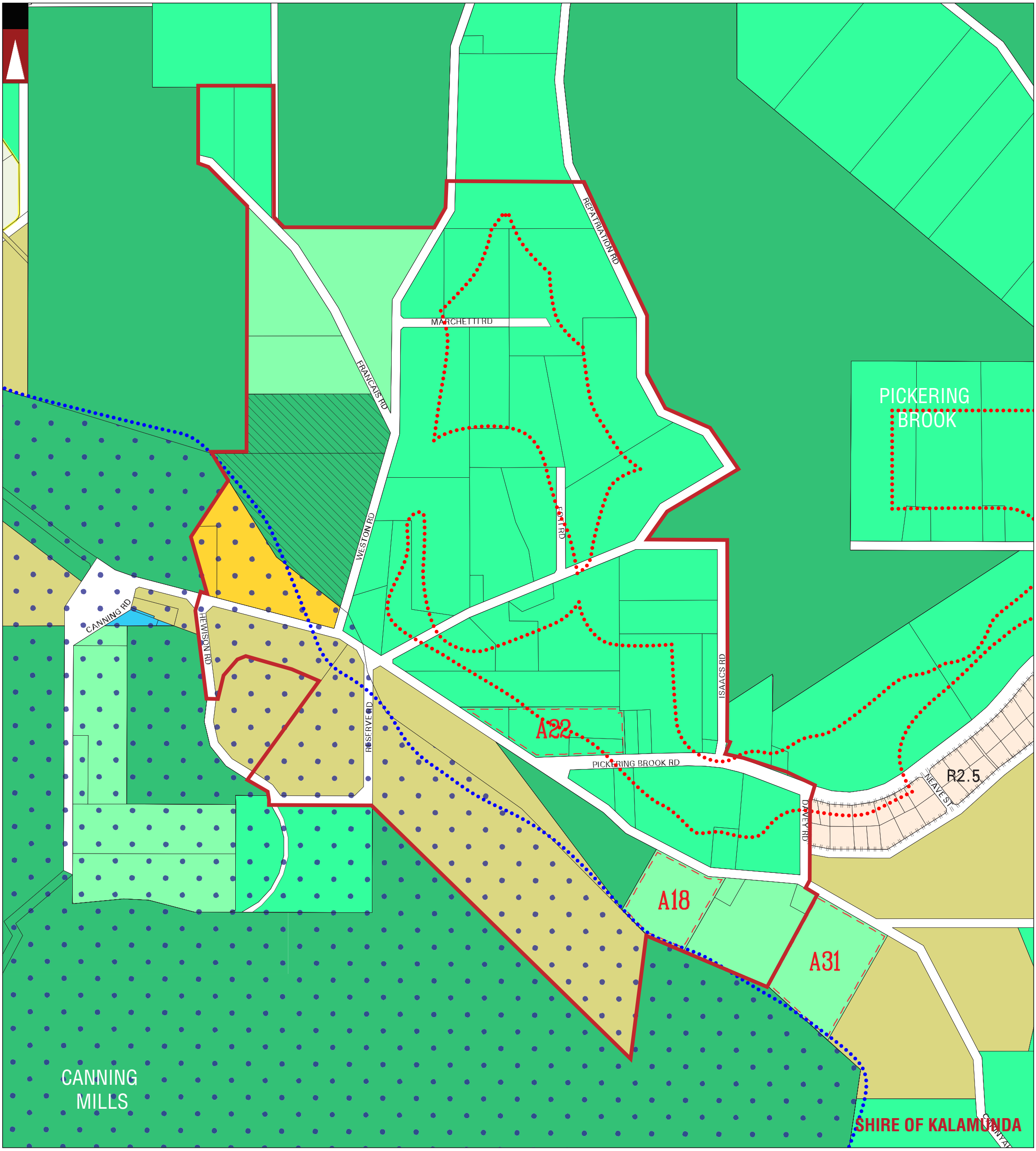
Appendix 2

Transport Planning and Traffic Plans



Parks and Recreation
Water Catchments
Rural Argiculture
Special Rural
Bushfire Prone Areas
Local Open Space
Residential Bushland
Rural Conservation
R20 — R Codes
SC5 - Middle helena catchment area
State Forrest
Commercial
Rural Landscape Interest
A1 — Additional Uses
Location Boundary

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: Shire of Kalamunda LPS No 3 (Map 08)

DRAWING NUMBER: KC00315.000_S01

DRAWN BY: K.P.

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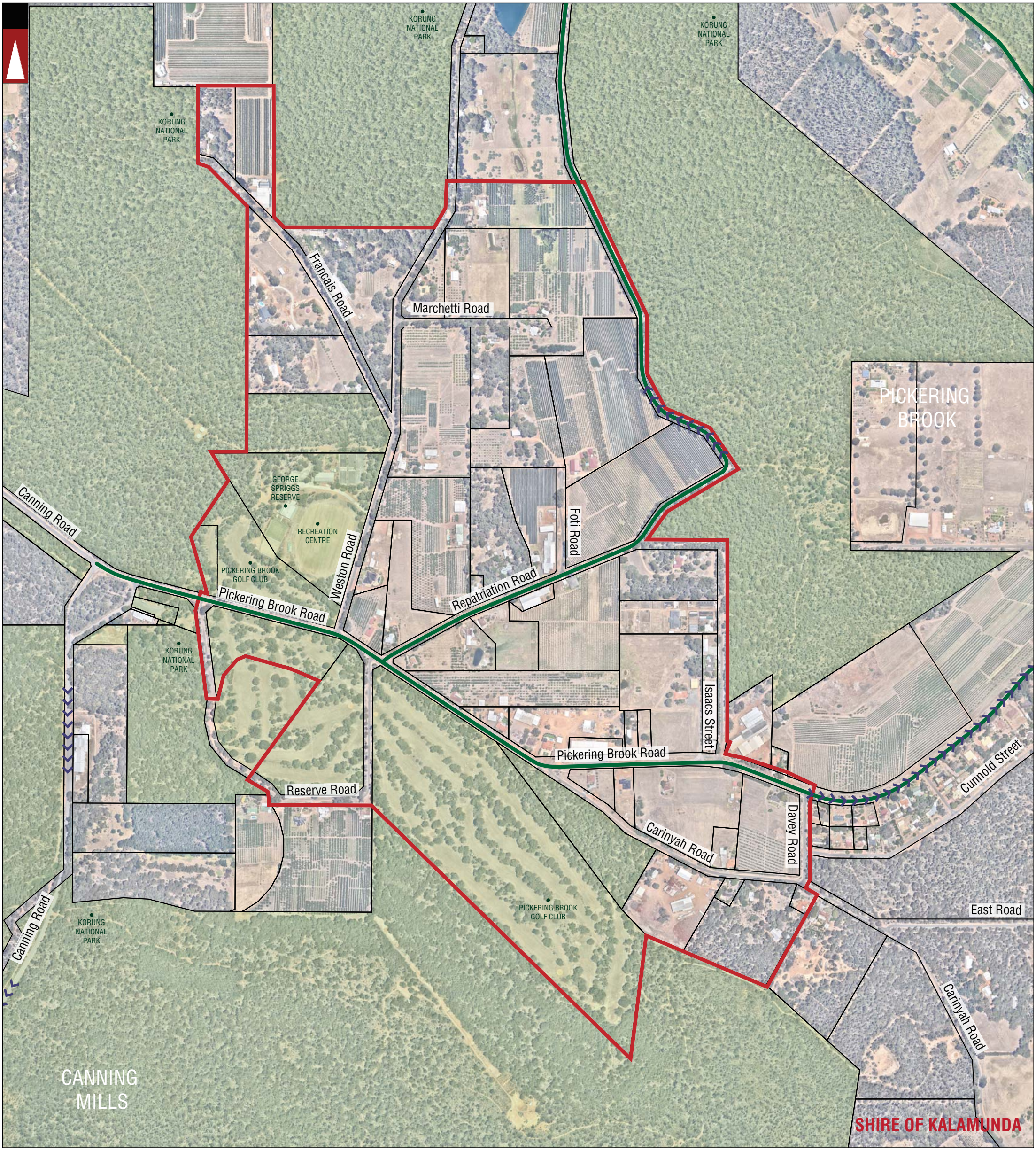

PARKS AND RECREATION

PUBLIC FACILITIES

WATER

GOOD ROAD RIDING ENVIRONMENT

LOCATION BOUNDARY

LOCAL GOVERNMENT AUTHORITY BOUNDARY

STEEP INCLINE

ROAD

DISTANCE FROM LOCATION

PICKERING BROOK — LOCAL GOVERNMENT NAME

Canning Rd — STREET NAME

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: PBN Plan

DRAWING NUMBER: KC00315.000_S02

DRAWN BY: K.P.

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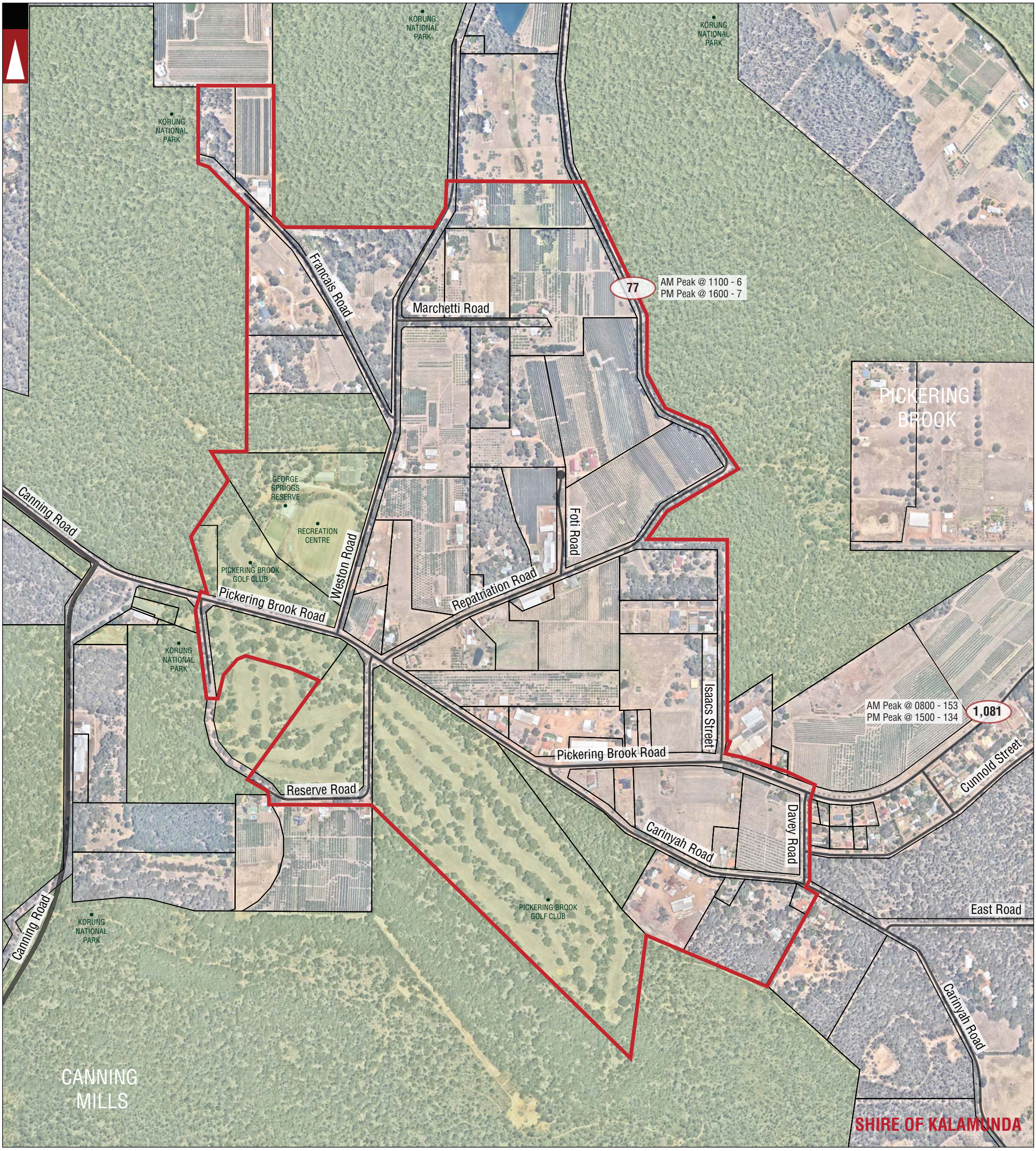

PARKS AND RECREATION

PUBLIC FACILITIES

WATER

7,418 NUMBER OF VEHICLES PER DAY

LOCATION BOUNDARY

LOCAL GOVERNMENT AUTHORITY BOUNDARY

ROAD

DISTANCE FROM LOCATION

PICKERING BROOK LOCAL GOVERNMENT NAME

Canning Rd STREET NAME

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: Existing Traffic Counts

DRAWING NUMBER: KC00315.000_S05

DRAWN BY: K.P.

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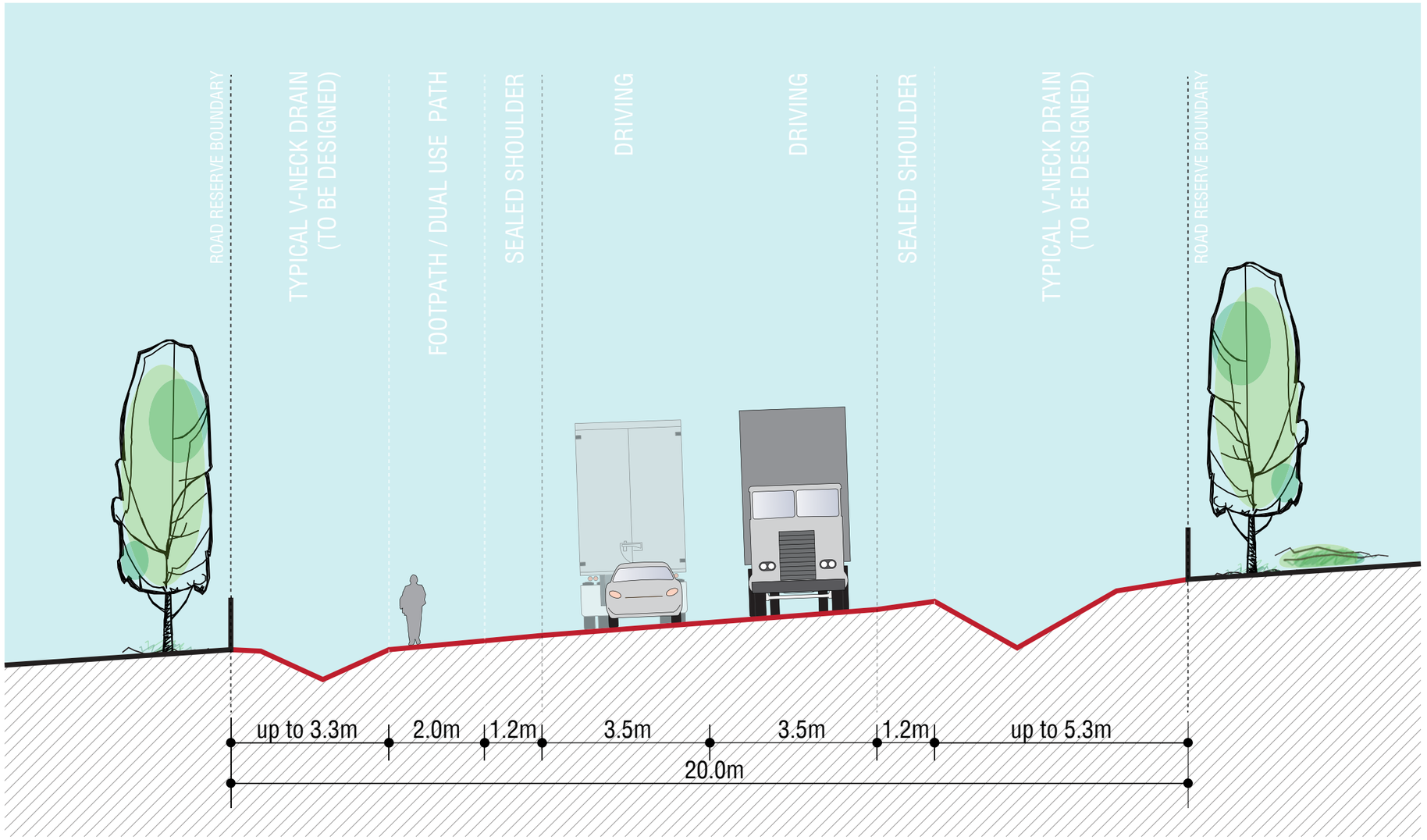
Appendix 3

Typical Road Cross Sections



B	13-06-2016	PROPOSED LAYOUT AMENDED
A	16-03-2015	ISSUED FOR REVIEW
No	DATE	AMENDMENT

PROJECT:
PICKERING BROOK TOWNSITE EXPANSION

TITLE:
Typical road cross-section for Existing and Proposed Roads 20.0m - 7.0m

DRAWING NUMBER:
KC00315.000_S30

DRAWN BY:
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Appendix 6

Infrastructure Servicing Report – (KCTT)

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INFRASTRUCTURE SERVICING REPORT

Pickering Brook Townsite Expansion,

Pickering Brook

June 2016,

Rev B

kctt

HISTORY AND STATUS OF THE DOCUMENT

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Rev A	28.04.2015	C Kleyweg	C Kleyweg	28.04.2015	Issued for Review
Rev B	13.06.2016	C Kleyweg	C Kleyweg	13.06.2016	Issued for Final

DISTRIBUTION OF COPIES

Revision	Date of issue	Quantity	Issued to
Rev A	28.04.2015	1 (PDF)	Mrs Nina Lytton and Mr Jordan Koroveshi (Shire of Kalamunda); Mr Murray Casselton (TPG Town Planning, Urban Design and Heritage)
Rev B	13.06.2016	1 (PDF)	Mrs Nina Lytton and Mr Jordan Koroveshi (Shire of Kalamunda); Mr Murray Casselton (TPG Town Planning, Urban Design and Heritage)

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Project Manager	Colin Kleyweg
Name of the Project	Pickering Brook Townsite Expansion
Name of the Document	Pickering Brook Townsite Expansion – Infrastructure Servicing Report
Document Version	KC00315.000_R02_Rev B

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Table of Contents

1. Introduction

As a part of the proposed Metropolitan Region Scheme (MRS) amendment for the Pickering Brooks Townsite Expansion, KCTT have been requested to provide and Infrastructure Servicing Report (ISR). This report provides an assessment of the proposed townsite expansion feasibility from the perspective of infrastructure servicing and the general requirements for the rezoning of the land. The Pickering Brook Townsite is within the Shire of Kalamunda, who is the direct client of this report.

1.1 Scope of the ISR

The information provided herein addresses the civil engineering aspects of potential residential and local centre development of the subject landholdings and assesses the availability of existing and proposed infrastructure assets in proximity of the project area. Rational engineering judgement will be exercised to provide advice on potential infrastructure requirements to support the townsite expansion. The professional advice provided in this report is preliminary and subject to change in the planning, detailed design and implementation phases of the project as the information we are receiving from the agencies is preliminary until a formal planning phase is commenced. In addition to assessing the existing conditions of the project area and describing the general site works required for the nature of the works involved, this report discusses the upgrade / connection requirements for the proposed townsite expansion in terms of major infrastructure, which includes: -

- **Roads** – Internal roads will be required for the expansion of the townsite in order to service the future development layout. General requirements for road upgrades on the existing road network will be considered in this MRS amendment phase.
- **Stormwater** – The Shire of Kalamunda (SoK) will provide the technical requirements for stormwater drainage. Convevance of internal road drainage and treatment of 1, 5 and 100 year storm events are likely to be the key requirements with the stormwater drainage system likely to be an overland flow system, reliant on drainage swales and areas for drainage detention, prior to release into downstream environments.
- **Wastewater (Sewer)** – The extension of wastewater (sewer) assets is not applicable to the project area. The Water Corporation has no wastewater assets in proximity to Pickering Brook, therefore this has not been considered in this ISR. It is assumed that the proposed developments will be required to install aerobic Treatment Unit's (or ATU's).
- **Potable Water Supply** – The Water Corporation has provided general information relating to major asset requirements for the distribution of water through Pickering Brook. KCTT will hold informal discussions with Water Corporation Officers and document the findings in this report. The Water Corporation will need to enter into a formal planning phase with the Shire of Kalamunda, which will include using specific concept plan layouts for the proposed townsite expansion prior to providing finalised information.

- **Power** – KCTT will assess the closest possible location for connection of services to support residential land development through the project area. KCTT will review the Western Power Network Capacity Model and the Dial Before You Dig data and provide general commentary only for the extension of Western Power assets.
- **Telecommunications** – KCTT will provide general commentary relating to telecommunications requirements based on the information available as at the date of this reporting. We will discuss potential connection points based on the information identified from Dial before You Dig data.
- **Gas** – Discuss potential opportunities for the connection and extension of gas through the project area.

1.2 Location and Description of the Proposed Townsite Expansion

The project area comprises the Pickering Brook Townsite, which is shown in Appendix 2 and includes Pickering Brook Road, Carinyah Road, Repatriation Road, Weston Road, Francais Road, Foti Road, Marchetti Road and Isaacs Street. The land uses surrounding the project area include agricultural, sports and recreational uses.

1.3 Available Information and Technical Literature

This section provides a brief description of the inputs used in the compilation of this report:

- **Dial Before You Dig** – KCTT have collected data through the Dial Before You Dig (DBYD) service. This was performed in multiple enquiries to cover the area of interest.
- **Aerial Imagery (Nearmaps)** – Nearmaps has been utilised to obtain aerial imagery of the project area. The imagery obtained will aid in the determination of the vegetation coverage of the area proposed for the development.
- **Landgate SLIP** – The use of the Landgate SLIP program will enable KCTT to locate existing utility services on and around the project area. The SLIP enabler can also reveal information about the topography, soil conditions, surrounding environmentally sensitive areas and planned capital works by the various authorities, (inclusing the Water Corporation).
- **ESINet** – The ESINet platform provides information relating to existing wastewater and water infrastructure and contour information. As previously described in this report, there are no wastewater assets available in Pickering Brook.
- **Site Visit** – Colin Kleyweg of KCTT has conducted a site inspection as part of this ISR.

Note: Some information included in this report has been sought from the relevant regulatory authorities, although it is important to note that the information given is preliminary in nature. If the townsite expansion is to proceed, the client is advised to note that the information received from these authorities is subject to change in the formal application process. Of further importance, no service authority can guarantee the information provided in this report as each authority will need to proceed with formal planning once the MRS amendment request is submitted for consideration to the Western Australian Planning Commission (WAPC).

2. Infrastructure Servicing

The area of study for this ISR is the Pickering Brook Townsite Expansion as mentioned above in Section 1 of this report. The project area generally covers landholdings to the north of Pickering Brook Road and includes landholdings in Carinyah Road, Davey Road, Isaacs Road, Repatriation Road, McCorkhill Road, Weston Road and Marchetti Road. Refer to Appendix 2 for the Locality Plan.

This section on Infrastructure Servicing includes the following discussion points: -

- Section 2.1 – Topography and Environment
- Section 2.2 – Geotechnical Conditions
- Section 2.3 – Building and Earthworks
- Section 2.4 – Roads and Stormwater Drainage
- Section 2.5 – Water
- Section 2.6 – Power, Telecommunications and Gas Supply

2.1 Topography and Environment

The project area exhibits strong changes in topography with some grades greater than 10%. The existing topography should be strongly considered in terms of its impact upon road and drainage design criteria, with most local governments now preferring maximum road grades of 8% and requiring significant lining works for stormwater drainage open channels where longitudinal grades are also greater than 5%.

The existing landholdings used for agricultural purposes have generally been cleared, with existing road reservations, boundaries and areas external to agricultural landholdings featuring varying degrees of remnant vegetation. The project area features up to 60% of the total landholding with existing orchards, with the majority of these located on the northern side of Pickering Brook Road and Repatriation Road.

Existing residential landholdings are located to the southeast of the project area in Cunnold Street, Davey Street and Pickering Brook Road (east of Davey Street). The Pickering Brook Golf Course is located on the southern side of Pickering Brook Road.

The project area features a valley generally through the centre with general low points as follows: -

- To the north at RL 218.0m AHD and generally to the east of the project area.
- At the eastern end of the Marchetti Road reservation around RL 242.0m AHD.
- At the intersection of Repatriation Road and McCorkhill Road around RL 256.0m AHD.
- Pickering Brook Road (midway between Repatriation Road and Carinyah Road) at RL 275.0m AHD.

There are a series of regional high points adjacent to and encircling the project area. These are located as follows: -

- Southeast of Carinyah Road at RL 309.0m AHD.
- Immediately adjacent to Isaacs Road (eastern side) at RL285.0m AHD.
- On the western side of the Pickering Brook Recreation area adjacent to the existing water supply tower at RL315.0m AHD (west of Weston Road).
- West of Weston Road north of the project area at RL 267.0m AHD.
- West of Repatriation Road at RL293.0m AHD.

2.2 Geotechnical Conditions

Repatriation Road (450m north of McCorkill Road):

- AM peak occurs in the period between 11:00-12:00. Traffic volumes in the AM peak are approximately 7.79% of total daily volumes; and
- PM peak occurs in the period between 16:00-17:00. Traffic volumes in the PM peak are approximately 9.09% of total daily volumes.

The project area will be categorised by soils featuring "colluvium and laterite over Mesozoic sediments; Colluvium including valley-fill deposits, variably laterised" with some areas of "laterite over Mesozoic sediments and Precambrian crystalline rocks." While KCTT are not qualified to discuss the geotechnical issues associated with these type of formations, generally the issues these types of soils present from an engineering perspective include: -

- Soils in valleys tend to include clays and sometimes include perched water tables at / or near the surface.
- In steeper sections, sites such as this tend to exhibit strong rock at or near the surface. This is due to softer rock being eroded over time, leaving the stronger "bed-rock" exposed.

We expect that road and stormwater drainage design should consider the existing topography and consider the geotechnical constraints associated with development in areas of this nature. Cut to fill techniques should only be employed where the qualities of existing soils in the area are known to a reasonable degree of accuracy. Generally, excavation in rock is expensive and time consuming.

In areas where significant new works are required, (such as new roads, stormwater drainage infrastructure etc) detailed geotechnical reporting should be undertaken prior to the commencement of the design phase as the presence of hard rock, soft clays and other deleterious materials will impact the design intent. This information should be available in detail to inform the general design.

2.3 Building and Earthworks

The development of rural-residential and large lot residential landholdings generally does not require the importation of substantial volumes of fill material. We believe this should considered strongly in the Shire of Kalamunda's

approach to design in the area. The use of imported fill in an area such as Pickering Brook is likely to be expensive, (in the current market upwards of $30 per m^3). Earthworks in the project area should be confined to: -

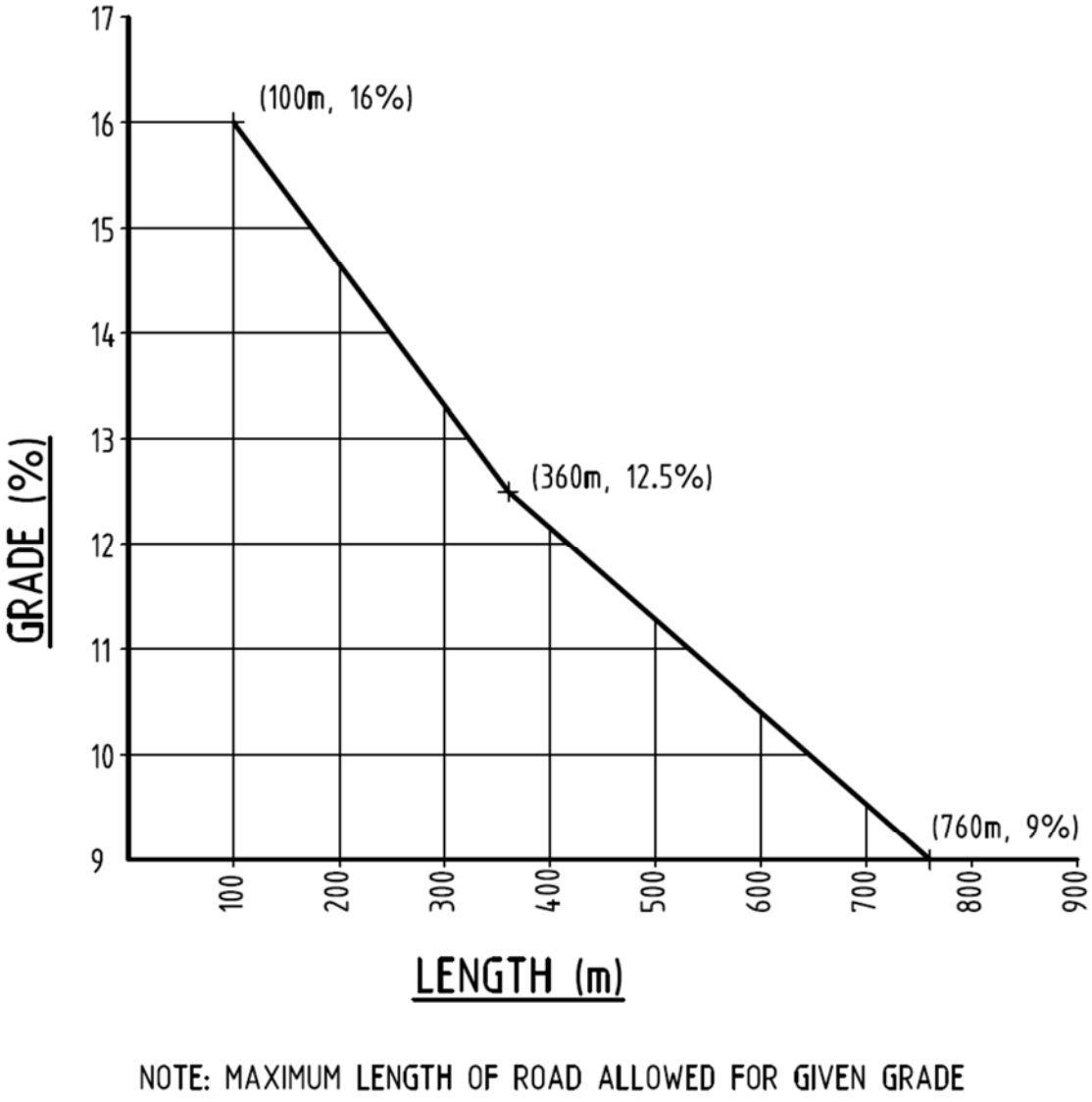
- Replacement of local materials which are not suitable as sub-grades in road construction;
- Removal of material for the construction of stormwater drainage infrastructure;
- Importation of fill for areas of road construction which sit directly above hard rock, bed rock or similar;
- Replacement of existing material in trenches for water, power, gas and telco services (import select fill).

For future lots greater than 2,000m^2 we do not believe these lots should be earthworked until the lots are purchased by end-purchasers. The lots can then be earthworked specifically to suit the building requirements of each landowner at the development application or building permit stage.

2.4 Roads and Stormwater Drainage

As described in Sections 2.2 and 2.3 the presence of hard rock will have a particular impact upon the design for roads in the project area. The Shire of Kalamunda also has an important role in developing the design by offering a pragmatic approach to construction of roads on steeper slopes. In some local government authorities there has been a recent move to limit longitudinal grades to a preferred maximum of 6%. We believe this will be an overly conservative measure which will have a major impact on construction costs in the project area. We believe 9% is a more reasonable maximum grade target, with some allowance for steeper grades in situations where extensive hard rock, (or other impediments) are found. The City of Swan have a standard detail for determining maximum road grades, which could be utilised by the Shire of Kalamunda in the project area.

Figure 1 - Maximum Allowable Road Longitudinal Grades (reference: City of Swan Standard Drawing No 82-1s)



The general composition of these roads needs to consider the following requirements: -

- The likely traffic volume on each of these roads is expected to be less than 1,000 VPD, with Pickering Brook Road the only exception. This is discussed in further detail in our Transport Impact Assessment.
- The general cross section of each road should be to a “rural road” design with 7.2 metre width 2-coat seal pavements and 1.2 metre width unsealed shoulders on both sides of the roadway.
- Swale drains and bridle / pedestrian paths provided where required.
- Intersections should be designed with a 40mm thick AC14 intersection mix as the wearing course.
- Intersections should be kerbed to protect the integrity of the asphalt wearing course, given its greater cost to supply and install.

- In areas of fill, steep embankments at intersections should have kerb openings with rock-lining or revetment mattress protection.
- Consideration should also be given to kerbing steeper sections of roadway (for example, steeper than 5%) to protect earth embankments from excessive general erosion. Surface runoff can therefore channelized into a kerb opening with rock protection.

One of the key items to consider in designing the road reservation widths will be the stormwater drainage requirements in terms of the width of the drainage swale and the location of any drainage detention structures which will be required. This can either be provided within a formalised road reserve, or it can be included in private landholdings with a specific area for easement purposes to the benefit of the Shire of Kalamunda.

The project area has a fairly simple overland flow-path with the overland flow generally directed centrally within the project area and draining toward the north. This area will need to be protected as part of the overall design ethos.

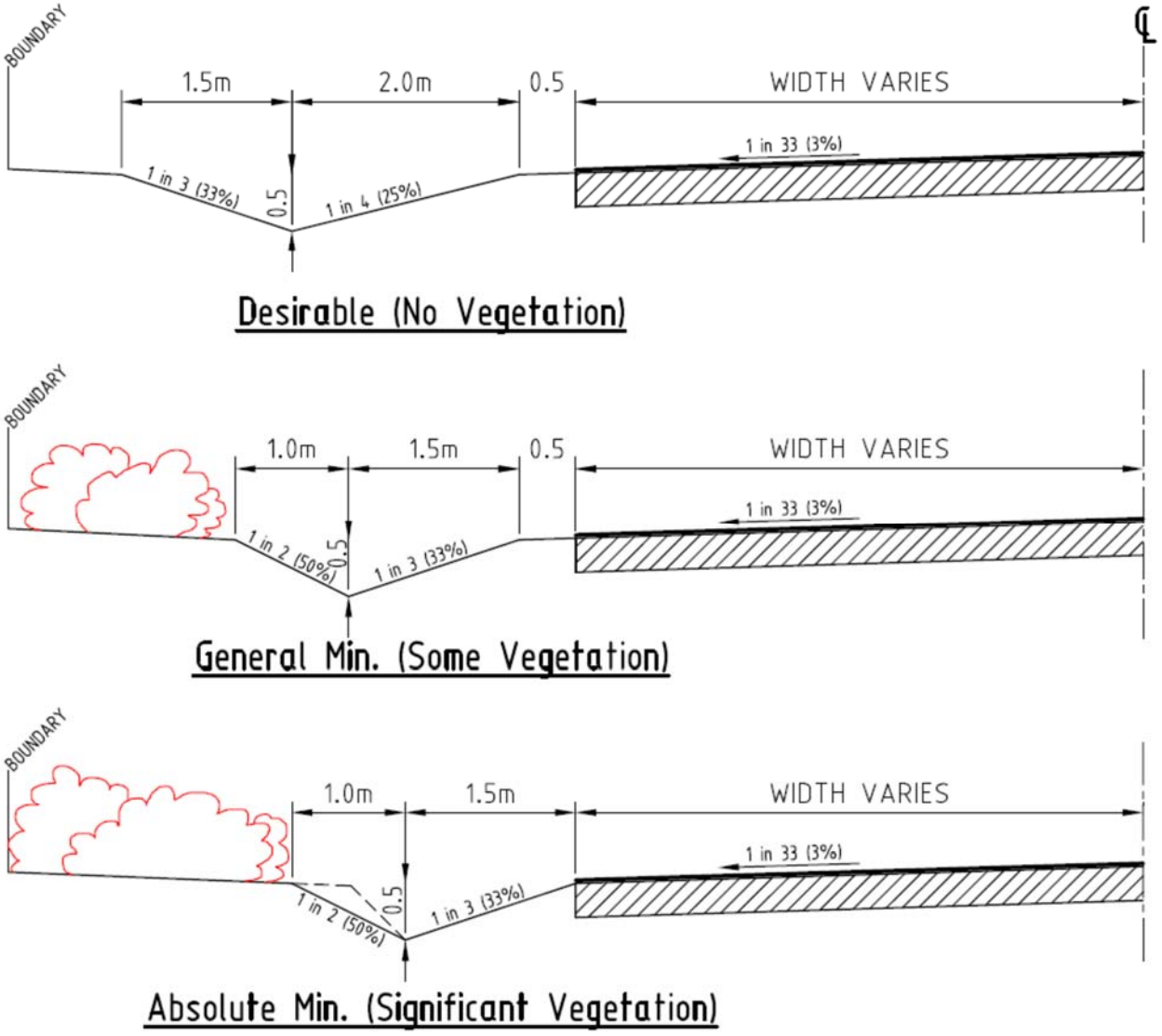
Weir structures or riffles should be considered at suitable spacing's commensurate with the design longitudinal grade of the swale drain. The Department of Water states in its design considerations for swale drains that the longitudinal should be between 1% and 4%. The riffles in these instances are generally 100mm in height, again, dependent on the slope of the drainage. Their purpose is to limit the velocities of runoff and therefore to limit the potential for downstream erosion. The riffles should be designed suitably to ensure the riffles themselves are robust and are not eroded, or require undue maintenance. Generally riffle structures should be constructed across the full width of the base of the swale drain and up the side slopes. On slopes steeper than 5% consideration should be given to cement mortaring the riffles in place.

The riffles typically use a mixture of 100mm to 300mm average least diameter (ALD) rocks which are mortared, or loosely placed so as to create a "natural" deviation in the stormwater overland flow. These types of ricks can also be used in kerb openings, lined sections of swale and spoon drains and to prevent erosion on the upstream and downstream side of headwalls.

Where drainage swales exceed 8%, the management of erosion and velocities can become difficult. In this instance, consideration should be given to piping sections of stormwater drainage where longitudinal grades are excessive. The design requirements for stormwater drainage pits and pipes shall be in accordance with the Shire of Kalamunda's Standards.

The swale cross sections should consider the existing terrain in Pickering Brook and the presence of natural vegetation. We have provided a general detail which has been sourced from the City of Swan's general standards. We believe this should be used as a guide only, with the actual swale cross-section to be dependent upon retention of natural vegetation to retain the areas general feel.

Figure 2 - Requirements for Swale Drains (City of Swan Standard Drawing STD 67-1s)



In summary, we believe the general design ethos for roads and stormwater drainage should be considered in tandem. The design of these two items separately will not be conducive to a design which considers the natural topography.

2.5 Water

KCTT have undertaken formal discussions with the water Corporation on a number of occasions through the research phase of this project. The following email was received from the Water Corporation, (Mr Mark Busher) dated 13th March 2015: -

Water

This area is within the Bickley scheme.

This is an old scheme which would have assumed little, if any growth of services within Pickering Brook.

There are no plans to review water or wastewater schemes for this area.

I suggest the Local Authority contact our Development Services Branch, Land Planning group re any zoning or development intentions for this area.

Contact, in the first instance should be from the Shire to the Manager Land Planning, Peter Howard.

The formal instrument for the Water Corporation to commence this review is to receive a copy of the proposed MRS amendment from the Shire of Kalamunda via the WAPC. Generally, we can confirm the following items were discussed verbally with a Water Corporation Officer in April 2015: -

- There may be potential to develop an early stage in Pickering Brook without further augmentation or bolstering of the existing pipework and headworks. The quantum of development is not known and the requirements for improvements could only be confirmed upon formal application to the Water Corporation;
- There is likely to be a requirement for upgrade of existing pipe headworks infrastructure. This means the main pipe coming into Pickering Brook may need to be upsized to cater for future development in the project area;
- It is likely that an additional water tank will be required on the eastern side of the project area at one of the high points, either south-east of Carinyah Road at RL 309.0m AHD or immediately adjacent to Isaacs Road (eastern side) at RL 285.0m AHD.

Hydrants will need to be provided at 200 metre spacings in accordance with Water Corporation requirements. Fire management will be an important consideration in the overall design of the water reticulation syste

Recent advice sent to TPG Town Planning, Urban Design and Heritage in March 2016 suggests that they have “just finished forecasting for Pickering Brook and found there were minimal constraints to developing the entire area that we have identified. Some upgrades to reticulation pipes may be required but this will be monitored in the future by the Water Corporation”.

2.6 Power, Telecommunications and Gas Supply

The provision of power, telecommunications and gas supply will be a requirement for all future developers in the Pickering Brook Townsite Expansion area. Western Power requires that developers underground all existing overhead power assets which are located on the development side of any road reservation. This cost should be considered in any future development.

Western Power has an online management tool known as the Network Capacity Mapping Tool, or NCMT. Using this tool, we have reviewed the "forecast remaining capacity" and found that the area has between 20 and 25 MVA of available network capacity over the project area through to 2034.

High Voltage overhead 3 phase power infrastructure is currently available through most of the project area as follows: -

- Pickering Brook Road, between Marchetti Road and Isaacs Street;
- Marchetti Road, to a location north of Francais Road;
- Repatriation Road, to a location southwest of the intersection with Foti Road;
- Carinyah Road, to a location east southeast of the intersection of Pickering Brook Road.

The Pickering Brook Townsite Expansion area has existing telecommunications assets which are suitable for general telephony. NBN Co are currently seeking to locate a tower in the area to provide improved telephony and internet services. The outcome of this however is unknown at the time of writing this report.

No ATCO Gas services have been found in our Dial Before You Dig search over the area.

3. Opportunities and Challenges

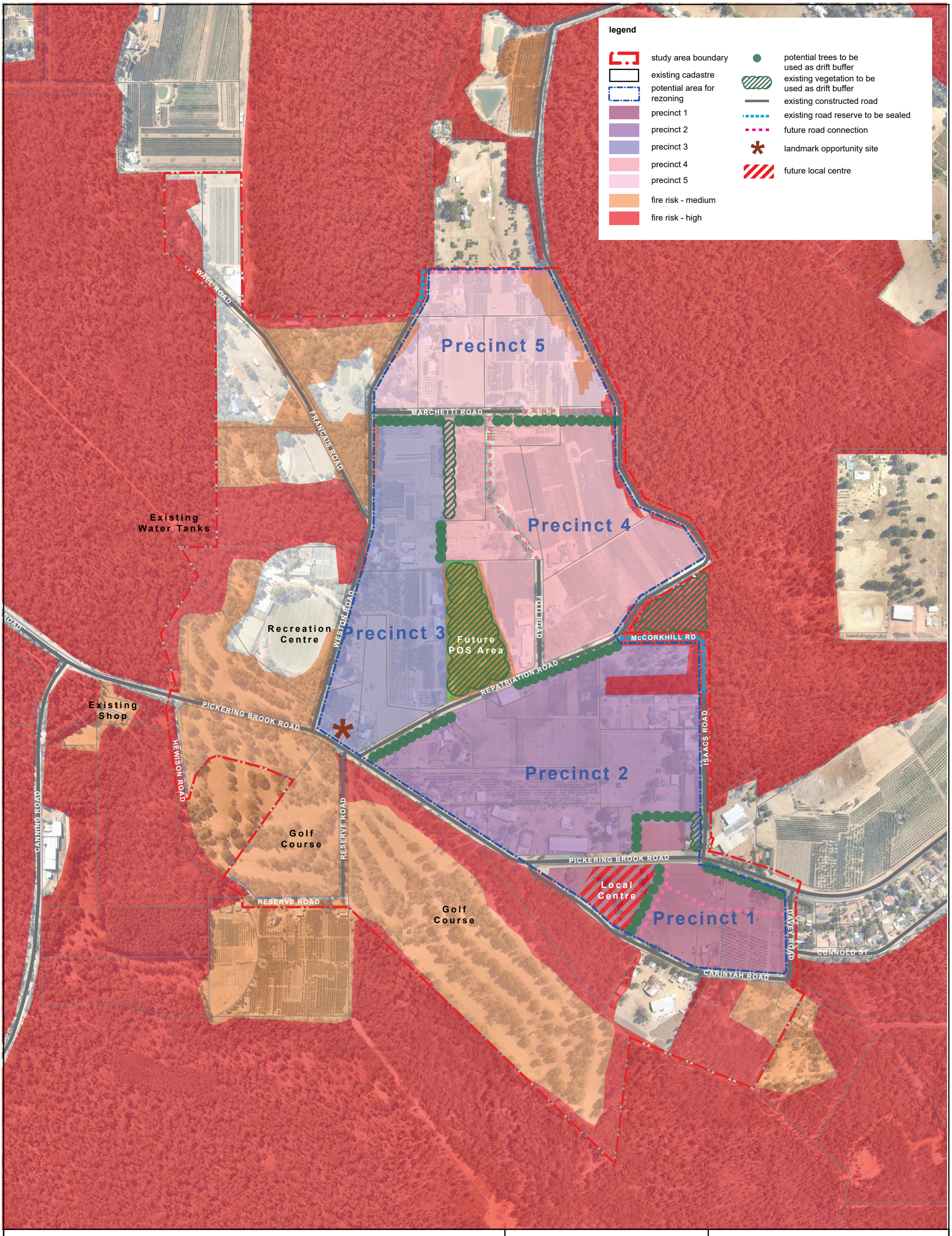
The Pickering Brook Townsite Expansion project area offers a series of opportunities and challenges in terms of infrastructure provision. The key items for consideration in the development of a suitable residential layout include: -

- Shaping the road layout and stormwater drainage infrastructure to suit the topography and therefore to minimize the volume of imported fill required.
- To design roads and drainage systems that maintain the overall aesthetics and feel that make Pickering Brook the place it is today. This requires design that again is sympathetic to the overall topography and not "over-engineering" the new proposed infrastructure so that it looks obviously different to existing.
- To partner with the various regulatory authorities to examine the requirements for power, water and telecommunications to make the future development of the Pickering Brook Townsite Expansion area robust and vibrant.
- To provide effective measures to limit damage to roadways, sub-grades and drainage infrastructures from storm damage and erosion.
- To develop an effective strategy to mitigate excessive construction costs in rock excavation.

We believe these are the key infrastructure opportunities and challenges in relation to the future development of the project area.

Appendix 1

The Layout of the Indicative Development Precinct Plan



PLAN 3
Indicative Development Precincts
Pickering Brook

0 | 75 | 150m

Project Manager: MC
Drawn: GW
Checked: OP
Date: 3 March 2016
Scale: 1:7,500 @ A3
Drawing No. 713-432 CP 3 A

tpg
TOWN PLANNING
URBAN DESIGN AND HERITAGE

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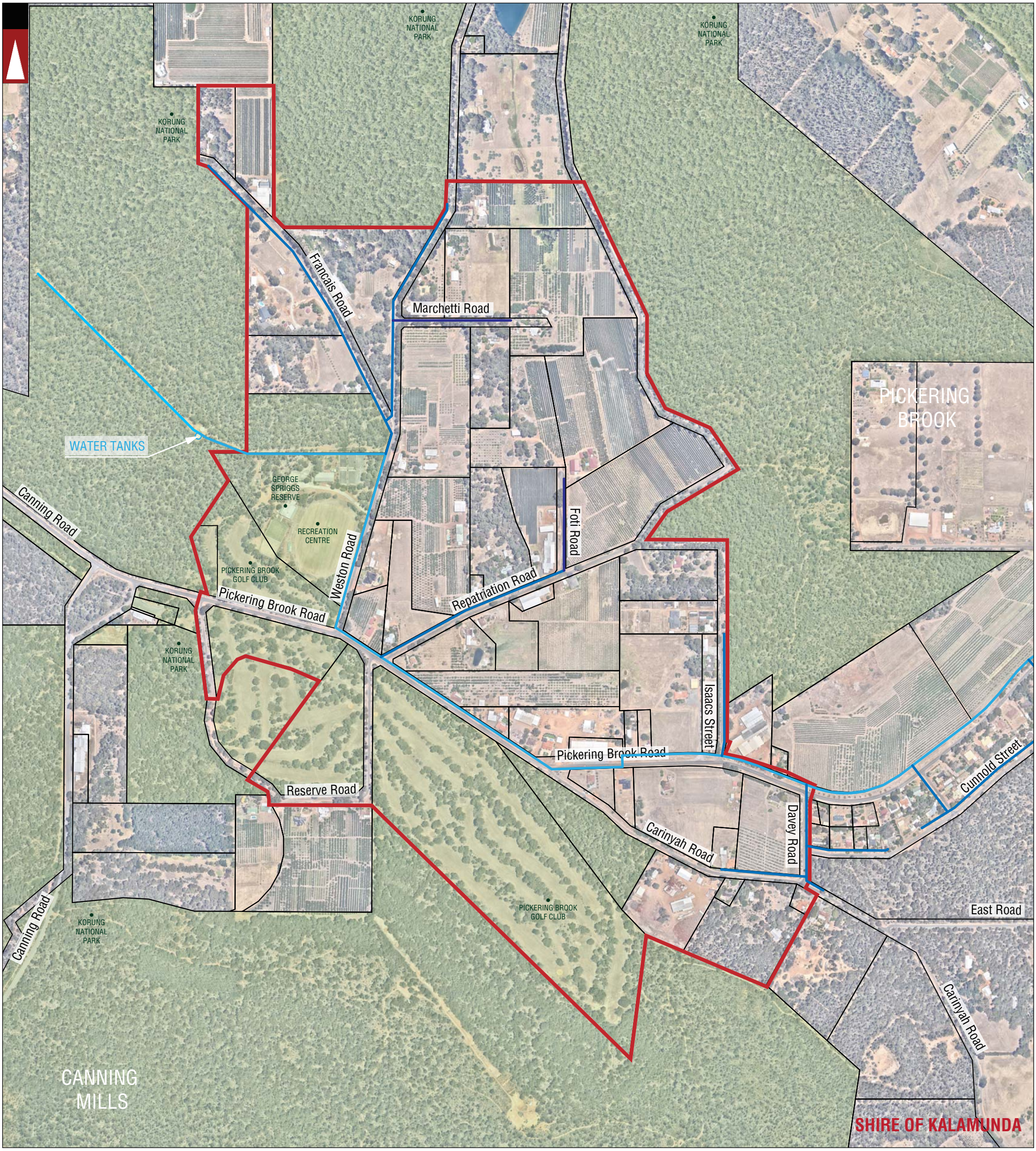
The Planning Group WA Pty Ltd
ABN 36 097 273 222

Appendix 2

Infrastructure Plans



PARKS AND RECREATION
PUBLIC FACILITIES
WATER
58AC WATER MAIN
LOCATION BOUNDARY
LOCAL GOVERNMENT AUTHORITY BOUNDARY
ROAD
100AC WATER MAIN
DISTANCE FROM LOCATION
PICKERING BROOK — LOCAL GOVERNMENT NAME
Canning Rd — STREET NAME
150AC WATER MAIN

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: Existing Water Infrastructure

DRAWING NUMBER: KC00315.000_S10

DRAWN BY: K.P.

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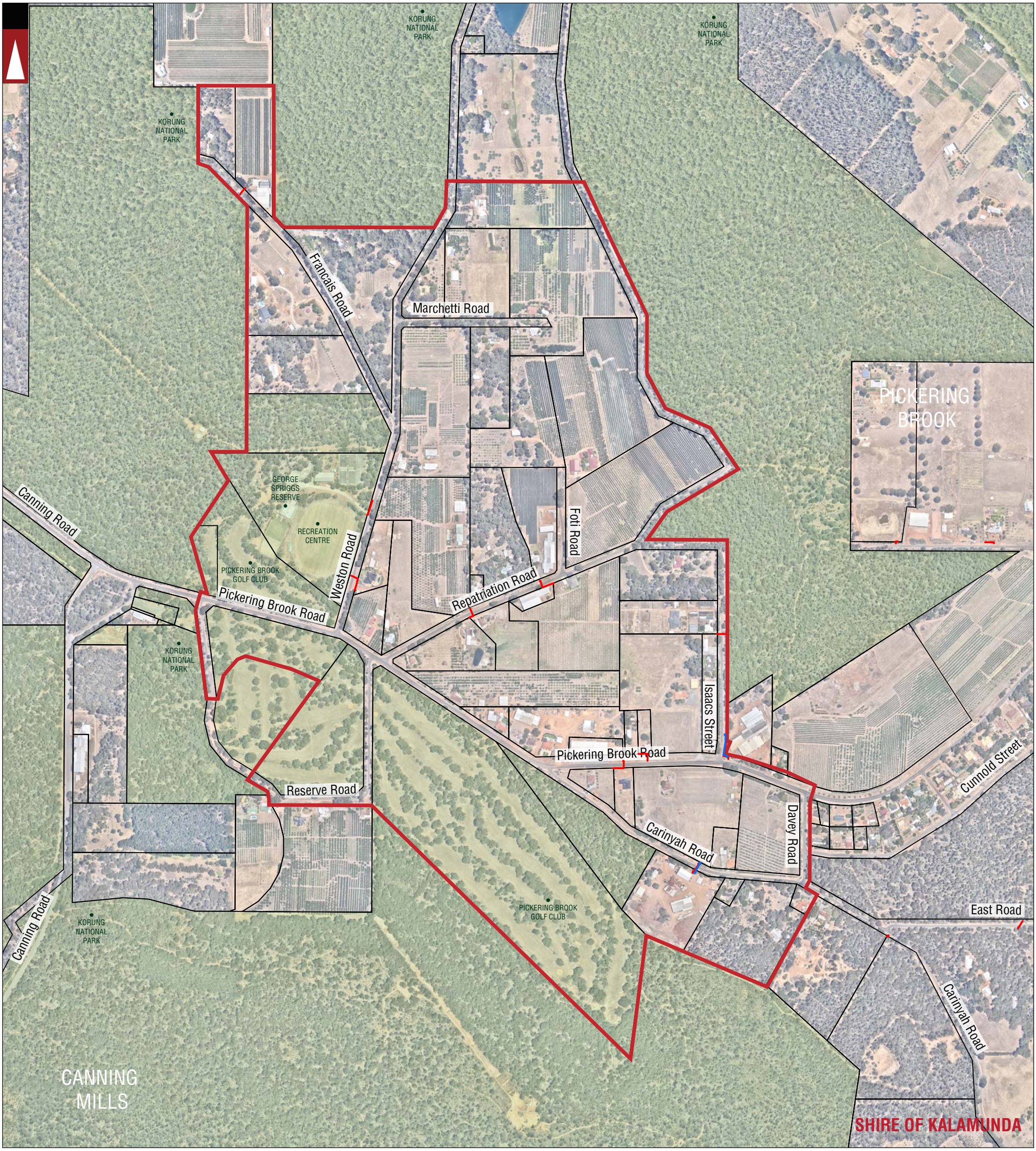

PARKS AND RECREATION

PUBLIC FACILITIES

WATER

HIGH VOLTAGE CABLE (1KV - 33KV)

LOCATION BOUNDARY

LOCAL GOVERNMENT AUTHORITY BOUNDARY

ROAD

LOW VOLTAGE CABLE (< 1KV)

DISTANCE FROM LOCATION

PICKERING BROOK — LOCAL GOVERNMENT NAME

Canning Rd — STREET NAME

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: Existing Electricity Supply - HVLV Assets

DRAWING NUMBER: KC00315.000_S13a

DRAWN BY: K.P.

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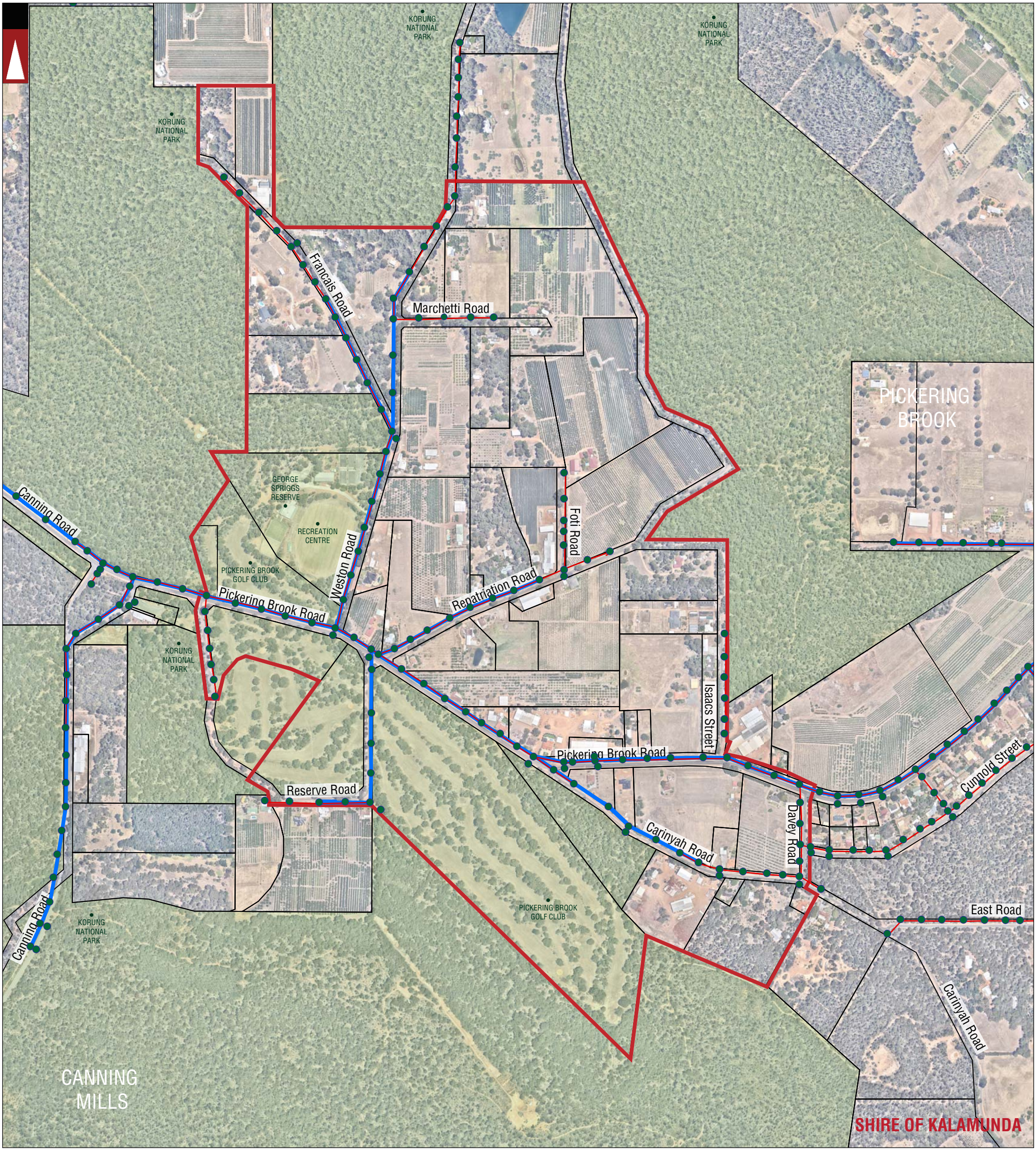

PARKS AND RECREATION

PUBLIC FACILITIES

WATER

HIGH VOLTAGE (1KV - 33KV)

LOCATION BOUNDARY

LOCAL GOVERNMENT AUTHORITY BOUNDARY

ROAD

LOW VOLTAGE (< 1KV)

DISTANCE FROM LOCATION

PICKERING BROOK — LOCAL GOVERNMENT NAME

Canning Rd — STREET NAME

POWER POLE

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: Existing Electricity Supply - Overhead Assets

DRAWING NUMBER: KC00315.000_S13b

DRAWN BY: K.P.

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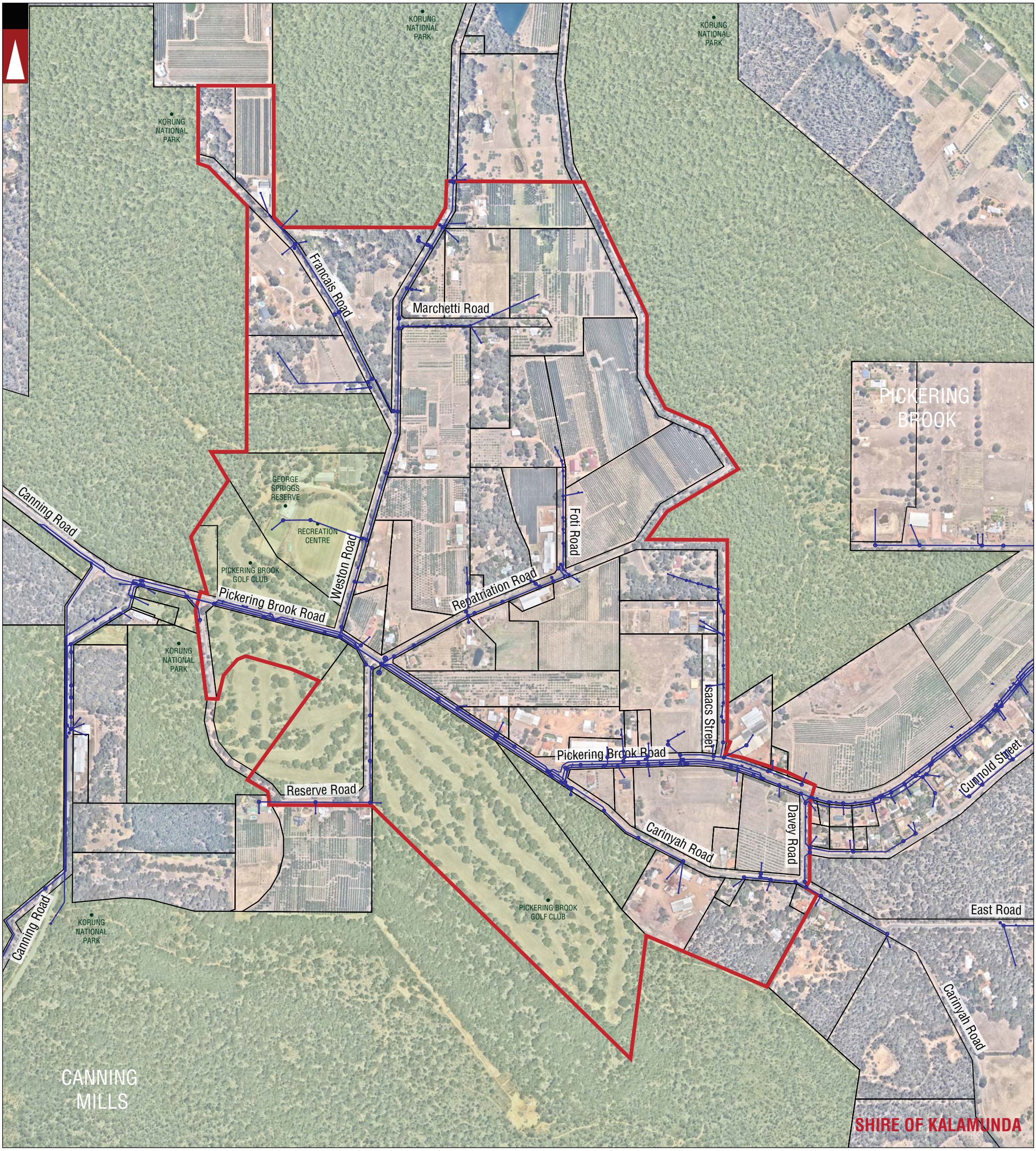

PARKS AND RECREATION

PUBLIC FACILITIES

WATER

TELSTRA CABLE

LOCATION BOUNDARY

LOCAL GOVERNMENT AUTHORITY BOUNDARY

ROAD

DISTANCE FROM LOCATION

PICKERING BROOK — LOCAL GOVERNMENT NAME

Canning Rd — STREET NAME

LEGEND

No	DATE	AMENDMENT
B	10-06-2016	PROPOSED LAYOUT AMENDED
A	13-03-2015	ISSUED FOR REVIEW

PROJECT: PICKERING BROOK TOWNSITE EXPANSION

TITLE: Existing Telecommunications Supply - Telstra Cable Plan

DRAWING NUMBER: KC00315.000_S14

DRAWN BY: K.P.

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Appendix 7

Extract from Shire of Kalamunda Submission on Perth and Peel@3.5 million

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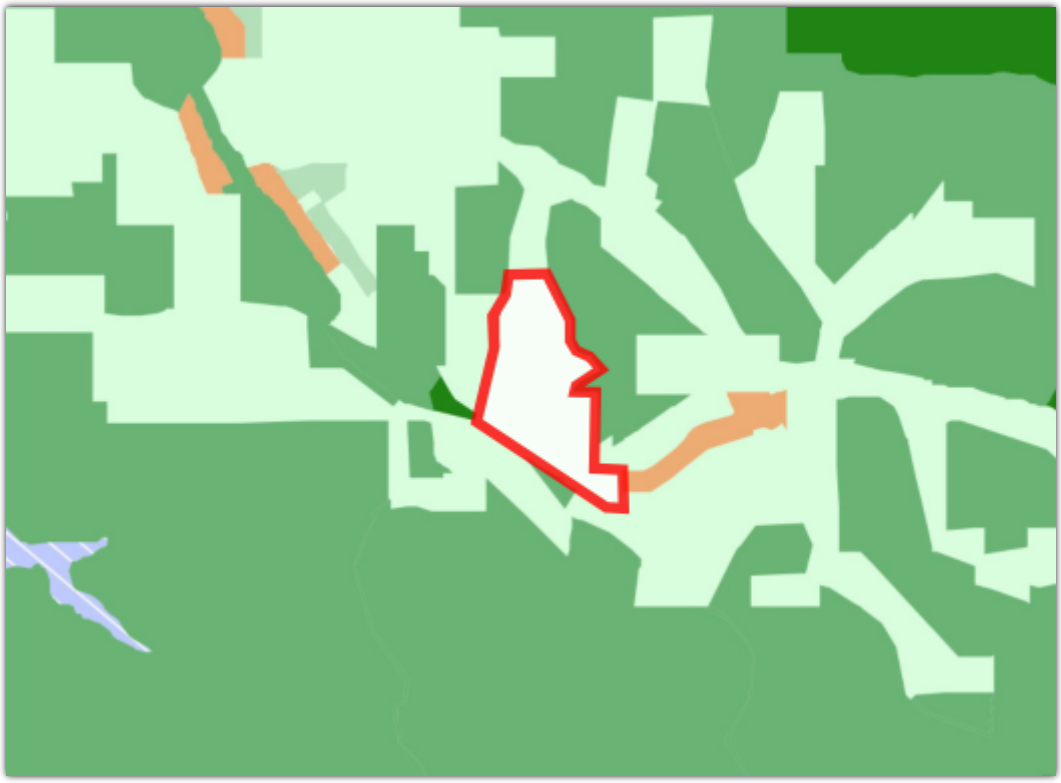
2.3 Area 3: Pickering Brook Townsite Expansion Area

2.3.1 Local Planning Strategy

The Shire's Local Planning Strategy identifies the Pickering Brook Townsite as an investigation area (Attachment 1). The proposed outcome will be low density residential properties approximately 2000sqm surrounding an improved and expanded commercial town centre. Through increasing population and flexibility of land uses, the Shire is also aiming to improve tourism and small business activity in the area.



Planning is already underway for this project, including preliminary involvement from Department of Planning, Department of Water and the Water Corporation. The Shire has contracted and completed studies to address bushfire risk, environmental constraints, traffic impact and issues and servicing requirements in the proposed area. These studies have been used to inform an MRS amendment request to rezone the land from Rural to Urban, which is currently being prepared by the Shire.

2.3.2 Bushfire Risk Analysis

The proposed Pickering Brook townsite expansion area is surrounded by dense vegetated areas including Korung National Park, a popular location for bushwalking and mountain biking. Given the level of vegetation within close proximity to the site, it is crucial that fire risks are accounted for during design of the proposed expansion.

A preliminary bushfire risk assessment has been undertaken that shows the proposed urban area as being surrounded by medium and high fire risk areas. The assessment suggests:

- Locating development away from high risk areas;

- Connecting roads for evacuation purposes; and
- Preparing a fire management plan at the local structure planning stage.

The Shire considers that, for the purposes of an MRS amendment, the investigation into the bushfire issues and possible mitigation has demonstrated that the bushfire risk can be addressed in order to facilitate a low key commercial and low density residential development in this area.

2.3.3 Environmental Study

The area in question is characterised by a number of properties engaged in agricultural activities and predominantly cleared, some intermittent vegetated areas and quite a dense bush outside the boundaries of the proposed town centre. Shire engaged a consultant to determine environmental impacts of the proposed development in this area as part of an MRS amendment application. The consultant identified the following characteristics of the area:

- Low to nil risk of aced sulfate soils;
- Existing agriculture may cause issues with proposed residential;
- Site is currently a Priority 2 PDWSA;
- Not located within a groundwater area;
- The majority of the vegetation is rated as 'Completely Degraded' due to historical clearing for agricultural activity;
- Unlikely to be a significant site for protected species; and
- No registered contaminated sites.

To enable future residential development, the environmental study suggests the following investigations/management measures are undertaken:

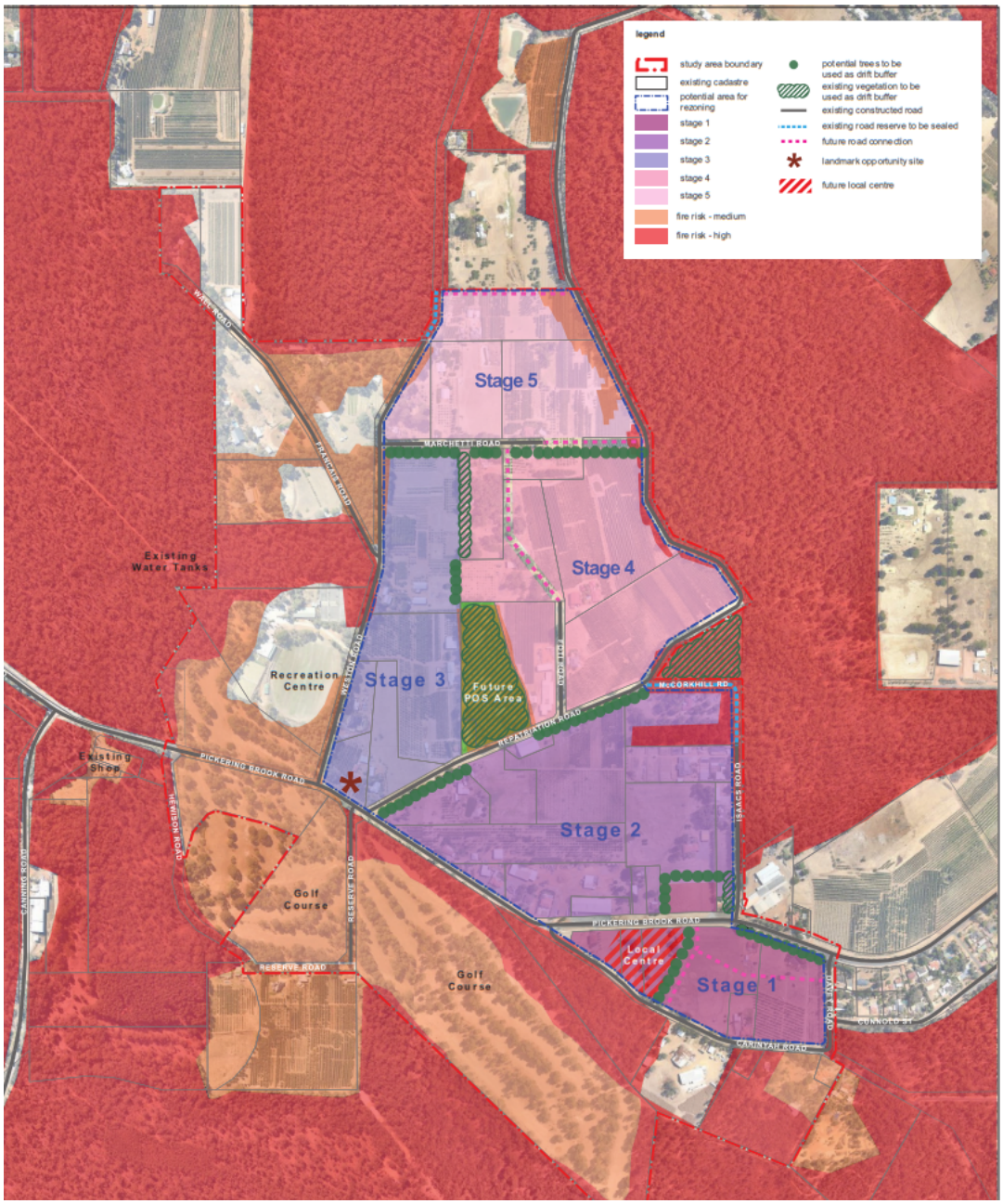
- Level 2 flora and vegetation assessment of two specific lots;
- Significant tree assessment focused on 4 specific lots;
- Creation of vegetated buffer areas to protect from spray drift;
- A preliminary site investigation for each subdivision to ensure there is no contamination of soils; and
- Reclassifying the Priority 2 PDWSA to a Priority 3 area, which the Shire has progressed through discussions with Department of Water and engaging a consultant to create a District Water Management Strategy.

The environmental study concludes that development of the site for residential purposes is likely to have minimal potential environmental impacts provided the above issues are addressed prior to development. Final design for the development will incorporate additional environmental management actions to assist in the retention of environmental values at the site.

2.3.4 Servicing and Traffic Study

These studies identified the potential challenges of servicing the future residential/commercial development in the future.

Based on the opportunities and constraints inherent to the site, the progress of planning work is proposed to be done in five stages. First three stages will be able to be progressed without too many issues, whereas the stages 4 and 5 might need to address a number of potential constraints further before being able to be developed.



Conclusion

The Shire is of the opinion that the area as shown on the attached map, should be included as Urban Expansion in the North East Sub-Regional Framework. The investigations conducted thus far, and the discussions/meetings held with government agencies including the Department of Planning, indicate there are no inherent constraints that would prevent the area from being identified Urban Expansion.

Recommendation

19. That Area 3 – Pickering Brook Townsite be identified as Urban Expansion in the Sub-regional Framework.