Local Structure Plan

Mandogalup East

SPN/0774

ROWE GROUP DESIGN

OUR REF: 7282 28/10/2025

ENDORSEMENT PAGE

This Local Structure Plan is prepared under the provisions of the City of Kwinana Town Planning Scheme No. 2.

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

28 MARCH 2018



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



..... Witness

..... 28 March 2018 ..... Date

..... 28 March 2028 ..... Date of Expiry

Table of Amendments

Amendment No.	Summary	Amendment Type	WAPC Endorsement Date
1	*Inclusion of approximately 37 hectares of land, comprising the balance of Lots 9002 and 9006, as well as Lot 11 and Lot 9000, within the Structure Plan boundary. Proposed residential development and associated land uses.*	Standard	15 May 2026

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Executive Summary

This Local Structure Plan addresses the Urban zoned land comprising Lots 9000, 11, 9002 and 9006 Hoffman Road and Lot 9060 (previously Lot 9019) Rowley Road, Mandogalup. The Local Structure Plan area also includes a portion of the Peel Main Drain (Lot 8018). The subject site is herein referred to as the Mandogalup East Local Structure Plan.

The Structure Plan was originally approved on March 28, 2018, comprising approximately 42.67 hectares of Urban zoned land. This Structure Plan comprises an amendment to the existing approved Structure Plan, seeking to include approximately 37 hectares of additional urban land adjoining the existing boundary to the south west. This additional land was not previously included due to zoning of the land at that time. The zoning has since been resolved and therefore the inclusion of the land is a logical extension of the existing Structure Plan.

The purpose of this Local Structure Plan is to provide a plan for the coordination of the future subdivision of the subject land to facilitate development for residential purposes, complementary to its Urban zoning.

The preparation of this Local Structure Plan has been undertaken in liaison and collaboration with Qube and their associated project team (the adjacent landholder comprising the Mandogalup West Local Structure Plan), the City of Kwinana and all other relevant approval agencies.

This Structure Plan comprises the following sections:

- **Part One – Implementation**: includes the Structure Plan map (Plan 1) and outlines the requirements that will be applied when assessing subdivision and development applications over the land to which the Structure Plan relates.
- **Part Two – Explanatory Section**: is to support the Structure Plan contained in Part One by providing the background and explanatory information used to prepare the Structure Plan.
- **Technical Appendices**: contains all technical and specialist reports prepared in support of the Structure Plan.

Structure Plan Summary

Item	Data	Section number referenced in Part 2 of report
Total area covered by the Structure Plan	79.49 hectares	1.2.2
Area of each land use proposed: Residential Public Open Space Primary Schools	 34.97 hectares 18.78 hectares 5.73 hectares	3
Total estimated lot yield	911 lots	3.3
Estimated number of dwellings	920 dwellings	3.3
Estimated residential site density	26.3 dwellings per site hectare	3.3
Estimated population	2,576 people @2.8 ppl/household	3.3
Number of high schools	nil	3.7
Number of primary schools	2 primary schools	3.7
Estimated commercial floor space	nil	3.8
Estimated area and percentage of (credited) public open space given over to: - Neighbourhood parks - Local parks - Local Playing Fields	 - 4.77 hectares, 5 parks - 2.67 hectares, 7 parks - 1.15 hectares, 1 park	3.2
Estimate percentage of natural area	18.78 hectares, 23.6%	3.2

Note: All information and areas are approximate only and are subject to survey and detailed design.

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Technical Appendices

Appendix Number	Document Title	Nature of Document	Referral/Approval Agency	Approval status and Modifications
1.	Certificates of Title	Supporting	-	-
2.	Environmental Assessment Report	Supporting	-	-
3A.	Bushfire Management Plan (Subdivision Specific)	Requires Approval	DFES and DPLH	Pending
3B.	Bushfire Management Plan Addendum (Structure Plan)	Requires Approval	DFES and DPLH	Pending
4.	Road and Railway Noise Assessment Report	Requires Approval	Main Roads WA	Pending
5.	Previously Approved Landscape Feature and Tree Retention Management Plan	Supporting	-	Approved
6.	Approved Acid Sulphate Soils and Dewatering Management Plan	Supporting	-	Approved
7.	DER Correspondence, Confirmation of Decontamination	Supporting	-	Approved
8.	Landscape Masterplan	Supporting	-	-
9.	Transport Assessment	Supporting	-	-
10.	Local Water Management Strategy	Requires Approval	DWER / City of Kwinana	DWER Approved
11.	Engineering Services Report	Supporting	-	-

Part One

Implementation

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1. Local Structure Plan Area and Operation

1.1 Structure Plan Area

This Structure Plan applies to the land contained within the inner edge of the line denoting the Structure Plan boundary on the Local Structure Plan map (Refer **Plan 1** situated at the end of Part 1 of this Structure Plan report).

1.2 Operation

In accordance with Schedule 2, Part 4 of the *Planning and Development (Local Planning Schemes) Regulations 2015*, this Structure Plan shall come into operation when it is approved by the Western Australian Planning Commission (WAPC) pursuant to Schedule 2, Part 4, Clause 22 of the Regulations.

2. Staging

Figure 14 of Part Two of this Local Structure Plan depicts the indicative staging for the subdivision of the Local Structure Plan area. Development of the Structure Plan has commenced generally north of the Peel Main Drain.

Future development of the site will generally occur south from the Peel Main Drain on a staged basis. The Structure Plan is intended to be developed across approximately 18 stages of approximately 30-60 lots per stage, commencing in the north and progressing south. Stages 1-6 of the estate have already been delivered, with stages 7-9 currently under construction. There are existing subdivision approvals in place for the entirety of the current MELSP, with a development approval for preliminary earthworks issued for the proposed amendment area (additional land).

3. Subdivision & Development Requirements

3.1 Land Use Zones and Reserves

The **Plan 1- Structure Plan Map** designates the land uses, zones and reserves applicable to the Structure Plan area. Land use permissibility within the Structure Plan area shall be in accordance with the corresponding zone or reserve under the City of Kwinana Local Planning Scheme No.2.

3.1.1.1 Residential Zone

Subdivision and development of the land is to be undertaken in accordance with the Structure Plan and the residential densities outlined in Part 2, Section 3.3.

A Residential Density Code Plan is to be approved at the time of subdivision.

3.1.2 Road Reserves

Road reserves provided in the Structure Plan area are distributed generally in accordance with **Plan 1 – Structure Plan Map**, and cross-sections are generally as per WAPC's Liveable Neighbourhoods, as outlined in **Table 1** below.

Road Classification	Typical Reserve Width	Typical Application
Neighbourhood Connector	24.4 metres	Primary connectors through the MELSP and MWLSP, providing an extension of Quartermaine Boulevard, and connecting between Rowley Road in the north and Anketell Road in the south (via the future Hammond Road extension).

Road Classification	Typical Reserve Width	Typical Application
Access Street B	17.9 metres	Primary north-south connector through the MELSP (Brilliant Boulevard), and providing for appropriate circulation around the proposed school sites.
Access Street C	15.4 metres	Comprises majority of local residential streets throughout the Structure Plan area
Access Street D	13.2 metres	Applies to roads where services are only required to one side – abutting public open space and the eastern noise attenuation wall.
Laneway (rear)	6 metres	To provide for rear vehicular access to lots, in certain locations where design warrants.

Table 1: Proposed Road Classification

3.1.3 Public Open Space

Public open space is to be provided generally in accordance with the **Plan 1 – Structure Plan Map.**

The Structure Plan is to provide a minimum 10 per cent of the gross subdivisible area as public open space, in accordance with the WAPC's Liveable Neighbourhoods requirements.

3.2 Density and Development

Having consideration for the density code ranges prescribed by the Structure Plan, a Residential Density Code Plan is to be submitted at the time of application for subdivision to the WAPC. The Residential Density Code Plan is to be submitted for the entire Structure Plan area but may be reviewed and updated at the time of each subdivision application, where subdivision and development is intended to be delivered in stages.

Where a revised Residential Density Code Plan is submitted with subsequent subdivision applications, it shall indicate the following:

a) The allocation of specific residential density codes to the proposed lots;

b) Residential density codes already designated to the previously approved lots (where applicable); and

c) The balance of lots subject to future subdivision applications.

The Residential Density Code Plan will allocate specific Residential Density Codes to the proposed street block/lots (as the case requires). Once approved by the WAPC, the Residential Density Code Plan forms part of the Structure Plan.

A Residential Density Code Plan(s) is not required if the WAPC considers the subdivision is for one or more of the following:

a) the amalgamation of lots;

b) facilitating the provision of access, service or infrastructure; or

c) the subdivision of land which, by virtue of its zoning or reservation under the Structure Plan, cannot be developed for residential purposes; or

d) is in accordance with a previously approved Residential Density Code Plan.

The allocation of residential densities shall be in accordance with the following criteria:

(i) an R30 Residential Density Code applies to all residential lots, except in the circumstances described below.

(ii) An R35, R40, R50 or R60 Residential Density Code may be applied to lots located within 400 metres of school, a public transport route, a neighbourhood connector and/or public open space.

3.3 Local Development Plans

A Local Development Plan is required in the following circumstances:

a) Lots with area of 260 square metres or less;

b) Irregular shaped lots;

c) Lots where specific vehicle access and egress control is required

d) Lots abutting a reserve for public open space and/or infrastructure (for example, the Peel Main Drain, electricity transmission lines or the Dampier to Bunbury Natural Gas Pipeline):

e) Lots with particular site constraints; and

f) Lots that require quiet house design for noise attenuation through deemed-to-comply noise insulation packages, and/or lots identified as requiring specialist acoustic requirements.

Where a Local Development Plan is required, a condition of subdivision approval should be imposed by the WAPC, requiring the preparation, approval and implementation of a Local Development Plan.

3.4 Other Requirements

3.4.1 Bushfire Management

Land within the Structure Plan area is mapped as being bushfire prone under the Department of Fire and Emergency Services Bushfire Prone Mapping.

This Structure Plan is supported by a Bushfire Management Plan, prepared in accordance with *State Planning Policy 3.7 – Planning in Bushfire Prone Areas* ('SPP 3.7'). Any development on land within the Structure Plan area shall be constructed in accordance with the recommendations made by the Bushfire Management Plan (as approved) and shall comply with the requirements of *Australian Standard 3959 – Construction of Buildings in Bushfire Prone Areas*.

An Addendum to the Bushfire Management Plan ('BMP') is to be lodged with any subdivision application for the site, containing the necessary development and associated bushfire planning detail, in accordance with the stated requirements of the BMP.

Alternatively, at a minimum, a Bushfire Attack Level Contour Plan, prepared in accordance with an approved Bushfire Management Plan, will be required to be submitted at the time of lodgement of an application for subdivision and/or development approval.

3.4.2 Transport Noise

The Structure Plan area adjoins the Kwinana Freeway on its eastern boundary.

The Structure Plan is supported by an Acoustic Assessment, prepared in accordance with *State Planning Policy 5.4 – Road and Rail Noise*. Subdivision and development of land within the Structure Plan area shall comply with any recommendations outlined in the Acoustic Assessment, and may require:

- A notification being placed on the Certificate of Title(s) of affected lots to advise landowners of potential for noise impacts from the Kwinana Freeway.

- Dwellings being constructed to comply with relevant Quiet House Design Packages.

The management of transport noise mitigation requirements will ultimately be considered as part of future applications to subdivide or develop land within the Structure Plan area. A condition of subdivision or development approval, requiring the preparation, approval and implementation of a Noise Management Plan, where applicable, may be required at that time.

A noise attenuation wall is being constructed along the eastern boundary of the site, in a staged approach, in accordance with the previously approved Noise Management plan for the Structure Plan area.

3.4.3 Development Contributions

The Structure Plan area is subject to contributions toward the costs of common infrastructure. In accordance with the City of Kwinana Town Planning Scheme No.2, the following development contribution arrangements apply and/ or are contemplated:

a) Development Contribution Area 8 for the funding of community infrastructure; and
b) Development Contribution Area 6 for traditional 'hard' infrastructure.

4. Additional Details

The details of additional information required to be submitted and the stage which it is to be submitted, are summarised below.

Additional Information / Purpose	Approval Stage	Responsible Agency (Consultation Required)
Bushfire Management Plan (Addendum) or Bushfire Attack Level Contour Plan	Subdivision Application	City of Kwinana Department of Fire and Emergency Services
Noise Management Plan	Subdivision Application	City of Kwinana Main Roads WA
Residential Density Code Plan	Subdivision Application	Western Australian Planning Commission

Table 2: Information to be Submitted with an Application

Condition of Subdivision Approval	Approval Stage
Local Development Plan	City of Kwinana Western Australian Planning Commission (if required)
Urban Water Management Plan	City of Kwinana
Landscape Feature and Tree Retention Management Plan	City of Kwinana
Arborist Report	City of Kwinana
Midge and Mosquito Management Plan	City of Kwinana

Table 3: Information Required as Condition of Subdivision Approval.

LEGEND

LAND USE

- RESIDENTIAL - MEDIUM DENSITY (R30 - R60)
- PS — PRIMARY SCHOOL
- PUBLIC OPEN SPACE
- DRAINAGE

MOVEMENT NETWORK

- NEIGHBOURHOOD CONNECTOR
- ACCESS STREET B
- ACCESS STREET D
- SHARED USE PATH

NOTE: ROAD LAYOUT SUBJECT TO DETAILED DESIGN
TO BE DETERMINED AT SUBDIVISION STAGE.

SERVICES & EASEMENTS

- POWERLINE EASEMENT CORRIDOR
- 330kv OVERHEAD POWER LINE
- TRANSMISSION TOWER
- DBNGP EASEMENT

OTHER

- STRUCTURE PLAN BOUNDARY
- IMPROVEMENT PLAN 47

ROWLEY ROAD
BOULEVARD
QUATERMAINE
KWINANA FREEWAY
PS
IP47
PS
HOFFMAN ROAD
KWINANA FREEWAY

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PLAN 1 - LOCAL STRUCTURE PLAN

VARIOUS LOTS - KWINANA FREEWAY & ROWLEY ROAD
MANDOGALUP

N

0 200 m
SCALE @ A3: 1:7500

7282D-LSP-09-B

DRAWN: WC
DATE CREATED: 2025.10.28
PROJECTION: PCG94
CADASTRE: LANDGATE

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LEGEND

LAND USE

- RESIDENTIAL - MEDIUM DENSITY (R30 - R60)
- PS — PRIMARY SCHOOL
- PUBLIC OPEN SPACE
- DRAINAGE

MOVEMENT NETWORK

- NEIGHBOURHOOD CONNECTOR
- ACCESS STREET B
- ACCESS STREET D
- SHARED USE PATH

NOTE: ROAD LAYOUT SUBJECT TO DETAILED DESIGN
TO BE DETERMINED AT SUBDIVISION STAGE.

SERVICES & EASEMENTS

- POWERLINE EASEMENT CORRIDOR
- 330kv OVERHEAD POWER LINE
- TRANSMISSION TOWER
- DBNGP EASEMENT

OTHER

- STRUCTURE PLAN BOUNDARY
- AMENDMENT AREA
- IMPROVEMENT PLAN 47

ROWLEY ROAD
BOULEVARD
QUATERMAINE
KWINANA FREEWAY
HOFFMAN ROAD
PS
IP47

N:\TOWN PLANNING\7000-7999\7282\7282A\DRAFTING\A CAD - WC - 2025.10.28

PLAN 1A - LOCAL STRUCTURE PLAN (PROPOSED AMENDMENT)

VARIOUS LOTS - KWINANA FREEWAY & ROWLEY ROAD
MANDOGALUP

N

0 200 m
SCALE @ A3: 1:7500

7282D-LSP-08-G

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Part Two

Explanatory Section

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1. Planning Background

1.1 Introduction And Purpose

This Structure Plan comprises an amendment to the existing approved Mandogalup East Local Structure Plan ('MELSP'), endorsed by the WAPC on 28 March, 2018.

The original approved MELSP was prepared for the landholdings zoned 'Urban' under the Metropolitan Region Scheme ('MRS') at that time, comprising Part Lots 9002, 9006 and 11 Hoffman Road, and Lot 9019 (now Lot 9060) Rowley Road. Subsequent to approval of the original MELSP, the WAPC resolved to transfer the land comprising the balance of Lots 9002, 9006 and 11 Hoffman Road, as well as Lot 9000, Mandogalup, from the 'Urban Deferred' zone to the 'Urban' zone under the MRS. In accordance with the *Planning and Development Act 2005*, the Amendment area was also subsequently rezoned from the 'Rural A' to the 'Development' zone under the City of Kwinana Local Planning Scheme No.2, by notice in the Government Gazette on 31 October 2023.

The purpose of this Amendment No.1 is to therefore include the additional Urban land comprising Lots 9000, 9002 9006 and 11 Hoffman Road, Mandogalup within the MELSP boundary. The existing Structure Plan area will remain generally as previously approved, majority of which has already been developed, or is subject to existing subdivision approvals. Therefore, for the purposes of the 'Part Two – Explanatory Section' of the Structure Plan, this report (from herein) will primarily focus on the portion of the Structure Plan subject to modification (herein referred to as the subject site or Amendment area), as defined on **Plan 1.**

This Structure Plan will provide a general planning framework to guide the future subdivision and development of the land in an integrated and cohesive manner.

1.1.1 Purpose

The purpose of this report is to provide the relevant background and explanatory information, forming the basis of the Mandogalup East Local Structure Plan. In this regard, the Structure Plan seeks to guide future land use and development over the subject land, providing a framework for more detailed planning at subdivision.

The following sections provide further detail and explanation for the Structure Plan Part 1 provisions.

1.1.2 Structure Plan Content

This Structure Plan comprises the following sections:

- **Part One – Implementation**: includes the Structure Plan map (Plan 1) and outlines the requirements that will be applied when assessing subdivision and development applications over the land to which the Structure Plan relates.
- **Part Two – Explanatory Section**: is to support the Structure Plan contained in Part One by providing the background and explanatory information used to prepare the Structure Plan.
- **Technical Appendices**: contains all technical and specialist reports prepared in support of the Structure Plan.

1.1.3 Project Team

The following multi-disciplinary project team has been engaged to progress the preparation of the MELSP, as amended:

Discipline	Consultant
Acoustic	Herring Storer Acoustics
Civil Engineering	Peritas Engineering
Environmental	JBS&g
Fire Management	JBS&g
Hydrological	JDA
Landscape Architecture	Emerge
Survey	MNG
Town Planning and Design	Rowe Group
Traffic	Transcore

Table 4: Project Team

1.1.4 Mandogalup West Local Structure Plan

The MELSP is adjoined on its western boundary by land comprising the Mandogalup West Local Structure Plan ('MWLSP'). The original MWLSP was approved on 26 March 2018, generally concurrently with the MELSP, and represented a collaboration between the relevant landowners and project consultant teams across both the MWLSP and the MELSP.

Similarly to the proposed amended MELSP, a modification to the MWLSP has also been proposed to include additional land which was previously excluded due to zoning at that time.

As with the existing approvals, the amendments to both the MELSP and MWLSP will provide for a coordinated planning and design approach between the two Local Structure Plan areas. The concept subdivision designs for both Structure Plan areas ensure the seamless alignment of local and neighbourhood connector roads, coordinated distribution of public open space, consideration of adjoining residential boundaries, alignment of service infrastructure provision and development staging.

Refer **Figure 9 – Combined MELSP and MWLSP Concept Plan.**

1.2 Land Description

1.2.1 Location

The MELSP is located within the metropolitan southwest corridor, within the municipality of the City of Kwinana. The site is situated approximately 24 kilometres south of the Perth Central Area and is accessible via the Kwinana Freeway. The Kwinana Town Centre is located approximately 8 kilometres south of the site and the Spectacle Regional Reserve approximately 4 kilometres from the subject site.

The subject site is generally bound by the Kwinana Freeway to the east, Rowley Road to the north, and Anketell Road in the south. The site is currently accessed from the north via Quartermaine Boulevard through the adjoining Apsley estate (MWLSP), connecting with Rowley Road.

Refer to **Figure 1** – Regional Location.

Refer to **Figure 2** – Local Location.

1.2.2 Area and Land Use

The MELSP, as amended, comprises a total of approximately 79.9 hectares of land.

The MELSP is progressively being developed in a staged approach under existing approvals, known as *Florence* estate. To date, approximately 215 lots have been delivered across 5 stages, with Stage 6 of a total 18 stages currently being constructed. The amendment area generally comprises Stages 10 to 18 of the estate.

Historically, the land has been used for agricultural purposes including grazing, cropping and horse agistment. As such, majority of the amendment area is in a degraded state, with existing trees and vegetation dispersed throughout.

The amendment area is currently being used for the stockpiling of fill and topsoil, progressively being used for the development of the estate.

Refer to **Figure 3** – Site Plan

1.2.3 Legal Description and Ownership

The MELSP, as amended, comprises of 6 undeveloped parent lots, being;

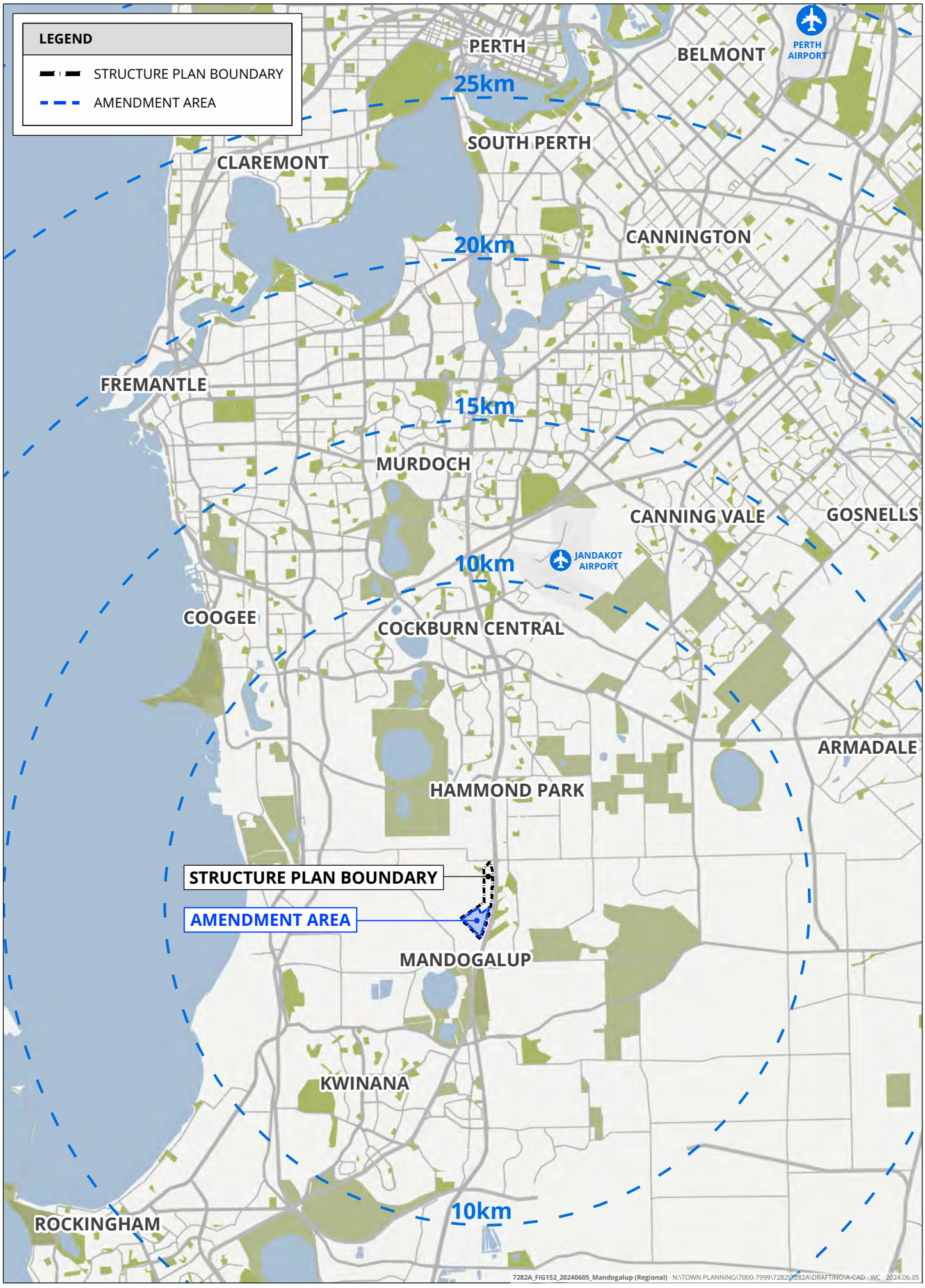
Lot No.	Proprietor	Deposited Plan	Volume / Folio	Area (Approx)
9000	Wandi Anketell Holdings Pty Ltd	31293	2525 / 87	0.57 hectares
11	Santo Galati Rando Annunziata Galati Rando	76538	2809 / 569	5.64 hectares
9002	Wandi Anketell Holdings Pty Ltd	69132	2758 / 177	26.11 hectares
9006	Wandi Anketell Holdings Pty Ltd	70124	2769 / 846	24.35 hectares
Part Lot 9060	Wandi Anketell Holdings Pty Ltd	427273	4051 / 54	4.87 hectares
8018 (Peel Main Drain)	State of Western Australia	77243	LR3024 / 314	1.067 hectares

Table 5: Lot Details

The balance of the Structure Plan area has already been developed for residential lots and associated public open space and roads. Part of Lot 9060 has also been set aside for a future primary school and local playing fields.

Refer to **Figure 3** – Site Plan

Refer to **Appendix 1** – Certificates of Title.



0 5000 m

SCALE @ A4: 1:150,000

FIGURE 1

REGIONAL LOCATION

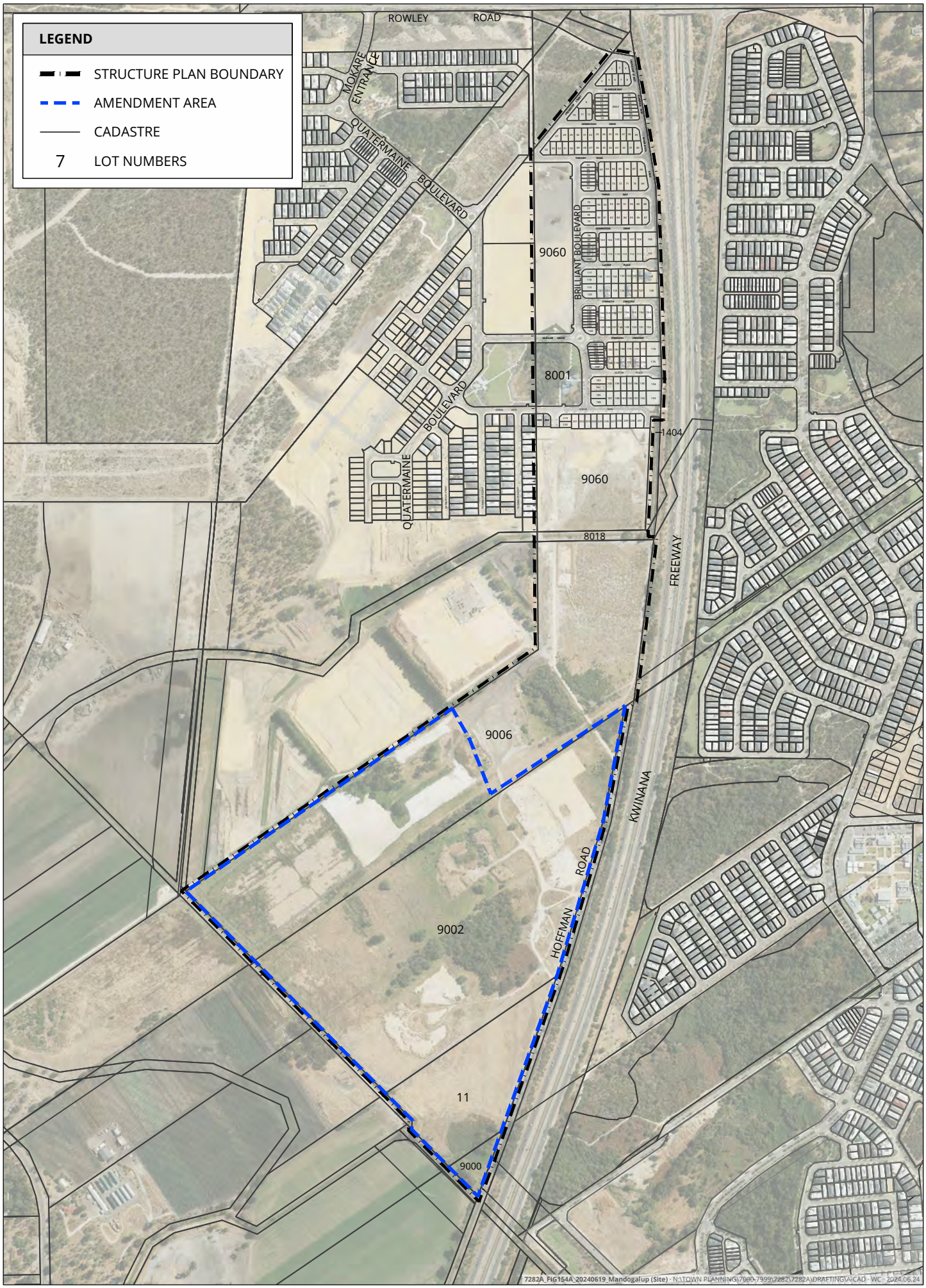


0 1000 m

SCALE @ A4: 1:30,000

FIGURE 2

LOCAL LOCATION



0 250 m

SCALE @ A4: 1:10,000

FIGURE 3

SITE PLAN

1.3 Planning Framework

1.3.1 Zoning and Reservations

Land within the Structure Plan boundary is zoned 'Urban' under the Metropolitan Region Scheme ('MRS'), and 'Development' under the City of Kwinana Town Planning Scheme No.2 ('TPS 2').

A small portion of the Structure Plan area (approximately 2.8 hectares) remains Urban Deferred, and is included within the boundary of Improvement Area 47. Given the locational context of this portion of land, consideration as part of this Structure Plan is logical to ensure a coordination of planning and design.

The Hoffman Road reservation runs parallel to the Kwinana Freeway. Hoffman Road provides access to the site from Anketell Road and will form part of the development of the site, however, is excluded from the MELSP boundary.

The Peel Drain dissects the site in an east-west direction, comprising Lot 8018.

The Dampier to Bunbury Natural Gas Pipeline (DBNGP) also dissects the site generally in an east-west direction along the southern boundary of Lot 9006.

Refer **Figure 4** – Metropolitan Region Scheme Zoning.

Refer **Figure 5** – Town Planning Scheme No.2 Zoning.

1.3.2 Improvement Area 47

Improvement Area 47 (IP47) came into effect in April 2019 and comprises approximately 330 hectares of land adjacent to the Structure Plan area, generally west of the high voltage powerline easement.

The draft Improvement Scheme for IP47 was publicly advertised between January and April 2024, and is currently being progressed by the WAPC, with Ministerial approval anticipated by the end of 2024. The advertised draft Scheme included a Scheme Map, Scheme Text, Scheme Report, Concept Land Use Plan, Technical Appendices and a Preliminary Road Design for the Hammond Road Extension.

The Improvement Scheme Text and Scheme Map will replace the Metropolitan Region Scheme and Local Planning Scheme as the statutory land use planning instrument over the area. The Improvement Scheme Report, Concept Plan and technical reports provide the context and explanatory commentary on the draft Scheme.

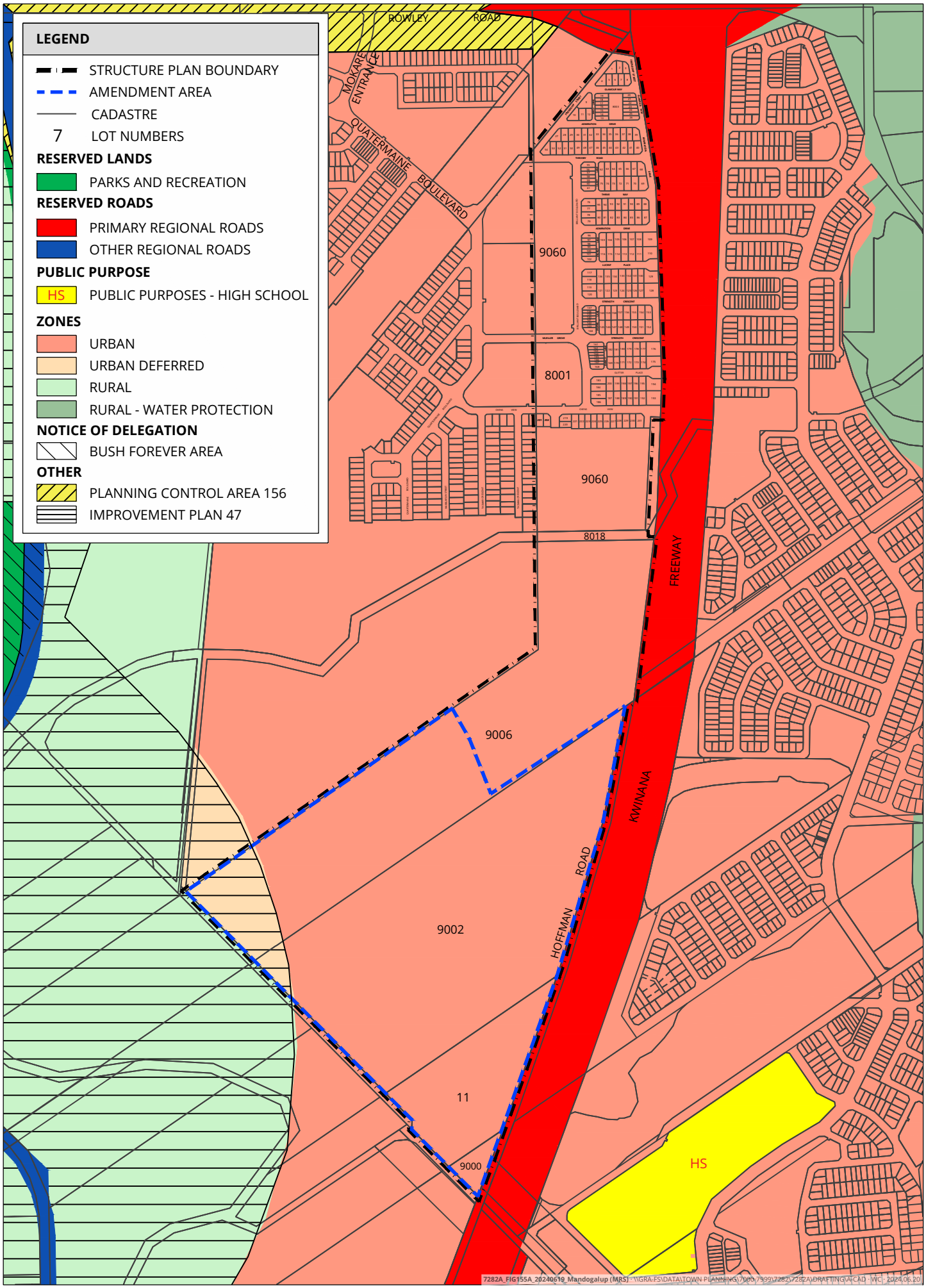
The draft Improvement Scheme Map and Land Use Concept, as advertised, identifies land in proximity to the Structure Plan area for a mix of Light Industry, Residential and drainage, as well as providing for the extension of and connections to Hammond Road between Rowley Road and Anketell Road.

A small portion of the subject land (approximately 2.8 hectares) is situated within the boundary of IP47. The draft IP47 Scheme Map identifies this portion of land for Residential zoning, with the draft IP47 Land Use Concept further designating this area for public open space (drainage), consistent with the District Water Management Strategy and previous planning for this area. The proposed Structure Plan is consistent with the zoning and land use designations identified under the Draft IP47 Scheme for this portion of the site.

Whilst it is acknowledged the portion of the subject land within the IP47 boundary will be governed by that planning framework, given its locational context and land tenure, it will form part of the development of the later stages of the Florence estate (comprising the MELSP). Therefore, to ensure a coordinated approach to planning and design, this land is included conceptually as part of the proposed Structure Plan, and is included as part of technical reporting for the Structure Plan.

Refer **Figure 6** – Draft Improvement Scheme Map.

Refer **Figure 7** – Draft Improvement Scheme Land Use Concept.

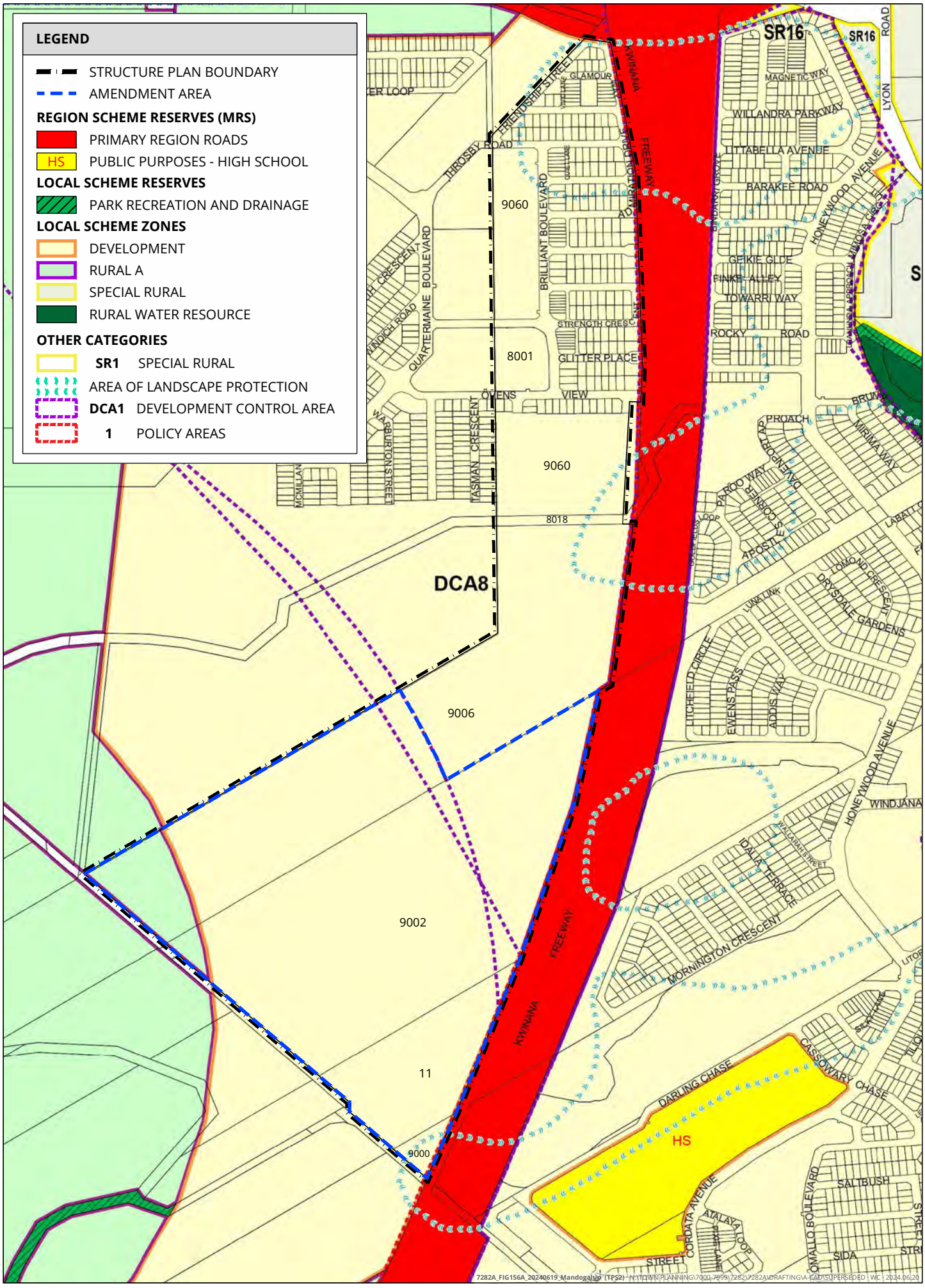


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FIGURE 4

METROPOLITAN REGION SCHEME ZONING

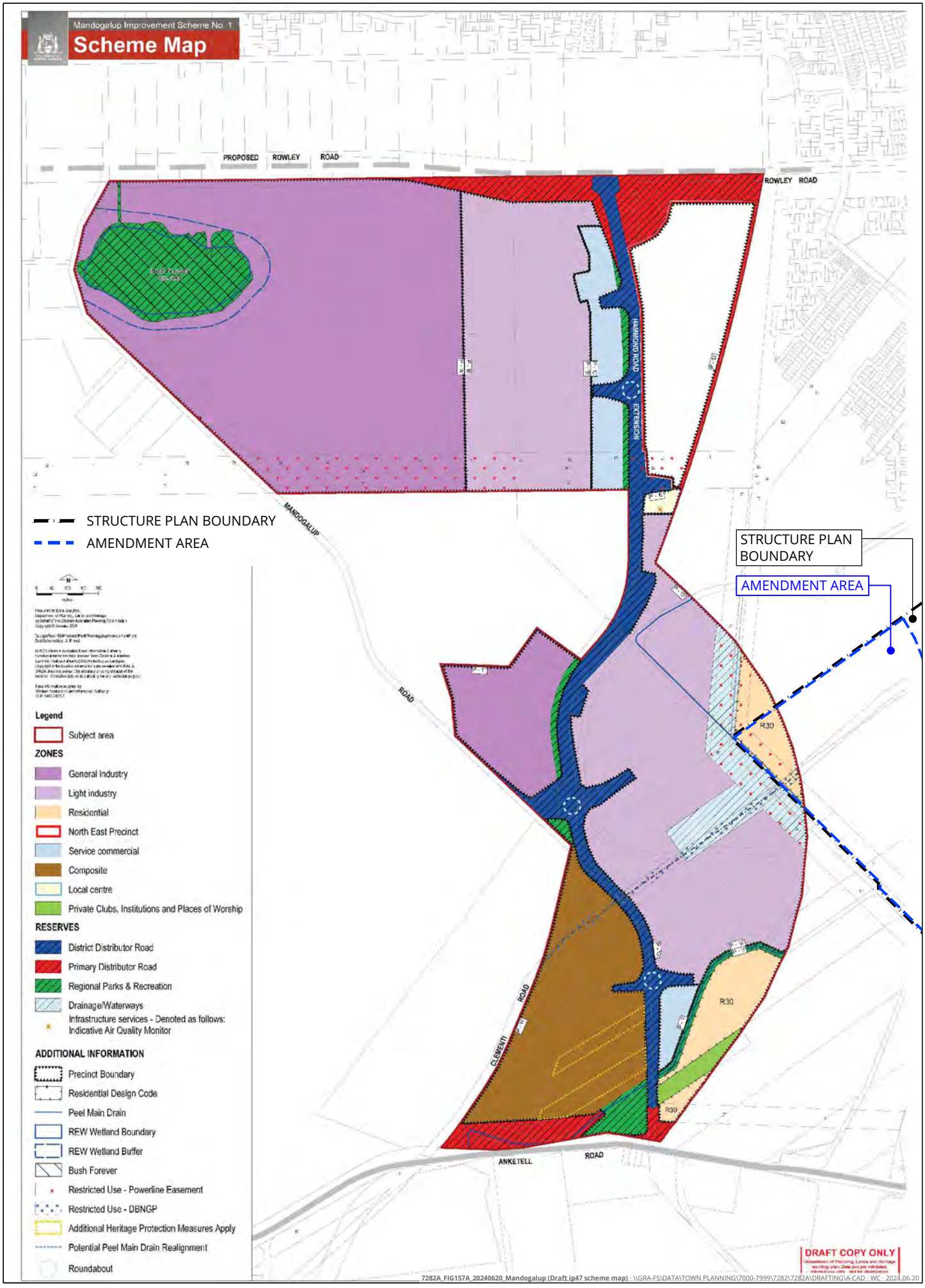


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FIGURE 5

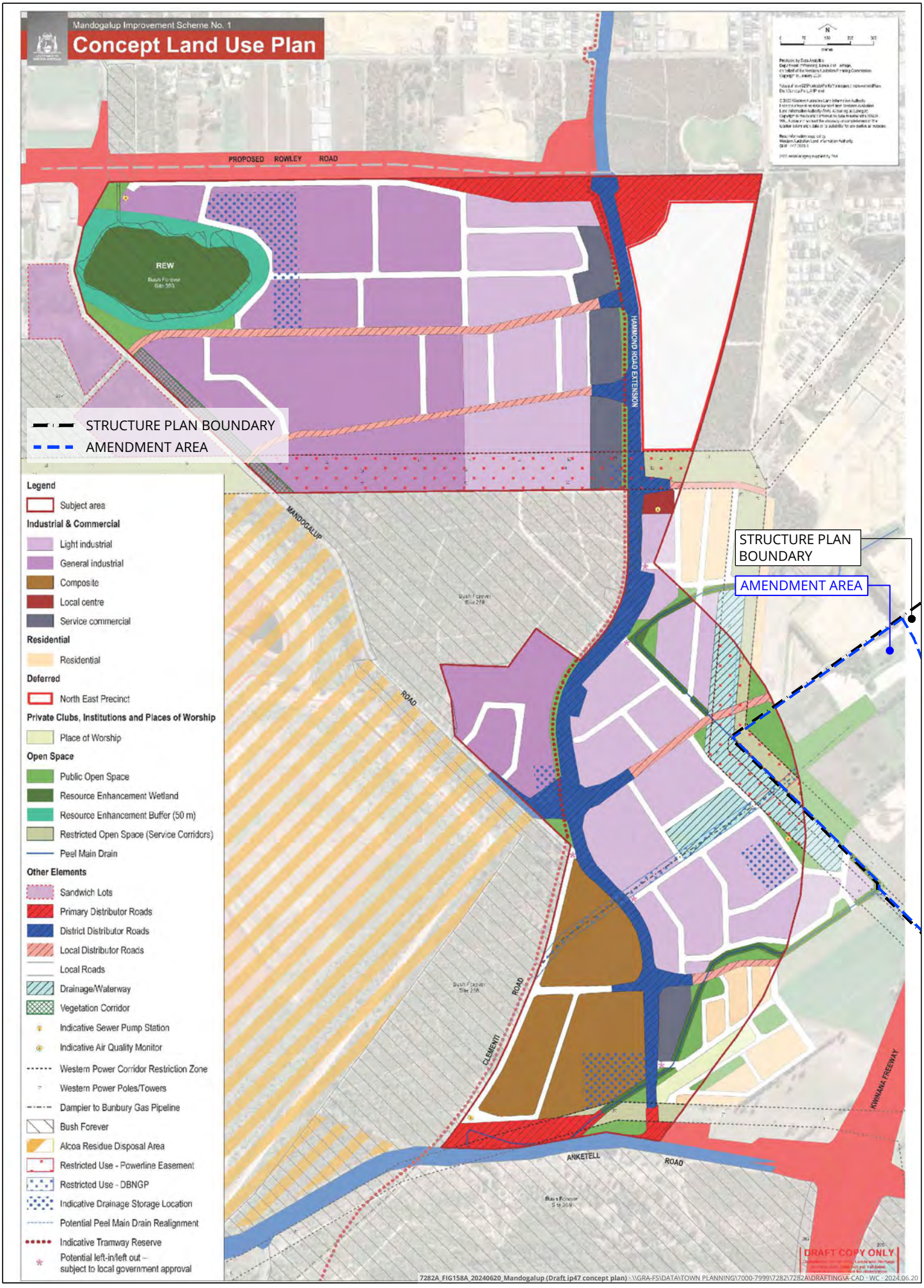
CITY OF KWINANA TOWN PLANNING SCHEME No. 2 ZONING



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FIGURE 6

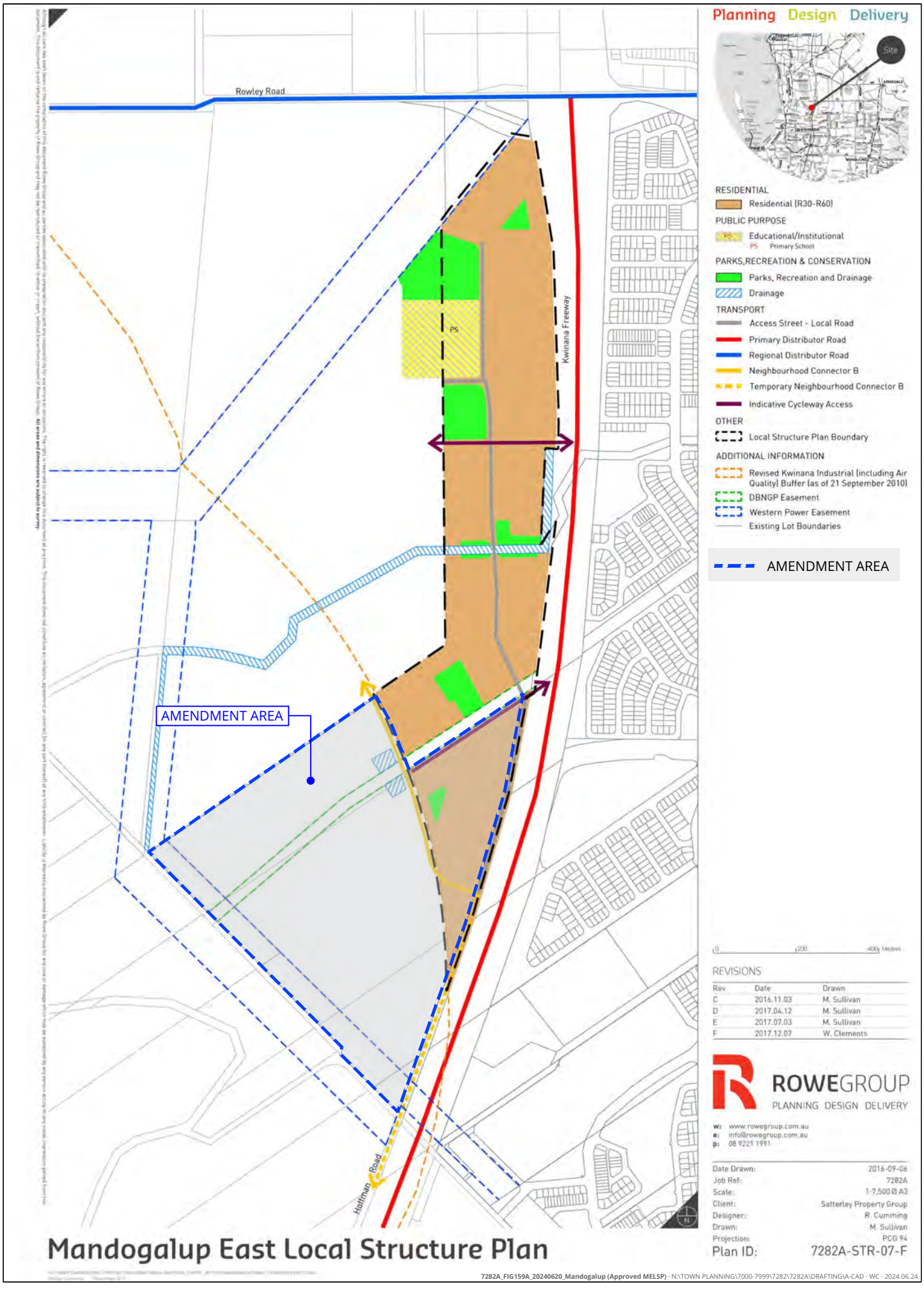
DRAFT IMPROVEMENT SCHEME 47 MAP



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FIGURE 7

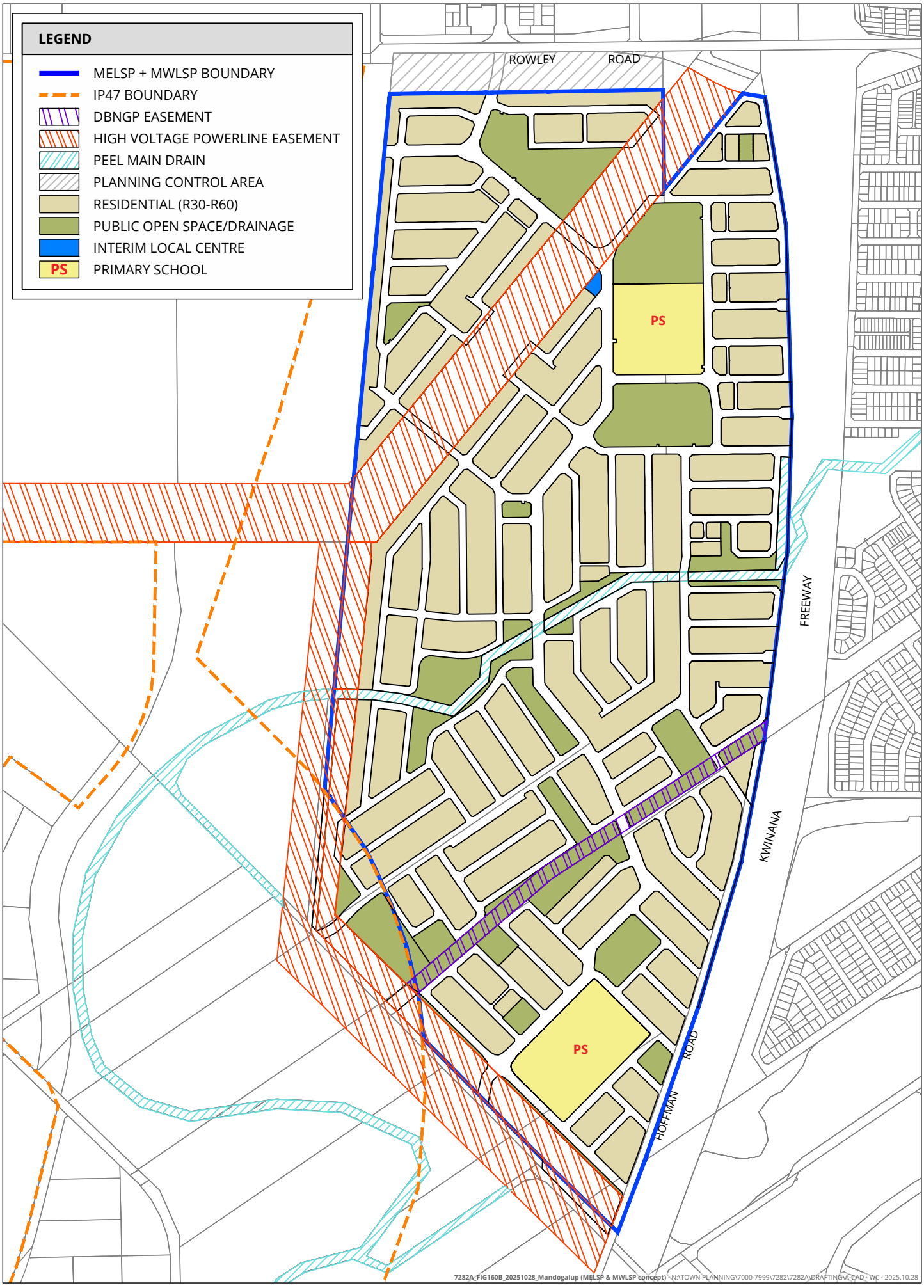
DRAFT IMPROVEMENT SCHEME 47 CONCEPT LAND USE PLAN



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FIGURE 8

EXISTING APPROVED MANDOGALUP EAST LOCAL STRUCTURE PLAN



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FIGURE 9

COMBINED MELSP & MWLSP CONCEPT

1.3.3 Regional Structure Plans

1.3.3.1 Jandakot Structure Plan

In 1993, a Select Committee Report on Metropolitan Development and Groundwater Supplies reviewed the boundaries of the Jandakot Underground Water Pollution Control Area ('JUWPCA'). This review decreased the extent of the JUWPCA and as a result, revealed an area that was without any strategic planning for future use and development. The Jandakot Structure Plan was prepared over this subsidiary piece of land and was subsequently adopted, by the WAPC, in August 2007.

The Jandakot Structure Plan sets out the broad strategic planning framework for the 'U' shaped parcel of land surrounding the Rural Water Protection area. It covers an area of land up to Rowley Road to the north and Millar and Jackson Roads to the south, dealing with issues of both groundwater and stormwater management. The Jandakot Structure Plan requires that a Local Water Management Strategy ('LWMS'), consistent with the Jandakot Water Resources Management Strategy ('JWRMS'), be prepared and lodged with any subsequent Local Structure Plan.

The Jandakot Structure Plan identifies the MELSP area for urban development.

The proposed MELSP is consistent with the intent and requirements of the Jandakot Structure Plan.

The district level requirements of the Jandakot Structure Plan and ERIC, such as the identification and preservation of natural areas, the allocation of public open space and public purpose areas, road network and hierarchy, and the allocation of school sites have been further refined through the preparation of this Local Structure Plan.

1.3.3.2 Eastern Residential Intensification Concept (ERIC)

The Eastern Residential Intensification Concept (ERIC) was prepared by the then Town of Kwinana in November 2005 and provides strategic direction and refinement of the future urban areas identified under the Jandakot Structure Plan. In particular, it expands upon the opportunities and constraints inherent to the land and, whilst never formally adopted by Council, 'defines a framework by which urban subdivision and development is able to occur in an orderly and co-ordinated manner'.

The MELSP has been prepared giving due consideration to the provisions of ERIC, albeit updated to respond to the current planning framework, policies, principles and objectives. The MELSP provides a response to more detailed site-specific analysis as required by ERIC, such as flora and fauna, water management, noise controls and traffic management and those requirements emanating from WAPC Statement of Planning Policies.

1.4 Regional Planning Strategies

1.4.1.1 Perth and Peel @ 3.5 Million

The *Perth and Peel @3.5 Million* (March 2018) suite of documents provide a framework for the development of the Perth and Peel regions as the population reaches an estimated 3.5 million by 2050. The documents seek to meet the targets identified under Directions 2031 and the State Planning Strategy 2050. The suite of documents includes four sub-regional planning frameworks for the Central, North-west, North-East and South Metropolitan Peel sub-regions. The four Sub-Regional Planning Framework details where future homes and employment should be located, and where important environmental assets should be avoided and protected.

The Structure Plan is included within the South Metropolitan Peel Sub-Regional Planning Framework and is identified as 'Urban', consistent with the current MRS zoning.

1.4.1.2 South Metropolitan Peel Sub-Regional Planning Framework

The *South Metropolitan Peel Sub-Regional Planning Framework* (the 'Framework') represents a whole State Government approach to managing the future urban form within the sub-region and identifies sufficient land to meet the increased demand for residential dwellings, The South Metropolitan Peel sub-region is proposed to accommodate more than 1.26 million people, over 507,000 homes and approximately 430,000 jobs, with a projected additional dwelling target of 19,549 (49,499 people) within the City of Kwinana.

The development of the Structure Plan area for residential development, consistent with the Urban land use designation under the Framework, will contribute to meeting the relevant dwelling targets for the City of Kwinana.

1.5 Local Planning Strategies

1.5.1 City of Kwinana Local Commercial and Activity Centres Strategy 2023

The City of Kwinana *Local Commercial and Activity Centres Strategy* (LCACS), adopted in 2023, guides the development of commercial and activity centres across the City, and will ultimately be incorporated into the City's Local Planning Strategy.

The document reviews and responds to the state policy setting and analyses the current configuration and future requirements for activity centres within the City based upon retail trends and projected population. Based on robust modelling and analysis, the LCACS ensures a hierarchy of activity centres is appropriately distributed throughout the City.

Consistent with the LCACS centre allocation and hierarchy, no commercial or activity centres are identified within the proposed Structure Plan. The closest local centre is identified within the adjacent MWLSP.

1.5.2 City of Kwinana Community Infrastructure Plan 2011-2036

The City of Kwinana Community Infrastructure Plan was originally adopted in 2009, and most recently revised in 2022.

The Community Infrastructure Plan is based on a detailed Community Needs Assessment and provides a strategic framework for providing community infrastructure across the City of Kwinana, primarily focusing on facilities provided by Local Government, such as local playing fields and associated clubrooms, community centres and libraries.

The Community Infrastructure Plan has been prepared to meet the requirements of the WAPC's *State Planning Policy 3.6: Infrastructure Contributions*, and establishes a framework upon with the Policy can be applied and implemented. While a stand alone Plan in its own right, the Community Infrastructure Plan is considered an important part of the City's Development Contribution Plans contained in Town Planning Scheme No. 2.

The Structure Plan area is partially situated within Development Contribution Area 8 for the purposes of contributing to the provision of community infrastructure within Mandogalup and surrounds.

In accordance with the Community Infrastructure Plan, Development Contribution Area 8 is identified as providing one local sports ground within Mandogalup. This is provided for in the north of the Structure Plan area, with the location and configuration endorsed as part of the existing approved MELSP and MWLSP.

Consistent with the Community Infrastructure Plan, no additional community infrastructure, beside local public open space, is required or proposed within the amended MELSP.

1.6 State Planning Policies

1.6.1 State Planning Policy 2.1 – Peel Harvey Coastal Plain Catchment

State Planning Policy 2.1: Peel-Harvey Coastal Plain Catchment ('SPP 2.1') seeks to ensure the intensification of land within the Peel-Harvey Coastal Plain Catchment is balanced to prevent potential environmental damage within the Catchment. A Local Water Management Strategy has been prepared in accordance with the SPP 2.1, in support of the Structure Plan.

Further subdivision and development within the MELSP will be required to prepare and implement an Urban Water Management Plan.

1.6.2 State Planning Policy No. 2.9 – Planning for Water (Draft)

The WAPC has prepared the draft *State Planning Policy No. 2.9 – Planning for Water* ('draft SPP 2.9') and supporting Guidelines, which were advertised for public comment in 2021. Draft SPP 2.9 and the associated Guidelines seek to consolidate and replace several existing State planning policies, including *SPP 2.7 – Public Drinking Water Source Policy* and *SPP 2.9 – Water Resources*.

The draft policy was prepared to ensure planning and development considers water resource management and includes appropriate water management measures to achieve optimal water resource outcomes. As discussed, a Local Water Management Strategy has been prepared in accordance with the draft SPP 2.9, in support of the Structure Plan. The Local Water Management Strategy demonstrates the proposed development can appropriately manage stormwater, groundwater and will not negatively impact the surrounding environment. The Local Water Management Strategy is detailed further in Section 3.6 of this Report, demonstrating the proposal is consistent with the objectives of draft SPP 2.9.

1.6.3 State Planning Policy No 3. - Urban Growth and Settlement

State Planning Policy No. 3 – Urban Growth and Settlement ('SPP 3') sets out the principles and considerations in the promotion of sustainable growth across Western Australia. A number of key objectives of SPP 3, as outlined below, are relevant to this Structure Plan:

- 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.
- To build on existing communities with established local and regional economies, concentrate investment in the improvement of services and infrastructure and enhance the quality of life in those communities.
- To manage the growth and development of urban areas in response to the social and economic needs of the community and in recognition of relevant climatic, environmental, heritage and community values and constraints.
- To promote the development of a sustainable and liveable neighbourhood form which reduces energy, water and travel demand whilst ensuring safe and convenient access to employment and services by all modes, provides choice and affordability of housing and creates an identifiable sense of place for each community.
- To coordinate new development with the efficient, economic and timely provision of infrastructure and services.

The proposed Structure Plan is consistent with the abovementioned objectives for future urban growth. Consideration of the strategic and physical context of the subject site is discussed further within this document and more detailed design provisions are to be addressed and considered at the subdivision stage.

1.6.4 State Planning Policy 3.7 - Planning in Bushfire Prone Areas

State Planning Policy 3.7 – Planning in Bushfire Prone Areas ('SPP 3.7') seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure.

The subject land is identified as a Bushfire Prone Area on the Department of Fire and Emergency Services ('DFES') mapping. Accordingly, a Bushfire Management Plan is required to support any strategic planning applications for the development the subject land, prepared in accordance with the requirements of SPP 3.7. A Bushfire Management Plan has therefore been prepared by JBS&G in support of this Structure Plan and is discussed in detail in Section 2.4 of this Report.

Refer **Appendix 3A – Bushfire Management Plan (Subdivision Specific)**

Refer **Appendix 3B – Bushfire Management Addendum (Structure Plan)**

1.6.5 State Planning Policy 5.4 - Road and Rail Noise

State Planning Policy No. 5.4 – Road and Rail Noise ('SPP 5.4') was prepared to assist in minimising the adverse impact of road and rail noise on noise sensitive land uses and/or development, within the specified trigger distance of strategic freight and major traffic routes. The Structure Plan area adjoins the Kwinana Freeway and Perth-to-Mandurah Railway Line on its eastern boundary and is therefore subject to the requirements of SPP 5.4.

In accordance with the requirements of SPP 5.4, a detailed acoustic assessment has been prepared in support of the Structure Plan, which confirms future residential lots that may be impacted by noise can be appropriately mitigated through the construction of a Noise Wall along the eastern boundary of the site, and the application of standard 'Quiet House Design' noise insulation packages.

Refer **Appendix 4 – Acoustic Assessment.**

1.7 Operational Policies

1.7.1 Liveable Neighbourhoods

Liveable Neighbourhoods (2009) was prepared by the WAPC to implement the objectives of the State Planning Strategy and deliver the strategies and actions of metropolitan spatial frameworks. Liveable Neighbourhoods is an operational policy that guides structure planning (regional, district and local), subdivision and development for new urban areas, including greenfield and large brownfield (urban infill) sites. Liveable Neighbourhoods seeks to promote the design of walkable neighbourhoods; places that offer community and a sense of place; mixed uses and active streets; accessible and sustainable parks; energy efficient design; and a variety of lot sizes and housing types.

The MELSP has been designed in accordance with the principles and requirements of Liveable Neighbourhoods and is addressed in further detail in Section 3 of this Report.

The indicative layout has been designed using relatively short street blocks to provide for a permeable and legible pedestrian, cycle and vehicle movement network. The public open space network provides for connectivity through the site, intended to serve a variety of functions to cater for a wide demographic, with all proposed lots within a 200 metre or five minute walkable catchment of at least one area of open space.

The Local Structure Plan provides for a primary school and local playing fields in the north of the site, with a second primary school being identified within the Amendment area.

The indicative layout has also had consideration for the existing topography and landform of the site, as well as facilitating solar orientation of future lots. Servicing and water management considerations have also been facilitated within the indicative layout.

In accordance with Liveable Neighbourhoods requirements for a minimum average density of 22 dwellings per residential site hectare, indicative subdivision design for the MELSP achieves approximately 26.3 Dwellings per residential site hectare.

1.8 Local Planning Policies

The following City of Kwinana Local Planning Policies are to be addressed and considered through the subdivision and detailed design stages:

- Local Planning Policy No.1: Landscape Feature and Tree Retention
- Local Planning Policy No. 2: Streetscapes
- Local Planning Policy No. 8: Designing Out Crime
- Local Planning Policy No. 14: Residential Development.
- Residential Subdivision and Development Guidelines

2. Site Conditions and Constraints

The following provides a summary of the environmental site conditions and constraints as it relates to the MELSP Amendment area. For further detail, the Environmental Assessment Report ('EAR') is provided at **Appendix 2.**

2.1 Biodiversity and Natural Area Assets

2.1.1 Flora and Vegetation

A Level 2 Flora Survey was undertaken over the entire Mandogalup East Local Structure Plan (MELSP) during Spring 2004 and 2006, and Autumn 2007. A Targeted Threatened Flora Survey was also undertaken in 2013. Further to this, a renaissance flora survey was performed in 2017 and a flora and vegetation survey undertaken in 2018.

The surveys identified the subject site as being predominantly cleared farmland with patches of Eucalypts. Vegetation types were mapped across the site, comprising of:

1. *Eucalyptus rudis* and *Melaleuca rhaphiophylla* woodland over *Pteridium esculentum, *Zantedeschia aethiopica, *Phytolacca octandra and *Gomphocarpus fruticosus* low shrubland over introduced grasses and herbs including **Ehrharta calycina, *Cynodon dactylon* and **Cirsium vulgare.*
2. *Eucalyptus rudis* and open woodland over *Pteridium esculentum* shrubland over introduced grasses including **Ehrharta calycina and *Avena barbata*

As a result of long-term degradation of the site associated with intensive agricultural use, the entirety of the site has been classified as Completely Degraded.

2.1.2 Significant Trees and Landscape Features

In accordance with the City of Kwinana *Landscape Feature and Tree Retention Policy*, trees were surveyed across the site by Arborlogic in March and October 2016 (the findings of which are summarised in **Error! Reference source not found.** of the EAR) to identify significant trees and landscape features within the subject site.

In response to the *Landscape Feature and Tree Retention Policy,* arboricultural assessments of individual trees within unique landscape areas and/or having a diameter breast height greater than 500mm were undertaken across the site. Assessment of the structural integrity and viability of retaining individual trees within the site was also undertaken.

During October 2016, Arborlogic completed a site wide assessment of significant trees, assessing 173 trees (125 in the amendment area) as having a retention value of 'very low', 'low', 'medium' or 'high'. The retention value was based on an assessment of health and/or structural integrity. This study has been used to inform the location and configuration of public open space across the site, as well as road network configuration considerations. Of the 125 significant trees identified within the MELSP Amendment area, 76 have been identified for retention in streetscapes and public open space (subject to detailed design), of which majority are classified as having either a High or Medium retention value, and which include 41 Black Cockatoo trees.

A *Significant Trees and Landscape Strategy* is provided within the attached EAR, and shows considerable effort has been made to accommodate the majority of significant trees surveyed within public open space.

A *Landscape Feature and Tree Retention Management Plan* was also approved in 2020 for the existing MELSP, required as a condition of subdivision approval for that land. This is being implemented as part of existing approvals in a staged development approach. Similarly, a Landscape Feature and Tree Retention Management Plan will be required as a condition of subdivision approval for the MELSP Amendment area.

Refer **Appendix 5** – Previously Approved Landscape Feature and Tree Retention Management Plan.

2.1.3 Conservation Areas

There are no Bush Forever sites, or other areas identified for conservation within the site or immediate surrounds.

A Protected Matters database search identified eight threatened species protected under the *Environmental Protection and Biodiversity Conservation Act* ('EPBC Act') that may occur within the subdivision area. However, during surveys undertaken for the site during the structure planning process, no Threatened Ecological Communities ('TEC') as listed under the EPBC Act or the *Wildlife Conservation Act 1950*, or Priority Ecological Communities ('PEC') as listed by Department of Biodiversity, Conservation and Attractions (Parks and Wildlife Service) were recorded on the site.

2.1.4 Wetlands

A Multiple-Use category wetland is mapped over the subject site, Multiple Use Wetlands are considered wetlands with few important ecological attributes and function remaining. In this regard, the wetland is not considered a constraint to development.

The closest Ramsar-listed wetland to the site is 'The Spectacles Reserve,' situated approximately 4 kilometres south of the site. The Spectacles wetland is classified as a Conservation Category Wetland by the Department of Biodiversity, Conservation and Attractions and is also situated within Bush Forever site number 269.

The Thomsons Lake Nature Reserve is situated approximately 3 kilometres to the north of the site and comprises the Ramsar-listed Thomsons Lake. This area forms part of the Beeliar Regional Park.

The Spectacles and Thomsons Lake reserves are removed from and will not be impacted by the development of the subject site.

2.2 Landform and Soils

The site is situated within the Bassendean Dune system, which can be categorised as sand dunes and sand plains comprising swamps and flats on sandy alluvium over sedimentary rocks. Soils within the site are predominantly Lacustrine deposits consisting of dark brownish grey silt, with disseminated fine-grained quartz sand, firm, with variable clay content.

The topography of the MELSP Amendment area is mostly low lying and gently undulating, with elevations across the site ranging from approximately 14 metres AHD in the west, to approximately 16 metres AHD in the east.

2.2.1 Acid Sulphate Soils

The Department of Water and Environmental Regulation ('DWER') Acid Sulphate Soil Risk Mapping identifies the site as having a predominantly 'High to Moderate' risk of Acid Sulphate Soils ('ASS') occurring within three metres of natural soil surface.

A study undertaken for the site in 2009 determined there was a risk of disturbing potential or actual ASS during ground intrusive earthworks in the low-lying areas of the site, given parts of this area are less than 1 metre above the water table. In this regard, in March 2017, the proponent engaged WSP Australia Pty Ltd to undertake an Acid Sulphate Soil and Groundwater Investigation and subsequently, the preparation of an ASS and Dewatering Management Plan (ASSDMP) for the site.

Strategen Environmental (JBS&G) were subsequently engaged by the proponent in April 2018 to finalise the ASSDMP for lodgement with the Department of Water and Environment Regulation. The ASSDMP outlines the various management strategies and processes which will need to be followed by the Contractor, Environmental Consultant and Superintendent as part of future construction works. In this regard, the ASS management strategies to be applied to the proposed site development works include:

- Infrastructure excavation management;
- Temporary soil stockpiling and limestone pad construction;
- Neutralisation (lime treatment) at the maximum limiting rates determined from the Suspension Peroxide Combined Acidity and Sulfur ('SPOCAS') testing of different soil types; and
- Stockpile monitoring program to validate the lime treatment.

The ASSDMP concludes that all soil types encountered during the site investigation are considered to have acid generating capacity and therefore, a management plan has been prepared, which must be complied with during site development works. The Management Plan has been approved and partly implemented as part of progressive staged development across the Structure Plan area.

Refer **Appendix 6** – Approved ASS and Dewatering Management Plan.

2.2.2 Contamination

The DWER Contaminated Sites Database does not list the site as being a known or suspected contaminated site.

Notwithstanding, a Preliminary Site Investigation was undertaken for the site in 2015, which identified potential contamination sources and activities previously occurring on site. On this basis, remediation was undertaken between June 2015 and February 2016 to remove known potential contamination sources.

Following removal of all known potential contamination sources to an off-site licensed landfill facility, the soil and groundwater quality was further investigated (Detailed Site Investigation) to:

- Assess the nature and extent of contamination, if any, following preliminary remediation activities at the site; and
- Assess the future risk to human health and the environment from residual site contamination.

Based upon the results of the Detailed Site Investigation ('DSI'), a human health and ecological risk assessment for the site was undertaken and concluded:

- Residual contaminant sources have been removed from the site and there are no residual soil risks to human health or the environment;
- Groundwater and surface water is suitable for non-potable use and irrigation, and is not considered to be a risk to human health. Groundwater is not recommended for drinking water purposes; and
- Groundwater quality is indicative of the regional superficial aquifer and minor groundwater contamination is considered a result of regional agricultural activities. There are no unacceptable groundwater or surface water contamination risks to human health and/or the environment.

Based on the DSI results, no further investigations to characterise soil, groundwater and/or surface water contamination are deemed necessary and the site is considered to be suitable for residential purposes, as proposed by the MELSP. In this regard, the Department of Environmental Regulation confirmed by way of

correspondence dated 15 February 2017 that the site is free of contamination and is suitable for all land uses and therefore, the site has been classified 'decontaminated' under the *Contaminated Sites Act 2003*.

Refer **Appendix 7** – DER Correspondence, Confirmation of Decontamination.

2.3 Groundwater and Surface Water

2.3.1 Groundwater

There are two aquifers of significance underlying the site; each assigned the name of the major geological unit in which the aquifer occurs. In descending order of depth from natural surface they are:

- Superficial Aquifer (unconfined, +20 to -25 mAHD)
- Leederville Aquifer (confined, -25 to -250 mAHD)

2.3.1.1 Superficial Aquifer

The superficial aquifer in this region is referred to as the Jandakot Mound and covers approximately 522 square kilometres. The aquifer consists of a thin veneer of Bassendean Sand overlying sandy clays of the Guildford Formation.

The Superficial Formation forms an unconfined aquifer containing generally fresh to slightly brackish groundwater (500 to 1500 mg/L Total Dissolved Solids), with slightly acid to neutral pH (5 to 7). The water table is shallow in places, rising to the surface during winter, depending on surface elevation.

Pre-development groundwater monitoring was completed in 2007 to determine the estimated Average Annual Groundwater Maximum Level ('AAMGL'). Water quality bores were monitored monthly from October 2004 to September 2006.

A summary of the monitoring results are as follows:

- Average Total Nitrogen (TN) concentrations for all bores were above the ANZECC 2000 TN guideline of 1.2 mg/L with the exception of WAM3(d).
- Average Total Phosphorus (TP) concentrations varied between bores. WAM3(d), WAM4(s) and WAM4(d) were above the Peel-Harvey WQIP TP target value of 0.1 mg/L.
- The pH is slightly acidic to neutral (4.5 to 7.1) and below ANZECC guideline values.

The site is characterised by high nutrient concentrations and pH levels generally less than 6.0. Groundwater quality at the water table, within the Bassendean Sand, is generally acidic due to organic acids generated by decomposition of vegetation in swampy environments. High nitrate and phosphorous levels are present in the superficial aquifer in areas of intensive horticulture as a direct result of fertiliser leaching.

The Superficial Aquifer is the most feasible groundwater source for irrigation of public open space for the development of the site.

2.3.1.2 Leederville Aquifer

The Leederville Aquifer is a major regional aquifer from which large yields of fresh groundwater can be obtained. The groundwater in the Leederville Formation is confined within the potentiometric surface in this area approximately at ground level.

The South Perth Shale is present from -260 to -310m AHD and forms the confining layer between the Leederville Aquifer and Yarragadee Aquifer.

2.3.2 Surface Water

The Peel Main Drain runs east to west through the MELSP. This section of the Peel Main Drain has been previously approved as part of the existing MELSP and subsequent Subdivision Approvals to be incorporated into public open space as a living stream. The works associated with the Peel Main Drain form part of current development stages for the estate.

The Peel Main Drain flows into the Mandogalup Swamp at the southern boundary of the site and the Spectacles Wetland south of Anketell Road. The Peel Main Drain outlets at the Serpentine River and ultimately to the Peel Harvey Estuary.

The Peel Main Drain was modelled by the Department of Water as part of the preparation of the Jandakot District Water Management Plan, and confirmed through modelling undertaken for IP47. The maximum flood level for the 100-year ARI for the existing system is 13.7 metres AHD, upstream of the Mandogalup Swamp, causing inundation of the Mandogalup Swamp area along the southern boundary of the site. The balance of the site is not expected to be affected by flooding.

The MELSP makes allowance for regional flood storage within public open space, consistent with the District Water Management Plan.

Surface water quality in the Peel Main Drain was measured by JDA as part of pre-development monitoring from October 2004 to September 2006. Results indicate the PMD is characterised by high nutrient concentrations and pH levels generally less than 6.8, consistent with other drains in the area and historic land use.

2.4 Bushfire Hazard

The Department of Fire and Emergency Services – Map of Bushfire Prone Areas online mapping tool identifies majority of the MELSP as being 'bushfire prone'. This classification is due to existing remnant vegetation being present within the site, on adjoining landholdings and within the Kwinana Freeway reserve. On this basis, a Bushfire Management Plan (BMP) was prepared and approved for the existing MELSP in accordance with *State Planning Policy 3.7- Planning in Bushfire Prone Areas* ('SPP 3.7'), *The Guidelines for Planning in Bushfire Prone Areas Version 1.1* (the 'Guidelines') and *Australia Standard 3959 Construction of buildings in bushfire prone areas* ('AS 3959'). Subdivision was subsequently approved for the existing MELSP, also supported by a detailed subdivision stage BMP.

Subsequently, an Addendum to existing approved Bushfire Management Plan (BMP Addendum) has been prepared in support of this Structure Plan amendment. The BMP Addendum provides an updated strategic level bushfire assessment specific to the Amendment area. This is provided at **Appendix 3** and should be read in conjunction with the original MELSP BMP and the detailed subdivision stage BMP.

The BMP Addendum includes the following:

- A revised bushfire assessment including:
  - updated pre and post-development vegetation classification and effective slope maps specific to the Amendment area, and current/proposed vegetation conditions, and
  - updated pre and post-development Bushfire Hazard Level (BHL) assessments specific to the Amendment area, and current/proposed vegetation conditions mapped from the above;
- A revised assessment against the bushfire protection criteria of *Guidelines for Planning in Bushfire Prone Areas Version 1.4* (the Guidelines; WAPC 2021) demonstrating compliance can be achieved at subsequent planning stages; and

- A list of responsibilities for implementation of the bushfire management measures to guide future planning stages of the development.

The BMP Addendum is provided at **Appendix 3**, however the following provides an overview of fire management assessment undertaken and applicable provisions to development of the site.

2.4.1 Hazard Assessment

A pre and post development Bushfire Hazard Level assessment has been undertaken for the Amendment area as part of the BMP Addendum.

The pre-development assessment identifies the Amendment area as currently comprising land with Moderate and Extreme Bushfire Hazard Levels. On completion of development however, it is expected the majority of vegetation within the Amendment area will be modified to be excluded from classification, with the only remaining classified vegetation potentially being present within revegetated portions of Public Open Space area reference 13, the regional drainage area, and a component of the Western Power easement; however noting this is subject to further review as part of detailed landscaping design. Therefore, the post-development hazard assessment demonstrates all proposed lots within the Amendment area will be located on land with either a Low or Moderate Bushfire Hazard Level. This achieves compliance with the bushfire protection criteria of the Guidelines.

Consideration will need to be given at the subdivision stage to any on-site/external classified vegetation, and therefore, the applicable setbacks for habitable development to achieve a Bushfire Attack Level rating of BAL–29 or below. The Amendment area and proposed development cells are considered of sufficient size such that any interface with post-development classified vegetation could be readily accommodated through compliant subdivision design to ensure all future habitable development achieves BAL-29 or lower. This will be demonstrated through preparation of a BAL contour map at the subdivision stage.

2.4.2 Bushfire Attack Level (BAL) Contour Assessment

Vegetation with a 'Moderate' or 'Extreme' bushfire hazard level is considered bushfire prone and any proposed development within 100 metres of the bushfire prone vegetation extent will require application of *Australian Standard AS 3959–2009 Construction of Buildings in Bushfire-prone Areas (SA 2009)* via implementation of increased building construction standards in response to the assessed Bushfire Attack Level (BAL).

Low threat separation for future habitable development to achieve BAL–29 or lower is to be implemented for all relevant lots where required. This will be predominantly achieved through appropriate subdivision design and the use of perimeter roads/low threat staging buffers at interfaces with on-site and external classified vegetation. Delivery of BAL-29 or lower for all proposed habitable development will be demonstrated through preparation of a BAL contour map at the subdivision stage.

The Bushfire Management Plan will be required to be implemented as a condition of subdivision approval.

Refer **Appendix 3** – Bushfire Management Plan Addendum.

2.5 Heritage

2.5.1 Aboriginal Heritage

A search of the Department of Planning, Lands and Heritage Aboriginal Cultural Heritage Inquiry System (ACHIS) identified no registered sites of aboriginal heritage significance within the site area or immediate surrounds. However, the search did identify one 'Other Heritage Place' being a mythological site (*Site 3427 – Mandogalup Swamp / Spectacle*) that extends partially into the southern portion of the site. However, only a

small portion of the subject area is within the actual boundary as administered by DPLH. Details of the identified site are outlined below.

ACH ID 00003427 Mandogalup Swamp/ Spectacles

Status	**Historic**
ACH Type	Place
Place Type	Creation / Dreaming Narrative; Hunting Place, Water Source
Region	Metro/Wheatbelt
State Significance	No
Culturally Sensitive	No
Restricted Place	No
Boundary Reliable	No
Knowledge Holders	Registered Knowledge Holder names available from DPLH
Legacy Place Status (as at 30 June 2023)	**Stored Data / Not a Site**
Boundary Last Update Date	19 February 2004

Table 6: Aboriginal Cultural Heritage

Based on the ACHIS and subsequent advice from DPLH, we understand this listing does not restrict development and therefore has no bearing on this application.

2.5.2 European Heritage

A search of the Western Australian Register of Heritage Places and the City of Kwinana's Municipal Heritage Inventory identified no sites of State or local heritage or historic significance within the site.

2.6 Context and Other Land Use Constraints and Opportunities

2.6.1 Peel Main Drain

The Peel Main Drain (comprising Lot 8018) dissects the Structure Plan area in an east west direction between Lots 9060 and 9006. The drain is currently constructed to a 'rural' standard and is intended to be upgraded and landscaped to an urban standard as part of residential development works, ensuring its integration into public open space as a living stream. Approval for the development of the Peel Main Drain as a living stream, incorporated into public open space, has been obtained under the existing MELSP, subsequent Subdivision Approval and approved Water Management Plans for the site. The construction of the Peel Main Drain living stream and public open space is being delivered as part of current development stages for the Florence estate.

Following the relevant upgrade works and required developer maintenance period, the City of Kwinana will take over management of the Peel Main Drain.

2.6.2 Dampier to Bunbury Natural Gas Pipeline

The Dampier to Bunbury Natural Gas Pipeline ('DBNGP') traverses the Structure Plan area in an east west direction between Lots 9006 and 9002. The DBNGP is protected by an easement for its full extent.

The DGNGP is intended to be landscaped to a minimum urban standard (in accordance with the relevant limitations for development within the easement), providing a linear active public open space corridor through the site. This is consistent with the landscape treatment for the DBNGP corridor on the eastern side of the

Kwinana Freeway within the Wandi North LSP area (Honeywood estate), and as previously approved under the existing MELSP.

As with the Peel Main Drain, upon completion of works and the relevant maintenance period, the City of Kwinana will take over the management of the reserve.

Any works undertaken within and in proximity to the easement will require prior approval of the relevant Pipeline Operator.

2.6.3 High Voltage Power Line Easement

The Western Power High Voltage Power Line Easement traverses the southwestern boundary of the Amendment area. The easement is intended to be delivered as restricted open space and comprises Regional Flood Storage for the Mandogalup Swamp, consistent with the District Water Management Strategy.

The easement will also provide separation to the future Light Industrial uses considered under the draft IP47 Scheme Map and Land Use Concept.

The Structure Plan provides a road interface to the Easement, with no direct development proposed.

2.6.4 Noise Management

The Kwinana Freeway and the Perth to Mandurah railway line abuts the MELSP on its eastern boundary. On this basis, in accordance with *State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (SPP 5.4), a Road and Railway Noise Assessment has been prepared to inform the MELSP, included as **Appendix 4** of this report.

In accordance with SPP 5.4, the acoustic modelling and assessment considers the potential noise impacts from the Kwinana Freeway within a 20 year planning horizon. Modelling for the railway line was undertaken based on the current 2024 situation.

The acoustic modelling indicates that transport noise from both the road and rail infrastructure are likely to cause noise impacts above the prescribed criteria under SPP 5.4. On this basis, modelling considered the effect of the continuation of the 4 metre high noise attenuation wall along the extent of the MELSP abutting the Kwinana Freeway. The noise wall showed a significant reduction in the predicted transport noise levels, and is consistent with the noise mitigation strategy adopted for the existing MELSP.

Notwithstanding the construction of a noise attenuation wall, a number of dwellings will still be affected by traffic noise above acceptable SPP 5.4 criteria. This will be managed through notifications on Certificates of Title, requiring dwellings to be constructed to minimum construction standards consistent with the 'deemed to comply' noise limit packages and/ or quiet house design. These requirements are outlined within the Noise Assessment Report contained in **Appendix 4** of this report.

2.6.5 Improvement Area 47

As detailed in Section 1.3.2 of this report, Improvement Area 47 adjoins the MELSP on its western boundary.

A small portion of the subject land (approximately 2.8 hectares) is situated within the boundary of IP47. The draft IP47 Scheme Map identifies this portion of land for Residential zoning, with the draft IP47 Land Use Concept further designating this area for public open space (drainage), consistent with the District Water Management Strategy and previous planning for this area. The proposed Structure Plan is consistent with the zoning and land use designations identified under the Draft IP47 Scheme for this portion of the site, providing for regional flood storage in this location. This will be delivered as part of the public open space across the site.

The proposed Structure Plan provides for the relevant road connections to the future Hammond Road extension, as identified under IP47, recognising this is the ultimate primary movement network through the area, connecting between Rowley Road in the north and Anketell Road in the south.

The high voltage powerline easement and drainage corridor along the western boundary of the Structure Plan area provides separation to the light industrial land use identified within IP47.

3. Land Use and Subdivision Requirements

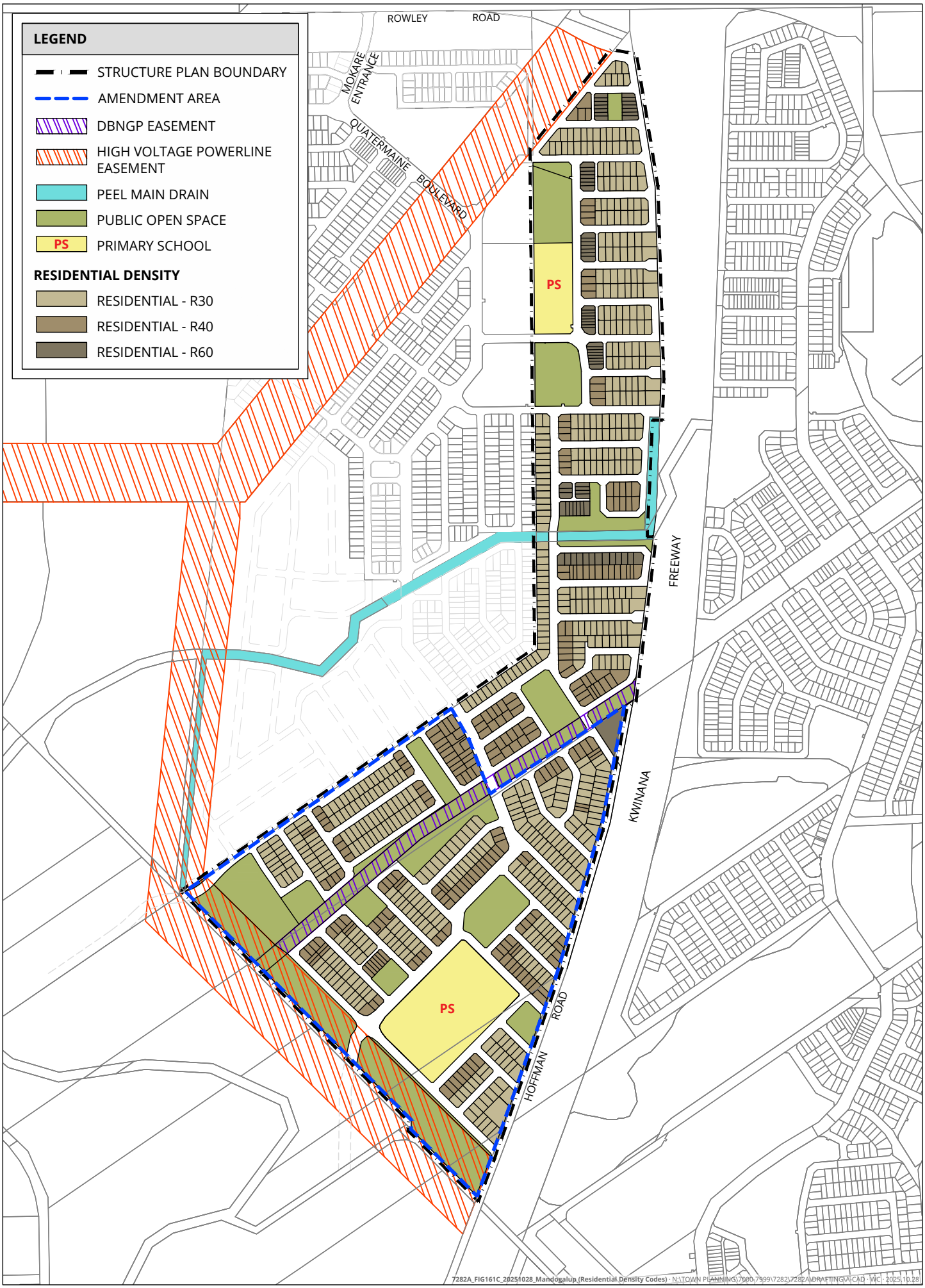
3.1 Land Use

The MELSP sets out land use, residential densities, public open space, vehicle and pedestrian movements, environmental considerations, and engineering and servicing requirements for the subject land.

The MELSP is proposed to comprise residential development with density codes ranging from R30 to R60. The MELSP is proposed to comprise a range of local and neighbourhood public open space areas in accordance with Liveable Neighbourhood requirements, as well as a Primary School site to service the Mandogalup catchment. The Amendment area also makes provision for a second Primary School, should it be required.

The following sections describe the design response under the MELSP (with a focus on the Amendment area) and addresses the relevant elements of Liveable Neighbourhoods. Please also refer to the land use summary table provided within the Executive Summary on Page IV of this report.

Please also refer to **Plan 1 – MELSP**, and **Figure 10** – Indicative Zoning and Residential Density Code Plan.



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FIGURE 10

RESIDENTIAL DENSITY CODE PLAN

3.2 Public Open Space

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

In accordance with Liveable Neighbourhoods, the MELSP provides a framework for the hierarchy and location of public open space across the site, considering the requirements for drainage and tree retention. Detailed subdivision design will provide further refinement to the MELSP public open space framework, defining the configuration, uses and treatment within each public open space area.

The MELSP provides for approximately 8.6 hectares of public open space ('POS') across the entire Structure Plan area by way of 5 neighbourhood and 7 local parks, as well as local playing fields. This comprises approximately 5.03 hectares of unrestricted (8.01%) and approximately 2.77 hectares of restricted (4.41%) open space.

In addition to credited public open space, the MELSP will also deliver the Peel Main Drain as a living stream, incorporated in to public parkland, as well as the DBNGP easement delivered as a linear active open space corridor. With the addition of these areas, the MELSP will deliver a total of 12.15 hectares as public open space, equating to approximately 15.2% of the Structure Plan area. The Western Power easement and regional drainage within the site will also be landscaped, contributing to an overall of 23. 6% (18.78 hectares) of the Structure Plan area provided as green space.

In accordance with Liveable Neighbourhoods requirements, the hierarchy and location of public open space areas across the MELSP have been designed to ensure all residents are within:

- 200 metres of a local park;
- 400 metres of a neighbourhood park; and
- 600 metres – 1 kilometre of an active playing field.

Refer Figure 11 – Public Open Space Distribution Plan, and **Figure 12 –** Public Open Space Schedule.

A Landscape and Public Open Space Masterplan has been prepared for the MELSP Amendment area, depicting the anticipated use and intent of each of the public open space areas. Refer **Appendix 8.** North of the Amendment area, public open space is being delivered in accordance with existing approvals for the site.

3.2.1 Tree Retention

Public open space across the MELSP has been designed to maximise the retention of significant trees across the site, as defined by the City of Kwinana *Landscape Feature and Tree Retention Policy*.

Of the 125 significant trees identified within the MELSP Amendment area, 76 have been identified for retention in streetscapes and public open space (subject to detailed design), of which majority are classified as having either a High or Medium retention value, and which include 41 Black Cockatoo trees.

A *Significant Trees and Landscape Strategy* is provided within the attached EAR (refer **Appendix 2**) and shows considerable effort has been made to accommodate the majority of significant trees surveyed within public open space.

A *Landscape Feature and Tree Retention Management Plan* will be required as a condition of subdivision approval.

3.2.2 Peel Main Drain

The Peel Main Drain traverses the northern portion of the MELSP area abutting Lots 9060 and 9006. As previously discussed, the drain currently exists within a 20 metre wide corridor and is built to a rural standard. The MELSP provides public open space either side of the existing Peel Main Drain to provide sufficient width to facilitate the urbanisation of the drain to a living stream profile (with appropriate urban grades). The reconfiguration of the drain will utilise a mixture of planted, walled or contoured banks, with native sedges and rushes to assist with nutrient stripping and midge and mosquito control. The reconfigured drain will be unfenced and landscaped in accordance with Liveable Neighbourhoods to allow for informal and passive recreational uses, to be integrated with the adjoining parkland.

The landscaped outcome of the reconfigured Peel Main Drain and associated parkland will continue the landscaping treatment of the Peel Main Drain within the Wandi North Local Structure Plan area (Honeywood estate), and is currently being constructed under existing approvals for the site.

Whilst intended to serve a passive recreational function and landscaped accordingly, the Peel Main Drain does not form part of the credited public open space provision for the site.

3.2.3 DBNGP Corridor

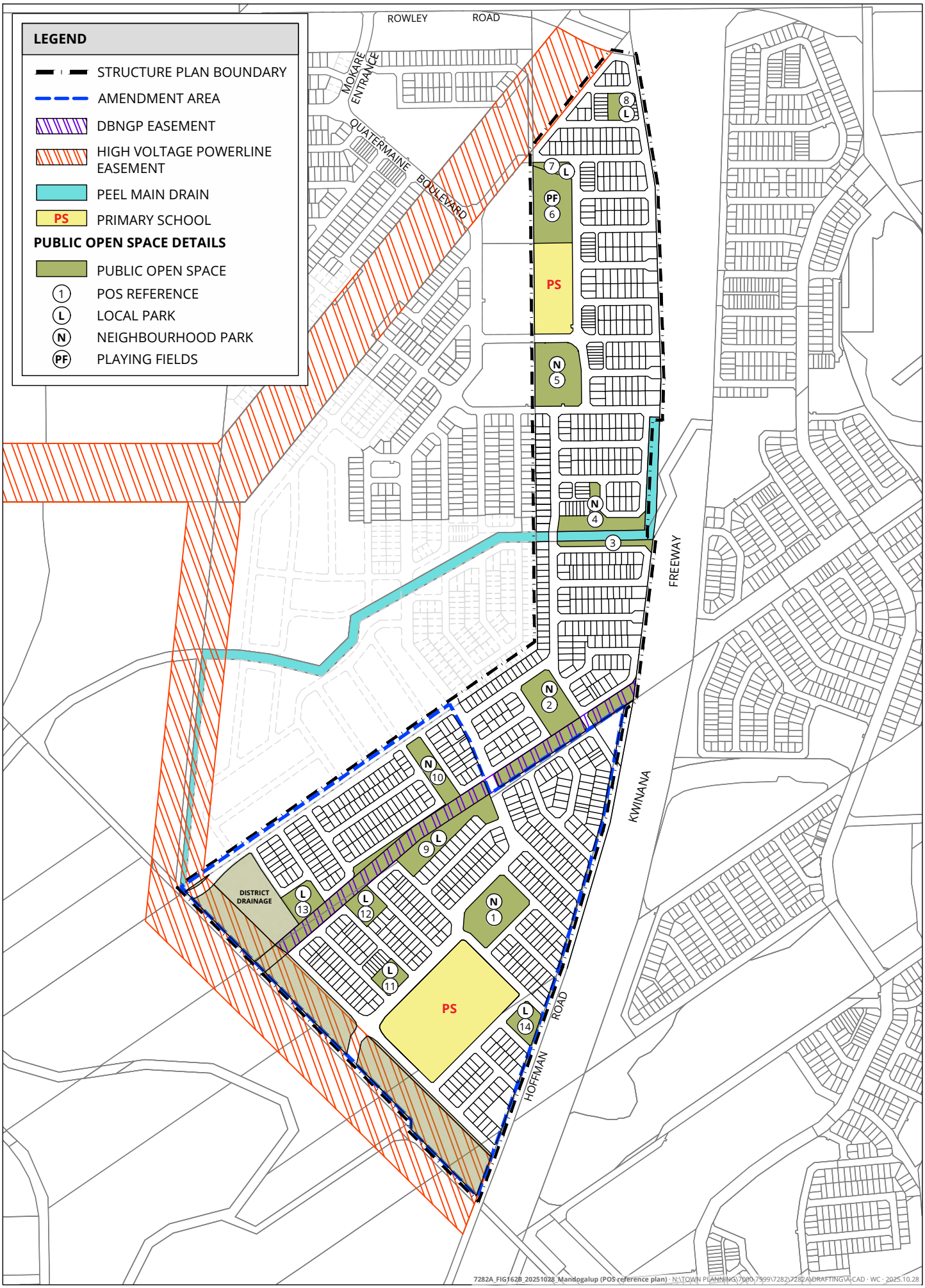
The DBNGP, traversing the site between Lots 9006 and 9002, comprises an underground high-pressure gas pipeline protected within a 30 metre wide easement. As per the landscape response delivered within the Wandi North Local Structure Plan area (Honeywood estate), the MELSP proposes the development of the DBNGP as a lineal public open space corridor to an urban standard, serving an active recreation function, however noting this land is not credited towards the site's public open space provision.

The DBNGP corridor will also comprise a stormwater conveyance function. Stormwater from detention basins in the adjoining public open space will discharge into a swale in the easement, which conveys flow to the Peel Main Drain west of the Structure Plan area, working with the existing drainage flows across the site in accordance with the District Water Management Strategy.

3.2.4 Regional Drainage

In accordance with the requirements of the Jandakot District Water Management Plan (and confirmed as part of modelling for IP47), the MELSP provides for an area of public open space (approximately 1.49 hectares) adjacent to the Western Power easement for use as regional stormwater detention, associated with the Mandogalup Swamp.

The Peel Main Drain was modelled by the Department of Water as part of the preparation of the Jandakot District Water Management Plan. The maximum flood level for the 100-year ARI for the existing system is 13.7 metres AHD, upstream of the Mandogalup Swamp, causing inundation of the Mandogalup Swamp area along the southern boundary of the site. The balance of the site is not anticipated to be affected by flooding.



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FIGURE 11

PUBLIC OPEN SPACE DISTRIBUTION PLAN

Mandogalup East Local Structure Plan – Public Open Space Schedule

Lots 9000, 9002 & 9006 Hoffman Road, Lot 9033 Rowley Road, and Crown Lots 1404 & 8018

ROWE GROUP DESIGN

22.10.2025

Site Area (Local Structure Plan Boundary)			79.49
Less			
Total		0.00	
Net Site Area			**79.49**
Deductions			
Primary School (north)	1.48		
Primary School (south)	4.25		
Peel Main Drain (Lot 8018) (excl Roads)	0.95		
Western Power Easement	5.15		
DBNGP Easement (excl Roads)	2.60		
District / Regional Drainage	1.48		
Dedicated Drainage (1:1yr ARI / First 15mm)	0.80		
Total		16.71	
Gross Subdivisible Area			**62.78**
POS @10%			6.28
Public Open Space Contribution			
May comprise:			
Min 80% unrestricted POS		5.02	
Min 20% restricted use POS		1.26	
Total Required POS			**6.28**

POS Reference Number (area within urban zone/LSP boundary only)		1:1yr / First 15mm Drainage (m^2) *Deduction from Net Area*	Unrestricted POS area (m^2)	Credited Restricted POS area (m2)
1	11220	1499	7220	2501
2	8507	1132	4507	2868
3	2437	55	1932	450
4	6808	480	3973	2355
5	12136	550	3011	8575
6 (Playing Fields)	11549	0	11549	0
7	1623	450	168	1005
8	1630	285	945	400
9	8738	1160	4018	3560
10	6607	439	4907	1261
11	3075	342	2075	658
12	3741	608	1641	1492
13	4325	1014	725	2586
14	3596	0	3596	0
Total	**85994**	**8014**	**50269**	**27711**
	8.60	**0.80**	**5.03**	**2.77**
Percentage of gross subdivisible area		**1.28%**	**8.01%**	**4.41%**

Notes:

1. This Public Open Space Schedule is based on the Subdivision Concept Plan prepared by Rowe Group (Plan ID: 7282A-CON37G).

2. This Public Open Space Schedule is based on the drainage assumptions as per the Local Water Management Strategy prepared by JDA dated 28 March 2024 (JDA Ref: J7502).

3. Restricted Open Space credit based on 5 yr/ 20% drainage area less the 1yr / 15mm area. POS area 5 also includes 9124.8m2 of retained vegetation, also included as Restricted Open Space. Therefore, Restricted Open Space actual land area equals Restricted open space credited area plus the 15mm area.

4. Restricted Open Space actual 'on the ground' land area equals Restricted open space credited area plus the 1 yr / 15mm area.

5. Drainage calculations for Catchments A-D are based on the previously approved LWMS (J6863b 8)

FIGURE 12

PUBLIC OPEN SPACE SCHEDULE

3.3 Residential

An indicative subdivision layout has been prepared for the site, identifying a yield of approximately 911 lots (approximately 920 dwellings) across the Structure Plan area.

Based on 920 dwellings, the Structure Plan achieves a density of approximately 26.3 dwellings per residential site hectare, and 11.6 dwellings per gross urban hectare. This is consistent with Liveable Neighbourhoods targets for a minimum average residential density of 22 dwellings per residential site hectare for greenfield subdivision areas. Whilst not achieving the density target of 15 dwellings per gross urban hectare set out under the Sub-Regional Planning Framework, given the existing site constraints impacting the developable area, such as the Peel Main Drain, DBNGP corridor, Western Power easement, regional drainage and provision for two primary school sites, the densities achieved are considered appropriate and justified.

For reference, an indicative subdivision concept is provided at **Figure 10 (Indicative Residential Density Code Plan)**. This is provided for explanatory purposes only, and is subject to review and detailed design at the subdivision stage.

Whilst the MELSP Plan 1 provides a density code range of R30-R60 across the site to provide for flexibility at detailed design stage, lot specific residential density codes have been indicatively allocated across the site and have been used in the preparation of an indicative subdivision layout and density calculations. The MELSP allocates a base density of R30, with areas of R40 and R60 allocated to lots within proximity to areas of high amenity and access including (but not limited to) within proximity to the primary school(s), around public open space, and adjacent to neighbourhood connectors and future public transport routes.

The density code range also facilities a diversity of lot product across the site, providing for a range of dwelling types. The preparation of Local Development Plans will also assist in facilitating the delivery of diversity in lot product, as well as seeking to achieve bult form outcomes consistent with the development intent of the site.

Refer to **Figure 10** –Indicative Residential Density Code Plan (Indicative Subdivision Concept).

3.4 Local Development Plans

A Local Development Plan is required for the following circumstances:

- Lots with an area of 260 square metres or less;
- Irregular shaped lots;
- Lots where specific vehicle access and egress control is required;
- Lots abutting a reserve for public open space and/or infrastructure (for example, the Peel Main Drain, electricity transmission lines or the Dampier to Bunbury Natural Gas Pipeline)
- Lots with particular site constraints; and
- Lots that require quiet house design for noise attenuation through deemed-to-comply noise insulation packages, and/or lots identified as requiring specialist acoustic requirements.

Local Development Plans are to address, as a minimum, the following:

- Dwelling orientation;
- Type of fencing;

- Location of carports/ garages and vehicular access;
- Visual surveillance;
- Setback variations;
- Solar Orientation; and
- Requirements for dwelling construction compliant with an approved Bushfire Management Plan and Noise Management Plan.

In preparing Local Development Plans, the design responses and interface treatments between the MELSP and MWLSP will need to be considered to ensure an effortless transition between the two estates (Florence and Apsley), however noting the different design objectives of the two estates to create individual character and sense of place. Similarly, Local Development Plans will need to have consideration for existing approved and constructed dwellings and built form outcomes within the Structure Plan area.

Any amendment(s) to Residential Design Codes deemed-to-comply requirements in any future Local Development Plan would need to be considered by the local government and, if required, the Western Australian Planning Commission in accordance with:

- the Planning and Development (Local Planning Schemes) Regulations 2015, Schedule 2, Part 6, Section 52; and
- the Residential Design Codes, Part A, Section 3.0 Local Planning Framework.

3.5 Movement Networks

The following provides a summary of the proposed movement network. For further information, refer to **Appendix 9** – Transport Assessment.

3.5.1 Existing Road Network

3.5.1.1 Hoffman Road

Hoffman Road is a local access road that runs parallel to the Kwinana Freeway and connects the MELSP to Anketell Road in the south. Hoffman Road provides interim secondary access to the MELSP, with primary access being from the north.

The intersection of Hoffman Road and Anketell Road is currently a basic T-intersection. Hoffman Road is currently constructed to a sealed rural standard and is intended to be upgraded to an urban standard as part of the development of the site. The Hoffman Road/ Anketell Road intersection will ultimately be downgraded to a left in-left out access, or otherwise terminated, with connection to Anketell Road to be via a north-south extension of Hammond/Mandogalup Road, further to the west.

There is no existing traffic volume data available for Hoffman Road, however given the limited development adjacent to Hoffman Road volumes are likely low.

3.5.1.2 Rowley Road

Rowley Road is classified as a Regional Distributor in the Main Roads WA Functional Road Hierarchy. It provides an east-west connection between the South Western Highway (via Eleventh Avenue in Armadale), Tonkin Highway, Kwinana Freeway and Rockingham Road in Wattleup (via Wattleup Road).

Rowley Road is currently constructed as a rural standard single carriageway road. Rowley Road is identified as future freight corridor and will ultimately be upgraded to a four lane divided standard, however timing for works is unknown at this stage.

The MELSP connects to Rowley Road, via Quartermaine Boulevard through the Apsley estate (MWLSP). Rowley Road provides the primary access in to the MELSP.

3.5.1.3 Anketell Road

Anketell Road is classified as a Regional Distributor in the Main Roads WA Functional Road Hierarchy and is constructed as a single carriageway road.

Anketell Road has been identified as a freight route to the Naval Base/ Kwinana Beach Industrial areas. Anketell Road will ultimately be constructed to a dual divided carriageway standard between the Kwinana Freeway and Leath Road in Kwinana. The intersection with Mandogalup Road will also be upgraded.

3.5.1.4 Mandogalup Road

Mandogalup Road is classified as a Local Distributor primarily running in a north-south direction from Wattleup Road in the north to Anketell Road in the south.

Mandogalup Road is currently constructed as a single carriageway to a rural standard, with a reserve width of 20 metres.

The southern extension of Mandogalup Road to Anketell Road is planned to be upgraded as part of the future extension of Hammond Road.

3.5.1.5 Hammond Road (Future extension)

Current planning identifies the extension of Hammond Road south to Rowley Road, ultimately connecting with Anketell Road. The connections of Hammond Road with Rowley and Anketell Roads are intended to be full movement intersections.

The Hammond Road extension has already been reserved under the Metropolitan Region Scheme as an 'Other Regional Road'.

The extension of Hammond Road will provide for the primary north-south movements through Mandogalup and Hammond Park.

Consistent with planning under IP47, the two east west Neighbourhood Connectors through the MELSP, running north through the MWLSP area (Quartermaine Boulevard), will ultimately connect with Hammond Road to the west, providing a higher order access from the site to Anketell and Rowley Roads.

3.5.2 Proposed Road Network

The proposed road hierarchy for the MELSP has been determined from modelling based on the indicative subdivision layout for the Amendment area or as otherwise previously approved. The road hierarchy and layout remains generally consistent with the existing approved MELSP, as is being progressively developed in a staged approach, with majority of the road network in the north of the structure plan area already delivered.

With the inclusion of the additional landholdings and progression of planning through IP47, the amended Structure Plan seeks to deliver the ultimate movement network through the locality. This includes the redirection of the primary north-south connectors through the site, to connect with the future extension of Hammond Road. There will ultimately be three east-west Neighbourhood Connectors intersecting with Hammond Road from the MELSP and MWLSP areas, providing for the primary north-south movements through the area between Rowley Road and Anketell Road. These have been provided for in the current

amendment proposals for both the MELSP and MWLSP and generally align with the draft Hammond Road design provided in the advertised IP47 documentation.

The proposed local movement network reflects a strong north-south and east-west modified grid configuration, with a number of direct connections to the road network within the MWLSP. The street block lengths are consistent with the requirements of Liveable Neighbourhoods, providing for connectivity and permeability through the site, for both pedestrians and vehicles.

The indicative road network is proposed to comprise of the following road classifications:

Road Classification (Based on Traffic Modelling)	Typical Road Reserve Width (as per LN)
Neighbourhood Connector B	24.4 metres
Access Street B	17.9 metres
Access Street D (with widened reserve)	15.4 metres
Access Street D (single sided)	13.2 metres
Laneway (rear)	6 metres

Table 7: Road Reserve Widths

Whilst traffic modelling indicates lower order streets can be delivered, the MELSP seeks to adopt wider reserves to enable flexibility in cross section design than is typically allowed under Liveable Neighbourhoods.

The road hierarchy primarily consists of local access roads, with a central Access Street B providing the key north-south movements through the MELSP, constructed to a 17.9 metre cross section. Access Street B roads are also proposed around the primary school sites, providing for on street parking on both sides.

The MELSP Amendment area also provides for two Neighbourhood Connector roads, connecting west to the future Hammond Road, via an extension of Quartermaine Boulevard through the Apsley estate (MWLSP) to the north. The Neighbourhood Connectors are proposed to be constructed to a 24.4 metre cross section, consistent with the existing Quartermaine Boulevard.

The access streets are proposed to primarily consist of Access Street D roads, designed to a 15.4 metre cross-section. Where services are only required to one side of the road, such as adjacent to public open space or the Kwinana Freeway reserve, a reduced cross-section of 13.2 metres is proposed. This is consistent with the approach taken for the existing development in the north of the MELSP.

Traffic volumes along the access roads are typically estimated to be in the order of 1,000 to 3,000 vehicle movements per day, which is consistent with the road hierarchy classification under Liveable Neighbourhoods.

Traffic modelling for the MELSP estimates the completed development will generate in the order of approximately 6,952 vehicle movements per day, or 9,112 vehicle movements per day where a second primary school site is delivered.

Refer to **Figure 13** – Proposed Movement Network.

3.5.3 Public Transport

The Public Transport Authority has advised the area west of the Kwinana Freeway will be serviced by future Bus routes 535 and 536, with route 536 being the most likely to service the Structure Plan area, given its locational context in proximity to Kwinana Freeway. It is the intention of the Public Transport Authority to run bus route 536 along the north-south spine road within the MWLSP and MELSP, south of Rowley Road. The proposed bus route is likely to traverse southbound on Barfield Road from Hammond Park and then across

Rowley Road into Mandogalup. This will ultimately be re-routed to Hammond Road upon the closure of the Barfield Road intersection.

Timing for the commencement of those services is unknown at this stage, and are subject to the progress of adjoining development and availability of funding. These services will operate out of the Russel Road, Success train station, and are intended to ultimately connect Hammond Park to Mandogalup.

Timing for the extension of bus services through Mandogalup is not known at this stage. Notwithstanding, the proposed Neighbourhood Connectors have sufficient reserve widths to accommodate buses, should future services be established.

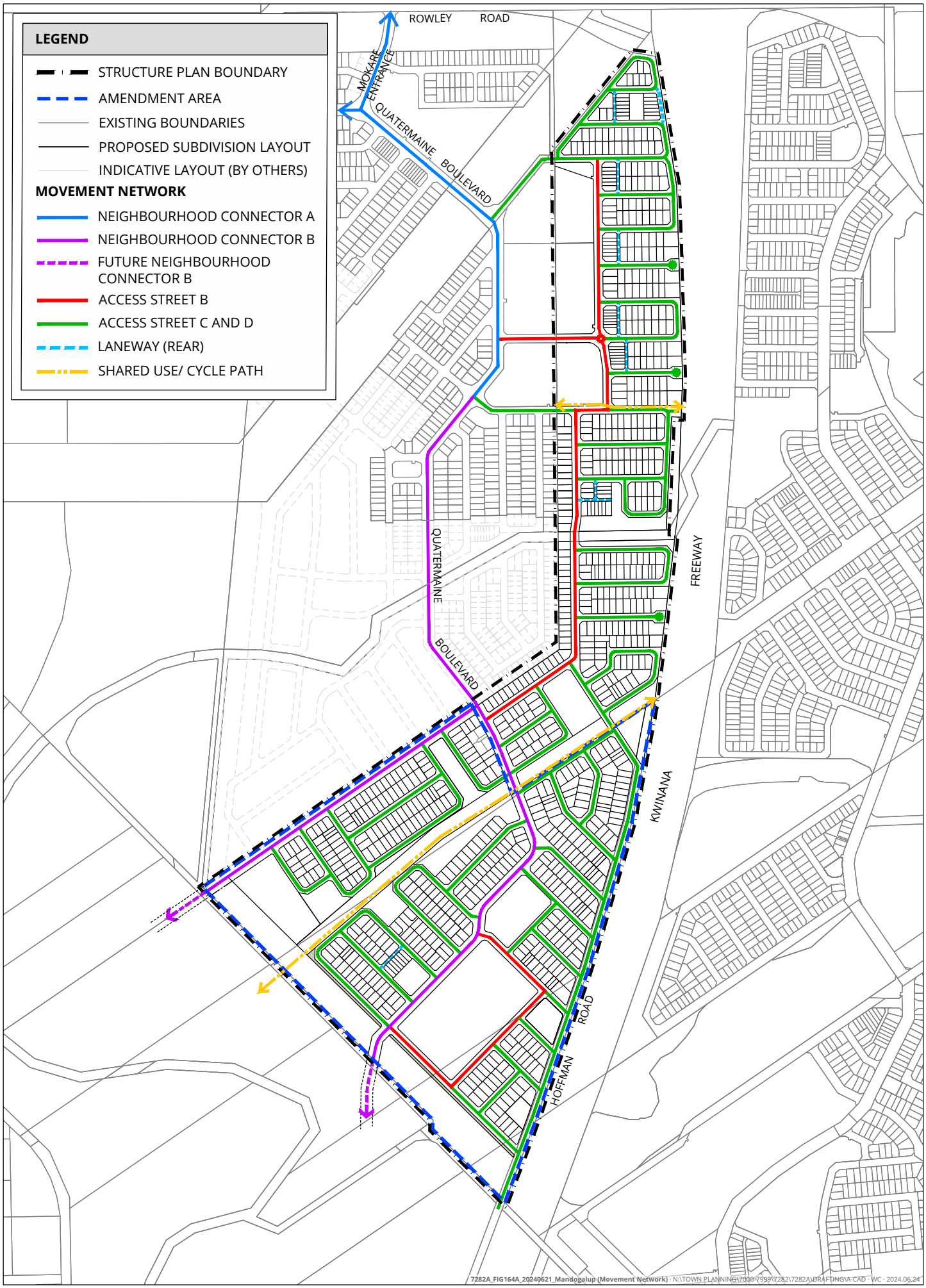
The Perth to Mandurah railway line runs along the eastern boundary of the site within the Kwinana Freeway reserve. The closest passenger stations to the site are Success, approximately 2.7 kilometres to the north, and Kwinana, approximately 5 kilometres to the south.

3.5.4 Pedestrian and Cycle Network

In accordance with Liveable Neighbourhoods requirements, footpaths will be provided on at least one side of every street.

Neighbourhood Connector Roads within the MELSP are planned to accommodate 2.5 metre wide designated cycleways in the verge, on one side of the road. A shared path is also proposed along the Access Street B running north south through the site and adjacent to the proposed Primary School(s).

The Perth Bike Map series shows an existing principal shared path (PSP) along the Kwinana Freeway adjacent to the MELSP area. The Perth bike Map designates Rowley Road and Barfield Road (north of the site) as being part of the Perth Bicycle Network and nominates these as continuous signed routes. The MELSP proposes two connections to the PSP, one in the north of the site and one in the south.



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FIGURE 13

MOVEMENT NETWORK

3.6 Water Management

3.6.1 Regional Water Management Strategy

The Jandakot Drainage and Water Management Plan (JDWMP) was released by the Department of Water in December 2009. The JDWMP provides district scale flood modelling, a surface water management strategy and a groundwater management strategy, which specify post-development levels and flows to address the City of Kwinana's District Structure Plan (ERIC).

3.6.2 District Water Management Strategy

A District Water Management Strategy (DWMS) was prepared in 2011 and provides guidance on water re-use options, stormwater detention basins, monitoring requirements, and structural and non-structural controls for stormwater treatment. The DWMS has been approved by both the City of Kwinana and the Department of Water.

3.6.3 Local Water Management Strategy

A Local Water Management Strategy ('LWMS') was prepared and approved as part of the original approved Structure Plan, with an Urban Water Management Plan also approved and progressively being implemented. Subsequently, an updated LWMS has been prepared by JDA Hydrology in support of this Amendment and is provided in **Appendix 10** of this Report.

The LWMS addresses the land south of the Peel Main Drain and has been prepared in accordance with the WAPC's Better Urban Water Management Framework and provides details of the management of stormwater, groundwater and water quality at a local scale. The key guiding principles of the LWMS are outlined as follows:

- 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
- To minimise public risk, including risk of injury or loss of life.
- Protection of infrastructure and assets from flooding and inundation; and
- To maintain the total water cycle

Details of the LWMS are provided in the sections below.

In accordance with the processes defined under Better Urban Water Management, an Urban Water Management Plan (UWMP) will be required to be prepared and implemented at the time of subdivision. The UWMP will refine and implement the proposed drainage network/system, as identified under the LWMS.

Refer **Appendix 10 – Local Water Management Strategy.**

3.6.4 Water Conservation and Sustainability

In accordance with the State Water Plan, the LWMS seeks to minimise the use of water and maximise water use efficiency where possible. In this regard, the LWMS outlines objectives for the subject site, outlined in **Table 5** below.

Level	Water Conservation Measures
Development Scale	- Strategic planning (orientation, shape, elevation etc.) of irrigation areas such as pocket parks, active and passive public open space areas, and road reserves to minimise long-term irrigation demand. - Where possible co-locate facilities with significant irrigation demand. - Use of non-potable water supply source (groundwater abstraction bore). - Within irrigation areas, the use of waterwise landscaping practices including hydrozoning, mulching, soil amendments, water retention products and installation of appropriate water efficient irrigation fixtures.
Lot Scale	- Increased residential density, including smaller lots with reduced ex-house irrigation areas. - Buildings constructed to current Building Codes of Australia (BCA) water efficiency standards and the State - Government 5 Star Plus Scheme. These include using AAA rated appliances such as toilets, washing machines, dishwashers, water saving showerheads, taps and toilets and sub-surface irrigation where possible. The Water Corporation's Waterwise Rebate Program will also assist in encouraging the purchase of waterwise AAA rated appliances. - Initiatives to encourage waterwise landscaping of residential lots including hydrozoning, mulching, soil amendments, water retention products and installation of appropriate irrigation fixtures. - Encourage use of non-potable water supply options for ex-house irrigation uses (ie. Rainwater tanks, greywater recycling, garden bore etc.)
Public Open Spaces	- Where appropriate, native species will be used in selected garden bed areas within landscaped Public Open Space. Native species should make up at least 50% of the total plants across the development. The irrigation system, if applicable, will be designed to water wise principles.

Table 8: Water Efficiency Measures

3.6.5 Stormwater (Surface Water) Management

Local stormwater management is proposed to be consistent with water sensitive design practices and to reflect the stormwater design approach presented in the District Water Management Strategy, as well as a continuation of the approach approved under the existing MELSP LWMS. Stormwater management has been designed based on small events, minor drainage and major drainage, and is detailed in the sections below.

3.6.5.1 Small Event Management

The following strategies are proposed to meet the criteria for small event management:

- All residential lots are to retain and infiltrate the first 15 mm of rainfall from connected impervious areas. This can be achieved by means of systems such as soakwells and/or other underground storage devices.
- Stormwater runoff from roads will be managed by tree pits and roadside swales. These will be underlain with amended soils and planted with suitable plant species, consistent with *Vegetation Guidelines for Biofilters in South-West Western Australia*. They will also be underlain with subsoil to control groundwater levels and prevent waterlogging.

3.6.5.2 Minor Drainage

To meet the design criteria for the minor drainage system (for events up to the 20% AEP), the following strategies are proposed:

- Runoff generated within residential lots in excess of lot underground storage devices (e.g. soakwells) will flow overland via driveways or front of lots into the pit-pipe road drainage network. Where proposed lots are less than 350m^2, underground storage devices (e.g. soakwells) are to be interconnected within the lot.
- Stormwater flow from roads will be conveyed primarily as piped flow to the downstream Flood Management Area ('FMA').
- The FMA located at the catchment low-point in the POS will provide both infiltration and detention of stormwater runoff, with outflow at pre-development rates outlined in the DWMS. The FMA will have a minimum side slope of 1:6 and be planted with appropriate vegetation and have subsoil drainage to prevent waterlogging and ponding of standing water.

3.6.5.3 Major Drainage

The major drainage system is designed to manage rainfall events greater than the 20% AEP event up to the 1% AEP event. Key points of the major drainage system strategy are as follows:

- Runoff generated within residential lots in excess of lot underground storage devices (e.g. soakwells) will flow overland via driveways or front of lots into the pit-pipe road drainage network.
- Road reserves will provide flood storage and conveyance. In major storm events, the minor drainage pit and pipe system will be full with excess stormwater bypassing the minor drainage structures and flowing overland within the road carriageway, with roads graded towards the downstream FMA located within the POS.
- The FMA will manage up to the 1% AEP flood event via infiltration and detention of stormwater runoff in the POS with outflow at pre-development rates outlined in the DWMS (JDA, 2011).
- Minimum habitable building floor levels will have a 300 mm (0.3 m) clearance from the top water level of the FMA.

3.6.6 Groundwater Management

Groundwater Management for the Amendment area has been prepared in line with design criteria presented in the DWMS (JDA,2011), *Water Resource Considerations when Controlling Groundwater Levels in Urban Areas* (DoW, 2013) and the *Stormwater Management Manual for Western Australia* (DWER, 2022):

- Manage groundwater levels to protect infrastructure and assets.
- Maintain groundwater regime for the protection of groundwater-dependent ecosystems.
- Protect the value of groundwater resources.
- Adopt nutrient load reduction design objectives for discharge to groundwater

To protect infrastructure from high seasonal groundwater levels post development, a combination of importation of sand fill and subsoil drainage will be required to provide a controlled groundwater level with the following criteria:

- Subsoils will discharge treated stormwater directly into the Peel Main Drain;
- Subsoils installed where required to ensure sufficient clearance to lot finished levels and operation of minor drainage system; and
- Subsoils will be set at or above pre-development AAMGL.

Based on the depth to groundwater levels, majority of the Amendment area is expected to require subsoils to control groundwater levels. Water table mounding will occur between subsoil drain inverts and will be allowed for in detailed design. Groundwater mounding should be calculated from the nearest subsoil invert level.

Lot finished levels should have 1 metre separation to the post development groundwater level, which accounts for groundwater rise post development and mounding between subsoils. runoff.

3.7 Education Facilities

The existing MELSP provides for one primary school site in the north, shared on a pro rata basis with the adjoining MWLSP. This primary school site is co-located with a local playing field, and has been approved and is being delivered under existing approvals. However, timing for construction of the school is unknown at this stage.

It is also understood the Mandogalup cell will be serviced by the future Wandi High School site located within the Wandi South Local Structure Plan area, east of the Kwinana Freeway. Timing for the delivery of this High School is unknown at this stage.

In the interim, a search of the Department of Education system identifies the Mandogalup area as being within the intake area for the Hammond Park Primary School (approximately 4.7km to the north) and Hammond Park Secondary College (approximately 1.2km from the site) and Atwell College (approximately 4.5 km from the site). It is understood these will service the proposed Mandogalup population until such time as the Mandogalup Primary school and Wandi High School are delivered.

3.7.1 Second Primary School Site

With the additional developable area to be included in both the MELSP and MWLSP, as well as considerations for additional residential land within IP47 and surrounds, the total residential yield triggers the need for a second primary school within the Mandogalup catchment. The Department of Education has also advised the existing surrounding schools are nearing or at capacity and therefore cannot accommodate the proposed additional Mandogalup catchment.

Therefore, whilst the MELSP alone does not trigger the need for the second school site, given the site constraints in this part of the catchment, provision for the second school site has been accommodated within the MELSP Amendment area. In the event the second primary school is not required to be delivered within the MELSP, and is located elsewhere, the land identified will be developed for residential purposes.

Through preliminary discussions, the Department of Education has informally advised their preference for the location of the second primary school within the MELSP. In reviewing the location of the second school site, it was recognised the need to be generally located south of the Peel Main Drain, with sufficient distance from the northern school site, to provide for the southern catchment. The locational constraints were also considered. These included the need to provide for a 200 metre separation from the DBNGP corridor, as well as considering the narrow catchment between the Kwinana Freeway and the Western Power easement, and the DPLH's opposition to locating the school within IP47 area.

Whilst identified within the MELSP, an alternate location was also explored with the Department of Education, west of the Western Power easement and southeast of the IP47 boundary, within the area currently subject to an MRS Amendment to rezone the land for Urban purposes. Whilst not ruled out by the Department of Education, this location is subject to further catchment planning and review by the Department, in the context of staging and timeframes for the delivery of the relevant catchment, as well as certainty in the planning mechanisms to ensure the site can be delivered. In undertaking this review, consideration should also be given to the current housing supply deficiencies across the metropolitan region, ensuring planning does not unnecessarily quarantine readily available residential land for a number of years, where suitable alternate locations can be explored.

3.8 Activity Centres and Employment

Consistent with the City of Kwinana *Local Commercial and Activity Centres Policy* (2023), the MELSP does not propose any commercial or retail uses.

3.8.1 Secondary Centre

In accordance with *State Planning Policy 4.2 – Activity Centres for Perth and Peel* (SPP 4.2), the closest secondary centres to the MELSP are Cockburn Gateway (approximately 6 kilometres to the north) and the Kwinana Town Centre (approximately 7.5 kilometres to the south).

Beside the Perth City Centre (Strategic Metropolitan Centre), these centres comprise the main regional activity centres within relatively close proximity to Mandogalup. They provide a diversity of uses, providing for a range of economic and community services required to service the future population.

3.8.2 District Centre

Current strategic planning identifies a future District Centre to be located within Wandi on Anketell Road, east of Kwinana Freeway.

Under the City of Kwinana's *Local Commercial and Activity Centres Policy* (LCAC), the District Centre has been allocated approximately 20,000m^2 of retail floor space and 10,000m^2 of 'other retail', including bulky goods/ showroom floor space. This floor space allocation is capable of supporting two full line supermarkets and a discount department store, as well as a wide range of complementary specialty shops.

In accordance with the City of Kwinana *Community Infrastructure Plan* (2022), the District Centre is also intended to comprise a range of community facilities.

Mandogalup residents will have direct access to the District Centre via Anketell Road. The centre will provide for the daily and weekly needs of residents.

Planning for the centre is progressing, with a Structure Plan currently with the WAPC for assessment and determination. Current advice suggests the landowner intends to commence construction of the centre by end of 2025.

3.8.3 Neighbourhood/Local Centre

Consistent with the City's LCACS, the MELSP does not propose a Neighbourhood or Local Centre within the MELSP. A small Local Centre is indicatively shown within the MWLSP, intended to service the Mandogalup catchment, including the MELSP. A Local Centre is also identified north-west of the site as part of concept planning for IP47.

3.9 Infrastructure Coordination, Servicing and Staging

The following provides a summary of the infrastructure and servicing for the MELSP. Further information is contained within the Engineering Services Report provided at **Appendix 11**.

3.9.1 Water

Preliminary information from the Water Corporation indicates there are no existing potable water services within the Amendment area. Notwithstanding, planning for a number of developments to the north and within the existing MELSP has now resolved supply issues, enhancing the regional network to ultimately provide services to the site.

The existing MELSP development area is serviced from an extension of water distribution mains in the north.

The strategy for this area, as advised by the Water Corporation, involves enabling developers to progressively extend large water mains (250mm) southward in phases to cater to subdivision stages. The Water Corporation is actively monitoring water pressure at strategic high points within the Hammond Park area, located north of Rowley Road, to effectively time the extension of sizable distribution mains as required.

A project is also underway to construct a 1.7 kilometre extension of the DN600 steel distribution main southward along Hammond Road, aiming to intersect with the 250P mains at the intersection of Frankland Road. Further development stages of the distribution network are planned to proceed from the western corner of Frankland Avenue, proceeding east along Frankland, and then south along Frankland up to Rowley Road. Ultimately, this distribution main is envisaged to extend further southward as a 700mm mainline through the western perimeter of the Amendment area.

All internal water reticulation pipe work will be designed and constructed in accordance with Water Corporation standards and requirements. Standard Water Corporation head work charges will apply.

3.9.2 Sewer

Preliminary information from the Water Corporation indicates there are no existing wastewater services available to the Amendment area. Notwithstanding, wastewater planning for development to the north has now resolved supply issues adjacent to the site, enhancing the regional network to ultimately accept discharge from the MELSP area.

The MELSP area will be serviced in accordance with current Water Corporation sewerage planning. This sewer planning identifies the need for a prefunded waste water pump station (WWPS), with a long term pumping rate of approximately 190 litres per second. This is intended to be located within Mandogalup, within or adjacent to the southern extents of the MELSP.

In the interim, a series of plans have been developed by Peritas for a staged approach to use the existing Honeywood WWPS (Thompsons Lake Pump Station J) by diverting flow under the Kwinana Freeway from the southern corner of the Mandogalup precinct and upgrading the existing pump station for the increased flow conditions. This may be a temporary or an interim measure until such time as the Mandogalup catchment develops to its full extent.

3.9.3 Electricity

It is intended all lots within the MELSP area will be serviced with underground power.

There are currently two options for the provision of electricity infrastructure to the service the Amendment area, as follows:

- **Option 1 – Power Extension from Rowley Road**

  The current MELSP and MWLSP development areas have extended power supply from a feeder at Rowley Road, and would provide a 'working end' for the initial stages of development within the Amendment area. The HV cable will be extended south as the development progresses until the existing power feeder reaches capacity. Some intermediate upgrades might be required during construction and will depend on the development activity in the area.

- **Option 2 – Power Supply from Anketell Road**

  The Proponent has engaged Western Power to undertake a preliminary feasibility study to establish the capacity of the current network in the vicinity of Anketell Road to service the MELSP, including the Amendment area. The study undertaken by Western Power has indicated the existing power network in the vicinity of MELSP area has insufficient capacity to accommodate the whole

development and provided recommendations on possible network extensions that would be required to deliver power services to the estate.

Servicing of the site will ultimately be determined as part of detailed design at subdivision stage.

Standard Western Power requirements will apply, including the cost for head works upgrades and exclusions to service the site.

It is understood, as is standard practice, that a number of pad mount sites will be required throughout the development. The location of these will be determined as part of detailed design at subdivision stage.

3.9.4 Gas

ATCO Gas has advised reticulated gas services are available in the surrounding locality.

ATCO gas may provide road crossing conduits for future use; however this is subject to cost allocations and budgets being approved by the relevant gas authorities.

No developer contributions to provide for future reticulated gas supplies are anticipated.

3.9.5 Telecommunications

It is intended all lots within the MELSP area will be serviced with telecommunication services, provided by an external private provider such as Opticomm.

The selected provider will install telecommunication facilities to the future subdivision, subject to the developer providing trenching for cable laying, at their own cost.

The service provider will be responsible for installing telecommunication facilities within the development. The developer will fund the provision of trenches for cable laying. Alternatively, where cable routes are on the same alignment as Western Power underground power supply routes, the telecommunications will use, where possible, the Western Power trenches in lieu of the developer providing additional trenching.

Headworks charger for telecommunication service extensions are anticipated

3.9.6 Indicative Staging

An Indicative Staging Plan has been prepared for the site, provided at Figure 14.

Development of the MELSP has commenced generally north of the Peel Main Drain.

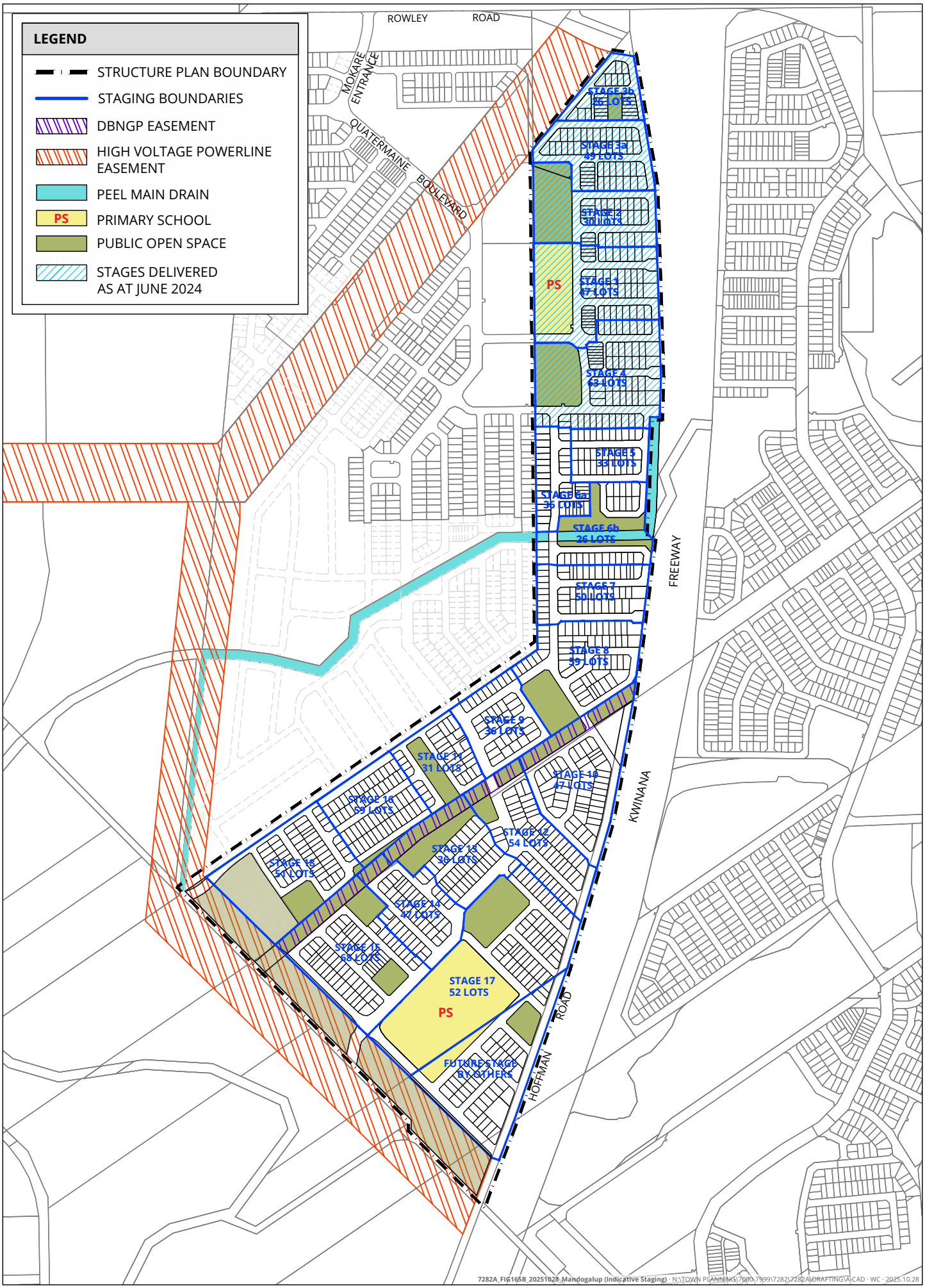
Future development of the site will generally occur south from the Peel Main Drain on a staged basis. The MELSP is intended to be developed across approximately 18 stages of approximately 30-60 lots per stage, commencing in the north and progressing south. Stages 1-6 of the estate have already been delivered, with stages 7-9 currently under construction. There are existing subdivision approvals in place for the entirety of the current MELSP, with a development approval for preliminary earthworks issued for the proposed amendment area (additional land).

Please refer to **Figure 14 – Indicative Staging Plan**. This is subject to further detailed design and is provided for explanatory purposes only.

3.10 Developer Contribution Arrangements

The MELSP is partly situated within the Mandogalup cell for the purposes of Developer Contribution arrangements, and forms part of Development Contribution Areas 8 (DCA 8) for community infrastructure and Development Contribution Area (DCA 6) for traditional infrastructure.

The Amendment area is not currently included within the boundaries of DCA 6 or 8. Notwithstanding, there is a legal agreement in place between the two primary landowners for the MELSP and MWLSP to ensure a coordinated delivery of key infrastructure, including water and sewer service infrastructure, and the primary movement network through the two structure plan areas.



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FIGURE 14

INDICATIVE STAGING PLAN

APPENDIX 1

Certificates of Title

WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
2525	**87**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9000 ON DEPOSITED PLAN 31293

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(T J271366) REGISTERED 3/5/2005

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

1. C463023 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DP31293 REGISTERED 2/12/1982.
2. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
3. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
4. O083528 CAVEAT BY QUBE MANDOGALUP DEVELOPMENT PTY LTD, JJ WHITE PTY LTD, GRETA WHITE PTY LTD LODGED 4/2/2019.

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STATEMENTS:

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SKETCH OF LAND:	DP31293
PREVIOUS TITLE:	1913-655
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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WESTERN AUSTRALIA

TITLE NUMBER	
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2758	**177**

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9002 ON DEPOSITED PLAN 69132

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF L494837) REGISTERED 1/12/2010

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

1. B927637 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 69132. REGISTERED 29/5/1980.
2. C463023 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 69132. REGISTERED 2/12/1982.
3. C556532 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 69132. REGISTERED 26/5/1983.
   H622728 SUNDRY. THE GRANTEE OF TRANSFER C556532 IS NOW THE DBNGP LAND ACCESS MINISTER PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. REGISTERED 14/12/2000.
4. H622728 SUNDRY. PORTION OF THE LAND HEREIN IS WITHIN THE DBNGP CORRIDOR PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. SEE LAND ADMINISTRATION PLAN 15576. REGISTERED 14/12/2000.
5. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
6. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
7. P334467 EASEMENT TO CITY OF KWINANA FOR PUBLIC EMERGENCY ACCESS PURPOSES - SEE DEPOSITED PLAN 423735 REGISTERED 27/10/2022.
8. P334468 CAVEAT BY QUBE MANDOGALUP DEVELOPMENT PTY LTD, JJ WHITE PTY LTD, GRETA WHITE PTY LTD LODGED 27/10/2022.

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SKETCH OF LAND:	DP69132
PREVIOUS TITLE:	1911-23, 1919-564
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
2769	**846**

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9006 ON DEPOSITED PLAN 70124

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF L608279) REGISTERED 16/5/2011

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

1. C463023 EASEMENT TO STATE ENERGY COMMISSION OF WESTERN AUSTRALIA FOR ELECTRICITY PURPOSES- SEE SKETCH ON DEPOSITED PLAN 70124 AND INSTRUMENT C463023. REGISTERED 2/12/1982.
2. D311642 EASEMENT TO STATE ENERGY COMMISSION OF WESTERN AUSTRALIA FOR ELECTRICITY PURPOSES - SEE SKETCH ON DEPOSITED PLAN 70124 AND INSTRUMENT D311642. REGISTERED 27/8/1986.
   H621767 SUNDRY. THE GRANTEE OF TRANSFER D311642 IS NOW THE DBNGP LAND ACCESS MINISTER PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. REGISTERED 13/12/2000.
3. H621767 SUNDRY. PORTION OF THE LAND HEREIN IS WITHIN THE DBNGP CORRIDOR PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. SEE DEPOSITED PLAN 215575 AND 215576 REGISTERED 13/12/2000.
4. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
5. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
6. P334467 EASEMENT TO CITY OF KWINANA FOR PUBLIC EMERGENCY ACCESS PURPOSES - SEE DEPOSITED PLAN 423735 REGISTERED 27/10/2022.
7. P334468 CAVEAT BY QUBE MANDOGALUP DEVELOPMENT PTY LTD, JJ WHITE PTY LTD, GRETA WHITE PTY LTD LODGED 27/10/2022.

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STATEMENTS:

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

SKETCH OF LAND:	DP70124
PREVIOUS TITLE:	2229-81, 2229-82
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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Landgate

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WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
2809	**569**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 11 ON DEPOSITED PLAN 76538

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SANTO GALATI RANDO
ANNUNZIATA GALATI RANDO
BOTH OF 72 THE HORSESHOE, WANDI
AS JOINT TENANTS

(AF M209157) REGISTERED 26/3/2013

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

1. C788797 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE DEPOSITED PLAN 76538 REGISTERED 8/6/1984.

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

STATEMENTS:

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

SKETCH OF LAND:	DP76538
PREVIOUS TITLE:	1979-881
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
4051	**54**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9060 ON DEPOSITED PLAN 427273

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 3 27-31 TROODE STREET WEST PERTH WA 6005
(AF P940465) REGISTERED 8/4/2024

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

1. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
2. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER. MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
3. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE/IRRIGATION/WATER SUPPLY/SEWERAGE PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 427273 AS CREATED ON DEPOSITED PLAN 417452
4. P243458 EASEMENT TO CITY OF KWINANA FOR FIRE EMERGENCY ACCESS PURPOSES - SEE DEPOSITED PLAN 427273 REGISTERED 26/10/2022.
5. P243465 RESTRICTIVE COVENANT TO ELECTRICITY NETWORKS CORPORATION - SEE DEPOSITED PLAN 427273 REGISTERED 26/10/2022.
6. P243466 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. - SEE DEPOSITED PLAN 427273 LODGED 26/10/2022.
7. P387807 EASEMENT TO CITY OF KWINANA FOR NOISE WALL ACCESS PURPOSES - SEE DEPOSITED PLAN 427273 REGISTERED 12/12/2022.
8. P855059 RESTRICTIVE COVENANT TO ELECTRICITY NETWORKS CORPORATION - SEE DEPOSITED PLAN 427273 REGISTERED 9/2/2024.
9. P855060 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. - SEE DEPOSITED PLAN 427273 LODGED 9/2/2024.
10. P940477 CAVEAT BY QUBE MANDOGALUP DEVELOPMENT PTY LTD, JJ WHITE PTY LTD, GRETA WHITE PTY LTD LODGED 8/4/2024.

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

STATEMENTS:

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

SKETCH OF LAND:	DP427273
PREVIOUS TITLE:	4050-945
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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Landgate

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WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
LR3024	**314**

RECORD OF CERTIFICATE OF CROWN LAND TITLE

UNDER THE TRANSFER OF LAND ACT 1893
AND THE LAND ADMINISTRATION ACT 1997

The undermentioned land is Crown land in the name of the STATE OF WESTERN AUSTRALIA, subject to the interests and Status Orders shown in the first schedule which are in turn subject to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts
REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 8018 ON DEPOSITED PLAN 77243

STATUS ORDER AND PRIMARY INTEREST HOLDER:
(FIRST SCHEDULE)

STATUS ORDER/INTEREST: UNALLOCATED CROWN LAND

PRIMARY INTEREST HOLDER: STATE OF WESTERN AUSTRALIA

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

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required. Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF CROWN LAND TITLE----------

STATEMENTS:

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

SKETCH OF LAND:	DP77243
PREVIOUS TITLE:	LR3013-104
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA
RESPONSIBLE AGENCY:	DEPARTMENT OF PLANNING, LANDS AND HERITAGE (SLSD)

NOTE 1: M474366 CORRESPONDENCE FILE 00473-2009-01RO
NOTE 2: P459789 INTEREST ONLY DEPOSITED PLAN 423734 LODGED

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APPENDIX 2

Environmental Assessment Report

Mandogalup, Florence – Environmental Assessment Report (EAR) amendment

Satterley Property Group

Report

JBS&G 66402 | 157,146

30 January 2024

We acknowledge the Traditional Custodians of Country throughout Australia and their connections to land, sea and community.

We pay respect to Elders past and present and in the spirit of reconciliation, we commit to working together for our shared future.



Caring for Country The Journey of JBS&G
Artist: Patrick Caruso, Eastern Arrernte

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1. Introduction

1.1 Background

Satterley Property Group (Satterley) are proposing to develop approximately 35.05 ha in Mandogalup within the City of Kwinana (CoK). The site is located in north-east Mandogalup, west of the Kwinana Freeway and south of Rowley Road, approximately 7.5 km south of Cockburn City Centre and 6.5 north of Kwinana City Centre. A Local Structure Plan (LSP) will be prepared and submit for this area.

The LSP is a guiding framework to maximise the capacity for greater diversity in housing options, employment, and economic development options, while identifying and providing for the retention of environmental assets. The LSP depicts the following proposed uses for the site:

- Residential uses;
- Primary school;
- Mixed use facility;
- Public Open Space (POS) areas;
- Conservation Areas; and
- Transport infrastructure (i.e., roads and roundabouts).

1.2 Purpose and scope of this document

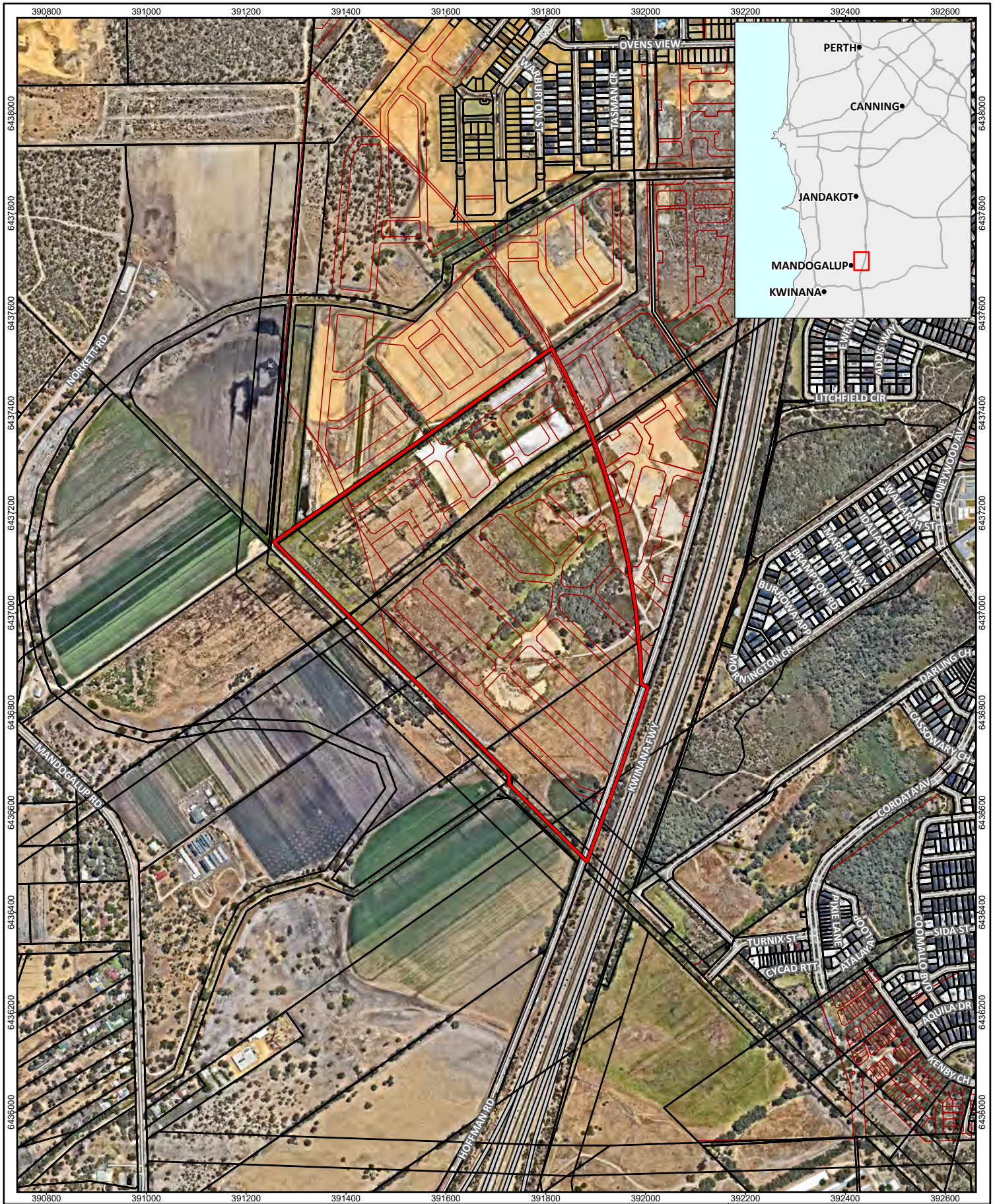
This Environmental Assessment Report (EAR) has been prepared to support the Local Strcuture Plan, the locations of which is shown in Figure 1-1 and the Subdivision Concept Plan in Appendix A.

The purpose of this EAR is to demonstrate that all environmental considerations associated with the future land use and development scenario can be managed in accordance with policy requirements. As such the EAR addresses:

- applicable legislation, policy, and guidance;
- the environmental, bushfire, and heritage values of the site;
- potential impacts to the above characteristics associated with the proposed development; and
- the spatial and management response of the development to ensure that any identified potential impacts can be mitigated or managed to avoid 'significant' impact.

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Figure 1-1: Site Location



Legend

- Project area
- Cadastral boundary
- Concept plan layout
- Highway
- Minor road
- Track

Scale: 1:10,000 at A4 (0, 100, 200 metres)

Coord. Sys. GDA2020 MGA Zone 50

Job Number: 66402

Client: Satterley Property Group

Version: A | Date: 27-Feb-2024

Drawn By: ianandagoda | Checked By: MDruck

Hoffman Road
Mandogalup, WA

PROJECT AREA

FIGURE 1.1

JBS&G

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Image Reference: www.nearmap.com© - Imagery Date: 31 January 2024.

2. Legislation, policies, and guidelines

The following legislation and guidelines and their implementation may be applicable for the redevelopment of the Residential development.

2.1 Federal Legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EpAct, 1999) EPBC Act is administered by the Department of Agriculture Water and the Environment (DAWE). The EPBC Act aims to protect and manage nine Matters of National Environmental Significance (MNES) throughout Australia including:

- World Heritage Properties
- National Heritage Places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth Marine Areas
- Great Barrier Reef Marine Park
- nuclear actions (including uranium mines)
- a water resource, in relation to coal seam gas development and large coal mining development.

An EPBC referral was made to the Department of the Environment and Energy for listed Threatened species and ecological communities, specifically, impacts to all three species of south-west Black Cockatoo (*Calyptorhynchus latirostris*, *Calyptorhynchus banksia naso*, and *Calyptorhynchus baudinii*). This referral was subsequently determined to be not a controlled action on the 18th December 2018 (EPBC 2018/8264; Appendix B) meaning that no further assessment and approval under the EPBC Act is required before the action can proceed.

2.2 State Legislation

The environmental assessment has been conducted with reference to the following State legislation which provides for the environmental and heritage values, and bushfire risk addressed within this report:

- *Environmental Protection Act 1986* (EP Act, 1986);
- *Biodiversity Conservation Act 2016* (BC Act, 2016);
- *Biosecurity and Agriculture Management Act 2007* (BAM Act, 2007);
- *Rights in Water and Irrigation Act 1914* (DWER, 1914);
- *Metropolitan Water Supply, Sewerage and Drainage Act 1909* (DWER, Metropolitan Water Supply, Sewerage, and Drainage Act 1909, 1909);
- *Aboriginal Heritage Act 1972 (WA)* (DPLH, Aboriginal Heritage Act 1972, 1972);
- *Contaminated sites Act 2003* (DWER, 2003);

- Contaminated Sites Regulations 2006 (DWER, 2006); and
- *Planning and Development Act 2005* (DPLH, 2005).

2.2.1 Environmental Protection Act 1986

The *Environmental Protection Act 1986* (EP Act, 1986) is administered by the Environmental Protection Authority (EPA) and the Department of Water and Environmental Regulation (DWER). The Act provides for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing.

Part IV of the EP Act makes provisions for the EPA to undertake environmental impact assessment of significant proposals, strategic proposals and land use planning schemes. The EPA uses environmental principles, factors and associated objectives as the basis for assessing whether a proposal or land use planning scheme's impact on the environment is acceptable.

2.2.2 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act, 2016) has now replaced the *Wildlife Conservation Act 1950*. On 3 December 2016, several parts of the new Act were enacted by the State Governor. The remaining parts of the Act and the associated Regulations came into effect on 1 January 2019.

In addition to providing for the protection of flora and fauna, the *Biodiversity Conservation Act 2016* includes provisions for threatened ecological communities, threatening processes, critical habitats and environmental pests.

2.3 Environmental Protection Authority (EPA) guidance

The assessment has given consideration to the recommendations of EPA regulatory guidance as listed below:

- *Environmental Factor Guideline - Social Surroundings;*
- *Environmental Factor Guideline - Human Health;*
- *Environmental Factor Guideline - Inland Waters;*
- *Environmental Factor Guideline - Terrestrial Fauna;*
- *Environmental Factor Guideline - Terrestrial Environmental Quality;*
- *Environmental Factor Guideline – Landforms;*
- *Environmental Factor Guideline - Flora and Vegetation;*
- *Technical Guidance - Terrestrial fauna surveys;*
- *Technical Guidance - Sampling methods for terrestrial vertebrate fauna;*
- *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment;*
- *EPA Guidance Statement No. 33 Environmental Guidance for Planning and Development;*
- *Environmental Protection Bulletin No. 20 Protection of naturally vegetated areas through planning and development; and*
- *Mandogalup area dust impacts – s16e advice.*

2.3.1 State Planning Policies

The Western Australian Planning Commission (WAPC) prepares and adopts state planning policies under statutory procedures set out in part 3 of the *Planning and Development Act 2005* (WAPC, 2005). State planning policies relevant to the project are listed below:

- State Planning Policy 2.4: *Basic raw materials* (SPP 2.4)
- State Planning Policy 2.8: *Bushland Policy for the Perth Metropolitan Region* (SPP 2.8)
- Draft State Planning Policy 2.9 *Planning for Water* (SPP 2.9) *and Planning for Water Guidelines*
- State Planning Policy 3.7: *Planning in Bushfire Prone Areas* (SPP 3.7)
- State Planning Policy 5.4: *Road and Rail Transport Noise* (SPP 5.4)

2.4 Local government policies, strategies and guidance

The City of Kwinana has developed numerous polices, strategies and guidelines relevant to planning and the environment, as listed below. Reference to these documents has been made throughout the report where applicable to a specific environmental factor.

- *Local Planning Policy No. 1 - Landscape Feature and Tree Retention* (City Of Kwinana, 2016).
- *Town of Kwinana Local Planning Scheme No.2*
- *City of Kwinana Natural Areas Management Plan 2014-2024*

3. Overview of existing environmental

3.1 Land use

3.1.1 Current land use

The site is currently zoned Urban under the Metropolitan Region Scheme (MRS) and 'Development' development under the City of Kwinana Local Planning Scheme (LPS)No 2.

Market gardening activities have ceased on site and presently, the site is mainly cleared pasture with native vegetation occurring as isolated pockets in the centre and south.

3.1.2 Previous land uses

The local area has been used for agricultural purposes including market gardening, grazing, cropping and horse agistment, and the site is predominately cleared. Surrounding land uses include residential.

Surrounding land uses include residential directly adjacent to the north, east and west of the site, Thomsons Lake Nature Reserve is located approximately 3 km to the north of the Proposal Area and encompasses the Ramsar-listed Thomsons Lake (see Section 3.5). Thompsons Lake Nature Reserve is part of Beeliar Regional Park, sand quarry is located approximately 4 km to the west, poultry farming to south and industrial (Alcoa tailing ponds and the Kwinana Wastewater Treatment Plant)

The Kwinana Freeway is located to the east and is reserved Primary Regional Road. It also includes the central rail corridor for the Perth – Mandurah line.

3.2 Climate

The climate of this region is described as Mediterranean, similar to that of other coastal areas in the Perth Metropolitan region, with hot dry summers and mild wet winters and rainfall ranging between 600 and 1000 mm annually (D, K, & Desmond, 2002).

The South-west Region has a Mediterranean climate consisting of warm, dry summers and cool, wet winters. The nearest weather station which records both temperature and rainfall data is the Jandakot Airport station (station 009172), approximately 11 km from the Survey Area. The average annual rainfall from 1972-2023 was 812.10 mm, with the highest monthly rainfall occurring from May to September (Figure 3.1). The average mean maximum temperature ranges from 18.1°C in July to 36.1°C in February. The average mean minimum temperature ranges from 7.1°C in July to 17.2 in February (Figure 3-1) (BoM, 2024).

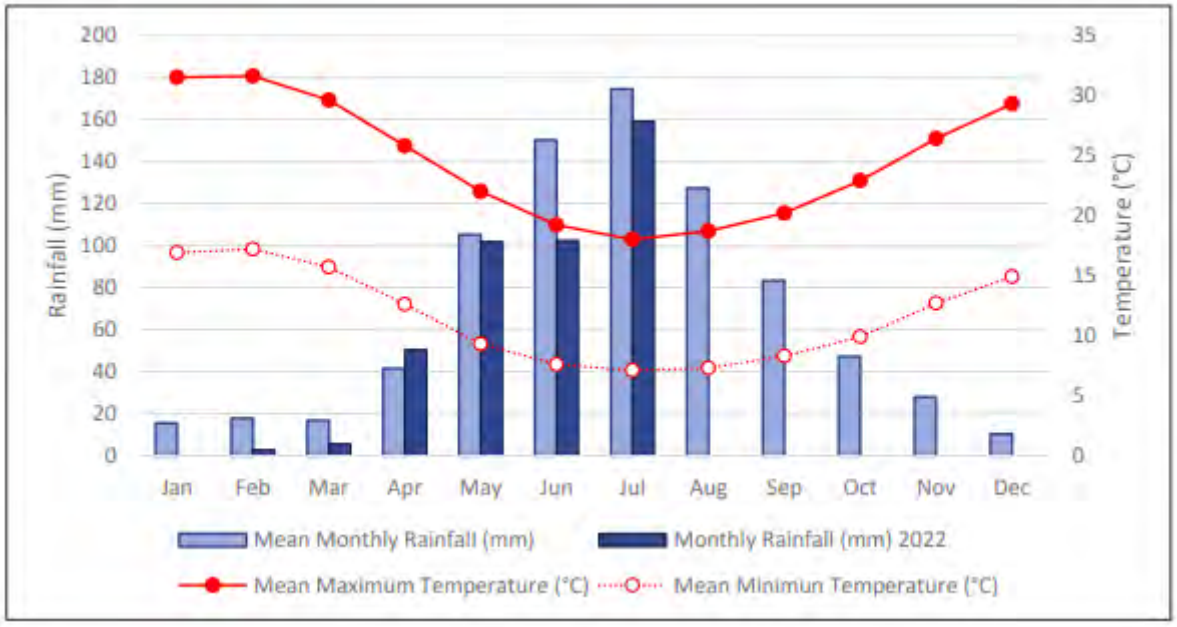


Figure 3-1: Monthly average temperature and rainfall at Jandakot Airport Station (009172)

3.3 Topography, Geology and soils

3.3.1 Topography

The topography of the site is predominantly low with gentle undulations, with elevation across the site ranges from approximately 14 m Australian Height Datum (AHD) in the west to approximately 16 m AHD in the east (Figure 3-2).

3.3.2 Geology and soils

The Swan Coastal Plain comprises five major geomorphic systems that lie parallel to the coast, the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward, 1980). The site lies within the Bassendean Dune system, which can be characterised as sand dunes and sand plains comprising swamps and flats on sandy alluvium over sedimentary rocks (DPIRD, 2019).

Soils within the site are predominately lacustrine deposits consisting of dark brownish grey silt, with disseminated fine-grained quartz sand, firm, with variable clay content (JR., 1983)

3.4 Hydrology

3.4.1 Groundwater

Depth to groundwater across the proposal area ranges from 13 m AHD in the northwest corner to 15 mAHD in the southeast corner and flows in an east to west direction. This corresponds to groundwater levels between 1 metre below ground level (mbgl) to as little as 0.3 mbgl (DWER, 2019). Groundwater flow direction within the site generally follows the natural topography and flows in a south-westerly direction according to the Perth Groundwater Atlas (DWER, 2019) and observations made at the site (JDA, 2024).

3.4.2 Surface water

The site is located within the Serpentine surface water catchment areas and Lower Serpentine subarea.

The Peel Main Drain, which flows from Banjup Swamp (located near Gibbs Rd, Aubin Grove) in the north to the Peel-Yalgorup system in the south (via Serpentine River), passes through the Proposal Area. Given that this

portion of the Proposal Area is cleared and the site itself and the surrounding land is currently used for horticultural activities, implementation of the Proposal is unlikely to lead to a decline in the water quality of the drain. Instead, nutrient loads may decrease over time due to the cessation of horticultural activities within the site and the surrounding area.

3.4.3 Public drinking water source area

The Metropolitan Water Supply, Sewerage and Drainage Act 1909 (MWSSD Act) and the Country Areas Water Supply Act 1947 (CAWS Act) identify and categorise public drinking water source areas as catchment areas, water reserves, or underground water pollution control areas.

The Jandakot Mound supplies groundwater for public water supply, private abstraction for irrigated agriculture, industry, public open space and recreation grounds. Although the site is within the Jandakot Mound catchment, it is not within a proclaimed public drinking water source area (JDA, 2024).

3.5 Wetlands

3.5.1 Conservation significant wetlands

Two Ramsar-listed wetlands are located in proximity to the Proposal Area as identified in an EPBC Act Protected Matters search:

- Forrestdale and Thomsons lakes—located within 10 km of the site (to the northeast and north respectively); and
- Peel-Yalgorup system— site is located within catchment area (the Ramsar site, the Spectacles Wetlands, is located approximately 4 km away to the south).

3.5.1.1 Forrestdale and Thomsons lakes

Surface water within the site flows in a south-westerly direction towards the Spectacles wetlands via the Peel Main Drain (RPS, 2009). Groundwater under the Proposal Area generally flows west-southwest towards the ocean (DWER, 2019). Therefore, surface water and groundwater from the Proposal Area flows away from both Forrestdale and Thomsons lakes.

3.5.1.2 Peel-Yalgorup system

The Peel Main Drain, which flows from Banjup Swamp (located near Gibbs Rd, Aubin Grove) in the north to the Peel-Yalgorup system in the south (via Serpentine River), passes through the Proposal Area. Given that this portion of the Proposal Area is cleared and the surrounding land in the MWLSP area is currently used for horticultural activities, implementation of the Proposal is unlikely to lead to a decline in the water quality of the drain. Nutrient loads may decrease over time due to the cessation of horticultural activities in the MWLSP area.

3.5.2 Geomorphic wetlands

The nature of the protection and management of Swan Coastal Plain wetlands should be afforded is guided by the appropriate management category they have been assigned. These management categories are listed below.

Table 3.1: Wetland management categories and management objectives

Category	Objective
Conservation (C category) Wetlands	To preserve wetland (natural) attributes and functions
Resource Enhancement (R category) wetlands	To restore wetlands through maintenance and enhancement of wetland functions and attributes

Multiple Use (M category) wetlands	To use, develop and manage wetlands in the context of water, town and environmental planning

The majority of the site is mapped by the DBCA as a Multiple Use Category Dampland (seasonally waterlogged flat; Figure 3-3). Multiple Use Wetlands (MUW's) are typically wetlands with few important ecological attributes and function remaining. Approved development can progress within MUW's and therefore these wetland values do not represent a constraint to development, other than the limitations associated within the site's geology and depth to groundwater / perched surface water as previously discussed.

3.6 Conservation areas

The State Planning Policy 2.8: Bushland Policy for the Perth Metropolitan Region (SPP 2.8) aims to provide a policy and implementation framework that ensures bushland protection and management issues throughout the Perth Metropolitan Region are adequately addressed and integrated with broader land use planning and decision-making (WAPC, 2010). In accordance with SPP 2.8, proposals must recognise regionally significant bushland and outline methods by which it will avoid, minimise, and offset any likely adverse impacts it will have on regionally significant bushland.

The policy predominantly deals with two distinct subjects, Bush Forever areas and local bushland areas.

The Spectacles wetlands occur approximately 4 km the south of the Proposal Area (see Section 3.5). The Spectacles are Ramsar-listed (RPS, 2009), and are also identified under the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 (WA). The Spectacles are classified as a conservation category wetland (Landgate, 2016)(Figure 4-1:Regional Conservation Areas).

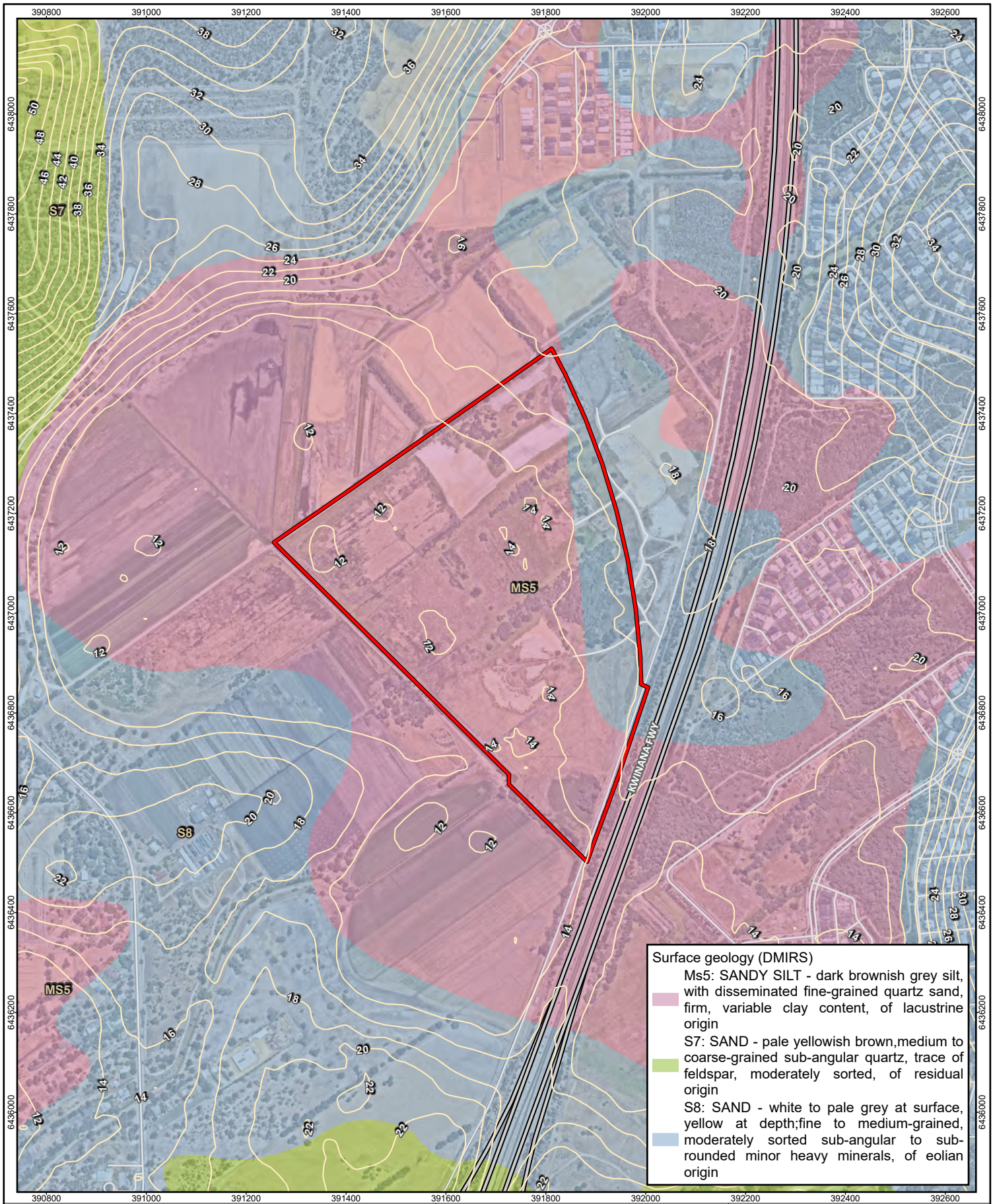
Thomsons Lake Nature Reserve is located approximately 3 km to the north of the Proposal Area and encompasses the Ramsar-listed Thomsons Lake (see Section 3.5). Thompsons Lake Nature Reserve is part of Beeliar Regional Park.

In addition, numerous Bush Forever sites are also located nearby including:

- site 268 Mandogalup Road bushland (located within 1 km of the proposal area, to the west);
- site 269 the Spectacles (located within 1 km of the proposal area, to the southwest);
- site 270 Sandy Lake and adjacent bushland (located within 1 km of the proposal area, to the south);
- site 347 Wandi Nature reserve and Anketell Road bushland (located within 1 km of the proposal area, to the northwest); and
- site 392 Harry waring Marsupial Reserve (located within 2 km of the proposal area, to the northwest).

None of these conservation places will be affected by the proposed development.

Figure 3-2: Topography, geology and soils



Legend

- Project area
- Topographic contours - 2m (mAHD)
- Highway
- Minor road
- Track

Scale: 1:10,000 at A4 (0, 100, 200 metres)

Coord. Sys. GDA2020 MGA Zone 50

Job Number: 66402

Client: Satterley Property Group

Version: A | Date: 27-Feb-2024

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Hoffman Road
Mandogalup, WA

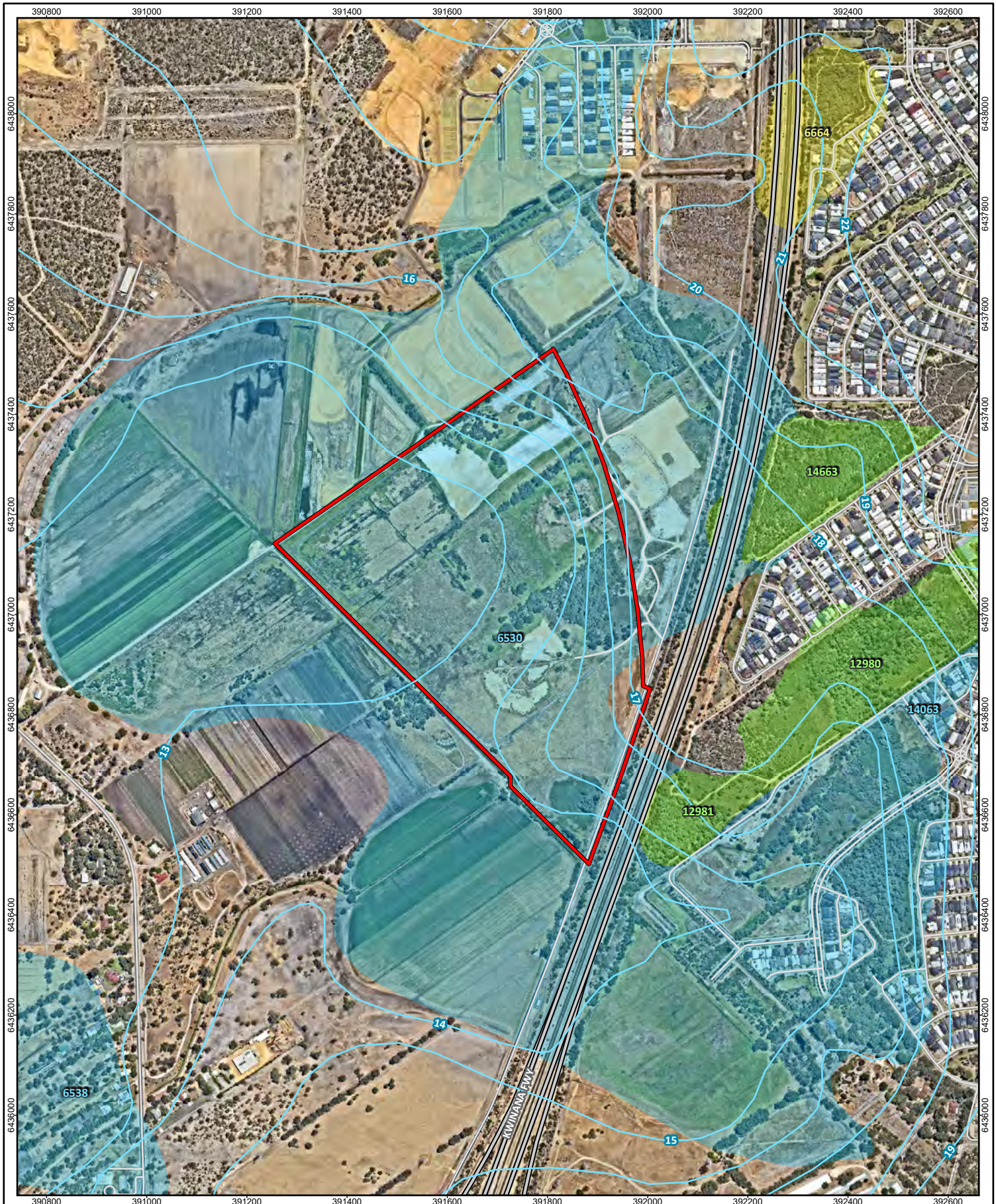
TOPOGRAPHY, GEOLOGY AND SOILS

FIGURE 3.2

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Figure 3-3: Hydrology and Wetlands



Legend

- Project area

Geomorphic wetlands (DBCA-019)

- Conservation
- Multiple Use
- Resource Enhancement

- Groundwater contours- maximum (DWER-096)
- Highway
- Minor road
- Track

Scale: 1:10,000 at A4 (0 100 200 metres)	**Hoffman Road Mandogalup, WA**
Coord. Sys. GDA2020 MGA Zone 50	**HYDROLOGY AND WETLANDS**
Job Number: 66402	
Client: Satterley Property Group	**FIGURE 3.3**
Version: A / Date: 27-Feb-2024	JBS&G
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3.7 Environmentally sensitive areas

Environmentally Sensitive Areas (ESAs) are areas that have been identified for protection due to their environmental significance as outlined in the Western Australian Environmental Protection (Environmentally Sensitive Areas) Notice 2005, which was gazetted on 8 April 2005.

No ESA's are located within the site boundary according to the DWER Environmentally Sensitive Areas Map Viewer. (DWER, 2024) The nearest ESA is located approximately 200 m north of the site within the MELSP, and is associated with the 50 m buffer of a Conservation Category Wetland.

3.8 Acid sulfate soils

Acid Sulfate Soils (ASS) are naturally occurring, iron-sulphide rich soils, sediments, or organic substrates, formed under waterlogged conditions. If exposed to air, these sulphides can oxidise and release sulphuric acid and heavy metals. This process can occur due to drainage, dewatering or excavation.

Regional ASS mapping indicates that he majority of the site is mapped has having a High to Moderate (Class 1) ASS disturbance risk within 3 m of the soil surface, while the remainder of the site has been mapped as having a Moderate to Low (Class 2) ASS disturbance risk (Figure 3-4).

RPS (RPS, 2009) undertook a desktop analysis of the site and wider MELSP area to determine the likelihood of ASS being present. This analysis incorporated geomorphic and Proposal Area description criteria, including:

- soil and sediment of recent geological age (Holocene)
- marine or estuarine sediments and tidal lakes
- low-lying coastal wetlands or back swamp areas, waterlogged or scalded areas, stranded beach ridges and adjacent swales, interdunal swales or coastal sand dunes
- coastal alluvial valleys
- areas where dominant vegetation is tolerant of salt, acid and/or water-logging conditions, e.g. mangroves, salt couch, swamp-tolerant reeds, rushes, paperbarks (*Melaleuca* spp.) and swamp oak (*Casuarina* spp.)
- areas identified in geological descriptions or in maps as bearing sulfide minerals, coal deposits or marine shales/sediments, and deep older estuarine sediments below ground surface of either Holocene or pre-Holocene age.

RPS (2009) concluded that there was a high risk of disturbing potential or actual ASS during ground intrusive earthworks in the low-lying central, western and northern areas of the Proposal Area, as most of this area is less than 1 m above the water table.

Based on these desktop findings, an ASS investigation was undertaken across the site in 2015 and 2016. The investigation identified various amounts of ASS present across the site, which will require management during intrusive development works to prevent environmental harm. The development and implementation of an ASS Management Plan prior to intrusive disturbance works being undertaken will manage environmental risk.

3.9 Contamination

The *Contaminated Sites Act 2003* (DWER, 2003) defines contamination as having a substance present in land or water above background concentrations that presents a risk of harm to human health or the environment. The act also provides for the identification, recording, management and remediation of contaminated sites. Contamination commonly occurs through accidental leakage and spillage, or poor site management practices.

An assessment of the site undertaken in 2015 confirmed a number of potential contamination sources within the site and surrounding area. (Cumming, 2017) These include:

- illegally fly-tipped waste including chemical storage containers and inert waste;
- storage of dangerous goods (petroleum hydrocarbons);
- surficial and partially buried potential asbestos containing material (PACM);
- potential pesticide application (intensive agriculture) in a stock yard; and
- construction of a horse training track.

Remediation was undertaken within the site and wider Mandogalup East Local Structure Plan (MELSP) area between June 2015 and 2016 to remove known potential contamination sources (Strategen, 2016). Following removal of all known potential contamination sources to an off-site licensed landfill facility the soil and groundwater quality was further investigated to:

- assess the nature and extent of contamination, if any, following preliminary remediation activities at the site
- assess the future risk to human health and the environment from residual site contamination.

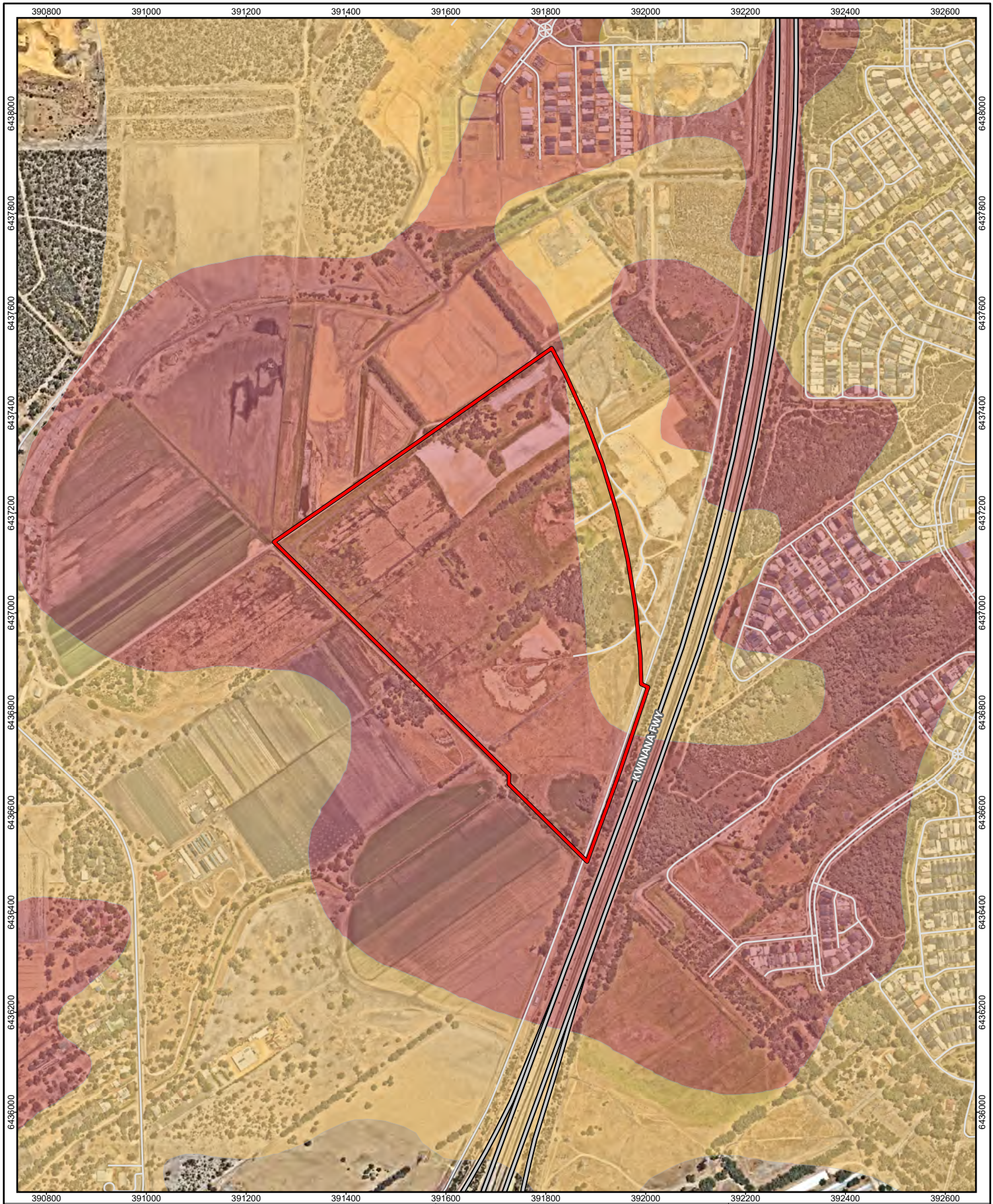
Based upon the results of the Detailed Site Investigation (DSI) (Cumming, 2017) a human health and ecological risk assessment for the site and wider MELSP area was undertaken and concluded:

- Residual contaminant sources have been removed from the site and there are no residual soil risks to human health or the environment.
- Groundwater and surface water is suitable for non-potable use and irrigation and is not considered to be a risk to human health. Groundwater is not recommended for drinking water purposes.
- Groundwater quality is indicative of the regional superficial aquifer and minor groundwater contamination is considered as a result of regional agricultural activities. There are no unacceptable groundwater or surface water contamination risks to human health or the environment.

Based on the DSI results, no further investigations to characterise soil, groundwater and/or surface water contamination are deemed necessary and the site is considered to be suitable for residential purposes based as proposed.

A Contaminated Sites Auditor accredited under the *Contaminated Sites Act 2003*, was commissioned to prepare a voluntary audit report (VAR) for the Proposal Area and surrounds following completion of the DSI. This audit report was submitted to the then Department of Environmental Regulation (now Department of Water and Environmental Regulation [DWER]) to support the assessment of the MELSP application under the *Planning and Development Act 2005*. Based on a review of the VAR, DWER determined that investigations for soil, groundwater and surface water contamination at the site were carried out according to DWER's *Contaminated Sites Guidelines* 2014, and that all identified soil and groundwater contamination at the site has been successfully remediated (DWER, 2017).

Figure 3-4: Acid sulfate soils



Legend

- Project area

Acid sulfate soil (DWER-055)

- High to moderate risk
- Moderate to low risk
- Highway
- Minor road
- Track

Scale: 1:10,000 at A4 (0 100 200 metres)	**Hoffman Road Mandogalup, WA**
Coord. Sys. GDA2020 MGA Zone 50	**ACID SULFATE SOILS (DWER-055)**
Job Number: 66402	
Client: Satterley Property Group	**FIGURE 3.4**
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3.10 Bushfire risk

The majority of the site is designated as bushfire prone according to the Western Australia Map of Bushfire Prone Areas (DFES, 2019)(Figure 3-5).

As a result of the bushfire prone status of the site, a Bushfire Management Plan (BMP) is required to accompany the TPS amendment application to address the following requirements of State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7), namely Policy Measure 6.3:

- a bushfire hazard level (BHL) assessment or where lot layout is known, a Bushfire Attack Level (BAL) contour assessment to determine the indicative acceptable BAL ratings across the site
- identification of any bushfire hazard issues arising from the above assessment
- assessment against the bushfire protection criteria requirements contained within the Guidelines demonstrating compliance can be achieved in subsequent planning stages.

A BMP will be prepared by JBS&G as part of the LSP submission in accordance with Guidelines for Planning in Bushfire Prone Areas (WAPC, State Planning Policy 2.8: Bushland Policy for the, 2010). The BMP will includes consideration of environmental values and therefore bushfire management has not been discussed further in this report.

3.11 Heritage

3.11.1 Indigenous heritage

The *Aboriginal Heritage Act 1972* (DPLH, 1972) aims to protect Aboriginal heritage by registering Aboriginal sites (places and/or objects) that are of cultural importance to Aboriginal people. Any proposal to use or alter an area of land, for purposes such as research or development, must first determine if Aboriginal sites occur within the proposed area. If an Aboriginal site is found to occur, permission must be sought from the Minister for Aboriginal Affairs before that land can be used or altered in any way.

A search of the Department of Planning, Lands and Heritage – Aboriginal Heritage Places mapping tool found no registered Aboriginal heritage sites within or immediately adjacent to the site (DPLH D. o., Aboriginal Heritage Places, 2019). However, one mythological site, Site 3427 (Mandogalup Swamp / Spectacles) occurs across the majority of the northern half of the site.

Due to Site 3427's status as "Stored Data / Not a Site", protection is not afforded to the site under Schedule 5 of the *Aboriginal Heritage Act 1972*.

3.11.2 European heritage

A search of the Heritage Council of Western Australia's *InHerit* database not identify any European heritage places within the site (SHC, 2016) The nearest European heritage listed place is "Mandogalup school – site of" (Place no. 12100) which is located approximately 660 m south west of the site.

Figure 3-5:Bushfire Prone Areas



Legend

- Project area
- Bushfire prone areas (OBRM-019)
- Highway
- Minor road

Scale: 1:5,000 at A4 (0, 50, 100 metres)		**Hoffman Road Mandogalup, WA**
Coord. Sys. GDA2020 MGA Zone 50		**BUSHFIRE PRONE AREAS**
Job Number: 66402		
Client: Satterley Property Group		**FIGURE 3.5**
Version: A	Date: 27-Feb-2024	JBS&G
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Image Reference: www.nearmap.com© - Imagery Date: 31 January 2024.

3.12 Vegetation and flora

3.12.1 Desktop Assessment

3.12.1.1 Pre-European Vegetation

The National Objectives and Targets for Biodiversity Conservation 2001-2005 recognises that a retention of 30% or more of the pre-clearing (termed pre-European) extent of each ecological community is necessary if Australia's biological diversity is to be protected (ANZECC, 2000). The Western Australian Environmental Protection Authority has previously adopted the ANECC 30% retention target; however, under Position Statement No. 2, it also adopted a 10% level of the pre-clearing extent of vegetation that was regarded as being a level representing 'endangered' (EPA 2000)(Table 3.2).

The Position Statement has subsequently been replaced with the EPA's Environmental Factor Guideline (EPA, 2016b) which describes a more qualitative approach to biodiversity and no longer mentions percentage targets. Notwithstanding, State Planning Policy 2.8: Bushland policy for the Perth Metropolitan Region (2010) recognises the Perth Metropolitan Region as a 'constrained area' and establishes a target of 10% retention for each vegetation complex. The vegetation statistics available through the Government of Western Australia (2019) are based on this dataset in combination with the vegetation association and complex datasets (DPIRD, 2019) discussed further below.

Beard (Beard, 1990) Botanical Subdistrict

The site occurs within the Drummond Botanical Subdistrict, which is characterised by low *Banksia* woodlands on leached sands; *Melaleuca* swamps on poorly-drained depressions; and *Eucalyptus gomphocephala* (tuart), *Eucalyptus marginata* (jarrah) and *Corymbia calophylla* (marri) woodlands on less leached soils (Beard, 1990). Mapping undertaken by Beard indicates that the majority of the site is within vegetation association Bassendean 1001: Medium very sparse woodland, jarrah, with low woodland; *Banksia & Casuarina.*

IBRA subregion

The site occurs within the Swan Coastal Plain IBRA region and Perth subregion, which is dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains and paperbark (*Melaleuca*) in swampy areas (Heddle EM, 1980).

Vegetation associations

Regional vegetation was initially mapped at a broad scale by Beard (Beard, 1990). This dataset has formed the basis of several regional mapping systems, including physiographic regions defined by Beard; System 6 Vegetation Complex mapping undertaken by Heddle (Heddle EM, 1980); and the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia, IBRA) for Western Australia.

Vegetation complexes

System 6 mapping refers to vegetation mapping undertaken at a vegetation complex scale by Heddle et al. (1980). This is the primary source of information used to calculate potential impacts of proposals to clear native vegetation on the Swan Coastal Plain.

The site occurs within the Herdsman vegetation complex, which is described as vegetation dominated by sedgelands and woodland of *Eucalyptus rudis – Melaleuca* spp. with the species of *Melaleuca* depending on the local drainage and adjacent soils. This vegetation is associated with the series of swamps and small lakes on the Swan Coastal Plain. Other plants include species of *Typha, Baumea, Juncus, Leptocarpus* and *Cyperus.*

The pre-European and current extent of the Bassendean 1001 vegetation association and Herdsman Complex within the state, as well as the current extent within DBCA managed land is listed below in Table 3.2, based on the latest GIS-based estimate undertaken by DBCA (Government of Western Australia, 2019).

Table 3.2: Pre-European and current extent of vegetation association

Vegetation association/complex	Pre-European extent (ha)	Current extent (ha)	Percentage (%) remaining	Percentage (%) of current extent in DBCA managed lands
Bassendean 1001	53,283.54	11,394.19	21.38	15.72
Herdsman Complex	9,665.15	3,103.7	32.11	10.83

The current extent for Herdsman Complex and Bassendean 1001 vegetation association is well above the 10% threshold for constrained areas.

3.12.1.2 Conservation Significant Flora

Threatened flora is afforded protection under the BC Act at a State level, and under the EPBC Act at the Commonwealth level. Under the BC Act, taking of Threatened flora requires authorisation from the State Minister of Environment. Under the EPBC Act, approval is required from the Commonwealth Minister of Environment for significant impacts to Threatened flora. In addition, at a State level, the DBCA lists 'Priority' flora which are considered possibly threatened species that do not meet survey criteria or are otherwise data deficient.

A desktop assessment of Threatened and Priority Flora and/or communities potentially occurring within 3 km of the site was undertaken using the Department of Biodiversity Conservation and Attractions (DBCA'S) *Naturemap* database and the DCCEEW Protected Matters Search Tool (PMST). The assessment report (Appendix C) identified 11 flora taxa of conservation significance. Of these species, 8 species were listed as threatened under the EPBC Act or the BC Act. The remaining 3 flora taxa are priority listed flora species (

Table 3.4).

Following receipt of the database searches, habitat and flowering information was collated for the species identified as potentially occurring in the area, and a likelihood of their presence in the site was determined on the basis of habitat information and regional distribution as outlined in Table 3.3. Four taxa were considered likely to occur at the site, including three taxa listed as threatened under the BC Act or EPBC Act and one Priority flora taxa listed by DBCA:

- *Caladenia huegelii* (T);
- *Dodonaea hackettiana* (P4)*;*
- *Drakaea elastica* (T); and
- *Drakaea micrantha* (T).

3.12.1.3 Threatened and Priority Ecological Communities

A DBCA Threatened and Priority Ecological Community Database search (DPAW, 2016) also identified one threatened ecological community (TEC) within the site. In addition, one TEC and three priority ecological community (PEC) were identified within 5 km of the site (Table 3.3).

Table 3.3: Likelihood of occurrence assessment; categories and definitions

Likelihood	Definition
Present	The taxon has been recorded within the site
Likely	The site contains suitable habitat for the taxon and it is likely the taxon may occur based on presence of a recent historical record close (within 2.5 km) to the site.
Possible	The site contains suitable habitat for the taxon but there is no other information to suggest that the taxon may occur within or close to the site, or habitat information is lacking for the taxon
Unlikely	he site does not contain suitable habitat for the taxon, regional records suggest the taxon does not occur near the site1 , or the site contains suitable habitat for the taxon within which thorough targeted searches were completed and conclusion has been made that the taxon is unlikely to be present.
Absent	Habitats present within the site preclude the possibility of this taxon occurring. E.g. aquatic taxa at a site where no seasonally inundated areas occur.

Table 3.4: Conservation significant flora identified by database searches and their likelihood of presence in the site

Species	EPBC Act	BC Act	Description	Likelihood Assessment
Andersonia gracilis	Endangered	Threatened	A slender shrub to 50 cm tall with few, spreading branches. Flowers are pink to pale mauve. Habitat for this species occurs within seasonally damp, black sandy clay flats near swamps (Western Australian Herbarium 1998-, DotE 2015). Species only known from the Badgingarra, Kenwick and Dandaragan areas where it is found on seasonally damp, black sandy clay flats near or on the margins of swamps; often on duplex soils supporting low open heath vegetation with species such as *Calothamnus hirsutus*, *Verticordia densiflora* and *Kunzea recurva* over sedges (DotE 2015).	**Unlikely** due to absence of preferred habitat
Caladenia huegelii	Threatened – Endangered	Threatened	A slender orchid from 30 to 50 cm tall. One or two striking flowers characterised by a greenish-cream lower petal with a maroon tip. Other petals are cream with red or pink suffusions. Habitat for this species occurs within well-drained, deep sandy soils in low mixed *Banksia*, *Allocasuarina* and Jarrah woodlands (Western Australian Herbarium 1998-, DoEE 2018b).	**Possible** due to presence of preferred habitat.
Diuris micrantha	Threatened – Vulnerable	Threatened	A slender orchid to 60 cm tall. Yellow flowers with reddish-brown markings measuring 1.3 cm across. Habitat for this species occurs within clay-loam substrates in winter-wet depressions or swamps.	**Unlikely** due to absence of preferred habitat.
Diuris purdiei	Threatened – Endangered	Threatened	A slender orchid to 0.35 m tall. Flowers are yellow and visible from September to October. Habitat for this species is grey-black sand substrates in winter-wet swamps which have high moisture (Western Australian Herbarium 1998-). Diuris purdiei occurs from Perth south to near the Whicher Range, within the Swan (Western Australia) Natural Resource Management Region. It grows on sand to sandy clay soils, in areas subject to winter inundation, and amongst native sedges and dense heath with scattered emergent *Melaleuca preissiana*, *Corymbia calophylla*, *E. marginata* and *Nuytsia floribunda* (DoEE 2017b).	**Unlikely** due to absence of preferred habitat.
Dodonaea hackettiana	-	P4	An erect shrub or tree, 100 to 500 cm tall. Flowers are yellow to green/red and occur mainly from July to October. Habitat for this species occurs in sand and outcropping limestone (Western Australian Herbarium 1998-).	**Possible** due to presence of preferred habitat.
Drakaea elastica	Threatened – Endangered	Threatened	A slender orchid to 30 cm tall with a prostrate, round to heart shaped leaf. Singular, bright green, glossy flower. The species grows on bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps, typically in banksia (*Banksia menziesii*, *B. attenuata* and *B. ilicifolia*) woodland or spearwood (*Kunzea glabrescens*) thicket vegetation. *D. elastica* often occurs with other orchid species (DoEE 2017b).	**Possible** due to presence of marginal habitat (Banksia woodland).
Drakaea micrantha	Threatened – Vulnerable	Threatened	A tuberous, terrestrial herb which has a diminutive red and yellow flower, 1.2–2.5 cm long, on a stem that grows to 30 cm. Flowering occurs form September to October. Its heart-shaped leaf, about 1.5 cm long, is silvery grey with prominent green veins. Habitat for this species occurs within cleared firebreaks or open sandy patches that have been disturbed, where competition from other plants has been removed (Western Australian Herbarium 1998-, DoEE 2017b).	**Possible** due to presence of preferred habitat.
Eleocharis keigheryi	Threatened – Vulnerable	Threatened	A rhizomatous, tufted/clumped perennial herb, reaching a maximum diameter of 40 cm. It has erect, smooth, green stems that are 20–40 cm tall and hollow, supporting cross bars that are 2 mm in diameter. This species grows in small clumps in a substrate of clay or sandy loam. This species is emergent in freshwater creeks, and transient waterbodies such as drainage lines and claypans in water to approximately 15 cm deep. Fringing woodland species and associated species include Swamp Sheoak (*Casuarina obesa*), Flooded Gum (*Eucalyptus rudis*), Red Robin Bush (*Melaleuca lateritia*), Swamp Paperbark (*M. rhaphiophylla*), Common Spike-sedge (*Eleocharis acuta*), *Aponogeton hexatepalus*, Veined Swamp Wallaby Grass (*Amphibromus nervosus*) and herbs such as *Wurmbea*, *Tribonanthes* and *Leptocarpus* spp. (Western Australian Herbarium 1998-, DoEE 2017b).	**Unlikely** due to absence of preferred habitat and associated species.

Lepidosperma rostratum	Threatened – Endangered	-	A rhizomatous sedge to 30 cm in diameter. Stems are circular in cross section and flowers are spike-like and up to 4 cm long. Habitat for this species occurs in sandy soils among low heath comprised of *Banksia telmatiaea* and *Calothamnus hirsutus* in winter-wet swamps (Western Australian Herbarium 1998-, DoEE 2017b).	**Unlikely** due to absence of preferred habitat and associated species.
Pimelea calcicola	-	P3	An erect to spreading shrub to 1 m tall. Flowers are pink and visible between September to November. Habitat for this species occurs in sand on coastal limestone ridges (Western Australian Herbarium 1998-).	**Unlikely** due to absence of preferred habitat.
Stylidium paludicola	-	P3	Reed-like perennial, herb, 35 to 100 cm tall. Leaves are tufted, linear or subulate or narrowly oblanceolate. Flowers are pink and occur in October to December. Habitat for this species occurs in peaty sand over clay and winter wet areas, often in Marri and Melaleuca woodland or Melaleuca shrubland (Western Australian Herbarium 1998-).	**Unlikely** due to absence of preferred habitat and associated species.
Banksia woodlands of the Swan Coastal Plain	Endangered	Various listings; encompasses multiple state-listed TECs and PECs	Banksia dominated woodlands of the Swan Coastal Plain Bioregion	**Unlikely.** Not mapped within the site.
Limestone ridges (SCP 26a)	NA	Endangered	*Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges	**Unlikely.** DBCA maps the site within 5 km.
SCP21c	NA	Priority 3	Low lying *Banksia attenuata* woodlands or shrublands	**Unlikely.** DBCA maps the site within 5 km.
SCP22	NA	Priority 3	*Banksia ilicifolia* woodlands	**Unlikely.** DBCA maps the site within 5 km.
SCP24	NA	Priority 3	Northern Spearwood shrublands and woodlands	**Unlikely.** DBCA maps the site within 5 km.

3.12.2 Site Surveys

To date, four flora and vegetation surveys within the development area and are described in Table 3.5.

Table 3.5: Previous flora and vegetation surveys

Reference	Description
RPS (2009)	A level 2 flora survey was undertaken in accordance with EPA Guidance Statement No. 51 (EPA 2004) in Spring of 2004 and 2006, and Autumn of 2007 (RPS, 2009)
Woodman (2014)	A 2013 targeted Threatened flora survey (Woodman, 2014)
Strategen (2017)	A reconnaissance flora and vegetation survey (Appendix F)c (Strategen S. E., 2017)
Strategen (2018a)	A flora and vegetation survey undertaken for the site and surrounding area according to EPA technical guidance (EPA 2016)(Appendix D) (Strategen, 2018a)

It should be noted that the RPS level 2 survey area was 232 ha in size and included not only the site and wider MELSP area but also land to the east of Kwinana Freeway in the suburb of Wandi.

Strategen-JBS&G Site Assessment

The most recent flora and vegetation study of the site was conducted by Strategen in 2018, the results of which are detailed in Appendix F. It should be noted that the survey was undertaken to support the Lifting of Urban Deferment under the MRS (MRS amendment 1350/27) and that the survey area was 65.5 ha in size and

included not only the site but Qube's landholdings, which formed the northern portion of MRS amendment 1350/27.

Assessment of significant tree

Arbor logic (Arbor Logic, 2017) completed an assessment of significant trees (Diameter at Breast Height [DBH] greater than 500mm) across the site. The assessment responds to the City of Kwinana Local Planning Policy No.1 *Landscape Feature and Tree Retention* and in addition assessed the structural integrity and viability of retaining individual trees within the site. A total of 125 trees were assessed as having a retention value of "very low", "low", "medium" or "high". The retention value was based on an assessment of health and/or structural integrity.

3.12.2.2 Vegetation type

Within the site, a total of two native vegetation types (VT's) (Table 3.1) were defined and mapped which are summarised below in Table 3.6. Areas containing vegetation in a highly degraded state have not been counted as unique native VTs but have been included in Table 3.6 for area calculation purposes. Total areas occupied within the survey area by each of the identified VTs are set out in.Table 3.6. Vegetation types recorded within the survey area do not resemble any known TECs or PECs

Table 3.6: Vegetation types

Vegetation Type	*Description*	Area (ha) within site	% of site
1	*Eucalyptus rudis* and *Melaleuca rhaphiophylla* woodland over *Pteridium esculentum*, **Zantedeschia aethiopica*, **Phytolacca octandra* and **Gomphocarpus fruticosus* low shrubland over introduced grasses and herbs including **Ehrharta calycina*, **Cynodon dactylon* and **Cirsium vulgare*. This VT aligns with the Herdsman Complex.	4.07	10.72
2	*Eucalyptus rudis* and open woodland over *Pteridium esculentum* shrubland over introduced grasses including **Ehrharta calycina and *Avena barbata.* This VT aligns with the Herdsman Complex.	1.00	2.63
Cleared	Historically cleared area containing introduced grasses including **Eragrostis curvula* and **Ehrharta calycina* on sandy soils	32.91	86.65
Total		**37.98**	**100**

The total area mapped within the survey area was 37.98 ha which includes highly degraded and fully cleared areas (Table 5). The dominant VT2 within the survey area was VT 1 (4.07 ha) which can be broadly described as Eucalyptus rudis and Melaleuca rhaphiophylla woodland over Pteridium esculentum,*Zantedeschia aethiopica, **Phytolacca octandra* and **Gomphocarpus fruticosus* low shrubland over exotic species including *Ehrharta calycina, **Cynodon dactylon* and *Cirsium vulgare on sandy soils (Strategen, 2018a)

3.12.2.3 Vegetation Condition

As a result of long-term degradation of the site associated with intensive agricultural use, the entirety of the site has been classified as Completely Degraded (Keighery, 1994). Degrading factors across the site include:

- livestock grazing;
- weed invasion; and
- clearing of remnant vegetation.

Figure 3-6: Vegetation Types



Legend

- Project area

Vegetation type

- VT1
- VT2
- Cleared
- Highway
- Minor road

Scale: 1:5,000 at A4 (0, 50, 100 metres)	**Hoffman Road Mandogalup, WA**
Coord. Sys. GDA2020 MGA Zone 50	**VEGETATION TYPES**
Job Number: 66402	
Client: Satterley Property Group	**FIGURE 3.6**
Version: A — Date: 27-Feb-2024	JBS&G
Drawn By: ianandagoda — Checked By: MDruck	

File Name: C:\Users\ianandagoda\JBS&G Australia\JBS&G - DCS - Internal - Documents\Projects\Satterley Property Group\Mandogalup\66402_Mandogalup_EAR\GIS\02_MapProjects\66402_EAR_R01\66402_EAR_R01.aprx
Image Reference: www.nearmap.com© - Imagery Date: 31 January 2024.

3.12.2.4 Flora

Native flora

A total of 40 native vascular plant taxa from 36 plant genera and 20 plant families were recorded from quadrats within the survey area. The majority of taxa were recorded within the Fabaceae (seven taxa) and Myrtaceae (four taxa) families (Strategen, 2018a). The relatively low number of plant genera recorded reflects the disturbed nature of the survey area.

Conservation significant flora

No Threatened flora species as listed under section 178 of the EPBC Act or pursuant to section 19 of the BC Act as listed by DBCA were recorded within the site. No Priority flora species as listed by the Western Australian Herbarium (Herbarium, 1998) were recorded within the site.

Introduced (exotic) taxa

A total of 18 introduced (exotic) taxa were recorded within the survey area:

- *Arctotheca calendula*
- *Briza maxima*
- *Carpobrotus edulis*
- *Carthamus lanatus*
- *Conyza bonariensis*
- *Crassula glomerata*
- *Ehrharta longiflora*
- *Euphorbia terracina*
- *Gladiolus caryophyllaceus*
- *Hypochaeris glabra*
- *Lysimachia arvensis*
- *Oxalis pes-caprae*
- *Phytolacca octandra*
- *Poaceae sp.*
- *Romulea rosea var. australis*
- *Solanum nigrum*
- *Ursinia anthemoides*
- *Zantedeschia aethiopic*

One weed species that was identified during the vegetation survey, *Zantedeschia aethiopica* is a Declared Plant species in Western Australia pursuant to section 22 of the BAM Act. This species typically requires regular and ongoing weed control.

Significant trees and landscape strategy

Significant trees were surveyed across the site by Arborlogic in March and October 2016 (the findings of which are summarised in Appendix F). The assessment involved traversing the survey area on foot, identifying significant trees and tagging these trees with a metal plate containing an ID number. All trees on the survey area were visually inspected from ground level. Any tree found to have a DBH of 500mm or greater (significant tree) was subsequently included in the assessment. The GPS coordinates of each significant tree (MGA Zone 50) and any comments deemed pertinent to the tree were recorded.

The details of each significant tree were also recorded, including:

- Species;
- Physical size;

- Health condition;
- Structural condition;
- Hollows (>10 cm in diameter);
- Tree protection zone (TPZ) and Structural Root Zone (SRZ) based on AS4970 and AS4373); and
- Suitability for retention in a residential development.

All of these trees were assessed in accordance with visual tree assessment ("VTA") methods and principles adopted by Abor logic. The VTA method is based on the science of tree biology, physiology, tree structure and tree biomechanics and is widely used to identify visible signs on trees that indicate any health or potential structural issues that in turn could increase the risks associated with the given tree.

Tree health

The overall health of each tree was adjudged from an inspection of its leaf, overall percentage of leaf mass within the canopy of the tree and the presence (or absence) of any pest or disease factor that could have an effect on the overall health of the tree. The tree health rating scale used by Arbor logic is presented in Table 3.7.

Table 3.7: Tree health rating scale utilised during the survey

Health rating	Description of classification
Excellent	Shows to have typical foliage condition and amount of foliage mass for a specimen of the species. May have a minor amount of deadwood, but no signs of any pest or disease factor that may affect its health.
Good	Shows to have typical foliage condition. Canopy foliage may be slightly chlorotic, or it may have a slightly higher percentage of deadwood than usual, or exhibit signs of being affected by environmental conditions. May have a minor pest or disease present that could start to affect its health.
Fair	Shows to have a relatively high percentage of deadwood than considered typical for a specimen of the given species and/or a low volume of live canopy leaf mass for a specimen of the given species. Apical sections of the canopy (may also be) dead. Signs of a pest or disease factor evident.
Poor	Has a high percentage of deadwood material in its canopy and a low volume of live canopy mass (typically <20%).
Dead	Shows to have either no live tissue within its structure, or at best has <5% live foliage mass remaining in its canopy.

Structural condition

The structural integrity of each tree was determined from a visual inspection of its main stem, primary (and secondary) branch unions to determine the presence of any areas considered to be a structural 'defect' or 'imperfection' such as unions with included bark, swelling, or noticeable splitting at them.

Symptoms of decay, growth patterns and defects are identified and assessed in terms of their potential to cause failure of the whole tree, part of the tree or branches. Where considered necessary, further investigation using sounding techniques was utilised to determine the presence and general extent of any areas of cavity or associated decay within a tree's main stem structure.

The tree's root plate area was also inspected to identify any visible signs of root plate, movement, cracking or heave from which a determination of the in-ground stability of the tree can be ascertained. It is important to note that there are limitations in verifying the in-ground stability of a tree based on a "one-off" cursory visual observation; particularly in a forest type habitat where ground cover and leaf litter prevent or limit visual observations, particularly if the inspection is undertaken during a period of 'fine' weather with little to no wind (as was the case over the period of this assessment).

The tree structure rating scale used by Arbor logic (Arbor Logic, 2017) is presented in Table 3.8

Table 3.8 Tree structure rating scale utilised during the survey

Structure rating	Description of classification
Good	Shows typical structural form for a specimen of the species. Branch unions show typical form at the point of attachment. May have a small number of minor structural defects, but are within the scope of tree surgery management to rectify. Shows to be root-stable.
Acceptable	Shows an acceptable form, but may have a number of structural defects present i.e. bi-furcation (but with no major swelling or movement), or areas of stem cavities. Structure remains within the scope of management at this stage, albeit with a higher risk/management requirement. Can include previously lopped trees that are known to have good points of attachment of any regrowth that occurs.
Questionable	Shows an undesirable structure for a specimen of the species. Structural condition likely to cause future issues in regard to the potential for branch or even complete tree failure to occur. Generally includes previously lopped trees, trees with large areas of cavity and/or associated decay that may be starting to affect its structural integrity, trees with bi-furcated unions with notable bark and swelling that are considered to have an increased potential to fail.
Poor	Major structural defects evident. May have very large stem cavities, extensive termite damage, or noticeable movement in main stem, branch unions or root plate area.

Suitability for retention in the development

Suitability of each tree for use in an urban area, with consideration of the species traits, was also identified. Species that can be subject to sudden branch failure or known to be potentially problematic in terms of self-sowing (weed) issues were also considered as part of the assessment process.

The known root zone morphology of the species was considered when allocating the recommended TPZ for each of the identified trees. The ability of a tree to cope with disturbances to its root zone that typically occur as part of a development process, as well as its ability to cope with the new parameters that are commonly created by an urban development (i.e. decreased soil oxygen due to compaction, increased unseasonal watering from irrigation, increased pollution, increased radiated heat/light from urban infrastructure such as roads, walls, buildings) were all also taken into consideration.

The following classification was used during this assessment for retention value of the significant trees identified (Table 3.10). Of the 125 significant trees identified during the survey, 76 have been identified for retention within streetscaping and POS, of which the majority are classified as having either a High or Medium retention value, and which include 41 Black Cockatoo significant trees (Figure 3-7; **Error! Reference source not found.**).

Table 3.9: Significant trees proposed to be retained within POS

Retention Value	Number of trees proposed to be retained
High	17
Medium	28
Low	10
Very Low	21
Total	**76**

Table 3.10: Retention value classification used during arboriculture assessment

Retention value	Description of classification
High	Generally a good/very good specimen that shows good health, structural and aesthetic form. Trees with High retention value are generally strongly recommended to be retained as part of development and would be suitable for POS or even in some circumstances road reserves and/or lots depending on detailed design and ability to maintain/protect a sufficient area of its TPZ.
Medium	Reasonably good specimen of its species and worth retaining as part of development. These trees may have reduced health/vigour, or structural imperfections that (whilst within the realms and scope of management) may have higher management and maintenance requirements. Such trees are generally suitable for road reserves, POS or even lots depending on detailed design and ability to maintain/protect a sufficient area of its TPZ.
Low	Reasonable specimen. This typically includes trees that indicate a declining health or have structural imperfections that are assessed to be starting to affect the structural integrity of the tree. Retention of such trees within a road reserve or lot would not be recommended due to potential impact from development, and/or a risk management perspective. Low retention value trees may have high environmental benefits, but their structure may limit their potential for retention other than in areas of POS where the risks associated with the tree can then be better managed by way of good design.
Very Low	These are generally poor-quality trees that are typically suggested to be removed from a risk management perspective. Typically includes dead trees and trees with poor structural form that have a high probability of failure. Such trees may have high environmental benefit, but retention even within an area of open space would be highly questioned from a risk management perspective, unless design of the area around them was able to prevent potential targets from entering into their fall zone.

Figure 3-7: Significant trees retained withing POS



Legend

- Project area
- POS new
- High voltage powerline easement
- Highway
- Minor road

Scale: 1:5,000 at A4 (0, 50, 100 metres)

Coord. Sys. GDA2020 MGA Zone 50

Job Number: 66402

Client: Satterley Property Group

Version: A | Date: 17-May-2024

Drawn By: ianandagoda | Checked By: MDruck

Hoffman Road
Mandogalup, WA

SIGNIFICANT TREES RETAINED WITHIN POS

FIGURE 3.7

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3.13 Fauna and habitat

3.13.1 Desktop assessment

A desktop assessment of conservation significant fauna potentially occurring within 3 km of the site was undertaken using the DBCA's *Naturemap* database and the DoEE's *Protected Matters Search Tool* (DoEE, PBC Act Protected Matters Search Tool, [Online], Australian Government, 2018). The assessment report (Appendix C) identified 13 Threatened and four Priority fauna species which may potentially occur in the vicinity of the site. The search reports also identified the potential for one Internationally Protected fauna and one Specially Protected fauna to occur in the vicinity of the site. These species are listed in Table 3.11 along with a description of their preferred habitat and likelihood of occurrence within the site.

Based on the results of the database searches and consideration of each species preferred habitat types and available habitat within the site, the following species have been identified as potentially occurring within the site:

- *Calyptorhynchus banksii subsp. naso* (FRTBC; Forest Red-tailed Black Cockatoo) – Threatened;
- *Calyptorhynchus latirostris* (CBC; Carnaby'S Black Cockatoo) – Threatened;
- *Isoodon fusciventer* (Quenda) – P4;
- *Lerista lineata* (Perth Slider) – P3; and
- *Synemon gratiosa* (Graceful Sunmoth) – P4.

Table 3.11: Threatened and Priority fauna species potentially occurring within the survey area

Species	Conservation status		Description	Potential to occur
	EPBC Act	BC Act		
Botaurus poiciloptilus Australasian Bittern	Threatened - Endangered	Threatened	Species inhabits terrestrial wetlands and, rarely, estuarine habitats. It favours wetlands with tall, dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus) or cutting grass (Gahnia) growing over muddy or peaty substrate. A portion of the Proposal Area may provide habitat for this species during the winter wet season; however, the species has not been recorded in the area (Western Wildlife 2007). Due to their transient nature, and wide distribution (DotE 2013), the Australasian Bittern is not expected to be impacted by the proposed clearing and therefore is not discussed further. The Proposal is not expected to have a significant impact on this species.	**Possible** – low risk of significant impact
Calidris canutus (Red knot)	Threatened – Endangered	Threatened	Red Knots gather in large flocks on the coast in sandy estuaries with tidal mudflats.	**Unlikely.** The site is not on the coast, nor is suitable habitat present
Calidris ferruginea (Curlew Sandpiper)	Threatened – Critically Endangered	Threatened	The Curlew Sandpiper occurs on intertidal mudflats of sheltered coastal areas such as estuaries, bays, inlets and lagoons, in shallow waters. They also occur in non-tidal swamps, lakes and lagoons. They occur less often in inland areas such as	**Unlikely.** The site is not on the coast, nor is

			ephemeral and permanent lakes, dams, waterholes and bore drains.	suitable habitat present
Calyptorhynchus banksii subsp. naso (FRTBC; Forest Red-tailed Black Cockatoo)	Threatened - Vulnerable	Threatened	It inhabits the dense Eucalyptus marginate (Jarrah), E. diversicolor (Karri) and Corymbia calophylla (Marri) forests receiving more than 600mm of annual average rainfall (DSEWPaC 2012).	**Likely**. The site is within the known distribution (DSEWPC 2012).
Calyptorynchus baudinii (BBC; Baudin's Back Cockatoo)	Threatened – Endangered	Threatened	Baundin's Cockatoo occurs predominantly in jarrah, marri and karri eucalypt forests, and less frequently in woodlands and cleared urban areas. During breeding season they forage on banksia, hakea, and dryandra species. During non-breeding season they forage in marri forests. Breeding occurs predominantly in woodland or forest habitats, nesting in hollows of live or dead trees of karri, marri, wandoo and tuart (DSEWPaC 2012). They roost typically in eucalypt trees near permanent water sources.	**Unlikely.** The site is outside the known distribution of the species (DSEWPC 2012).
Calyptorynchus latirostris (CBC; Carnaby'S Black Cockatoo)	Threatened - Endangered	Threatened	Typically occurs in woodlands and scrubs of semiarid interior of Western Australia, in non-breeding season wandering in flocks to coastal areas, especially pine plantations and Banksia woodlands. Food includes the flowers, nectar and seeds of Banksia, Dryandra, Hakea, Eucalyptus, Corymbia, Grevillea, also seeds of Pinus.	**Likely.** The site is within the known distribution (DSEWPC 2012).
Dasyurus geoffroi (Western Quoll)	Threatened – Vulnerable	Threatened	Forest, mallee shrublands, woodland and desert. The densest populations have been found in riparian jarrah forest.	**Unlikely**. Outside of known distribution area and there is no jarrah forest on site.
Falco peregrinus Peregrine Falcon	-	Specially protected	The Peregrine Falcon may forage over the Proposal Area, and may nest on the Proposal Area in a tall tree. If the Peregrine Falcon is present in the Proposal Area, the Proposal Area would only be a part of a larger home range for a pair of birds (Western Wildlife 2007). The Proposal is not expected to have a significant impact on this species.	**Possible** – low risk of significant impact
Isoodon Fusciventer (Quenda)	-	P4	Quenda have a patchy distribution through the Jarrah and Karri forest, the Swan Coastal Plain. Scrubby, often swampy, vegetation with dense cover up to 1 m high, often feeds in adjacent forest and woodland that is burnt on a regular basis and in areas of pasture and cropland lying close to dense cover.	**Possible.** Suitable habitat is present within the site
Leipoa ocellata (Malleefowl)	Threatened - Vulnerable	Threatened	The Malleefowl occurs in shrublands and low woodlands dominated by mallee and acacia species. They favour environments with dense vegetation and require an abundance of leaf litter and a sandy substrate for breeding.	**Unlikely.** Suitable habitat not present
Lerista lineata (Perth Slider, Lined Skink)	-	P3	The restricted mainland habitat occupied by this species is pale sands (calcareous and siliceous) on coastal plains with Banksia and/or Eucalyptus, and coastal and low fixed dunes, supporting heathlands and shrublands, providing a well-developed patchy litter ground cover (Maryan et al. 2015)	**Possible.** Suitable habitat is present on site.
Myrmecobius fasciatus	Vulnerable	Threatened	Numbats inhabit areas of open woodland, dominated by Wandoo, with minimal undergrowth. They require an abundant supply of hollow Wandoo logs on the ground, which provide	**Unlikely**. No suitable habitat is

Numbat, Walpurti			plenty of protection and shelter, as well as a constant food supply of termites which attack the Wandoo. This habitat type is absent from the Proposal Area. The Proposal is not expected to have a significant impact on this species.	present within the site.
Numenius madagascariensis (Eastern Curlew)	Threatened – Critically Endangered	Threatened	The Eastern Curlew occurs on mudflats or sandflats associated with sheltered coastal areas, such as estuaries, bays, harbours, inlets and lagoons. They are also often recorded within mangroves and saltmarshes. The Eastern Curlew does not breed in Australia. In southern Western Australia, eastern curlews are recorded from Eyre, and there are scattered records from Stokes Inlet to Peel Inlet. The species is a scarce visitor to Houtman Abrolhos and the adjacent mainland and is also recorded around Shark Bay. It is also recorded on Norfolk Island and Lord Howe Island (Marchant & Higgins 1993).	**Unlikely.** The site is not situated on the coast, nor is suitable habitat present within the site.
Oxyura australis (Blue-billed Duck)	-	P3	The Blue-billed Duck is almost wholly aquatic, and is seldom seen on land. Non-breeding flocks, often with several hundred individuals, congregate on large, deep open freshwater dams and lakes in autumn. The Blue-billed duck occurs in freshwater to saline terrestrial wetlands (Birdlife Australia 2019).	**Unlikely.** There is no suitable habitat present within the site.
Pseudocheirus occidentalis (Western Ringtail possum)	Threatened – Critically Endangered	Threatened	There are three main areas known to, or previously known to, support large numbers of western ringtail possums. These three management areas are: • Swan Coastal Plain zone: Peppermint woodlands and Peppermint/Tuart forests on the southern extremity of the Swan Coastal Plain, principally around Busselton. • Southern Forest zone: Jarrah forests near Manjimup where Peppermint is generally absent. • South Coast zone: a diverse range of vegetation types between Denmark and Mount Manypeaks, but principally in near-coastal limestone heath, Jarrah Marri thicket woodland and forest, riparian, Peppermint woodland and Karri forest vegetation.	**Unlikely**. No suitable habitat occurs within the site.
Rostratula australis (Australian Painted Snipe)	Threatened - Endangered	Threatened	The Australian Painted Snipe occurs in shallow terrestrial wetlands, permanent and temporary lakes, swamps and claypans. They favour environments hosting tussocks of grass, sedges, rushes/reeds and samphire. They breed and nest in shallow wetlands with areas of bare wet mud and canopy cover nearby.	**Unlikely.** There are no wet areas present within the site, and no native vegetation surrounding the central minor waterway
Synemon gratiosa (Graceful Sunmoth)	-	P4	Sun-moths are most common in sedgelands, heathlands, woodlands and sometimes in open parts of the forest where their 'foodplants' (various grasses, sedges and mat-rushes) are found. Most sun-moths only breed on one or two plant species - their caterpillars are adapted to feed only on these particular plants. The graceful sunmoth breeds on two species of *Lomandra* mat-rushes (*L. maritima* and *L. hermaphrodita*).	**Unlikely.** No suitable habitat is present within the site
Tringa nebularia (Common Greenshank, greenshank)	-	IA	The Common Greenshank occurs across a range of inland wetland and sheltered coastal habitats. They forage at the edges of wetlands in soft muds and shallow waters, and along fringing vegetation such as sedges and saltmarsh.	**Unlikely.** Minimal suitable habitat is present within the

				site. What habitat is present has been classified as completely degraded.
Westralunio carteri (Carter's Freshwater Mussel)	Threatened - Vulnerable	Threatened	The Carter's Freshwater Mussel occurs in freshwater lakes, rivers and streams in sandy or muddy sediments. Greatest densities associated with exposed submerged tree roots (Eucalyptus rudis, Melaleuca spp. and others), woody debris and overhanging riparian vegetation near stream banks and edges of lakes/dams	**Unlikely.** No suitable habitat is present within the site
Apus pacificus Fork-tailed Swift	Migratory	-	The Fork-tailed Swift is a largely aerial species and the effect of the residential development on this species is likely to be negligible (Western Wildlife 2007). The Proposal is not expected to have a significant impact on this species.	**Likely**– low risk of significant impact
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	-	This species potentially utilises some sections of the site as part of a much larger home range. On this basis, the proposed clearing is likely to have minimal impact on this species.	**Likely**– low risk of significant impact
Ardea alba Great Egret, White Egret	Migratory	-	This species is likely to commonly visit the area in low numbers, particularly in winter when adjacent areas of pasture are flooded but the Proposal Area is unlikely to represent key habitat. On this basis, the proposed clearing is likely to have minimal impact on this species. The Proposal is not expected to have a significant impact on this species.	**Likely** – low risk of significant impact
Ardea ibis Cattle Egret	Migratory	-	This species may potentially infrequently visit the general area, however was not recorded in the Proposal Area during the most recent Birds Australia Atlas survey (Barrett 2003), nor are there any WA Museum records in the region. On this basis, the proposed clearing is likely to have minimal impact on this species.	**Possible** – low risk of significant impact
Calidris ruficollis Red-necked Stint	Migratory	-	The Red-necked Stint is mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. They sometimes use flooded paddocks or damp grasslands (Higgins & Davies 1996). This species may infrequently visit the Proposal Area, particularly in winter when adjacent pastures are flooded. On this basis, the proposed action is likely to have minimal impact on this species.	**Possible** – low risk of significant impact
Limosa limosa Black-tailed Godwit	Migratory	-	The Black-tailed Godwit has a primarily coastal habitat environment. There are a few inland records, around shallow, freshwater and saline lakes, swamps, dams and bore-overflows (Higgins & Davies 1996). This species may infrequently visit the Proposal Area, particularly in winter when adjacent pastures are flooded. On this basis, the proposed action is likely to have minimal impact on this species.	**Possible** – low risk of significant impact
Tringa glareola Wood Sandpiper	Migratory	-	The Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially *Melaleuca* and River Red Gums *Eucalyptus camaldulensis* and often with fallen timber. They also frequent inundated grasslands, short herbage or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops (Higgins & Davies 1996). This species is likely to	**Likely** – low risk of significant impact

			commonly visit the general area, particularly in winter when areas of adjacent pasture are flooded but is unlikely to rely on the habitat for survival. On this basis, the proposed clearing is likely to have minimal impact on this species.	
Tringa nebularia Common greenshank	Migratory	-	The Common Greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity, typically with large mudflats and saltmarsh, mangroves or seagrass. Habitats include embayments, harbours, river estuaries, deltas and lagoons and are recorded less often in round tidal pools, rock-flats and rock platforms. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and saltflats. The edges of the wetlands used are generally of mud or clay, occasionally of sand, and may be bare or with emergent or fringing vegetation, including short sedges and saltmarsh, thickets of rushes, and dead or live trees (Higgins & Davies 1996).	**Possible** – low risk of significant impact

3.13.2 Site survey

The following studies have been undertaken on fauna and habitat within the site:

- Level 1 fauna assessment (2007);
- Black Cockatoo habitat survey – Strategen (Strategen, 2013);
- Significant tree assessment (Arbor Logic, 2017); and
- Black Cockatoo hollow assessment (Strategen, Re-assessment of Hollows for Black Cockatoo Nesting – Mandogalup. Memo report prepared for Satterley Property Group, 2018b) (Appendix E).

Five fauna habitat types were recorded in the LSP area within properties for which access was provided. Excluding the substantial cleared and hardstand areas, the predominant fauna habitat identified during the LSP area surveys is scattered (introduced and native) trees, with localised areas of planted and maintained gardens

Black Cockatoos

Black cockatoos breed in large hollow-bearing trees, generally within woodlands or forests, from July to - December, or at any time of the year for the Forest Red-tailed Black Cockatoo (DCCEEW, 2022).

An estimated number and location of potential nesting trees. Potential nesting trees have a suitable diameter at breast height (DBH) to develop a nest hollow, but do not have hollows. For most species of trees, suitable nest hollows are only found in live trees with a DBH of at least 500 mm. Trees suitable to develop a nest hollow in the future are 300-500 mm DBH. Note that many species of eucalypt may develop suitable hollows for breeding (DCCEEW, 2022).

Carnaby's Black Cockatoos, listed as Endangered under the EPBC Act, feed on the seeds, nuts and flowers, of a variety of native and introduced plant species and insect larvae. Food plants generally occur within proteaceous genera such as Banksia, Hakea and Grevillea, Carnaby's Black Cockatoo are known to forage on eucalypt species in woodland areas. Carnaby's Black Cockatoos have also adapted to feeding on exotic species such as pines and cape lilac and weeds such as wild radish and wild geranium. Carnaby's Black Cockatoos usually breed between July and December in the hollows of live or dead eucalypts; primarily in Salmon Gum and Wandoo, but also within Jarrah, Marri and other eucalypt species (Johnstone, Kirkby, & and Sarti, 2013).

On the Swan Coastal Plain most nests are in Tuart. Eggs are laid on a mat of wood chips at the bottom of a large hollow (mostly top entry hollows) ranging from a few centimetres to 5 m deep.

Forest Red-tailed Black Cockatoos, listed as Vulnerable under the EPBC Act, depend primarily on Marri and Jarrah trees for both foraging and nesting. The seeds of both eucalypts are the favoured food source of the birds and hollows within live or dead individual trees are utilised for nesting purposes (Johnstone and Kirkby 2010). Breeding varies between years and occurs at times of Jarrah and Marri fruiting. These black cockatoos breed in woodland, forest or artificial nest boxes, but may also breed in former woodland or forest that has been reduced to isolated trees.

Baudin's Black Cockatoos, listed as Endangered under the EPBC Act, primarily occur in eucalypt forests and forage at all strata levels within the forests with a tendency to favour areas containing Marri (Johnstone, Kirkby, & and Sarti, 2013). Breeding generally occurs in the Jarrah, Marri and Karri forests of the southwest of Western Australia in areas averaging more than 600 mm of rainfall annually (Johnstone and Kirkby 2010).

The initial Black Cockatoo habitat survey was conducted for the site and wider MELSP area and included assessments of foraging habitat and breeding habitat within the survey area.

As an update to the 2013 survey, a significant tree assessment was conducted of the site in January 2017 with the purpose of informing the future development design (Arbor Logic, 2017). In accordance with the City of Kwinana Local Planning Policy No.1 any trees within the site with a Diameter at Breast Height (DBH) greater than 500 mm were included in the assessment.

Three tree species were identified within the site: Bangalay (*Eucalyptus botryoides*), Flooded Gum (*Eucalyptus rudis*), and Freshwater paperbark (*Melaleuca rhaphiophylla*). Of these, only *Eucalyptus rudis* is considered a potential breeding tree species. None of these species, nor any understorey species present at the site are known dietary items of Black Cockatoos.

A total of 91 potential breeding trees with a DBH greater than 500 mm were identified within the site, of which 22 were found to be dead with no live leaf mass remaining within their canopy. Six trees were identified to contain hollows that could potentially be used as habitat by Black Cockatoos (Figure 3-8).

Subsequent to this significant tree assessment, a re-assessment of tree hollows was undertaken by Strategen-JBS&G in November 2018 (Strategen, Re-assessment of Hollows for Black Cockatoo Nesting – Mandogalup. Memo report prepared for Satterley Property Group, 2018b)(Appendix E) with the purpose of assessing the suitability of the hollows previously identified. Based on measurements taken of the size of the hollow opening, height of the hollow from the ground, and angle of the hollow, none of the previously identified hollows were considered suitable for breeding by Black Cockatoos.

Two dawn and two dusk visits were also carried out to determine if the site was being used as a roost. No Black Cockatoos were seen or heard roosting at the site, and none were seen foraging or flying over (Strategen, Re-assessment of Hollows for Black Cockatoo Nesting – Mandogalup. Memo report prepared for Satterley Property Group, 2018b).

No roosting sites for either species of Black Cockatoo are mapped within the site boundary. The nearest confirmed roost is located approximately 1.5 km north-east of the site and has counted five Carnaby's Black Cockatoos and no Forest Red-tailed Black Cockatoos between 2010 and 2018.

Figure 3-8:Black Cockatoo Significant Trees



Legend

- Project area

Black Cockatoo significant trees

- Bangalay (*Eucalyptus botryoides*)
- Flooded Gum (*Eucalyptus rudis*)
- Freshwater Paperbark (*Melaleuca rhaphiophylla*)
- Highway
- Minor road

Scale: 1:5,000 at A4 (0, 50, 100 metres)		**Hoffman Road Mandogalup, WA**
Coord. Sys. GDA2020 MGA Zone 50		**BLACK COCKATOO SIGNIFICANT TREES**
Job Number: 66402		
Client: Satterley Property Group		**FIGURE 3.8**
Version: A	Date: 27-Feb-2024	JBS&G
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4. Potential impacts and proposed management measures

The potential impacts of urban development within the LSP area have been assessed based on the applicable policy considerations, receiving environment, potential impacts, management measures to be implemented, and the predicted outcomes.

Based on the findings of the desktop assessment, the following Key Environmental Factors are considered relevant to the proposal:

- Social surroundings;
- Vegetation and Flora;
- Fauna and Habitat;
- Hydrology;
- Acid Sulfate Soils; and

4.1 Social surroundings

4.1.1 Potential impacts

The major impact associated with the amendment to the LPS is a reduction in social amenity associated with traffic noise from Kwinana Freeway and railway noise from the Perth to Mandurah railway line. Impacts to the site are expected to be similar to that area covered by the MELSP, based on the results of a Road and Railway Noise Assessment (ATP, 2017).

4.1.2 Policy and management objectives

The EPA outlines a number of key considerations for social surroundings within the *Environmental Factor Guideline: Social surroundings.* Within the context of social surroundings, noise is of particular importance to this project. Key considerations for noise are outlined within State Planning Policy 5.4: Road and Rail Noise (SPP 5.4) (DPLH D. o., 2019b). These policies are discussed below, where relevant, with relation to the proposed development.

4.1.3 Proposed Management

The following management measures and proposed environmental scheme provisions have been identified to ensure potential impacts to social surrounds are appropriately managed as development progresses,

Table 4.1: Management measures for sensitive land uses

Parameter	Management measure	Timing/Responsibility
Reduce impacts to local traffic travelling on Rowley Road or Kwinana Freeway during construction	Development and approval of a Construction Environmental Management Plan (CEMP) as a condition of subdivision to incorporate environmental elements during pre-construction and during construction, including: • inductions and pre-start meetings to include noise and dust management; • environmental outcomes and performance indicators; • management measures and monitoring; • contingency response and corrective actions; and • reporting and review.	Prior to bulk earthworks and as a condition of subdivision. CoK / developer

Reduce impacts to social surrounds	Prior to local structure planning, undertake an acoustic assessment of the site to determine appropriate mitigation and management measures for the development. Any recommendations made as part of the assessment are to be implemented for the development as a condition of subdivision. These management and mitigation measures may include: • notification under certificate of title • specification of a type of dwelling to be constructed on noise affected allotments.	Local Structure Plan / subdivision stages Developer

4.1.4 Predicted Environmental Outcomes

Residual impacts to social surrounds will be managed through the implementation of the Construction Environmental Management Plan and detailed noise mitigation measures, which may include:

• notification under certificate of title

• specification of increased construction standards on noise affected allotments

4.2 Vegetation and Flora

4.2.1 Potential impacts

The major impacts associated with the development of the site for residential purposes include vegetation clearing. No threatened or priority flora species or ecological communities occur within the site.

The proposed clearing of up to 5.07 ha of native vegetation within the project area is highly degraded and is not considered of high conservation significance. The survey area has experienced significant modification due to historical clearing and agricultural land uses. The vegetation recorded within the survey area was highly degraded and did not resemble any TECs or PECs. No conservation significant species were recorded within the survey area. Vegetation condition within the survey area was mapped as Completely Degraded (Strategen, 2018a).

4.2.2 Policy and management objectives

Flora and Vegetation surveys that have informed planning for the site have been conducted in accordance with the Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016a) and the Environmental Factor Guideline: Flora and Vegetation (EPA, 2016b). The EPA outlines a number of key considerations for flora and vegetation within the Environmental Factor Guideline: Flora and Vegetation (EPA, 2016b), which are discussed below, where relevant, with relation to the proposed development.

4.2.3 Proposed Management

The following mitigation and management measures (Table 4.2) have been identified to ensure impacts to flora and vegetation are appropriately managed as development of the site progresses.

Table 4.2: Management measures for vegetation and flora

Parameter	Proposed scheme provisions / Management actions	Timing / responsibility
Protection of adjacent remnant vegetation	Development and approval of a Construction Environmental Management Plan (CEMP) as a condition of subdivision to incorporate environmental elements during pre-construction and during construction:	Prior to bulk earthworks and as a condition of subdivision. Developer in consultation with City of Kwinana

	• identification of potential threats/impacts and risks associated with construction activities within and adjacent to areas of remnant vegetation (i.e. dieback, fauna and habitat management) • clear demarcation of clearing areas • inductions and pre-start meetings to include fauna and vegetation management requirements GPS enabled earth moving equipment with approved clearing area maps to assist in avoiding conservation areas • installation of temporary fencing to prevent unauthorised access • environmental outcomes and performance indicators • management measures and monitoring • contingency response and corrective actions • reporting and review	
Tree retention	Develop a Landscape Feature and Tree Retention Plan as part local structure planning and in accordance with Local Planning Policy 1.1.	Prior to LSP. Developer in consultation with City of Kwinana.
	Where possible retention of significant trees within designated POS and streetscapes.	Prior to subdivision design. Developer in consultation with the City of Kwinana

4.2.4 Predicted Environmental Outcomes

No Threatened or Priority ecological communities were identified within the site. As such, none will be directly or indirectly impacted by the proposed development.

Up to 76 Significant trees will be retained throughout the development within designated POS and streetscapes where possible in accordance with the Significant Tree Assessment: Balance of MELSP (Arborlogic 2017), and in consultation with the City of Kwinana (Figure 3.7; Appendix A).

The proposed clearing of up to 5.07 ha of native vegetation within the project area is highly degraded and is not considered of high conservation significance (Strategen S. E., 2017).

All residual impacts to flora and vegetation will be managed through the implementation of the proposed CEMP and Landscape Feature and Tree Retention Plan.

4.3 Fauna and Habitat

4.3.1 Potential impacts

The proposal will result in direct and indirect impacts to terrestrial fauna as a result of:

- Clearing of up to 4.93 ha of native vegetation that provides habitat for an array of fauna
- Removal of Black Cockatoo significant trees, none of which contain hollows suitable for breeding.

No other conservation significant species are considered likely to be significantly affected by the Proposal.

4.3.2 Policy and management objectives

The EPA outlines a number of key considerations for terrestrial fauna within the Environmental Factor Guideline: Terrestrial Fauna (EPA 2016), which are discussed below, where relevant, with relation to the proposed development.

EPBC Approval

Development of the site was referred to the Department of Environment and Energy (DoEE, 2018) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) in July 2018 (EPBC 2018/8264) for potential impacts to Black Cockatoos.

The proposed action was subsequently determined to be not a controlled action, meaning the proposed action does not require further assessment and approval under the EPBC Act before it can proceed.

4.3.3 Proposed Management

The following management measures and proposed environmental scheme provisions have been identified to ensure potential impacts to terrestrial fauna are appropriately managed as development progresses (Table 4.3).

Table 4.3: Management requirements for terrestrial fauna

Parameter	Proposed scheme provisions / Management actions	Timing / responsibility
Fauna	Development and approval of a fauna management plan (FMP) as a condition of subdivision to ensure that impacts to fauna (including Black Cockatoos) are limited and no individuals are injured or killed during clearing works. The FMP will include site specific measures such as: • If clearing is proposed during the Carnaby's Black Cockatoo breeding season (July to November), then potential breeding trees are to be inspected by a suitably qualified ecologist prior to their removal • inductions and pre-start meetings to include fauna management requirements • restrictions on vehicle movements and access to cleared areas • pre-clearing fauna inspections, as well as trapping and relocation of fauna, if required, • staged fencing of site • new fauna desktop review and site survey required	Prior to subdivision. Developer in consultation with City of Kwinana.
Protection of adjacent remnant vegetation	Development and approval of a Construction Environmental Management Plan (CEMP) as a condition of subdivision to incorporate environmental elements during pre-construction and during construction: • identification of potential threats/impacts and risks associated with construction activities within and adjacent to areas of remnant vegetation (i.e. dieback, fauna and habitat management) • clear demarcation of clearing areas • inductions and pre-start meetings to include fauna management requirements GPS enabled earthmoving equipment with approved clearing maps • installation of temporary fencing to prevent unauthorised access • environmental outcomes and performance indicators • management measures and monitoring • contingency response and corrective actions • reporting and review	Prior to bulk earthworks and as a condition of subdivision. Developer in consultation with City of Kwinana
Tree retention	Develop a Landscape Feature and Tree Retention Plan as part local structure planning and in accordance with Local Planning Policy 1.1.	Prior to LSP. Developer in consultation with City of Kwinana.

	Where possible retention of Black Cockatoo habitat trees within designated POS and streetscapes.	Prior to subdivision design. Developer in consultation with the City of Kwinana

4.3.4 Predicted Environmental Outcomes

Considering the above, and mirroring EPBC approval 2018/8264, it is expected that there will be no significant direct, indirect or cumulative impacts to Black Cockatoos resulting from the proposed development.

A number of DBCA managed nature reserves are also present within the regional area which provide foraging and nesting habitat to Black Cockatoos (Figure 4-1).

All residual impacts to fauna will be managed through the implementation of the following environmental management plans:

- Construction Environmental Management Plan
- Fauna Management Plan
- Landscape Feature and Tree Retention Plan

Figure 4-1:Regional Conservation Areas



Legend

- Project area
- 10km buffer
- Bush Forever site (DPLH-022)

Legislated lands and waters (DBCA - 011)

- Conservation Park
- Crown Freehold - Dept Managed
- Nature Reserve
- Section 5(1)(h) Reserve
- Highway

Scale: 1:110,000 at A4 (0, 1, 2 Kilometres)	**Hoffman Road Mandogalup, WA**
Coord. Sys. GDA2020 MGA Zone 50	**REGIONAL CONSERVATION AREAS**
Job Number: 66402	
Client: Satterley Property Group	**FIGURE 4.1**
Version: A / Date: 27-Feb-2024	JBS&G
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4.4 Hydrology

4.4.1 Potential impacts

Surface water

While the site's pre-development and post-development surface water flows are to coincide in accordance with WAPC (WAPC, State Planning Policy 2.8: Bushland Policy for the, 2010) *Better Urban Water Management Guidelines*, the estimated surface water volumes are expected to increase through urbanisation within the precinct.

Groundwater

Residential development of the site will potentially increase recharge of rainfall into groundwater through increased surface area of residential roofs, driveways, car parks and roads. Also, the creation of residential gardens and POS areas may lead to a minor increase in the amount of nitrates and phosphates being discharged into the groundwater.

Mosquitoes and midges

The risk of mosquitoes breeding within the site is expected to be low because there are no permanent wetlands/water bodies on the site and future development will be designed to prevent standing water occurring for periods of greater than 96 hours. However due to the prevalence of low-lying dampland wetlands within the City of Kwinana including the Mandogalup area, and the medium risk of mosquito and midge habitat developing in low-lying areas near and within the Peel Main Drain there is a potential public health risk posed by mosquitoes and nuisance levels and impact upon amenity from midges

4.4.2 Policy and management objectives

The key principles and objectives for sustainable water management for the residential development is provided in the following:

- Liveable Neighbourhoods (WAPC, Liveable Neighbourhodds; a Western Australian Government sustainable cities initiative, 2009)
- Water Resources Statement of Planning Policy 2.9 (WAPC, 2006)
- Stormwater Management Manual for WA (DWER, 2022)
- Decision Making Process for Stormwater in Western Australia (DWER, Decision process for stormwater management in Western Australia, 2017)
- Interim: Developing a Local Water Management Strategy (DoW, Interim: Developing a local water management strategy, 2008)
- Mandogalup District Water Management Strategy (JDA, 2011).
- Florence Estate, Mandogalup Stages 12 to 19 – Local Water Management Strategy (JDA, Florence Estate, Mandogalup Stages 12 to 19 – Local Water Management Strategy, unpublished report prepared by JDA for Satterley Property Group, 2024)

The Peel Main Drain has been identified as a significant surface water feature running along the southern boundary of the site. The *Jandakot drainage and water management plan: Peel main drain catchment* (DoW, 2009), outlines specific management provisions for land development within the Peel main drain catchment area, including that which states that extensive modification of existing waterways is generally not supported. Modifications may be proposed however future development will be required to ensure the ability of streamlines to safely contain flow, and subsequently the overall drainage network concept.

The following Department of Health guidelines (DoH, 2020) will be used to guide future management of mosquitoes and midges:

- *A guide to developing management for Local Government – Part A Template and guidance notes*
- *A guide to developing management for Local Government – Part B Case study examples.*

4.4.3 Proposed Management

Management measures have been identified to assist in achieving the hydrology management objectives (Table 4.4)

Table 4.4: Management measures for hydrology

Parameter	Proposed scheme provisions / Management actions	Timing / Responsibility
Groundwater and surface water	A Local Water Management Strategy has been prepared to support the LSP which: • Provide a stormwater management framework to support future residential development for the proposal area • Incorporate appropriate best management practices into the drainage systems	As part of local structure planning. Developed in consultation with DWER
	Development and approval of an Urban Water Management Plan as a condition of subdivision including: • Water management outcomes and performance indicators • Risk assessment and management measures • Monitoring • Contingency response and corrective actions • Report and review	Prior to development commencing and as a condition of subdivision. Developed in consultation with the City of Kwinana
Mosquitoes and midges	Development of a Mosquito and Midge Management Plan as a condition of subdivision, which will include: • A strategy of implementation of physical controls to eliminate risk of breeding on the site at project design • determine an appropriate monitoring program and remedial actions for mosquito control in accordance with the CoK's specifications (Coordinator Environmental Health and Waste Services, 2018 pers comm) • a public education strategy to ensure that residents implement personal preventative measures that reduce the risk of being bitten.	Prior to development commencement and as a condition of subdivision. Developed in consultation with the City of Kwinana.

4.4.4 Predicted Environmental Outcomes

Considering the above, it is not expected that the proposed development of the site will result in significant direct, indirect, or cumulative impacts to hydrology within the site.and it is not expected that the proposed development will result in significant public health risks posed by mosquitoes and nuisance levels and impact upon amenity from midges

Potential impacts to hydrology will be addressed at the Local Structure Plan and Subdivision stages of development through preparation of an LWMS and DWMP respectively, and mitigated through the implementation of best practice urban water management.

4.5 Acid sulfate soils

4.5.1 Potential impacts

A desktop analysis undertaken by RPS (RPS, 2009) indicates that the majority of the site has been mapped as having a Moderate to High (Class 1) ASS disturbance risk within 3 m of the soil surface, while the remainder of the site has been mapped as having a Low to Moderate (Class 2) ASS disturbance risk.

4.5.2 Policy and management objectives

To ensure that the subdivision and development of land containing ASS is planned and undertaken in accordance with the DER (DER, 2015) *Treatment and management of soils and water in acid sulfate soil landscapes*.

4.5.3 Proposed Management

Management measures have been identified to assist in achieving acid sulfate soil objectives (Table 4.5).

Table 4.5: Management requirements for ASS

Parameter	Proposed scheme provisions / management actions	Timing / Responsibility
ASS	Confirm if dewatering below the water table or the excavation of more than 100 m3 is required as part of earthworks fir future development prior to subdivision.	Prior to subdivision and earthworks commencing within the proposal. Developer.
	Development and approval of an ASS Management Plan as a condition of subdivision that includes: • Potential environmental impacts – groundwater drawdown, disruption to existing bore users, vegetation stress, reduction in water quality, noise and air impacts; • Earthwork strategy – soil extraction methods, stockpile management, soil treatment / neutralisation, calculated liming rate and disposal techniques • Dewatering strategy – procedure and control measures, treatment and disposal options, contingency measures if acidification of groundwater occurs • Monitoring program including soil management, groundwater management, noise control and dust control.	Prior to bulk earthworks commencing on site and as a condition of subdivision. Developer.

4.5.4 Predicted Environmental Outcomes

Through the implementation of the management recommendations outlined in, the quality of land and soils can be managed during construction.

4.6 Potential contamination and future land uses

4.6.1 Potential impacts

Based upon the results of the Detailed Site Investigation (DSI) (Cumming, 2017), no further investigations to characterise soil, groundwater and/or surface water contamination are deemed necessary. Management actions to ensure the ongoing protection of human health and the environment are outlined below.

4.6.2 Policy and management objectives

To ensure that the subdivision and development of land is planned and undertaken in accordance with DER (DWER, 2021) *Assessment and management of contaminated sites*

4.6.3 Proposed Management

Management measures have been identified to assist in achieving the potential contamination and future land uses objectives (Table 4.6).

Table 4.6: Management measures for potential contamination

Parameter	Proposed scheme provisions / Management actions	Timing / Responsibility
Potential contamination	Development and approval of a Construction Environmental Management Plan (CEMP) to address recommendations provided in the DSI, as per Auditor Advice (Senversa 2016) including: • Provisions for routine inspection of onsite soils for signs of discolouration, odours and other noticeable signs of contamination throughout the duration of site preparation and construction works • Contingency measures in the event that any soils show signs of contamination, including: o Confirmatory sampling, analysis and assessment and; o If any soils are confirmed as unacceptably contaminated, development of appropriate management measures in conjunction with an appropriately qualified environmental scientist.	Prior to bulk earthworks and as a condition of subdivision. City of Kwinana / Developer.

4.6.4 Predicted Environmental Outcomes

Based on the results of the DSI, there are not expected to be any limitations or constraints on the proposed development of the site. All risks and uncertainties are expected to be effectively managed through the implementation of the Construction Environmental Management Plan.

4.7 Bushfire management

As a result of the bushfire prone status of the site, a Bushfire Management Plan (BMP) is required to accompany the scheme amendment application to address the following requirements of State Planning Policy 3.7 Planning in Bushfire prone areas (SPP 3.7), namely, Policy Measure 6.3:

- A bushfire hazard level (BHL) assessment or where lot layout is known, a Bushfire Attack Level (BAL) contour assessment to determine the indicative acceptable BAL rating across the site
- Identification of any bushfire hazard issues arising from the above assessment
- Assessment against the bushfire protection criteria requirements contained within the Guidelines demonstrating compliance can be achieved in subsequent planning stages.

A BMP will be prepared by JBS&G as part of the LSP submission in accordance with Guidelines for Planning in Bushfire Prone Areas (WAPC, State Planning Policy 2.8: Bushland Policy for the, 2010). The BMP will includes consideration of environmental values and therefore bushfire management has not been discussed further in this report

5. Conclusion

This report has been prepared to support the Local Structure Plan for the development of the Lot 9006, Lot 9002, Lot 11 and Lot 9000 in Mandogalup. This report provides a description of the environmental values present within and adjacent to the site proposed for residential development, a discussion of the potential impacts to those values, and how they will be managed.

The site has previously formed part of an EPBC referral, for which approval was provided with conditions in year (EPBC 2018/8264). The proposed development is not expected to result in significant impact to any environmental values, that have not already been subject to assessment under EPBC 2018/8264.

The avoidance and mitigation measures presented in this EAR and environmental management plans that will be prepared and implemented to support the Local Structure Plan will reduce the likelihood of unforeseen environmental impact through development. The environmental management plans that will be prepared to support subsequent planning stages that have been identified in this document will provide greater detail and specific implementation protocols including monitoring and reporting requirements and procedures.

6. Limitations

Scope of services

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

Reliance on data

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

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law 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, including to any third parties, and no liability will be accepted for use or interpretation of this report by any third party.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Concept Plan

LEGEND

- PUBLIC OPEN SPACE
- DBNGP EASEMENT
- HIGH VOLTAGE POWERLINE EASEMENT
- POWERLINE
- TRANSMISSION TOWER
- PEEL MAIN DRAIN
- INDICATIVE SUBDIVISION BY OTHERS

INDICATIVE SUBDIVISION BY OTHERS
- REF: **QUB MAN RD1 516 B**
- INDICATIVE QUBE LAYOUT TBC

TREE RETENTION DETAILS
- TREES TO BE RETAINED (COK 2016)
- SIGNIFICANT TREES (MEDIUM - HIGH RETENTION)
- SIGNIFICANT TREES (LOW RETENTION)
- SIGNIFICANT TREES (VERY LOW RETENTION)
- TREE PROTECTION ZONE

QUB MAN RD1 516 B

PUBLIC OPEN SPACE 6808m² (4)
PUBLIC OPEN SPACE 2437m² (3)
PUBLIC OPEN SPACE 8507m² (2)
6413m²
8311m²
6715m² (10)
1.63ha
8944m² (9)
1.49ha
PUBLIC OPEN SPACE 4529m² (13)
3941m² (12)
3112m² (11)
PUBLIC OPEN SPACE 1.12ha (1)
NOTIONAL SCHOOL SITE ONLY
SUBJECT TO FURTHER INVESTIGATION
4.00ha

ROAD TO BE CLOSED

KWINANA FREEWAY

HOFFMAN ROAD

SUBDIVISION CONCEPT PLAN

LOTS 9000, 9002 AND 9006 HOFFMAN ROAD
MANDOGALUP

DRAFT

N

0 125 m

SCALE @ A1: 1:2500

7282A-CON-36-J

DRAWN:	VR
DATE CREATED:	2024.04.17
PROJECTION:	PCG94
CADASTRE:	LANDGATE
SURVEY:	MNG 98728-028-G
AERIAL:	METROMAP 2023

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ROWE GROUP DESIGN

Appendix B EPBC 2018/8264

Notification of

REFERRAL DECISION – not controlled action

Residential Estate, Multiple Lots, Mandogalup, WA (EPBC 2018/8264)

This decision is made under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

Person proposing to take the action	Satterley Property Group Pty Ltd ACN: 009 054 979
proposed action	To clear approximately 5.07 ha of vegetation and develop approximately 37.98 ha of land for construction of a residential estate at Part Lots 9006, 9002 and 11 Hoffman Road, and Lot 9000, Mandogalup, 30 km south of Perth, WA [See EPBC Act referral 2018/8264].

Referral decision: Not a controlled action

status of proposed action	The proposed action is not a controlled action.

Person authorised to make decision

Name and position	Chris Videroni A/g Assistant Secretary Assessments (WA, SA, NT) and Post Approvals Branch
signature	
date of decision	18 December 2018

Appendix C Desktop assessment results (DBCA 2019;DoEE 2016)

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 23/07/2019

Conservation Status	Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only	Yes
Core Datasets Only	Yes
Method	'By Circle'
Centre	115° 50' 53" E,32° 11' 30" S
Buffer	3km
Group By	Kingdom

Kingdom	Species	Records
Animalia	8	108
Fungi	1	1
Plantae	5	16
TOTAL	**14**	**125**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Animalia					
1.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
2.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
3.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
4.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
5.	25147	*Lerista lineata (Perth Slider, Lined Skink)*		P3	
6.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
7.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	
8.	24808	*Tringa nebularia (Common Greenshank, greenshank)*		IA	
Fungi					
9.	48332	*Amanita preissii (Cinnamon-ring Lepidella)*		P3	
Plantae					
10.	1596	*Caladenia huegelii (Grand Spider Orchid)*		T	
11.	12938	*Diuris micrantha*		T	
12.	4763	*Dodonaea hackettiana (Hackett's Hopbush)*		P4	
13.	1639	*Drakaea elastica (Glossy-leaved Hammer Orchid)*		T	
14.	8163	*Pithocarpa corymbulosa (Corymbose Pithocarpa)*		P3	

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

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

Australian Government

Department of the Environment

EPBC Act Protected Matters Report

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

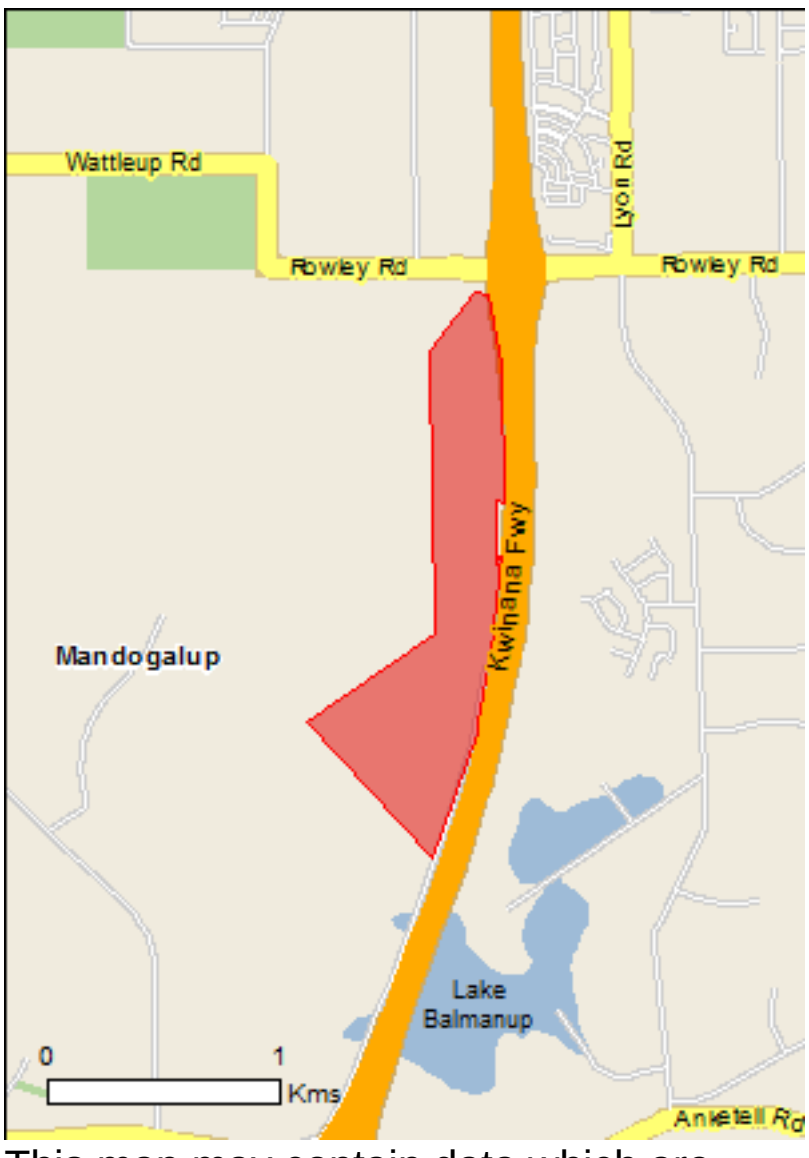
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

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

Report created: 23/09/16 17:04:06

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

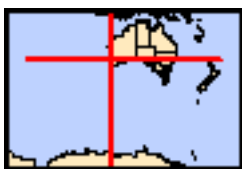
Caveat
Acknowledgements



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

Coordinates

Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	18
Listed Migratory Species:	17

Other Matters Protected by the EPBC Act

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

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

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

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	26
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine:	None

Extra Information

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

State and Territory Reserves:	6
Regional Forest Agreements:	None
Invasive Species:	42
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Forrestdale and thomsons lakes	Within Ramsar site
Peel-yalgorup system	30 - 40km upstream

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Baudin's Black-Cockatoo, Long-billed Black-Cockatoo [769]	Vulnerable	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Vulnerable	Species or species habitat likely to occur within area
Plants		

Name	Status	Type of Presence
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat known to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer-orchid, Praying Virgin [16753]	Endangered	Species or species habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	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
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Charadrius dubius Little Ringed Plover [896]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur

Name	Threatened	Type of Presence within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Charadrius dubius Little Ringed Plover [896]		Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Black-winged Stilt [870]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Species or species habitat known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Harry Waring Marsupial Reserve	WA
Modong	WA
Thomsons Lake	WA
Unnamed WA48291	WA
Unnamed WA49561	WA
Wandi	WA

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus		
House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus		
Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis		
Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis		
Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
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 aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		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
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within

Name	Status	Type of Presence
		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 sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Protasparagus densiflorus Asparagus Fern, Plume Asparagus [5015]		Species or species habitat likely to occur within area
Protasparagus plumosus Climbing Asparagus-fern, Ferny Asparagus [11747]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
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
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Gibbs Road Swamp System	WA
Spectacles Swamp	WA

Name	State
Thomsons Lake	WA

Caveat

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

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

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

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

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.

Coordinates

-32.183349 115.853858,-32.181423 115.855617,-32.181532 115.856089,-32.183784 115.856562,-32.188252 115.856733,-32.188215 115.856433,-32.190286 115.85639,-32.18985 115.856647,-32.193118 115.856218,-32.195443 115.855703,-32.195733 115.85566,-32.199837 115.853987,-32.195406 115.849094,-32.192574 115.854072,-32.183385 115.853858,-32.183385 115.853858,-32.183349 115.853858

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-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Atherton and Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Other groups and individuals

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Appendix D Flora and vegetation survey – Lifting of Urban Deferred Zoning Mandogalup



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Lifting of Urban Deferred Zoning - Mandogalup

Flora and Vegetation Survey

FINAL

Prepared for
Satterley Property Group and Qube Property Group
by Strategen

September 2018

strategen
ENVIRONMENTAL

Lifting of Urban Deferred Zoning - Mandogalup

Flora and Vegetation Survey

FINAL

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September 2018

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Client: Satterley Property Group and Qube Property Group

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
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1. Introduction

This report presents the findings of a detailed flora and vegetation survey undertaken for Satterley Property Group and Qube Property Group.

1.1 Background

Satterley Property Group and Qube Property Group are proposing to lodge a request to lift the balance of the Urban Deferred zoning at Mandogalup (Figure 1).

Vegetation and flora surveys and Targeted Priority and Threatened Flora survey have previously been completed by Carndo (2005) and Plantecology Consulting Conservation Act 1999 (EPBC) referral and subsequent approval (EPBC 2014/7126). This information was also submitted to the Environmental Protection Authority (EPA) as part of a lifting of urban deferment request. The EPA requested that a detailed Spring flora and vegetation survey be undertaken to determine the environmental values of remnant native vegetation within the project area.

1.2 Scope

The scope of this flora and vegetation survey was to undertake a desktop assessment and field assessment within the survey area (Figure 1).

The objectives were to:

- conduct a desktop survey for Threatened and Priority flora which have been identified as being present in or around the survey area
- collect and identify the vascular plant species present within the survey area
- search areas of suitable habitat for Threatened and/or Priority flora
- define and map the native vegetation communities present within the survey area
- map vegetation condition within the survey area
- provide recommendations on the local and regional significance of the vegetation communities
- prepare a report summarising the findings.



Figure 1: The survey area

Legend

Survey area

Cadastral boundary

N

Scale 1:7,500 at A4

0 100 200 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/09/2018

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2. Context

2.1 Legislative context

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

- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – Australian Government
- *Wildlife Conservation Act 1950* (WC Act) – State
- *Environmental Protection Act 1986* (EP Act) – State
- *Biosecurity and Agriculture Management Act 2007* (BAM Act) – State.

Non-legislative measures:

- WA Department of Biodiversity, Conservation and Attractions (DBCA) Priority lists for flora, ecological communities and fauna
- Weeds of National Significance
- Recognition of locally significant populations by the DBCA.

A short description of each is given below. Other definitions, including species conservation categories, are provided in Appendix 1.

2.1.1 EPBC Act

The EPBC Act aims to protect matters of national environmental significance, which are detailed in Appendix 1. Under the EPBC Act, the Commonwealth Department of the Environment and Energy (DEE) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the Act. Species are conservation significant if they are listed as Threatened (i.e. Critically Endangered, Endangered and Vulnerable) or Migratory.

2.1.2 WC Act

DBCA lists taxa (flora and fauna) under the provisions of the WC Act as protected and are classified as Schedule 1 to Schedule 7 according to their need for protection (see Appendix 1). The WC Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the WC Act.

2.1.3 EP Act

Threatened flora, fauna (and significant habitat necessary for the maintenance of indigenous fauna) and (TECs are given special consideration in environmental impact assessments and have special status as Environmentally Sensitive Areas (ESAs) under the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions for a clearing permit do not apply in an ESA.

2.1.4 BAM Act

The BAM Act provides for management and control of listed organisms, including introduced flora species (weeds). Species listed as declared pests under the BAM Act are classified under three categories:

- C1 Exclusion: Pests assigned under this category are not established in Western Australia, and control measures are to be taken to prevent them entering and establishing in the State.
- C2 Eradication: Pests assigned under this category are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.

- C3 Management: Pests assigned under this category are established in Western Australia, but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area that is currently free of that pest.

Under the BAM Act, land managers are required to manage populations of declared pests as outlined under the relevant category.

2.2 Environmental setting

2.2.1 Soils and topography

The survey area is located within the Swan Coastal Plain 2 (SWA2 – Swan Coastal Plain subregion) of Western Australia (Mitchell et al. 2002). The Swan Coastal Plain comprises five major geomorphologic systems that lie parallel to the coast, namely (from west to east) the Quindalup Dunes, Spearwood Dunes, Bassendean Dunes, Pinjarra Plain and Ridge Hill Shelf (Churchward & McArthur 1980; Gibson *et al.* 1994). Each major system is composed of further subdivisions in the form of detailed geomorphologic units (Churchward & McArthur 1980; Semeniuk 1990; Gibson *et al.*1994). Beard (1990) describes the Swan Coastal Plain as a low-lying coastal plain, often swampy, with sandhills also containing dissected country rising to the duricrusted Dandaragan plateau on Mesozoic, mainly sandy, yellow soils.

Specifically, the survey area is located on Aeolian Deposits, on Bassendean dunes and can be described as sandy plains with low dunes and occasional swamps (Churchward & McArthur 1980).

2.2.2 Climate

The Mandogalup locality experiences a Mediterranean climate characterised by mild, wet winters and warm to hot, dry summers. The nearest Bureau of Meteorology (BoM) weather station at Medina Research Centre (Station No. 009194) provides average monthly climate statistics for the Mandogalup locality (Figure 2). Average annual rainfall recorded at Medina Research Centre since 1983 is 745.5 mm (BoM 2018). Rainfall may occur at any time of year; however, most occurs in winter in association with cold fronts from the southwest. Highest temperatures occur between January and February, with average monthly maximums ranging from 18°C in July to 31.5°C in February (BoM 2018). Lowest temperatures occur in July and August, with average monthly minimums ranging from 8.2°C in July and August to 17.6°C in February (BoM 2018).

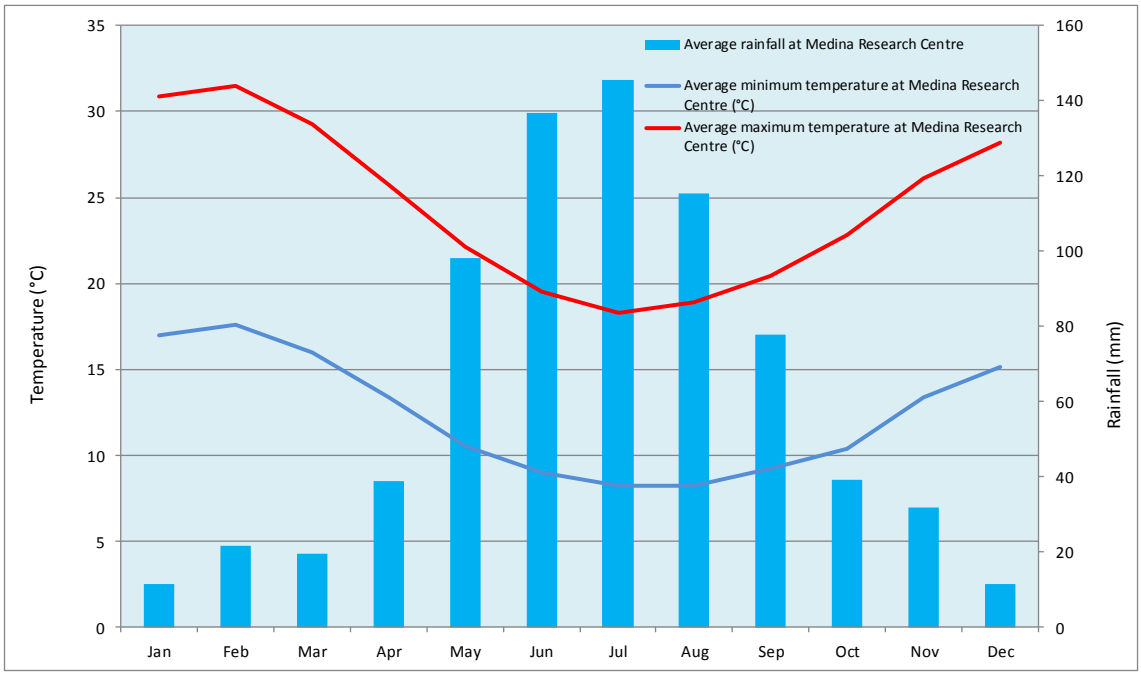


Figure 2: Mean monthly climatic data (temperature and rainfall) for Medina Research Centre

2.2.3 Hydrology

Mapping of the geomorphic wetlands of the Swan Coastal Plain (Figure 3) identifies Mandogalup Swamp South (UFI 6530) occurring within the survey area. This Multiple Use Category wetland is classified as a Dampland. No other wetlands are mapped within the survey area.

The nearest Conservation Category Wetland (CCW) (UFI 12981) is mapped 30 m East of the southern extent of the Project area, separated by the Kwinana Freeway (Figure 3).

2.2.4 Conservation areas

There are no conservation areas located within the survey area. The nearest Bush Forever site, Mandogalup Road Bushland (site no. 268), is located 350 m west of the survey area. The nearest DBCA managed land is located 2 km north of the project area (Figure 3)

2.2.5 Land use

The primary land uses within the Swan Coastal Plain 2 subregion are agriculture, conservation, Unallocated Crown Land and Crown Reserves, urban, rural residential, forestry and infrastructure. Historically, the project area has been utilised for agriculture.

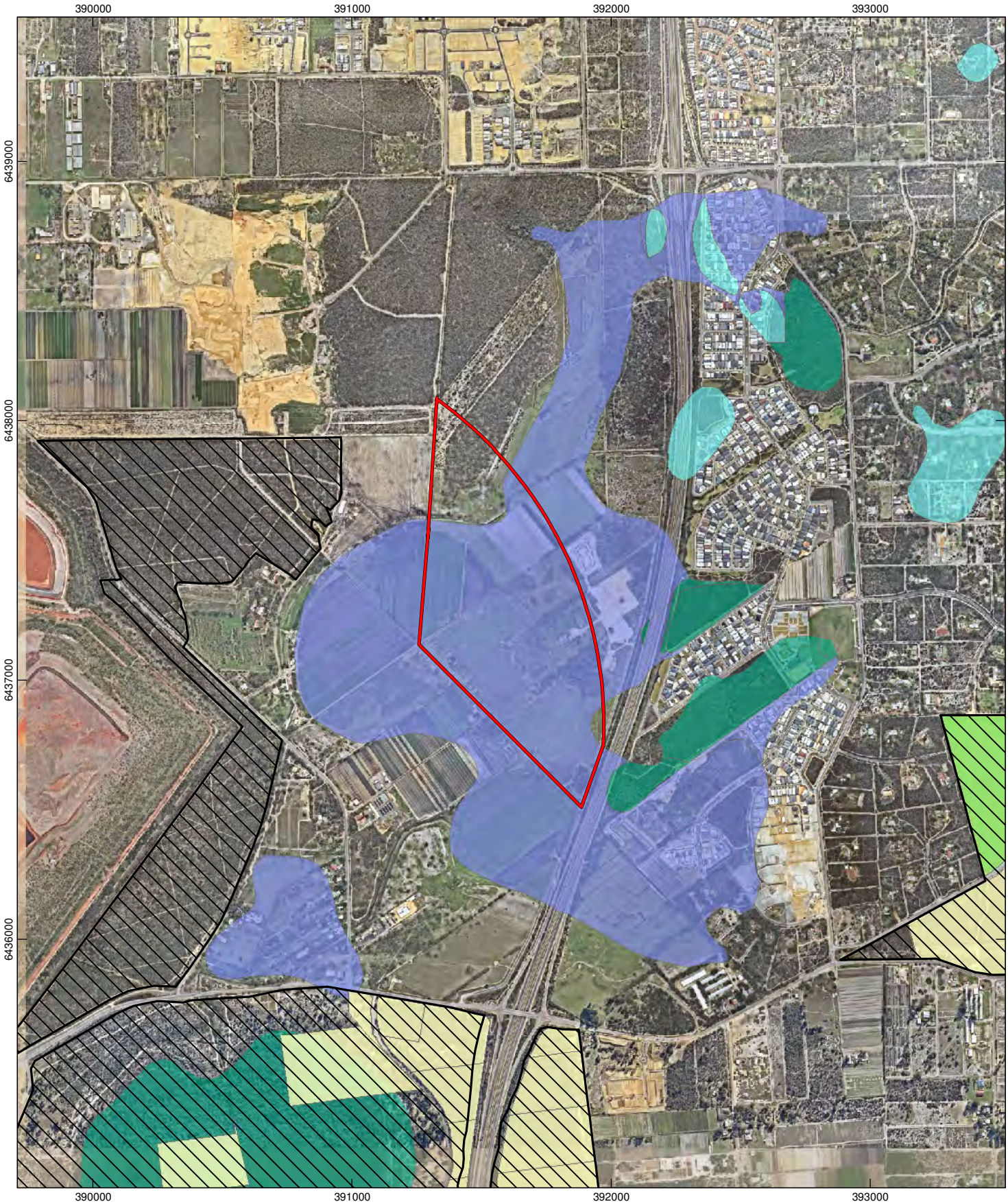


Figure 3: Wetlands and other conservation areas

N

Scale 1:20,000 at A4

0 250 500 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/09/2018

Legend

Geomorphic wetlands
- Conservation
- Multiple Use
- Resource Enhancement

Bush Forever areas

Legislated lands and waters (DBCA)
- Crown Freehold - Dept Managed
- Nature Reserve

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2.2.6 Regional vegetation

Beard (1990) Botanical Subdistrict

The survey area occurs within the Drummond Botanical Subdistrict which is characterised by low *Banksia* woodlands on leached sands; *Melaleuca* swamps on poorly-drained depressions; and *Eucalyptus gomphocephala* (Tuart), *Eucalyptus marginata* (Jarrah) and *Corymbia calophylla* (Marri) woodlands on less leached soils (Beard 1990).

IBRA subregion

IBRA describes a system of 85 'biogeographic regions' (bioregions) and 403 subregions covering the entirety of the Australian continent (Thackway & Cresswell 1995). Bioregions are defined on the basis of climate, geology, landforms, vegetation and fauna.

The survey area occurs within the Swan Coastal Plain 2 IBRA subregion which is dominated by *Banksia* or Tuart on sandy soils, *Casuarina obesa* on outwash plains and paperbark (*Melaleuca*) in swampy areas (Mitchell et al. 2002).

Vegetation system association and System 6 mapping

Vegetation occurring within the region was initially mapped at a broad scale (1: 1 000 000) by Beard during the 1970s. This dataset formed the basis of several regional mapping systems, including the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia) for Western Australia (DEE 2018a), physiographic regions defined by Beard (1981), and System 6 Vegetation Complex mapping undertaken by Heddle et al. (1980).

The project area comprises one Beard (1981) vegetation association (Table 1).

Table 1: Beard (1981) vegetation associations within the project area

Vegetation System Association	Description	Percent remaining in IBRA Region
Bassendean 1001	Medium very sparse woodland; jarrah, with low woodland; banksia & casuarina	21.46

Based on regional vegetation complex mapping (Heddle et al. 1980) the project area comprises two vegetation complexes, (Table 2, Figure 4). One complex, Bassendean Complex-Central and South, has less than 30% of the original extent remaining in the IBRA bioregion (GoWA 2018b).

Table 2: Heddle et al. (1980) vegetation complexes within the project area

Vegetation Complex	Description	Percent remaining in IBRA Region
Bassendean Complex-Central and South	Vegetation ranges from woodland of *Eucalyptus marginata* (Jarrah) - *Allocasuarina fraseriana* (Sheoak) - *Banksia* species to low woodland of *Melaleuca* species, and sedgelands on the moister sites. This area includes the transition of *Eucalyptus marginata* (Jarrah) to *Eucalyptus todtiana* (Pricklybark) in the vicinity of Perth.	26.90
Herdsman Complex	Sedgelands and fringing woodland of *Eucalyptus rudis* (Flooded Gum) - *Melaleuca* species.	31.88

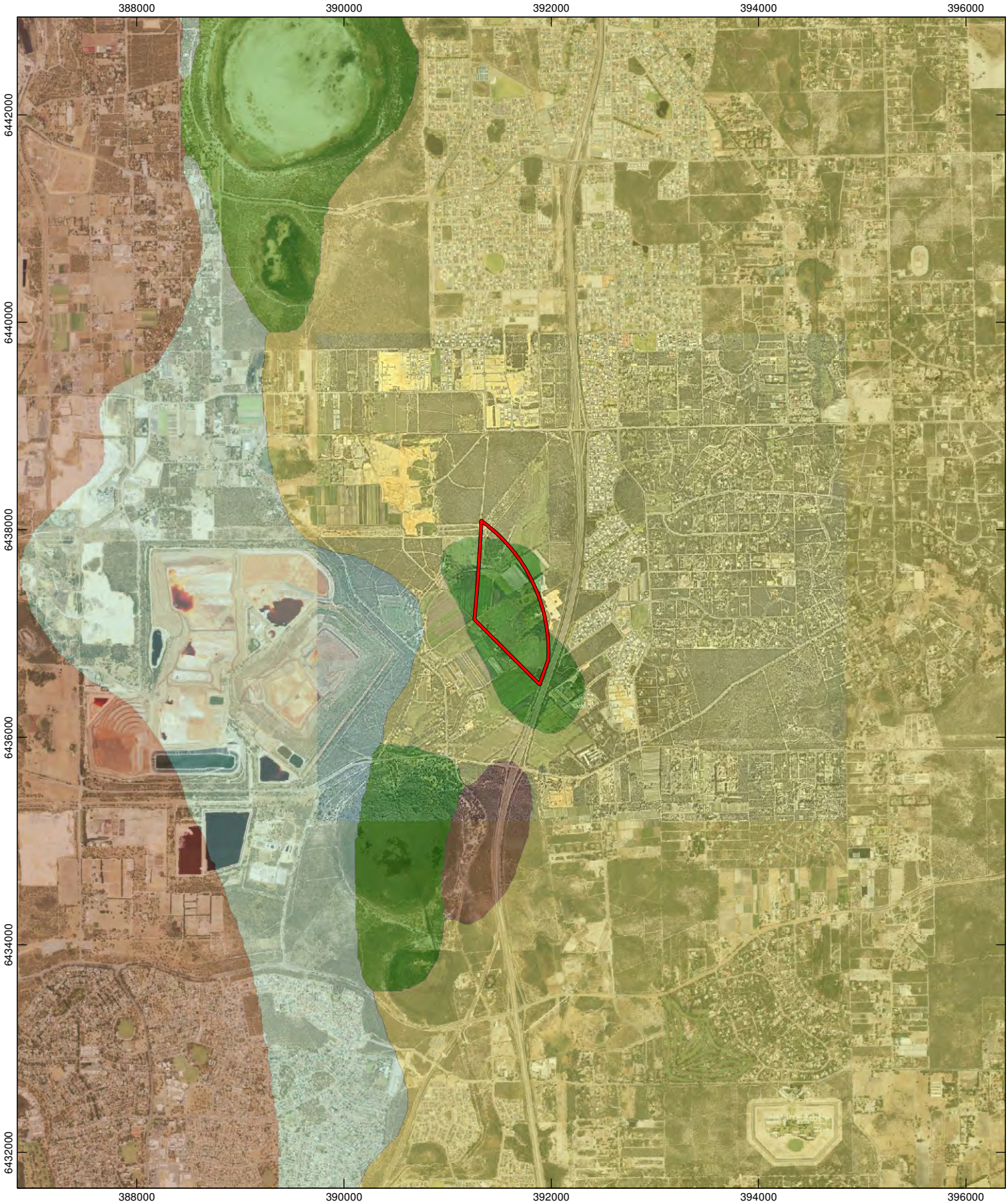


Figure 4: Regional vegetation mapping

N

Scale 1:50,000 at A4

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/09/2018

Legend

- Survey area

System 6 vegetation

- Bassendean complex - central and south
- Cottesloe complex - central and south
- Herdsman Complex
- Karrakatta complex - central and south

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3. Methods

3.1 Desktop assessment

Database searches were undertaken to generate a list of vascular flora previously recorded within, and nearby the project – with an emphasis on species of conservation significance and introduced species (Table 3). Five database searches were conducted around a central coordinate (50H, 391492 mE, 6437915 mN). Search buffers differed due to the technical capabilities of individual databases as well as ecological features surrounding the project area relevant to different species groups.

Table 3: Database searches conducted for the desktop assessment

Custodian	Database	Taxonomic group	Reference	Buffer (km)
DEE	Protected Matters	Flora, Vegetation	DEE 2018b	5
DBCA	NatureMap	Flora	DBCA 2018b	5
DBCA	Threatened and Priority Ecological Communities	Flora, Vegetation	DBCA 2018c	5
DBCA	Threatened and Priority Flora	Flora	DBCA 2018d	5

Reports that document regional flora and vegetation within the surrounds of the project area were also reviewed prior to the field assessment.

3.2 Field assessment

The field survey was conducted by one Senior Ecologist from Strategen on 3 September 2018 with appropriate qualifications (Table 4). All plants collected were taken under flora collecting permits listed in Table 4, pursuant to WC Act Section 23C and Section 23F

Table 4: Personnel

Name	Role	Flora collection permit
Tristan Sleigh (Lead Ecologist)	Planning, fieldwork, plant identification, data interpretation and report preparation	SL012431

Quadrats were sampled to characterise vegetation types and condition, and ensure appropriate representation of the flora and vegetation present. Indicative site locations were identified prior to commencement of the field survey using aerial photography, topographic maps and existing vegetation maps, to ensure that all broad vegetation types and landforms within the project area would be sampled. A total of eight quadrats were surveyed within the project area.

At each quadrat the following information was recorded:

- GPS co-ordinates (recorded in GDA94 UTM 50H);
- photograph of the vegetation;
- vegetation condition
- brief vegetation description;
- vascular flora taxa present (with average height and total percentage foliage cover of each taxon);
- topography (landform type and aspect)
- soil type and colour
- geology (type, size and cover of any rocks, stones, gravel or outcropping)
- average percentage cover of leaf litter and bare ground; and
- disturbance details including fire history (time since last fire), and physical disturbance including evidence of erosion, grazing and weed invasion.

Any flora taxa observed opportunistically around quadrats or while traversing on foot within the project area were also recorded. For any populations of taxa known to be conservation significant or introduced flora observed, a GPS location and a count of the individuals present, or percentage foliar cover for a given area, were recorded.

Prior to the survey, a list of conservation significant flora with the potential to occur within the project area was compiled. Field personnel familiarised themselves with photographs, reference samples and descriptions of these taxa before conducting the survey and once on the ground actively searched for them around quadrats, while traversing on foot within the project and in known locations or preferred habitat encountered in the field.

All plant specimens collected during the field surveys were identified using appropriate reference material or through comparisons with pressed specimens housed at the Western Australian Herbarium where necessary. Nomenclature of the species recorded is in accordance with Western Australian Herbarium (1998-).

Vegetation condition was recorded at all quadrats, and opportunistically within the project area during the field assessment where required. Vegetation condition was described using the vegetation condition scale for the South West Botanical Province (Keighery 1994; Table 5). Vegetation condition polygon boundaries were developed using this information in conjunction with aerial photography interpretation, and were digitised as for vegetation type mapping polygon boundaries.

Table 5: Vegetation condition scale (Keighery 1994)

Condition rating	Description
Pristine (1)	Pristine or nearly so, no obvious sign 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 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, 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.

Vegetation types were delineated using a combination of results site observations and cluster analysis. Aerial photography interpretation and field notes taken during the survey were then used to develop VT mapping polygon boundaries over the project area. These polygon boundaries were then digitised using Geographic Information System (GIS) software.

VT descriptions (though floristic in origin) have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI 2003), a system of describing structural vegetation units (based on dominant taxa). This model follows nationally-agreed guidelines to describe and represent vegetation types, so that comparable and consistent data is produced nation-wide. For the purposes of this report, a VT is considered equivalent to a NVIS sub-association as described in ESCAVI (2003).

To identify possible TECs and PECs in the project area, vegetation quadrats (and subsequently, Vegetation Types) were compared to Floristic Community Types (FCTs) defined by Gibson et al. (1994). An association matrix was prepared using the Bray-Curtis coefficient, resulting in pairwise coefficients of similarities between quadrats (both recorded during the survey and from the SCP dataset). Agglomerative hierarchical clustering, using flexible UPGMA (β=-0.1) was used to generate quadrat classification dendrograms for each quadrat within the project area.

The broad nature of FCTs lead many vegetation types to comprise admixtures and transition zones between FCTs. In addition, the project area was mapped based on extrapolated quadrat data from a single flora assessment, rather than accumulated species data over successive seasons within known vegetation community types as per Gibson et al. (1994). Consequently, assigned FCTs within the project area are inferred and not absolute; i.e. a vegetation code assigned to an FCT is inferred to resemble floristic aspects of that FCT as defined by Gibson et al. (1994).

3.3 Survey limitations and constraints

There are possible limitations and constraints that can impinge on the adequacy of vegetation and flora surveys. The flora and vegetation assessment has been evaluated against a range of potential limitations (Table 6). Based on this evaluation, the assessment has not been subject to limitations or constraints that have affected the thoroughness of the assessment and the conclusions reached.

Table 6: Flora and vegetation survey potential limitations and constraints

Potential limitation	Impact on assessment	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	**Not a constraint.**	The survey has been undertaken in the Drummond Botanical Subdistrict on the Swan Coastal Plain which has been well studied and documented with ample literature available (Beard 1990).
Scope (i.e. what life forms, etc., were sampled).	**Not a constraint.**	Number of species recorded, number of quadrats sampled and timing of the survey (i.e. spring) were adequate for this level of survey.
Proportion of flora collected and identified (based on sampling, timing and intensity).	**Not a constraint.**	The proportion of flora surveyed was adequate. All areas of remnant vegetation within the survey area were traversed and flora species were recorded systematically.
Completeness and further work which might be needed (i.e. was the relevant project area fully surveyed).	**Not a constraint.**	The information collected during the survey was sufficient to assess the vegetation that was present during the time of the survey.
Mapping reliability.	**Not a constraint.**	Aerial photography of a suitable scale was used to map the project area. Sites were chosen from these aerials to reflect changes in community structure. Vegetation types were assigned to each site based on topography, soil type and presence/absence and percent foliage cover of vegetation.
Timing, weather, season, cycle.	**Not a constraint.**	Flora and vegetation surveys are normally conducted following winter rainfall in the South-West Province, ideally during spring (EPA 2016). The field assessment was conducted in September (i.e. spring) in fine weather conditions and therefore these factors are not deemed to be constraints for the spring survey.
Disturbances (fire flood, accidental human intervention, etc.).	**Not a constraint.**	The project area and regional surrounds have been subject to disturbance over a significant period of time. Given the wide range of this disturbance, this is not considered to be a limitation within the project area.
Intensity (in retrospect, was the intensity adequate).	**Not a constraint.**	The project area was traversed on foot and all differences in vegetation structure were recorded appropriately.
Resources (i.e. were there adequate resources to complete the survey to the required standard).	**Not a constraint.**	The available resources were adequate to complete the survey.

Potential limitation	Impact on assessment	Comment
Access problems (i.e. ability to access project area).	**Not a constraint.**	The project area was easily traversed on foot enabling adequate access to survey the vegetation within the project area.
Experience levels (e.g. degree of expertise in species identification to taxon level).	**Not a constraint.**	All survey personnel have the appropriate training in sampling and identifying the flora of the region.

4. Results

4.1 Desktop assessment

Threatened and Priority flora

A total of eight flora taxa of conservation significance were identified by the database searches (Table 7; Appendix 2). Of these, four species listed as Threatened under the Wildlife Conservation Act 1950 (WC Act), or the EPBC Act (see Appendix 1 for information on the conservation codes) were identified. The remaining four flora taxa identified are priority listed flora species (Table 7).

The potential for these plants to occur within the project area was assessed based on general habitat requirements and distribution (Table 7). Three Threatened, and one Priority flora species were considered to have the potential to occur within the project area:

- *Caladenia huegelii* (T)
- *Dodonaea hackettiana* (P4)
- *Drakaea elastica* (T)
- *Drakaea micrantha* (T).

Table 7: Threatened and Priority flora potentially occurring within the survey area

Species	Conservation status		Description	Potential to occur
	EPBC Act	WC Act		
Caladenia huegelii	Threatened – Endangered	Threatened	A slender orchid from 30 to 50 cm tall. One or two striking flowers characterised by a greenish-cream lower petal with a maroon tip. Other petals are cream with red or pink suffusions. Habitat for this species occurs within well-drained, deep sandy soils in low mixed *Banksia*, *Allocasuarina* and Jarrah woodlands (Western Australian Herbarium 1998-, DEE 2017b).	**Possible** due to presence of preferred habitat.
Diuris micrantha	Threatened – Vulnerable	Threatened	A slender orchid to 60 cm tall. Yellow flowers with reddish-brown markings measuring 1.3 cm across. Habitat for this species occurs within clay-loam substrates in winter-wet depressions or swamps.	**Unlikely** due to absence of preferred habitat.
Diuris purdiei	Threatened – Endangered	Threatened	A slender orchid to 0.35 m tall. Flowers are yellow and visible from September to October. Habitat for this species is grey-black sand substrates in winter-wet swamps which have high moisture (Western Australian Herbarium 1998-). Diuris purdiei occurs from Perth south to near the Whicher Range, within the Swan (Western Australia) Natural Resource Management Region. It grows on sand to sandy clay soils, in areas subject to winter inundation, and amongst native sedges and dense heath with scattered emergent *Melaleuca preissiana*, *Corymbia calophylla*, *E. marginata* and *Nuytsia floribunda* (DEE 2017b).	**Unlikely** due to absence of preferred habitat.
Dodonaea hackettiana	-	P4	An erect shrub or tree, 100 to 500 cm tall. Flowers are yellow to green/red and occur mainly from July to October. Habitat for this species occurs in sand and outcropping limestone (Western Australian Herbarium 1998-).	**Possible** due to presence of preferred habitat.
Drakaea elastica	Threatened – Endangered	Threatened	A slender orchid to 30 cm tall with a prostrate, round to heart shaped leaf. Singular, bright green, glossy flower. The species grows on bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps, typically in banksia (*Banksia menziesii*, *B. attenuata* and *B. ilicifolia*) woodland or spearwood (*Kunzea glabrescens*) thicket vegetation. *D. elastica* often occurs with other orchid species (DEE 2017b).	**Possible** due to presence of marginal habitat (Banksia woodland).
Drakaea micrantha	Threatened – Vulnerable	Threatened	A tuberous, terrestrial herb which has a diminutive red and yellow flower, 1.2–2.5 cm long, on a stem that grows to 30 cm. Flowering occurs form September to October. Its heart-shaped leaf, about 1.5 cm long, is silvery grey with prominent green veins. Habitat for this species occurs within cleared firebreaks or open sandy patches that have been disturbed, where competition from other plants has been removed (Western Australian Herbarium 1998-, DEE 2017b).	**Possible** due to presence of preferred habitat.

Species	Conservation status		Description	Potential to occur
	EPBC Act	WC Act		
Eleocharis keigheryi	Threatened – Vulnerable	Threatened	A rhizomatous, tufted/clumped perennial herb, reaching a maximum diameter of 40 cm. It has erect, smooth, green stems that are 20–40 cm tall and hollow, supporting cross bars that are 2 mm in diameter. This species grows in small clumps in a substrate of clay or sandy loam. This species is emergent in freshwater creeks, and transient waterbodies such as drainage lines and claypans in water to approximately 15 cm deep. Fringing woodland species and associated species include Swamp Sheoak (*Casuarina obesa*), Flooded Gum (*Eucalyptus rudis*), Red Robin Bush (*Melaleuca lateritia*), Swamp Paperbark (*M. rhaphiophylla*), Common Spike-sedge (*Eleocharis acuta*), *Aponogeton hexatepalus*, Veined Swamp Wallaby Grass (*Amphibromus nervosus*) and herbs such as *Wurmbea*, *Tribonanthes* and *Leptocarpus* spp. (Western Australian Herbarium 1998-, DEE 2017b).	**Unlikely** due to absence of preferred habitat and associated species.
Lepidosperma rostratum	Threatened – Endangered	-	A rhizomatous sedge to 30 cm in diameter. Stems are circular in cross section and flowers are spike-like and up to 4 cm long. Habitat for this species occurs in sandy soils among low heath comprised of *Banksia telmatiaea* and *Calothamnus hirsutus* in winter-wet swamps (Western Australian Herbarium 1998-, DEE 2017b).	**Unlikely** due to absence of preferred habitat and associated species.
Pimelea calcicola	-	P3	An erect to spreading shrub to 1 m tall. Flowers are pink and visible between September to November. Habitat for this species occurs in sand on coastal limestone ridges (Western Australian Herbarium 1998-).	**Unlikely** due to absence of preferred habitat.
Stylidium paludicola	-	P3	Reed-like perennial, herb, 35 to 100 cm tall. Leaves are tufted, linear or subulate or narrowly oblanceolate. Flowers are pink and occur in October to December. Habitat for this species occurs in peaty sand over clay and winter wet areas, often in Marri and Melaleuca woodland or Melaleuca shrubland (Western Australian Herbarium 1998-).	**Unlikely** due to absence of preferred habitat and associated species.

Threatened and Priority Ecological Communities

The Parks and Wildlife Threatened and Priority Ecological Community Database search (DBCA 2018c) identified one TEC within the project area. In addition, one TEC, and three PECs were identified within the 5 km of the project area (Table 8, Figure 5).

Table 8: TECs and PECs identified within and near the project area

Community	Conservation Status		Description
	EPBC Act	WC Act	
Banksia woodlands of the Swan Coastal Plain	Endangered	Various listings; encompasses multiple state-listed TECs and PECs	Banksia dominated woodlands of the Swan Coastal Plain Bioregion
Limestone ridges (SCP 26a)	NA	Endangered	*Melaleuca huegelii - Melaleuca systena* shrublands on limestone ridges
SCP21c	NA	Priority 3	Low lying *Banksia attenuata* woodlands or shrublands
SCP22	NA	Priority 3	*Banksia ilicifolia* woodlands
SCP24	NA	Priority 3	Northern Spearwood shrublands and woodlands

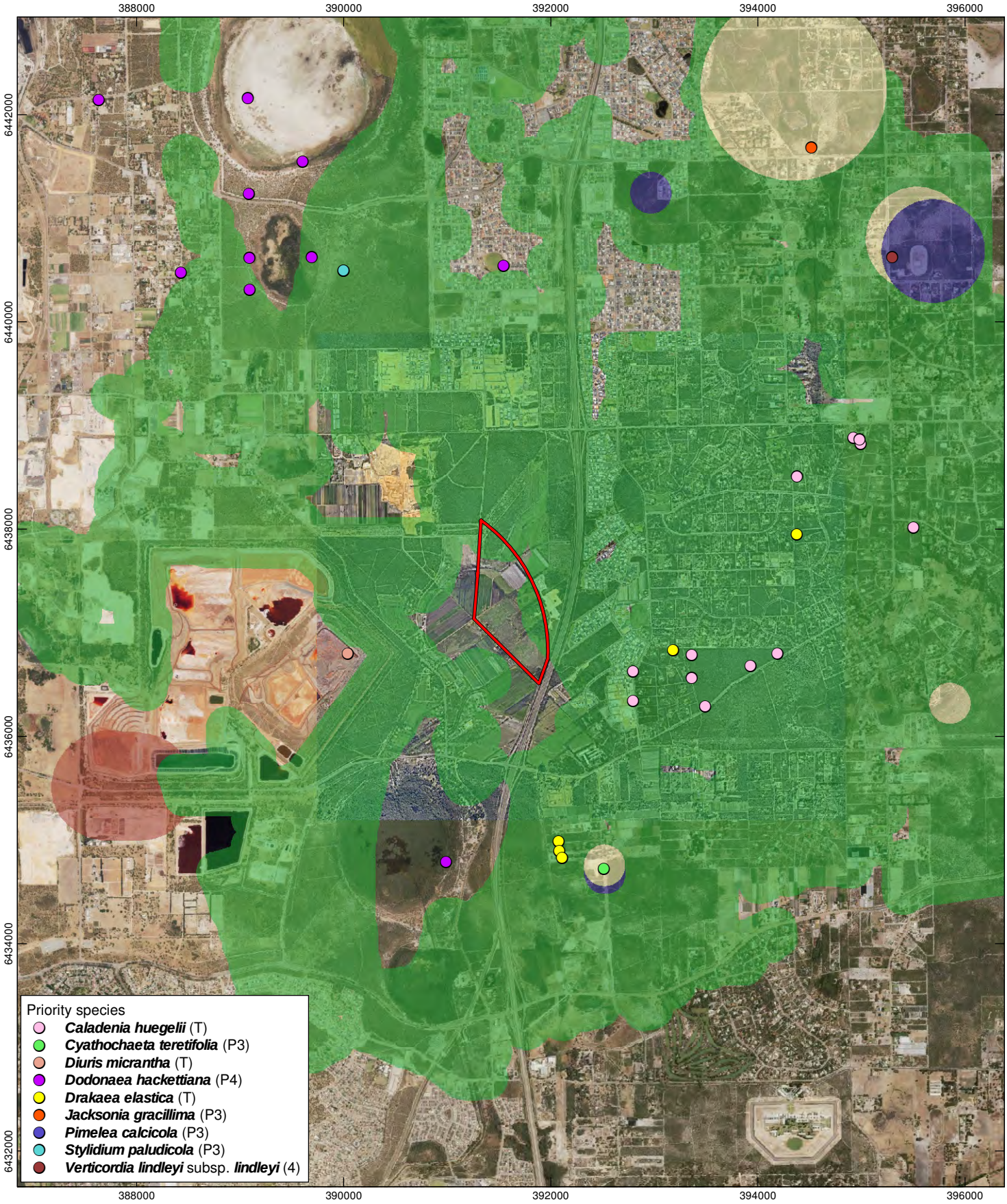


Figure 5: Location of TECs and PECs within 5 km of the survey area

N

Scale 1:50,000 at A4

0 500 1,000 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/09/2018

Legend

TEC PEC areas

- Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region
- Banksia ilicifolia woodlands
- Low lying Banksia attenuata woodlands or shrublands
- Melaleuca huegelii - Melaleuca acerosa (currently M. systena) shrublands on limestone ridges (Gibson et al. 1994 type 26a)
- Northern Spearwood shrublands and woodlands

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4.2 Field survey

A total of nine quadrats sites were sampled across the project area. Raw quadrat data is provided in Appendix 4.

4.2.1 Native flora

A total of 40 native vascular plant taxa from 36 plant genera and 20 plant families were recorded from quadrats within the survey area. The majority of taxa were recorded within the Fabaceae (seven taxa) and Myrtaceae (four taxa) families (Appendix 3). The relatively low number of plant genera recorded reflects the disturbed nature of the survey area.

4.2.2 Conservation significant flora

No Threatened flora species as listed under section 178 of the EPBC Act or pursuant to Schedule 1 of the WC Act and as listed by Parks and Wildlife (2015) were recorded within the survey area. No Priority flora species as listed by Western Australian Herbarium (1998-) were recorded within the survey area.

4.2.3 Introduced (exotic) taxa

A total of 18 introduced (exotic) taxa were recorded within the survey area (Appendix 3):

- **Arctotheca calendula*
- **Briza maxima*
- **Carpobrotus edulis*
- **Carthamus lanatus*
- **Conyza bonariensis*
- **Crassula glomerata*
- **Ehrharta longiflora*
- **Euphorbia terracina*
- **Gladiolus caryophyllaceus*
- **Hypochaeris glabra*
- **Lysimachia arvensis*
- **Oxalis pes-caprae*
- **Phytolacca octandra*
- **Poaceae sp.*
- **Romulea rosea* var. *australis*
- **Solanum nigrum*
- **Ursinia anthemoides*
- **Zantedeschia aethiopica*

One of these species (**Zantedeschia aethiopica*) is a Declared Plant species in Western Australia pursuant to section 22 of the *Biosecurity and Agriculture Management Act 2007* (BAM Act) according to the Western Australian Department of Agriculture and Food (DPIRD 2018). Table 9 display the species recorded and their locations within the survey area.

Table 9: Locations of Declared Plant species pursuant to section 22 of the BAM Act recorded within the survey area

Species	GPS location (GDA 94)	
	Easting	Northing
**Zantedeschia aethiopica*	391937	6436968
**Zantedeschia aethiopica*	391942	6436988
**Zantedeschia aethiopica*	391902	6436976
**Zantedeschia aethiopica*	391844	6437027
**Zantedeschia aethiopica*	391876	6437075
**Zantedeschia aethiopica*	391904	6437107

4.2.4 Survey adequacy

A total of nine quadrats were sampled across the project area, with approximately 0.14 sites completed per hectare (0.8 sites per ha in vegetated areas). This was considered adequate for ensuring that at least three flora sites were sampled in all vegetation types large enough and for ensuring that coverage across the site was sufficient.

4.2.5 Vegetation types

Three native vegetation types (VTs) were defined and mapped within the survey area (Figure 6) and are summarised in Table 10. Areas containing vegetation in parkland cleared or highly degraded state have not been counted as unique native VTs but have been included in Table 10 for area calculation purposes. The total area mapped within the survey area was 65.5 ha which includes parkland cleared and fully cleared areas. The dominant native VT within the survey area was VT 1 which can be broadly described as a *Eucalyptus rudis* and *Melaleuca rhaphiophylla* woodland.

Table 10: Vegetation Types

Vegetation Type	Description	Area (ha) within project/survey area	% of survey area	Representative photograph
VT1	*Eucalyptus rudis* and *Melaleuca rhaphiophylla* woodland over *Pteridium esculentum*, **Zantedeschia aethiopica*, **Phytolacca octandra* and **Gomphocarpus fruticosus* low shrubland over introduced grasses and herbs including **Ehrharta calycina*, **Cynodon dactylon* and **Cirsium vulgare*. This VT aligns with the Herdsman Complex.	4.0	6.1	
VT2	*Eucalyptus rudis* and open woodland over *Pteridium esculentum* shrubland over introduced grasses including **Ehrharta calycina and *Avena barbata.* This VT aligns with the Herdsman Complex.	1.5	2.3	

Vegetation Type	Description	Area (ha) within project/survey area	% of survey area	Representative photograph
VT3	*Eucalyptus marginata*, *Banksia attenuata* and *Banksia menziesii* mid to low woodland of over *Xanthorrhoea preissii*, *Acacia pulchella* and *Stirlingia latifolia* mid shrubland over *Hibbertia hypericoides*, *Hypocalymma robustum* and *Tetraria capillaris* low shrubland. This VT aligns with the Bassendean Complex-Central and South.	3.5	5.3	
PC	Parkland cleared areas consisting of *Eucalyptus marginata*, *Banksia attenuata* and *Banksia menziesii* open woodland over **Eragrostis curvula* and **Ehrharta calycina*	2.1	3.3	N/A
C	Historically cleared area containing introduces grasses including **Eragrostis curvula* and **Ehrharta calycina*	54.3	82.9	N/A
Total		**65.5**	**100**	



Figure 6: Vegetation types

Legend

Survey area

Vegetation type
- Cleared
- PC
- VT1
- VT2
- VT3

N

Scale 1:7,500 at A4

0 100 200 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/09/2018

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Vegetation condition

The survey area shows signs of having been degraded for a long period of time. The majority of the survey area has been cleared for agricultural use, with remanet vegetation subject to grazing, weeds and partial clearing as a result. As such, vegetation condition within the survey area ranged from Good to Completely Degraded (Keighery 1994; Figure 7).

Table 11 gives a numerical breakdown of the area occupied by each vegetation condition rating within the survey area.

Table 11: Area (ha) covered by each vegetation condition category within the survey area

Vegetation Condition	Area (ha)	Percentage of the survey area
Good	2.3	3.5
Degraded	1.8	2.8
Completely Degraded	61.4	93.8
Grand Total	**65.5**	**100**

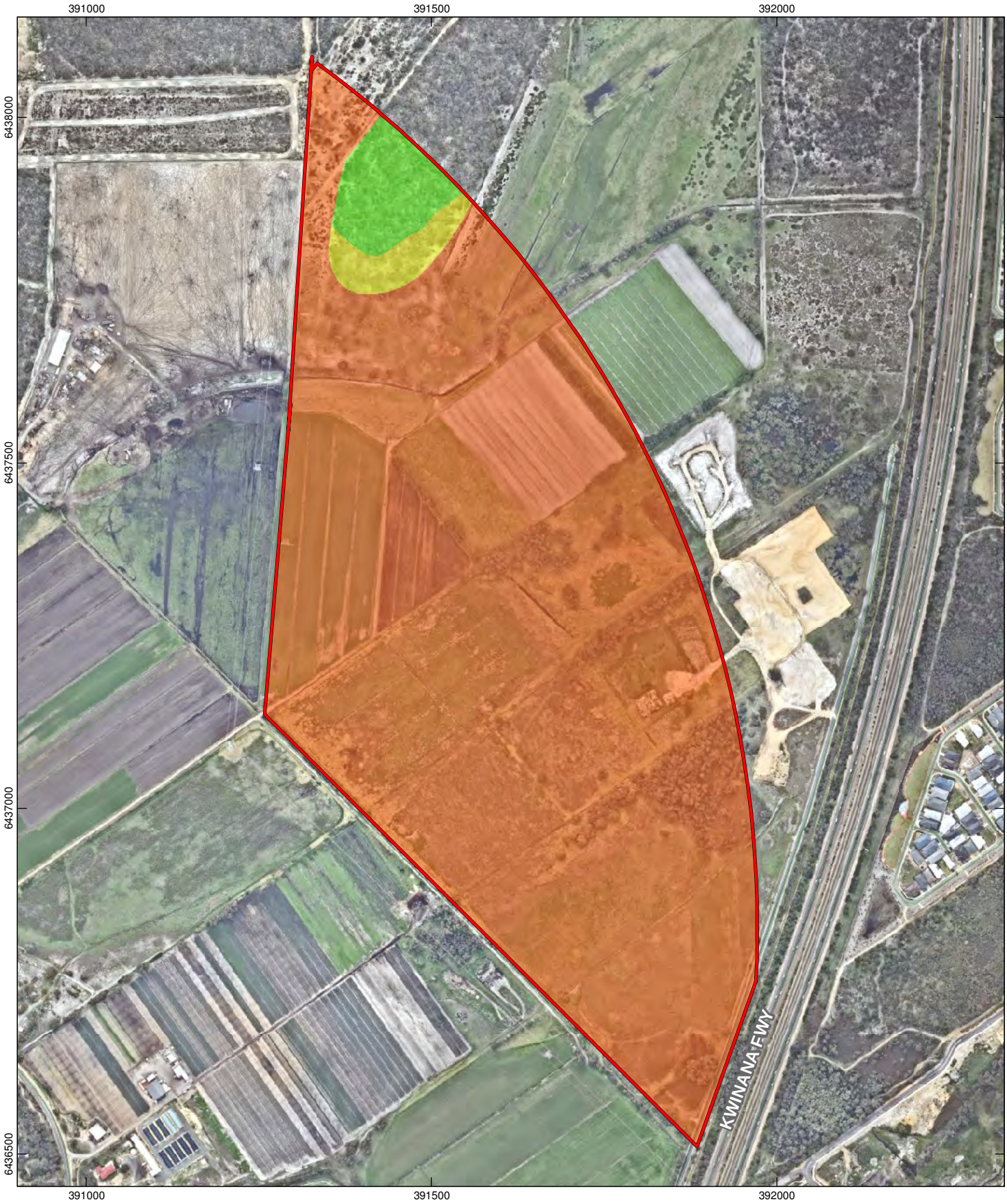


Figure 7: Vegetation condition within the survey area

N

Scale 1:7,500 at A4

0 100 200 m

Coordinate System: GDA 1994 MGA Zone 50

Date: 18/09/2018

Legend

- Survey area

Vegetation condition

- CD
- D
- G

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4.2.6 FCT similarity analysis

Remnant vegetation of the southern Swan Coastal Plain was surveyed and mapped by Gibson *et al.* (1994) to provide an understanding of the major floristic types and transitions across the region. The major FCTs were defined by classifying the data collected according to the similarities in species composition between plots. When determining the FCT of a new record, a floristic analysis of species composition provides the most robust method that is consistent with the original classification.

The results for the hierarchical clustering analysis show that the original dendrogram has been disrupted to some extent when analysing each plot (Table 12). Site 2 (VT 3) fuses with some sites from FCTs 23a, 21a and 28. Sites 1 and 3 (VT 3) fuse with some sites from FCTs 5 and 6.

The three nearest neighbours for each site using the Bray-Curtis distance are shown in Table 13. The nearest neighbour assignment for both sites was consistent for both resemblance measures. All sites showed similarities to FCTs 28 and 21a. Given the location of the project area within the Swan Coastal plain and the species composition, FCT 21a is the most likely community type associated with Vegetation Type VT3.

Table 12: Results of hierarchical analysis for plots from the survey area

Site	VT	FCT First fusion	FCT of nearest main group fusion	Likely FCT
Q1	VT3	6	21c	N/A
Q2	VT3	23a, 21a, 28	21a	21a
Q3	VT3	6	21c	N/A

Table 13: Results of Nearest Neighbour analysis using the Bray-Curtis dissimilarity coefficient

Site	VT	Nearest Neighbour (FCT)	2nd Nearest Neighbour (FCT)	3rd Nearest Neighbour (FCT)
Q1	VT3	28	21a	24
Q2	VT3	28	21a	23a
Q3	VT3	28	21a	24

4.2.7 Threatened and Priority Ecological Communities

Site observations and quadrat data collected during the survey indicated that one TEC is potentially represented by vegetation types within the project area. This is:

- *Banksia woodlands of the Swan Coastal Plain* TEC potentially represented by VT3.

The TEC/PEC database search (DBCA 2017c) identified the some of the survey area as comprising *Banksia woodlands of the Swan Coastal Plain* TEC or the associated buffer. Vegetation within the study area was assessed against the key diagnostic criteria for the *Banksia woodlands of the Swan Coastal Plain* TEC (TSSC 2016). One vegetation type within the project area, VT3, was found to meet the diagnostic criteria provided in the approved conservation advice for the *Banksia woodlands of the Swan Coastal Plain* TEC (Table 14).

Table 14: Characteristics of the Banksia woodland within the survey area compared to the key diagnostic criteria as per TSSC (2016)

Key diagnostic criteria (TSSC 2016)	Banksia woodlands within the project area
Location: Occurs in the Swan Coastal Plain or Jarrah Forest IBRA bioregions.	Yes. Banksia woodlands within the project area occur on the Swan Coastal Plain.
Soils and landform: Occurs on: • well drained, low nutrient soils on sandplain landforms, particularly deep Bassendean and Spearwood sands and occasionally on Quindalup sands • sandy colluviums and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau • transitional substrates and sandflats.	Yes. Banksia woodlands within the project area occur on Bassendean sands.
Structure: Low woodland to forest with: • a distinctive upper sclerophyllous layer of low trees (occasionally large shrubs more than 2 m tall), typically dominated or co-dominated by one or more of the banksia species identified below • emergent trees of medium or tall (>10 m) height. *Eucalyptus* or *Allocasuarina* species may sometimes be present above the banksia canopy • an often highly species-rich understorey.	Yes. VT3 represents a low woodland structure.
Composition: Contains at least one of the following species: • *Banksia attenuata* • *Banksia menziesii* • *Banksia prionotes* • *Banksia ilicifolia.*	Yes. VT3 contains *Banksia attenuata* and/or *Banksia menziesii*.
Condition (Keighery 1994): 'Pristine': no minimum patch size 'Excellent': 0.5 ha 'Very Good': 1 ha 'Good': 2 ha.	Yes. Banksia woodlands within the project area are in Completely Degraded to Good condition. One patch is present in the northern extent of the survey area, with 2.3 ha in Good condition. This patch meets the minimum size for vegetation in Good condition.

5. Discussion

The flora and vegetation assessment of the survey area was conducted during September 2018, which was prime flowering time for the majority of species within the region. The field survey focussed on traversing the entire survey area to delineate vegetation types and is consistent with the requirements of a detailed flora and vegetation survey as specified in *Technical Guidance: Flora and Vegetation surveys for Environmental Impact Assessment* (EPA 2016).

Forty native vascular plant taxa from 36 plant genera and 20 plant families as well as 18 exotic taxa were recorded within the survey area.

The following Threatened and Priority Flora species have the potential to occur within the survey area based on habitat requirements:

- *Caladenia huegelii* (T)
- *Dodonaea hackettiana* (P4)
- *Drakaea elastica* (T)
- *Drakaea micrantha* (T).

No Threatened flora species as listed under section 178 of the EPBC Act or pursuant to Schedule 1 of the WC Act and as listed by Parks and Wildlife (2015) were recorded within the survey area. Additionally, no Priority flora species as listed by Western Australian Herbarium (1998-), including those listed above, were recorded. The priority 4 species *Dodonaea hackettiana*, is unlikely to have been flowering at the time of survey; however, it is a perennial species and would have been visible and identifiable if present. The remaining three conservation significant species would have been identifiable during the time of survey. While a full targeted survey was not conducted, it is unlikely that these species occur within the survey area given the disturbance within the areas of potential habitat.

One broad-scale vegetation association falls within the survey area, Bassendean 1001, of which 21.46% of its pre-European extent remains, as at the most recent assessment in 2017 (Government of Western Australia 2017a). The survey area occurs within the 'Bassendean complex – central and south' and 'Herdsman Complex' Vegetation complexes of which 26.90% and 31.88 % of their pre-European extent remains within the Swan Coastal Plain bioregion respectively (Government of Western Australia 2017b). Three VTs were mapped within the survey area, as well as cleared areas. The survey area was dominated by woodland of *Eucalyptus rudis and Melaleuca rhaphiophylla*.

Vegetation condition within the survey area ranged from Completely Degraded to Good (Keighery 1994), with the majority of vegetation (93%) rated as Completely Degraded. Vegetation rated as good was confined to vegetation mapped as VT3. While this area has been subject to disturbances from livestock grazing and weed invasion, it still retains basic structure. Given the approved clearing of vegetation immediately to the north, and 93% of the vegetation within the survey area is completely degraded, its retention for conservation value is diminished.

Statistical analyses of vegetation data from the survey area determined one broad FCT (FCT21a), was present (VT3). FCT21a is included as one of the FCTs constituting the *Banksia woodlands of the Swan Coastal Plain* TEC, which is listed as Endangered under the EPBC Act. This vegetation type was considered to constitute the *Banksia woodlands of the Swan Coastal Plain* TEC (TSSC 2016), meeting all of the diagnostic characteristics of the TEC (Table 14). As such, areas mapped as VT3 should be considered to be part of the *Banksia woodlands of the Swan Coastal Plain* TEC. This area of vegetation is subject to an EPBC Act approval (2014/7126) and associated offsets package which has been paid in full, upfront. Retention of vegetation, in excellent condition, has already been provided to the north in the approved subdivision area (WAPC 155567). Given this, the environmental impacts of the clearing have been accounted for.

The proposed areas of vegetation retention have focused on accessibility, usability and ongoing management requirements. The area proposed for retention is located in areas that are completely degraded; however, this area retains a number of large trees which provide both aesthetic and conservation value to the proposed development (Appendix 5). This area has been positioned to take into account the cut and fill levels of the previously approved subdivision plan (WAPC 155567). This location also provides a continual linear park network to the retained vegetation north-east in the approved subdivision area.

This retention plan assessed the value of retaining the small area of native vegetation, mapped as V3, for the development. As the approved subdivision plan to the north of the survey area involves cut and fill, the retention of the remnant vegetation would have required a 5 metre retaining wall to be built. Along with restricting usability of the POS, the cut and fill process would likely change the hydrology within the remnant vegetation, potentially reducing water availability. Given the existing disturbance within this vegetation, cattle grazing and weeds, and the isolation of the remnant, it is unlikely it would be valuable as an area for conservation with post development works, even with ongoing management. The retention of this area would therefore be unlikely to have an ecological benefit within the local area.

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Appendix 1
Conservation significant flora and ecological community definitions

Department of Parks and Wildlife

CONSERVATION CODES

For Western Australian Flora and Fauna

Specially protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

T **Threatened species**

Published as Specially Protected under the *Wildlife Conservation Act 1950,* and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR **Critically endangered species**

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN **Endangered species**

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU **Vulnerable species**

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX **Presumed extinct species**

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA **Migratory birds protected under an international agreement**

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: 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 are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.
(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

[1] The definition of flora includes algae, fungi and lichens
[2]Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Department of Environment and Conservation
January 2013

DEFINITIONS, CATEGORIES AND CRITERIA FOR THREATENED AND PRIORITY ECOLOGICAL COMMUNITIES

1. GENERAL DEFINITIONS

Ecological Community
A naturally occurring biological assemblage that occurs in a particular type of habitat.

Note: The scale at which ecological communities are defined will often depend on the level of detail in the information source, therefore no particular scale is specified.

A **threatened ecological community** (TEC) is one which is found to fit into one of the following categories; "presumed totally destroyed", "critically endangered", "endangered" or "vulnerable".

Possible threatened ecological communities that do not meet survey criteria are added to DEC's Priority Ecological Community Lists under Priorities 1, 2 and 3. Ecological Communities that are adequately known, are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

An **assemblage** is a defined group of biological entities.

Habitat is defined as the areas in which an organism and/or assemblage of organisms lives. It includes the abiotic factors (eg. substrate and topography), and the biotic factors.

Occurrence: a discrete example of an ecological community, separated from other examples of the same community by more than 20 metres of a different ecological community, an artificial surface or a totally destroyed community.

By ensuring that every discrete occurrence is recognised and recorded future changes in status can be readily monitored.

Adequately Surveyed is defined as follows:
"An ecological community that has been searched for thoroughly in most likely habitats, by relevant experts."

Community structure is defined as follows:
"The spatial organisation, construction and arrangement of the biological elements comprising a biological assemblage" (eg. *Eucalyptus salmonophloia* woodland over scattered small shrubs over dense herbs; structure in a faunal assemblage could refer to trophic structure, eg. dominance by feeders on detritus as distinct from feeders on live plants).

Definitions of Modification and Destruction of an ecological community:

Modification: "changes to some or all of ecological processes (including abiotic processes such as hydrology), species composition and community structure as a

direct or indirect result of human activities. The level of damage involved could be ameliorated naturally or by human intervention."

Destruction: "modification such that reestablishment of ecological processes, species composition and community structure within the range of variability exhibited by the original community is unlikely within the foreseeable future even with positive human intervention."

Note: Modification and destruction are difficult concepts to quantify, and their application will be determined by scientific judgement. Examples of modification and total destruction are cited below:

Modification of ecological processes: The hydrology of Toolibin Lake has been altered by clearing of the catchment such that death of some of the original flora has occurred due to dependence on fresh water. The system may be bought back to a semblance of the original state by redirecting saline runoff and pumping waters of the rising watertable away to restore the hydrological balance. Total destruction of downstream lakes has occurred due to hydrology being altered to the point that few of the original flora or fauna species are able to tolerate the level of salinity and/or water logging.

Modification of structure: The understorey of a plant community may be altered by weed invasion due to nutrient enrichment by addition of fertiliser. Should the additional nutrients be removed from the system the balance may be restored, and the original plant species better able to compete. Total destruction may occur if additional nutrients continue to be added to the system causing the understorey to be completely replaced by weed species, and death of overstorey species due to inability to tolerate high nutrient levels.

Modification of species composition: Pollution may cause alteration of the invertebrate species present in a freshwater lake. Removal of pollutants may allow the return of the original inhabitant species. Addition of residual highly toxic substances may cause permanent changes to water quality, and total destruction of the community.

Threatening processes are defined as follows:
"Any process or activity that threatens to destroy or significantly modify the ecological community and/or affect the continuing evolutionary processes within any ecological community."

Examples of some of the continuing threatening processes in Western Australia include: general pollution; competition, predation and change induced in ecological communities as a result of introduced animals; competition and displacement of native plants by introduced species; hydrological changes; inappropriate fire regimes; diseases resulting from introduced microorganisms; direct human exploitation and disturbance of ecological communities.

Restoration is defined as returning an ecological community to its pre-disturbance or natural state in terms of abiotic conditions, community structure and species composition.

Rehabilitation is defined as the re-establishment of ecological attributes in a damaged ecological community although the community will remain modified.

2. DEFINITIONS AND CRITERIA FOR PRESUMED TOTALLY DESTROYED, CRITICALLY ENDANGERED, ENDANGERED AND VULNERABLE ECOLOGICAL COMMUNITIES

Presumed Totally Destroyed (PD)
An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future.

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

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

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

Critically Endangered (CR)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated.

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

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

i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years);

ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated.

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

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years);

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

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

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

Endangered (EN)
An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.

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

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

i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years);

ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated.

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

i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years);

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

iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes.

C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).

Vulnerable (VU)
An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

An ecological community will be listed as **Vulnerable** when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium (within approximately 50 years) to long-term future. This will be determined on the basis of the best available information by it meeting **any one or more of** the following criteria (A, B or C):

A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated.

B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations.

C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long-term future because of existing or impending threatening processes.

3. DEFINITIONS AND CRITERIA FOR PRIORITY ECOLOGICAL COMMUNITIES

Possible threatened ecological communities that do not meet survey criteria or that are not adequately defined are added to the Priority Ecological Community List under priorities 1, 2 and 3. These three categories are ranked in order of priority for survey and/or definition of the community. Ecological communities that are adequately known, and are rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. These ecological communities require regular monitoring. Conservation Dependent ecological communities are placed in Priority 5.

Priority One: Poorly-known ecological communities

Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.

Priority Two: Poorly-known ecological communities

Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.

Priority Three: Poorly known ecological communities

(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or:
(ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or;
(iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc.

Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.

Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring.

(i) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands.

(ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category.

(iii) Ecological communities that have been removed from the list of threatened communities during the past five years.

Priority Five: Conservation Dependent ecological communities

Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Definition of Threatened Ecological Communities -EPBC Act (DEE 2017c)

Critically endangered

An ecological community is facing an extremely high risk of extinction in the wild in the immediate future (indicative timeframe being the next 10 years).

Endangered

An ecological community is not critically endangered but is facing a very high risk of extinction in the wild in the near future (indicative timeframe being the next 20 years).

Vulnerable

An ecological community is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium–term future (indicative timeframe being the next 50 years).

Appendix 2
Desktop assessment results (Parks and Wildlife 2007-)

NatureMap Species Report

Created By Guest user on 28/06/2017

Kingdom Plantae
Conservation Status Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 115° 50' 36" E,32° 11' 05" S
Buffer 3km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	1596	*Caladenia huegelii (Grand Spider Orchid)*		T	
2.	12938	*Diuris micrantha*		T	
3.	4763	*Dodonaea hackettiana (Hackett's Hopbush)*		P4	
4.	1639	*Drakaea elastica (Glossy-leaved Hammer Orchid)*		T	
5.	5237	*Pimelea calcicola*		P3	
6.	25800	*Stylidium paludicola*		P3	

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

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

Appendix 3
Vascular plant taxa recorded from quadrats within the survey area

Family	Taxa	
Aizoaceae	*	*Carpobrotus edulis*
Araceae	*	*Zantedeschia aethiopica*
Araliaceae		*Trachymene pilosa*
Asparagaceae		*Chamaescilla corymbosa*
		Lomandra hermaphrodita
		Thysanotus manglesianus
Asteraceae	*	*Arctotheca calendula*
		Carthamus lanatus
		Conyza bonariensis
		Hypochaeris glabra
		Ursinia anthemoides
		Lagenophora huegelii
Casuarinaceae		*Allocasuarina fraseriana*
Crassulaceae	*	*Crassula glomerata*
Cyperaceae		*Schoenus curvifolius*
		Tetraria capillaris
		Tetraria octandra
Dennstaedtiaceae		*Pteridium esculentum*
Dilleniaceae		*Hibbertia hypericoides*
Droseraceae		*Drosera erythrorhiza*
Ericaceae		*Leucopogon propinquus*
		Styphelia tenuiflora
Euphorbiaceae	*	*Euphorbia terracina*
Fabaceae		*Acacia pulchella*
		Bossiaea ornata
		Daviesia sp.
		Gompholobium tomentosum
		Hardenbergia comptoniana
		Hovea pungens
		Isotropis cuneifolia
Geraniaceae		*Erodium cygnorum*
Goodeniaceae		*Dampiera linearis*
		Scaevola repens var. *repens*
Haemodoraceae		*Anigozanthos manglesii* subsp. *manglesii*
		Conostylis serrulata
		Conostylis setigera subsp. *setigera*
Hemerocallidaceae		*Corynotheca micrantha* var. *micrantha*
Iridaceae	*	*Gladiolus caryophyllaceus*
		Romulea rosea var. australis
Myrtaceae		*Eucalyptus marginata*

Family	Taxa	
Myrtaceae		*Eucalyptus rudis* subsp. *rudis*
		Hypocalymma robustum
		Melaleuca rhaphiophylla
Orchidaceae		*Caladenia flava* subsp. *flava*
		Pyrorchis nigricans
Oxalidaceae	*	*Oxalis pes-caprae*
Phyllanthaceae		*Phyllanthus calycinus*
Phytolaccaceae	*	*Phytolacca octandra*
Poaceae	*	*Briza maxima*
		Ehrharta longiflora
		Poaceae sp.
Primulaceae	*	*Lysimachia arvensis*
Proteaceae		*Banksia attenuata*
		Banksia menziesii
		Stirlingia latifolia
Restionaceae		*Desmocladus flexuosus*
Solanaceae	*	*Solanum nigrum*
Xanthorrhoeaceae		*Xanthorrhoea preissii*

Appendix 4
Raw Quadrat Data

Site Q01

GPS Coordinat 51H 391413 mE; 6437848 mN

Landform upper slope of dun

Slope (degrees) 3

Aspect SE

Soil sand; grey

Ground cover: Bare ground (%) 5 Litter (%) 10

Condition Good Fire Age 5



Disturbance weeds; cattle;

Vegetation Description Banksia attenuata and Banksia menziesii woodland

Taxa	Height (m)	% Cover
Banksia attenuata	4	8
Banksia menziesii	4	3
Xanthorrhoea preissii	1	6
Acacia pulchella	1	5
Stirlingia latifolia	1	5
Hovea pungens	0	2
**Ehrharta longiflora*	0	15
Drosera erythrorhiza	0	0
Styphelia tenuiflora	0	0
Desmocladus flexuosus	0	0
Chamaescilla corymbosa	0	1
Conostylis setigera subsp. setigera	0	1
Erodium cygnorum	0	1
Tetraria capillaris	0	0
Hypocalymma robustum	0	3
Hibbertia hypericoides	0	10
**Crassula glomerata*	0	0
**Hypochaeris glabra*	0	2
**Poaceae sp.*	0	10
**Arctotheca calendula*	0	10
**Ursinia anthemoides*	0	10
Daviesia sp.	0	1
Eucalyptus marginata		
Allocasuarina fraseriana		

Site Q02

GPS Coordinat 51H 391446 mE; 6437956 mN

Landform dune crest

Slope (degrees) 3

Aspect SE

Soil sand; grey

Ground cover: Bare ground (%) 5 Litter (%) 10

Condition Good Fire Age 5



Disturbance weeds; cattle;

Vegetation Description Banksia attenuata and Banksia menziesii woodland

Taxa	Height (m)	% Cover
Eucalyptus marginata	10	15
Allocasuarina fraseriana	8	1
Banksia attenuata	4	5
Banksia menziesii	4	5
Acacia pulchella	1	2
Anigozanthos manglesii subsp. manglesii	0	0
Daviesia sp.	0	1
**Ursinia anthemoides*	0	2
Conostylis serrulata	0	1
Caladenia flava subsp. flava	0	0
Thysanotus manglesianus	0	0
Erodium cygnorum	0	5
Scaevola repens var. repens	0	0
Isotropis cuneifolia	0	0
Chamaescilla corymbosa	0	0
Lagenophora huegelii	0	1
Hardenbergia comptoniana	0	2
Corynotheca micrantha var. micrantha	0	0
**Ehrharta longiflora*	0	10
Pyrorchis nigricans	0	0
Desmocladus flexuosus	0	2
Drosera erythrorhiza	0	1
**Briza maxima*	0	15
**Gladiolus caryophyllaceus*	0	0
Dampiera linearis	0	1
**Hypochaeris glabra*	0	5
**Romulea rosea var. australis*	0	2
**Carpobrotus edulis*	0	0
Stirlingia latifolia	0	2
Hibbertia hypericoides	0	10
Hypocalymma robustum	0	3
Tetraria capillaris	0	1
Leucopogon propinquus	0	2
Lomandra hermaphrodita	0	1

Schoenus curvifolius	0	1
Gompholobium tomentosum	0	1
Tetraria octandra	0	2

Site Q03

GPS Coordinat 51H 391496 mE; 6437885 mN

Landform slope

Slope (degrees) 5

Aspect SE

Soil sand; grey

Ground cover: Bare ground (%) 5 Litter (%) 20

Condition Good Fire Age 5



Disturbance weeds; cattle;

Vegetation Description Banksia attenuata and Banksia menziesii woodland

Taxa	Height (m)	% Cover
Eucalyptus marginata	12	15
Drosera erythrorhiza	8	0
Allocasuarina fraseriana	8	7
Banksia attenuata	5	10
Stirlingia latifolia	1	2
Acacia pulchella	1	5
Xanthorrhoea preissii	1	5
**Lysimachia arvensis*	0	1
Conostylis serrulata	0	1
Trachymene pilosa	0	0
Lagenophora huegelii	0	2
Erodium cygnorum	0	1
**Ehrharta longiflora*	0	25
Caladenia flava subsp. flava	0	0
Bossiaea ornata	0	0
Tetraria capillaris	0	0
Phyllanthus calycinus	0	1
Hovea pungens	0	1
**Gladiolus caryophyllaceus*	0	1
Hibbertia hypericoides	0	8
Anigozanthos manglesii subsp. manglesii	0	0
**Hypochaeris glabra*	0	5
Chamaescilla corymbosa	0	1
**Euphorbia terracina*	0	0
**Romulea rosea var. australis*	0	1
**Ursinia anthemoides*	0	3
**Briza maxima*	0	15
Tetraria octandra	0	5

Site Q04

GPS Coordinat 51H 391937 mE; 6436968 mN

Landform flat

Slope (degrees) nil

Aspect -

Soil sandy loam; brown

Ground cover: Bare ground (%) 0 Litter (%) 10

Condition Completely Degra Fire Age 5

Disturbance weeds

Vegetation Description Eucalyptus rudis woodland



Taxa	Height (m)	% Cover
Eucalyptus rudis subsp. rudis	15	8
**Zantedeschia aethiopica*	1	25
**Briza maxima*	1	10
Pteridium esculentum	1	60
**Oxalis pes-caprae*	0	2

Site Q05

GPS Coordinat 51H 391942 mE; 6436988 mN

Landform flat

Slope (degrees) nil

Aspect -

Soil sandy loam; brown

Ground cover: Bare ground (%) 0 Litter (%) 10

Condition Completely Degra Fire Age 5

Disturbance weeds

Vegetation Description Eucalyptus rudis woodland



Taxa	Height (m)	% Cover
Eucalyptus rudis subsp. rudis	15	2
Pteridium esculentum	1	60
**Zantedeschia aethiopica*	1	25
**Briza maxima*	1	10
**Hypochaeris glabra*	0	1
**Arctotheca calendula*	0	1
**Oxalis pes-caprae*	0	2

Site Q06

GPS Coordinat 51H 391902 mE; 6436976 mN

Landform flat

Slope (degrees) nil

Aspect -

Soil sandy loam; brown

Ground cover: Bare ground (%) 0 Litter (%) 10

Condition Completely Degra Fire Age 5

Disturbance weeds

Vegetation Description Eucalyptus rudis woodland



Taxa	Height (m)	% Cover
Eucalyptus rudis subsp. rudis	15	30
Pteridium esculentum	1	5
**Zantedeschia aethiopica*	1	75
**Briza maxima*	1	2
**Oxalis pes-caprae*	0	2
**Hypochaeris glabra*	0	1
**Arctotheca calendula*	0	1
**Ehrharta longiflora*	0	15
**Carthamus lanatus*	0	1

Site Q07

GPS Coordinat 51H 391844 mE; 6437027 mN

Landform flat

Slope (degrees) nil

Aspect -

Soil sandy loam; brown

Ground cover: Bare ground (%) 0 Litter (%) 10

Condition Completely Degra Fire Age 5

Disturbance weeds

Vegetation Description Eucalyptus rudis woodland



Taxa	Height (m)	% Cover
Eucalyptus rudis subsp. rudis	15	30
Pteridium esculentum	1	30
**Zantedeschia aethiopica*	1	60
**Solanum nigrum*	1	0
**Oxalis pes-caprae*	0	1
**Ehrharta longiflora*	0	1
**Hypochaeris glabra*	0	1

Site Q08

GPS Coordinat 51H 391876 mE; 6437075 mN

Landform flat

Slope (degrees) nil

Aspect -

Soil sandy loam; brown

Ground cover: Bare ground (%) 0 Litter (%) 10

Condition Completely Degra Fire Age 5

Disturbance weeds

Vegetation Description Eucalyptus rudis woodland



Taxa	Height (m)	% Cover
Eucalyptus rudis subsp. rudis	15	30
Melaleuca rhaphiophylla	10	8
**Phytolacca octandra*	1	1
Pteridium esculentum	1	10
**Zantedeschia aethiopica*	1	80
**Oxalis pes-caprae*	0	2

Site Q09

GPS Coordinat 51H 391904 mE; 6437107 mN

Landform flat

Slope (degrees) nil

Aspect -

Soil sandy loam; brown

Ground cover: Bare ground (%) 0 Litter (%) 10

Condition Completely Degra Fire Age 5

Disturbance weeds

Vegetation Description Eucalyptus rudis woodland



Taxa	Height (m)	% Cover
Eucalyptus rudis subsp. rudis	15	15
Melaleuca rhaphiophylla	8	2
**Conyza bonariensis*	1	1
**Zantedeschia aethiopica*	1	35
**Briza maxima*	1	5
Pteridium esculentum	1	45
**Oxalis pes-caprae*	0	10
**Ehrharta longiflora*	0	15

Appendix 5
Landscape Principles Plan



RECREATION NODE WITH PAVED SEATING AREA & SHELTER OVERLOOKING REVEGETATED CREEK.

REGIONAL MAIN DRAIN

THE REGIONAL MAIN DRAIN IS AN IMPORTANT REFERENCE TO THE RURAL/AGRICULTURAL HERITAGE OF THE SITE AND SHOULD BE CELEBRATED IN THE LANDSCAPE. IT FORMS A SIGNIFICANT EAST/ WEST GREEN LINK & RECREATION CORRIDOR, CONNECTING MAJOR OPEN SPACES & INTERSECTING WITH THE MAIN BOULEVARD WHICH FORMS THE NORTH-SOUTH GREEN LINK. MUCH OF THE DRAIN TO BE REVEGETATED WITH NATIVE SPECIES.

EXISTING TREES TO BE RETAINED.

EXISTING AVENUE OF SHEOAKS TO BE RETAINED IN LINEAR PARK, PROVIDING AN IMPORTANT GREEN LINK CONNECTION TO THE EAST/WEST GREEN LINK & THE MAJOR CENTRAL PARK IN THE ESTATE.

COMMUNITY PAVILION WITH SEATING AREAS & PLAYGROUND.

MAJOR CENTRAL PARK WITH LARGE LAWN AREA TO ALLOW FOR ACTIVE INFORMAL PLAY & ACCOMMODATE COMMUNITY ACTIVITIES & EVENTS.

RECREATION NODE WITH PAVED SEATING AREA, SHELTER & JUNIOR PLAY AREA.

APSLEY CENTRAL PARK

LANDSCAPE PRINCIPLES PLAN

SEPTEMBER 2018

JOB NO. 1403301

1:1250 @ A3

SK.101

REV A

0 6.25 12.5 25 37.5 62.5m

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PLAN E

LANDSCAPE ARCHITECTS

414 ROKEBY RD SUBIACO WA 6008

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BESPOKE SHADE STRUCTURE
+ PICNIC FACILITIES

REVEGETATED PEEL MAIN
DRAIN WITH RETAINED TREES

BESPOKE SHADE STRUCTURE
+ PICNIC FACILITIES

NATURE PLAYGROUNDS

BESPOKE SHADE STRUCTURE
+ PICNIC FACILITIES

LOW RETAINING WALL

OPEN TURF AREA

NATIVE WETLAND PLANTING
TO DRAINAGE BASIN















MANDOGALUP DEVELOPMENT - PMD

LANDSCAPE CONCEPT PLAN
NOVEMBER 2017

JOB NO. 1403301
1:500 @ A1

C1.107

0 5 10 20 30 50m

REV A

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PLAN E

LANDSCAPE ARCHITECTS

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Appendix E Black Cockatoo hollow assessment

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Project No: SPG18229.02

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Inquiries: Kathy Choo

Re-assessment of Hollows for Black Cockatoo Nesting - Mandogalup

Background

A previous assessment of trees at the Mandogalup site identified six trees with hollows that were identified as potential habitat hollows, however, no dimensions for the entrance openings were provided as the primary objective of the assessment was about tree health and retention (Arbor logic 2017).

Given there was no information on the dimensions of the hollows in these six trees or whether or not the site was being used as a roost, these six trees and their hollows were re-assessed for their suitability to support Black Cockatoo nesting and to see if the site was being used as a roost.

Methods

The site visit was undertaken on 26, 29, and 30 October. The co-ordinates of the previously identified six trees (tree identifier numbers 329, 336, 347-348, and 368; these numbers refer to the corresponding tree tag numbers in the Arbor logic [2017] report) with hollows were entered on the GPS so that they could be located.

At each tree, we assessed from the ground (with the naked eye and with binoculars) and estimated the following three characteristics that might make a tree suitable for Black Cockatoos to nest in:

- size of the hollow opening (mm)
- height (m) of the hollow from the ground
- angle of the hollow (whether the hollow was in a branch or main trunk).

Please note that these characteristics were observed and measured (estimated) as they are important aspects to consider whether a hollow is suitable for Black Cockatoos to nest in and they can be measured without having to climb the tree. The internal dimensions of a hollow are critical and ultimately determine whether the hollow is suitable or not in order for a nest to be constructed; however, to do this the tree needs to be climbed and the internal dimensions of the hollow measured (as previously mentioned).

The literature was consulted in order to determine what size, height and angle the three characteristics of a tree above need to be to make them a potentially suitable nest tree. Past studies have found that on average hollow openings are 250 mm x 270 mm (Saunders et al. 1982, Saunders and Dawson 2017) and 300 mm x 340 mm (Johnstone et al. 2013). The height of a hollow entrance off the ground is on average14.49 m (Johnstone et al. 2013). Nearly all hollows that are used for nesting by Black Cockatoos are located in the main trunk and have a vertical aspect (Johnstone et al. 2013, Saunders and Dawson 2017). Black Cockatoos are large birds with shoulders that are about 100 mm wide, therefore they require hollows with an entrance bigger than this (as shown above they are typically much larger), but the internal dimensions (depth and floor base) need to be much larger in order for it to be suitable to lay eggs in and for adults to be able to move around.

None of the species present at the site are known dietary items of Black Cockatoos.

Two dawn and two dusk visits were also carried out in order to determine if the site was being used as a roost. The dawn visits involved arriving at the site just prior to civil twilight and looking (naked eye and binoculars) and listening for the calls and movements of Black Cockatoos until sunrise. The dusk visits involved arriving at the site prior to sunset and remaining there until the end of civil twilight while looking (naked eye and binoculars) and listening for the calls and movements of Black Cockatoos.

Results and Discussion

None of the hollow openings in the six trees were considered large enough from the ground for Black Cockatoos to enter (see photos in Appendix A). The largest hollow opening was estimated to be 60 mm wide at its widest point. Several also appeared to be blind openings (i.e. they did not go far in enough to be suitable), or were not high enough off the ground. All of the six trees were dead Flooded Gum and had a structure that was unlikely to make them suitable for nesting i.e. their main trunks split into several smaller trunks (most did this between 2-4 m), consequently, the DBH of these trunks was likely to make them too small to be used for nesting.

During the four visits (dawn and dusk) no Black Cockatoos were seen or heard roosting at the site and none were seen foraging or flying over.

References

Arbor logic 2017, Significant tree assessment; Balance of Mandogalup east local structure plan. Unpublished report prepared for Strategen Environmental.

Johnstone, R. E, Kirkby, T., and Sarti, K. 2013, The breeding biology of the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* Gould in south-western Australia. I. Characteristics of nest trees and nest hollows. *Pacific Conservation Biology* **19**, 121–142.

Saunders, D. A., Smith, G. T. and Rowley, I. 1982, The availability and dimensions of tree hollows that provide nest sites for cockatoos (Psittaciformes) in Western Australia. *Australian Wildlife Research* **9**, 541-56.

Saunders, D. A. and Dawson, R. 2017, Cumulative learnings and conservation implications of a long-term study of the endangered Carnaby's Cockatoo *Calyptorhynchus latirostris*. *Australian Zoologist* **40**, 1-19.

Appendix A: Photos



Tree 329



Tree 336



Tree 347



Tree 348



Tree 349



Tree 368

Appendix F Balance of site environmental assessment

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To: John Hirdman

Date: 3 July 2018

Company: Satterley Property Group

Project No: SPG17013.01

Fax/email: johnh@satterley.com.au

Inquiries: Dehlia Goundrey

Mandogalup Urban Development
Balance of site environmental assessment

This technical note presents the results of an environmental assessment of the Mandogalup Balance site located on the western side of the Kwinana Freeway, comprising Part Lot 9006, Part Lot 9002 and Part Lot 11 Hoffman Road, Mandogalup (Figure 1; survey area).

Strategen was commissioned by Satterley Property Group (Satterley) to undertake an environmental assessment of the survey area to inform development design. The survey area comprises a total area of 42.67 ha located approximately 30 km south of Perth in the City of Kwinana. The survey area is bounded by the Mandogalup East Local Structure Plan to the north, Kwinana Freeway to the east, Anketell Road to the south and Mandogalup West Local Structure Plan to the west.

The environmental assessment of the site comprised a vegetation, landscape feature, significant tree and arboriculture survey. A significant tree is defined in the City of Kwinana (CoK) *Local Planning Policy No. 1 - Landscape Feature and Tree Retention* as a tree with a diameter at breast height (DBH) of 500 mm or greater.

The assessment undertaken provides an appropriate level of information to support development design and assessment in accordance with the City of Kwinana (CoK) Local Planning Policy No.1.

Scope

The objectives of this assessment were to:

- undertake a reconnaissance flora and vegetation survey within the survey area
- identify, tag and map significant trees (DBH >500 mm) within the survey area
- record the species, physical size, health condition, structural condition and any comments deemed pertinent to a significant tree
- identify the suitability for retention of the significant trees in a residential development, considering the Tree Protection Zone (TPZ) and Structural Root Zone (SRZ) (based on Australian Standard [AS] 4970 [2009]; Protection of trees on development sites and AS 4373 [2007]; Pruning of amenity trees)
- prepare a report summarising the findings.

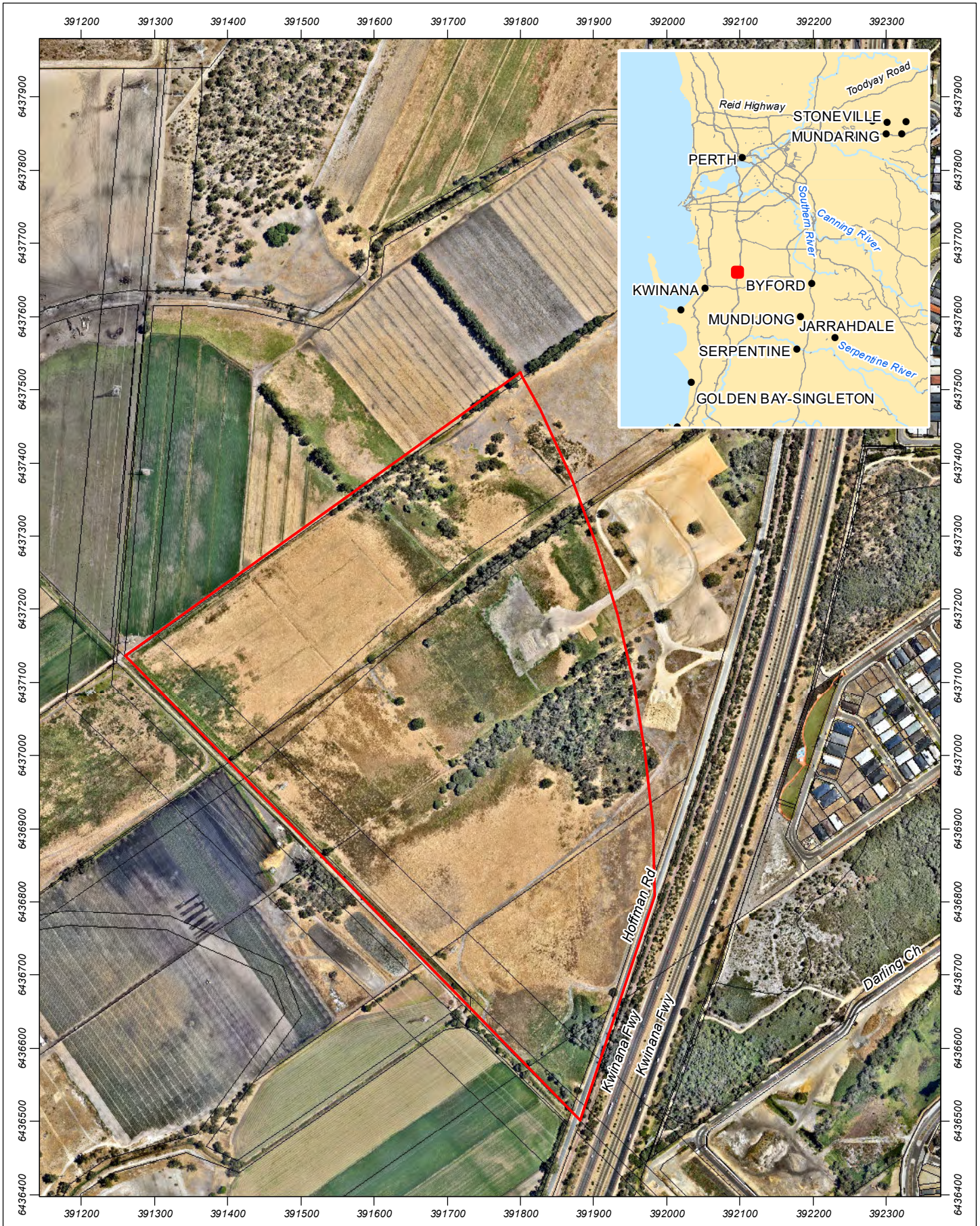


Figure 1: Survey area

Scale 1:7,000 at A4

0 50 100 150 200 250 m

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 1/02/2017

Author: DWhite

Source: Existing cadastre: SLIP database, Landgate 2017; Aerial: Nearmap Jan 2017; Roads: Main Roads 2012; Native vegetation extent: DAFWA Oct 2016.

Path: Q:\Consult\2017\SPG\SPG17013\ArcMap_documents\M001\SPG17013_01_M001_RevA_F001.mxd

Legend

Survey area



strategen ENVIRONMENTAL
info@strategen.com.au
www.strategen.com.au

Methods

The survey was undertaken by qualified ecological and arboriculture consultants Strategen and ArborLogic on 19 January 2017.

Flora, vegetation and landscape feature survey

The survey area comprises of predominantly cleared highly disturbed flat agricultural land. The landscape features within the survey area are displayed through the existing areas of native vegetation.

The level 1 flora and vegetation survey was conducted according to standards set out in the EPA '*Technical Guidance – Flora and vegetation surveys for Environmental Impact Assessment*' (EPA 2016). The survey area was traversed on foot to record native and introduced species, percentage cover of each species, and vegetation condition. Four relevés were surveyed to identify vegetation types within the survey area.

Flora and vegetation was described and sampled systematically at each relevé and additional opportunistic collecting was undertaken wherever previously unrecorded plants were observed. At each relevé the following floristic and environmental parameters were noted:

- GPS location
- topography
- soil type and colour
- outcropping rocks and their type
- percentage cover and average height of each vegetation stratum.

For each vascular plant species, the average height, number of plants and percent cover were recorded.

Significant tree and arboriculture assessment

The significant tree and arboriculture assessment involved traversing the survey area on foot, identifying significant trees and tagging these trees with a metal plate containing an ID number. All trees on the survey area were visually inspected from ground level. Any tree found to have a main stem diameter of 50 cm or greater (significant tree) was subsequently included in the assessment. The GPS co-ordinates of each significant tree (MGA Zone 50) and any comments deemed pertinent to the tree were recorded.

The details of each significant tree were also recorded including:

- tree species
- physical size
- health condition
- structural condition
- hollows (>10 cm diameter)
- Tree Protection Zone (TPZ) and Structural Root Zone (SRZ) (based on AS4970 and AS4373)
- suitability for retention in a residential development.

All of these trees were assessed in accordance with visual tree assessment ("VTA") methods and principles adopted by Abor Logic. The VTA method is based on the sciences of tree biology, physiology, tree structure, and tree bio-mechanics and is widely used to identify visible signs on trees that indicate any health or potential structural issues that in turn could increase the risks associated with the given tree.

Tree health

The overall health of each tree was adjudged from an inspection of its leaf, overall percentage of leaf mass within the canopy of the tree, and the presence (or absence) of any pest or disease factor that could have an effect on the overall health of the tree. The tree health rating scale used by ArborLogic is presented in Table 1.

Table 1: Tree health rating scale utilised during the survey (ArborLogic 2017).

Health rating	Description of classification
Excellent	Shows to have typical foliage condition and amount of foliage mass for a specimen of the species. May have a minor amount of deadwood, but no signs of any pest or disease factor that may affect its health.
Good	Shows to have typical foliage condition. Canopy foliage may be slightly chlorotic, or it may have a slightly higher percentage of deadwood than usual, or exhibit signs of being affected by environmental conditions. May have a minor pest or disease present that could start to affect its health.
Fair	Shows to have a relatively high percentage of deadwood than considered typical for a specimen of the given species and/or a low volume of live canopy leaf mass for a specimen of the given species. Apical sections of the canopy (may also be) dead. Signs of a pest or disease factor evident.
Poor	Has a high percentage of deadwood material in its canopy and a low volume of live canopy mass (typically <20%).
Dead	Shows to have either no live tissue within its structure, or at best has <5% live foliage mass remaining in its canopy.

Structural condition

The structural integrity of each tree was determined from a visual inspection of its main stem, primary (and secondary) branch unions to determine the presence of any areas considered to be a structural 'defect' or 'imperfection' such as unions with included bark, swelling, or noticeable splitting at them.

Symptoms of decay, growth patterns and defects are identified and assessed in terms of their potential to cause failure of the whole tree, part of the tree or branches. Where considered necessary, further investigation using sounding techniques was utilised to determine the presence and general extent of any areas of cavity or associated decay within a tree's main stem structure.

The tree's root plate area was also inspected to identify any visible signs of root plate, movement, cracking or heave from which a determination of the in-ground stability of the tree can be ascertained. It is important to note that there are limitations in verifying the in-ground stability of a tree based on a 'one-off' cursory visual observation; particularly in a forest type habitat where ground cover and leaf litter prevent or limit visual observations, particularly if the inspection is undertaken during a period of 'fine' weather with little to no wind (as was the case over the period of this assessment).

The tree structure rating scale used by ArborLogic is presented in Table 1.

Table 2: Tree structure rating scale utilised during the survey (ArborLogic 2017).

Structure rating	Description of classification
Good	Shows typical structural form for a specimen of the species. Branch unions show typical form at the point of attachment. May have a small number of minor structural defects, but are within the scope of tree surgery management to rectify. Shows to be root-stable.
Acceptable	Shows an acceptable form, but may have a number of structural defects present i.e. bi-furcation (but with no major swelling or movement), or areas of stem cavities. Structure remains within the scope of management at this stage, albeit with a higher risk/management requirement. Can include previously lopped trees that are known to have good points of attachment of any regrowth that occurs.
Questionable	Shows an undesirable structure for a specimen of the species. Structural condition likely to cause future issues in regards to the potential for branch or even complete tree failure to occur. Generally includes previously lopped trees, trees with large areas of cavity and/or associated decay that may be starting to affect its structural integrity, trees with bi-furcated unions with notable bark and swelling that are considered to have an increased potential to fail.
Poor	Major structural defects evident. May have very large stem cavities, extensive termite damage, or noticeable movement in main stem, branch unions or root plate area.

Suitability for retention in the development

The suitability of each tree for use in an urban area, with consideration of the species traits, was also identified. Species that can be subject to sudden branch failure or known to be potentially problematic in terms of self-sowing (weed) issues were also considered as part of the assessment process.

The known root zone morphology of the species was considered when allocating the recommended TPZ for each of the identified trees[1]. The ability of a tree to cope with disturbances to its root zone that typically occur as part of a development process, as well as its ability to cope with the new parameters that are commonly created by an urban development (i.e. decreased soil oxygen due to compaction, increased unseasonal watering from irrigation, increased pollution, increased radiated heat/light from urban infrastructure such as roads, walls, buildings) were all also taken into consideration.

The following classification was used during this assessment for retention value of the significant trees identified (Table 3).

Table 3: Retention value classification used during the arboriculture assessment (ArborLogic 2016)

Retention value	Description of classification
High	Generally a good/very good specimen that shows good health, structural and aesthetic form. Trees with High retention value are generally strongly recommended to be retained as part of development and would be suitable for POS or even in some circumstances road reserves and/or lots depending on detailed design and ability to maintain/protect a sufficient area of its TPZ.
Medium	Reasonably good specimen of its species and worth retaining as part of development. These trees may have reduced health/vigour, or structural imperfections that (whilst within the realms and scope of management) may have higher management and maintenance requirements. Such trees are generally suitable for road reserves, POS or even lots depending on detailed design and ability to maintain/protect a sufficient area of its TPZ.
Low	Reasonable specimen. This typically includes trees that indicate a declining health or have structural imperfections that are assessed to be starting to affect the structural integrity of the tree. Retention of such trees within a road reserve or lot would not be recommended due to potential impact from development, and/or a risk management perspective. Low retention value trees may have high environmental benefits, but their structure may limit their potential for retention other than in areas of POS where the risks associated with the tree can then be better managed by way of good design.
Very Low	These are generally poor quality trees that are typically suggested to be removed from a risk management perspective. Typically includes dead trees and trees with poor structural form that have a high probability of failure. Such trees may have high environmental benefit, but retention even within an area of open space would be highly questioned from a risk management perspective, unless design of the area around them was able to prevent potential targets from entering into their fall zone.

[1] Whilst some reference and acknowledgment is given to the guidelines set down in AS 4970, the TPZ for each tree has been based on the known typical root zone morphology for specimens of their species, the condition of the given tree, and the known tolerance to root zone disturbance of the given species.

Results

Flora and vegetation survey

Native flora

A total of four native vascular plant taxa from three plant genera and two plant families were recorded within the survey area. The majority of taxa were from within the Myrtaceae (three taxa) family (Appendix 1). The relatively low number of plant genera recorded reflects the extremely disturbed nature of the survey area.

Threatened and Priority flora

No Threatened flora species as listed under section 178 of the EPBC Act or pursuant to Schedule 1 of the WC Act and as listed by Parks and Wildlife (2015) were recorded within the survey area and no Priority flora species as listed by Western Australian Herbarium (1998-) were also recorded within the survey area.

Introduced (exotic) taxa

A total of 20 introduced (exotic) taxa were recorded within the survey area (Appendix 1):

One of these species (**Zantedeschia aethiopica* [Arum Lily]) is a Declared Plant species in Western Australia pursuant to section 22 of the *Biosecurity and Agriculture Management Act 2007* (BAM Act) according to the Western Australian Department of Agriculture and Food (DAFWA 2016). This species was recorded throughout VT1 and VT2.

Vegetation types

Two vegetation types (VTs) were defined and mapped within the survey area (Figure 2; Appendix 2) and are summarised in Table 4. Areas containing vegetation in a highly degraded state have not been counted as unique native VTs but have been included in Table 4 for area calculation purposes. Total areas occupied within the survey area by each of the identified VTs are set out in Table 5.

Vegetation types recorded within the survey area do not resemble any known TECs or PECs.

Table 4: Vegetation Types

Vegetation Type	Description
1	*Eucalyptus rudis and Melaleuca rhaphiophylla woodland* over *Pteridium esculentum, *Zantedeschia aethiopica, *Phytolacca octandra* and **Gomphocarpus fruticosus* low shrubland over exotic grasses and herbs including **Ehrharta calycina, *Cynodon dactylon* and **Cirsium vulgare* on sandy soils.
2	*Eucalyptus rudis* and **Ficus carica* open woodland over *Pteridium esculentum* shrubland over exotic grasses including **Ehrharta calycina and *Avena barbata* on sandy soils.
Cleared	Historically cleared area containing exotic grasses including **Eragrostis curvula* and **Ehrharta calycina* on sandy soils.

Vegetation type coverage

The total area mapped within the survey area was 37.98 ha which includes highly degraded and fully cleared areas (Table 5). The dominant VT[2] within the survey area was VT 1 (4.07 ha) which can be broadly described as *Eucalyptus rudis and Melaleuca rhaphiophylla woodland* over *Pteridium esculentum, *Zantedeschia aethiopica, *Phytolacca octandra* and **Gomphocarpus fruticosus* low shrubland over exotic species including **Ehrharta calycina, *Cynodon dactylon* and **Cirsium vulgare* on sandy soils.

[2] Not including highly degraded areas.

Table 5: Area (ha) covered by each VT within the survey area

VT	Area (ha)	Percentage of the Survey area
1	4.07	10.72
2	1.00	2.63
Cleared	32.91	86.65
TOTAL	**37.98**	**100**

Landscape feature

As discussed the survey site is completed degraded agricultural land. Landscape features on the site are limited to the presence of native vegetation. A3.17 ha area of native vegetation comprising of VT1 (2.17 ha) and VT2 (1 ha) is located on the mid-point of the eastern survey site boundary. This area of vegetation may be considered a landscape feature within the site due to the absence of landscape features generally within the survey area.

Vegetation condition

The survey area shows signs of having been degraded for a long period of time due to historical clearing and agricultural land use. As such, vegetation condition within the survey was Completely Degraded (Keighery 1994; Figure 2; Table 6).

Table 7 gives a numerical breakdown of the area occupied by each vegetation condition rating within the survey area.

Table 6: Vegetation condition scale (Keighery 1994)

Condition rating	Description
Pristine (1)	Pristine or nearly so, no obvious sign 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 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, 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.

Table 7: Area (ha) covered by each vegetation condition category within the survey area

Vegetation Condition	Area (ha)	Percentage of the Survey area
Completely Degraded	37.98	100
Total	**37.98**	**100**

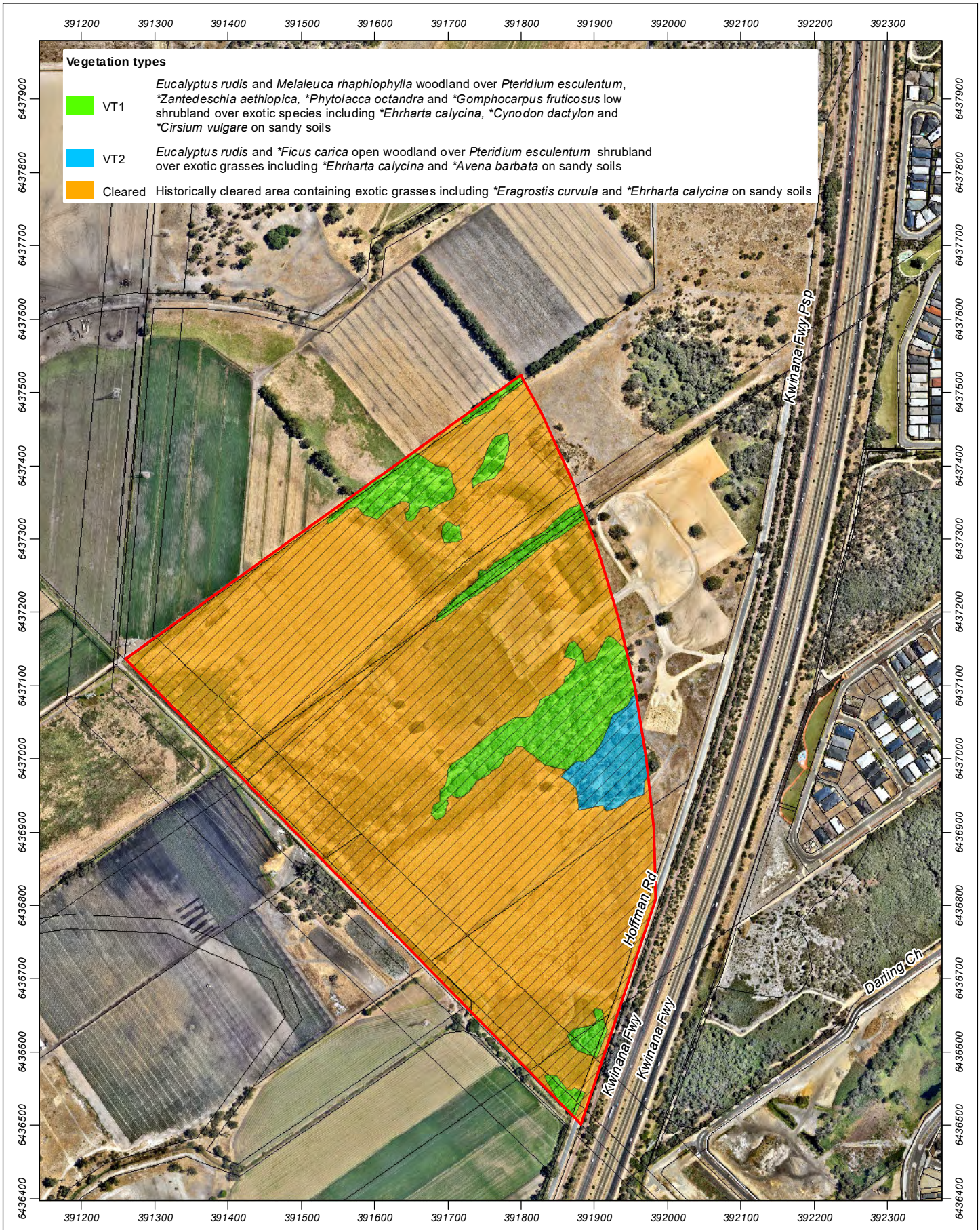


Figure 2: Vegetation types mapped within the survey area

Scale 1:7,000 at A4

0 50 100 150 200 250 m

Coordinate System: GDA 1994 MGA Zone 50
Note that positional errors may occur in some areas
Date: 1/02/2017
Author: DWhite
Source: Existing cadastre: SLIP database, Landgate 2017; Aerial: Nearmap Jan 2017; Roads: Main Roads 2012.

Legend

Survey area

Vegetation condition

Completely Degraded

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Significant tree and arboriculture assessment

A total of 125 significant trees were recorded within the survey area, which included 91 Flooded Gum (*Eucalyptus rudis*), 32 Freshwater Paperbark (*Melaleuca rhaphiophylla*) and two Bangalay (**E. botryoides*) trees (refer to Appendix 3).

Tree health

The health of the trees identified within the survey area varied significantly. A total of 22 of the trees were found to be dead with no live leaf mass remaining within their canopy; most of these trees (21) were Flooded Gum. A further 13 Flooded Gum trees were considered to be in a poor health condition and were likely to have limited life span remaining. These trees are considered unlikely to survive the extent of disturbance and changes to their surrounds that typically occurs as a result of a development process.

A total of 28 Flooded Gum trees were considered to be in a 'fair' health condition during the survey. The cause of the reduced vigour was considered to be associated with environmental factors rather than any pest or disease pathogen. Some (if not all) of these trees may recover over time depending on seasonal rainfalls and treatment during a develop process.

The remaining 62 trees recorded showed to be in good health and no visible evidence of any pest or disease pathogen that could have a major impact to their health was observed.

Whilst a number of trees showed to have varying amounts of deadwood in their canopy, it is likely due to the natural growth processes rather than a pest or disease pathogen. Minor pest/disease issues were observed in some trees, however they were considered unlikely to have a major impact to the future health of these trees.

Structural condition

The majority of the significant trees showed to have typical structural forms for specimens of their given species. Whilst a number of the trees showed to have 'structural defects' such as bi-furcated unions with signs of swelling and included bark (which are considered to potentially have an increased likelihood for failure than other forms of branch unions), the majority of structural defects or imperfections were not considered to be of any major concern at the time of the survey.

The development and structural form of some of the trees was noted to have been affected and influenced by the proximity of adjacent trees, with some trees growing on a lean and others having developed 'leggy' canopy form with high bending movement in winds and little to no lower canopy mass. Overall, this was not considered to be of any major concern at the time of the survey, however issues may arise if surrounding trees are removed, thereby increasing the exposure to wind forces particularly in the wetland areas. Branch failures were observed to have occurred on ten of the trees. All of the failures were considered to have occurred as a result of force loading (i.e. wind/storm damage) as opposed to any predisposition for failure.

Areas of decay were observed in a number of the trees, particularly some of the larger and older Flooded Gum. Overall, the decay was not considered to compromise the structural integrity of the trees, although the structural form of 16 trees was considered to be questionable. Three trees with questionable structure showed good/excellent health, however the extent of decay present in their structure indicates an increased potential for failure to occur. The trees showing poor structural form were considered to have a high probability for failure to occur. The structural form of five of the dead trees (and 10 of the trees in poor health) was considered to be acceptable at the time of the survey, however, natural decay pathogens will likely to continue to impact and potentially compromise their structural integrity over time.

Suitability for retention in the development

Retention value of the various tree species and individual tree specimens is subject to the opinion of the assessor. In general, trees displaying good health and deemed to have a good aesthetic quality are considered to have a high retention value. Conversely, dead or declining trees, tree species known (or considered) to be problematic in terms of having a propensity for branch failures, species that could self-seed freely, or trees that display low aesthetic traits would typically be considered to have a low retention value.

Other aspects of the tree must be considered as part of ascertaining the suitability for inclusion into a development, primarily its structural form and suitability for inclusion into an urbanised area with high volumes of potential targets (e.g. people, structures etc.) and its potential to cope with changes to its soil and surrounding environment that typically occur as part of a development process (e.g. landscape works).

The majority of identified trees were considered suitable for retention and inclusion into urban areas such as public open space, with the exception of the dead, declining and those with potentially hazardous structural form, however, retention of some of the trees will be dependent on aspects of the development design and what potential targets will be introduced into the fall zone of those trees. Should targets be introduced into the fall zone of these trees, then retention may become questionable. Some of the better quality trees would be suitable for retention into lots or road side verges providing development design can accommodate protection of their root zone area.

The majority of trees (46) had a medium retention value and just 19 trees had a high retention value. A summary of the significant trees recorded during the survey including their health, structure and retention values are presented in Figure 3 and Table 8.

Table 8: Summary of significant trees recorded within the survey area

Species		Eucalyptus botryoides	Eucalyptus rudis	Melaleuca rhaphiophylla	Total
Health	Excellent	2	11	27	40
	Good	0	18	4	22
	Fair	0	28	0	28
	Poor	0	13	0	13
	Dead	0	21	1	22
Structure	Good	2	21	15	38
	Acceptable	0	49	16	65
	Questionable	0	15	1	16
	Poor	0	5	0	5
	Potentially Hazardous	0	1	0	1
Retention value	**High**	0	8	11	19
	Medium	2	25	19	46
	Low	0	24	1	25
	Very Low	0	34	1	35

Black cockatoo habitat

'Breeding habitat' for black cockatoos is defined in DSEWPaC (2012) as trees of species known to support breeding within the range of the species which either have a suitable nest hollow or are of a suitable DBH to develop a nest hollow (i.e. significant trees). Significant trees may also be large enough to provide roosting habitat (i.e. trees which provide a roost or rest area for the birds). Significant trees which contain hollows that have an entrance diameter of more than 100 mm are suitable for use by black cockatoos (Whitford and Williams 2002). The survey area is located within the breeding range of Carnaby's Black Cockatoos (CBC) (Parks and Wildlife 2013).

The site contains 91 *Eucalyptus rudis* trees and a total of six of these trees contain a hollow of sufficient size to be utilised by black cockatoos (Figure 3). All six of the trees are located within the potential landscape feature. There were no visual evidence of these trees being in use. The *E. rudis* trees provide both breeding and roosting habitat for CBC only and therefore the significant tree assessment applies only to CBC.

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391600 391800 392000

6437400 6437200 6437000 6436800 6436600

Retention value (*tree species*)

- High, Flooded Gum (*Eucalyptus rudis*)
- High, Freshwater Paperbark (*Melaleuca rhaphiophylla*)
- Medium, Bangalay (*Eucalyptus botryoides*)
- Medium, Flooded Gum (*Eucalyptus rudis*)
- Medium, Freshwater Paperbark (*Melaleuca rhaphiophylla*)
- Low, Flooded Gum (*Eucalyptus rudis*)
- Low, Freshwater Paperbark (*Melaleuca rhaphiophylla*)
- Very Low, Flooded Gum (*Eucalyptus rudis*)
- Very Low, Freshwater Paperbark (*Melaleuca rhaphiophylla*)

Figure 3: Retention value of significant trees (DBH>50cm) located within the survey area

Scale 1:2,961 at A3

0 50 100 150 200 250 Meters

Coordinate System: GDA 1994 MGA Zone 50

Note that positional errors may occur in some areas

Date: 1/02/2017

Author: DWhite

Source: Existing cadastre: SLIP database, Landgate 2017; Aerial: Nearmap Jan 2017; Roads: Main Roads 2012.

Legend

Survey area

Hollow (>10cm diameter)

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Discussion

Vegetation within the survey area comprises two VTs and cleared areas. The number of native and exotic species recorded within the survey area totalled four native vascular plant taxa from three plant genera and two plant families as well as 20 exotic taxa. One Declared Plant species pursuant to section 22 of the BAM Act (**Zantedeschia aethiopica* [Arum Lily]) was recorded within the survey area.

The survey area has experienced significant modification due to historical clearing and agricultural land uses. The vegetation recorded within the survey area was highly degraded and did not resemble any TECs or PECs. No conservation significant species were recorded within the survey area. Vegetation condition within the survey area was mapped as Completely Degraded (Keighery 1994).

A total of 125 significant trees were recorded within the survey area, which included 91 Flooded Gum (*Eucalyptus rudis*), 32 Freshwater Paperbark (*Melaleuca rhaphiophylla*) and two Bangalay (*E. botryoides*) trees. The majority of trees (46) had a medium retention value, while 19 trees had a high retention value. Six *E. rudis* trees contained hollows of suitable size to be utilised by CBC for breeding.

Conclusion

Adequate data has been collected to define and assess the presence, extent and significance of vegetation communities within the survey area which contains approximately 5.07 ha of native vegetation (i.e. VT 1, VT 2). The overall vegetation within the survey area is highly degraded and is not considered of high conservation significance.

In summary, the survey area contains the following environmental attributes:

- 5.07 ha of native vegetation in Completely Degraded condition
- 125 significant trees, 6 of which contain potential breeding habitat for CBC
- 19 significant trees of High retention value; 8 *Eucalyptus rudis* and 11 *Melaleuca rhaphiophylla* trees
- 1 potential landscape feature is present comprising of 3.17 ha of 2 vegetation types.

Overall, the findings of this assessment provide an appropriate level of information to support development design and assessment in accordance with the City of Kwinana (CoK) Local Planning Policy No.1.

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Appendix 1
Vascular plant taxa recorded within the survey area

Family	Species
Asteraceae	**Arctotheca calendula*
Poaceae	**Avena barbata*
Malvaceae	**Brachychiton populneus*
Poaceae	**Bromus diandrus*
Asteraceae	**Cirsium vulgare*
Poaceae	**Cynodon dactylon*
Boraginaceae	**Echium plantagineum*
Poaceae	**Ehrharta calycina*
Poaceae	**Eragrostis curvula*
Myrtaceae	*Eucalyptus botryoides*
	Eucalyptus rudis
Moraceae	**Ficus carica*
Apocynaceae	**Gomphocarpus fruticosus*
Fabaceae	**Lotus subbiflorus*
Myrtaceae	*Melaleuca rhaphiophylla*
Oleaceae	**Olea europaea*
Phytolaccaceae	**Phytolacca octandra*
Dennstaedtiaceae	*Pteridium esculentum*
Polygonaceae	**Rumex crispus*
Solanaceae	**Solanum nigrum*
Asteraceae	**Sonchus oleraceus*
Poaceae	**Triticum aestivum*
Araceae	**Zantedeschia aethiopica*

Appendix 2
Photos of vegetation types



VT1: *Eucalyptus rudis and Melaleuca rhaphiophylla woodland* over *Pteridium esculentum, *Zantedeschia aethiopica, *Phytolacca octandra* and **Gomphocarpus fruticosus* low shrubland over exotic species including **Ehrharta calycina, *Cynodon dactylon* and **Cirsium vulgare* on sandy soils



VT2: *Eucalyptus rudis* and **Ficus carica* open woodland over *Pteridium esculentum* shrubland over exotic grasses including **Ehrharta calycina and *Avena barbata* on sandy soils



Cleared: Historically cleared area containing exotic grasses including **Eragrostis curvula* and **Ehrharta calycina* on sandy soils

Appendix 3
Summary of arboriculture survey

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
328	Flooded Gum (Eucalyptus rudis)	16	62	Fair	Acceptable	Mature	Canopy is reasonably sparse and suggests that it may be starting to decline in health. Termites seen.	7.4		Low	391942.7	6436966
329	Flooded Gum (Eucalyptus rudis)	15	61, 52	Dead	Acceptable	Mature	Dead tree. Main stem bi-furcates but union looks to be Ok at this stage. Area of decay noted and could be impacting structural integrity to some extent.	7.3	2	Very Low	391949.6	6436979
330	Flooded Gum (Eucalyptus rudis)	16	70	Dead	Acceptable	Mature	Dead tree. Main stem bi-furcates but union looks to be Ok at this stage. Area of decay noted and could be impacting structural integrity to some extent.	8.4		Very Low	391920.1	6436980
331	Flooded Gum (Eucalyptus rudis)	18	88	Fair	Good	Mature	Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Area of decay noted but not of a major concern at this time. Termites at base of main stem.	10.6		Medium	391905.6	6436948
332	Flooded Gum (Eucalyptus rudis)	17	65	Poor	Acceptable	Mature	Main stem bi-furcates but union looks to be Ok at this stage. Area of decay noted but not of a major concern at this time. Mostly dead Section of its canopy has snapped.	7.8		Very Low	391893.1	6436965
333	Flooded Gum (Eucalyptus rudis)	19	65	Poor	Acceptable	Mature	Area of decay noted and could be impacting structural integrity to some degree. Termites seen. Mostly dead; canopy is sparse.	7.8		Very Low	391900.4	6436983
334	Flooded Gum (Eucalyptus rudis)	16	70	Fair	Acceptable	Mature	Canopy is reasonably sparse but what leaf mass is present shows good condition and form. Canopy is one sided east.	8.4		Low	391884.7	6437001
335	Flooded Gum (Eucalyptus rudis)	18	85	Fair	Good	Mature	Canopy is reasonably sparse and suggests it may have limited life span remaining. Main stem bi-furcates but union looks to be Ok at this stage.	10.2		Low	391885.6	6437010
336	Flooded Gum (Eucalyptus rudis)	16	60	Dead	Acceptable	Mature	Dead tree.	7.2	2	Very Low	391896.1	6437009
337	Flooded Gum (Eucalyptus rudis)	19	95	Poor	Acceptable	Mature	Near dead tree. Canopy is very sparse.	11.4		Very Low	391882.4	6437020
338	Flooded Gum (Eucalyptus rudis)	20	67	Fair	Acceptable	Mature	Canopy is slightly sparse but what leaf mass is present shows good condition and form. Leggy upright canopy form.	8		Low	391870.3	6437010
339	Flooded Gum (Eucalyptus rudis)	20	64, 61	Poor	Acceptable	Mature	Section of its canopy is dead. Remaining canopy is relatively sparse. Main stem bi-furcates but union looks to be Ok at this stage.	7.7		Very Low	391875.5	6437006
340	Flooded Gum (Eucalyptus rudis)	20	64, 62, 43	Fair	Acceptable	Mature	Canopy is reasonably sparse and suggests it may have limited life span remaining. Multi-stemmed from ground level.	7.7		Low	391870.9	6437029
341	Flooded Gum (Eucalyptus rudis)	20	75, 57, 45	Dead	Questionable	Mature	Dead tree. Multi-stemmed from ground level. Area of decay noted and could be impacting structural integrity to some extent.	9		Very Low	391877.8	6437030
342	Flooded Gum (Eucalyptus rudis)	15	63 56	Dead	Questionable	Mature	Dead tree. Multi-stemmed from ground level. Area of decay noted and could be impacting structural integrity to some extent.	7.6		Very Low	391881.2	6437045
343	Flooded Gum (Eucalyptus rudis)	19	50	Poor	Acceptable	Mature	Canopy condition suggests it may have limited life span remaining. Upper canopy is dead.	6		Very Low	391893.8	6437044
344	Flooded Gum (Eucalyptus rudis)	19	62	Fair	Acceptable	Mature	Canopy condition suggests it may have limited life span remaining. Canopy is relatively sparse.	7.4		Low	391893.5	6437056
345	Flooded Gum (Eucalyptus rudis)	17	59, 55	Dead	Questionable	Mature	Dead tree. Main stem bi-furcates but union looks to be Ok at this stage.	7.1		Very Low	391888.2	6437061
346	Flooded Gum (Eucalyptus rudis)	22	62, 44, 43	Good	Acceptable	Mature	Large mature specimen. Main stem furcates into three. Union looks to be ok at this time.	7.4		High	391878.7	6437055

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
347	Flooded Gum (Eucalyptus rudis)	20	53	Dead	Potentially Hazardous	Mature	Dead tree. Main stem looks to have partially snapped.	6.4	1	Very Low	391861.6	6437060
348	Flooded Gum (Eucalyptus rudis)	18	57	Dead	Poor	Mature	Dead tree. Canopy is one sided north.	6.8	1	Very Low	391867.2	6437074
349	Flooded Gum (Eucalyptus rudis)	21	53, 47	Dead	Questionable	Mature	Dead tree. Main stem bi-furcates but union looks to be Ok at this stage.	6.4	1	Very Low	391893.6	6437069
350	Flooded Gum (Eucalyptus rudis)	22	56	Dead	Questionable	Mature	Dead tree.	6.7		Very Low	391904.4	6437079
351	Flooded Gum (Eucalyptus rudis)	19	59	Dead	Questionable	Mature	Dead tree.	7.1		Very Low	391888	6437091
352	Flooded Gum (Eucalyptus rudis)	18	64	Dead	Poor	Mature	Dead tree. Top has snapped.	7.7		Very Low	391922.7	6437091
353	Flooded Gum (Eucalyptus rudis)	24	66	Dead	Poor	Mature	Dead tree. Evidence of previous branch failures (>200mm diameter).	7.9		Very Low	391950.9	6437127
354	Flooded Gum (Eucalyptus rudis)	14	63	Poor	Questionable	Mature	Section of its canopy is dead and remaining canopy suggests it may have limited life span remaining. Area of decay noted but not of a major concern at this time.	7.6		Very Low	391948	6437149
355	Flooded Gum (Eucalyptus rudis)	14	71	Dead	Poor	Mature	Dead tree. Termites seen. Area of decay noted and could be impacting structural integrity to some extent.	8.5		Very Low	391930.2	6437145
356	Flooded Gum (Eucalyptus rudis)	20	65	Fair	Acceptable	Mature	Reasonably good specimen. Canopy is slightly sparse and suggests that it may be starting to decline in health. Main stem bi-furcates but union looks to be Ok at this stage.	7.8		Medium	391919.9	6437140
357	Flooded Gum (Eucalyptus rudis)	20	69	Fair	Acceptable	Mature	Ok specimen. Canopy is reasonably sparse and suggests that it may be starting to decline in health.	8.3		Medium	391913.4	6437132
358	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	60	Good	Good	Mature	Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage.	7.2		Medium	391907.5	6437133
359	Flooded Gum (Eucalyptus rudis)	18	72	Poor	Acceptable	Mature	Has grown on a lean but not considered to be of any issue at to its integrity. Mostly dead tree. Canopy is one sided north.	8.6		Very Low	391903.8	6437131
360	Freshwater Paperbark (Melaleuca rhaphiophylla)	12	64	Excellent	Good	Mature	Large mature specimen. Multi-stemmed from near ground level. Canopy is ever-so slightly sparse but what leaf mass is present shows good condition at this time.	7.7		Medium	391898.7	6437128
361	Flooded Gum (Eucalyptus rudis)	16	53	Good	Good	Mature	Ok specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	6.4		Medium	391897	6437122
362	Freshwater Paperbark (Melaleuca rhaphiophylla)	16	56	Good	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is one sided north.	6.7		Medium	391892.7	6437120
363	Freshwater Paperbark (Melaleuca rhaphiophylla)	18	53	Excellent	Good	Mature	Good specimen. Tall for species.	6.4		High	391889.3	6437119
364	Flooded Gum (Eucalyptus rudis)	18	54	Dead	Questionable	Mature	Dead tree.	6.5		Very Low	391887.5	6437116

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
365	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	87	Excellent	Acceptable	Mature	Large mature specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Area of decay noted but not of a major concern at this time. Canopy is one sided west.	10.4		Medium	391884.5	6437121
366	Freshwater Paperbark (Melaleuca rhaphiophylla)	16	160	Excellent	Acceptable	Mature	Large mature specimen. Area of decay noted but not of a major concern at this time. Evidence of previous branch failures (100-200mm diameter). Old specimen. High retention value.	19.2		High	391879.4	6437116
367	Freshwater Paperbark (Melaleuca rhaphiophylla)	17	76	Excellent	Good	Mature	Large mature specimen. Old specimen. Canopy is one sided west. High retention value.	9		Medium	391875.7	6437111
368	Flooded Gum (Eucalyptus rudis)	19	66, 65	Dead	Questionable	Mature	Dead tree. Main stem bi-furcates but union looks to be Ok at this stage. Area of decay noted but not of a major concern at this time.	7.9	2	Very Low	391873.3	6437106
369	Freshwater Paperbark (Melaleuca rhaphiophylla)	10	70	Dead	Questionable	Mature	Dead tree. Area of decay noted and could be impacting structural integrity to some extent. Possible termites. 'Mud' noted but no active termites seen during the inspection.	8.4		Very Low	391871.2	6437109
370	Freshwater Paperbark (Melaleuca rhaphiophylla)	11	56	Excellent	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is one sided south-west.	6.7		Medium	391869.4	6437107
371	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	181	Excellent	Acceptable	Mature	Large mature specimen. Multi-stemmed from near ground level. Looks to be regrowth off/around an old stump/original tree. Good aesthetic form. High retention value.	21.7		High	391849.5	6437087
372	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	107, 63	Excellent	Acceptable	Mature	Large mature specimen. Multi-stemmed from ground level. Good aesthetic form. High retention value.	12.8		High	391844	6437082
373	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	123	Excellent	Acceptable	Mature	Large mature specimen. Area of decay noted but not of a major concern at this time. Looks to be splitting apart to some extent.	14.8		Medium	391779.2	6437041
374	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	123	Excellent	Acceptable	Mature	Large mature specimen. Area of decay noted but not of a major concern at this time. High retention value. Old tree.	30.2		Medium	391773.5	6437036
375	Freshwater Paperbark (Melaleuca rhaphiophylla)	11	64	Excellent	Acceptable	Mature	Large mature specimen. Multi-stemmed from ground level. One stem looks to have partially failed but then kept growing. Part of a clump of Melaleuca. High retention value collectively.	7.7		Medium	391787.4	6437029
376	Freshwater Paperbark (Melaleuca rhaphiophylla)	12	64	Excellent	Good	Mature	Large mature specimen. Good aesthetic form/value. Part of a clump of Melaleuca.	7.7		Medium	391789	6437028
377	Flooded Gum (Eucalyptus rudis)	16	56	Fair	Good	Mature	Reasonably good specimen. Canopy is relatively sparse but what leaf mass is present shows good condition and form.	6.7		Medium	391779.1	6437023

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
378	Flooded Gum (Eucalyptus rudis)	16	53, 45, 43, 40	Fair	Good	Mature	Reasonably good specimen. Canopy is relatively sparse but what leaf mass is present shows good condition and form. Multi-stemmed from ground level.	6.4		Medium	391776.4	6437021
379	Freshwater Paperbark (Melaleuca rhaphiophylla)	9	63, 35, 30, 25	Excellent	Good	Mature	Good specimen. Multi-stemmed from ground level. Part of a clump of Melaleuca.	7.6		Medium	391769.1	6437016
380	Flooded Gum (Eucalyptus rudis)	15	59	Fair	Acceptable	Mature	Canopy is relatively sparse and suggests that it may be starting to decline in health. Area of decay noted but not of a major concern at this time.	7.1		Medium	391748.4	6437017
381	Flooded Gum (Eucalyptus rudis)	15	50, 40	Dead	Questionable	Mature	Dead tree. Main stem bi-furcates but union looks to be Ok at this stage.	6		Very Low	391739.7	6437011
382	Freshwater Paperbark (Melaleuca rhaphiophylla)	9.5	70, 63	Excellent	Acceptable	Mature	Reasonably good specimen. Multi-stemmed from ground level. Area of decay noted but not of a major concern at this time. A third stem has previously failed.	8.4		Medium	391705.6	6436986
383	Freshwater Paperbark (Melaleuca rhaphiophylla)	9	69, 53	Excellent	Good	Mature	Good mature specimen. Multi-stemmed from near ground level. Good aesthetic form/value.	8.3		High	391687.2	6436931
384	Flooded Gum (Eucalyptus rudis)	19	62, 58, 55, 50	Fair	Acceptable	Mature	Large mature specimen. Multi-stemmed from ground level. Canopy is relatively sparse but what leaf mass is present shows good condition and form.	7.4		Low	391838.9	6437030
385	Flooded Gum (Eucalyptus rudis)	21	72	Fair	Acceptable	Mature	Large mature specimen. Area of decay noted but not of a major concern at this time. Canopy is relatively sparse but what leaf mass is present shows good condition and form.	8.6		Low	391847.5	6437031
386	Flooded Gum (Eucalyptus rudis)	18	55	Dead	Questionable	Mature	Dead tree. Area of decay noted and could be impacting structural integrity to some extent.	6.6		Very Low	391852.4	6437028
387	Flooded Gum (Eucalyptus rudis)	16	59	Excellent	Good	Mature	Good mature specimen. Good aesthetic form/value. High retention value.	7.1		High	391841.2	6436965
388	Flooded Gum (Eucalyptus rudis)	23	67, 42, 42	Good	Good	Mature	Large mature specimen. Multi-stemmed from near ground level. Canopy is relatively sparse but what leaf mass is present shows good condition and form.	8		Medium	391908.6	6436636
389	Flooded Gum (Eucalyptus rudis)	23	73, 64, 53	Poor	Good	Mature	Large mature specimen. Multi-stemmed from near ground level. Canopy is relatively sparse.	8.8		Low	391902.7	6436634
390	Flooded Gum (Eucalyptus rudis)	23	73	Poor	Good	Mature	Large mature specimen. Canopy is relatively sparse and suggests it may have limited life span remaining.	8.8		Low	391899.4	6436627
391	Flooded Gum (Eucalyptus rudis)	20	55	Poor	Acceptable	Mature	Large mature specimen. Canopy is relatively sparse and suggests it may have limited life span remaining. Evidence of previous branch failures (100-200mm diameter).	6.6		Low	391897.2	6436622
392	Flooded Gum (Eucalyptus rudis)	20	52	Good	Good	Mature	Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	6.2		Medium	391876.7	6436611
393	Flooded Gum (Eucalyptus rudis)	20	88	Fair	Good	Mature	Large mature specimen. Canopy is reasonably sparse but what leaf mass is present shows good condition and form.	10.6		Low	391850.6	6436563

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
394	Bangalay (Eucalyptus botryoides)	19	79	Excellent	Good	Mature	Reasonably good specimen. Main stem bi-furcates but union looks to be Ok at this stage.	9.5		Medium	391658.7	6437043
395	Bangalay (Eucalyptus botryoides)	14	59	Excellent	Good	Mature	Reasonably good specimen. Main stem bi-furcates but union looks to be Ok at this stage.	7.1		Medium	391675.8	6437156
396	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	83	Excellent	Acceptable	Mature	Reasonably good specimen. Multi-stemmed from ground level. Area of decay noted but not of a major concern at this time. In drainage ditch.	10		High	391690.1	6437198
397	Freshwater Paperbark (Melaleuca rhaphiophylla)	7	55	Excellent	Good	Mature	Good mature specimen. Good aesthetic form/value. In drainage ditch.	6.6		High	391699.3	6437206
398	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	75	Excellent	Good	Mature	Good mature specimen. Good aesthetic form/value. In drainage ditch.	9		High	391712.5	6437213
399	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	60, 55, 50, 50	Excellent	Acceptable	Mature	Large mature specimen. Multi-stemmed from ground level. Split developing/noted in main stem but not considered to be of any major concern at this time. In drainage ditch. One stem is a Flooded Gum.	7.2		Medium	391715.1	6437219
400	Freshwater Paperbark (Melaleuca rhaphiophylla)	9	113	Excellent	Good	Mature	Large mature specimen. Good aesthetic form/value. High retention value. In drainage ditch.	13.6		High	391732.1	6437230
401	Flooded Gum (Eucalyptus rudis)	20	94	Good	Acceptable	Mature	Large mature specimen. Area of decay noted but not of a major concern at this time. Canopy is slightly sparse but what leaf mass is present shows good condition and form. In drainage ditch.	11.3		Medium	391740	6437231
402	Freshwater Paperbark (Melaleuca rhaphiophylla)	7	63	Good	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Area of decay noted but not of a major concern at this time. Canopy is one sided east. In drainage ditch.	7.6		Low	391743.5	6437232
403	Flooded Gum (Eucalyptus rudis)	24	97, 78	Good	Good	Mature	Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage. Canopy is slightly sparse but what leaf mass is present shows good condition and form. In drainage ditch.	11.6		High	391739	6437235
404	Flooded Gum (Eucalyptus rudis)	15	62	Good	Questionable	Mature	Ok specimen. Evidence of previous branch failures (100-200mm diameter). Canopy is one sided south. In drainage ditch.	7.4		Very Low	391753	6437242
405	Flooded Gum (Eucalyptus rudis)	11	62	Good	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Main stem bi-furcates and evidence of included bark at the union. Canopy is one sided west. In drainage ditch.	7.4		Medium	391752.4	6437240
406	Flooded Gum (Eucalyptus rudis)	25	127	Good	Good	Mature	Large mature specimen. Area of decay noted but not of a major concern at this time. Main stem bi-furcates but union looks to be Ok at this stage. Canopy is slightly sparse. In drainage ditch.	15.2		Medium	391756.7	6437241
407	Flooded Gum (Eucalyptus rudis)	25	66	Good	Good	Mature	Large mature specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is one sided west. In drainage ditch.	7.9		Medium	391756.6	6437249

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
408	Flooded Gum (Eucalyptus rudis)	25	90	Fair	Good	Mature	Large mature specimen. Canopy is slightly sparse and suggests that it may be starting to decline in health. Main stem bi-furcates but union looks to be Ok at this stage. Area of decay in main stem. In drainage ditch.	10.8		Medium	391762.5	6437248
409	Flooded Gum (Eucalyptus rudis)	24	79	Good	Good	Mature	Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Canopy is one sided west. In drainage ditch.	9.5		Medium	391759.4	6437253
410	Flooded Gum (Eucalyptus rudis)	19	85	Good	Good	Mature	Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Canopy is one sided west. In drainage ditch.	10.2		Medium	391766.5	6437254
411	Flooded Gum (Eucalyptus rudis)	25	131	Fair	Good	Mature	Large mature specimen. Main stem bi-furcates and evidence of included bark at the union. Canopy is reasonably sparse in sections but what leaf mass is present shows good condition and form. In drainage ditch.	15.7		Medium	391769.3	6437250
412	Flooded Gum (Eucalyptus rudis)	16	55	Excellent	Acceptable	Mature	Reasonably good specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is one sided east. In drainage ditch.	6.6		Medium	391769.7	6437255
413	Flooded Gum (Eucalyptus rudis)	29	118	Excellent	Acceptable	Mature	Very large mature specimen. High aesthetic and amenity value. Main stem bi-furcates and evidence of included bark and swelling at the union. Area of decay and cavity noted but not of a major concern at this time. Bees in cavity. In drainage ditch.	14.2		High	391782.6	6437265
414	Flooded Gum (Eucalyptus rudis)	11	68	Excellent	Questionable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Evidence of previous branch failures (>200mm diameter). Large sections of its canopy look to have previously failed. In drainage ditch.	8.2		Very Low	391786.7	6437266
415	Freshwater Paperbark (Melaleuca rhaphiophylla)	10	55	Excellent	Acceptable	Mature	Reasonably good specimen. Area of decay noted but not of a major concern at this time. In drainage ditch.	6.6		Medium	391788.2	6437270
416	Flooded Gum (Eucalyptus rudis)	12	56	Poor	Acceptable	Mature	Near dead tree. Canopy condition suggests it may have limited life span remaining. Canopy is one sided west.	6.7		Low	391790	6437275
417	Freshwater Paperbark (Melaleuca rhaphiophylla)	11	55	Good	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is one sided east. In drainage ditch.	6.6		Medium	391798.8	6437275
418	Flooded Gum (Eucalyptus rudis)	25	170	Good	Acceptable	Mature	Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Evidence of previous branch failures (>200mm diameter). Main stem bi-furcates. In drainage ditch.	20.4		High	391795.9	6437278
419	Flooded Gum (Eucalyptus rudis)	24	85	Good	Good	Mature	Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Canopy is one sided north-east. In drainage ditch.	10.2		High	391803.7	6437278
420	Flooded Gum (Eucalyptus rudis)	25	85, 55	Good	Good	Mature	Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Multi-stemmed from ground level possibly more than the one tree. Canopy is one sided west. In drainage ditch.	10.2		High	391811.9	6437289
421	Flooded Gum (Eucalyptus rudis)	25	86	Excellent	Acceptable	Mature	Large mature specimen. Area of decay and cavity noted but not of a major concern at this time. Evidence of previous branch failures (>200mm diameter). In drainage ditch.	10.3		High	391816.8	6437292

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
422	Flooded Gum (Eucalyptus rudis)	25	116	Excellent	Questionable	Mature	Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage. Evidence of a broken (hanging) branch in the canopy. One of its main stems has snapped In drainage ditch.	13.9		Very Low	391821	6437297
423	Flooded Gum (Eucalyptus rudis)	17	62	Excellent	Acceptable	Mature	Reasonably good specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is one sided west. In drainage ditch.	7.4		Medium	391824.7	6437298
424	Freshwater Paperbark (Melaleuca rhaphiophylla)	15	83, 65	Excellent	Good	Mature	Large mature specimen. Multi-stemmed from ground level possibly more than the one tree. In drainage ditch.	10		High	391831.1	6437298
425	Flooded Gum (Eucalyptus rudis)	13	52	Excellent	Poor	Mature	Top of main stem has snapped.	6.2		Very Low	391838.8	6437299
426	Freshwater Paperbark (Melaleuca rhaphiophylla)	11	63	Excellent	Good	Mature	Good mature specimen. In drainage ditch.	7.6		Medium	391837.8	6437299
427	Freshwater Paperbark (Melaleuca rhaphiophylla)	11	73	Excellent	Good	Mature	Good mature specimen. In drainage ditch.	8.8		Medium	391838.1	6437306
428	Flooded Gum (Eucalyptus rudis)	23	97	Good	Acceptable	Mature	Large mature specimen. Evidence of previous branch failures (>200mm diameter). Area of decay noted but not of a major concern at this time. Reasonably sparse canopy.	11.6		Medium	391845	6437307
429	Flooded Gum (Eucalyptus rudis)	17	81	Fair	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Area of decay noted but not of a major concern at this time. Reasonably sparse canopy and canopy is one sided west.	9.7		Low	391844	6437314
430	Flooded Gum (Eucalyptus rudis)	19	101	Fair	Acceptable	Mature	Large mature specimen. Evidence of previous branch failures (100-200mm diameter). Area of decay noted but not of a major concern at this time. Reasonably sparse canopy.	12.1		Low	391856.5	6437312
431	Flooded Gum (Eucalyptus rudis)	22	51	Poor	Acceptable	Mature	Mostly dead tree.	6.1		Very Low	391850.7	6437316
432	Freshwater Paperbark (Melaleuca rhaphiophylla)	15	58	Excellent	Acceptable	Mature	Large mature specimen. Reasonably good specimen. Area of decay noted but not of a major concern at this time.	7		High	391853.9	6437318
433	Flooded Gum (Eucalyptus rudis)	17	71	Fair	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Reasonably sparse canopy.	8.5		Low	391854.3	6437319
434	Flooded Gum (Eucalyptus rudis)	15	56	Fair	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Reasonably sparse. Top section of its canopy is dead. Canopy is one sided west.	6.7		Low	391856.4	6437324
435	Flooded Gum (Eucalyptus rudis)	16	75	Fair	Acceptable	Mature	Ok specimen. Canopy condition suggests it may have limited life span remaining. Reasonably sparse. Section of its canopy is dead.	9		Low	391862.8	6437325
436	Flooded Gum (Eucalyptus rudis)	16	56	Fair	Acceptable	Mature	Ok specimen. Evidence of previous branch failures (100-200mm diameter). Reasonably sparse canopy.	6.7		Low	391863.9	6437329
437	Flooded Gum (Eucalyptus rudis)	17	51, 48	Dead	Questionable	Mature	Dead tree. Multi-stemmed from near ground level.	6.1		Very Low	391867.3	6437333

Tree Tag No.	Species	App-rox. Height (m)	DBH (cm)	Health	Structure	Age Class	Comments	TPZ (m)	Holl-ows Noted	Reten-tion Value	Easting	Northing
438	Freshwater Paperbark (Melaleuca rhaphiophylla)	9	58, 35	Excellent	Good	Mature	Good mature specimen. Multi-stemmed from near ground level.	7		Medium	391872.7	6437328
439	Flooded Gum (Eucalyptus rudis)	11	74	Excellent	Acceptable	Mature	Good mature specimen. Area of decay noted but not of a major concern at this time. Possible termites. 'Mud' noted but no active termites seen during the inspection. Low canopy spread.	8.9		Medium	391852	6437388
440	Flooded Gum (Eucalyptus rudis)	18	118	Dead	Acceptable	Mature	Dead tree.	14.2		Very Low	391791.4	6437459
441	Flooded Gum (Eucalyptus rudis)	14	83	Dead	Acceptable	Mature	Dead tree.	10		Very Low	391787.1	6437476
442	Flooded Gum (Eucalyptus rudis)	17	50, 40, 35	Excellent	Acceptable	Mature	Good mature specimen. Good aesthetic form/value. Multi-stemmed from near ground level.	6		Medium	391760.3	6437416
443	Flooded Gum (Eucalyptus rudis)	16	64, 62, 40, 40	Excellent	Acceptable	Mature	Good mature specimen. Good aesthetic form/value. Multi-stemmed from near ground level. Low canopy spread.	7.7		Medium	391763.5	6437398
444	Flooded Gum (Eucalyptus rudis)	20	50, 48, 35	Fair	Acceptable	Mature	Large mature specimen. Main stem furcates into three. Relatively sparse. Section of its canopy is dead.	6		Low	391691.8	6437393
445	Flooded Gum (Eucalyptus rudis)	14	50, 40	Fair	Acceptable	Mature	Ok specimen. Multi-stemmed from ground level. Multi-stemmed from ground level. Relatively sparse. Section of its canopy is dead.	6		Low	391678.2	6437394
446	Flooded Gum (Eucalyptus rudis)	12	84	Good	Acceptable	Mature	Reasonably good specimen. Main stem bi-furcates but union looks to be Ok at this stage. Low canopy spread.	10.1		Medium	391650.7	6437355
447	Flooded Gum (Eucalyptus rudis)	20	71, 54, 50	Fair	Acceptable	Mature	Large mature specimen. Multi-stemmed from near ground level. Canopy is relatively sparse.	8.5		Low	391598.1	6437352
448	Flooded Gum (Eucalyptus rudis)	18	67, 64	Poor	Acceptable	Mature	Large mature specimen. Multi-stemmed from near ground level. Canopy is sparse.	8		Very Low	391607.1	6437347
449	Flooded Gum (Eucalyptus rudis)	15	59	Fair	Acceptable	Mature	Ok specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Canopy is relatively sparse. Canopy is one sided south.	7.1		Low	391607.6	6437340
450	Freshwater Paperbark (Melaleuca rhaphiophylla)	8	50, 40, 35, 30	Excellent	Good	Mature	Good mature specimen. Multi-stemmed from ground level. Good aesthetic form/value.	6		Medium	391646.8	6437340
451	Flooded Gum (Eucalyptus rudis)	14	58	Fair	Acceptable	Mature	Reasonably good specimen. Has grown on a lean but not considered to be of any issue at to its integrity. Area of decay noted but not of a major concern at this time. Canopy is fairly sparse.	7		Low	391694.7	6437355
452	Flooded Gum (Eucalyptus rudis)	14	75, 52, 51	Good	Good	Mature	Large mature specimen. Multi-stemmed from ground level possibly more than the one tree. Area of decay noted but not of a major concern at this time. Section of its canopy slightly sparse.	9		Medium	391702.3	6437308

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1.1.1.1 Document Distribution

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1.1.1.2 Document Status

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APPENDIX 3A

Bushfire Management Plan (Subdivision Specific)

Bushfire management plan / statement addressing the bushfire protection criteria coversheet

Site address: Florence Estate Stages 11-18 (Lots 9002, 9006 & part Lot 9018 Hoffman Rd, Mand

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 21 Month February Year 2024

Report author or reviewer: Zac Cockerill

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☑ Level 3 practitioner ☐

If accredited please provide the following.

BPAD accreditation number: 37803 Accreditation expiry: Month August Year 2025

Bushfire management plan version number: 68614 Rev 0

Bushfire management plan date: Day 4 Month April Year 2025

If one or more of the following are selected, then these should be automatically referred to DFES	YES	NO
Strategic planning is required to address SPP 3.7 and the Guidelines	☐	☑
The application is a vulnerable land use	☐	☑

None of the Above ☑

If one or more of the following are selected, and the decision-maker requires input form DFES, then the application can be referred.	YES	NO
The BAL rating has been calculated by a method other than Method 1 as prescribed by AS 3959	☐	☑
An outcomes-based approach has been submitted to demonstrate compliance with the bushfire protection criteria	☐	☑

None of the Above ☑

Note: If a subdivision or development application meets all the acceptable solutions and does not otherwise trigger a referral as listed above, seeking advice from DFES on SPP 3.7 or other matters is at the discretion of the decision-maker.

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author or reviewer 

Date 4/4/25

Name: John Hirdman
Date: 4 April 2025
Company: Satterley Property Group
Job/Doc No: 68614/164,863
Email: johnh@satterley.com.au
Inquiries: Zac Cockerill

Bushfire Management Plan Addendum: Mandogalup Florence Estate Stages 11–18 Subdivision Application

Proposal details

Satterley Property Group (Satterley) is seeking subdivision approval for Stages 11–18 of Florence Estate, Mandogalup. The proposed subdivision area is contained within Lots 9002, 9006 and part Lot 9018 Hoffman Road, Mandogalup (hereon referred to as the project area), located within the City of Kwinana. Proposed subdivision of Stages 11–18 will create the following, as depicted in Figure 1:

- 398 proposed residential lots
- six proposed Public Open Space (POS) areas (nominated as POS 1 and 9–13), along with proposed landscaping within the Western Power easement, Dampier to Bunbury Natural Gas Pipeline (DBNGP) easement and Regional Flood Storage Area (refer to Landscape Concept Plans in Attachment A)
- proposed internal public road network providing access connections
    - northeast to previous stages of Florence Estate via Magnificent Drive
    - north to adjacent stages of Apsley Estate via Quartermaine Boulevard
    - south to Hoffman Road
- proposed school site to be ceded to Department of Education
- proposed balance lots.

JBS&G prepared a Bushfire Management Plan (BMP) in July 2024 to support the Florence Estate Structure Plan amendment, which included the project area. This BMP is an addendum to the JBS&G (2024) BMP and provides an updated bushfire assessment specific to the Stages 11–18 subdivision area as required to support subdivision application. This BMP addendum should be read in conjunction with the JBS&G (2024) BMP and includes the following information:

1. A revised bushfire assessment including:
    a. updated post-development vegetation classifications and effective slopes specific to the project area and the anticipated post-development vegetation conditions (Figure 2)
    b. updated Bushfire Attack Level (BAL) contour assessment specific to the project area and the post-development vegetation conditions mapped from Item 1a (Figure 3).
2. Assessment against Bushfire Protection Criteria 5 of *Planning for Bushfire Guidelines* (the Guidelines; WAPC 2024a) demonstrating bushfire compliance via acceptable solutions (Table 3).
3. Bushfire management actions and responsibilities for implementation specific to the proposed subdivision (Table 4) that can be appropriately conditioned as part of subdivision approval.

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Purpose of this report

The project area is partially situated in a designated bushfire prone area (Area 2) on the Map of Bush Fire Prone Areas (Plate 1; ORBM 2024). Therefore, bushfire risk considerations and assessment are required to inform proposed subdivision, as per requirements of Policy Measure 7.1 (General Measures) of *State Planning Policy 3.7 Bushfire* (SPP3.7; WAPC 2024b).

This BMP addendum has been prepared to accompany subdivision application for the project area and address subdivision planning requirements under Policy Measure 7.1 in accordance with the Guidelines.

Compliance with Element 1: Location of SPP3.7 (2024)

The project area was previously assessed and approved under SPP3.7 (2015) as part of the Florence Estate Structure Plan amendment BMP (JBS&G 2024). As such, compliance with Element 1: Location has already been satisfied and accepted for the project area; therefore, demonstration of compliance with the new Broader Landscape Assessment methodology for Element 1: Location under SPP3.7 (2024) is not required as per provisions of Section 1.3.1 of the Guidelines.

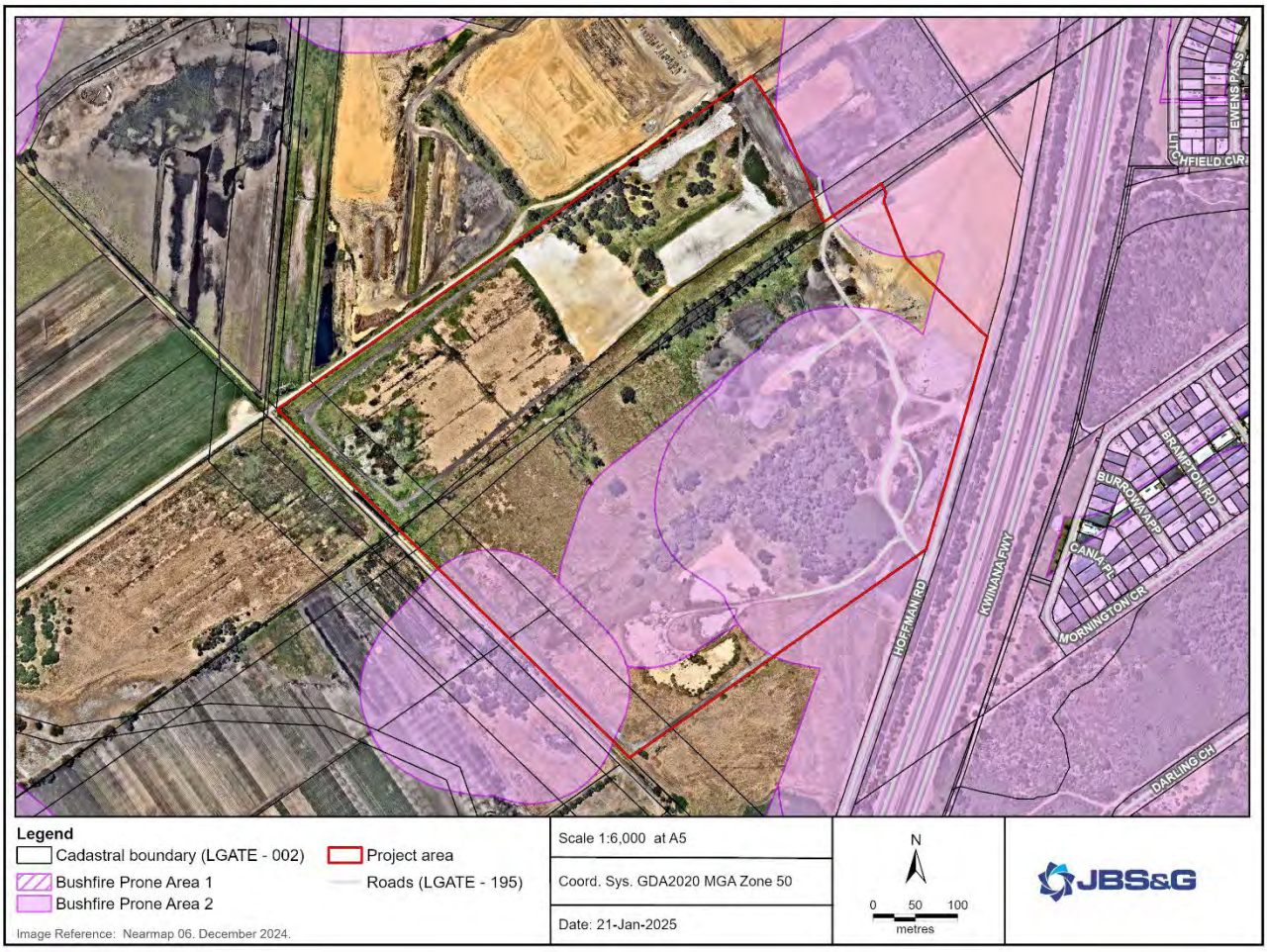
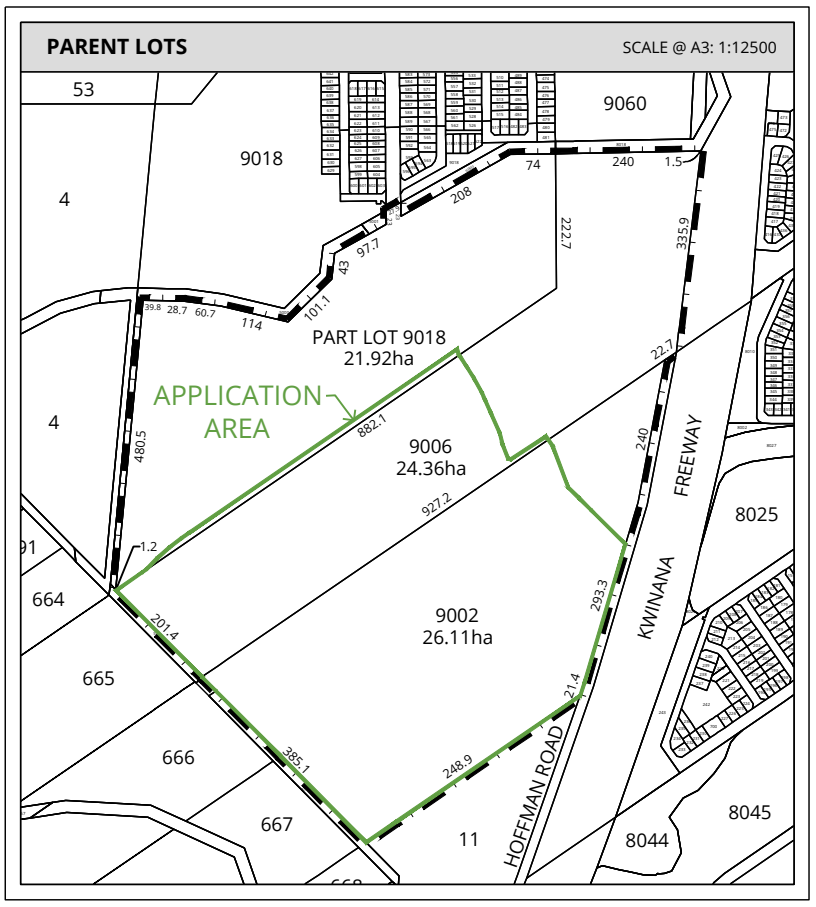
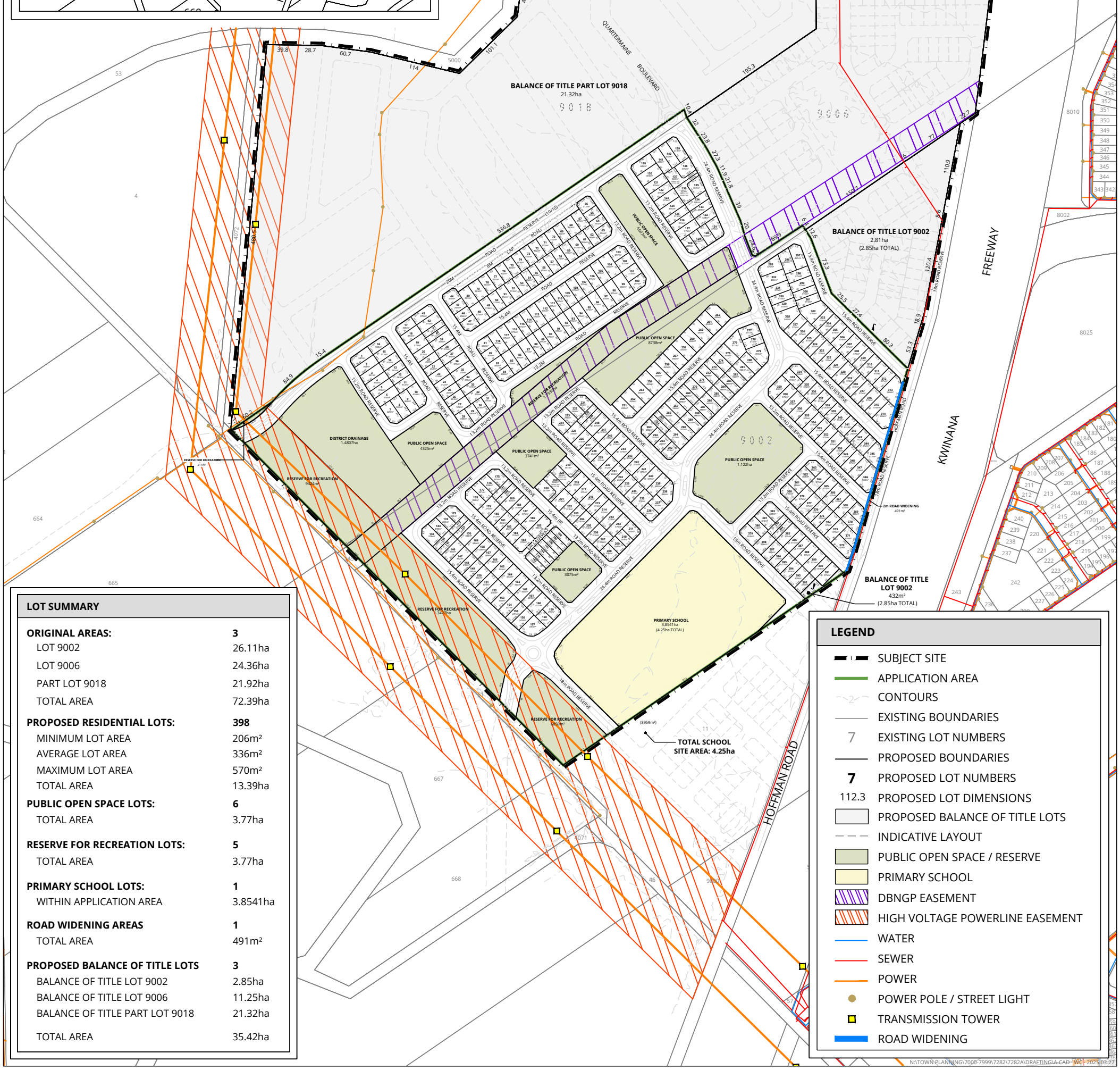


Plate 1: Bushfire prone designation of the project area (ORBM 2024)





LOT SUMMARY

ORIGINAL AREAS:	**3**
LOT 9002	26.11ha
LOT 9006	24.36ha
PART LOT 9018	21.92ha
TOTAL AREA	72.39ha
PROPOSED RESIDENTIAL LOTS:	**398**
MINIMUM LOT AREA	206m²
AVERAGE LOT AREA	336m²
MAXIMUM LOT AREA	570m²
TOTAL AREA	13.39ha
PUBLIC OPEN SPACE LOTS:	**6**
TOTAL AREA	3.77ha
RESERVE FOR RECREATION LOTS:	**5**
TOTAL AREA	3.77ha
PRIMARY SCHOOL LOTS:	**1**
WITHIN APPLICATION AREA	3.8541ha
ROAD WIDENING AREAS	**1**
TOTAL AREA	491m²
PROPOSED BALANCE OF TITLE LOTS	**3**
BALANCE OF TITLE LOT 9002	2.85ha
BALANCE OF TITLE LOT 9006	11.25ha
BALANCE OF TITLE PART LOT 9018	21.32ha
TOTAL AREA	35.42ha

LEGEND

- SUBJECT SITE
- APPLICATION AREA
- CONTOURS
- EXISTING BOUNDARIES
- 7 EXISTING LOT NUMBERS
- PROPOSED BOUNDARIES
- **7** PROPOSED LOT NUMBERS
- 112.3 PROPOSED LOT DIMENSIONS
- PROPOSED BALANCE OF TITLE LOTS
- INDICATIVE LAYOUT
- PUBLIC OPEN SPACE / RESERVE
- PRIMARY SCHOOL
- DBNGP EASEMENT
- HIGH VOLTAGE POWERLINE EASEMENT
- WATER
- SEWER
- POWER
- POWER POLE / STREET LIGHT
- TRANSMISSION TOWER
- ROAD WIDENING

N:\TOWN PLANNING\7000-7999\7282\7282A\DRAFTING\A-CAD - WC - 2025.03.27

FREEHOLD PLAN OF SUBDIVISION

LOTS 9002, 9006 AND PART LOT 9018 HOFFMAN ROAD
MANDOGALUP

N

0 150 m

SCALE @ A3: 1:5000
SCALE @ A1: 1:2500

7282D-SUB-33-A

DRAWN: WC
DATE CREATED: 2025.03.26
PROJECTION: PCG94
CADASTRE: LANDGATE
PRECAL: MNG (98728-167-B)

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ROWE GROUP DESIGN

Bushfire Attack Level Contour Assessment

A Bushfire Attack Level (BAL) contour assessment has been undertaken for the project area in accordance with Method 1 of *AS3959–2018 Construction of Buildings in Bushfire-prone Areas* (AS3959; SA 2018). The Method 1 procedure incorporates the following factors:

- state-adopted FDI 80 rating
- vegetation classification
- effective slope
- distance maintained between proposed development areas and the classified vegetation.

The BAL rating gives an indication of the level of bushfire attack (i.e. the radiant heat flux) that may be received by future development and subsequently informs the standard of building construction and/or setbacks required for proposed habitable development to potentially withstand such impacts and/or deliver compliance with the bushfire protection criteria of the Guidelines.

The BAL contours are based on:

- the classification of and effective slope under vegetation that will be retained post-development both within the site and on adjacent land
- consideration of the proposed clearing extent within the project area and modification of vegetation to a non-vegetated/low threat managed state as part of subdivisional works
- consideration of the existing extent of non-vegetated/low threat managed land and ongoing maintenance thereof throughout cleared/earthworked areas and developed areas of the site and adjacent Apsley Estate
- implementation of various planting regimes within the Western Power easement, Regional Flood Storage Area, POS 13 drainage basin and Apsley drainage POS cell in the northwest, consistent with the landscape concept plans contained in Attachment A
- implementation of a combination of non-vegetated and low threat managed landscaping treatments throughout POS 1 and 9–12, the DBNGP easement and urban street verges
- retention of existing vegetation within POS 2 to the northeast of the project area
- separation distances between future habitable development and classified vegetation achieved in line with the plan of subdivision (Figure 1).

Assessment inputs

Vegetation classification

Classified vegetation and exclusions were assessed most recently within the project area and adjoining 150 m (the assessment area) on 21 February 2024 as part of the JBS&G (2024) Structure Plan amendment BMP in accordance with AS3959 and the *Visual guide for bushfire risk assessment in Western Australia* (Department of Planning 2016).

A review of on-ground conditions using Nearmap aerial imagery (dated 3 February 2025) determined that aside from new clearing, earthworks and development associated with new stages of construction within Florence Estate to the northeast and Apsley Estate to the north, the extent of classified vegetation has not materially changed since the previous February 2024 assessment. Vegetation classifications and exclusions are summarised as follows and depicted in Figure 2:

- existing Class A forest opposite Kwinana Freeway to the east, comprising an overstorey of eucalyptus trees over a shrub midstorey and grassy understorey
- existing Class B woodland comprising sparse canopy trees over unmanaged grass within:
    - a small, narrow section of Kwinana Freeway reserve to the northeast
    - small pockets and narrow strips within adjacent horticultural lots to the southwest
    - adjacent Apsley Estate to the north, noting that these narrow woodland plots are temporary and will be excluded following future clearing and construction
- existing Class D scrub within Kwinana Freeway reserve to the east, comprising shrubs with a continuous horizontal fuel profile between 2–6 m in height
- future Class D scrub revegetation proposed throughout the Western Power easement, Regional Flood Storage Area, POS 13 drainage basin and Apsley drainage POS cell in the northwest, consistent with the landscape concept plans contained in Attachment A
- existing Class C shrubland within adjacent Lot 11 to the south, comprising shrubs with a continuous horizontal fuel profile less than 2 m in height
- existing Class G grassland throughout surrounding areas of cleared, unmanaged grass/weeds greater than 100 mm in height at maturity, noting that the current grassland plots contained to the north within Apsley Estate and to the south within Lot 11 are temporary and will be excluded following future clearing and construction
- existing vegetation within POS 2 (to the northeast of the project area) will be retained; however, this will be less than 1 ha in size and be situated greater than 100 m from any other classified vegetation, so will be excludable under Clause 2.2.3.2 (b) of AS3959
- current vegetation within the project area will be modified to a non-vegetated/low threat managed state as part of proposed development in accordance with AS3959 Clause 2.2.3.2 (e) and (f) exclusions, including low threat landscaping throughout POS 1 and 9–12, the DBNGP easement and urban street verges, except where concept landscaping plans indicate otherwise via proposed drainage revegetation (as per Attachment A)
- existing cleared land occupied by the current earthworked extent, buildings, roads, and tracks, as well as any land in an existing low threat managed state (such as managed gardens, urban street verges and managed POS), were assessed to be excluded from classification under Clauses 2.2.3.2 (e) and (f) of AS3959.

Proposed revegetation and non-vegetated/low threat managed land within the Western Power easement, DBNGP easement and on-site POS has been currently classified/excluded on the basis of landscape concept design in Attachment A. However, the final determination and extent of vegetation classifications/exclusions throughout these areas may be refined subject to detailed landscape design at the subdivision clearance stage.

Effective slope

Effective slope under classified vegetation within the assessment area was assessed as part of the JBS&G (2024) Structure Plan amendment BMP in accordance with AS3959. Results were cross-referenced with DPIRD 2m contour data and are depicted in Figure 2. Results indicate the effective slope under classified vegetation is flat or upslope in all instances due to the flat, low-lying nature of the site.

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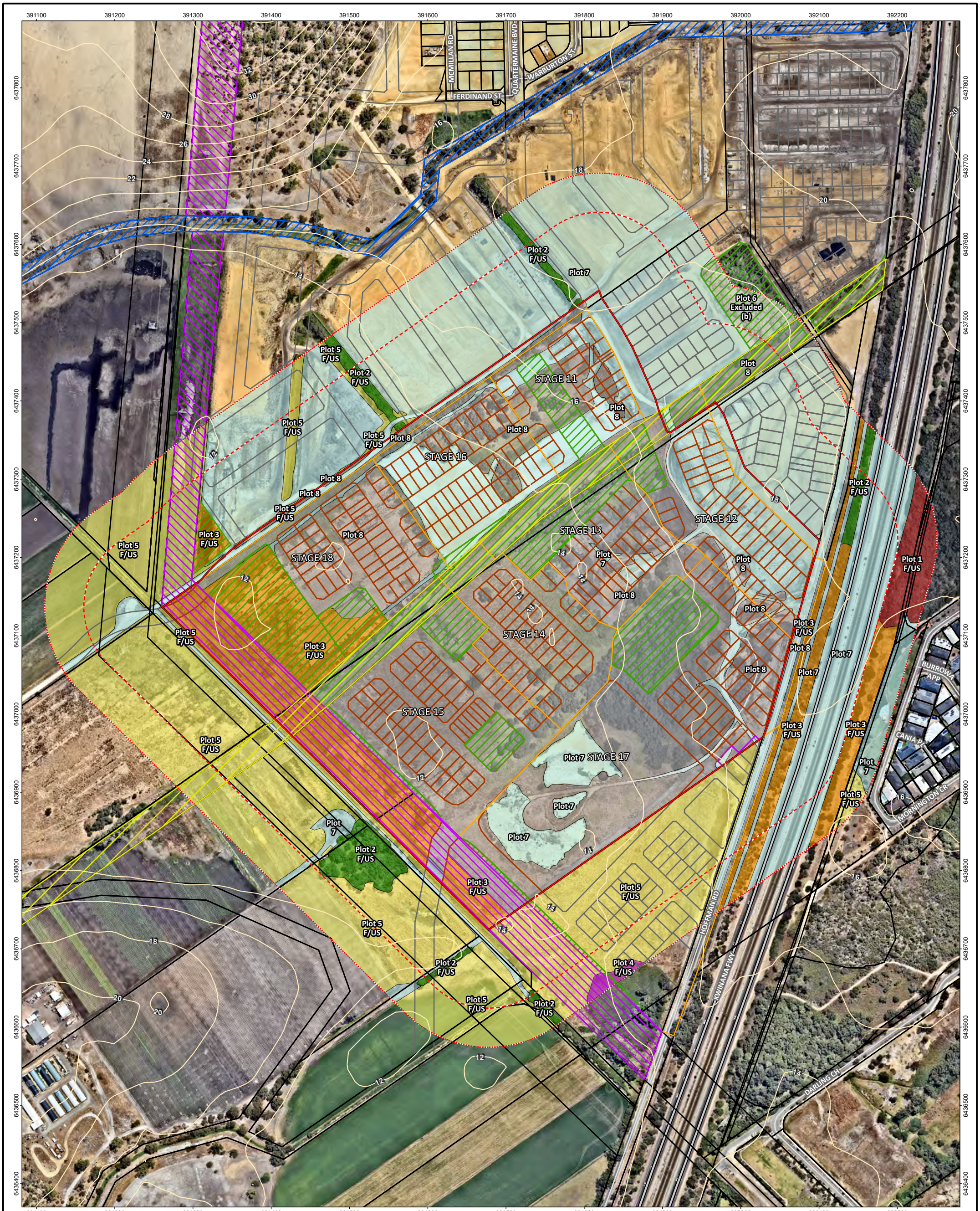
Summary of inputs

Figure 2 illustrates the anticipated post-development vegetation classifications, exclusions and effective slope following completion of subdivision works throughout the project area and implementation of low threat POS landscaping and revegetation as previously described. The post-development vegetation classifications, exclusions and effective slope are summarised in Table 1.

Table 1: Summary of post-development vegetation classifications, exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class A Forest	Flat/upslope (0°)	Forest vegetation consisting of an overstorey of eucalyptus trees 10–30 m high, a shrub midstorey and a grassy understorey
2	Class B Woodland	Flat/upslope (0°)	Sparse overstorey trees with a grassy understorey
3	Class D Scrub	Flat/upslope (0°)	Shrubs between 2–6 m high with a continuous horizontal fuel profile
4	Class C Shrubland	Flat/upslope (0°)	Shrubs less than 2 m in height with a continuous horizontal fuel profile
5	Class G Grassland	Flat/upslope (0°)	Grassland greater than 100 mm in height at maturity
6	Excluded – Clause 2.2.3.2 [b]	N/A	Vegetation less than 1 ha in size and not within 100 m of any other classified vegetation
7	Excluded – Non-vegetated and low threat (Clause 2.2.3.2 [e] & [f])	N/A	Existing non-vegetated land/low threat managed areas including buildings, infrastructure, roads, access tracks, earthworked land, urban street verges, managed POS, etc
8	Area to be modified to low threat (Clause 2.2.3.2)	N/A	Area to be modified to a non-vegetated/low threat managed state as part of proposed development

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Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- DBNGP easement
- Peel main drain
- High voltage powerline easement
- Proposed POS
- Stage boundaries
- Proposed lot layout
- Indicative future subdivisions on adjacent stages
- Balance lots
- Topographic contours (mAHD)
- Highway
- Minor road

Vegetation classification

- Class A Forest
- Class B Woodland
- Class C Shrubland
- Class D Scrub
- Class G Grassland
- Clause 2.2.3.2 (a), (b), (c) and (d)
- Clause 2.2.3.2 (e) & (f)
- Area to be modified to non-vegetated and low threat state

JBS&G

0 100 metres

Job Number: 68614

Scale 1:4,400 at A3

Client: Satterley Property Group

Coord. Sys. GDA2020 MGA Zone 50

Drawn By: jcrute | Checked By: MG | Version: Rev A | Date: 04-Apr-2025

Florence Estate Stages 11-18, Mandogalup, WA

POST-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE: 2

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Image Reference: www.nearmap.com© - Imagery Date: 03. February 2025.

Assessment outputs

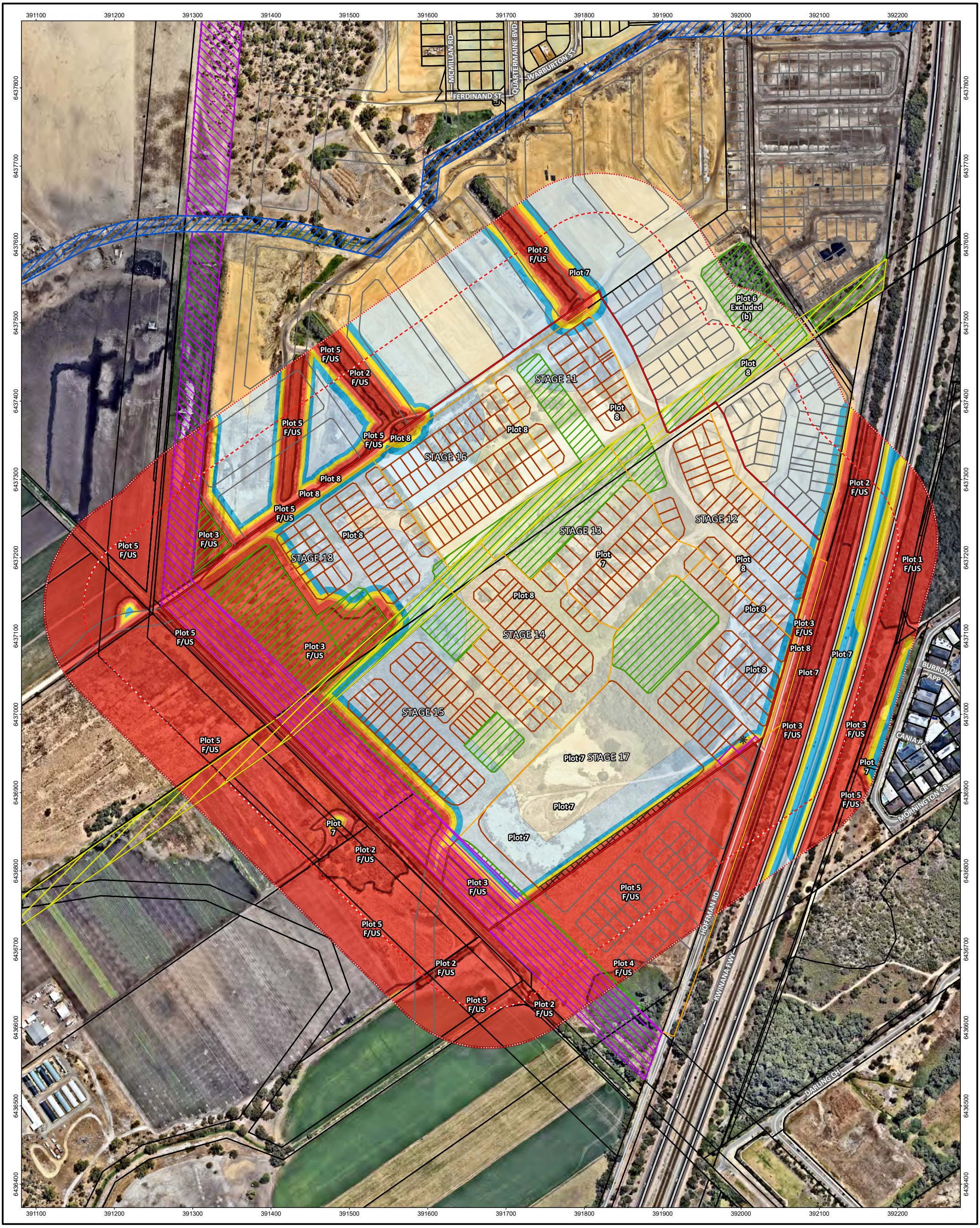
Results of the BAL contour assessment are detailed in Table 2 and illustrated in Figure 3. The highest BAL applicable to the external boundary of the proposed lots is **BAL–FZ,** which impacts one lot in the southeast. Another four lots in the north are subject to **BAL–40**. The current vegetation extent impacting these five lots with BAL-40/FZ is temporary, subject to future clearing and construction associated with subdivision by others on adjacent Apsley estate to the north and within Lot 11 to the south. As such, these five lots are proposed to be temporarily quarantined from creation of title via condition of subdivision until such time that BAL-29 or lower can be demonstrated.

Table 2: BAL contour assessment results

Method 1 BAL determination				
Plot	**Vegetation classification**	**Effective slope**	**Separation distance (to nearest lot boundary)**	**Highest BAL (to nearest lot boundary)**
1	Class A Forest	Flat/upslope (0°)	100 m	BAL–Low
2	Class B Woodland	Flat/upslope (0°)	20 m	BAL–19
3	Class D Scrub	Flat/upslope (0°)	13 m	BAL–29
4	Class C Shrubland	Flat/upslope (0°)	>100 m	BAL–Low
5	Class G Grassland	Flat/upslope (0°)	2 m	BAL–FZ*
6	Excluded – Clause 2.2.3.2 [b]	N/A	N/A	N/A
7	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	N/A	N/A
8	Modified to non-vegetated and/or low threat (Clauses 2.2.3.2 [e] and/or [f])	N/A	N/A	N/A
Highest BAL				**BAL–FZ**

* One proposed lot in the southeast subject to BAL–FZ will be temporarily quarantined from creation of title until such time that BAL–29 or lower can be demonstrated following removal of the adjacent south temporary vegetation. In addition, the proposed primary school site will require a temporary 8 m wide APZ setback along its southern boundary until removal of the adjacent south temporary vegetation.

Highest BAL following temporary lot quarantine and APZ setback	**BAL–29**



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- DBNGP easement
- Peel main drain
- High voltage powerline easement
- Proposed POS
- Classified vegetation
- 8m wide temporary APZ setback
- Stage boundaries
- Proposed lot layout
- Indicative future subdivisions on adjacent stages
- Balance lots
- Highway
- Minor road

BAL contours

- BAL FZ
- BAL 40
- BAL 29
- BAL 19
- BAL 12.5
- BAL Low

* Lot to be temporarily quarantined until such time that BAL-29 or lower can be demonstrated

JBS&G

0 100 metres

Job Number: 68614		Scale 1:4,400 at A3	
Client: Satterley Property Group		Coord. Sys. GDA2020 MGA Zone 50	
Drawn By: jcrute	Checked By: MG	Version: Rev A	Date: 04-Apr-2025

Florence Estate Stages 11-18, Mandogalup, WA

BAL CONTOUR MAP

FIGURE: 3

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Assessment against Bushfire Protection Criteria 5

Compliance with Bushfire Protection Criteria 5: Structure plans and subdivision applications

Compliance with Elements 1–4 of Bushfire Protection Criteria (BPC) 5: Structure Plans and subdivision applications is demonstrated by meeting the acceptable solutions, as detailed in Table 3.

Table 3: Compliance with BPC 5: Structure Plans and subdivision applications

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
Element 1: Location				
O1 – Avoid broader landscapes that present an unacceptable bushfire risk to life, property and infrastructure.	**A1.1a Broader Landscape Type A** The subject site is located in an area that is a Broader Landscape Type A. This location satisfies the policy outcome for Element 1: Location and no additional consideration is required.	N/A	Not applicable to this subdivision application. Section 1.3.1 of the Guidelines (2024) states that demonstration of compliance with the new methodology for Element 1 is not required where the project area was assessed and approved under a previous version of SPP3.7 and the Guidelines. Element 1 Location was previously assessed and approved for the project area as part of the Apsley Structure Plan amendment BMP (JBS&G 2024).	N/A
	A1.1b Broader Landscape Type B The subject site is located in an area that is a Broader Landscape Type B which presents an unacceptable bushfire risk of a landscape-scale bushfire resulting in impacts to people, property and infrastructure. This location does not satisfy the acceptable solution for Element 1: Location. Where the practitioner considers that further analysis could demonstrate to the decision-maker that the risks can be appropriately managed, and/or mitigated, an outcomes-based	N/A	Not applicable to this subdivision application. Refer to justification provided above.	N/A

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	approach should be prepared, in accordance with policy measure 7.5 of SPP 3.7. Further explanatory notes are provided in Appendix B.1 of the Guidelines.			
Element 2: Siting and design				
O2 – Ensure siting and design solutions: • manage or mitigate the bushfire risk to people, property and infrastructure; and • avoid, or where unavoidable, minimises the clearing of native vegetation.	**A2.1 Siting and design** Ensure that each proposed and existing lot(s) contains a sufficient development site(s) that can achieve a radiant heat impact not exceeding 29 kW/m² (BAL-29).	Acceptable solution	The BAL contour assessment (see Figure 3 and Table 2) indicates that all future habitable development can achieve a radiant heat impact of BAL-29 or lower subject to: • the temporary quarantine of one lot in the southeast, which is subject to temporary BAL–40/FZ impacts • establishment of a temporary 8 m wide APZ setback along the southern boundary of the primary school site. The one lot in the southeast will be quarantined from creation of title until such time that BAL–29 or lower can be demonstrated through future removal of adjacent south vegetation. The temporary APZ setback within the primary school site will apply until such time that the adjacent south vegetation is removed on development of Lot 11.	✓
	A2.2 Asset Protection Zone (APZ) Where a development site cannot be wholly located within an area with a radiant heat impact not exceeding 29 kW/m² (BAL-29) in its pre-	Acceptable solution	A temporary 8 m wide APZ setback is required along the southern boundary of the primary school site to deliver BAL-29 or lower, as stated above. All land within the project area to be modified to a non-vegetated/low threat managed state as part of proposed development (including any internal	✓

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	development state, an indicative APZ is to be provided and meet the following requirements: • Width – the APZ is to be measured from the development site, and of sufficient size to ensure the radiant heat impact of a bushfire does not exceed 29 kW/m² (BAL-29) in all circumstances. • Location – the APZ is to be contained solely within the boundaries of the lot, except in instances where: o the vegetation on the adjoining lot(s) is, and will continue to be, low threat as per Clause 2.2.3.2 of AS 3959 or the requirements of Appendix B.2, Table 9 – APZ technical requirements, or an alternative standard in a local planning scheme, on an ongoing basis in perpetuity as agreed upon via a substantiated management agreement between the applicable landowners and the local government; or o the adjoining land is, and will remain in perpetuity, non-vegetated such as a sealed or unsealed road, or a water body. • Management – the APZ is managed in accordance with the requirements of Appendix B.2, Table 9 – APZ technical requirements, or an alternative standard in a gazetted local planning scheme.		100 m wide low threat staging buffers) will comply with APZ technical requirements of the Guidelines (Attachment B).	

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	A2.3 Clearing of native vegetation The structure plan or subdivision avoids, or where unavoidable, minimises the clearing of native vegetation.	Acceptable solution	The project area is significantly cleared and degraded; therefore, the extent of vegetation clearing required to deliver the proposal is minor and in line with previous environmental approvals. The proposed clearing extent has been minimised to achieve construction of proposed lots, roads and POS through vegetation retention within the various POS, streetscapes and infrastructure corridors where practicable.	✓
Element 3: Vehicular access				
O3 – Ensure the design and capacity of vehicular access and egress provide: • for efficient and effective evacuation to a suitable destination(s) and/or • as a contingency measure for vulnerable land uses, an on-site shelter, where	**A3.1 Public roads** Public roads are to meet the technical requirements in Appendix B.3, Table 10.	Acceptable solution	All public roads will be constructed to the relevant technical requirements of the Guidelines.	✓
	A3.2 Access routes **Area 1 (Urban)**: Public road access is to be provided to at least one suitable destination. **Area 2**: Public road access should be provided in two different directions to two different suitable destinations, with an all-weather surface.	Acceptable solution	A combination of the existing surrounding public road network and proposed internal public roads will provide all occupants with the option of travelling to more than two different suitable destinations, as follows: • northeast to previous stages of Florence Estate via Magnificent Drive • north to adjacent stages of Apsley Estate via Quartermaine Boulevard • south to Hoffman Road. The above access routes will provide broader access to Rowley Road to the north, Anketell Road to the south and Kwinana Freeway to the east, including the localities of Wandi (east), Wattleup and Naval	✓

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
demonstrated appropriate, as a last resort option.			Base (west), Mandogalup and Hammond Park (north) and Bertram and Wellard (south).	
	A3.3a No-through roads **Area 1**: No limitation on no-through road lengths. **Area 2**: If the public road access to the subject site is via a no-through road which cannot be avoided due to demonstrated site constraints, the public road access is to be a maximum of 200 metres from the proposed lot(s) boundary to an intersection where two-way access is provided. The no-through road may exceed 200 metres if it is demonstrated that an alternative access, including an emergency access way, cannot be provided due to site constraints and the following requirements are met: • the no-through road travels towards a suitable destination; and • the balance of the no-through road that is greater than 200 metres from the subject site is wholly within BAL-LOW, or is within a residential built-out area, or is within Area 1 (Figure 29).	Acceptable solution	Two temporary no-through roads are required on either side of the future primary school site at the interface with Lot 11 to the south, which is being developed by others. These temporary no-through roads will be less than 200 m in length with compliant turnaround heads and will be resolved following extension as through roads on development of Lot 11 to the south.	✓
	A3.3b No-through road requirements A no-through road is to meet all the following requirements: • requirements of a public road (Appendix B.3, Table 10, Column 2); and	Acceptable solution	The two temporary no-through roads discussed under A3.3a above, as well as any additional temporary no-through roads required as part of internal development staging, will be constructed to the relevant technical requirements of the Guidelines.	✓

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	• turn-around area/head (Figure 30).			
	A3.4 Emergency access way *Where it is demonstrated that A3.2 and A3.3 cannot be achieved due to site constraints or where an alternative design option does not exist, an emergency access way can be considered as an acceptable solution.* An emergency access way is to meet the following requirements: • the requirements of Appendix B.3, Table 10, Column 3; • provides a through connection to a public road; • is no more than 500 metres in length; • connects to a public road network (note: an emergency access way onto the State Road Network requires access approval from Main Roads WA); • the proponent obtaining consent from the local government, that it will accept care, control and management for the access way; and is signposted and, if gated, gates must open for the whole carriageway width and remain unlocked.	Acceptable solution	The project area does not require any permanent Emergency Access Ways (EAWs) to provide through access to a public road. Any temporary EAWs required as part of internal development staging will be constructed to the relevant technical requirements of the Guidelines.	✓
	A3.5a Perimeter roads A perimeter road is a public road and is to be provided for greenfield or infill development	Acceptable solution	Perimeter roads have been provided at all interfaces with the external classified vegetation extent.	✓

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	where 10 or more lots are proposed (including as part of a staged subdivision) with the aim of: • separating areas of permanent classified vegetation under AS 3959 which adjoin the subject site, from the proposed lot(s); and • removing the need for battle-axe lots that back onto areas of classified vegetation. A perimeter road is to meet the requirements contained in Appendix B.3, Table 10, Column 1. A perimeter road may not be required where: • the adjoining classified vegetation is Class G Grassland; • lots are zoned for rural living or equivalent; • it is demonstrated that it cannot be provided due to site constraints; or • all lots have frontage to an existing public road.			
	A3.5b Fire service access route *Where proposed lots adjoin classified vegetation under AS 3959 (excluding Class G Grassland), and a perimeter road is not required in accordance with A3.5a, a fire service access route is to be provided to provide firefighter access, where access is not available to the classified vegetation.* A fire service access route is to meet the following requirements: • requirements of Appendix B.3, Table 10, Column 4;	N/A	The proposed subdivision does not require fire service access routes (FSARs) to achieve access within and around the perimeter of the project area since perimeter public roads will be provided at the required external development interfaces.	N/A

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	• be through-routes with no dead-ends; • must be signposted; • no further than 500 metres from a public road; • the proponent obtaining consent from the local government that it will accept care, control and management; and if gated, gates must open the whole carriageway width and can be locked by the local government and/or the emergency services, if keys are provided for each gate.			
	A3.6 Battle-axe access legs *Where it is demonstrated that a battle-axe access leg cannot be avoided due to site or design constraints, it can be considered as an acceptable solution.* There are no battle-axe technical requirements where the point of the battle-axe access leg joins the effective area of the battle-axe lot, is less than 50 metres from a public road in a reticulated water area. In circumstances where the above acceptable solution is not met, or the battle-axe lot is in a non-reticulated water area, the battle-axe leg is to meet the following requirements: • requirements in Appendix B.3, Table 10, Column 5; • passing bays every 200 metres with a minimum length of 20 metres and a	Acceptable solution	Four unavoidable battle-axe lots are proposed in the central and northeast portions of the site, which are unavoidable due to limitations on driveway access in proximity to the main intersection with Quartermain Boulevard to the north, as well as limitations due to POS frontage. It is noted that these lots are not situated in a designated bushfire prone area, will achieve BAL-Low following development of adjacent stages of Apsley Estate to the north and the length of the battle-axe access legs are less than 50 m, so no technical requirements apply as per A3.6.	✓

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	minimum additional carriageway width of two metres • (i.e. the combined carriageway width of the passing bay and constructed private driveway to be a minimum six metres); and turn-around area/head (Figure 30).			
Element 4: Water supply				
O4 – Ensure that sufficient water is available and accessible for emergency services, to enable people, property and infrastructure to be defended from bushfire.	**A4.1 Water supply for structure plans** Evidence that a reticulated or sufficient and sustainable non-reticulated water supply for bushfire firefighting can be provided at the subdivision and/or development application stage, in accordance with the specifications of the relevant water supply authority or the requirements in Appendix B.4: Water Supply dedicated for bushfire firefighting. Where the provision of a strategic water tank(s) is required, a suitable area should be identified as a Crown reserve on the structure plan, to the satisfaction of the WAPC on advice from the local government.	N/A	Not applicable to the subdivision planning stage.	N/A
	A4.2 Water supply for subdivision applications Where a reticulated water supply is existing or proposed, a hydrant connection(s) should be	Acceptable solution	The proposed development will be connected to a reticulated water supply via extension of services from adjacent developed stages of Florence Estate in accordance with Water Corporation Design Standard 63 requirements.	✓

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	provided in accordance with the specifications of the relevant water supply authority. Where these specifications cannot be met, then the following applies: • the provision of a water tank(s) in accordance with the requirements of Appendix B.4, Table 11 – Water supply dedicated for bushfire firefighting; and Where the provision of a strategic water tank(s) is applicable, then the following requirements apply: • land to be ceded free of cost to the Crown for the placement of the tank(s); • the proposed reserve where the tank is to be located is identified on the plan of subdivision; • tank capacity, construction and fittings, provided in accordance with the requirements of Appendix B.4; and • a strategic water tank is to be located no more than a 10-minute drive from the furthest development site (at legal road speeds).			
	A4.3 Water supply for existing habitable building(s) Where subdivision includes an existing habitable building(s) that is to be retained, a hydrant connection(s) should be provided in accordance	N/A	Not applicable to this application. There are no existing habitable buildings within the project area.	N/A

Outcomes	Acceptable solutions	Method of compliance	Statement of development compliance	Compliance achieved
	with the specifications of the relevant water supply authority. Where these specifications cannot be met, a water tank(s) should be provided in accordance with the requirements of Appendix B.4, Table 5 – Water supply dedicated for bushfire firefighting.			

Responsibilities for implementation and management of the bushfire measures

Implementation of this BMP addendum applies to the developer and prospective landowners to ensure bushfire management measures are adopted and implemented on an ongoing basis. A bushfire management responsibilities table is provided in Table 4 to drive implementation of all bushfire management works associated with this BMP addendum, with the 'developer commitments prior to issue of titles' to be conditioned as part of subdivision approval.

Table 4: Responsibilities for implementation and management of the bushfire measures

Implementation/management table	
No.	**Implementation action**
1 - Developer – prior to issue of titles	
1-1	Construct (or have works bonded) the public roads, no-through roads (including any temporary no-through roads/EAWs required as part of internal development staging) and reticulated water supply to the standards stated in this BMP addendum.
1-2	Prepare detailed Landscape Plans to confirm revegetation and low threat landscaping outcomes anticipated throughout on-site POS, Western Power easement, DBNGP easement and the Regional Flood Storage Area, consistent with the provisions of this BMP addendum.
1-3	Establish all non-vegetated and low threat managed areas (i.e. proposed lots, roads, 100 m wide low threat staging buffers, relevant areas of POS, etc) and revegetation to the standards stated in this BMP addendum and consistent with the detailed landscape plans stated above.
1-4	Temporarily quarantine the one proposed lot in the southeast from creation of title through condition of subdivision until such time that BAL-29 or lower can be demonstrated, as per Figure 3.
1-5	Apply a temporary 8 m wide APZ setback within the southern boundary of the primary school site until such time that the adjacent grassland hazard within Lot 11 to the south is removed, as per Figure 3.
1-6	Comply with the City of Kwinana annual firebreak notice as amended (refer to Attachment C).
1-7	Undertake a BMP compliance assessment to demonstrate implementation of the required bushfire management actions throughout subdivisional works.
2 - Developer – until sale/transfer of lots	
2-1	Maintain all non-vegetated and low threat managed areas (i.e. proposed lots, roads, 100 m wide low threat staging buffers, relevant areas of POS, etc) and revegetation to the standards stated in this BMP addendum and consistent with the detailed landscape plans stated above.
2-2	Comply with the City of Kwinana annual firebreak notice as amended (refer to Attachment C).
3 - Landowner/occupier – prior to building construction and ongoing	
3-1	Maintain cleared/vacant lots in a low threat state to achieve exclusion Clause 2.2.3.2 (f) of AS3959, including slashing/mowing of grassland and weeds to height of less than 50 mm, until developed to a permanent low fuel state.
3-2	Where required, undertake individual lot BAL assessment prior to issuing of building permits.
3-3	Where required, adopt bushfire construction measures relevant to the assessed BAL rating.
3-4	Comply with the City of Kwinana annual firebreak notice as amended (refer to Attachment C).

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Limitations

Scope of services

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

Reliance on data

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

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law 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, including to any third parties, and no liability will be accepted for use or interpretation of this report by any third party.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Attachment A Landscape concept plans

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LEGEND

- EXTENT OF WORKS BOUNDARY
- FOOTPATH NETWORK
- OPEN TURF AREA
- NATIVE PLANTING
- SHELTER AND PICNIC AREA
- PLAYGROUND
- RETAINED TREES
- PROPOSED TREES
- STREET TREES
- INDICATIVE FLOOD STORAGE AREA IN POS
- CONVEYANCE SWALE
- MANDOGALUP SWAMP REGIONAL FLOOD STORAGE AREA



FLORENCE SOUTH, MANDOGALUP
LANDSCAPE MASTERPLAN

DWG **MA-22-01**
REV **B**
DATE **28.05.24**
0 20 40 60 80 100 m
SCALE **1 : 4000 @ A3**

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SYMBOL KEY

- PLAYGROUND
- DRINK FOUNTAIN
- BBQ
- PICNIC SETTING
- RETAINED VEGETATION
- SHELTER
- LOOKOUT
- WALKING TRAIL
- PASSIVE RECREATION
- SWALE / BASIN

PREVIOUSLY APPROVED STRUCTURE PLAN AREA

PEEL MAIN DRAIN

KWINANA FREEWAY

POS 2

POS 10

DBNGP EASEMENT

POS 9

REGIONAL FLOOD STORAGE AREA

POS 13

POS 12

POS 1

POS 11

INDICATIVE FUTURE SCHOOL SITE (SUBJECT TO FURTHER INVESTIGATION)

WESTERN POWER EASEMENT

WESTERN POWER EASEMENT LANDSCAPED AND MAINTAINED TO A PERMANENT LOW THREAT STATE

FLORENCE SOUTH, MANDOGALUP

SPATIAL AMENITY PLAN

DWG MA-22 -02
REV B
DATE 28.05.24

0 20 40 60 80 100 m

SCALE 1 : 4000 @ A3

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LEGEND

STREET TREES



Liquidambar styraciflua
Sweetgum

Eucalyptus torquata
Coral Gum



Eucalyptus sideroxylon rosea
Ironbark

Melaleuca leucadendra
Weeping Paperbark



Eucalyptus victrix
Little Ghost Gum

Melaleuca preissiana
Stout Paperbark



Melaleuca quinquenervia
Broad-leaved Paperbark

Cupaniopsis anarcardioides
Tuckeroo



Melaleuca viridiflora
Broad-leaved Paperbark



FLORENCE SOUTH, MANDOGALUP

STREET TREE MASTERPLAN

DWG **MA-22-03**
REV **B**
DATE **28.05.24**

0 20 40 60 80 100 m

SCALE **1 : 4000 @ A3**

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DBNGP EASEMENT

POS TYPOLOGY

- DBNGP Easement POS

SIZE

- 2.06ha m2 + verge.

DRAINAGE CONSIDERATION

- Swale for conveyance of minor and major stormwater discharge to Regional Flood Storage Area.

CONCEPT & FUNCTION

The DBNGP Easement POS landscape is designed to deliver:

- Passive and active recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Seating areas for rest and recuperation
- Open turf areas for informal sport activities
- Native, waterwise planting
- Clear and easy maintenance access for gas utility providers across entire easement.

** DBNGP Easement POS landscape design to be in accordance with DBNGP land use requirements.







FLORENCE SOUTH, MANDOGALUP

DBNGP EASEMENT POS LANDSCAPE CONCEPT

DWG **MA-22-04**
REV **B**
DATE **28.05.24**
SCALE **1 : 2000 @ A3**
0 10 20 30 40 50 m

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KEY PLAN













POS 1

FLOOD MANAGEMENT AREA H

POS TYPOLOGY

- Neighbourhood POS

SIZE

- 1.12ha + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1800m3

Major Event 1% AEP

TWL Area: 5000m^2

Volume: 4600m3

CONCEPT & FUNCTION

The POS 1 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas in selected locations throughout the POS
- Shelter and picnic node
- Large playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Open lawn/ kick-about space
- Native, water wise planting
- Drainage basin for stormwater management

FLORENCE SOUTH, MANDOGALUP

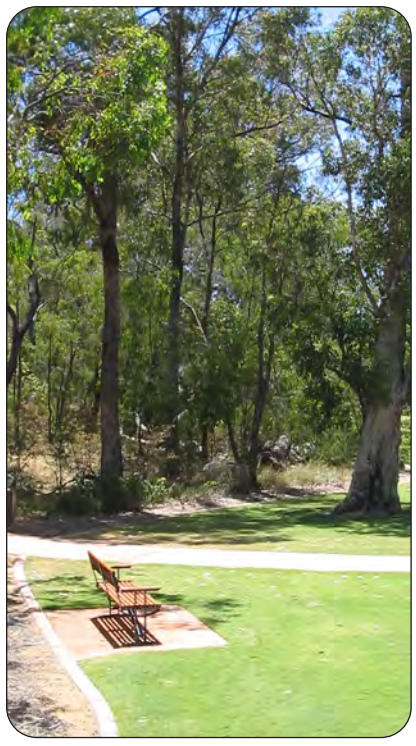
POS 1 LANDSCAPE CONCEPT

DWG **MA-22-05**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
0 5 10 15 20 25 m

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POS 2

FLOOD MANAGEMENT AREA E

POS TYPOLOGY
- Neighbourhood POS

SIZE
- 8507m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1350m3

Major Event 1% AEP

TWL Area: 4900m^2

Volume: 3900m3

CONCEPT & FUNCTION

The POS 2 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing melaleuca trees and understorey vegetation for shade and biodiversity, incorporated into drainage where appropriate.
- Shaded seating areas in selected locations throughout the POS
- Shelter structures with bbq and picnic facilities
- Playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



Fflorence south, mandogalup

POS 2 LANDSCAPE CONCEPT

DWG **MA-22-06**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
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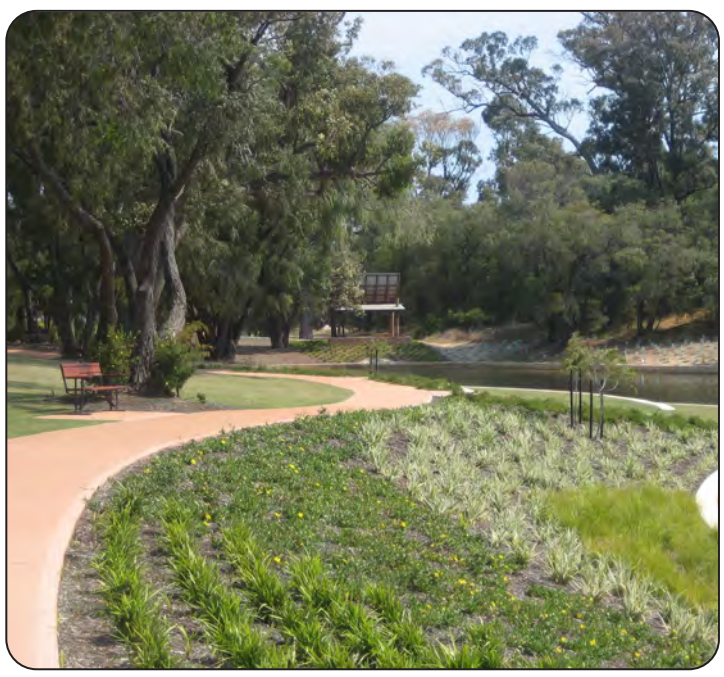
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POS 9

FLOOD MANAGEMENT AREA F

POS TYPOLOGY
Nature Space/ Local Open Space

SIZE
- 8944m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 900m^2

Volume: 340m3

Major Event 1% AEP

TWL Area: 1400m^2

Volume: 1025m3

CONCEPT & FUNCTION

The POS 9 landscape proposals will deliver the following:

- Opportunities for nature-based recreational activities, such as picnicking, bird watching, walking.
- Retention of existing trees and understorey vegetation for shade and biodiversity.
- Shaded seating areas
- Footpath network with access through the POS and to the greater pedestrian path network
- Access into POS from nested lots
- Small open lawn area for informal recreation
- Native, waterwise planting
- Planting designed to maintain a low-fuel state for bushfire managemant purposes
- Drainage basin for stormwater management





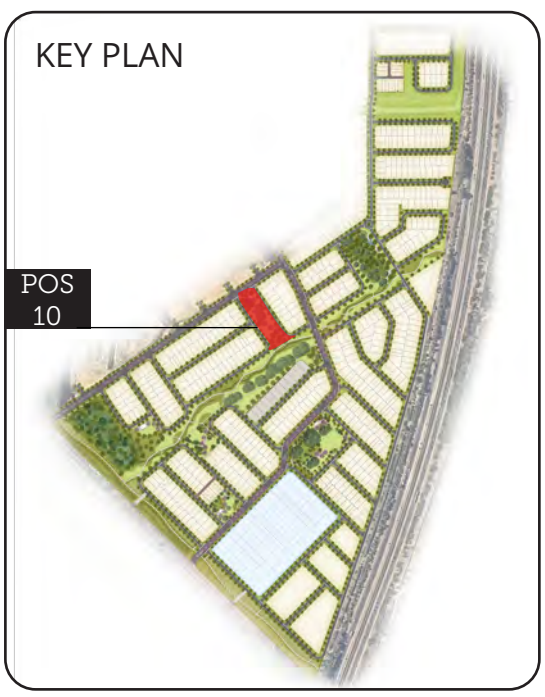
FLORENCE SOUTH, MANDOGALUP
POS 9 LANDSCAPE CONCEPT

DWG **MA-22-07**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 10

FLOOD MANAGEMENT AREA G

POS TYPOLOGY
- Neighbourhood Park

SIZE
- 6715m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 1700m^2

Volume: 380m3

Major Event 1% AEP

TWL Area: 2100m^2

Volume: 1150m3

CONCEPT & FUNCTION

The POS 10 landscape proposals will deliver the following:
- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas
- Shelter structures with bbq and picnic facilities
- Inclusive nature playground with shade sails
- Open lawn areas for informal sports and recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 10 LANDSCAPE CONCEPT

DWG **MA-22-08**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 11

FLOOD MANAGEMENT AREA K

POS TYPOLOGY
Local Park

SIZE
- 3112m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area:1000m^2

Volume: 260m3

Major Event 1% AEP

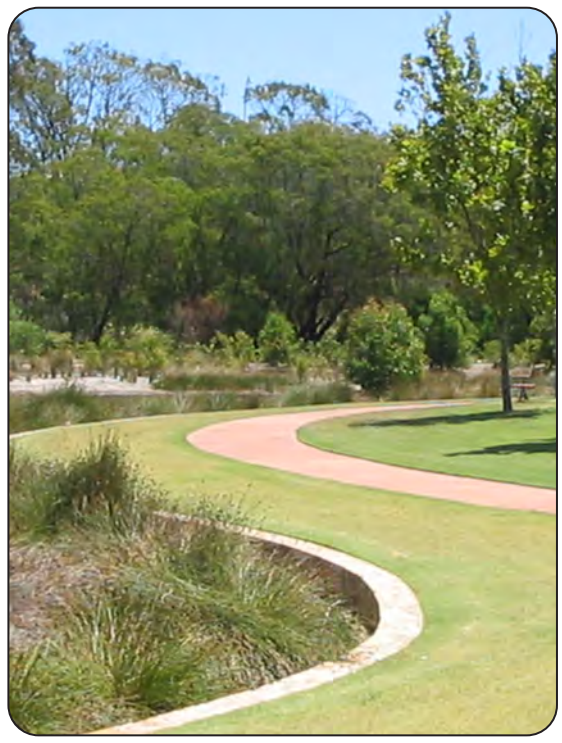
TWL Area:1300m^2

Volume: 700m3

CONCEPT & FUNCTION

The POS 11 landscape proposals will deliver the following:
- Predominantly passive recreation opportunities
- Retention of existing trees for shade and biodiversity
- Shaded seating areas
- Shelter and picnic node
- Open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 11 LANDSCAPE CONCEPT

DWG **MA-22-09**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 12

FLOOD MANAGEMENT AREA J

POS TYPOLOGY

- Local Park

SIZE

- 3941m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 2100m^2

Volume: 735m3

Major Event 1% AEP

TWL Area: 2800m^2

Volume: 2350m3

CONCEPT & FUNCTION

The POS 12 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management

POS 13

FLOOD MANAGEMENT AREA I

POS TYPOLOGY

- Local Park

SIZE

- 4529m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 3600m^2

Volume: 1200m3

Major Event 1% AEP

TWL Area: 4500m^2

Volume: 3400m3

CONCEPT & FUNCTION

The POS 13 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



FLORENCE SOUTH, MANDOGALUP

POS 12 & POS 13 LANDSCAPE CONCEPTS

DWG **MA-22-10**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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WESTERN POWER EASEMENT

POS TYPOLOGY

- High Voltage Powerline Easement

SIZE

- 5.14ha

DRAINAGE CONSIDERATIONS

The Western Power Easement is part of the Mandogalup Swamp Regional Flood Storage Area.

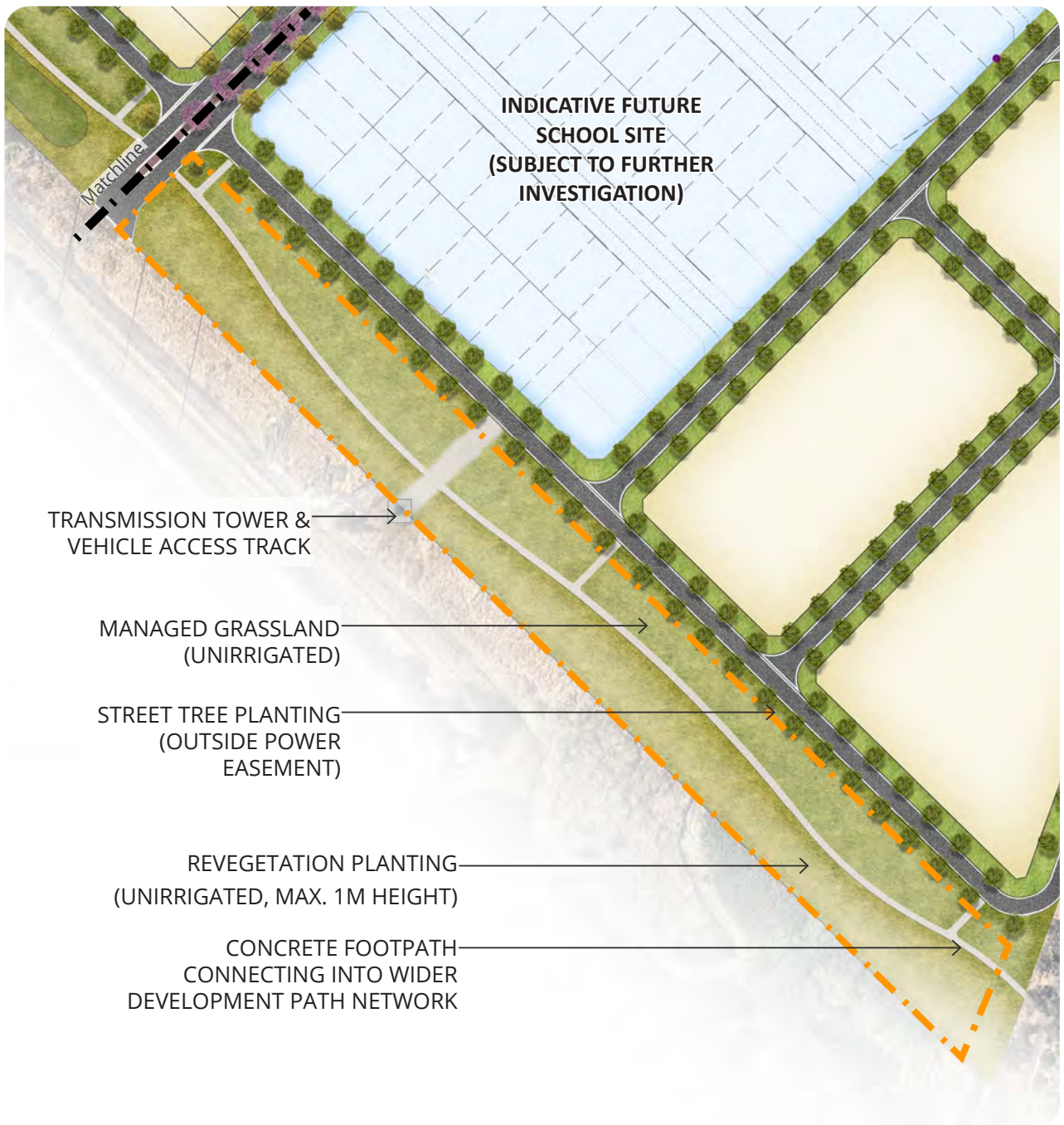
Overland flows from the DBNGP Easement, POS 11 (FMA K), the indicative future school site and FMA M will discharge into the Western Power Easement POS.

CONCEPT & FUNCTION

The Western Power Easement landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Unirrigated, managed grassland planting
- Unirrigated native revegetation planting, to a max. height of 1m.
- Flood storage areas for stormwater management
- Clear and easy maintenance access for power utility providers to transmission towers and across entire easement.

** Western Power Easement landscape design to be in accordance with Western Power easement land use requirements.



FLORENCE SOUTH, MANDOGALUP

WESTERN POWER EASEMENT LANDSCAPE CONCEPT

DWG **MA-22-11**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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Attachment B Asset Protection Zone standards

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Appendix B.2, Table 9: Asset Protection Zones technical requirements	
Object	**Requirement**
Fences within the APZ	• Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Appendix F of AS 3959).
Fine fuel load (combustible, dead vegetation matter less than 6 mm in thickness)	• Should be managed and removed on a regular basis to be maintained as low threat vegetation. • Should be maintained at less than two tonnes per hectare (on average). • Mulches should be non-combustible such as stone, gravel, shells, rock or crushed mineral earth or wood mulch more than five millimetres in thickness.
Trees* (more than 6 m in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building. • Branches at maturity should not touch or overhang a building or powerline. • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be less than 15 per cent of the total APZ area. • Tree canopies at maturity should be at least 5 m apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided the total canopy cover within the APZ does not exceed 15 per cent and is not connected to the tree canopy outside the APZ. 
Shrub* and scrub* (0.5 m to 6 m in height). Shrub and scrub more than 6 m in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings. • Should not be planted in clumps more than five square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground cover* (less than 0.5 m in height. Ground cover more than 0.5 m in height is to be treated as shrub)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. • Can be located within two metres of a structure but three metres from windows or doors if more than 100 mm in height.
Grass	• Grass should be maintained at a height of 100 mm or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.
Defendable space	• Within three metres of each wall or supporting post of a habitable building; the area is kept free from vegetation but can include ground cover, grass and non- combustible mulches as prescribed above.

Appendix B.2, Table 9: Asset Protection Zones technical requirements	
Object	**Requirement**
Liquid petroleum gas cylinders	• Should be located on the side of a building farthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. • The pressure relief valve should point away from the house. • No flammable material within six metres from the front of the valve. • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

***** *Plant flammability, landscaping design and maintenance should be considered – refer to explanatory notes*

Source: *Planning for Bushfire Guidelines (WAPC 2024)*

Attachment C City of Kwinana Fire Hazard Compliance Notice 2024/2025

FIRST AND FINAL NOTICE

FIRE HAZARD COMPLIANCE NOTICE 2024/2025

Important The works outlined below **must** be completed by 1 December 2024 and maintained up to and including 31 May 2025, unless otherwise stated in this notice.

COMPLIANCE DUE BY

1 December 2024

INSPECTIONS COMMENCE FROM

1 December 2024

Notice to all landowners within the City of Kwinana

This Fire-Break/Hazard Compliance Notice is issued by the City of Kwinana pursuant to *Section 33 of the* ***Bush Fires Act 1954*** to assist with the prevention, control and extinguishment of bush fires or to prevent the spread or extension of a bush fire to any adjoining land.

All property owners and/or occupiers of land within the City of Kwinana are hereby served with a first and final Fire-Break/ Hazard Compliance Notice (the Notice) and are required to comply with the requirements in full.

Failure or neglect to comply with this notice is an offence and may result in a penalty of up to $5,000.

The table below outlines the requirements of landowners and/or occupiers in the City of Kwinana. Please refer to the column that best describes your land size to view your legal responsibilities.

Land with a total area of:	3,501m² (0.35ha) or greater	1,501m² (0.15ha) up to 3,500m² (0.35ha)	Less than 1,500m² (0.15ha)
Fire Breaks Install and maintain mineral earth fire breaks as per the specifications defined below.	✓		
Asset Protection Zone Maintain a reduced fuel zone around all habitable buildings which extends twenty (20) metres as per the specifications below.	✓		
Defendable Space Within three (3) metres of all walls or supporting posts of a habitable building, the area is kept free from vegetation including overhanging branches within three (3) metres of any habitable building.		✓	
Flammable Ground Fuel • Reduce and/or maintain all Dead Flammable Material (DFM) on the ground across the entire property to a "fuel load" of below eight (8) tonnes per hectare. See definition below. • Ensure that all long grass and weeds are slashed, mowed or trimmed down to a height no greater than 50mm across your entire property. (Compliance required year-round)		✓	✓
Driveways Ensure driveways and access ways to all buildings are maintained at a minimum of three (3) metres in width and a vertical clearance height of four (4) metres to allow emergency vehicle access.	✓	✓	✓
Flammable Material Gutters, roofs, and walls of all buildings to be free of flammable matter and maintained.	✓	✓	✓

Variations to Notice

If it is impractical for you to install a firebreak as specified in this Notice, you may apply to vary the location of your firebreak within your property by completing and submitting an 'Application to Vary Location and Type of Firebreaks' form available on the City's Fire Permits and Burn Offs page.

Submit completed forms to customer@kwinana.wa.gov.au marked for the attention of the Chief Bush Fire Control Officer – no later than 31 October 2024.

Additional Works

Regardless of land size and location, the City or its Bush Fire Control Officers may require additional work to be undertaken on a property to improve access, and/or undertake further works to reduce a hazard that may be conducive to preventing an outbreak and/or the spread or extension of a bush fire.

'**Industrial Zoned**' areas may require additional works as identified by the Bush Fire Control Officer during fire hazard inspections.

Bushfire Management Plan

Where a property is affected by an approved bushfire management plan, the property owner and/or occupier must still comply with all requirements in this notice and with ALL additional requirements outlined within that plan.

Engagement of contractors by owner and/or occupier to carry out works

Any owner and/or occupier who engages a contractor to undertake works on their behalf is responsible for ensuring that such works when completed meet the requirements of this Notice.

Firebreak/fire hazard compliance inspections

To promote community safety and education, property inspections will be carried out by the City's Bush Fire Control Officers to identify non-compliant properties from 1 December 2024.

No burning in areas defined as Urban

Pursuant to section, *24G (2) of the* ***Bush Fires Act 1954***, no burning of garden refuse is to be undertaken in areas defined as "Urban" without written approval by the City of Kwinana.

Environmental and Heritage Conditions

Any property subject to environmental and heritage value such as, but not limited to, Threatened Ecological Communities (TEC), Bush Forever sites, Declared Rare Flora, and Fauna (DRF) sites and Aboriginal Heritage sites, etc should seek further information about what can or cannot be carried out prior to complying with the requirements under this Notice.

If you do not meet your fire prevention responsibilities as a property owner, you could be liable for a maximum penalty of $5,000 plus costs. The City may also access a property and undertake the required work at the expense of the owner.

For further information, please contact the City of Kwinana, view the included brochure or the City of Kwinana website kwinana.wa.gov.au/fires

Definitions

Firebreak:
A strip of mineral earth land free of all flammable material with the intention of minimising the spread or extension of a bushfire and provide safe access on the property for emergency vehicles and other firefighting operations.

- Clearance must be 3 metres wide and 4 metres in height as close as practically possible, inside and along all boundaries of the perimeter of the land.
- Living green lawn is acceptable in lieu of mineral earth firebreaks, provided that the same width and height requirements for a firebreak are maintained.
- Must have a corner turning radius of up to 10 metres.
- Must be a continuous trafficable surface for a 4WD vehicle and be clear of any obstructions and must not terminate in a dead end.

Asset Protection Zone: Maintain a fuel-reduced zone around all habitable buildings which extends 20 metres (m) from the outermost point of the building.

- Fuel load within the 10m inner zone is reduced and maintained to no more than 2 tonne per hectare. Fuel load within the 10-20m outer zone is reduced and maintained to below 8 tonne per hectare.
- Trees over 5m in height within the 20m zone to be under pruned up to 2m.
- Trees or shrubs within 3m of the asset shall be pruned to a maximum height of 2m and/or pruned to ensure a 2m wide vertical clearance from the asset.

Fuel Load: Can be live and dead vegetation that accumulates over time. This Notice refers only to dead vegetation.

- A fuel load depth of 15mm (fine fuels) to the mineral earth is indicative of approximately 8 tonne per hectare. The more fuel load, the higher the flame height and increased fire intensity.
- Mulch piles, stored firewood and burn piles can contribute to fuel loading on land and must be stored safely away from assets, removed from the property, or actioned as directed by a Fire Control Officer.
- Fine fuels include Leaf litter, grasses, twigs (up to 6mm diameter), bark etc.

Flammable Material: Any bush, plant, tree, grass, vegetation, object, or material that may or is likely to catch fire and burn.

Wayne Jack,
Chief Executive Officer

Administration
Cnr Gilmore Ave & Sulphur Rd, Kwinana WA 6167 | PO Box 21, Kwinana WA 6966
Hours Mon-Fri 8:30am-4:30pm | **Telephone** Mon-Fri 8:00am-5:00pm 08 9439 0200
customer@kwinana.wa.gov.au | **www.kwinana.wa.gov.au**

City of Kwinana

APPENDIX 3B

Bushfire Management Plan Addendum (Structure Plan)

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details

Site Address / Plan Reference: Lots 9002, 9006, 11 and 9000 (Florence Estate)

Suburb: Mandogalup **State:** WA **P/code:** 6167

Local government area: City of Kwinana

Description of the planning proposal: Structure Plan Amendment

BMP Plan / Reference Number: 66354/157,843 **Version:** M01 Rev 0 **Date of Issue:** 12/07/2024

Client / Business Name: Satterley Property Group

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☒	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The proposed Structure Plan Amendment is a strategic planning proposal.

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
Zac Cockerill	Level 2	BPAD 37803	31/08/2024
Company		**Contact No.**	
JBS&G Australia Pty Ltd		(08) 9792 4797	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct

Signature of Practitioner  **Date** 12/07/2024

Name:	John Hirdman	Date:	12 July 2024
Company:	Satterley Property Group	Job/Doc. No.:	66354/157,843
Email:	johnh@satterley.com.au	Inquiries:	Zac Cockerill

Bushfire Management Plan Addendum: Florence Estate Structure Plan Amendment

1. Introduction

Satterley Property Group (Satterley) is lodging a Structure Plan Amendment over Florence Estate, Mandogalup in the City of Kwinana, to incorporate the balance of Lots 9002, 9006, 11 and the whole of Lot 9000 Hoffman Road, Mandogalup (hereon referred to as the project area) into the overall Structure Plan area. These landholdings were previously excluded from the original Mandogalup East Local Structure Plan due to the presence of the Kwinana Industrial Buffer. The Structure Plan Amendment, as depicted in **Figure 1**, proposes residential areas, a potential primary school site (subject to further investigation), Public Open Space (POS)/drainage, road reserves, Western Power easement and the Dampier to Bunbury Natural Gas Pipeline (DBNGP) easement throughout the project area.

Strategen (now JBS&G), prepared a comprehensive Bushfire Management Plan (BMP) in 2017 to support Satterley in their original Local Structure Plan submission for Florence Estate. Subdivision was subsequently approved throughout the Structure Plan area, supported by a detailed subdivision stage BMP (Strategen-JBS&G 2020).

This BMP has been prepared as an addendum to the original Mandogalup East Local Structure Plan BMP (Strategen 2017) and provides for an updated strategic level bushfire assessment specific to the project area, as required to support the proposed Structure Plan Amendment. This BMP addendum should be read in conjunction with the original Structure Plan BMP (Strategen 2017), as well as the updated assessments documented in the subsequent subdivision stage BMP (Strategen-JBS&G 2020). This BMP addendum includes the following information:

1. A revised bushfire assessment including:
    a. updated pre and post-development vegetation classification and effective slope maps specific to the project area and current/proposed vegetation conditions (**Figure 2** and **Figure 3**)
    b. updated pre and post-development Bushfire Hazard Level (BHL) assessments specific to the project area and current/proposed vegetation conditions mapped from Item 1a above (**Figure 4** and **Figure 5**)
2. A revised assessment against the bushfire protection criteria of *Guidelines for Planning in Bushfire-Prone Areas Version 1.4* (the Guidelines; WAPC 2021) demonstrating that compliance can be achieved at subsequent planning stages (**Table 4**).
3. A list of responsibilities for implementation of the bushfire management measures to guide future planning stages of the development.

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1.1 Purpose

A portion of the project area is designated bushfire prone on the Map of Bush Fire Prone Areas (refer to Plate 1; DFES 2021); therefore, bushfire risk considerations and assessment are required to inform the Structure Plan Amendment as per requirements under Policy Measure 6.3 of *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP3.7; WAPC 2015).

This BMP addendum has been prepared to accompany the proposed Structure Plan Amendment to address strategic planning requirements under Policy Measure 6.3 of SPP3.7 in accordance with the Guidelines.



Plate 1: Designated bushfire prone status of the project area (DFES 2021)

LEGEND

LAND USE

- RESIDENTIAL - MEDIUM DENSITY (R30 - R60)
- PS — PRIMARY SCHOOL
- PUBLIC OPEN SPACE
- DRAINAGE

MOVEMENT NETWORK

- NEIGHBOURHOOD CONNECTOR
- ACCESS STREET B
- ACCESS STREET D
- SHARED USE PATH

NOTE: ROAD LAYOUT SUBJECT TO DETAILED DESIGN TO BE DETERMINED AT SUBDIVISION STAGE.

SERVICES & EASEMENTS

- POWERLINE EASEMENT CORRIDOR
- 330kv OVERHEAD POWER LINE
- TRANSMISSION TOWER
- DBNGP EASEMENT

OTHER

- STRUCTURE PLAN BOUNDARY
- AMENDMENT AREA
- IP47 AREA BOUNDARY
- PS* — PRIMARY SCHOOL - NOTIONAL SCHOOL SITE ONLY. SUBJECT TO FURTHER INVESTIGATION

ROWLEY ROAD

KWINANA FREEWAY

HOFFMAN ROAD

PS

PS*

\\GRA-FS\DATA\TOWN PLANNING\7000-7999\7282\7282A\DRAFTING\A-CAD - VR - 2024.04.17

PLAN 1 - LOCAL STRUCTURE PLAN

VARIOUS LOTS - KWINANA FREEWAY & ROWLEY ROAD
MANDOGALUP

DRAFT

N

0 200 m

SCALE @ A3: 1:7500

7282D-LSP-08-D

DRAWN:	WC
DATE CREATED:	2024.04.17
PROJECTION:	PCG94
CADASTRE:	LANDGATE

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ROWE GROUP DESIGN

2. Bushfire assessment results

2.1 Assessment inputs

2.1.1 Vegetation Classification

JBS&G assessed classified vegetation and exclusions within the project area and surrounding 150 m through on-ground verification on 10 October 2023 and 21 February 2024.

Vegetation classifications have been assigned in accordance with *AS3959—2018 Construction of Buildings in Bushfire-Prone Areas* (AS3959; SA 2018) and the *Visual Guide for Bushfire Risk Assessment in Western Australia* (DoP 2016). Georeferenced site photos and a description of the vegetation classifications and exclusions are contained in Appendix A. Assessment results are outlined in **Table 1** and **Figure 2** for existing pre-development conditions; and **Table 2** and **Figure 3** for anticipated post-development conditions.

The current pre-development extent of classified vegetation and exclusions is described below and depicted in **Figure 2**:

- Class A forest comprising a multi-tiered fuel structure with a eucalyptus overstorey, shrub midstorey and grassy understorey:
  - within remnant bushland east of Kwinana Freeway
  - within the eastern and western verges of Kwinana Freeway reserve
  - within isolated pockets of the project area, some of which will be retained in on-site POS
- Class B woodland comprising sparse overstorey trees over a grassy understorey:
  - within isolated pockets of the project area
  - on land external to the project area under control by others to the northwest and southwest
- Class D scrub comprising shrubs with a continuous horizontal fuel profile 2–6 m in height:
  - within remnant bushland east of Kwinana Freeway
  - within the eastern and western verges of Kwinana Freeway reserve
  - within isolated pockets of the project area
- Class C shrubland comprising shrubs with a continuous horizontal fuel profile less than 2 m in height within isolated pockets of the project area
- Class G grassland within and adjacent to the project area in numerous locations comprising unmanaged grass greater than 100 mm in height at maturity.

Existing non-vegetated land (e.g. buildings/infrastructure, access tracks, roads, earthworked land, etc), as well as any existing land managed in a low threat state (e.g. urban street verges, low threat staging buffers, etc), were assessed to be excluded from classification under Clauses 2.2.3.2 (e) and (f) of AS 3959.

Post-development conditions, as depicted in **Figure 3**, will require modification to the following areas to a non-vegetated/low threat managed state to achieve exclusion under Clause 2.2.3.2 of AS3959:

- proposed residential areas, including those northeast of the project area within existing Florence Estate subject to existing subdivision approval and BMP
- proposed primary school site
- proposed roads reserves and streetscapes, including Hoffman Road
- POS 1, 9, 10, 11 and 12, as well as the DBNGP easement and a component of the Western Power easement that will result in low threat areas such as turf, footpaths, infrastructure, managed gardens, managed grassland and nature strips, as per the Landscape Masterplan contained in Appendix A
- POS 2, which will comprise retained forest vegetation less than 1 ha in size and not within 100 m of any other classified vegetation, thereby meeting the criteria to be excluded under Clause 2.2.3.2 (b).

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Post-development conditions, as depicted in **Figure 3**, may also result in revegetation throughout proposed POS drainage and flood storage areas, including POS 13, the northwest flood storage area and a component of the Western Power easement, as per the Landscape Masterplan contained in Appendix A. Classification of these areas as Class D scrub is precautionary at this stage based on conceptual landscape design and is subject to change at future planning stages dependent on detailed landscape design.

2.1.2 Effective Slope

JBS&G assessed effective slope under classified vegetation within the assessment area through on ground verification on 10 October 2023 and 21 February 2024 in accordance with AS3959. Results were cross referenced with DPIRD 2 m contour data. Effective slope results are outlined in **Table 1** and **Figure 2** for existing pre-development conditions; and **Table 2** and **Figure 3** for anticipated post-development conditions. Results indicate that effective slope within and surrounding the project area is predominantly flat/upslope (0 degrees).

2.1.3 Pre-development inputs

A summary of the assessed pre-development classified vegetation, exclusions and effective slope within the project area and adjacent 150 m are listed in **Table 1** and illustrated in **Figure 2**.

Table 1: Summary of pre-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class A Forest	Flat/upslope (0°)	Forest vegetation consisting of overstorey trees 10–30 m high, a midstorey and a grassy understorey
2	Class B Woodland	Flat/upslope (0°)	Sparse overstorey trees with a grassy understorey
3	Class D Scrub	Flat/upslope (0°)	Scrub vegetation between 2–6 m high with a continuous horizontal fuel profile
4	Class C Shrubland	Flat/upslope (0°)	Shrub vegetation less than 2 m in height
5	Class G Grassland	Flat/upslope (0°)	Grassland greater than 100 mm in height at maturity
6	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated land/low threat managed areas including buildings, infrastructure, roads, access tracks, low threat staging buffers, earthworked land, urban street verges, etc

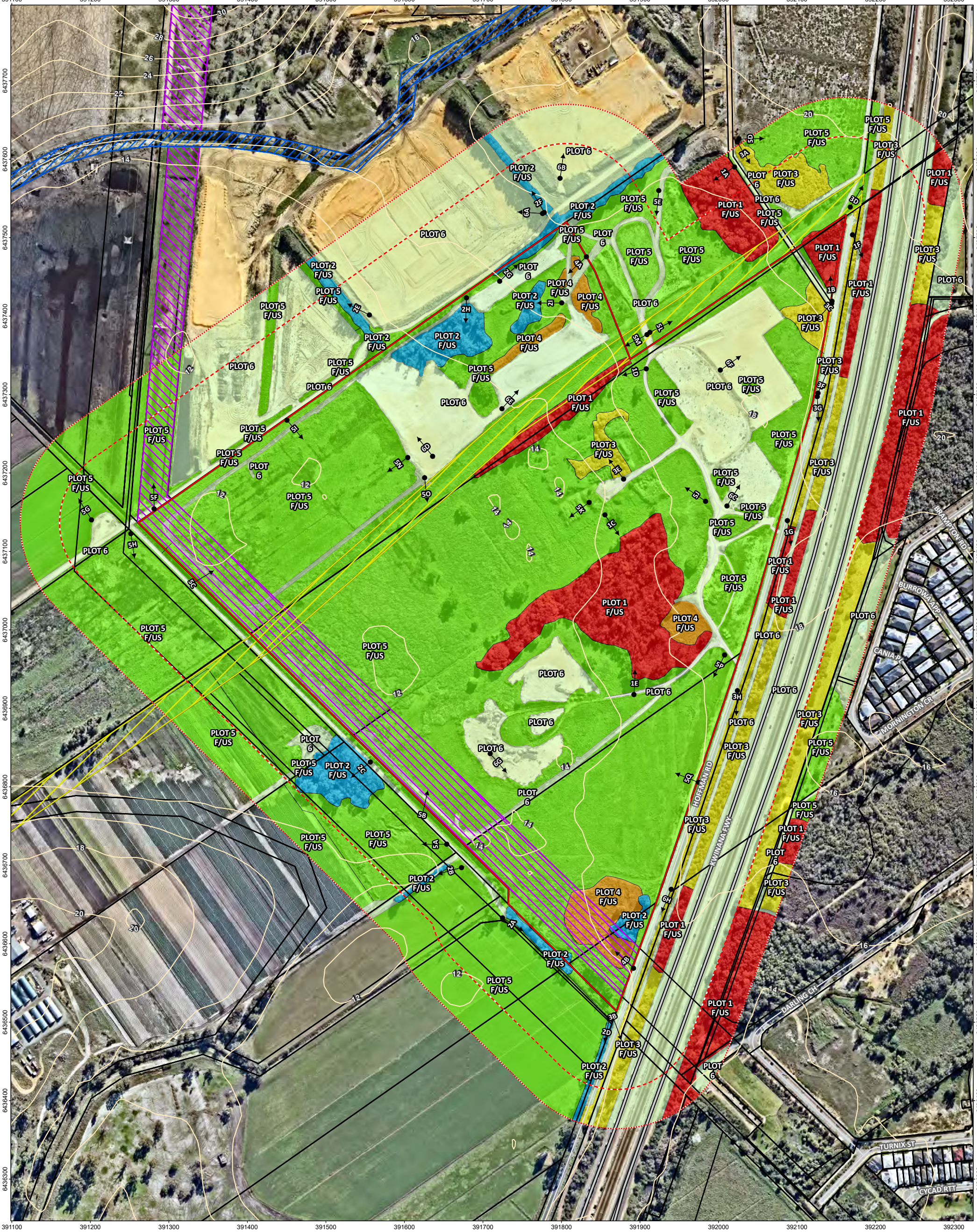
2.1.4 Post-development inputs

A summary of the expected post-development classified vegetation, exclusions and effective slope within the project area and adjacent 150 m are listed in **Table 2** and depicted in **Figure 3**.

The post-development vegetation classifications for all land external to the project area are expected to remain the same as pre-development conditions. Land to the north/northwest of the project area is being developed within Apsley Estate by QUBE and components of this land will be modified to a non-vegetated/low threat managed state in an unknown timeframe, so vegetation has been classified as a precautionary measure as part of this assessment.

Table 2: Summary of post-development vegetation classifications, exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class A Forest	Flat/upslope (0°)	Forest vegetation consisting of overstorey trees 10–30 m high, a midstorey and a grassy understorey
2	Class B Woodland	Flat/upslope (0°)	Sparse overstorey trees with a grassy understorey
3	Class D Scrub	Flat/upslope (0°)	Scrub vegetation between 2–6 m high with a continuous horizontal fuel profile
4	Class G Grassland	Flat/upslope (0°)	Grassland greater than 100 mm in height at maturity
5	Excluded – Clause 2.2.3.2 [b]	N/A	Vegetation less than 1 ha in size and not within 100 m of any other classified vegetation
6	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated land/low threat managed areas including buildings, infrastructure, roads, access tracks, low threat staging buffers, earthworked land, urban street verges, etc
7	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Areas to be modified to a non-vegetated/low threat managed state as part of proposed development, as per the documented assumptions



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- DBNGP easement
- Peel main drain
- High voltage powerline easement
- Topographic contours (mAHD)
- Highway
- Minor road
- Photo point directions

Vegetation classification

- Class A Forest
- Class B Woodland
- Class C Shrubland
- Class D Scrub
- Class G Grassland
- Clause 2.2.3.2 (e) & (f)

JBS&G

0 100 metres

Job Number: 66354

Scale 1:4,500 at A3

Client: Satterley Property Group

Coord. Sys. GDA2020 MGA Zone 50

Drawn By: jcrute | Checked By: ZC | Version: Rev A | Date: 12-Jul-2024

Florence, Mandogalup Structure Plan Amendment, Mandogalup, WA

PRE-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE: 2

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Image Reference: www.nearmap.com© - Imagery Date: 13. June 2024.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Proposed POS
- Proposed cell layout
- Indicative subdivision by others
- Primary School site (subject to further investigation)
- High voltage powerline easement
- DBNGP easement
- Peel main drain
- Future subdivisions on adjacent stages
- Topographic contours (mAHD)
- Highway
- Minor road

Vegetation classification

- Class A Forest
- Class B Woodland
- Class D Scrub
- Class G Grassland
- Clause 2.2.3.2 (b)
- Clause 2.2.3.2 (e) & (f)
- Area to be modified to non-vegetated and low threat state

JBS&G

0 100 metres

Florence, Mandogalup Structure Plan Amendment, Mandogalup, WA

POST-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

Job Number: 66354		Scale 1:4,500 at A3	
Client: Satterley Property Group		Coord. Sys. GDA2020 MGA Zone 50	
Drawn By: jcrute	Checked By: ZC	Version: Rev A	Date: 12-Jul-2024

FIGURE: 3

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Image Reference: www.nearmap.com© - Imagery Date: 13. June 2024.

2.2 Assessment outputs

2.2.1 Pre-development BHL assessment

The pre-development classified vegetation extent has been assigned various BHLs in accordance with methodology detailed in Appendix 2 of the Guidelines, as outlined in **Table 3**.

Table 3: BHL assessment results

Bushfire Hazard Level	Characteristics*
Extreme	• Class A Forest • Class B Woodland (05) • Class D Scrub • Any classified vegetation with a greater than 10° slope.
Moderate	• Class B Low Woodland (07) • Class C Shrubland • Class E Mallee/Mulga • Class G Grassland, including sown pasture and crops • Class G Grassland: Open woodland (06), Low open woodland (08), Open shrubland (09) • Vegetation that has a low hazard level but is within 100 metres of vegetation classified as a moderate or extreme hazard, is to adopt a moderate hazard level.
Low	• Low threat vegetation may include areas of maintained lawns, golf courses, public recreation reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks • Managed grassland in a minimal fuel condition (insufficient fuel is available to significantly increase the severity of the bushfire attack). For example, short-cropped grass to a nominal height of 100 millimetre • Non-vegetated areas including waterways, roads, footpaths, buildings and rock outcrops.
*Vegetation classifications from AS 3959-2018 Table 2.3.	

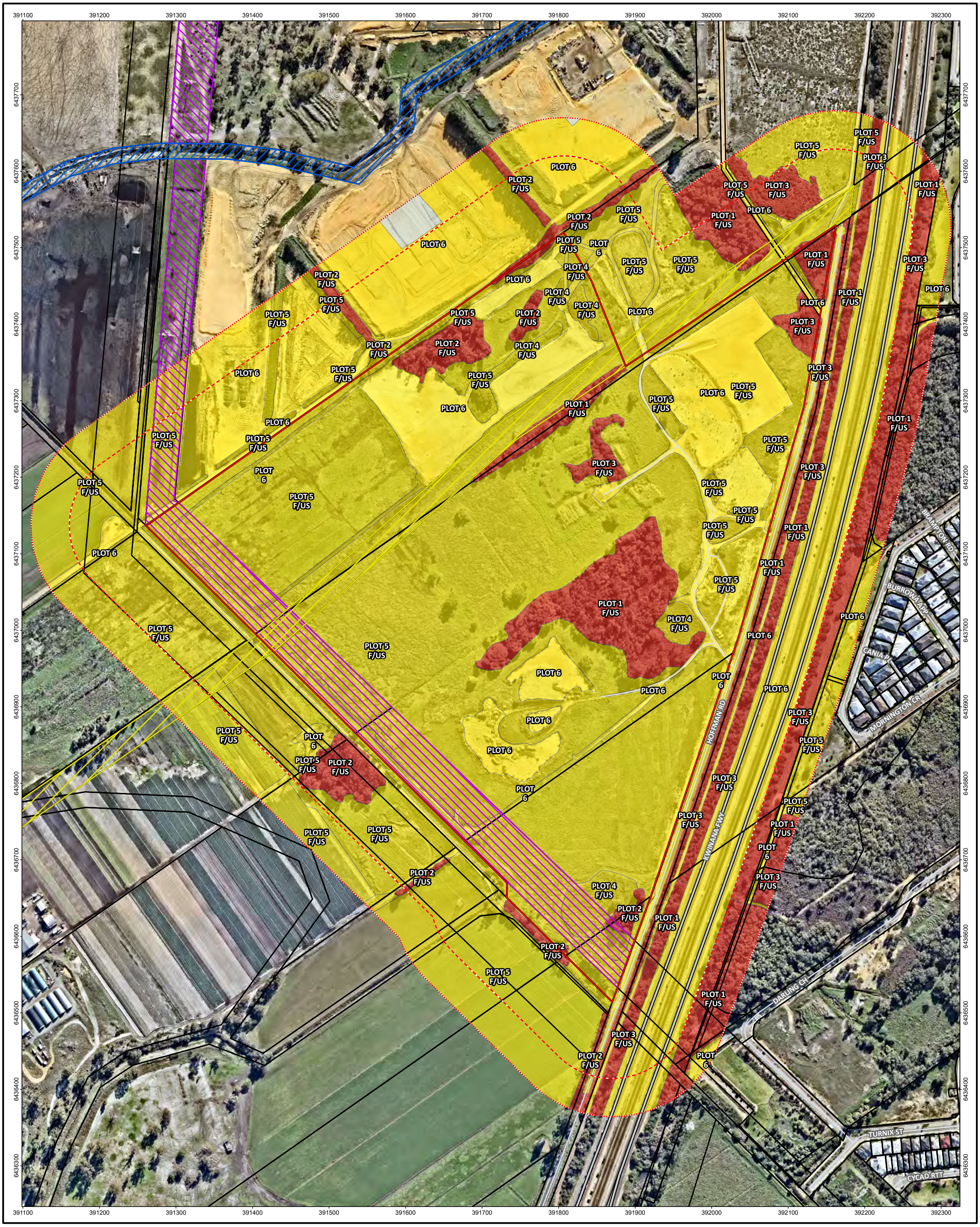
JBS&G has mapped the pre-development BHLs within the project area and surrounding 150 m. The BHLs have been assessed on the basis of the vegetation summarised in Section 2.1.3 (i.e. the current pre-development extent of classified vegetation within and surrounding the project area).

The pre-development BHL assessment (refer to **Figure 4**) indicates that based on the existing vegetation extent, the project area contains land with Moderate and Extreme BHLs. Whilst some of the project area is rated with a pre-development Extreme BHL, the majority of on-site vegetation is temporary and subject to modification to a non-vegetated/low threat managed state as part of proposed development. Therefore, the post-development BHL will be significantly reduced following proposed development.

2.2.2 Post-development BHL assessment

The post-development BHLs have been mapped within the assessment area on the basis of the anticipated post-development vegetation summarised in Section 2.1.4.

The post-development BHL assessment map (**Figure 5**) demonstrates that all proposed development areas will be located on land with either a Low or Moderate BHL. This achieves compliance with Element 1 of the bushfire protection criteria of the Guidelines, as discussed in Section 3.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- DBNGP easement
- Peel main drain
- High voltage powerline easement
- Highway
- Minor road

Bushfire hazard level

- Extreme
- Moderate
- Low

JBS&G

0 100 metres

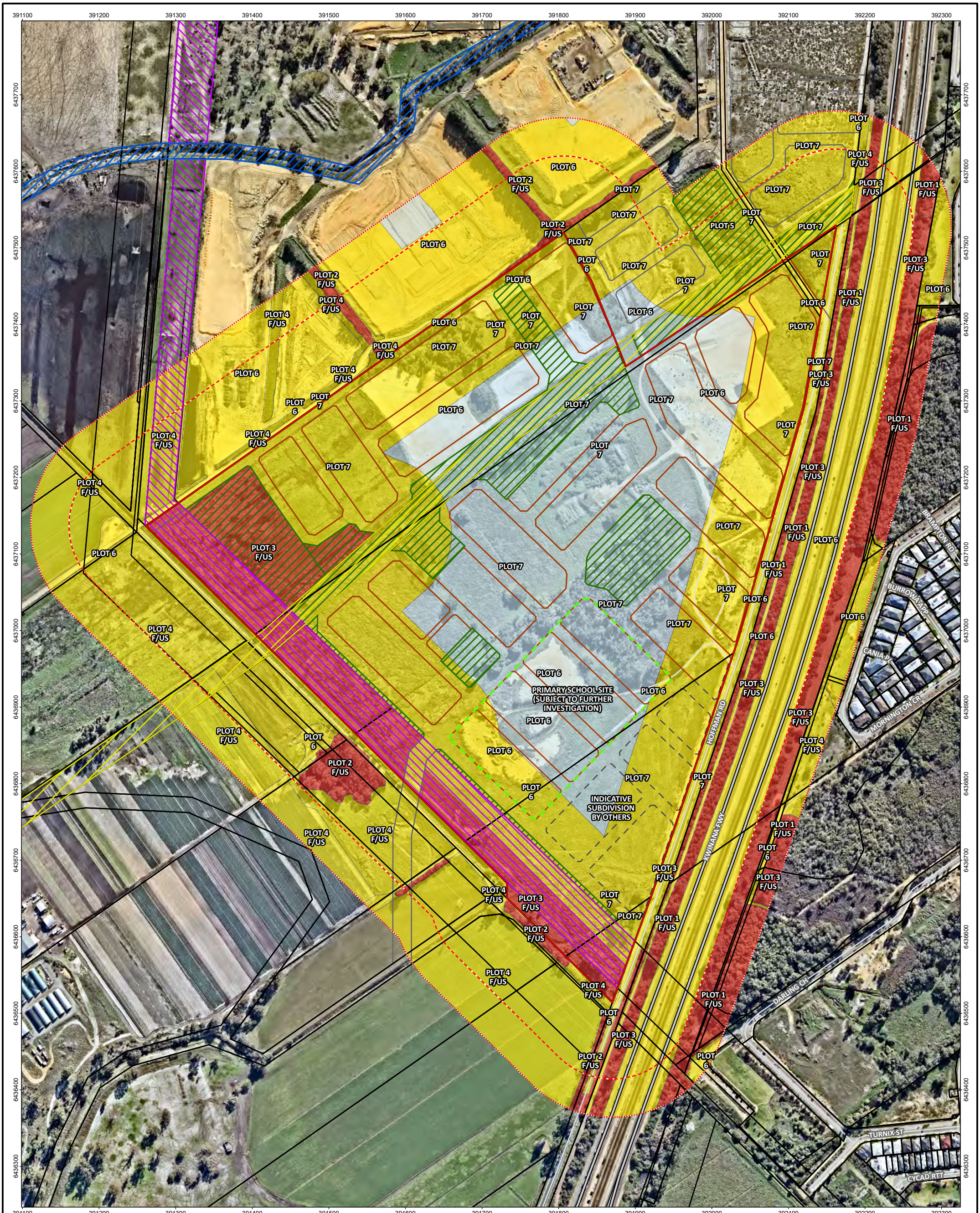
Florence, Mandogalup Structure Plan Amendment, Mandogalup, WA

PRE-DEVELOPMENT BUSHFIRE HAZARD LEVELS

Job Number: 66354		Scale 1:4,500 at A3		
Client: Satterley Property Group		Coord. Sys. GDA2020 MGA Zone 50		
Drawn By: jcrute	Checked By: ZC	Version: Rev A	Date: 12-Jul-2024	**FIGURE: 4**

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Image Reference: www.nearmap.com© - Imagery Date: 13. June 2024.



Legend

- Project area
- 100m assessment area
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- Proposed cell layout
- Indicative subdivision by others
- Primary School site (subject to further investigation)
- High voltage powerline easement
- DBNGP easement
- Peel main drain
- Future subdivisions on adjacent stages
- Highway
- Minor road

Bushfire hazard level

- Extreme
- Moderate
- Low

JBS&G

0 100 metres

Job Number: 66354

Scale 1:4,500 at A3

Client: Satterley Property Group

Coord. Sys. GDA2020 MGA Zone 50

Drawn By: jcrute | Checked By: ZC | Version: Rev A | Date: 12-Jul-2024

Florence, Mandogalup Structure Plan Amendment, Mandogalup, WA

POST-DEVELOPMENT BUSHFIRE HAZARD LEVELS

FIGURE: 5

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Image Reference: www.nearmap.com© - Imagery Date: 13. June 2024.

3. Assessment against bushfire protection criteria

3.1 Compliance with Elements 1–4

Demonstration that the proposed development can comply with relevant acceptable solutions of Elements 1–4 of the bushfire protection criteria of the Guidelines (Version 1.4) is outlined in **Table 4**.

Table 4: Compliance with the bushfire protection criteria of the Guidelines (Elements 1–4)

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
Element 1: Location	**Performance Principle P1** The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the decision-maker.	**A1.1 Development location** The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.	The pre-development BHL assessment (**Figure 4**) identifies that the project area currently contains land with Moderate and Extreme BHLs. On completion of development however, it is expected that the majority of vegetation within the project area will be modified to be excluded from classification, with the only remaining classified vegetation potentially being present within revegetated portions of POS 13, the northwest flood storage area and a component of the Western Power easement (as per the Landscape Masterplan contained in Appendix A), noting this is subject to change as part of detailed landscaping design. Therefore post-development BHLs were assessed to be Low or Moderate in locations of proposed habitable development (see **Figure 5**). Consideration at the subdivision stage will need to be given to any on-site/external classified vegetation and the setbacks for habitable development to achieve BAL–29 or lower. The project area and proposed development cells are considered of sufficient size such that any interface with post-development classified vegetation could be readily accommodated through compliant subdivision design to ensure all future habitable development achieves BAL-29 or lower. This will be demonstrated through preparation of a BAL contour map at the subdivision stage.	✓

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
Element 2: Siting and design	**Performance Principle P2** The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. The proposal incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.	**A2.1 Asset Protection Zone** Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the requirements set out in Schedule 1.	Low threat separation for future habitable development to achieve BAL–29 or lower is to be implemented for all relevant lots where required. This will be predominantly achieved through appropriate subdivision design and the use of perimeter roads/low threat staging buffers at interfaces with on-site and external classified vegetation. Delivery of BAL-29 or lower for all proposed habitable development will be demonstrated through preparation of a BAL contour map at the subdivision stage. Any APZs/low threat separation are to be implemented and maintained in accordance with Schedule 1 of the Guidelines **(Appendix C**).	✓
Element 3: Vehicular access	**Performance Principle P3i** The design and capacity of vehicular access and egress is to provide for the community to evacuate to a suitable destination before a bushfire arrives at the site, allowing emergency services personnel to attend the site and/or hazard vegetation.	**A3.1 Public roads** *The minimum requirements under this acceptable solution are applicable to all proposed and existing public roads.* Public roads are to meet the minimum technical requirements in Table 6, Column 1. The trafficable (carriageway/pavement) width is to be in accordance with the relevant class of road in the Local Government Guidelines for Subdivisional Development (IPWEA Subdivision Guidelines), Liveable Neighbourhoods, Austroad standards and/or any applicable standards for the local government area.	All proposed public roads will be designed and constructed to comply with the technical requirements of the Guidelines (refer to A3.1 and **Appendix D**). This will be demonstrated at the subdivision stage of planning.	✓
		A3.2a Multiple access routes Public road access is to be provided in two different directions to at least two different suitable destinations with an all-weather surface (two-way access). If the public road access to the subject site is via a no-through road which cannot be	On completion of development, the existing and future public road network will provide all occupants with the option of travelling to multiple suitable destinations as detailed below: • access north through existing stages of Florence and Apsley Estates to Rowley Road • access east through to Hoffman Road.	✓

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
		avoided due to demonstrated site constraints, the road access is to be a maximum of 200 metres from the subject lot(s) boundary to an intersection where two-way access is provided. The no-through road may exceed 200 metres if it is demonstrated that an alternative access, including an emergency access way, cannot be provided due to site constraints and the following requirements are met: • the no-through road travels towards a suitable destination; and • the balance of the no-through road, that is greater than 200 metres from the subject site, is wholly within BAL-LOW, or is within a residential built-out area – Figure 23.	• it should also be noted that multiple connections north/northwest to the adjacent Apsley Estate will ultimately be provided. A minimum of two access routes to two suitable destinations will also need to be provided during staging of subdivision, which will be demonstrated as part of a subdivision stage BMP.	
		A3.2b Emergency access way *Where it is demonstrated that A3.2a cannot be achieved due to site constraints, or where an alternative design option does not exist, an emergency access way can be considered as an acceptable solution.* An emergency access way is to meet all the following requirements: • requirements in Table 6, Column 2; • provides a through connection to a public road; • be no more than 500 metres in length; and	No permanent EAWs are proposed or required as part of the development. Any temporary EAWs required as part of staged development are to be constructed to the technical requirements of the Guidelines (see A3.2b and Appendix D), which will be confirmed as part of a subdivision stage BMP.	✓

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
		• must be signposted and if gated, gates must open the whole trafficable width and remain unlocked.		
		A3.3 Through-roads All public roads should be through-roads. No-through roads should be avoided and should only be considered as an acceptable solution where: • it is demonstrated that no alternative road layout exists due to site constraints; and • the no-through road is a maximum length of 200 metres to an intersection providing two-way access, unless it satisfies the exemption provisions in A3.2a of this table. A no-through road is to meet all the following requirements: • requirements of a public road (Table 6, Column 1); and • turn-around area as shown in Figure 24.	All proposed public roads will be through-roads. Temporary no-through roads may also be required during development staging and will need to comply with relevant technical requirements under the Guidelines (refer A3.3 and **Appendix D**). This will be confirmed as part of a subdivision stage BMP.	✓
	Performance Principle P3ii The design of vehicular access and egress provides: • access and egress for emergency service vehicles while allowing the community to evacuate; • a defendable space for emergency services personnel on the interface • between classified vegetation and development site; and	**A3.4a Perimeter roads** A perimeter road is a public road and should be provided for greenfield or infill development where 10 or more lots are being proposed (including as part of a staged subdivision) with the aim of: • separating areas of classified vegetation under AS3959, which adjoin the subject site, from the proposed lot(s); and	The proposed public road network provides perimeter access at all anticipated interfaces with classified vegetation in accordance with A3.4a.	✓

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
	• hazard separation between classified vegetation and the subject site to reduce the potential radiant heat that may impact a lot(s).	• removing the need for battle-axe lots that back onto areas of classified vegetation. A perimeter road is to meet the requirements contained in Table 6, Column 1. A perimeter road may not be required where: • the adjoining classified vegetation is Class G Grassland; • lots are zoned for rural living or equivalent; • it is demonstrated that it cannot be provided due to site constraints; or • all lots have frontage to an existing public road.		
	Performance Principle P3iii Vehicular access is provided which allows: • access and egress for emergency service vehicles; • defendable space for emergency services • personnel on the interface between classified vegetation and development; and • hazard separation between classified vegetation and the site to reduce the potential radiant heat that may impact a lot(s).	**A3.4b Fire service access route** *Where proposed lots adjoin classified vegetation under AS3959, and a perimeter road is not required in accordance with A3.4a, a fire service access route can be considered as an acceptable solution to provide firefighter access, where access is not available, to the classified vegetation.* A fire service access route is to meet all the following requirements: • requirements in Table 6, Column 3; • be through-routes with no dead-ends; • linked to the internal road system at regular intervals, every 500 metres; • must be signposted;	As previously stated, the proposed public road network provides perimeter access to the surrounding bushfire hazards. On this basis, no FSARs will be required.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
		• no further than 500 metres from a public road; • if gated, gates must open the required horizontal clearance and can be locked by the local government and/or emergency services, if keys are provided for each gate; and • turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres.		
	Performance Principle P3iv Vehicular access is provided which allows emergency service vehicles to directly access all habitable buildings and water supplies and exit the lot without entrapment.	**A3.5 Battle-axe access legs** *Where it is demonstrated that a battle-axe cannot be avoided due to site constraints, it can be considered as an acceptable solution.* There are no battle-axe technical requirements where the point the battle-axe access leg joins the effective area of the lot, is less than 50 metres from a public road in a reticulated area. In circumstances where the above condition is not met, or the battle-axe is in a non-reticulated water area, the battle-axe is to meet all the following requirements: • requirements in Table 6, Column 4; and • passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres).	A3.5 is applicable to subdivision stage only.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
		A3.6 Private driveways There are no private driveway technical requirements where the private driveway is: • within a lot serviced by reticulated water; • no greater than 70 metres in length between the most distant external part of the development site and the public road measured as a hose lay; and • accessed by a public road where the road speed limit is not greater than 70 km/h. In circumstances where all of the above conditions are not met, or the private driveway is in a non-reticulated water area, the private driveway is to meet all the following requirements: • requirements in Table 6, Column 4; • passing bays every 200 metres with a minimum length of 20 metres and a minimum • additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres); and • turn-around area as shown in Figure 28 and within 30 metres of the habitable building.	A3.6 is applicable to the DA stage only.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
Element 4: Water	No performance principle applies	**A4.1 Identification of future water supply** Evidence that a reticulated or sufficient non-reticulated water supply for bushfire fighting can be provided at the subdivision and/or development application stage, in accordance with the specifications of the relevant water supply authority or the requirements of Schedule 2. Where the provision of a strategic water tank(s) is required a suitable area within a road reserve or a dedicated lot the location should be identified, should be identified on the structure plan, to the satisfaction of the local government.	Reticulated water supply services will be extended throughout the project area from services currently present within surrounding areas of development, which will result in provision of a reticulated mains water supply and network of street hydrants for future habitable development to Water Corporation Design Standard 63 requirements.	✓
	Performance Principle P4 Provide a permanent water supply that is: • sufficient and available for firefighting purposes; • constructed from non-combustible materials (e.g. steel), or able to maintain its integrity throughout a bushfire; and • accessible, with legal access for maintenance and re-filling by tankers and emergency service vehicles.	**A4.2 Provision of water for firefighting purposes** Where a reticulated water supply is existing or proposed, hydrant connection(s) should be provided in accordance with the specifications of the relevant water supply authority. Where these specifications cannot be met, then the following applies: • The provision of a water tank(s), in accordance with the requirements of Schedule 2; and • Where the provision of a strategic water tank(s) is applicable, then the following requirements apply: – land to be ceded free of cost to the local government for the placement of the tank(s); – the lot or road reserve where the tank is to be located is	A4.2 is applicable to the subdivision and DA stages only.	N/A

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Proposed bushfire management strategies	Compliance achievable at future planning stages
		identified on the plan of subdivision; – tank capacity, construction, and fittings, provided in accordance with the requirements of Schedule 2; and – a strategic water tank is to be located no more than 10 minutes from the subject site (at legal road speeds). Where a subdivision includes an existing habitable building(s) that is to be retained, a water supply should be provided to this existing habitable building(s), in accordance with the requirements listed above.		

4. Responsibilities for implementation and management of the bushfire measures

This BMP addendum has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs/addendums to accompany future subdivision/development applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs/addendums prepared to accompany future subdivision/development applications are to meet the relevant commitments outlined in this strategic level BMP addendum, address the relevant requirements of SPP 3.7 (i.e. Policy Measures 6.4 and 6.5 respectively) and demonstrate in detail how the proposed development will comply with the relevant acceptable solutions of the Guidelines. Future BMPs/addendums prepared to accompany future subdivision/development applications are to include the following detailed information:

- proposed lot layout, including any public open space (POS) and drainage areas
- detailed landscaping design in regard to POS and drainage to delineate low threat exclusions from classified vegetation
- confirmation of any retained vegetation or revegetation areas, particularly throughout drainage/flood storage areas
- confirmation of the post-development classified vegetation extent, effective slope and separation distances to proposed areas of habitable development
- BAL contour mapping demonstrating that proposed development areas will achieve a rating of BAL–29 or lower
- width and alignment of compliant low threat separation or APZs, including any APZ setback requirements into proposed lots
- confirmation of how bushfire management will be addressed regarding temporary bushfire hazards on adjacent future development stages, including low threat staging buffers or temporary quarantining of lots where required
- vehicular access provisions, including demonstration that a minimum of two access routes will be achieved for each stage of development (may require consideration of temporary compliant access provisions such as no-through roads and/or EAWs)
- confirmation of a compliant reticulated water supply
- provisions for notification on Title for any future lots with a rating of BAL-12.5 or greater as a condition of subdivision
- compliance requirements with the annual City of Kwinana firebreak notice (see Appendix E)
- assessment against the bushfire protection criteria of the Guidelines
- proposed implementation and audit program outlining all measures requiring implementation and the appropriate timing and responsibilities for implementation.

Based on the information contained in this BMP, JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks are readily manageable through adoption of standard acceptable solutions outlined in the Guidelines, which will be implemented as required throughout future planning stages. JBS&G considers that on implementation of the proposed management measures, the site will be able to be developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines.

5. References

Department of Fire and Emergency Services (DFES) 2021, *Map of Bush Fire Prone Areas*, [Online], Government of Western Australia, available from: https://maps.slip.wa.gov.au/landgate/bushfireprone/, [08/02/2024].

Department of Planning (DoP) 2016, *Visual guide for bushfire risk assessment in Western Australia*, Department of Planning, Perth.

Standards Australia (SA) 2018, Australian Standard *AS 3959–2018 Construction of Buildings in Bushfire-prone Areas*, Standards Australia, Sydney.

Strategen 2017, *Bushfire Management Plan: Mandogalup East Local Structure Plan*, report prepared for Satterley Property Group, November 2017.

Strategen-JBS&G 2020, *Bushfire Management Plan (Subdivision Application): Mandogalup East Subdivision, Mandogalup*, report prepared for Satterley Property Group, November 2020.

Western Australian Planning Commission (WAPC) 2015, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2021, *Guidelines for Planning in Bushfire Prone Areas*, Version 1.4 December 2021, Western Australian Planning Commission, Perth.

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Appendix A Landscape Masterplan

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LEGEND

- EXTENT OF WORKS BOUNDARY
- FOOTPATH NETWORK
- OPEN TURF AREA
- NATIVE PLANTING
- SHELTER AND PICNIC AREA
- PLAYGROUND
- RETAINED TREES
- PROPOSED TREES
- STREET TREES
- INDICATIVE FLOOD STORAGE AREA IN POS
- CONVEYANCE SWALE
- MANDOGALUP SWAMP REGIONAL FLOOD STORAGE AREA



FLORENCE SOUTH, MANDOGALUP
LANDSCAPE MASTERPLAN

DWG **MA-22-01**
REV **B**
DATE **28.05.24**
0 20 40 60 80 100 m
SCALE **1 : 4000 @ A3**

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SYMBOL KEY

- PLAYGROUND
- DRINK FOUNTAIN
- BBQ
- PICNIC SETTING
- RETAINED VEGETATION
- SHELTER
- LOOKOUT
- WALKING TRAIL
- PASSIVE RECREATION
- SWALE / BASIN

PREVIOUSLY APPROVED STRUCTURE PLAN AREA

PEEL MAIN DRAIN

KWINANA FREEWAY

POS 2

POS 10

DBNGP EASEMENT

POS 9

REGIONAL FLOOD STORAGE AREA

POS 13

POS 12

POS 1

POS 11

INDICATIVE FUTURE SCHOOL SITE (SUBJECT TO FURTHER INVESTIGATION)

WESTERN POWER EASEMENT

WESTERN POWER EASEMENT LANDSCAPED AND MAINTAINED TO A PERMANENT LOW THREAT STATE

FLORENCE SOUTH, MANDOGALUP

SPATIAL AMENITY PLAN

DWG MA-22 -02
REV B
DATE 28.05.24

0 20 40 60 80 100 m

SCALE 1 : 4000 @ A3

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LEGEND

STREET TREES



Liquidambar styraciflua
Sweetgum

Eucalyptus torquata
Coral Gum



Eucalyptus sideroxylon rosea
Ironbark

Melaleuca leucadendra
Weeping Paperbark



Eucalyptus victrix
Little Ghost Gum

Melaleuca preissiana
Stout Paperbark



Melaleuca quinquenervia
Broad-leaved Paperbark

Cupaniopsis anarcardioides
Tuckeroo



Melaleuca viridiflora
Broad-leaved Paperbark



FLORENCE SOUTH, MANDOGALUP

STREET TREE MASTERPLAN

DWG **MA-22-03**
REV **B**
DATE **28.05.24**

0 20 40 60 80 100 m

SCALE **1 : 4000 @ A3**

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DBNGP EASEMENT

POS TYPOLOGY

- DBNGP Easement POS

SIZE

- 2.06ha m2 + verge.

DRAINAGE CONSIDERATION

- Swale for conveyance of minor and major stormwater discharge to Regional Flood Storage Area.

CONCEPT & FUNCTION

The DBNGP Easement POS landscape is designed to deliver:

- Passive and active recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Seating areas for rest and recuperation
- Open turf areas for informal sport activities
- Native, waterwise planting
- Clear and easy maintenance access for gas utility providers across entire easement.

** DBNGP Easement POS landscape design to be in accordance with DBNGP land use requirements.







FLORENCE SOUTH, MANDOGALUP

DBNGP EASEMENT POS LANDSCAPE CONCEPT

DWG **MA-22-04**
REV **B**
DATE **28.05.24**
SCALE **1 : 2000 @ A3**
0 10 20 30 40 50 m

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KEY PLAN













POS 1

FLOOD MANAGEMENT AREA H

POS TYPOLOGY

- Neighbourhood POS

SIZE

- 1.12ha + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1800m3

Major Event 1% AEP

TWL Area: 5000m^2

Volume: 4600m3

CONCEPT & FUNCTION

The POS 1 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas in selected locations throughout the POS
- Shelter and picnic node
- Large playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Open lawn/ kick-about space
- Native, water wise planting
- Drainage basin for stormwater management

FLORENCE SOUTH, MANDOGALUP

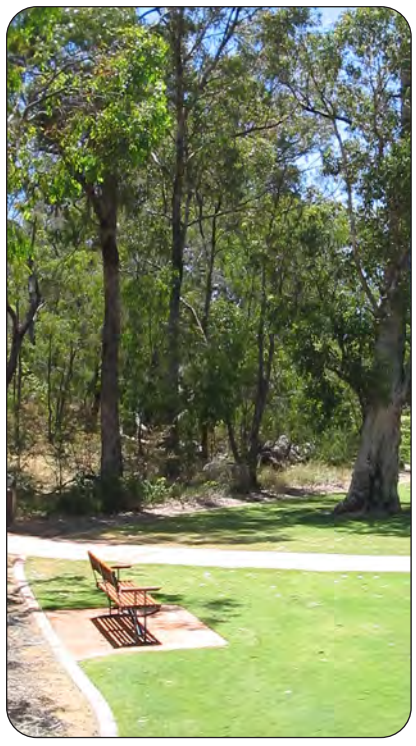
POS 1 LANDSCAPE CONCEPT

DWG **MA-22-05**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
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POS 2

FLOOD MANAGEMENT AREA E

POS TYPOLOGY
- Neighbourhood POS

SIZE
- 8507m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1350m3

Major Event 1% AEP

TWL Area: 4900m^2

Volume: 3900m3

CONCEPT & FUNCTION

The POS 2 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing melaleuca trees and understorey vegetation for shade and biodiversity, incorporated into drainage where appropriate.
- Shaded seating areas in selected locations throughout the POS
- Shelter structures with bbq and picnic facilities
- Playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



Fflorence south, mandogalup

POS 2 LANDSCAPE CONCEPT

DWG **MA-22-06**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
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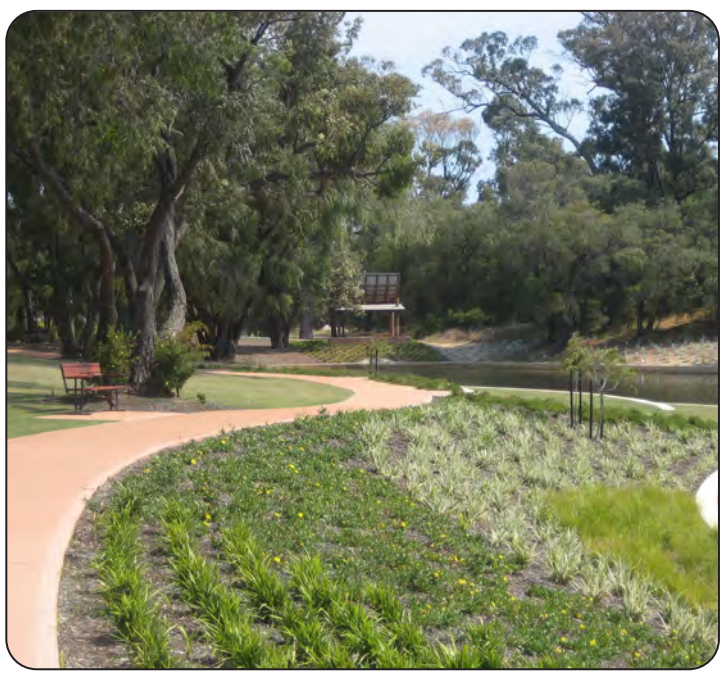
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POS 9

FLOOD MANAGEMENT AREA F

POS TYPOLOGY
Nature Space/ Local Open Space

SIZE
- 8944m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 900m^2

Volume: 340m3

Major Event 1% AEP

TWL Area: 1400m^2

Volume: 1025m3

CONCEPT & FUNCTION

The POS 9 landscape proposals will deliver the following:

- Opportunities for nature-based recreational activities, such as picnicking, bird watching, walking.
- Retention of existing trees and understorey vegetation for shade and biodiversity.
- Shaded seating areas
- Footpath network with access through the POS and to the greater pedestrian path network
- Access into POS from nested lots
- Small open lawn area for informal recreation
- Native, waterwise planting
- Planting designed to maintain a low-fuel state for bushfire managemant purposes
- Drainage basin for stormwater management





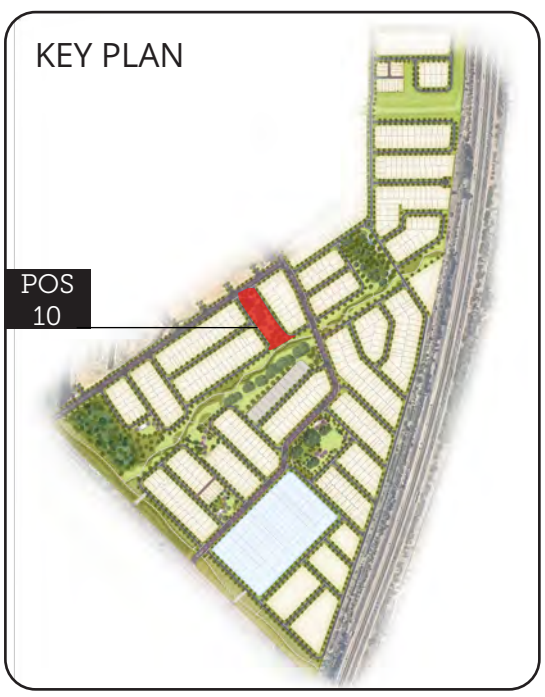
FLORENCE SOUTH, MANDOGALUP
POS 9 LANDSCAPE CONCEPT

DWG **MA-22-07**
REV **B**
DATE **28.05.24**
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SCALE **1 : 1000 @ A3**

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POS 10

FLOOD MANAGEMENT AREA G

POS TYPOLOGY
- Neighbourhood Park

SIZE
- 6715m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 1700m^2

Volume: 380m3

Major Event 1% AEP

TWL Area: 2100m^2

Volume: 1150m3

CONCEPT & FUNCTION

The POS 10 landscape proposals will deliver the following:
- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas
- Shelter structures with bbq and picnic facilities
- Inclusive nature playground with shade sails
- Open lawn areas for informal sports and recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 10 LANDSCAPE CONCEPT

DWG **MA-22-08**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 11

FLOOD MANAGEMENT AREA K

POS TYPOLOGY
Local Park

SIZE
- 3112m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area:1000m^2

Volume: 260m3

Major Event 1% AEP

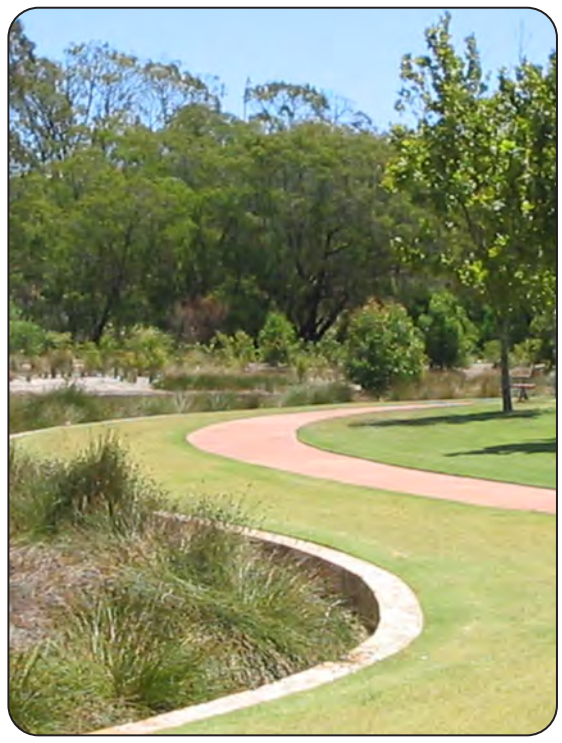
TWL Area:1300m^2

Volume: 700m3

CONCEPT & FUNCTION

The POS 11 landscape proposals will deliver the following:
- Predominantly passive recreation opportunities
- Retention of existing trees for shade and biodiversity
- Shaded seating areas
- Shelter and picnic node
- Open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 11 LANDSCAPE CONCEPT

DWG **MA-22-09**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 12

FLOOD MANAGEMENT AREA J

POS TYPOLOGY

- Local Park

SIZE

- 3941m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 2100m^2

Volume: 735m3

Major Event 1% AEP

TWL Area: 2800m^2

Volume: 2350m3

CONCEPT & FUNCTION

The POS 12 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management

POS 13

FLOOD MANAGEMENT AREA I

POS TYPOLOGY

- Local Park

SIZE

- 4529m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 3600m^2

Volume: 1200m3

Major Event 1% AEP

TWL Area: 4500m^2

Volume: 3400m3

CONCEPT & FUNCTION

The POS 13 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



FLORENCE SOUTH, MANDOGALUP

POS 12 & POS 13 LANDSCAPE CONCEPTS

DWG **MA-22-10**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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emerge ASSOCIATES





WESTERN POWER EASEMENT

POS TYPOLOGY

- High Voltage Powerline Easement

SIZE

- 5.14ha

DRAINAGE CONSIDERATIONS

The Western Power Easement is part of the Mandogalup Swamp Regional Flood Storage Area.

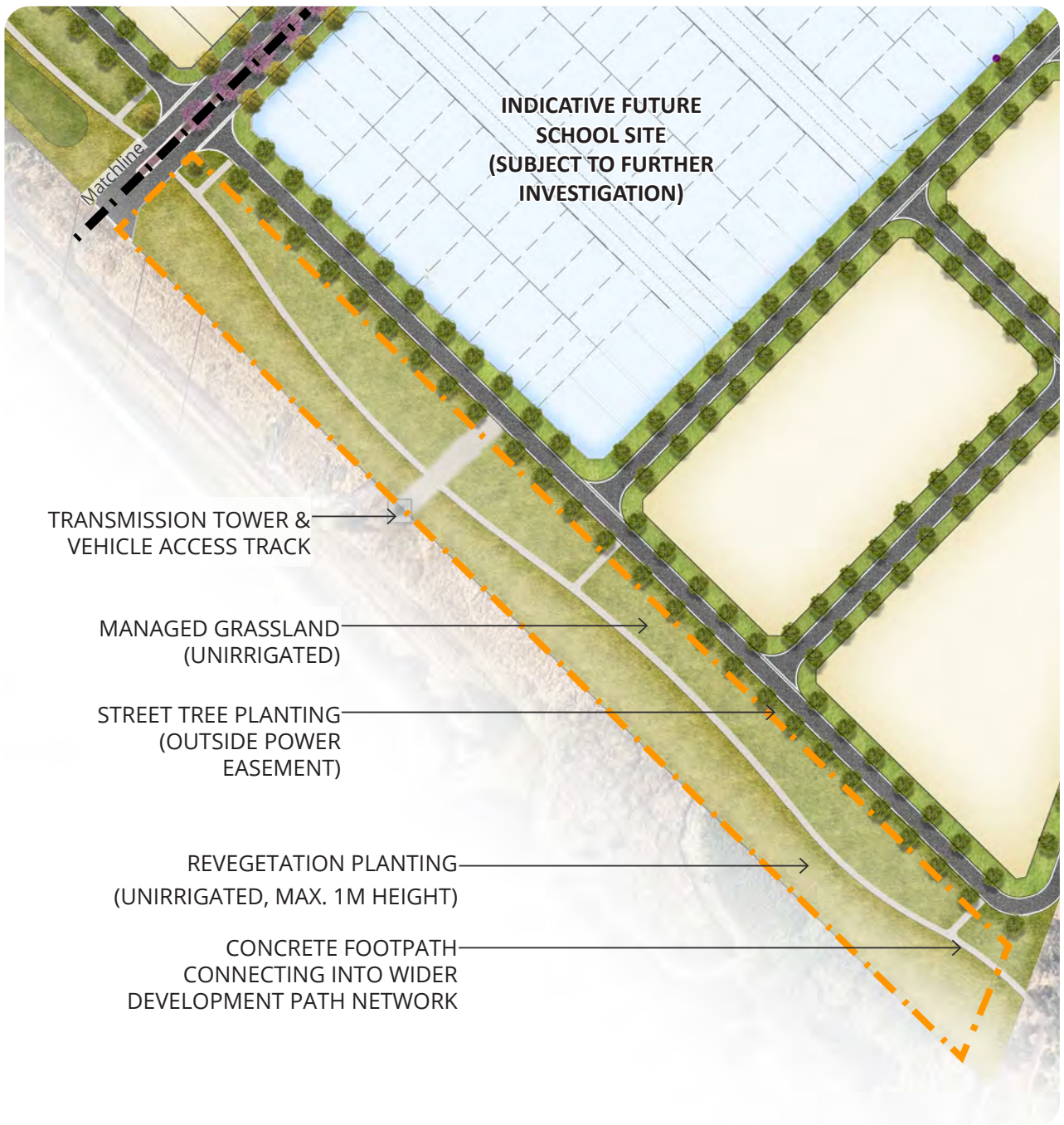
Overland flows from the DBNGP Easement, POS 11 (FMA K), the indicative future school site and FMA M will discharge into the Western Power Easement POS.

CONCEPT & FUNCTION

The Western Power Easement landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Unirrigated, managed grassland planting
- Unirrigated native revegetation planting, to a max. height of 1m.
- Flood storage areas for stormwater management
- Clear and easy maintenance access for power utility providers to transmission towers and across entire easement.

** Western Power Easement landscape design to be in accordance with Western Power easement land use requirements.



FLORENCE SOUTH, MANDOGALUP

WESTERN POWER EASEMENT LANDSCAPE CONCEPT

DWG **MA-22-11**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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Appendix B Pre-development vegetation plot photos and descriptions

Plot 1	
Vegetation classification	Class A Forest
Description / justification	Trees 10-30 m high at maturity, dominated by Eucalypts, multi-tiered structure comprising tall canopy layer, shrubby middle layer and grass/herb/sedge understorey



Photo ID: 1a



Photo ID: 1b



Photo ID: 1c (background)



Photo ID: 1d (background)



Photo ID: 1e (to right and background)



Photo ID: 1f (background)

Plot 1	
 **Photo ID:** 1g	

Plot 2	
Vegetation classification	Class B Woodland
Description / justification	Trees 2-30 m at maturity, dominated by trees with a grassy understorey (lacks shrubby middle layer and deep surface litter)



Photo ID: 2a



Photo ID: 2b



Photo ID: 2c



Photo ID: 2d

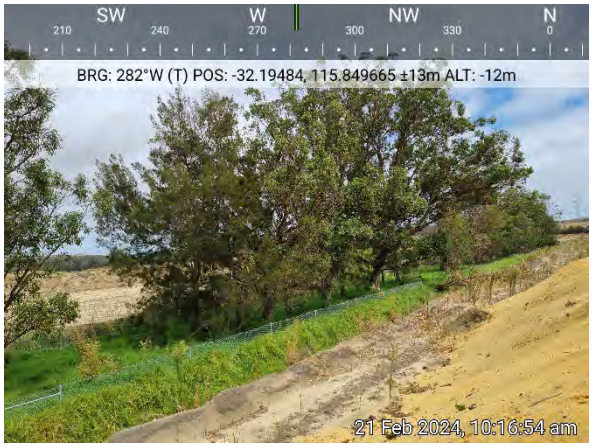


Photo ID: 2e



Photo ID: 2f

Plot 2	
 **Photo ID:** 2g	 **Photo ID:** 2h
 **Photo ID:** 2i (background)	

Plot 3	
Vegetation classification	Class D Scrub
Description / justification	Vegetation with a continuous horizontal and vertical structure, greater than 2 m high at maturity

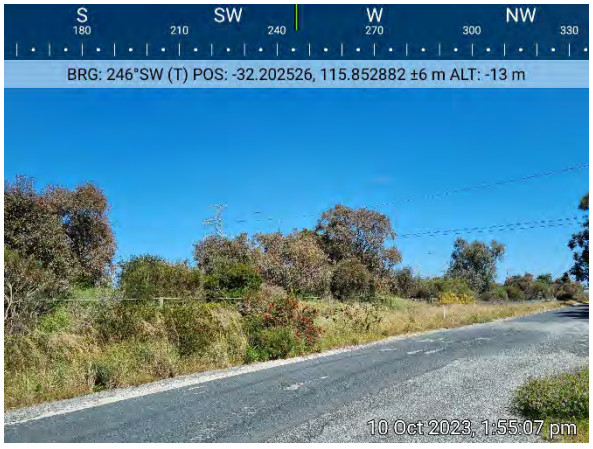


Photo ID: 3a



Photo ID: 3b

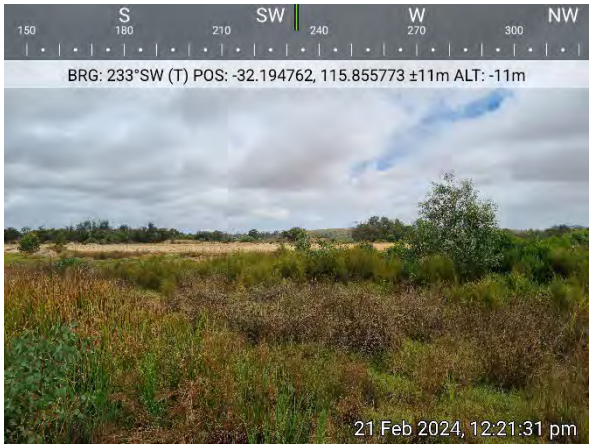


Photo ID: 3c



Photo ID: 3d (background)



Photo ID: 3e



Photo ID: 3f

Plot 3	
	
Photo ID: 3g	**Photo ID:** 3h

Plot 4	
Vegetation classification	Class C Shrubland
Description / justification	Shrub vegetation less than 2 m high at maturity



Photo ID: 4a

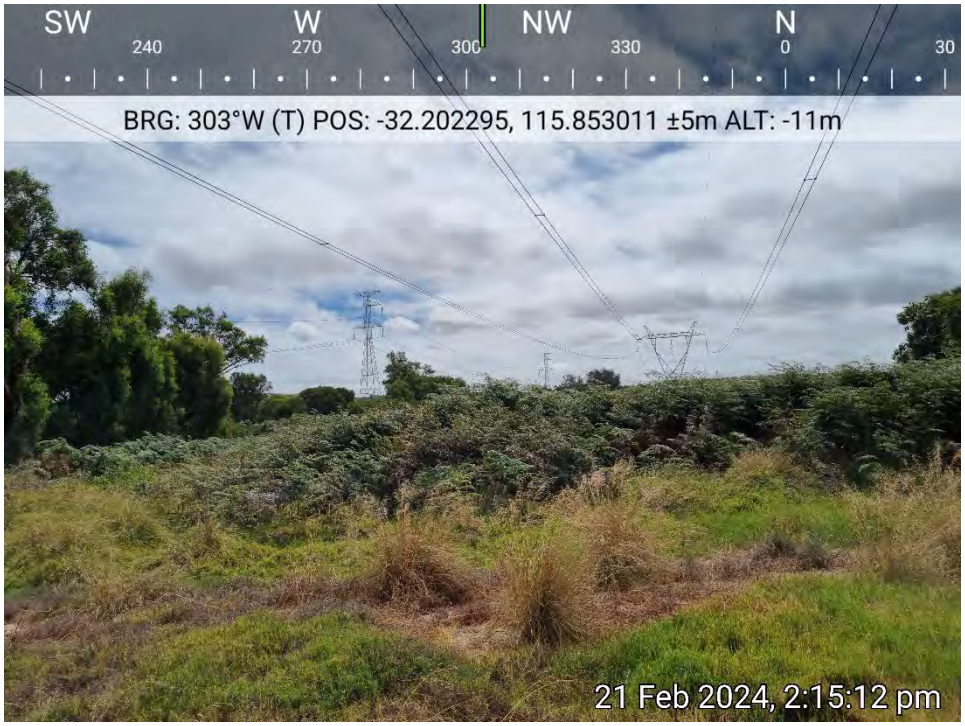


Photo ID: 4b

Plot 5	
Vegetation classification	Class G Grassland
Description / justification	Grassland greater than 100 mm in height



Photo ID: 5a



Photo ID: 5b



Photo ID: 5c



Photo ID: 5d

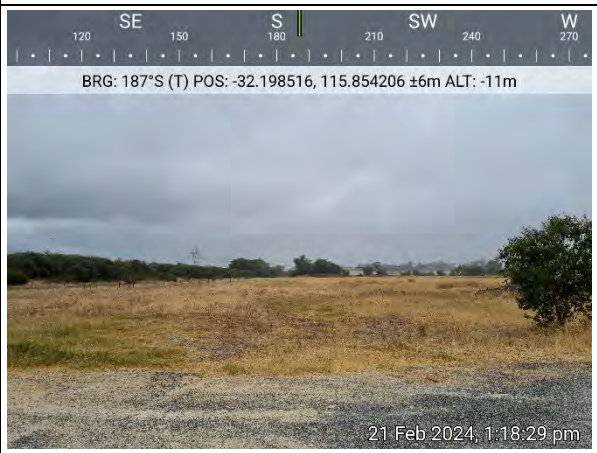


Photo ID: 5e



Photo ID: 5f

Plot 5	
 **Photo ID:** 5g	 **Photo ID:** 5h
 **Photo ID:** 5i	 **Photo ID:** 5j
 **Photo ID:** 5k	 **Photo ID:** 5l

Plot 5	
 **Photo ID:** 5m	 **Photo ID:** 5n
 **Photo ID:** 5o	 **Photo ID:** 5p
 **Photo ID:** 5q	

Plot 6	
Vegetation classification	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])
Description / justification	Existing non-vegetated land/low threat managed areas including buildings, roads, access tracks, bushfire staging buffers, land already cleared for development, etc



Photo ID: 6a



Photo ID: 6b



Photo ID: 6c



Photo ID: 6d



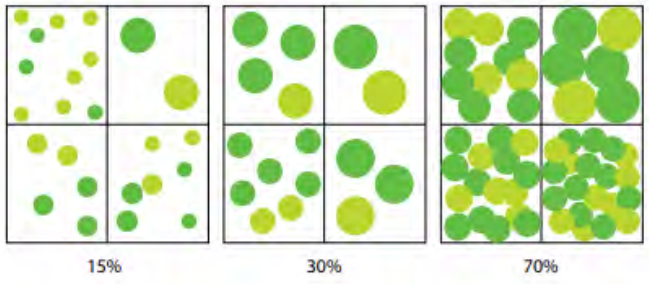
Photo ID: 6e



Photo ID: 6f

Plot 6	
	
Photo ID: 6g	**Photo ID:** 6h (to right)

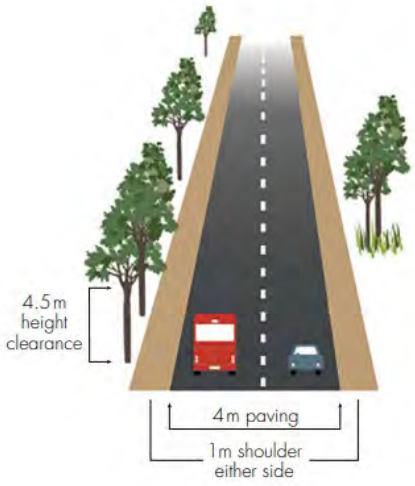
Appendix C APZ Standards (Schedule 1 of the Guidelines)

Schedule 1: Standards for Asset Protection Zones	
Object	**Requirement**
Fences within the APZ	Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Appendix F of AS 3959).
Fine fuel load (Combustible, dead vegetation matter <6 millimetres in thickness)	Should be managed and removed on a regular basis to maintain a low threat state. Should be maintained at <2 tonnes per hectare (on average). Mulches should be non-combustible such as stone, gravel or crushed mineral earth or wood mulch >6 millimetres in thickness.
Trees* (>6 metres in height)	Trunks at maturity should be a minimum distance of six metres from all elevations of the building. Branches at maturity should not touch or overhang a building or powerline. Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. Canopy cover within the APZ should be <15 per cent of the total APZ area. Tree canopies at maturity should be at least five metres apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided that the total canopy cover within the APZ will not exceed 15 per cent and are not connected to the tree canopy outside the APZ. **Figure 19:** Tree canopy cover – ranging from 15 to 70 per cent at maturity 
Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres in height are to be treated as trees.	Should not be located under trees or within three metres of buildings. Should not be planted in clumps >5 square metres in area. Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above. Can be located within two metres of a structure, but three metres from windows or doors if >100 millimetres in height.
Grass	Grass should be maintained at a height of 100 millimetres or less, at all times. Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.

Schedule 1: Standards for Asset Protection Zones	
Defendable space	Within three metres of each wall or supporting post of a habitable building, the area is kept free from vegetation, but can include ground covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	Should be located on the side of a building furthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building. The pressure relief valve should point away from the house. No flammable material within six metres from the front of the valve. Must sit on a firm, level and non-combustible base and be secured to a solid structure.

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Appendix D Vehicular access technical standards of the Guidelines

Acceptable Solution A3.1 – Public Roads
Explanatory Note E3.1
These Guidelines do not prescribe values for the trafficable (carriageway/pavement) width of public roads as they should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area. The IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards do not prescribe a horizontal clearance. However, it is recommended that a traversable verge is provided to allow for emergency services vehicles to stop and operate on the side of the public road, specifically where the public road may traverse large areas of classified vegetation. Where local government roads are proposed to be widened by the proponent, they must obtain approval from the local government.    Figure 20: Example of a public road
Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2a – Multiple access routes

Explanatory Note E3.2a

Two-way public road access is public road access from a lot in at least two different directions to two suitable destinations, and provides residents and the community, as well as emergency services, with access and egress from both the subdivision and individual habitable buildings/development in the event of a bushfire emergency. A single road provides no alternative route if the access becomes congested or is unable to be traversed due to smoke and/or fallen trees during a bushfire.

Two-way public road access applies to access/egress routes leading into a subdivision, as well as those within a subdivision. A road that loops back onto itself does not constitute the option of two different directions.

Two-way public road access should always be the first option. Where the site is not able to achieve two-way access within 200 metres of the lot boundary, due to demonstrated site or environmental constraints, the proponent should identify options for an emergency access way from the subject site to a suitable destination. Where an emergency access way cannot be provided, the proponent should demonstrate compliance with the performance principle.

Subject sites or proposed lots greater than 200 metres from an intersection, which provides two-way access, do not satisfy the requirement for two-way access unless they meet the provisions which allow for no-through roads greater than 200 metres in A3.2a.

To demonstrate compliance with the performance principle for two-way access, the bushfire planning practitioner may have regard to:

a. the extent of the bushfire hazard, location and vegetation classification, the likelihood, potential severity and impact of bushfire to the subject site and the road network;
b. time between fire detection and the onset of conditions in comparison to travel time for the community to evacuate to a suitable destination;
c. available access route(s) travelling towards a suitable destination; and
d. turn-around area for a fire appliance for no-through roads.



Figure 21: Example of compliant and non-compliant two-way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2b – Emergency access way

Explanatory Note E3.2b

An emergency access way is not a preferred alternative to through public road access and should only be considered acceptable where it has been demonstrated that it will provide the safety and performance needs of emergency services and the community, including consideration for future needs, and that public road access to satisfy A3.2a cannot be achieved due to site constraints, such as an established road network with no opportunity to provide a public road for secondary access. Acceptance of an emergency access way should also consider the ability to accommodate reasonable worst-case vehicle volumes.

The principle function of the emergency access way is to provide a contingency (second) community evacuation route and simultaneously provide access for emergency services, in the event of a bushfire emergency. Where an emergency access way traverses classified vegetation, which has the potential to create a bushfire hazard, an emergency access way performs the secondary function of providing access by emergency services to this vegetation.

Emergency access ways should connect to a public road to allow alternative two-way through access. An emergency access way should not exceed 500 metres in length as they may not be as safe for road-use due to not being designed or constructed to the full requirements of a public road and may present uncertainties to emergency service personnel and the public as they are not part of the daily road network and not identified on Maps.

Permanent public emergency access way

An emergency access way can be provided as either a public easement in gross or a right-of-way. In both approaches, the management of the emergency access way is by the local government as the grantee of the easement or management body of the right-of-way. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the easement or right-of-way; this must be provided to the decision-maker prior to granting planning approval. The approach taken is at the discretion of the decision-maker and/ or the local government and is also dependent on whether the land is to remain in private ownership or be ceded to the Crown. Consultation with Land Use Management at the Department of Planning, Lands and Heritage should also be considered if the land is to be ceded to the Crown or if the local government is uncertain of which approach to take.

If the emergency access way is provided as an easement, it should be provided as a public easement in gross under sections 195 and 196 of the Land Administration Act 1997 in favour of the local government and/or public authority, to ensure accessibility for emergency services and the public at all times. To be provided as a right-of-way the emergency access way should be vested in the Crown under section 152 of the Planning and Development Act 2005 as a right-of-way and such land to be ceded free of cost and without any payment or compensation by the Crown. If gates are used to control traffic flow during non-emergency periods, these will be managed by the local government and must not be locked. Gates should be double gates wide enough to access the full pavement width and accommodate Type 3.4 fire appliances with the design and construction to be approved by the relevant local government.

Temporary public emergency access way

A temporary emergency access way may be proposed to facilitate the staging arrangements of a subdivision. The provision of two public roads may not be possible in the first stage of the subdivision and an emergency access way can be provided as an interim access route until the second public road is developed and gazetted in a subsequent stage of the subdivision (see figure 22). The emergency access way should be provided in the same manner as a permanent emergency access way, but it should be removed from the certificate of title once the public road is developed and gazetted. Where an emergency access way is proposed as an alternative to a public road, the Bushfire Management Plan should provide thorough justification for its use.

Restricted public emergency access way

There may be some instances where a restricted emergency access way is proposed as a performance principle based solution where access is only available to the public in the event of a bushfire emergency. This option can only be considered where the local government or Main Roads WA have advised that vehicular access on the emergency access way is not allowed during non-emergency periods, as it provides an additional thoroughfare and entry point on a local or State road. In this scenario, the emergency access way can be

provided as an easement under section 195 of the Land Administration Act 1997, as public access in the event of a bushfire emergency or vested in the Crown as a reserve under section 152 of the Planning and Development Act 2005. Such land is to be ceded free of cost without any payment or compensation by the Crown. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the proposed reserve and agree to the terms of the Management Order Conditions (if applicable); this must be provided to the decision-maker prior to granting planning approval.

The purpose of the reserve should be for a public purpose specified in the condition related to the subdivision, for example for emergency access only, or for emergency access and recreation. A reserve for emergency access and recreation can optimise the land-use as a dual purpose where it provides vehicular access in the event of a bushfire emergency, but can be accessed by the public (on foot) on a day-to-day basis as a recreation link. Appropriate signage can ensure the general public is aware of the purpose of the reserve. The approach taken is at the discretion of the decision-maker and/or local government.

Right-of-carriageway emergency access way

There may be some instances where a right-of-carriageway easement is proposed as a performance principle-based solution. This may be where particular landowner(s) and emergency services, but not the public, require access over a neighbouring lot(s). A right-of-carriageway easement should be provided under section 195 of the Land Administration Act 1997. The easement is to provide alternative access for the particular landowner(s) in the event of a bushfire emergency and not for use by the public. In this scenario, support will be necessary from the adjoining lot owner(s). The easement is to be granted to the local government and it is to agree with the landowner on the arrangements of the management of the easement area by deed. These management arrangements will be at the discretion of the local government. If gated, the easement area can be locked to restrict day-to-day vehicular access.

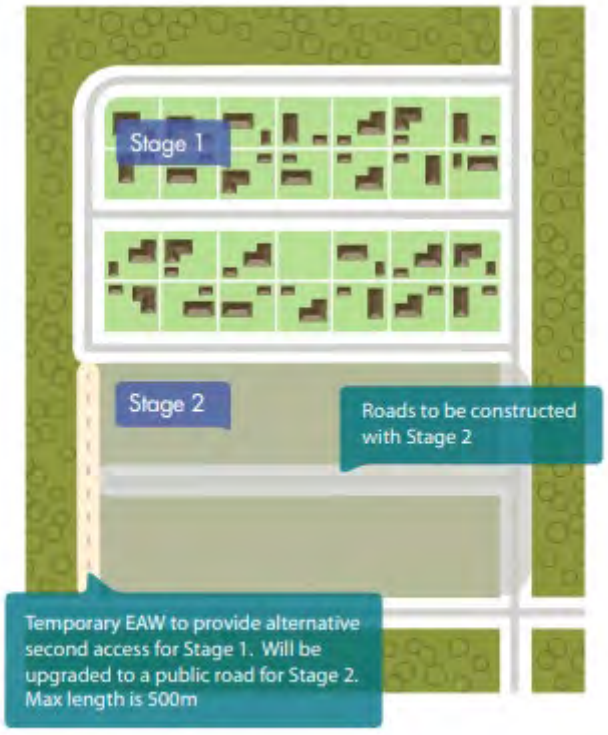


Figure 22: Example of an emergency access way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.3 – Through roads

Explanatory Note E3.3

In bushfire prone areas, a proposed structure plan or subdivision that incorporates no-through roads should be avoided because they do not provide a connected and legible design that allows for easy access and egress by the community, residents and emergency services in the event of a bushfire. No-through roads also reduce the options available for access and egress in the event of a bushfire emergency.

There will however be situations where a subject site is accessed via an existing or proposed no-through road and alternative access cannot be provided. In these situations, the proponent should demonstrate to the decision-maker, that all efforts have been made with the local government and/or adjoining landowners to secure alternative public road access or an emergency access way and that a redesign has been explored. The bushfire planning practitioner may need to develop a performance principle-based solution or address the non-compliance and demonstrate to the decisionmaker why discretion should be exercised in accordance with section 2.6 of these Guidelines.

No-through roads will only be considered an acceptable solution where it is demonstrated by the proponent, to the satisfaction of the decision maker, that a no through-road cannot be avoided due to site constraints. For example, the internal road design of a structure plan or subdivision where site constraints, such as a water body or Bush Forever, prevent the ability to create a through-road and a no through road may be a more appropriate road layout.

No-through roads should be a maximum of 200 metres from the lot(s) boundary to an intersection where two-way access is provided and may only exceed 200 metres if it meets the provisions which allow for no-through roads greater than 200 metres in A3.2a.

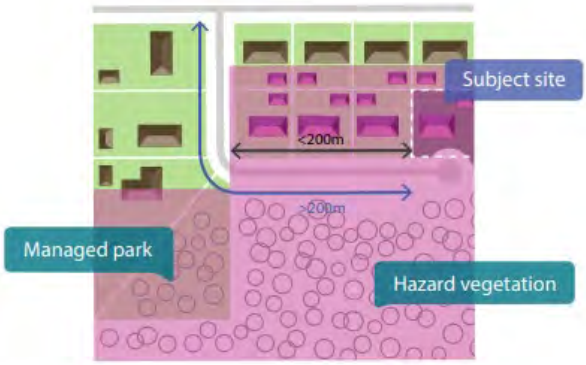


Figure 23: Example of a site on a no-through road greater than 200 metres from the intersection, but within 200 metres of BAL-LOW

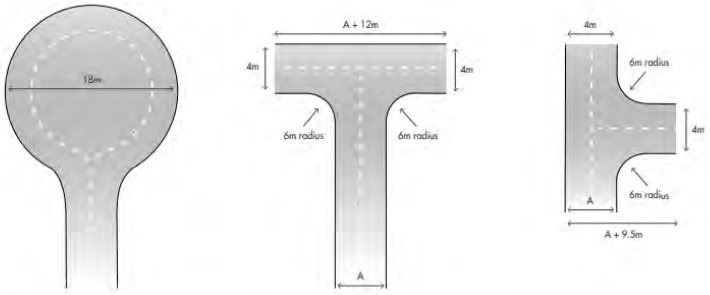


Figure 24: Turn-around area dimensions for a no-through road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.4a – Perimeter roads

Explanatory Note E3.4a

Where a planning proposal includes the creation of 10 or more lots adjacent to each other, which adjoin classified vegetation under AS 3959 with the exception of Class G Grassland, as part of a greenfield development or large urban infill site, hazard separation and defendable space should be provided in the form of a perimeter road. Greenfield is 'undeveloped or minimally developed areas that have been identified for urban development'; and urban infill is 'the redevelopment of existing urban areas at a higher density than currently exists'. The creation of 10 or more lots includes cumulative subdivision applications where the subdivision application may be part of a staged subdivision.

A perimeter road should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area as per the requirements of a public road in Table 6, Column 1.

As the road is likely to function as a key neighbourhood distributor, or similar, consideration should be given to the provision of additional width to allow for emergency services vehicles to stop and operate on the side of the perimeter road, whilst simultaneously proving for the evacuation of the community (Figure 20).

When designing a strategic planning proposal and/or subdivision, creating a large setback between classified vegetation and proposed lots with a perimeter road, and orientating habitable buildings to front onto (rather than back onto) areas of vegetation has many benefits, including:

- passive surveillance;
- defendable space for firefighting and emergency management purposes;
- reducing the potential radiant heat that may impact a habitable building in a bushfire event;
- reducing the need for battle-axe lots; and
- unconstrained public access/egress for the community in the event of a bushfire.

In developments where no perimeter road exists, property defence in a bushfire event is difficult and can be impossible. Where proposed lots have frontage to an existing public road and abut the hazard at the rear or side, it may be an undesirable planning outcome to create lots which front the existing public road and back onto a perimeter road. In this instance, consideration should be given to a fire service access route. Refer to E3.4b below.



Figure 25: Example of a perimeter road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Technical requirement	1	2	3	4
	Public road	Emergency access way[1]	Fire service access route[1]	Battle-axe and private driveways[2]
Minimum trafficable surface (m)	In accordance with A3.1	6	6	4
Minimum horizontal clearance (m)	N/A	6	6	6
Minimum vertical clearance (m)	4.5	4.5	4.5	4.5
Minimum weight capacity (t)	15	15	15	15
Maximum grade unsealed road[3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Maximum grade sealed road[3]		1:7 (14.3%, 8°)	1:7 (14.3%, 8°)	1:7 (14.3%, 8°)
Maximum average grade sealed road		1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Minimum inner radius of road curves (m)		8.5	8.5	8.5

[1] To have crossfalls between 3 and 6%

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision

[3] Dips must have no more than a 1 in 8 (12.5% -7.1 degree) entry and exit angle.

Appendix E City of Kwinana annual firebreak notice

City of Kwinana

FIRST AND FINAL NOTICE

FIRE HAZARD COMPLIANCE NOTICE 2023/2024

COMPLIANCE DUE BY

30 November 2023

INSPECTIONS COMMENCE FROM

1 December 2023

Important The works outlined below must be completed by midnight 30 November 2023 and maintained up to and including 31 May 2024.

Notice to all landowners within the City of Kwinana

This Fire-Break/Hazard Compliance Notice is issued by the City of Kwinana pursuant to section 33 of the Bush Fires Act 1954 to assist with the prevention, control and extinguishment of bush fires or to prevent the spread or extension of a bush fire to any adjoining land.

All property owners and/or occupiers of land within the City of Kwinana are hereby served with a first and final Fire-Break/ Hazard Compliance Notice (the Notice) and are required to comply with the requirements in full.

Failure or neglect to comply with this notice is an offence and may result in a penalty of up to $5,000.

Land with a total area of 3,501m² (0.35ha) or greater

Fire Breaks
Owners and/or occupiers of land that is 3,501m² or greater are required to construct and maintain a 3-metre-wide mineral earth, by 4-metre-high vertical clearance, continuous (no dead ends) trafficable fire break as close as possible inside and along all boundaries of the entire perimeter of the land.

Asset Protection Zone
Maintain a reduced fuel zone around all buildings and assets which extends 20 metres from the outermost point of all buildings and assets.

Flammable Material
Gutters, roofs, and walls of all buildings to be free of flammable matter and maintained.

Land with a total area of 1,500m² (0.15ha) up to 3,500m² (0.35ha)

The works outlined in this category must be maintained all year round.

Asset Protection Zone
Maintain a reduced fuel zone around all buildings and assets which extends 20 metres from the outermost point of all buildings and assets.

Flammable Material
Gutters, roofs, and walls of all buildings to be free of flammable matter and maintained.

Ensure that all long grass and weeds are slashed, mowed or trimmed down to a height no greater than 50mm across your entire property.

Land with a total area up to 1,500m² (0.15ha)

The works outlined in this category must be maintained all year round.

Flammable Material
Gutters, roofs, and walls of all buildings to be free of flammable matter and maintained.

Ensure that all long grass and weeds are slashed, mowed or trimmed down to a height no greater than 50mm across your entire property.

Variations to Notice

If it is impractical for you to install a firebreak as specified in this Notice, you may apply to vary the location of your firebreak within your property by completing and submitting an 'Application to Vary Location and Type of Firebreaks' form available on the City's **Fire Permits and Burn Offs page**.

Submit completed forms to **customer@kwinana.wa.gov.au** marked for the attention of the Chief Bush Fire Control Officer – no later than 31 October 2023.

Additional Works

Regardless of land size and location, the City or its Bush Fire Control Officers may require additional work to be undertaken on a property to improve access, and/or undertake further works to reduce a hazard that may be conducive to preventing an outbreak and/or the spread or extension of a bush fire.

'**Industrial Zoned**' areas may require additional works as identified by the Bush Fire Control Officer during fire hazard inspections.

Where a property is affected by an approved bushfire management plan, property owner and/or occupier must still comply with all requirements in this notice and with ALL additional requirements outlined within that plan.

Owners and/or occupiers of land should note that emergency access ways, if any, are for emergency service vehicles only and are not to be considered as an escape route unless declared as such by the Incident Controller during an emergency.

Engagement of contractors by owner and/or occupier to carry out works

Any owner and/or occupier who engages a contractor to undertake works on their behalf is responsible for ensuring that such works when completed meet the requirements of this Notice.

Firebreak/fire hazard compliance inspections

To promote community safety and education, property inspections will be carried out by the City's Bush Fire Control Officers to identify non-compliant properties.

In addition, Drones (Unmanned Remotely Piloted Aircraft) may also be used at times to conduct firebreak/fire hazard inspections. Drones are required to be operated in accordance with the guidelines of the Civil Aviation Safety Authority (CASA).

No burning in areas defined as Urban

Pursuant to section, 24G (2) of the *Bush Fires Act 1954*, no burning of garden refuse is to be undertaken in areas defined as "Urban" without written approval by the City of Kwinana.

Wayne Jack,
Chief Executive Officer

If you do not meet your fire prevention responsibilities as a property owner, you could be liable for a maximum penalty of $5,000 plus costs. The City may also access a property and undertake the required work at the expense of the owner.

Definitions

Firebreak A strip of land 3 metres wide of mineral earth, effectively creating a 3-metre by 4-metre area that is clear of all vegetation allowing unrestricted access for fire and emergency vehicles. Living green lawn may be accepted instead of mineral earth.

Flammable Material Any bush, plant, tree, grass, vegetation, object, or material that may or is likely to catch fire and burn.

Asset protection zone An area with radius of 20 metres measured from any building/s or as stated in your approved Bushfire Attack Level (BAL) assessment, within the boundaries of the lot. Fuel loads in this zone shall be maintained to 2 tonnes per hectare or less.

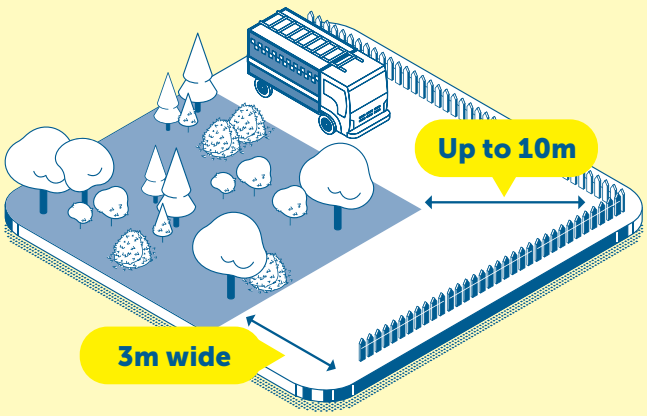
Bush Fire Control Officer An officer appointed by the City to exercise the powers and duties of a Bush Fire Control Officer appointed under s38(1) of the Bush Fires Act 1954.

Industrial zoned areas Land on which manufacturing, processing, warehousing and related activities are undertaken, as defined in Metropolitan Region Schemes.

Mineral earth Land clear of flammable material, consisting of ploughed or cleared soil, stone, hardstand or any mixture of these.

Trafficable To be able to travel from one point to another in a fire vehicle on a firm and stable surface, unhindered without any obstruction that may endanger resources. A fire-break must not terminate without provision for egress or a cleared turn around area of not less than a 21-metre radius.

Firebreak Specifications



For further information, please contact the City of Kwinana, view the included brochure or the City of Kwinana website **www.kwinana.wa.gov.au/fires**

Administration
Cnr Gilmore Ave & Sulphur Rd, Kwinana WA 6167 | PO Box 21, Kwinana WA 6966
Hours Mon-Fri 8:30am-4:30pm | **Telephone** Mon-Fri 8:00am-5:00pm 08 9439 0200
customer@kwinana.wa.gov.au | **www.kwinana.wa.gov.au**

City of Kwinana

APPENDIX 4

Road and Railway Noise Assessment Report

HERRING STORER ACOUSTICS

SATTERLEY

MANDOGALUP ESTATE STRUCTURE PLAN AMENDMENT LOTS 11, 9000, 9002 AND 9006 HOFFMAN ROAD

SPP 5.4 NOISE ASSESSMENT

JULY 2024

OUR REFERENCE: 32357-8-24045

Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
HERRING STORER ACOUSTICS
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DOCUMENT CONTROL PAGE

NOISE ASSESSMENT
MANDOGALUP ESTATE

Job No: 24045

Document Reference: 32357-8-24045

FOR

SATTERLEY

DOCUMENT INFORMATION			
Author:	Paul Daly	**Checked By:**	George Watts
Date of Issue:	5 March 2024		

REVISION HISTORY

Revision	Description	Date	Author	Checked
1	Update for school site and Lot numbers	10/05/2024	PLD	
2	Updated plans and Stage 6A Inclusion	08/07/2024	PLD	
3	Updated for Lot 11	15/07/2024	PLD	
4	Revised Lot numbers	29/08/2024	PLD	
5	Update of Lot Numbers	24/09/2024	PLD	
6	Inclusion of night noise levels as per MRWA request	15/07/2025	PLD	
7	Updated to reference noise wall location	24/04/2026	PLD	

DOCUMENT DISTRIBUTION

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1	8	Rowe Group Att: Rebecca Thompson Email: Rebecca.Thompson@rowegroup.com.au		✓

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A	Subdivision Plan
B	Noise Contour Plot
C	Quiet House Design – Individual Lot Requirements
D	Quiet House Design Guidelines
E	Noise Monitoring Data
F	Traffic Data

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Satterley to undertake a road and rail traffic noise assessment for the proposed development of Lots 11, 9000, 9002 and 9006 Hofman Road, Mandogalup.

The purpose of this assessment was to assess noise received within the development from vehicles travelling along the Kwinana Freeway for the future and passenger rail associated with the Perth to Mandurah passenger railway line.

The traffic noise assessment has been carried out in accordance with the WAPC State Planning Policy 5.4 *"Road and Rail Noise"*.

For information, the development plan is attached in Appendix A.

2. SUMMARY

Under the Western Australian Planning Commission (WAPC) Planning Policy 5.4 *"Road and Rail Noise"* (SPP5.4), the appropriate criteria for assessment for this development are as listed below for "Noise Limits".

EXTERNAL

$L_{Aeq(Day)}$ of 55 dB(A); and
$L_{Aeq(Night)}$ of 50 dB(A).

INTERNAL

$L_{Aeq(Day)}$ of 40 dB(A) in living and work areas; and
$L_{Aeq(Night)}$ of 35 dB(A) in bedrooms.

Noise received at an outdoor area should also be reduced as far as practicable, with an aim of achieving an L_{Aeq} (night) of 50 dB(A).

From the modelling undertaken for the future Kwinana Freeway, noise received at the development would exceed the above criteria.

It is understood the noise wall will be 4.0m high and a continuation of the current wall for the northern development. The noise wall would be a minimum surface density of 15kg/m^2.

Appendix C details the Quiet House Design Packages required for each individual Lot with Appendix D containing the deemed to satisfy construction methods. We note that alternative constructions as to those listed in Appendix D, are acceptable, provided they are supported by an assessment undertaken by a suitably qualified acoustic consultant.

Due to the orientation of the lots, the outdoor living areas would be situated to the rear, behind the house, away from the Freeway, therefore providing a barrier to Freeway noise, hence compliance with the L_{Aeq} (night) of 50 dB(A) criteria is achieved.

Additionally, noise modelling indicates that noise received at the closest residences from the Passenger Railway Line would comply with the above criteria. Therefore, no acoustic amelioration, or notifications are required for those residential lots located adjacent to the Railway Line.

3. ACOUSTIC CRITERIA

3.1 ROAD AND RAIL TRAFFIC NOISE

The Western Australian Planning Commission (WAPC) released on 6th September 2019 State Planning Policy 5.4 *"Road and Rail Noise".* The requirements of State Planning Policy 5.4 are outlined below.

POLICY APPLICATION (Section 4)

When and where it applies (Section 4.1)

SPP 5.4 applies to the preparation and assessment of planning instruments, including region and local planning schemes; planning strategies, structure plans; subdivision and development proposals in Western Australia, where there is proposed:

a) noise-sensitive land-use within the policy's trigger distance of a transport corridor as specified in Table 1;

b) New or major upgrades of roads as specified in Table 1 and maps (Schedule 1,2 and 3); or

c) New railways or major upgrades of railways as specified in maps (Schedule 1, 2 and 3); or any other works that increase capacity for rail vehicle storage or movement and will result in an increased level of noise.

Policy trigger distances (Section 4.1.2)

Table 1 identifies the State's transport corridors and the trigger distances to which the policy applies.

The designation of land within the trigger distances outlined in Table 1 should not be interpreted to imply that land is affected by noise and/or that areas outside the trigger distances are un-affected by noise.

Where any part of the lot is within the specified trigger distance, an assessment against the policy is required to determine the likely level of transport noise and management/ mitigation required. An initial screening assessment (guidelines: Table 2: noise exposure forecast) will determine if the lot is affected and to what extent."

TABLE 1: TRANSPORT CORRIDOR CLASSIFICATION AND TRIGGER DISTANCES

Transport corridor classification	*Trigger distance*	*Distance measured from*
Roads		
Strategic freight and major traffic routes *Roads as defined by Perth and Peel Planning Frameworks and/or roads with either 500 or more Class 7 to 12 Austroads vehicles per day, and/or 50,000 per day traffic volume*	*300 metres*	*Road carriageway edge*
Other significant freight/traffic routes *These are generally any State administered road and/or local government road identified as being a future State administered road (red road) and other roads that meet the criteria of either >=23,000 daily traffic count (averaged equivalent to 25,000 vehicles passenger car units under region schemes)*	*200 metres*	*Road carriageway edge*
Passenger railways		
	100 metres	*Centreline of the closest track*
Freight railways		
	200 metres	*Centreline of the closest track*

Proponents are advised to consult with the decision making authority as site specific conditions (significant differences in ground levels, extreme noise levels) may influence the noise mitigation measures required, that may extend beyond the trigger distance.

POLICY MEASURES (Section 6)

The policy applies a performance-based approach to the management and mitigation of transport noise. The policy measures and resultant noise mitigation will be influenced by the function of the transport corridor and the type and intensity of the land-use proposed. Where there is risk of future land-use conflict in close proximity to strategic freight routes, a precautionary approach should be applied. Planning should also consider other broader planning policies. This is to ensure a balanced approach takes into consideration reasonable and practical considerations.

Noise Targets (Section 6.1)

Table 2 sets out noise targets that are to be achieved by proposals under which the policy applies. Where exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.

In the application of the noise targets the objective is to achieve:

- *indoor noise levels as specified in Table 2 in noise sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and*
- *a reasonable degree of acoustic amenity for outdoor living areas on each residential lot. For non-residential noise-sensitive developments, for example schools and child care centres the design of outdoor areas should take into consideration the noise target.*

It is recognised that in some instances, it may not be reasonable and/or practicable to meet the outdoor noise targets. Where transport noise is above the noise targets, measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

TABLE 2: NOISE TARGETS

Proposals	*New/Upgrade*	*Noise Targets*		
		Outdoor		*Indoor*
		Day (L_{Aeq}(Day) dB) (6 am-10 pm)	*Night (L_{Aeq}(Night) dB) (10 pm-6 am)*	*(L_{Aeq} dB)*
Noise-sensitive land-use and/or development	*New noise sensitive land use and/or development within the trigger distance of an existing/proposed transport corridor*	*55*	*50*	*L_{Aeq} (Day) 40(Living and work areas)* *L_{Aeq} (Night) 35 (bedrooms)*
Roads	*New*	*55*	*50*	*N/A*
	Upgrade	*60*	*55*	*N/A*
Railways	*New*	*55*	*50*	*N/A*
	Upgrade	*60*	*55*	*N/A*

Notes:

- *The noise target is to be measured at one metre from the most exposed, habitable façade of the proposed building, which has the greatest exposure to the noise-source. A habitable room has the same meaning as defined in State Planning Policy 3.1 Residential Design Codes.*
- *For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (as amended) for each relevant time period.*
- *The 5dB difference in the criteria between new and upgrade infrastructure proposals acknowledges the challenges in achieving noise level reduction where existing infrastructure is surrounded by existing noise-sensitive development.*
- *Outdoor targets are to be met at all outdoor areas as far as is reasonable and practical to do so using the various noise mitigation measures outlined in the guidelines. For example, it is likely unreasonable for a transport infrastructure provider to achieve the outdoor targets at more than 1 or 2 floors of an adjacent development with direct line of sight to the traffic.*

Noise Exposure Forecast (Section 6.2)

When it is determined that SPP 5.4 applies to a planning proposal as outlined in Section 4, proponents and/or decision makers are required to undertake a preliminary assessment using Table 2: noise exposure forecast in the guidelines. This will provide an estimate of the potential noise impacts on noise-sensitive land-use and/ or development within the trigger distance of a specified transport corridor. The outcomes of the initial assessment will determine whether:

- *no further measures is required;*
- *noise-sensitive land-use and/or development is acceptable subject to deemed-to- comply mitigation measures; or*
- *noise-sensitive land-use and/or development is not recommended. Any noise-sensitive land-use and/ or development is subject to mitigation measures outlined in a noise management plan."*

4. NOISE MONITORING

Noise monitoring was undertaken as part of the study with the results used to calibrate the noise model.

In summary, the monitoring was undertaken over seven-day period commencing 6th February 2024. Monitoring was conducted at the boundary of the development, facing Kwinana Freeway. The monitor was placed 30m from the nearest running edge of respective road of interest. It is noted that for this section of the development, there is an earthen bund located between the cycle path and the Freeway. The height of the bund is approximately 3m.

The results of this monitoring are summarised in Table 4.1.

TABLE 4.1: SUMMARY OF MEASURED ROAD TRAFFIC NOISE LEVELS (dB(A))

Date	Kwinana Freeway Monitor		
	$L_{A10(18hour)}$	$L_{Aeq,day}$ (6am to 10pm)	$L_{Aeq,night}$ (10pm to 6am)
AVERAGE	**63.5**	**62.6**	**59.1**

Based on the above monitoring results, the night period is less than 5 dB of the day period. However, analysis of the monitored noise levels verses the hourly traffic flows and speeds shows that there may be influence on the morning part of the day period noise levels. Therefore, analysis of the hourly traffic flows for the day and night periods has been undertaken. Figure 4.1 below details the speed of the vehicles past the development. As can be seen there is a significant decrease in speed from 06:00 to 09:00am. This speed change, likely due to traffic build up, is unduly altering the differential between the night and day periods.

Given the traffic flows are based on average counts, for the purpose of the assessment, it has been considered that the L_{Aeqday} is the most critical for compliance, however for completeness the night period noise levels have also been included.

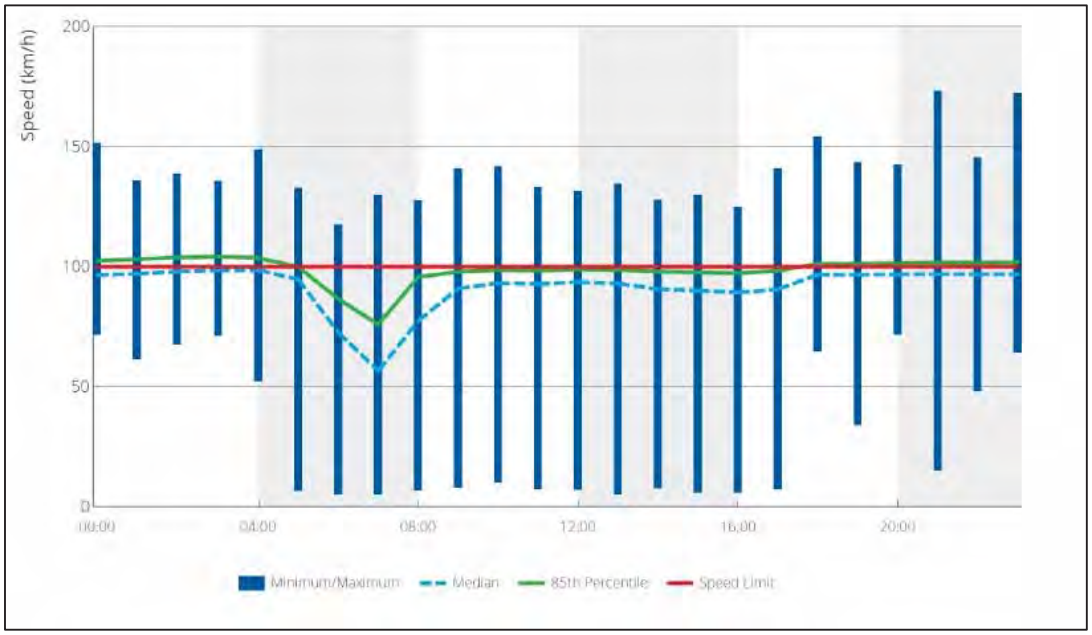


FIGURE 4.1 – HOURLY TRAFFIC SPEEDS

For information, the results of the monitoring are shown graphically in Appendix E with Figure 4.2 showing the location map, and Figure 4.3 showing the monitor in situ.



FIGURE 4.2 - NOISE MONITOR LOCATION PLAN



FIGURE 4.3 - NOISE MONITOR IN SITU

5. MODELLING

5.1 ROAD TRAFFIC NOISE

Modelling of noise received within the development from the Kwinana Freeway was carried out using SoundPlan, using the Calculation of Road Traffic Noise (CoRTN) algorithms. The input data for the model included the parameters detailed in Table 5.1.

TABLE 5.1 - SUMMARY OF TRAFFIC DATA

Parameter	Current (2021) MRWA Provided	Current (2024) Calculated	Future (2041) MRWA Provided	Future (2044) Calculate
Traffic flows VPD South Bound	45,800	50,018	82,400	89,988
Traffic flows VPD North Bound	45,500	49,690	80,800	88,241
Heavy Vehicles (%)	8.4%	8.4%	8.4%	8.4%
Traffic Speed km/hr	100	100	100	100
Road Surface	-	Open Grade Asphalt	Open Grade Asphalt	Open Grade Asphalt
Façade Correction	-	-	+2.5	+2.5

The future road traffic volumes were based on information provided by the MRWA ROM department (shown in Appendix F) and the traffic maps.

Other input data for the model included:

- Traffic data from MRWA (https://mrapps.mainroads.wa.gov.au/TrafficMap/)
- Traffic as provided by the MRWA ROM Department, as attached in Appendix F. Note, MRWA ROM modelling provided 2041 traffic forecasts. As SPP 5.4 requires 20-year future, the annual percentage increase between the MRWA provided 2021 and 2041 volumes has been used for the increase to 2043. For this road system it is a 5% annual increase.
- Noise source heights for the three road source strings (Passenger Vehicles, Heavy Vehicles Engine and Heavy Vehicle Exhausts) are +0.5, +1.5 and +3.6m, with a noise correction of -0.8 and -8.0 applied to the heavy vehicle's engine and exhaust noise sources.
- Topographical data, with the ground level within the development based on natural ground levels as per surveys conducted.
- A +2.5 dB adjustment to allow for façade reflection.
- Development receiver heights at 1.4m above ground level.
- Future buildings located on the boundary Lots of the development (assumed to be present for future road traffic volumes).
- Calculations based on CoRTN algorithms.
- Other parameter listed in SPP 5.4 as to guidance for modelling road traffic noise / assessment.

Noise modelling for road noise was undertaken for the following scenarios:

S1 Current (2024) traffic volumes for calibration to noise monitoring data.

S2 Noise emissions from Kwinana Freeway (Future traffic flows 2044) without noise amelioration.

S2 Noise emissions from Kwinana Freeway (Future traffic flows 2044) with a 4m noise wall, and future housing on Lots.

The 1.8m wall for the side facing lots has been assumed to be a Colorbond or equivalent.

For the noise modelling of future traffic, it has been assumed that the percentage of future heavy vehicles remains the same as for the current traffic flows. In this case, we believe that this is a conservative approach, as we believe that the percentage of heavy vehicles would fall over time.

5.2 PASSENGER TRAIN NOISE

To differentiate the noise associated with only passenger rail from the overall noise levels influenced by vehicles on the road network, analysis of individual train evens has undertaken.

Measurements of the current passenger rail system have been conducted. Noise level measurements of individual train pass-by events were conducted on the Perth to Mandurah line for the 130km/hr 6 carriage B-Series trains.

Using the measured levels of the train as a basis for calibration, predictive noise modelling using Soundplan has been carried out. Predictive noise levels for the rail line which is at grade have been calculated. Nord2000 railway algorithms have been used.

Utilising this detailed data, noise levels for each train pass-by event were analysed with the resultant levels detailed in Table 4.1. For the purpose of limiting the amount of data, only a sample of train pass by events have been noted.

TABLE 5.1 - SUMMARY OF MEASURED TRAIN NOISE LEVELS

Time (Seconds)	Train 1 (15m)	Train 2 (8m)	Train 3 (8m)	Train 4 (8m)	Train 5 (15m)
1	63	57	62	60	69
2	69	61	67	67	65
3	68	66	72	88	65
4	64	78	88	92	67
5	79	92	93	92	82
6	84	92	93	92	85
7	85	93	92	91	85
8	84	92	91	78	84
9	83	87	79	71	82
10	74	74	72	70	71
11	70	72	72	68	73
12	67	71	69	65	72
13	65	70	62	60	70
L_{Aeq} Train Pass-by Event	**79**	**88**	**88**	**87**	**80**

Based on analysis of the measured noise levels, at the 15m monitoring point, train noise is present for an average of 13 seconds. Using a conservative approach, the highest individual L_{Aeq} of a train pass-by event, being a noise level of $L_{Aeq(13seconds)}$ 80 dB(A) has been considered as the calibration point of 15m from the rail line for the current passenger rail use.

The above individual train pass noise level can be used to calculate the $L_{Aeq(16hour)}$ Day, and the $L_{Aeq(8hour)}$ Night noise levels. This is based on the quantity of trains for each period, referencing the passenger rail timetable. Hence, Table 5.2 contains the details used for the calculations.

TABLE 5.2 – RELATIONSHIP BETWEEN MEASURED NOISE LEVELS AND TRAIN VOLUMES

Description	Value
Train Qty per 24 hours	179
Train Qty per 16 hours Day	156
Train Qty per 8 hours Night	23
Distance of receiver (metres)	15
$L_{Aeq(20second)}$ at receiver (Train pass by event)	80
Time train noise is present (Seconds)	13
Total time noise present (Minutes) Day	34
Total time noise present (Minutes) Night	5
Total time noise present (Minutes) 24 hours	39
$L_{Aeq(16hour)}$ Day period @15m	**65.5**
$L_{Aeq(8hour)}$ Night period @15m	**60.2**

Based on the above monitoring results, for this project, the difference between the $L_{Aeq,8hr}$ and the $L_{Aeq,16hr}$ has been taken to be those listed in Table 5.2. It was assumed that these differences would apply in the future.

We note that with the difference between the $L_{Aeq,8hr}$ and the $L_{Aeq,16hr}$ being greater than 5 dB(A), achieving compliance with the day period criteria will also achieve compliance with the night period criteria. Thus, only noise contour plots for the day period have been shown.

To calibrate the noise model, the existing traffic volumes and current layout were modelled in Soundplan. The resultant noise level at the monitoring locations was compared to the calculated results and an adjustment made in the model to calibrate to the same result.

Noise modelling for the future passenger train was carried out based on the number of train movements as summarised in Table 5.1.

TABLE 5.3 – TRAIN MOVEMENTS

Parameter	Train Movements (per hour)		Speed
	Day	Night	Km/hour
North Bound			
6 Car Set (150 metres long)	5.9	0.75	130
South Bound			
6 Car Set (150 metres long)	6.3	0.9	130

Based on the above number of train movements, once again if compliance is achieved with the day period criteria, compliance will also be achieved with the night period criteria. Therefore, noise modelling was only undertaken for the day period.

Noise modelling for rail was undertaken for the following scenario:

S1 Noise emissions from Mandurah passenger railway, without noise amelioration.

S2 Noise emissions from Mandurah passenger railway, with 4.0m noise wall.

6. ASSESSMENT

In accordance with the WAPC Planning Policy 5.4, an assessment of the noise that would be received within the development located at Mandogalup Estate from vehicles travelling on the Kwinana Freeway and passenger rail associated with the Perth to Mandurah rail line has been undertaken.

In accordance with the Policy, the following would be the acoustic criteria applicable to this project:

External

Day	Maximum of 55 dB(A) L_{Aeq}
Night	Maximum of 50 dB(A) L_{Aeq}
Outdoor Living Areas (Night)	Maximum of 50 dB(A) L_{Aeq}

Internal

Sleeping Areas	35 dB(A) $L_{Aeq(night)}$
Living Areas	40 dB(A) $L_{Aeq(day)}$

Noise received at an outdoor area should also be reduced as far as practicable with an aim of achieving an $L_{Aeq\ (night)}$ of 50 dB(A).

From the modelling undertaken for the future Kwinana Freeway, noise received at the development would exceed the above criteria.

It is understood the noise wall will be 4.0m high and a continuation of the current wall for the northern development. The noise wall would be a minimum surface density of 15kg/m^2.

Appendix C details the Quiet House Design Packages required for each individual Lot with Appendix D containing the deemed to satisfy construction methods. It is noted that an alternative to the school site has been in the south of the development has been provided as residential as final design is still underway. Additionally, Lot 11 has been included in the LSP amendment, however, at this stage of the development, the Lot alignment has not been finalised.

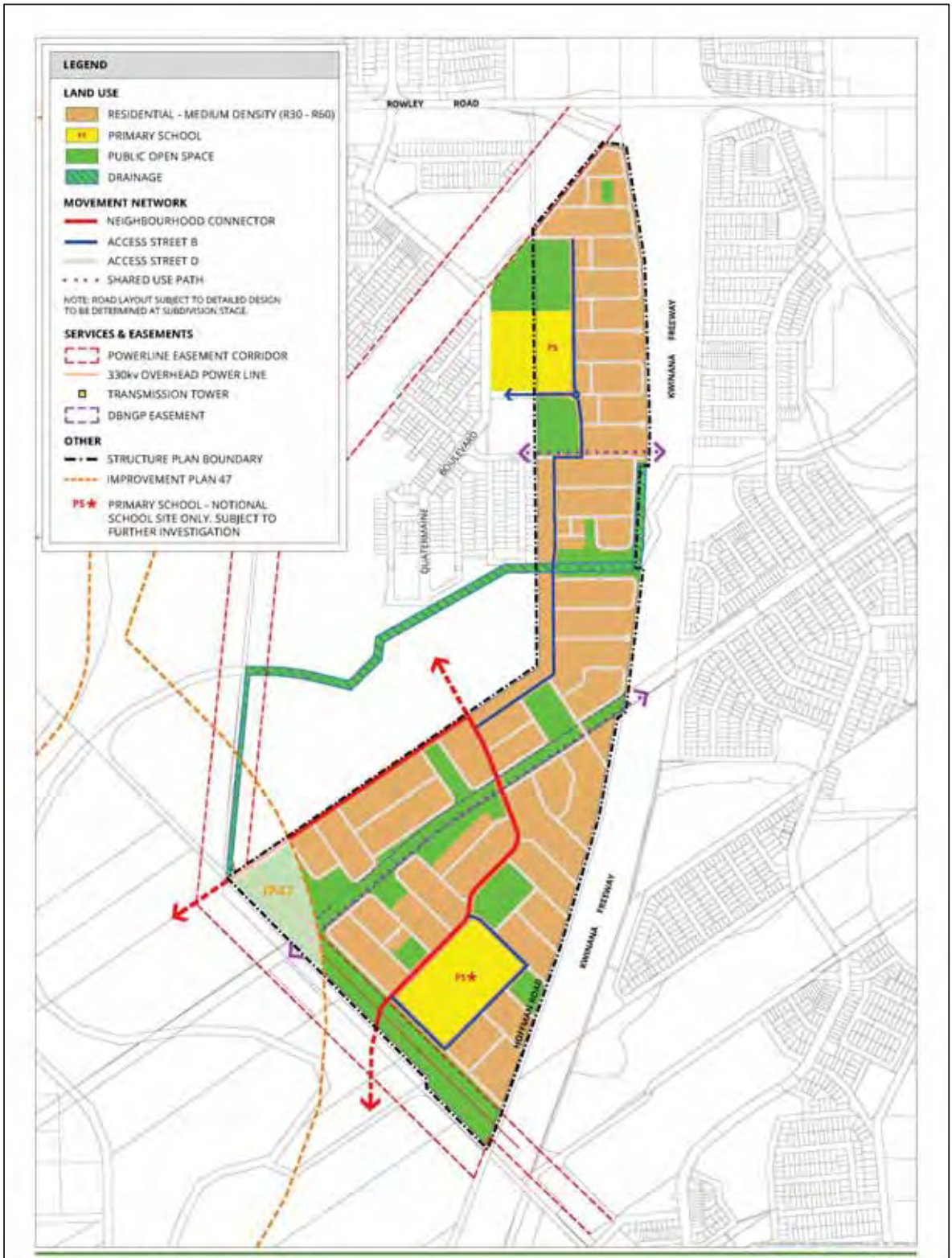
We note that alternative constructions as to those listed in Appendix D, are acceptable, provided they are supported by an assessment undertaken by a suitably qualified acoustic consultant.

Due to the orientation of the lots, the outdoor living area is situated behind the house, away from the Freeway, therefore providing a barrier to noise level, hence compliance is achieved with the L_{Aeq} (night) of 50 dB(A).

Additionally, noise modelling indicates that noise received at the closest residence for the Passenger Railway Line would comply with the above criteria. Therefore, no acoustic amelioration, or notifications are required for those residential lots located adjacent to the Railway Line.

APPENDIX A

DEVELOPMENT PLAN



PLAN 1 - LOCAL STRUCTURE PLAN

VARIOUS LOTS - KWINANA FREEWAY & ROWLEY ROAD
MANDOGALUP

7282D-LSP-09-A

ROWE GROUP DESIGN



RESIDENTIAL DENSITY CODE PLAN
VARIOUS LOTS HOFFMAN ROAD
MANDOGALUP

DRAFT

7282A-FIG-161-A

ROWE GROUP DESIGN

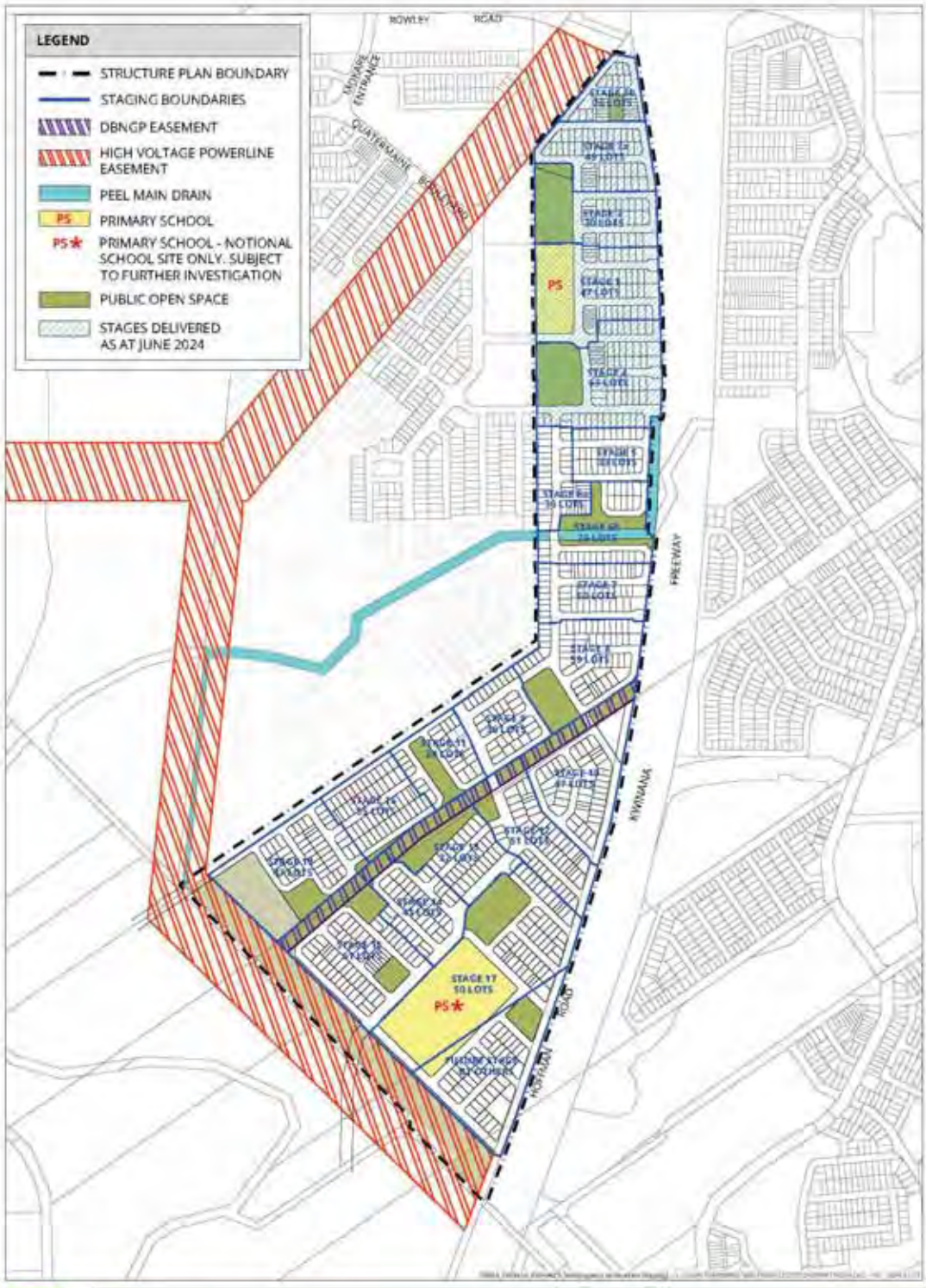


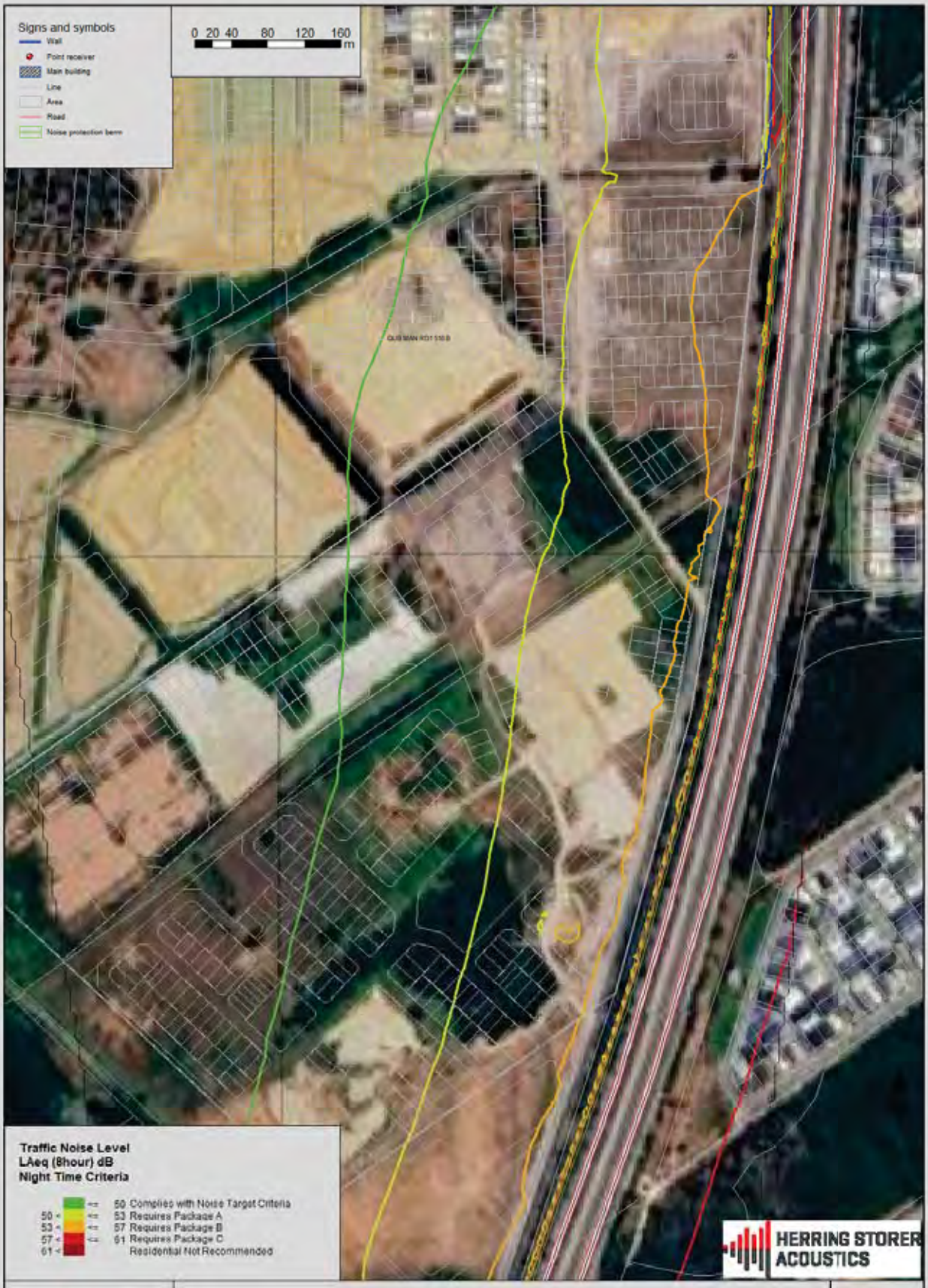
FIGURE 14
INDICATIVE STAGING PLAN

APPENDIX B

NOISE CONTOUR PLOTS



Herring Storer Acoustics Job No - 24045	MANDOGALUP ESTATE - KWINANA FREEWAY Current Traffic Volumes 2024 LAeq (16hour) Day Noise Level Contour	Figure B1 Ref # 003



Herring Storer Acoustics Job No - 24045	MANDOGALUP ESTATE - KWINANA FREEWAY Current Traffic Volumes 2024 LAeq (8hour) Night Noise Level Contour	Figure B2 Ref # 003A



Herring Storer Acoustics
Job No - 24045

MANDOGALUP ESTATE - KWINANA FREEWAY
Future Traffic Volumes - No Noise Control
LAeq (16hour) Day Noise Level Contour

Figure 83
Ref # 004



Herring Storer Acoustics
Job No - 24045

MANDOGALUP ESTATE - KWINANA FREEWAY
Future Traffic Volumes - No Noise Control
LAeq (8hour) Night Noise Level Contour

Figure B4
Ref # 604A



Herring Storer Acoustics
Job No - 24045

MANDOGALUP ESTATE - KWINANA FREEWAY
Future Traffic Volumes - With Noise Wall
LAeq (16hour) Day Noise Level Contour

Figure B5
Ref # 006



Herring Storer Acoustics
Job No - 24045

MANDOGALUP ESTATE - KWINANA FREEWAY
Future Traffic Volumes - With Noise Wall
LAeq (8hour) Night Noise Level Contour

Figure B6
Ref # 006A


Signs and symbols
Wall
Point receiver
Main building
Line
Area
Road
Noise protection barrier
Railway
Railway axis
Emission line
Surface
0 20 40 80 120 160 m
QUATERMAINE BOULEVARD
HOFFMAN ROAD
FREEWAY
PS
1947
N
Traffic Noise Level
LAeq (16hour) dB
Day Time Criteria
55 Complies with Noise Target Criteria
58 Requires Package A
62 Requires Package B
66 Requires Package C
Residential Not Recommended
HERRING STORER ACOUSTICS
Herring Storer Acoustics
Job No - 24045
MANDOGALUP ESTATE - PASSENGER RAIL
Future Traffic Volumes - No Noise Control
LAeq (16hour) Day Noise Level Contour
Figure 67
Ref # 007


Signs and symbols
Wall
Point receiver
Main building
Line
Area
Road
Noise projection berm
Railway
Railway axis
Emission line
Surface
0 20 40 80 120 160 m
QUATERMAINE
BOULE
IP47
PS7
HOFFMAN ROAD
FREEWAY
N
Traffic Noise Level
LAeq (16hour) dB
Day Time Criteria
<= 55 Complies with Noise Target Criteria
55 < <= 58 Requires Package A
58 < <= 62 Requires Package B
62 < <= 66 Requires Package C
66 < Residential Not Recommended
HERRING STORER ACOUSTICS
Herring Storer Acoustics
Job No - 24045
MANDOGALUP ESTATE - PASSENGER RAIL
Future Traffic Volumes - With Noise Wall
LAeq (16hour) Day Noise Level Contour
Figure B8
Ref # 008


Signs and symbols
Wall
Point receiver
Main building
Link
Area
Road
Noise protection berm
Railway
Railway axis
Emission line
Surface
0 20 40 80 120 160
m
QUATERMAINE
BOULE
IP47
PS1
HOFFMAN ROAD
FREEWAY
N
Traffic Noise Level
LAeq (16hour) dB
Day Time Criteria
<= 55 Complies with Noise Target Criteria
55 < <= 58 Requires Package A
58 < <= 62 Requires Package B
62 < <= 66 Requires Package C
66 < Residential Not Recommended
HERRING STORER ACOUSTICS
Herring Storer Acoustics
Job No - 24045
MANDOGALUP ESTATE - COMBINED FREEWAY AND PASSENGER RAIL
Future Traffic Volumes - With Noise Wall
LAeq (16hour) Day Noise Level Contour
Figure 09
Ref # 010



Herring Storer Acoustics Job No - 24045	MANDOGALUP ESTATE - COMBINED FREEWAY AND PASSENGER RAIL Future Traffic Volumes - With Noise Wall LAeq (8hour) Night Noise Level Contour	Figure B10 Rel # B10A

APPENDIX C

Quiet House Design – Individual Lot Requirements

APPENDIX C – QHD REQUIREMENTS INDIVIDUAL LOTS NO SCHOOL SITE OPTION					
Lot Number	**Stage**	**Acoustic Requirement**	**Lot Number**	**Stage**	**Acoustic Requirement**
300	7	No Acoustic Requirement	354	7	Notification on Title and Package B
301	7	No Acoustic Requirement	355	7	Notification on Title and Package B
302	7	No Acoustic Requirement	356	7	Notification on Title and Package A
303	7	No Acoustic Requirement	357	7	Notification on Title and Package A
304	7	No Acoustic Requirement	358	7	Notification on Title and Package A
305	7	No Acoustic Requirement	359	7	Notification on Title and Package A
306	7	No Acoustic Requirement	360	7	No Acoustic Requirement
307	7	No Acoustic Requirement	361	7	No Acoustic Requirement
308	7	No Acoustic Requirement	362	7	No Acoustic Requirement
309	7	No Acoustic Requirement	363	7	No Acoustic Requirement
326	7	Notification on Title and Package A	364	7	No Acoustic Requirement
327	7	Notification on Title and Package A	365	7	No Acoustic Requirement
328	7	Notification on Title and Package A	381	8	No Acoustic Requirement
329	7	Notification on Title and Package A	382	8	No Acoustic Requirement
330	7	Notification on Title and Package A	383	8	No Acoustic Requirement
331	7	No Acoustic Requirement	384	8	No Acoustic Requirement
332	7	No Acoustic Requirement	385	8	No Acoustic Requirement
333	7	No Acoustic Requirement	386	8	No Acoustic Requirement
334	7	No Acoustic Requirement	387	8	No Acoustic Requirement
335	7	No Acoustic Requirement	388	8	No Acoustic Requirement
336	7	No Acoustic Requirement	389	8	No Acoustic Requirement
337	7	No Acoustic Requirement	390	8	No Acoustic Requirement
338	7	No Acoustic Requirement	391	8	No Acoustic Requirement
339	7	No Acoustic Requirement	392	8	No Acoustic Requirement
340	7	No Acoustic Requirement	393	8	Notification on Title
341	7	No Acoustic Requirement	394	8	Notification on Title
342	7	No Acoustic Requirement	395	8	Notification on Title and Package A
343	7	No Acoustic Requirement	396	8	Notification on Title and Package A
344	7	No Acoustic Requirement	397	8	Notification on Title and Package A
345	7	No Acoustic Requirement	398	8	Notification on Title and Package A
346	7	No Acoustic Requirement	399	8	Notification on Title and Package A
347	7	No Acoustic Requirement	400	8	Notification on Title and Package A
348	7	No Acoustic Requirement	401	8	Notification on Title and Package A
349	7	Notification on Title and Package A	402	8	Notification on Title and Package B
350	7	Notification on Title and Package A	403	8	Notification on Title and Package B
351	7	Notification on Title and Package A	404	8	Notification on Title and Package A
352	7	Notification on Title and Package A	405	8	Notification on Title and Package A
353	7	Notification on Title and Package A	406	8	Notification on Title and Package A

APPENDIX C – QHD REQUIREMENTS INDIVIDUAL LOTS NO SCHOOL SITE OPTION					
Lot Number	**Stage**	**Acoustic Requirement**	**Lot Number**	**Stage**	**Acoustic Requirement**
407	8	Notification on Title and Package A	470	10	Notification on Title and Package A
408	8	No Acoustic Requirement	471	10	Notification on Title and Package A
409	8	No Acoustic Requirement	472	10	Notification on Title and Package A
410	8	Notification on Title	473	10	Notification on Title and Package A
411	8	No Acoustic Requirement	474	10	Notification on Title and Package A
412	8	No Acoustic Requirement	475	10	Notification on Title and Package A
413	8	No Acoustic Requirement	476	10	Notification on Title and Package A
414	8	No Acoustic Requirement	477	10	Notification on Title and Package A
415	8	No Acoustic Requirement	478	10	Notification on Title and Package A
416	8	No Acoustic Requirement	479	10	Notification on Title and Package A
417	8	No Acoustic Requirement	480	10	Notification on Title
418	8	No Acoustic Requirement	481	10	Notification on Title
419	8	No Acoustic Requirement	482	10	Notification on Title and Package A
420	8	No Acoustic Requirement	483	10	Notification on Title and Package A
421	8	Notification on Title and Package A	484	10	Notification on Title and Package A
422	8	Notification on Title and Package A	485	10	Notification on Title and Package A
423	8	Notification on Title and Package A	486	10	Notification on Title and Package A
424	8	Notification on Title and Package A	487	10	Notification on Title and Package B
425	8	Notification on Title and Package A	488	10	Notification on Title and Package B
426	8	Notification on Title and Package B	489	10	Notification on Title and Package B
427	8	Notification on Title and Package B	490	10	Notification on Title and Package B
428	8	Notification on Title and Package A	491	10	Notification on Title and Package B
429	8	Notification on Title and Package A	492	10	Notification on Title and Package B
430	8	Notification on Title and Package A	493	10	Notification on Title and Package B
431	8	Notification on Title	494	10	Notification on Title and Package B
432	8	Notification on Title	495	10	Notification on Title and Package B
433	8	No Acoustic Requirement	496	10	Notification on Title and Package B
434	8	No Acoustic Requirement	497	10	Notification on Title and Package B
435	8	No Acoustic Requirement	498	10	Notification on Title and Package B
436	8	No Acoustic Requirement	499	10	Notification on Title and Package A
437	8	No Acoustic Requirement	500	10	Notification on Title and Package A
438	8	No Acoustic Requirement	501	10	No Requirements
439	8	No Acoustic Requirement	502	10	No Requirements
466	10	Notification on Title and Package A	503	10	No Requirements
467	10	Notification on Title and Package A	504	10	No Requirements
468	10	Notification on Title and Package A	505	10	No Requirements

APPENDIX C – QHD REQUIREMENTS INDIVIDUAL LOTS NO SCHOOL SITE OPTION					
Lot Number	**Stage**	**Acoustic Requirement**	**Lot Number**	**Stage**	**Acoustic Requirement**
506	10	No Requirements	564	12	No Requirements
507	10	No Requirements	565	12	No Requirements
508	10	No Requirements	566	12	No Requirements
509	10	No Requirements	567	12	Notification on Title and Package A
510	10	No Requirements	568	12	Notification on Title and Package A
511	10	No Requirements	569	12	Notification on Title and Package A
512	10	Notification on Title and Package B	570	12	Notification on Title and Package A
537	12	Notification on Title and Package A	571	12	Notification on Title and Package A
538	12	Notification on Title and Package A	572	12	Notification on Title and Package A
539	12	Notification on Title and Package A	573	12	No Acoustic Requirement
540	12	Notification on Title and Package A	574	12	No Acoustic Requirement
541	12	Notification on Title and Package A	575	12	No Acoustic Requirement
542	12	Notification on Title and Package A	576	12	No Acoustic Requirement
543	12	Notification on Title and Package A	577	12	No Acoustic Requirement
544	12	Notification on Title and Package A	578	12	No Acoustic Requirements
545	12	Notification on Title and Package A	579	12	No Acoustic Requirements
546	12	Notification on Title and Package A	580	12	No Acoustic Requirements
547	12	Notification on Title and Package A	581	12	No Acoustic Requirements
548	12	Notification on Title and Package A	582	12	Notification on Title and Package A
549	12	Notification on Title and Package A	583	12	Notification on Title and Package A
550	12	Notification on Title and Package A	584	12	Notification on Title and Package A
551	12	Notification on Title and Package A	585	12	Notification on Title and Package A
552	12	Notification on Title and Package A	586	12	Notification on Title and Package A
553	12	Notification on Title and Package A	587	12	Notification on Title and Package B
554	12	Notification on Title and Package B	911	17	Notification on Title and Package A
555	12	Notification on Title and Package B	910	17	Notification on Title and Package A
556	12	Notification on Title and Package A	909	17	No Requirements
557	12	Notification on Title and Package A	908	17	No Requirements
558	12	Notification on Title	907	17	No Requirements
559	12	No Requirements	906	17	No Requirements
560	12	No Requirements	905	17	No Requirements
561	12	No Requirements	904	17	No Requirements
562	12	No Requirements	903	17	No Requirements
563	12	No Requirements	902	17	No Requirements

APPENDIX C – QHD REQUIREMENTS INDIVIDUAL LOTS NO SCHOOL SITE OPTION					
Lot Number	**Stage**	**Acoustic Requirement**	**Lot Number**	**Stage**	**Acoustic Requirement**
901	17	No Requirements	879	17	No Acoustic Requirements
900	17	No Requirements	880	17	No Acoustic Requirements
886	17	No Requirements	881	17	No Acoustic Requirements
885	17	No Requirements	882	17	No Acoustic Requirements
884	17	No Requirements	287	6B	Notification on Title and Package A
883	17	No Requirements	288	6B	Notification on Title and Package A
887	17	Notification on Title and Package A	289	6B	Notification on Title and Package A
888	17	Notification on Title and Package A	290	6B	Notification on Title and Package A
889	17	Notification on Title and Package A	291	6B	Notification on Title and Package A
890	17	Notification on Title and Package A	292	6B	Notification on Title and Package A
891	17	Notification on Title and Package A	293	6B	Notification on Title and Package A
892	17	Notification on Title and Package A	294	6B	Notification on Title and Package A
893	17	Notification on Title and Package A	295	6B	Notification on Title and Package A
894	17	Notification on Title and Package B	296	6B	Notification on Title and Package A
895	17	Notification on Title and Package A	310	6B	No Acoustic Requirements
896	17	No Requirements	311	6B	No Acoustic Requirements
897	17	No Requirements	312	6B	No Acoustic Requirements
898	17	No Requirements	313	6B	No Acoustic Requirements
899	17	No Requirements	314	6B	No Acoustic Requirements
865	17	No Requirements	315	6B	No Acoustic Requirements
864	17	No Requirements	316	6B	No Acoustic Requirements
863	17	No Requirements	317	6B	No Acoustic Requirements
862	17	No Requirements	318	6B	No Acoustic Requirements
866	17	No Requirements	319	6B	Notification on Title
867	17	No Requirements	320	6B	Notification on Title and Package A
868	17	Notification on Title and Package A	321	6B	Notification on Title and Package A
869	17	Notification on Title and Package A	322	6B	Notification on Title and Package A
870	17	Notification on Title and Package A	323	6B	Notification on Title and Package A
871	17	Notification on Title and Package A	324	6B	Notification on Title and Package A
872	17	Notification on Title and Package A	325	6B	Notification on Title and Package A
873	17	Notification on Title and Package B			
874	17	Notification on Title and Package A			
875	17	Notification on Title and Package A			
876	17	Notification on Title and Package A			
877	17	Notification on Title and Package A			
878	17	No Acoustic Requirements			

APPENDIX C – QHD REQUIREMENTS INDIVIDUAL LOTS WITH SCHOOL SITE OPTION					
Lot Number	**Stage**	**Acoustic Requirement**	**Lot Number**	**Stage**	**Acoustic Requirement**
840	17	No Acoustic Requirements	837	17	No Acoustic Requirements
841	17	No Acoustic Requirements	838	17	No Acoustic Requirements
842	17	Notification on Title	839	17	No Acoustic Requirements
843	17	Notification on Title and Package A	797	17	No Acoustic Requirements
844	17	Notification on Title and Package A	798	17	Notification on Title
845	17	Notification on Title and Package A	799	17	Notification on Title
846	17	Notification on Title and Package A	800	17	Notification on Title
847	17	Notification on Title and Package A	801	17	Notification on Title
848	17	Notification on Title and Package A	802	17	Notification on Title
849	17	Notification on Title and Package A	803	17	Notification on Title
850	17	Notification on Title and Package A	804	17	Notification on Title
851	17	Notification on Title and Package B	805	17	Notification on Title
852	17	Notification on Title and Package B	806	17	Notification on Title
853	17	Notification on Title and Package B	807	17	Notification on Title and Package A
854	17	No Acoustic Requirements	808	17	Notification on Title and Package A
855	17	Notification on Title	809	17	Notification on Title and Package A
856	17	Notification on Title	810	17	Notification on Title
857	17	No Acoustic Requirements	811	17	No Acoustic Requirements
858	17	No Acoustic Requirements	812	17	No Acoustic Requirements
859	17	No Acoustic Requirements	813	17	No Acoustic Requirements
860	17	No Acoustic Requirements	814	17	No Acoustic Requirements
861	17	No Acoustic Requirements	815	17	No Acoustic Requirements
816	17	No Acoustic Requirements	777	17	No Acoustic Requirements
817	17	No Acoustic Requirements	778	17	No Acoustic Requirements
818	17	No Acoustic Requirements	779	17	No Acoustic Requirements
819	17	No Acoustic Requirements	780	17	No Acoustic Requirements
820	17	Notification on Title and Package A	781	17	No Acoustic Requirements
821	17	Notification on Title	782	17	No Acoustic Requirements
822	17	Notification on Title and Package A	783	17	No Acoustic Requirements
823	17	Notification on Title and Package A	784	17	No Acoustic Requirements
824	17	Notification on Title and Package A	785	17	No Acoustic Requirements
825	17	Notification on Title and Package A	786	17	No Acoustic Requirements
826	17	Notification on Title and Package A	787	17	No Acoustic Requirements
827	17	Notification on Title and Package A	788	17	Notification on Title and Package A
828	17	Notification on Title and Package B	789	17	No Acoustic Requirements
829	17	Notification on Title and Package B	790	17	No Acoustic Requirements

APPENDIX C – QHD REQUIREMENTS INDIVIDUAL LOTS WITH SCHOOL SITE OPTION					
Lot Number	**Stage**	**Acoustic Requirement**	**Lot Number**	**Stage**	**Acoustic Requirement**
830	17	Notification on Title and Package B	791	17	No Acoustic Requirements
831	17	Notification on Title and Package B	792	17	No Acoustic Requirements
832	17	Notification on Title and Package A	793	17	No Acoustic Requirements
833	17	Notification on Title and Package A	794	17	No Acoustic Requirements
834	17	Notification on Title	795	17	No Acoustic Requirements
835	17	No Acoustic Requirements	796	17	No Acoustic Requirements
836	17	No Acoustic Requirements			

APPENDIX D

QUIET HOUSE DESIGN GUIDELINES

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
A **Quiet House A**	**Facing**	**Bedroom and Indoor Living and work areas to Rw + Ctr 45dB** **Stud Frame Walls** ➢ One row of 92mm studs at 60mm centres with: ➢ Resilient steel channels fixed to the outside of the studs; and ➢ 9.5mm hardboard or 9mm fibre cement weatherboards or one layer of 19mm board cladding fixed to the outside of the channels; and ➢ 75mm glass wool (11kg/m3) or 75mm polyester (14kg/m3) insulation, positioned between the studs; and ➢ -Two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs. **Brick Walls** ➢ Single leaf of 150mm brick masonry with 13mm cement render on each face: **OR** ➢ Double brick: two leaves of 90 mm clay brick masonry with a 20mm cavity between leaves.	**Bedrooms**: ➢ Fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 28 dB**). Sealed awning or casement windows may use 6 mm glazing instead**: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB**)**: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB : OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).	**To R_w+C_{tr} 35dB** ➢ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling	➢ At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** into sensitive spaces ➢ Evaporative systems require attenuated ceiling air vents to allow closed windows ➢ Refrigerant-based systems need to be designed to achieve National Construction Code fresh air ventilation requirements ➢ Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable
	Side On		As per "Facing" above, except R_w+C_{tr} values may be 3dB less, e.g. glazed sliding door with 10 mm glass and weather seals for bedrooms	As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%			
	Opposite		No specific requirements	No specific requirements			

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

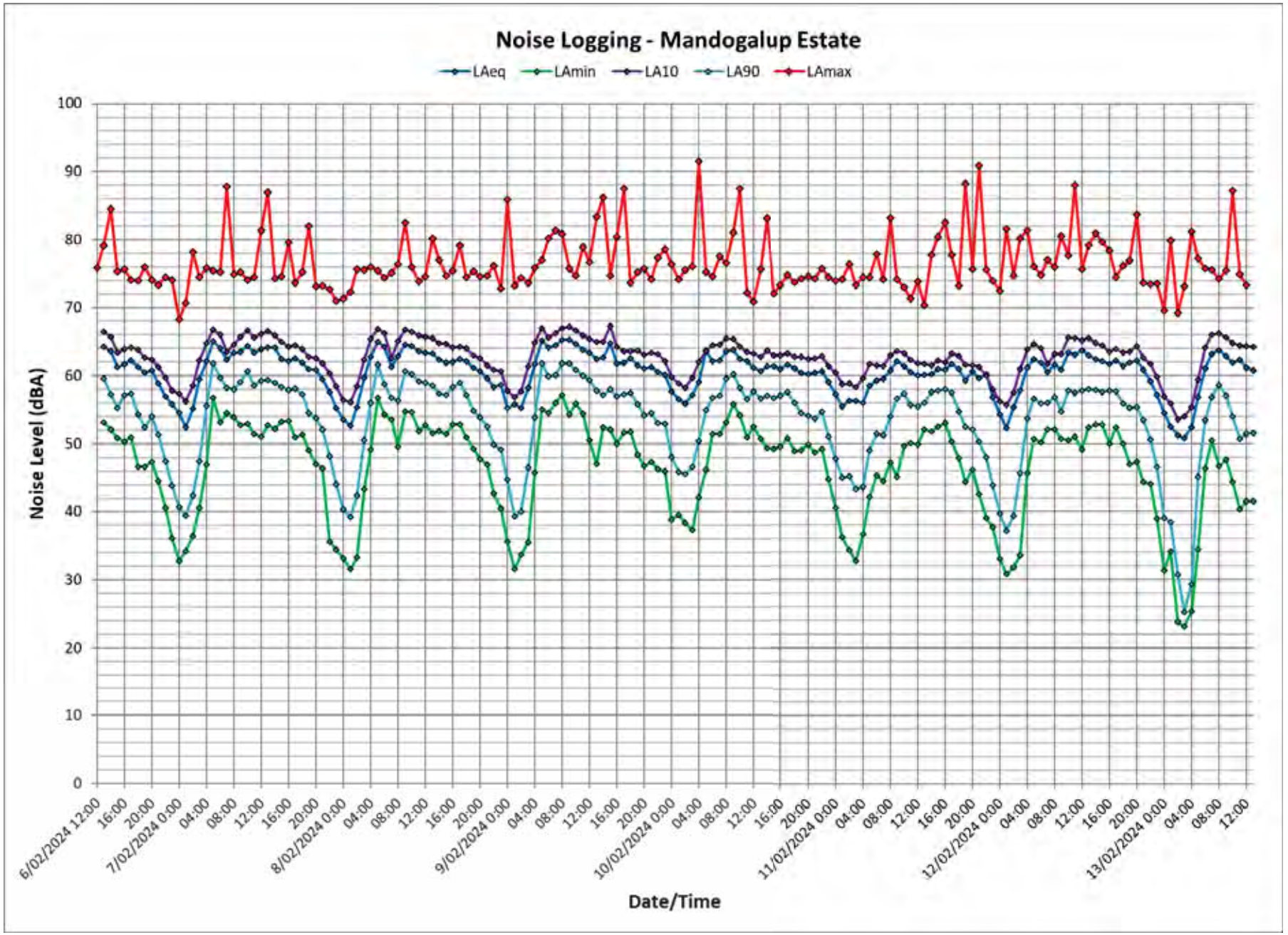
Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/ air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
B **Quiet House B**	**Facing**	**Bedroom and indoor living and work areas to R_w+C_{tr} 50dB** **Single leaf of 90 mm clay brick masonry with:** ➢ A row of 70 mm x 35 mm timber studs or 64 mm steel studs at 600 mm centres; ➢ A cavity of 25 mm between leaves; ➢ 50 mm glass wool or polyester cavity insulation (R2.0+) insulation between studs; and ➢ One layer of 10mm plasterboard fixed to the inside face ➢ Single leaf of 220mm brick masonry with 13mm cement render on each face ➢ 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face **Double brick: two leaves of 90mm clay brick masonry with:** ➢ A 50mm cavity between leaves ➢ 50mm glass wool or polyester cavity insulation (R2.0+) ➢ Resilient ties where required to connect leaves **Double brick: two leaves of 110mm clay brick masonry with** ➢ 50mm cavity between leaves and R2.0+ cavity insulation	**Bedrooms** ➢ Fully glazed hinged door with certified **R_w+C_{tr} 31dB** rated door and frame including seals and 10mm glass **Indoor Living and work areas** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor areas: Fixed sash, awning or casement with minimum 6mm single or 6mm-12mm-6mm double insulted glazing (**Rw+Ctr 31dB**). ➢ Up to 60% floor area: as per above but must be minimum10mm single or 6mm-12mm-10mm double insulated glazing (**Rw+Ctr 34dB**) **Indoor Living and work areas** ➢ Up to 40% floor area; Sliding or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (R_w+C_{tr} 28dB). Sealed awning or casement windows may use 6mm glazing instead. **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**R_w+C_{tr} 31dB**). **: OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 34dB).**	**To R_w+C_{tr} 35dB** ➢ Concrete or terracotta tile sarking and at least 10mm plasterboard ceiling, R3.0+ insulation **OR** ➢ Metal sheet roof, sarking and at least 10mm plasterboard ceiling, R3.0+ insulation	➢ At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2.4 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** into sensitive spaces ➢ Evaporative systems require attenuated ceiling air vents to allow closed windows ➢ Refrigerant-based systems need to be designed to achieve National Construction Code fresh air ventilation requirements ➢ Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable
	Side-On		**Bedrooms**: ➢ Fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 28 dB**). Sealed awning or casement windows may use 6 mm glazing instead. **: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB**). **: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB**) **: OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).			
	Opposite		As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%	As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%			

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	**Mechanical ventilation/ air conditioning considerations**
C **Quiet House C**	**Facing**	**Bedroom and indoor living and work areas to R_w+C_{tr} 50dB** **Single leaf of 90 mm clay brick masonry with:** ➢ A row of 70 mm x 35 mm timber studs or 64 mm steel studs at 600 mm centres; ➢ A cavity of 25 mm between leaves; ➢ 50 mm glass wool or polyester cavity insulation (R2.0+) insulation between studs; and ➢ One layer of 10mm plasterboard fixed to the inside face ➢ Single leaf of 220mm brick masonry with 13mm cement render on each face ➢ 150mm thick unlined concrete panel or 200mm thick concrete panel with one layer of 13mm plasterboard or 13mm cement render on each face **Double brick: two leaves of 90mm clay brick masonry with:** ➢ A 50mm cavity between leaves ➢ 50mm glass wool or polyester cavity insulation (R2.0+) ➢ Resilient ties where required to connect leaves **Double brick: two leaves of 110mm clay brick masonry with** ➢ 50mm cavity between leaves and R2.0+ cavity insulation	**Bedrooms** ➢ External doors to bedrooms facing the corridor are not recommended. **Indoor Living and work areas** ➢ Fully glazed hinged door with certified **Rw+Ctr 31dB** rated door and frame including seals and 10mm glass**: OR** 40mm solid core timber frame and door (without glass or with glass inserts not less than 6mm), side hinged with certified **Rw 32dB** acoustically rated door and frame system including seals	**Bedrooms**: ➢ Total external door and window system area up to 20% of room floor area: Fixed sash, awning or casement with minimum 6mm single or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 31dB): OR** ➢ Up to 40% floor area; as per above but must be minimum 10mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 34dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulated glazing (**R_w+C_{tr} 31dB**). Sealed awning or casement windows may use 6mm glazing instead**: OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr 34dB)**	**To R_w+C_{tr} 40dB** ➢ To al bedrooms, 2 layers of 10mm plasterboard, or one layer 13mm high density sealed plasterboard (minimum surface density of 12.5 kg/m2), affixed using steel furring channels beneath ceiling rafters/supports**: and** ➢ R3.0+ insulation batts laid in cavity **: and** ➢ Concrete or terracotta tile roof with sarking, or metal sheet roof with foil backed R2.0+ fibre insulation between steel sheeting and roof battens	➢ At least one outdoor living area located on the opposite side of the building from the corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2.4 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of Rw 40dB into sensitive spaces. ➢ Evaporative systems require attenuated ceiling air cents to allow closed windows. ➢ Refrigerant-based systems need to be designed to achieve National Construction Code fresh air ventilation requirements ➢ Openings such as eaves, vents and air inlets must be acoustically treated, close or relocated to building sides facing away from the corridor where practicable.
	Side-on		**Bedrooms** ➢ Fully glazed hinged door with certified **R_w+C_{tr} 31dB** rated door and frame including seals and 10mm glass **Indoor Living and work areas** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals				
	Opposite		**Bedrooms**: ➢ Fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 28 dB**). Sealed awning or casement windows may use 6 mm glazing instead**: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB): OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB : OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).			

APPENDIX E

NOISE MONITORING DATA


Noise Logging - Mandogalup Estate
LAeq
LAmin
LA10
LA90
LAmax
Noise Level (dBA)
100
90
80
70
60
50
40
30
20
10
0
6/02/2024 12:00
16:00
20:00
7/02/2024 0:00
04:00
08:00
12:00
16:00
20:00
8/02/2024 0:00
04:00
08:00
12:00
16:00
20:00
9/02/2024 0:00
04:00
08:00
12:00
16:00
20:00
10/02/2024 0:00
04:00
08:00
12:00
16:00
20:00
11/02/2024 0:00
04:00
08:00
12:00
16:00
20:00
12/02/2024 0:00
04:00
08:00
12:00
16:00
20:00
13/02/2024 0:00
04:00
08:00
12:00
Date/Time

APPENDIX F

TRAFFIC DATA

2021 ROM24 Scenario - Link Volume Plot for Kwinana Fwy, Mandogalup Noise Assessment
All Day
Land Use Scenario: Westport Land Use based on DAEDS Version 3.3

MODEL ASSUMPTIONS

NETWORK: 2021 Westport Network

LAND USE: 2021 Westport Land Use based on DAEDS Version 3.3

ROM24 Multi-Modal Model V4.40

24-Hour Traffic Volumes (Factor X 100)

Terms & Conditions

MRWA Traffic Modelling Data as supplied to approved clients is confidential and is not to be made available to unauthorised persons or organisations. This data should not be used for any purpose other than the stated purpose for which it was requested from MRWA. The MRWA ROM is for estimating regional traffic volumes on regional and major local roads, and it should not be used for estimating local traffic on local roads. The MRWA ROM includes local roads but this is to provide connectivity in the model. MRWA Traffic Modelling Data should be interpreted by an experienced/qualified person. This data should not be used in making decisions relating to commercial or residential developments.



mainroads WESTERN AUSTRALIA

Transport Modelling Section
Enquiries Mark Yu (6304 4867)
MRWA Reference Job #12819
Mon 12 Feb 2024
T:\VOYAGER\JOBS\12024\42819\Reports\...\P42619_AI Day_LVP_Y21 Westport_Kwinana Fwy_Mandogalup.VPR

- 1 Lane Each Direction
- 2 Lanes Each Direction
- 3 Lanes Each Direction
- >=4 Lanes Each Direction
- Zone Connector

(Licensed to Main Roads WA - Don Aitken Centre)

2041 ROM24 Scenario - Link Volume Plot for Kwinana Fwy, Mandogalup Noise Assessment
All Day
Land Use Scenario: Westport Land Use based on DAEDS Version 3.3

MODEL ASSUMPTIONS

NETWORK: 2041 Westport Network

LAND USE: 2041 Westport Land Use based on DAEDS Version 3.3

ROM24 Multi-Modal Model V4.40

24-Hour Traffic Volumes (Factor X 100)

Terms & Conditions

MRWA Traffic Modelling Data as supplied to approved clients is confidential and is not to be made available to unauthorised persons or organisations. This data should not be used for any purpose other than the stated purpose for which it was requested from MRWA. The MRWA ROM is for estimating regional traffic volumes on regional and major local roads, and it should not be used for estimating local traffic on local roads. The MRWA ROM includes local roads but this is to provide connectivity in the model. MRWA Traffic Modelling Data should be interpreted by an experienced/qualified person. This data should not be used in making decisions relating to commercial or residential developments.



mainroads WESTERN AUSTRALIA

Transport Modelling Section
Enquiries Diane Yu 8304 4867
MRWA Reference Job #12819
Mon 12 Feb 2024
T:\VOYAGER\LOBS\V2024\42819\Reports\...VP42819_AI Day_LVP_Y41Westport_Kwinana Fwy_Mandogalup.VP3

- 1 Lane Each Direction
- 2 Lanes Each Direction
- 3 Lanes Each Direction
- >=4 Lanes Each Direction
- Zone Connector

(Licensed to Main Roads WA - Don Aitken Centre)

Surface Detail

Road	Start SLK	End SLK	CWY	Start True Dist	End True Dist	Inv Type	XSP	Width (m)	Year	Type	Aggregate Material	Aggregate Size	Adhesion Agent	Bitumen Class	Asphalt Depth (mm)	Enrich Year
H015	25.26	25.46	L	25.26	25.46	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2016	Asphalt Open Graded	Granite				30	
						SULA	L2	3.5	2016	Asphalt Open Graded	Granite				30	
						SULA	ER	3.5	2015	Asphalt Open Graded	Granite				30	
						SUSH	L	2.5	2015	Asphalt Open Graded	Granite				30	
	25.46	25.68	L	25.46	25.68	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2016	Asphalt Open Graded	Granite				30	
						SULA	L2	3.5	2016	Asphalt Open Graded	Granite				30	
						SULA	ER	3.5	2010	Asphalt Open Graded	Granite			320	30	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	25.68	25.84	L	25.68	25.84	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2016	Asphalt Open Graded	Granite				30	
						SULA	L2	3.5	2016	Asphalt Open Graded	Granite				30	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	25.84	26.79	L	25.84	26.79	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L2	3.5	2015	Asphalt Open Graded	Granite			170	70	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	26.79	27.62	L	26.79	27.62	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2015	Asphalt Open Graded	Granite			170	40	
						SULA	L2	3.5	2015	Asphalt Open Graded	Granite			170	40	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	27.62	27.63	L	27.62	27.63	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2015	Asphalt Open Graded	Granite			170	40	
						SULA	L2	3.5	2019	Asphalt Open Graded	Granite			170	30	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	27.63	27.68	L	27.63	27.68	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2015	Asphalt Open Graded	Granite				35	
						SULA	L2	3.5	2019	Asphalt Open Graded	Granite			170	30	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	27.68	27.82	L	27.68	27.82	SUSH	R	1.5	2001	Asphalt Open Graded	Granite				30	
						SULA	L1	3.5	2015	Asphalt Open Graded	Granite				35	
						SULA	L2	3.5	2019	Asphalt Open Graded	Granite			170	30	

Surface Detail

Road	Start SLK	End SLK	CWY	Start True Dist	End True Dist	Inv Type	XSP	Width (m)	Year	Type	Aggregate Material	Aggregate Size	Adhesion Agent	Bitumen Class	Asphalt Depth (mm)	Enrich Year
						SULA	ER	7.0	2019	Asphalt Open Graded	Granite			170	30	
						SUSH	L	2.5	2001	Asphalt Open Graded	Laterite				30	
	25.26	25.46	R	25.26	25.46	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2019	Asphalt Open Graded	Granite			170	30	
						SULA	R2	3.5	2019	Asphalt Open Graded	Granite			170	30	
						SULA	ER	7.0	2019	Asphalt Open Graded	Granite			170	30	
						SUSH	R	3.0	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
	25.46	25.51	R	25.46	25.51	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2009	Asphalt Open Graded	Granite			320	30	
						SULA	R2	3.5	2011	Asphalt Open Graded	Granite				30	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	25.51	25.56	R	25.51	25.56	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2001	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2011	Asphalt Open Graded	Granite				30	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	25.56	25.69	R	25.56	25.69	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2008	Asphalt Open Graded on Dense Graded	Granite			320	60	
						SULA	R2	3.5	2011	Asphalt Open Graded	Granite				30	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	25.69	25.88	R	25.69	25.88	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2008	Asphalt Open Graded on Dense Graded	Granite			320	60	
						SULA	R2	3.5	2011	Asphalt Open Graded	Granite				30	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	25.88	26.09	R	25.88	26.09	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2019	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2015	Asphalt Open Graded	Granite				25	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	26.09	26.27	R	26.09	26.27	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	

Surface Detail

Road	Start SLK	End SLK	CWY	Start True Dist	End True Dist	Inv Type	XSP	Width (m)	Year	Type	Aggregate Material	Aggregate Size	Adhesion Agent	Bitumen Class	Asphalt Depth (mm)	Enrich Year
						SULA	R1	3.5	2015	Asphalt Open Graded	Granite				25	
						SULA	R2	3.5	2015	Asphalt Open Graded	Granite				25	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	26.27	26.84	R	26.27	26.84	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2019	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2015	Asphalt Open Graded	Granite				25	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	26.84	27.60	R	26.84	27.60	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2019	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2019	Asphalt Open Graded	Granite				30	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	27.60	27.66	R	27.60	27.66	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2019	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2019	Asphalt Open Graded	Granite				30	
						SULA	ER	3.8	2015	Asphalt Open Graded	Granite				25	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	27.66	27.77	R	27.66	27.77	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2017	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2017	Asphalt Open Graded	Granite				30	
						SULA	ER	3.8	2015	Asphalt Open Graded	Granite				25	
						SUSH	R	3.0	2001	Asphalt Open Graded	Laterite				30	
	27.77	27.87	R	27.77	27.87	SUSH	L	2.5	2001	Asphalt Open Graded on Dense Graded	Laterite				30	
						SULA	R1	3.5	2017	Asphalt Open Graded	Granite				30	
						SULA	R2	3.5	2017	Asphalt Open Graded	Granite				30	
						SULA	ER	3.8	2015	Asphalt Open Graded	Granite				25	
						SUSH	R	3.0	2015	Asphalt Open Graded	Laterite				25	

APPENDIX 5

Previously Approved Landscape Feature and Tree Retention Management Plan

Satterley Property Group

Mandogalup East Residential Development

Landscape Feature and Tree Retention Management Plan

25 August 2020

58859/129747 (Rev 1)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

www.jbsg.com.au

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Appendices

Appendix A Subdivision plan
Appendix B Clearing Plan
Appendix C Mandogalup Urban Development Site Lyon Road, Mandogalup Tree Survey (PaperbarkTechnologies 2014)
Appendix D Assessment of Melaleuca: Mandogalup (Arborlogic March 2016)
Appendix E Significant Tree Assessment: Mandogalup (Arborlogic October 2016)

1. Introduction

1.1 Project background

Satterley Property Group (the proponent) is proposing to construct the Mandogalup East Residential Development Project (the site; Figure 1.1) in accordance with the Mandogalup East Local Structure Plan (MELSP) and approved Plan of Subdivision (WAPC 158176). The site is located approximately 30 km south of the Perth CBD within the City of Kwinana and comprises a total area of 42.67 ha. The site is bounded by the Kwinana Freeway to the east, Anketell Road to the south, Mandogalup West Local Structure Plan to the west, and Rowley Road to the north.

The site is currently zoned Urban under the Metropolitan Region Scheme (MRS), and Development under the City of Kwinana Local Planning Scheme (LPS).

1.2 Existing approvals

Development of the site was referred under the EPBC Act in May 2014, for potential impacts to foraging and breeding habitat for Black Cockatoos (EPBC 2014/7308). The proposed action was subsequently determined to be a controlled action subject to conditions on 27 July 2015 and conditions of the approval notice required that the proponent not clear more than 19.7 ha of Carnaby's Black Cockatoo foraging and potential breeding habitat, provide funds to the Department of Biodiversity, Conservation and Attractions (DBCA) for the acquisition and management of a 95 ha offset property in Cullalla and during the breeding season for Black Cockatoos undertake inspections of potential breeding trees to detect the presence of Carnaby's Black Cockatoos using hollows.

The MELSP was approved by Western Australian Planning Commission (WAPC) in March 2018. The MELSP covers the remaining northern portions of Lots 9006 and 9002, and Lot 9019 which are also part of Satterley's land holdings. The MELSP sets out land uses, residential densities, public open space network, public and private transport provision, environmental considerations and servicing requirements.

Since then, a Plan of Subdivision (WAPC 158176) with conditions was approved by WAPC in April 2020 and develop the site for residential purposes, including residential lots, an internal public access road network, primary school, and public open space (POS) (Appendix A). The approved subdivision is consistent with the requirements of the MELSP. The proposed Clearing Plan is provided in Appendix B.

1.3 Purpose and scope of this document

This Landscape Feature and Tree Retention Management Plan (LFTRMP) has been prepared in accordance with the City of Kwinana *Local Planning Policy (LPP) No 1: Landscape Feature and Tree Retention* for the WAPC subdivision approval No. 158176 Condition No. 27, as outlined below:

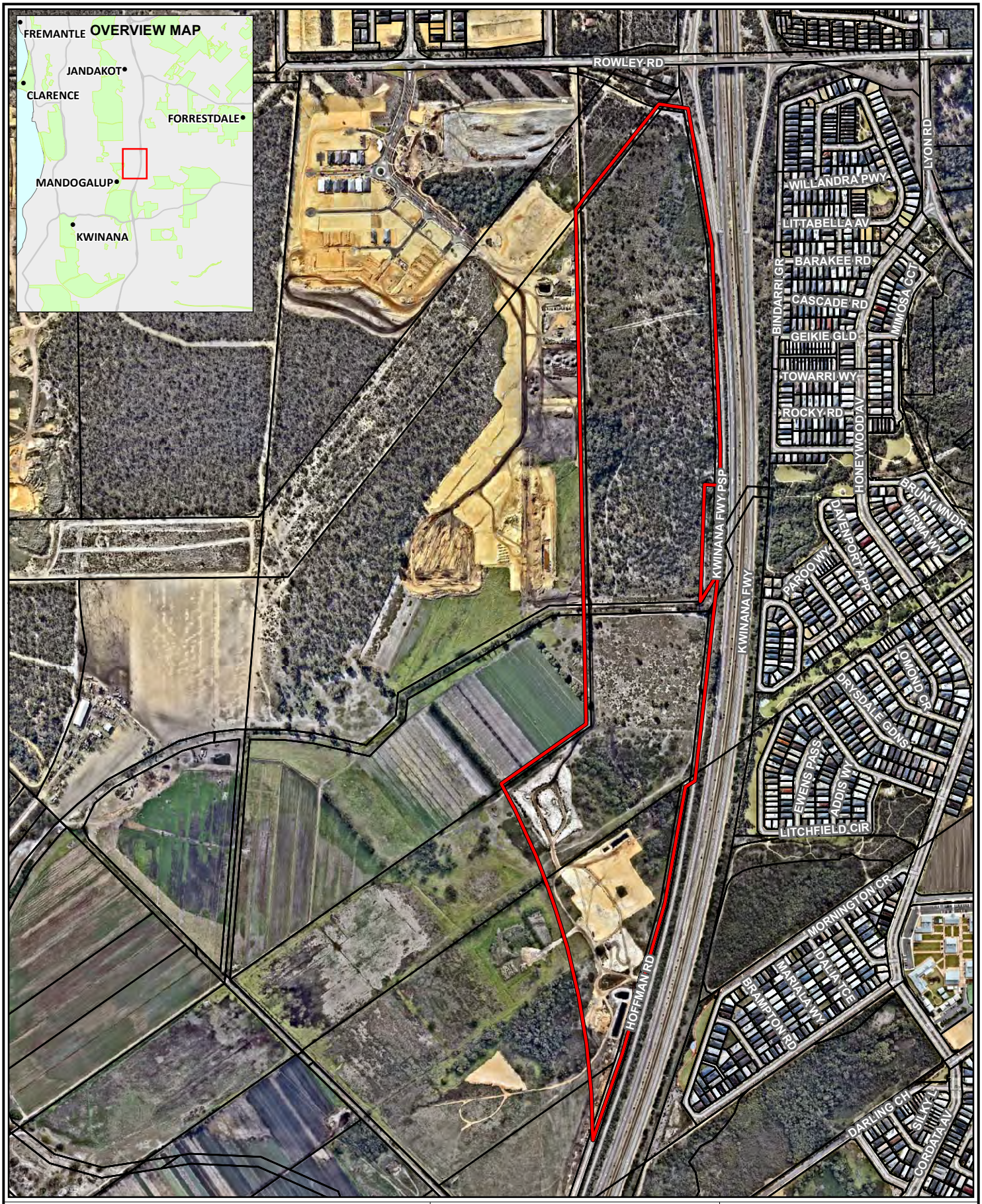
"Prior to the commencement of subdivision works a landscape feature and tree retention management plan is to be prepared and approved to ensure the protection and management of the sites environmental assets, in accordance with the Mandogalup East Local Structure Plan, with satisfactory arrangements being made for the implementation of the approved plan."

To date, the following tree surveys have been undertaken within the MELSP area):

- Mandogalup Urban Development Site Lyon Road, Mandogalup Tree Survey (Appendix C; Paperbark Technologies 2014)
- Assessment of Melaleuca: Mandogalup (Appendix D; Arborlogic 2016)
- Significant Tree Assessment: Mandogalup (Appendix E; Arborlogic 2017)

Based on the above tree surveys, this LFTRMP has been prepared to:

- Summarise and illustrate the location, species, size and structural health of significant trees on site
- Summarise and illustrate which significant trees and landscape features are to be retained and which significant trees are to be removed, fill or cut at the significant tree location and the location of services and infrastructure
- If applicable, buffer distances around significant trees in accordance with AS 4970-2009 – Protection of Trees on Development Sites
- Methodology to avoid impacts to landscape features and trees which are proposed to be retained
- Management and maintenance actions.



Legend

- Site boundary
- Cadastral boundary
- Roads (MRWA)

Scale 1:10,000 at A4	0 100 200 metres	**Mandogalup, WA**
Coord. Sys. GDA 1994 MGA Zone 50		**SITE OVERVIEW**
Job No: 58859		
Client: Satterley Property Group		**FIGURE 1.1**
Version: A	Date: 19-Jun-2020	strategen JBS&G
Drawn By: hsullivan	Checked By: CT	

File Name: \\606prfil\604\60471\jbsg.aust\JBS Perth\Projects\Open\Satterley Property Group\Mandogalup\58859 Mandogalup subdivision approval compliance\GIS\Maps\R02_Rev_A\58859_01_1_SiteOverview.mxd

Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.

2. Existing environment

2.1 Topography and soils

The topography of the site is mostly low and gently undulating, with local relief from 12 m AHD at the westernmost point to 28 m AHD in the north, and sloping in a generally south westerly direction (DWER 2020).

The site is situated on the interface of the Bassendean and Spearwood dune systems. Soils within the site are predominantly lacustrine deposits consisting of sandy silt (black friable silt with abundant organic material, variable fine quartz content, soft) and light grey, fine to medium grey sand (Bassendean Sand) over Lacustrine deposits (Gozzard 1983).

2.2 Hydrology

2.2.1 Groundwater

Groundwater levels beneath the site range from 21 m AHD to 13 m AHD inland, corresponding to groundwater levels between 15 metres below ground level (mbgl) to as little as 0.3 mbgl (RPS 2009). Groundwater flow direction within the site generally follows the natural topography and flows in a south-westerly direction according to the Perth Groundwater Atlas (DWER 2020) and observations made at the site (JDA 2014).

The Jandakot Mound supplies groundwater for public water supply, private abstraction for irrigated agriculture, industry, public open space and recreation grounds. Although the site is within the Jandakot Mound catchment, it is not within a proclaimed public drinking water source area (JDA 2014).

2.2.2 Surface water and wetlands

Surface water within the Proposal Area flows in a southerly direction towards the Spectacles wetlands via the Peel Main Drain (RPS 2009). Groundwater under the Proposal Area generally flows west-southwest towards the ocean (DWER 2020).

The Peel Main Drain, which flows from Banjup Swamp (located near Gibbs Rd, Aubin Grove) in the north to the Peel-Yalgorup system in the south (via Serpentine River), passes through the site. Given that this portion of the site is cleared and the surrounding land is currently used for horticultural activities, implementation of the Proposal is unlikely to lead to a decline in the water quality of the drain. Nutrient loads may decrease over time due to the cessation of horticultural activities in the surrounding area.

2.3 Flora and vegetation

The following flora and vegetation surveys have been undertaken within the site:

- A level 2 flora survey was undertaken in spring of 2004 and 2006, and autumn 2007 (RPS 2010)
- A 2013 targeted Threatened flora survey (Woodman 2014)

A summary of the results of the above surveys is presented in the following sections.

2.3.1 Flora

During the surveys undertaken, no Threatened flora species as listed under the EPBC Act, or the *Wildlife Conservation Act 1950* (WC Act), which has since been replaced by the *Biodiversity Conservation Act* 2016, have been identified within the site.

Two Priority flora species (*Cyathochaeta teretifolia* [P3] and *Jacksonia sericea* [P4]) have been identified within the site. RPS (2010) recorded a population of *C. teretifolia* in the site within the ErOF vegetation type (Table 2.1; Figure 2.1). This area will be retained as Public Open Space (POS), thus removing potential impacts to this species resulting from the development.

One individual of *Jacksonia sericea* (P4) was recorded within the site (Woodman 2014). Woodman (2014) states that removal of this individual to facilitate development is not considered to constitute a significant impact to this taxon.

2.3.2 Vegetation types

The site is predominately cleared farmland with some small patches of eucalypts. A total of seven vegetation types have been identified within the site, which are described below in Table 2.1, and displayed in Figure 2.1.

Table 2.1: Vegetation types

Vegetation type	Description
BLOW(J)	*Banksia attenuata - B. menziesii - B. ilicifolia* Low Woodland, with *Eucalyptus marginata, Dasypogon bromeliifolius, Phlebocarya ciliata*, local *Melaleuca preissiana*, *Pultenaea reticulata* and *Hypocalymma angustifolium*, some other natives and, commonly, weeds.
BLW(J)	*Banksia attenuata - B. menziesii* Low Woodland, with *Eucalyptus marginata, Allocasuarina fraseriana* and understoreys of *Xanthorrhoea preissii, Adenanthos cygnorum, Acacia pulchella, Stirlingia latifolia* and other natives, and of weeds; much of it regenerating after 2004 fire.
BLWAc	*Banksia attenuata - B. menziesii* Low Woodland, with thickets of *Adenanthos cygnorum*.
ErOF	*Eucalyptus rudis* very healthy Open Forest in soak/spring, with *Melaleuca preissiana* and *M. rhaphiophylla* tall trees, over *Pteridium esculentum - Cyathochaeta teretifolia - Baumea articulata* Closed Herb-Sedgeland; with *Lepidosperma longitudinale, Hemarthria uncinata, Hibbertia perfoliata, Dielsia stenostachya, Baumea vaginalis, Poa serpentum*; few aliens.
ErW	*Eucalyptus rudis* (largely leafless) Woodland (to Open Forest) over *Kunzea glabrescens* and *Astartea sp*. Closed Tall Scrubs, dense *Pteridium esculentum* and weeds; locally with healthy *Eucalyptus marginata* and *Melaleuca preissiana* trees.
KgCT-TO	*Kunzea glabrescens* Closed Tall to Tall Open Scrub; with, in more open sites, *Dasypogon bromeliifolius*, *Phlebocarya ciliata*, *Euchilopsis linearis* and other natives; some weedy Degraded areas and many dead shrubs over 1 m tall.
Weeds	Fields of established aliens, in some places with scattered natives; apparently not recently plowed or cropped.

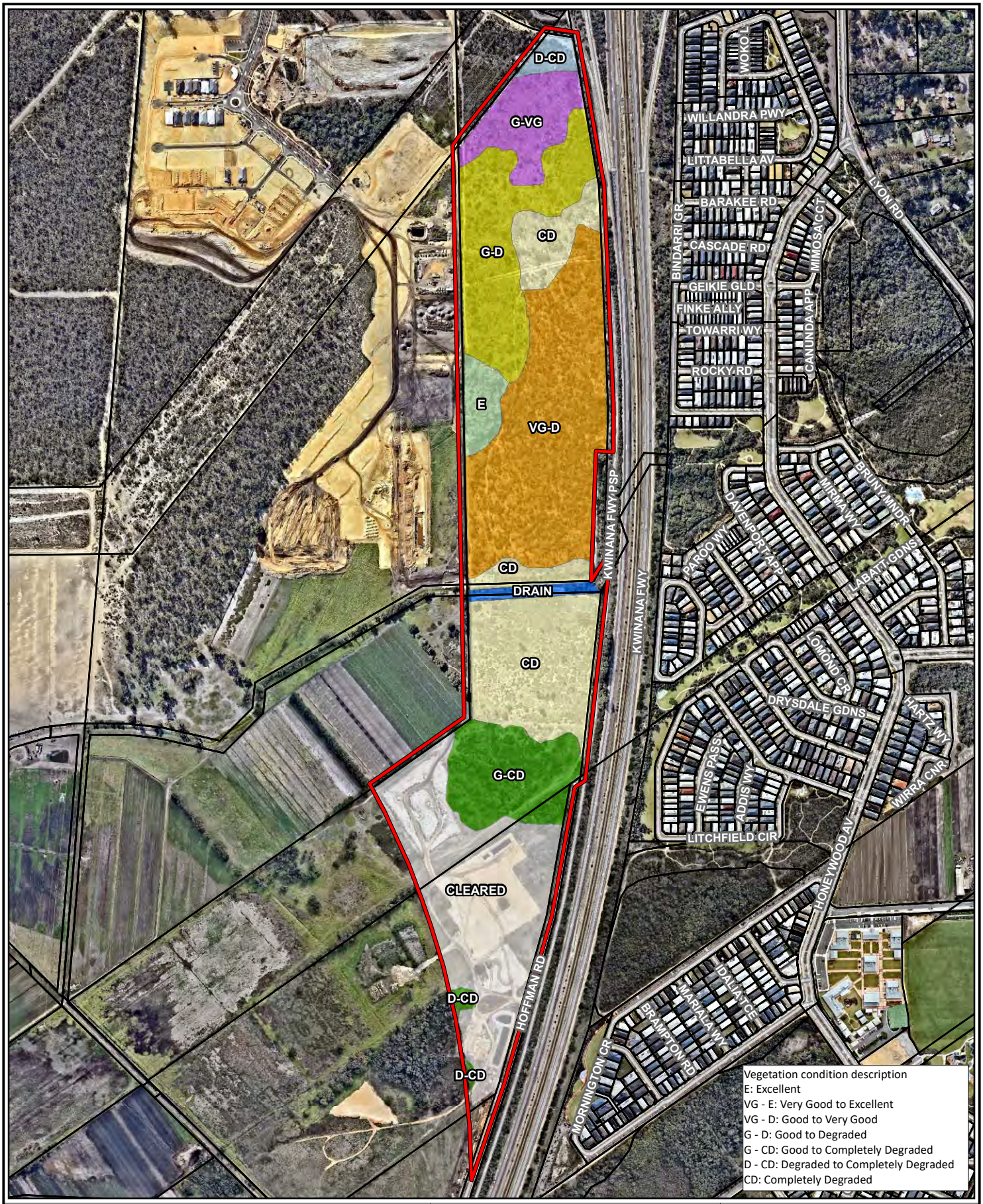
2.3.3 Vegetation condition

Vegetation condition was assessed using the Keighery (1994) scale, as presented in Table 2.2.

The condition of the vegetation ranged from Completely Degraded to Excellent, with most remnant vegetation being 'Very Good' to 'Degraded' condition (Figure 2.1). The site south of the Peel Main Drain has been subject to historical clearing and grazing. Weeds are common in the majority of bushland and previously cleared areas of the site. Vegetation condition is displayed in Figure 2.1.

Table 2.2: Vegetation condition scale (Keighery 1994)

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	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	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	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 frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	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.



Legend

- Survey area
- Cadastral boundary
- Roads (MRWA)

Vegetation type

- BLOW(J)
- BLW(J)
- ErOF
- ErW
- KgCT-TO
- BLWAc
- Weeds
- Drain
- Cleared

Scale 1:9,000 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58859

Client: Satterley Property Group

Version: A — Date: 19-Jun-2020

Drawn By: hsullivan — Checked By: CT

Mandogalup, WA

VEGETATION TYPE AND CONDITION

FIGURE 2.1

strategen JBS&G

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Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.

2.4 Fauna and habitat

2.4.1 Fauna

A 2015 desktop review of the then Department of Parks and Wildlife (now DBCA) "Naturemap" search tool identified 180 animal taxa (of which 172 are native), from 68 families that have the potential to occur within 5 km of the site. Western Wildlife undertook a Level 1 fauna survey of the site in accordance with EPA guidance Statement 56 (EPA 2004) in 2007. Western Wildlife determined that the cleared areas of the site offer very little habitat for fauna while vegetated areas of the site may support a range of fauna typical of Banksia / Eucalypt woodland of the Swan Coastal Plain, including a number of conservation significant fauna.

Subsequent to the above, Strategen in conjunction with Bamford Consulting Ecologists undertook a black cockatoo habitat assessment of the site and remainder of Lots 9006, and 9002 in 2013. The assessment included a survey to assess the potential of the survey area to provide foraging, roosting and nesting habitat for black cockatoos, as well as an assessment of black cockatoo significant trees across the site.

2.4.2 Quenda

The Quenda (*Isoodon fusciventer*) is currently listed as a Priority 4 species by the Western Australian State Government. Current threats to this species include habitat clearing and fragmentation, fire, and predation by foxes, cats and domestic dogs. The species favours areas with dense understorey, and is often particularly common in dense wetland vegetation.

Western Wildlife (2007) determined that the Quenda is likely to be present on the site in any areas with a dense understorey. Furthermore, Quenda have been recorded at the southern end of the site (from 1999) on the (then) Department of Environment and Conservation's (now DBCAs) Threatened and Priority Fauna Database.

Strategen (2013) identified the site as potentially containing habitat suitable for Quenda (*Isoodon fusciventer*). While this species was not recorded on the site during the level 1 fauna survey, mapping undertaken by Ramalho *et al.* (2013) indicates that remnant vegetation within the site may still support Quenda populations.

2.4.3 Black cockatoos

There are three species of black cockatoo that occur within the south west of Western Australia: Baudin's Black Cockatoo (*Calytporhynchus baudinii*; BBC), Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*; CBC), and Forest Red-tailed Black Cockatoo (*Calyptohynchus banksii naso*; FRTBC). All three species are listed as Threatened under both the EPBC Act and the BC Act. The modelled distribution of each of these species (DEE 2017) indicates that two are likely to occur within the site; namely CBC and FRTBC. It should be noted however that the site is located within the non-breeding range for CBC only. The site is located outside of the modelled distribution of BBC, and as such BBC are not discussed further.

2.4.3.1 Carnaby's Black Cockatoo

The 2013 habitat assessment (Strategen 2013) identified three main food species for CBC: *Banksia attenuata, B. menziesii* and *B. ilicifolia.* Other species were present which may be used as foraging items such as Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) however these were present in lower densities and are not easily assessed.

CBC foraging signs (cone follicle fragments and discarded cones) were present at 24% of *Banksia menziesii,* 40% of *B. attenuata* and 33% of *Banksia ilicifolia* trees within the quadrats surveyed. Most of the discarded cones appeared quite fresh, indicating that the site was recently used for foraging (Strategen 2013).

2.4.3.2 Forest Red-tailed Black Cockatoo

No FRTBC were recorded during the survey (Strategen 2013). The low numbers of preferred native food sources (such as Jarrah) at the site means that this is unsuitable for foraging by this species. As a result, the site is unlikely to be potential foraging habitat for FRTBC, however birds may occasionally pass through the site.

2.5 Dieback status

A dieback assessment of the site was undertaken on 6 November 2013 by Glevan (2013).

Much of the site was found to be either heavily disturbed (hence unmappable), or completely void of vegetation (excluded from the assessment). No confirmed dieback infestations were recorded in the site; however, some wetland areas exhibited a pattern of vegetation decline consistent with Phytophthora dieback infestation and are almost certainly infested (Plate 2.1) (Glevan 2013).

A single, uninfested protectable area was identified and demarcated during the assessment. The area exhibited some signs of vegetation decline; however, representative samples were negative for the presence of *Phytophthora cinnamomi* (Glevan 2013).

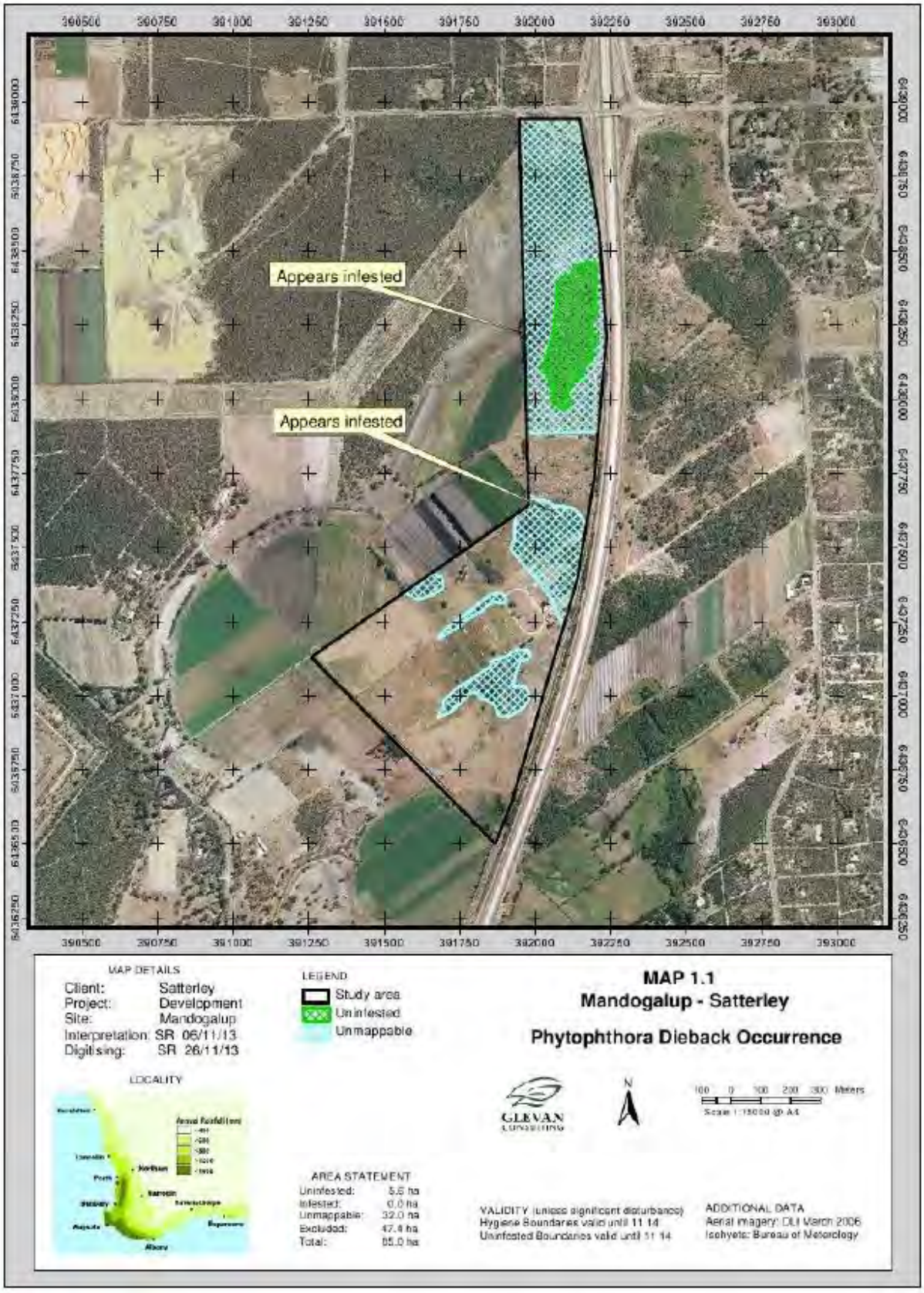


Plate 2.1: Phytophthora Dieback Occurrence (Glevan 2013)

3. Landscape features

3.1 Landscape feature criteria

Within the City of Kwinana LPP No. 1, a Landscape Feature is defined as:

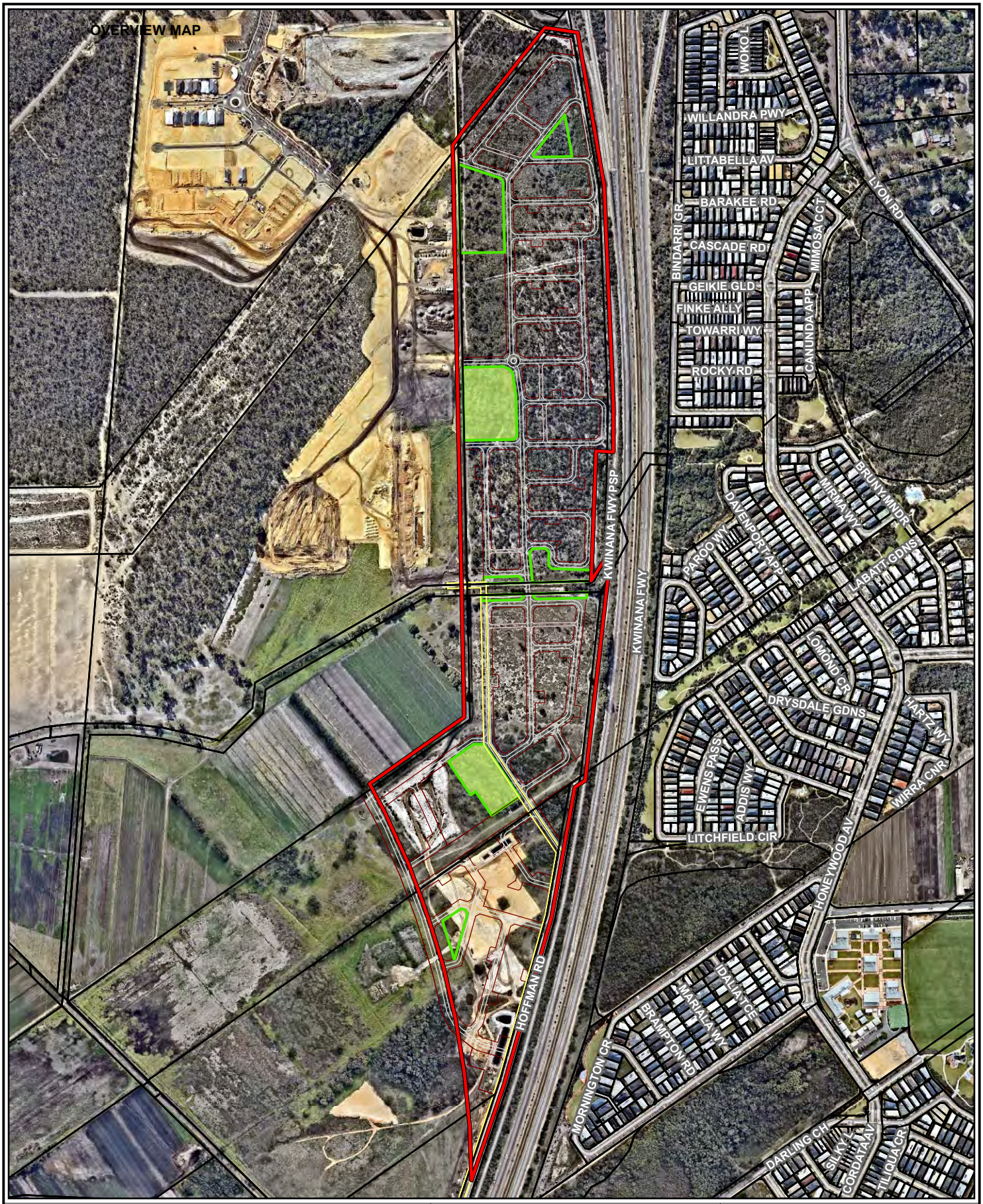
"A unique or identifiable feature of the landscape including ridgelines, rocky outcrops, vegetation, creek lines and wetlands."

3.2 Identified landscape features

In consultation with the City of Kwinana Environmental Services between 2014 and 2016, two landscape features consistent with the LPP No. 1 definition were identified for retention within the site:

1. Stand of *Eucalyptus rudis* open forest comprising of *Eucalyptus rudis* open forest in soak/spring with *Melaleuca preissiana* and *Melaleuca rhaphiophylla* tall trees
2. Stand of Melaleuca comprising of *Melaleuca preissiana* and *Melaleuca rhaphiophylla.*

These landscape feature areas are shown in Figure 3.1.



Legend

- Site boundary
- Cadastral boundary
- Landscape feature retention

Subdivision plan

- Sewer alignment
- Public open space
- Road reserve
- Subvision layout
- Roads (MRWA)

Scale 1:9,000 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58859

Client: Satterley Property Group

Version: A | Date: 19-Jun-2020

Drawn By: hsullivan | Checked By: CT

Mandogalup, WA

LANDSCAPE FEATURES FOR RETENTION

FIGURE 3.1

strategen JBS&G

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Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.

4. Significant tree assessment

4.1 Significant tree criteria

The City of Kwinana LPP No. 1 defines a Significant Tree as:

"A tree with a diameter at breast height (DBH) of 0.5 metres or greater."

Under LPP No. 1, a tree may also be considered as Culturally significant if it is:

"A tree which has special significance because of its aesthetic, historic, scientific or social significance."

4.2 Identified significant trees

To date, the following tree surveys have been undertaken within the site:

1. Mandogalup Urban Development Site Lyon Road, Mandogalup Tree Survey (Paperbark Technologies 2014)
2. Assessment of Melaleuca: Mandogalup (Arborlogic 2016)
3. Significant Tree Assessment: Mandogalup (Arborlogic 2017)

Trees with a DBH of 0.5 m or greater (significant trees) and those significant trees within the identified Landscape Feature areas were assessed, tagged and assigned a tree retention value based on the following attributes:

- Tree location
- Species
- Size
- Structural health/condition

A total of 171 significant trees were identified within the site, comprising of the following species:

- Bangalay (*Eucalyptus botryoides*)
- Candlestick Banksia (*Banksia attenuata*)
- Common Sheoak (*Allocasuarina fraseriana*)
- Flooded Gum (*Eucalyptus rudis*)
- Freshwater Paperbark (*Melaleuca rhaphiophylla*)
- Jarrah (*Eucalyptus marginata*)
- Lemon Scented Gum (*Corymbia citriodora*)
- Red River Gum (*Eucalyptus camaldulensis 'Camaldulensis'*)
- Stout Paperbark (*Melaleuca preissiana*)
- West Australian Christmas Tree (*Nuytsia floribunda*)

In order to maximise the retention of viable trees and avoid impacts to significant trees and landscape features on site the following measures were undertaken:

- An assessment of the landscape features and significant trees was undertaken within the context of the proposed development.

Public Open Space areas were located to maximise retention of the *Eucalyptus rudis* Open Forest and Melaleuca.

An engineering and planning assessment was undertaken, with a key consideration in this assessment being the level of cut and fill that would be required at the location of the significant tree. A significant tree was retained where the tree met all of the following criteria, being:

a. of 'high' and 'medium' retention value located within and outside areas of Public Open Space
b. located in fill less than 0.5m
c. a species retained by the City of Kwinana
d. able to be designed into a location of public open space, road reserve, rebated lot rain gardens, group housing or education.

In consultation with the City of Kwinana Environment Services all trees identified with a 'very low' or 'low' retention value located outside of a Public Open Space are not considered as a viable tree for retention due to the potential risk to community. Therefore, trees of 'very low' or 'low' retention value located outside Public Open Space are not proposed to be retained.

The above measures reduced impact on significant trees through a number of development design amendments being undertaken to maximise significant tree retention and landscape value retained within the site including:

- the retention of two landscape features within Public Open Space comprising:
  - a stand of *Eucalyptus rudis* Open Forest located north of the site
  - a stand of Melaleuca, which is adjacent to the site
- the retention of 62 significant trees retained in Public Open Space
- the retention of an additional 9 significant trees subject to detailed design.

4.3 Significant trees to be retained

Of the 171 significant trees, 62 will be retained, largely within the Landscape Feature areas within Public Open Space (POS) and 9 more trees may possibly be retained, where development design and engineering requirements can accommodate. Table 4.1 identifies each of the significant trees to be retained and their required Tree Protection Zones (TPZ), and the location of each of these trees in relation to the development is shown in Figure 4.1.

Table 4.1: Significant trees to be retained

Tree tag ID	Species	DBH (cm)	TPZ (m radius)	Retention Value	Retention status
7	West Australian Christmas Tree (*Nuytsia floribunda*)	52	4.7	Medium	Design permitting
8	Jarrah (*Eucalyptus marginata*)	59	5.3	Medium	Design permitting
9	Jarrah (*Eucalyptus marginata*)	63	7.6	High	Design permitting
15	Jarrah (*Eucalyptus marginata*)	92	8.3	High	Design permitting
16	Jarrah (*Eucalyptus marginata*)	54	6.5	Medium	Design permitting
17	Jarrah (*Eucalyptus marginata*)	75	6.8	High	Design permitting
18	Flooded Gum (*Eucalyptus rudis*)	50	4.5	High	Design permitting
20	Jarrah (*Eucalyptus marginata*)	83	7.5	High	Retained
21	Jarrah (*Eucalyptus marginata*)	145	13.1	Low	Retained
22	Flooded Gum (*Eucalyptus rudis*)	55	6.6	Low	Retained
23	Flooded Gum (*Eucalyptus rudis*)	50	6	Low	Retained
24	Flooded Gum (*Eucalyptus rudis*)	52	6.2	Low	Retained
25	Flooded Gum (*Eucalyptus rudis*)	50	6	Low	Retained
26	Jarrah (*Eucalyptus marginata*)	60	7.2	Low	Retained
27	Flooded Gum (*Eucalyptus rudis*)	66	5.9	Medium	Retained
28	Jarrah (*Eucalyptus marginata*)	180	15	Low	Retained
29	Flooded Gum (*Eucalyptus rudis*)	77	9.2	Low	Retained
30	Stout Paperbark (*Melaleuca preissiana*)	69	6.2	High	Retained

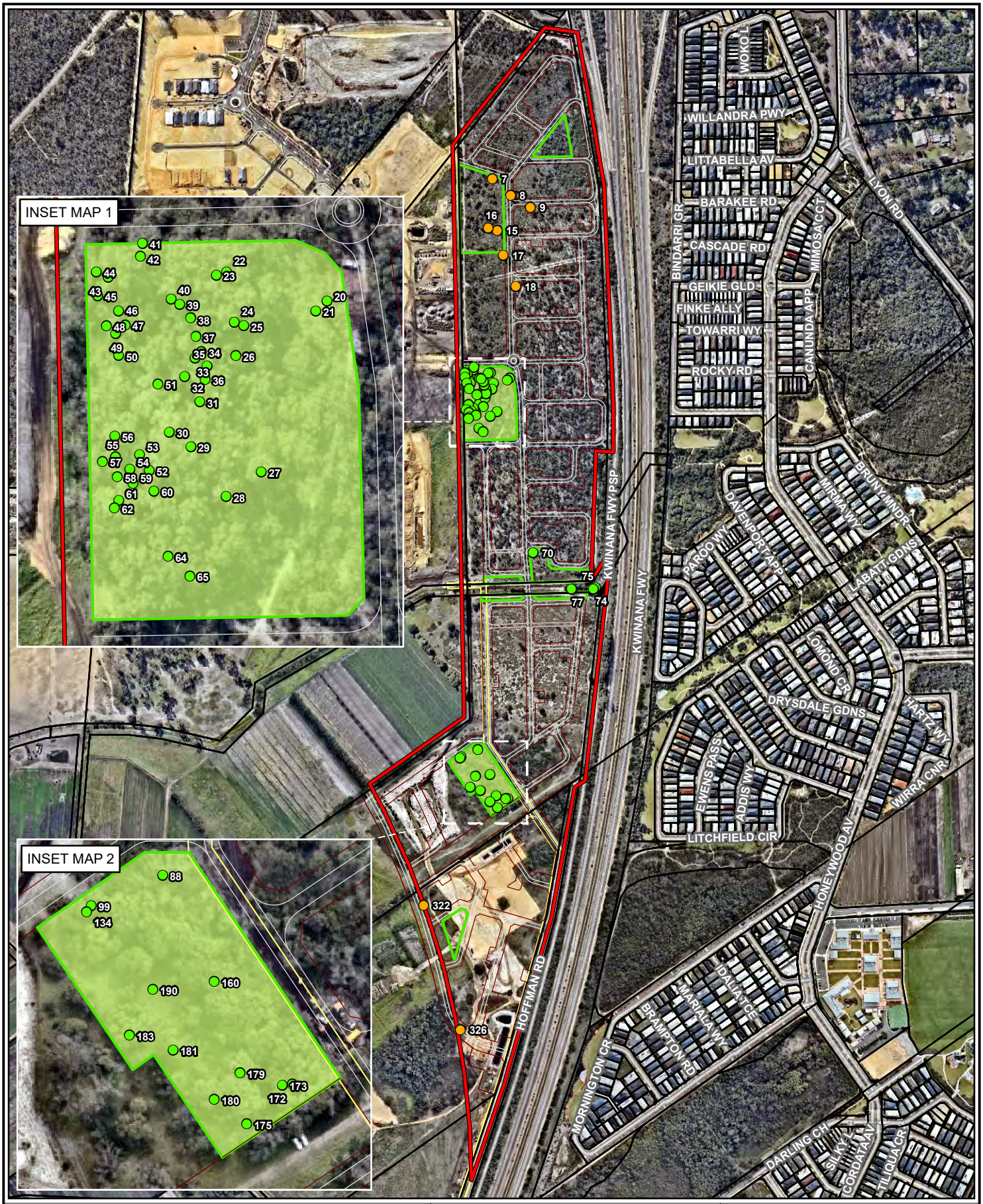
Tree tag ID	Species	DBH (cm)	TPZ (m radius)	Retention Value	Retention status
31	Stout Paperbark (*Melaleuca preissiana*)	84	7.6	High	Retained
32	Flooded Gum (*Eucalyptus rudis*)	72	8.6	Very Low	Retained
33	Stout Paperbark (*Melaleuca preissiana*)	60	5.4	High	Retained
34	Stout Paperbark (*Melaleuca preissiana*)	61	5.5	High	Retained
35	Stout Paperbark (*Melaleuca preissiana*)	68	6.1	High	Retained
36	Stout Paperbark (*Melaleuca preissiana*)	73	6.6	High	Retained
37	Stout Paperbark (*Melaleuca preissiana*)	57	5.1	High	Retained
38	Stout Paperbark (*Melaleuca preissiana*)	69	6.2	High	Retained
39	Stout Paperbark (*Melaleuca preissiana*)	73	8.8	Medium	Retained
40	Stout Paperbark (*Melaleuca preissiana*)	56	6.7	Medium	Retained
41	Flooded Gum (*Eucalyptus rudis*)	53	6.4	Low	Retained
42	Flooded Gum (*Eucalyptus rudis*)	50	6	Low	Retained
43	Flooded Gum (*Eucalyptus rudis*)	88	7.9	Medium	Retained
44	Flooded Gum (*Eucalyptus rudis*)	67	8	Very Low	Retained
45	Flooded Gum (*Eucalyptus rudis*)	60	7.2	Low	Retained
46	Stout Paperbark (*Melaleuca preissiana*)	72	6.5	Medium	Retained
47	Stout Paperbark (*Melaleuca preissiana*)	71	6.4	Medium	Retained
48	Stout Paperbark (*Melaleuca preissiana*)	71	6.4	Medium	Retained
49	Flooded Gum (*Eucalyptus rudis*)	50	6	Low	Retained
50	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	50	4.5	Medium	Retained
51	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	52	4.7	Medium	Retained
52	Stout Paperbark (*Melaleuca preissiana*)	58	5.2	Medium	Retained
53	Stout Paperbark (*Melaleuca preissiana*)	70	6.3	Medium	Retained
54	Stout Paperbark (*Melaleuca preissiana*)	71	6.4	Medium	Retained
55	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	53	4.8	Medium	Retained
56	Flooded Gum (*Eucalyptus rudis*)	80	9.6	Low	Retained
57	Flooded Gum (*Eucalyptus rudis*)	70	8.4	Low	Retained
58	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	81	7.3	Medium	Retained
59	Flooded Gum (*Eucalyptus rudis*)	58	7	Low	Retained
60	Flooded Gum (*Eucalyptus rudis*)	59	7.1	Low	Retained
61	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	50	4.5	Medium	Retained
62	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	57	5.1	Medium	Retained
64	Flooded Gum (*Eucalyptus rudis*)	62	7.4	Medium	Retained
65	Flooded Gum (*Eucalyptus rudis*)	70	8.4	Medium	Retained
70	West Australian Christmas Tree (*Nuytsia floribunda*)	53	4.8	High	Retained
74	Stout Paperbark (*Melaleuca preissiana*)	65	5.9	Medium	Retained
75	Stout Paperbark (*Melaleuca preissiana*)	68	6.1	High	Retained
76	Stout Paperbark (*Melaleuca preissiana*)	73	6.6	Medium	Retained
77	Flooded Gum (*Eucalyptus rudis*)	50	4.5	Medium	Retained
88	Flooded Gum (*Eucalyptus rudis*)	56	6.7	Very Low	Retained
99	Flooded Gum (*Eucalyptus rudis*)	73	3	Very Low	Retained
134	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	55	5	High	Retained
160	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	55	5	High	Retained
172	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	50	4.5	Low	Retained
173	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	50	4.5	Medium	Retained
175	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	65	5.9	High	Retained

Tree tag ID	Species	DBH (cm)	TPZ (m radius)	Retention Value	Retention status
179	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	50	4.5	Medium	Retained
180	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	80	7.2	High	Retained
181	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	~100	9	High	Retained
183	Freshwater Paperbark (*Melaleuca rhaphiophylla*)		5.4	Medium	Retained
190	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	65	5.9	Medium	Retained
322	Flooded Gum (*Eucalyptus rudis*)	54	4.9	Medium	Design permitting
326	Flooded Gum (*Eucalyptus rudis*)	69	6.2	Medium	Design permitting

The number of trees to be retained, by retention value, is presented in Table 4.2.

Table 4.2: Significant trees to be retained by retention value

Retention value	Number of trees
High	20
Medium	30
Low	17
Very Low	4



Legend

- Site boundary
- Cadastral boundary
- Landscape feature retention

Subdivision plan

- Sewer alignment
- Public open space
- Road reserve
- Subvision layout
- Roads (MRWA)

- Significant trees design permitting
- Significant trees for retention

Scale 1:9,000 at A4 — 0 100 200 metres

Coord. Sys. GDA 1994 MGA Zone 50

Job No: 58859

Client: Satterley Property Group

Version: A | Date: 22-Jun-2020

Drawn By: hsullivan | Checked By: CT

Mandogalup, WA

SIGNIFICANT TREES TO BE RETAINED

FIGURE 4.1

strategen JBS&G

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Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.

4.4 Significant trees to be removed

A total of 100 significant trees will be removed, as outlined in Table 4.3 below and as shown in Figure 4.2.

Table 4.3: Significant trees to be removed

Tree tag ID	Species	DBH (cm)	Retention value
1	Jarrah (*Eucalyptus marginata*)	76	High
2	Candle Banksia (*Banksia attenuata*)	55	Medium
3	Jarrah (*Eucalyptus marginata*)	69	Very Low
4	Jarrah (*Eucalyptus marginata*)	76	Very Low
5	West Australian Christmas Tree (*Nuytsia floribunda*)	53	High
6	Jarrah (*Eucalyptus marginata*)	54	Medium
10	Jarrah (*Eucalyptus marginata*)	66	High
11	Jarrah (*Eucalyptus marginata*)	80	High
12	Jarrah (*Eucalyptus marginata*)	84	High
13	Common Sheoak (*Allocasuarina fraseriana*)	57	Medium
14	Common Sheoak (*Allocasuarina fraseriana*)	50	Medium
19	Jarrah (*Eucalyptus marginata*)	111	High
63	Flooded Gum (*Eucalyptus rudis*)	72	Very Low
66	Flooded Gum (*Eucalyptus rudis*)	53	Very Low
67	Flooded Gum (*Eucalyptus rudis*)	73	Very Low
68	Jarrah (*Eucalyptus marginata*)	52	Very Low
69	Jarrah (*Eucalyptus marginata*)	89	Medium
70	West Australian Christmas Tree (*Nuytsia floribunda*)	53	High
71	West Australian Christmas Tree (*Nuytsia floribunda*)	58	High
72	Jarrah (*Eucalyptus marginata*)	189	Very Low
73	West Australian Christmas Tree (*Nuytsia floribunda*)	51	Low
76	Stout Paperbark (*Melaleuca preissiana*)	73	Medium
78	Jarrah (*Eucalyptus marginata*)	52	Low
79	Jarrah (*Eucalyptus marginata*)	64	Very Low
80	Common Sheoak (*Allocasuarina fraseriana*)	54	Low
81	Jarrah (*Eucalyptus marginata*)	87	Very Low
82	Flooded Gum (*Eucalyptus rudis*)	53	Very Low
83	Flooded Gum (*Eucalyptus rudis*)	61	Very Low
84	Flooded Gum (*Eucalyptus rudis*)	50	Very Low
85	Flooded Gum (*Eucalyptus rudis*)	61	Very Low
86	Flooded Gum (*Eucalyptus rudis*)	63	Very Low
87	Flooded Gum (*Eucalyptus rudis*)	69	Low
89	Flooded Gum (*Eucalyptus rudis*)	55	Very Low
90	Flooded Gum (*Eucalyptus rudis*)	55	Very Low
91	Flooded Gum (*Eucalyptus rudis*)	52	Low
92	Flooded Gum (*Eucalyptus rudis*)	59	Very Low
93	Flooded Gum (*Eucalyptus rudis*)	61	Very Low
94	Flooded Gum (*Eucalyptus rudis*)	53	Low
95	Flooded Gum (*Eucalyptus rudis*)	54	Very Low
96	Jarrah (*Eucalyptus marginata*)	116	Low
97	Jarrah (*Eucalyptus marginata*)	97	Low
98	Jarrah (*Eucalyptus marginata*)	56	Low
101	Flooded Gum (*Eucalyptus rudis*)	56	Low
102	Flooded Gum (*Eucalyptus rudis*)	59	Low
103	Flooded Gum (*Eucalyptus rudis*)	53	Very Low
104	Flooded Gum (*Eucalyptus rudis*)	56	Very Low
105	Flooded Gum (*Eucalyptus rudis*)	55	Very Low
106	Flooded Gum (*Eucalyptus rudis*)	52	Very Low
107	Jarrah (*Eucalyptus marginata*)	53	Medium
108	Jarrah (*Eucalyptus marginata*)	59	Very Low
109	Jarrah (*Eucalyptus marginata*)	160	Medium
110	Jarrah (*Eucalyptus marginata*)	88	Medium

Tree tag ID	Species	DBH (cm)	Retention value
111	Flooded Gum (*Eucalyptus rudis*)	68	Very Low
112	Flooded Gum (*Eucalyptus rudis*)	64	Very Low
113	Flooded Gum (*Eucalyptus rudis*)	79	Very Low
114	Flooded Gum (*Eucalyptus rudis*)	70	Very Low
115	Flooded Gum (*Eucalyptus rudis*)	94	Very Low
116	Flooded Gum (*Eucalyptus rudis*)	67	Very Low
117	Flooded Gum (*Eucalyptus rudis*)	75	Low
118	Stout Paperbark (*Melaleuca preissiana*)	68	Low
119	Flooded Gum (*Eucalyptus rudis*)	62	Very Low
120	Flooded Gum (*Eucalyptus rudis*)	65	Very Low
121	Flooded Gum (*Eucalyptus rudis*)	50	Very Low
122	Flooded Gum (*Eucalyptus rudis*)	52	Very Low
123	Flooded Gum (*Eucalyptus rudis*)	96	Very Low
124	Flooded Gum (*Eucalyptus rudis*)	59	Very Low
125	Stout Paperbark (*Melaleuca preissiana*)	59	Medium
126	Flooded Gum (*Eucalyptus rudis*)	64	Low
127	Flooded Gum (*Eucalyptus rudis*)	55	Very Low
128	Flooded Gum (*Eucalyptus rudis*)	95	Low
129	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	57	Medium
130	Flooded Gum (*Eucalyptus rudis*)	77	Low
131	Flooded Gum (*Eucalyptus rudis*)	63	Low
132	Flooded Gum (*Eucalyptus rudis*)	89	Low
133	Flooded Gum (*Eucalyptus rudis*)	72	Very Low
301	Flooded Gum (*Eucalyptus rudis*)	56	Medium
302	Flooded Gum (*Eucalyptus rudis*)	58	Medium
303	Flooded Gum (*Eucalyptus rudis*)	181	Very Low
304	Tasmanian Blue Gum (*Eucalyptus globulus*)	52	Very Low
305	Tasmanian Blue Gum (*Eucalyptus globulus*)	69	Very Low
306	Tasmanian Blue Gum (*Eucalyptus globulus*)	88	Very Low
307	Tasmanian Blue Gum (*Eucalyptus globulus*)	76	Very Low
308	Tasmanian Blue Gum (*Eucalyptus globulus*)	89	Very Low
309	Tasmanian Blue Gum (*Eucalyptus globulus*)	84	Very Low
310	Tasmanian Blue Gum (*Eucalyptus globulus*)	72	Very Low
311	Flooded Gum (*Eucalyptus rudis*)	85	Very Low
312	Flooded Gum (*Eucalyptus rudis*)	77	Very Low
313	Flooded Gum (*Eucalyptus rudis*)	59	Very Low
314	Lemon Scented Gum (*Corymbia citriodora*)	63	High
315	Bangalay (*Eucalyptus botryoides*)	91	Medium
316	Flooded Gum (*Eucalyptus rudis*)	102	Very Low
317	Flooded Gum (*Eucalyptus rudis*)	72	Very Low
318	Flooded Gum (*Eucalyptus rudis*)	72	Medium
319	Flooded Gum (*Eucalyptus rudis*)	129	Very Low
320	Flooded Gum (*Eucalyptus rudis*)	66	Medium
321	Flooded Gum (*Eucalyptus rudis*)	69	Very Low
323	Bangalay (*Eucalyptus botryoides*)	57	Medium
324	River Red Gum (*Eucalyptus camaldulensis 'Camaldulensis'*)	75	Medium
325	Jarrah (*Eucalyptus marginata*)	77	Very Low
327	Flooded Gum (*Eucalyptus rudis*)	62	Low

The number of trees to be removed, by retention value, is presented in Table 4.4.

Table 4.4: Significant trees to be removed by retention value

Retention value	Number of trees
High	9
Medium	18
Low	19
Very Low	54



Legend

- Site boundary
- Cadastral boundary
- Landscape feature retention

Subdivision plan

- Sewer alignment
- Public open space
- Road reserve
- Subvision layout
- Roads (MRWA)
- Significant trees removed

Scale 1:9,000 at A4 (0 100 200 metres)		**Mandogalup, WA**
Coord. Sys. GDA 1994 MGA Zone 50		**SIGNIFICANT TREES TO BE REMOVED**
Job No: 58859		
Client: Satterley Property Group		**FIGURE 4.2**
Version: A	Date: 22-Jun-2020	strategen JBS&G
Drawn By: hsullivan	Checked By: CT	

File Name: \\008pmpmr004v001.jbsg.aust\JBS Perth\Projects\1)Open\Satterley Property Group\Mandogalup\58859 Mandogalup subdivision approval compliance\GIS\Maps\R02_Rev_A\58859_04_2_SigTrees_Removed.mxd
Image Reference: www.nearmap.com© - Imagery Date: 12 May 2020.

5. Management and maintenance

Table 5.1 below outlines the proposed management measures, timing and responsibilities for the protection and maintenance of significant trees to be retained on site.

Table 5.1: Proposed protection and maintenance management measures for significant trees to be retained

Aspect	Management measure	Timing	Responsibility
Protection of retained trees and landscape features	The City of Kwinana should be contacted in the event that a significant tree identified in Table 4.1 is removed without appropriate authorisation or damaged to a point where removal is necessary.	During site works	Engineering Contractor
	Remove and salvage grass trees and Zamia Palms.	Prior to clearing	Civil or Landscape Contractor
	In accordance with Section 4 of AS 4970-2009, establish/delineate TPZs for each significant tree (refer to Table 4.1) and install protective measures (if applicable) such as: • Protection fencing in accordance with AS4970-2009 • Signs • Trunk and branch protection • Ground protection.	Prior to clearing	Civil or Landscape Contractor
	Ground truth public open space and road reserves prior to clearing, with a representative from the City of Kwinana to ensure all significant trees and landscape features that are to be retained are surveyed and clearly identified.	Prior to clearing	Engineering or Civil Contractor
	Exclude the following activities within the TPZs: • Machine excavation including trenching • Cultivation • Storage of equipment • Parking of vehicles and plant machinery • Dumping of waste • Placement filling • Physical damage of tree.	During site works and construction	Civil or Landscape Contractor
	Future civil design drawings (submitted to the City of Kwinana) to incorporate the requirements of this LFTRMP (including for retaining walls, drainage and POS, roads, services and footpaths).	During site works and construction	Engineering Contractor
	Remove tree protection measures (if installed).	Post subdivisional works, at landscaping stage	Civil or Landscape Contractor
Maintenance of retained trees	All retained trees should be pruned to remove dead branches.	Practical completion of subdivision works	Landscaping Contractor
	Tree limbs overhanging properties should be pruned by the proponent as advised by the City of Kwinana in consultation with the proponent's arborist.	Practical completion of subdivision works	Landscaping Contractor
	Any retained trees with significant damage may require review by an independent arborist to determine if the tree remains viable.	Practical completion of subdivision works	Landscaping Contractor
	Retained trees that are not viable will be removed (including the stump) and replaced with semi mature tree of the same species by the proponent.	Practical completion of subdivision works	Landscaping Contractor
	Feral beehives in trees to be retained or cleared shall be removed and relocated out of the subdivision. Native bees in trees to be cleared will be relocated within the development. Native beehives in trees that are to be retained will not be removed.	Practical completion of subdivision works	Landscaping Contractor

6. Limitations

Scope of services

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

Reliance on data

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

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

Environmental conclusions

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

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Subdivision plan

DEPARTMENT OF PLANNING, LANDS AND HERITAGE

FILE 158176

DATE 01-Apr-2020

PARENT LOTS

1:8000 @ A3 1:4000 @ A1

SECONDARY ACCESS

PRIMARY ACCESS

EMERGENCY ACCESSWAY (EASEMENT TO CONNECT TO HOFFMAN ROAD)

LOT 9006 BALANCE OF LOT 12.1045ha

LOT 9002 BALANCE OF LOT 18.694ha

LOT 9000 BALANCE OF LOT 5449m²

2M ROAD WIDENING (83m²)

2M ROAD WIDENING (97m²)

2M ROAD WIDENING (402m²)

2M ROAD WIDENING (121m²)

2M ROAD WIDENING (291m²)

ROWLEY ROAD

HOFFMAN ROAD

MOIARRE ENTRANCE

QUATERMAINE BOULEVARD

FREEWAY

KWINANA

PLAYING FIELDS 1.1553ha

PRIMARY SCHOOL 1.4863ha

PUBLIC OPEN SPACE 1.2185ha

PUBLIC OPEN SPACE 2744m²

PUBLIC OPEN SPACE 8082m²

GROUP HOUSING SITE 9764m²

GROUP HOUSING SITE 2747m²

POS 3617m²

POS 2008m²

POS 812m²

POS 746m²

POS 946m²

DRAINAGE RESERVE 2020m²

DRAINAGE RESERVE 2121m²

RECREATION RESERVE 2244m²

LEGEND

- SUBJECT SITE
- CONTOURS
- EXISTING BOUNDARIES
- 7 EXISTING LOT NUMBERS
- PROPOSED BOUNDARIES
- **7** PROPOSED LOT NUMBERS
- 112.3 PROPOSED LOT DIMENSIONS
- (112.3) EXISTING LOT DIMENSIONS
- LOTS SUBJECT TO BUSHFIRE MANAGEMENT PLAN CONDITION REQUIREMENTS
- LOTS SUBJECT TO FUTURE SUBDIVISION
- INDICATIVE FUTURE SUBDIVISION LAYOUT
- PRIMARY ACCESS
- SECONDARY ACCESS
- EMERGENCY ACCESSWAY (EASEMENT TO CONNECT TO HOFFMAN ROAD)
- WATER
- SEWER
- POWER
- POWER POLE
- EASEMENT
- ROAD WIDENING
- PROPOSED SEWER EXTENSION SUBJECT TO DETAILED DESIGN
- INDICATIVE LAYOUT BY OTHERS
- PRIMARY SCHOOL
- PUBLIC OPEN SPACE / PLAYING FIELDS
- DBNGP EASEMENT
- HIGH VOLTAGE POWERLINE EASEMENT
- PEEL MAIN DRAIN
- RAIN GARDENS INCORPORATED INTO ROAD RESERVE

LOT SUMMARY - GROUP HOUSING

No. OF LOTS	2
TOTAL AREA OF LOTS	12512m²
AVERAGE AREA OF LOTS	6256m²
MINIMUM LOT AREA	2747m²
MAXIMUM LOT AREA	9764m²

LOT SUMMARY - RESIDENTIAL

No. OF LOTS	464
TOTAL AREA OF LOTS	16.82ha
AVERAGE AREA OF LOTS	363m²
MINIMUM LOT AREA	188m²
MAXIMUM LOT AREA	1021m²

LOT SUMMARY - LOTS 575, 576 AND 580

No. OF LOTS	3
TOTAL AREA OF LOTS	5.38ha
AVERAGE AREA OF LOTS	1.8ha
MINIMUM LOT AREA	1.75ha
MAXIMUM LOT AREA	1.84ha

PLAN OF SUBDIVISION

LOTS 9000, 9002 & 9006 HOFFMAN ROAD, LOT 9033 ROWLEY ROAD AND PART LOT 8018 ON DEPOSITED PLAN 77243

MANDOGALUP

NORTH

0 125 m

SCALE @ A3: 1:5000

7282A-SUB-15-A

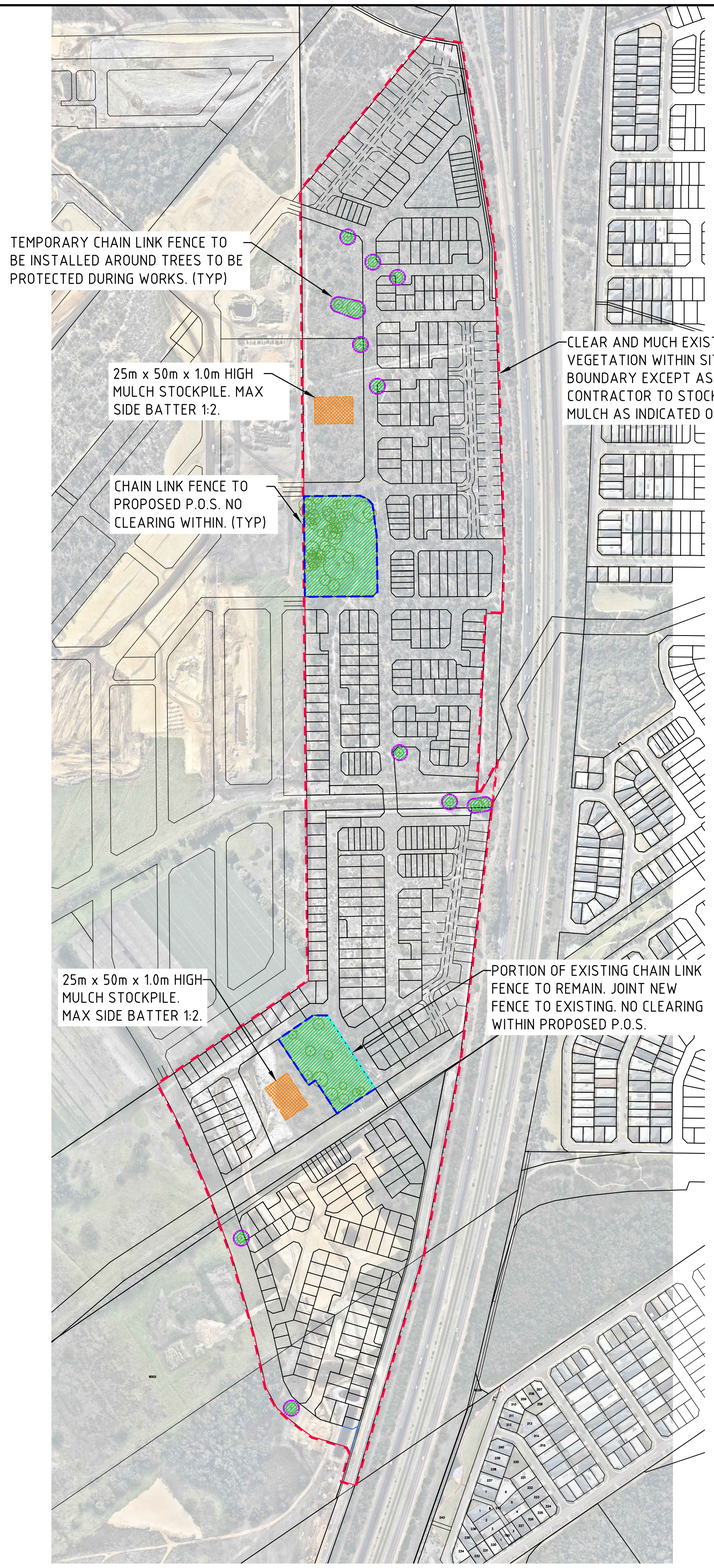
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7282A_SUB15A_20200331_Mandogalup (Subdivision) - DRAWN: W. CLEMENTS - DATE CREATED: 2020.03.31 - PROJECTION: MGA50 GDA94 -

Appendix B Clearing Plan



LEGEND

- SITE BOUNDARY. PROPOSED CLEARING WITHIN BOUNDARY EXCEPT AS NOTED.
- PROPOSED PERMANENT CHAIN LINK FENCE
- PROPOSED TEMPORARY CHAIN LINK FENCE. REFER TO NOTE 2 BELOW
- EXISTING PERMANENT CHAIN LINK FENCE
- NO CLEARING TO BE CARRIED OUT (PROPOSED P.O.S)
- PROPOSED MULCH STOCKPILE LOCATION

NOTES

1. FENCES TO BE INSTALLED AS PER AS4970 REQUIREMENTS.
2. INSTALL TEMPORARY CHAIN LINK FENCE AROUND TREES TO AS4970. TREES IDENTIFIED FOR RETENTION SUBJECT TO DETAILED DESIGN IN THE AREA.
3. INSTALL PERMANENT CHAIN LINK FENCE TO PROPOSED P.O.S LOCATIONS AS INDICATED. NO CLEARING TO OCCUR WITHIN THESE AREAS. ACCESS GATE LOCATIONS TO BE CONFIRMED ON SITE.
4. TREES TO BE MULCHED ON SITE AND STOCKPILE AS INDICATED. MULCH TO BE STOCKPILED WITHIN 500m OF CLEARED AREA.

PRELIMINARY

1:2500 AT A1

0 25m 50m 100m 150m

DIAL 1100 BEFORE YOU DIG

WARNING

BEWARE OF UNDERGROUND SERVICES

The location of underground cables are approximate only and their exact position should be checked on site. No guarantee is given that all existing cables and services are shown. Locate all underground cables and services before commencement of work. Refer to Worksafe Regulation 3.21.

28/05/2020 3:48:38 PM Anthony Connolly
N:\Archive\Projects\Civil\2014\PC14033 – Mandogalup LSP Preparation\5.0 Drawings\5.1 Civil\1. Acad\PC14033-SK41.dwg

No.	REVISION	BY	DATE
B	DRAWING UPDATED	AC	28.05.20
A	ISSUED FOR INITAL APPROVAL	AC	20.05.20

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CLIENT: SATTERLEY PROPERTY GROUP PTY LTD

PROJECT: MANDOGALUP

DRAWING TITLE: CLEARING PLAN

SCALE	1:2500	FILE	–
HORIZONTAL		DESIGN	AC
VERTICAL		DRAWN	AC
SURVEY DATUM	AHD	CHECKED	00
WAPC No	155567	DATE	MAY 20
CADFILE NAME	PC14033	DRAWING No.	SK41
REV.	B		

THIS PLAN IS NOT TO BE USED FOR CONSTRUCTION UNLESS SIGNED BELOW

APPROVED .....

Appendix C Mandogalup Urban Development Site Lyon Road, Mandogalup Tree Survey (PaperbarkTechnologies 2014)

Mandogalup Urban Development Site
Lyon Rd, Mandogalup

Tree survey

July 2014



Andrew Morrissey
Arboricultural Consultant
Paperbark Technologies Pty Ltd
ISA Certified ArboristAU0039A/AU0341A
Quantified Tree Risk Assessor, Licensed user 1082/3442
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CERTIFIED ARBORIST ISA

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BRIEF:

Strategen has commissioned this consultant to inspect and submit a report in respect of 26 nominated trees located within Lot 9500, Pt Lot 9006 and Pt Lot 9002 Lyon Rd Mandogalup in accordance with the Mandogalup Local Structural Plan (LSP) as indicated on the aerial map SK0004 Mandogalup – Trees of Importance dated 13/05/2014.

The objective of the survey was to undertake an inspection of each tree to confirm the trees species, height and canopy spread, health of the tree, structure of the tree, diameter taken at breast height (DBH), age of the tree, identify tree problems and if any recommended works are required. In addition to the visual tree assessment, tree protection zones (TPZ) and structural root zone (SRZ) details have been provided to assist designing around the retained trees. Finally each tree has been assessed in relation to inclusion in an urban setting and whether the tree/species and structural condition is considered suitable.

The inspection consisted of several parts.

- Examination, observation and documenting the health, the condition and tree inventory details.
- Provide TPZ and SRZ radius details for each tree recommended to be retained.
- Provide advice as to whether each tree is considered suitable for inclusion in an urban development based upon species characteristics, health and structural condition.

This consultant confirms that the site inspections were carried out between the 3rd of July and 8th of July 2014 with a total number of 26 trees audited.

FORM AND APPROACH:

This consultant referred to the aerial photo of the site SK0004 Mandogalup – Trees of Importance dated 13/05/2014 and, with assistance, located and tagged each of the 26 trees. Where tags corresponding with the number of the tree as noted on the aerial photo of the site were available they were used, otherwise tags numbering 376 - 394 were used and the appropriate designated numerical character was then documented within the tree survey data to assist identification.

Below are the definitions for the captured information provided.

Botanical and common name Information:

Botanical names are listed detailing the generic name followed by the specific epithet. The variety is named where applicable. The common name for each tree is also provided and is the name of a species that is not its botanical or scientific name. The common name is a general name given to a tree species and each species may have many common names depending on its location and language. Only the scientific and botanical names should be accepted to identify an exact tree species.

Tree Age:

Tree age is based on the age of the tree that would be considered typical for the species in the general area. It is not based on the health of the tree.

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Young
The tree has recently been planted or self-sown (within the last 3 – 5 years).

Semi mature
The tree has become established in the site and may be approaching its expected mature size. If correctly maintained the specimen will continue to grow to maturity.

Mature
Usually the tree will have reached the expected size for the species in the site.

Post mature
The tree has passed the mature stage of its life and is characterized by both a very slow growth rate and by intolerance to disturbances. The post-mature tree has limited energy reserves to fight invading diseases and insects, especially pruning wounds. Removal of live tissue is something to avoid.

Severe decline
The tree is in its final stages of life, the tree is beginning to lose its ability to defend itself. It is at this stage that the tree becomes susceptible to pests and disease. The tree will be assessed for hazards and may require reduction pruning or removal.

Note
It is important to note that tree age is not directly related to tree health. For example: It is possible for a young tree to have very poor health and a mature tree to have good health.

Tree health:

Good
The tree is demonstrating good or exceptional growth for the species. The tree should exhibit a full canopy of foliage, and have only minor pest or diseases problems. Foliage colour, size and density should be typical of a healthy specimen of that species.

Fair
The tree is in reasonable condition and growing well for the species. The tree should exhibit an adequate canopy of foliage. There may be some dead wood present in the crown, some grazing by insects or animals may be evident and/or foliage colour, size or density may be atypical for a healthy specimen of that species.

Poor
The tree is not growing to its full capacity; extension growth of the laterals may be minimal. The canopy may be thinning or sparse. Large amounts of dead wood may be evident throughout the crown. Significant pest and disease problems may be evident or symptoms of stress indicating tree decline.

Very poor
The tree appears to be in a state of decline and the canopy may be very thin and sparse. A significant volume of deadwood may be present in the canopy or pest and disease problems may be causing a severe decline in tree health.

Dead
The tree is dead.

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Tree Structure:

Each tree surveyed was examined in detail to ascertain its overall structural condition.

The assessed tree was then placed into one of five categories:

- *Good:* The tree has a well-defined and balanced crown. Branch unions appear to be strong, with no defects evident in the trunk or the branches. Major limbs are well defined. The tree would be considered a good example of the species. Probability of significant failure is highly unlikely.

- *Fair:* The tree has some minor problems in the structure of the crown. The crown may be slightly out of balance, and some branch unions or branches may be exhibiting minor structural faults. If the tree is single trunked, this may be on a slight lean or be exhibiting minor defects. Probability of significant failure is low.

- *Poor:* The tree may have a poorly structured crown. The crown may be unbalanced or exhibit large gaps. Major limbs may not be well defined. Branches may be rubbing or crossing over. Branch unions may be poor or faulty at the point of attachment. The tree may have suffered major root damage. Probability of significant failure is moderate.

- *Very Poor:* The tree has a poorly structured crown. The crown is unbalanced or exhibits large gaps. Major limbs are not well defined. Branch unions may be poor or faulty at the point of attachment. A section of the tree has failed or is in imminent danger of failure. Active failure may be present or failure is probable in the immediate future.

- *Has Failed:* A significant section of the tree or the whole tree has failed.

Suitable for retention
The tree is considered suitable to retain within an urban development due to its current health and structural condition. The characteristics of the tree are considered appropriate for inclusion within a high use area.

Not suitable for retention
The tree is not considered suitable to retain within an urban development due to its poor health or poor structural condition. The characteristics of this tree are considered inappropriate for inclusion within a high use area due to being a very large tree or species prone to shedding limbs.

Possibly suitable for retention
The tree may be suitable for retention however this is dependent on the final design around the tree and what target is within falling distance of the tree. This tree would require re-assessment once the design stage is completed. This is due to the tree being a large sized tree or the species has an increased propensity to shed limbs or the tree displays some structural issues such as decay. The tree may be able to be retained in public open space or large verge areas. The tree was in fair health and fair structural condition at the time of inspection displaying some problems. Some trees which have been noted as possibly suitable are potential habitat specimens.

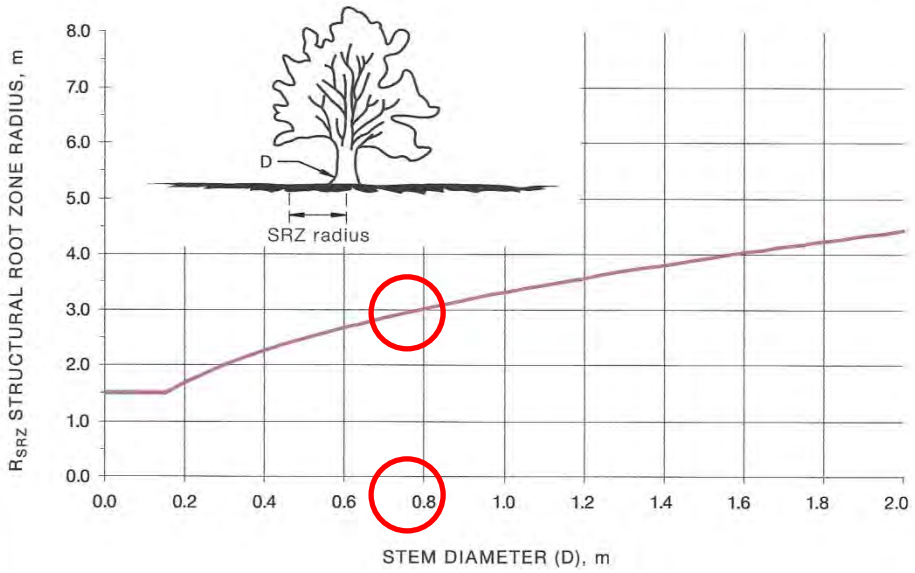
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TPZ – Tree Protection zone
As per the Australian Standards AS 4970-2009 *Protection of trees on development sites* the tree protection zone (TPZ) is the principal means of protecting trees on development sites. The TPZ is a combination of the root area and crown area requiring protection. It is an area isolated from construction disturbance, so that the tree remains viable.

The radius of the TPZ is calculated for each tree by multiplying its DBH x 12.
Eg. DBH is 0.5m x 12 = 6m radius (TPZ = 6m measured from the centre of the trunk at ground level.)
If the proposed encroachment is greater than 10% into the TPZ or SRZ the project Arborist must demonstrate that the tree(s) would remain viable. Once the design is completed the project Arborist may need to re-inspect selected trees to ensure the trees are adequately protected. The purpose of this is to determine the potential impact on trees proposed to be retained.

SRZ – Structural Root zone
This consultant advises that a structural root zone area of a tree is required for tree stability. Using Australian Standards AS 4970-2009 *Protection of trees on development sites* the structural root zone area can be calculated when major encroachment into a TPZ is proposed. An indicative SRZ radius can be determined from the trunk diameter measured immediately above the buttress using the following formula. SRZ radius = $(D \times 50)^{0.42} \times 0.64$ or using the following guide from AS 4970-2009. Eg. Diameter at root flare is 0.8m (red circle) and using the graph below a 3m SRZ radius is required. This is measured from the centre of the trunk at ground level.

A1



The curve can be expressed by the following formula:
$R_{SRZ} = (D \times 50)^{0.42} \times 0.64$

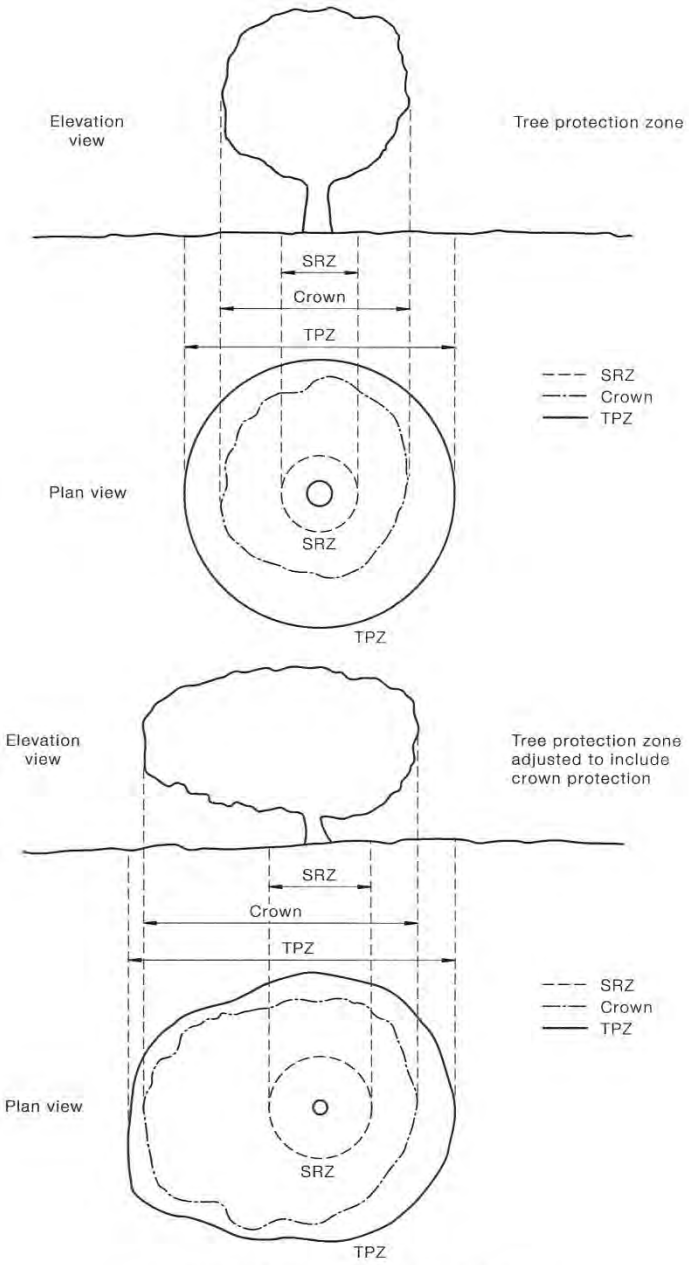
NOTES:
1 R_{SRZ} is the calculated structural root zone radius (SRZ radius).
2 D is the stem diameter measured immediately above root buttress.
3 The R_{SRZ} for trees less than 0.15 m diameter is 1.5 m.
4 The R_{SRZ} formula and graph do not apply to palms, other monocots, cycads and tree ferns.
5 This does not apply to trees with an asymmetrical root plate.

FIGURE 1 STRUCTURAL ROOT ZONE CALCULATION

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The SRZ is only required to be used when major encroachment into a TPZ is proposed. The SRZ radius is not a calculation in which all roots outside the SRZ radius can be severed otherwise to do so will cause the tree to become structurally unstable and a high risk of whole tree failure. Encroachment within the TPZ and SRZ which may adversely affect root systems requires approval from the Project Arborist to ensure the tree remains structurally stable.

Below is a diagram of an indicative tree protection zone



NOTE: Refer to Clause 3.2 for calculation of TPZ.

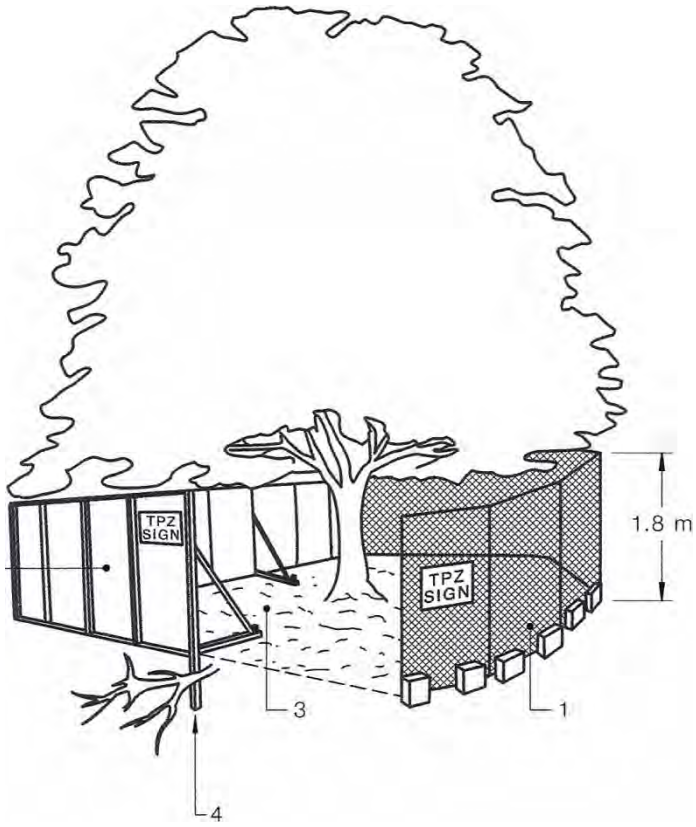
FIGURE 2 INDICATIVE TREE PROTECTION ZONE

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Example of Tree Protection fencing

It is recommended that tree protection fencing be erected around the tree protection zone.



LEGEND:
1 Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.
2 Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the TPZ.
3 Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
4 Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.

FIGURE 3 PROTECTIVE FENCING FROM AS 4970-2009

Tree Survey Details over leaf.

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Tree No. (tag #)	Botanical and Common name	Approx. Height (m)	Canopy Spread (m)	DBH (cm)	DRF (cm)	Age class	Health & Structural Condition	TPZ (m) (radius)	SRZ (m) (radius)	Comments and Recommendations
71(71)	*Eucalyptus marginata* Jarrah	14	9.5	66.5	73.5	Mature	Fair health and fair structural condition displaying previous fire damage and basal cavity. Leaning. Suckers developing around the base. Canopy displays a healthy foliage cover. Major dead wood. Bark wound and hollows visible.	8.0	2.9	Not suitable for retention due to size and structural condition.
72(72)	*Eucalyptus marginata* Jarrah	17.5	12.5	82.5	103	Mature	Good health and poor structural condition displaying a significant fire damage and open basal cavity and prominent basal flare. Upper canopy displays healthy foliage and extension growth. Major dead wood held throughout. Central cavities within first order limbs visible.	9.9	3.4	Not suitable for retention due to size and structural condition.
73(73)	*Eucalyptus marginata* Jarrah	17.5	14.0	83.5	104	Mature	Good health and poor structural condition displaying significant fire damage and an open basal cavity. A suitable cover of healthy foliage held in the upper canopy, some minor epicormic growth. Major dead wood held throughout. Leaning. Central cavities evident within major limbs.	10.0	3.4	Not suitable for retention due to size and structural condition.

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77(77)	*Eucalyptus marginata* Jarrah	23.5	12.0	115	140.5	Mature	Good health and fair structural condition displaying significant fire damage with an open basal cavity and prominent basal flare. Deadwood held throughout, some of a size and weight to represent a hazard. Previous major limb failure Central cavities within major limbs evident.	13.8	3.8	Not suitable for retention due to size and structural condition.
80(80)	*Eucalyptus marginata* Jarrah	18.0	10.5	82.5	94	Mature	Good health and fair structural condition displaying a suitable canopy of healthy foliage and healthy extension growth. Some dieback evident and epicormic growth is developing throughout. Fire damage and a significant open cavity at the base of the tree extend several metres up the trunk. Bird damage is evident within major limb forks and the previous failure of second order limbs is evident. Dead wood is predominantly held within the upper canopy.	9.9	3.2	Possibly suitable for retention within a within a POS. Major dead wood removal required.
91(91)	*Eucalyptus marginata* Jarrah	13.5	11.0	72	76.5	Mature	Fair health and poor structural condition displaying canopy dieback and epicormic growth held throughout and developing close to the base of the tree. Leaning. Mechanical wounding of the trunk and previous significant limb failure evident. No visible evidence of decay.	8.6	3	Not suitable for retention due to size and structural condition.

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95(95)	*Eucalyptus marginata* Jarrah	24.5	8.0	143.5	164	Post mature	This tree is in decline with limited canopy structure remaining. Significant fire damage and an open basal cavity which extends up much of the trunk are evident. Major dead wood. Active bees. Termite damage and active termites evident.	17.2	4.1	Possibly suitable for retention as a habitat tree only if located in a low target area within the POS. Canopy reduction pruning, major dead wood removal and termite treatment required.
96(96)	*Eucalyptus marginata* Jarrah	18.5	11.5	84	91.5	Mature	Good health and fair structural condition displaying a suitable canopy density and healthy foliage and healthy extension growth. Mature epicormic growth has developed within the lower canopy. Codominant stems. Major dead wood. Previous major limb failure. Evidence of central cavity/nesting hollows within major limbs.	10.1	3.2	Possibly suitable for retention within POS with major dead wood removal.
101(386)	*Eucalyptus rudis* Flooded Gum	21.5	8.5	107	145	Mature	Good health and fair structural condition with twin stems and holding a small amount of dead wood some of a size and weight to represent a hazard. Limited epicormic growth.	12.9	3.9	Suitable for retention.

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103(384)	*Eucalyptus rudis* Flooded Gum	12.5	9.5	79	96.5	Mature	Poor health and fair structural condition displaying a poorly formed canopy with significant dieback, previous major limb failure, major deadwood held throughout and epicormic growth developing in the lower and central canopy.	9.5	3.3	Possibly suitable retention within a POS with canopy reduction and major dead wood removal.
105(382)	*Eucalyptus rudis* Flooded Gum	20.0	11.0	105	119.5	Mature	Fair health and poor structural condition displaying multiple stems forming narrow included forks. Multiple previous limb failure evident on the northern side.	12.6	3.6	Possibly suitable retention within low target areas of a POS with canopy reduction with canopy reduction and major dead wood removal.
106(385)	*Eucalyptus rudis* Flooded Gum	19.0	11.5	73	88	Mature	Fair health and fair structural condition with codominant stems, previous limb failure from the central canopy, some deadwood held in the lower canopy and limited epicormic growth.	8.8	3.1	Possibly suitable for retention within a POS.
107(380)	*Eucalyptus marginata* Jarrah	23.0	13.0	180	215	Mature	Post mature tree in decline displaying extensive fire damage at the base and extending up the trunk and previous significant limb failure. Active termites and fungal fruiting bodies evident on the trunk.	21.6	4.6	Not suitable for retention due to structural condition.

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108(381)	*Eucalyptus rudis* Flooded Gum	21.0	11.5	67.5	73	Mature	Good health and good structural condition displaying a sound branch structure and codominant stems supporting a full and healthy canopy holding a small amount of minor deadwood.	8.1	2.9	Suitable for retention.
110(376)	*Eucalyptus rudis* Flooded Gum	20.0	12.0	87	101	Mature	Poor health and poor structural condition displaying significant canopy dieback and holding major deadwood. Epicormic growth developing throughout.	10.4	3.3	Possibly suitable for retention within a POS with canopy reduction with canopy reduction and major dead wood removal.
111(378)	*Eucalyptus rudis* Flooded Gum	20.0	13.0	98	125	Mature	Good health and fair structural condition displaying twin stems supporting a healthy canopy with sporadic predominantly minor dead wood. Leaning in a northerly direction.	11.8	3.6	Suitable for retention.
112(379)	*Eucalyptus rudis* Flooded Gum	19.0	8.5	70	85	Mature	Good health and fair structural condition displaying a sound limb structure, holding a small amount of predominantly minor deadwood and limited epicormic growth. Leaning in a westerly direction.	8.4	3.1	Suitable for retention.
144(388)	*Eucalyptus marginata* Jarrah	10	6.5	87	104	Mature	This tree is dead. Open cavities and decay extending up the trunk and to major limbs was evident.	NA	NA	Not suitable for retention.

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149(389)	*Eucalyptus rudis* Flooded Gum	15	9.5	87	93.5	Mature	Poor health and poor structural condition displaying codominant stems, significant dieback and canopy decline with major dead wood held in the lower canopy. Northern stem appears overextended. Termite damage visible.	10.4	3.2	Possibly suitable for retention within a POS with canopy reduction with canopy reduction and major dead wood removal.
153(390)	*Eucalyptus rudis* Flooded Gum	10.5	6.0	95	117	Mature	This tree is dead. Active termites were evident within the outer wood and at the base of the tree.	NA	NA	Not suitable for retention.
156(391)	*Eucalyptus rudis* Flooded Gum	12.5m	7.5	64	71	Mature	Good health and fair structural condition. Leaning. Previous lower limb removal from the southern side and some canopy dieback evident and dead wood predominantly held in the upper canopy. Some major deadwood.	7.7	2.9	Possibly suitable for retention within a POS with major dead wood removal.
163(392)	*Eucalyptus rudis* Flooded Gum	16	12.0	115	146.5	Mature	Fair health and structural condition with multiple stems forming a crowded cluster, significantly included stem forks and major deadwood. No visible cavities or evidence of decay. Epicormic growth developing throughout.	14	3.9	Possibly suitable for retention within a POS with canopy reduction and major dead wood removal.
164(393)	*Eucalyptus rudis* Flooded Gum	15.0	6.5	91.5	106.5	Mature	Fair health and structural condition with secondary stems forming narrow included forks. Dieback evident with deadwood held throughout, some of a size and weight to represent a hazard.	11	3.4	Possibly suitable for retention within a POS with canopy reduction and major dead wood removal.

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102(387)	*Eucalyptus rudis* Flooded Gum	18.0	12.0	112	134	Mature	Multi stemmed tree in poor health and structural condition displaying significant canopy decline with major dead wood held throughout and visible cavities within major limbs. Limited epicormic growth.	13.5	3.7	Possibly suitable for retention within a POS with canopy reduction and major dead wood removal.
104(383)	*Eucalyptus rudis* Flooded Gum	22.0	8.5	75.5	91	Mature	Fair health and structural condition displaying a secondary stem developing at the base and codominant stems forming the canopy structure. Previous major limb failure evident, some canopy dieback and epicormic growth developing in the lower and central canopy.	9.1	3.2	Possibly suitable for retention within a POS.
109(377)	*Eucalyptus rudis* Flooded Gum	19.0	10.5	89	104	Mature	Poor health and poor structural condition with decline and dieback of major limbs in the upper canopy evident and holding major deadwood. Some epicormic growth developing.	10.7	3.4	Possibly suitable for retention within a POS with canopy reduction and major dead wood removal.

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Summary

This consultant's inspection of the trees within Lot 9500, Pt Lot 9006 and Pt Lot 9002 Lyon Rd, Mandogalup revealed that they were predominantly in fair health, however two trees have died and a number of trees displayed very poor structural condition.

The tree audit identified out of the 26 specimens audited;

- 3 trees are recommended for removal due to poor structural condition or they have died.
- 5 trees are noted as not suitable to retain within the new development
- 14 trees are noted as possibly suitable. These are predominantly located within or close to areas of proposed POS and will require re-assessment in relation to the final design.
- 4 trees **are** considered suitable to retain within the new development.
- 12 trees have been recommended for remedial pruning works which consists predominantly of major deadwood pruning, however depending on the targets, minor deadwood pruning may be required at a later stage on more trees.

It is advised that all remedial tree surgery works be carried out by a competent Arborist to the relevant Australian Standards - Pruning of amenity trees 4373-2007.

The future management, maintenance and condition of the trees have a considerable bearing on their location, with safety to property and persons the main priority. Therefore each tree retained is recommended to be re-inspected in relation to its location within the target zone annually to ensure that the level of risk is deemed acceptable.

Established trees of good vigour and structure represent an asset to any development site. Trees are living organisms that require certain environmental conditions in order to maintain their value as an asset. Damage must be avoided or minimized during the development process and procedures to ensure the protection of trees must be in place at all stages.



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Quantified Tree Risk Assessor Lic-1082/3442
Diploma of Horticulture/Arboriculture

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Limitation of liability

Trees can be managed, but they cannot be controlled. To live or work near a tree involves a degree of risk.

This report only covers identifiable defects present at the time of inspection. Paperbark Technologies accepts no responsibility and cannot be held liable for any structural defect or unforeseen event/situation or adverse weather conditions that may occur after the time of inspection.

Paperbark Technologies cannot guarantee that the tree/s contained within this report will be structurally sound under all circumstances, and is not able to detect every condition that may possibly lead to the structural failure of a tree. Paperbark Technologies cannot guarantee that the recommendations made will categorically result in the tree being made safe.

Unless specifically mentioned this report will only be concerned with above ground inspections, as such all observations have been visually assessed from ground level. Trees are living organisms and as such cannot be classified as safe under any circumstances. Trees fail in ways that the arboriculture industry does not fully understand.

The recommendations are made on the basis of what can be reasonably identified at the time of inspection therefore Paperbark Technologies accepts no liability for any recommendations made.

All care has been taken to obtain information from reliable sources, however Paperbark Technologies can neither guarantee or be responsible for the accuracy of information provided by others.

In the event that re inspection of the tree/s is recommended it is the client's responsibility to make arrangements with Paperbark Technologies.

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Map of the site showing the location of the trees



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Photos



Tree 71.JPG



Tree 72.JPG



Tree 73.JPG



Tree 77.JPG



Tree 80.JPG



Tree 91.JPG

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Tree 95.JPG



Tree 96.JPG



Tree 101(386).JPG



Tree 103(384).JPG



Tree 105(382).JPG



Tree 106(385).JPG

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Tree 107(380).JPG



Tree 108(381).JPG



Tree 110(376).JPG



Tree 111(378).JPG



Tree 112(379).JPG



Tree 144(388).JPG

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Tree 149(389).JPG



Tree 153(390).JPG



Tree 156(391).JPG



Tree 163(392).JPG



Tree 164(393).JPG



Tree 102(387).JPG

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Tree 104(383).JPG



Tree 109(377).JPG

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Appendix D Assessment of Melaleuca: Mandogalup (Arborlogic March 2016)

Rev_0; March 10, 2016

Satterley Property Group Pty Ltd
PO Box 410
South Perth WA 6951

Attention: **John Hirdman**
Cc: **Dehlia Goundrey (Strategen)**

RE: **Assessment of *Melaleuca*; Mandogalup**

Dear John,

Further to your request, please find attached my comments on the identified trees at Mandogalup.

Should you have any queries regarding the findings of this report, or if I can be of any further assistance in the management of the identified trees, please do not hesitate to contact me.

Yours sincerely



JASON ROYAL

Dip. Arboriculture (UK)
Tech. Arbor A

1. Terminology

The following terms have been commonly used in this document.

"Trees" meaning the *Melaleuca* trees identified in the Stategen plan provided

"AS 4970" meaning Australian Standards 4970; Protection of Trees on Development Sites

"AS 4373" meaning Australian Standards 4373; Pruning of Amenity Trees

2. Assessment Methodology Applied

The identified Trees were assessed in accordance with 'visual tree assessment' methods[1] and principles.

This is a method based on the sciences of tree biology, physiology, tree structure, and tree bio-mechanics. It is a method widely used by arborists worldwide to identify visible signs on trees that provide an indication as to its health and structural properties at the time of inspection.

The overall health of each Tree was adjudged from an inspection of its leaf, overall percentage of leaf mass present in the canopy of the tree, and the presence (or absence) of any pest or disease factor that could have an effect on the overall health of the tree.

The structural integrity of each tree was determined from a visual inspection of its main stem, primary (and secondary) branch unions to determine the presence of any areas considered to be a structural 'defect' or 'imperfection' such as unions with included bark, swelling, or noticeable splitting at them. Symptoms of decay, growth patterns and defects are identified and assessed as to their potential to cause whole tree, part tree or branch failure, and where considered necessary further investigation by way of the use of sounding techniques was utilised to determine the presence and general extent of any areas of cavity or associated decay within a tree's main stem structure.

Species suitability for use in an urban area, and if the identified Tree is of a species that can be subject to the sudden branch failure phenomenon, or shows evidence of a history of branch failure, or looks to be a potentially problematic based its current structural condition was also considered as part of the assessment process when considering the Tree's suitability to the proposed development.

With regards to any future development the known natural species traits of the given tree and its ability to cope with disturbances to its root zone that typically occur as part of a development process, as well as its ability to cope with the new parameters that are commonly created by an urban development (i.e. decreased soil oxygen due to compaction, increased un-seasonal watering from irrigation, increased pollution, increased radiated heat/light from urban infrastructure (roads, walls, buildings etc.) are all also taken into consideration.

[1] Field Guide for Visual Tree Assessment (VTA); The Body Language of Trees, A Handbook for Failure Analysis; C Matteck, H Breloer

3. Summary of Findings

3.1 General Comments

Two species were identified on the Site; Stout Paperbark (*Melaleuca preissiana*) and Swamp Paperbark (*Melaleuca raphiophylla*).

The health of the majority of the Trees was considered to be excellent at this time and no pest or disease pathogen that could have a major impact on their health was visible at the time of inspection.

The structural condition of the majority of the Trees was considered to be good/typical for specimens of this species. Many were noted to have multiple main stem structures from ground/near ground level which is fairly typical for specimens of these species.

A large clump of the Trees were noted to extent east-west and effectively form the one canopy. In amongst the larger Trees, a large number of smaller diameter trees of the same species were also noted to be present; creating a dense area of trees.

The table attached to this report provides further information on each of the Trees inspected.

3. Summary of Findings

3.2 Identify individual / stands of trees that are suitable for retention as a *Melaleuca* community and are not dependent on other existing environmental factors such as surrounding stands of trees which may be creating specific microclimates resulting in the trees current vitality (excluding the maintenance of groundwater levels).

Trees #134 through to #171 form a large group of trees and a large number of smaller diameter trees was noted in amongst them. Within this group there are a few individual good quality trees that could be retained as individuals. However, the development of the majority has clearly been influenced by adjacent Trees as such they are quite possibly partially reliant on the protection that they provide.

These trees are therefore recommended to be retained a group; either in its entirety or in sections should Site design require the removal of some of the Trees.

In the event that areas of the group are removed, the maintaining the density of vegetation in remaining areas (including retaining all of the smaller trees in amongst the larger ones) is seen as critical to the success of their retention and minimising impact of the sudden exposure that's likely to result.

Trees #175-#180 form their own small group of Trees and could be retained separate to the larger group nearby. Within this group Trees # 175, #178, #179 and #180 could actually be retained as individual trees in their own right.

Trees #134, #135, #137, #138, #160, #180, #181, #182, #183, #188, #190, #191 are all considered to be trees that could be retained as induvial specimens in their own right. Some impact to these trees is likely to occur as a result of clearly of surrounding vegetation, although with the correct care and management during the development process they should be anticipated to survive and adapt to the changes to their surrounds.

The aerial below highlights those Trees considered suitable to be retained as individual trees (in green).



3. Summary of Findings

3.3 Identify individual / stands of trees which are not considered <u>unsuitable</u> for retention based on their health and/or structural condition.

Trees #136, #138, #163, #172, #184, #185, #186 and #189 are all considered to have a low retention value due to its structural form.

Conversely Trees #134, #137, #160, #175, #178, #180, #181, 182, #191 and #198 were all considered to be very good specimens of their species, showed good health and structural form and were considered to have a 'high' retention value.

All of the other Trees including the majority in the larger area were considered to have a 'medium' retention value.

The aerial below shows the Trees with their 'retention' value overlaid.



3.4 Provide Root Protection zone distances for each tree in accordance with AS 4970 guidelines.

Root protection zones are provided on the table attached to this report.

The TPZ of all Trees are strongly recommended to be overlaid onto <u>all</u> drawings and designs of the proposed development, including ALL underground services (power, gas, water, telecommunications etc.), drainage, road pavement, cut/fill.

3. Summary of Findings

3.5 Identify any individual trees that may be suitable for transplanting within the site area.

Both species of *Melaleuca* found on this site are known to be able to be transplanted.

Of the trees on the site a large number were however **not** considered **suitable** for relocation due to their structural form (multiple main stems from ground/near ground level), or proximity to other trees and probable reliance on being retained as a group.

Trees #134, #139, #141, #148, #160, #179, #191 and #198 were however all considered to be suitable for transplanting.

Trees #165, #166, #167 were also considered suitable for transplanting, although two of these Trees would probably need to be sacrificed to enable the one to be relocated (due to extent of excavation required and probable impact to the other tree during the process).

Similarly, Trees #137, #156, #187, #195 was also considered suitable for transplanting, although adjacent Trees would probably need to be sacrificed to enable them to be relocated.

Trees #180 and #190 are possibly able to be transplanted subject to further inspection and verification from a transplant company.

The aerial below highlights those Trees considered suitable for transplanting (in green), and possibly suitable (in orange).



3. Summary of Findings

Melaleuca will typically require a 3-6 month preparation time frame before being relocated.

Without sufficient preparation the risk increases that the relocation process will result in the decline of the Tree shortly after being moved.

It is also generally required that the preparation phase includes a growing season (i.e. spring/summer period), and should be accounted for in any site development planning process.

Maintaining soil moisture during the preparation phase will be of critical importance to the success of their relocation, and will need to be allowed for.

Ideally relocation would occur during cooler periods of the year (i.e. late autumn through winter).

3.6 Recommend the minimum distance requirement from the canopy drip line of each tree proposed to be retained that a retaining wall of maximum 0.5m height above existing ground level (and acknowledge below ground footings) may be placed without impacting on the long term viability of the tree.

Without undertaking exploratory excavations around each tree to verify the full extent and spread of each tree's root zone at this time it is recommended to align/delineate all retaining wall and other structures outside of designated TPZ areas.

Where encroachments into a designated TPZ are found to be required, further discussion with an experienced independent arboricultural consultant is an important part of the tree protection process.

3.7 Recommended maximum levels of imported soil that can be placed within the future proposed Public Open Space, and proximity / exclusion area for imported soil to base of retained trees.

This species of tree will tolerate an extent of fill being placed over part of their root zone areas.

Typically, up to 200mm of fill is likely to have limited impact to trees of these species that are in good health; depending on the extent of each Tree's TPZ that requires the fill.

Strategies are available to allow for greater volumes of fill to be placed over the root zone of trees and mitigate the impact.

However which strategy to use would need to be based on aspects of detailed design such as level of fill required and final landscape of the area above the fill.

3.8 Provide recommendations for the ongoing monitoring principles during construction phases onsite.

It will remain important to maintain ground water and any seasonal water table fluctuations that the Trees are accustomed to during the works.

In the event that dewatering works or changes to the natural drainage of the area around the Trees is anticipated to occur then measures will be required to undertake supplementary watering to help maintain soil moisture and plant functions**.**

Piezometers may need to be installed within areas of the Site to monitor ground water.

3. Summary of Findings

3.9 Protection During Development; Design Stages

Effective protection of trees as part of any development must start at the design stages so that protection during physical construction stages will remain viable and achievable within the parameters of the approved design.

The TPZ of all Trees are strongly recommended to be overlaid onto all drawings and designs of the proposed development, including ALL underground services (power, gas, water, telecommunications etc.), drainage, road pavement, cut/fill.

Where encroachments into a designated TPZ are found to be required, further discussion with an experienced independent arboricultural consultant is an important part of the tree protection process.

It is of critical importance that this aspect occurs at the design stage so that any potential issues or conflicts can be recognised and addressed before construction works commence on Site.

3.10 Protection During Development; Construction Stages

3.10.1 Protective fencing

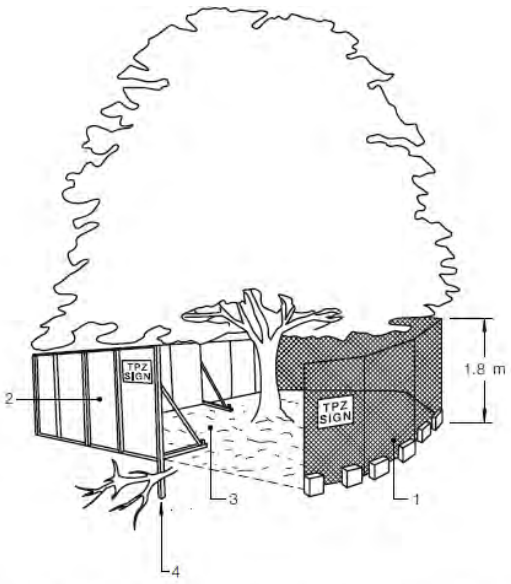
The TPZ of any Tree is recommended to be fenced off in accordance with AS 4970 guidelines PRIOR to any site clearing works.

In instances where TPZ areas overlap, a single larger TPZ is recommended to be fenced off incorporating all Trees present.

TPZ fencing is to remain in situ and undisturbed for the duration of the development.

In the event that works are required to occur within a TPZ area, and fencing is required to be altered then further discussion with the arboricultural consultant will be required.

Fig. 1 TPZ Fencing Requirements



LEGEND:
1 Chain wire mesh panels with shade cloth (if required) attached, held in place with concrete feet.
2 Alternative plywood or wooden paling fence panels. This fencing material also prevents building materials or soil entering the TPZ.
3 Mulch installation across surface of TPZ (at the discretion of the project arborist). No excavation, construction activity, grade changes, surface treatment or storage of materials of any kind is permitted within the TPZ.
4 Bracing is permissible within the TPZ. Installation of supports should avoid damaging roots.

AS 4970 guidelines

3. Summary of Findings

3.10.2 Site Clearing Works

Site clearing works are to be undertaken in a manner that does not impact on any part of any Tree's above, or below ground parts or TPZ area.

Site clearing is not to be undertaken within a TPZ area without prior discussion and approval from the arboricultural consultant.

No contact with the upper canopy of any of the Trees is to occur during site clearing works.

In the event that branches from the canopy of any Tree require removal to enable demolition works to occur, then canopy pruning will need to be undertaken prior to the demolition works occurring. All canopy pruning works must comply with AS 4373 (2007); *Pruning of Amenity Trees*. Canopy pruning works are to only be undertaken by qualified and experienced persons; minimum AQF certificate 3 arboriculture.

In the event that other trees are required to be removed adjacent a Tree that is to be retained, then the removal of the trees is to be undertaken in a manner that does not cause any damage to the above or below ground parts of the Tree being retained.

In the event that Works are required to occur in a TPZ area, further discussion with the arboricultural consultant will be required.

TPZ fencing is NOT to be altered without prior discussion and consent from the arboricultural consultant.

3.10.3 Protection during Works

The TPZ of each Tree will need to be protected in accordance with AS 4970 guidelines at all times during the works.

Once set-up, the TPZ of the Tree is to remain undisturbed during development process and treated in accordance with AS 4970 and as detailed below:

The TPZ must not at any time be utilised for the purposes of:

- Traversing and/or parking of plant machinery or vehicles
- Storage for construction or deleterious materials
- Vehicle refuelling
- Storage of surplus fill
- Preparation of chemicals and/or cement products (or within 15 metres of the TPZ)
- Areas to dump construction and general waste
- Wash down or cleaning
- Locations for site offices or toilets
- Or any activity that may harm or injure the tree above or below ground parts

All contractors involved with any part of the Works are to be made aware of the Trees, their TPZ and their protection requirements.

No Works are to occur within the TPZ without prior discussion and approval of the arboricultural consultant.

In the event that works are required to occur within a TPZ area, further discussion with the arboricultural consultant will be required.

3. Summary of Findings

3.11 Canopy Works

No canopy works are considered necessary at this time on any of the Trees in view of risk management requirements.

In the event that greater vertical clearance is required for purposes of development, further discussion will be required with the arboricultural consultant before any occur; **particularly for the Trees with low canopy form where retention of the low canopy would be important to maintain the integrity of the Tree.**

Alternative measures to canopy pruning are to be explored further before looking at undertaking canopy works.

In the event that branches from the canopy of any Tree are required to be removed then all canopy pruning works must comply with AS 4373 (2007); *Pruning of Amenity Trees*.

Canopy pruning works are to only be undertaken by qualified and experienced persons; minimum AQF certificate 3 arboriculture.

3.12 Monitoring during Works

Provision is to be made for the arboricultural consultant to be able to conduct regular periodic inspections of the Tree and its TPZ to monitor its progress and or modify its TPZ and/or ongoing maintenance schedule as necessary.

Full access and co-operation is expected from all parties involved in the development process without impediment to the arboricultural consultant's requirements.

Frequency of inspections to be determined pending the set-up of the TPZ and compliance of the contractor to its protection.

Attachments to this Report

Attachment 1; Table of Information on the Identified Trees

Attachment 2; Company Information & Disclaimer

Attachment 1; Table of Information on the Identified Trees

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
				N-S	E-W						
134	*Melaleuca rhaphiophylla*	8	55	6	8	Good mature specimen. Good individual tree as well as being on edge of the larger group of trees		4.95	Yes	Yes	High
135	*Melaleuca rhaphiophylla*	6	45, 45, 20	7	7	Ok mature specimen. Multi-stemmed from ground level		4.05	No	Yes	Medium
136	*Melaleuca rhaphiophylla*	5	40, 35, 30	6	9	Ok mature specimen. Multi-stemmed from ground level; one stem looks to have failed		3.6	No	No	Low
137	*Melaleuca rhaphiophylla*	5	45, 40	8	6	Good mature specimen(s); looks to be two trees in close proximity that effectively form the one canopy. Good individual tree but need to retain both as one tree		4.05	Possibly; but one of these trees would need to be 'sacrificed' to enable the other to be relocated	Yes	High
138	*Melaleuca rhaphiophylla*	5	35, 20, 20	8	7	Ok specimen. Multi-stemmed from ground level and very low spreading canopy that would need to be retained to retain integrity		3.15	No	Yes	Low
139	*Melaleuca rhaphiophylla*	8	45	6	8	Reasonably good mature tree. Good individual as well as being on the edge of a large group. Branch failure noted but otherwise ok		4.05	Yes	Yes	Medium

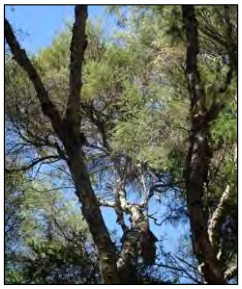
Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
				N-S	E-W						
140	*Melaleuca rhaphiophylla*	10	35, 30	6	6	Two trees in close proximity that effectively form the one canopy. On edge of larger group of trees; need to retain as one		3.15	No	No	Medium
141	*Melaleuca preissiana*	7	35	4	4	Good mature tree. Good aesthetic form/qualities. On edge of larger group but should be ok to retain as an individual		3.15	Yes	Yes	Medium
142	*Melaleuca preissiana*	7	30, 18, 18	4	4	Reasonably good mature specimen. Canopy is slightly sparse in areas but otherwise ok. Multi-stemmed from ground level and on edge of larger group		2.7	No	No	Medium
143	*Melaleuca rhaphiophylla*	7	20 x3, 18, 15	4	4	Ok mature specimen. Multi-stemmed (probably more than the one tree). Part of the larger group		2.25	No	No	Medium
144	*Melaleuca rhaphiophylla*	10	35, 25	4	4	Ok mature specimen. Multi-stemmed (probably more than the one tree). Part of the larger group		3.15	No	No	Medium
145	*Melaleuca rhaphiophylla*	10	30	4	4	Ok mature specimen. Multi-stemmed (probably more than the one tree). Part of the larger group		2.7	No	No	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter) N-S	E-W	Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
146	*Melaleuca preissiana*	7	30, 20, 20	5	4	Sections of canopy are slightly sparse but otherwise ok. Multi-stemmed from ground level		2.7	No	Yes	Medium
147	*Melaleuca preissiana*	7	25	4	4	Ok mature specimen. Edge of large group area but surrounded by (mostly dead) Flooded Gum		2.25	No	No	Medium
148	*Melaleuca preissiana*	7	20	4	4	Ok mature specimen. Edge of large group area but surrounded by (mostly dead) Flooded Gum		2	Yes	No	Medium
149	*Melaleuca rhaphiophylla*	9	25	3	3	Ok mature specimen. Canopy is one sided (north) but otherwise ok		2.25	No	No	Medium
150	*Melaleuca rhaphiophylla*	11	30	3	3	Reasonably good mature tree. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		2.7	No	No	Medium
151	*Melaleuca rhaphiophylla*	11	30x3	5	3	Reasonably good mature tree. Multi-stemmed from near ground level. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		2.7	No	No	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
				N-S	E-W						
152	*Melaleuca rhaphiophylla*	10	35	3	3	Good mature specimen. Part of a large clump of trees. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		3.15	No	No	Medium
153	*Melaleuca rhaphiophylla*	11	30X3	5	4	Reasonably good mature tree. Multi-stemmed from near ground level. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		2.7	No	No	Medium
154	*Melaleuca rhaphiophylla*	11	40, 30	4	4	Reasonably good mature tree. Multi-stemmed from near ground level. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		3.6	No	No	Medium
155	*Melaleuca rhaphiophylla*	11	35, 25	4	4	Reasonably good mature tree. Multi-stemmed from near ground level. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		3.15	No	No	Medium
156	*Melaleuca rhaphiophylla*	6	30	4	4	Reasonably good mature tree. Multi-stemmed from near ground level. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		2.7	Possibly	No	Medium
157	*Melaleuca rhaphiophylla*	11	40	5	4	Reasonably good mature tree. Multi-stemmed from near ground level. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		3.6	No	No	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
				N-S	E-W						
158	*Melaleuca rhaphiophylla*	10	30	4	4	Reasonably good mature tree. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		2.7	No	No	Medium
159	*Melaleuca rhaphiophylla*	9	30	4	4	Reasonably good mature tree. Situated in a very densely vegetated area and effectively forms the one canopy with the adjacent trees		2.7	No	No	Medium
160	*Melaleuca rhaphiophylla*	8	55	7	8	Very good mature specimen. Good individual tree as well as being on the edge of the larger group		4.95	Yes	Yes	High
161	*Melaleuca rhaphiophylla*	12	30	6	6	Good mature specimen. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Medium
162	*Melaleuca rhaphiophylla*	11	30	6	6	Good mature specimen. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Medium
163	*Melaleuca rhaphiophylla*	13	30, 25	6	6	Ok mature specimen. Looks to be leaning and may have been subject to partial failure. May have low retention value depending on final landscape around it. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Low

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter) N-S	E-W	Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
164	*Melaleuca rhaphiophylla*	9	30	4	4	Good mature specimen. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Medium
165	*Melaleuca rhaphiophylla*	9	30					2.7		No	Medium
166	*Melaleuca rhaphiophylla*	12	30	7		Good mature specimens. Effectively forms the one canopy with each other. Would need to be retained as one tree rather than individuals		2.7	Possibly but the other two trees would need to be 'sacrificed' to enable the relocation of one of them	No	Medium
167	*Melaleuca rhaphiophylla*	12	45					4.05		No	Medium
168	*Melaleuca rhaphiophylla*	12	45	6	6	Good mature specimen. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		4.05	No	No	Medium
169	*Melaleuca rhaphiophylla*	8	45, 40, 30	7	8	Good mature specimen. Multi-stemmed from near ground level. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		4.05	No	No	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
				N-S	E-W						
170	*Melaleuca rhaphiophylla*	7	30	8	8	Good mature specimen. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Medium
171	*Melaleuca rhaphiophylla*	9	30	8	8	Good mature specimen. Part of a large clump of trees that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Medium
172	*Melaleuca rhaphiophylla*	8	50	5	5	Multi-stemmed from ground level. One stem looks to have recently failed. **Low retention value**		4.5	No	No	Low
173	*Melaleuca rhaphiophylla*	8	50	6	6	Ok mature specimen. Sections of canopy are slightly sparse. Looks to have previously snapped		4.5	No	No	Medium
175	*Melaleuca rhaphiophylla*	11	65	10	8	Reasonably good specimen. Effectively forms part of a group with 176-179; suggest retain as a group		5.85	No	Yes	High
176	*Melaleuca rhaphiophylla*	10	40	4	4	Reasonably good specimen. Effectively forms part of a group with 175 and 177-179; suggest retain as a group		3.6	No	No	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter) N-S	E-W	Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
177	*Melaleuca rhaphiophylla*	10	30x2	5	8	Good mature specimen. Effectively forms part of a group with 175, 176 and 178-179; suggest retain as a group		2.7	No	No	Medium
178	*Melaleuca rhaphiophylla*	10	30, 25	8	7	Good mature specimen. Multi-stemmed from near ground level. Low canopy could be raised in this instance without impacting the trees. Effectively forms part of a group with 175 - 177 and 178-179; suggest retain as a group		2.7	No	Yes	High
179	*Melaleuca rhaphiophylla*	11	50	7	7	Good mature specimen. Effectively forms part of a group with 175-178; suggest retain as a group but this one could be an individual tree if necessary		4.5	Yes	Yes	Medium
180	*Melaleuca rhaphiophylla*	11	80	9	8	Good mature specimen. On edge of 175-179 group. Branch failure has occurred but overall ok		7.2	Possibly	Yes	High
181	*Melaleuca rhaphiophylla*	11	100 (approx.)	11	10	Large mature very good specimen. Good individual tree. Structure probably limits potential for transplanting		9	No	Yes	High
182	*Melaleuca rhaphiophylla*	9	100 (approx.)	9	9	Good mature specimen. Multi-stemmed from ground level and one stem has failed but otherwise ok		9	No	Yes	High

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter) N-S	E-W	Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
183	*Melaleuca rhaphiophylla*	9	60, 30 x30	8	7	Good mature specimen. Canopy is slightly sparse but otherwise ok		5.4	No	Yes	Medium
184	*Melaleuca rhaphiophylla*	3	30	6	4	Ok mature specimen. Suppressed by the adjacent Flooded Gum and as a result canopy is very one-sided (north) and ahs grown on a lean north		2.7	No	No	Low
185	*Melaleuca rhaphiophylla*	6	30 x2	5	5	Ok mature specimen. Slightly suppressed by the adjacent Flooded Gum but otherwise ok. Part of a small clump of trees		2.7	No	No	Low
186	*Melaleuca rhaphiophylla*	7	40, 25, 15	5	6	Ok mature specimen. Multi-stemmed. Slightly suppressed by the adjacent Flooded Gum but otherwise ok. Part of a small clump of trees		3.6	No	No	Low
187	*Melaleuca rhaphiophylla*	6	45	5	5	Ok mature specimen. Slightly suppressed by the adjacent Flooded Gum and canopy is one sided as a result but otherwise ok. Part of a small clump of trees		4.05	Possibly	No	Medium
188	*Melaleuca rhaphiophylla*	7	45, 40, 35	7	7	Good mature specimen. Multi-stemmed from ground level		4.05	No	Yes	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter) N-S	E-W	Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
189	*Melaleuca rhaphiophylla*	5	30, numerous 20	6	7	Ok specimen. Multi-stemmed from ground level and very low spreading canopy that would need to be retained to retain integrity		2.7	No	Yes	Low
190	*Melaleuca rhaphiophylla*	10	65	8	9	Good mature specimen. Canopy could be raised in this instance if required		5.85	Possibly	Yes	Medium
191	*Melaleuca rhaphiophylla*	6	45	7	6	Good mature specimen. Branch failure looks to have occurred but overall ok. Canopy could be raised in this instance if required		4.05	Yes	Yes	High
192	*Melaleuca rhaphiophylla*	8	30	5	4	Good mature specimen. Part of a large clump of trees with 140-171 that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	Possibly	No	Medium
193	*Melaleuca rhaphiophylla*	10	35	5	4	Good mature specimen. Part of a large clump of trees with 140-171 that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		3.15	No	No	Medium
194	*Melaleuca rhaphiophylla*	10	30 x2	4	4	Good mature specimen. Part of a large clump of trees with 140-171 that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		2.7	No	No	Medium

Tree ID#	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Comment	Image	TPZ (metres radius)	Transplantable	Retain as Individual?	Retention Value
				N-S	E-W						
195	*Melaleuca rhaphiophylla*	11	45	5	58	Good mature specimen. Part of a large clump of trees with 140-171 that also have a lot of smaller trees amongst them. Would be better to retain as a group rather than as individual trees		4.05	Possibly	No	Medium
197	*Melaleuca rhaphiophylla*	9	30	4	4	Good mature specimen. Main stem bi-furcates but union looks to be ok at this time. Part of a large clump of smaller trees along eastern boundary. Suggest retain as a group rather than individuals		2.7	No	No	Medium
198	*Melaleuca rhaphiophylla*	10	35	4	5	Good mature specimen. Good form		3.15	Yes	Yes	High

Attachment 2; Company Information

Company Name:	ARBOR logic
A.C.N.:	107 194 061
A.B.N.:	66 566 369 687

Insurance Details:

General Liability;	Zurich	$20 million
Professional Indemnity;	Vero	$5 million
Personal Protection;	Macquarie	

Office/Contact Details

Postal Address:	PO Box 1025, Balcatta WA 6914
Physical Office Address:	4c/5 Mumford Place, Balcatta
Ph:	(08) 9240 7555
Fax:	(08) 9240 7522

Consultant Details

Consultant Contact: Jason Royal
Dip. Arboriculture (UK)
Tech. Arbor A

MEMBER ISA — J. Royal; 172723

Arboriculture Australia™ — Member No. 1254

QTRA Registered User — Lic. No. 1743

Ph:	(08) 9240 7555
Mobile:	0409 105 745
Email:	jason@arborlogic.com.au

Disclaimer

This Report has been provided in good faith and based upon the material information provided by the Client to Arbor logic, and/or based on the visual inspection of the tree(s) at the time this advice was prepared.

The contents of this Report should be read in full, and at no time shall any part of the Report be referred to unless taken in full context with the remainder of the document.

The contents of this Report may not be reissued to another party or published in part or full without Arbor logic's written permission.

Arbor logic does not accept liability arising out of loss or damage that results from: -

- Material information not being provided by the Client to Arbor logic at the time this advice was prepared.
- The provision of misleading or incorrect information by the Client or any other party to Arbor logic upon which this advice was prepared.
- This advice being used by the Client or any other party in circumstances or situations other than the specific subject of this advice.
- Failure by the Client to follow this advice.
- The action(s) or inaction(s) of the Client or any other party that gives rise to the loss of, or damage to, the tree(s) that are the subject of this advice.

It is also important to take into consideration that all trees are living organisms and as such there are many variables that can affect their health and structural properties that remain beyond the scope of reasonable management practices or the advice provided in this Report based on the visual inspection of the tree(s).

As such a degree of risk will still remain with any given tree(s) despite the adoption of any best management practices or recommendations made in this Report.

Appendix E Significant Tree Assessment: Mandogalup (Arborlogic October 2016)

October 13, 2016

Strategen Environmental
PO Box 243
Subiaco WA 6904

Attention: **Dehlia Goundrey**

RE: **Significant Tree Assessment; Mandogalup**

Dear Dehlia,

Further to your request, the following is a summary of my assessment for significant trees within the proposed local structure plan area of Mandogalup.

Should you have any queries regarding the findings of this report, or if I can be of any further assistance in the management of the identified trees, please do not hesitate to contact me.

Yours sincerely



JASON ROYAL

Dip. Arboriculture (UK)
Tech. Arbor A

Significant Tree Assessment; Local Structure Plan area of Mandogalup

Prepared For

Strategen Environmental

Prepared By

ARBOR logic

Contents

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2. Scope of Works Page 1

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6. Further Considerations; Development Design and Construction Page 34 - 35

Attachments to the Report

Attachment 1; Tree Location Guide

Attachment 2; Tree Location Guide with retention value overlaid

Attachment 3; Glossary of Arboricultural Terms

Attachment 4; Company Information & Disclaimer

1. Particulars to the Assessment

1.1 Terms Used

The following terms have been used in this report:

'Site' meaning the Local Structure Plan area of Mandogalup that was included in this particular assessment

'Tree' meaning any tree identified on Site that has then been included in the assessment

'AS 4970' meaning Australian Standards guideline 4970 (2009); Protection of trees on development sites

'AS 4373' meaning Australian Standards guideline 4373 (2007); Pruning of amenity trees

'TPZ' meaning Tree Protection Zone; the area where the majority of the given Tree's root mass is considered likely to be found, and the area that is recommended to be protected during any development or landscape activity

1.2 Limitations and Particulars of this Assessment

The information and opinions provided in this document are based on the findings from the visual observations of the Trees on the Site during the inspections undertaken September 27 and 28, 2016.

All observations of all of the Trees were undertaken from ground level.

In accordance with City of Kwinana Local Planning Policy No.1 any trees on the Site with a main stem diameter of 50cm or greater have been included in this assessment.

Any trees found to have a main stem diameter less than 50cm were excluded from this assessment.

No exploratory excavations were undertaken as part of this particular assessment to verify the actual root spread of any given Tree.

As such the allocation of TPZ for each Tree has at this stage been based on AS 4970 guidelines, with some amendments being made for the physical size and canopy dimensions of the Tree, its condition, the known root zone morphology of its given species in the sort of soil profile considered to be typical to this area of Western Australia.

2. Scope of Works

At the request of Satterley Property Group I have been commissioned to undertake an inspection of all of the trees found on the Site to identify any trees that meet the definition of a significant tree under the guidelines of City of Kwinana Local Planning Policy No. 1.

Information on any tree that met the Policy guideline requirements was to be collected with details of each Tree's species, physical size (height, main stem calliper, canopy width, health condition, and structural condition), recommended zone of protection, and any comments deemed pertinent to the identified tree (i.e. any hazards, defects, issues etc.).

3. Tree Assessment Methodology

3.1 Methodology of the Assessment

All trees on the Site were visually inspected from ground level.

Any tree found to have a main stem diameter of 50cm or greater was subsequently included in the assessment.

All of these Trees were then assessed in accordance with visual tree assessment ("VTA") methods and principles. The VTA method is based on the sciences of tree biology, physiology, tree structure, and tree bio-mechanics. It is a method widely used by arborists worldwide to identify visible signs on trees that indicate any health or potential structural issues that in turn could increase the risks associated with the given tree.

The overall health of each Tree was adjudged from an inspection of its leaf, overall percentage of leaf mass present in the canopy of the Tree, and the presence (or absence) of any pest or disease factor that could have an effect on the overall health of the Tree.

The structural integrity of each Tree was determined from a visual inspection of its main stem, primary (and secondary) branch unions to determine the presence of any areas considered to be a structural 'defect' or 'imperfection' such as unions with included bark, swelling, or noticeable splitting at them.

Symptoms of decay, growth patterns and defects are identified and assessed as to their potential to cause whole tree, part tree or branch failure, and where considered necessary further investigation by way of the use of sounding techniques was utilised to determine the presence and general extent of any areas of cavity or associated decay within a tree's main stem structure.

The Tree's root plate area was also inspected to identify any visible signs of root plate, movement, cracking or heave from which a determination of the in-ground stability of the Tree can be ascertained. It is however important to note that there are limitations in verifying the in-ground stability of a tree based on a 'one-off' cursory visual observation; particularly in a forest type habitat where ground cover and leaf litter prevent or limit visual observations, and particularly if the inspection is undertaken during a period of 'fine' weather with little to no wind; as was the case over the period of this assessment.

With regards to any future development the known natural species traits of the given tree and its suitability for use in an urban area and if the identified specimen is of a species that can be subject to the sudden branch failure phenomenon or is known to be potentially problematic in terms of self-sowing (weed) issues, was also considered as part of the assessment process.

The Tree's species and its ability to cope with disturbances to its root zone that typically occur as part of a development process, as well as its ability to cope with the new parameters that are commonly created by an urban development (i.e. decreased soil oxygen due to compaction, increased un-seasonal watering from irrigation, increased pollution, increased radiated heat/light from urban infrastructure (roads, walls, buildings etc.) are all also taken into consideration.

The known root zone morphology of the species was taken into consideration when allocating the recommended TPZ for each of the identified trees. Note: Whilst some reference and acknowledgment is given to the guidelines set down in AS 4970, the TPZ for each Tree has been based on the known typical root zone morphology for specimens of their species, the condition of the given Tree, and the known tolerance to root zone disturbance of the given species.

4. Summary of Key Findings of the Assessment

4.1 No of Trees Identified

A total of 171 Trees were identified during the assessment that met City of Kwinana Local Planning Policy No.1 guidelines for a significant tree.

A guide to their location has been provided in attachment 1 of this report.

4.2 Species Identified

11 different species of tree were identified on the Site.

Seven species were identified as West Australian native species, with the remaining four species native to eastern parts of Australia.

All of the species were considered to be common species for the Perth metropolitan area.

Flooded Gum (*Eucalyptus rudis*) were by far the most common species of tree on this Site with 81 specimens, followed by Jarrah (*Eucalyptus marginata*).

Table 1; List of Species of Significant Tree

Species	No of	Origin
Bangalay (*Eucalyptus botryoides*)	2	Aus native
Candle Banksia (*Banksia attenuata*)	1	WA native
Common Sheoak (*Allocasuarina fraseriana*)	3	WA native
Flooded Gum (*Eucalyptus rudis*)	81	WA native
Freshwater Paperbark (*Melaleuca rhaphiophylla*)	18	WA native
Jarrah (*Eucalyptus marginata*)	31	WA native
Lemon Scented Gum (*Corymbia citriodora*)	1	Aus native
River Red Gum (*Eucalyptus camaldulensis 'Camaldulensis'*)	1	Aus native
Stout Paperbark (*Melaleuca preissiana*)	21	WA native
Tasmanian Blue Gum (*Eucalyptus globulus*)	7	Aus native
West Australian Christmas Tree (*Nuytsia floribunda*)	5	WA native

4. Summary of Key Findings of the Assessment

4.3 Health Condition

The health of the Trees identified was noted to vary.

22 of the Trees were found to be dead with no live leaf mass remaining within their canopy.

This includes 12 Flooded Gum (*Eucalyptus rudis*), eight Jarrah (*Eucalyptus marginata*), and two Tasmanian Blue Gum (*Eucalyptus globulus*).

A further 31 Trees were considered to be in a poor health condition and look likely to have limited life span remaining. This includes 30 Flooded Gum (*Eucalyptus rudis*), and one Jarrah (*Eucalyptus marginata*).

These Trees are considered unlikely to survive the extent of disturbance and changes to their surrounds that typically occurs as a result of a development process.

A further 46 Trees were considered to be in a 'fair' health condition at this time. The cause of the reduced vigour looks (at this stage) to be more associated with environmental factors rather than any pest or disease pathogen.

Some (if not all) of these Trees may recover over time depending on seasonal rainfalls, and treatment during a develop process.

This includes 32 Flooded Gum (*Eucalyptus rudis*), 10 Jarrah (*Eucalyptus marginata*), four Stout Paperbark (*Melaleuca preissiana*) and one West Australian Christmas Tree (*Nuytsia floribunda*).

The remaining 71 Trees showed to be in good health or better at this time and I could see no visible evidence of any pest or disease pathogen that could have a major impact to their health at the time of my inspection.

Whilst a number showed to have varying amounts of varying diameter sized deadwood in their canopy, it looks to have occurred as part of the natural growth processes of tree's rather than being caused by any pest or disease pathogen, and whilst a number showed to have some minor pest/disease issues they were considered unlikely to have a major impact to the future health of these Trees.

4.4 Structural Condition

The vast majority of the Trees showed to have (what is considered to be) typical structural forms for specimens of their given species.

Whilst a number of the Trees showed to have what are considered to be 'structural defects' such as bi-furcated unions with signs of swelling and included bark (which are considered to potentially have an increased likelihood for failure than other forms of branch unions) for the most part any structural defect or imperfections were not considered to be of any major concern at this time.

The development and structural form of some of the Trees was noted to have been affected and influenced by the proximity of adjacent Trees, with some having grown on a lean, and other having developed 'leggy' canopy form with high bending movement in winds and little to no lower canopy mass. For the most part this was not considered to be of any major concern at this time although issues may arise should surrounding Trees be removed and exposure to wind forces be increased; particularly in the wetland areas.

Branch failures were observed to have occurred on nine of the Trees. All of the failures were considered to have occurred as a result of force loading (i.e. wind/storm damage) as opposed to any predisposition for failure.

4. Summary of Key Findings of the Assessment

Areas of decay were observed in a number of the Trees, particularly some of the larger older Jarrah.

For the most part did not look to be to an extent where the structural integrity of the Tree has been compromised as a result, although the decay in a small number of the Trees does look to be at a point where its structural integrity is becoming questionable, particularly for the Tasmanian Blue Gum (*Eucalyptus globulus*) specimens which are prone to failure as a result of decay.

The structural form of 25 Trees was considered to be questionable, including 15 of the dead Trees and three of the Trees in poor health.

The remaining seven Tree's with questionable structure showed good /excellent health. However the extent of decay present in their structure suggests an increased potential for failure to occur.

A structural form of a further four Trees was considered to be poor and there looks to be a high probability for failure to occur in those specimens.

The structural form of six of the dead Trees (and 23 of the Trees in poor health) was considered to be acceptable at this time.

However natural decay pathogens will likely to continue to impact their structural integrity over time; quite possibly to a point where it becomes compromised as a result.

4.5 Suitability for inclusion into an area of Development

Retention value of the various tree species and even individual tree specimens will always be open to some personal opinion.

In general trees displaying good health and deemed to have a good aesthetic quality will be generally considered to have a high retention value.

Conversely, dead or declining trees, or tree species known (or considered) to be problematic in terms of having a propensity for branch failures, or ones that could self-seed freely, or one that display low aesthetic traits would typically be considered to have a low retention value.

Whilst all of these trees may have high environmental benefits (particularly any with visible signs of potential habitat hollows) as part of ascertaining the suitability for inclusion into a development other aspects of the tree must be considered; primarily its structural form and suitability for inclusion into an urbanised area with high volumes of potential targets (such as people, structures etc.), and its potential to cope with changes to its soil and surrounding environment that typically occur as part of a development process; even if it is only to be landscape works.

In many respects with the exception of the dead, declining and those with potentially hazardous structural form, the majority of the identified Trees were considered suitable for retention and inclusion into urban areas such as public open space.

However retention of some of the Trees will however be somewhat dependent on aspects of design and what potential targets (people, structures etc.) will be introduced into the fall zone of those Trees as part of development in view of the risk management responsibilities that are generally associated with trees.

Should targets be introduced into the fall zone of these Trees, then retention may become questionable.

Some of the better quality Trees would be suitable for retention into areas of Lot, or road side verge; providing development design can accommodate protection of sufficient volume of their root zone area.

4. Summary of Key Findings of the Assessment

The following classification was used during this assessment for retention value.

High Retention Value; Generally a good/very good specimen that shows good health, structural and aesthetic form. Trees with High retention value are generally strongly recommended to be retained as part of development and would generally would be suitable for POS or even in some circumstances road reserve and/or Lot situation depending on detailed design and ability to maintain/protect sufficient area of its TPZ.

29 of the Trees on this Site were considered to have a High retention value (although due to their proximity to each other three of these Trees are considered to have a High retention value collectively as opposed to individual trees).

Medium Retention Value; Reasonably good specimen of its species and worth retaining as part of development. These trees may have reduced health/vigour, or structural imperfections that (whilst within the realms and scope of management) may have higher management and maintenance requirements. Such trees are generally suitable for road reserve, POS or even Lot situation depending on detailed design and ability to maintain/protect sufficient area of its TPZ.

48 of the Trees were considered to have a Medium retention value.

Low Retention Value; Ok specimen. This typically includes trees that indicate a declining health or have structural imperfections that are assessed to be starting to affect the structural integrity of the tree. Can also include trees that are of species that generally do not tolerate development/disturbance to their root zone (i.e. Banksia). Retention of such trees within a Road reserve or Lot would NOT be recommended due to potential impact from development, and/or a risk management perspective. Low retention value trees may have high environmental benefits, but their structure may limit their potential for retention other than in areas of POS where the risks associated with the Tree can then be better managed by way of good design.

36 Trees were considered to have a Low retention value.

Very Low Retention Value; These are generally poor quality trees that are typically suggested to be removed from a risk management perspective. Typically includes dead trees and trees with poor structural form that look to have a high probability for failure. Such trees may have high environmental benefit, but retention even within an area of open space would be highly questioned from a risk management responsibility UNLESS design of the area around them was able to prevent potential targets from entering into their fall zone.

58 Trees were considered to have a Very Low retention value.

Attachment 2 of this report provides an aerial view of the Site with the retention value of each Tree overlaid and colour coded for ease of reference.

5. Table of Information on the Trees identified during the Assessment

The following pages provide further information on the Trees identified during this assessment.

Explanation of Fields of Information in the Table

Tree ID. Provides an identification number for the identified Tree corresponding to its tree tag number on Site

Species Provides the botanical and most commonly used species name of the Tree.

Height Provides the height of the Tree (in metres) to the nearest metre.

DBH (Trunk Calliper) Provides the diameter of the Tree's main stem (trunk) in centimetres, and generally measured at 1.4 metres above ground level as per the industry standard. Should lower canopy formation start below 1.4 metres above ground level, the DBH is estimated at the point below the furcation of its main stem. In instances where the tree has multiple main stem structures, the DBH of all has been provided.

Estimated Canopy Spread Provides an estimated spread of the Tree's canopy; provided in metres diameter. Both north-south and east – west canopy dimensions have been provided.

Health Condition Provides a view of the Tree's health/vigour condition at the time of inspection based on a number of predetermined criteria.

Health Rating	Explanation
Excellent	Shows to have typical foliage condition and amount of foliage mass for a specimen of the species. May have a minor amount of deadwood, but no signs of any pest or disease factor that may affect its health.
Good	Shows to have typical foliage condition. Canopy foliage may be slightly chlorotic, or it may have a slightly higher percentage of deadwood than usual, or exhibit signs of being affected by environmental conditions. May have a minor pest or disease present that could start to affect its health.
Fair	Shows to have a relatively high percentage of deadwood than considered typical for a specimen of the given species and/or a low volume of live canopy leaf mass for a specimen of the given species. Apical sections of the canopy (may also be) dead. Signs of a pest or disease factor evident.
Poor	Canopy mass and foliage condition shows to be in a poor state for a specimen of the species. Has a high percentage of deadwood material in its canopy and a low volume of live canopy mass (typically <20%).
Dead	Shows to have either no live tissue within its structure, or at best has <5% live foliage mass remaining in its canopy.

5. Table of Information on the Trees identified during the Assessment

Structural Form Provides a view of the Tree's structural form at the time of inspection based on a number of predetermined criteria.

Structure Rating	Explanation
Good	Shows typical structural form for a specimen of the species. Branch unions show typical form at the point of attachment. May have a small number of minor structural defects; but are within the scope of tree surgery management to rectify. Shows to be root-stable.
Acceptable	Shows an acceptable form, but may have a number of structural defects present i.e. bi-furcation (but with no major swelling or movement), or areas of stem cavities, but structure remains within the scope of management at this stage; albeit with a higher risk/management requirement. Can include previously lopped trees that are known to have good points of attachment of any regrowth that occurs.
Questionable	Shows an undesirable structure for a specimen of the species. Structural condition likely to cause future issues in regards to the potential for branch or even complete tree failure to occur. Generally includes previously lopped trees, trees with large areas of cavity and/or associated decay that may be starting to affect its structural integrity, trees with bi-furcated unions with notable included bark and swelling that are considered to have an increased potential to fail.
Poor	Major structural defects evident. May have very large stem cavities, extensive termite damage, or noticeable movement in main stem, branch unions or root plate area.

Comment Provides any additional information (seen as relevant in the context of this report) to the Tree. Comments are (generally) self-explanatory.

An explanation of arboricultural terms has been provided as an attachment to this document.

TPZ Meaning the Tree's protection zone; the area where the majority of the given Tree's root mass is considered likely to be found.

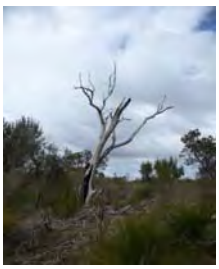
Any works required in this zone are considered likely to have some potential to impact the Tree.

Habitat Hollows Provides an indication of any potential hollows identified in the Tree that may be able to be used by habitat (birds) for nesting

Previous Tag # Provides the Tag ID number of the Tree that a number of the Trees were found to have during the assessment that were included in an earlier report undertaken on some of the Trees by Paperbark Technologies. Note: The tags were removed as part of this assessment and a new unique ID number assigned.

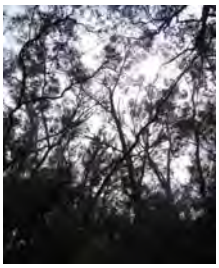
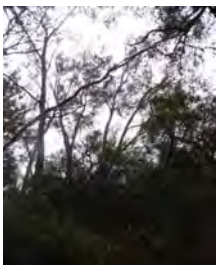
Retention Value Provides an overall 'opinion' on the quality of the Tree and its suitability for retention as part of the development.

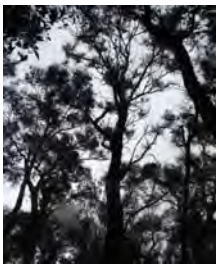
This opinion rating has been colour-coded for ease of reference.

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
1	Jarrah (*Eucalyptus marginata*)	14	76	10-11	8-9	Good	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage.	6.84			**High**
2	Candle Banksia (*Banksia attenuata*)	8.5	55	5-6	4-5	Good	Acceptable		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Bark damage to base of main stem structure. Probably more suited for POS	4.95			Medium
3	Jarrah (*Eucalyptus marginata*)	12	69	10-11	5-6	Dead	Acceptable		Dead tree, which looks to have died since PB inspection. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity although structure likely to deteriorate over time now that it is dead.	n/a		91	Very Low
4	Jarrah (*Eucalyptus marginata*)	12	76	5-6	4-5	Dead	Questionable		Dead tree. Area of decay and cavity noted and could be impacting structural integrity to some extent.	n/a	3-4 potential habitat hollows		Very Low
5	West Australian Christmas Tree (*Nuytsia floribunda*)	9	53, 52	6-7	5-6	Excellent	Good		Good mature specimen. Main stem bi-furcates but union looks to be Ok at this stage.	4.77	3-4 potential habitat hollows		**High**
6	Jarrah (*Eucalyptus marginata*)	11	54	5-6	5-6	Good	Acceptable		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Bark damage to base of main stem structure. Possibly regrowth around an old stump	4.86			Medium
7	West Australian Christmas Tree (*Nuytsia floribunda*)	8	52	4-5	3-4	Excellent	Good		Good mature specimen. Main stem bi-furcates but union looks to be Ok at this stage.	4.68			Medium

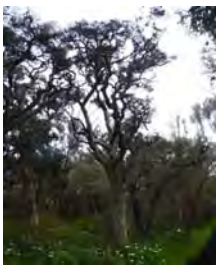
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
8	Jarrah (*Eucalyptus marginata*)	13	59	7-8	6-7	Good	Good		Good mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.31			Medium
9	Jarrah (*Eucalyptus marginata*)	14	63	7-8	6-7	Fair	Good		Canopy condition suggests it may have limited life span remaining. Canopy is sparse and apical sections are dead. Better suited to POS	6.3			**High**
10	Jarrah (*Eucalyptus marginata*)	12	66	9-10	6-7	Fair	Acceptable		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Area of decay noted but not of a major concern at this time to its structural integrity. Effectively forms the one canopy with the adjacent tree; High retention if adjacent Trees are retained; otherwise would have a Low retention value on its own	6.6		71	**High** **Low**
11	Jarrah (*Eucalyptus marginata*)	14	80	11-12	11-12	Good	Acceptable		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Basal cavity. Effectively forms the one canopy with the adjacent tree. Better suited to POS. High retention if adjacent Trees are retained; otherwise would have a Medium retention value on its own	8	2 potential habitat hollows.	72	**High** **Medium**
12	Jarrah (*Eucalyptus marginata*)	13	84	10-11	8-9	Good	Acceptable		Ok specimen. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Basal cavity. Effectively forms the one canopy with the adjacent tree. Better suited to POS. High retention if adjacent Trees are retained; otherwise would have a Medium (possibly even Low) retention value on its own	7.56	2 potential habitat hollows.	73	**High** **Medium**
13	Common Sheoak (*Allocasuarina fraseriana*)	9	57, 46	6-7	7-8	Excellent	Acceptable		Reasonably good specimen. Main stem bi-furcates but union looks to be Ok at this stage.	5.13			Medium
14	Common Sheoak (*Allocasuarina fraseriana*)	11	50	6-7	6-7	Excellent	Acceptable		Reasonably good specimen. Looks to be regrowth off/around an old stump/original tree.	4.5			Medium

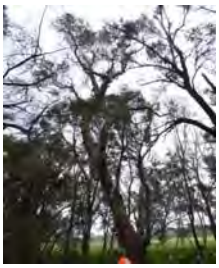
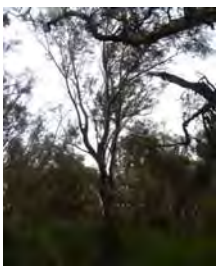
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
15	Jarrah (*Eucalyptus marginata*)	16	92	10-11	10-11	Good	Good		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage.	8.28			**High**
16	Jarrah (*Eucalyptus marginata*)	12	54	6-7	6-7	Fair	Good		Ok specimen. Canopy is sparse.	5.4			Medium
17	Jarrah (*Eucalyptus marginata*)	15	75	11-12	11-12	Good	Good		Good mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Good aesthetic form/value.	6.75			**High**
18	Flooded Gum (*Eucalyptus rudis*)	14	50	9-10	9-10	Excellent	Good		Good mature specimen. Canopy is ever-so slightly sparse but what leaf mass is present shows good condition and form. Good aesthetic form/value.	4.5			**High**
19	Jarrah (*Eucalyptus marginata*)	18	111	13-15	11-12	Excellent	Acceptable		Good mature specimen. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Large basal cavity. Probably better suited to POS	9.99	2 potential habitat hollows.	77	**High**
20	Jarrah (*Eucalyptus marginata*)	19	83	11-12	13-15	Excellent	Good		Large mature specimen. Canopy is ever-so slightly sparse but what leaf mass is present shows good condition and form. One sided (north) due to proximity of adjacent tree but not of any concerns probably better suited to POS	7.47		96	**High**
21	Jarrah (*Eucalyptus marginata*)	25	145	11-12	13-15	Excellent	Questionable		Large mature specimen. Canopy is ever-so slightly sparse but what leaf mass is present shows good condition and form. Major column of decay in main stem visible. Numerous bee hives noted. Suited to a low (no) Target area of POS IF retained	13.05	3-4 potential habitat hollows	95	Low

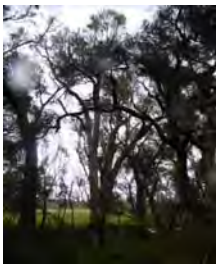
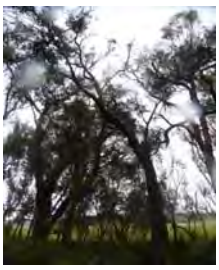
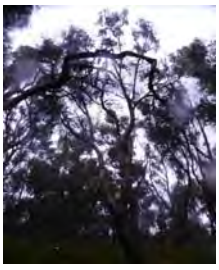
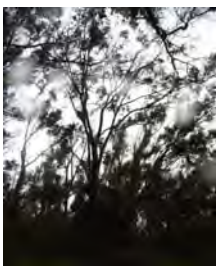
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				N-S	E-W								
22	Flooded Gum (*Eucalyptus rudis*)	17	55	10-11	13-15	Fair	Acceptable		Ok specimen. Canopy is sparse and suggests that it may be starting to decline in health. Canopy is one sided (north). Part of a group; suggest only retain with surrounding trees	5.5			Low
23	Flooded Gum (*Eucalyptus rudis*)	15	50	9-10	9-10	Fair	Acceptable		Ok specimen. Canopy is sparse and suggests that it may be starting to decline in health. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Canopy is one sided (west). Part of a group; suggest only retain with surrounding trees	5			Low
24	Flooded Gum (*Eucalyptus rudis*)	17	52	8-9	8-9	Fair	Acceptable		Ok specimen. Canopy is sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Canopy is one sided (south) part of a group; suggest only retain with surrounding trees	5.2			Low
25	Flooded Gum (*Eucalyptus rudis*)	18	50	10-11	10-11	Fair	Good		Reasonably good specimen. Canopy is sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage. Part of a group; suggest only retain with surrounding trees	5			Low
26	Jarrah (*Eucalyptus marginata*)	11	60	6-7	5-6	Fair	Acceptable		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Basal cavity. Canopy is one sided (north) due to proximity of adjacent tree; only retain if adjacent tree is retained!	6	1 potential habitat hollow		Low
27	Flooded Gum (*Eucalyptus rudis*)	24	66	9-10	9-10	Excellent	Good		Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage.	5.94			Medium
28	Jarrah (*Eucalyptus marginata*)	22	180	12-13	9-10	Fair	Acceptable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Major basal cavity noted. Better suited to POS	18	4 potential habitat hollows	380 (107)	Low

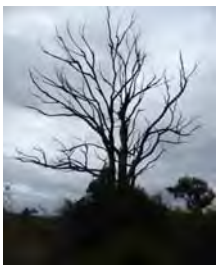
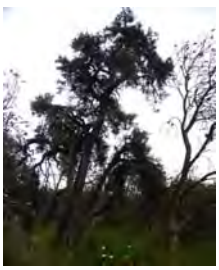
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
29	Flooded Gum (*Eucalyptus rudis*)	25	77	10-11	10-11	Fair	Acceptable		Large mature specimen. Canopy is sparse and suggests that it may be starting to decline in health. Main stem bi-furcates but union looks to be Ok at this stage.	7.7	1 potential habitat hollow	377 (109)	Low
30	Stout Paperbark (*Melaleuca preissiana*)	13	69	8-9	7-8	Good	Good		Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage.	6.21			High
31	Stout Paperbark (*Melaleuca preissiana*)	10	84	9-10	9-10	Excellent	Good		Very good specimen of its species. Good aesthetic form/value.	7.56			High
32	Flooded Gum (*Eucalyptus rudis*)	16	72	9-10	9-10	Poor	Acceptable		Canopy is sparse and suggests it may have limited life span remaining. Basal cavity noted.	8.64		376 (110)	Very Low
33	Stout Paperbark (*Melaleuca preissiana*)	11	60	6-7	7-8	Good	Good		Good mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.4			High
34	Stout Paperbark (*Melaleuca preissiana*)	11	61	7-8	7-8	Good	Good		Good mature specimen. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity.	5.49			High
35	Stout Paperbark (*Melaleuca preissiana*)	13	68	7-8	7-8	Good	Good		Good mature specimen. Main stem bi-furcates but union looks to be Ok at this stage.	6.12			High

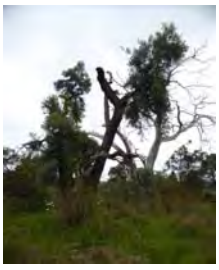
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
36	Stout Paperbark (*Melaleuca preissiana*)	10	73, 50	7-8	9-10	Good	Good		Good mature specimen. Multi-stemmed from ground level possibly more than the one tree. Good aesthetic form/value.	6.57			High
37	Stout Paperbark (*Melaleuca preissiana*)	10	57	6-7	6-7	Good	Good		Good mature specimen.	5.13			High
38	Stout Paperbark (*Melaleuca preissiana*)	11	69	6-7	6-7	Good	Good		Good mature specimen. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity.	6.21			High
39	Stout Paperbark (*Melaleuca preissiana*)	11	73	6-7	6-7	Fair	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form.	7.3			Medium
40	Stout Paperbark (*Melaleuca preissiana*)	10	56	4-5	4-5	Fair	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.6			Medium
41	Flooded Gum (*Eucalyptus rudis*)	20	53, 47, 42	9-10	11-12	Fair	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Multi-stemmed from ground level possibly more than the one tree.	5.3			Low
42	Flooded Gum (*Eucalyptus rudis*)	20	50	8-9	8-9	Fair	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Main stem bi-furcates but union looks to be Ok at this stage.	5			Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
43	Flooded Gum (*Eucalyptus rudis*)	24	88, 54	15-16	9-10	Good	Good		Large mature specimen. Multi-stemmed from ground level. Main stem bi-furcates and evidence of included bark at the union. Union looks to be ok at this time Canopy is one sided (east) due to proximity of adjacent tree	7.92		386 (101)	Medium
44	Flooded Gum (*Eucalyptus rudis*)	24	67, 63, 49	15-16	9-10	Poor	Good		Large mature specimen. Canopy is sparse and suggests it may have limited life span remaining. Main stem furcates into three Some larger dead sections	8.04		387 (102)	Very Low
45	Flooded Gum (*Eucalyptus rudis*)	19	60	12-13	12-13	Fair	Good		Large mature specimen. Canopy is sparse and suggests that it may be starting to decline in health.	6			Low
46	Stout Paperbark (*Melaleuca preissiana*)	11	72	8-9	7-8	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Good aesthetic form/value.	6.48			Medium
47	Stout Paperbark (*Melaleuca preissiana*)	11	71	8-9	7-8	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Good aesthetic form/value.	6.39			Medium
48	Stout Paperbark (*Melaleuca preissiana*)	11	71	8-9	7-8	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Good aesthetic form/value.	6.39			Medium
49	Flooded Gum (*Eucalyptus rudis*)	15	50	8-9	8-9	Fair	Acceptable		Ok specimen. Has grown on a lean but not considered to be of any issue at. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5			Low

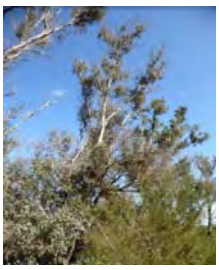
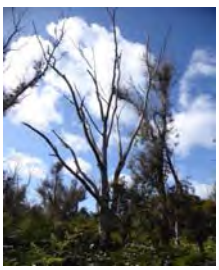
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
50	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	13	50	5-6	5-6	Good	Good		Ok specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	4.5			Medium
51	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	15	52, 47	5-6	9-10	Good	Good		Ok specimen. Main stem bi-furcates but union looks to be Ok at this stage. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	4.68			Medium
52	Stout Paperbark (*Melaleuca preissiana*)	17	58	6-7	8-9	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Part of a large group	5.22			Medium
53	Stout Paperbark (*Melaleuca preissiana*)	11	70	6-7	6-7	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Part of a large group	6.3			Medium
54	Stout Paperbark (*Melaleuca preissiana*)	9	71	6-7	6-7	Good	Questionable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Area of decay and cavity noted and could be impacting structural integrity to some extent. Large basal cavity	6.39			Medium
55	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	11	53	6-7	6-7	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity.	4.77			Medium
56	Flooded Gum (*Eucalyptus rudis*)	23	80	11-12	10-11	Fair	Good		Large mature specimen. Canopy is sparse and suggests that it may be starting to decline in health.	8		378 (111)	Low

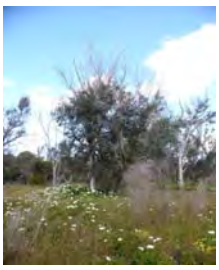
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
57	Flooded Gum (*Eucalyptus rudis*)	23	70	10-11	10-11	Fair	Good		Large mature specimen. Canopy is sparse and suggests that it may be starting to decline in health. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity.	7		379 (112)	Low
58	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	15	81	7-8	7-8	Good	Acceptable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates and evidence of included bark and swelling at the union. Union looks to be ok at this time	7.29			Medium
59	Flooded Gum (*Eucalyptus rudis*)	16	58	9-10	7-8	Fair	Acceptable		Ok specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity. Canopy is one sided south	5.8			Low
60	Flooded Gum (*Eucalyptus rudis*)	19	59	11-12	7-8	Fair	Good		Canopy is sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage. Evidence of previous branch failures (>200mm diameter).	5.9		385 (106)	Low
61	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	15	50, 39	9-10	9-10	Good	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage.	4.5			Medium
62	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	15	57	8-9	8-9	Good	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.13			Medium
63	Flooded Gum (*Eucalyptus rudis*)	18	72	10-11	9-10	Poor	Good		Canopy is very sparse and suggests it may have limited life span remaining. Evidence of previous branch failures (100-200mm diameter).	8.64		382 (105)	Very Low

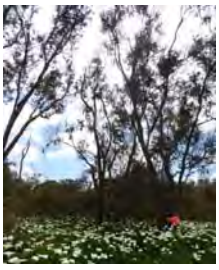
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
64	Flooded Gum (*Eucalyptus rudis*)	18	62	10-11	10-11	Fair	Good		Large mature specimen. Canopy is sparse but what leaf mass is present shows good condition and form.	6.2			Medium
65	Flooded Gum (*Eucalyptus rudis*)	15	70	9-10	9-10	Fair	Acceptable		Area of decay noted but not of a major concern at this time to its structural integrity. Canopy is sparse but what leaf mass is present shows good condition and form.	7			Medium
66	Flooded Gum (*Eucalyptus rudis*)	16	53, 53	9-10	9-10	Dead	Acceptable		Near dead tree. Canopy is sparse and suggests it may have limited life span remaining.	n/a			Very Low
67	Flooded Gum (*Eucalyptus rudis*)	23	73	11-12	11-12	Poor	Acceptable		Canopy condition suggests it may have limited life span remaining. Main stem bi-furcates but union looks to be Ok at this stage. Evidence of previous branch failures (100-200mm diameter).	8.76		383 (104)	Very Low
68	Jarrah (*Eucalyptus marginata*)	16	52	7-8	7-8	Dead	Acceptable		Dead tree. Few epicormic shoots at base but original main stem/part of the tree is dead	n/a			Very Low
69	Jarrah (*Eucalyptus marginata*)	20	89	11-12	10-11	Good	Acceptable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Basal cavity	8.01		80	Medium
70	West Australian Christmas Tree (*Nuytsia floribunda*)	10	53	5-6	4-5	Excellent	Good		Good mature specimen. Good aesthetic form/value.	4.77			**High**

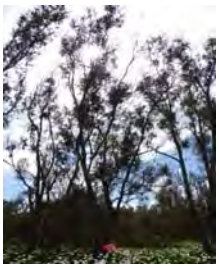
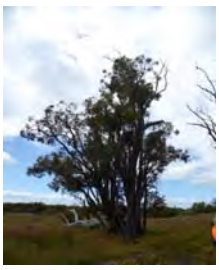
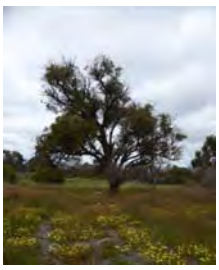
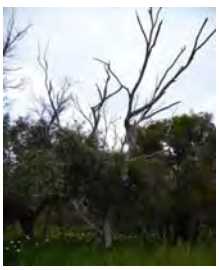
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
71	West Australian Christmas Tree (*Nuytsia floribunda*)	8	58	4-5	4-5	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage.	5.22	Potential habitat hollows		**High**
72	Jarrah (*Eucalyptus marginata*)	20	189	13-15	9-10	Dead	Questionable		Dead tree. Area of decay and cavity noted and could be impacting structural integrity to some extent. Major basal cavity	n/a	7 potential habitat hollows		Very Low
73	West Australian Christmas Tree (*Nuytsia floribunda*)	7	51, 42, 20	4-5	4-5	Fair	Good		Ok specimen. Canopy is sparse and suggests that it may be starting to decline in health. Multi-stemmed from near ground level.	5.1			Low
74	Stout Paperbark (*Melaleuca preissiana*)	11	65	7-8	5-6	Good	Acceptable		Large mature specimen. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Main stem bi-furcates and evidence of included bark at the union. Probably better suited to POS	5.85			Medium
75	Stout Paperbark (*Melaleuca preissiana*)	11	68	7-8	7-8	Good	Acceptable		Large mature specimen. Area of decay and cavity noted but not of a major concern at this time to its structural integrity. Basal cavity Probably better suited to POS	6.12			**High**
76	Stout Paperbark (*Melaleuca preissiana*)	10	73, 32	7-8	7-8	Good	Acceptable		Large mature specimen. Multi-stemmed from ground level. Section of its canopy is dead. Remainder ok Probably better suited to POS	6.57			Medium
77	Flooded Gum (*Eucalyptus rudis*)	14	50, 47	11-12	12-13	Good	Good		Reasonably good specimen. Main stem bi-furcates but union looks to be Ok at this stage. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Low spreading canopy	4.5			Medium

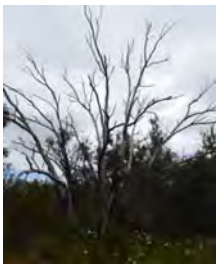
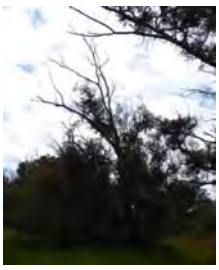
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
78	Jarrah (*Eucalyptus marginata*)	10	52, 27	7-8	7-8	Poor	Acceptable		Multi-stemmed from ground level. Area of decay noted but not of a major concern at this time to its structural integrity. Upper section of its canopy is dead. Suited to POS only	6.24			Low
79	Jarrah (*Eucalyptus marginata*)	14	64	7-8	7-8	Dead	Questionable		Dead tree. Area of decay and cavity noted and could be impacting structural integrity to some extent. Basal cavity	n/a	5 potential habitat hollows		Very Low
80	Common Sheoak (*Allocasuarina fraseriana*)	11	54, 32	7-8	5-6	Excellent	Poor		Multi-stemmed from ground level. Area of decay noted and could be impacting structural integrity to some extent. Section of its canopy have already failed	4.86			Low
81	Jarrah (*Eucalyptus marginata*)	17	87	9-10	8-9	Dead	Questionable		Dead tree. Area of decay and cavity noted but not of a major concern at this time to its structural integrity.	n/a	4 potential habitat hollows	388 (144)	Very Low
82	Flooded Gum (*Eucalyptus rudis*)	20	53	6-7	8-9	Poor	Acceptable		Canopy condition suggests it may have limited life span remaining. Canopy is sparse and apical section of its canopy are dead	6.36			Very Low
83	Flooded Gum (*Eucalyptus rudis*)	22	61	7-8	10-11	Poor	Acceptable		Canopy condition suggests it may have limited life span remaining. Canopy is sparse and apical section of its canopy are dead	7.32			Very Low
84	Flooded Gum (*Eucalyptus rudis*)	18	50	7-8	10-11	Dead	Acceptable		Near dead tree. 90% dead/defoliated	n/a			Very Low

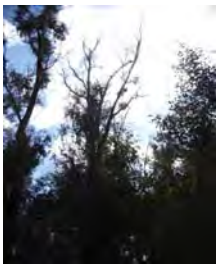
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
85	Flooded Gum (*Eucalyptus rudis*)	22	61	6-7	6-7	Poor	Acceptable		Canopy condition suggests it may have limited life span remaining. Canopy is sparse and apical sections of its canopy are dead	7.32			Very Low
86	Flooded Gum (*Eucalyptus rudis*)	22	63	6-7	8-9	Poor	Acceptable		Canopy condition suggests it may have limited life span remaining. Area of decay noted but not of a major concern at this time to its structural integrity. Fungal bracket on main stem. Canopy is sparse and apical sections of its canopy are dead	7.56			Very Low
87	Flooded Gum (*Eucalyptus rudis*)	18	69	8-9	8-9	Fair	Good		Canopy is relatively sparse but shows signs of recovery although all leaf mas is epicormic shoots	6.9			Low
88	Flooded Gum (*Eucalyptus rudis*)	22	56, 45, 41	11-12	10-11	Poor	Acceptable		Large mature specimen. Multi-stemmed from ground level. Canopy is sparse and apical sections of its canopy are dead	6.72			Very Low
89	Flooded Gum (*Eucalyptus rudis*)	23	55, 54, 50, 46	11-12	10-11	Poor	Acceptable		Large mature specimen. Multi-stemmed from ground level. Canopy condition suggests it may have limited life span remaining. Canopy is sparse and apical sections of its canopy are dead	6.6			Very Low
90	Flooded Gum (*Eucalyptus rudis*)	16	55	9-10	9-10	Dead	Questionable		Dead tree.	n/a			Very Low
91	Flooded Gum (*Eucalyptus rudis*)	17	52, 35	7-8	9-10	Fair	Acceptable		Near dead tree. Main stem bi-furcates and evidence of included bark at the union. Apical sections of its canopy are dead	5.2			Low

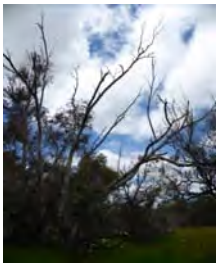
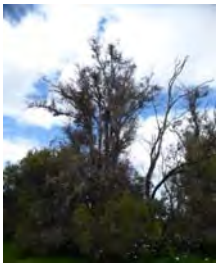
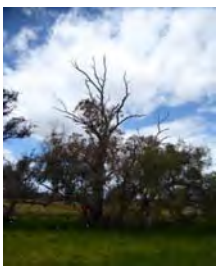
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
92	Flooded Gum (*Eucalyptus rudis*)	17	59	7-8	7-8	Poor	Acceptable		Near dead tree. Canopy is 80-90% dead	7.08			Very Low
93	Flooded Gum (*Eucalyptus rudis*)	17	61	9-10	7-8	Dead	Questionable		Dead tree.	n/a	3 potential habitat hollows		Very Low
94	Flooded Gum (*Eucalyptus rudis*)	16	53, 47	11-12	13-15	Fair	Good		Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates but union looks to be Ok at this stage. looks to recovering canopy although some larger deadwood	5.3			Low
95	Flooded Gum (*Eucalyptus rudis*)	16	54	6-7	6-7	Poor	Acceptable		Canopy condition suggests it may have limited life span remaining. Area of decay noted but not of a major concern at this time to its structural integrity. Top 50% of its canopy is dead	6.48			Very Low
96	Jarrah (*Eucalyptus marginata*)	8	116	3-4	3-4	Fair	Poor		Canopy condition suggests it may have limited life span remaining. Major basal cavity main stem has previously snapped only 15-20% holding wood remaining	11.6			Low
97	Jarrah (*Eucalyptus marginata*)	17	97	8-9	9-10	Fair	Acceptable		Canopy condition suggests it may have limited life span remaining. Canopy is slightly sparse and suggests that it may be starting to decline in health. Area of decay and cavity noted and could be impacting structural integrity to some extent. Major basal cavity large section of main stem has previously snapped fire damage	9.7			Low
98	Jarrah (*Eucalyptus marginata*)	11	56	8-9	7-8	Fair	Acceptable		Ok specimen. Fire damage but looks to be recovering well	5.6			Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
99	Flooded Gum (*Eucalyptus rudis*)	16	73	10-11	9-10	Dead	Questionable		Dead tree.	n/a			Very Low
100	Flooded Gum (*Eucalyptus rudis*)	22	81	16-18	16-18	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Main stem bi-furcates and evidence of included bark at the union. Union looks to be ok at this time	7.29			Medium
101	Flooded Gum (*Eucalyptus rudis*)	21	56, 55, 46, 42	16-18	16-18	Fair	Good		Large mature specimen. Canopy is slightly sparse and suggests that it may be starting to decline in health. Multi-stemmed from near ground level. Sections of its canopy are dead. Remainder sparse but showing some signs of recovery. Area of decay in base but not of any concerns at this time	5.6			Low
102	Flooded Gum (*Eucalyptus rudis*)	21	59, 50	11-12	10-11	Fair	Good		Large mature specimen. Multi-stemmed from ground level. Sections of its canopy are dead. Remainder sparse but showing some signs of recovery	5.9			Low
103	Flooded Gum (*Eucalyptus rudis*)	21	53, 49	10-11	10-11	Poor	Good		Large mature specimen. Multi-stemmed from ground level. Canopy condition suggests it may have limited life span remaining. Sections of its canopy are dead. Remainder sparse and only minor signs of recovery	6.36			Very Low
104	Flooded Gum (*Eucalyptus rudis*)	18	56, 46	9-10	10-11	Poor	Acceptable		Large mature specimen. Main stem bi-furcates and evidence of included bark at the union. Union looks to be ok at this time. Canopy is sparse and only minor signs of recovery	6.72			Very Low
105	Flooded Gum (*Eucalyptus rudis*)	16	55, 38	9-10	10-11	Poor	Acceptable		Large mature specimen. Multi-stemmed from near ground level. Canopy is sparse and only minor signs of recovery	6.6			Very Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
106	Flooded Gum (*Eucalyptus rudis*)	18	52, 46	10-11	8-9	Poor	Acceptable		Main stem bi-furcates but union looks to be Ok at this stage. Canopy is sparse and only minor signs of recovery at this time	6.24			Very Low
107	Jarrah (*Eucalyptus marginata*)	14	53, 46, 24, 22	9-10	9-10	Good	Acceptable		Multi-stemmed from ground level. Looks to be regrowth off/around an old stump/original tree. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Recovering well from recent fire	4.77			Medium
108	Jarrah (*Eucalyptus marginata*)	13	59	8-9	8-9	Dead	Acceptable		Dead tree.	n/a			Very Low
109	Jarrah (*Eucalyptus marginata*)	16	160	8-9	8-9	Good	Questionable		Large mature specimen. Evidence of previous branch failures (>200mm diameter). Major basal cavity; 80% hollow. Large section of canopy has already failed. Suitable for a low (no) Target area only	14.4			Medium
110	Jarrah (*Eucalyptus marginata*)	15	88	9-10	10-11	Fair	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Looks to be recovering well from recent fire	8.8			Medium
111	Flooded Gum (*Eucalyptus rudis*)	14	68	9-10	8-9	Poor	Acceptable		Ok specimen. Upper section of its canopy is dead. Lower canopy ok but mostly epicormic shoots	8.16			Very Low
112	Flooded Gum (*Eucalyptus rudis*)	11	64	6-7	6-7	Dead	Questionable		Dead tree. Area of decay noted and could be impacting structural integrity to some extent.	n/a			Very Low

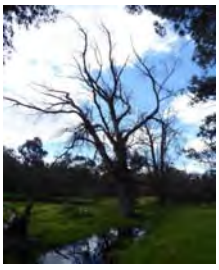
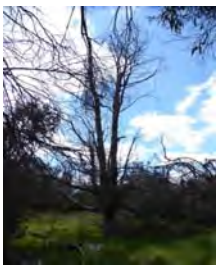
Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
113	Flooded Gum (*Eucalyptus rudis*)	17	79, 75	13-15	12-13	Dead	Questionable		Dead tree. Main stem bi-furcates but union looks to be Ok at this stage. Area of decay noted but not of a major concern at this time to its structural integrity.	n/a			Very Low
114	Flooded Gum (*Eucalyptus rudis*)	18	70	11-12	9-10	Poor	Acceptable		. Top section of its canopy is dead. Lower canopy ok but mostly epicormic shoots	8.4			Very Low
115	Flooded Gum (*Eucalyptus rudis*)	22	94	11-12	9-10	Poor	Acceptable		Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage. Apical section of its canopy is dead and remaining leaf mass is all epicormic shoots. May recover ok given time	11.28		389 (149)	Very Low
116	Flooded Gum (*Eucalyptus rudis*)	22	67	12-13	9-10	Poor	Acceptable		Large mature specimen. Evidence of previous branch failures (>200mm diameter). Apical sections of its canopy are dead and remaining leaf mass is all epicormic shoots. May recover ok given time Better suited to POS	8.04			Very Low
117	Flooded Gum (*Eucalyptus rudis*)	23	75, 73	10-11	18-20	Fair	Acceptable		Large mature specimen. Multi-stemmed from near ground level. Apical sections of its canopy are dead and remaining leaf mass is all epicormic shoots. May recover ok given time. Better suited to POS	7.5			Low
118	Stout Paperbark (*Melaleuca preissiana*)	10	68	6-7	9-10	Fair	Good		Large mature specimen. Canopy is sparse and suggests that it may be starting to decline in health. Better suited to POS	6.8			Low
119	Flooded Gum (*Eucalyptus rudis*)	14	62, 59	10-11	15-16	Dead	Questionable		Dead tree. Multi-stemmed from near ground level. Area of decay noted and could be impacting structural integrity to some extent.	n/a			Very Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
120	Flooded Gum (*Eucalyptus rudis*)	22	65	8-9	9-10	Poor	Acceptable		Large mature specimen. Canopy condition suggests it may have limited life span remaining. Top section of its canopy is dead. Lower canopy sparse	7.8			Very Low
121	Flooded Gum (*Eucalyptus rudis*)	22	50	5-6	7-8	Poor	Questionable		Large mature specimen. Canopy condition suggests it may have limited life span remaining. Area of decay noted but not of a major concern at this time to its structural integrity. Top section of its canopy is dead. Lower canopy sparse. Upper canopy has grown on an angle east	6			Very Low
122	Flooded Gum (*Eucalyptus rudis*)	22	52	7-8	4-5	Poor	Acceptable		Large mature specimen. Top section of its canopy is dead. Lower canopy sparse but may recover over time	6.24			Very Low
123	Flooded Gum (*Eucalyptus rudis*)	22	96	5-6	13-15	Dead	Questionable		Dead tree. Area of decay noted and could be impacting structural integrity to some extent.	n/a			Very Low
124	Flooded Gum (*Eucalyptus rudis*)	21	59	6-7	10-11	Poor	Acceptable		Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage. Upper section of its canopy is dead. Remainder ok but sparse. May recover over time	7.08			Very Low
125	Stout Paperbark (Melaleuca preissiana)	9	59	6-7	6-7	Fair	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.9			Medium
126	Flooded Gum (*Eucalyptus rudis*)	18	64	6-7	6-7	Fair	Acceptable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean but not considered to be of any issue at this time to its structural or in-ground integrity.	6.4		391 (156)	Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
127	Flooded Gum (*Eucalyptus rudis*)	14	55, 35, 30	9-10	9-10	Dead	Acceptable		Dead tree. Multi-stemmed from ground level.	n/a			Very Low
128	Flooded Gum (*Eucalyptus rudis*)	22	95	11-12	12-13	Fair	Acceptable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Some section of its canopy are dead. Remainder ok at this time	9.5			Low
129	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	8	57	3-4	4-5	Good	Good		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.13			Medium
130	Flooded Gum (*Eucalyptus rudis*)	18	77	6-7	12-13	Fair	Good		Large mature specimen. Main stem bi-furcates but union looks to be Ok at this stage. Apical section of its canopy is dead. Remainder ok and may recover over time	7.7			Low
131	Flooded Gum (*Eucalyptus rudis*)	16	63	6-7	11-12	Fair	Good		Large mature specimen. Canopy is sparse	6.3			Low
132	Flooded Gum (*Eucalyptus rudis*)	17	89	6-7	10-11	Fair	Good		Large mature specimen. Canopy is sparse but may recover over time	8.9		393 (164)	Low
133	Flooded Gum (*Eucalyptus rudis*)	16	72	8-9	8-9	Poor	Good		Large mature specimen. Top section of its canopy is dead. Lower canopy ok but mostly epicormic shoots	8.64			Very Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
134	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	8	55	6	8	Excellent	Good		Good mature specimen. Good individual tree as well as being on edge of the larger group of trees	4.95			**High**
160	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	8	55	7	8	Excellent	Good		Very good mature specimen. Good individual tree as well as being on the edge of the larger group	4.95			**High**
172	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	8	50	5	5	Excellent	Good		Multi-stemmed from ground level. One stem looks to have recently failed. **Low retention value**	4.5			Low
173	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	8	50	6	6	Excellent	Good		Ok mature specimen. Sections of canopy are slightly sparse. Looks to have previously snapped	4.5			Medium
175	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	11	65	10	8	Excellent	Good		Reasonably good specimen. Effectively forms part of a group with 176-179; suggest retain as a group	5.85			**High**
179	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	11	50	7	7	Excellent	Good		Good mature specimen. Effectively forms part of a group with 175-178; suggest retain as a group but this one could be an individual tree if necessary	4.5			Medium
180	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	11	80	9	8	Excellent	Good		Good mature specimen. On edge of 175-179 group. Branch failure has occurred but overall ok	7.2			**High**

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
181	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	11	100 (approx .)	11	10	Excellent	Good		Large mature very good specimen. Good individual tree. Structure probably limits potential for transplanting	9			**High**
182	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	9	100 (approx .)	9	9	Excellent	Good		Good mature specimen. Multi-stemmed from ground level and one stem has failed but otherwise ok	9			**High**
183	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	9	60, 30 x30	8	7	Excellent	Good		Good mature specimen. Canopy is slightly sparse but otherwise ok	5.4			Medium
190	Freshwater Paperbark (*Melaleuca rhaphiophylla*)	10	65	8	9	Excellent	Good		Good mature specimen. Canopy could be raised in this instance if required	5.85			Medium
301	Flooded Gum (*Eucalyptus rudis*)	11	56	7-8	7-8	Fair	Good		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	5.6			Medium
302	Flooded Gum (*Eucalyptus rudis*)	14	58	9-10	7-8	Fair	Good		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Looks to be recovering ok	5.8			Medium
303	Flooded Gum (*Eucalyptus rudis*)	18	181	13-15	13-15	Poor	Questionable		Large mature specimen. Area of decay and cavity noted and could be impacting structural integrity to some extent. Canopy is sparse and large sections of its canopy are dead. Major basal cavity	15	2 potential habitat hollows		Very Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
304	Tasmanian Blue Gum (*Eucalyptus globulus*)	15	52	7-8	8-9	Good	Questionable		Canopy is slightly sparse and suggests that it may be starting to decline in health. Has grown on a lean and its lean could be a concern to its structural or in-ground stability. Low retention value	4.68			Very Low
305	Tasmanian Blue Gum (*Eucalyptus globulus*)	17	69	8-9	8-9	Good	Questionable		Canopy is slightly sparse and suggests that it may be starting to decline in health. Has grown on a lean and its lean could be a concern to its structural or in-ground stability. Low retention value	6.21			Very Low
306	Tasmanian Blue Gum (*Eucalyptus globulus*)	15	88	8-9	11-12	Dead	Questionable		Dead tree. Has grown on a lean and its lean could be a concern to its structural or in-ground stability.	n/a			Very Low
307	Tasmanian Blue Gum (*Eucalyptus globulus*)	16	76	7-8	10-11	Dead	Questionable		Dead tree. Main stem bi-furcates but union looks to be Ok at this stage.	n/a			Very Low
308	Tasmanian Blue Gum (*Eucalyptus globulus*)	23	89	7-8	8-9	Good	Good		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	8.01			Very Low
309	Tasmanian Blue Gum (*Eucalyptus globulus*)	23	84	7-8	8-9	Good	Questionable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean and its lean could be a concern to its structural or in-ground stability to its structural or in-ground stability. Main stem bi-furcates. Low retention value	7.56			Very Low
310	Tasmanian Blue Gum (*Eucalyptus globulus*)	21	72	7-8	9-10	Good	Questionable		Large mature specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Has grown on a lean and its lean could be a concern to its structural or in-ground stability to its structural or in-ground stability. Main stem bi-furcates. Termites and decay in base of main stem. Low retention value	6.48			Very Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
311	Flooded Gum (*Eucalyptus rudis*)	13	85	5-6	9-10	Fair	Poor		Canopy condition suggests it may have limited life span remaining. Area of decay and cavity noted and could be impacting structural integrity to some extent. Major basal cavity and large section of its canopy has already failed	8.5			Very Low
312	Flooded Gum (*Eucalyptus rudis*)	19	77, 69	13-15	12-13	Dead	Questionable		Dead tree. Main stem bi-furcates but union looks to be Ok at this stage. Just outside existing fence	n/a			Very Low
313	Flooded Gum (*Eucalyptus rudis*)	13	59	9-10	9-10	Poor	Acceptable		Near dead tree with <10% live leaf mass remaining	7.08			Very Low
314	Lemon Scented Gum (*Corymbia citriodora*)	19	63, 57	16-18	16-18	Excellent	Acceptable		Large mature specimen. Good aesthetic form/value. Main stem bi-furcates and evidence of included bark and swelling at the union. Union looks to be ok at this time but may cause issues longer term. Probably better suited to POS	5.67			**High**
315	Bangalay (*Eucalyptus botryoides*)	17	91	13-15	15-16	Excellent	Acceptable		Large mature specimen. Good aesthetic form/value. Evidence of previous branch failures (100-200mm diameter). Looks to have been storm damage. Probably better suited to POS	8.19			Medium
316	Flooded Gum (*Eucalyptus rudis*)	17	102	12-13	13-15	Poor	Good		Large mature specimen. Canopy is sparse. Large sections of its canopy are dead	12.24			Very Low
317	Flooded Gum (*Eucalyptus rudis*)	15	72	3-4	3-4	Dead	Poor		Dead tree. Leaning into adjacent tree and possibly partially collapsed	n/a	1 potential habitat hollow		Very Low

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
318	Flooded Gum (*Eucalyptus rudis*)	15	72	9-10	10-11	Fair	Good		Large mature specimen. Canopy is sparse but what leaf mass is present shows good condition and form. Area of decay noted but not of a major concern at this time to its structural integrity.	7.2			Medium
319	Flooded Gum (*Eucalyptus rudis*)	19	129, 85	15-16	20-22	Poor	Acceptable		Large mature specimen. Evidence of previous branch failures (>200mm diameter). Two trees in close proximity that effectively form the one canopy. Both very sparse with large section of deadwood	15			Very Low
320	Flooded Gum (*Eucalyptus rudis*)	12	66, 61	9-10	9-10	Fair	Acceptable		Ok specimen. Main stem bi-furcates but union looks to be Ok at this stage. Canopy is sparse and lot of leaf insect damage. Bees noted in potential habitat hollow	6.6	1 potential habitat hollow		Medium
321	Flooded Gum (*Eucalyptus rudis*)	12	69, 65, 49	9-10	7-8	Poor	Questionable		Near dead tree. Area of decay noted and could be impacting structural integrity to some extent. Evidence of previous branch failures (>200mm diameter). Main stem furcates into three. Canopy is sparse and lot of Lerp damage	8.28			Very Low
322	Flooded Gum (*Eucalyptus rudis*)	14	54	7-8	7-8	Good	Good		Good mature specimen. Good aesthetic form/value. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Lerp damage but should recover over time	4.86			Medium
323	Bangalay (*Eucalyptus botryoides*)	16	57, 46, 42	12-13	9-10	Excellent	Acceptable		Ok specimen. Main stem bi-furcates and evidence of included bark and swelling at the union. Evidence of a broken (hanging) branch in the canopy. Union looks to be ok at this time but may cause issues longer term	5.13			Medium
324	River Red Gum (*Eucalyptus camaldulensis 'Camaldulensis'*)	16	75	8-9	8-9	Good	Good		Reasonably good specimen. Canopy is slightly sparse but what leaf mass is present shows good condition and form.	6.75			Medium

Tree ID	Species	Approx. Height (metres)	DBH (cm)	Canopy Spread (metres diameter)		Health	Structure	Image	Comments	TPZ (metres RADIUS)	Potential Habitat Hollows Noted	Previous Tag#	Retention Value
				N-S	E-W								
325	Jarrah (*Eucalyptus marginata*)	18	77	10-11	9-10	Dead	Questionable		Dead tree. Area of decay noted and could be impacting structural integrity to some extent.	n/a	1 potential habitat hollow		Very Low
326	Flooded Gum (*Eucalyptus rudis*)	8	69	9-10	9-10	Good	Good		Reasonably good specimen. Main stem bi-furcates but union looks to be Ok at this stage. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Low canopy	6.21			Medium
327	Flooded Gum (*Eucalyptus rudis*)	12	62, 56	12-13	11-12	Fair	Good		Reasonably good specimen. Multi-stemmed from near ground level. Canopy is slightly sparse but what leaf mass is present shows good condition and form. Low canopy. Section of its canopy is dead but remainder ok	6.2			Low

6. Further Considerations; Development Design and Construction

6.1 Protection of Trees as part of Development

It is difficult to provide any further specific comments for each Tree as to the potential of the impact from the development of this Site at this stage, as much of the impact caused will be very much dependent on the detailed design aspects of any proposed development.

The retention of the existing current ground level and soil profile within a Tree's designated TPZ will however be of paramount and key importance in the success of the retention of any Tree.

Effective tree protection must also begin with good design and specifications, so that protection during the construction/landscape stages of a development will be achievable and practicably possible.

As an initial recommendation:

1. Efforts are recommended to be spent on the inclusion of the Trees with high retention value.
2. The Very Low and Low retention value Trees are recommended to be excluded from the development and removed as part of development works unless the design of the area around them takes sufficient measures to address the potential risks associated with those Trees, in which case they may be able to be retained for purposes of habitat if desired.
3. The TPZ of each Tree is strongly recommended to be overlaid onto all drawings and designs of the proposed development where the Tree is proposed to be retained.

   Where encroachments into a designated TPZ are found to be required, further discussion with an experienced independent arboricultural consultant is an important part of the tree protection process.

   This is not to say that some encroachment and development activity would not be permitted to be undertaken within a TPZ area as part of a development process. However any encroachment required/proposed will require further input and discussion with the arboricultural consultant as part of any detailed design process to determine what the potential impact on the given Tree will be, and what design modifications or measures may need to be implemented to mitigate any potential negative impact on the given Tree.

   If considered necessary, some exploratory excavation works may also be required to verify actual root spread and determine what impact could occur.

Aspects such as resulting levels, delineation of any underground service pipework, drainage, sewerage etc. can all have (potentially) a major impact on a tree's root zone, and in turn its future health and potential lifespan.

During the design process further arboricultural input will likely be required to discuss:

- Current existing ground levels and proposed resulting levels of the various areas of the Site. Note: As previously mentioned, retaining and maintaining current existing ground levels within the designated TPZ of any tree is of paramount importance to the success of tree retention.
- Delineation of <u>any</u> underground services pipework including drainage, sewerage, water, gas, electricity, telecommunications and the like; specifically should they pass through any designated TPZ.
- Location of any drainage near to the Trees and their TPZ.
- Any site remediation requirements within TPZ areas as part of the Site clearing process.

6. Further Considerations; Development Design and Construction

6.2 Physical Protection of Trees during Development

Physical protection measures in accordance with AS 4970 will also be required for any Tree selected for retention; details of any measures to be implemented will be very much dependent on the final detailed design.

It will be of critical importance that the appropriate protection measures are set up and maintained from the outset; i.e. before any Site clearing/demolition works commence.

Implementing tree protection measures after damage has occurred from works is often of little to no value other than affording some protection from further damages occurring.

6.3 Canopy Works

Canopy works are likely to be required on a number of the Trees as part of the development process.

The extent of canopy works on each Tree is however very much dependent on the eventual landscape around the Tree and what potential targets (people, structures etc.) may eventually be within the given Tree's projected fall zone.

At this stage canopy works are likely to be restricted to the removal of any larger diameter deadwood (i.e. any dead branches 50mm or greater in diameter) and/or the raising of canopy's where necessary to provide clearances for future footpaths, structures and/or roads.

Other canopy works may be required pending results of detailed design and what targets will be within the given Tree's projected fall zone.

All canopy works are recommended to be undertaken by suitably qualified and experienced tree surgeons, who possess a minimum qualification of AQF certificate 3 arboriculture, or recognised equivalent qualification.

All canopy pruning works must also comply with Australian Standards 4373; Pruning of Amenity Trees.

Attachments to this Report

Attachment 1; Tree Location Guide

Attachment 2; Tree Location Guide with retention value overlaid

Attachment 3; Glossary of Arboricultural Terms

Attachment 4; Company Information & Disclaimer

Attachment 2; Tree Location Guide

All Trees located to GDA 1994 MGA Zone 50 datum

All Trees have been tagged on Site with a metal identification plate referring to its corresponding data within the table provided in this report

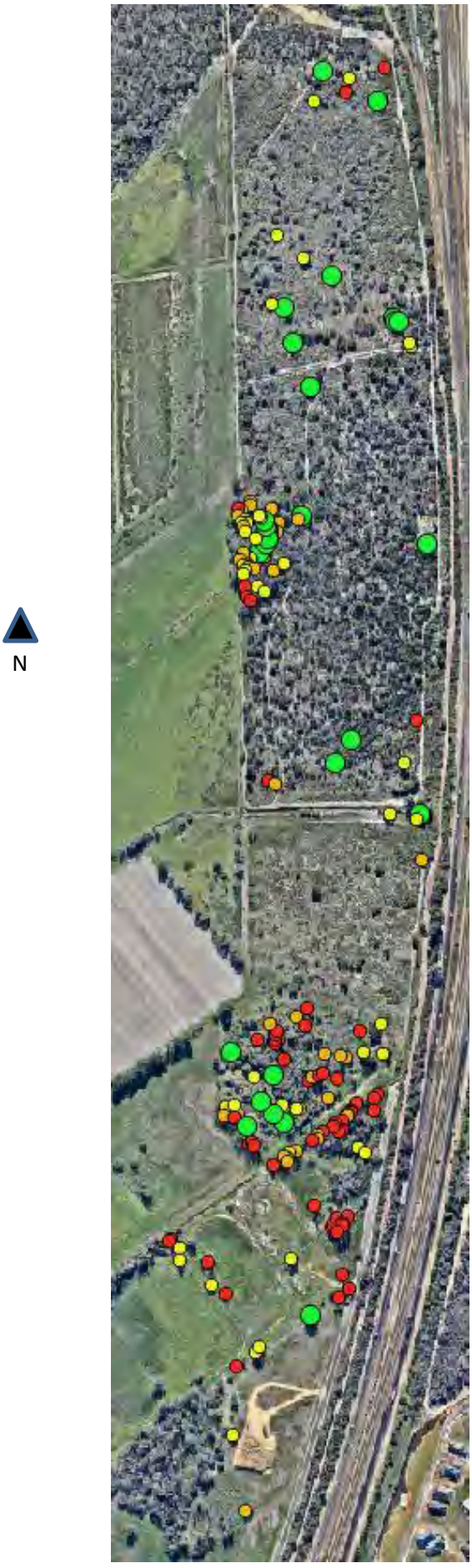


Aerial Source; Nearmap.com

Attachment 2; Tree Location Guide (with retention value overlaid)

Key

●	High Retention Value	Tree of particular note due to size, age, condition, species
●	Medium Retention Value	Reasonably good/good Tree
●	Low Retention Value	Trees displaying reduced health and/or questionable structural form but considered ok for low target areas of POS
●	Very Low Retention Value	Trees with poor structure, possibly limited life span remaining, undesirable species



Aerial Source; Nearmap.com

Attachment 3; Glossary of Arboricultural Terms

GLOSSARY OF ARBORICULTURAL TERMS

Abscission. The shedding of a leaf or other short-lived part of a woody plant, involving the formation of a corky layer across its base; in some tree species twigs can be shed in this way

Abiotic. Pertaining to non-living agents; e.g. environmental factors

Absorptive roots. Non-woody, short-lived roots, generally having a diameter of less than one millimetre, the primary function of which is uptake of water and nutrients

Adaptive growth. In tree biomechanics, the process whereby the rate of wood formation in the cambial zone, as well as wood quality, responds to gravity and other forces acting on the cambium This helps to maintain a uniform distribution of mechanical stress

Adaptive roots. The adaptive growth of existing roots; or the production of new roots in response to damage, decay or altered mechanical loading

Adventitious shoots. Shoots that develop other than from apical, axillary or dormant buds; see also 'epicormic'

Anchorage. The system whereby a tree is fixed within the soil, involving cohesion between roots and soil and the development of a branched system of roots which withstands wind and gravitational forces transmitted from the aerial parts of the tree

Architecture. In a tree, a term describing the pattern of branching of the crown or root system

Axil. The place where a bud is borne between a leaf and its parent shoot

Bacteria. Microscopic single-celled organisms, many species of which break down dead organic matter, and some of which cause diseases in other organisms

Bark. A term usually applied to all the tissues of a woody plant lying outside the vascular cambium, thus including the phloem, cortex and periderm; occasionally applied only to the periderm or the phellem

Basidiomycotina (Basidiomycetes). One of the major taxonomic groups of fungi; their spores are borne on microscopic peg-like structures (basidia), which in many types are in turn borne on or within conspicuous fruit bodies, such as brackets or toadstools. Most of the principal decay fungi in standing trees are basidiomycetes

Bolling. A term sometimes used to describe pollard heads

Bottle-butt. A broadening of the stem base and buttresses of a tree, in excess of normal and sometimes denoting a growth response to weakening in that region, especially due to decay involving selective delignification

Bracing. The use of rods or cables to restrain the movement between parts of a tree

Branch:

- **Primary.** A first order branch arising from a stem
- **Lateral.** A second order branch, subordinate to a primary branch or stem and bearing sub-lateral branches
- **Sub-lateral.** A third order branch, subordinate to a lateral or primary branch, or stem and usually bearing only twigs

Branch bark ridge. The raised arc of bark tissues that forms within the acute angle between a branch and its parent stem

Branch collar. A visible swelling formed at the base of a branch whose diameter growth has been disproportionately slow compared to that of the parent stem; a term sometimes applied also to the pattern of growth of the cells of the parent stem around the branch base

Brown-rot. A type of wood decay in which cellulose is degraded, while lignin is only modified

Buckling. An irreversible deformation of a structure subjected to a bending load

Buttress zone. The region at the base of a tree where the major lateral roots join the stem, with buttress-like formations on the upper side of the junctions

Cambium. Layer of dividing cells producing xylem (woody) tissue internally and phloem (bark) tissue externally

Canker. A persistent lesion formed by the death of bark and cambium due to colonisation by fungi or bacteria

Canopy species. Tree species that mature to form a closed woodland canopy

Cleaning out. The removal of dead, crossing, weak, and damaged branches, where this will not damage or spoil the overall appearance of the tree

Compartmentalization. The confinement of disease, decay or other dysfunction within an anatomically discrete region of plant tissue, due to passive and/or active defences operating at the boundaries of the affected region

Compression strength. The ability of a material or structure to resist failure when subjected to compressive loading; measurable in trees with special drilling devices

Compressive loading. Mechanical loading which exerts a positive pressure; the opposite to tensile loading

Condition. An indication of the physiological vitality of the tree. Where the term 'condition' is used in a report, it should not be taken as an indication of the stability of the tree

Construction exclusion zone. Area based on the Root Protection Area (in square metres) to be protected during development, by the use of barriers and/or ground protection

Crown/Canopy. The main foliage bearing section of the tree

Crown lifting. The removal of limbs and small branches to a specified height above ground level

Crown thinning. The removal of a proportion of secondary branch growth throughout the crown to produce an even density of foliage around a well-balanced branch structure

Crown reduction/shaping. A specified reduction in crown size whilst preserving, as far as possible, the natural tree shape

Crown reduction/thinning. Reduction of the canopy volume by thinning to remove dominant branches whilst preserving, as far as possible the natural tree shape

Deadwood. Dead branch wood

Decurrent. In trees, a system of branching in which there is a well defined central main stem, bearing branches which are limited in their length, diameter and secondary branching (cf. excurrent) In fungi with toadstools as fruit bodies, the description of gills which run some distance down the stem, rather than terminating abruptly

Defect. In relation to tree hazards, any feature of a tree which detracts from the uniform distribution of mechanical stress, or which makes the tree mechanically unsuited to its environment

Delamination. The separation of wood layers along their length, visible as longitudinal splitting

Dieback. The death of parts of a woody plant, starting at shoot-tips or root-tips

Disease. A malfunction in or destruction of tissues within a living organism, usually excluding mechanical damage; in trees, usually caused by pathogenic micro-organisms

Distal. In the direction away from the main body of a tree or subject organism (cf. proximal)

Dominance. In trees, the tendency for a leading shoot to grow faster or more vigorously than the lateral shoots; also the tendency of a tree to maintain a taller crown than its neighbours

Dormant bud. An axial bud which does not develop into a shoot until after the formation of two or more annual wood increments; many such buds persist through the life of a tree and develop only if stimulated to do so

Dysfunction. In woody tissues, the loss of physiological function, especially water conduction, in sapwood

DBH (Diameter at Breast Height). Stem diameter measured at a height of 1.5 metres (UK) or the nearest measurable point. Where measurement at a height of 1.5 metres is not possible, another height may be specified

Deadwood. Branch or stem wood bearing no live tissues. Retention of deadwood provides valuable habitat for a wide range of species and seldom represents a threat to the health of the tree. Removal of deadwood can result in the ingress of decay to otherwise sound tissues and climbing operations to access deadwood can cause significant damage to a tree. Removal of deadwood is generally recommended only where it represents an unacceptable level of hazard

Endophytes. Micro-organisms which live inside plant tissues without causing overt disease, but in some cases capable of causing disease if the tissues become physiologically stressed, for example by lack of moisture

Epicormic shoot. A shoot having developed from a dormant or adventitious bud and not having developed from a first year shoot

Excrescence. Any abnormal outgrowth on the surface of tree or other organism

Excurrent. In trees, a system of branching in which the crown is borne on a number of major widely-spreading and secondarily branched limbs (cf. excurrent)

Felling licence. In the UK, a permit to fell trees in excess of a stipulated number of stems or volume of timber

Flush-cut. A pruning cut which removes part of the branch bark ridge and or branch-collar

Girdling root. A root which circles and constricts the stem or roots possibly causing death of phloem and/or cambial tissue

Guying a form of artificial support with cables for trees with a temporarily inadequate anchorage

Habit. The overall growth characteristics, shape of the tree and branch structure

Hazard beam. An upwardly curved part of a tree in which strong internal stresses may occur without being reduced by adaptive growth; prone to longitudinal splitting

Heartwood/false-heartwood/ripewood. Sapwood that has become dysfunctional as part of the natural aging processes

Heave. A term mainly applicable to a shrinkable clay soil which expands due to re-wetting after the felling of a tree which was previously extracting moisture from the deeper layers; also the lifting of pavements and other structures by root diameter expansion; also the lifting of one side of a wind-rocked root-plate

High canopy tree species. Tree species having potential to contribute to the closed canopy of a mature woodland or forest

Incipient failure. In wood tissues, a mechanical failure which results only in deformation or cracking, and not in the fall or detachment of the affected part

Included bark (ingrown bark). Bark of adjacent parts of a tree (usually forks, acutely joined branches or basal flutes) which is in face-to-face contact

Increment borer. A hollow auger, which can be used for the extraction of wood cores for counting or measuring wood increments or for inspecting the condition of the wood

Infection. The establishment of a parasitic micro-organism in the tissues of a tree or other organism

Internode. The part of a stem between two nodes; not to be confused with a length of stem which bear nodes but no branches

Lever arm. A mechanical term denoting the length of the lever represented by a structure that is free to move at one end, such as a tree or an individual branch

Lignin. The hard, cement-like constituent of wood cells; deposition of lignin within the matrix of cellulose microfibrils in the cell wall is termed Lignification

Lions tailing. A term applied to a branch of a tree that has few if any side-branches except at its end, and is thus liable to snap due to end-loading

Loading. A mechanical term describing the force acting on a structure from a particular source; e.g. the weight of the structure itself or wind pressure

Longitudinal. Along the length (of a stem, root or branch)

Lopping. A term often used to describe the removal of large branches from a tree, but also used to describe other forms of cutting

Mature Heights (approximate)**:**

- **Low maturing –** less than 8 metres high
- **Moderately high maturing –** 8 – 12 metres high
- **High maturing –** greater than 12 metres high

Microdrill. An electronic rotating steel probe, which when inserted into woody tissue provides a measure of tissue density

Minor deadwood. Deadwood of a diameter less than 25mm and or unlikely to cause significant harm or damage upon impact with a target beneath the tree

Mulch. Material laid down over the rooting area of a tree or other plant to help conserve moisture; a mulch may consist of organic matter or a sheet of plastic or other artificial material

Mycelium. The body of a fungus, consisting of branched filaments (hyphae)

Occluding tissues. A general term for the roll of wood, cambium and bark that forms around a wound on a woody plant (cf. woundwood)

Occlusion. The process whereby a wound is progressively closed by the formation of new wood and bark around it

Pathogen. A micro-organism which causes disease in another organism

Photosynthesis. The process whereby plants use light energy to split hydrogen from water molecules, and combine it with carbon dioxide to form the molecular building blocks for synthesizing carbohydrates and other biochemical products.

Phytotoxic. Toxic to plants

Pollarding. The removal of the tree canopy, back to the stem or primary branches. Pollarding may involve the removal of the entire canopy in one operation, or may be phased over several years. The period of safe retention of trees having been pollarded varies with species and individuals. It is usually necessary to re-pollard on a regular basis, annually in the case of some species.

Primary branch. A major branch, generally having a basal diameter greater than 0.25 x stem diameter

Primary root zone. The soil volume most likely to contain roots that are critical to the health and stability of the tree and normally defined by reference to Table 1 of BS5837 (1991) Guide for Trees in Relation to Construction.

Priority. Works may be prioritised, 1. = high, 5. = low

Probability. A statistical measure of the likelihood that a particular event might occur

Proximal. In the direction towards from the main body of a tree or other living organism (cf. distal)

Pruning. The removal or cutting back of twigs or branches, sometimes applied to twigs or small branches only, but often used to describe most activities involving the cutting of trees or shrubs

Radial. In the plane or direction of the radius of a circular object such as a tree stem

Rams-horn. In connection with wounds on trees, a roll of occluding tissues which has a spiral structure as seen in cross-section

Rays. Strips of radially elongated parenchyma cells within wood and bark. The functions of rays include food storage, radial translocation and contributing to the strength of wood

Red-rot. A form of decay in which reddish pigments are present but which is biochemically a white-rot; not to be confused with brown-rots which sometimes also have a reddish-brown colour

Reactive Growth/Reaction Wood. Production of woody tissue in response to altered mechanical loading; often in response to internal defect or decay and associated strength loss (cf. adaptive growth)

Removal of dead wood. Unless otherwise specified, this refers to the removal of all accessible dead, dying and diseased branchwood and broken snags

Removal of major dead wood. The removal of, dead, dying and diseased branchwood above a specified size

Respacing. Selective removal of trees from a group or woodland to provide space and resources for the development of retained trees.

Residual wall. The wall of non-decayed wood remaining following decay of internal stem, branch or root tissues

Root-collar. The transitional area between the stem/s and roots

Root-collar examination. Excavation of surfacing and soils around the root-collar to assess the structural integrity of roots and/or stem

Root protection area. An area of ground surrounding a tree that contains sufficient rooting volume to ensure the tree's survival. Calculated with reference to Table 2 of BS5837 (2005) and shown in plan form in square metres

Root zone. Area of soils containing absorptive roots of the tree/s described

microscopic and dispersed in air or water. The **Primary** root zone is that which we consider of primary importance to the physiological well-being of the tree

Sapwood. Living xylem tissues

Secondary branch. A branch, generally having a basal diameter of less than 0.25 x stem diameter

Selective delignification. A kind of wood decay (white-rot) in which lignin is degraded faster than cellulose

Shedding. In woody plants, the normal abscission, rotting off or sloughing of leaves, floral parts, twigs, fine roots and bark scales

Silvicultural thinning. Removal of selected trees to favour the development of retained specimens to achieve a management objective

Simultaneous white-rot. A kind of wood decay in which lignin and cellulose are degraded at about the same rate

Snag. In woody plants, a portion of a cut or broken stem, branch or root which extends beyond any growing-point or dormant bud; a snag usually tends to die back to the nearest growing point

Soft-rot. A kind of wood decay in which a fungus degrades cellulose within the cell walls, without any general degradation of the wall as a whole

Spores. Propagules of fungi and many other life-forms; most spores are
Shrub species. Woody perennial species forming the lowest level of woody plants in a woodland and not normally considered to be trees

Sporophore. The spore bearing structure of fungi

Sprouts. Adventitious shoot growth erupting from beneath the bark

Stem/s. The main supporting structure/s, from ground level up to the first major division into branches

Stress. In plant physiology, a condition under which one or more physiological functions are not operating within their optimum range, for example due to lack of water, inadequate nutrition or extremes of temperature

Stress. In mechanics, the application of a force to an object

Stringy white-rot. The kind of wood decay produced by selective delignification

Storm. A layer of tissue which supports the fruit bodies of some types of fungi, mainly ascomycetes

Structural roots. Roots, generally having a diameter greater than ten millimetres, and contributing significantly to the structural support and stability of the tree

Subsidence. In relation to soil or structures resting in or on soil, a sinking due to shrinkage when certain types of clay soil dry out, sometimes due to extraction of moisture by tree roots

Subsidence. In relation to branches of trees, a term that can be used to describe a progressive downward bending due to increasing weight

Taper. In stems and branches, the degree of change in girth along a given length

Target canker. A kind of perennial canker, containing concentric rings of dead occluding tissues

Targets. In tree risk assessment (with slight misuse of normal meaning) persons or property or other things of value which might be harmed by mechanical failure of the tree or by objects falling from it

Topping. In arboriculture, the removal of the crown of a tree, or of a major proportion of it

Torsional stress. Mechanical stress applied by a twisting force

Translocation. In plant physiology, the movement of water and dissolved materials through the body of the plant

Transpiration. The evaporation of moisture from the surface of a plant, especially via the stomata of leaves; it exerts a suction which draws water up from the roots and through the intervening xylem cells

Understorey. A layer of vegetation beneath the main canopy of woodland or forest or plants forming this

Understorey tree species. Tree species not having potential to attain a size at which they can contribute to the closed high canopy of a woodland

Vascular wilt. A type of plant disease in which water-conducting cells become dysfunctional

Vessels. Water-conducting cells in plants, usually wide and long for hydraulic efficiency; generally not present in coniferous trees

Veteran tree. A loosely defined term for an old specimen that is of interest biologically, culturally or aesthetically because of its age, size or condition and which has usually lived longer than the typical upper age range for the species concerned

White-rot. A range of kinds of wood decay in which lignin, usually together with cellulose and other wood constituents, is degraded

Wind exposure. The degree to which a tree or other object is exposed to wind, both in terms of duration and velocity

Wind pressure. The force exerted by a wind on a particular object

Windthrow. The blowing over of a tree at its roots

Wound dressing. A general term for sealants and other materials used to cover wounds in the hope of protecting them against desiccation and infection; only of proven value against fresh wound parasites

Woundwood. Wood with atypical anatomical features, formed in the vicinity of a wound'

Attachment 4; Company Information & Disclaimer

Company Name:	ARBOR logic
A.C.N.:	107 194 061
A.B.N.:	66 566 369 687

Insurance Details:

General Liability;	QBE	$20 million
Professional Indemnity;	Vero	$10 million
Personal Protection;	Macquarie, Asteron	

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Disclaimer

This Report has been provided in good faith and based upon the material information provided by the Client to Arbor logic, and/or based on the visual inspection of the tree(s) at the time this advice was prepared.

The contents of this Report should be read in full, and at no time shall any part of the Report be referred to unless taken in full context with the remainder of the document.

The contents of this Report may not be reissued to another party or published in part or full without Arbor logic's written permission.

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- Material information not being provided by the Client to Arbor logic at the time this advice was prepared.
- The provision of misleading or incorrect information by the Client or any other party to Arbor logic upon which this advice was prepared.
- This advice being used by the Client or any other party in circumstances or situations other than the specific subject of this advice.
- Failure by the Client to follow this advice.
- The action(s) or inaction(s) of the Client or any other party that gives rise to the loss of, or damage to, the tree(s) that are the subject of this advice.

It is also important to take into consideration that all trees are living organisms and as such there are many variables that can affect their health and structural properties that remain beyond the scope of reasonable management practices or the advice provided in this Report based on the visual inspection of the tree(s).

As such a degree of risk will still remain with any given tree(s) despite the adoption of any best management practices or recommendations made in this Report.

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1	1 Electronic (Final)	Satterley Property Group (Client) / City of Kwinana	25/08/2020

Document Status

Rev No.	Author	Reviewer	Approved for Issue		
		Name	Name	Signature	Date
A	J. Hyatt	K. Choo	K. Choo		23/06/2020
0	J. Hyatt	K. Choo	K. Choo		30/06/2020
1	K. Choo	K. Choo	K. Choo		25/08/2020



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APPENDIX 6

Approved Acid Sulphate Soils and Dewatering Management Plan



intelligent outcomes | respected experience

Mandogalup Subdivision Housing Development

Acid Sulfate Soil and Dewatering Management Plan

Prepared for
Satterley Property Group
by Strategen

April 2018

strategen
ENVIRONMENTAL

Mandogalup Subdivision Housing Development

Acid Sulfate Soil and Dewatering Management Plan

Strategen is a trading name of
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April 2018

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consultants 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 (specifically WSP/Parsons Brinckerhoff), 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: Satterley Property Group

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	A	Client review	K Oliver/P Bourgault	Electronic	4/4/2018
Final Report	0	Submission to the DWER	P Bourgault	Electronic	13/4/2018

Filename: SPG17253_01 R003 Rev 0 - 13 April 2018

Executive Summary

WSP Australia Pty Limited (WSP | Parsons Brinckerhoff) was commissioned by Satterley Property Group Pty Ltd (Satterley) to undertake an acid sulfate soil (ASS), groundwater investigation and subsequent ASS and Dewatering Management Plan ('ASSDMP') for the proposed Mandogalup Subdivision Development. Strategen were commissioned to finalise the ASSDMP and submit it to the Department of Water and Environment Regulation. The figures, field data, the interpretation of the data and the majority of the ongoing management recommendations were prepared by WSP | Parsons Brinckerhoff. Strategen has relied on the accuracy and integrity of this data in finalising this report.

The site is located along Hoffman Road in Mandogalup, approximately 25 km south of Perth, has a total area of approximately 146 ha. The development works for the site comprise various civil infrastructural works below ground surface inclusive of but not limited to installation of drainage and sewer. It is expected that the average depth of excavation for the installation underground infrastructure will occur at 3 mBGL with respect to the natural ground surface, with some deeper sections for gravity sewer connections.

Objectives

This ASSDMP aims to meet the following objectives:

- Determine the distribution of ASS on the site.
- Determine soil types present at the site with supplementing information obtained from the Golder Associates Geotechnical Investigations (2014).
- Determine the acid generating capacity of each identified soil type.
- Determine the baseline water quality at the site.
- Develop an ASS investigation and management plan that defines management strategies.

Scope of works

The following scope of works were undertaken by WSP | Parsons Brinckerhoff to meet the project objectives:

- Undertake a desktop review of the following information, to identify areas that are considered a risk:
  - DER ASS Map series (Swan Coastal Plain) from Landgate's SLIP Enabler Portal.
  - Geological Survey of WA (GWSA) Environmental 1:50 000 Map Series.
  - Perth Groundwater Atlas.
- Installation of 10 soil bores to approximately 6 m below ground level (mBGL) and conversion of 9 soil bores to groundwater monitoring wells to 2 metres past the water table.
- Collection of 24 samples per bore at depth intervals of 0.25 m to a maximum of 6 mBGL (a total of 240 primary samples and 12 quality control, quality control (QC) samples.
- Analysis of 479 soil samples, which includes the 206 samples from the Golder Associates' geotechnical investigation and 15 QC soil samples for field pH (pH_F) and field pH after oxidation (pH_{FOX}) at a National Association of Testing Authorities (NATA) accredited laboratory.
- Analysis of 129 soil samples, including 52 samples from the geotechnical investigation and 7 QC soil samples for acid base accounting by the Suspension Peroxide Combined Acidity and Sulfur (SPOCAS) method, at a frequency of one sample per metre, ensuring that at least one sample per soil type is accounted for.
- Analysis of two soil samples per soil bore (a total of 72 soil samples and 4 QC samples) for chromium reducible sulfur (S_{Cr}) to confirm the SPOCAS measurements.
- Analysis of one sample per soil bore (a total of 10 soil samples and 1 QC samples) for total metals analysis for As, Al, Cr, Cd, Fe, Mn, Pb and Zn.

- Purging and development of 9 newly installed wells, one day (24 hours) after the installation of the newly installed wells.
- Groundwater sampling from the 9 wells in March and September 2016. Submission of 9 primary and QC groundwater samples to a NATA accredited laboratory for analysis of pH, EC, TDS, acidity, sulfide, nitrate, total nitrogen, total phosphorus, ammonia, major cations, major anions, total Fe and Al, and dissolved As, Al, Cr, Cd, Fe, Mn, Pb and Zn.
- Preparation of a combined ASS investigation and dewatering management plan for the site and submission of the plan to DWER for approval.

Summary of analytical results

Soil

WSP | Parsons Brinckerhoff identified the dominant soil type at the site is pale grey to grey sand ranging from 0 mBGL up to 6mbgl, underlain by light brown to brown sands. The south and south west portion of the site is predominantly pale grey to brown/dark brown clays.

pH_F and pH_{FOX} results indicated that various colours of SANDS contained pH_F ranging from 4.1 to 8.5, and pH_{FOX} ranging from 1.5 to 5.8. CLAY contained pH_F ranging from 5.3 to 9.4, and pH_{FOX} ranging from 2.2 to 8.8.

SPOCAS and CRS results indicated that:

- The S_{Cr} concentrations were <LOR in the majority of samples, except sample SB1_3.25 (dark grey sands, S_{Cr} value of 0.041% S).
- No sample of light grey to grey sands exceeded assessment criteria, however, 11 samples (0.05%) had pH_{FOX} <3 at depth ranging from 0.15 to 2.75 mBGL.
- dark grey sands contained S_{Cr} <0.03%S in 6 out of 7 samples analysed (one exception of SB01_3.25) and net acidity ranging from <0.02% S to 0.32% S. 24 samples (44%) had pH_{FOX} <3.
- Nearly half (44%) of samples from the LIGHT brown TO brown sands contained pH_{FOX} <3, of which S_{Cr} was below assessment criteria and net acidity ranged between <0.02% S and 0.05% S.
- DARK BROWN SILTY SAND / SAND contained pH_{FOX} <3 in 56% of samples and net acidity up to 0.44% S.
- WHITE TO PALE GREY/GREEN SILTY CLAY / CLAY had pH_F ranging from 5.3 to 9.4 and contained only one sample (0.02%) with pH_{FOX} <3; 6 of 10 samples from this soil type had net acidity exceeding assessment criteria whilst S_{Cr} <LOR in all 3 samples analysed.
- BROWN TO DARK GREY CLAY contained net acidity ranging from <LOR to 0.45% S, exceeding assessment criteria in 5 of 8 samples analysed, and S_{Cr} between <LOR and 0.019% S.

Groundwater

WSP | Parsons Brinckerhoff found that groundwater levels at the site ranged between 0.92 to 3.72 mBGL in March and between 0.11 to 3.52 mBGL in September. Groundwater flows in a south westerly direction with hydraulic gradient of 0.006.

The pH of the groundwater beneath the site is near neutral with pH values ranging between 5.72 and 7.90. Chloride/sulfate ratios exceeded the DER criterion in all wells except MW02, MW04 and MW06, whilst alkalinity/sulfate ratios exceeded the DER criterion in all samples. The dissolved aluminium concentrations were below the DER criterion.

Summary of ASS Management strategies

The SPOCAS and CRS results indicated all soil types encountered during the investigation have acid generating capacity, and therefore require management. The ASS management strategies to be applied to the proposed site development works include:

- Infrastructure excavation management.
- Temporary soil stockpiling and limestone pad construction.
- Neutralisation (lime treatment) at the maximum liming rates determined from the SPOCAS testing of different soil types.
- Stockpile monitoring program to validate the lime treatment.

Contingency plans have been developed that will be implemented if nominated targets for soil treatment are exceeded.

Summary of dewatering management strategies

Cone of depression modelling was undertaken using the DWER's cone of depression calculator. The results indicated that the radius of the cone of depression ranges from 31 to 290m for sand and 13 to 19m for clay. Average pumping rate is 22L/s for sand and 3L/s for clay. Time required for establishing a stable drawdown cone would be between 6 and 419 hours.

Based on the modelling, a dewatering management plan has been developed. Water quality and drawdown trigger levels will be determined based on a groundwater monitoring event to be undertaken within two weeks of the commencement of dewatering. If trigger levels are exceeded, various contingency plans will be implemented. Additional modelling may be required for dewatering associated with the installation of a sewer pump station, where drawdown to 7mbgl is expected.

Summary of conclusions

All soil types encountered during this investigation at the site are considered to have acid generating capacity. Therefore, an ASS and dewatering management plan (ASSDMP) has been prepared, herein and must be complied with during site development works. This ASSDMP is provided to the DWER for review and endorsement ahead of an anticipated WAPC condition regarding the assessment and management of Acid Sulfate Soils.

Abbreviations

AASS	Actual acid sulfate soils
Al	Aluminium
ASS	Acid sulfate soils
As	Arsenic
Cd	Cadmium
Cr	Chromium
DWER	Department of Water and Environment Regulation
ENV	Effective Neutralising Value
Fe	Iron
LOR	Limit of reporting
mAHD	Metres Australian Height Datum
mBGL	Metres below ground level
mBTOC	Metres below top of casing
Mn	Manganese
QA	Quality Assurance
QC	Quality Control
PASS	Potential acid sulfate soils
Pb	Lead
pH_F	Field pH
pH_{FOX}	Field pH after oxidation
POS	Public open space
RPD	Relative percentage difference
TAA	Titratable actual acidity
TDS	Total dissolved salts
TPA	Titratable potential acidity
TSA	Titratable sulfidic acidity
S_{Cr}	Chromium reducible sulfur
SPOCAS	Suspension peroxide oxidisable combined acidity and sulfur suite
WAPC	Western Australian Planning Commission
Zn	Zinc

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1. Introduction

WSP Australia Pty Limited | Parsons Brinckerhoff were commissioned by Satterley Property Group (Satterley) to undertake an Acid Sulfate Soil (ASS) and groundwater investigation and prepare a draft ASS and Dewatering Management Plan (ASSDMP) for the proposed Mandogalup Subdivision Development (the site). In 2018, Satterley commissioned Strategen to complete the ASSDMP and submit to the Department of Water and Environment Regulation (DWER) for approval, ahead of undertaking site works that may disturb ASS. The figures, field data, the interpretation of the data and the majority of the ongoing management recommendations were prepared by WSP | Parsons Brinckerhoff. Strategen has relied on the accuracy and integrity of this data in finalising this report.

1.1 Proposed subdivision development

The site is located along Hoffman Road in Mandogalup, approximately 25 km south of Perth, Western Australia (W.A.) and comprises of Lot 9033 on Plan 407811, Lot 9006 on Plan 70124, Lot 9002 on Plan 69132 and Lot 9000 on Plan 31293 (Figure 1, Appendix 1). The land is zoned 'urban' under the Metropolitan Region Scheme Amendment 1260/27 and 'Development Zone' under the Town of Kwinana Local Planning Scheme No 2. The development is planned to comprise a mixture of low to medium density residential lots, a school site and areas of Public Open Space (POS).

The site is to be developed in multiple stages, with construction of Stage 1 not yet scheduled, although the installation of drainage and sewer is anticipated to be constructed in late 2018. The average depth of excavation for the installation underground infrastructure is expected to be approximately 3 m below ground level (BGL). Some deeper dewatering and excavation will be required for gravity sewer connections and possible pump station. The project engineers Peritas Group are developing the cut and fill plans for the site and are developing engineering drawings for below ground infrastructure. It is anticipated most of the site will require filling to raise finished levels, which will reduce the potential below ground disturbance.

1.2 Background

Most of the site lies in an area mapped as having a high risk of containing Class I ASS within 3 m of the natural soil surface (DWER Swan Coastal Plain ASS Risk map, Figure 2). An investigation was therefore undertaken to confirm the presence of ASS and determine the extent and acid generating capacity of identified ASS types. These results informed the proposed management responses. It is anticipated that ASS and dewatering management will be required during the installation of sewer pipe and any pump station proposed to service the development.

The management of ASS and dewatering will draw on the results of investigations undertaken by WSP | Parsons Brinckerhoff. Other environmental investigations have been carried out at the site including:

- Contaminated sites investigation based on the sites previous land use (Strategen 2016).
- Geotechnical investigation completed by Golder Associates.

1.3 Objective

This investigation report and ASSDMP aims to meet the following objectives:

- Determine the distribution of ASS on the site.
- Determine ASS types present at the site.
- Determine the acid generating capacity of each identified soil type.
- Determine the baseline water quality at the site.
- Develop an ASS and dewatering management plan for the site.

1.4 Scope of works

WSP conducted the following scope of works was undertaken to meet the project objectives:

- A desktop review of the following information, to identify areas that were considered a risk:
  - DER ASS Map series (Swan Coastal Plain) from Landgate's SLIP Enabler Portal.
  - Geological Survey of WA (GWSA) Environmental 1:50 000 Map Series.
  - Perth Groundwater Atlas.
- Prepare a health, safety and environment plan (HESP).
- Install 10 soil bores to approximately 6 m below ground level (BGL) and conversion of 9 soil bores to groundwater monitoring wells, screened to 2 metres below the water table.
- Collection of 24 samples per bore at depth intervals of 0.25 m to a maximum of 6 mBGL (a total of 240 primary samples and 12 quality control, quality control (QC) samples.
- Analysis of 479 soil samples, which includes the 206 samples from the Golder Associates' geotechnical investigation and 15 QC soil samples for field pH (pH_F) and field pH after oxidation (pH_{FOX}) at a National Association of Testing Authorities (NATA) accredited laboratory.
- Analysis of 129 soil samples, including 52 samples from the geotechnical investigation and 7 QC soil samples for acid base accounting by the Suspension Peroxide Combined Acidity and Sulfur (SPOCAS) method, at a frequency of one sample per metre, ensuring that at least one sample per soil type is accounted for.
- Analysis of two soil samples per soil bore (a total of 72 soil samples and 4 QC samples) for chromium reducible sulfur (S_{Cr}) to confirm the SPOCAS measurements.
- Analysis of one sample per soil bore (a total of 10 soil samples and 1 QC samples) for total metals analysis for As, Al, Cr, Cd, Fe, Mn, Pb and Zn.
- Purging and development of 9 newly installed wells, one day (24 hours) after the installation of the newly installed wells.
- Groundwater sampling from the 9 wells in March 2016 and September 2016. Submission of 9 primary and QC groundwater samples to a NATA accredited laboratory for analysis of pH, EC, TDS, acidity, sulfide, nitrate, total nitrogen, total phosphorus, ammonia, major cations, major anions, total Fe and Al, and dissolved As, Al, Cr, Cd, Fe, Mn, Pb and Zn.
- Preparation of a draft ASS investigation and management plan for the site. The plan was completed by Strategen Environmental (herein) for submission to the DWER for approval.

2. Site description

2.1 Site location

Site location details are provided in Table 2.1 below, with certificates of title included in Appendix 2.

Table 2.1: Site location – Source WSP | Parsons Brinckerhoff

SITE ADDRESS	3, 1705-7993 Hoffman Road, Mandogalup
CERTIFICATE OF TITLE DETAILS	Lot 9033 on Plan 407811 Lot 9006 on Plan 70124 Lot 9002 on Plan 69132 Lot 9000 on Plan 31293
SITE CO-ORDINATES	Lot 9000 on Plan 31293 (Western Power easement): → NE: 391914E, 6436649N → NW: 391813E, 6436579 N → S: 391869 E, 6436517 N Lot 9033 on Plan 407811 and Lot 9006 on Plan 70124 (clockwise) (former market gardens): → NE corner: 391978E, 6437864N → NW corner: 392213E, 6437871N → SE corner: 392184E, 6437545N → SW corner: 391412E, 6437003N → Western most point: 391264E, 6437147N → Mid-northwest point: 391978E, 6437460N Lot 9002 on Plan 69132 (bushland): → NE: 392169E, 6438868N → NW: 391951E, 6438957N → SE: 392203E, 6437898N → SW: 391983E, 6437902N
LOCAL GOVERNMENT	City of Kwinana
LANDUSE ZONING	→ 'Urban' under the Metropolitan Region Scheme Amendment 1260/27 → 'Development Zone' under the Town of Kwinana Local Planning Scheme No 2
SITE AREA	~146 ha
HISTORICAL SITE USE	The site formerly comprised of market gardens in the south (Lots 9000, 9033 and 9006) and unoccupied bushland to the north (Lot 9002).
PROPOSED LANDUSE	The majority of the site is planned to be developed into residential lots and group housing lots. A primary school is also proposed for the subdivision.
SITE DESCRIPTION	The site comprises of disused paddocks on Lots 9033 and Lot 9006, as well as a Western Power easement on Lot 9000. Lot 9006 comprises native bushland. At the time of the site visit, bulk rubbish, comprising household goods, general rubbish was observed in the northern portion of the site on Lot 9002. The Peel Main Drain crosses the northern portion of the site through Lot 9002. The Dampier to Bunbury Natural Gas Pipeline (DBNGP) approximately bisects the site (Figure 1, Appendix A). The majority of the site is a wetland classified by the DER for multiple use (Figure 3, Appendix A).

2.2 Physical site setting

Table 2.2: Summary physical site setting – Source WSP | Parsons Brinckerhoff

TOPOGRAPHY	The elevation is variable across the site. The southern portions of the site are generally flat and low lying with an average elevation of 19 metres Australian Height Datum (mAHD) (Department of Water 2015). The elevation increases towards the east reaching a maximum height of 28 mAHD.
VEGETATION	Vegetation at the site comprised scrubland and native trees in the northern portion of the site (Lot 9002) and grass with stands of isolated paper barks in the lower lying areas in the south, for example around the Peel Main Drain. During the site investigation, the vegetation on the site appeared relatively healthy.
GEOLOGY	The regional geology of the site comprises Bassendean Sand geological unit and thin Bassendean Sands overlying Guildford formation (GSWA 1986). The Bassendean Sand geological unit is a dunal system of Aeolian origin covering most of the Swan Coastal Plain. Bassendean Sand generally comprises fine to coarse grained, pale grey to white and may become clayey at depth.
HYDROGEOLOGY	The site sits within the Jandakot Mound groundwater area, an active groundwater recharge area The Jandakot Mound is an unconfined aquifer that occupies an area of approximately 522 km^2. Groundwater discharges from the Jandakot Mound along seven discrete flow paths into Lake Forrestdale in the east, Kamup Drain to the southeast, the Southern River in the south, the Canning and Swan Rivers in the north and the Indian Ocean further west. Groundwater recharge occurs mainly via infiltration from rainfall (Davidson 1995). The regional groundwater flow direction is expected to be in a south westerly direction, most likely discharging ultimately into the Indian Ocean.

Table 2.3: Regional geology summary – Source WSP | Parsons Brinckerhoff

GEOLOGICAL UNIT	DESCRIPTION	OCCURRENCE (mBGL)
Bassendean Unit	SAND: consists of white to paly grey sand at the surface, yellow at depth, fine to medium grained, sub-angular to sub-rounded, moderately sorted, minor heavy minerals of aeolian origin. Highly permeable lithology.	0 – 42
Thin Bassendean Unit over Guildford Formation	SAND: thin veneer of Bassendean SAND over strong, blocky, brown silts and clays. The overlying sand is highly permeable.	0 - 40
Sandy Silt (Swamp deposits)	Sandy SILT: dark brownish grey, silt, with disseminated fine-grained quartz sand, firm, variable clay content of lacustrine origin.	0 - 15

Table 2.4: Regional hydrogeology summary – Source WSP | Parsons Brinckerhoff

AQUIFER	Jandakot mound superficial aquifer
TOP OF AQUIFER	13–20 mAHD (or 1 – 8.5 mBGL beneath the natural surface of the site)
TDS (mg/L)	1,000 – 3,000
HIGHEST POTENTIAL BENEFICIAL USE	Non potable domestic groundwater use
PERMEABILITY	Low – high
DEPTH OF AQUIFER	-15.0 mAHD to -20.0 mAHD (or 33 mBGL to 37 mBGL beneath the site)
EXPECTED FLOW DIRECTION AND DISCHARGE POINT	South west towards the Indian Ocean
PREFERRED PATHWAYS	Infiltration into lower Leederville Aquifer and Rockingham Aquifer

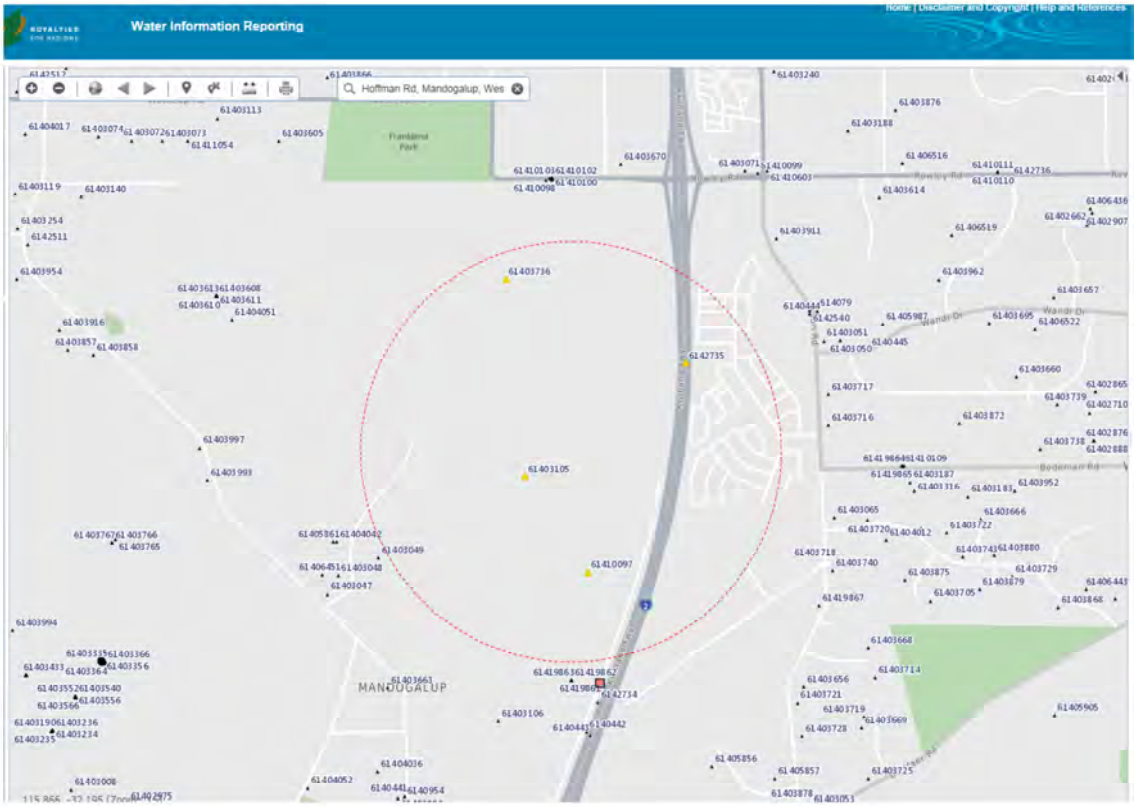
2.3 Sensitive receptors

2.3.1 Surface water receptors

No surface water was observed during the investigation; however the Peel Main Drain transects the site from east to west. Most of the site is mapped as seasonal dampland, particularly in the southern portion of the site and is categorised as multiple use (Landgate 2016, Figure 3). The Spectacles Wetland, which is part of the Beeliar Regional Park is located approximately 1.4 km south west of the site at its closest point.

2.3.2 Groundwater receptors

A search of the Department of Water (DoW), Water Information Reporting (WIR) database indicated that there were four registered sites within 1 km radius of the centre of the site (see Image 2-1 below), three of which are groundwater bores.



Source: DoW Water Information Reporting (2015) – Source WSP | Parsons Brinckerhoff

Image 2-1: Licensed groundwater wells within 1 km radius of the site.

Additionally, a proclaimed Class 2 drinking water source protection area is located approximately 2 km east of the site.

2.4 ASS risk

The site overlies both moderate to low and high to moderate risk categories for ASS occurrence (Landgate 2016). The majority of the southern portion of the site is classed as having a high to moderate risk of ASS occurrence within 3m of the soil surface (Figure 2, Appendix 1).

3. Methodology

3.1 Soil investigation

A detailed assessment of the acid generating potential of the shallow soil profile was undertaken by WSP | Parsons Brinckerhoff. Additional data was obtained from Golder Associates geotechnical investigation (Golder 2014). Based on the results from both investigations, a thorough representative understanding of the prevailing soil types and their acid generating capacity was obtained. Soil bore logs are provided in Appendix 3, with test pit data sourced from Golder Associates provided in Figure 5, Appendix 1.

3.1.1 Methodology

The methodology employed for the soil investigation is summarised in Table 3.1.

Table 3.1: Soil investigation methodology – Source WSP | Parsons Brinckerhoff

ACTIVITY	DETAILS
Services location	DBYD services location plans were inspected prior to undertaking the intrusive works. All locations were cleared using a hand auger to 1.5 mBGL.
Soil bore installation	10 soil bores (SB01-SB10) were installed across the site to a depth of 6 mBGL using auger methodology.
Sampling depth	Samples were taken from the surface (0.1 mBGL) at 0.25 mBGL intervals thereafter to the desired depth.
Soil logging	Soil and rock type was logged and classified based on field interpretation. Soil bore logs are presented in Appendix C.
Soil sampling	Soil samples were obtained from the auger and placed into laboratory (ALS) supplied, designated ASS bags.
Soil sample nomenclature	Each sample bag was clearly labelled with the soil bore number and depth as well as the sample date.
Monitoring well installation	9 soil bores were converted to monitoring wells (MW01- MW09). Each well was constructed with 50 mm diameter, Class 18, polyvinyl chloride (PVC), 0.050 mm factory slotted well screen. A 50 mm diameter, class 18 PVC end cap was threaded to the bottom of each well. Wells were screened so that approximately 0.5 m of slotted screen extended above the observed groundwater. Where practicable, this was assisted by gauging adjacent monitoring wells prior to nominating the screen height. A graded gravel pack (1.6–3.2 mm) was placed around each well screen from the bottom of the borehole to approximately 0.5 m above the top of the well screen. A bentonite seal was placed on top of the gravel pack and the annular space above this backfilled with soil removed during drilling. Each well was completed with a lockable steel riser.
Monitoring well development	In order to ensure interconnection between the aquifer and the well, and to remove drilling fines, each well was developed with a 12 V plastic high flow pump once constructed.
Bore abandonment	Bores were backfilled using the cuttings.
Sample preservation	Samples were stored in a sealed esky with frozen ice bricks while on-site and in transit to the laboratory. Samples not able to be transported to the laboratory on the same day were frozen.
Sample handling	Samples submitted to the laboratory were accompanied by Chain of Custody (COC) documentation.
Well Survey	Following construction, the location of each groundwater well was surveyed to the Geocentric Datum of Australia (GDA) 1994. The gauging point marked on the top of the internal uPVC casing (TOC) was surveyed relative to Australian Height Datum (mAHD).

Acid generating potential

The Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DER 2015a) provides action criteria for the assessment ASS risks. The action criteria are based on the net acidity where:

Net acidity = Potential Acidity + Existing acidity

Clay content influences the natural pH buffering capacity of soil. Therefore, the action criteria are grouped into three broad texture categories – coarse, medium, and fine. The criteria are used to define when ASS disturbed at a site needs to be treated and managed. Table 3.2 summarises the action criteria.

The revised DER guidelines (DER 2015a) include criteria for Bassendean Sands due to the presence of micro-framboidal aggregates of secondary pyrite. Additionally, Bassendean Sands lack buffering capacity. Where S_{Cr} in Bassendean Sands is less than 0.03%S and the field pH_{FOX} <3, this is classed as having exceeded the action criterion for potential ASS (PASS).

In addition to the action criteria, the guidelines define indicator pH values for pH_F and pH_{FOX} to assist with identifying likely acid generating soils. The pH indicator values are defined as:

- pH_F <4 oxidation of sulfides probably occurred in past – presence of AASS (when pH >4 but <5 indicates acid soil, but needs to be further investigated by laboratory analysis).
- pH_{FOX} <3 and a significant reaction – strongly indicates PASS.
- Significantly lower pH_{FOX} than pH_F – the greater the difference the more indicative the presence of potential acid sulfate soils (PASS), $pH_{F\text{-}FOX}$ >2 is used as an indicative trigger value.

Table 3.2: Texture based acid sulfate soils action criteria – Source WSP | Parsons Brinckerhoff

TYPE OF MATERIAL		ACTION CRITERIA IF <1,000 TONNES OF MATERIAL IS DISTURBED		ACTION CRITERIA IF >1,000 TONNES OF MATERIAL IS DISTURBED	
Texture Range	Approx. Clay Content	Equivalent Sulfur (%S)	Equivalent Acidity (mol H+/tonne) (oven dry basis)	Equivalent Sulfur (%S) (oven dry basis)	Equivalent Acidity (mol H+/tonne) (oven dry basis)
Coarse – sands to loamy sands	<5%	0.03	18	0.03	18
Medium – sandy loams to light clays	5–40%	0.06	36	0.03	18
Fine – medium to heavy clays and silty clays	>40%	0.1	62	0.03	18

Reference: (DER 2015a)

Heavy metals in soil

Soil analysis results for heavy metals were assessed against the most sensitive current health-based Investigation Levels (HILs A – ASC NEPM, 1999, as amended in 2013) to determine whether metal concentrations pose a risk to the future residential users of the site (including site workers) given its intended future landuse of the site.

Heavy metal concentrations in soil are also compared against the contaminant threshold for Class II waste (CT2) (minimum landfill class for disposal of ASS) in the Landfill Waste Classification and Waste Definitions (DEC 2009). Where CT2 criteria are exceeded, leachability testing should be undertaken to ascertain the appropriate landfill class. It is noted that leachability testing did not occur as part of this investigation.

The adopted assessment criteria are provided below in Table 3.3.

Table 3.3: Assessment criteria for metals in soil (mg/kg) – Source WSP | Parsons Brinckerhoff

METAL	HIL A	CT2 LANDFILL CRITERIA
Al	-	-
As	100	14
Cd	20	0.4
Cr(VI)	100	10
Pb	300	2
Ni	400	4
Fe	-	-
Zn	7400	-

*Conservative values of HIL for residential land use were adopted for assessment.

3.2 Groundwater investigation

3.2.1 Methodology

Monitoring wells MW01–MW09 were gauged and sampled on 11/03/2016 and 22-27/09/2016.The methodology used to sample the wells is provided in Table 3.4 below. Groundwater Sampling Field Sheets are provided in Appendix 4 and Equipment Calibration Certificates in Appendix 5.

Table 3.4: Groundwater assessment methodology – Source WSP | Parsons Brinckerhoff

ACTIVITY	DETAILS
Groundwater monitoring well gauging	All monitoring wells were gauged for the SWL using a water level meter (Heron™) prior to commencing the sampling.
Groundwater monitoring well purging and sampling	Low flow micropurge sampling methods were used to complete the groundwater sampling. Monitoring wells were initially purged at rate of approximately 0.2 L/m and the following water quality parameters were collected using a Hanna hand held meter at approximately 5 minute intervals: → pH: ± 0.10 → Electric Conductance: ± 3% → Oxidation-reduction (Redox) potential:- ± 10 mV → Dissolved oxygen (DO): ± 10% → Temperature: ± 10%
Sample collection	Groundwater samples were collected according to the following Australian and New Zealand Standards relevant to groundwater sampling; AS/NZS 5667.1 (1998) and AS/NZS 5667.11 (1998). Samples were collected low-flow peristaltic pump. Samples were collected into new, appropriately preserved bottles provided by the analysing laboratory. Samples for metals analysis were field filtered.
Decontamination	New disposable tubing was used at each location for the collection of groundwater samples to prevent cross-contamination of samples.
Sample Preservation	Samples were stored in an insulated esky with ice bricks and received chilled by the analytical laboratory.

3.2.2 Assessment criteria

Chemical indicators that may indicate that groundwater is being affected by the oxidation of sulfides include the following (DER 2015a):

- A chloride/sulfate ratio of less than 2.
- An alkalinity/sulfate ratio of less than 5.
- A pH of less than 5; and
- A soluble aluminium concentration of greater than 1 mg/L.

The DER have developed a ranking scheme (presented in DER 2015b) based on work by the Swedish Environmental Protection Authority (Swedish EPA 2002) which is designed to estimate the buffering capacity of groundwater. The assessment is based on alkalinity and pH as shown in Table 3.5.

Table 3.5: Buffering capacity of groundwater – Source WSP | Parsons Brinckerhoff

CLASS	DESIGNATION	ALKALINITY (mg/L)	PHF RANGE	DESCRIPTION
1	Very high alkalinity	>180	>6.5	Generally adequate to maintain acceptable pH level in the future
2	High alkalinity	60–80	>6.0	Generally adequate to maintain acceptable pH level in the future.
3	Moderate alkalinity	30–60	5.5–7.5	Inadequate to maintain stable acceptable pH level in areas vulnerable to acidification
4	Low alkalinity	10-30	5.0–6.0	Inadequate to maintain stable acceptable pH level.
5	Very low alkalinity	<10	<6.0	Unacceptable pH level under all circumstances

Reference: (DER 2015b)

Due to the presence of three groundwater bores in the area there is potential for groundwater to be abstracted for drinking water purposes, however it is considered unlikely based on the salinity of the groundwater as reported in the DoW WIR system, and the areas where the bores locate are within the Perth Metropolitan area scheme water supply.

Fresh Waters assessment criteria specified in ANZECC and ARMCANZ (2000) have also been included given that the Spectacles Wetlands has been identified as a potential receptor. It is noted that exceedances in the Freshwater Guideline criteria do not directly apply to groundwater quality results as groundwater abstracted from the site will not be directly discharged into any surface water receptors, however exceedances of more than 10 times the freshwater guideline where applicable (i.e. not for pH) in groundwater will be assessed as a potentially high-risk impact to the receiving environment.

Table 3.6 outlines the adopted groundwater investigation levels adopted for ASS specific parameters for beneficial and likely uses of groundwater beneath the site.

Table 3.6: Groundwater assessment criteria – beneficial and likely uses – Source WSP | Parsons Brinckerhoff

ANALYTE	FRESH(1) (mg/L)	NON-POTABLE GROUNDWATER(2) USE (mg/L)
pH	6.5–8.5	-
Chloride	-	250
Sulfate	-	1,000
Al	<0.055 (if pH >6.5)	0.2
As	0.024 (III) 0.013(V)	0.1
Cd	0.0002	0.02
Cr	0.001(VI)	0.5(VI)
Fe	-	0.3 (total)
Pb	0.0034	0.1
Mn	1.9	5
Ni	0.011	0.2
Se	0.011(total)	0.1(total)
Zn	0.008	3

(1) Aquatic Ecosystems (Freshwater with 95% protection level), ANZECC, 2000

(2) DoH (2014) Contaminated sites ground and surface water chemical screening guidelines

4. Sampling, analysis and quality plan (SAQP)

Table 4.1 summarises the sampling and analysis plan for the site.

Table 4.1: Sampling and analysis plan – Source WSP | Parsons Brinckerhoff

SAMPLE TYPE	AREA SIZE (HA)	NUMBER OF BORES OR TEST PITS SAMPLED	ANALYSIS
Soil	146	36 (10 new, 26 sample locations from Golder Associates) One sample per 0.25 metres and QC, 479 samples in total	pH_F, pH_{FOX}
Soil	146	36 (10 new, 26 sample locations from Golder Associates) One sample per metre and QC, 129 samples in total	SPOCAS
Soil	146	36 (10 new, 26 sample locations from Golder Associates) 2 samples per bore and QC, 76 samples in total	S_{Cr}
Soil	146	36 (10 new, 26 sample locations from Golder Associates) 1 sample per bore and QC, 11 samples in total	Metals (As, Al, Cr, Cd, Fe, Mn, Pb and Zn)
Groundwater	-	9 (9 new from soil-converted bores) Existing bore BH01 was not accessible at the time of sampling	pH, EC, TDS, acidity, sulfide, nitrate, total nitrogen, total phosphorus, ammonia, major cations and anions, total Fe and Al, dissolved iron, Al, As, Cr, Cd, Mn, Pb and Zn

5. Results and discussion

5.1 Soil

5.1.1 Soil types encountered

There are approximately six distinct soil types encountered across the site (detailed in Table 5.1). The dominant soil type is pale grey to grey sand ranging in depths from 0 mbgl up to 6.0 mbgl, underlain by light brown to brown sands. The south and south west portion of the site is predominately pale grey to brown/dark brown clays. Soil bore logs are provided in Appendix 3.

5.1.2 Field screening (pH_F and pH_{FOX})

Field pH (pH_F) and field pH after oxidation (pH_{FOX}) analysis was carried out on all samples. Tabulated Soil ASS field test results are provided in Appendix 7. Certified laboratory analytical reports and chain of custody documentation are provided within Appendix 8. A summary of pH_F and pH_{FOX} results from the 247 primary WSP Parsons Brinckerhoff samples and 206 Golder Associates primary samples are summarised in Appendix 7 Tables 1 and 2 respectively. Soil types have been generalised according to Table 5.1 below.

Table 5.1: Summary of pH_F and pH_{FOX} results – Source WSP | Parsons Brinckerhoff

SOIL TYPE	SAMPLES ANALYSED	PHF RANGE	NO. OF SAMPLES PHF < 4	PH_{FOX} RANGE	NO. OF SAMPLES PH_{FOX} < 3	SAMPLES WITH ΔPHF-PH_{FOX} >2	REACTION RATES
SAND: pale grey to grey **Fine to medium grained, well sorted.**	197	4.1-8.5	0	2.1-5.6	11 (0.05%)	49 (25%)	Slight (132) Moderate (65)
SAND: dark grey **Fine to medium grained, well sorted.**	54	4.3-8.3	0	1.8-5.2	24 (44%)	41 (75%)	Slight (12) Moderate (19) Strong (11) Extreme (10)
SAND: light brown to brown **Fine to medium grained, well sorted.**	85	4.4-7.3	0	1.8-5.2	38 (44%)	54 (63%)	Slight (42) Moderate (40) Strong (3)
Silty SAND / SAND: dark brown **Fine to medium grained, well sorted.**	41	4.9-7.5	0	1.5-5.8	23 (56%)	32 (78%)	Slight (7) Moderate (26) Strong (7) Extreme (1)
Silty CLAY / CLAY: white to pale grey green **Moderate to high plasticity**	42	5.3-9.4	0	2.7-8.8	1 (0.02%)	23 (54%)	Moderate (16) Strong (12) Extreme (13)
CLAY: brown to dark grey **High plasticity**	34	5.3-8.8	0	2.2-8	1 (0.02%)	27 (79%)	Slight (5) Moderate (14) Strong (13) Extreme (3)

WSP | Parsons Brinckerhoff presented the following conclusions based on the pH_F and pH_{FOX} results:

- All soil types contained pH_F values above 4, indicative a lack of actual ASS.
- The dominant soil type light grey to grey sands reported pH_{FOX} < 3 in only 11 of the 197 samples indicating a likely absence of PASS, however, 84 of the 197 samples reported pH_F between 4 and 5.5, indicating that some actual acidity may be present. Whilst 25% of samples observed a change between pH_F and pH_{FOX} >2 pH units (ΔpH_F-pH_{FOX} >2), but the majority of samples (67%) only reported a slight reaction rate.
- 14% of dark grey sands reported pH_F ranging between 4 and 5.5, indicating that actual acidity may be present. The likely presence of PASS was noted in 44% of samples, supported by ΔpH_F-pH_{FOX} >2 and pH_{FOX} <3. Extreme reactions in 10 samples also support the presence of PASS.
- 44% of LIGHT brown TO brown sands reported pH_{FOX} <3 and 63% of samples contained ΔpH_F-pH_{FOX} >2, indicating the likely presence of PASS. Most samples reported a slight or moderate reaction rate. It is noted that the occurrence of this lithology was mostly close to or below the water table.
- 56 % of DARK BROWN SILTY SANDS / SANDS reported pH_{FOX} <3 and 78% of samples had $\Delta pH_F pH_{FOX}$ >2, indicating the likely presence of PASS.
- Only 1 of the 42 samples from WHITE TO PALE GREY/GREEN SILTY CLAY / CLAY reported pH_{FOX} <3. ΔpH_F-pH_{FOX} >2 was recorded for 54% of samples.19 samples recorded pH_F >7 indicating alkaline conditions. Moderate to extreme reaction rates were observed.
- Only 1 of the 34 samples from BROWN TO DARK GREY CLAY reported pH_{FOX} was <3. 79% of samples had ΔpH_F-pH_{FOX} >2. 24 samples contained pH_F >7 indicating alkaline un-oxidised soil relative to the high plasticity nature of the clay and consistent with water logged areas in the south and south west portion of the site. 16 samples showed strong to extreme reaction rates.

Actual and potential acidity was noted in the majority of the soil types at the site, and therefore, further laboratory analysis was required to confirm the presence of actual and potential acidity.

5.1.3 Laboratory results – (SPOCAS and S_{Cr})

Laboratory analysis for SPOCAS and chromium reducible sulfate (S_{Cr}) was carried out on 134 of the 453 soil samples to confirm field results, targeting high risk samples and ensuring adequate representation across all lithologies and depth. The results are shown in Table 5.2.

WSP | Parsons Brinckerhoff concluded the following based on the laboratory results:

- pH_{KCl} shows an agreement with pH_F ranging from acidic (above 4) to alkaline (below 9.4).
- The S_{Cr} concentrations were <LOR in the majority of samples, except sample SB1_3.25 (dark grey sands), which exceeded the assessment criteria with S_{Cr} value of 0.041% S.
- light grey to grey sands contained S_{Cr} below assessment criteria all 23 analysed samples. None of samples analysed contained net acidity exceeding assessment criteria. 11 samples (0.05%) had pH_{FOX} <3 at depth ranging from 0.15 to 2.75 mbgl. As these sands are considered likely to be Bassendean Sands, as per the DER guidance (2015a) management and/or treatment applies.
- dark grey sands contained S_{Cr} <0.03%S in 6 out of 7 samples analysed (one exception of SB01_3.25) and net acidity ranging from <0.02% S to 0.32% S. 24 samples (44%) had pH_{FOX} <3. As the sands are considered to be Bassendean Sands, management and/or treatment applies.
- Nearly half (44%) of samples from the LIGHT brown TO brown sands contained pH_{FOX} <3, of which S_{Cr} was below assessment criteria and net acidity ranged between <0.02% S and 0.05% S. Given the sands are likely to be Bassendean Sands, management and/or treatment is therefore required.
- DARK BROWN SILTY SAND / SAND contained pH_{FOX} <3 in 56% of samples and net acidity up to 0.44% S and therefore is considered acid generating and required management and/or treatment.
- WHITE TO PALE GREY/GREEN SILTY CLAY / CLAY had pH_F ranging from 5.3 to 9.4 and contained only one sample (0.02%) with pH_{FOX} <3; 6 of 10 samples from this soil type had net acidity exceeding assessment criteria whilst S_{Cr} <LOR in all 3 samples analysed. Therefore, this soil type has potential acid generating capacity mainly derived from organic sources, consequently, will require treatment.
- BROWN TO DARK GREY CLAY contained net acidity ranging from <LOR to 0.45% S, exceeding assessment criteria in 5 of 8 samples analysed, and S_{Cr} between <LOR and 0.019% S. Therefore, this soil type has potential acid generating capacity derived from both organic and sulphide sources and will require management and/or treatment.

Table 5.2: SPOCAS and S_{Cr} results – Source WSP | Parsons Brinckerhoff

LITHOLOGY	SAMPLES ANALYSED	ACID GENERATING CAPACITY (%S)							
		TAA	TSA	TPA	S_{POS}	ANC EXCESS	NET ACIDITY (EX ANC)	CHROMIUM REDUCIBLE SULFUR (SCR)	# EXCEEDING NET ACIDITY (EX ANC) CRITERION
SAND: pale grey to grey	53	<LOR – 0.03	<LOR – 0.21	<LOR – 0.19	<LOR – 0.01	-	<LOR – 0.03	<LOR – 0.01 (23*)	0
SAND: dark grey	22	<LOR – 0.131	<LOR – 1.55	<LOR – 1.48	<LOR – 0.041	-	<LOR – 0.32	<LOR – 0.041 (7*)	19
SAND: light brown to brown	27	<LOR – 0.013	<LOR – 0.264	<LOR – 0.251	<LOR – 0.019	-	<LOR – 0.05	<LOR – 0.08 (12*)	4
Silty SAND / SAND: dark brown	14	<LOR – 0.24	<LOR – 0.815	<LOR – 0.623	<LOR – 0.01	-	<LOR – 0.44	<LOR – 0.01 (2*)	9
Silty CLAY / CLAY: white to pale grey green	10	<LOR – 0.043	<LOR – 0.034	<LOR	<LOR	-	<LOR – 0.23	<LOR (3*)	6
CLAY: brown to dark grey	8	<LOR – 0.153	<LOR – 1.1	<LOR – 0.951	<LOR	<0.020 – 1.91	<LOR – 0.45	<LOR – 0.019 (4*)	5

*Number of samples analysed.

5.1.4 ASS occurrence

All soil types encountered at the site were considered to have acid generating capacity with a notable number of samples containing pH_{FOX} <3 and various levels of net acidity, although with one exception the S_{Cr} complied with the assessment criteria. CLAYS beneath the site mostly indicated alkaline conditions with net acidity exceeding assessment levels whilst S_{Cr} below assessment levels, suggesting potential acidity likely derived from organic source.

5.1.5 Heavy metals

Tabulated metals results are provided in Appendix 7. Concentrations of heavy metals were below the adopted health investigation levels (HILs) in all samples, however:

- Lead exceeded the CT 2 Landfill threshold in one sample of SILT CLAY (SB02_2.0). This is only an issue if this particular soil requires landfill disposal, which is not expected.
- Cadmium concentrations were below LOR (1 mg/kg) in all samples, whilst the CT 2 Landfill threshold is 0.4 mg/kg. Further analysis of Cadmium concentrations is not warranted.

5.2 Groundwater

The following findings are based on data (field and laboratory) collected during groundwater sampling conducted on 11 March 2016, and 22-27 September 2016.

Field groundwater sheets and tabulated laboratory analytical data are provided in Appendix 4 and Appendix 6 respectively. Certified laboratory analytical reports and chain of custody documentation are provided in Appendix 8.

5.2.1 Groundwater Level

The elevation of the site varies between 13.3 mAHD (MW04, south) and 23.8 mAHD (MW09, northern). The southern portion of the site displays wetland characteristics and can be waterlogged during heavy rainfall periods.

Groundwater levels in March were between 1.525 mBTOC (MW06) to 4.322 mBTOC (MW02) whilst in September were between 0.712 mBTOC (MW06) to 4.115 mBTOC (MW09). Groundwater contours based on March measurement (in mAHD) is presented in Figure 5, Appendix 1, indicating groundwater flows in a south westerly direction with hydraulic gradient of ~0.006.

5.2.2 Water quality

Two groundwater monitoring events were conducted at the site representing end of summer (11 March 2016) and end of winter (22-27 September 2016) conditions. Laboratory analytical results of the groundwater from both monitoring events (inclusive of quality control data) are provided in Appendix 8 and select results are presented in Table 5.3.

The results of both monitoring events indicate the following:

- The groundwater is very slightly acidic to very slightly alkaline with pH values ranging between 5.72 and 7.90.
- TDS concentrations ranged between 332 mg/L (MW06) and 1,020 mg/L (MW07) in summer and 306 mg/L (MW06) and 920 mg/L (MW07) in winter, indicating groundwater to be fresh to slightly brackish.
- Total Alkalinity ranged from 4 mg/L at MW06 (considered very low) to 169 mg/L at MW04.
- Chloride to sulfate ratio <2 in all wells except MW02, MW04 and MW06.
- The dissolved (filtered) aluminium concentrations were below ASS indicator value of 1 mg/L in all samples.

- The groundwater may have already been affected by the oxidation of sulfides as indicated by the low ratios of chloride to sulfate (<2) and alkalinity to sulfate (<5) in all samples.
- Groundwater in MW07 contained elevated concentrations of EC, TDS, sodium, sulfate and chloride.

Table 5.3: Summary of groundwater analytical results – Source WSP | Parsons Brinckerhoff

ANALYTE	MIN CONC.	MAX CONC.	SAMPLES EXCEEDING ADOPTED ASSESSMENT CRITERIA/INDICATIVE OF IMPACT/ADDITIONAL COMMENTS
Calcium mg/L	22	70	-
	13	81	
Magnesium mg/L	7	33	-
	9	34	
Sodium mg/L	35	124	Elevated in MW02 and MW07
	30	133	Elevated in MW02 and MW07
Potassium mg/L	4	14	Elevated in MW07
	3	20	Elevated in MW07
Sulfate as SO_4^{2-} mg/L	14	182	Elevated in MW07
	<1	216	Elevated in MW07
Chloride mg/L	32	280	Elevated in MW02 and MW07
	34	286	Elevated in MW02 and MW07
Total Alkalinity as $CaCO_3$ mg/L	15	169	Elevated in MW01 and MW04
	4	140	Elevated in MW04. MW05 (4 mg/L).
Ionic balance	1.79%	8.04%	Generally within acceptable limits (<5%) with the exception of MW02 (8.04%), MW07 (5.09%) and MW08 (5.07%). Ionic balance lying outside of 5% may be influenced by turbidity or the presence of an additional ion not included in the analytical suite.
	0.45%	8.27%	Generally within acceptable limits (<5%) with the exception of MW02 (8.27%), MW06 (5.76%) and MW08 (8.24%).
Total acidity mg/L	17	104	Elevated in MW01 and MW02
	7	98	Elevated in MW01 and MW02. MW07 (7mg/L)
pH (pH units)	5.96	7.9	MW2 (5.96) and MW08 (6.38) are outside the recommended range for Aquatic Ecosystems - fresh
	5.72	7.58	All wells excluding MW3 and MW4 are outside the recommended range for Aquatic Ecosystems – fresh
TDS mg/L	332	1020	
	306	920	
Chloride:sulfate ratio	0.5	11	MW01, MW03, MW05, MW07, MW08 and MW09 all <2 (ASS indicator)
	0.3	7.9	Ration in all wells excluding MW02, MW04 and MW06 <2 (ASS indicator)
Alkalinity:sulfate ratio	0.3	1.6	All wells <5 (ASS indicator)
	0.1	1.2	All wells <5 (ASS indicator)

ANALYTE	MIN CONC.	MAX CONC.	SAMPLES EXCEEDING ADOPTED ASSESSMENT CRITERIA/INDICATIVE OF IMPACT/ADDITIONAL COMMENTS
Aluminium µg/L	2120	11,200	All samples exceed the DOH non-potable guideline of 200 µg/L and the Aquatic Ecosystems – Fresh (55 mg/L).
	<LOR	1520	
Aluminium (filtered) µg/L	40	710	MW02 (510 µg/L), MW05 (520 µg/L), MW06 (710 µg/L) and MW08 (460 µg/L) exceed DOH non-potable guideline of 200 µg/L. All samples are below the DER ASS trigger value of 1000 µg/L. Difference in filtered and non-filtered Al may be attributed to adherence of Al to particulates in the groundwater
	20	850	MW01 (360 µg/L), MW02 (850 µg/L), MW03 (820 µg/L), MW05 (370 µg/L), MW06 (290 µg/L), MW08 (590 µg/L) and MW09 (210 µg/L) exceed DOH non-potable guideline of 200 µg/L. All samples are below the DER ASS trigger value of 1000 µg/L. Difference in filtered and non-filtered Al may be attributed to adherence of Al to particulates in the groundwater
Iron µg/L	380	37,500	All samples exceed the DOH non-potable and Aquatic Ecosystems – Fresh guideline.
	<LOR	16,800	All samples with the exception of MW09 exceed the DOH non-potable and Aquatic Ecosystems – Fresh guidelines with the exception of MW07 and MW09.
Iron (filtered) µg/L	80	15,900	All samples with the exception of MW09 exceed the DOH non-potable and Aquatic Ecosystems – Fresh guideline with the exception of MW09.
	60	15,400	All samples with the exception of MW09 exceed the DOH non-potable and Aquatic Ecosystems – Fresh guidelines with the exception of MW07 and MW09.
Cadmium (filtered) µg/L	<0.1	0.3	MW03 (0.3 µg/L in summer) marginally exceeds the Aquatic Ecosystems – Fresh guideline of 0.2 µg/L.
Selenium (filtered) µg/L	All samples reported below the LOR of 10 µg/L for both monitoring events however this value is marginally above the guideline criteria of 5 µg/L		
Zinc (filtered) µg/L	<5	29	MW1, MW2 and MW3 marginally exceed the Aquatic Ecosystems – Fresh guideline of 8 µg/L.
	<5	35	MW3 and MW6 marginally exceed the Aquatic Ecosystems – Fresh guideline of 8 µg/L.
As, Ba, Be, Bo, Cr, Co, Cu, Pb, Mn, Hg (filtered) µg/L	All samples reported concentrations below adoption assessment criteria for both monitoring events.		

Note: shading denotes winter results.

6. Quality assurance/quality control (QA/QC)

WSP | Parsons Brinckerhoff collected QC samples in accordance with Schedule B2 of the NEPM (ASC NEPM 1999 amended in 2013). Field methodologies were consistent with regulatory guidelines, Australian Standard AS5667.1-1998 and WSP | Parsons Brinckerhoff's internal procedures. Validation of the field methods and laboratory analytical data (i.e. QA) is presented in Appendix 8.

The field method and laboratory analytical data QA/QC measures employed throughout the investigation have enabled the quality of field sample collection and laboratory analytical procedures to be assessed.

In accordance with the DER guidelines (DER 2015a), field duplicates were collected at a rate of one for every 20 samples collected. Field duplicates are used to identify variation in analyte concentration between samples collected from the same sampling point and/or the repeatability of the laboratory analysis. These samples were submitted to the same laboratory for analysis.

6.1 Analytical method validation

An analytical QC assessment of results is summarised in Table 6.1 below. Refer to Appendix 8 for complete laboratory reports.

Table 6.1: Laboratory analytical method validation – Source WSP | Parsons Brinckerhoff

Requirement	Completed (Y/N)	Comments
All analyses NATA-accredited	Y	ALS (primary) and MPL (triplicate) laboratories are NATA-accredited for the analyses performed, except field pH (pH_F and pH_{FOX}).
Sample holding times within acceptable range (collection to extraction)	Y	All samples were received and extracted by the laboratory within sample holdings times.
Appropriate analytical methodologies used.	Y	Refer to the laboratory certificates presented in Appendix H for both soil and groundwater respectively.
Within acceptable internal laboratory QA/QC limits	Y	EP1602127 indicates TDS maybe bias high due to presence of fine particular matter. EP1602127 the LOR for MW8 was raised due to sample matrix interference.
Acceptable laboratory LORs adopted	Y with exception	The LOR for selenium exceeds the Freshwater Ecosystems investigation levels, however this is not considered to significant for the purpose of this investigation which focuses on the risk of acid sulfate soils.
Ionic balance within 5%	Y with exception	See Table 5.3.

6.2 Precision – field method validation

The adoption of the general ranges for specific recoveries has been used to screen laboratory data. Where recoveries are outside these ranges the data were assessed in relation to specific laboratory comments, published industry 'norms' for specific parameters and/or the likely impact on the interpretation of the meaning of the results.

The precision of the results for each analyte between the primary sample and the field duplicate/triplicate in the samples was determined by calculating the Relative Percentage Difference (RPD), as follows:

$$RPD = \frac{(Concentration\ 1 - Concentration\ 2) \times 100}{(Concentration\ 1 + Concentration\ 2) \div 2}$$

For the purposes of this assessment, replicate data with concentrations above 10 times the LOR have a RPD <30% and replicate data with concentrations below 10 times LOR have RPD <50%. RPDs are presented in the tabulated laboratory analytical data in Appendix 6 and Appendix 7.

All duplicates were found within the acceptable RPD range of 30–50% (Standards Australia, AS 4482.1–2005) for both the soil and the groundwater samples.

6.3 Summary

Based on the information detailed above, the data is considered of acceptable quality for interpretation and environmental assessment of the site.

7. ASS management

Management of ASS is essential to ensure there are no adverse impacts on sensitive environmental receptors in and surrounding the site. The following management practices will be undertaken to minimise the risks associated with the disturbance of the acid generating units.

As the preliminary bulk earthworks strategy requires the import of fill, it is expected that some of the ASS identified across the site will not be disturbed. However, it is expected bulk earthworks and dewatering for the installation of infrastructure will result in some ASS disturbance.

7.1 Strategy

The following management strategy were developed by WSP | Parsons Brinckerhoff for the site. The following terms are referenced:

- Contractor: Civil earthworks contractor appointed by Satterley Property Group.
- Environmental Consultant: Environmental consultant appointed by Satterley Property Group.
- Superintendent: Project engineer appointed by Satterley Property Group.

The Contractor will be responsible for ensuring that all management measures outlined in the management strategy (or as agreed otherwise) are adhered to for the duration of their contract.

The ASS management strategies discussed in the following sections of the report apply to the proposed site development works only.

7.2 Performance objectives

Environmental targets and performance indicators have been developed based on ASS management objectives (Table 7.1).

Table 7.1: ASS management objectives, targets and performance indicators

Management objective	Target	Measurement criteria
Ensure that there are no adverse impacts to sensitive receptors as a result of excavation, stockpiling or dewatering of ASS.	No exposure of untreated ASS materials during construction works.	• Groundwater and surface water quality near the construction footprint is not degraded as a result of soil disturbance activities. • Stockpiling of ASS does not result in any visual ASS oxidation impacts. • The acid generating potential of treated ASS is confirmed as neutralised by testing.

7.3 Additional investigation requirements

While all soil types identified at the site have been classed as PASS, additional soil investigation may be beneficial along specific infrastructure routes such as sewer lines, to confirm specific risks associate with linear infrastructure installation. Contingencies are proposed to ensure that appropriate management strategies if ASS is encountered. Additional soil investigations will allow calculation of variable liming rates to suit different soil types. and enable the developer to plan for appropriate management strategies specific to each stage prior to the start of earthworks. WSP | Parsons Brinckerhoff recommended the following additional investigation prior to the start of each stage to assist in confirming ASS disturbance risk:

- Confirmatory drilling/test pits should be carried out at 200 m intervals along linear infrastructure such as sewer lines (or a minimum of 3 bores per stage) and logged by an appropriately qualified person to 1.0 m below the maximum depth of excavation.

- Soil bores installed as part of the ASS investigation reported herein are considered representative of soil types within each stage if they were installed within 20m of the proposed alignment of the linear infrastructure and they extend to a depth of 1m below the proposed depth of excavation.
- Additional ASS investigations should occur at a minimum of 3 locations in any portion of the site where deep infrastructure installation is proposed (such as a waste water pump station) to a depth of at least 1 m below the proposed depth of disturbance.
- Where dewatering is expected to be undertaken in high ASS risk areas within each stage, for more than seven days, or at a rate of greater than 5L/s, this plan requires a minimum of two bores are located within the expected cone of depression. This may require the installation of additional groundwater monitoring bores.

7.4 Management strategies

The following management strategies are proposed to manage disturbed ASS:

All excavated natural soils that are temporarily stockpiled for >18 hours will be stockpiled and treated on a minimum 300 mm thick bunded treatment pad. The bunded pad should be constructed of alkaline material and shall be graded to ensure good drainage. All sides shall be bunded with limestone or similar alkaline material to a minimum height of approximately 150 mm above the surface of the pad to prevent lateral run-off. Excavated natural soils that will be backfilled within 18 hours of excavation will be treated immediately adjacent to sewer reticulation trenches rather than on a 300 mm thick bunded treatment pad.

Based on the PASS types encountered at the site, and in accordance with the ***Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes*** guideline (DEC 2015b), the maximum period for short term stockpiling of untreated PASS is as follows:

- Sands – 18 hours.
- Silts/clays – 70 hours.

In addition, the following stockpile design considerations should be taken into account for temporary storage of excavated natural soils:

- The surface area of stockpiles older than 18 hours should be minimised to reduce exposure to atmospheric oxygen (i.e. capping or lining).
- The surface of stockpiles older than 18 hours should be kept moist but caution should be applied so as not to cause run-off.
- Measures to contract erosion and sediment movement (i.e. control structures).

7.5 ASS neutralisation and handling

Any ASS treatment and handling will be undertaken in accordance with the following procedure:

- All excavated acid generating types will be lime treated onsite. The lime treatment will eliminate long term oxidation issues associated with the materials. High ENV (Effective Neutralising Value) ag-lime will be used as a neutralising agent. The amount of lime to be used for neutralisation will be calculated using the following equation (Equation 1).

Lime (kg /m3 soil) = Soil bulk density x (Net acidity (%S x 30.59) x 1.02 x Safety Factor) / ENV

Equation 1

Where:

- %S is the maximum net acidity detected in the samples, i.e. 0.05%:
  - SAND: pale grey to grey – 0.03%S, TOPSOIL (0-0.25mbgl) 0.1%S.
  - SAND: dark grey – 0.32.
  - SAND: light brown to brown – 0.05.

    - Silty SAND to SAND: dark brown – 0.44.
    - Silty CLAY to CLAY: white to pale grey green – 0.23.
    - CLAY: brown to dark grey – 0.45.
- The ENV as quoted by the supplier must be consider the particle size distribution of the neutralising agent.
- 30.59 x 1.02 is the conversion factor from H_2SO_4 to $CaCO_3$ (Ahern et al., 2002).
- 1.5 is the safety factor to be employed for high risk acid generating potential (DER 2015b).
- Neutralisation should be undertaken by mechanical application on the containment pad at the time of stockpiling to achieve uniform blending of the neutralised material and the acid generating soils.

Based on the above, and assuming ag-lime of 75% ENV is used, Table 7.2 shows the neutralisation rate required for each soil type identified in the investigation. This value will vary depending on the ENV of the neutralising material used.

Table 7.2: Identified ASS to be disturbed and neutralisation rate – Source WSP | Parsons Brinckerhoff

SOIL TYPE	DEPTH ENCOUNTERED (mBGL)	MAXIMUM ACID GENERATING CAPACITY (%S)	ASSUMED BULK DENSITY (g/m^3)	LIME DOSAGE RATE (kg/m^3)(1,2)	DEWATERING OF SOIL TYPE(3)? (Y/N)
SAND: pale grey to grey	0 – 0.25	0.11	1.6	10.98	Y
SAND: pale grey to grey	0.25 - 6.0	0.03	1.6	3.00	Y
SAND: dark grey	0 - 6.0	0.32	1.6	31.95	Y
SAND: light brown to brown	0 - 6.0	0.05	1.6	4.99	Y
Silty SAND to SAND: dark brown	0 - 6.0	0.44	1.6	43.93	Y
Silty CLAY to CLAY: white to pale grey green	0.3 - 6.0	0.23	1.05	15.07	Y
CLAY: brown to dark grey	0.15 – 2.3(4)	0.45	1.05	29.49	Y

(1) Assuming 75% ENV. This rate will need to be recalculated if a neutralising material with a different ENV is used on site.
(2) See Table 7.2 for bulk densities.
(3) Groundwater is present at 10.53-21.35 mAHD (average depth based on March and September 2016 data).
(4) Maximum depth investigated.

Table 7.3: Typical bulk densities – Source WSP | Parsons Brinckerhoff

Textural Class	Bulk Density (t/m^3)
Sand	1.6
Loamy sand	1.5
Sandy loam	1.4
Loam	1.3
Silty loam	1.2
Clay loam	1.1
Clay	1.05
Peat	1.0

Source: DER 2015b

7.6 Neutralising materials

Aglime or lime sands are the preferred neutralising materials for treatment of ASS. The Environmental Consultant MUST be consulted if any other types of neutralising materials are proposed.

Neutralising materials obtained for use on site will be accompanied by the supplier's Certificate including information on the material's effective neutralising value (ENV), which is a measure of soils neutralising capacity in relation to particle size distribution of the neutralising material. A copy of this Certificate must be forwarded to the Environmental Consultant.

If the ENV is not provided by the supplier, the Environmental Consultant should be notified for testing of the neutralising material. The Environmental Consultant or the Contractor (following advice from the Environmental Consultant) shall arrange for samples to be sent to a NATA accredited laboratory for testing of Calcium Carbonate Equivalence to determine the neutralising value (NV), the particle size distribution (PSD) of the materials, pH, chemical constituents, moisture content and solubility. The number of samples shall be in accordance with the DER's Landfill Waste Classification and Waste Definitions (as amended, 2009). Table 7.2 and Equation 1 will be used to determine the quantity of lime to be used to treat ASS.

7.7 Validation of soil treatment

The civil works contractor will liaise with the appointed Environmental Consultant to arrange for verification testing of the treated natural soils prior to re-use of the material or backfilling of trench excavations. Liaison between the two parties will also include the determination of periods/times suitable for verification testing (i.e. based on other monitoring/sampling requirements coinciding).

Treated material will be sampled and subjected to field testing (carried out by the laboratory) to verify that the pH_F and pH_{FOX} values are greater than 6.5 pH units. The number of samples required will be determined in accordance with the Landfill Waste Classification and Waste Definitions 1996 (DEC 2009 as amended 2009) based on the volume of the stockpile requiring verification. The mean of the field testing results from each validation event will be used to assess the success of the treatment of the stockpiled PASS. If the mean plus one standard deviation of the results of each validation event is above 6.5 pH units, the treated PASS will be considered to have met the field test criterion. If the mean batch verification testing results do not comply with the criteria, additional treatment by the civil works contractor will occur within 48 hours, before being re-tested.

In addition to field testing, approximately 25% of verification samples collected will be submitted to the laboratory for SPOCAS analysis.

To validate neutralisation, the soils will need to comply with the following:

- The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil, (e.g. pH_{FOX} must be > 5).
- The neutralising material has been thoroughly mixed with the soil.
- Soil pH must be in the range 6.0 to 8.5.
- Excess neutralising agent must remain within the soil until all acid generation reactions are complete and the soil has no further capacity to generate acidity.
- For poorly buffered sands, measurements of total potential acidity (TPA) should be less than the limits of reporting.

Strategen will provide informal verification results to the civil works contractor when validation assessment has taken place and conclusions have been made. These results will be compiled by the Environmental Consultant and provided in an ASS closure report at the completion staged civil works.

7.8 Fate of treated material

It is anticipated that all treated material will be re-used as backfill soon after the installation of infrastructure.

7.9 Off-site ASS treatment and disposal

It is the DER's preference that treated ASS to be re-used onsite. In the unlikely event ASS has to be removed from site the following protocols will apply.

- ASS may be disposed off-site to a licensed facility with a DER approved ASSMP. A number of licensed ASS treatment facilities are present in metropolitan Perth and in the South West region.
- Acceptance of ASS for disposal at a licensed facility must be in accordance with the Landfill Waste Classification and Waste Definitions 1996 (as amended, DEC 2009).
- Prior to disposal, soils will be tested at a rate in accordance with the Landfill Waste Classification and Waste Definitions Waste (as amended DEC 2009) for the estimated volume requiring disposal. ASLP leachate testing may be required for As, Be, Cr, Cd, Hg, Pb, Mo, Ni, Se and Ag where the total concentrations of these metals exceed the CT2 criteria.
- The receiving facility will be notified in writing of the acid generating capacity of the soils to be disposed including provision of laboratory certificates of analysis.
- Tip receipts and total volumes of soil disposed must be recorded and provided to the DWER with the Initial Closure Report.

7.10 Contingency planning

As part of this management plan, contingencies will be developed to address actions to be undertaken where the defined performance criteria are not met. Contingencies may include:

- Should the duration of the civil works and dewatering be significantly extended, a review of the management strategies will be undertaken to assess if additional management or monitoring is required during or following works.
- If soil neutralisation treatment performance criteria are not met, the following will be undertaken:
  - If pH_F and pH_{FOX} results are outside the criteria, SPOCAS results will be reviewed before a decision is made to re-treat the excavated material.
  - If SPOCAS analysis of soils identifies high acidity, additional lime treatment will be undertaken until such criteria are met (the rate for addition of extra lime will be based on the results exceeding the criteria).
- If runoff/leachate of untreated material exceeds the performance criteria it will require neutralisation or appropriate disposal. Neutralisation may be undertaken in the soil treatment area, or elsewhere on-site. The water will need to meet the ASS performance criteria prior to re-infiltration.

7.11 Reporting by civil works contractor

The civil works contractor will prepare and maintain a log of the PASS treatment operation. The log will track the total volume of PASS disturbed, the quantity and type of neutralising agent used, the dates over which the treatment operation ran, the approximate location of re-used treated PASS on-site and (if any) volumes of PASS (treated or untreated) disposed of off-site and the corresponding location/s. The log will be submitted to the environmental consultant at the end of each week during the dewatering stages in addition to the landfill receipt and treatment dockets (if any).

8. Dewatering management

8.1 Dewatering management level classification

It is anticipated that dewatering will be required to facilitate the installation of portions of the sewer lines and stormwater drainage throughout various stages of development. It is noted that under the Rights in Water and Irrigation Act (1914) the developer is required to obtain either a Section 5C or Section 26D dewatering licence prior to abstracting groundwater for any water abstraction from a bore where the pump volume is predicted to exceed 25,000 kL or the duration of abstraction exceeds 30 days.

Groundwater dewatering is conservatively estimated to create a cone of depression of >50m for a period in excess of seven days. On this basis, level 2 dewatering management will be applied at the site in accordance with ***Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes*** guideline (DEC 2015b).

8.2 Performance objectives

Active management of civil works and dewatering operations is required to minimise potential impacts on the environment and other groundwater users. This ASSDMP section presents Operating Strategies (OS) for managing the proposed dewatering and earth-working of ASS at the site.

The ASSDMP specifically addresses the following measures:

- Water-table management to mitigate offsite environmental impacts; this includes groundwater recharge of dewatering effluent and use of groundwater monitoring programs.
- Assessment of baseline groundwater quality data against applicable DER guidelines in establishing environmental trigger levels.
- Contingency measures and corrective actions that will be implemented to rectify any breaches of the nominated triggers and management measures.
- Management of soil excavation, handling and stockpiling operations, including the neutralisation of inherent acidity associated with ASS.
- Soil and groundwater monitoring and validation to confirm works are undertaken in accordance with the performance objectives detailed in this ASSDMP.

8.3 Potential impacts

Any dewatering strategy needs to ensure that:

1. All dewatering effluent shall be discharged through a monitoring/treatment system to ensure that the pH of water discharged to the environment is at all times above pH 6.0, and the total acidity is less than 40 mg $CaCO_3$/L.
2. Groundwater quality shall not be adversely affected as a result of the civil works and dewatering. A guiding principle should be to conduct operations in a manner that will not reduce pH in on-site monitoring bores. Both pH and total acidity of groundwater will be monitored in order to ensure that groundwater quality can be maintained.
3. Treated dewatering effluent is reinfiltrated to ground to minimise the drawdown effect on surrounding groundwater users surrounding the site. Temporary lowering of the groundwater table should not impact off-site bores to the point where they are no longer operable (i.e. dry).
4. Treated dewatering effluent is reinfiltrated to ground as close as practicable to the excavations to maintain surface water levels but not so close as to significantly affect the efficiency and rate of dewatering.
5. Treated dewatering effluent is not discharged directly to wetlands.

With the implementation of this management plan, it is anticipated that there will be no significant impacts on the environment or to surrounding groundwater users.

8.3.1 Cone of depression modelling

Cone of depression modelling was undertaken using the DER's cone of depression calculator (https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/66-cone-of-depression) for the sewer. Inputs into the calculator were based on site-specific data where possible (e.g. soil logs). The purpose of the cone of depression modelling was to assess the likely steady-state extent of groundwater drawdown and potential impacts on adjacent wetlands and other groundwater users.

Model inputs

Table 8.1 summarises the input data for the calculator. The required groundwater drawdowns were conservatively calculated based on groundwater levels observe in September 2016. The required drawdown is expected to be significantly less when dewatering take place over the summer months as the overall groundwater table will be lower.

Sections 1–6 are possible dewatering scenarios at the site for the different soil types. Section 7 represents works associated with the proposed sewer pump station.

Table 8.1: Drawdown cone of depression estimates – model inputs – Source WSP | Parsons Brinckerhoff

SECTION	LENGTH OF EXCAVATION (m)	WIDTH OF EXCAVATION (m)	REQUIRED GROUNDWATER DRAWDOWN(1) (m)	SATURATED THICKNESS OF AQUIFER(2) (m)	HYDRAULIC CONDUCTIVITY (m/s)(3)
1 (sand)	80	3	2	20	0.000191
2 (silty sand)	80	3	2	20	0.0000463
3 (clay)	80	3	2	20	0.00000463
4 (sand)	80	5	3	20	0.0000116
5 (silty sand)	80	5	3	20	0.0000116
6 (clay)	80	5	3	20	0.0000116
7 (sand)	20	20	7	20	0.000191

(1) Based on observed groundwater levels (see Figure 4, Appendix A).
(2) Department of Water, Perth Groundwater Atlas (accessed 20 September 2016).
(3) Hydraulic conductivity estimated for sand (medium grained), silty sand and clay (see Appendix C soil bore logs), from DER cone of depression calculator (https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/66-cone-of-depression).

Predicted radius of influence

Table 8.2 summarises the predicted radius of influence for each section/soil type. In practice, each drawdown cone of depression will take effect only as each section of sewer is completed in a stage manner.

Table 8.2: Drawdown cone of depression estimates – model outputs – Source WSP | Parsons Brinckerhoff

SECTION	EFFECTIVE RADIUS OF PUMPING WELL (m)	RADIUS OF CONE OF DEPRESSION (m)	TOTAL PUMPING RATE (l/s)	TIME TO ESTABLISH CONE OF DEPRESSION (hr)
1 (sand)	9	83	20	25
2 (silty sand)	12	31	5	59
3 (clay)	9	13	3	25
4 (sand)	11	124	28	59
5 (silty sand)	8	41	14	6
6 (clay)	11	19	3	59
7 (sand)	11	290	43	419

The predicted drawdowns are anticipated to be confined to the site, except where infrastructure is to be installed near the site boundaries. Where off-site impacts are indicated, management methods such as the use of infiltration trenches to restrict drawdown or horizontal boring techniques will be considered.

The above estimates are conservative as trenches are normally open in short sections and spear points are moved (i.e. the pumps are switched off) to the next section of sewer, thereby allowing the groundwater levels to recover. In addition, pumps are generally switched off over the weekend when works are not progressing, providing further groundwater recovery time.

8.4 Dewatering management

8.4.1 Dewatering discharge treatment

Dewatering discharge will require treatment to ensure that the water does not have any adverse impact to receiving environment. Treatment may include but is not limited to sediment filtration or settlement, neutralisation, and/or contaminant removal. The need for dewatering discharge treatment is determined through monitoring of the dewatering discharge, groundwater and/or surface waters in the area.

Treatment of groundwater in all environments to near neutral pH (6.5 to 8.5) is generally required to ensure mobilisation of metals is prevented. The need for treatment of groundwater will be determined based on the baseline groundwater quality obtained from the groundwater monitor bores installed in the vicinity of the excavation.

Table 8.3 summarises the key treatment methods that will be adopted based on the groundwater quality indicators.

Table 8.3: Dewatering discharge treatment options – Source WSP | Parsons Brinckerhoff

WATER QUALITY TRIGGER	TREATMENT METHOD
pH < 5.0	Neutralisation treatment using calcite pellets, lime sands, or hydrated lime, as appropriate for the project.
pH of dewatering discharge more than 1 pH unit less than pH of receiving water body	pH adjustment (e.g. neutralisation)
Total Titratable Acidity > 40 mg/L	Neutralisation treatment and aeration and settlement to precipitate dissolved metals
Total Suspended Solids – visible	Re-infiltration through an infiltration basin, working as a sediment filtration system
Metals/toxicants concentration in dewatering discharge could result in an increase of the seasonal background concentration of the receiving body by >10%	Suitable toxicant filtration/flocculation method to be employed.
Nutrient concentrations in dewatering discharge could result in an increase of the seasonal background concentration of the receiving body by >10%	Nutrient-stripping containment basin (aerobic/anaerobic "wetland")

8.4.2 Dewatering discharge disposal

Due to the limited storage and acid buffering capacity of the upper portion of the superficial aquifer, management of dewatering discharge will be essential to minimise impacts to environmental receptors. The following options of discharging excess water will be implemented in the following order of preference:

- The Infiltration system will include installation of an infiltration basin via overflow from a lined, settlement basin, to prevent flooding of the surrounding environment. Where required, bunds will be constructed around on-site drains and low lying areas to contain the dewatering effluent on-site. The location of discharge for each stage will minimises potential impacts to vegetation and sensitive environmental receptors, and maximise the potential for infiltration through use of areas with thicker sand profiles. Infiltration basins are to be constructed as close as possible to within the stage in which dewatering is to take place.
- Dewatering discharge will be able to be used for dust suppression during construction works.

8.4.3 Dewatering effluent monitoring and performance criteria

Table 8.4 summarises the monitoring program to be adopted for dewatering influent and effluent during the dewatering program. This monitoring program is based on the DER's Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes (DER 2015b) guidelines.

The pre-treatment and post-treatment water as well as flow rates will be measured by the Contractor. It is recommended that the effluent is sampled directly from the pipe as it comes out of the ground and then directly from the impermeable settling basin, before overflow, to provide consistent sampling locations and to avoid excessive interference from turbidity.

Table 8.4: Effluent laboratory analysis frequency

TTA	pH	Laboratory Analysis Frequency
TTA < 40 mg/L	pH > 6	Fortnightly – Total Acidity (TA), Total Alkalinity (TAlk), pH
TTA < 40 mg/L	4 < pH < 6	Weekly – TA, TAlk, pH
40 mg/L < TTA < 100 mg/L	pH > 6	Weekly – TA, TAlk, pH
40 mg/L < TTA < 100 mg/L	4 < pH < 6	Weekly – TA, TAlk, pH
TTA > 100 mg/L (or) Total Alkalinity < 30 mg/L	(or) pH < 4	Weekly – TA, TAlk, pH. Fortnightly - TA, TAlk, pH, Total Metals, Dissolved Al, Dissolved Fe, Electrical Conductivity (EC), Ammoniacal Nitrogen, Total Nitrogen (TN), Total Phosphorus (TP), Hydrogen Sulfide, Total Suspended Solids (TSS), Total Dissolved Salts (TDS)

8.4.4 Groundwater monitoring and performance criteria

Groundwater monitoring well locations and construction

In addition to the existing groundwater monitoring well locations a minimum of one additional groundwater monitoring well may be required to be installed during each stage of development to ensure compliance with the requirement for two monitoring bores within the estimated cone of depression.

New monitoring wells will be installed using a hollow stem auger. The wells will be constructed using 50 mm diameter Class 18 PVC casing with a 3m machine slotted section extending from approximately 1 m above the water table to 2 m below the water table. A graded gravel pack will be placed around each well screen from the bottom of the borehole to approximately 0.5 m above the top of the well screen. A bentonite seal will be placed on top of the sand pack with the remaining annular space filled with a cement/bentonite grout from the top of the bentonite seal to ground surface. Each well will be finished with steel risers at least 1m above ground level. These steel risers will be clearly marked to avoid being destroyed by earth moving machinery.

8.4.5 Groundwater monitoring requirements

In addition to the monitoring of discharge water, monitoring of the effects of dewatering on groundwater where the radial cone of depression is greater than 50 m, or near the wetlands, or where dewatering exceeds 7 days, groundwater monitoring must be undertaken. Table 8.5 summarises the monitoring program to be adopted for surface and groundwater receptors.

Table 8.5: Summary of groundwater monitoring program

Parameters	Frequency and duration	Responsibility
Field pH, EC, TA, groundwater levels	Twice weekly for the duration of dewatering.	Civil works Contractor
ASS groundwater analytical suite	Fortnightly for duration of dewatering, together with one pre-dewatering monitoring event and one immediately post-dewatering monitoring event.	Environmental Consultant
	Groundwater samples to be collected from all groundwater monitoring bores for laboratory analysis at intervals of one month, two months and six months post dewatering. This must include at least one groundwater monitoring event taken at the time of seasonal groundwater high.	

Table 8.6: Dewatering effluent monitoring matrix: radius of influence of dewatering >50m and/or duration of groundwater pumping >7 days (Level 2)

	Trigger	Action	Monitoring
1a.	**Total titratable acidity <40mg/L**, pH>6	Continue daily field measurements of pH and total titratable acidity.	**Daily**—field measurement: pH, redox (Eh), electrical conductivity (EC) and Total Titratable Acidity (TTA), total alkalinity (TAlk) **Fortnightly**—laboratory analysis: total acidity, total alkalinity, pH
2a.	**Total titratable acidity <40mg/L**, pH in range 4 to 6	Undertake neutralisation treatment (liming).	**Daily**—field measurement: pH, Eh, EC & TTA, TAlk **Weekly**—laboratory analysis: total acidity, total alkalinity,
3a.	**Total titratable acidity in range 40mg/L to 100mg/L**, pH>6	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	**Daily**—field measurement: pH, Eh, EC & TTA, TAlk, dissolved oxygen (DO), **Weekly**—laboratory analysis: total acidity, TAlk, pH
4a.	**Total titratable acidity in range 40mg/L to 100mg/L,** pH in range 4 to 6	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Undertake neutralisation treatment (liming).	**Daily**—field measurement: pH, Eh, DO,EC, TTA, TAlk **Weekly**—laboratory analysis: total acidity, TAlk, pH **Fortnightly**—laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide*, EC, Total Suspended Solids (TSS), Total Dissolved Salts (TDS), Total Nitrogen (TN), Total Phosphorus (TP)

	Trigger	Action	Monitoring
5a.	**Total titratable acidity >100mg/L** or pH<4 or **total alkalinity <30mg/L**	Effluent should be aerated to precipitate dissolved iron and directed to a series of settlement basins/trenches or other treatment system to allow removal of iron and other metals. Increase neutralisation treatment (liming) rate. Advise DER immediately. Contaminated Sites Branch (CSB) may advise appropriate action which may include ceasing dewatering.	**Twice daily**—field measurement: pH, Eh, DO, EC, TTA, TAlk **Weekly**—laboratory analysis: total acidity, total alkalinity, pH, sulfate, chloride, sodium, total iron, dissolved iron (filtered), total aluminium, dissolved aluminium (filtered), total arsenic, total chromium, total cadmium, total manganese, total nickel, total zinc, total selenium, ammoniacal nitrogen, hydrogen sulfide*, EC, TSS, TDS, TN, TP May be needed to undertake investigations to determine the size of the 'acidic footprint' created and manage this impact appropriately.

8.5 Groundwater trigger levels

To protect off-site groundwater users and sensitive ecological receptors, groundwater level triggers will be calculated based on the following equation:

Trigger (mAHD) = Baseline GWL (mAHD) – Predicted Drawdown (m) – 0.5 (m, for seasonal variation).

Other environmental triggers (as per Table 8.7) will also be assigned based on the pre-dewatering groundwater monitoring event (GME). Triggers will be set at 10% more than baseline values for all parameters except pH, for which the trigger is set as the baseline pH minus 0.5.

The baseline GWL will be determined within two weeks of the commencement of dewatering. The DWER will be notified as to the calculated trigger levels.

Table 8.7 Groundwater quality triggers (to be determined based on baseline groundwater monitoring program to be undertaken within two weeks of commencement of dewatering

Bore	Drawdown (m)	pH		EC (uS/cm)	Total Acidity (mg/L CaCO3)	Total Alkalinity (mg/L CaCO3)	Dissolved Al (mg/L)

8.6 Decommissioning of treatment ponds

At the completion of the works the Environmental Consultant will collect samples of the accumulated sediments at the base of each infiltration trench to determine the appropriate decommissioning requirements in accordance with the sampling frequency recommended by the NSW EPA (1995) Sampling Design Guidelines.

Sample analysis will include, but not necessarily be limited to total metals (aluminium, arsenic, chromium, copper, iron, lead, manganese, selenium and zinc). In the event these metal concentrations are elevated above background, an assessment of the risk to ecological values and/or human health will be undertaken to determine the appropriate management option. This may include the excavation of the sediment in the trench and off-site disposal to an appropriate landfill.

8.7 Contingencies

As part of the management of dewatering effluent, the following contingency measures will be implemented if performance criteria are not met:

- An additional lime-dosing plant should be on standby in the event dewatering effluent does not comply with nominated criteria.
- If pH and total acidity for dewatering effluent is outside the ranges identified in Table 8.4, additional samples must be collected in accordance with DEC (2015b).
- In the event of the preferred method of discharge is shown to be causing adverse environmental impact alternative disposal options will be formulated. This may include re-injection of neutralised discharge between receptors and the area of dewatering activities following a reduction in dewatering rates.
- Cessation of dewatering may occur if specified criteria cannot be achieved through standard treatment measures (including contingencies 1 above). Alternatively:
    - Pumping rates may be reduced.
    - The area under abstraction at any one time may be reduced.
    - Recharge trench arrangement may be modified.

8.8 Reporting by civil works contractor

The civil works contractor will prepare and maintain a log of the treatment operation. The log will track the total volume of dewatering effluent treated, the quantity and type of neutralising agent used, the dates over which the treatment operation ran, daily lime dosing unit operational readings and the approximate on-site location of disposal of treated effluent. The log will be submitted to the environmental consultant at the end of each week.

9. Reporting

9.1 Record keeping

The Contractor shall prepare and maintain a log of the following activities:

- The log will track the total volume of ASS disturbed.
- The quantity and type of neutralising agent used.
- The dates over which the treatment operation ran.
- The approximate on-site location of treatment pads.
- Volumes of any material disposed off-site.
- Landfill receipt volumes, dockets and documentation confirming any off-site soil disposal that was undertaken.

9.2 Post Closure

9.2.1 Initial closure report/WAPC condition clearance report

At the completion of the earthworks and de-watering program for each development stage, and following the first post closure GME at 1 week, the DWER will be provided with an Initial Closure Report (ASSICR). The report will include:

- A current site plan detailing existing infrastructure and the Development Stages.
- Soil and water management strategies employed on site.
- Volumes of neutralising agent brought to the site.
- Volumes of soils and groundwater treated for each stage and timeframe of treatment.
- Photographs demonstrating the soil management process to confirm adherence to the management Plan.
- Results of the stockpile monitoring and validation program.
- Results of the dewatering effluent monitoring program.
- Results and interpretation of the groundwater monitoring program (and surface water, if applicable).
- Risk assessments including receptor identification and sensitivity as well human health risk.
- Post dewatering monitoring requirements.
- Landfill receipt volumes, dockets and documentation confirming any off-site soil disposal that was undertaken.

9.2.2 Post dewatering monitoring closure reports

Following the completion of all stages of the program to which the approved ASSDMP is applicable and following the completion of the 1-month, 3-month and 6-month post-dewatering groundwater monitoring events, a Final Closure Report (ASSFCR) will be submitted to the DWER. The ASSFCR will provide a complete data set from the earthworks and dewatering monitoring program.

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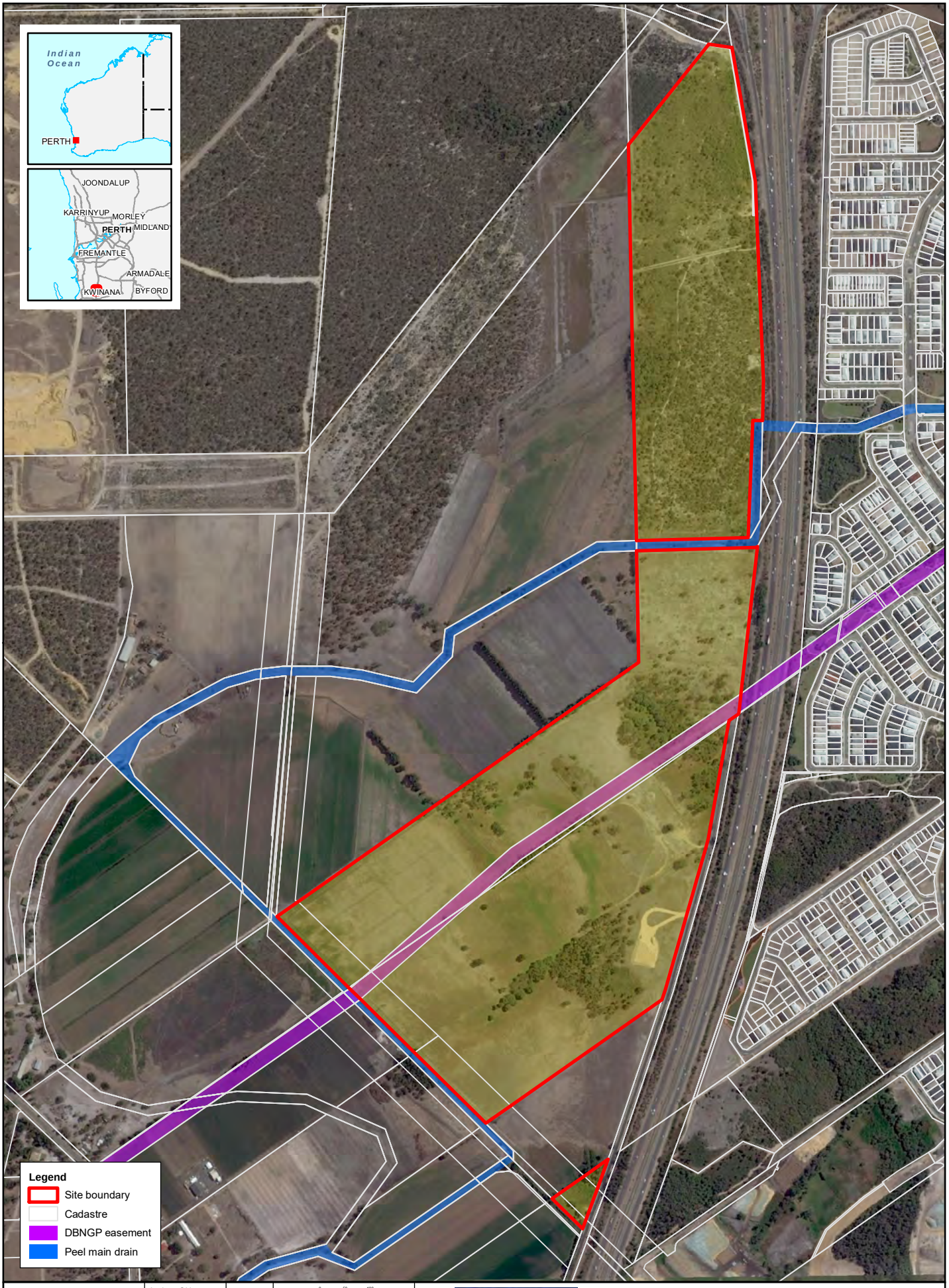
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Appendix 1
Figures

Source WSP | Parsons Brinckerhoff



Map: 2268443A_GIS_001_A	Author: SH
Date: 11/08/2016	Approved by: EO

Data source: Rowe Group (2014)
Landgate (2016)

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Coordinate system: GDA 1994 MGA Zone 50
Scale ratio correct when printed at A4

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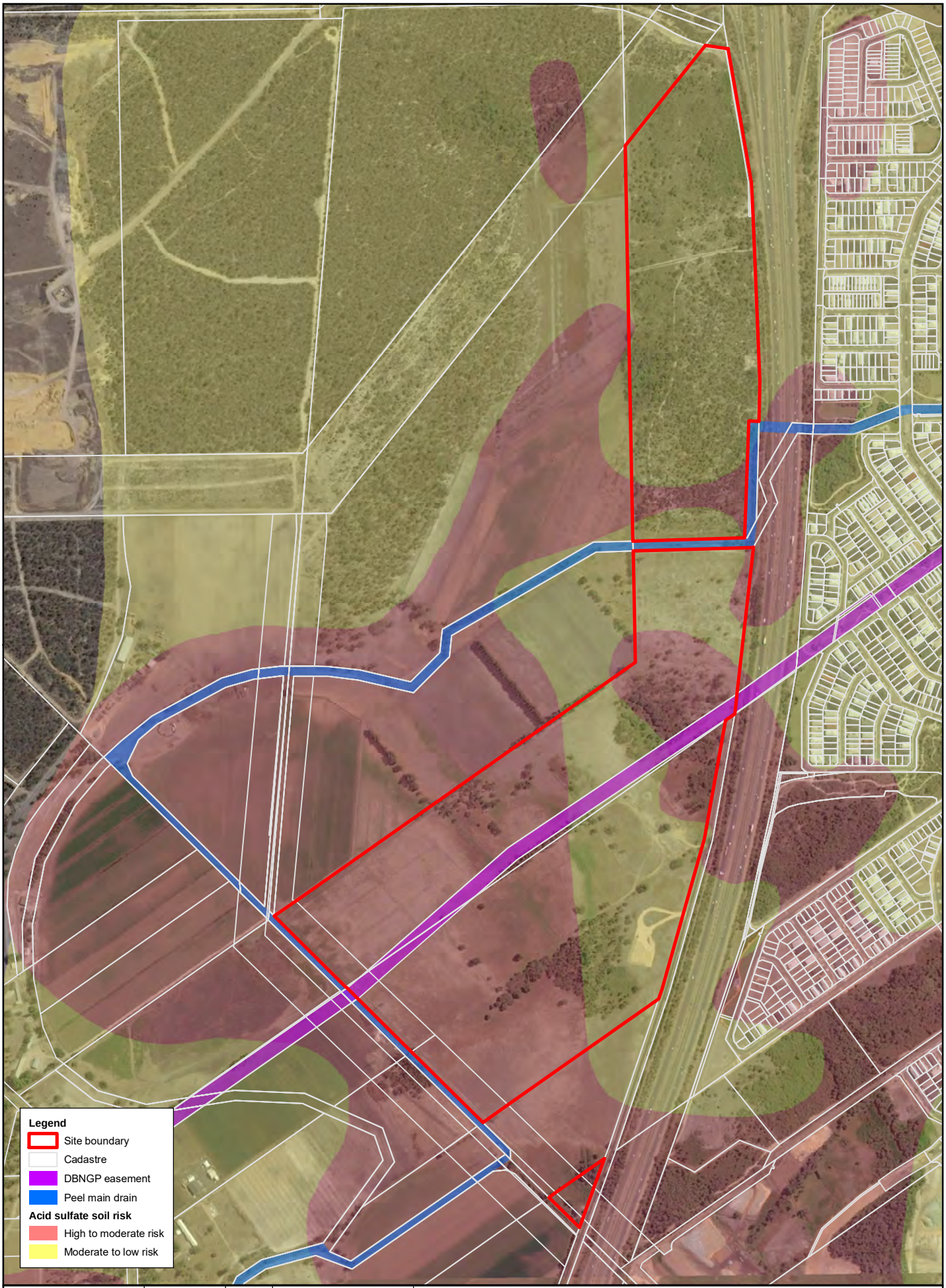
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Mandogalup ASS and Dewatering Management Plan

Figure 1

Site location



Map: 2268443A_GIS_003_A	Author: XX
Date: 11/08/2016	Approved by: EO

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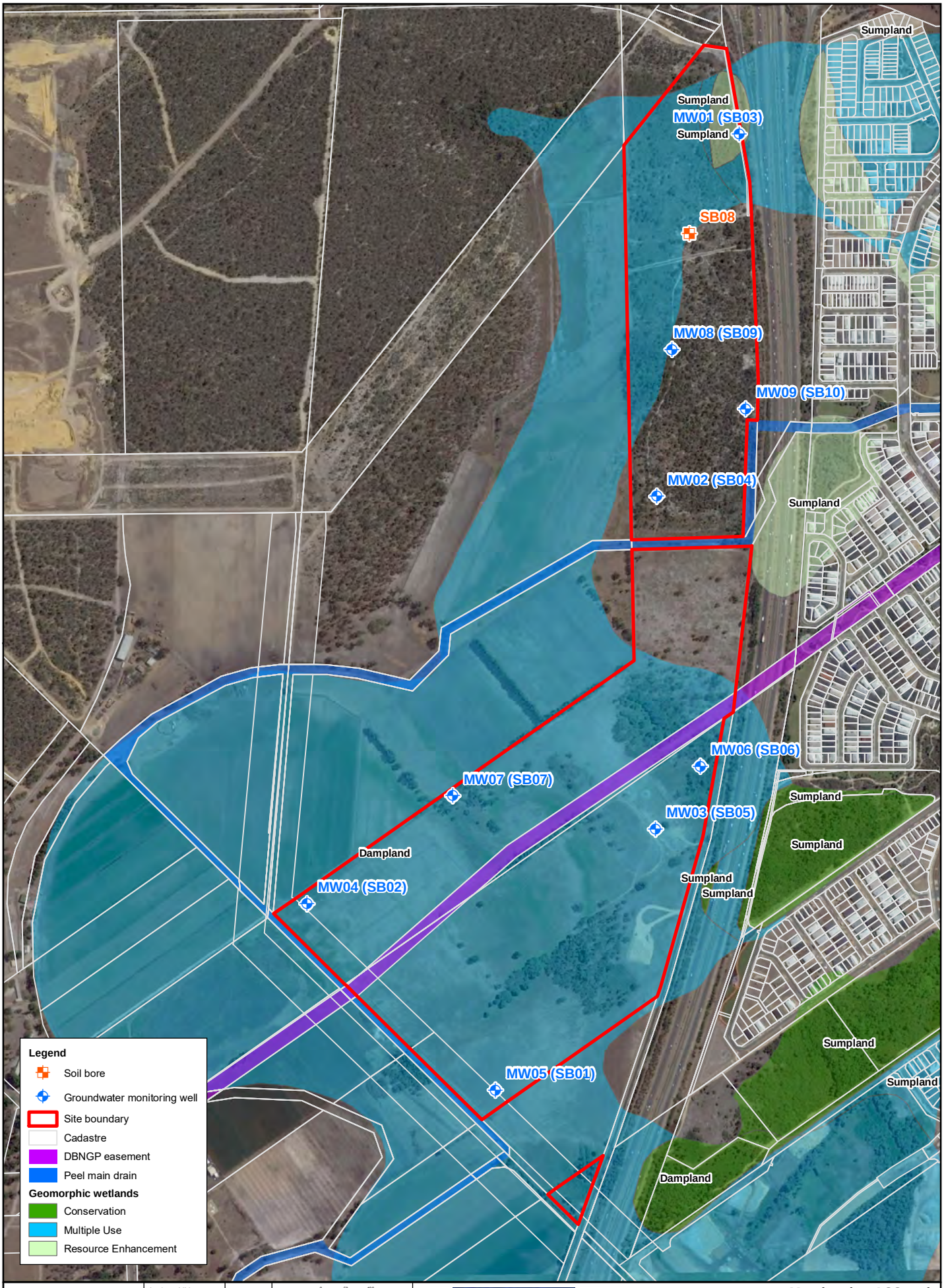
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Mandogalup ASS and Dewatering Management Plan

Figure 2

Regional ASS map



Map: 2268443A_GIS_004_A	Author: XX	
Date: 11/08/2016	Approved by: EO	

Data source: Rowe Group (2014)
Landgate (2016)

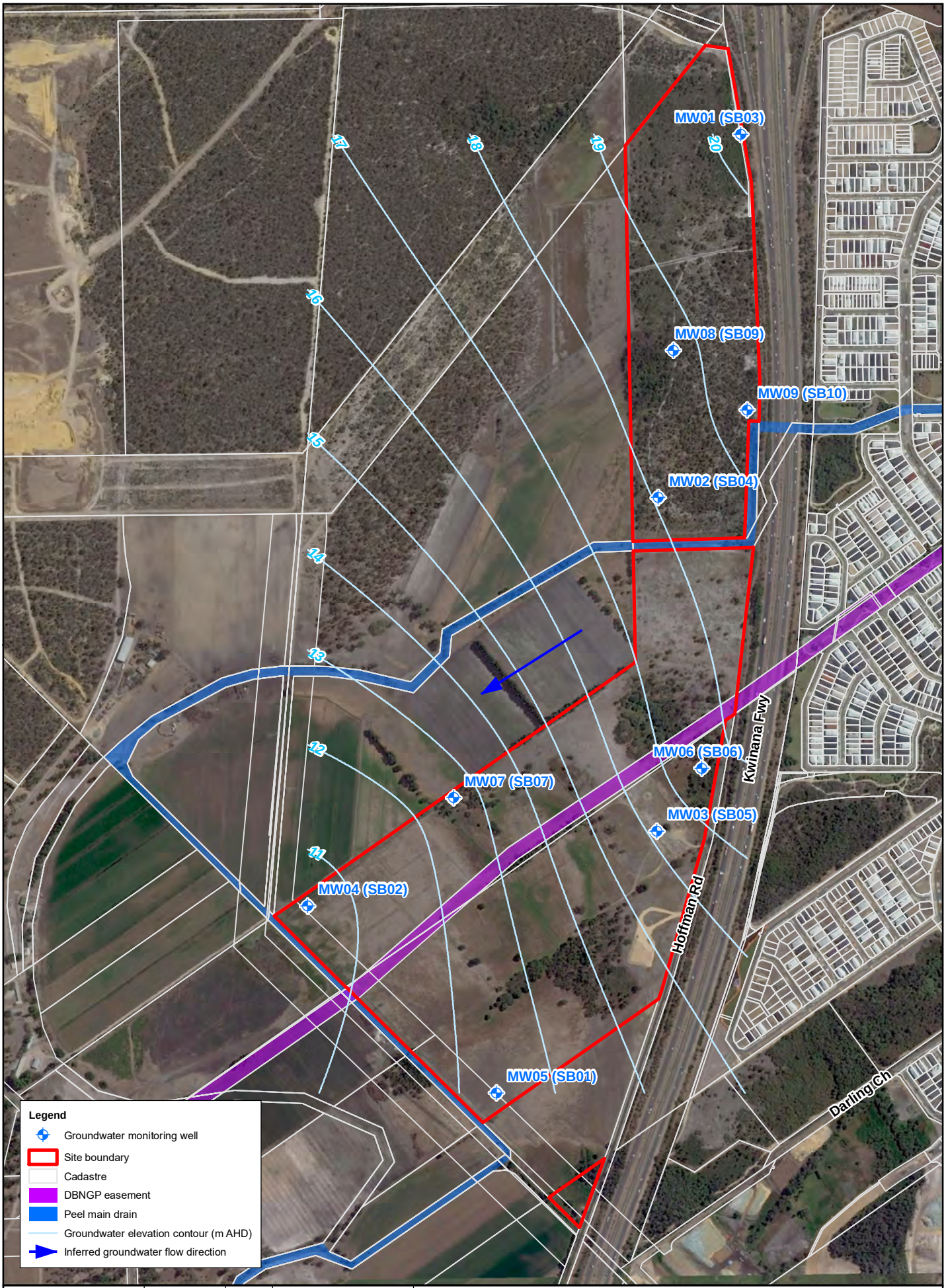
0 50 100 m
1:10,000
Coordinate system: GDA 1994 MGA Zone 50
Scale ratio correct when printed at A4

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Satterley

WSP | PARSONS BRINCKERHOFF

Mandogalup ASS and Dewatering Management Plan
Figure 3
Soil bore and groundwater monitoring well locations



Map: 2268443A_GIS_005_A	Author: XX
Date: 11/08/2016	Approved by: EO

Data source: Rowe Group (2014)
Landgate (2016)

1:10,000

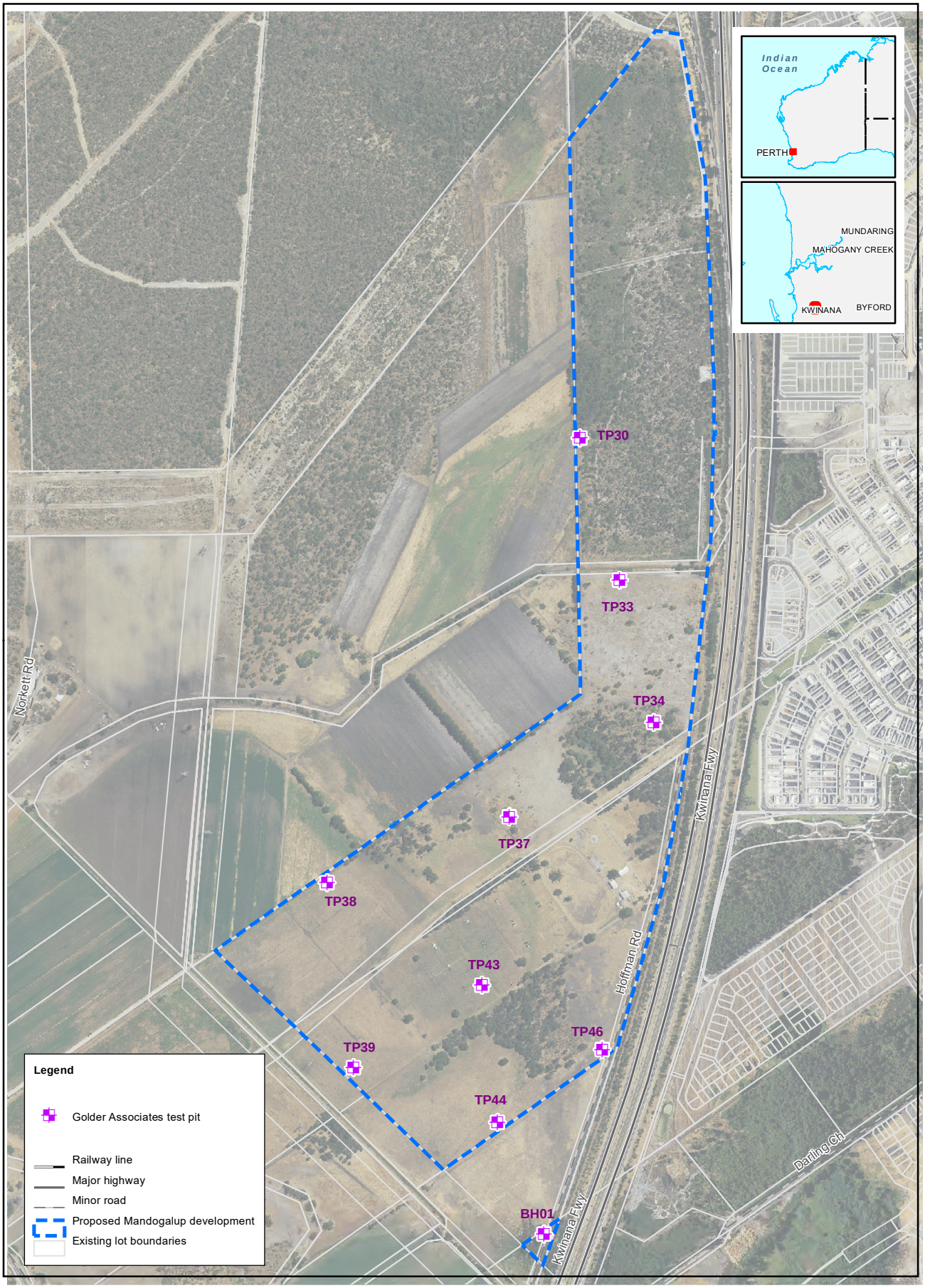
Coordinate system: GDA 1994 MGA Zone 50
Scale ratio correct when printed at A4

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Mandogalup ASS and Dewatering Management Plan
Figure 4
Groundwater elevation contours



Satterley

Data Source:
Rowe Group 2014
Landgate, DEC 2013

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esri Partner Network Silver

Map No:	201402331_GIS_001_A2
Author:	SH
Approved by:	AB
Date:	30/10/2015

0 50 100
m
1:10,000

N

Scale ratio correct when printed at A4

Projection: Transverse Mercator
Coord Sys: GDA 1994 MGA Zone 50

Mandogalup
Acid Sulfate Soil Investigation
Figure 5
Selected Golder Associates sample locations

Appendix 2
Certificates of title

WESTERN AUSTRALIA

REGISTER NUMBER	
9000/DP31293	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
4	14/2/2011

VOLUME 2525 FOLIO 87

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 9000 ON DEPOSITED PLAN 31293

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(T J271366) REGISTERED 3/5/2005

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

1. C463023 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DP31293 REGISTERED 2/12/1982.
2. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
3. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.

L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP31293
PREVIOUS TITLE:	1913-655
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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WESTERN AUSTRALIA

REGISTER NUMBER	
9002/DP69132	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	14/2/2011

VOLUME 2758 FOLIO 177

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 9002 ON DEPOSITED PLAN 69132

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF L494837) REGISTERED 1/12/2010

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

1. B927637 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 69132. REGISTERED 29/5/1980.
2. C463023 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 69132. REGISTERED 2/12/1982.
3. C556532 EASEMENT TO THE STATE ENERGY COMMISSION OF WESTERN AUSTRALIA. SEE SKETCH ON DEPOSITED PLAN 69132. REGISTERED 26/5/1983.
   H622728 SUNDRY. THE GRANTEE OF TRANSFER C556532 IS NOW THE DBNGP LAND ACCESS MINISTER PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. REGISTERED 14/12/2000.
4. H622728 SUNDRY. PORTION OF THE LAND HEREIN IS WITHIN THE DBNGP CORRIDOR PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. SEE LAND ADMINISTRATION PLAN 15576. REGISTERED 14/12/2000.
5. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
6. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
7. *L556227 CAVEAT BY TOWN OF KWINANA LODGED 2/3/2011.

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP69132
PREVIOUS TITLE:	1911-23, 1919-564
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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WESTERN AUSTRALIA

REGISTER NUMBER	
9006/DP70124	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	18/5/2011

VOLUME 2769 FOLIO 846

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 9006 ON DEPOSITED PLAN 70124

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF L608279) REGISTERED 16/5/2011

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

1. C463023 EASEMENT TO STATE ENERGY COMMISSION OF WESTERN AUSTRALIA FOR ELECTRICITY PURPOSES- SEE SKETCH ON DEPOSITED PLAN 70124 AND INSTRUMENT C463023. REGISTERED 2/12/1982.
2. D311642 EASEMENT TO STATE ENERGY COMMISSION OF WESTERN AUSTRALIA FOR ELECTRICITY PURPOSES - SEE SKETCH ON DEPOSITED PLAN 70124 AND INSTRUMENT D311642. REGISTERED 27/8/1986.
   H621767 SUNDRY. THE GRANTEE OF TRANSFER D311642 IS NOW THE DBNGP LAND ACCESS MINISTER PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. REGISTERED 13/12/2000.
3. H621767 SUNDRY. PORTION OF THE LAND HEREIN IS WITHIN THE DBNGP CORRIDOR PURSUANT TO THE DAMPIER TO BUNBURY PIPELINE ACT 1997. SEE DEPOSITED PLAN 215575 AND 215576 REGISTERED 13/12/2000.
4. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
5. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.

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

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

STATEMENTS:

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and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP70124
PREVIOUS TITLE:	2229-81, 2229-82
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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WESTERN AUSTRALIA

REGISTER NUMBER	
9033/DP407811	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	31/8/2016

VOLUME 2907 FOLIO 100

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9033 ON DEPOSITED PLAN 407811

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WANDI ANKETELL HOLDINGS PTY LTD OF LEVEL 2, 18 BOWMAN STREET, SOUTH PERTH
(AF N359300) REGISTERED 31/8/2016

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

1. L537548 MORTGAGE TO AUSTRALIA & NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
2. L537549 MORTGAGE TO WANDI ANKETELL LAND FINANCE COMPANY PTY LTD REGISTERED 24/1/2011.
   L537550 TRANSFER OF MORTGAGE L537549, MORTGAGEE NOW AUSTRALIA AND NEW ZEALAND BANKING GROUP LTD REGISTERED 24/1/2011.
3. M460534 EASEMENT TO WATER CORPORATION WATER CORPORATION FOR WATER AND WASTE WATER PIPELINE PURPOSES. SEE DEPOSITED PLAN 407811 AS CREATED ON DEPOSITED PLAN 404553 REGISTERED 12/11/2013.

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP407811
PREVIOUS TITLE:	2874-468
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF KWINANA

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Appendix 3
Soil bore logs

BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB01/MW05

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**9/3/16**
Project:	**2268443A**	Date Completed:	**9/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:		Surface RL:	
Borehole Diameter:	**75 mm**	Driller Lic No:		Co-ords:	**E 391703 N 6436782**

Borehole Information | **Field Material Description**

1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		9/3/16	topcap; cement; grout; gravel pack; screen; bottom cap	0.25					SAND; fine grained, subrounded, grey, well sorted, poor grading, dry			O.M
				0.50					SAND; fine grained, subangular to subrounded, grey, well sorted, poor grading, dry			Bassendean
				1					SAND; medium grained, subangular to subrounded, grey, well sorted, poor grading, dry			
				1.25					SAND; fine grained, subangular to subrounded, light grey, well sorted, poor grading, moist			Bassendean
				2								
				2.25					dark grey, well sorted, poor grading, moist to wet			Wet at 3 meters, Hydrogen Sulfide at ~ 3.0 - 3.5 meters
				3								
				4								
				5								
				6					END OF BOREHOLE AT 6.00 m			

TOS 0.4m AGL

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB02 / MW04

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**9/3/16**
Project:	**2268443A**	Date Completed:	**9/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:		Surface RL:	
Borehole Diameter:	**75 mm**	Driller Lic No:		Co-ords:	**E 391326 N 6437155**

Borehole Information | **Field Material Description**

1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA			topcap Top of Riser 0.6m AGL cement grout gravel pack screen 9/03/2016 bottom cap	0.75 1 1.50 2 3.00 3 4 4.35 5.00 5 6					SILT; fine grained, dark brown, moderately sorted, moderate grading, dry			High O. M.
									silty CLAY; moderate plasticity, white clay, well sorted, poor grading, moist			White clay. Kaolin?
									CLAY; high plasticity, brown/beige, dry			Orange/red mottling. Wet at 2.8 meters.
									CLAY; high plasticity, grey/ green, wet			Saturated at 4.5 meters
									sandy CLAY; moderate plasticity, brown, wet			Saturated
									CLAY; high plasticity, grey, wet/ saturated			Saturated
									END OF BOREHOLE AT 6.50 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB03 / MW01

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**9/3/16**
Project:	**2268443A**	Date Completed:	**9/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:	Surface RL:
Borehole Diameter:	**100 mm**	Driller Lic No:	Co-ords: **E 392203 N 6438694**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		9/03/2016	topcap; cement; grout; gravel pack; screen; bottom cap	3.00; 5.25					SAND; fine grained, subangular, grey, well sorted, poor grading, dry			Roots 0-0.1 meters. Moist at 2.5 meters, wet at 2.7 meters.
									SAND; fine grained, subangular, grey, well sorted, poor grading, wet			Hydrogen Sulfide at 3.5 - 3.75 meters. Saturated.
									SAND; fine grained, subangular, brown, well sorted, poor grading, wet			Hydrogen Sulfide
									END OF BOREHOLE AT 6.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB04 / MW02

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**9/3/16**
Project:	**2268443A**	Date Completed:	**9/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:	Surface RL:
Borehole Diameter:	**100 mm**	Driller Lic No:	Co-ords: **E 392026 N 6437971**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		9/03/2016	topcap Top of riser pipe 0.64m AGL cement grout gravel pack screen bottom cap	0.25 1 2 2.25 3 3.75 4 5 5.25 6					SAND; fine grained, subangular, grey, moderate to well sorted, moderate grading, dry			Topsoil some O.M roots.
									SAND; fine grained, subangular, grey, well sorted, poor grading, dry			
									SAND; fine grained, subangular, beige, well sorted, poor grading, dry to moist			
									SAND; fine grained, brown, well sorted, poor grading, wet			Coffee rock. Indurated; Hydrogen Sulfide; indurated at 3.75 meters;
									SAND; fine grained, subangular, dark brown, well sorted, poor grading, wet			
									END OF BOREHOLE AT 6.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB05/ MW03

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**9/3/16**
Project:	**2268443A**	Date Completed:	**9/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:	Surface RL:
Borehole Diameter:	**100 mm**	Driller Lic No:	Co-ords: **E 392024 N 6437304**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		9/03/2016	topcap cement grout gravel pack screen bottom cap	0.25 3.00 4.50					SAND; fine grained, subangular, grey, moderate to well sorted, moderate grading, dry			Topsiol O.M; Roots
									SAND; fine grained, subangular, grey, well sorted, poor grading, moist			Saturated at 2.5 meters
									SAND; fine grained, subangular, brown to dark brown, well sorted, poor grading, wet			Becoming dark brown at 4 meters
									silty SAND; fine grained, subangular, dark brown, well sorted, poor grading, wet			
									END OF BOREHOLE AT 6.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB06 / MW06

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**9/3/16**
Project:	**2268443A**	Date Completed:	**9/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:	Surface RL:
Borehole Diameter:	**100 mm**	Driller Lic No:	Co-ords: **E 392115 N 6437431**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		09/03/2016	topcap Top of casing 0.04m AGL cement grout gravel pack screen bottom cap	0.25 0.50 1 1.50 2 3 4 5 6					silty SAND; fine grained, subangular, grey, moderately sorted, moderate grading, dry			Topsoil; O.M, Roots
									silty SAND; fine grained, subangular, grey, well sorted, poor grading, dry			
									silty SAND; fine grained, subangular, dark brown, well sorted, poor grading, moist			
									SAND; fine grained, subangular, light brown/ beige, well sorted, poor grading, wet			
									END OF BOREHOLE AT 6.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB07 / MW07

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**10/3/16**
Project:	**2268443A**	Date Completed:	**10/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:	Surface RL:
Borehole Diameter:	**100 mm**	Driller Lic No:	Co-ords: **E 391618 N 6437372**

Borehole Information | **Field Material Description**

1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		10/03/2016	topcap; cement; grout; gravel pack; screen; bottom cap	0.10 / 0.25 / 1.00 / 1.50 / 2.25 / 3.00					SILT SAND; fine grained, subangular, dark brown, moderately sorted, moderate grading, moist			White clay
									silty SAND; fine grained, subangular, light grey, moderately sorted, moderate grading, moist			
									silty SAND; fine grained, subangular, dark brown, well sorted, poor grading, moist			
									SAND; fine grained, subangular, light brown, well sorted, poor grading, moist			
									silty SAND; subangular, dark brown, well sorted, poor grading, moist			Coffee rock; indurated; dark brown, wet at 2 meters
									SAND; fine grained, subangular, dark brown, well sorted, poor grading, wet			Wet at 2.25 meters, grading to dark brown at 2.5 - 3 meters
									silty SAND; fine grained, subangular, dark brown, well sorted, poor grading, wet			
									END OF BOREHOLE AT 6.00 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE ENGINEERING LOG

BOREHOLE NO. **SB08**

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**10/3/16**
Project:	**2268443A**	Date Completed:	**10/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:		Surface RL:	
Borehole Diameter:	**100 mm**	Driller Lic No:		Co-ords:	**E 392092 N 6438498**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA		▼ 10/03/2016		1 2 3 4					SAND; fine grained, subangular, light grey, well sorted, poor grading, dry			
									END OF BOREHOLE AT 4.50 m			

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB09/ MW08

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**10/3/16**
Project:	**2268443A**	Date Completed:	**10/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:		Surface RL:	
Borehole Diameter:	**100 mm**	Driller Lic No:		Co-ords:	**E 392058 N 6438268**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA			topcap Top of Riser 0.6m AGL cement grout gravel pack screen bottom cap	1 1.50 2 2.25 3 4 5 6					silty SAND; fine grained, subangular, dark grey, well sorted, poor grading, dry			Topsoil; O.M, roots
									silty SAND; fine grained, subangular, dark brown, well sorted, poor grading, moist			
									SAND; fine grained, subangular, light brown, well sorted, poor grading, moist			
									END OF BOREHOLE AT 6.00 m			

11/03/2016

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENGINEERING LOG SB10/ MW09

SHEET 1 OF 1

Client:	**Satterly Property Group**	Date Commenced:	**10/3/16**
Project:	**2268443A**	Date Completed:	**10/3/16**
Borehole Location:	**Mandogalup, WA**	Recorded By:	**YM**
Project Number:		Log Checked By:	

Drill Model/Mounting:		Driller:	Surface RL:
Borehole Diameter:	**100 mm**	Driller Lic No:	Co-ords: **E 392207 N 6438147**

Borehole Information | **Field Material Description**

1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
HSA			topcap Top of Casing 0.00m AGL cement grout gravel pack screen bottom cap	0.25 0.75 1 2 3.00 3 4 5 6					silty SAND; fine grained, subangular, grey, moderately soted, moderate grading, dry silty SAND; fine grained, subangular, grey, well sorted, poor grading, dry SAND; fine grained, subangular, grey, well sorted, poor grading, dry SAND; fine grained, grey, well sorted, poor grading, dry END OF BOREHOLE AT 4.50 m			Trace Silt

10/03/2016

This borehole log should be read in conjunction with Parsons Brinckerhoff's accompanying standard notes.

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DRAFT REPORT OF BOREHOLE: BH01

SHEET: 1 OF 1

CLIENT: Satterley Property Group
DRILL RIG: Comacchio Geo 305

PROJECT: Proposed Residential Subdivision
COORDS: 391910 m E 6436639 m N MGA94 50
CONTRACTOR: Proline Drilling

LOCATION: Mandogalup
INCLINATION: -90°
LOGGED: JPH DATE: 12/6/14

JOB NO: 147642090
HOLE DIA: 75 mm HOLE DEPTH: 15.00 m
CHECKED: DATE:

Drilling				Sampling		Field Material Description and Instrumentation			
METHOD	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION	AIRLIFT YIELD (L/s)	CONSTRUCTION
HQ3	24/06/14	0	0.80	DS 0.10-0.50 m Rec = 400/400 mm			ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand dry, firm to stiff		Bentonite Seal Class 18 Blank PVC
			1.30	DS 1.00-1.50 m Rec = 500/500 mm			Silty CLAY / Clayey SILT high plasticity, grey dry to wet, firm to stiff		
		2	2.20	SPT 1.50-1.95 m 14, 8, 8 N=16 Rec = 140/450 mm			very weakly cemented in parts (recovered as occasional cemented gravel fragments)		
			2.50	DS 2.20-2.50 m Rec = 300/300 mm			Clayey SAND fine to coarse grained, brown, with approximately 30-35% high plasticity clay wet, firm		Gravel Filter Pack Class 18 Machine Slotted PVC
			3.50	SPT 3.00-3.45 m 4, 9, 11 N=20 Rec = 0/450 mm			SAND fine to coarse grained, brown, trace silt wet, medium dense to very dense		
			4.00	DS 3.50-4.00 m Rec = 500/500 mm			with some low to medium plasticity clay		
		4	4.50	DS 4.00-4.50 m Rec = 500/500 mm			locally very weakly cemented in lenses		Gravel
				SPT 4.50-4.95 m 9, 19, 21 N=40 Rec = 340/450 mm			pale brown, low plasticity, trace clay, uncemented		
		6	6.25	SPT 6.00-6.45 m 8, 13, 17 N=30 Rec = 340/450 mm			predominantly medium to coarse grained, grey/pale grey/white (no clay)		
			7.50	DS 6.50-7.00 m Rec = 500/500 mm			fine to coarse grained, trace / clay fines silt		
		8		SPT 7.50-7.95 m 9, 16, 18 N=34 Rec = 350/450 mm					
			9.00	SPT 9.00-9.45 m 10, 22, 28 N=50 Rec = 360/450 mm			pale grey-brown		
		10	11.00	SPT 10.50-10.80 m 16, 34/150mm N>34 Rec = 280/300 mm			grey		
			11.50				pale brown		
		12	12.00	SPT 12.00-12.28 m 15, 25/130mm N>25 Rec = 0/280 mm			pale grey		
			13.00				pale brown		
			13.50	SPT 13.50-13.95 m 12, 22, 23 N=45 Rec = 270/450 mm			pale brown, predominantly fine to medium grained, trace silt/clay fines		
		14	15.00				END OF BOREHOLE @ 15.00 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.80 m DEPTH STANDPIPE INSTALLED		
		16							

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DRAFT REPORT OF TEST PIT: T01

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392021 m E 6436981 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.15	ASS T01-1 0.00-0.15 m Rec = 150/150 mm			SP	TOPSOIL: SAND fine to medium grained, dark brown, with some low plasticity silt, trace organics, trace grass roots (1 mm diameter)	M	L		seat
								SP	SAND fine to medium grained, pale grey		MD		
			0.5		ASS T01-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T01-3 0.70-0.80 m Rec = 100/100 mm						D		
			1.0		ASS T01-4 0.95-1.05 m Rec = 100/100 mm								
					ASS T01-5 1.20-1.30 m Rec = 100/100 mm Field Duplicate: D14								
			1.5	1.50					pale grey and pale brown	M - W	MD		
					ASS T01-6 1.80-1.90 m Rec = 100/100 mm					W			
			2.0		ASS T01-7 2.00-2.10 m Rec = 100/100 mm				TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.80 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T02

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392070 m E 6437156 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.15	ASS T02-1 0.00-0.15 m Rec = 150/150 mm Geotech Sample T02-1 0.00-0.15 m Rec = 150/150 mm			SM	TOPSOIL: Silty SAND fine to medium grained, black, approximately 15%-20% non-plastic to low plasticity silt, trace organics, trace grass roots (1 mm diameter)				seat
								SP	SAND fine to medium grained, grey				
			0.5		ASS T02-2 0.45-0.55 m Rec = 100/100 mm					M	L		
				0.80	ASS T02-3 0.70-0.80 m Rec = 100/100 mm Field Duplicate: D15				pale grey				
			1.0		ASS T02-4 0.95-1.05 m Rec = 100/100 mm								
				1.20	ASS T02-5 1.20-1.30 m Rec = 100/100 mm				pale grey and pale brown	M - W			
			1.5		ASS T02-6 1.40-1.50 m Rec = 100/100 mm						MD	Could not collect representative ASS sample below 1.5 m depth.	
										W			
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.60 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T03

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392115 m E 6437324 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.15	ASS T03-1 0.00-0.15 m Rec = 150/150 mm			SM	TOPSOIL: Silty SAND fine to medium grained, black, approximately 15%-20% low plasticity silt silt, trace organics, trace grass roots (3 mm diameter)	M			seat
								SP	SAND fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend down to groundwater	M - W	L		
			0.5		ASS T03-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T03-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T03-4 0.95-1.05 m Rec = 100/100 mm					W	MD	Could not collect representative ASS sample below 1.1 m depth.	
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER ENCOUNTERED @ 0.80 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T04

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391986 m E 6437272 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0	0.15				SP	TOPSOIL: SAND fine to medium grained, brown, with some low plastcity clay, trace grass roots (1 mm diameter)		L		seat
				0.35				SP	SAND fine to medium grained, dark grey, with some low plasticity silt, trace grass roots (1 mm diameter), roots extend to about 500 mm depth	M			
			0.5						pale grey, without silt		MD		
			1.0										
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T05

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391924 m E 6437326 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0					SP	TOPSOIL: SAND fine to medium grained, yellow brown, trace fines, trace grass roots (1 mm diameter), trace organics		L		seat
				0.20	ASS T05-1 0.20-0.30 m Rec = 100/100 mm			SP	SAND fine to medium grained, dark grey, with some low plasticity silt, trace grass roots (1 mm diameter), trace shrub roots (50 mm diameter), roots extend to about 1200 mm depth				
			0.5	0.50	ASS T05-2 0.40-0.50 m Rec = 100/100 mm				pale grey, without silt	M			
					ASS T05-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T05-4 0.90-1.00 m Rec = 100/100 mm								
				1.20	ASS T05-5 1.20-1.30 m Rec = 100/100 mm				white		MD	Could not collect representative ASS sample below 1.3 m depth.	
			1.5							M - W			
			2.0										
				2.40						W			
			2.5					SC / SM	Clayey/Silty SAND fine to medium grained, brown, approximately 15%-20% low plasticity clay/silt				
									TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.20 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T06

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391992 m E 6437377 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0	0.15				SP / SM	TOPSOIL: Silty SAND / SAND fine to medium grained, black, approximately 10%-15% non-plastic silt, trace organics, trace grass roots (5 mm diameter)		L		seat
			0.5		Geotech Sample T06-1 0.70-1.20 m Rec = 500/500 mm			SP	SAND fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale grey, trace grass roots (1 mm diameter), roots extend to about 500 mm depth	M	MD		
			1.0										
			1.5	1.80					pale brown	M - W			
			2.0						TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T07

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392063 m E 6437416 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0					SP / SM	TOPSOIL: Silty SAND / SAND approximately 10%-15% non-plastic silt, trace ogranics, trace grass roots (2 mm diameter)	M			seat
				0.25				SP	SAND fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale grey, trace grass roots (1 mm diameter), roots extend to about 600 mm depth	M - W	L		
			0.5										
			1.0							W	MD		
			1.5										
				2.00				SM	Silty SAND fine to medium grained, brown, approximately 15%-20% low plasticity silt				
			2.0						TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER ENCOUNTERED @ 0.80 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T08

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391952 m E 6437472 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0	0.15	Geotech Sample T08-1 0.00-0.15 m Rec = 150/150 mm			SP	TOPSOIL: SAND fine to medium grained, black, with some low plasticity silt, trace organics, trace grass roots (1 mm diameter), trace shrub roots (20 mm diameter), root mass down to 800 mm depth	M	L		seat
			0.5					SP	SAND fine to medium grained, pale grey, trace grass roots (1 mm diameter), trace shrub roots (20 mm diameter), roots extend to about 1200 mm dpeth				
			1.0	1.30					pale brown		MD		
			1.5							M - W			
			2.0						TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T09

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392025 m E 6437536 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 1.50 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0		Geotech Sample T09-1 0.00-1.00 m Rec = 1000/1000 mm ASS T09-1 0.10-0.20 m Rec = 100/100 mm			SM	SAND fine to medium grained, black to dark grey, approximately 10% silt fines , with organics, trace shrub roots (20 mm diameter), roots inferred to extend below groundwater, moderate sulphide odour	W	L	Approximately 100 mm of perched surface water present during test pit excavation.	0 5 10 15 20 25 seat
			0.5		ASS T09-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T09-3 0.70-0.80 m Rec = 100/100 mm								
			1.0	1.10				SP	SAND fine to medium grained, brown, with some medium plasticity clay		MD	Could not collect representative ASS sample below 1.0 m depth.	
				1.20				SC	Clayey SAND fine to medium grained, brown, approximately 20%-30% medium plasticity clay				
	H			1.40				SC	CEMENTED CLAYEY SAND fine to medium grained, brown, approximately 20%-30% medium plasticity clay , weakly to well iron cemented	D - M			
			1.5						TEST PIT DISCONTINUED @ 1.50 m REFUSAL GROUNDWATER ENCOUNTERED @ 0.90 m DEPTH BACKFILLED				
			2.0										
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T10

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392117 m E 6437589 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
			0.0										0 5 10 15 20 25
				0.20	ASS T10-1 0.00-0.20 m Rec = 200/200 mm Field Duplicate: D16			SP	TOPSOIL: SAND fine to medium grained, black, trace silt, trace grass roots (3 mm diameter)				seat
								SP	SAND fine to medium grained, grey, trace grass roots (3 mm diameter), trace shrub roots (30 mm diameter), roots extend down to about 800 mm depth		L		
			0.5		ASS T10-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T10-3 0.70-0.80 m Rec = 100/100 mm								
				1.00									
EX	M		1.0		ASS T10-4 1.00-1.10 m Rec = 100/100 mm				becoming pale grey	M			
				1.20	ASS T10-5 1.20-1.30 m Rec = 100/100 mm				becoming pale grey and pale brown				
			1.5		ASS T10-6 1.70-1.80 m Rec = 100/100 mm						MD		
			2.0		ASS T10-7 2.00-2.20 m Rec = 200/200 mm								
									TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T11

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392191 m E 6437690 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT
DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED:
DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0		Geotech Sample T11-1 0.00-0.25 m Rec = 250/250 mm			SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (5 mm diameter				seat
				0.25				SP	SAND fine to medium grained, grey, trace silt, trace grass roots (3 mm diameter), roots extend down to about 1300 mm depth		L	80 mm diameter tree root at 400 mm depth.	
			0.5	0.80					pale grey				
			1.0							M			
			1.5								MD		
			2.0						TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

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DRAFT REPORT OF TEST PIT: T12

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392085 m E 6437714 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.40 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0					SP	TOPSOIL: SAND fine to medium grained, dark brown, trace/some silt, trace grass roots (5 mm diameter), trace shrub roots (10 mm diameter)				seat
				0.20				SP	SAND fine to medium grained, grey, trace silt, trace grass roots (5 mm diameter), trace shrub roots (10 mm diameter), roots extend down to about 1200 mm depth pale grey	M	L		
			0.5	0.50									
			1.0										
				1.40					white		MD		
			1.5										
			2.0										
			2.5						TEST PIT DISCONTINUED @ 2.40 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T13

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391994 m E 6437723 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0		ASS T13-1 0.00-0.10 m Rec = 100/100 mm			SP	TOPSOIL: SAND fine to medium grained, grey, trace/some silt, trace organics, trace grass roots (1 mm diameter)				seat
				0.25				SP	SAND fine to medium grained, grey, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter), roots extend down to about 1200 mm depth		L		
				0.40					pale grey				
			0.5		ASS T13-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T13-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T13-4 0.95-1.05 m Rec = 100/100 mm					M			
				1.20					white				
					ASS T13-5 1.20-1.30 m Rec = 100/100 mm Field Duplicate: D18						MD		
			1.5		ASS T13-6 1.50-1.60 m Rec = 100/100 mm								
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T14

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392053 m E 6437852 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0		ASS T14-1 0.10-0.20 m Rec = 100/100 mm			SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)	M	L		seat
				0.30				SP	SAND fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend to about 1100 mm depth			60 mm diameter tree root at 300 mm depth.	
			0.5		ASS T14-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T14-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T14-4 0.95-1.05 m Rec = 100/100 mm						MD		
					ASS T14-5 1.20-1.30 m Rec = 100/100 mm								
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T15

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392184 m E 6437900 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.40 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M	▽	0.0	0.25	ASS T15-1 0.00-0.10 m Rec = 100/100 mm Geotech Sample T15-1 0.00-0.25 m Rec = 250/250 mm			SP	TOPSOIL: SAND fine to medium grained, black, trace silt, trace grass roots (2 mm diameter), trace shrub roots (10 mm diameter)				seat
				0.40	ASS T15-2 0.40-0.50 m Rec = 100/100 mm			SP	SAND fine to medium grained, grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1000 mm depth pale grey	M	L		
			0.5		ASS T15-3 0.70-0.80 m Rec = 100/100 mm								
			1.0	1.10	ASS T15-4 0.95-1.05 m Rec = 100/100 mm				white				
					ASS T15-5 1.20-1.30 m Rec = 100/100 mm								
			1.5	1.60	ASS T15-6 1.50-1.60 m Rec = 100/100 mm				brown, with some low plasticity fines	M - W	MD		
			2.0		ASS T15-7 2.20-2.30 m Rec = 100/100 mm					W			
			2.5						TEST PIT DISCONTINUED @ 2.40 m COLLAPSE GROUNDWATER ENCOUNTERED @ 2.00 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T16

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392046 m E 6437972 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.10 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0					SP	TOPSOIL: SAND fine to medium grained, grey, trace/some silt, trace grass roots (5 mm diameter), trace shrub roots (20 mm diameter)	M	L		seat
				0.15				SP	SAND fine to medium grained, grey, trace silt, trace grass roots (5 mm diameter), trace shrub roots (20 mm diameter), roots extend down to about 1500 mm depth				
				0.30					pale grey				
			0.5	0.70					white				
			1.0										
			1.5								MD		
			2.0						TEST PIT DISCONTINUED @ 2.10 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T17

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392082 m E 6438059 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.30 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0		ASS T17-1 0.10-0.20 m Rec = 100/100 mm			SP	TOPSOIL: SAND fine to medium grained, grey-brown, trace/some silt, trace grass roots (2 mm diameter), trace shrub roots (20 mm diameter)	M	L		seat
				0.25				SP	SAND fine to medium grained, yellow, trace fines, trace grass roots (2 mm diameter), trace shrub roots (20 mm diameter), roots extend down to about 1200 mm depth				
			0.5		ASS T17-2 0.45-0.55 m Rec = 100/100 mm Geotech Sample T17-1 0.50-1.00 m Rec = 500/500 mm ASS T17-3 0.70-0.80 m Rec = 100/100 mm ASS T17-4 0.95-1.05 m Rec = 100/100 mm								
			1.0		ASS T17-5 1.20-1.30 m Rec = 100/100 mm								
			1.5		ASS T17-6 1.70-1.80 m Rec = 100/100 mm								
			2.0		ASS T17-7 2.20-2.30 m Rec = 100/100 mm						MD		
			2.5						TEST PIT DISCONTINUED @ 2.30 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T18

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392198 m E 6438056 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.40 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0					SP	TOPSOIL: SAND fine to medium grained, grey, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)				seat
				0.20				SP	SAND fine to medium grained, grey, trace silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter), roots extend down to about 1500 mm depth			50 mm diameter tree root at 500 mm depth.	
			0.5	0.45					pale grey		L		
			1.0	1.00					white	M			
			1.5								MD		
			2.0										
			2.5						TEST PIT DISCONTINUED @ 2.40 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T22

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392216 m E 6438267 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0	0.15				SP	TOPSOIL: SAND fine to medium grained, grey, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter)				seat hammer weight
								SP	SAND fine to medium grained, pale yellow, trace grass roots (3 mm diameter), roots extend down to about 1300 mm depth	M	L MD	130 mm diameter tree root at 1000 mm depth.	
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				

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DRAFT REPORT OF TEST PIT: T23

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391940 m E 6437205 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0					SC	TOPSOIL: Clayey SAND fine to medium grained, black, approximately 15%-25% medium plasticity clay, with some low plastcity silt, trace grass roots (1 mm diameter), trace organics	D - M			seat
				0.30				SP	SAND fine to medium grained, pale grey, trace grass roots (1 mm diameter), roots extend to about 500 mm depth	M	L		
			0.5										
				1.00	Geotech Sample T23-1 1.00-1.20 m Rec = 200/200 mm				white	M - W	MD		
			1.0										
			1.5										
			2.0						TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T24

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391978 m E 6438118 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.30 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0	0.20	ASS T24-1 0.00-0.10 m Rec = 100/100 mm Field Duplicate: D19			SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)				seat
								SP	SAND fine to medium grained, grey, trace silt, trace grass roots (3 mm diameter), roots extend to about 1000 mm depth				
			0.5	0.50	ASS T24-2 0.40-0.50 m Rec = 100/100 mm				pale grey		L		
				0.85	ASS T24-3 0.70-0.80 m Rec = 100/100 mm				white				
			1.0		ASS T24-4 0.95-1.05 m Rec = 100/100 mm					M			
					ASS T24-5 1.20-1.30 m Rec = 100/100 mm						MD		
			1.5										
					ASS T24-6 1.80-1.90 m Rec = 100/100 mm					M - W			
			2.0		ASS T24-7 2.20-2.30 m Rec = 100/100 mm								
									TEST PIT DISCONTINUED @ 2.30 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T25

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392080 m E 6438536 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0					SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)				seat
				0.30				SP	SAND fine to medium grained, pale grey, trace silt, trace grass roots (3 mm diameter), roots extend down to about 1500 mm depth		L		
			0.5										
			1.0	1.00					white	M			
			1.5								MD		
				1.90					white to pale brown				
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T29

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391984 m E 6438579 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.15	Geotech Sample T29-1 0.00-0.15 m Rec = 150/150 mm			SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (2 mm diameter), trace shrub roots (5 mm diameter)	M	L		seat
								SP	SAND fine to medium grained, pale grey, trace grass roots (2 mm diameter), roots extend down to about 1200 mm depth				
			0.5		Geotech Sample T29-2 0.50-1.20 m Rec = 700/700 mm								
			1.0	1.20					pale grey and white	M - W	MD		
			1.5										
			2.0	2.00					pale grey and pale brown	W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.00 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

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DRAFT REPORT OF TEST PIT: T30

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 392057 m E 6438429 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 1.90 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0					SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter)				seat
				0.35				SP	SAND fine to medium grained, pale grey, trace silt, trace grass roots (3 mm diameter), roots extend down to about 1300 mm depth		L	50 mm diameter tree root at 500 mm depth.	
			1.0	1.20					white	M	MD		
			2.0						TEST PIT DISCONTINUED @ 1.90 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				

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DRAFT REPORT OF TEST PIT: T31

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391413 m E 6437209 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		Geotech T31-1 0.10-0.40 m Rec = 300/300 mm PP = 3 kg / cm^2 ASS T31-1 0.20-0.30 m Rec = 100/100 mm ASS T31-2 0.45-0.55 m Rec = 100/100 mm PP = 4-5 kg / cm^2 ASS T31-3 0.70-0.80 m Rec = 100/100 mm Geotech T31-2 0.80-1.00 m Rec = 200/200 mm ASS T31-4 0.95-1.05 m Rec = 100/100 mm ASS T31-5 1.20-1.30 m Rec = 100/100 mm Geotech T31-3 1.50-1.80 m Rec = 300/300 mm ASS T31-6 1.70-1.80 m Rec = 100/100 mm ASS T31-7 2.20-2.30 m Rec = 100/100 mm			CH-OH	ORGANIC CLAY / SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D	Fb		seat
			0.5	*0.40*				MH	Silty CLAY / Clayey SILT high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter)		St		
			1.0	*1.20*				CH	CLAY high plasticity, brown, trace fine grained sand	M	F - St		
			1.5										
			2.0										
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T32

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391507 m E 6437291 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.60 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0					CH-OH	Peaty CLAY / CLAY high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)		Fb		seat
				0.30	ASS T32-1 0.20-0.30 m Rec = 100/100 mm PP = 2.5-3.5 kg / cm^2			CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter)	D			
			0.5		ASS T32-2 0.45-0.55 m Rec = 100/100 mm PP = 2-2.5 kg / cm^2								
					ASS T32-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T32-4 0.95-1.05 m Rec = 100/100 mm								
				1.20	PP = 1-2 kg / cm^2 ASS T32-5 1.20-1.30 m Rec = 100/100 mm			CH	CLAY high plasticity, brown, trace fine grained sand		F - St		
			1.5		ASS T32-6 1.70-1.80 m Rec = 100/100 mm PP = 1.5-2.5 kg / cm^2								
			2.0							M			
					ASS T32-7 2.20-2.30 m Rec = 100/100 mm Geotech T32-1 2.20-2.30 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.60 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T33

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391564 m E 6437329 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.70 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0					CH-OH	Peaty CLAY / CLAY high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)		Fb		seat
				0.25	PP = 4-6 kg / cm^2			CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (3 mm diameter), roots extend down to about 700 mm depth				
			0.5		Geotech T33-1 0.50-0.80 m Rec = 300/300 mm PP > 6 kg / cm^2								
	H		1.0		PP > 6 kg / cm^2					D	St - VSt		
			1.5		Geotech T33-2 1.20-1.80 m Rec = 600/600 mm								
				2.00				CH	CLAY high plasticity, brown, trace fine grained sand				
	M		2.5							M	F - St		
									TEST PIT DISCONTINUED @ 2.70 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T34

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391632 m E 6437367 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 1.00 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0	0.10				SM	TOPSOIL: Silty SAND fine to medium grained, black, approximately 20%-30% low to medium plasticity silt, trace grass roots (2 mm diameter)	M	L		seat
					ASS T34-1 0.20-0.30 m Rec = 100/100 mm Field Duplicate: D01			CL	Silty CLAY low plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (3 mm diameter) and tree roots (100 mm diameter)	D	St		
			0.5	0.60							VSt		
	H				ASS T34-2 0.60-0.70 m Rec = 100/100 mm Field Duplicate: D02 ASS T34-3 0.80-0.90 m Rec = 100/100 mm Field Duplicate: D03 ASS T34-4 0.90-1.00 m Rec = 100/100 mm			SP	CEMENTED SAND fine to medium grained, dark brown and black, with some low plasticity silt, weakly to well iron cemented		D		
			1.0								VD		
									TEST PIT DISCONTINUED @ 1.00 m REFUSAL GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			1.5										
			2.0										
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T35

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391848 m E 6437413 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
EX	M		0.0	0.15	ASS T35-1 0.20-0.30 m Rec = 100/100 mm			SM	TOPSOIL: Silty SAND fine to medium grained, grey and black, approximately 15%-25% low plasticity silt, trace grass roots (1 mm diameter) and shrub roots (10 mm diameter)	M	L		seat
			0.5		ASS T35-2 0.45-0.55 m Rec = 100/100 mm Field Duplicate: D05			SP	SAND fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1200 mm depth				
					ASS T35-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T35-4 0.95-1.05 m Rec = 100/100 mm								
					ASS T35-5 1.20-1.30 m Rec = 100/100 mm						MD		
			1.5		ASS T35-6 1.50-1.60 m Rec = 100/100 mm								
				1.90					white				
			2.0		ASS T35-7 2.10-2.20 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T36

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391809 m E 6437362 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.30 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0		ASS T36-1 0.20-0.30 m Rec = 100/100 mm			OH / SC	Interbedded ORGANIC CLAY and Clayey SAND trace grass roots (2 mm diameter), approximately 50% Clayey Sand and 50% Peaty Clay, clay is: high plasticity, black, trace fine grained sand, sand is: fine to medium grained, black and white, approximately 40%-50% high plasticity clay	D - M	St - MD		seat
			0.5	0.60	Geotech Sample T36-1 0.40-0.50 m Rec = 100/100 mm								
					ASS T36-2 0.45-0.55 m Rec = 100/100 mm			SP	SAND fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1000 mm depth	M			
					ASS T36-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T36-4 0.95-1.05 m Rec = 100/100 mm							Moderate sulphide odour associated with groundwater.	
			1.5		ASS T36-6 1.50-1.60 m Rec = 100/100 mm					W	MD		
			2.0		ASS T36-7 2.20-2.30 m Rec = 100/100 mm Field Duplicate: D04				TEST PIT DISCONTINUED @ 2.30 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.00 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T37

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391760 m E 6437335 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	H		0.0		PP > 6 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D	Fb		seat
				0.40				CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (3 mm diameter)		VSt		
			0.5		PP > 6 kg / cm^2						H		
				0.75				SP	SAND fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale brown				
				1.00					pale grey	D - M			
	M		1.5		Geotech T37-1 1.50-1.70 m Rec = 200/200 mm						MD		
		▽	2.0							M			
										W			
									TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER ENCOUNTERED @ 2.00 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T38

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391692 m E 6437288 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0					CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	M	St - F		seat
				0.40	ASS T38-1 0.20-0.30 m Rec = 100/100 mm PP = 5-6 kg / cm^2								
			0.5		ASS T38-2 0.45-0.55 m Rec = 100/100 mm PP = 3-4 kg / cm^2				with some fine to medium grained sand, trace grass roots (1 mm diameter), roots inferred to extend below groundwater				
				0.60				SP	SAND fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale brown, trace fines	M - W			
				0.90	ASS T38-3 0.70-0.80 m Rec = 100/100 mm				brown				
			1.0		ASS T38-4 0.95-1.05 m Rec = 100/100 mm						MD		
					ASS T38-5 1.20-1.30 m Rec = 100/100 mm					W			
			1.5		ASS T38-6 1.70-1.80 m Rec = 100/100 mm								
					ASS T38-7 1.90-2.00 m Rec = 100/100 mm								
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.00 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T39

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391896 m E 6437564 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT
DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED:
DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M		0.0	0.15				SM	TOPSOIL: Silty SAND fine to medium grained, black, approximately 15%-25% low plasticity silt, trace organics, trace grass roots (1 mm diameter), trace shrub roots (20 mm diameter), root mass down to 1300 mm depth	M	L		seat
				0.40				SP	SAND fine to medium grained, grey, trace silt, trace grass roots (1 mm diameter), roots extend down to about 1200 mm depth pale grey				
			0.5										
			1.0								MD		
			1.5										
			2.0							M - W			
									TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T40

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391582 m E 6437280 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.60 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		0.00 m PP = 2.5-3 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)				seat
				0.35				CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 500 mm depth	D	F - St		
			0.5		PP = 2.5-3 kg / cm^2								
			1.0		PP = 2.5-3.5 kg / cm^2								
				1.20				CH	CLAY high plasticity, brown, trace fine grained sand				
			1.5							M	F		
			2.0										
					PP = 1-1.5 kg / cm^2								
			2.5						TEST PIT DISCONTINUED @ 2.60 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T41

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391518 m E 6437250 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
													0 5 10 15 20 25
EX	M		0.0		0.00 m PP = 2.5-3 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)				seat
				0.35				CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 500 mm depth	D	F - St		
			0.5		PP = 2-3 kg / cm^2								
			1.0	*1.20*									
					PP = 1.5 kg / cm^2			CH	CLAY high plasticity, brown, trace fine grained sand				
			1.5							M	F		
			2.0		PP = 1-1.5 kg / cm^2								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T42

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391444 m E 6437162 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm (0 5 10 15 20 25)
EX	M		0.0	0.00 m	PP = 3 kg / cm²			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)				seat
				0.35				CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 400 mm depth	D	F - St		
			0.5		PP = 4-5 kg / cm²								
			1.0	1.10				CH	CLAY high plasticity, brown, trace fine grained sand	D - M			
			1.5		PP = 1.5-2.5 kg / cm²					M	F		
			2.0		PP = 1-1.5 kg / cm²								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T43

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391541 m E 6437195 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		ASS T43-1 0.20-0.30 m Rec = 100/100 mm PP = 5-6 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)		Fb		seat
				0.30									
			0.5		ASS T43-2 0.45-0.55 m Rec = 100/100 mm PP = 1-2.5 kg / cm^2			CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 600 mm depth	D			
					ASS T43-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T43-4 0.95-1.05 m Rec = 100/100 mm								
				1.20									
			1.5		ASS T43-5 1.20-1.30 m Rec = 100/100 mm			CH	CLAY high plasticity, brown, trace fine grained sand		F - St		
					PP = 2-2.5 kg / cm^2 ASS T43-6 1.70-1.80 m Rec = 100/100 mm					D - M			
			2.0		ASS T43-7 2.20-2.30 m Rec = 100/100 mm PP = 2-3 kg / cm^2								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T44

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391589 m E 6437230 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.60 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		Geotech Sample T44-1 0.10-0.25 m Rec = 150/150 mm PP = 1.5-2.5 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)		Fb		seat
			0.5	0.50				CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth	D	St		
			1.0	1.20	PP = 5-6 kg / cm^2			CH	CLAY high plasticity, brown, trace fine grained sand				
			1.5		Geotech Sample T44-2 1.40-1.60 m Rec = 200/200 mm PP = 1 kg / cm^2					M	F		
			2.0		Geotech Sample T44-3 2.00-2.20 m Rec = 200/200 mm PP = 1 kg / cm^2								
			2.5						TEST PIT DISCONTINUED @ 2.60 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T45

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391643 m E 6437266 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.70 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm 0 5 10 15 20 25
EX	M		0.0		Geotech Sample T45-1 0.10-0.20 m Rec = 100/100 mm PP = 4-4.5 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.35				CH	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 500 mm depth		H		
			0.5		PP > 6 kg / cm^2								
			1.0		PP = 4.5-6 kg / cm^2					D			
				1.30				CH	CLAY high plasticity, brown, trace fine grained sand, trace organics, trace wood fragments (up to 5 mm diameter)		VSt		
			1.5										
			2.0							D - M	St		
				2.40					brown blue green, trace wood fragments (up to 10 mm diameter), trace white calareous fragments (up to 5 mm long, 2 mm in diameter)	M	F		
			2.5		Geotech Sample T45-2 2.40-2.70 m Rec = 300/300 mm								
									TEST PIT DISCONTINUED @ 2.70 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T46

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391788 m E 6437227 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0	0.10	0.00 m			CH-OH CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
					PP = 2.5-3.5 kg / cm²				CLAY high plasticity, dark grey to black, trace fine grained sand, trace grass roots (1 mm diameter)		F - St		
			0.5	0.60									
				0.70	PP = 2.5-3.5 kg / cm²				with some fine to medium grained sand	M			
								SP	SAND fine to medium grained, pale grey				
			1.0	1.20					trace fines		MD		
			1.5							W			
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER ENCOUNTERED @ 0.90 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T47

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391734 m E 6437179 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0		ASS T47-1 0.20-0.30 m Rec = 100/100 mm Geotech Sample T47-1 0.20-0.40 m			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D	Fb		seat
			0.5	0.50	Rec = 200/200 mm ASS T47-2 0.40-0.50 m Rec = 100/100 mm PP = 2-3.5 kg / cm^2 Geotech Sample T47-2 0.60-0.80 m Rec = 200/200 mm ASS T47-3 0.70-0.80 m Rec = 100/100 mm Field Duplicate: D08 PP = 0.5-1 kg / cm^2			MH	Cleyey SILT medium to high plasticity, dark grey, trace fine grained sand, trace grass roots (1 mm diameter), roots extend down to about 700 mm depth		F - St		
			1.0	1.20						M	F		
			1.5		ASS T47-4 0.95-1.00 m Rec = 100/50 mm ASS T47-5 1.20-1.30 m Rec = 100/100 mm			SP	SAND fine to medium grained, pale grey and pale brown, trace fines				
			2.0		ASS T47-6 1.70-1.80 m Rec = 100/100 mm					W	MD		
			2.5		ASS T47-7 2.30-2.40 m Rec = 100/100 mm				TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.05 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

DRAFT

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DRAFT REPORT OF TEST PIT: T48

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391785 m E 6437164 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.40 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▷	0.0					CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
					PP = 1.5-2 kg / cm^2								
			0.5	*0.50*	Geotech Sample T48-1 0.50-0.70 m Rec = 200/200 mm PP = 1.5 kg / cm^2			CI	Silty CLAY medium plasticity, dark grey to black, trace fine grained sand, trace grass roots (1 mm diameter)	M	F		
				0.70				CI	Silty Sandy CLAY medium plasticity, dark grey to black, approximately 30%-40% fine to medium grained sand				
				0.80				SP	SAND fine to medium grained, pale grey and pale brown, trace fines	W	MD		
			1.0										
			1.5										
			2.0										
			2.5						TEST PIT DISCONTINUED @ 2.40 m COLLAPSE GROUNDWATER ENCOUNTERED @ 0.80 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T49

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391860 m E 6437200 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.40 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0	0.25	ASS T49-1 0.20-0.30 m Rec = 100/100 mm Field Duplicate: D10 Geotech Sample T49-1 0.30-0.60 m			CL	CLAY low plasticity, brown, trace fine grained sand, trace organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
	M-H		0.5	0.60	Rec = 300/300 mm ASS T49-2 0.45-0.55 m Rec = 100/100 mm PP > 6 kg / cm^2 Geotech Sample T49-2 0.60-0.70 m			MH	Clayey SILT high liquid limit, grey white, trace fine grained sand, trace organics, trace grass roots (1 mm diameter)	D	VSt		
				0.90				CI	CLAY medium plasticity, dark brown and brown, trace fine grained sand, with organics, trace grass roots (1 mm diameter), roots extend down to about 700 mm depth		H		
			1.0		Rec = 100/100 mm PP > 6 kg / cm^2 ASS T49-3 0.70-0.80 m Rec = 100/100 mm ASS T49-4 0.95-1.05 m Rec = 100/100 mm ASS T49-5 1.20-1.30 m Rec = 100/100 mm			SP	SAND fine to medium grained, pale grey, trace fines	D - M			
	M	▽	1.5		ASS T49-6 1.70-1.90 m Rec = 200/200 mm					M	MD		
			2.0		ASS T49-7 2.00-2.20 m Rec = 200/200 mm					W			
			2.5						TEST PIT DISCONTINUED @ 2.40 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.60 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T50

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391842 m E 6437129 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0	0.10	Geotech Sample T50-1 0.10-0.25 m Rec = 150/150 mm PP = 2-2.5 kg / cm²			CH-OH CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.40	PP = 2-3 kg / cm² Geotech Sample T50-2 0.40-0.60 m Rec = 200/200 mm PP = 1.5-2.5 kg / cm²				Silty CLAY high plasticity, dark grey to black, trace fine grained sand, trace grass roots (1 mm diameter)		St		
			0.5	0.60					dark brown		St - F		
				0.70					dark grey to black	M			
								SP	SAND fine to medium grained, pale grey to pale brown, trace fines				
			1.0										
				1.40					brown, with some low to medium plasticity clay		MD		
			1.5							W			
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.00 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T51

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391929 m E 6437129 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0					SM	TOPSOIL: Silty SAND / SAND fine to medium grained, black, approximately 10%-20% low plasticity silt, trace organics, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter), 20 mm thick brown lense at 100 mm depth				0 5 10 15 20 25 seat
				0.35	ASS T51-1 0.20-0.30 m Rec = 100/100 mm			SP	SAND fine to medium grained, grey, with some low plasticity silt, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter), roots extend down to about 1300 mm depth		L		
			0.5	0.60	ASS T51-2 0.45-0.55 m Rec = 100/100 mm				pale grey, without silt	M			
					ASS T51-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T51-4 0.95-1.05 m Rec = 100/100 mm								
					ASS T51-5 1.20-1.30 m Rec = 100/100 mm								
			1.5							M - W	MD		
					ASS T51-6 1.70-1.80 m Rec = 100/100 mm								
			2.0							W			
					ASS T51-7 2.20-2.30 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.80 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T52

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391796 m E 6437099 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.30 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0					CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D	Fb		seat
				0.25	ASS T52-1 0.15-0.25 m Rec = 100/100 mm PP = 3.5-5 kg / cm²			CH	Silty CLAY high plasticity, dark grey to black, trace fine grained sand, trace grass roots (1 mm diameter)		St		
			0.5	0.55	ASS T52-2 0.45-0.55 m Rec = 100/100 mm PP = 0.5-1 kg / cm²				dark brown	D - M	F		
				0.75									
				0.85	ASS T52-3 0.75-0.85 m Rec = 100/100 mm PP = 2-2.5 kg / cm²				dark grey to black				
			1.0		ASS T52-4 1.00-1.10 m Rec = 100/100 mm Field Duplicate: D09			SP	SAND fine to medium grained, pale grey to pale brown, trace fines				
				1.40	ASS T52-5 1.30-1.40 m Rec = 100/100 mm			SC	Clayey SAND fine to medium grained, pale grey to pale brown, approximately 20%-30% medium to high plasticity clay, with organics, with black fibrous wood fragments (medium to coarse gravel size)	W	MD	Could not collect representative ASS sample below 1.4 m depth.	
			1.5		Geotech Sample T52-1 1.50-2.00 m Rec = 500/500 mm								
			2.0										
			2.5						TEST PIT DISCONTINUED @ 2.30 m COLLAPSE GROUNDWATER ENCOUNTERED @ 0.90 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T53

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391733 m E 6437086 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0	0.25	Geotech Sample T53-1 0.10-0.25 m Rec = 150/150 mm			CH / OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D	Fb		seat
			0.5	0.70	PP = 4.5-6 kg / cm²			CH	CLAY high plasticity, dark grey, with some silt, trace grass roots (1 mm diameter)		St		
			1.0	1.05	PP = 5-5.5 kg / cm²			CL-CI	Silty CLAY low to medium plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 800 mm depth				
			1.5	1.60	PP = 1-1.5 kg / cm²			CH	CLAY high plasticity, brown, trace fine to medium grained sand	M	F		
				1.90				CI	Sandy CLAY medium plasticity, yellow brown, approximately 30%-40% fine to medium grained sand				
			2.0					SC	Clayey SAND fine to medium grained, yellow brown, approximately 15%-25% medium to high plasticity clay	W	MD		
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.60 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

DRAFT

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DRAFT REPORT OF TEST PIT: T54

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391684 m E 6436964 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm (0 5 10 15 20 25)
EX	M	▽	0.0	0.20				OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)		Fb		seat
					ASS T54-1 0.20-0.30 m Rec = 100/100 mm			CI / CH	Silty CLAY medium to high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 800 mm depth	D - M	St		
			0.5		ASS T54-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T54-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T54-4 0.95-1.05 m Rec = 100/100 mm								
			1.5	1.50				CH	CLAY high plasticity, grey brown	M	F		
					ASS T54-5 1.70-1.80 m Rec = 100/100 mm								
				1.90				SP	SAND fine to medium grained, pale grey		MD		
			2.0		ASS T54-6 1.90-2.00 m Rec = 100/100 mm					W			
					ASS T54-7 2.30-2.40 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.10 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T55

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391626 m E 6437068 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0					CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.40	ASS T55-1 0.20-0.30 m Rec = 100/100 mm PP = 1.5-2 kg / cm²			CH	Silty CLAY high plasticity, dark grey to black, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 800 mm depth		F - St		
			0.5		ASS T55-2 0.45-0.55 m Rec = 100/100 mm PP = 4-4.5 kg / cm²								
					ASS T55-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T55-4 0.95-1.05 m Rec = 100/100 mm PP = 0.5-1 kg / cm²								
				1.20	ASS T55-5 1.20-1.30 m Rec = 100/100 mm Field Duplicate: D07			CH	CLAY high plasticity, brown, trace fine grained sand		F		
			1.5										
				1.80	ASS T55-6 1.70-1.80 m Rec = 100/100 mm				with 50 mm to 200 mm thick Clayey SAND (SC) lenses, fine to medium grained, approximately 20%-30% high plasticity clay	M			
			2.0										
				2.40	ASS T55-7 2.30-2.40 m Rec = 100/100 mm			SP	SAND fine to medium grained, pale grey, trace fines	W	MD		
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.40 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T56

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391590 m E 6437015 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm (0 5 10 15 20 25)
EX	M		0.0		PP = 1.5-2 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)		Fb		seat
				0.35									
			0.5		PP = 1-2 kg / cm^2			CH	Silty CLAY high plasticity, dark grey with black, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots down to about 500 mm depth		F		
				1.00									
			1.0		1.00-1.10 m Rec = 100/100 mm PP = 1-1.5 kg / cm^2			CH	CLAY high plasticity, brown, trace fine grained sand	D - M	F - St		
				2.10					with 50 mm to 100 mm thick Clayey SAND (SC) lenses, fine to medium grained, approximately 20%-30% high plasticity clay	M - W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T57

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391557 m E 6436946 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm (0 5 10 15 20 25)
EX	M		0.0		ASS T57-1 0.20-0.30 m Rec = 100/100 mm Field Duplicate: D06 PP = 1.5-2 kg / cm²			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter), roots down to 750 mm depth	M	Fb		seat
			0.5	0.50	ASS T57-2 0.45-0.55 m Rec = 100/100 mm PP > 6 kg / cm² ASS T57-3 0.70-0.80 m Rec = 100/100 mm			CH	Silty CLAY high plasticity, dark grey with white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots down to 750 mm depth, roots extend down to about 750 mm depth	D - M	VSt		
			1.0	1.00	ASS T57-4 0.90-1.00 m Rec = 100/100 mm Geotech Sample T57-1 1.00-1.10 m Rec = 100/100 mm Geotech Sample T57-2 1.10-1.40 m Rec = 300/300 mm			CH	CLAY high plasticity, brown, trace fine grained sand white		F - St		
				1.10									
				1.40				CH / SC	Interbedded CLAY and Clayey SAND brown, approximately 30%-50% clay and 50%-70% clayey sand, high plasticity, trace fine to medium grained sand				
			1.5		PP = 3.5-4 kg / cm² ASS T57-5 1.60-1.70 m Rec = 100/100 mm						MD - St		
			2.0		ASS T57-6 2.00-2.10 m Rec = 100/100 mm					M			
				2.30									
					ASS T57-7 2.30-2.50 m Rec = 200/200 mm Geotech Sample T57-3 2.30-2.50 m Rec = 200/200 mm			SC	Clayey SAND fine to medium grained, pale grey and and pale green, approximately 15%-20% high plasticity clay		MD		
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T58

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391620 m E 6436975 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		PP = 1.5-2.5 kg / cm^2			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.35									
			0.5		PP > 6 kg / cm^2			CH	Silty CLAY high plasticity, dark grey and grey, trace fine grained sand, trace grass roots (1 mm diameter), roots extend down to about 600 mm depth		St - VSt		
				0.90						D			
			1.0		Geotech Sample T58-1 0.90-1.40 m Rec = 500/500 mm			ML	Sandy SILT high plasticity, white, approximately 35% fine to medium grained sand , trace organics, trace grass roots (2 mm diameter)		Fb		
				1.40									
			1.5					CH	CLAY high plasticity, brown, trace fine to medium grained sand, with approximately 30 mm thick Clayey SAND (SC) lenses, fine to medium grained, approximately 20%-30% high plasticity clay	D - M	St		
				1.80					thickness of Clayey SAND lenses increasing to approximately 100 mm	M			
			2.0	2.10				SC	Clayey SAND fine to medium grained, pale brown, approximately 20%-30% high plasticity clay, with approximately 50 mm thick CLAY (CH) lenses, high plasticity	M - W	MD		
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T59

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391665 m E 6437026 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.60 m
LOGGED: JMT/SL DATE: 16/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0	0.00 m	0.00 m			CH-OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.25	PP = 4-5 kg / cm²			CH / MH	Silty CLAY / Clayey SILT high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter), roots extend down to about 600 mm depth	D	F - St		
			0.5		PP = 2.5-3 kg / cm²								
			1.0	1.00	PP = 1-1.5 kg / cm²			CH	CLAY high plasticity, brown, trace fine grained sand	M	F		
			1.5										
			2.0	2.00					sand content increasing with depth				
			2.5						TEST PIT DISCONTINUED @ 2.60 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T60

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391736 m E 6437002 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT
DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED:
DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0	0.20	PP = 2-3 kg / cm²			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	M	Fb		seat
				0.45	PP = 4-6 kg / cm²			CI / CH	Silty CLAY medium to high plasticity, grey white, trace fine grained sand, trace grass roots (1 mm diameter), trace tree roots (100 mm diameter)	D - M	St		
			0.5	0.85	PP = 1-1.5 kg / cm²			CH	CLAY high plasticity, black, trace grass roots (1 mm diameter), trace tree roots (50 mm diameter)	M	F		
	H		1.0	1.30	PP = 4-6 kg / cm² PP > 6 kg / cm²			CH / MH	Silty CLAY / CLAY medium to high plasticity, grey white, trace fine grained sand, trace grass roots (1 mm diameter)	D - M	VSt		
			1.5	2.00	Geotech Sample T60-1 1.30-1.50 m Rec = 200/200 mm			CI	Silty CLAY medium plasticity, yellow brown to yellow white, trace organics, with some fine to medium grained sand	D	St - VSt		
			2.0	2.30	Geotech Sample T60-2 2.00-2.30 m Rec = 300/300 mm			CH	CLAY high plasticity, brown, with some fine to medium grained sand	D - M	F - St		
			2.5					CH	Sandy CLAY high plasticity, yellow brown, approximately 30%-40% fine to medium grained sand				
									TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T61

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391804 m E 6437045 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.30 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0		Geotech Sample T61-1 0.00-0.65 m Rec = 650/650 mm PP = 1.5-2 kg / cm^2			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter), trace shrub roots (20 mm diameter), slight sulphide odour	M	F		seat
			0.5		PP = 1-1.5 kg / cm^2								
				0.65	PP = 1 kg / cm^2			SP	SAND fine to coarse grained, sub-rounded to sub-angular, pale grey				
			1.0										
				1.40					pale brown, trace fines	W	MD		
			1.5										
			2.0										
			2.5						TEST PIT DISCONTINUED @ 2.30 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.00 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T62

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391905 m E 6437049 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT
DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED:
DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.20				MH / SM	TOPSOIL: Sandy Silt / Silty SAND approximately 40%-50% silt and 50%-60% sand, black, trace organics, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter), sand is, fine to medium grained, silt is, medium to high plasticity		F - L		0 5 10 15 20 25
								SP	SAND fine to medium grained, pale grey, trace grass roots (1 mm diameter), trace shrub roots (5 mm diameter), roots extend down to about 900 mm depth	M	L		seat
			1.0	1.10					pale grey and pale brown, with some low plasticity silt	M - W	MD		
			1.5							W			
			2.0						TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.50 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T63

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391905 m E 6436980 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.20 m
LOGGED: JMT
DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED:
DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.20	Geotech Sample T63-1 0.00-0.20 m Rec = 200/200 mm			CI	TOPSOIL: Sandy CLAY medium plasticity, black, approximately 40%-50% fine to medium grained sand, trace organics, trace grass roots (4 mm diameter), trace shrub roots (20 mm diameter)	M	F		seat
								SP	SAND fine to medium grained, pale grey, trace grass roots (2 mm diameter), trace shrub roots (10 mm diameter), roots extend down to about 1000 mm depth		L		
			1.00						brown, with some low plasticity silt	M - W	MD		
			2.0							W			
									TEST PIT DISCONTINUED @ 2.20 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.80 m DEPTH BACKFILLED				

0 5 10 15 20 25

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DRAFT REPORT OF TEST PIT: T64

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391850 m E 6436995 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0	0.15	ASS T64-1 0.00-0.15 m Rec = 150/150 mm PP = 1.5-2 kg / cm^2 Geotech Sample T64-1 0.15-0.65 m Rec = 500/500 mm PP = 2.5-4 kg / cm^2 ASS T64-2 0.40-0.50 m Rec = 100/100 mm PP = 5-6 kg / cm^2			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - W	Fb		seat
				0.40				CH	CLAY high plasticity, pale brown, with organics, trace grass roots (3 mm diameter), trace shrub roots (30 mm diameter)	M	F - St		
			0.5	0.65					dark grey		St		
	H				PP > 6 kg / cm^2 ASS T64-3 0.70-0.80 m Rec = 100/100 mm Field Duplicate: D12			CI	Silty CLAY / Clayey SILT medium plasticity, grey white, trace shrub roots (30 mm diameter)	D	VSt		
			1.0	1.00	ASS T64-4 1.00-1.10 m Rec = 100/100 mm PP > 6 kg / cm^2			CI / CH	CLAY medium to high plasticity, dark grey to black, trace grass roots (3 mm diameter)	D - M			
				1.20	ASS T64-5 1.20-1.30 m Rec = 100/100 mm			SP	SAND fine to medium grained, pale grey, trace fines	D			
	M		1.5	1.70	ASS T64-6 1.70-1.80 m Rec = 100/100 mm				pale brown	M			
					ASS T64-7 2.20-2.30 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T65

Golder Associates

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391779 m E 6436957 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.00 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		ASS T65-1 0.00-0.20 m Rec = 200/200 mm PP = 1-1.5 kg / cm^2			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	M	Fb		seat
				0.20	ASS T65-2 0.20-0.40 m Rec = 200/200 mm PP > 6 kg / cm^2			CI-CH / MH	Silty CLAY / Clayey SILT medium to high plasticity, dark grey, trace grass roots (1 mm diameter)	D - M	VSt		
				0.40	ASS T65-3 0.40-0.55 m Rec = 150/150 mm PP = 2-3 kg / cm^2			CI / CH	CLAY medium to high plasticity, dark grey and black, trace grass roots (1 mm diameter)		F - St		
			0.5	0.55	ASS T65-4 0.55-0.75 m Rec = 200/200 mm			SC	Clayey SAND fine to medium grained, dark brown, approximately 30%-40% high plasticity clay, trace grass roots (1 mm diameter)				
				0.75	ASS T65-5 0.75-1.00 m Rec = 250/250 mm Field Duplicate: D11			SP	SAND fine to medium grained, pale grey	M	MD		
			1.0										
					ASS T65-6 1.30-1.50 m Rec = 200/200 mm								
			1.5	1.60					brown				
					ASS T65-7 1.70-1.80 m Rec = 100/100 mm								
			2.0						TEST PIT DISCONTINUED @ 2.00 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T66

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391733 m E 6436910 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0	0.15	0.00 m			CH / OH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.35	PP = 4.5-6 kg / cm²			ML	Clayey SILT non to low plastic, grey, trace grass roots (1 mm diameter)	D			
			0.5	0.55	PP = 4-4.5 kg / cm²			CI	CLAY medium plasticity, black, trace grass roots (1 mm diameter)	D - M	St		
				0.60				SM SP	Silty SAND fine to medium grained, dark brown, approximately 15%-25% low plasticity silt, trace grass roots (1 mm diameter)				
			1.0						SAND fine to medium grained, pale grey	M			
			1.5								MD		
			2.0							W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.30 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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GAP gINT FN. F01i RL3

GAP 8_08.04 LIB.GLB Log GAP NON-CORED FULL PAGE 147642090 - MASTER.GPJ <<DrawingFile>> 14/07/2014 09:58 8.30.003 Datgel Tools

DRAFT REPORT OF TEST PIT: T67

SHEET: 1 OF 1

CLIENT: Satterley Property Group
PROJECT: Proposed Residential Subdivision
LOCATION: Mandogalup
JOB NO: 147642090

COORDS: 391701 m E 6436854 m N MGA94 50
PIT DEPTH: 2.40 m
BUCKET TYPE: 600 mm toothed

MACHINE: JCB 3CX
CONTRACTOR: N. Cornwell
LOGGED: JMT/SL DATE: 17/6/14
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0					OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.30	ASS T67-1 0.20-0.30 m Rec = 100/100 mm			SP	SAND fine to medium grained, pale grey, trace grass roots (1 mm diameter), roots extend down to about 500 mm depth				
			0.5		ASS T67-2 0.45-0.55 m Rec = 100/100 mm					M			
					ASS T67-3 0.70-0.80 m Rec = 100/100 mm								
				1.00									
			1.0		ASS T67-4 1.00-1.10 m Rec = 100/100 mm				brown, with some non-plastic fines				
					ASS T67-5 1.30-1.40 m Rec = 100/100 mm						MD		
			1.5										
					ASS T67-6 1.70-1.80 m Rec = 100/100 mm					M - W			
			2.0										
					ASS T67-7 2.20-2.30 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.40 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T68

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391767 m E 6436868 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT/SL DATE: 17/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0	0.10	Geotech Sample T68-1 0.10-0.20 m Rec = 100/100 mm			OL / CL	ORGANIC Silty CLAY / Clayey SILT low plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.20				ML		D	St		
				0.30				CI	Clayey SILT non to low plastic, grey, trace grass roots (1 mm diameter)				
				0.40				SM		D - M			
			0.5					SP	CLAY medium plasticity, black, trace grass roots (1 mm diameter)				
									Silty SAND fine to medium grained, dark brown, approximately 15%-25% low plasticity silt, trace grass roots (1 mm diameter)	M			
			1.0						SAND fine to medium grained, pale grey				
			1.5								MD		
			2.0							W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.30 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF TEST PIT: T69

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391809 m E 6436909 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT
DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED:
DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0		Geotech Sample T69-1 0.00-0.25 m Rec = 250/250 mm PP > 6 kg / cm^2			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	M	Fb		seat
				0.25									
	H		0.5		Geotech Sample T69-2 0.25-0.65 m Rec = 400/400 mm PP > 6 kg / cm^2			MH	Clayey SILT high liquid limit, grey white, trace grass roots (1 mm diameter)		H		
				0.65									
					Geotech Sample T69-3 0.65-0.90 m Rec = 250/250 mm PP = 5.5-6 kg / cm^2			CL	CLAY low plasticity, black		St - VSt		
				0.90				SP	SAND fine to medium grained, pale grey, trace fines	D - M			
	M		1.5								MD		
				1.90					brown	M			
			2.0							W			
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.30 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T70

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391825 m E 6436846 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0	0.15	ASS T70-1 0.00-0.10 m Rec = 100/100 mm			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	D - M	Fb		seat
				0.40	Geotech Sample T70-1 0.00-0.15 m Rec = 150/150 mm PP = 1-2.5 kg / cm² PP = 3-4 kg / cm²			CI / CH	Silty CLAY medium to high plasticity, grey white, trace grass roots (1 mm diameter), roots extend down to about 400 mm depth		St		
			0.5	0.60	ASS T70-2 0.30-0.40 m Rec = 100/100 mm				low plasticity, brown				
					ASS T70-3 0.40-0.50 m Rec = 100/100 mm Geotech Sample T70-2 0.40-0.60 m				medium to high plasticity, grey white	D	H		
				0.90	Rec = 200/200 mm PP = 2-2.5 kg / cm²			SC	Clayey SAND fine to medium grained, dark brown, approximately 15%-25% medium plasticity clay		MD		
			1.0	1.10	ASS T70-4 0.60-0.70 m Rec = 100/100 mm PP > 6 kg / cm²			SP	SAND fine to medium grained, pale grey				
					ASS T70-5 0.90-1.00 m Rec = 100/100 mm Geotech Sample T70-3 1.10-2.50 m Rec = 1400/1400 mm ASS T70-6 1.50-1.70 m Rec = 200/200 mm					D - M	MD		
			2.0	2.00	ASS T70-7 2.00-2.20 m Rec = 200/200 mm				white	M			
			2.5							W			
									TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.30 m DEPTH BACKFILLED					
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T71

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391896 m E 6436911 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.30 m
LOGGED: JMT DATE: 18/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
EX	M	▽	0.0	0.15	ASS T71-1 0.00-0.15 m Rec = 150/150 mm Field Duplicate: D13 Geotech Sample T71-1 0.00-0.15 m Rec = 150/150 mm			SM	TOPSOIL: Silty SAND fine to medium grained, dark brown, approximately 30%-40% low plasticity silt, trace organics, trace grass roots (1 mm diameter)		L		seat
								SP	SAND fine to medium grained, pale grey, trace grass roots (1 mm diameter), roots extend down to about 1000 mm depth	M			
			0.5		ASS T71-2 0.45-0.55 m Rec = 100/100 mm								
					ASS T71-3 0.70-0.80 m Rec = 100/100 mm								
			1.0		ASS T71-4 0.95-1.05 m Rec = 100/100 mm								
				1.20	ASS T71-5 1.20-1.30 m Rec = 100/100 mm				fine to coarse grained, predominately fine to medium grained		MD		
			1.5							M - W			
					ASS T71-6 1.70-1.80 m Rec = 100/100 mm								
			2.0							W			
					ASS T71-7 2.20-2.30 m Rec = 100/100 mm				TEST PIT DISCONTINUED @ 2.30 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.80 m DEPTH BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

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GAP gINT FN. F01i RL3

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DRAFT REPORT OF TEST PIT: T72

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391904 m E 6436632 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M	▽	0.0		Geotech Sample T72-1 0.00-0.50 m Rec = 500/500 mm			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter), trace tree roots (50 mm diameter)	M	Fb		seat
			0.5	0.50	PP = 0.5-1.5 kg / cm^2			MH	Clayey SILT high plasticity, grey, trace fine grained sand, trace grass roots (3 mm diameter)	D	F - St		
	H				PP = 2-3 kg / cm^2 Geotech Sample T72-2 0.70-0.90 m Rec = 200/200 mm PP = 2-4 kg / cm^2								
			1.0										
			1.5	1.60	Geotech Sample T72-3 1.60-1.70 m Rec = 100/100 mm			CI / CH	CLAY medium to high plasticity, brown, with some fine to medium grained sand, trace organics, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)	D - M			
	M-H			1.90				CI	Sandy CLAY medium plasticity, brown, approximately 30%-40% fine to medium grained sand	M			
			2.0	2.20	Geotech Sample T72-4 2.20-2.40 m Rec = 200/200 mm			SP	SAND fine to coarse grained, pale brown, with some low plasticity clay	W	MD		
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.10 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF TEST PIT: T73

SHEET: 1 OF 1

CLIENT: Satterley Property Group
COORDS: 391885 m E 6436618 m N MGA94 50
MACHINE: JCB 3CX

PROJECT: Proposed Residential Subdivision
CONTRACTOR: N. Cornwell

LOCATION: Mandogalup
PIT DEPTH: 2.50 m
LOGGED: JMT DATE: 19/6/14

JOB NO: 147642090
BUCKET TYPE: 600 mm toothed
CHECKED: DATE:

Excavation					Sampling		Field Material Description						
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	DCP TEST (AS1289.6.3.2) Blows per 100 mm
EX	M		0.0		ASS T73-1 0.20-0.30 m Rec = 100/100 mm PP = 1-2 kg / cm^2			OH / CH	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (3 mm diameter), trace shrub roots (20 mm diameter), trace tree roots (50 mm diameter)	M	Fb		seat
	H		0.5	0.60	ASS T73-2 0.45-0.55 m Rec = 100/100 mm			CH / MH	Silty CLAY / Clayey SILT medium to high plasticity, grey, trace fine grained sand, trace grass roots (3 mm diameter)	D	VSt		
				0.80	PP > 6 kg / cm^2 ASS T73-3 0.70-0.80 m Rec = 100/100 mm PP = 2-2.5 kg / cm^2				high plasticity, becoming black, sand content increasing with depth	D - M	F - St		
			1.0		ASS T73-4 0.95-1.05 m Rec = 100/100 mm								
				1.20				SC	Clayey SAND fine to medium grained, brown grey, approximately 15%-25% medium plasticity clay, trace grass roots (3 mm diameter), inferred roots extend below groundwater	M			
	M		1.5		ASS T73-5 1.20-1.30 m Rec = 100/100 mm Field Duplicate: D17								
				1.70				SP	SAND fine to medium grained, pale brown, trace fines	W	MD		
			2.0		ASS T73-6 1.70-1.80 m Rec = 100/100 mm								
					ASS T73-7 2.20-2.30 m Rec = 100/100 mm								
			2.5						TEST PIT DISCONTINUED @ 2.50 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 1.40 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DCP TEST (AS1289.6.3.2) Blows per 100 mm: 0 5 10 15 20 25

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA01

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392167 m E 6438735 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JMT DATE: 12/6/14

JOB NO: 147642090

HOLE DIA: 75 mm HOLE DEPTH: 2.60 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L	▽	0.0					SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace organics (grass roots up to 1 mm diameter)	M	L		Seat
				0.30				SP	SAND fine to medium grained, quartz, grey	D			
			0.5	0.70					pale grey				
			1.0		HA01-1 BDS 1.00-2.00 m Rec = 1000/1000 mm					M	MD		
			1.5										
			2.0							W			
			2.5						END OF HAND AUGER @ 2.60 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.10 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

This report of hand augered borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA02

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392073 m E 6438637 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JMT DATE: 12/6/14

JOB NO: 147642090

HOLE DIA: 75 mm HOLE DEPTH: 2.30 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L	▽	0.0	0.20	HA02-1 BDS 0.00-0.20 m Rec = 200/200 mm			SP	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace organics (grass roots up to 1 mm diameter and shrub roots up to 5 mm diameter)		L		seat
				0.40	HA02-2 BDS 0.40-1.00 m Rec = 600/600 mm			SP	SAND fine to medium grained, quartz, grey pale grey	M	MD	20 mm diameter tree root encountered at 500 mm depth.	
			0.5										
			1.0										
			1.5										
			2.0							W			
			2.5						END OF HAND AUGER @ 2.30 m COLLAPSE GROUNDWATER ENCOUNTERED @ 1.90 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA03

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392174 m E 6438590 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JMT DATE: 12/6/14

JOB NO: 147642090

HOLE DIA: 75 mm HOLE DEPTH: 2.60 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L	▽	0.0	0.20				SP	TOPSOIL: SAND fine to medium grained, dark brown, with some silt, trace organics (grass roots up to 5 mm diameter and shrub roots up to 5 mm diameter)	D	L		seat
			0.5					SP	SAND fine to medium grained, quartz, grey, trace fines				
			1.0	1.00					pale grey		MD		
			1.5							M			
			2.0	2.10					slight organic / hydrogen sulphide odour	W			
			2.5						END OF HAND AUGER @ 2.60 m TARGET DEPTH GROUNDWATER ENCOUNTERED @ 2.10 m DEPTH BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

DRAFT

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA04

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392223 m E 6438379 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JPH DATE: 25/6/14

JOB NO: 147642090

HOLE DEPTH: 1.80 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
HA	L		0.0					SP	TOPSOIL: SAND fine to medium grained, grey, trace low plasticity silt, trace organics, trace rootlets	D		Rootlets to 0.2 m	seat
				0.20				SP	SAND fine to medium grained, pale yellow, trace silt		L		
			0.5										
			1.0							D - M			
				1.20					yellow				
			1.5								L - MD		
			2.0						END OF HAND AUGER @ 1.80 m COLLAPSE GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			2.5										
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

DRAFT

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GAP gINT FN. F01h RL3

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA05

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392076 m E 6438284 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JMT DATE: 12/6/14

JOB NO: 147642090

HOLE DIA: 75 mm HOLE DEPTH: 2.50 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm 0 5 10 15 20 25
HA	L		0.0					SP	TOPSOIL: SAND fine to medium grained, grey, trace/some silt, trace organics (grass roots up to 1 mm diameter and shrub roots up to 3 mm diameter)		VL		seat hammer weight hammer weight
				0.40				SP	SAND fine to medium grained, quartz, grey, trace fines	D - M			
			0.5	0.90					pale grey, without fines				
			1.0										
			1.5								MD		
			2.0							M			
			2.5						END OF HAND AUGER @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA06

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392085 m E 6438173 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JMT DATE: 12/6/14

JOB NO: 147642090

HOLE DIA: 75 mm HOLE DEPTH: 2.50 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0		HA06-1 BDS 0.00-0.40 m Rec = 400/400 mm			SP	TOPSOIL: SAND fine to medium grained, dark brown, trace/some silt, with approximately 10%-20% organics (grass roots up to 2 mm diameter, shrub roots up to 10 mm diameter and charcoal nodules up to 50 mm diameter)		VL		seat hammer weight hammer weight
				0.40									
			0.5		HA06-2 BDS 0.40-1.00 m Rec = 600/600 mm			SP	SAND fine to medium grained, quartz, grey, trace fines		L		
				1.00									
			1.0		HA06-3 BDS 1.00-2.50 m Rec = 1500/1500 mm				pale grey, without fines	M			
				1.50									
			1.5						white		MD		
			2.0										
			2.5						END OF HAND AUGER @ 2.50 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.0										
			3.5										
			4.0										
			4.5										
			5.0										

PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm: 0 5 10 15 20 25

DRAFT

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DRAFT REPORT OF HAND AUGERED BOREHOLE: HA07

SHEET: 1 OF 1

CLIENT: Satterley Property Group

PROJECT: Proposed Residential Subdivision

COORDS: 392187 m E 6438166 m N MGA94 50

LOCATION: Mandogalup

INCLINATION: -90°

LOGGED: JMT DATE: 12/6/14

JOB NO: 147642090

HOLE DIA: 75 mm HOLE DEPTH: 3.00 m

CHECKED: DATE:

Drilling					Sampling		Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS	PERTH PENETROMETER TEST (AS1289.6.3.3) Blows per 150 mm
HA	L		0.0	0.20	ASS HA07-1 BDS 0.00-0.20 m Rec = 200/200 mm			SP	TOPSOIL: SAND fine to medium grained, brown, trace/some silt, trace organics (grass roots up to 2 mm diameter)				seat
					ASS HA07-2 BDS 0.20-0.40 m Rec = 200/200 mm			SP	SAND fine to medium grained, quartz, grey, trace fines		L		
			0.5	0.80	ASS HA07-3 BDS 0.70-0.80 m Rec = 100/100 mm				pale grey, without fines				
			1.0		ASS HA07-4 BDS 0.80-1.00 m Rec = 200/200 mm								
				1.40	ASS HA07-5 BDS 1.20-1.30 m Rec = 100/100 mm				white	M			
			1.5		ASS HA07-6 BDS 1.70-1.80 m Rec = 100/100 mm						MD		
			2.0		ASS HA07-7 BDS 2.20-2.30 m Rec = 100/100 mm								
			2.5		ASS HA07-8 BDS 2.70-2.80 m Rec = 100/100 mm								
			3.0						END OF HAND AUGER @ 3.00 m TARGET DEPTH GROUNDWATER NOT ENCOUNTERED BACKFILLED				
			3.5										
			4.0										
			4.5										
			5.0										

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Appendix 4
Groundwater purge sheets

460 3 1380

PB 100 YEARS	Professional Services	
	Australia–Pacific	**Form** PS-302-HAZ-F12

Groundwater Field Parameters

Rev: B

Job no:		**Well no:**	MW5
Client:		**Purging date:**	
Site location:	~~MW5~~ MANDOGOLUP.	**Sampling date:**	9/3/16
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	0.60m,	**Depth to groundwater (mBTOC):**	2.732
Bore locked/covered?:	Yes.	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	5.763
Well condition:	GREAT.	**Depth to be purged (m):**	3.031

Purging information

Purge 5 casing volumes or until 'dry': Flow RATE = 14L/m

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: 30 Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☑ Other: ____	Actual Purge Volume: 280 Litres
Start time (2400 hour): 0835	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC SPC (µS/cm)	Redox (mV)	DO units % ~~☑~~ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	0835	5.93	0.494	—	~~8.38~~ 0.5	—	23.8°
After **2** purge volume:	0840	5.75	0.460	—	~~5.30~~ 0.35	—	23.6°
After **3** purge volume:	0845	5.72	0.431	—	0.34	—	23.5°
After **4** purge volume:	0850	5.71	0.432	—	0.27	—	23.5°
After **5** purge volume:	0.855	5.70	0.426	—	0.24	—	23.4
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details		Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☐ PVC ☐ Other:		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____		PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☑		Metals	☑		☐
Colour: Dark tea	Odour: H_2S	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☐ High ☑		Rinse Blank After: Yes ☐ No ☐		Triplicate ID:	

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☐ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations: Dark tea colour; H_2S; purged to ground

Sampler's Initials:	Purger's Initials: Y.M.

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PB 100 YEARS	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW4
Client:		**Purging date:**	9.8.16
Site location:	Mandogetup	**Sampling date:**	—

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	4.760
Bore locked/covered?:	Steel riser	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	6.374
Well condition:	Good	**Depth to be purged (m):**	5.614

Purging information

Purge 5 casing volumes or until 'dry': 10L/min

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: 56 Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: ~220 Litres
Start time (2400 hour): 10.18	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	10.30	7.43	0.71		1.12		21.0
After **2** purge volume:	10.35	7.49	0.70		0.39		20.4
After **3** purge volume:	10.40	7.50	0.70		0.35		20.3
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?:

Sampling details		**Analysis details**			
Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: ____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____		PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☑		Metals	☐		☐

Colour:	Odour: None	Sample ID:	Duplicate ID:
Turbidity: Low ☐ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☐	Triplicate ID:

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☐ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations:

Sampler's Initials:	Purger's Initials: Y.M.

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PB	Professional Services		
	Australia–Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW1
Client:		**Purging date:**	9/3/16
Site location:	Mandoseley	**Sampling date:**	

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	3.080
Bore locked/covered?:	Steel riser	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	5.760
Well condition:		**Depth to be purged (m):**	2.680

Purging information

Purge 5 casing volumes or until 'dry': 14L/min

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: 26.8 Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: ~ 210 Litres
Start time (2400 hour): 12.45	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (mS/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	12.50	5.84	0.61	—	0.45	—	24.6
After **2** purge volume:	12.55	5.82	0.51	—	0.40	—	24.6
After **3** purge volume:	13.00	5.82	0.489	—	0.36	—	24.3
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y.

Sampling details		Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: ____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____		PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☑		Metals	☐		☐
Colour: Dark brown	Odour: H_2S	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☐ High ☑		Rinse Blank After: Yes ☐ No ☐		Triplicate ID:	

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☐ Clear ☐ Medium ☑ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☑ Breeze ☐ Windy	☑ Dusty

Other comments and observations:

Sampler's Initials:	Purger's Initials: Y.M.

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PB 100 YEARS	Professional Services		
	Australia–Pacific	Form	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW02
Client:	Mondaze Lup	**Purging date:**	9/3/16
Site location:		**Sampling date:**	
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	~ 0.6	**Depth to groundwater (mBTOC):**	4.635
Bore locked/covered?:	Steel riser (yellow)	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	6.604
Well condition:		**Depth to be purged (m):**	~ 1.969

Purging information

Purge 5 casing volumes or until 'dry': ~ 10L/min

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: ~20 Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: ~250 Litres
Start time (2400 hour): 2.20	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (µS/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	2.35	5.33	0.87	—	0.35	—	22.3
After **2** purge volume:	2.40	5.34	0.86	—	0.28	—	21.8
After **3** purge volume:	2.45	5.34	0.88	—	0.27	—	21.5
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y.

Sampling details		Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other:		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____		PAHs	☑		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☐		Metals	☑		☐
Colour: Yellow	Odour: H_2S	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☐		Triplicate ID:	

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☑ Breeze ☐ Windy	☐ Dusty

Other comments and observations: —

Sampler's Initials: Purger's Initials: T.M.

Prepared: Des Dickie **Approved:** J Throssell

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PB	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW03
Client:	Satterley	**Purging date:**	9.3.16
Site location:	Mandogalup	**Sampling date:**	"

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	2.325
Bore locked/covered?:	Steel riser (Yellow)	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	4.884
Well condition:	Fantastic !	**Depth to be purged (m):**	—

Purging information

Purge 5 casing volumes or until 'dry': ~ 14L/min

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☐ PVC ☑ Other: ____	Actual Purge Volume: Litres
Start time (2400 hour):	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	1633	6.00	0.71	—	0.51	—	25.3
After **2** purge volume:	1640	5.94	0.69	—	0.39	—	25.1
After **3** purge volume:	1645	5.92	0.69	—	0.35	—	25.1
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details	Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☑	TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☑ HDPE ☐ PVC ☐ Other: ____	BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____	PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☑	Metals	☐		☐

Colour: Yellow	Odour: H_2S	Sample ID: —	Duplicate ID: —
Turbidity: Low ☐ Medium ☐ High ☑	Rinse Blank After: Yes ☐ No ☑		Triplicate ID: —

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations: Purged dicernable

Sampler's Initials: Purger's Initials: Y.M.

Prepared: Des Dickie **Approved:** J Throssell

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PB 100 YEARS	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW06.
Client:		**Purging date:**	9/3/16.
Site location:	MANDOGALUP.	**Sampling date:**	

Casing diameter (mm):	50.	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	1.568
Bore locked/covered?:	Steel Riser	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	4.413
Well condition:	Average (Dave)	**Depth to be purged (m):**	—

Purging information

Purge 5 casing volumes or until 'dry': ~14L/min

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: Litres
Start time (2400 hour): 1719	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (MS/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	1729	5.71	0.363	—	0.49	—	22.8
After **2** purge volume:	1735	5.58	0.356	—	0.31	—	22.6
After **3** purge volume:	1740	5.55	0.353	—	0.26	—	22.5
After **4** purge volume:	1745	5.54	0.350	—	0.25	—	22.4
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details	**Analysis details**			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐	TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☐ PVC ☐ Other: ____	BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____	PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☐	Metals	☐		☐

Colour: Yellow	Odour: Hrs	Sample ID:	Duplicate ID:
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☐	Triplicate ID:

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations:

Sampler's Initials:	Purger's Initials: Y.M.

Prepared: Des Dickie **Approved:** J Throssell

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PB 100 YEARS	Professional Services		
	Australia-Pacific	Form	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW07
Client:		**Purging date:**	10.3.16
Site location:	Mendooglup	**Sampling date:**	

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	–
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	2.580
Bore locked/covered?:	Steel Riser (Yes)	**Product thickness (mm):**	–
Cap type:	PVC	**Well depth from TOC (m):**	5.085
Well condition:	Excellent	**Depth to be purged (m):**	–

Purging information ~10 L/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: _____	Actual Purge Volume: Litres
Start time (2400 hour): 800	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	815	5.87	1.13		0.46		21.1
After **2** purge volume:	820	5.87	1.14		0.41		21.0
After **3** purge volume:							
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?:

Sampling details		Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☑ HDPE ☐ PVC ☐ Other: _____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: _____		PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☑		Metals	☐		☐

Colour: Yellow	Odour: H_2S	Sample ID:	Duplicate ID:
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☐	Triplicate ID:

Weather conditions

☐ Cold ☑ Cool ☐ Mild ☐ Warm ☐ Hot	☐ Clear ☐ Medium ☑ Cloudy Fog	☐ Dry ☐ Medium ☑ Humid ☐ Rain	☐ Still ☑ Breeze ☐ Windy	☐ Dusty

Other comments and observations:

Sampler's Initials: –	Purger's Initials: YM.

Prepared: Des Dickie	***Approved:*** *J Throssell*

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PB	Professional Services		
	Australia–Pacific	Form	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW08
Client:	Satterley	**Purging date:**	10.3.16
Site location:	Mandogalup	**Sampling date:**	

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	3.612
Bore locked/covered?:	Steel lined	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	6.644
Well condition:	Excellent	**Depth to be purged (m):**	—

Purging information

Purge 5 casing volumes or until 'dry': ~14 L/mi

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: _____	Actual Purge Volume: Litres
Start time (2400 hour): 10.20	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	10.18	5.56	0.57		0.53		20.6
After **2** purge volume:	10.35	5.51	0.56		0.45		20.3
After **3** purge volume:	10.40	5.49	0.56		0.42		20.2
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y.

Sampling details

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐

Material: Teflon ☐ S/Steel ☐ HDPE ☐ PVC ☐ Other: _____

Equipment: Dedicated ☐ Decontaminated ☐ Other: _____

Is there a hydrocarbon sheen?: Yes ☐ No ☐

Analysis details

TPH	☐	VOCs	☐
BTEX	☐	SVOCs	☐
PAHs	☐		☐
Metals	☐		☐

Colour: Yellow	Odour: Strong H2S	Sample ID:	Duplicate ID:
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☐	Triplicate ID:

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☐ Dry ☐ Medium ☑ Humid ☐ Rain	☐ Still ☑ Breeze ☐ Windy	☐ Dusty

Other comments and observations: Located amongst tall trees & thicker undergrowth. Very

Sampler's Initials: Purger's Initials: Y.M.

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PB	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MWD9
Client:		**Purging date:**	10.3.16
Site location:	Mandogalup	**Sampling date:**	
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	4.970
Bore locked/covered?:	Steel Riser	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	7.070
Well condition:	Excellent	**Depth to be purged (m):**	—

Purging information

Purge 5 casing volumes or until 'dry': ~8L/min

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☑ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: — Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: — Litres
Start time (2400 hour): 1130	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity	Temp. °C
After **1** purge volume:	1142	6.00	0.425	—	0.53	—	22.8°
After **2** purge volume:	1148	5.94	0.428	—	0.37	—	22.9°
After **3** purge volume:	1154	5.92	0.433	—	0.27	—	24.2°
After **4** purge volume:	12.00	5.94	0.432	—	0.24	—	24.3°
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y.

Sampling details		**Analysis details**			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☐ PVC ☐ Other: ____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: ____		PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☐		Metals	☐		☐
Colour: Yellow	Odour: H_2S	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☐		Triplicate ID:	

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy ☐ Dusty

Other comments and observations:

Sampler's Initials: | Purger's Initials: Y.M.

Prepared: Des Dickie | ***Approved:*** *J Throssell*

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PB 100 YEARS	Professional Services		
	Australia–Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW01
Client:	Batterley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11.3.16

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	Not detected
Casing height above-ground level (mAGL):	~ 0.6	**Depth to groundwater (mBTOC):**	3.055
Bore locked/covered?:	covered	**Product thickness (mm):**	N.A.
Cap type:	PVC	**Well depth from TOC (m):**	5.735
Well condition:	good	**Depth to be purged (m):**	1.680

Purging information Flow rate = 187 mL/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peristaltic ☑	Planned Purge Volume: N/A Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: ~5 Litres
Start time (2400 hour): 07.23	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	~~Turbidity~~ SWL mBTOC	Temp. °C
After **1** purge volume:	7.28	5.98	0.522	-185.7	1.21	3.055	22.2
After **2** purge volume:	7.33	5.99	0.522	-182.3	0.98	3.057	22.1
After **3** purge volume:	7.40	6.00	0.521	-182.1	0.50	3.057	22.5
After **4** purge volume:	7.44	5.99	0.521	-178.0	0.39	3.058	22.2
After **5** purge volume:	7.50	5.99	0.522	-178.5	0.35	3.059	22.2
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details	**Analysis details**			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ Peristaltic ☑	TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: ____	BTEX	☐	SVOCs	☐
Equipment: Dedicated ☑ Decontaminated ☐ Other: ____	PAHs	☐	Nut	☑
Is there a hydrocarbon sheen?: Yes ☐ No ☑	Metals pH GC	☑	perf	☑

Colour: Yellow	Odour: H_2S	Sample ID: MW01	Duplicate ID: —
Turbidity: Low ☑ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: —

Weather conditions

☐ Cold ☐ Cool ☑ Mild ☐ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☑ Still ☐ Breeze ☐ Windy	☐ Dusty

Other comments and observations: Y.M. TTA = 55 mg/L

Sampler's Initials: Y.M.	Purger's Initials: Field filtered

Prepared: Des Dickie	***Approved:*** *J Throssell*

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PB 100 YEARS	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MWØ9
Client:	Sattorley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11/3/16
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	N.D.
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	4.980
Bore locked/covered?:	covered	**Product thickness (mm):**	Ø
Cap type:	PVC	**Well depth from TOC (m):**	7.135
Well condition:	good	**Depth to be purged (m):**	

Purging information

F.R ≈ 190 mL/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ Peri ☑	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: Litres
Start time (2400 hour):	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity SWL	Temp. °C
After **1** purge volume:	8.01	6.50	0.521	-155.0	0.92	4.978	20.7
After **2** purge volume:	8.05	6.61	0.504	-171.9	0.67	4.980	21.3
After **3** purge volume:	8.10	6.70	0.500	-170.6	0.44	4.980	21.3
After **4** purge volume:	8.15	6.70	0.500	-174.5	0.38	4.981	21.3
After **5** purge volume:	8.20	6.71	0.500	-174.0	0.35	4.982	21.3
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?:

Sampling details	Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ Peri	TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other:	BTEX	☐	SVOCs	☐
Equipment: Dedicated ☑ Decontaminated ☐ Other: ____	PAHs	☐	ABS suite	☑
Is there a hydrocarbon sheen?: Yes ☐ No ☑	Metals	☐		☐

Colour: Yellow	Odour: H_2S	Sample ID: MWØ9	Duplicate ID: —
Turbidity: Low ☑ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: —

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☑ Still ☐ Breeze ☐ Windy	☐ Dusty

Other comments and observations: TTA = 0.1 x 500 = 50 mg/L

Sampler's Initials: Y.M.	Purger's Initials:

Prepared: Des Dickie **Approved:** J Throssell

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PB 100 YEARS	Professional Services		
	Australia–Pacific	Form	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW02
Client:	Satterley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11.3.16

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	Not detected
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	4.322
Bore locked/covered?:	covered	**Product thickness (mm):**	—
Cap type:	PVC	**Well depth from TOC (m):**	6.660
Well condition:	Good	**Depth to be purged (m):**	2.338

Purging information — Flow rate = ~216 mL/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ Peri ☑	Planned Purge Volume: N/A Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: Litres
Start time (2400 hour): 8.40	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	~~Turbidity~~ mBTOC	Temp. °C
After **1** purge volume:	8.42	6.29	0.89	-98.4	0.90	4.329	21.3
After **2** purge volume:	8.46	6.36	0.90	-110.2	0.57	4.329	21.2
After **3** purge volume:	8.49	6.40	0.91	-114.3	0.44	4.330	21.1
After **4** purge volume:	8.54	6.43	0.92	-110.0	0.36	4.330	21.1
After **5** purge volume:	8.59	6.40	0.92	-116.9	0.35	4.330	21.2
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details		**Analysis details**	
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	TPH ☐	VOCs ☐	
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: ____	BTEX ☐	SVOCs ☐	
Equipment: Dedicated ☑ Decontaminated ☐ Other: ____	PAHs ☐	pH, EC, perf, nut	☑
Is there a hydrocarbon sheen?: Yes ☐ No ☑	Metals ☑	ASS suite	☑

Colour: Yellow	Odour: H_2S	Sample ID: MW02	Duplicate ID: —
Turbidity: Low ☑ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: —

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☑ Breeze ☐ Windy	☐ Dusty

Other comments and observations: TTA = 0.3 x 500 = 150 mg/L

Sampler's Initials: Y.M.	Purger's Initials:

Prepared: Des Dickie	***Approved:*** *J Throssell*

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PB	Professional Services		
	Australia–Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW08
Client:	Sattelite	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11.3.16

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	N.D.
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	3.615
Bore locked/covered?:	Covered	**Product thickness (mm):**	0
Cap type:	PVC	**Well depth from TOC (m):**	6.715
Well condition:	Good	**Depth to be purged (m):**	3.100

Purging information F.R ≙ 216 ml/m

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	Planned Purge Volume: N/A Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: _____	Actual Purge Volume: ~5.2 Litres
Start time (2400 hour): 9.10	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity SWL	Temp. °C
After **1** purge volume:	9.15	6.83	0.65	-179.9	0.68	3.617	19.9
After **2** purge volume:	9.20	6.90	0.65	-188.6	0.44	3.617	19.9
After **3** purge volume:	9.24	6.98	0.64	-197.1	0.33	3.618	20.0
After **4** purge volume:	9.28	7.04	0.65	-191.1	0.25	3.618	20.1
After **5** purge volume:	9.34	7.04	0.65	-190.9	0.24	3.619	20.1
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details		**Analysis details**			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: _____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☑ Decontaminated ☐ Other: _____		PAHs	☐	ASS	☑
Is there a hydrocarbon sheen?: Yes ☐ No ☑		Metals	☐		☐

Colour: Yellow	Odour: H2S	Sample ID: MW08	Duplicate ID: –
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: –

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☑ Breeze ☐ Windy	☐ Dusty

Other comments and observations: T1A = 0.18 × 500 = 90 m/L

Sampler's Initials: J.M.	Purger's Initials:

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Professional Services		
Australia–Pacific	**Form**	PS-302-HAZ-F12
Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW05
Client:	Satterley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11.3.16

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	Not Detected
Casing height above-ground level (mAGL):	06	**Depth to groundwater (mBTOC):**	2.715
Bore locked/covered?:	covered	**Product thickness (mm):**	-
Cap type:	PVC	**Well depth from TOC (m):**	5.960
Well condition:	Good	**Depth to be purged (m):**	3.045

Purging information

Flow ~ 200 ml/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	Planned Purge Volume: N/A Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: _____	Actual Purge Volume: ~3 Litres
Start time (2400 hour): 10.00	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	~~Turbidity~~ SWL	Temp. °C
After **1** purge volume:	10.00	6.97	0.53	-65.9	0.87	2.720	23.6
After **2** purge volume:	10.05	6.73	0.52	-120.1	0.28	2.728	23.8
After **3** purge volume:	10.10	6.77	0.508	-127.3	0.22	2.728	23.7
After **4** purge volume:	10.15	6.78	0.507	-126.0	0.22	2.730 ~~2.729~~	23.8
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y.

Sampling details

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑			
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: _____			
Equipment: Dedicated ☑ Decontaminated ☐ Other: _____			
Is there a hydrocarbon sheen?: Yes ☐ No ☑			
Colour: Yellow	Odour: None	Sample ID: MW05	Duplicate ID: -
Turbidity: Low ☑ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: -

Analysis details

TPH	☐	VOCs	☐
BTEX	☐	SVOCs	☐
PAHs	☐	pH, EC, nut, pest	☑
Metals	☑	Ass suite	☐

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☐ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☐ Windy	☐ Dusty

Other comments and observations: TTA = 75 mg/L

Sampler's Initials: Y.M.	Purger's Initials:

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PB 100 YEARS	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW04
Client:	Sattelley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	Not detected
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	3.410
Bore locked/covered?:	covered	**Product thickness (mm):**	~~Not~~ N/A
Cap type:	PVC	**Well depth from TOC (m):**	6.374
Well condition:	good	**Depth to be purged (m):**	

Purging information

Flow rate = ~175 mL/min
Flow rate 2 = ~420 mL/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	Planned Purge Volume: N/A Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: _____	Actual Purge Volume: ~2.075 Litres
Start time (2400 hour): 1045	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (~S/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity SWL	Temp. °C
After **1** purge volume:	1045	8.45	0.81	-120.5	0.84	3.419	20.5°C
After **2** purge volume:	1050	9.00	0.81	-136.9	0.31	3.456	20.4°C
After **3** purge volume:	1055	9.02	0.80	-146.6	0.19	3.469	20.0
After **4** purge volume:	1100	9.03	0.80	-147.6	0.17	3.473	21.0
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details	**Analysis details**
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	TPH ☑ VOCs ☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other:	BTEX ☑ SVOCs ☐
Equipment: Dedicated ☑ Decontaminated ☐ Other: _____	PAHs ☐ pH, EC, nat test ☑
Is there a hydrocarbon sheen?: Yes ☐ No ☑	Metals ☑ ASS suite ☑

Colour: Yellow	Odour: None	Sample ID: MW04	Duplicate ID: —
Turbidity: Low ☑ Medium ☐ High ☐	Rinse Blank After: Yes ☐ No ☑		Triplicate ID:

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☑ Warm ☐ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations: Reduced flow rate after 1050 TTA = 0.1 x 500 = 50mg/L

Sampler's Initials: Y.M.	Purger's Initials:

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Professional Services		
Australia-Pacific	**Form**	PS-302-HAZ-F12
Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW03
Client:	Satterley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11/3/16

Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	Not detected
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	2.316
Bore locked/covered?:	Covered	**Product thickness (mm):**	N/A
Cap type:	PVC	**Well depth from TOC (m):**	4.950
Well condition:	Good	**Depth to be purged (m):**	2.634

Purging information Flow rate = ~ 120 mL/min

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	Planned Purge Volume: N/A Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: 3.6 Litres
Start time (2400 hour): 1015	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (mS/cm)	Redox (mV)	DO units % ☐ ppm ☑	Turbidity SVL	Temp. °C
After **1** purge volume:	1020	6.53	0.68	-99.7	0.70	2.325	25.4
After **2** purge volume:	1035	6.70	0.69	-110.6	0.69	2.325	26.0
After **3** purge volume:	1140	6.73	0.68	-116.2	0.61	2.325	26.2
After **4** purge volume:	1145	6.78	0.69	-115.7	0.62	2.325	25.6
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details		**Analysis details**			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑		TPH	☑	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: ____		BTEX	☑	SVOCs	☐
Equipment: Dedicated ☑ Decontaminated ☐ Other: ____		PAHs	☐	PH, EC, Nut, pest	☑
Is there a hydrocarbon sheen?: Yes ☐ No ☐		Metals	☑	ASS suit	☑
Colour: slight yellow	Odour: None	Sample ID: MW03		Duplicate ID: QC01	
Turbidity: Low ☑ Medium ☐ High ☐		Rinse Blank After: Yes ☑ No ☐		Triplicate ID: QC01A	

Weather conditions QC02 & QC03

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations: TTA = 75 mg/L

Sampler's Initials: Y.M Purger's Initials:

Prepared: Des Dickie **Approved:** J Throssell

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PB 100 YEARS	Professional Services		
	Australia–Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW06
Client:	Sutherby	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11/3/16
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	N.D
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	1.525
Bore locked/covered?:	covered	**Product thickness (mm):**	–
Cap type:	PVC	**Well depth from TOC (m):**	4.472
Well condition:	good	**Depth to be purged (m):**	2.947

Purging information

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: ____	Actual Purge Volume: Litres
Start time (2400 hour): 12.05	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (mS/cm)	Redox (mV)	DO units % ☐ ppm ☑	~~Turbidity~~	Temp. °C
After **1** purge volume:	1210	7.06	0.420	-129.2	0.57	2.535	19.2
After **2** purge volume:	1215	7.04	0.421	-141.7	0.42	2.535	19.5
After **3** purge volume:	1220	6.46	0.422	-141.9	0.33	2.536	19.3
After **4** purge volume:	1225	6.53	0.420	-146.9	0.29	2.536	19.6
After **5** purge volume:	1230	6.56	0.418	-150.7	0.28	2.537	19.8
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?: Y

Sampling details	Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other:	BTEX	☐	SVOCs	☐
Equipment: Dedicated ☑ Decontaminated ☐ Other: ____	PAHs	☐	A88	☑
Is there a hydrocarbon sheen?: Yes ☐ No ☑	Metals	☐		☐

Colour: Yellow	Odour: none	Sample ID: MW06	Duplicate ID: –
Turbidity: Low ☑ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: –

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☐ Windy	☐ Dusty

Other comments and observations: TTA = 50 mg/L

Sampler's Initials: Y.H	Purger's Initials:

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Professional Services		
Australia–Pacific	Form	PS-302-HAZ-F12
Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	MW07
Client:	Satterley	**Purging date:**	
Site location:	Mandogalup	**Sampling date:**	11/3/16
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	N.D
Casing height above-ground level (mAGL):	0.6	**Depth to groundwater (mBTOC):**	2.485
Bore locked/covered?:	covered.	**Product thickness (mm):**	N/A
Cap type:	PVC	**Well depth from TOC (m):**	5.150
Well condition:	Gd	**Depth to be purged (m):**	

Purging information

flow rate ~ 225mL/m

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑	Planned Purge Volume: — Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☑ PVC ☐ Other: _____	Actual Purge Volume: — Litres
Start time (2400 hour): 12 45	Did well purge 'dry'? No ☑ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units % ☐ ppm ☑	~~Turbidity~~ SWL	Temp. °C
After **1** purge volume:	12.50	6.81	1.39	-161.6	0.57	2.486	21.0
After **2** purge volume:	12.55	6.94	1.39	-175.2	0.37	2.486	20.8
After **3** purge volume:	1300	6.96	1.39	-178.4	0.26	2.486	20.7
After **4** purge volume:	1305	6.96	1.39	-178.5	0.23	2.486	20.7
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

Are the field results acceptable?:

Sampling details

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐ peri ☑

Material: Teflon ☐ S/Steel ☐ HDPE ☑ PVC ☐ Other: _____

Equipment: Dedicated ☑ Decontaminated ☐ Other: _____

Is there a hydrocarbon sheen?: Yes ☐ No ☑

Analysis details

TPH	☐	VOCs	☐
BTEX	☐	SVOCs	☐
PAHs	☐	ABS suite	☑
Metals	☐		☐

Colour: Yellow	Odour: None	Sample ID: MW07	Duplicate ID: —
Turbidity: Low ☐ Medium ☑ High ☐		Rinse Blank After: Yes ☐ No ☑	Triplicate ID: —

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☑ Hot	☑ Clear ☐ Medium ☐ Cloudy	☑ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☑ Windy	☐ Dusty

Other comments and observations: TTA = 157 ug/L

Sampler's Initials: Y.M.	Purger's Initials:

Prepared: Des Dickie **Approved:** J Throssell

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PB 100 YEARS	Professional Services		
	Australia-Pacific	**Form**	PS-302-HAZ-F12
	Groundwater Field Parameters		Rev: B

Job no:		**Well no:**	JDA
Client:	Satterley	**Purging date:**	11/3/16
Site location:	Mandogalup	**Sampling date:**	—
Casing diameter (mm):	50	**Depth to floating product (mBTOC):**	—
Casing height above-ground level (mAGL):	~0.6	**Depth to groundwater (mBTOC):**	—
Bore locked/covered?:	locked!	**Product thickness (mm):**	—
Cap type:	—	**Well depth from TOC (m):**	—
Well condition:	—	**Depth to be purged (m):**	—

Purging information

Purge 5 casing volumes or until 'dry':

1 casing volume = 2 L/m for 50 mm ID wells. *1 casing volume = 8 L/m for 100 mm ID wells.*

Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐	Planned Purge Volume: Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☐ PVC ☐ Other: _____	Actual Purge Volume: Litres
Start time (2400 hour):	Did well purge 'dry'? No ☐ Yes ☐ At?: Litres

Field results while purging

	Time	pH	EC (___S/cm)	Redox (mV)	DO units % ☐ ppm ☐	Turbidity	Temp. °C
After **1** purge volume:							
After **2** purge volume:							
After **3** purge volume:							
After **4** purge volume:							
After **5** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/- 0.05	+/- 3%	+/- 10%	+/- 10%	N/A	+/- 10%

UNABLE TO ACCESS WELL BORE LOCKED

Are the field results acceptable?:

Sampling details		Analysis details			
Method/Pump Type: Bailer ☐ Waterra ☐ Whaler ☐ Micro-Purge ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/Steel ☐ HDPE ☐ PVC ☐ Other: _____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: _____		PAHs	☐		☐
Is there a hydrocarbon sheen?: Yes ☐ No ☐		Metals	☐		☐
Colour:	Odour:	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☐ High ☐		Rinse Blank After: Yes ☐ No ☐		Triplicate ID:	

UNABLE TO ACCESS WELL

Weather conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☐ Hot	☐ Clear ☐ Medium ☐ Cloudy	☐ Dry ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☐ Windy	☐ Dusty

Other comments and observations:

Sampler's Initials:	Purger's Initials:

Prepared: Des Dickie | ***Approved:*** *J Throssell*

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Appendix 5
Equipment calibration certificates

ECO Environmental

Environmental monitoring
& sampling equipment
Rentals and sales.

Tel: +61 8 9328 2900
fax: +61 8 9328 2677
eco@ecoenvironmental.com.au
www.ecoenvironmental.com.au
214 Lord St Perth WA 6000

Equipment Information

Instrument: YSIPP7
Serial Number: Serial #: 14C100712 (Display)
Lot #: 15J100050 (Sonde)

Equipment Check

	Enclosed	Comment
YSI Pro Plus Display	☑	
YSI Quatro Sonde	☑	
- YSI 1001 pH Probe *(LN: YSI1001 13B)*	☑	
- YSI 1002 ORP Probe *(LN: YSI1002 13B)*	☑	
- YSI 5560 Cond/Temp Probe (LN: 13A100566)	☑	
- YSI Polarographic DO Sensor *(LN: 13B10029)*	☑	
Flow Cell	☑	
Probe Guard	☑	
Rubber Storage/Calibration Sleeve	☑	
Calibration Cup + Cap	☑	
YSI Cable Management Kit	☑	
YSI Pro Series ProComm II Kit	☑	
Instruction Manual + Instruction and Calibration Sheets	☑	
Spare Batteries (x 2)	☑	

Sensor Calibration Details

	Calibration Undertaken	Accuracy	Pass	Fail
Temperature	Factory Calibrated	±0.2°C	☑	☐
Dissolved Oxygen	☑ 100% Saturation	±2%	☑	☐
	Pressure Compensation	1012 hPa	☑	☐
Conductivity	☑ 1288mS/cm	±0.5%	☑	☐
	☑ Check linearity at 1.4mS/cm	±0.5%	☑	☐
Salinity	Auto Calibrated	±1%	☑	☐
pH	☑ pH 7.00	± 0.2	☑	☐
	☐ pH 4.00	± 0.2	☑	☐
ORP	☑ 220mV at 29°C	±20mV	☑	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards

EM 8.3.16

Equipment Specialist
ECO Environmental

ECO Environmental

Environmental monitoring
& sampling equipment
Rentals and sales

Tel: +61 8 9328 2900
fax: +61 8 9328 2677
eco@ecoenvironmental.com.au
www.ecoenvironmental.com.au
214 Lord St Perth WA 6000

Equipment Information

Instrument: YSIPP2
Serial Number: 11F100649 (Display)
14H100037 (Sonde)

Equipment Check

	Enclosed	Comment
YSI Pro Plus Display	☑	
YSI Quatro Sonde	☑	
- YSI 1001 pH Probe *(LN: YSI1001A 11E)*	☑	
- YSI 1002 ORP Probe *(LN: YSI1002 11B)*	☑	
- YSI 5560 Cond/Temp Probe (LN: 11F100408)	☑	
- YSI Polarographic DO Sensor *(LN: 11C 102881)*	☑	
Flow Cell	☑	
Probe Guard	☑	
Rubber Storage/Calibration Sleeve	☑	
Calibration Cup + cap	☑	
YSI Cable Management Kit	☑	
YSI Pro Series ProComm II Kit	☑	
Instruction Manual + Instruction and Calibration Sheets	☑	
Spare Batteries (x 2)	☑	

Sensor Calibration Details

	Calibration Undertaken	Accuracy	Pass	Fail
Temperature	Factory Calibrated	±0.2°C	☑	☐
Dissolved Oxygen	☑ 100% Saturation	±2%	☑	☐
	Pressure Compensation	1011.6 hPa	☑	☐
Conductivity	☑ 1288mS/cm	±0.5%	☑	☐
	☑ Check linearity at 1.4mS/cm	±0.5%	☑	☐
Salinity	Auto Calibrated	±1%	☑	☐
pH	☑ pH 7.00	± 0.2	☑	☐
	☑ pH 4.00	± 0.2	☑	☐
ORP	☑ 228mV at 25.5°C	±20mV	☑	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

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Regards

EM 10-3-16

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214 Lord St Perth WA 6000

Equipment Information

Instrument: HIM203
Serial Number: 24983 – Reel and Tape
02-0573 – Control Panel

Equipment Check

	Enclosed	Returned	Comment
Heron Interface Level Meter	☑	☐	
Heron Carry Bag	☑	☐	
Spare 9V. Battery	☑	☐	

Inspection Details

	Pass	Fail	Comment
De-con wash of tape (20m)	☑	☐	
De-con wash of reel	☑	☐	
Inspection for faults, corrosion, damage	☑	☐	
Meter in good working order, clean and ready for use	☑	☐	

This is to certify that where possible, this instrument has been cleaned in accordance with the manufacturer's general maintenance procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards

24.2.2016

Equipment Specialist
ECO Environmental

Appendix 6
Groundwater results summary tables

Mandogalup - Acid Sulfate Soil and Dewatering Management Plan

Table 1. Groundwater Analytical Results - Acidity, alkalinity, sulfate and chloride, metals and metalloids and nutrients

Sample ID	Sample Date	QA Sample Type	Physicochem			Alkalinity and Acidity				Sulfate and Chloride		Ratios		Nutrients							
			pH (Lab)	EC @ 25°C	TDS @ 25°C	Alkalinity (Hydroxide) as CaCO3	Acidity as $CaCO_3$	Alkalinity (Total) as CaCO3	Acidity - Total Alkalinity/3	Sulfate as SO_4^{2-}	Chloride	Alkalinity/SO_4^{2-}	Cl/SO_4^{2-}	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N	Kjeldahl Nitrogen Total	Total Nitrogen	Phosphorus	Sulfide
Units			*pH Unit*	*µS/cm*	*mg/L*	mg/L				mg/L		mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L
ASS Indicators			<5									<5	<2								
Domestic non-potable groundwater use			-							1,000	2,500										
Aquatic Ecosystems (Fresh)			<6.5-8.5>																		
MW01	11/03/2016	Primary	7.22	480	432	<1	104	166	131	64	32	1.6	0.5	0.35	<0.01	<0.01	<0.01	1.8	1.8	0.11	1000
	27/09/2016	Primary	6.25	452	334	<1	60	90	70	100	34	0.6	0.3	0.73	<0.01	<0.01	<0.01	1.2	1.2	<0.01	<100
MW02	11/03/2016	Primary	5.96	856	617	<1	98	15	-18	87	230	1.1	2.6	0.36	<0.01	<0.01	<0.01	1.4	1.4	0.1	<100
	27/09/2016	Primary	5.72	809	543	<1	98	20	-13	84	212	1.2	2.5	0.4	<0.01	<0.01	<0.01	0.8	0.8	<0.01	<100
MW03	11/03/2016	Primary	7.16	646	480	<1	29	56	46	102	117	0.3	1.1	0.64	0.03	<0.01	0.03	1.1	1.1	0.16	<100
	22/09/2016	Primary	6.54	479	520	<1	48	62	46	<1	124	-	-	0.02	<0.01	0.02	0.02	4.8	4.8	0.6	<100
MW04	11/03/2016	Primary	7.9	727	576	<1	17	169	163	14	154	1.2	11.0	0.58	0.01	<0.01	0.01	1.2	1.2	0.97	<100
	27/09/2016	Primary	7.58	716	469	<1	7	140	138	20	158	0.4	7.9	0.51	0.01	<0.01	0.01	1	1	3.32	<100
MW05	11/03/2016	Primary	6.89	450	460	<1	46	46	31	109	58	0.4	0.5	0.74	<0.01	<0.01	<0.01	1.8	1.8	0.62	<100
	22/09/2016	Primary	5.79	463	380	<1	30	4	-6	135	52	0.2	0.4	0.5	<0.01	3.53	3.53	1.9	5.4	0.65	<100
MW06	11/03/2016	Primary	6.54	356	332	<1	33	12	1	40	86	0.8	2.2	0.1	<0.01	<0.01	<0.01	1.3	1.3	0.07	200
	22/09/2016	Primary	6.33	436	306	<1	24	22	14	43	104	0.6	2.4	0.2	<0.01	<0.01	<0.01	1.1	1.1	0.04	<100
MW07	11/03/2016	Primary	6.85	1300	1020	<1	54	78	60	182	280	0.3	1.5	0.99	<0.01	<0.01	<0.01	2.2	2.2	0.08	200
	27/09/2016	Primary	6.46	1300	920	<1	32	86	75	216	286	0.1	1.3	0.76	<0.01	<0.01	<0.01	1.6	1.6	0.05	<100
MW08	11/03/2016	Primary	6.38	609	577	<1	42	23	9	122	116	0.3	1.0	0.55	<0.01	<0.01	<0.01	1.8	1.8	<0.05	1800
	27/09/2016	Primary	5.97	367	308	<1	26	20	11	128	58	0.2	0.5	0.26	<0.01	<0.01	<0.01	0.9	0.9	<0.01	<100
MW09	11/03/2016	Primary	7.01	471	383	<1	31	40	30	94	74	0.3	0.8	0.66	<0.01	<0.01	<0.01	1.1	1.1	0.1	600
	27/09/2016	Primary	6.15	619	470	<1	22	27	20	110	133	0.2	1.2	0.46	<0.01	<0.01	<0.01	1.2	1.2	<0.01	<100
Quality Control																					
QC2	11/03/2016	Fieldblank	-	-	-	-	-		-	-	-	-	-	<0.01	-	-	<0.01	<0.1	<0.1	<0.01	-
QC3	11/03/2016	Rinsate	-	-	-	-	-		-	-	-	-	-	0.04	-	-	<0.01	<0.1	<0.1	<0.01	-
Relative Percentage Difference %			*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
QC1	11/03/2016	Duplicate	7.35	631	474	<1	25,000	72	-	106	116	-	-	0.58	0.03	<0.01	0.03	1.2	1.2	0.16	<100
MW03	11/03/2016	Primary	7.16	646	480	<1	29,000	56	-	102	117	-	-	0.64	0.03	<0.01	0.03	1.1	1.1	0.16	<100
Relative Percentage Difference %			3	2	1	na	15	25	na	4	1	na	*na*	10	0	na	0	9	9	0	na
QC01	11/03/2016	Triplicate	6.5	670	-	-	-	-	-	-	-	-	-	0.46	0.015	<0.005	-	1.2	1.2	0.17	-
MW03	11/03/2016	Primary	7.16	646	480	<1	29,000	56	-	102	117	-	-	0.64	0.03	<0.01	0.03	1.1	1.1	0.16	<100
Relative Percentage Difference %			10	4	na	na	na	na	na	na	na	na	na	33	67	na	na	9	9	6	na
QC1	22/09/2016	Duplicate	6.28	453	317	<1	19	21	-			-	-								
	11/03/2016	Primary							-			-	-								
Relative Percentage Difference %			100	100	100	*na*	*na*	100	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*

na	Not applicable as primary and/or QC sample are less than PQLs.
-	No investigation level available or data not available
*	Where applicable, criteria have been multiplied by a factor of 10 due to disposed groundwater not being discharged to a surface water receptor.
#	Aesthetic value
	Shading denotes exceedence of RPDs

Mandogalup - Acid Sulfate Soil and Dewatering Management Plan

Table 2. Groundwater Analytical Results Contd.- Physiochemical parameters and major cations and anions

Sample ID	Sample Date	QA Sample Type	Major cations and anions									
			Calcium	Magnesium	Sodium	Potassium	Sulfate as SO_4^{2-}	Chloride	Total Alkalinity as $CaCO_3$	Total cations	Total anions	Ionic balance
Units			*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	*mg/L*	meq/L	meq/L	*%*
Limit of Reporting												
ASS Indicators			-	-	-	-			-	-	-	-
DoH - Domestic non-potable groundwater use			-	-	-	-		2500	-			
Aquatic Ecosystems (Fresh)			-	-	-	-			-			
										-		
MW01	11/03/2016	Primary	51	18	35	8	64	32	166	5.75	5.55	1.79
	27/09/2016	Primary	23	20	42	4	100	34	90	4.84	4.72	1.23
MW02	11/03/2016	Primary	24	15	110	4	87	230	15	7.32	8.6	8.04
	27/09/2016	Primary	21	14	106	3	84	212	20	8.13	6.89	8.27
MW03	11/03/2016	Primary	52	13	51	6	102	117	56	6.04	6.54	4.01
	22/09/2016	Primary	33	9	57	4	<1	124	62	4.74	4.97	2.41
MW04	11/03/2016	Primary	63	14	67	4	14	154	169	7.31	8.01	4.55
	27/09/2016	Primary	65	16	72	3	20	158	140	7.67	7.77	0.65
MW05	11/03/2016	Primary	37	13	29	13	109	58	46	4.51	4.82	3.35
	22/09/2016	Primary	34	11	30	16	135	52	4	4.36	4.32	0.45
MW06	11/03/2016	Primary	16	7	41	6	40	86	12	3.31	3.5	2.74
	22/09/2016	Primary	14	9	52	4	43	104	22	4.27	3.8	5.76
MW07	11/03/2016	Primary	70	33	124	14	182	280	78	12	13.2	5.09
	27/09/2016	Primary	81	34	133	20	216	286	86	14.3	13.1	4.17
MW08	11/03/2016	Primary	22	23	58	6	122	116	23	5.67	6.27	5.07
	27/09/2016	Primary	13	15	46	4	128	58	20	4.7	3.99	8.24
MW09	11/03/2016	Primary	29	16	37	4	94	74	40	4.48	4.84	3.94
	27/09/2016	Primary	28	19	67	6	110	133	27	6.58	6.03	4.38
Quality Control												
QC2	11/03/2016	Fieldblank	-	-	-	-	-	-	-	-	-	-
QC3	11/03/2016	Rinsate	-	-	-	-	-	-	-	-	-	-
QC1	11/03/2016	Duplicate	51	13	49	6	106	116	72	5.9	6.92	7.92
MW03	11/03/2016	Primary	52	13	51	6	102	117	56	6.04	6.54	4.01
Relative Percentage Difference %			2	0	4	0	4	1	25	2	6	66
QC01	11/03/2016	Triplicate	-	-	-	-	-	-	-	-	-	-
MW03	11/03/2016	Primary	52	13	51	6	102	117	56	6.04	6.54	4.01
Relative Percentage Difference %			na	na	na	na	na	na	na	na	na	na
QC01	22/09/2016	Duplicate	14	9	51	4	44	106	21	4.32	3.76	7
	22/09/2016	Primary										
Relative Percentage Difference %			na	na	na	na	na	na	na	na	na	na

na	Not applicable as primary and/or QC sample are less than PQLs.
-	No investigation level available or data not available
*	Where applicable, criteria have been multiplied by a factor of 10 due to disposed groundwater not being discharged to a surface water receptor.
	Shading denotes exceedence of adopted performance criteria
	Shading denotes exceedence of RPDs
(1)	pH should be maintained above
(2)	<40 mg/L or if concentration exceeds background
(3)	>2 or if concentration exceeds background concentrations by 15%

Mandogalup - Acid Sulfate Soil and Dewatering Management Plan
Table 3. Groundwater Analytical Results Contd. - Metals and metalloids

Sample ID	Sample Date	QA Sample Type	Metals and Metalloids																			
			Aluminium	Aluminium (Filtered)	Arsenic (Filtered)	Barium (Filtered)	Berrylium (Filtered)	Boron (Filtered)	Cadmium (Filtered)	Chromium (Filtered)	Cobalt (Filtered)	Copper (Filtered)	Iron	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Nickel (Filtered)	Selenium (Filtered)	Vanadium (Filtered)	Zinc (Filtered)	Phosphorus
Units			µg/L																			mg/L
Limit of Reporting			10	10	1	1	1	50	0.1	1	1	1	50	50	1	1	0.1	1	10	10	5	0.01
ASS Indicators			-	>1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DoH 2014 - Domestic non-potable groundwater use			200	200	-	20000	600	40000	20	-	-	20000	300	300	100	5000	10	200	100	-	3000	-
Aquatic Ecosystems (Fresh)			55	55	13	-	-	370	0.2	-	-	1.4	300	300	3.4	1900	0.06	11	5	-	8	-
MW01	11/03/2016	Primary	2800	180	<1	28	<1	<50	<0.1	<1	<1	<1	1440	540	<1	6	<0.1	<1	<10		12	0.11
	27/09/2016	Primary	360	360	<1	-	-	-	<0.1	<1	-	-	770	960	-	3	-	<1	<10	-	<5	
MW02	11/03/2016	Primary	11,200	510	3	30	<1	<50	<0.1	2	13	<1	15200	15900	<1	33	<0.1	3	<10	<10	14	0.1
	27/09/2016	Primary	1240	850	2	-	-	-	<0.1	1	-	-	16800	15400	-	5	-	3	<10	-	<5	
MW03	11/03/2016	Primary	1290	60	<1	55	<1	<50	0.3	3	<1	<1	1570	660	<1	34	<0.1	1	<10	<10	29	0.16
	22/09/2016	Primary	680	820	2	-	-	-	<0.1	11	-	-	6960	7180	-	24	-	8	<10	-	28	
MW04	11/03/2016	Primary	8000	40	2	98	<1	<50	<0.1	2	11	<1	37500	478	<1	46	<0.1	2	<10	<10	5	0.97
	27/09/2016	Primary	<10	20	<1	-	-	-	<0.1	<1	-	-	3590	1650	-	12	-	<1	<10	-	<5	
MW05	11/03/2016	Primary	3690	520	5	118	<1	<50	<0.1	3	2	<1	2580	1970	<1	46	<0.1	<1	<10	<10	8	0.62
	22/09/2016	Primary	1520	370	2	-	-	-	<0.1	4	-	-	5160	2450	-	40	-	6	<10	-	<5	
MW06	11/03/2016	Primary	2720	710	3	-	-	-	<0.1	2	-	-	1710	1030	-	26	-	<1	<10	-	8	0.07
	22/09/2016	Primary	300	290	<1	-	-	-	<0.1	1	-	-	811	1030	-	13	-	<1	<10	-	35	
MW07	11/03/2016	Primary	6460	180	<1	-	-	-	<0.1	2	-	-	1620	420	-	21	-	<1	<10	-	<5	0.08
	27/09/2016	Primary	200	80	<1	-	-	-	<0.1	1	-	-	70	60	-	20	-	<1	<10	-	<5	
MW08	11/03/2016	Primary	2120	460	<1	-	-	-	<0.1	1	-	-	840	1940	-	14	-	<1	<10	-	<5	<0.05
	27/09/2016	Primary	580	590	<1	-	-	-	<0.1	2	-	-	350	1920	-	2	-	<1	<10	-	<5	
MW09	11/03/2016	Primary	4430	130	<1	-	-	-	<0.1	<1	-	-	380	80	-	6	-	<1	<10	-	<5	0.1
	27/09/2016	Primary	250	210	<1	-	-	-	<0.1	1	-	-	<50	<50	-	7	-	<1	<10	-	<5	
Quality Control																						
QC2	11/03/2016	Fieldblank	-	<10	<1	<1	<1	<50	<0.1	<1	<1	<1	-	<0.05	<1	<1	<0.1	<1	<10	<10	<5	<0.01
QC3	11/03/2016	Rinsate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01
QC1	11/03/2016	Duplicate	1190	60	<1	51	<1	<50	<0.1	3	<1	<1	1.49	0.64	<1	35	<0.1	<1	<10	<10	<5	0.16
MW03	11/03/2016	Primary	1290	60	<1	55	<1	<50	0.3	3	<1	<1	1.57	0.66	<1	34	<0.1	1	<10	<10	29	0.16
Relative Percentage Difference %			8	0	na	8	na	na	na	0	na	na	5	3	na	3	na	na	na	na	na	0
QC01	11/03/2016	Triplicate	-	-	<1	53	<0.5	-	<0.1	3	<1	<1	-	-	<1	29	<0.05	<1	-	4	3	0.17
MW03	11/03/2016	Primary	1290	60	<1	55	<1	<50	0.3	3	<1	<1	1.57	0.66	<1	34	<0.1	1	<10	<10	29	0.16
Relative Percentage Difference %			na	na	na	4	na	na	na	0	na	na	na	na	na	16	na	na	na	na	163	6
QC1	22/09/2016	Duplicate	310	310	1				<0.1	2			830	1050		14		<1	<10		27	
		Primary																				
			na	na	na	#DIV/0!	na	na	na	100	na	na	na	na	na	100	na	na	na	na	100	#DIV/0!

na	Not applicable as primary and/or QC sample are less than PQLs.
-	No investigation level available or data not available
*	Where applicable, criteria have been multiplied by a factor of 10 due to disposed groundwater not being discharged to a surface water receptor.
	Shading denotes exceedence of adopted performance criteria
	Shading denotes exceedence of RPDs
(1)	Criteria for Arsenic as As(v) shown

Mandogalup - Acid Sulfate Soil and Dewatering Management Plan
Table 4. TPH, BTEX and PAH

Sample ID	Sample Date	QA Sample Type	TRH					BTEX							Solvents	PAH
			+C10 - C36 (Sum of total)	C6 - C9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29-C36 Fraction	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	Sum of BTEX	Methyl Tert-Butyl Ether (MTBE	Naphthalene
Units			µg/L					µg/L								
Limit of Reporting			50	20	50	100	50	1	2	2	2	2	2	1	1	5
ASS Indicators			-	-	-	-	-	-	-	-	-	-	-	-	-	-
DoH 2014 - Domestic non-potable groundwater use			-	-	-	-	-	10	25	3	-	-	20	-	-	-
Aquatic Ecosystems (Fresh)			600	150	-	-	-	950	-	-	-	-	-	-	-	16
MW01	11/03/2016	Primary	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW02	11/03/2016	Primary	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW03	11/03/2016	Primary	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
MW04	11/03/2016	Primary	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
MW05	11/03/2016	Primary	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
MW06	11/03/2016	Primary	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW07	11/03/2016	Primary	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW08	11/03/2016	Primary	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW09	11/03/2016	Primary	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quality Control																
QC2	11/03/2016	Fieldblank	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
QC3	11/03/2016	Rinsate	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
QC1	11/03/2016	Duplicate	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
MW03	11/03/2016	Primary	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
Relative Percentage Difference %			*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
QC01	11/03/2016	Triplicate	-	<10	<50	<100	<100	<1	<1	<1	<2	<1	-	-	<1	<1
MW03	11/03/2016	Primary	<50	<20	<50	<100	<50	<1	<2	<2	<2	<2	<2	<1	-	<5
Relative Percentage Difference %			*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*

na	Not applicable as primary and/or QC sample are less than PQLs.
-	No investigation level available or data not available
*	Where applicable, criteria have been multiplied by a factor of 10 due to disposed groundwater not being discharged to a surface water receptor.
	Shading denotes exceedence of adopted performance criteria
	Shading denotes exceedence of RPDs

Mandogalup - Acid Sulfate Soil and Dewatering Management Plan
Table 5. Field parameters

Well ID	Date	Easting	Northing	Well elevation at top of casing	Surface Elevation	Depth to Groundwater	Groundwater elevation	pH	Electrical Conductivity	Redox	Dissolved Oxygen	Temperature	Comments
		m	m	mAHD	mAHD	mBTOC	mAHD	-	mS/cm	mV	ppm	ºC	
MW01	11/03/2016	392191.750	6438697.708	23.292	22.692	3.055	20.24	5.99	0.522	-178.5	0.35	22.2	
	27/09/2016			23.292		1.998	21.29	5.74	5.05	-136.3	0.51	15.0	
MW02	11/03/2016	392026.523	6437971.213	22.389	21.789	4.322	18.07	6.40	0.92	-116.9	0.35	21.2	
	27/09/2016			22.389		3.285	19.10	5.10	0.89	-43.4	-		
MW03	11/03/2016	392024.235	6437304.546	18.494	17.894	2.316	16.18	6.78	0.69	-115.7	0.62	25.8	
	22/09/2016			18.494		1.295	17.20	6.04	0.524	-148.0	0.30	15.9	
MW04	11/03/2016	391326.131	6437155.368	13.939	13.339	3.410	10.53	9.03	0.8	-147.6	0.17	21.0	
	27/09/2016			13.939		1.018	12.92	7.48	0.79	-127.8	-	16.9	
MW05	11/03/2016	391703.521	6436781.836	15.055	14.455	2.715	12.34	6.78	0.507	-126.0	0.22	23.8	
	22/09/2016			15.055		1.859	13.20	5.15	0.45	-101.0	1.00	15.8	
MW06	11/03/2016	392113.761	6437430.480	19.312	18.712	1.525	17.79	6.56	0.418	-150.7	0.28	19.8	
	22/09/2016			19.312		0.712	18.60	5.85	0.455	-162.0	0.51	15.9	
MW07	11/03/2016	391618.607	6437371.570	14.939	14.339	2.485	12.45	6.96	1.39	-178.5	0.23	20.7	
	27/09/2016			14.939		0.825	14.11	5.94	1.42	-138.4	0.37	17.2	
MW08	11/03/2016	392057.001	6438266.097	23.024	22.424	3.615	19.41	7.04	0.65	-190.9	0.24	20.1	
	27/09/2016			23.024		2.626	20.40	5.51	0.407	-131.7	0.53	16.0	
MW09	11/03/2016	392204.567	6438146.718	24.409	23.809	3.055	21.35	6.71	0.5	-174.0	0.35	21.3	
	27/09/2016			24.409		4.115	20.29	5.69	0.68	-152.4	0.35	17.6	

AHD - Australian Height Datum

Mandogalup - Acid Sulfate Soil and Dewatering Management Plan
Table 6. Survey Results (eDrill)

		GDA94 (MGA50)				AHD71								
ID	Description	Easting (m)	Horizontal Accuracy (m)	Northing (m)	Horizontal Accuracy (m)	Ellipsoidal Height (m)	Vertical Accuracy (m)	n Value (m)	AHD (m) T.O.C.	Height Pipe A.G.L. (m)	Surface Elevation (m)	SWL T.O.C.(m)	RWL (m)	Notes
MW01 (SB03)	Piezometer	392191.750	0.020	6438697.708	0.020	-8.848	0.020	-32.140	23.292	0.60	22.692	3.06	20.237	DGPS Control
MW02 (SB04)	Piezometer	392026.523	0.020	6437971.213	0.020	-9.744	0.020	-32.133	22.389	0.60	21.789	4.32	18.067	DGPS Control
MW03 (SB05)	Piezometer	392024.235	0.020	6437304.546	0.020	-13.635	0.020	-32.129	18.494	0.60	17.894	2.32	16.178	DGPS Control
MW04 (SB02)	Piezometer	391326.131	0.020	6437155.368	0.020	-18.235	0.020	-32.174	13.939	0.60	13.339	3.41	10.529	DGPS Control
MW05 (SB01)	Piezometer	391703.521	0.020	6436781.836	0.020	-17.086	0.020	-32.141	15.055	0.60	14.455	2.72	12.340	DGPS Control
MW06 (SB06)	Piezometer	392113.761	0.020	6437430.480	0.020	-12.812	0.020	-32.124	19.312	0.60	18.712	1.53	17.787	DGPS Control
MW07 (SB07)	Piezometer	391618.607	0.020	6437371.570	0.020	-17.218	0.020	-32.157	14.939	0.60	14.339	2.49	12.454	DGPS Control
SB08	SOIL BORE	392092		6438498										
MW08 (SB09)	Piezometer	392057.001	0.020	6438266.097	0.020	-9.114	0.020	-32.138	23.024	0.60	22.424	4.32	18.702	DGPS Control
MW09 (SB10)	Piezometer	392204.567	0.020	6438146.718	0.020	-7.721	0.020	-32.130	24.409	0.60	23.809	4.98	19.429	DGPS Control

*** Good Bore Development (Yield >=15L p/min.)
** Reasoanble Bore Development (Yield <15L p/min.)
* Poor Bore Development (Low yield or ran dry)

Appendix 7
Soil results summary tables

Table 1. Results summary table field pH, suspension peroxide oxidisable combined acidity and sulfur (SPOCAS)

					Field			SPOCAS																				
					pH (Field)	pH (fox)	Difference in pH(Field) and pH(fox)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	Sulfidic - Titratable Actual Acidity (TAA)	Sulfidic - Titratable Peroxide Acidity (TPA)	Sulfidic - Titratable Sulfidic Acidity (TSA)	Acidity - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	Liming Rate excluding ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Sulfidic - Excess Acid Neutralising Capacity	Acidity - Excess Acid Neutralising Capacity	ANC Fineness Factor	Liming Rate	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	Net Acidity (acidity units)	Net Acidity (sulfur units)
					pH_Units	pH_Units		pH_Units	%	H+/t	H+/t	H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	% S	mole H+/t	-	kg CaCO3/t	mole H+/t	% S	mole H+/t	% S
				EQL	0.1	0.1		0.1	0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	0.02	10	0.5	1	10	0.02	10	0.02
					<4	<3			0.1	62	62	62	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-	-	62	0.1	62	0.1
					4.0 - 5.5	3.0 - 4.0			0.06	36	36	36	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-	-	36	0.06	36	0.06
					>7	>5	>2[a]		0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-	-	18	0.03	18	0.03
Location	**Sample ID (inc**	**Sampled Date**	**Soil Description**	**Reaction Rate**																								
SB01/MW05	SB01_0.0	9/03/2016	SAND: grey, fine grained, subrounded, well sorted, dry	Moderate	4.9	4.1	0.80	5.6	<0.005	5	<2	<2	0.007	<0.005	<0.005	10	0.016	1	6	<5	-	1.5	1	15	0.02	<10	0.02
	SB01_0.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	4.9	3.9	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_0.5	9/03/2016	SAND: grey, medium grained, subangular to subrounded, well sorted, dry	Moderate	5	4.2	0.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_0.75	9/03/2016	SAND: grey, medium grained, subangular to subrounded, well sorted, dry	Slight	4.9	4.1	0.80	5.7	-	6	<2	<2	0.009	<0.005	<0.005	<5	<0.005	1	<5	<5	-	-	1.5	1	<10	<0.02	20	<0.02
	SB01_1.0	9/03/2016	SAND: grey, medium grained, subangular to subrounded, well sorted, dry	Slight	5.2	3.6	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_1.25	9/03/2016	SAND: light grey, medium grained, subangular to subrounded, well sorted, moist	Moderate	5.5	4.8	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_1.50	9/03/2016	SAND: light grey, medium grained, subangular to subrounded, well sorted, moist	Slight	5.3	4.9	0.40	5.80	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	10	<0.02
	SB01_1.75	9/03/2016	SAND: light grey, medium grained, subangular to subrounded, well sorted, moist	Slight	5.3	5.2	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_2.0	9/03/2016	SAND: light grey, medium grained, subangular to subrounded, well sorted, moist	Slight	5.4	5.4	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_2.25	9/03/2016	SAND: dark grey, fine grained, well sorted, moist to wet.	Slight	5.8	4	1.80	6.60	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	24	<0.02
	SB01_2.50	9/03/2016	SAND: dark grey, fine grained, well sorted, moist to wet.	Slight	5.8	5.1	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_2.75	9/03/2016	SAND: dark grey, fine grained, well sorted, moist to wet.	Moderate	4.5	2.4	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_3.0	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Moderate	4.5	2.2	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_3.25	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Slight	4.6	2	2.60	5.50	0.041	3	21	17	0.006	0.033	0.028	28	0.055	2	<5	<5	-	-	1.5	2	31	0.05	39	0.05
	SB01_3.50	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Slight	5.3	2	3.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_3.75	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5	2.3	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_4.0	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.3	2.1	3.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_4.25	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.7	2.1	3.60	5.50	-	<2	23	22	<0.005	0.038	0.036	34	0.055	3	<5	<5	-	-	1.5	3	35	0.06	30	0.06
	SB01_4.50	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.6	2.1	3.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_4.75	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.9	2	3.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_5.0	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.9	2	3.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_5.25	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.9	2	3.90	5.60	-	<2	56	55	<0.005	0.09	0.088	67	0.108	5	<5	<5	-	-	1.5	5	69	0.11	<10	0.11
	SB01_5.50	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	6.1	2	4.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_5.75	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	6.1	2	4.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB01_6.0	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	6.1	2	4.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB02/MW04	SB02_0.0	9/03/2016	SILT: dark brown, fine grained, moderately sorted, dry	Moderate	5.3	2.6	2.70	5	0.005	120	508	389	0.192	0.815	0.623	139	0.224	19	<5	<5	-	-	1.5	19	259	0.42	37	0.42
	SB02_0.25	9/03/2016	SILT: dark brown, fine grained, moderately sorted, dry	Extreme	5	2.6	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_0.5	9/03/2016	SILT: dark brown, fine grained, moderately sorted, dry	Moderate	5	2.2	2.80	4.6	-	150	413	264	0.24	0.663	0.422	122	0.195	20	44	<5	-	-	1.5	20	272	0.44	<10	0.44
	SB02_0.75	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Moderate	5.6	2.6	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_1.0	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Moderate	5.7	3	2.70	5.1	-	27	14	<2	0.043	0.022	<0.005	14	0.023	3	<5	8	-	-	1.5	3	41	0.07	31	0.07
	SB02_1.25	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Moderate	6.2	3.6	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_1.5	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Moderate	6.1	3.6	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_1.75	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Extreme	6.4	3.8	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_2.0	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Moderate	6.1	3.4	2.70	5.2	<0.005	20	<2	<2	0.031	<0.005	<0.005	13	0.021	2	15	<5	-	-	1.5	2	32	0.05	259	0.05
	SB02_2.25	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Strong	7.5	6.7	0.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_2.50	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Strong	7.7	6.6	1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_2.75	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Extreme	7.8	7.6	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_3.0	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	9	8.4	0.60	6.9	-	<2	<2	<2	<0.005	<0.005	<0.005	13	0.021	1	<5	12	0.245	153	1.5	<1	13	0.02	16	0.02
	SB02_3.25	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	8	7.8	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_3.50	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	9	8.7	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_3.75	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	8.7	8.8	-0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_4.0	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	9	8.4	0.60	7.8	-	<2	<2	<2	<0.005	<0.005	<0.005	146	0.234	11	1250	111	1.91	1200	1.5	<1	146	0.23	22	<0.02
	SB02_4.25	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	9.4	8.8	0.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_4.50	9/03/2016	Sandy CLAY: brown, moderate plasticity, wet	Extreme	8.8	7.1	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_4.75	9/03/2016	Sandy CLAY: brown, moderate plasticity, wet	Extreme	7.8	5.6	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_5.0	9/03/2016	CLAY: grey, high plasticity, saturated	Extreme	8.9	7	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_5.25	9/03/2016	CLAY: grey, high plasticity, saturated	Extreme	8.1	6.5	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_5.50	9/03/2016	CLAY: grey, high plasticity, saturated	Extreme	8.6	6.9	1.70	5.8	-	20	21	<2	0.032	0.034	<0.005	28	0.045	4	11	8	-	-	1.5	4	48	0.08	<10	0.08
	SB02_5.75	9/03/2016	CLAY: grey, high plasticity, saturated	Extreme	8.7	7	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB02_6.0	9/03/2016	CLAY: grey, high plasticity, saturated	Extreme	8.5	6.8	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB03/MW01	SB03_0.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	6.2	4.2	2.00	5.7	-	8	103	95	0.013	0.165	0.152	<5	0.008	1	<5	<5	-	-	1.5	1	13	0.02	66	0.02
	SB03_0.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5.8	4.3	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_0.5	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5.1	4.2	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_0.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	4.9	4	0.90	6.3	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	6	0.009	1	6	<5	-	-	1.5	1	<10	<0.02	<10	<0.02
	SB03_1.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5	4	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_1.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5.3	4.3	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_1.5	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.5	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_1.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5.6	4.5	1.10	6.5	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB03_2.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	6.5	5.1	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_2.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	7.2	5.6	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_2.50	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	7.2	5.1	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_2.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	7.1	5.2	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_3.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	6.9	4.6	2.30	6.8	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.008	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB03_3.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.3	4.7	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_3.50	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.5	4.9	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_3.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.4	4.6	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_4.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.3	4.4	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_4.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.3	4.8	2.50	6.6	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.008	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB03_4.50	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.3	4.5	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_4.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.4	4.4	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_5.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.4	4	3.40	7	-	<2	<2	<2	<0.005	<0.005	<0.005	11	0.017	1	10	<5	-	-	1.5	<1	11	0.02	<10	<0.02
	SB03_5.25	9/03/2016	SAND: brown, fine grained, subangular, well sorted, wet	Moderate	7.3	4.4	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_5.50	9/03/2016	SAND: brown, fine grained, subangular, well sorted, wet	Moderate	6.8	3	3.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_5.75	9/03/2016	SAND: brown, fine grained, subangular, well sorted, wet	Moderate	6.9	3.3	3.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB03_6.0	9/03/2016	SAND: brown, fine grained, subangular, well sorted, wet	Moderate	6.3	2.9	3.40	5.9	0.008	3	7	4	0.006	0.011	0.006	13	0.021	1	<5	<5	-	-	1.5	1	16	0.03	<10	0.03
SB04/MW02	SB04_0.0	9/03/2016	SAND: grey, fine grained, subangular, moderate to well sorted, dry	Moderate	5.5	4.4	1.10	5.5	-	8	129	121	0.013	0.207	0.194	<5	<0.005	1	<5	<5	-	-	1.5	1	11	0.02	<10	0.02
	SB04_0.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5.1	4.1	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_0.5	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.6	4.6	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_0.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.3	5	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_1.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.1	4.8	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_1.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.2	4.6	0.60	6.2	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	35	<0.02
	SB04_1.5	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.2	4.4	0.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_1.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	4.7	4	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_2.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5	4.3	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_2.25	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Slight	4.7	3.8	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_2.5	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Slight	4.7	3.8	0.90	6.8	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	69	<0.02
	SB04_2.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Slight	5	4.1	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_3.0	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Slight	4.9	3.6	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_3.25	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Moderate	5	3.6	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_3.50	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Moderate	4.9	3.4	1.50	5.7	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	272	<0.02
	SB04_3.75	9/03/2016	SAND: brown, fine grained, well sorted, wet	Moderate	4.6	2.9	1.70	5.9	<0.005	7	50	43	0.011	0.08	0.069	13	0.02	1	<5	<5	-	-	1.5	1	20	0.03	41	0.03
	SB04_4.0	9/03/2016	SAND: brown, fine grained, well sorted, wet	Slight	4.8	2.6	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_4.25	9/03/2016	SAND: brown, fine grained, well sorted, wet	Moderate	5.2	2.8	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_4.50	9/03/2016	SAND: brown, fine grained, well sorted, wet	Moderate	5.5	2.8	2.70	5.6	<0.005	8	26	18	0.013	0.041	0.028	14	0.022	2	<5	<5	-	-	1.5	2	22	0.03	<10	0.03
	SB04_4.75	9/03/2016	SAND: brown, fine grained, well sorted, wet	Moderate	5.4	2.7	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_5.0	9/03/2016	SAND: brown, fine grained, well sorted, wet	Moderate	5.4	2.7	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_5.25	9/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	5.3	2.8	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_5.50	9/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	5.3	2.7	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB04_5.75	9/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	5.3	2.8	2.50	6.6	-	<2	18	18	<0.005	0.028	0.028	8	0.014	1	<5	<5	-	-	1.5	1	<10	<0.02	<10	0.02
	SB04_6.0	9/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	5.4	2.7	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SB05/MW03	SB05_0.0	9/03/2016	SAND: grey, fine grained, subangular, moderate to well sorted, dry	Moderate	6.9	4.7	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SB05_0.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	6.6	4.7	1.90	7.5	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	5	0.008	<1	7	<5	-	-	1.5	<1	<10	<0.02	48	<0.02

Table 1. Results summary table field pH, suspension peroxide oxidisable combined acidity and sulfur (SPOCAS)

					Field			SPOCAS																			
					pH (Field)	pH (fox)	Difference in pH(Field) and pH(fox)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	Sulfidic - Titratable Actual Acidity (TAA)	Sulfidic - Titratable Peroxide Acidity (TPA)	Sulfidic - Titratable Sulfidic Acidity (TSA)	Acidity - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	Liming Rate excluding ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Sulfidic - Excess Acid Neutralising Capacity	Acidity - Excess Acid Neutralising Capacity	ANC Fineness Factor	Liming Rate	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	Net Acidity (acidity units)	Net Acidity (sulfur units)
					pH_Units	pH_Units		pH_Units	%	H+/t	H+/t	H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	% S	mole H+/t	-	kg CaCO3/t	mole H+/t	% S	mole H+/t	% S
				EQL	0.1	0.1		0.1	0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	0.02	10	0.5	1	10	0.02	10	0.02
					<4	<3			0.1	62	62	62	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-	-	62	0.1	62	0.1
					4.0 - 5.5	3.0 - 4.0			0.06	36	36	36	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-	-	36	0.06	36	0.06
					>7	>5	>2[1]		0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-	-	18	0.03	18	0.03
Location	**Sample ID (inc**	**Sampled Date**	**Soil Description**	**Reaction Rate**																							
	SB05_0.50	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	6.5	5.1	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_0.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.2	5.3	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_1.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.2	5.2	2.00	7	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<0.005	<5	-	-	1.5	<1	<10	<0.02	13	<0.02
	SB05_1.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.2	5.2	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_1.50	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.4	5.2	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_1.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.3	5.1	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_2.0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.2	5	2.20	7.1	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB05_2.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	6.9	4.6	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_2.50	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Moderate	6.6	3.1	3.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_2.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Moderate	6.5	2.7	3.80	6.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB05_3.0	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	1.9	4.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_3.25	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.8	2.7	4.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_3.50	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.8	2.4	4.40	7	-	<2	<2	<2	<0.005	<0.005	<0.005	5	0.009	<1	<0.005	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB05_3.75	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.9	2.2	4.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_4.0	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.6	2	4.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_4.25	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	1.8	4.70	6.8	0.019	<2	6	6	<0.005	0.009	0.009	19	0.03	1	<5	<5	-	-	1.5	1	19	0.03	11	0.02
	SB05_4.50	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.6	1.9	4.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_4.75	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Strong	6.4	1.6	4.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_5.0	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Strong	6.4	1.6	4.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_5.25	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Strong	6.4	1.6	4.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_5.50	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Strong	6.4	1.6	4.80	6.8	-	<2	32	32	<0.005	0.052	0.052	53	0.085	4	<5	<5	-	-	1.5	3	53	0.09	<10	0.06
	SB05_5.75	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.3	1.7	4.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB05_6.0	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	1.5	4.90	6.5	-	<2	30	30	<0.005	0.048	0.048	43	0.069	3	<5	<5	-	-	1.5	3	43	0.07	<10	0.05
SB09/MW08	SB06_0.0	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	5.2	3	2.20	5.2	-	24	294	270	0.039	0.472	0.433	21	0.033	3	17	<5	-	-	1.5	3	45	0.07	15	0.07
	SB06_0.25	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	5.1	2.7	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_0.50	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	5	2.6	2.40	5.4	<0.005	8	78	70	0.013	0.125	0.112	15	0.025	2	<5	<5	-	-	1.5	2	24	0.04	<10	0.04
	SB06_0.75	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	4.7	2.7	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_1.0	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	5.7	3	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_1.25	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	5.5	3	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_1.50	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Slight	5.5	3	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_1.75	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Slight	4.9	2.9	2.00	5.6	-	8	165	157	0.013	0.264	0.251	42	0.068	4	<5	<5	-	-	1.5	4	51	0.08	<10	0.08
	SB06_2.0	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Slight	5.2	2.9	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_2.25	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.7	3.2	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_2.50	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.7	3.1	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_2.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.4	2.8	2.60	5.7	-	8	165	157	0.013	0.264	0.251	13	0.02	1	<5	<5	-	-	1.5	1	16	0.03	<10	0.03
	SB06_3.0	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.4	2.8	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_3.25	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.4	2.7	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_3.50	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.6	2.7	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_3.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.5	2.8	2.70	5.8	-	3	13	9	0.006	0.021	0.015	<5	0.006	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB06_4.0	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.4	2.8	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_4.25	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	6.1	2.2	3.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_4.50	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.8	2.2	3.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_4.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.6	2.1	3.50	6.5	-	<2	<2	<2	<0.005	<0.005	<0.005	6	0.01	<1	<5	<5	-	-	1.5	<1	<10	<0.02	39	<0.02
	SB06_5.0	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.7	1.9	3.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_5.25	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.9	1.9	4.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_5.50	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.5	1.9	3.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB06_5.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.6	2.1	3.50	6.4	-	<2	<2	<2	<0.005	<0.005	<0.005	21	0.033	2	<5	<5	-	-	1.5	2	22	0.04	51	0.04
	SB06_6.0	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	5.4	1.8	3.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SB07/MW07	SB07_0.0	10/03/2016	Silty SAND: dark brown, fine grained, subangular, moderately sorted, moist	Moderate	6	4.1	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_0.25	10/03/2016	Silty SAND: light grey, fine grained, subangular, moderately sorted, moist	Moderate	6.1	4.4	1.70	5.8	<0.005	16	105	89	0.026	0.168	0.142	50	0.08	5	<5	<5	-	-	1.5	5	66	0.11	16	0.11
	SB07_0.50	10/03/2016	Silty SAND: light grey, fine grained, subangular, moderately sorted, moist	Moderate	6.1	4.5	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_0.75	10/03/2016	Silty SAND: light grey, fine grained, subangular, moderately sorted, moist	Moderate	6.2	4.6	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_1.0	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	6.8	4.6	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_1.25	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	6.7	4.6	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_1.50	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Moderate	7.3	5.2	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_1.75	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	7.4	5.8	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_2.0	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Slight	6.6	4.4	2.20	6.2	0.01	3	<2	<2	0.006	<0.005	<0.005	35	0.057	3	8	<5	-	-	1.5	3	39	0.06	<10	0.06
	SB07_2.25	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Slight	6.2	3.6	2.60	6.1	-	<2	<2	<2	<0.005	<0.005	<0.005	13	0.022	1	8	<5	-	-	1.5	1	15	0.02	<10	0.02
	SB07_2.5	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	4.1	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_2.75	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.2	3.6	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_3.0	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.1	2.4	3.70	6.4	-	<2	<2	<2	<0.005	<0.005	<0.005	15	0.025	1	<5	<5	-	-	1.5	1	17	0.03	22	0.03
	SB07_3.25	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.3	3.5	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_3.50	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.3	3.5	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_3.75	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.3	2.1	4.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_4.0	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.3	2.1	4.20	6.1	-	3	2	<2	0.006	<0.005	<0.005	21	0.033	2	<5	<5	-	-	1.5	2	24	0.04	17	0.04
	SB07_4.25	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	2	4.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_4.50	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	2	4.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_4.75	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	2.8	3.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_5.0	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	2	4.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_5.25	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	2	4.50	6	-	2	25	23	<0.005	0.041	0.037	32	0.052	3	<5	<5	-	-	1.5	3	34	0.06	24	0.06
	SB07_5.50	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	1.8	4.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_5.75	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	1.9	4.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB07_6.0	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	1.8	4.60	5.9	-	<2	28	26	<0.005	0.044	0.042	36	0.058	3	<5	<5	-	1.8	<0.5	1.5	3	37	0.06	34	0.06
SB08	SB08_0.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Moderate	5.3	4.2	1.10	6.5	-	<2	76	76	<0.005	0.121	0.121	<5	0.008	<1	6	<5	-	-	1.5	4	<10	<0.02	52	0.08
	SB08_0.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.2	4.8	0.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_0.5	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.3	5	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_0.75	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.8	5.3	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_1.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	4.9	4.5	0.40	5.8	<0.005	2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB08_1.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.3	5.2	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_1.5	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.3	5.2	0.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_2.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.5	5.4	0.10	6.1	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB08_2.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.6	5.3	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_2.50	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.9	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_2.75	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	5.2	0.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_3.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.5	5.1	0.40	6	-	2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB08_3.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.3	4.8	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_3.50	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.9	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_3.75	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.5	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_4.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.4	1.00	5.6	-	3	<2	<2	0.006	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	36	<0.02
	SB08_4.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.3	4.8	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_4.50	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.1	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_4.75	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.6	4.1	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_5.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.9	4.3	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_5.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.8	3.8	2.00	5.6	<0.005	<2	4	3	<0.005	0.007	0.006	6	0.01	1	<5	<5	-	-	1.5	1	<10	<0.02	10	<0.02
	SB08_5.50	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Moderate	5.8	3.4	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_5.75	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.8	4.8	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB08_6.0	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.9	3.8	2.10	5.6	-	2	4	2	<0.005	0.007	<0.005	13	0.021	1	7	<5	-	-	1.5	1	15	0.02	<10	0.02
SB09/MW10	SB09_0.0	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	4.9	4.2	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB09_0.25	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	4.6	3.8	0.80	4.9	-	29	309	280	0.046	0.496	0.45	7	0.011	3	13	<5	-	-	1.5	3	36	0.06	<10	0.06
	SB09_0.5	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	4.8	3.8	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB09_0.75	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	4.6	3.8	0.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SB09_1.0	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	4.3	3.5	0.80	4.9	<0.005	26	201	174	0.042	0.322	0.28	<5	<0.005	2	<5	<5	-	-	1.5	2	30	0.05	<10	0.05
	SB09_1.25	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	4.7	3.7	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 1. Results summary table field pH, suspension peroxide oxidisable combined acidity and sulfur (SPOCAS)

					Field			SPOCAS																				
					pH (Field)	pH (fox)	Difference in pH(Field) and pH(fox)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	Sulfidic - Titratable Actual Acidity (TAA)	Sulfidic - Titratable Peroxide Acidity (TPA)	Sulfidic - Titratable Sulfidic Acidity (TSA)	Acidity - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	Liming Rate excluding ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Sulfidic - Excess Acid Neutralising Capacity	Acidity - Excess Acid Neutralising Capacity	ANC Fineness Factor	Liming Rate	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	Net Acidity (acidity units)	Net Acidity (sulfur units)
					pH_Units	pH_Units		pH_Units	%	H+/t	H+/t	H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	% S	mole H+/t	-	kg CaCO3/t	mole H+/t	% S	mole H+/t	% S
				EQL	0.1	0.1		0.1	0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	0.02	10	0.5	1	10	0.02	10	0.02
					<4	<3			0.1	62	62	62	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-	-	62	0.1	62	0.1
					4.0 - 5.5	3.0 - 4.0			0.06	36	36	36	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-	-	36	0.06	36	0.06
					>7	>5			0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-	-	18	0.03	18	0.03
Location	**Sample ID (inc**	**Sampled Date**	**Soil Description**	**Reaction Rate**																								
	SB09_1.5	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Moderate	4.9	3.8	1.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_2.0	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Slight	5	4	1.00	5.2	-	7	106	99	0.011	0.17	0.158	<5	0.005	1	<5	<5	-	-	1.5	1	10	0.02	<10	0.02
	SB09_2.25	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Moderate	4.6	3.5	1.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_2.50	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.6	3.6	1.00	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_2.75	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.5	3.9	0.60	5.4	-	2	28	26	<0.005	0.045	0.041	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB09_3.0	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.4	3.7	0.70	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_3.25	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.6	3.2	1.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_3.50	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.7	3.3	1.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_3.75	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.9	4	0.90	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_4.0	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5	3.7	1.30	5.4	-	5	<2	<2	0.007	<0.005	<0.005	<5	<0.005	1	<5	<5	-	-	1.5	1	<10	<0.02	<10	<0.02
	SB09_4.25	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.1	3.4	1.70	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_4.50	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.2	3.1	2.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_4.75	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5	3.6	1.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_5.0	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.8	3.8	1.00	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_5.25	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.8	4	0.80	5.4	<0.005	3	38	35	0.006	0.061	0.056	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB09_5.50	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.8	3.7	1.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_5.75	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5	3.9	1.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB09_6.0	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.1	3.9	1.20	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
SB10/MW10	SB10_0.0	10/03/2016	Silty SAND: grey, fine grained, subangular, moderately sorted , dry	Slight	5.7	4.7	1.00	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_0.25	10/03/2016	Silty SAND: grey, fine grained, subangular, well sorted , dry	Slight	5.8	4.6	1.20	5.9	<0.005	<2	60	58	<0.005	0.095	0.094	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB10_0.5	10/03/2016	Silty SAND: grey, fine grained, subangular, well sorted , dry	Slight	6	4.6	1.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_0.75	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.8	4.5	1.30	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_1.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.3	5.1	0.20	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_1.25	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.5	4.9	0.60	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_1.5	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.6	4.9	0.70	5.8	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	34	<0.02
	SB10_2.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.3	4.9	0.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_2.25	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.4	4.9	0.50	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_2.50	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.3	4.9	0.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_2.75	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.3	5.1	0.20	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_3.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.4	5.2	0.20	5.8	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	45	<0.02
	SB10_3.25	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.3	5.1	0.20	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_3.50	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.3	5	0.30	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_3.75	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.1	5.2	-0.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_4.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5	5	0.00	5.7	-	2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	15	<0.02
	SB10_4.25	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	6.7	4.9	1.80	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_4.50	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.2	4.8	1.40	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_4.75	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.1	5.2	0.90	5.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	37	<0.02
	SB10_5.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.4	4.7	1.70	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_5.25	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.1	4.8	1.30	5.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	15	<0.02
	SB10_5.50	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	5.7	4.9	0.80	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
	SB10_5.75	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Moderate	6.3	4.9	1.40	5.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
	SB10_6.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.1	5	1.10	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	

Notes

1 Field results asessment criteria adopted from Department of Environment and Conservation (2015), *Identification and investigation of acid sulfate soils and acidic landscapes*

2 The lower the final pHFOX value, the better the indication of a positive result for potential acid sulfate soils (PASS), *i.e.* a 1 unit pH change from pH 8 to 7 does not indicate PASS but a 1 unit change from pH 3.5 to 2.5 would be indicative of PASS)

Difference in pH and pH (FOX)

Comments

The following field pH test performance criteria are based on the DER's Identification and investigation of acid sulfate soils and acidic landscapes (2015)

pHF<4	*Actual acid sulfate soils (AASS) indicating oxidation of sulfides*
pH F(4-5.5) 5.5	*An acid soil*
pHF>7	*Expected in water logged, unoxidised, or poorly drained soils*
pHFOX<3	*Strong indication for PASS - potential for the soil to produce sulfidic acid upon oxidation*
pHFOX (3-4)	*Borderline result, sulfides may be present but organic matter may be present as well. Laboratory analysis recommended for verfication*
pHFOX>5	*Little net acidifying ability. Laboratory analysis recommended for verification*
	Net acidity action criteria for medium to heavy clays and silty clays
	Net acidity action criteria for medium texutre sandy loams to light clays
	Net acidity action criteria for coarse texture sands to loamy sands

Table 2. Results summary table (Golder\: oxH. susoension oeroxide oxidisable combined acidity and sulfur (SPOCAS)

						pH (Field)	pH (Lab)	Difference in pH(field) and pH(lab)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	sHCl-: Titratable Actual Acidity (TAA)	sHCl-: Titratable Peroxide Acidity (TPA)	sHCl-: Titratable Sulfidic Acidity (TSA)	Acidity - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	Liming Rate-sHCl Acidity ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Acidity - Excess Acid Neutralising Capacity	sHCl-: Excess Acid Neutralising Capacity	Acidity - Excess Acid Neutralising Capacity	ANC Fineness Factor	Liming Rate	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	Net Acidity (acidity units)	Net Acidity (sulfur units)
						pH_Units	pH_Units		pH_Units	%S	H+/t	H+/t	H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	mole H+/t	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	%S	mole H+/t	%S
						0.1	0.1		0.1	0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	10	0.02	10	0.5	1	10	0.02	10	0.02
						<4	<3		-	0.1	64.8	64.8	64.8	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-		62	0.1	62	0.1
						4.0 - 5.5	3.0 - 4.0		-	0.06	37.4	37.4	37.4	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-		36	0.06	36	0.06
						>7	>5	>2	-	0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-		18	0.03	18	0.03
Sample ID	**Sampled Date**	**Sample Depth**	**Generalised Soil Description**	**Reaction Rate**																											
ASS HA07-1	12/06/2014	0.20	TOPSOIL: SAND fine to medium grained, brown, trace/some silt, trace organics (grass roots up to 2 mm diameter)	Slight	5.4	3.4	2.00	5.6	<0.005	10	10	<2	0.016	0.017	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	10	<0.02	10	<0.02
ASS HA07-2	12/06/2014	0.40	SAND: fine to medium grained, quartz, grey, trace fines	Slight	5.7	4.1	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS HA07-3	12/06/2014	0.80	SAND: fine to medium grained, quartz, pale grey	Slight	5.5	5	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS HA07-4	12/06/2014	1.00	SAND: fine to medium grained, quartz, pale grey	Slight	5.9	4.9	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS HA07-5	12/06/2014	1.10	SAND: fine to medium grained, quartz, pale grey	Slight	6.1	5.1	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS HA07-6	12/06/2014	1.80	SAND: fine to medium grained, quartz, pale grey	Slight	6.5	5.9	0.60	6.1	-	<2	6	6	<0.005	0.009	0.009	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS HA07-7	12/06/2014	2.30	SAND: fine to medium grained, quartz, pale grey	Slight	6.2	5.3	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS HA07-8	12/06/2014	2.80	SAND: fine to medium grained, quartz, pale grey	Slight	6.4	5.2	1.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T01-1	18/06/2014	0.15	TOPSOIL: SAND fine to medium grained, dark brown, with some low plasticity silt, trace organics, trace grass roots (1 mm diameter)	Moderate	7.4	5.5	1.90	6.5	-	<2	8	8	<0.005	0.014	0.014	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T01-2	18/06/2014	0.55	SAND: fine to medium grained, pale grey	Slight	6.7	5.4	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T01-3	18/06/2014	0.80	SAND: fine to medium grained, light grey/brown	Slight	6.9	5.3	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T01-4	18/06/2014	1.05	SAND: fine to medium grained, light grey/brown	Slight	6.2	4.8	1.40	5.9	<0.005	<2	8	8	<0.005	0.014	0.014	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T01-5	18/06/2014	1.30	SAND: fine to medium grained, light grey/brown	Slight	6.5	5.2	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T01-6	18/06/2014	1.90	SAND: fine to medium grained, light grey/brown	Slight	7	5.2	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T01-7	18/06/2014	2.10	SAND: fine to medium grained, light grey/brown	Slight	7.1	5.3	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T02-1	18/06/2014	0.15	TOPSOIL: Silty SAND fine to medium grained, black, approximately 15%-20% non-plastic to low plasticity	Moderate	8.3	5.2	3.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T02-2	18/06/2014	0.55	SAND: fine to medium grained, grey	Slight	5.2	3.2	2.00	5.7	<0.005	2	3	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T02-3	18/06/2014	0.80	SAND: fine to medium grained, pale grey	Slight	7.1	5.2	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T02-4	18/06/2014	1.05	SAND: fine to medium grained, light grey/brown	Slight	7.1	5.2	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T02-5	18/06/2014	1.30	SAND: fine to medium grained, light grey/brown	Slight	5.6	3.1	2.50	5.8	-	<2	2	2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T02-6	18/06/2014	1.50	SAND: fine to medium grained, light grey/brown	Moderate	5.7	4.2	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T03-1	18/06/2014	0.15	TOPSOIL: Silty SAND fine to medium grained, black, approximately15%-20% low plasticity silt, trace gr	Slight	5.5	2.5	3.00	5.3	<0.005	33	955	921	0.053	1.53	1.48	57	0.092	7	12	<5	-	-	1.5	7	90	0.14	90	0.14
ASS T03-2	18/06/2014	0.55	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale grey	Slight	7.2	5.4	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T03-3	18/06/2014	0.80	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale grey	Slight	7	5.4	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T03-4	18/06/2014	1.05	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale grey	Moderate	6.8	3.3	3.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T05-1	17/06/2014	0.30	TOPSOIL: SAND fine to medium grained, yellow brown, trace fines, trace grass roots (1 mm diameter), trace rootlets	Slight	6.9	3.9	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T05-2	17/06/2014	0.50	SAND: fine to medium grained, pale grey,	Slight	6.8	4.9	1.90	6.2	<0.005	2	6	4	<0.005	0.010	0.006	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T05-3	17/06/2014	0.80	SAND: fine to medium grained, pale grey,	Slight	6.7	4.8	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T05-4	17/06/2014	1.00	SAND: fine to medium grained, pale grey,	Slight	6.3	5.2	1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T05-5	17/06/2014	1.30	SAND: fine to medium grained, pale grey,	Slight	6.5	3.5	2.80	5.9	-	6	7	<2	0.009	0.012	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T09-1	19/06/2014	0.20	SAND: fine to medium grained, black to dark grey, approximately 10% silt fines , with organics, trace r	Moderate	6.3	3.9	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T09-2	19/06/2014	0.55	SAND: fine to medium grained, black to dark grey, approximately 10% silt fines	Moderate	6.2	3.7	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T09-3	19/06/2014	0.80	SAND: fine to medium grained, black to dark grey, approximately 10% silt fines	Moderate	6	3.5	2.50	6	<0.005	5	5	<2	0.008	0.008	<0.005	24	0.039	2	<5	<5	-	-	1.5	2	29	0.05	29	0.05
ASS T10-1	18/06/2014	0.20	TOPSOIL: SAND fine to medium grained, black, trace silt,	Moderate	5.2	3.5	2.00	4.5	-	48	457	409	0.077	0.733	0.656	<5	<0.005	4	11	<5	-	-	1.5	4	48	0.08	48	0.08
ASS T10-2	18/06/2014	0.55	SAND: fine to medium grained, grey, trace grass roots (3 mm diameter)	Slight	4.7	3.2	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T10-3	18/06/2014	0.80		Slight	4.9	3.7	1.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T10-4	18/06/2014	1.10	SAND: fine to medium grained, pale grey, trace grass roots (3 mm diameter)	Slight	5.4	3.8	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T10-5	18/06/2014	1.30	SAND: fine to medium grained, pale grey/brown, trace grass roots (3 mm diameter),	Slight	4.7	3.8	1.90	5.6	<0.005	7	26	19	0.011	0.042	0.031	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T10-6	18/06/2014	1.80	SAND: fine to medium grained, pale grey/brown, trace grass roots (3 mm diameter),	Slight	5.2	3.8	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T10-7	18/06/2014	2.20	SAND: fine to medium grained, pale grey/brown, trace grass roots (3 mm diameter),	Slight	4.9	3.6	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T13-1	19/06/2014	0.10	TOPSOIL: SAND fine to medium grained, grey, trace/some silt, trace organics, tracer- grass roots (1 mm diameter)	Moderate	5	2.7	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T13-2	19/06/2014	0.55	SAND: fine to medium grained, pale grey, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter) . roots extend down to about 1200 mm	Slight	5.3	3.1	2.20	5.5	-	4	5	<2	0.006	0.007	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T13-3	19/06/2014	0.80	SAND: fine to medium grained, pale grey, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter)	Slight	5.2	4.1	1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T13-4	19/06/2014	1.05		Slight	5.3	4.6	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T13-5	19/06/2014	1.30	SAND: fine to medium grained, white, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter)	Slight	5.2	2.4	2.80	5.9	<0.005	<2	6	6	<0.005	0.010	0.010	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T13-6	19/06/2014	1.60	SAND: fine to medium grained, white, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter)	Slight	6.1	4.8	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T14-1	19/06/2014	0.20	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trac	Moderate	5.8	3.3	2.50	4.7	-	75	966	891	0.120	1.55	1.43	16	0.026	7	14	<5	-	-	1.5	7	91	0.14	91	0.14
ASS T14-2	19/06/2014	0.55	SAND: fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend down to about 1100 mm	Slight	5.4	4	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T14-3	19/06/2014	0.80	SAND: fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend down to	Slight	5.8	4.6	1.20	5.9	<0.005	<2	3	3	<0.005	0.005	0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T14-4	19/06/2014	1.05	SAND: fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend down to	Slight	5.4	4.5	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T14-5	19/06/2014	1.30	SAND: fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend down to	Slight	5.2	3.7	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2. Results summary table (Golder\: pH. susoension peroxide oxidisable combined acidity and sulfur (SPOCAS)

Sample ID	Sampled Date	Sample Depth	Generalised Soil Description	Reaction Rate	pH (Field)	pH (Ox)	Difference in pH(field) and pH(Ox)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	sHCl-: Titratable Actual Acidity (TAA)	sHCl-: Titratable Peroxide Acidity (TPA)	sHCl-: Titratable Sulfidic Acidity (TSA)	Skeldy - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	1moj Bore eluding ANC	Skeldy - Acid Reacted Calcium	Skeldy - Acid Reacted Magnesium	Skeldy - Excess Acid Neutralising Capacity	sHCl-: Excess Acid Neutralising Capacity	Skeldy - Excess Acid Neutralising Capacity	ANC Fineness Factor	1moj Base	NetAcidityexcluding ANC (skeldy units)	NetAcidityexcluding ANC (sulfur units)	NetAcidity (skeldy units)	NetAcidity (sulfur units)
					pH_Units	pH_Units		pH_Units	%S	mole H+/t	mole H+/t	mole H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	mole H+/t	%S	mole H+/t	-	kg CaCO3/t	mole H+/t	%S	mole H+/t	%S
					0.1	0.1	1		0.1	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	10	0.03	10	0.5	1	10	0.02	10	0.02
					<4	<3		-	0.1	64.8	64.8	64.8	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-		62	0.1	62	0.1
					4.0 - 5.5	3.0 - 4.0		-	0.06	37.4	37.4	37.4	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-		36	0.06	36	0.06
					>7	>5	>2	-	0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-		18	0.03	18	0.03
ASS T15-1	19/06/2014	0.10	TOPSOIL: SAND fine to medium grained, black, trace silt, trace grass roots (2 mm diameter), trace shell	Moderate	5.3	2.7	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T15-2	19/06/2014	0.50	SAND fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1000 mm depth	Slight	5.6	4.2	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T15-3	19/06/2014	0.80	SAND fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1000 mm depth	Slight	5.4	4.2	1.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T15-4	19/06/2014	1.05	SAND fine to medium grained, pale erew, trace fines	Slight	5.6	4.2	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T15-5	19/06/2014	1.30	SAND fine to medium grained, white, trace fines	Slight	5.2	4.7	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T15-6	19/06/2014	1.60	SAND fine to medium grained, brown, trace fines	Slight	5.3	4.2	1.10	5.8	-	3	4	<2	0.005	0.006	<0.005	<5	-	<1	131	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T15-7	19/06/2014	2.30	SAND fine to medium grained, brown, trace fines	Moderate	5.8	3.3	2.50	5.6	<0.005	8	18	10	0.013	0.028	0.015	14	-	2	<5	<5	-	-	1.5	2	22	0.04	22	0.04
ASS T17-1	19/06/2014	0.20	TOPSOIL: SAND fine to medium grained, grey-brown, trace/some silt,	Strong	6.1	2.6	3.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T17-2	19/06/2014	0.55	SAND: fine to medium grained, yellow, trace fines, trace grass roots (2 mm diameter)	Moderate	6.4	3.6	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T17-3	19/06/2014	0.80	SAND: fine to medium grained, yellow, trace fines,	Moderate	6.7	5	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T17-4	19/06/2014	1.05		Slight	6.7	4.2	2.50	5.8	-	2	19	17	<0.005	0.031	0.027	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T17-5	19/06/2014	1.30	SAND: fine to medium grained. yellow. trace fines	Slight	6.7	4.9	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T17-6	19/06/2014	1.80		Slight	7	5	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T17-7	19/06/2014	2.30		Slight	6.7	4.8	1.90	6	<0.005	<2	6	6	<0.005	0.010	0.010	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T24-1	19/06/2014	0.10	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trac	Moderate	6	3.7	2.30	6.6	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	34	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T24-2	19/06/2014	0.50	SAND: fine to medium grained, pale grey, trace silt,	Slight	5.4	3.3	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T24-3	19/06/2014	0.80	SAND: fine to medium grained, pale grey, trace silt,	Slight	5.1	3.6	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T24-4	19/06/2014	1.05	SAND: fine to medium grained, white, trace silt	Slight	5.2	4.2	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T24-5	19/06/2014	1.30		Slight	5.6	4.6	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T24-6	19/06/2014	1.90		Slight	5.8	4	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T24-7	19/06/2014	2.30		Slight	5.5	3.7	1.80	5.8	<0.005	<2	4	4	<0.005	0.007	0.007	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T31-1	16/06/2014	0.30	ORGANIC CLAY / SILT: high plasticity, black, trace fine grained sand, with organics, trace grass roots (1	Strong	5.3	2.3	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T31-2	16/06/2014	0.55	Silty CLAY / Clayey SILT high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace eras roots (1 mm diameter)	Strong	6.5	3.6	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T31-3	16/06/2014	0.80	Silty CLAY / Clayey SILT high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter)	Moderate	7.4	5	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T31-4	16/06/2014	1.05		Strong	7.3	3.1	4.20	5.5	-	14	16	<2	0.022	0.025	<0.005	26	0.042	3	<5	<5	-	-	1.5	3	40	0.06	40	0.06
ASS T31-5	16/06/2014	1.30	CLAY high plasticity. brown. trace fine grained sand	Moderate	8	6	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T31-6	16/06/2014	1.80		Moderate	8.2	5.9	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T31-7	16/06/2014	2.30		Moderate	8.3	6.1	2.20	5.4	-	17	24	7	0.027	0.038	0.011	24	0.038	3	<5	6	-	-	1.5	3	41	0.06	41	0.06
ASS T32-1	16/06/2014	0.30	Peaty CLAY / CLAY high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	Strong	5.3	2.2	3.10	4.9	0.019	96	689	593	0.153	1.10	0.951	186	0.298	21	<5	<5	-	-	1.5	21	281	0.45	281	0.45
ASS T32-2	16/06/2014	0.55	Silty CLAY high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace eras roots (1 mm diameter)	Moderate	7.6	5.1	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T32-3	16/06/2014	0.80		Moderate	7.8	5.6	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T32-4	16/06/2014	1.05		Moderate	8	5.8	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T32-5	16/06/2014	1.30	CLAY high plasticity, brown, trace fine grained sand	Slight	8.1	6	2.10	5.8	-	10	15	6	0.016	0.024	0.009	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T32-6	16/06/2014	1.80		Slight	8.2	6.2	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T32-7	16/06/2014	2.30		Slight	8.3	6.1	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T34-1	16/06/2014	0.30	Silty CLAY: low plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace	Strong	6.7	4.9	1.80	5.5	<0.005	14	15	<2	0.023	0.024	<0.005	<5	<0.005	1	<5	<5	-	-	1.5	1	14	0.02	14	0.02
ASS T34-2	16/06/2014	0.70	CEMENTED SAND: fine to medium grained, dark brown and black, with some low plasticity silt, weakly	Strong	6.2	4.6	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T34-3	16/06/2014	0.90		Strong	6.4	4.3	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T34-4	16/06/2014	1.00		Strong	6.6	4.8	1.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T35-1	16/06/2014	0.30	SAND: fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1200 mm depth	Moderate	5.1	4.8	0.30	5.5	-	9	10	<2	0.014	0.016	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T35-2	16/06/2014	0.55		Moderate	5.2	4.2	1.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T35-3	16/06/2014	0.80		Moderate	5.1	3.8	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T35-4	16/06/2014	1.05		Moderate	5.1	4	1.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T35-5	16/06/2014	1.30	SAND: fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter)	Moderate	4.9	4.2	0.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T35-6	16/06/2014	1.60		Moderate	5	3.6	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T35-7	16/06/2014	2.20	SAND: fine to medium grained. white, trace fines, trace eras roots (2 mm diameter)	Moderate	5.3	4.1	1.20	5.5	<0.005	6	7	<2	0.010	0.012	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T36-1	16/06/2014	0.30	Interbedded ORGANIC CLAY and Clayey SAND: trace grass roots (2 mm diameter), approx 50% Clayey Sand and 50% Peaty Clay, clay is: high plasticity, black, trace fine grained sand, sand is: fine to medium grained, black and white, approx 40%-50% high plasticity clay	Moderate	5.4	3.2	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T36-2	16/06/2014	0.55		Moderate	5.4	3.3	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T36-3	16/06/2014	0.80	SAND: fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1000 mm depth	Moderate	5	3.7	1.30	5.7	-	5	5	<2	0.008	0.008	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T36-4	16/06/2014	1.05		Moderate	5.1	3.8	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T36-6	16/06/2014	1.60		Moderate	5.7	3.1	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T36-7	16/06/2014	2.30		Moderate	6	2.9	3.10	5.6	<0.005	3	7	4	<0.005	0.011	0.006	13	0.02	1	<5	<5	-	-	1.5	1	16	0.02	16	0.02
ASS T38-1	16/06/2014	0.30	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	Strong	6.1	3.5	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T38-2	16/06/2014	0.55	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace	Moderate	6.8	4.4	2.40	6.2	-	6	6	<2	0.010	0.010	<0.005	39	0.062	3	<5	<5	-	-	1.5	3	45	0.07	45	0.07
ASS T38-3	16/06/2014	0.80	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, pale brown, trace fines	Slight	6.7	5.2	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T38-4	16/06/2014	1.05	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, brown, trace fines	Slight	6.8	5.1	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T38-5	16/06/2014	1.30	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, brown, trace fines	Moderate	6.8	3.9	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T38-6	16/06/2014	1.80	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, brown, trace fines	Strong	6.8	2.2	4.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T38-7	16/06/2014	2.00	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium grained, brown, trace fines	Strong	6.8	2.1	4.70	6	0.018	2	4	<2	<0.005	0.006	<0.005	28	0.044	2	<5	<5	-	-	1.5	2	30	0.05	30	0.05
ASS T43-1	16/06/2014	0.30	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (3 mm diameter)	Strong	5	1.8	3.20	4.8	-	82	497	415	0.131	0.796	0.666	120	0.192	15	<5	13	-	-	1.5	15	201	0.32	201	0.32
ASS T43-2	16/06/2014	0.55	Silty CLAY: high plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (1 mm diameter)	Strong	5.4	3.1	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T43-3	16/06/2014	0.80	Silty CLAY: high plasticity, grey white, trace fine grained sand, silt content decreasing with depth,	Moderate	5.3	3.4	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T43-4	16/06/2014	1.05	Silty CLAY: high plasticity, grey white, trace fine grained sand, silt content decreasing with depth,	Moderate	5.7	3.8	1.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T43-5	16/06/2014	1.30	CLAY: high plasticity. brown. trace fine grained sand	Moderate	6.5	5.2	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T43-6	16/06/2014	1.80	CLAY: high plasticity. brown. trace fine grained sand	Slight	7.7	6.4	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T43-7	16/06/2014	2.30	CLAY: high plasticity. brown. trace fine grained sand	Slight	7.8	6.1	1.70	6.1	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	6	0.009	<1	14	24	<0.020	<10	1.5	<1	<10	<0.02	<10	<0.02
ASS T47-1	17/06/2014	0.30	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand, with organics	Strong	6.9	3.3	3.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T47-2	17/06/2014	0.50	Clayey SILT: medium to high plasticity, dark grey, trace fine grained sand, trace grass roots	Strong	7.2	4.2	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T47-3	17/06/2014	0.80	Clayey SILT: medium to high plasticity, dark grey, trace fine grained sand, trace grass roots	Moderate	7.3	4.6	2.70	6	-	11	13	2	0.017	0.021	<0.005	27	0.043	3	<5	20	-	-	1.5	3	37	0.06	37	0.06
ASS T47-4	17/06/2014	1.00	Clayey SILT: medium to high plasticity, dark grey, trace fine grained sand, trace grass roots	Moderate	7.2	4.9	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T47-5	17/06/2014	1.30	SAND: fine to medium grained, pale grey and pale brown, trace fines	Slight	7.3	5	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T47-6	17/06/2014	1.80	SAND: fine to medium grained, pale grey and pale brown, trace fines	Slight	7.8	3.8	4.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T47-7	17/06/2014	2.40	SAND: fine to medium grained. pale grey and pale brown. trace fines	Moderate	7.5	3.3	4.20	6.3	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	18	0.028	1	18	26	-	-	1.5	1	18	0.03	18	0.03

Table 2. Results summary table (Golder\: pH. susoension peroxide oxidisable combined acidity and sulfur (SPOCAS)

						pH (Field)	pH (Lab)	Difference in pH(field) and pH(lab)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	sulfidic - Titratable Actual Acidity (TAA)	sulfidic - Titratable Peroxide Acidity (TPA)	sulfidic - Titratable Sulfidic Acidity (TSA)	Peroxide Oxidisable Sulfur	Liming Rate including ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Acidity - Excess Acid Neutralising Capacity	sulfidic - Excess Acid Neutralising Capacity	ANC Fineness Factor	Liming Rate	Net Acidity excluding ANC (lab/dry units)	Net Acidity excluding ANC (as-Sulfur units)	Net Acidity (lab/dry units)	Net Acidity (sulfur units)
						pH_Units	pH_Units		pH_Units	%	mole H+/t	mole H+/t	mole H+/t	%S	%S	%S	%S	kg CaCO3/t	mole H+/t	mole H+/t	mole H+/t	%S	mole H+/t		kg CaCO3/t	mole H+/t	%S	mole H+/t	%S
						0.1	0.1		0.1	0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	0.02	10	0.5	1	10	0.02	10	0.02
						<4	<3		-	0.1	64.8	64.8	64.8	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-		62	0.1	62	0.1
						4.0 - 5.5	3.0 - 4.0		-	0.06	37.4	37.4	37.4	0.06	0.06	0.06	38	0.06	-	38	38	0.06	38	-		38	0.06	38	0.06
						>7	>5	>2	-	0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-		18	0.03	18	0.03
Sample ID	**Sampled Date**	**Sample Depth**	**Generalised Soil Description**	**Reaction Rate**																										
ASS T49-1	17/06/2014	0.30	Clay: firm, medium to high plasticity, grey mottled sand, trace organics	Strong	6.3	3.7	2.60	5.7	-	25	26	<2	0.041	0.042	<0.005	43	0.068	5	<5	10	-	-	1.5	5	68	0.11	68	0.11
ASS T49-2	17/06/2014	0.55	Clayey SILT: high liquid limit, grey white, trace fine grained sand, trace organics	Strong	7.2	4.8	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T49-3	17/06/2014	0.80	SAND: fine to medium grained, dark grey, trace fine grained sand, with organics	Moderate	6.9	4.4	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T49-4	17/06/2014	1.00	SAND: fine to medium grained, pale grey, trace fines	Slight	6.4	4.9	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T49-5	17/06/2014	1.30	SAND: fine to medium grained, pale grey, trace fines	Slight	6.6	5.2	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T49-6	17/06/2014	1.90	SAND: fine to medium grained, pale grey, trace fines	Moderate	5.2	3.5	1.70	5.8	<0.005	<2	4	4	<0.005	0.006	0.006	<5	<0.005	<1	14	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T49-7	17/06/2014	2.20	SAND: fine to medium grained, pale grey, trace fines	Moderate	6.6	3.3	3.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T51-1	18/06/2014	0.30	TOPSOIL: Silty SAND / SAND: fine to medium grained, black, approximately 10%-20% low plasticity silt, trace organics, 20 mm thick brown lense at 100 mm depth	Strong	4.8	2.8	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T51-2	18/06/2014	0.55	SAND: fine to medium grained, grey, with some low plasticity silt, trace grass roots	Strong	4.6	2.3	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T51-3	18/06/2014	0.80	SAND: fine to medium grained, pale grey	Moderate	4.4	3.4	1.00	5.3	-	6	6	<2	0.01	0.01	<0.005	<5	<0.005	<1	5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T51-4	18/06/2014	1.05	SAND: fine to medium grained, pale grey	Moderate	4.1	3.5	0.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T51-5	18/06/2014	1.30	SAND: fine to medium grained, pale grey		4.4	3.5	0.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T51-6	18/06/2014	1.80	SAND: fine to medium grained, pale grey	Moderate	4.8	3	1.90	5.4	<0.005	6	6	<2	0.009	0.01	<0.005	<5	<0.005	<1	14	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T51-7	18/06/2014	2.30	SAND: fine to medium grained, pale grey	Moderate	6	2.3	3.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T52-1	17/06/2014	0.25	Silty CLAY: high plasticity, dark grey to black, trace fine grained sand	Strong	6.8	3.4	3.40	6	-	11	22	11	0.017	0.035	0.018	49	0.078	4	<5	<5	-	-	1.5	4	60	0.1	60	0.1
ASS T52-2	17/06/2014	0.55	Silty CLAY: high plasticity, dark brown, trace fine grained sand	Moderate	7	3.9	3.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T52-3	17/06/2014	0.85	Silty CLAY: high plasticity, dark grey to black, trace fine grained sand	Moderate	6.8	4	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T52-4	17/06/2014	1.10	SAND: fine to medium grained, pale grey to pale brown, trace fines	Slight	6.7	4.5	2.20	6	<0.005	<2	2	2	<0.005	<0.005	<0.005	<5	<0.005	<1	15	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T52-5	17/06/2014	1.40	Clayey SAND: fine to medium grained, pale grey to pale brown, approximately 20%-30% medium to high plasticity clay, with organics	Moderate	6.5	2.6	3.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T54-1	17/06/2014	0.30	Silty CLAY: medium to high plasticity, grey white, trace fine grained sand, silt content decreasing with depth	Strong	6.7	4.2	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T54-2	17/06/2014	0.55	Silty CLAY: medium to high plasticity, grey white, trace fine grained sand, silt content decreasing with	Moderate	7.1	4.9	2.20	6	-	<2	<2	<2	<0.005	<0.005	<0.005	10	0.015	<1	6	10	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T54-3	17/06/2014	0.80	Silty CLAY: medium to high plasticity, grey white, trace fine grained sand, silt content decreasing with	Moderate	7.2	5.2	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T54-4	17/06/2014	1.05	Silty CLAY: medium to high plasticity, grey white, trace fine grained sand, silt content decreasing with	Moderate	7.3	5.2	2.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T54-5	17/06/2014	1.80	CLAY: high elasticity, grey brown	Moderate	6.4	3.9	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T54-6	17/06/2014	2.00	SAND: fine to medium grained, pale grey	Slight	5.7	2.7	3.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T54-7	17/06/2014	2.40	SAND: fine to medium grained, pale grey	Slight	6.1	2.2	3.90	5.8	0.01	<2	18	18	<0.005	0.028	0.028	15	0.024	1	15	<5	-	-	1.5	1	15	0.02	15	0.02
ASS T55-1	16/06/2014	0.30	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	7.4	4.2	3.20	6.7	-	<2	186	186	<0.005	0.298	0.298	89	0.143	12	<5	13	-	-	1.5	12	154	0.25	154	0.25
ASS T55-2	16/06/2014	0.55	Silty CLAY: high plasticity, dark grey to black, trace fine grained sand, silt content decreasing with depth	Strong	7.4	4.7	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T55-3	16/06/2014	0.80	Silty CLAY: high plasticity, dark grey to black, trace fine grained sand, silt content decreasing with	Strong	8.1	4.9	3.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T55-4	16/06/2014	1.05	Silty CLAY: high plasticity, dark grey to black, trace fine grained sand, silt content decreasing with	Strong	8.3	5.8	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T55-5	16/06/2014	1.30	CLAY: high elasticity, brown, trace fine grained sand	Strong	8.2	6.1	2.10	6.9	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	16	0.025	1	<5	35	0.229	143	1.5	<1	16	0.02	<10	<0.02
ASS T55-6	16/06/2014	1.80	CLAY: high elasticity, brown, trace fine grained sand, clayey sand lenses	Extreme	8.3	8	0.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T55-7	16/06/2014	2.40	CLAY: high elasticity, brown, trace fine grained sand, clayey sand lenses	Strong	8.1	5.2	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T57-1	16/06/2014	0.30	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	6.4	2.8	3.60	6.2	-	7	217	210	0.011	0.348	0.337	104	0.166	8	<5	24	-	-	1.5	8	111	0.18	111	0.18
ASS T57-2	16/06/2014	0.55	Silty CLAY: high plasticity, dark grey with white, trace fine grained sand	Moderate	7.6	5.6	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T57-3	16/06/2014	0.80	Silty CLAY: high plasticity, dark grey with white, trace fine grained sand	Strong	8	5.8	2.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T57-4	16/06/2014	1.00	CLAY: high elasticity, brown, trace fine grained sand	Moderate	8.1	6	2.10	5.8	<0.005	14	29	16	0.022	0.047	0.025	17	0.027	2	<5	21	-	-	1.5	2	30	0.05	30	0.05
ASS T57-5	16/06/2014	1.70	Interbedded CLAY and Clayey SAND: brown, approximately 30%-50% clay and 50%-70% clayey sand, high plasticity	Moderate	8.5	5.7	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T57-6	16/06/2014	2.10	Interbedded CLAY and Clayey SAND: brown	Strong	8.4	6	2.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T57-7	16/06/2014	2.50	Clayey SAND: fine to medium grained, pale grey and and pale green, approximately 15%-20% high plasticity clay	Moderate	8.5	5.2	3.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T64-1	18/06/2014	0.15	CLAY: high elasticity, pale brown, with organics	Strong	6.6	3.4	3.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T64-2	18/06/2014	0.50	CLAY: high elasticity, dark grey, with organics	Moderate	7.1	4.4	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T64-3	18/06/2014	0.80	Silty CLAY / Clayey SILT: medium plasticity, grey white	Strong	6.9	4.4	2.50	6	-	4	5	<2	0.007	0.008	<0.005	18	0.029	2	12	12	-	-	1.5	2	22	0.04	22	0.04
ASS T64-4	18/06/2014	1.10	SAND: fine to medium grained, pale grey, trace fines	Moderate	7	3.9	3.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T64-5	18/06/2014	1.30	SAND: fine to medium grained, pale grey, trace fines	Moderate	6.4	5	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T64-6	18/06/2014	1.80	SAND: fine to medium grained, pale brown, trace fines	Moderate	6.6	3.7	2.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T64-7	18/06/2014	2.30	SAND: fine to medium grained, pale brown, trace fines	Moderate	6.3	4.9	1.40	5.9	-	<2	3	3	<0.005	<0.005	<0.005	<5	<0.005	<1	10	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T65-1	18/06/2014	0.20	Silty CLAY / Clayey SILT: medium to high plasticity, dark grey	Strong	6.5	3.2	3.30	5.8	-	20	76	56	0.031	0.121	0.09	69	0.11	7	<5	<5	-	-	1.5	7	88	0.14	88	0.14
ASS T65-2	18/06/2014	0.40	CLAY: medium to high plasticity, dark grey and black,	Strong	6.7	4.7	2.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T65-3	18/06/2014	0.55	Clayey SAND: fine to medium grained, dark brown, approximately 30%-40% high plasticity clay	Moderate	7.5	4.9	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T65-4	18/06/2014	0.75	SAND: fine to medium grained, pale grey	Moderate	7.5	4.7	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T65-5	18/06/2014	1.00	SAND: fine to medium grained, pale grey	Slight	7	5.2	1.80	6.2	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	20	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T65-6	18/06/2014	1.50	SAND: fine to medium grained, pale grey	Moderate	6.7	4	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T65-7	18/06/2014	1.80	SAND: fine to medium grained, brown	Moderate	7	3.9	3.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T67-1	17/06/2014	0.30	SAND: fine to medium grained, pale grey	Strong	5	2.4	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T67-2	17/06/2014	0.55	SAND: fine to medium grained, pale grey	Moderate	6.5	4.2	2.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T67-3	17/06/2014	0.80	SAND: fine to medium grained, pale grey	Slight	6.7	5.1	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T67-4	17/06/2014	1.10	SAND: fine to medium grained, brown	Slight	5.3	2.9	2.40	5.3	<0.005	<2	3	3	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	10	<0.02	10	<0.02
ASS T67-5	17/06/2014	1.40	SAND: fine to medium grained, brown	Slight	6.1	3.3	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T67-6	17/06/2014	1.80	SAND: fine to medium grained, brown	Slight	6.2	1.9	4.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T67-7	17/06/2014	2.30	SAND: fine to medium grained, brown	Slight	6.2	2.1	4.10	5.7	0.014	4	5	<2	0.007	0.008	<0.005	18	0.029	2	<5	<5	-	-	1.5	2	23	0.04	23	0.04
ASS T70-1	18/06/2014	0.10	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	6	3	3.00	4.8	-	77	137	60	0.123	0.22	0.097	53	0.085	10	<5	<5	-	-	1.5	10	130	0.21	130	0.21
ASS T70-2	18/06/2014	0.40	Silty CLAY: low elasticity, brown	Strong	7	4.4	2.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T70-3	18/06/2014	0.50	Silty CLAY: med-high plasticity, grey/white	Moderate	7.9	5.2	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T70-4	18/06/2014	0.70	Silty CLAY: med-high plasticity, grey/white	Moderate	8.2	4.9	3.30	6.1	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T70-5	18/06/2014	1.60	SAND: fine to medium grained, pale grey,	Strong	7.4	3.9	3.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T70-6	18/06/2014	1.70	SAND: fine to medium grained, pale grey	Slight	6.7	5.1	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T70-7	18/06/2014	2.20	SAND: fine to medium grained, pale grey	Moderate	6	3.5	2.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T71-1	18/06/2014	0.15	SAND: fine to medium grained, pale grey	Strong	4.9	2.1	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T71-2	18/06/2014	0.55	SAND: fine to medium grained, pale grey	Slight	5.3	3.1	2.20	5.3	-	10	12	2	0.015	0.019	<0.005	<5	<0.005	<1	12	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T71-3	18/06/2014	0.80	SAND: fine to medium grained, pale grey	Slight	5.4	3.8	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T71-4	18/06/2014	1.05	SAND: fine to medium grained, pale grey	Slight	5.6	3.9	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T71-5	18/06/2014	1.30	SAND: fine to coarse grained, pale grey	Slight	5.7	4.4	1.30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T71-6	18/06/2014	1.80	SAND: fine to coarse grained, pale grey	Slight	6.1	4.5	1.60	5.6	<0.005	2	5	3	<0.005	0.008	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T71-7	18/06/2014	2.30	SAND: fine to coarse grained, pale grey	Moderate	5.4	2.7	2.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T73-1	19/06/2014	0.30	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	7.6	3.9	3.70	6.6	-	<2	<2	<2	<0.005	<0.005	<0.005	91	0.146	2	<5	<5	-	-	1.5	2	30	0.05	30	0.05
ASS T73-2	19/06/2014	0.55	Silty CLAY / Clayey SILT: medium to high plasticity, grey	Strong	7.4	3.7	3.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T73-3	19/06/2014	0.80	Silty CLAY / Clayey SILT: medium to high plasticity, grey, trace fine grained sand	Strong	7	3.2	3.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T73-4	19/06/2014	1.05	Silty CLAY / Clayey SILT: medium to high plasticity, grey, trace fine grained sand	Strong	6.2	2.7	3.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T73-5	19/06/2014	1.30	Clayey SAND: fine to medium grained, brown grey, approximately 15%-25% medium plasticity clay,	Moderate	6.2	2.8	3.40	5.8	<0.005	<2	3	3	<0.005	0.005	0.005	<5	<0.005	<1	13	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T73-6	19/06/2014	1.80	SAND: fine to medium grained, pale brown, trace fines	Moderate	6.7	5	1.70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ASS T73-7	19/06/2014	2.30	SAND: fine to medium grained, pale brown, trace fines	Moderate	6.9	4.1	2.80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 3. Results summary table suspension peroxide oxidisable combined acidity and chromium reducible sulfur (SPOCAS)

					Field			SPOCAS																							
					pH (Field)	pH (Fox)	Difference in pH(field) and pH(Fox)	pH (KCl)	Chromium Reducible Sulphur (Scr)	TAA Titratable Actual Acidity (TAA)	TPA Titratable Peroxide Acidity (TPA)	TSA Titratable Sulfidic Acidity (TSA)	Sulfidic - Titratable Actual Acidity (TAA)	Sulfidic - Titratable Peroxide Acidity (TPA)	Sulfidic - Titratable Sulfidic Acidity (TSA)	Acidity - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	Liming Rate excluding ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Sulfidic - Excess Acid Neutralising Capacity	Acidity - Excess Acid Neutralising Capacity	ANC Fineness Factor	Liming Rate	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	Net Acidity (acidity units)	Net Acidity (sulfur units)
				EQL	pH_Units	pH_Units		pH_Units	%	H+/t	H+/t	H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	%S	mole H+/t	-	kg CaCO3/t	mole H+/t	% S	mole H+/t	% S
					0.1	0.1			0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	0.02	10	0.5	1	10	0.02	10	0.02
					<4	<3				0.1	62	62	62	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-	-	62	0.1	62	0.1
					4.0 - 5.5	3.0 - 4.0				0.06	36	36	36	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-	-	36	0.06	36	0.06
					>7	>5	>2			0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-	-	18	0.03	18	0.03
Location	**Sample Depth**	**Sampled Date**	**Soil Description**	**Reaction Rate**																											
SB01/MW05	0	9/03/2016	SAND: grey, fine grained, subrounded, well sorted, dry	Moderate	4.9	4.1	0.80	5.6	<0.005	5	<2	<2	0.007	<0.005	<0.005	10	0.016	1	6	<5	-	-	1.5	1	15	0.02	<10	0.02
SB03/MW01	0	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	6.2	4.2	2.00	5.7	-	8	103	95	0.013	0.165	0.152	<5	0.008	1	<5	<5	-	-	1.5	1	13	0.02	66	0.02
SB04/MW02	0	9/03/2016	SAND: grey, fine grained, subangular, moderate to well sorted. dry	Moderate	5.5	4.4	1.10	5.5	-	8	129	121	0.013	0.207	0.194	<5	<0.005	1	<5	<5	-	-	1.5	1	11	0.02	<10	0.02
SB08	0	10/03/2016	SAND: light grey, fine grained. subangular, well sorted, dry	Moderate	5.3	4.2	1.10	6.5	-	<2	76	76	<0.005	0.121	0.121	<5	0.008	<1	6	<5	-	-	1.5	4	<10	<0.02	52	0.08
SB07/MW07	0.25	10/03/2016	Silty SAND: light grey, fine grained, subangular, moderately sorted, moist	Moderate	6.1	4.4	1.70	5.8	<0.005	16	105	89	0.026	0.168	0.142	50	0.08	5	<5	<5	-	-	1.5	5	66	0.11	16	0.11
SB05/MW03	0.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	6.6	4.7	1.90	7.5	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	5	0.008	<1	7	<5	-	-	1.5	<1	<10	<0.02	48	<0.02
ASS TS5-1	0.30	16/06/2014	SAND: fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1200 mm depth	Moderate	5.1	4.8	0.30	5.5	-	9	10	<2	0.014	0.016	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TD5-2	0.50	17/06/2014	SAND: fine to medium grained, pale grey,	Slight	6.8	4.9	1.90	6.2	<0.005	2	6	4	<0.005	0.01	0.006	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TD2-2	0.55	18/06/2014	SAND: fine to medium grained, grey	Slight	5.2	3.2	2.00	5.7	<0.005	2	3	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS3-2	0.55	19/06/2014	SAND: fine to medium grained, pale grey, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter),	Slight	5.3	3.1	2.20	5.5	-	4	5	<2	0.006	0.007	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TT1-2	0.55	18/06/2014	SAND: fine to medium grained, pale grey	Slight	5.3	3.1	2.20	5.3	-	10	12	2	0.015	0.019	<0.005	<5	<0.005	<1	12	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB01/MW05	0.75	9/03/2016	SAND: grey, medium grained, subangular to subrounded, well sorted, dry	Slight	4.9	4.1	0.80	5.7	-	6	<2	<2	0.009	<0.005	<0.005	<5	<0.005	1	<5	<5	-	-	1.5	1	<10	<0.02	20	<0.02
SB03/MW01	0.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	4.9	3.9	0.90	6.1	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.009	1	6	<5	-	-	1.5	1	<10	<0.02	<10	<0.02
ASS TS4-3	0.80	19/06/2014	SAND: fine to medium grained, pale grey, trace grass roots (3 mm diameter), roots extend down to about 1100 mm	Slight	5.8	4.6	1.20	5.9	<0.005	<2	3	3	<0.005	0.005	0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T36-3	0.80	16/06/2014	SAND: fine to medium grained, pale grey, trace fines, trace grass roots (2 mm diameter), roots extend down to about 1000 mm depth	Moderate	5	3.7	1.30	5.7	-	5	5	<2	0.008	0.008	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS1-3	0.80	18/06/2014	SAND: fine to medium grained, pale erev	Moderate	4.4	3.4	1.00	5.3	-	6	6	<2	0.01	0.01	<0.005	<5	<0.005	<1	5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TR5-5	1.00	18/06/2014	SAND: fine to medium grained, pale grey	Slight	7	5.2	1.80	6.2	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	20	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB05/MW03	1	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.2	5.2	2.00	<2	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<0.005	<5	-	-	1.5	<1	<10	<0.02	13	<0.02
SB08	1	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	4.9	4.5	0.40	5.8	<0.005	2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TD1-4	1.05	18/06/2014	SAND: fine to medium grained, light grey/brown	Slight	6.2	4.8	1.40	5.9	<0.005	<2	8	8	<0.005	0.014	0.014	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS2-4	1.10	17/06/2014	SAND: fine to medium grained, pale grey to grey brown, trace fines	Slight	6.7	4.7	2.00	6	<0.005	<2	2	2	<0.005	<0.005	<0.005	<5	<0.005	<1	15	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB04/MW02	1.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Slight	5.2	4.6	0.60	6.2	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	35	<0.02
ASS TD2-5	1.30	18/06/2014	SAND: fine to medium grained, light grey/brown	Slight	5.6	3.1	2.50	5.8	-	<2	2	2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TD5-5	1.30	17/06/2014	SAND: fine to medium grained, pale grey,	Slight	6.5	3.5	3.00	5.9	-	6	7	<2	0.009	0.012	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS10-5	1.30	18/06/2014	SAND: fine to medium grained, pale grey/brown, trace grass roots (3 mm diameter),	Slight	4.7	2.8	1.90	5.6	<0.005	7	26	19	0.011	0.042	0.031	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS3-5	1.30	19/06/2014	SAND: fine to medium grained, white, trace silt, trace charcoal nodules (medium to coarse gravel size), trace grass roots (1 mm diameter)	Slight	5.2	2.4	2.80	5.9	<0.005	<2	6	6	<0.005	0.01	0.01	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB10/MW10	1.5	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.6	4.9	0.70	5.8	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	34	<0.02
SB01/MW05	1.5		SAND: light grey, medium grained, subangular to subrounded, well sorted, moist	Slight	5.3	4.9	0.40	5.80	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	10	<0.02
SB03/MW01	1.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	Moderate	5.6	4.5	1.10	6.5	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS HA07-6	1.80	12/06/2014	SAND: fine to medium grained, quartz, pale grey	Slight	6.5	5.9	0.60	6.1	-	<2	6	6	<0.005	0.009	0.009	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS1-6	1.80	18/06/2014	SAND: fine to medium grained, pale grey	Moderate	4.9	3	1.90	5.4	<0.005	6	6	<2	0.009	0.01	<0.005	<5	<0.005	<1	14	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TT1-6	1.80	18/06/2014	SAND: fine to coarse grained, pale grey	Slight	6.1	4.5	1.60	5.6	<0.005	2	5	3	<0.005	0.008	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TR9-6	1.90	17/06/2014	SAND: fine to medium grained, pale grey, trace fines	Moderate	5.2	3.5	1.70	5.8	<0.005	<2	4	4	<0.005	0.006	0.006	<5	<0.005	<1	14	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB08	2	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.5	5.4	0.10	6.1	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB05/MW03	2	9/03/2016	SAND: grey, fine grained, subangular, well sorted, moist	Slight	7.2	5	2.20	7.1	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TS5-7	2.20	16/06/2014	SAND: fine to medium grained, white, trace fines, trace grass roots	Moderate	5.3	4.1	1.20	5.5	<0.005	6	7	<2	0.01	0.012	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T36-7	2.30	16/06/2014	SAND: fine to medium grained, pale grey, trace fines, trace grass roots	Moderate	6	3.8	2.10	5.6	<0.005	3	7	4	<0.005	0.011	0.006	13	0.022	1	<5	<5	-	-	1.5	1	16	0.02	16	0.02
ASS TZ4-7	2.30	19/06/2014	SAND: fine to medium grained, white, trace silt	Slight	5.5	3.7	1.80	5.8	<0.005	<2	4	4	<0.005	0.007	0.007	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TA7-7	2.40	17/06/2014	SAND: fine to medium grained. pale erev and pale brown. trace fines	Moderate	7.5	3.3	4.20	6.3	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	18	0.028	1	18	26	-	-	1.5	1	18	0.03	18	0.03
ASS TS4-7	2.40	17/06/2014	SAND: fine to medium grained. pale erev	Slight	6.1	2.2	3.90	5.8	0.01	<2	18	18	<0.005	0.028	0.028	15	0.024	1	15	<5	-	-	1.5	1	15	0.02	15	0.02
SB05/MW03	2.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted. moist	Moderate	6.5	2.7	3.80	6.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB08	3	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.5	5.1	0.40	6	-	2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB10/MW10	3	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5.4	5.2	0.20	5.8	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	45	<0.02
SB03/MW01	3	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	6.9	4.6	2.30	6.8	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.008	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB08	4	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.4	4.4	1.00	5.6	-	3	<2	<2	0.006	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	36	<0.02
SB10/MW10	4	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	Slight	5	5	0.00	5.7	-	2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	15	<0.02
SB03/MW01	4.25	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.3	4.8	2.50	6.6	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	0.008	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB10/MW10	4.75	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.1	5.2	0.90	5.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	37	<0.02
SB03/MW01	5	9/03/2016	SAND: grey, fine grained, subangular, well sorted, wet	Moderate	7.4	4	3.40	7	-	<2	<2	<2	<0.005	<0.005	<0.005	11	0.017	1	10	<5	-	-	1.5	<1	11	0.02	<10	<0.02
SB08	5.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.8	3.8	2.00	5.6	<0.005	<2	4	3	<0.005	0.007	0.006	6	0.01	1	<5	<5	-	-	1.5	1	<10	<0.02	10	<0.02
SB10/MW10	5.25	10/03/2016	SAND: grey, fine grained, subangular, well sorted, wet.	Slight	6.1	4.8	1.30	5.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	15	<0.02
SB10/MW10	5.75	10/03/2016	SAND: grey, fine grained. subangular, well sorted. wet.	Moderate	6.3	4.9	1.40	5.9	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB08	6	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	Slight	5.9	3.8	2.10	5.6	-	2	4	2	<0.005	0.007	<0.005	13	0.021	1	7	<5	-	-	1.5	1	15	0.02	<10	0.02
SB09/MW08	0	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	5.2	3	2.20	5.2	-	24	294	270	0.039	0.472	0.433	21	0.033	3	17	<5	-	-	1.5	3	45	0.07	15	0.07
ASS TZ4-1	0.10	19/06/2014	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)	Moderate	6	3.7	2.30	6.6	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	34	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS TD3-1	0.15	18/06/2014	TOPSOIL: Silty SAND fine to medium grained, black, approximately15%-20% low plasticity silt, trace organics, trace grass roots (3 mm diameter)	Slight	5.5	2.5	3.00	5.3	<0.005	33	955	921	0.053	1.53	1.48	57	0.092	7	12	<5	-	-	1.5	7	90	0.14	90	0.14
ASS T10-1	0.20	18/06/2014	TOPSOIL: SAND fine to medium grained, black, trace silt,	Moderate	5.2	2.5	2.70	4.5	-	48	457	409	0.077	0.733	0.656	<5	<0.005	4	11	<5	-	-	1.5	4	48	0.08	48	0.08
ASS TS14-1	0.20	19/06/2014	TOPSOIL: SAND fine to medium grained, black, trace/some silt, trace grass roots (3 mm diameter), trace shrub roots (10 mm diameter)	Moderate	5.8	3.3	2.50	4.7	-	75	966	891	0.12	1.55	1.43	16	0.026	7	14	<5	-	-	1.5	7	91	0.14	91	0.14
SB09/MW10	0.25	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	4.6	3.8	0.80	4.9	-	29	309	280	0.046	0.496	0.45	7	0.011	3	13	<5	-	-	1.5	3	36	0.06	<10	0.06
SB10/MW10	0.25	10/03/2016	Silty SAND: grey, fine grained, subangular, well sorted , dry	Slight	5.8	4.6	1.20	5.9	<0.005	<2	60	58	<0.005	0.095	0.094	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB09/MW08	0.5	9/03/2016	SILTY SAND: dark grey, fine grained, subangular, well sorted, dry	Slight	5	2.6	2.40	5.4	<0.005	8	78	70	0.013	0.125	0.112	15	0.025	2	<5	<5	-	-	1.5	2	24	0.04	<10	0.04
ASS T008	0.80	19/06/2014	SAND: fine to medium grained, black to dark grey, approximately 10% silt fines	Moderate	6	3.5	2.50	6	<0.005	5	5	<2	0.008	0.008	<0.005	24	0.039	2	<5	<5	-	-	1.5	2	29	0.05	29	0.05
ASS T47-3	0.80	17/06/2014	Clayey SILT: medium to high plasticity, dark grey, trace fine grained sand, trace grass roots	Moderate	7.3	4.6	2.70	6	-	11	13	2	0.017	0.021	<0.005	27	0.043	3	<5	20	-	-	1.5	3	37	0.06	37	0.06
SB09/MW10	1	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	Moderate	4.3	3.5	0.80	4.9	<0.005	26	201	174	0.042	0.322	0.28	<5	<0.005	2	<5	<5	-	-	1.5	2	30	0.05	<10	0.05
SB01/MW05	2.25	9/03/2016	SAND: dark grey, fine grained, well sorted, moist to wet.	Slight	5.8	4	1.80	6.60	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	24	<0.02
SB01/MW05	3.25	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Slight	4.6	2	2.60	5.50	0.041	3	21	17	0.006	0.033	0.028	28	0.055	2	<5	<5	-	-	1.5	2	31	0.05	39	0.05
SB01/MW05	4.25	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.7	2.1	3.60	5.50	-	<2	23	22	<0.005	0.038	0.036	34	0.055	3	<5	<5	-	-	1.5	3	35	0.06	30	0.06
SB01/MW05	5.25	9/03/2016	SAND: dark grey, fine grained, well sorted, wet.	Extreme	5.9	2	3.90	5.60	<2	56	55	<0.005	0.09	0.088	67	0.108	5	<5	<5	-	-	1.5	5	69	0.11	<10	0.11
ASS TD1-1	0.15	18/06/2014	TOPSOIL: SAND fine to medium grained, dark brown, with some low plasticity silt, trace	Moderate	7.4	5.5	1.90	6.5	-	<2	8	8	<0.005	0.014	0.014	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS HA07-1	0.20	12/06/2014	TOPSOIL: SAND fine to medium grained, brown, trace/some silt, trace organics (grass roots	Slight	5.4	3.4	2.00	5.6	<0.005	10	10	<2	0.016	0.017	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	10	<0.02	10	<0.02
ASS T17-4	1.05	19/06/2014	SAND: fine to medium grained, yellow, trace fines,	Slight	6.7	4.2	2.50	5.8	-	2	19	17	<0.005	0.031	0.027	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T67-4	1.10	17/06/2014	SAND: fine to medium grained, brown	Slight	5.3	2.9	2.40	5.3	<0.005	<2	3	3	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	10	<0.02	10	<0.02
ASS T73-5	1.30	19/06/2014	Clayey SAND: fine to medium grained, brown grey, approximately 15%-25% medium	Moderate	6.2	2.8	3.40	5.8	<0.005	<2	3	3	<0.005	0.005	0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T15-6	1.60	19/06/2014	SAND fine to medium grained, brown, trace fines	Slight	5.3	4.2	1.10	5.8	-	3	4	<2	0.005	0.006	<0.005	<5		<1	131	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T38-7	2.00	16/06/2014	SAND: fine to coarse grained, sub-rounded to sub-angular, predominately fine to medium	Strong	6.8	3.4	3.40	6.60	0.018	2	4	<2	<0.005	0.006	<0.005	28	0.044	2	<5	<5	-	-	1.5	2	30	0.05	30	0.05
ASS T15-7	2.30	19/06/2014	SAND fine to medium grained, brown, trace fines	Moderate	5.8	3.3	2.50	5.6	<0.005	8	18	10	0.013	0.028	0.015	14		2	<5	<5	-	-	1.5	2	22	0.04	22	0.04
ASS T17-7	2.30	19/06/2014	SAND: fine to medium grained, yellow, trace fines	Slight	6.7	4.8	1.90	6	<0.005	<2	6	6	<0.005	0.010	0.010	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T64-7	2.30	18/06/2014	SAND: fine to medium grained, pale brown, trace fines	Moderate	6.3	4.9	1.40	5.9		<2	3	3	<0.005	<0.005	<0.005	<5	<0.005	<1	10	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T67-7	2.30	17/06/2014	SAND: fine to medium grained, brown	Slight	6.2	2.1	4.10	5.7	0.014	4	5	<2	0.007	0.008	<0.005	18	0.029	2	<5	<5	-	-	1.5	2	23	0.04	23	0.04
SB04/MW02	2.5	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Slight	4.7	3.8	0.90	6.8	-	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	69	<0.02
SB09/MW08	2.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.4	2.8	2.60	5.7	-	8	165	157	0.013	0.264	0.251	13	0.02	1	<5	<5	-	-	1.5	1	16	0.03	<10	0.03
SB09/MW10	2.75	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	4.5	3.9	0.60	5.4	-	2	26	26	<0.005	0.045	0.041	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB04/MW02	4	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, dry to moist	Moderate	4.9	3.7	1.20	5.7	<2	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	272	<0.02
SB05/MW03	3.5	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	Moderate	6.8	2.4	4.40	7	-	<2	<2	<2	<0.005	<0.005	<0.005	5	0.009	<1	<0.005	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB04/MW02	3.75	9/03/2016	SAND: brown, fine grained, well sorted, wet	Moderate	4.6	2.9	1.70	5.9	<0.005	7	50	43	0.011	0.08	0.069	13	0.02	1	<5	<5	-	-	1.5	1	20	0.03	41	0.03
SB09/MW08	3.75	9/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5.5	2.8	2.70	5.8	-	3	13	9	0.006	0.021	0.015	<5	0.006	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
SB09/MW10	4	10/03/2016	SAND: light brown, fine grained, subangular, well sorted, moist	Slight	5	3.7	1.30	5.4

Table 3. Results summary table suspension peroxide oxidisable combined acidity and chromium reducible sulfur (SPOCAS)

				Field			SPOCAS																						
				pH (Field)	pH (Fox)	Difference in pH(field) and pH(Fox)	pH (KCl)	Chromium Reducible Sulphur (Scr)	Titratable Actual Acidity (TAA)	Titratable Peroxide Acidity (TPA)	Titratable Sulfidic Acidity (TSA)	Sulfidic - Titratable Actual Acidity (TAA)	Sulfidic - Titratable Peroxide Acidity (TPA)	Sulfidic - Titratable Sulfidic Acidity (TSA)	Acidity - Peroxide Oxidisable Sulfur	Peroxide Oxidisable Sulfur	liming Rate excluding ANC	Acidity - Acid Reacted Calcium	Acidity - Acid Reacted Magnesium	Sulfidic - Excess Acid Neutralising Capacity	Acidity - Excess Acid Neutralising Capacity	ANC Fineness Factor	liming Rate	Net Acidity excluding ANC (acidity units)	Net Acidity excluding ANC (sulfur units)	Net Acidity (acidity units)	Net Acidity (sulfur units)
				pH_Units	pH_Units		pH_Units	%	H+/t	H+/t	H+/t	%S	%S	%S	mole H+/t	%S	kg CaCO3/t	mole H+/t	mole H+/t	% S	mole H+/t	-	kg CaCO3/t	mole H+/t	% S	mole H+/t	% S
			EQL	0.1	0.1		0.1	0.005	2	2	2	0.005	0.005	0.005	10	0.005	1	10	10	0.02	10	0.5	1	10	0.02	10	0.02
				<4	<3			0.1	62	62	62	0.1	0.1	0.1	62	0.1	-	62	62	0.1	62	-	-	62	0.1	62	0.1
				4.0 - 5.5	3.0 - 4.0			0.06	36	36	36	0.06	0.06	0.06	36	0.06	-	36	36	0.06	36	-	-	36	0.06	36	0.06
				>7	>5	>2*		0.03	18	18	18	0.03	0.03	0.03	18	0.03	-	18	18	0.03	18	-	-	18	0.03	18	0.03
Location	**Sample Depth**	**Sampled Date**	**Soil Description**	**Reaction Rate**																									
SB03/MW01	6	9/03/2016	SAND: brown, fine grained, subangular, well sorted, wet	Moderate	6.3	2.9	3.40	5.9	0.008	3	7	4	0.006	0.011	0.006	13	0.021	1	<5	<5	-	-	1.5	1	16	0.03	<10	0.03
SB02/MW04	0	9/03/2016	SILT: dark brown, fine grained, moderately sorted, dry	Moderate	5.3	2.6	2.70	5	0.005	120	508	389	0.192	0.815	0.623	139	0.224	19	<5	<5	-	-	1.5	19	259	0.42	37	0.42
SB02/MW04	0.5	9/03/2016	SILT: dark brown, fine grained, moderately sorted, dry	Moderate	5	2.2	2.80	4.6	-	150	413	264	0.24	0.663	0.422	122	0.195	20	44	<5	-	-	1.5	20	272	0.44	<10	0.44
SB09/MW08	1.75	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Slight	4.9	2.9	2.00	5.6	-	8	165	157	0.013	0.264	0.251	42	0.068	4	<5	<5	-	-	1.5	4	51	0.08	<10	0.08
SB07/MW07	2	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Slight	6.6	4.4	2.20	6.2	0.01	3	<2	<2	0.006	<0.005	<0.005	35	0.057	3	8	<5	-	-	1.5	3	39	0.06	<10	0.06
SB09/MW10	2	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, moist	Slight	5	4	1.00	5.2	-	7	106	99	0.011	0.17	0.158	<5	0.005	1	<5	<5	-	-	1.5	1	10	0.02	<10	0.02
SB07/MW07	2.25	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	Slight	6.2	3.6	2.60	6.1	-	<2	<2	<2	<0.005	<0.005	<0.005	13	0.022	1	8	<5	-	-	1.5	1	15	0.02	<10	0.02
SB07/MW07	3	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.1	2.4	3.70	6.4	-	<2	<2	<2	<0.005	<0.005	<0.005	15	0.025	1	<5	<5	-	-	1.5	1	17	0.03	22	0.03
SB07/MW07	4	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.3	2.1	4.20	6.1	-	3	2	<2	0.006	<0.005	<0.005	21	0.033	2	<5	<5	-	-	1.5	2	24	0.04	17	0.04
SB07/MW07	5.25	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.5	2	4.50	6	-	2	25	23	<0.005	0.041	0.037	32	0.052	3	<5	<5	-	-	1.5	3	34	0.06	24	0.06
SB05/MW03	5.5	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Strong	6.4	1.6	4.80	6.8	-	<2	32	32	<0.005	0.052	0.052	53	0.085	4	<5	<5	-	-	1.5	3	53	0.09	<10	0.06
SB05/MW03	6	9/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	1.5	4.90	6.5	-	<2	30	30	<0.005	0.048	0.048	43	0.069	3	<5	<5	-	-	1.5	3	43	0.07	<10	0.05
SB07/MW07	6	10/03/2016	Silty SAND: dark brown, fine grained, subangular, well sorted, wet	Moderate	6.4	1.8	4.60	5.9	-	<2	28	26	<0.005	0.044	0.042	36	0.058	3	<5	<5	-	-	1.5	3	37	0.06	34	0.06
ASS T34-1	0.30	16/06/2014	Silty CLAY: low plasticity, grey white, trace fine grained sand, silt content decreasing with depth, trace grass roots (3 mm diameter) and tree roots (100 mm diameter)	Strong	6.7	4.9	1.80	5.5	<0.005	14	15	<2	0.023	0.024	<0.005	<5	<0.005	1	<5	<5	-	-	1.5	1	14	0.02	14	0.02
ASS T54-2	0.55	17/06/2014	Silty CLAY: medium to high plasticity, grey white, trace fine grained sand, silt content	Moderate	7.1	4.9	2.20	6	-	<2	<2	<2	<0.005	<0.005	<0.005	10	0.015	<1	6	10	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T70-4	0.70	18/06/2014	Silty CLAY: med-high plasticity, grey/white	Moderate	8.2	4.9	3.30	6.1	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T64-3	0.80	18/06/2014	Silty CLAY / Clayey SILT: medium plasticity, grey white	Strong	6.9	4.4	2.50	6	-	4	5	<2	0.007	0.008	<0.005	18	0.029	2	12	12	-	-	1.5	2	22	0.04	22	0.04
SB02/MW04	1	9/03/2016	Silty CLAY: white, moderate plasticity, moist	Moderate	5.7	3	2.70	5.1	-	27	14	<2	0.043	0.022	<0.005	14	0.023	1	<5	8	-	-	1.5	1	41	0.07	31	0.07
ASS T31-4	1.05	16/06/2014	Silty CLAY / Clayey SILT high plasticity, grey white, trace fine grained sand	Strong	7.3	3.1	4.20	5.5	-	14	16	<2	0.022	0.025	<0.005	26	0.042	3	<5	<5	-	-	1.5	3	40	0.06	40	0.06
SB02/MW04	2	9/03/2016	Silty CLAY: white. moderate plasticity. moist	Moderate	6.1	3.4	2.70	5.2	<0.005	20	<2	<2	0.031	<0.005	<0.005	13	0.021	2	15	<5	-	-	1.5	2	32	0.05	259	0.05
SB02/MW04	3	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	9	8.4	0.60	6.9	-	<2	<2	<2	<0.005	<0.005	<0.005	13	0.021	1	<5	12	0.245	153	1.5	<1	13	0.02	16	0.02
SB02/MW04	4	9/03/2016	CLAY: grey/green, high plasticity, wet	Extreme	9	8.4	0.60	7.8	-	<2	<2	<2	<0.005	<0.005	<0.005	146	0.234	11	1250	111	1.91	1200	1.5	<1	146	0.23	22	<0.02
SB02/MW04	5.5	9/03/2016	CLAY: grey, high plasticity, saturated	Extreme	8.6	6.9	1.70	5.8	-	20	21	<2	0.032	0.034	<0.005	28	0.045	4	11	8	-	-	1.5	4	48	0.08	<10	0.08
ASS T70-1	0.10	18/06/2014	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	6	3	3.00	4.8	-	77	137	60	0.123	0.22	0.097	53	0.085	10	<5	<5	-	-	1.5	10	130	0.21	130	0.21
ASS T65-1	0.20	18/06/2014	Silty CLAY / Clayey SILT: medium to high plasticity, dark grey	Strong	6.5	3.2	3.30	5.8	-	20	76	56	0.031	0.121	0.09	69	0.11	7	<5	<5	-	-	1.5	7	88	0.14	88	0.14
ASS T52-1	0.25	17/06/2014	Silty CLAY: high plasticity, dark grey to black, trace fine grained sand	Strong	6.8	3.4	3.40	6	-	11	22	11	0.017	0.035	0.018	49	0.078	4	<5	<5	-	-	1.5	4	60	0.1	60	0.1
ASS T73-1	0.30	19/06/2014	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	7.6	3.9	3.70	6.6	-	<2	<2	<2	<0.005	<0.005	<0.005	91	0.146	2	<5	<5	-	-	1.5	2	30	0.05	30	0.05
ASS T32-1	0.30	16/06/2014	Peaty CLAY / CLAY high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	Strong	5.3	2.2	3.10	4.9	0.019	96	689	593	0.153	1.10	0.951	186	0.298	21	<5	<5	-	-	1.5	21	281	0.45	281	0.45
ASS T49-1	0.30	17/06/2014	CLAY: low plasticity, brown, trace fine grained sand, trace organics	Strong	6.3	3.7	2.60	5.7	-	25	26	<2	0.041	0.042	<0.005	43	0.068	5	<5	10	-	-	1.5	5	68	0.11	68	0.11
ASS T55-1	0.30	16/06/2014	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	7.4	4.2	3.20	6.7	-	<2	186	186	<0.005	0.298	0.298	89	0.143	12	<5	13	-	-	1.5	12	154	0.25	154	0.25
ASS T57-1	0.30	16/06/2014	ORGANIC Silty CLAY / Clayey SILT: high plasticity, black, trace fine grained sand	Strong	6.4	2.8	3.60	6.2	-	7	217	210	0.011	0.348	0.337	104	0.166	8	<5	24	-	-	1.5	8	111	0.18	111	0.18
ASS T43-1	0.30	16/06/2014	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with organics, trace grass roots (1 mm diameter)	Strong	5	1.8	3.20	4.8	-	82	497	415	0.131	0.796	0.666	120	0.192	15	<5	13	-	-	1.5	15	201	0.32	201	0.32
ASS T38-2	0.55	16/06/2014	ORGANIC Silty CLAY / Clayey SILT high plasticity, black, trace fine grained sand, with	Moderate	6.8	4.4	2.40	6.2	-	6	6	<2	0.010	0.010	<0.005	39	0.062	3	<5	<5	-	-	1.5	3	45	0.07	45	0.07
ASS T57-4	1.00	16/06/2014	CLAY: high plasticity, brown, trace fine grained sand	Moderate	8.1	6	2.10	5.8	<0.005	14	29	16	0.022	0.047	0.025	17	0.027	2	<5	21	-	-	1.5	2	30	0.05	30	0.05
ASS T32-5	1.30	16/06/2014	CLAY high plasticity, brown, trace fine grained sand	Slight	8.1	6	2.10	5.8	-	10	15	6	0.016	0.024	0.009	<5	<0.005	<1	<5	<5	-	-	1.5	<1	<10	<0.02	<10	<0.02
ASS T55-5	1.30	16/06/2014	CLAY: high plasticity, brown, trace fine grained sand	Strong	8.2	6.1	2.10	6.9	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	16	0.025	1	<5	35	0.229	143	1.5	<1	16	0.02	<10	<0.02
ASS T31-7	2.30	16/06/2014	CLAY high plasticity, brown, trace fine grained sand	Moderate	8.3	6.1	2.20	5.4	-	17	24	7	0.027	0.038	0.011	24	0.038	3	<5	6	-	-	1.5	3	41	0.06	41	0.06
ASS T43-7	2.30	16/06/2014	CLAY: high plasticity, brown, trace fine grained sand	Slight	7.8	6.1	1.70	6.1	<0.005	<2	<2	<2	<0.005	<0.005	<0.005	6	0.009	<1	14	24	<0.020	<10	1.5	<1	<10	<0.02	<10	<0.02

Notes

1 Field results asessment criteria adopted from Department of Environment Regulation (2015), *Identification and investigation of acid sulfate soils and acidic landscapes*

2 The lower the final pHFOX value, the better the indication of a positive result for potential acid sulfate soils (PASS), *i.e.* a 1 unit pH change from pH 8 to 7 does not indicate PASS but a 1 unit change from pH 3.5 to 2.5 would be indicative of PASS)

Difference in pH and pH (FOX)

Comments

The following field pH test performance criteria are based on the DER's Identification and investigation of acid sulfate soils and acidic landscapes (2015)

pHF<4 *Actual acid sulfate soils (AASS) indicating oxidation of sulfides*

pH F(4-5.5) S *An acid soil*

pHF>7 *Expected in water logged, unoxidised, or poorly drained soils*

pHFOX<3 *Strong indication for PASS - potential for the soil to produce sulfidic acid upon oxidation*

pHFOX (3-4 *Borderline result; sulfides may be present but organic matter may be present as well. Laboratory analysis recommended for verfication*

pHFOX>5 *Little net acidifying ability. Laboratory analysis recommended for verification*

Net acidity action criteria for medium to heavy clays and silty clays

Net acidity action criteria for medium texutre sandy loams to light clays

Net acidity action criteria for coarse texture sands to loamy sands

Table 4. Results summary table metals

				Metals							
				Lead	Aluminium	Arsenic	Cadmium	Chromium (hexavalent)	Iron	Manganese	Zinc
				mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
				5	50	5	1	0.5	50	5	5
Health Investigation Level (HIL)				300	-	100	20	100	-	-	7,400
Class II Landfill				2	50,000	14	0.4	10	50,000	-	50,000
Location	Sample ID (includes depth)	Sampled Date	Soil Description								
SB01	SB01_0.0	9/03/2016	SAND: grey, fine grained, subrounded, well sorted, dry	<5	1180	<5	<1	<0.5	2140	23	<5
SB02	SB02_2.0	9/03/2016	Silty CLAY: white, moderate plasticity, moist	7	6370	11	<1	<0.5	6820	<5	<5
SB03	SB03_0.75	9/03/2016	SAND: grey, fine grained, subangular, well sorted, dry	<5	490	<5	<1	<0.5	2940	23	<5
SB04	SB04_3.75	9/03/2016	SAND: brown, fine grained, well sorted, wet	<5	4340	<5	<1	<0.5	6980	73	<5
SB05	SB05_4.25	9/03/2016	SAND: brown to dark brown, fine grained, subangular, well sorted, wet	<5	1070	<5	<1	<0.5	5130	52	<5
SB06	SB06_0.50	9/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	<5	160	<5	<1	<0.5	3800	40	82
SB07	SB07_2.0	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	<5	11,900	<5	<1	<0.5	2100	16	<5
SB08	SB08_5.25	10/03/2016	SAND: light grey, fine grained, subangular, well sorted, dry	<5	520	<5	<1	<0.5	2160	24	<5
SB09	SB09_1.0	10/03/2016	Silty SAND: dark grey, fine grained, subangular, well sorted, dry	<5	<50	<5	<1	<0.5	2370	26	<5
SB10	SB10_3.0	10/03/2016	SAND: grey, fine grained, subangular, well sorted, dry.	<5	<50	<5	<1	<0.5	1350	14	<5
SB07	QC9	10/03/2016	SAND: dark brown, fine grained, subangular, well sorted, wet	<5	10,200	<5	<1	<0.5	1650	12	<5

Table 5: Soil results QA/QC analysis

	Sample	SB02_1.5	QC1	RPD	SB02_3.0	QC2	RPD	SB03_0.0	QC3	RPD	SB04_1.0	QC4	RPD
Analyte	Units												
pH (Field)	pH_Units	6.1	6.2	2	9	8.4	7	6.2	6.1	2	5.1	5.3	4
pH (Ox)	pH_Units	3.6	3.4	6	8.4	7.6	10	4.2	3.9	7	4.8	4.3	11

	Sample	SB05_4.0	QC5	RPD	SB05_6.0	QC6	RPD	SB06_0.0	QC7	RPD	SB06_1.50	QC8	RPD
Analyte	Units												
pH (Field)	pH_Units	6.6	6.5	2	6.4	6.4	0	5.2	5.2	0	5.5	5.6	2
pH (Ox)	pH_Units	2	2.2	10	1.5	1.6	6	3	2.9	3	3	3	0

	Sample	SB07_2.0	QC9	RPD	SB08_0.5	QC10	RPD	SB09_1.0	QC11	RPD	SB10_0.75	QC12	RPD
Analyte	Units												
pH (Field)	pH_Units	6.6	6.3	5	5.3	5.8	9	4.3	4.4	2	5.9	5.7	3
pH (Ox)	pH_Units	4.4	4.6	4	5	4.2	17	3.5	3.4	3	4.9	4.2	15

	Sample	SB09_1.0	QC11	RPD	SB07_2.0	QC9	RPD
Analyte	Units						
Aluminium	mg/kg	-	-	-	11900	10200	15
Arsenic	mg/kg	-	-	-	<5.0	<5.0	0
Cadmium	mg/kg	-	-	-	<1.0	<1.0	0
Chromium (hexavalent)	mg/kg	-	-	-	<0.5	<0.5	0
Iron	mg/kg	-	-	-	2100	1650	24
Manganese	mg/kg	-	-	-	16	12	29
Zinc	mg/kg	-	-	-	<5.0	<5.0	0
Lead	mg/kg	-	-	-	<5.0	<5.0	0
acidity - Acid Reacted Calcium	mole H+/t	<5.0	6	18	8	17	72
Liming Rate excluding ANC	kg CaCO3/t	2	<1.0	na	3	3	0
Net Acidity excluding ANC	mole H+/t	30	<10.0	na	39	37	5
Net Acidity excluding ANC	% S	0.05	<0.02	na	0.06	0.06	0
acidity - Acid Reacted Magnesium	mole H+/t	<5.0	<5.0	na	<5.0	<5.0	na
acidity - Peroxide Oxidisable Sulfur	mole H+/t	<5.0	<5.0	na	35	34	3
ANC Fineness Factor	-	1.5	1.5	0	1.5	1.5	0
Liming Rate	kg CaCO3/t	2	<1.0	na	3	3	0
Net Acidity (acidity units)	mole H+/t	30	<10.0	na	39	37	5
pH (KCl)	pH_Units	4.9	5	2	6.2	6.1	2
pH (Ox)	pH_Units	2.7	2.8	4	4.1	4.2	2
Titratable Actual Acidity	mole H+/t	26	2	171	3	3	0

RPD *Relative percentage difference exceeds 50%, where RPD = 100*(primary - duplicate)/average(primary+duplicate)*

Appendix 8
Laboratory analysis certificates and chain of custody documents

CHAIN OF CUSTODY

CLIENT: WSP | Parsons Brinckerhoff Australia Pty Limited	TURNAROUND REQUIREMENTS : ☐ (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) ☒ Non Standard or urgent TAT (List due date): 14-3 16/03/2016 (3 day turnaround)		FOR LABORATORY USE ONLY (Circle)
OFFICE: Level 5 503 Muray St Perth WA 6000			Custody Seal Intact? Yes No N/A
PROJECT: 201402331	ALS QUOTE NO.:	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Yamin Ma CONTACT PH: 9217 3279		OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Yamin Ma SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY: / RECEIVED BY:
EDD FORMAT (or default):	*Yamin Ma*	Meredith	
Email Reports to (will default to PM if no other addresses are listed): Yma@pb.com.au	DATE/TIME:	DATE/TIME:	DATE/TIME: / DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed): APInvoices@pb.com.au	11/3/2016	11/3/16	

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	pH, EC	NEPM Metals (W-3)	Nutrients (NT-8)	TRH/BTEXN (W-4)	~~OC/OP LOR Compatible to NEPM Benchmarks~~	10143.			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	QC01/	11/03/2016	W		Various	X	X	X	X	X				DUPLICATE 10143
				TOTAL		1	1	1	3					

Empl Laboratories ENVIROLAB
Job No.- 178043
Date Rec - 11-3
Time Rec - 1720
Rec By - MC
TAT Req - SAME 1 / 2 / 3 / STD
Temp - cool / ambient
Cooling - Ice / Ice pack / None
Security Seal - Yes / No

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

16-18 Hayden Court, Myaree, Western Australia 6154
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email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 178043

Client:
Parsons Brinckerhoff - WA
Level 5
503 Murray St
Perth
WA 6000

Attention: Yamin Ma

Sample log in details:

Your Reference:	**201402331**
No. of samples:	1 Water
Date samples received:	11/03/2016
Date completed instructions received:	11/03/2016
Location:	

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

Report Details:

Date results requested by:	16/03/16
Date of Preliminary Report:	Not issued
Issue Date:	16/03/16

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

Results Approved By:

David Williams
Group Organics Manager

Joshua Lim
Operations Manager

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

Miscellaneous Inorganics		
Our Reference:	UNITS	178043-1
Your Reference	----------	QC01
Date Sampled	----------	11/03/2016
Type of sample		Water
Date prepared	-	15/03/2016
Date analysed	-	15/03/2016
pH	pH Units	6.5
Electrical Conductivity (EC)	µS/cm	670

Nutrients in Water		
Our Reference:	UNITS	178043-1
Your Reference	----------	QC01
Date Sampled	----------	11/03/2016
Type of sample		Water
Date prepared	-	15/03/2016
Date analysed	-	15/03/2016
Total Nitrogen	mg/L	1.2
TKN by Discrete Analyser	mg/L	1.2
NOx as N	mg/L	0.015
Nitrate as N	mg/L	0.015
Nitrite as N	mg/L	<0.005
Ammonia as N	mg/L	0.46
Total Phosphorus	mg/L	0.17

Dissolved Metals in Water		
Our Reference:	UNITS	178043-1
Your Reference	----------	QC01
Date Sampled	----------	11/03/2016
Type of sample		Water
Date prepared	-	15/03/2016
Date analysed	-	15/03/2016
Arsenic-Dissolved	mg/L	<0.001
Barium-Dissolved	mg/L	0.053
Beryllium-Dissolved	mg/L	<0.0005
Cadmium-Dissolved	mg/L	<0.0001
Chromium-Dissolved	mg/L	0.003
Cobalt-Dissolved	mg/L	<0.001
Copper-Dissolved	mg/L	<0.001
Mercury-Dissolved	mg/L	<0.00005
Manganese-Dissolved	mg/L	0.029
Nickel-Dissolved	mg/L	<0.001
Lead-Dissolved	mg/L	<0.001
Vanadium-Dissolved	mg/L	0.004
Zinc-Dissolved	mg/L	0.003

vTRH(C6-C10)/MBTEXN in water		
Our Reference:	UNITS	178043-1
Your Reference	----------	QC01
Date Sampled	----------	11/03/2016
Type of sample		Water
Date analysed	-	16/03/2016
$TRHC_6$ - C_9	µg/L	<10
$TRHC_6$ - C_{10}	µg/L	<10
$TRHC_6$-C_{10} less BTEX (F1)	µg/L	<10
MTBE	µg/L	<1
Benzene	µg/L	<1
Toluene	µg/L	<1
Ethylbenzene	µg/L	<1
m+p-xylene	µg/L	<2
o-xylene	µg/L	<1
Naphthalene	µg/L	<1
Surrogate Dibromofluorometha	%	111
Surrogate toluene-d8	%	104
Surrogate 4-BFB	%	94

svTRH(C10-C40) in water		
Our Reference:	UNITS	178043-1
Your Reference	----------	QC01
Date Sampled	----------	11/03/2016
Type of sample		Water
Date extracted	-	15/03/2016
Date analysed	-	15/03/2016
$TRHC_{10}$ - C_{14}	µg/L	<50
$TRHC_{15}$ - C_{28}	µg/L	<100
$TRHC_{29}$ - C_{36}	µg/L	<100
$TRH>C_{10}$ - C_{16}	µg/L	<50
$TRH>C_{10}$-C_{16} less N (F2)	µg/L	<50
$TRH>C_{16}$ - C_{34}	µg/L	<100
$TRH>C_{34}$ - C_{40}	µg/L	<100
Surrogate o-Terphenyl	%	77

Method ID	Methodology Summary
INORG-001	pH - Measured using pH meter and electrode base on APHA latest edition, Method 4500-H+. Please note that the results for water analyses may be indicative only, as analysis can be completed outside of the APHA recommended holding times. Soils are reported from a 1:5 water extract unless otherwise specified.
INORG-002	Conductivity and Salinity - measured using a conductivity cell at 25°C based on APHA latest edition Method 2510. Soils reported from a 1:5 water extract unless otherwise specified.
INORG-055	Total Nitrogen by colourimetric analysis based on APHA 4500-P J, 4500-NO3 F.
INORG-062	TKN by calculation fromTotal Nitrogen and NOx using APHA methodology.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-057	Ammonia by colourimetric analysis based on APHA latest edition 4500-NH3 F.
METALS-020	Metals in soil and water by ICP-OES.
Metals-022	Determination of various metals by ICP-MS.
Metals-021	Determination of Mercury by Cold Vapour AAS.
ORG-016	Soil samples are extracted with methanol and spiked into water prior to analysing by purge and trap GC-MS. Water samples are analysed directly by purge and trap GC-MS. F1 = (C6-C10)-BTEX as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater.
ORG-003	Soil samples are extracted with Dichloromethane/Acetone and waters with Dichloromethane and analysed by GC-FID. F2 = (>C10-C16)-Naphthalene as per NEPM B1 Guideline on Investigation Levels for Soil and Groundwater (HSLs Tables 1A (3, 4)). Note Naphthalene is determined from the VOC analysis.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			15/03/2016	[NT]	[NT]	LCS-1	15/03/2016
Date analysed	-			15/03/2016	[NT]	[NT]	LCS-1	15/03/2016
pH	pH Units		INORG-001	[NT]	[NT]	[NT]	LCS-1	101%
Electrical Conductivity (EC)	µS/cm	1	INORG-002	<1	[NT]	[NT]	LCS-1	104%
QUALITY CONTROL Nutrients in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			15/03/2016	[NT]	[NT]	LCS-1	15/03/2016
Date analysed	-			15/03/2016	[NT]	[NT]	LCS-1	15/03/2016
Total Nitrogen	mg/L	0.1	INORG-055	<0.1	[NT]	[NT]	LCS-1	104%
TKN by Discrete Analyser	mg/L	0.1	INORG-062	<0.1	[NT]	[NT]	[NR]	[NR]
NOx as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	92%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	92%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	100%
Ammonia as N	mg/L	0.005	INORG-057	<0.005	[NT]	[NT]	LCS-1	90%
Total Phosphorus	mg/L	0.05	METALS-020	<0.05	[NT]	[NT]	LCS-1	110%
QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			15/03/2016	178043-1	15/03/2016 || 15/03/2016	LCS-1	15/03/2016
Date analysed	-			15/03/2016	178043-1	15/03/2016 || 15/03/2016	LCS-1	15/03/2016
Arsenic-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	<0.001 || <0.001	LCS-1	111%
Barium-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	0.053 || 0.053 || RPD: 0	LCS-1	101%
Beryllium-Dissolved	mg/L	0.0005	Metals-022	<0.0005	178043-1	<0.0005 || <0.0005	LCS-1	84%
Cadmium-Dissolved	mg/L	0.0001	Metals-022	<0.0001	178043-1	<0.0001 || <0.0001	LCS-1	102%
Chromium-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	0.003 || 0.003 || RPD: 0	LCS-1	98%
Cobalt-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	<0.001 || <0.001	LCS-1	102%
Copper-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	<0.001 || <0.001	LCS-1	100%
Mercury-Dissolved	mg/L	0.00005	Metals-021	<0.00005	178043-1	<0.00005 || <0.00005	LCS-1	102%
Manganese-Dissolved	mg/L	0.005	Metals-022	<0.005	178043-1	0.029 || 0.029 || RPD: 0	LCS-1	95%
Nickel-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	<0.001 || <0.001	LCS-1	96%
Lead-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	<0.001 || <0.001	LCS-1	103%
Vanadium-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	0.004 || 0.004 || RPD: 0	LCS-1	102%

QUALITY CONTROL Dissolved Metals in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Zinc-Dissolved	mg/L	0.001	Metals-022	<0.001	178043-1	0.003 || 0.003 || RPD: 0	LCS-1	103%
QUALITY CONTROL vTRH(C6-C10)/MBTEXN in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date analysed	-			16/03/2016	[NT]	[NT]	LCS-1	16/03/2016
TRHC$_6$ - C$_9$	µg/L	10	ORG-016	<10	[NT]	[NT]	LCS-1	102%
TRHC$_6$ - C$_{10}$	µg/L	10	ORG-016	<10	[NT]	[NT]	LCS-1	102%
MTBE	µg/L	1	ORG-016	<1	[NT]	[NT]	[NR]	[NR]
Benzene	µg/L	1	ORG-016	<1	[NT]	[NT]	LCS-1	103%
Toluene	µg/L	1	ORG-016	<1	[NT]	[NT]	LCS-1	102%
Ethylbenzene	µg/L	1	ORG-016	<1	[NT]	[NT]	LCS-1	100%
m+p-xylene	µg/L	2	ORG-016	<2	[NT]	[NT]	LCS-1	102%
o-xylene	µg/L	1	ORG-016	<1	[NT]	[NT]	LCS-1	96%
Naphthalene	µg/L	1	ORG-016	<1	[NT]	[NT]	[NR]	[NR]
Surrogate Dibromofluorometha	%		ORG-016	97	[NT]	[NT]	LCS-1	106%
Surrogate toluene-d8	%		ORG-016	102	[NT]	[NT]	LCS-1	101%
Surrogate 4-BFB	%		ORG-016	106	[NT]	[NT]	LCS-1	121%
QUALITY CONTROL svTRH(C10-C40) in water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date extracted	-			15/03/2016	[NT]	[NT]	LCS-1	15/03/2016
Date analysed	-			15/03/2016	[NT]	[NT]	LCS-1	15/03/2016
TRHC$_{10}$ - C$_{14}$	µg/L	50	ORG-003	<50	[NT]	[NT]	LCS-1	92%
TRHC$_{15}$ - C$_{28}$	µg/L	100	ORG-003	<100	[NT]	[NT]	LCS-1	109%
TRHC$_{29}$ - C$_{36}$	µg/L	100	ORG-003	<100	[NT]	[NT]	LCS-1	104%
TRH>C$_{10}$ - C$_{16}$	µg/L	50	ORG-003	<50	[NT]	[NT]	LCS-1	100%
TRH>C$_{16}$ - C$_{34}$	µg/L	100	ORG-003	<100	[NT]	[NT]	LCS-1	110%
TRH>C$_{34}$ - C$_{40}$	µg/L	100	ORG-003	<100	[NT]	[NT]	LCS-1	108%
Surrogate o-Terphenyl	%		ORG-003	86	[NT]	[NT]	LCS-1	104%

Report Comments:

Definitions:

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

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

Quality Control Definitions

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

Laboratory Acceptance Criteria

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

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

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

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

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

SPLIT BATCH
Test All other samples.
Assoc. Batch No. EB1609349

							ANALYSIS REQUESTED		
	Location	SAMP_REF	Depth to Top of Sample (m bgl)	Depth to Base of Sample (m bgl)	Length of Sample Recovered (m)	Sample Date	pHF/FOX	SPOCAS	SCr
1	HA07	ASS HA07-1	0.00	0.20	0.2	12/06/2014	x	x	x
2	HA07	ASS HA07-2	0.20	0.40	0.2	12/06/2014	x		
3	HA07	ASS HA07-3	0.70	0.80	0.1	12/06/2014	x		
4	HA07	ASS HA07-4	0.80	1.00	0.2	12/06/2014	x		
5	HA07	ASS HA07-5	1.20	1.30	0.1	12/06/2014	x		
6	HA07	ASS HA07-6	1.70	1.80	0.1	12/06/2014	x	x	
7	HA07	ASS HA07-7	2.20	2.30	0.1	12/06/2014	x		
8	HA07	ASS HA07-8	2.70	2.80	0.1	12/06/2014	x		
9	T01	ASS T01-1	0.00	0.15	0.15	18/06/2014	x	x	
10	T01	ASS T01-2	0.45	0.55	0.1	18/06/2014	x		
11	T01	ASS T01-3	0.70	0.80	0.1	18/06/2014	x		
12	T01	ASS T01-4	0.95	1.05	0.1	18/06/2014	x	x	x
13	T01	ASS T01-5	1.20	1.30	0.1	18/06/2014	x		
14	T01	ASS T01-6	1.80	1.90	0.1	18/06/2014	x		
15	T01	ASS T01-7	2.00	2.10	0.1	18/06/2014	x		
16	T02	ASS T02-1	0.00	0.15	0.15	18/06/2014	x		
17	T02	ASS T02-2	0.45	0.55	0.1	18/06/2014	x	x	x
18	T02	ASS T02-3	0.70	0.80	0.1	18/06/2014	x		
19	T02	ASS T02-4	0.95	1.05	0.1	18/06/2014	x		
20	T02	ASS T02-5	1.20	1.30	0.1	18/06/2014	x	x	
21	T02	ASS T02-6	1.40	1.50	0.1	18/06/2014	x		
22	T03	ASS T03-1	0.00	0.15	0.15	18/06/2014	x	x	x
23	T03	ASS T03-2	0.45	0.55	0.1	18/06/2014	x		
24	T03	ASS T03-3	0.70	0.80	0.1	18/06/2014	x		
25	T03	ASS T03-4	0.95	1.05	0.1	18/06/2014	x		
26	T05	ASS T05-1	0.20	0.30	0.1	17/06/2014	x		
27	T05	ASS T05-2	0.40	0.50	0.1	17/06/2014	x	x	x
28	T05	ASS T05-3	0.70	0.80	0.1	17/06/2014	x		
29	T05	ASS T05-4	0.90	1.00	0.1	17/06/2014	x		
30	T05	ASS T05-5	1.20	1.30	0.1	17/06/2014	x	x	

Environmental Division
Brisbane
Work Order Reference
EB1609332
Telephone : +61-7-3243 7222

31	T09	ASS T09-1	0.10	0.20	0.1	19/06/2014	x		
32	T09	ASS T09-2	0.45	0.55	0.1	19/06/2014	x		
33	T09	ASS T09-3	0.70	0.80	0.1	19/06/2014	x	x	x
34	T10	ASS T10-1	0.00	0.20	0.2	18/06/2014	x	x	
35	T10	ASS T10-2	0.45	0.55	0.1	18/06/2014	x		
36	T10	ASS T10-3	0.70	0.80	0.1	18/06/2014	x		
37	T10	ASS T10-4	1.00	1.10	0.1	18/06/2014	x		
38	T10	ASS T10-5	1.20	1.30	0.1	18/06/2014	x	x	x
39	T10	ASS T10-6	1.70	1.80	0.1	18/06/2014	x		
40	T10	ASS T10-7	2.00	2.20	0.2	18/06/2014	x		
41	T13	ASS T13-1	0.00	0.10	0.1	19/06/2014	x		
42	T13	ASS T13-2	0.45	0.55	0.1	19/06/2014	x	x	
43	T13	ASS T13-3	0.70	0.80	0.1	19/06/2014	x		
44	T13	ASS T13-4	0.95	1.05	0.1	19/06/2014	x		
45	T13	ASS T13-5	1.20	1.30	0.1	19/06/2014	x	x	x
46	T13	ASS T13-6	1.50	1.60	0.1	19/06/2014	x		
47	T14	ASS T14-1	0.10	0.20	0.1	19/06/2014	x	x	
48	T14	ASS T14-2	0.45	0.55	0.1	19/06/2014	x		
49	T14	ASS T14-3	0.70	0.80	0.1	19/06/2014	x	x	x
50	T14	ASS T14-4	0.95	1.05	0.1	19/06/2014	x		
51	T14	ASS T14-5	1.20	1.30	0.1	19/06/2014	x		
52	T15	ASS T15-1	0.00	0.10	0.1	19/06/2014	x		
53	T15	ASS T15-2	0.40	0.50	0.1	19/06/2014	x		
54	T15	ASS T15-3	0.70	0.80	0.1	19/06/2014	x		
55	T15	ASS T15-4	0.95	1.05	0.1	19/06/2014	x		
56	T15	ASS T15-5	1.20	1.30	0.1	19/06/2014	x		
57	T15	ASS T15-6	1.50	1.60	0.1	19/06/2014	x	x	
58	T15	ASS T15-7	2.20	2.30	0.1	19/06/2014	x	x	x
59	T17	ASS T17-1	0.10	0.20	0.1	19/06/2014	x		
60	T17	ASS T17-2	0.45	0.55	0.1	19/06/2014	x		
61	T17	ASS T17-3	0.70	0.80	0.1	19/06/2014	x		
62	T17	ASS T17-4	0.95	1.05	0.1	19/06/2014	x	x	
63	T17	ASS T17-5	1.20	1.30	0.1	19/06/2014	x		

64	T17	ASS T17-6	1.70	1.80	0.1	19/06/2014	x		
65	T17	ASS T17-7	2.20	2.30	0.1	19/06/2014	x	x	x
66	T24	ASS T24-1	0.00	0.10	0.1	19/06/2014	x	x	
67	T24	ASS T24-2	0.40	0.50	0.1	19/06/2014	x		
68	T24	ASS T24-3	0.70	0.80	0.1	19/06/2014	x		
69	T24	ASS T24-4	0.95	1.05	0.1	19/06/2014	x		
70	T24	ASS T24-5	1.20	1.30	0.1	19/06/2014	x		
71	T24	ASS T24-6	1.80	1.90	0.1	19/06/2014	x		
72	T24	ASS T24-7	2.20	2.30	0.1	19/06/2014	x	x	x
73	T31	ASS T31-1	0.20	0.30	0.1	16/06/2014	x		
74	T31	ASS T31-2	0.45	0.55	0.1	16/06/2014	x		
75	T31	ASS T31-3	0.70	0.80	0.1	16/06/2014	x		
76	T31	ASS T31-4	0.95	1.05	0.1	16/06/2014	x	x	
77	T31	ASS T31-5	1.20	1.30	0.1	16/06/2014	x		
78	T31	ASS T31-6	1.70	1.80	0.1	16/06/2014	x		
79	T31	ASS T31-7	2.20	2.30	0.1	16/06/2014	x	x	
80	T32	ASS T32-1	0.20	0.30	0.1	16/06/2014	x	x	x
81	T32	ASS T32-2	0.45	0.55	0.1	16/06/2014	x		
82	T32	ASS T32-3	0.70	0.80	0.1	16/06/2014	x		
83	T32	ASS T32-4	0.95	1.05	0.1	16/06/2014	x		
84	T32	ASS T32-5	1.20	1.30	0.1	16/06/2014	x	x	
85	T32	ASS T32-6	1.70	1.80	0.1	16/06/2014	x		
86	T32	ASS T32-7	2.20	2.30	0.1	16/06/2014	x		
87	T34	ASS T34-1	0.20	0.30	0.1	16/06/2014	x	x	x
88	T34	ASS T34-2	0.60	0.70	0.1	16/06/2014	x		
89	T34	ASS T34-3	0.80	0.90	0.1	16/06/2014	x		
90	T34	ASS T34-4	0.90	1.00	0.1	16/06/2014	x		
91	T35	ASS T35-1	0.20	0.30	0.1	16/06/2014	x	x	
92	T35	ASS T35-2	0.45	0.55	0.1	16/06/2014	x		
93	T35	ASS T35-3	0.70	0.80	0.1	16/06/2014	x		
94	T35	ASS T35-4	0.95	1.05	0.1	16/06/2014	x		
95	T35	ASS T35-5	1.20	1.30	0.1	16/06/2014	x		
96	T35	ASS T35-6	1.50	1.60	0.1	16/06/2014	x		

97	T35	ASS T35-7	2.10	2.20	0.1	16/06/2014	x	x	x
98	T36	ASS T36-1	0.20	0.30	0.1	16/06/2014	x		
99	T36	ASS T36-2	0.45	0.55	0.1	16/06/2014	x		
100	T36	ASS T36-3	0.70	0.80	0.1	16/06/2014	x	x	
101	T36	ASS T36-4	0.95	1.05	0.1	16/06/2014	x		
102	T36	ASS T36-6	1.50	1.60	0.1	16/06/2014	x		
103	T36	ASS T36-7	2.20	2.30	0.1	16/06/2014	x	x	x
104	T38	ASS T38-1	0.20	0.30	0.1	16/06/2014	x		
105	T38	ASS T38-2	0.45	0.55	0.1	16/06/2014	x	x	
106	T38	ASS T38-3	0.70	0.80	0.1	16/06/2014	x		
107	T38	ASS T38-4	0.95	1.05	0.1	16/06/2014	x		
108	T38	ASS T38-5	1.20	1.30	0.1	16/06/2014	x		
109	T38	ASS T38-6	1.70	1.80	0.1	16/06/2014	x		
110	T38	ASS T38-7	1.90	2.00	0.1	16/06/2014	x	x	x
	T43	ASS T43-1	0.20	0.30	0.1	16/06/2014	x	x	
	T43	ASS T43-2	0.45	0.55	0.1	16/06/2014	x		
	T43	ASS T43-3	0.70	0.80	0.1	16/06/2014	x		
	T43	ASS T43-4	0.95	1.05	0.1	16/06/2014	x		
	T43	ASS T43-5	1.20	1.30	0.1	16/06/2014	x		
	T43	ASS T43-6	1.70	1.80	0.1	16/06/2014	x		
	T43	ASS T43-7	2.20	2.30	0.1	16/06/2014	x	x	x
	T47	ASS T47-1	0.20	0.30	0.1	17/06/2014	x		
	T47	ASS T47-2	0.40	0.50	0.1	17/06/2014	x		
	T47	ASS T47-3	0.70	0.80	0.1	17/06/2014	x	x	
	T47	ASS T47-4	0.95	1.00	0.1	17/06/2014	x		
	T47	ASS T47-5	1.20	1.30	0.1	17/06/2014	x		
	T47	ASS T47-6	1.70	1.80	0.1	17/06/2014	x		
	T47	ASS T47-7	2.30	2.40	0.1	17/06/2014	x	x	x
	T49	ASS T49-1	0.20	0.30	0.1	17/06/2014	x	x	
	T49	ASS T49-2	0.45	0.55	0.1	17/06/2014	x		
	T49	ASS T49-3	0.70	0.80	0.1	17/06/2014	x		
	T49	ASS T49-4	0.95	1.00	0.1	17/06/2014	x		
	T49	ASS T49-5	1.20	1.30	0.1	17/06/2014	x		

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T49	ASS T49-6	1.70	1.90	0.2	17/06/2014	x	x	x
T49	ASS T49-7	2.00	2.20	0.2	17/06/2014	x		
T51	ASS T51-1	0.20	0.30	0.1	18/06/2014	x		
T51	ASS T51-2	0.45	0.55	0.1	18/06/2014	x		
T51	ASS T51-3	0.70	0.80	0.1	18/06/2014	x	x	
T51	ASS T51-4	0.95	1.05	0.1	18/06/2014	x		
T51	ASS T51-5	1.20	1.30	0.1	18/06/2014	x		
T51	ASS T51-6	1.70	1.80	0.1	18/06/2014	x	x	x
T51	ASS T51-7	2.20	2.30	0.1	18/06/2014	x		
T52	ASS T52-1	0.15	0.25	0.1	17/06/2014	x	x	
T52	ASS T52-2	0.45	0.55	0.1	17/06/2014	x		
T52	ASS T52-3	0.75	0.85	0.1	17/06/2014	x		
T52	ASS T52-4	1.00	1.10	0.1	17/06/2014	x	x	x
T52	ASS T52-5	1.30	1.40	0.1	17/06/2014	x		
T54	ASS T54-1	0.20	0.30	0.1	17/06/2014	x		
T54	ASS T54-2	0.45	0.55	0.1	17/06/2014	x	x	
T54	ASS T54-3	0.70	0.80	0.1	17/06/2014	x		
T54	ASS T54-4	0.95	1.05	0.1	17/06/2014	x		
T54	ASS T54-5	1.70	1.80	0.1	17/06/2014	x		
T54	ASS T54-6	1.90	2.00	0.1	17/06/2014	x		
T54	ASS T54-7	2.30	2.40	0.1	17/06/2014	x	x	x
T55	ASS T55-1	0.20	0.30	0.1	16/06/2014	x	x	
T55	ASS T55-2	0.45	0.55	0.1	16/06/2014	x		
T55	ASS T55-3	0.70	0.80	0.1	16/06/2014	x		
T55	ASS T55-4	0.95	1.05	0.1	16/06/2014	x		
T55	ASS T55-5	1.20	1.30	0.1	16/06/2014	x	x	x
T55	ASS T55-6	1.70	1.80	0.1	16/06/2014	x		
T55	ASS T55-7	2.30	2.40	0.1	16/06/2014	x		
T57	ASS T57-1	0.20	0.30	0.1	16/06/2014	x	x	
T57	ASS T57-2	0.45	0.55	0.1	16/06/2014	x		
T57	ASS T57-3	0.70	0.80	0.1	16/06/2014	x		
T57	ASS T57-4	0.90	1.00	0.1	16/06/2014	x	x	x
T57	ASS T57-5	1.60	1.70	0.1	16/06/2014	x		

T57	ASS T57-6	2.00	2.10	0.1	16/06/2014	x		
T57	ASS T57-7	2.30	2.50	0.2	16/06/2014	x		
T64	ASS T64-1	0.00	0.15	0.15	18/06/2014	x		
T64	ASS T64-2	0.40	0.50	0.1	18/06/2014	x		
T64	ASS T64-3	0.70	0.80	0.1	18/06/2014	x	x	
T64	ASS T64-4	1.00	1.10	0.1	18/06/2014	x		
T64	ASS T64-5	1.20	1.30	0.1	18/06/2014	x		
T64	ASS T64-6	1.70	1.80	0.1	18/06/2014	x		
T64	ASS T64-7	2.20	2.30	0.1	18/06/2014	x	x	x
T65	ASS T65-1	0.00	0.20	0.2	18/06/2014	x	x	
T65	ASS T65-2	0.20	0.40	0.2	18/06/2014	x		
T65	ASS T65-3	0.40	0.55	0.15	18/06/2014	x		
T65	ASS T65-4	0.55	0.75	0.2	18/06/2014	x		
T65	ASS T65-5	0.75	1.00	0.25	18/06/2014	x	x	x
T65	ASS T65-6	1.30	1.50	0.2	18/06/2014	x		
T65	ASS T65-7	1.70	1.80	0.1	18/06/2014	x		
T67	ASS T67-1	0.20	0.30	0.1	17/06/2014	x		
T67	ASS T67-2	0.45	0.55	0.1	17/06/2014	x		
T67	ASS T67-3	0.70	0.80	0.1	17/06/2014	x		
T67	ASS T67-4	1.00	1.10	0.1	17/06/2014	x	x	
T67	ASS T67-5	1.30	1.40	0.1	17/06/2014	x		
T67	ASS T67-6	1.70	1.80	0.1	17/06/2014	x		
T67	ASS T67-7	2.20	2.30	0.1	17/06/2014	x	x	x
T70	ASS T70-1	0.00	0.10	0.1	18/06/2014	x	x	
T70	ASS T70-2	0.30	0.40	0.1	18/06/2014	x		
T70	ASS T70-3	0.40	0.50	0.1	18/06/2014	x		
T70	ASS T70-4	0.60	0.70	0.1	18/06/2014	x	x	x
T70	ASS T70-5	0.90	1.00	0.1	18/06/2014	x		
T70	ASS T70-6	1.50	1.70	0.2	18/06/2014	x		
T70	ASS T70-7	2.00	2.20	0.2	18/06/2014	x		
T71	ASS T71-1	0.00	0.15	0.15	18/06/2014	x		
T71	ASS T71-2	0.45	0.55	0.1	18/06/2014	x	x	
T71	ASS T71-3	0.70	0.80	0.1	18/06/2014	x		

T71	ASS T71-4	0.95	1.05	0.1	18/06/2014	x		
T71	ASS T71-5	1.20	1.30	0.1	18/06/2014	x		
T71	ASS T71-6	1.70	1.80	0.1	18/06/2014	x	x	x
T71	ASS T71-7	2.20	2.30	0.1	18/06/2014	x		
T73	ASS T73-1	0.20	0.30	0.1	19/06/2014	x	x	
T73	ASS T73-2	0.45	0.55	0.1	19/06/2014	x		
T73	ASS T73-3	0.70	0.80	0.1	19/06/2014	x		
T73	ASS T73-4	0.95	1.05	0.1	19/06/2014	x		
T73	ASS T73-5	1.20	1.30	0.1	19/06/2014	x	x	x
T73	ASS T73-6	1.70	1.80	0.1	19/06/2014	x		
T73	ASS T73-7	2.20	2.30	0.1	19/06/2014	x		
Field Duplicate: D14					18/06/2014	x		
Field Duplicate: D15					18/06/2014	x		
Field Duplicate: D16					18/06/2014	x		
Field Duplicate: D18					19/06/2014	x		
Field Duplicate: D19					19/06/2014	x		
Field Duplicate: D01					16/06/2014	x		
Field Duplicate: D02					16/06/2014	x		
Field Duplicate: D03					16/06/2014	x		
Field Duplicate: D05					16/06/2014	x		
Field Duplicate: D04					16/06/2014	x		
Field Duplicate: D08					17/06/2014	x		
Field Duplicate: D10					17/06/2014	x	x	
Field Duplicate: D09					17/06/2014	x	x	
Field Duplicate: D07					16/06/2014	x	x	
Field Duplicate: D06					16/06/2014	x	x	
Field Duplicate: D12					18/06/2014	x	x	
Field Duplicate: D11					18/06/2014	x	x	
Field Duplicate: D13					18/06/2014	x		
Field Duplicate: D17					19/06/2014	x	x	

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1609332**	Page	: 1 of 46
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Brisbane
Contact	: YAMIN MA	Contact	: ShukHui Li
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 08 94899700	Telephone	: 08 9209 7655
Project	: 147642090 - Mandogalup	Date Samples Received	: 07-Apr-2016 13:22
Order number	: ----	Date Analysis Commenced	: 18-Apr-2016
C-O-C number	: ----	Issue Date	: 19-Apr-2016 15:56
Sampler	: ----		
Site	: ----		
Quote number	: ----		
No. of samples received	: 110		
No. of samples analysed	: 110		

NATA Accredited Laboratory 825
Accredited for compliance with
ISO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

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

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils, Stafford, QLD

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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.

- ASS: EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA029 (SPOCAS): Excess ANC not required because pH OX less than 6.5.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.
- ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS HA07-1	ASS HA07-2	ASS HA07-3	ASS HA07-4	ASS HA07-5
			Client sampling date / time	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-001	EB1609332-002	EB1609332-003	EB1609332-004	EB1609332-005
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.4**	**5.7**	**5.5**	**5.9**	**6.1**
pH (Fox)	----	0.1	pH Unit	**3.7**	**4.1**	**5.0**	**4.9**	**5.1**
Reaction Rate	----	1	Reaction Unit	**1**	**1**	**1**	**1**	**1**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.6**	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	**3.4**	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**10**	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**10**	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	**0.016**	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.017**	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.040**	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.047**	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.007**	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	**0.006**	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS HA07-1	ASS HA07-2	ASS HA07-3	ASS HA07-4	ASS HA07-5
				Client sampling date / time	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-001	EB1609332-002	EB1609332-003	EB1609332-004	EB1609332-005
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		<0.005	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		**10**	----	----	----	----
Liming Rate	----	1	kg CaCO3/t		<1	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		**10**	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS HA07-6	ASS HA07-7	ASS HA07-8	ASS T01-1	ASS T01-2
			Client sampling date / time	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-006	EB1609332-007	EB1609332-008	EB1609332-009	EB1609332-010
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**6.5**	**6.2**	**6.4**	**7.4**	**6.7**
pH (Fox)	----	0.1	pH Unit	**5.4**	**5.3**	**5.2**	**4.7**	**5.4**
Reaction Rate	----	1	Reaction Unit	**1**	**1**	**1**	**2**	**1**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.1**	----	----	**6.5**	----
pH OX (23B)	----	0.1	pH Unit	**5.9**	----	----	**5.5**	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**6**	----	----	<2	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**6**	----	----	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	----	----	<0.005	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.009**	----	----	<0.005	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	**0.009**	----	----	<0.005	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	----	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	----	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	----	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	<0.005	----	----	**0.076**	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	<0.005	----	----	**0.077**	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	----	----	<0.005	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	<5	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	----	----	<0.005	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	----	----	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	----	----	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	----	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS HA07-6	ASS HA07-7	ASS HA07-8	ASS T01-1	ASS T01-2
				Client sampling date / time	[12-Jun-2014]	[12-Jun-2014]	[12-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-006	EB1609332-007	EB1609332-008	EB1609332-009	EB1609332-010
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		<0.005	----	----	<0.005	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S		<0.02	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t		<10	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t		<1	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	----	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	----	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T01-3	ASS T01-4	ASS T01-5	ASS T01-6	ASS T01-7
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-011	EB1609332-012	EB1609332-013	EB1609332-014	EB1609332-015
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.9	6.2	6.5	7.0	7.1
pH (Fox)	----	0.1	pH Unit	5.3	5.2	5.2	5.2	5.3
Reaction Rate	----	1	Reaction Unit	1	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.9	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	4.8	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	8	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	8	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.014	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	0.014	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	<0.005	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T01-3	ASS T01-4	ASS T01-5	ASS T01-6	ASS T01-7
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-011	EB1609332-012	EB1609332-013	EB1609332-014	EB1609332-015
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	<0.005	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T02-1	ASS T02-2	ASS T02-3	ASS T02-4	ASS T02-5
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-016	EB1609332-017	EB1609332-018	EB1609332-019	EB1609332-020
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	8.3	5.2	7.1	7.1	5.6
pH (Fox)	----	0.1	pH Unit	5.2	4.0	5.2	5.2	4.4
Reaction Rate	----	1	Reaction Unit	2	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.7	----	----	5.8
pH OX (23B)	----	0.1	pH Unit	----	3.2	----	----	3.1
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	2	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	3	----	----	2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	----	<0.005
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	<0.005	----	----	<0.005
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T02-1	ASS T02-2	ASS T02-3	ASS T02-4	ASS T02-5
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-016	EB1609332-017	EB1609332-018	EB1609332-019	EB1609332-020
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t		----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	<1	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T02-6	ASS T03-1	ASS T03-2	ASS T03-3	ASS T03-4
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-021	EB1609332-022	EB1609332-023	EB1609332-024	EB1609332-025
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.7	5.5	7.2	7.0	6.8
pH (Fox)	----	0.1	pH Unit	4.2	3.0	5.4	5.4	3.3
Reaction Rate	----	1	Reaction Unit	2	1	1	1	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.3	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	2.5	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	33	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	955	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	921	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.053	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	1.53	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	1.48	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	0.092	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	0.092	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	57	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.236	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.259	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.023	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	12	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.018	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	0.023	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	0.024	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T02-6	ASS T03-1	ASS T03-2	ASS T03-3	ASS T03-4
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-021	EB1609332-022	EB1609332-023	EB1609332-024	EB1609332-025
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	**0.14**	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	**90**	----	----	----
Liming Rate	----	1	kg CaCO3/t		----	**7**	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	**0.14**	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	**90**	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	**7**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T05-1	ASS T05-2	ASS T05-3	ASS T05-4	ASS T05-5
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-026	EB1609332-027	EB1609332-028	EB1609332-029	EB1609332-030
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.9	6.8	6.7	6.3	6.5
pH (Fox)	----	0.1	pH Unit	3.9	4.7	4.8	5.2	5.2
Reaction Rate	----	1	Reaction Unit	1	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.2	----	----	5.9
pH OX (23B)	----	0.1	pH Unit	----	4.9	----	----	3.5
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	2	----	----	6
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	6	----	----	7
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	4	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	0.009
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.010	----	----	0.012
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	0.006	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.119	----	----	0.027
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.121	----	----	0.027
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T05-1	ASS T05-2	ASS T05-3	ASS T05-4	ASS T05-5
				Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-026	EB1609332-027	EB1609332-028	EB1609332-029	EB1609332-030
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t		----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	<1	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T09-1	ASS T09-2	ASS T09-3	ASS T10-1	ASS T10-2
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-031	EB1609332-032	EB1609332-033	EB1609332-034	EB1609332-035
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.3	6.2	6.0	5.2	4.7
pH (Fox)	----	0.1	pH Unit	3.9	3.7	4.2	3.2	3.2
Reaction Rate	----	1	Reaction Unit	2	2	2	2	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	<0.005	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	6.0	4.5	----
pH OX (23B)	----	0.1	pH Unit	----	----	3.5	2.5	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	5	48	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	5	457	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	<2	409	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	0.008	0.077	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	0.008	0.733	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	<0.005	0.656	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	<0.005	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	0.039	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	0.039	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	24	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	0.122	0.114	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	0.129	0.136	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	0.006	0.022	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	<5	11	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	0.005	0.018	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	<0.005	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	<0.005	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	<0.005	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	<5	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T09-1	ASS T09-2	ASS T09-3	ASS T10-1	ASS T10-2
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-031	EB1609332-032	EB1609332-033	EB1609332-034	EB1609332-035
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	<0.005	<0.005	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	**1.5**	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S		----	----	**0.05**	**0.08**	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	**29**	**48**	----
Liming Rate	----	1	kg CaCO3/t		----	----	**2**	**4**	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	**0.05**	**0.08**	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	**29**	**48**	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	**2**	**4**	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T10-3	ASS T10-4	ASS T10-5	ASS T10-6	ASS T10-7
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-036	EB1609332-037	EB1609332-038	EB1609332-039	EB1609332-040
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	4.9	5.4	4.7	5.2	4.9
pH (Fox)	----	0.1	pH Unit	3.7	3.8	3.7	3.8	3.6
Reaction Rate	----	1	Reaction Unit	1	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	<0.005	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	5.6	----	----
pH OX (23B)	----	0.1	pH Unit	----	----	2.8	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	7	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	26	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	19	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	0.011	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	0.042	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	0.031	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	<0.005	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	<0.005	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	<0.005	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	<5	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	<0.005	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	<0.005	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	<0.005	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	<5	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	<0.005	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	<0.005	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	<0.005	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	<0.005	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	<5	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T10-3	ASS T10-4	ASS T10-5	ASS T10-6	ASS T10-7
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-036	EB1609332-037	EB1609332-038	EB1609332-039	EB1609332-040
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	<0.005	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	----	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	<10	----	----
Liming Rate	----	1	kg CaCO3/t		----	----	<1	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	<0.02	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	<10	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	<1	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T13-1	ASS T13-2	ASS T13-3	ASS T13-4	ASS T13-5
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-041	EB1609332-042	EB1609332-043	EB1609332-044	EB1609332-045
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.0	5.3	5.2	5.3	5.2
pH (Fox)	----	0.1	pH Unit	2.7	4.0	4.1	4.6	4.8
Reaction Rate	----	1	Reaction Unit	2	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.5	----	----	5.9
pH OX (23B)	----	0.1	pH Unit	----	3.1	----	----	2.4
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	4	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	5	----	----	6
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	6
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.006	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.007	----	----	0.010
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	0.010
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	----	<0.005
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	<0.005	----	----	<0.005
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T13-1	ASS T13-2	ASS T13-3	ASS T13-4	ASS T13-5
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-041	EB1609332-042	EB1609332-043	EB1609332-044	EB1609332-045
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t		----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	<1	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T13-6	ASS T14-1	ASS T14-2	ASS T14-3	ASS T14-4
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-046	EB1609332-047	EB1609332-048	EB1609332-049	EB1609332-050
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.1	5.8	5.4	5.8	5.4
pH (Fox)	----	0.1	pH Unit	4.8	3.3	4.0	4.6	4.5
Reaction Rate	----	1	Reaction Unit	1	2	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	<0.005	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	4.7	----	5.9	----
pH OX (23B)	----	0.1	pH Unit	----	3.6	----	3.2	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	75	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	966	----	3	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	891	----	3	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.120	----	<0.005	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	1.55	----	0.005	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	1.43	----	0.005	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	0.026	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	0.026	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	16	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.314	----	<0.005	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.342	----	<0.005	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.027	----	<0.005	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	14	----	<5	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.022	----	<0.005	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	0.027	----	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	0.028	----	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T13-6	ASS T14-1	ASS T14-2	ASS T14-3	ASS T14-4
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-046	EB1609332-047	EB1609332-048	EB1609332-049	EB1609332-050
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	<0.005	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S		----	**0.14**	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	**91**	----	<10	----
Liming Rate	----	1	kg CaCO3/t		----	**7**	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	**0.14**	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	**91**	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	**7**	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T14-5	ASS T15-1	ASS T15-2	ASS T15-3	ASS T15-4
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-051	EB1609332-052	EB1609332-053	EB1609332-054	EB1609332-055
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.2	5.3	5.6	5.4	5.6
pH (Fox)	----	0.1	pH Unit	3.7	2.7	4.2	4.2	4.2
Reaction Rate	----	1	Reaction Unit	1	2	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T14-5	ASS T15-1	ASS T15-2	ASS T15-3	ASS T15-4
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-051	EB1609332-052	EB1609332-053	EB1609332-054	EB1609332-055
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	----	----	----
Liming Rate	----	1	kg CaCO3/t		----	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T15-5	ASS T15-6	ASS T15-7	ASS T17-1	ASS T17-2
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-056	EB1609332-057	EB1609332-058	EB1609332-059	EB1609332-060
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.2	5.3	5.8	6.1	6.4
pH (Fox)	----	0.1	pH Unit	4.7	4.2	2.6	2.6	3.6
Reaction Rate	----	1	Reaction Unit	1	1	2	3	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	<0.005	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.8	5.6	----	----
pH OX (23B)	----	0.1	pH Unit	----	2.9	3.3	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	3	8	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	4	18	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	10	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.005	0.013	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.006	0.028	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	0.015	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	<0.005	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	0.022	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	0.022	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	14	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	0.027	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.263	0.028	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.263	<0.005	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	131	<5	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.211	<0.005	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	<0.005	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	<0.005	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	<0.005	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	<5	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T15-5	ASS T15-6	ASS T15-7	ASS T17-1	ASS T17-2
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-056	EB1609332-057	EB1609332-058	EB1609332-059	EB1609332-060
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	<0.005	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	<0.02	**0.04**	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	<10	**22**	----	----
Liming Rate	----	1	kg CaCO3/t		----	<1	**2**	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	<0.02	**0.04**	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	<10	**22**	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	<1	**2**	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T17-3	ASS T17-4	ASS T17-5	ASS T17-6	ASS T17-7
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-061	EB1609332-062	EB1609332-063	EB1609332-064	EB1609332-065
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.7	6.7	6.7	7.0	6.7
pH (Fox)	----	0.1	pH Unit	5.0	4.2	4.9	5.0	4.8
Reaction Rate	----	1	Reaction Unit	2	1	1	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.8	----	----	6.0
pH OX (23B)	----	0.1	pH Unit	----	3.7	----	----	4.3
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	2	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	19	----	----	6
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	17	----	----	6
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.031	----	----	0.010
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	0.027	----	----	0.010
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	----	<0.005
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	<0.005	----	----	<0.005
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T17-3	ASS T17-4	ASS T17-5	ASS T17-6	ASS T17-7
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-061	EB1609332-062	EB1609332-063	EB1609332-064	EB1609332-065
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T24-1	ASS T24-2	ASS T24-3	ASS T24-4	ASS T24-5
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-066	EB1609332-067	EB1609332-068	EB1609332-069	EB1609332-070
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**6.0**	**5.4**	**5.1**	**5.2**	**5.6**
pH (Fox)	----	0.1	pH Unit	**3.7**	**3.3**	**3.6**	**4.2**	**4.6**
Reaction Rate	----	1	Reaction Unit	**2**	**1**	**1**	**1**	**1**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**----**	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.6**	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	**3.2**	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.264**	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.332**	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.069**	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	**34**	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	**0.055**	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T24-1	ASS T24-2	ASS T24-3	ASS T24-4	ASS T24-5
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-066	EB1609332-067	EB1609332-068	EB1609332-069	EB1609332-070
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		<0.005	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		<10	----	----	----	----
Liming Rate	----	1	kg CaCO3/t		<1	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T24-6	ASS T24-7	ASS T31-1	ASS T31-2	ASS T31-3
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-071	EB1609332-072	EB1609332-073	EB1609332-074	EB1609332-075
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.8**	**5.5**	**5.3**	**6.5**	**7.4**
pH (Fox)	----	0.1	pH Unit	**4.0**	**3.7**	**2.3**	**3.6**	**5.0**
Reaction Rate	----	1	Reaction Unit	**1**	**1**	**3**	**3**	**2**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	**5.8**	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	**3.4**	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	**4**	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	**4**	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	**0.007**	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	**0.007**	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	<0.005	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T24-6	ASS T24-7	ASS T31-1	ASS T31-2	ASS T31-3
				Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-071	EB1609332-072	EB1609332-073	EB1609332-074	EB1609332-075
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	<0.02	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	<10	----	----	----
Liming Rate	----	1	kg CaCO3/t		----	<1	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	<0.02	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	<10	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	<1	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T31-4	ASS T31-5	ASS T31-6	ASS T31-7	ASS T32-1
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-076	EB1609332-077	EB1609332-078	EB1609332-079	EB1609332-080
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.3	8.0	8.2	8.3	5.3
pH (Fox)	----	0.1	pH Unit	3.1	6.0	5.9	6.1	2.2
Reaction Rate	----	1	Reaction Unit	3	2	2	2	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	0.019
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.5	----	----	5.4	4.9
pH OX (23B)	----	0.1	pH Unit	5.3	----	----	5.3	3.3
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	14	----	----	17	96
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	16	----	----	24	689
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	7	593
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.022	----	----	0.027	0.153
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.025	----	----	0.038	1.10
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	----	----	0.011	0.951
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	<0.005	0.023
Peroxide Sulfur (23De)	----	0.005	% S	0.042	----	----	0.038	0.321
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.042	----	----	0.038	0.298
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	26	----	----	24	186
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.326	----	----	0.504	0.578
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.331	----	----	0.505	0.360
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.005	----	----	<0.005	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	----	----	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.088	----	----	0.158	0.054
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.094	----	----	0.166	0.057
Acid Reacted Magnesium (23U)	----	0.005	% Mg	0.006	----	----	0.008	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	6	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T31-4	ASS T31-5	ASS T31-6	ASS T31-7	ASS T32-1
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-076	EB1609332-077	EB1609332-078	EB1609332-079	EB1609332-080
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		**0.008**	**----**	**----**	**0.010**	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	**----**	**----**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		**0.06**	**----**	**----**	**0.06**	**0.45**
Net Acidity (acidity units)	----	10	mole H+ / t		**40**	**----**	**----**	**41**	**281**
Liming Rate	----	1	kg CaCO3/t		**3**	**----**	**----**	**3**	**21**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		**0.06**	**----**	**----**	**0.06**	**0.45**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		**40**	**----**	**----**	**41**	**281**
Liming Rate excluding ANC	----	1	kg CaCO3/t		**3**	**----**	**----**	**3**	**21**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T32-2	ASS T32-3	ASS T32-4	ASS T32-5	ASS T32-6
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-081	EB1609332-082	EB1609332-083	EB1609332-084	EB1609332-085
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.6	7.8	8.0	8.1	8.2
pH (Fox)	----	0.1	pH Unit	5.1	5.6	5.8	6.0	6.2
Reaction Rate	----	1	Reaction Unit	2	2	2	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	5.8	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	6.4	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	10	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	15	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	6	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	0.016	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	0.024	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	0.009	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	0.552	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	0.554	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	<0.005	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	<5	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	<0.005	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	0.210	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	0.211	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T32-2	ASS T32-3	ASS T32-4	ASS T32-5	ASS T32-6
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-081	EB1609332-082	EB1609332-083	EB1609332-084	EB1609332-085
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	----	<0.005	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S		----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t		----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T32-7	ASS T34-1	ASS T34-2	ASS T34-3	ASS T34-4
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-086	EB1609332-087	EB1609332-088	EB1609332-089	EB1609332-090
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	8.3	6.7	6.2	6.4	6.6
pH (Fox)	----	0.1	pH Unit	6.1	4.9	4.6	4.3	4.8
Reaction Rate	----	1	Reaction Unit	1	3	3	3	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.5	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	5.6	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	14	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	15	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.023	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.024	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.116	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.120	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	0.030	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	0.034	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T32-7	ASS T34-1	ASS T34-2	ASS T34-3	ASS T34-4
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-086	EB1609332-087	EB1609332-088	EB1609332-089	EB1609332-090
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	**0.02**	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	**14**	----	----	----
Liming Rate	----	1	kg CaCO3/t		----	**1**	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	**0.02**	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	**14**	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	**1**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T35-1	ASS T35-2	ASS T35-3	ASS T35-4	ASS T35-5
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-091	EB1609332-092	EB1609332-093	EB1609332-094	EB1609332-095
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**5.1**	**5.2**	**5.1**	**5.1**	**4.9**
pH (Fox)	----	0.1	pH Unit	**3.4**	**4.2**	**3.8**	**4.0**	**4.2**
Reaction Rate	----	1	Reaction Unit	**2**	**2**	**2**	**2**	**2**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.5**	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	**4.8**	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**9**	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**10**	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	**0.014**	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.016**	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.081**	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.081**	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	**0.031**	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	**0.032**	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T35-1	ASS T35-2	ASS T35-3	ASS T35-4	ASS T35-5
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-091	EB1609332-092	EB1609332-093	EB1609332-094	EB1609332-095
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		<0.005	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		<10	----	----	----	----
Liming Rate	----	1	kg CaCO3/t		<1	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T35-6	ASS T35-7	ASS T36-1	ASS T36-2	ASS T36-3
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-096	EB1609332-097	EB1609332-098	EB1609332-099	EB1609332-100
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.0	5.3	5.4	5.4	5.0
pH (Fox)	----	0.1	pH Unit	3.6	4.1	3.2	3.3	3.7
Reaction Rate	----	1	Reaction Unit	2	2	2	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.5	----	----	5.7
pH OX (23B)	----	0.1	pH Unit	----	4.7	----	----	3.4
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	6	----	----	5
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	7	----	----	5
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.010	----	----	0.008
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.012	----	----	0.008
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.022	----	----	0.025
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.024	----	----	0.027
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	<0.005	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	<5	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T35-6	ASS T35-7	ASS T36-1	ASS T36-2	ASS T36-3
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-096	EB1609332-097	EB1609332-098	EB1609332-099	EB1609332-100
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	<0.005	----	----	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t		----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	<10	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	<1	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T36-4	ASS T36-6	ASS T36-7	ASS T38-1	ASS T38-2
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-101	EB1609332-102	EB1609332-103	EB1609332-104	EB1609332-105
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.1	5.7	6.0	6.1	6.8
pH (Fox)	----	0.1	pH Unit	3.8	3.1	2.9	3.5	4.4
Reaction Rate	----	1	Reaction Unit	2	2	2	3	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	<0.005	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	5.6	----	6.2
pH OX (23B)	----	0.1	pH Unit	----	----	3.7	----	5.0
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	3	----	6
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	7	----	6
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	4	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	<0.005	----	0.010
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	0.011	----	0.010
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	0.006	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	<0.005	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	----	0.020	----	0.062
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	0.020	----	0.062
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	13	----	39
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	0.023	----	0.250
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	0.024	----	0.251
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	<0.005	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	<5	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	<0.005	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	<0.005	----	0.046
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	<0.005	----	0.049
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	<0.005	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	<5	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T36-4	ASS T36-6	ASS T36-7	ASS T38-1	ASS T38-2
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-101	EB1609332-102	EB1609332-103	EB1609332-104	EB1609332-105
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	<0.005	----	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	----	**0.02**	----	**0.07**
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	**16**	----	**45**
Liming Rate	----	1	kg CaCO3/t		----	----	**1**	----	**3**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	**0.02**	----	**0.07**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	**16**	----	**45**
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	**1**	----	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T38-3	ASS T38-4	ASS T38-5	ASS T38-6	ASS T38-7
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609332-106	EB1609332-107	EB1609332-108	EB1609332-109	EB1609332-110
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.7	6.8	6.8	6.8	6.8
pH (Fox)	----	0.1	pH Unit	5.2	5.1	3.9	2.2	2.1
Reaction Rate	----	1	Reaction Unit	1	1	2	3	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	0.018
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	6.0
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	4.5
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	4
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	----	0.006
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	----	0.044
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	----	0.044
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	----	28
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	----	0.067
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	----	0.068
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T38-3	ASS T38-4	ASS T38-5	ASS T38-6	ASS T38-7
				Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609332-106	EB1609332-107	EB1609332-108	EB1609332-109	EB1609332-110
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	----	----	<0.005
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	----	----	----	**0.05**
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	----	----	**30**
Liming Rate	----	1	kg CaCO3/t		----	----	----	----	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	----	----	**0.05**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	----	----	**30**
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	----	----	**2**

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1609332**	Page	: 1 of 6
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Brisbane
Contact	: YAMIN MA	Telephone	: 08 9209 7655
Project	: 147642090 - Mandogalup	Date Samples Received	: 07-Apr-2016
Site	: ----	Issue Date	: 19-Apr-2016
Sampler	: ----	No. of samples received	: 110
Order number	: ----	No. of samples analysed	: 110

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.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

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

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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: **SOIL**

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
EA003 :pH (field/fox)							
Snap Lock Bag - frozen (EA003)							
ASS HA07-1, ASS HA07-2, ASS HA07-3, ASS HA07-4, ASS HA07-5, ASS HA07-6, ASS HA07-7, ASS HA07-8	**12-Jun-2014**	**18-Apr-2016**	07-Mar-2017	✓	**19-Apr-2016**	17-Jul-2016	✓
Snap Lock Bag - frozen (EA003)							
ASS T31-1, ASS T31-2, ASS T31-3, ASS T31-4, ASS T31-5, ASS T31-6, ASS T31-7, ASS T32-1, ASS T32-2, ASS T32-3, ASS T32-4, ASS T32-5, ASS T32-6, ASS T32-7, ASS T34-1, ASS T34-2, ASS T34-3, ASS T34-4, ASS T35-1, ASS T35-2, ASS T35-3, ASS T35-4, ASS T35-5, ASS T35-6, ASS T35-7, ASS T36-1, ASS T36-2, ASS T36-3, ASS T36-4, ASS T36-6, ASS T36-7, ASS T38-1, ASS T38-2, ASS T38-3, ASS T38-4, ASS T38-5, ASS T38-6, ASS T38-7	**16-Jun-2014**	**19-Apr-2016**	11-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA003)							
ASS T05-1, ASS T05-2, ASS T05-3, ASS T05-4, ASS T05-5	**17-Jun-2014**	**18-Apr-2016**	12-Mar-2017	✓	**19-Apr-2016**	17-Jul-2016	✓
Snap Lock Bag - frozen (EA003)							

Matrix: **SOIL**

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
EA003 :pH (field/fox) - Continued								
ASS T01-1,	ASS T01-2,	**18-Jun-2014**	**18-Apr-2016**	13-Mar-2017	✓	**19-Apr-2016**	17-Jul-2016	✓
ASS T01-3,	ASS T01-4,							
ASS T01-5,	ASS T01-6,							
ASS T01-7,	ASS T02-1,							
ASS T02-2,	ASS T02-3,							
ASS T02-4,	ASS T02-5,							
ASS T02-6,	ASS T03-1,							
ASS T03-2,	ASS T03-3,							
ASS T03-4,	ASS T10-1,							
ASS T10-2,	ASS T10-3,							
ASS T10-4,	ASS T10-5,							
ASS T10-6,	ASS T10-7							
Snap Lock Bag - frozen (EA003)								
ASS T09-1,	ASS T09-2,	**19-Jun-2014**	**18-Apr-2016**	14-Mar-2017	✓	**19-Apr-2016**	17-Jul-2016	✓
ASS T09-3								
Snap Lock Bag - frozen (EA003)								
ASS T13-1,	ASS T13-2,	**19-Jun-2014**	**19-Apr-2016**	14-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
ASS T13-3,	ASS T13-4,							
ASS T13-5,	ASS T13-6,							
ASS T14-1,	ASS T14-2,							
ASS T14-3,	ASS T14-4,							
ASS T14-5,	ASS T15-1,							
ASS T15-2,	ASS T15-3,							
ASS T15-4,	ASS T15-5,							
ASS T15-6,	ASS T15-7,							
ASS T17-1,	ASS T17-2,							
ASS T17-3,	ASS T17-4,							
ASS T17-5,	ASS T17-6,							
ASS T17-7,	ASS T24-1,							
ASS T24-2,	ASS T24-3,							
ASS T24-4,	ASS T24-5,							
ASS T24-6,	ASS T24-7							

Matrix: **SOIL**

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
EA026 : Chromium Reducible Sulfur							
Snap Lock Bag - frozen (EA026)							
ASS HA07-1	**12-Jun-2014**	**19-Apr-2016**	07-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA026)							
ASS T32-1, ASS T34-1, ASS T35-7, ASS T36-7, ASS T38-7	**16-Jun-2014**	**19-Apr-2016**	11-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA026)							
ASS T05-2	**17-Jun-2014**	**19-Apr-2016**	12-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA026)							
ASS T01-4, ASS T02-2, ASS T03-1, ASS T10-5	**18-Jun-2014**	**19-Apr-2016**	13-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA026)							
ASS T09-3, ASS T13-5, ASS T14-3, ASS T15-7, ASS T17-7, ASS T24-7	**19-Jun-2014**	**19-Apr-2016**	14-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
EA029-D: Calcium Values							
Snap Lock Bag - frozen (EA029)							
ASS HA07-1, ASS HA07-6	**12-Jun-2014**	**19-Apr-2016**	07-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA029)							
ASS T31-4, ASS T31-7, ASS T32-1, ASS T32-5, ASS T34-1, ASS T35-1, ASS T35-7, ASS T36-3, ASS T36-7, ASS T38-2, ASS T38-7	**16-Jun-2014**	**19-Apr-2016**	11-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA029)							
ASS T05-2, ASS T05-5	**17-Jun-2014**	**19-Apr-2016**	12-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA029)							
ASS T01-1, ASS T01-4, ASS T02-2, ASS T02-5, ASS T03-1, ASS T10-1, ASS T10-5	**18-Jun-2014**	**19-Apr-2016**	13-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓
Snap Lock Bag - frozen (EA029)							
ASS T09-3, ASS T13-2, ASS T13-5, ASS T14-1, ASS T14-3, ASS T15-6, ASS T15-7, ASS T17-4, ASS T17-7, ASS T24-1, ASS T24-7	**19-Jun-2014**	**19-Apr-2016**	14-Mar-2017	✓	**19-Apr-2016**	18-Jul-2016	✓

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: **SOIL**

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)							
Chromium Reducible Sulphur	EA026	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH field/fox	EA003	12	110	**10.91**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	4	33	**12.12**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Reducible Sulphur	EA026	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Reducible Sulphur	EA026	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	33	**6.06**	**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 field/fox	EA003	SOIL	In house: Referenced to Ahern et al 1998 - determined on a 1:5 soil/water extract designed to simulate field measured pH and pH after the extract has been oxidised with peroxide.
Chromium Reducible Sulphur	EA026	SOIL	In house: Referenced to Sullivan et al (1998) The CRS method converts reduced inorganic sulfur to H2S by CrCl2 solution ; the evolved H2S is trapped in a zinc acetate solution as ZnS which is quantified by iodometric titration.
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

SPLIT BATCH
Test All other samples.
Assoc. Batch No.
EB1609332

						ANALYSIS	REQUESTED	
Location	SAMP_REF	Depth to Top of Sample (m bgl)	Depth to Base of Sample (m bgl)	Length of Sample Recovered (m)	Sample Date	pHF/FOX	SPOCAS	SCr
HA07	ASS HA07-1	0.00	0.20	0.2	12/06/2014	x	x	x
HA07	ASS HA07-2	0.20	0.40	0.2	12/06/2014	x		
HA07	ASS HA07-3	0.70	0.80	0.1	12/06/2014	x		
HA07	ASS HA07-4	0.80	1.00	0.2	12/06/2014	x		
HA07	ASS HA07-5	1.20	1.30	0.1	12/06/2014	x		
HA07	ASS HA07-6	1.70	1.80	0.1	12/06/2014	x	x	
HA07	ASS HA07-7	2.20	2.30	0.1	12/06/2014	x		
HA07	ASS HA07-8	2.70	2.80	0.1	12/06/2014	x		
T01	ASS T01-1	0.00	0.15	0.15	18/06/2014	x	x	
T01	ASS T01-2	0.45	0.55	0.1	18/06/2014	x		
T01	ASS T01-3	0.70	0.80	0.1	18/06/2014	x		
T01	ASS T01-4	0.95	1.05	0.1	18/06/2014	x	x	x
T01	ASS T01-5	1.20	1.30	0.1	18/06/2014	x		
T01	ASS T01-6	1.80	1.90	0.1	18/06/2014	x		
T01	ASS T01-7	2.00	2.10	0.1	18/06/2014	x		
T02	ASS T02-1	0.00	0.15	0.15	18/06/2014	x		
T02	ASS T02-2	0.45	0.55	0.1	18/06/2014	x	x	x
T02	ASS T02-3	0.70	0.80	0.1	18/06/2014	x		
T02	ASS T02-4	0.95	1.05	0.1	18/06/2014	x		
T02	ASS T02-5	1.20	1.30	0.1	18/06/2014	x	x	
T02	ASS T02-6	1.40	1.50	0.1	18/06/2014	x		
T03	ASS T03-1	0.00	0.15	0.15	18/06/2014	x	x	x
T03	ASS T03-2	0.45	0.55	0.1	18/06/2014	x		
T03	ASS T03-3	0.70	0.80	0.1	18/06/2014	x		
T03	ASS T03-4	0.95	1.05	0.1	18/06/2014	x		
T05	ASS T05-1	0.20	0.30	0.1	17/06/2014	x		
T05	ASS T05-2	0.40	0.50	0.1	17/06/2014	x	x	x
T05	ASS T05-3	0.70	0.80	0.1	17/06/2014	x		
T05	ASS T05-4	0.90	1.00	0.1	17/06/2014	x		
T05	ASS T05-5	1.20	1.30	0.1	17/06/2014	x	x	

Environmental Division
Brisbane
Work Order Reference
EB1609349

Telephone : + 61-7-3243 7222

T09	ASS T09-1	0.10	0.20	0.1	19/06/2014	x		
T09	ASS T09-2	0.45	0.55	0.1	19/06/2014	x		
T09	ASS T09-3	0.70	0.80	0.1	19/06/2014	x	x	x
T10	ASS T10-1	0.00	0.20	0.2	18/06/2014	x	x	
T10	ASS T10-2	0.45	0.55	0.1	18/06/2014	x		
T10	ASS T10-3	0.70	0.80	0.1	18/06/2014	x		
T10	ASS T10-4	1.00	1.10	0.1	18/06/2014	x		
T10	ASS T10-5	1.20	1.30	0.1	18/06/2014	x	x	x
T10	ASS T10-6	1.70	1.80	0.1	18/06/2014	x		
T10	ASS T10-7	2.00	2.20	0.2	18/06/2014	x		
T13	ASS T13-1	0.00	0.10	0.1	19/06/2014	x		
T13	ASS T13-2	0.45	0.55	0.1	19/06/2014	x	x	
T13	ASS T13-3	0.70	0.80	0.1	19/06/2014	x		
T13	ASS T13-4	0.95	1.05	0.1	19/06/2014	x		
T13	ASS T13-5	1.20	1.30	0.1	19/06/2014	x	x	x
T13	ASS T13-6	1.50	1.60	0.1	19/06/2014	x		
T14	ASS T14-1	0.10	0.20	0.1	19/06/2014	x	x	
T14	ASS T14-2	0.45	0.55	0.1	19/06/2014	x		
T14	ASS T14-3	0.70	0.80	0.1	19/06/2014	x	x	x
T14	ASS T14-4	0.95	1.05	0.1	19/06/2014	x		
T14	ASS T14-5	1.20	1.30	0.1	19/06/2014	x		
T15	ASS T15-1	0.00	0.10	0.1	19/06/2014	x		
T15	ASS T15-2	0.40	0.50	0.1	19/06/2014	x		
T15	ASS T15-3	0.70	0.80	0.1	19/06/2014	x		
T15	ASS T15-4	0.95	1.05	0.1	19/06/2014	x		
T15	ASS T15-5	1.20	1.30	0.1	19/06/2014	x		
T15	ASS T15-6	1.50	1.60	0.1	19/06/2014	x	x	
T15	ASS T15-7	2.20	2.30	0.1	19/06/2014	x	x	x
T17	ASS T17-1	0.10	0.20	0.1	19/06/2014	x		
T17	ASS T17-2	0.45	0.55	0.1	19/06/2014	x		
T17	ASS T17-3	0.70	0.80	0.1	19/06/2014	x		
T17	ASS T17-4	0.95	1.05	0.1	19/06/2014	x	x	
T17	ASS T17-5	1.20	1.30	0.1	19/06/2014	x		

T17	ASS T17-6	1.70	1.80	0.1	19/06/2014	x		
T17	ASS T17-7	2.20	2.30	0.1	19/06/2014	x	x	x
T24	ASS T24-1	0.00	0.10	0.1	19/06/2014	x	x	
T24	ASS T24-2	0.40	0.50	0.1	19/06/2014	x		
T24	ASS T24-3	0.70	0.80	0.1	19/06/2014	x		
T24	ASS T24-4	0.95	1.05	0.1	19/06/2014	x		
T24	ASS T24-5	1.20	1.30	0.1	19/06/2014	x		
T24	ASS T24-6	1.80	1.90	0.1	19/06/2014	x		
T24	ASS T24-7	2.20	2.30	0.1	19/06/2014	x	x	x
T31	ASS T31-1	0.20	0.30	0.1	16/06/2014	x		
T31	ASS T31-2	0.45	0.55	0.1	16/06/2014	x		
T31	ASS T31-3	0.70	0.80	0.1	16/06/2014	x		
T31	ASS T31-4	0.95	1.05	0.1	16/06/2014	x	x	
T31	ASS T31-5	1.20	1.30	0.1	16/06/2014	x		
T31	ASS T31-6	1.70	1.80	0.1	16/06/2014	x		
T31	ASS T31-7	2.20	2.30	0.1	16/06/2014	x	x	
T32	ASS T32-1	0.20	0.30	0.1	16/06/2014	x	x	x
T32	ASS T32-2	0.45	0.55	0.1	16/06/2014	x		
T32	ASS T32-3	0.70	0.80	0.1	16/06/2014	x		
T32	ASS T32-4	0.95	1.05	0.1	16/06/2014	x		
T32	ASS T32-5	1.20	1.30	0.1	16/06/2014	x	x	
T32	ASS T32-6	1.70	1.80	0.1	16/06/2014	x		
T32	ASS T32-7	2.20	2.30	0.1	16/06/2014	x		
T34	ASS T34-1	0.20	0.30	0.1	16/06/2014	x	x	x
T34	ASS T34-2	0.60	0.70	0.1	16/06/2014	x		
T34	ASS T34-3	0.80	0.90	0.1	16/06/2014	x		
T34	ASS T34-4	0.90	1.00	0.1	16/06/2014	x		
T35	ASS T35-1	0.20	0.30	0.1	16/06/2014	x	x	
T35	ASS T35-2	0.45	0.55	0.1	16/06/2014	x		
T35	ASS T35-3	0.70	0.80	0.1	16/06/2014	x		
T35	ASS T35-4	0.95	1.05	0.1	16/06/2014	x		
T35	ASS T35-5	1.20	1.30	0.1	16/06/2014	x		
T35	ASS T35-6	1.50	1.60	0.1	16/06/2014	x		

T35	ASS T35-7	2.10	2.20	0.1	16/06/2014	x	x	x
T36	ASS T36-1	0.20	0.30	0.1	16/06/2014	x		
T36	ASS T36-2	0.45	0.55	0.1	16/06/2014	x		
T36	ASS T36-3	0.70	0.80	0.1	16/06/2014	x	x	
T36	ASS T36-4	0.95	1.05	0.1	16/06/2014	x		
T36	ASS T36-6	1.50	1.60	0.1	16/06/2014	x		
T36	ASS T36-7	2.20	2.30	0.1	16/06/2014	x	x	x
T38	ASS T38-1	0.20	0.30	0.1	16/06/2014	x		
T38	ASS T38-2	0.45	0.55	0.1	16/06/2014	x	x	
T38	ASS T38-3	0.70	0.80	0.1	16/06/2014	x		
T38	ASS T38-4	0.95	1.05	0.1	16/06/2014	x		
T38	ASS T38-5	1.20	1.30	0.1	16/06/2014	x		
T38	ASS T38-6	1.70	1.80	0.1	16/06/2014	x		
T38	ASS T38-7	1.90	2.00	0.1	16/06/2014	x	x	x
T43	ASS T43-1	0.20	0.30	0.1	16/06/2014	x	x	
T43	ASS T43-2	0.45	0.55	0.1	16/06/2014	x		
T43	ASS T43-3	0.70	0.80	0.1	16/06/2014	x		
T43	ASS T43-4	0.95	1.05	0.1	16/06/2014	x		
T43	ASS T43-5	1.20	1.30	0.1	16/06/2014	x		
T43	ASS T43-6	1.70	1.80	0.1	16/06/2014	x		
T43	ASS T43-7	2.20	2.30	0.1	16/06/2014	x	x	x
T47	ASS T47-1	0.20	0.30	0.1	17/06/2014	x		
T47	ASS T47-2	0.40	0.50	0.1	17/06/2014	x		
T47	ASS T47-3	0.70	0.80	0.1	17/06/2014	x	x	
T47	ASS T47-4	0.95	1.00	0.1	17/06/2014	x		
T47	ASS T47-5	1.20	1.30	0.1	17/06/2014	x		
T47	ASS T47-6	1.70	1.80	0.1	17/06/2014	x		
T47	ASS T47-7	2.30	2.40	0.1	17/06/2014	x	x	x
T49	ASS T49-1	0.20	0.30	0.1	17/06/2014	x	x	
T49	ASS T49-2	0.45	0.55	0.1	17/06/2014	x		
T49	ASS T49-3	0.70	0.80	0.1	17/06/2014	x		
T49	ASS T49-4	0.95	1.00	0.1	17/06/2014	x		
T49	ASS T49-5	1.20	1.30	0.1	17/06/2014	x		

20	T49	ASS T49-6	1.70	1.90	0.2	17/06/2014	x	x	x
21	T49	ASS T49-7	2.00	2.20	0.2	17/06/2014	x		
22	T51	ASS T51-1	0.20	0.30	0.1	18/06/2014	x		
23	T51	ASS T51-2	0.45	0.55	0.1	18/06/2014	x		
24	T51	ASS T51-3	0.70	0.80	0.1	18/06/2014	x	x	
25	T51	ASS T51-4	0.95	1.05	0.1	18/06/2014	x		
26	T51	ASS T51-5	1.20	1.30	0.1	18/06/2014	x		
27	T51	ASS T51-6	1.70	1.80	0.1	18/06/2014	x	x	x
28	T51	ASS T51-7	2.20	2.30	0.1	18/06/2014	x		
29	T52	ASS T52-1	0.15	0.25	0.1	17/06/2014	x	x	
30	T52	ASS T52-2	0.45	0.55	0.1	17/06/2014	x		
31	T52	ASS T52-3	0.75	0.85	0.1	17/06/2014	x		
32	T52	ASS T52-4	1.00	1.10	0.1	17/06/2014	x	x	x
33	T52	ASS T52-5	1.30	1.40	0.1	17/06/2014	x		
34	T54	ASS T54-1	0.20	0.30	0.1	17/06/2014	x		
35	T54	ASS T54-2	0.45	0.55	0.1	17/06/2014	x	x	
36	T54	ASS T54-3	0.70	0.80	0.1	17/06/2014	x		
37	T54	ASS T54-4	0.95	1.05	0.1	17/06/2014	x		
38	T54	ASS T54-5	1.70	1.80	0.1	17/06/2014	x		
39	T54	ASS T54-6	1.90	2.00	0.1	17/06/2014	x		
40	T54	ASS T54-7	2.30	2.40	0.1	17/06/2014	x	x	x
41	T55	ASS T55-1	0.20	0.30	0.1	16/06/2014	x	x	
42	T55	ASS T55-2	0.45	0.55	0.1	16/06/2014	x		
43	T55	ASS T55-3	0.70	0.80	0.1	16/06/2014	x		
44	T55	ASS T55-4	0.95	1.05	0.1	16/06/2014	x		
45	T55	ASS T55-5	1.20	1.30	0.1	16/06/2014	x	x	x
46	T55	ASS T55-6	1.70	1.80	0.1	16/06/2014	x		
47	T55	ASS T55-7	2.30	2.40	0.1	16/06/2014	x		
48	T57	ASS T57-1	0.20	0.30	0.1	16/06/2014	x	x	
49	T57	ASS T57-2	0.45	0.55	0.1	16/06/2014	x		
50	T57	ASS T57-3	0.70	0.80	0.1	16/06/2014	x		
51	T57	ASS T57-4	0.90	1.00	0.1	16/06/2014	x	x	x
52	T57	ASS T57-5	1.60	1.70	0.1	16/06/2014	x		

53	T57	ASS T57-6	2.00	2.10	0.1	16/06/2014	x		
54	T57	ASS T57-7	2.30	2.50	0.2	16/06/2014	x		
55	T64	ASS T64-1	0.00	0.15	0.15	18/06/2014	x		
56	T64	ASS T64-2	0.40	0.50	0.1	18/06/2014	x		
57	T64	ASS T64-3	0.70	0.80	0.1	18/06/2014	x	x	
58	T64	ASS T64-4	1.00	1.10	0.1	18/06/2014	x		
59	T64	ASS T64-5	1.20	1.30	0.1	18/06/2014	x		
60	T64	ASS T64-6	1.70	1.80	0.1	18/06/2014	x		
61	T64	ASS T64-7	2.20	2.30	0.1	18/06/2014	x	x	x
62	T65	ASS T65-1	0.00	0.20	0.2	18/06/2014	x	x	
63	T65	ASS T65-2	0.20	0.40	0.2	18/06/2014	x		
64	T65	ASS T65-3	0.40	0.55	0.15	18/06/2014	x		
65	T65	ASS T65-4	0.55	0.75	0.2	18/06/2014	x		
66	T65	ASS T65-5	0.75	1.00	0.25	18/06/2014	x	x	x
67	T65	ASS T65-6	1.30	1.50	0.2	18/06/2014	x		
68	T65	ASS T65-7	1.70	1.80	0.1	18/06/2014	x		
69	T67	ASS T67-1	0.20	0.30	0.1	17/06/2014	x		
70	T67	ASS T67-2	0.45	0.55	0.1	17/06/2014	x		
71	T67	ASS T67-3	0.70	0.80	0.1	17/06/2014	x		
72	T67	ASS T67-4	1.00	1.10	0.1	17/06/2014	x	x	
73	T67	ASS T67-5	1.30	1.40	0.1	17/06/2014	x		
74	T67	ASS T67-6	1.70	1.80	0.1	17/06/2014	x		
75	T67	ASS T67-7	2.20	2.30	0.1	17/06/2014	x	x	x
76	T70	ASS T70-1	0.00	0.10	0.1	18/06/2014	x	x	
77	T70	ASS T70-2	0.30	0.40	0.1	18/06/2014	x		
78	T70	ASS T70-3	0.40	0.50	0.1	18/06/2014	x		
79	T70	ASS T70-4	0.60	0.70	0.1	18/06/2014	x	x	x
80	T70	ASS T70-5	0.90	1.00	0.1	18/06/2014	x		
81	T70	ASS T70-6	1.50	1.70	0.2	18/06/2014	x		
82	T70	ASS T70-7	2.00	2.20	0.2	18/06/2014	x		
83	T71	ASS T71-1	0.00	0.15	0.15	18/06/2014	x		
84	T71	ASS T71-2	0.45	0.55	0.1	18/06/2014	x	x	
85	T71	ASS T71-3	0.70	0.80	0.1	18/06/2014	x		

86	T71	ASS T71-4	0.95	1.05	0.1	18/06/2014	x		
87	T71	ASS T71-5	1.20	1.30	0.1	18/06/2014	x		
88	T71	ASS T71-6	1.70	1.80	0.1	18/06/2014	x	x	x
89	T71	ASS T71-7	2.20	2.30	0.1	18/06/2014	x		
90	T73	ASS T73-1	0.20	0.30	0.1	19/06/2014	x	x	
91	T73	ASS T73-2	0.45	0.55	0.1	19/06/2014	x		
92	T73	ASS T73-3	0.70	0.80	0.1	19/06/2014	x		
93	T73	ASS T73-4	0.95	1.05	0.1	19/06/2014	x		
94	T73	ASS T73-5	1.20	1.30	0.1	19/06/2014	x	x	x
95	T73	ASS T73-6	1.70	1.80	0.1	19/06/2014	x		
96	T73	ASS T73-7	2.20	2.30	0.1	19/06/2014	x		
97	Field Duplicate: D14					18/06/2014	x		
98	Field Duplicate: D15					18/06/2014	x		
99	Field Duplicate: D16					18/06/2014	x		
100	Field Duplicate: D18					19/06/2014	x		
101	Field Duplicate: D19					19/06/2014	x		
102	Field Duplicate: D01					16/06/2014	x		
103	Field Duplicate: D02					16/06/2014	x		
104	Field Duplicate: D03					16/06/2014	x		
105	Field Duplicate: D05					16/06/2014	x		
106	Field Duplicate: D04					16/06/2014	x		
107	Field Duplicate: D08					17/06/2014	x		
108	Field Duplicate: D10					17/06/2014	x	x	
109	Field Duplicate: D09					17/06/2014	x	x	
110	Field Duplicate: D07					16/06/2014	x	x	
111	Field Duplicate: D06					16/06/2014	x	x	
112	Field Duplicate: D12					18/06/2014	x	x	
113	Field Duplicate: D11					18/06/2014	x	x	
114	Field Duplicate: D13					18/06/2014	x		
115	Field Duplicate: D17					19/06/2014	x	x	

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1609349**	Page	: 1 of 48
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Brisbane
Contact	: YAMIN MA	Contact	: ShukHui Li
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 08 94899700	Telephone	: 08 9209 7655
Project	: 147642090 - Mandogalup	Date Samples Received	: 07-Apr-2016 13:22
Order number	: ----	Date Analysis Commenced	: 20-Apr-2016
C-O-C number	: ----	Issue Date	: 20-Apr-2016 15:52
Sampler	: ----		
Site	: ----		
Quote number	: ----		
No. of samples received	: 115		
No. of samples analysed	: 115		

NATA Accredited Laboratory 825
Accredited for compliance with
ISO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

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

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Satishkumar Trivedi	Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils, Stafford, QLD

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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.

- ASS: EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.
- ASS: EA003 (NATA Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T43-1	ASS T43-2	ASS T43-3	ASS T43-4	ASS T43-5
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-001	EB1609349-002	EB1609349-003	EB1609349-004	EB1609349-005
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.0	5.4	5.3	5.7	6.5
pH (Fox)	----	0.1	pH Unit	1.8	3.1	3.4	3.8	5.2
Reaction Rate	----	1	Reaction Unit	3	3	2	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	4.8	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	3.4	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	82	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	497	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	415	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.131	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.796	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.666	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	0.040	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	0.232	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.192	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	120	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.500	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.182	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.082	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.098	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	0.016	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	13	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T43-1	ASS T43-2	ASS T43-3	ASS T43-4	ASS T43-5
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-001	EB1609349-002	EB1609349-003	EB1609349-004	EB1609349-005
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	**0.021**	----	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	**0.32**	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	**201**	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	**15**	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.32**	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**201**	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	**15**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T43-6	ASS T43-7	ASS T47-1	ASS T47-2	ASS T47-3
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-006	EB1609349-007	EB1609349-008	EB1609349-009	EB1609349-010
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.7	7.8	6.9	7.2	7.3
pH (Fox)	----	0.1	pH Unit	6.4	6.1	3.3	4.2	4.6
Reaction Rate	----	1	Reaction Unit	1	1	3	3	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.1	----	----	6.0
pH OX (23B)	----	0.1	pH Unit	----	6.6	----	----	5.5
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	11
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	<2	----	----	13
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	0.017
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	<0.005	----	----	0.021
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	0.046	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	0.054	----	----	0.043
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	0.009	----	----	0.043
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	6	----	----	27
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.438	----	----	0.461
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.466	----	----	0.345
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.028	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	14	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.023	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	0.184	----	----	0.065
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	0.213	----	----	0.090
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	0.029	----	----	0.024
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	24	----	----	20

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T43-6	ASS T43-7	ASS T47-1	ASS T47-2	ASS T47-3
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-006	EB1609349-007	EB1609349-008	EB1609349-009	EB1609349-010
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	**0.039**	----	----	**0.032**
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	<0.020	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	<10	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	<0.020	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	**0.06**
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	**37**
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	**3**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	**0.06**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	**37**
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	**3**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T47-4	ASS T47-5	ASS T47-6	ASS T47-7	ASS T49-1
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-011	EB1609349-012	EB1609349-013	EB1609349-014	EB1609349-015
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.2	7.3	7.8	7.5	6.3
pH (Fox)	----	0.1	pH Unit	4.9	5.0	3.8	3.3	3.7
Reaction Rate	----	1	Reaction Unit	2	1	1	2	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	<0.005	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	6.3	5.7
pH OX (23B)	----	0.1	pH Unit	----	----	----	5.4	3.9
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	25
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	<2	26
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	<0.005	0.041
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	<0.005	0.042
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	<0.005	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	0.028	0.068
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	0.028	0.068
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	18	43
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	0.097	0.390
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	0.134	0.298
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	0.036	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	18	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	0.029	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	<0.005	0.037
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	0.031	0.049
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	0.031	0.012
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	26	10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T47-4	ASS T47-5	ASS T47-6	ASS T47-7	ASS T49-1
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-011	EB1609349-012	EB1609349-013	EB1609349-014	EB1609349-015
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	----	**0.042**	**0.016**
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	**0.03**	**0.11**
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	**18**	**68**
Liming Rate	----	1	kg CaCO3/t	----	----	----	**1**	**5**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	**0.03**	**0.11**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	**18**	**68**
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	**1**	**5**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T49-2	ASS T49-3	ASS T49-4	ASS T49-5	ASS T49-6
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-016	EB1609349-017	EB1609349-018	EB1609349-019	EB1609349-020
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.2	6.9	6.4	6.6	5.2
pH (Fox)	----	0.1	pH Unit	4.8	4.4	4.9	5.2	3.5
Reaction Rate	----	1	Reaction Unit	3	2	1	1	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	5.8
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	5.2
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	4
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	4
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	----	0.006
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	----	0.006
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	----	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	----	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	----	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	----	0.025
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	----	0.052
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	----	0.028
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	----	14
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	----	0.022
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T49-2	ASS T49-3	ASS T49-4	ASS T49-5	ASS T49-6
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-016	EB1609349-017	EB1609349-018	EB1609349-019	EB1609349-020
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	----	----	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	----	<10
Liming Rate	----	1	kg CaCO3/t	----	----	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T49-7	ASS T51-1	ASS T51-2	ASS T51-3	ASS T51-4
			Client sampling date / time	[17-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-021	EB1609349-022	EB1609349-023	EB1609349-024	EB1609349-025
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.6	4.8	4.6	4.4	4.1
pH (Fox)	----	0.1	pH Unit	2.3	2.8	2.3	3.4	3.5
Reaction Rate	----	1	Reaction Unit	2	3	3	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	5.3	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	3.8	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	6	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	6	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	0.010	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	0.010	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	<0.005	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	0.023	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	0.033	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	0.010	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	5	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	0.008	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T49-7	ASS T51-1	ASS T51-2	ASS T51-3	ASS T51-4
			Client sampling date / time	[17-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-021	EB1609349-022	EB1609349-023	EB1609349-024	EB1609349-025
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	----	<0.005	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T51-5	ASS T51-6	ASS T51-7	ASS T52-1	ASS T52-2
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-026	EB1609349-027	EB1609349-028	EB1609349-029	EB1609349-030
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	4.4	4.9	6.0	6.8	7.0
pH (Fox)	----	0.1	pH Unit	3.5	3.0	2.3	3.4	3.9
Reaction Rate	----	1	Reaction Unit	2	2	2	3	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	5.4	----	6.0	----
pH OX (23B)	----	0.1	pH Unit	----	3.3	----	5.3	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	6	----	11	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	6	----	22	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	11	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.009	----	0.017	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.010	----	0.035	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	0.018	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	0.078	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	0.078	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	49	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	0.467	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.027	----	0.220	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.027	----	<0.005	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	14	----	<5	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.022	----	<0.005	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	0.056	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	0.062	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	0.006	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T51-5	ASS T51-6	ASS T51-7	ASS T52-1	ASS T52-2
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-026	EB1609349-027	EB1609349-028	EB1609349-029	EB1609349-030
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	<0.005	----	**0.007**	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	**0.10**	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	**60**	----
Liming Rate	----	1	kg CaCO3/t	----	<1	----	**4**	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	**0.10**	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	**60**	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	**4**	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T52-3	ASS T52-4	ASS T52-5	ASS T54-1	ASS T54-2
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-031	EB1609349-032	EB1609349-033	EB1609349-034	EB1609349-035
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.8	6.7	6.5	6.7	7.1
pH (Fox)	----	0.1	pH Unit	4.0	4.5	3.6	4.2	4.9
Reaction Rate	----	1	Reaction Unit	2	1	2	3	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.0	----	----	6.0
pH OX (23B)	----	0.1	pH Unit	----	4.8	----	----	5.5
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	<2	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	2	----	----	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	2	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	0.036
Peroxide Sulfur (23De)	----	0.005	% S	----	<0.005	----	----	0.052
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	<0.005	----	----	0.015
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	<5	----	----	10
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	<0.005	----	----	0.335
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.030	----	----	0.348
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.030	----	----	0.013
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	15	----	----	6
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.024	----	----	0.010
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	<0.005	----	----	0.065
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	<0.005	----	----	0.077
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	<0.005	----	----	0.012
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	<5	----	----	10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T52-3	ASS T52-4	ASS T52-5	ASS T54-1	ASS T54-2
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-031	EB1609349-032	EB1609349-033	EB1609349-034	EB1609349-035
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	<0.005	----	----	**0.016**
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	<10	----	----	<10
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	<10	----	----	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T54-3	ASS T54-4	ASS T54-5	ASS T54-6	ASS T54-7
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-036	EB1609349-037	EB1609349-038	EB1609349-039	EB1609349-040
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.2	7.3	6.4	5.7	6.1
pH (Fox)	----	0.1	pH Unit	5.2	5.2	3.9	2.2	2.2
Reaction Rate	----	1	Reaction Unit	2	2	2	3	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	0.010
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	5.8
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	4.1
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	18
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	18
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	----	0.028
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	----	0.028
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	----	0.024
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	----	0.024
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	----	15
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	----	<0.005
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	----	0.030
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	----	0.030
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	----	15
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	----	0.024
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T54-3	ASS T54-4	ASS T54-5	ASS T54-6	ASS T54-7
				Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-036	EB1609349-037	EB1609349-038	EB1609349-039	EB1609349-040
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	----	----	<0.005
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3		----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	----	----	----	**0.02**
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	----	----	**15**
Liming Rate	----	1	kg CaCO3/t		----	----	----	----	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	----	----	**0.02**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	----	----	**15**
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	----	----	**1**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T55-1	ASS T55-2	ASS T55-3	ASS T55-4	ASS T55-5
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-041	EB1609349-042	EB1609349-043	EB1609349-044	EB1609349-045
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.4	7.4	8.1	8.3	8.2
pH (Fox)	----	0.1	pH Unit	4.2	4.7	4.9	5.8	6.1
Reaction Rate	----	1	Reaction Unit	3	3	3	3	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.7	----	----	----	6.9
pH OX (23B)	----	0.1	pH Unit	4.6	----	----	----	7.4
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	186	----	----	----	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	186	----	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	----	----	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.298	----	----	----	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.298	----	----	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	0.068	----	----	----	0.055
Peroxide Sulfur (23De)	----	0.005	% S	0.211	----	----	----	0.080
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.143	----	----	----	0.025
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	89	----	----	----	16
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.885	----	----	----	1.03
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.278	----	----	----	1.03
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	----	----	----	0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	----	----	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.134	----	----	----	0.186
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.150	----	----	----	0.228
Acid Reacted Magnesium (23U)	----	0.005	% Mg	0.016	----	----	----	0.042
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	13	----	----	----	35

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T55-1	ASS T55-2	ASS T55-3	ASS T55-4	ASS T55-5
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-041	EB1609349-042	EB1609349-043	EB1609349-044	EB1609349-045
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	**0.021**	----	----	----	**0.056**
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	**0.716**
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	**143**
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	**0.229**
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.25**	----	----	----	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	**154**	----	----	----	<10
Liming Rate	----	1	kg CaCO3/t	**12**	----	----	----	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.25**	----	----	----	**0.02**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**154**	----	----	----	**16**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**12**	----	----	----	**1**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T55-6	ASS T55-7	ASS T57-1	ASS T57-2	ASS T57-3
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-046	EB1609349-047	EB1609349-048	EB1609349-049	EB1609349-050
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	8.3	8.1	6.4	7.6	8.0
pH (Fox)	----	0.1	pH Unit	8.0	5.2	2.8	5.6	5.8
Reaction Rate	----	1	Reaction Unit	4	3	3	2	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	6.2	----	----
pH OX (23B)	----	0.1	pH Unit	----	----	4.7	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	7	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	217	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	210	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	0.011	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	0.348	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	0.337	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	0.041	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	0.207	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	0.166	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	104	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	0.717	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	0.257	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	<0.005	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	<5	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	<0.005	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	0.102	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	0.131	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	0.029	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	24	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T55-6	ASS T55-7	ASS T57-1	ASS T57-2	ASS T57-3
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-046	EB1609349-047	EB1609349-048	EB1609349-049	EB1609349-050
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	**0.038**	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	**1.5**	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	**0.18**	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	**111**	----	----
Liming Rate	----	1	kg CaCO3/t	----	----	**8**	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	**0.18**	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	**111**	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	**8**	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T57-4	ASS T57-5	ASS T57-6	ASS T57-7	ASS T64-1
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-051	EB1609349-052	EB1609349-053	EB1609349-054	EB1609349-055
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	8.1	8.5	8.4	8.5	6.6
pH (Fox)	----	0.1	pH Unit	6.0	5.7	6.0	5.2	3.4
Reaction Rate	----	1	Reaction Unit	2	2	3	2	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.8	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	6.0	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	14	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	29	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	16	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.022	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.047	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.025	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	0.031	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	0.058	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.027	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	17	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.533	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.542	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.009	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	0.007	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.177	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.203	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	0.026	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	21	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T57-4	ASS T57-5	ASS T57-6	ASS T57-7	ASS T64-1
			Client sampling date / time	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-051	EB1609349-052	EB1609349-053	EB1609349-054	EB1609349-055
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	**0.034**	----	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	**30**	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	**2**	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.05**	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**30**	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T64-2	ASS T64-3	ASS T64-4	ASS T64-5	ASS T64-6
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-056	EB1609349-057	EB1609349-058	EB1609349-059	EB1609349-060
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.1	6.9	7.0	6.4	6.6
pH (Fox)	----	0.1	pH Unit	4.4	4.4	3.9	5.0	3.7
Reaction Rate	----	1	Reaction Unit	2	3	2	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	6.0	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	5.3	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	4	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	5	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	<2	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	0.007	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	0.008	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	<0.005	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	<0.005	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	0.029	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	0.029	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	18	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	0.225	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	0.250	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	0.025	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	12	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	0.020	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	0.042	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	0.057	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	0.015	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	12	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T64-2	ASS T64-3	ASS T64-4	ASS T64-5	ASS T64-6
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-056	EB1609349-057	EB1609349-058	EB1609349-059	EB1609349-060
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	**0.020**	----	----	----
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3		----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		----	**0.04**	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	**22**	----	----	----
Liming Rate	----	1	kg CaCO3/t		----	**2**	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	**0.04**	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	**22**	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	**2**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T64-7	ASS T65-1	ASS T65-2	ASS T65-3	ASS T65-4
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-061	EB1609349-062	EB1609349-063	EB1609349-064	EB1609349-065
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.3	6.5	7.2	7.5	7.5
pH (Fox)	----	0.1	pH Unit	4.9	3.2	4.7	4.9	4.7
Reaction Rate	----	1	Reaction Unit	2	3	3	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.9	5.8	----	----	----
pH OX (23B)	----	0.1	pH Unit	5.8	5.4	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	20	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	3	76	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	3	56	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	0.031	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	0.121	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	0.090	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	0.110	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	0.110	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	69	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.048	0.566	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.068	0.175	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.020	<0.005	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	10	<5	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	0.016	<0.005	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	0.048	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	0.054	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	0.006	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T64-7	ASS T65-1	ASS T65-2	ASS T65-3	ASS T65-4
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-061	EB1609349-062	EB1609349-063	EB1609349-064	EB1609349-065
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	**0.008**	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.14**	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**88**	----	----	----
Liming Rate	----	1	kg CaCO3/t	<1	**7**	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.14**	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	**88**	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**7**	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T65-5	ASS T65-6	ASS T65-7	ASS T67-1	ASS T67-2
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-066	EB1609349-067	EB1609349-068	EB1609349-069	EB1609349-070
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	**7.0**	**6.7**	**7.0**	**5.0**	**6.5**
pH (Fox)	----	0.1	pH Unit	**5.2**	**4.0**	**3.9**	**2.4**	**4.2**
Reaction Rate	----	1	Reaction Unit	**1**	**2**	**2**	**3**	**2**
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.2**	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	**5.3**	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	<0.005	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.040**	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.040**	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	**20**	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	**0.032**	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T65-5	ASS T65-6	ASS T65-7	ASS T67-1	ASS T67-2
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-066	EB1609349-067	EB1609349-068	EB1609349-069	EB1609349-070
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		<0.005	----	----	----	----
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3		----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t		<10	----	----	----	----
Liming Rate	----	1	kg CaCO3/t		<1	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		<0.02	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		<10	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T67-3	ASS T67-4	ASS T67-5	ASS T67-6	ASS T67-7
				Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-071	EB1609349-072	EB1609349-073	EB1609349-074	EB1609349-075
					Result	Result	Result	Result	Result
EA003 :pH (field/fox)									
pH (F)	----	0.1	pH Unit		6.7	5.3	6.1	6.2	6.2
pH (Fox)	----	0.1	pH Unit		5.1	2.9	3.3	1.9	2.1
Reaction Rate	----	1	Reaction Unit		1	1	1	1	1
EA026 : Chromium Reducible Sulfur									
Chromium Reducible Sulphur	----	0.005	%		----	----	----	----	0.014
EA029-A: pH Measurements									
pH KCl (23A)	----	0.1	pH Unit		----	5.3	----	----	5.7
pH OX (23B)	----	0.1	pH Unit		----	5.1	----	----	4.7
EA029-B: Acidity Trail									
Titratable Actual Acidity (23F)	----	2	mole H+ / t		----	10	----	----	4
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t		----	12	----	----	5
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t		----	<2	----	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S		----	0.017	----	----	0.007
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S		----	0.019	----	----	0.008
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S		----	<0.005	----	----	<0.005
EA029-C: Sulfur Trail									
KCl Extractable Sulfur (23Ce)	----	0.005	% S		----	<0.005	----	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S		----	<0.005	----	----	0.029
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S		----	<0.005	----	----	0.029
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t		----	<5	----	----	18
EA029-D: Calcium Values									
KCl Extractable Calcium (23Vh)	----	0.005	% Ca		----	0.021	----	----	0.053
Peroxide Calcium (23Wh)	----	0.005	% Ca		----	0.028	----	----	0.055
Acid Reacted Calcium (23X)	----	0.005	% Ca		----	0.006	----	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t		----	<5	----	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S		----	0.005	----	----	<0.005
EA029-E: Magnesium Values									
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg		----	<0.005	----	----	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg		----	<0.005	----	----	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg		----	<0.005	----	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t		----	<5	----	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T67-3	ASS T67-4	ASS T67-5	ASS T67-6	ASS T67-7
			Client sampling date / time	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-071	EB1609349-072	EB1609349-073	EB1609349-074	EB1609349-075
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	<0.005	----	----	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	**1.5**	----	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	<0.02	----	----	**0.04**
Net Acidity (acidity units)	----	10	mole H+ / t	----	**10**	----	----	**23**
Liming Rate	----	1	kg CaCO3/t	----	<1	----	----	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	<0.02	----	----	**0.04**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	**10**	----	----	**23**
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	<1	----	----	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T70-1	ASS T70-2	ASS T70-3	ASS T70-4	ASS T70-5
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-076	EB1609349-077	EB1609349-078	EB1609349-079	EB1609349-080
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.0	7.0	7.9	8.2	7.4
pH (Fox)	----	0.1	pH Unit	3.0	4.4	5.2	4.9	3.9
Reaction Rate	----	1	Reaction Unit	3	3	2	2	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	<0.005	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	4.8	----	----	6.1	----
pH OX (23B)	----	0.1	pH Unit	5.2	----	----	5.7	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	77	----	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	137	----	----	<2	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	60	----	----	<2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.123	----	----	<0.005	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.220	----	----	<0.005	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.097	----	----	<0.005	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	----	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	0.085	----	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.085	----	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	53	----	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.232	----	----	0.123	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.233	----	----	0.132	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	----	----	0.009	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	----	----	<5	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	----	----	0.007	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	----	----	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	----	----	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	----	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	----	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T70-1	ASS T70-2	ASS T70-3	ASS T70-4	ASS T70-5
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-076	EB1609349-077	EB1609349-078	EB1609349-079	EB1609349-080
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		<0.005	----	----	<0.005	----
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3		----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		**1.5**	----	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S		**0.21**	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t		**130**	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t		**10**	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		**0.21**	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		**130**	----	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		**10**	----	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T70-6	ASS T70-7	ASS T71-1	ASS T71-2	ASS T71-3
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-081	EB1609349-082	EB1609349-083	EB1609349-084	EB1609349-085
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.7	6.0	4.9	5.3	5.4
pH (Fox)	----	0.1	pH Unit	5.1	3.5	2.1	3.1	3.8
Reaction Rate	----	1	Reaction Unit	1	2	3	1	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	5.3	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	4.4	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	10	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	12	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	2	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	0.015	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	0.019	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	<0.005	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	<0.005	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	0.023	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	0.023	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	12	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	0.019	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T70-6	ASS T70-7	ASS T71-1	ASS T71-2	ASS T71-3
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-081	EB1609349-082	EB1609349-083	EB1609349-084	EB1609349-085
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	----	<0.005	----
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3		----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S		----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t		----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T71-4	ASS T71-5	ASS T71-6	ASS T71-7	ASS T73-1
			Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-086	EB1609349-087	EB1609349-088	EB1609349-089	EB1609349-090
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.6	5.7	6.1	5.4	7.6
pH (Fox)	----	0.1	pH Unit	3.9	4.4	4.5	2.7	3.9
Reaction Rate	----	1	Reaction Unit	1	1	1	2	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	<0.005	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	5.6	----	6.6
pH OX (23B)	----	0.1	pH Unit	----	----	4.4	----	5.8
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	2	----	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	5	----	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	3	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	<0.005	----	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	0.008	----	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	<0.005	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	<0.005	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	----	----	<0.005	----	0.146
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	<0.005	----	0.146
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	<5	----	91
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	<0.005	----	0.753
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	<0.005	----	0.188
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	<0.005	----	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	<5	----	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	<0.005	----	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	<0.005	----	0.115
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	<0.005	----	0.119
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	<0.005	----	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	<5	----	<5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	ASS T71-4	ASS T71-5	ASS T71-6	ASS T71-7	ASS T73-1
				Client sampling date / time	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit		EB1609349-086	EB1609349-087	EB1609349-088	EB1609349-089	EB1609349-090
					Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued									
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S		----	----	<0.005	----	**0.006**
EA029-F: Excess Acid Neutralising Capacity									
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3		----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t		----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S		----	----	----	----	----
EA029-H: Acid Base Accounting									
ANC Fineness Factor	----	0.5	-		----	----	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S		----	----	<0.02	----	**0.05**
Net Acidity (acidity units)	----	10	mole H+ / t		----	----	<10	----	**30**
Liming Rate	----	1	kg CaCO3/t		----	----	<1	----	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S		----	----	<0.02	----	**0.05**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t		----	----	<10	----	**30**
Liming Rate excluding ANC	----	1	kg CaCO3/t		----	----	<1	----	**2**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T73-2	ASS T73-3	ASS T73-4	ASS T73-5	ASS T73-6
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-091	EB1609349-092	EB1609349-093	EB1609349-094	EB1609349-095
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	7.4	7.0	6.2	6.2	6.7
pH (Fox)	----	0.1	pH Unit	3.7	3.2	2.7	2.8	5.0
Reaction Rate	----	1	Reaction Unit	3	3	3	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	<0.005	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	5.8	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	4.8	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	3	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	3	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	<0.005	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	0.005	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	0.005	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	<0.005	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	<0.005	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	<5	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	<0.005	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	0.026	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	0.026	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	13	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	0.021	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	<0.005	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	<0.005	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	<0.005	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	<5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T73-2	ASS T73-3	ASS T73-4	ASS T73-5	ASS T73-6
			Client sampling date / time	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-091	EB1609349-092	EB1609349-093	EB1609349-094	EB1609349-095
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	----	<0.005	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	**1.5**	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	<0.02	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	<10	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	<1	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T73-7	Field Duplicate: D14	Field Duplicate: D15	Field Duplicate: D16	Field Duplicate: D18
			Client sampling date / time	[19-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-096	EB1609349-097	EB1609349-098	EB1609349-099	EB1609349-100
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.9	6.8	5.0	5.0	5.4
pH (Fox)	----	0.1	pH Unit	4.1	4.2	3.2	2.6	4.5
Reaction Rate	----	1	Reaction Unit	2	2	1	3	1
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	ASS T73-7	Field Duplicate: D14	Field Duplicate: D15	Field Duplicate: D16	Field Duplicate: D18
			Client sampling date / time	[19-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-096	EB1609349-097	EB1609349-098	EB1609349-099	EB1609349-100
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Field Duplicate: D19	Field Duplicate: D01	Field Duplicate: D02	Field Duplicate: D03	Field Duplicate: D05
			Client sampling date / time	[19-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-101	EB1609349-102	EB1609349-103	EB1609349-104	EB1609349-105
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	5.4	6.7	6.4	6.4	5.4
pH (Fox)	----	0.1	pH Unit	3.3	4.8	3.7	3.7	3.6
Reaction Rate	----	1	Reaction Unit	2	3	3	3	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	----	----
pH OX (23B)	----	0.1	pH Unit	----	----	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	----	----	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Field Duplicate: D19	Field Duplicate: D01	Field Duplicate: D02	Field Duplicate: D03	Field Duplicate: D05
			Client sampling date / time	[19-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-101	EB1609349-102	EB1609349-103	EB1609349-104	EB1609349-105
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	----	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Field Duplicate: D04	Field Duplicate: D08	Field Duplicate: D10	Field Duplicate: D09	Field Duplicate: D07
			Client sampling date / time	[16-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-106	EB1609349-107	EB1609349-108	EB1609349-109	EB1609349-110
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.7	7.3	6.1	6.8	8.1
pH (Fox)	----	0.1	pH Unit	2.7	4.6	3.6	4.2	6.6
Reaction Rate	----	1	Reaction Unit	3	2	3	1	3
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	----	----	5.8	5.9	6.3
pH OX (23B)	----	0.1	pH Unit	----	----	5.2	4.6	6.7
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	17	<2	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	----	----	34	2	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	----	----	17	2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	----	----	0.027	<0.005	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	----	----	0.054	<0.005	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	----	----	0.027	<0.005	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	----	----	<0.005	<0.005	0.037
Peroxide Sulfur (23De)	----	0.005	% S	----	----	0.083	<0.005	0.040
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	----	----	0.083	<0.005	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	----	----	52	<5	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	----	----	0.492	<0.005	0.726
Peroxide Calcium (23Wh)	----	0.005	% Ca	----	----	0.231	0.024	0.745
Acid Reacted Calcium (23X)	----	0.005	% Ca	----	----	<0.005	0.024	0.020
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	----	----	<5	12	10
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	----	----	<0.005	0.020	0.016
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	----	----	0.053	<0.005	0.147
Peroxide Magnesium (23Tm)	----	0.005	% Mg	----	----	0.059	<0.005	0.156
Acid Reacted Magnesium (23U)	----	0.005	% Mg	----	----	0.006	<0.005	0.009
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	----	----	<5	<5	8

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Field Duplicate: D04	Field Duplicate: D08	Field Duplicate: D10	Field Duplicate: D09	Field Duplicate: D07
			Client sampling date / time	[16-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[17-Jun-2014]	[16-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-106	EB1609349-107	EB1609349-108	EB1609349-109	EB1609349-110
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	----	----	**0.008**	<0.005	**0.012**
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	**0.313**
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	**62**
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	**0.100**
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	----	----	**0.11**	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	**69**	<10	<10
Liming Rate	----	1	kg CaCO3/t	----	----	**5**	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	**0.11**	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	**69**	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	**5**	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Field Duplicate: D06	Field Duplicate: D12	Field Duplicate: D11	Field Duplicate: D13	Field Duplicate: D17
			Client sampling date / time	[16-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-111	EB1609349-112	EB1609349-113	EB1609349-114	EB1609349-115
				Result	Result	Result	Result	Result
EA003 :pH (field/fox)								
pH (F)	----	0.1	pH Unit	6.9	7.1	7.3	5.1	5.9
pH (Fox)	----	0.1	pH Unit	3.3	4.8	5.1	2.7	2.7
Reaction Rate	----	1	Reaction Unit	3	2	2	2	2
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.5	6.0	6.2	----	5.7
pH OX (23B)	----	0.1	pH Unit	4.8	5.8	5.3	----	4.6
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	2	<2	----	5
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	24	3	<2	----	6
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	24	<2	<2	----	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	----	0.008
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.039	0.006	<0.005	----	0.010
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.039	<0.005	<0.005	----	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	0.040	<0.005	<0.005	----	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.124	<0.005	<0.005	----	0.022
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.084	<0.005	<0.005	----	0.022
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	52	<5	<5	----	14
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.595	0.194	0.023	----	0.068
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.341	0.246	0.035	----	0.084
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	0.052	0.011	----	0.017
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	26	6	----	8
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	0.042	0.009	----	0.013
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.097	0.040	<0.005	----	0.022
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.117	0.052	<0.005	----	0.030
Acid Reacted Magnesium (23U)	----	0.005	% Mg	0.020	0.012	<0.005	----	0.007
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	16	10	<5	----	6

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Field Duplicate: D06	Field Duplicate: D12	Field Duplicate: D11	Field Duplicate: D13	Field Duplicate: D17
			Client sampling date / time	[16-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[18-Jun-2014]	[19-Jun-2014]
Compound	CAS Number	LOR	Unit	EB1609349-111	EB1609349-112	EB1609349-113	EB1609349-114	EB1609349-115
				Result	Result	Result	Result	Result
EA029-E: Magnesium Values - Continued								
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	**0.026**	**0.016**	<0.005	----	**0.010**
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	----	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	<0.02	<0.02	----	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	**34**	<10	<10	----	**19**
Liming Rate	----	1	kg CaCO3/t	**2**	<1	<1	----	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.05**	<0.02	<0.02	----	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**34**	<10	<10	----	**19**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	<1	<1	----	**1**

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1609349**	Page	: 1 of 6
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Brisbane
Contact	: YAMIN MA	Telephone	: 08 9209 7655
Project	: 147642090 - Mandogalup	Date Samples Received	: 07-Apr-2016
Site	: ----	Issue Date	: 20-Apr-2016
Sampler	: ----	No. of samples received	: 115
Order number	: ----	No. of samples analysed	: 115

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.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

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

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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: **SOIL**

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
EA003 :pH (field/fox)								
Snap Lock Bag - frozen (EA003)								
ASS T43-1,	ASS T43-2,	**16-Jun-2014**	**20-Apr-2016**	11-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
ASS T43-3,	ASS T43-4,							
ASS T43-5,	ASS T43-6,							
ASS T43-7,	ASS T55-1,							
ASS T55-2,	ASS T55-3,							
ASS T55-4,	ASS T55-5,							
ASS T55-6,	ASS T55-7,							
ASS T57-1,	ASS T57-2,							
ASS T57-3,	ASS T57-4,							
ASS T57-5,	ASS T57-6,							
ASS T57-7,	Field Duplicate: D01,							
Field Duplicate: D02,	Field Duplicate: D03,							
Field Duplicate: D05,	Field Duplicate: D04,							
Field Duplicate: D07,	Field Duplicate: D06							
Snap Lock Bag - frozen (EA003)								

Matrix: **SOIL**

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
EA003 :pH (field/fox) - Continued								
ASS T47-1,	ASS T47-2,	**17-Jun-2014**	**20-Apr-2016**	12-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
ASS T47-3,	ASS T47-4,							
ASS T47-5,	ASS T47-6,							
ASS T47-7,	ASS T49-1,							
ASS T49-2,	ASS T49-3,							
ASS T49-4,	ASS T49-5,							
ASS T49-6,	ASS T49-7,							
ASS T52-1,	ASS T52-2,							
ASS T52-3,	ASS T52-4,							
ASS T52-5,	ASS T54-1,							
ASS T54-2,	ASS T54-3,							
ASS T54-4,	ASS T54-5,							
ASS T54-6,	ASS T54-7,							
ASS T67-1,	ASS T67-2,							
ASS T67-3,	ASS T67-4,							
ASS T67-5,	ASS T67-6,							
ASS T67-7,	Field Duplicate: D08,							
Field Duplicate: D10,	Field Duplicate: D09							
Snap Lock Bag - frozen (EA003)								
ASS T51-1,	ASS T51-2,	**18-Jun-2014**	**20-Apr-2016**	13-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
ASS T51-3,	ASS T51-4,							
ASS T51-5,	ASS T51-6,							
ASS T51-7,	ASS T64-1,							
ASS T64-2,	ASS T64-3,							
ASS T64-4,	ASS T64-5,							
ASS T64-6,	ASS T64-7,							
ASS T65-1,	ASS T65-2,							
ASS T65-3,	ASS T65-4,							
ASS T65-5,	ASS T65-6,							
ASS T65-7,	ASS T70-1,							
ASS T70-2,	ASS T70-3,							
ASS T70-4,	ASS T70-5,							
ASS T70-6,	ASS T70-7,							
ASS T71-1,	ASS T71-2,							
ASS T71-3,	ASS T71-4,							
ASS T71-5,	ASS T71-6,							
ASS T71-7,	Field Duplicate: D14,							
Field Duplicate: D15,	Field Duplicate: D16,							
Field Duplicate: D12,	Field Duplicate: D11,							
Field Duplicate: D13								
Snap Lock Bag - frozen (EA003)								

Matrix: **SOIL**

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
EA003 :pH (field/fox) - Continued							
ASS T73-1, ASS T73-2, ASS T73-3, ASS T73-4, ASS T73-5, ASS T73-6, ASS T73-7, Field Duplicate: D18, Field Duplicate: D19, Field Duplicate: D17	**19-Jun-2014**	**20-Apr-2016**	14-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
EA026 : Chromium Reducible Sulfur							
Snap Lock Bag - frozen (EA026) ASS T43-7, ASS T55-5, ASS T57-4	**16-Jun-2014**	**20-Apr-2016**	11-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
Snap Lock Bag - frozen (EA026) ASS T47-7, ASS T49-6, ASS T52-4, ASS T54-7, ASS T67-7	**17-Jun-2014**	**20-Apr-2016**	12-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
Snap Lock Bag - frozen (EA026) ASS T51-6, ASS T64-7, ASS T65-5, ASS T70-4, ASS T71-6	**18-Jun-2014**	**20-Apr-2016**	13-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
Snap Lock Bag - frozen (EA026) ASS T73-5	**19-Jun-2014**	**20-Apr-2016**	14-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
EA029-D: Calcium Values							
Snap Lock Bag - frozen (EA029) ASS T43-1, ASS T43-7, ASS T55-1, ASS T55-5, ASS T57-1, ASS T57-4, Field Duplicate: D07, Field Duplicate: D06	**16-Jun-2014**	**20-Apr-2016**	11-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
Snap Lock Bag - frozen (EA029) ASS T47-3, ASS T47-7, ASS T49-1, ASS T49-6, ASS T52-1, ASS T52-4, ASS T54-2, ASS T54-7, ASS T67-4, ASS T67-7, Field Duplicate: D10, Field Duplicate: D09	**17-Jun-2014**	**20-Apr-2016**	12-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
Snap Lock Bag - frozen (EA029) ASS T51-3, ASS T51-6, ASS T64-3, ASS T64-7, ASS T65-1, ASS T65-5, ASS T70-1, ASS T70-4, ASS T71-2, ASS T71-6, Field Duplicate: D12, Field Duplicate: D11	**18-Jun-2014**	**20-Apr-2016**	13-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓
Snap Lock Bag - frozen (EA029) ASS T73-1, ASS T73-5, Field Duplicate: D17	**19-Jun-2014**	**20-Apr-2016**	14-Mar-2017	✓	**20-Apr-2016**	19-Jul-2016	✓

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: **SOIL**

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)							
Chromium Reducible Sulphur	EA026	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH field/fox	EA003	12	115	**10.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	4	35	**11.43**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Reducible Sulphur	EA026	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	35	**5.71**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Reducible Sulphur	EA026	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	2	35	**5.71**	**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 field/fox	EA003	SOIL	In house: Referenced to Ahern et al 1998 - determined on a 1:5 soil/water extract designed to simulate field measured pH and pH after the extract has been oxidised with peroxide.
Chromium Reducible Sulphur	EA026	SOIL	In house: Referenced to Sullivan et al (1998) The CRS method converts reduced inorganic sulfur to H2S by CrCl2 solution ; the evolved H2S is trapped in a zinc acetate solution as ZnS which is quantified by iodometric titration.
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

CHAIN OF CUSTODY

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095
Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740
Ph: 07 4944 0177 E: mackay@alsglobal.com

❑MELBOURNE 2-4 Westall Road Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

❑MUDGEE 27 Sydney Road Mudgee NSW 2850
Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

❑NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304
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❑NOWRA 4/13 Geary Place North Nowra NSW 2541
Ph: 024423 2063 E: nowra@alsglobal.com

❑PERTH 10 Hod Way Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsglobal.com

❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: WSP | Parsons Brinckerhoff Australia Pty Limited	**TURNAROUND REQUIREMENTS :** ☒	FOR LABORATORY USE ONLY (Circle)
OFFICE: Level 5 503 Muray St Perth WA 6000	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A

Environmental Division
Perth
Work Order Reference
EP1602099



Telephone : + 61-8-9209 7655

Rec'd STilson
10/3/16 1720
(work instruction)
10/3/16 1645
(samples)

PROJECT: 201402331			ALS QUOTE NO.: EN008/15 - YM PB - 201402331																
ORDER NUMBER:																			
PROJECT MANAGER: Yamin Ma			CONTACT PH: 9217 3279																
SAMPLER: Yamin Ma			SAMPLER MOBILE:																
COC emailed to ALS? (YES)			EDD FORMAT (or default):																
Email Reports to (will default to PM if no other addresses are listed): Yma@pb.com.au																			
Email Invoice to (will default to PM if no other addresses are listed): APInvoices@pb.com.au																			
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:																			

COC SEQUENCE NUMBER (Circle)

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

Free ice / frozen ice bricks present upon receipt? (Yes) No N/A

Random Sample Temperature on Receipt: -1.5 °C

Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Yamin Ma			STilson
DATE/TIME: 10/3/2016	DATE/TIME:	DATE/TIME:	DATE/TIME: 10/3/16 1720

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS	pHF/FOX	HOLD							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	SB01_0.0	9/03/2016	S		1	X	X							All samples kept frozen at WSP | Parsons Brinckerhoff after sampling
2	SB01_0.25	9/03/2016	S		1	X	X							
3	SB01_0.5	9/03/2016	S		1	X	X							
4	SB01_0.75	9/03/2016	S		1	X	X							
5	SB01_1.0	9/03/2016	S		1	X	X							
6	SB01_1.25	9/03/2016	S		1	X	X							
7	SB01_1.50	9/03/2016	S		1	X	X							
8	SB01_1.75	9/03/2016	S		1	X	X							
9	SB01_2.0	9/03/2016	S		1	X	X							
10	SB01_2.25	9/03/2016	S		1	X	X							
11	SB01_2.50	9/03/2016	S		1	X	X							
12	SB01_2.75	9/03/2016	S		1	X	X							
13	SB01_3.0	9/03/2016	S		1	X	X							
14	SB01_3.25	9/03/2016	S		1	X	X							
15	SB01_3.50	9/03/2016	S		1	X	X							
16	SB01_3.75	9/03/2016	S		1	X	X							
17	SB01_4.0	9/03/2016	S		1	X	X							
18	SB01_4.25	9/03/2016	S		1	X	X							
19	SB01_4.50	9/03/2016	S		1	X	X							
20	SB01_4.75	9/03/2016	S		1	X	X							

21	SB01_5.0	9/03/2016	S		1	X	X								
22	SB01_5.25	9/03/2016	S		1	X	X								
23	SB01_5.50	9/03/2016	S		1	X	X								
24	SB01_5.75	9/03/2016	S		1	X	X								
25	SB01_6.0	9/03/2016	S		1	X	X								
26	SB02_0.0	9/03/2016	S		1	X	X								
27	SB02_0.25	9/03/2016	S		1	X	X								
28	SB02_0.5	9/03/2016	S		1	X	X								
29	SB02_0.75	9/03/2016	S		1	X	X								
30	SB02_1.0	9/03/2016	S		1	X	X								
31	SB02_1.25	9/03/2016	S		1	X	X								
32	SB02_1.5	9/03/2016	S		1	X	X								
33	SB02_1.75	9/03/2016	S		1	X	X								
34	SB02_2.0	9/03/2016	S		1	X	X								
35	SB02_2.25	9/03/2016	S		1	X	X								
36	SB02_2.50	9/03/2016	S		1	X	X								
37	SB02_2.75	9/03/2016	S		1	X	X								
38	SB02_3.0	9/03/2016	S		1	X	X								
39	SB02_3.25	9/03/2016	S		1	X	X								
40	SB02_3.50	9/03/2016	S		1	X	X								
41	SB02_3.75	9/03/2016	S		1	X	X								
42	SB02_4.0	9/03/2016	S		1	X	X								
43	SB02_4.25	9/03/2016	S		1	X	X								
44	SB02_4.50	9/03/2016	S		1	X	X								
45	SB02_4.75	9/03/2016	S		1	X	X								
46	SB02_5.0	9/03/2016	S		1	X	X								
47	SB02_5.25	9/03/2016	S		1	X	X								
48	SB02_5.50	9/03/2016	S		1	X	X								
49	SB02_5.75	9/03/2016	S		1	X	X								
50	SB02_6.0	9/03/2016	S		1	X	X								
51	SB03_0.0	9/03/2016	S		1	X	X								

52	SB03_0.25	9/03/2016	S		1	X	X								
53	SB03_0.5	9/03/2016	S		1	X	X								
54	SB03_0.75	9/03/2016	S		1	X	X								
55	SB03_1.0	9/03/2016	S		1	X	X								
56	SB03_1.25	9/03/2016	S		1	X	X								
57	SB03_1.5	9/03/2016	S		1	X	X								
58	SB03_1.75	9/03/2016	S		1	X	X								
59	SB03_2.0	9/03/2016	S		1	X	X								
60	SB03_2.25	9/03/2016	S		1	X	X								
61	SB03_2.50	9/03/2016	S		1	X	X								
62	SB03_2.75	9/03/2016	S		1	X	X								
63	SB03_3.0	9/03/2016	S		1	X	X								
64	SB03_3.25	9/03/2016	S		1	X	X								
65	SB03_3.50	9/03/2016	S		1	X	X								
66	SB03_3.75	9/03/2016	S		1	X	X								
67	SB03_4.0	9/03/2016	S		1	X	X								
68	SB03_4.25	9/03/2016	S		1	X	X								
69	SB03_4.50	9/03/2016	S		1	X	X								
70	SB03_4.75	9/03/2016	S		1	X	X								
71	SB03_5.0	9/03/2016	S		1	X	X								
72	SB03_5.25	9/03/2016	S		1	X	X								
73	SB03_5.50	9/03/2016	S		1	X	X								
74	SB03_5.75	9/03/2016	S		1	X	X								
75	SB03_6.0	9/03/2016	S		1	X	X								
76	SB04_0.0	9/03/2016	S		1	X	X								
77	SB04_0.25	9/03/2016	S		1	X	X								
78	SB04_0.5	9/03/2016	S		1	X	X								
79	SB04_0.75	9/03/2016	S		1	X	X								
80	SB04_1.0	9/03/2016	S		1	X	X								
81	SB04_1.25	9/03/2016	S		1	X	X								
82	SB04_1.5	9/03/2016	S		1	X	X								

Rec'd 8PT 1720
10/3/16

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1602099**	Page	: 1 of 19
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Contact	: ShukHui Li
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: yma@pb.com.au	E-mail	: ShukHui.Li@alsglobal.com
Telephone	: +61 08 94899700	Telephone	: 08 9209 7655
Facsimile	: +61 08 93804060	Facsimile	: +61-8-9209 7600
Project	: 201402331	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 10-Mar-2016 16:45
C-O-C number	: ----	Date Analysis Commenced	: 10-Mar-2016
Sampler	: YAMIN MA	Issue Date	: 17-Mar-2016 15:55
Site	: ----		
		No. of samples received	: 82
Quote number	: ----	No. of samples analysed	: 82

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*
Daniel Fisher	Inorganics Analyst	Perth ASS, Malaga, WA

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.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB01_0.0	SB01_0.25	SB01_0.5	SB01_0.75	SB01_1.0
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-001	EP1602099-002	EP1602099-003	EP1602099-004	EP1602099-005
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**4.9**	**4.9**	**5.0**	**4.9**	**5.2**
pH (Fox)	----	0.1	pH Unit		**4.1**	**3.9**	**4.2**	**4.1**	**3.6**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_1.25	SB01_1.50	SB01_1.75	SB01_2.0	SB01_2.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-006	EP1602099-007	EP1602099-008	EP1602099-009	EP1602099-010
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.5**	**5.3**	**5.3**	**5.4**	**5.8**
pH (Fox)	----	0.1	pH Unit	**4.8**	**4.9**	**5.2**	**5.4**	**4.0**
Reaction Rate	----	1	-	**Moderate**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB01_2.50	SB01_2.75	SB01_3.0	SB01_3.25	SB01_3.50
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-011	EP1602099-012	EP1602099-013	EP1602099-014	EP1602099-015
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**5.8**	**4.5**	**4.5**	**4.6**	**5.3**
pH (Fox)	----	0.1	pH Unit		**5.1**	**2.4**	**2.2**	**2.0**	**2.0**
Reaction Rate	----	1	-		**Slight**	**Moderate**	**Moderate**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_3.75	SB01_4.0	SB01_4.25	SB01_4.50	SB01_4.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-016	EP1602099-017	EP1602099-018	EP1602099-019	EP1602099-020
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.0**	**5.3**	**5.7**	**5.6**	**5.9**
pH (Fox)	----	0.1	pH Unit	**2.3**	**2.1**	**2.1**	**2.1**	**2.0**
Reaction Rate	----	1	-	**Extreme**	**Extreme**	**Extreme**	**Extreme**	**Extreme**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_5.0	SB01_5.25	SB01_5.50	SB01_5.75	SB01_6.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-021	EP1602099-022	EP1602099-023	EP1602099-024	EP1602099-025
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.9**	**5.9**	**6.1**	**6.1**	**6.1**
pH (Fox)	----	0.1	pH Unit	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
Reaction Rate	----	1	-	**Extreme**	**Extreme**	**Extreme**	**Extreme**	**Extreme**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB02_0.0	SB02_0.25	SB02_0.5	SB02_0.75	SB02_1.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-026	EP1602099-027	EP1602099-028	EP1602099-029	EP1602099-030
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.3**	**5.0**	**5.0**	**5.6**	**5.7**
pH (Fox)	----	0.1	pH Unit	**2.6**	**2.6**	**2.2**	**2.6**	**3.0**
Reaction Rate	----	1	-	**Moderate**	**Extreme**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB02_1.25	SB02_1.5	SB02_1.75	SB02_2.0	SB02_2.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-031	EP1602099-032	EP1602099-033	EP1602099-034	EP1602099-035
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	6.2	6.1	6.4	6.1	7.5
pH (Fox)	----	0.1	pH Unit	3.6	3.6	3.8	3.4	6.7
Reaction Rate	----	1	-	Moderate	Moderate	Extreme	Moderate	Strong

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB02_2.50	SB02_2.75	SB02_3.0	SB02_3.25	SB02_3.50
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-036	EP1602099-037	EP1602099-038	EP1602099-039	EP1602099-040
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**7.7**	**7.8**	**9.0**	**8.0**	**9.0**
pH (Fox)	----	0.1	pH Unit		**6.6**	**7.6**	**8.4**	**7.8**	**8.7**
Reaction Rate	----	1	-		**Strong**	**Extreme**	**Extreme**	**Extreme**	**Extreme**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB02_3.75	SB02_4.0	SB02_4.25	SB02_4.50	SB02_4.75
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-041	EP1602099-042	EP1602099-043	EP1602099-044	EP1602099-045
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**8.7**	**9.0**	**9.4**	**8.8**	**7.8**
pH (Fox)	----	0.1	pH Unit		**8.8**	**8.4**	**8.8**	**7.1**	**5.6**
Reaction Rate	----	1	-		**Extreme**	**Extreme**	**Extreme**	**Extreme**	**Extreme**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB02_5.0	SB02_5.25	SB02_5.50	SB02_5.75	SB02_6.0
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-046	EP1602099-047	EP1602099-048	EP1602099-049	EP1602099-050
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**8.9**	**8.1**	**8.6**	**8.7**	**8.5**
pH (Fox)	----	0.1	pH Unit		**7.0**	**6.5**	**6.9**	**7.0**	**6.8**
Reaction Rate	----	1	-		**Extreme**	**Extreme**	**Extreme**	**Extreme**	**Extreme**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB03_0.0	SB03_0.25	SB03_0.5	SB03_0.75	SB03_1.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-051	EP1602099-052	EP1602099-053	EP1602099-054	EP1602099-055
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.2**	**5.8**	**5.1**	**4.9**	**5.0**
pH (Fox)	----	0.1	pH Unit	**4.2**	**4.3**	**4.2**	**4.0**	**4.0**
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB03_1.25	SB03_1.5	SB03_1.75	SB03_2.0	SB03_2.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-056	EP1602099-057	EP1602099-058	EP1602099-059	EP1602099-060
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	5.3	5.4	5.6	6.5	7.2
pH (Fox)	----	0.1	pH Unit	4.3	4.5	4.5	5.1	5.6
Reaction Rate	----	1	-	Moderate	Slight	Moderate	Moderate	Slight

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB03_2.50	SB03_2.75	SB03_3.0	SB03_3.25	SB03_3.50
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-061	EP1602099-062	EP1602099-063	EP1602099-064	EP1602099-065
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**7.2**	**7.1**	**6.9**	**7.3**	**7.5**
pH (Fox)	----	0.1	pH Unit		**5.1**	**5.2**	**4.6**	**4.7**	**4.9**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB03_3.75	SB03_4.0	SB03_4.25	SB03_4.50	SB03_4.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602099-066	EP1602099-067	EP1602099-068	EP1602099-069	EP1602099-070
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**7.4**	**7.3**	**7.3**	**7.3**	**7.4**
pH (Fox)	----	0.1	pH Unit	**4.6**	**4.4**	**4.8**	**4.5**	**4.4**
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB03_5.0	SB03_5.25	SB03_5.50	SB03_5.75	SB03_6.0
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-071	EP1602099-072	EP1602099-073	EP1602099-074	EP1602099-075
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**7.4**	**7.3**	**6.8**	**6.9**	**6.3**
pH (Fox)	----	0.1	pH Unit		**4.0**	**4.4**	**3.0**	**3.3**	**2.9**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB04_0.0	SB04_0.25	SB04_0.5	SB04_0.75	SB04_1.0
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602099-076	EP1602099-077	EP1602099-078	EP1602099-079	EP1602099-080
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**5.5**	**5.1**	**5.6**	**5.3**	**5.1**
pH (Fox)	----	0.1	pH Unit		**4.4**	**4.1**	**4.6**	**5.0**	**4.8**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_1.25	SB04_1.5	----	----	----
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit	EP1602099-081	EP1602099-082	--------	--------	--------
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.2**	**5.2**	----	----	----
pH (Fox)	----	0.1	pH Unit	**4.6**	**4.4**	----	----	----
Reaction Rate	----	1	-	**Slight**	**Slight**	----	----	----

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1602099**	Page	: 1 of 5
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Telephone	: 08 9209 7655
Project	: 201402331	Date Samples Received	: 10-Mar-2016
Site	: ----	Issue Date	: 17-Mar-2016
Sampler	: YAMIN MA	No. of samples received	: 82
Order number	: ----	No. of samples analysed	: 82

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.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

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

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: **SOIL** 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
EA037: Ass Field Screening Analysis							
Snap Lock Bag - frozen on receipt at ALS (EA037)							

Matrix: **SOIL**

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
EA037: Ass Field Screening Analysis - Continued							
SB01_0.0, SB01_0.25, SB01_0.5, SB01_0.75, SB01_1.0, SB01_1.25, SB01_1.50, SB01_1.75, SB01_2.0, SB01_2.25, SB01_2.50, SB01_2.75, SB01_3.0, SB01_3.25, SB01_3.50, SB01_3.75, SB01_4.0, SB01_4.25, SB01_4.50, SB01_4.75, SB01_5.0, SB01_5.25, SB01_5.50, SB01_5.75, SB01_6.0, SB02_0.0, SB02_0.25, SB02_0.5, SB02_0.75, SB02_1.0, SB02_1.25, SB02_1.5, SB02_1.75, SB02_2.0, SB02_2.25, SB02_2.50, SB02_2.75, SB02_3.0, SB02_3.25, SB02_3.50, SB02_3.75, SB02_4.0, SB02_4.25, SB02_4.50, SB02_4.75, SB02_5.0, SB02_5.25, SB02_5.50, SB02_5.75, SB02_6.0, SB03_0.0, SB03_0.25, SB03_0.5, SB03_0.75, SB03_1.0, SB03_1.25, SB03_1.5, SB03_1.75, SB03_2.0, SB03_2.25, SB03_2.50, SB03_2.75, SB03_3.0, SB03_3.25, SB03_3.50, SB03_3.75, SB03_4.0, SB03_4.25, SB03_4.50, SB03_4.75, SB03_5.0, SB03_5.25, SB03_5.50, SB03_5.75, SB03_6.0, SB04_0.0, SB04_0.25, SB04_0.5, SB04_0.75, SB04_1.0, SB04_1.25, SB04_1.5	**09-Mar-2016**	**10-Mar-2016**	05-Sep-2016	✓	**17-Mar-2016**	05-Sep-2016	✓

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: **SOIL**

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)							
ASS Field Screening Analysis	EA037	9	82	**10.98**	**10.00**	✓	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
ASS Field Screening Analysis	EA037	SOIL	In house: Referenced to Acid Sulfate Soils Laboratory Methods Guidelines, version 2.1 June 2004. As received samples are tested for pH field and pH fox and assessed for a reaction rating.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

❑MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

❑MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

❑NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

❑NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com

❑PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: WSP | Parsons Brinckerhoff Australia Pty Limited	TURNAROUND REQUIREMENTS : ☒	FOR LABORATORY USE ONLY (Circle)
OFFICE: Level 5 503 Muray St Perth WA 6000	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A

Environmental Division
Perth
Work Order Reference
EP1602103



Telephone : + 61-8-9209 7655

Received Stilson
10/3/16 1720
(Work Instruction)
10/3/16 1645
(samples)

PROJECT: 201402331	ALS QUOTE NO.: EN008/15 - YM PB - 201402331	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: -1.5 °C
PROJECT MANAGER: Yamin Ma	CONTACT PH: 9217 3279	OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Yamin Ma	SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY:
COC emailed to ALS? (YES)	EDD FORMAT (or default):	*Yamin Ma*	
Email Reports to (will default to PM if no other addresses are listed): Yma@pb.com.au		DATE/TIME: 10/3/2016	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed): APInvoices@pb.com.au		RELINQUISHED BY:	RECEIVED BY: STilson
		DATE/TIME:	DATE/TIME: 10/3/16 1720

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS	pHF/FOX	HOLD							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	SB01_0.0	9/03/2016	S		1	X	X							All samples kept frozen at WSP | Parsons Brinckerhoff after sampling
	SB01_0.25	9/03/2016	S		1	X	X							
	SB01_0.5	9/03/2016	S		1	X	X							
	SB01_0.75	9/03/2016	S		1	X	X							
	SB01_1.0	9/03/2016	S		1	X	X							
	SB01_1.25	9/03/2016	S		1	X	X							
	SB01_1.50	9/03/2016	S		1	X	X							
	SB01_1.75	9/03/2016	S		1	X	X							
	SB01_2.0	9/03/2016	S		1	X	X							
	SB01_2.25	9/03/2016	S		1	X	X							
	SB01_2.50	9/03/2016	S		1	X	X							
	SB01_2.75	9/03/2016	S		1	X	X							
	SB01_3.0	9/03/2016	S		1	X	X							
	SB01_3.25	9/03/2016	S		1	X	X							
	SB01_3.50	9/03/2016	S		1	X	X							
	SB01_3.75	9/03/2016	S		1	X	X							
	SB01_4.0	9/03/2016	S		1	X	X							
	SB01_4.25	9/03/2016	S		1	X	X							
	SB01_4.50	9/03/2016	S		1	X	X							
	SB01_4.75	9/03/2016	S		1	X	X							

	SB01_5.0	9/03/2016	S		1	X	X								
	SB01_5.25	9/03/2016	S		1	X	X								
	SB01_5.50	9/03/2016	S		1	X	X								
	SB01_5.75	9/03/2016	S		1	X	X								
	SB01_6.0	9/03/2016	S		1	X	X								
	SB02_0.0	9/03/2016	S		1	X	X								
	SB02_0.25	9/03/2016	S		1	X	X								
	SB02_0.5	9/03/2016	S		1	X	X								
	SB02_0.75	9/03/2016	S		1	X	X								
	SB02_1.0	9/03/2016	S		1	X	X								
	SB02_1.25	9/03/2016	S		1	X	X								
	SB02_1.5	9/03/2016	S		1	X	X								
	SB02_1.75	9/03/2016	S		1	X	X								
	SB02_2.0	9/03/2016	S		1	X	X								
	SB02_2.25	9/03/2016	S		1	X	X								
	SB02_2.50	9/03/2016	S		1	X	X								
	SB02_2.75	9/03/2016	S		1	X	X								
	SB02_3.0	9/03/2016	S		1	X	X								
	SB02_3.25	9/03/2016	S		1	X	X								
	SB02_3.50	9/03/2016	S		1	X	X								
	SB02_3.75	9/03/2016	S		1	X	X								
	SB02_4.0	9/03/2016	S		1	X	X								
	SB02_4.25	9/03/2016	S		1	X	X								
	SB02_4.50	9/03/2016	S		1	X	X								
	SB02_4.75	9/03/2016	S		1	X	X								
	SB02_5.0	9/03/2016	S		1	X	X								
	SB02_5.25	9/03/2016	S		1	X	X								
	SB02_5.50	9/03/2016	S		1	X	X								
	SB02_5.75	9/03/2016	S		1	X	X								
	SB02_6.0	9/03/2016	S		1	X	X								
	SB03_0.0	9/03/2016	S		1	X	X								

	SB03_0.25	9/03/2016	S		1	X	X							
	SB03_0.5	9/03/2016	S		1	X	X							
	SB03_0.75	9/03/2016	S		1	X	X							
	SB03_1.0	9/03/2016	S		1	X	X							
	SB03_1.25	9/03/2016	S		1	X	X							
	SB03_1.5	9/03/2016	S		1	X	X							
	SB03_1.75	9/03/2016	S		1	X	X							
	SB03_2.0	9/03/2016	S		1	X	X							
	SB03_2.25	9/03/2016	S		1	X	X							
	SB03_2.50	9/03/2016	S		1	X	X							
	SB03_2.75	9/03/2016	S		1	X	X							
	SB03_3.0	9/03/2016	S		1	X	X							
	SB03_3.25	9/03/2016	S		1	X	X							
	SB03_3.50	9/03/2016	S		1	X	X							
	SB03_3.75	9/03/2016	S		1	X	X							
	SB03_4.0	9/03/2016	S		1	X	X							
	SB03_4.25	9/03/2016	S		1	X	X							
	SB03_4.50	9/03/2016	S		1	X	X							
	SB03_4.75	9/03/2016	S		1	X	X							
	SB03_5.0	9/03/2016	S		1	X	X							
	SB03_5.25	9/03/2016	S		1	X	X							
	SB03_5.50	9/03/2016	S		1	X	X							
	SB03_5.75	9/03/2016	S		1	X	X							
	SB03_6.0	9/03/2016	S		1	X	X							
	SB04_0.0	9/03/2016	S		1	X	X							
	SB04_0.25	9/03/2016	S		1	X	X							
	SB04_0.5	9/03/2016	S		1	X	X							
	SB04_0.75	9/03/2016	S		1	X	X							
	SB04_1.0	9/03/2016	S		1	X	X							
	SB04_1.25	9/03/2016	S		1	X	X							
	SB04_1.5	9/03/2016	S		1	X	X							

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1	SB04_1.75	9/03/2016	S		1	X	X							
2	SB04_2.0	9/03/2016	S		1	X	X							
3	SB04_2.25	9/03/2016	S		1	X	X							
4	SB04_2.50	9/03/2016	S		1	X	X							
5	SB04_2.75	9/03/2016	S		1	X	X							
6	SB04_3.0	9/03/2016	S		1	X	X							
7	SB04_3.25	9/03/2016	S		1	X	X							
8	SB04_3.50	9/03/2016	S		1	X	X							
9	SB04_3.75	9/03/2016	S		1	X	X							
10	SB04_4.0	9/03/2016	S		1	X	X							
11	SB04_4.25	9/03/2016	S		1	X	X							
12	SB04_4.50	9/03/2016	S		1	X	X							
13	SB04_4.75	9/03/2016	S		1	X	X							
14	SB04_5.0	9/03/2016	S		1	X	X							
15	SB04_5.25	9/03/2016	S		1	X	X							
16	SB04_5.50	9/03/2016	S		1	X	X							
17	SB04_5.75	9/03/2016	S		1	X	X							
18	SB04_6.0	9/03/2016	S		1	X	X							
19	SB05_0.0	9/03/2016	S		1	X	X							
20	SB05_0.25	9/03/2016	S		1	X	X							
21	SB05_0.5	9/03/2016	S		1	X	X							
22	SB05_0.75	9/03/2016	S		1	X	X							
23	SB05_1.0	9/03/2016	S		1	X	X							
24	SB05_1.25	9/03/2016	S		1	X	X							
25	SB05_1.5	9/03/2016	S		1	X	X							
26	SB05_1.75	9/03/2016	S		1	X	X							
27	SB05_2.0	9/03/2016	S		1	X	X							
28	SB05_2.25	9/03/2016	S		1	X	X							
29	SB05_2.50	9/03/2016	S		1	X	X							
30	SB05_2.75	9/03/2016	S		1	X	X							
31	SB05_3.0	9/03/2016	S		1	X	X							

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32	SB05_3.25	9/03/2016	S		1	X	X							
33	SB05_3.50	9/03/2016	S		1	X	X							
34	SB05_3.75	9/03/2016	S		1	X	X							
35	SB05_4.0	9/03/2016	S		1	X	X							
36	SB05_4.25	9/03/2016	S		1	X	X							
37	SB05_4.50	9/03/2016	S		1	X	X							
38	SB05_4.75	9/03/2016	S		1	X	X							
39	SB05_5.0	9/03/2016	S		1	X	X							
40	SB05_5.25	9/03/2016	S		1	X	X							
41	SB05_5.50	9/03/2016	S		1	X	X							
42	SB05_5.75	9/03/2016	S		1	X	X							
43	SB05_6.0	9/03/2016	S		1	X	X							
44	SB06_0.0	9/03/2016	S		1	X	X							
45	SB06_0.25	9/03/2016	S		1	X	X							
46	SB06_0.5	9/03/2016	S		1	X	X							
47	SB06_0.75	9/03/2016	S		1	X	X							
48	SB06_1.0	9/03/2016	S		1	X	X							
49	SB06_1.25	9/03/2016	S		1	X	X							
50	SB06_1.5	9/03/2016	S		1	X	X							
51	SB06_1.75	9/03/2016	S		1	X	X							
52	SB06_2.0	9/03/2016	S		1	X	X							
53	SB06_2.25	9/03/2016	S		1	X	X							
54	SB06_2.50	9/03/2016	S		1	X	X							
55	SB06_2.75	9/03/2016	S		1	X	X							
56	SB06_3.0	9/03/2016	S		1	X	X							
57	SB06_3.25	9/03/2016	S		1	X	X							
58	SB06_3.50	9/03/2016	S		1	X	X							
59	SB06_3.75	9/03/2016	S		1	X	X							
60	SB06_4.0	9/03/2016	S		1	X	X							
61	SB06_4.25	9/03/2016	S		1	X	X							
62	SB06_4.50	9/03/2016	S		1	X	X							

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63	SB06_4.75	9/03/2016	S		1	X	X							
64	SB06_5.0	9/03/2016	S		1	X	X							
65	SB06_5.25	9/03/2016	S		1	X	X							
66	SB06_5.50	9/03/2016	S		1	X	X							
67	SB06_5.75	9/03/2016	S		1	X	X							
68	SB06_6.0	9/03/2016	S		1	X	X							
69	SB07_0.0	10/03/2016	S		1	X	X							
70	SB07_0.25	10/03/2016	S		1	X	X							
71	SB07_0.5	10/03/2016	S		1	X	X							
72	SB07_0.75	10/03/2016	S		1	X	X							
73	SB07_1.0	10/03/2016	S		1	X	X							
74	SB07_1.25	10/03/2016	S		1	X	X							
75	SB07_1.5	10/03/2016	S		1	X	X							
76	SB07_1.75	10/03/2016	S		1	X	X							
77	SB07_2.0	10/03/2016	S		1	X	X							
78	SB07_2.25	10/03/2016	S		1	X	X							
79	SB07_2.50	10/03/2016	S		1	X	X							
80	SB07_2.75	10/03/2016	S		1	X	X							
81	SB07_3.0	10/03/2016	S		1	X	X							
82	SB07_3.25	10/03/2016	S		1	X	X							
83	SB07_3.50	10/03/2016	S		1	X	X							
84	SB07_3.75	10/03/2016	S		1	X	X							
85	SB07_4.0	10/03/2016	S		1	X	X							
86	SB07_4.25	10/03/2016	S		1	X	X							
87	SB07_4.50	10/03/2016	S		1	X	X							
88	SB07_4.75	10/03/2016	S		1	X	X							
89	SB07_5.0	10/03/2016	S		1	X	X							
90	SB07_5.25	10/03/2016	S		1	X	X							
91	SB07_5.50	10/03/2016	S		1	X	X							
92	SB07_5.75	10/03/2016	S		1	X	X							
93	SB07_6.0	10/03/2016	S		1	X	X							

Recd SPT
10/3/16
1720

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1602103**	Page	: 1 of 21
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Contact	: ShukHui Li
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: yma@pb.com.au	E-mail	: ShukHui.Li@alsglobal.com
Telephone	: +61 08 94899700	Telephone	: 08 9209 7655
Facsimile	: +61 08 93804060	Facsimile	: +61-8-9209 7600
Project	: 201402331	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 10-Mar-2016 16:45
C-O-C number	: ----	Date Analysis Commenced	: 10-Mar-2016
Sampler	: YAMIN MA	Issue Date	: 16-Mar-2016 12:01
Site	: ----		
		No. of samples received	: 93
Quote number	: ----	No. of samples analysed	: 93

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*
Daniel Fisher	Inorganics Analyst	Perth ASS, Malaga, WA

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.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_1.75	SB04_2.0	SB04_2.25	SB04_2.5	SB04_2.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-001	EP1602103-002	EP1602103-003	EP1602103-004	EP1602103-005
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**4.7**	**5.0**	**4.7**	**4.7**	**5.0**
pH (Fox)	----	0.1	pH Unit	**4.0**	**4.3**	**3.8**	**3.8**	**4.1**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_3.0	SB04_3.25	SB04_3.50	SB04_3.75	SB04_4.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-006	EP1602103-007	EP1602103-008	EP1602103-009	EP1602103-010
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**4.9**	**5.0**	**4.9**	**4.6**	**4.8**
pH (Fox)	----	0.1	pH Unit	**3.6**	**3.6**	**3.4**	**2.9**	**2.6**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_4.25	SB04_4.50	SB04_4.75	SB04_5.0	SB04_5.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-011	EP1602103-012	EP1602103-013	EP1602103-014	EP1602103-015
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.2**	**5.5**	**5.4**	**5.4**	**5.3**
pH (Fox)	----	0.1	pH Unit	**2.8**	**2.8**	**2.7**	**2.7**	**2.8**
Reaction Rate	----	1	-	**Moderate**	**Slight**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_5.50	SB04_5.75	SB04_6.0	SB05_0.0	SB05_0.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-016	EP1602103-017	EP1602103-018	EP1602103-019	EP1602103-020
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.3**	**5.3**	**5.4**	**6.9**	**6.6**
pH (Fox)	----	0.1	pH Unit	**2.7**	**2.8**	**2.7**	**4.7**	**4.7**
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB05_0.50	SB05_0.75	SB05_1.0	SB05_1.25	SB05_1.50
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-021	EP1602103-022	EP1602103-023	EP1602103-024	EP1602103-025
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.5**	**7.2**	**7.2**	**7.2**	**7.4**
pH (Fox)	----	0.1	pH Unit	**5.1**	**5.3**	**5.2**	**5.2**	**5.2**
Reaction Rate	----	1	-	**Moderate**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB05_1.75	SB05_2.0	SB05_2.25	SB05_2.50	SB05_2.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-026	EP1602103-027	EP1602103-028	EP1602103-029	EP1602103-030
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**7.3**	**7.2**	**6.9**	**6.6**	**6.5**
pH (Fox)	----	0.1	pH Unit	**5.1**	**5.0**	**4.6**	**3.1**	**2.7**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB05_3.0	SB05_3.25	SB05_3.50	SB05_3.75	SB05_4.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-031	EP1602103-032	EP1602103-033	EP1602103-034	EP1602103-035
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.5**	**6.8**	**6.8**	**6.9**	**6.6**
pH (Fox)	----	0.1	pH Unit	**1.9**	**2.7**	**2.4**	**2.2**	**2.0**
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB05_4.25	SB05_4.50	SB05_4.75	SB05_5.0	SB05_5.25
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602103-036	EP1602103-037	EP1602103-038	EP1602103-039	EP1602103-040
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**6.5**	**6.6**	**6.4**	**6.4**	**6.4**
pH (Fox)	----	0.1	pH Unit		**1.8**	**1.9**	**1.6**	**1.6**	**1.6**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Strong**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB05_5.50	SB05_5.75	SB05_6.0	SB06_0.0	SB06_0.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-041	EP1602103-042	EP1602103-043	EP1602103-044	EP1602103-045
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.4**	**6.3**	**6.4**	**5.2**	**5.1**
pH (Fox)	----	0.1	pH Unit	**1.6**	**1.7**	**1.5**	**3.0**	**2.7**
Reaction Rate	----	1	-	**Strong**	**Strong**	**Strong**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB06_0.50	SB06_0.75	SB06_1.0	SB06_1.25	SB06_1.50
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602103-046	EP1602103-047	EP1602103-048	EP1602103-049	EP1602103-050
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**5.0**	**4.7**	**5.7**	**5.5**	**5.5**
pH (Fox)	----	0.1	pH Unit		**2.6**	**2.7**	**3.0**	**3.0**	**3.0**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_1.75	SB06_2.0	SB06_2.25	SB06_2.50	SB06_2.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-051	EP1602103-052	EP1602103-053	EP1602103-054	EP1602103-055
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**4.9**	**5.2**	**5.7**	**5.7**	**5.4**
pH (Fox)	----	0.1	pH Unit	**2.9**	**2.9**	**3.2**	**3.1**	**2.8**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_3.0	SB06_3.25	SB06_3.50	SB06_3.75	SB06_4.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-056	EP1602103-057	EP1602103-058	EP1602103-059	EP1602103-060
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.4**	**5.4**	**5.6**	**5.5**	**5.4**
pH (Fox)	----	0.1	pH Unit	**2.8**	**2.7**	**2.7**	**2.8**	**2.8**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_4.25	SB06_4.50	SB06_4.75	SB06_5.0	SB06_5.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-061	EP1602103-062	EP1602103-063	EP1602103-064	EP1602103-065
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.1**	**5.8**	**5.6**	**5.7**	**5.9**
pH (Fox)	----	0.1	pH Unit	**2.2**	**2.2**	**2.1**	**1.9**	**1.9**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB06_5.50	SB06_5.75	SB06_6.0	SB07_0.0	SB07_0.25
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602103-066	EP1602103-067	EP1602103-068	EP1602103-069	EP1602103-070
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**5.5**	**5.6**	**5.4**	**6.0**	**6.1**
pH (Fox)	----	0.1	pH Unit		**1.9**	**2.1**	**1.8**	**4.1**	**4.4**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB07_0.50	SB07_0.75	SB07_1.0	SB07_1.25	SB07_1.50
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-071	EP1602103-072	EP1602103-073	EP1602103-074	EP1602103-075
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.1**	**6.2**	**6.8**	**6.7**	**7.3**
pH (Fox)	----	0.1	pH Unit	**4.5**	**4.6**	**4.6**	**4.6**	**5.2**
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB07_1.75	SB07_2.0	SB07_2.25	SB07_2.5	SB07_2.75
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-076	EP1602103-077	EP1602103-078	EP1602103-079	EP1602103-080
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**7.4**	**6.6**	**6.2**	**6.4**	**6.2**
pH (Fox)	----	0.1	pH Unit	**5.8**	**4.4**	**3.6**	**4.1**	**3.6**
Reaction Rate	----	1	-	**Slight**	**Moderate**	**Moderate**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB07_3.0	SB07_3.25	SB07_3.50	SB07_3.75	SB07_4.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602103-081	EP1602103-082	EP1602103-083	EP1602103-084	EP1602103-085
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.1**	**6.3**	**6.3**	**6.3**	**6.3**
pH (Fox)	----	0.1	pH Unit	**2.4**	**3.5**	**3.5**	**2.1**	**2.1**
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB07_4.25	SB07_4.50	SB07_4.75	SB07_5.0	SB07_5.25
				Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602103-086	EP1602103-087	EP1602103-088	EP1602103-089	EP1602103-090
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**6.4**	**6.5**	**6.4**	**6.5**	**6.5**
pH (Fox)	----	0.1	pH Unit		**2.0**	**2.0**	**2.8**	**2.0**	**2.0**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB07_5.50	SB07_5.75	SB07_6.0	----	----
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	----	----
Compound	CAS Number	LOR	Unit	EP1602103-091	EP1602103-092	EP1602103-093	--------	--------
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.4**	**6.5**	**6.4**	----	----
pH (Fox)	----	0.1	pH Unit	**1.8**	**1.9**	**1.8**	----	----
Reaction Rate	----	1	-	**Moderate**	**Moderate**	**Moderate**	----	----

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1602103**	Page	: 1 of 6
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Telephone	: 08 9209 7655
Project	: 201402331	Date Samples Received	: 10-Mar-2016
Site	: ----	Issue Date	: 16-Mar-2016
Sampler	: YAMIN MA	No. of samples received	: 93
Order number	: ----	No. of samples analysed	: 93

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.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

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

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: **SOIL** 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
EA037: Ass Field Screening Analysis							
Snap Lock Bag - frozen (EA037)							

Matrix: **SOIL**

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
EA037: Ass Field Screening Analysis - Continued								
SB04_1.75,	SB04_2.0,	**09-Mar-2016**	**10-Mar-2016**	05-Sep-2016	✓	**15-Mar-2016**	05-Sep-2016	✓
SB04_2.25,	SB04_2.5,							
SB04_2.75,	SB04_3.0,							
SB04_3.25,	SB04_3.50,							
SB04_3.75,	SB04_4.0,							
SB04_4.25,	SB04_4.50,							
SB04_4.75,	SB04_5.0,							
SB04_5.25,	SB04_5.50,							
SB04_5.75,	SB04_6.0,							
SB05_0.0,	SB05_0.25,							
SB05_0.50,	SB05_0.75,							
SB05_1.0,	SB05_1.25,							
SB05_1.50,	SB05_1.75,							
SB05_2.0,	SB05_2.25,							
SB05_2.50,	SB05_2.75,							
SB05_3.0,	SB05_3.25,							
SB05_3.50,	SB05_3.75,							
SB05_4.0,	SB05_4.25,							
SB05_4.50,	SB05_4.75,							
SB05_5.0,	SB05_5.25,							
SB05_5.50,	SB05_5.75,							
SB05_6.0,	SB06_0.0,							
SB06_0.25,	SB06_0.50,							
SB06_0.75,	SB06_1.0,							
SB06_1.25,	SB06_1.50,							
SB06_1.75,	SB06_2.0,							
SB06_2.25,	SB06_2.50,							
SB06_2.75,	SB06_3.0,							
SB06_3.25,	SB06_3.50,							
SB06_3.75,	SB06_4.0,							
SB06_4.25,	SB06_4.50,							
SB06_4.75,	SB06_5.0,							
SB06_5.25,	SB06_5.50,							
SB06_5.75,	SB06_6.0							
Snap Lock Bag - frozen (EA037)								

Matrix: **SOIL**

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
EA037: Ass Field Screening Analysis - Continued								
SB07_0.0,	SB07_0.25,	**10-Mar-2016**	**10-Mar-2016**	06-Sep-2016	✓	**15-Mar-2016**	06-Sep-2016	✓
SB07_0.50,	SB07_0.75,							
SB07_1.0,	SB07_1.25,							
SB07_1.50,	SB07_1.75,							
SB07_2.0,	SB07_2.25,							
SB07_2.5,	SB07_2.75,							
SB07_3.0,	SB07_3.25,							
SB07_3.50,	SB07_3.75,							
SB07_4.0,	SB07_4.25,							
SB07_4.50,	SB07_4.75,							
SB07_5.0,	SB07_5.25,							
SB07_5.50,	SB07_5.75,							
SB07_6.0								

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: **SOIL**

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)							
ASS Field Screening Analysis	EA037	10	93	**10.75**	**10.00**	✓	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
ASS Field Screening Analysis	EA037	SOIL	In house: Referenced to Acid Sulfate Soils Laboratory Methods Guidelines, version 2.1 June 2004. As received samples are tested for pH field and pH fox and assessed for a reaction rating.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: WSP | Parsons Brinckerhoff Australia Pty Limited	**TURNAROUND REQUIREMENTS :** ☒	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Level 5 503 Muray St Perth WA 6000	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A

Environmental Division
Perth
Work Order Reference
EP1602105

Telephone : + 61-8-9209 7655

Redd Stilson
10/3/16 1720
(work instruction)
10/3/16 1645
(samples)

1	SB08_0.0	10/03/2016	S		1	X	X								
2	SB08_0.25	10/03/2016	S		1	X	X								
3	SB08_0.5	10/03/2016	S		1	X	X								
4	SB08_0.75	10/03/2016	S		1	X	X								
5	SB08_1.0	10/03/2016	S		1	X	X								
6	SB08_1.25	10/03/2016	S		1	X	X								
7	SB08_1.5	10/03/2016	S		1	X	X								
8	SB08_0.75	10/03/2016	S		1	X	X								
9	SB08_2.0	10/03/2016	S		1	X	X								
10	SB08_2.25	10/03/2016	S		1	X	X								
11	SB08_2.50	10/03/2016	S		1	X	X								
12	SB08_2.75	10/03/2016	S		1	X	X								
13	SB08_3.0	10/03/2016	S		1	X	X								
14	SB08_3.25	10/03/2016	S		1	X	X								
15	SB08_3.50	10/03/2016	S		1	X	X								
16	SB08_3.75	10/03/2016	S		1	X	X								
17	SB08_4.0	10/03/2016	S		1	X	X								
18	SB08_4.25	10/03/2016	S		1	X	X								
19	SB08_4.50	10/03/2016	S		1	X	X								
20	SB08_4.75	10/03/2016	S		1	X	X								
21	SB08_5.0	10/03/2016	S		1	X	X								
23	SB08_5.25	10/03/2016	S		1	X	X								
22	SB08_5.50	10/03/2016	S		1	X	X								
24	SB08_5.75	10/03/2016	S		1	X	X								
25	SB08_6.0	10/03/2016	S		1	X	X								
26	SB09_0.0	10/03/2016	S		1	X	X								
27	SB09_0.25	10/03/2016	S		1	X	X								
28	SB09_0.5	10/03/2016	S		1	X	X								
29	SB09_0.75	10/03/2016	S		1	X	X								
30	SB09_1.0	10/03/2016	S		1	X	X								
31	SB09_1.25	10/03/2016	S		1	X	X								

Rec'd SPT 10/31/16 1720

32	SB09_1.5	10/03/2016	S		1	X	X								
33	SB09_0.75	10/03/2016	S		1	X	X								
34	SB09_2.0	10/03/2016	S		1	X	X								
35	SB09_2.25	10/03/2016	S		1	X	X								
36	SB09_2.50	10/03/2016	S		1	X	X								
37	SB09_2.75	10/03/2016	S		1	X	X								
38	SB09_3.0	10/03/2016	S		1	X	X								
39	SB09_3.25	10/03/2016	S		1	X	X								
40	SB09_3.50	10/03/2016	S		1	X	X								
41	SB09_3.75	10/03/2016	S		1	X	X								
42	SB09_4.0	10/03/2016	S		1	X	X								
43	SB09_4.25	10/03/2016	S		1	X	X								
44	SB09_4.50	10/03/2016	S		1	X	X								
45	SB09_4.75	10/03/2016	S		1	X	X								
46	SB09_5.0	10/03/2016	S		1	X	X								
47	SB09_5.25	10/03/2016	S		1	X	X								
48	SB09_5.50	10/03/2016	S		1	X	X								
49	SB09_5.75	10/03/2016	S		1	X	X								
50	SB09_6.0	10/03/2016	S		1	X	X								
51	SB10_0.0	10/03/2016	S		1	X	X								
52	SB10_0.25	10/03/2016	S		1	X	X								
53	SB10_0.5	10/03/2016	S		1	X	X								
54	SB10_0.75	10/03/2016	S		1	X	X								
55	SB10_1.0	10/03/2016	S		1	X	X								
56	SB10_1.25	10/03/2016	S		1	X	X								
57	SB10_1.5	10/03/2016	S		1	X	X								
58	SB10_0.75	10/03/2016	S		1	X	X								
59	SB10_2.0	10/03/2016	S		1	X	X								
60	SB10_2.25	10/03/2016	S		1	X	X								
61	SB10_2.50	10/03/2016	S		1	X	X								
62	SB10_2.75	10/03/2016	S		1	X	X								

Rec'd SK
10/8/16
1720

63	SB10_3.0	10/03/2016	S		1	X	X								
64	SB10_3.25	10/03/2016	S		1	X	X								
65	SB10_3.50	10/03/2016	S		1	X	X								
66	SB10_3.75	10/03/2016	S		1	X	X								
67	SB10_4.0	10/03/2016	S		1	X	X								
68	SB10_4.25	10/03/2016	S		1	X	X								
69	SB10_4.50	10/03/2016	S		1	X	X								
70	SB10_4.75	10/03/2016	S		1	X	X								
71	SB10_5.0	10/03/2016	S		1	X	X								
72	SB10_5.25	10/03/2016	S		1	X	X								
73	SB10_5.50	10/03/2016	S		1	X	X								
74	SB10_5.75	10/03/2016	S		1	X	X								
75	SB10_6.0	10/03/2016	S		1	X	X								
76	QC1	9/03/2016	S		1	X	X								
77	QC2	9/03/2016	S		1	X	X								
78	QC3	9/03/2016	S		1	X	X								
79	QC4	9/03/2016	S		1	X	X								
80	QC5	9/03/2016	S		1	X	X								
81	QC6	9/03/2016	S		1	X	X								
82	QC7	9/03/2016	S		1	X	X								
83	QC8	9/03/2016	S		1	X	X								
84	QC9	10/03/2016	S		1	X	X								
85	QC10	10/03/2016	S		1	X	X								
86	QC11	10/03/2016	S		1	X	X								
87	QC12	10/03/2016	S		1	X	X								
				TOTAL											

Recd 8/11 10/3/16 12°

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1602105**	Page	: 1 of 20
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Contact	: ShukHui Li
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: yma@pb.com.au	E-mail	: ShukHui.Li@alsglobal.com
Telephone	: +61 08 94899700	Telephone	: 08 9209 7655
Facsimile	: +61 08 93804060	Facsimile	: +61-8-9209 7600
Project	: 201402331	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 10-Mar-2016 16:45
C-O-C number	: ----	Date Analysis Commenced	: 11-Mar-2016
Sampler	: YAMIN MA	Issue Date	: 18-Mar-2016 11:22
Site	: ----		
		No. of samples received	: 87
Quote number	: ----	No. of samples analysed	: 87

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*
Daniel Fisher	Inorganics Analyst	Perth ASS, Malaga, WA

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.

- ASS: EA037 (Rapid Field and F(ox) screening): pH F(ox) Reaction Rate: 1 - Slight; 2 - Moderate; 3 - Strong; 4 - Extreme
- EA037 ASS Field Screening: NATA accreditation does not cover performance of this service.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_0.0	SB08_0.25	SB08_0.5	SB08_0.75	SB08_1.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-001	EP1602105-002	EP1602105-003	EP1602105-004	EP1602105-005
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.3**	**5.2**	**5.3**	**5.1**	**4.9**
pH (Fox)	----	0.1	pH Unit	**4.2**	**4.8**	**5.0**	**4.7**	**4.5**
Reaction Rate	----	1	-	**Moderate**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_1.25	SB08_1.5	SB08_0.75	SB08_2.0	SB08_2.25
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-006	EP1602105-007	EP1602105-008	EP1602105-009	EP1602105-010
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.3**	**5.3**	**5.8**	**5.5**	**5.6**
pH (Fox)	----	0.1	pH Unit	**5.2**	**5.2**	**5.3**	**5.4**	**5.3**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_2.50	SB08_2.75	SB08_3.0	SB08_3.25	SB08_3.50
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-011	EP1602105-012	EP1602105-013	EP1602105-014	EP1602105-015
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.4**	**5.4**	**5.5**	**5.3**	**5.4**
pH (Fox)	----	0.1	pH Unit	**4.9**	**5.2**	**5.1**	**4.8**	**4.9**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_3.75	SB08_4.0	SB08_4.25	SB08_4.50	SB08_4.75
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-016	EP1602105-017	EP1602105-018	EP1602105-019	EP1602105-020
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.4**	**5.4**	**5.3**	**5.4**	**5.6**
pH (Fox)	----	0.1	pH Unit	**4.5**	**4.4**	**4.8**	**4.1**	**4.1**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_5.0	SB08_5.25	SB08_5.50	SB08_5.75	SB08_6.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-021	EP1602105-022	EP1602105-023	EP1602105-024	EP1602105-025
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.9**	**5.8**	**5.8**	**5.8**	**5.9**
pH (Fox)	----	0.1	pH Unit	**4.3**	**3.8**	**3.4**	**4.8**	**3.8**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Moderate**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB09_0.0	SB09_0.25	SB09_0.5	SB09_0.75	SB09_1.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-026	EP1602105-027	EP1602105-028	EP1602105-029	EP1602105-030
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**4.9**	**4.6**	**4.8**	**4.4**	**4.3**
pH (Fox)	----	0.1	pH Unit	**4.2**	**3.8**	**3.8**	**3.8**	**3.5**
Reaction Rate	----	1	-	**Slight**	**Moderate**	**Moderate**	**Slight**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB09_1.25	SB09_1.5	SB09_0.75	SB09_2.0	SB09_2.25
				Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602105-031	EP1602105-032	EP1602105-033	EP1602105-034	EP1602105-035
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**4.7**	**4.9**	**4.6**	**5.0**	**4.6**
pH (Fox)	----	0.1	pH Unit		**3.7**	**3.8**	**3.8**	**4.0**	**3.5**
Reaction Rate	----	1	-		**Moderate**	**Moderate**	**Slight**	**Slight**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB09_2.50	SB09_2.75	SB09_3.0	SB09_3.25	SB09_3.50
				Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602105-036	EP1602105-037	EP1602105-038	EP1602105-039	EP1602105-040
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**4.6**	**4.5**	**4.4**	**4.6**	**4.7**
pH (Fox)	----	0.1	pH Unit		**3.6**	**3.9**	**3.7**	**3.2**	**3.3**
Reaction Rate	----	1	-		**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB09_3.75	SB09_4.0	SB09_4.25	SB09_4.50	SB09_4.75
				Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602105-041	EP1602105-042	EP1602105-043	EP1602105-044	EP1602105-045
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**4.9**	**5.0**	**5.1**	**5.2**	**5.0**
pH (Fox)	----	0.1	pH Unit		**4.0**	**3.7**	**3.4**	**3.1**	**3.6**
Reaction Rate	----	1	-		**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB09_5.0	SB09_5.25	SB09_5.50	SB09_5.75	SB09_6.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-046	EP1602105-047	EP1602105-048	EP1602105-049	EP1602105-050
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**4.8**	**4.8**	**4.8**	**5.0**	**5.1**
pH (Fox)	----	0.1	pH Unit	**3.8**	**4.0**	**3.7**	**3.9**	**3.9**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB10_0.0	SB10_0.25	SB10_0.5	SB10_0.75	SB10_1.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-051	EP1602105-052	EP1602105-053	EP1602105-054	EP1602105-055
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.7**	**5.8**	**6.0**	**5.8**	**5.3**
pH (Fox)	----	0.1	pH Unit	**4.7**	**4.6**	**4.6**	**4.5**	**5.1**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SB10_1.25	SB10_1.5	SB10_0.75	SB10_2.0	SB10_2.25
				Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602105-056	EP1602105-057	EP1602105-058	EP1602105-059	EP1602105-060
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**5.5**	**5.6**	**5.9**	**5.3**	**5.4**
pH (Fox)	----	0.1	pH Unit		**4.9**	**4.9**	**4.9**	**4.9**	**4.9**
Reaction Rate	----	1	-		**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB10_2.50	SB10_2.75	SB10_3.0	SB10_3.25	SB10_3.50
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-061	EP1602105-062	EP1602105-063	EP1602105-064	EP1602105-065
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	5.3	5.3	5.4	5.3	5.3
pH (Fox)	----	0.1	pH Unit	4.9	5.1	5.2	5.1	5.0
Reaction Rate	----	1	-	Slight	Slight	Slight	Slight	Slight

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB10_3.75	SB10_4.0	SB10_4.25	SB10_4.50	SB10_4.75
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-066	EP1602105-067	EP1602105-068	EP1602105-069	EP1602105-070
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**5.1**	**5.0**	**6.7**	**6.2**	**6.1**
pH (Fox)	----	0.1	pH Unit	**5.2**	**5.0**	**4.9**	**4.8**	**5.2**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Slight**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB10_5.0	SB10_5.25	SB10_5.50	SB10_5.75	SB10_6.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602105-071	EP1602105-072	EP1602105-073	EP1602105-074	EP1602105-075
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**6.4**	**6.1**	**5.7**	**6.3**	**6.1**
pH (Fox)	----	0.1	pH Unit	**4.7**	**4.8**	**4.9**	**4.9**	**5.0**
Reaction Rate	----	1	-	**Slight**	**Slight**	**Slight**	**Moderate**	**Slight**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	QC1	QC2	QC3	QC4	QC5
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602105-076	EP1602105-077	EP1602105-078	EP1602105-079	EP1602105-080
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**6.2**	**8.4**	**6.1**	**5.3**	**6.5**
pH (Fox)	----	0.1	pH Unit		**3.4**	**7.6**	**3.9**	**4.3**	**2.2**
Reaction Rate	----	1	-		**Moderate**	**Extreme**	**Moderate**	**Slight**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	QC6	QC7	QC8	QC9	QC10
				Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602105-081	EP1602105-082	EP1602105-083	EP1602105-084	EP1602105-085
					Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis									
pH (F)	----	0.1	pH Unit		**6.4**	**5.2**	**5.6**	**6.3**	**5.8**
pH (Fox)	----	0.1	pH Unit		**1.6**	**2.9**	**3.0**	**4.6**	**4.2**
Reaction Rate	----	1	-		**Slight**	**Moderate**	**Moderate**	**Moderate**	**Moderate**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	QC11	QC12	----	----	----
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit	EP1602105-086	EP1602105-087	--------	--------	--------
				Result	Result	Result	Result	Result
EA037: Ass Field Screening Analysis								
pH (F)	----	0.1	pH Unit	**4.4**	**5.7**	----	----	----
pH (Fox)	----	0.1	pH Unit	**3.4**	**4.2**	----	----	----
Reaction Rate	----	1	-	**Moderate**	**Moderate**	----	----	----

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1602105**	Page	: 1 of 5
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Telephone	: 08 9209 7655
Project	: 201402331	Date Samples Received	: 10-Mar-2016
Site	: ----	Issue Date	: 18-Mar-2016
Sampler	: YAMIN MA	No. of samples received	: 87
Order number	: ----	No. of samples analysed	: 87

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.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

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

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: **SOIL** 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
EA037: Ass Field Screening Analysis							
Snap Lock Bag - frozen on receipt at ALS (EA037)							
QC1, QC2, QC3, QC4, QC5, QC6, QC7, QC8	**09-Mar-2016**	**11-Mar-2016**	05-Sep-2016	✓	**17-Mar-2016**	05-Sep-2016	✓
Snap Lock Bag - frozen on receipt at ALS (EA037)							

Matrix: **SOIL**

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
EA037: Ass Field Screening Analysis - Continued							
SB08_0.0, SB08_0.25, SB08_0.5, SB08_0.75, SB08_1.0, SB08_1.25, SB08_1.5, SB08_0.75, SB08_2.0, SB08_2.25, SB08_2.50, SB08_2.75, SB08_3.0, SB08_3.25, SB08_3.50, SB08_3.75, SB08_4.0, SB08_4.25, SB08_4.50, SB08_4.75, SB08_5.0, SB08_5.25, SB08_5.50, QC9, SB08_5.75, SB08_6.0, SB09_0.0, SB09_0.25, SB09_0.5, SB09_0.75, SB09_1.0, SB09_1.25, SB09_1.5, SB09_0.75, SB09_2.0, SB09_2.25, SB09_2.50, SB09_2.75, SB09_3.0, SB09_3.25, SB09_3.50, SB09_3.75, SB09_4.0, SB09_4.25, SB09_4.50, SB09_4.75, SB09_5.0, QC10, SB09_5.25, SB09_5.50, SB09_5.75, SB09_6.0, SB10_0.0, SB10_0.25, SB10_0.5, SB10_0.75, SB10_1.0, SB10_1.25, SB10_1.5, SB10_0.75, SB10_2.0, SB10_2.25, SB10_2.50, SB10_2.75, SB10_3.0, SB10_3.25, SB10_3.50, SB10_3.75, SB10_4.0, SB10_4.25, SB10_4.50, QC11, SB10_4.75, SB10_5.0, SB10_5.25, SB10_5.50, SB10_5.75, SB10_6.0, QC12	**10-Mar-2016**	**11-Mar-2016**	06-Sep-2016	✓	**17-Mar-2016**	06-Sep-2016	✓

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: **SOIL**

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)							
ASS Field Screening Analysis	EA037	9	87	**10.34**	**10.00**	✓	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
ASS Field Screening Analysis	EA037	SOIL	In house: Referenced to Acid Sulfate Soils Laboratory Methods Guidelines, version 2.1 June 2004. As received samples are tested for pH field and pH fox and assessed for a reaction rating.

Preparation Methods	Method	Matrix	Method Descriptions
Drying only	EN020D	SOIL	In house

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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MELBOURNE: 4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 Fax: 03 8549 9601 melbourne@alsglobal.com

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DARWIN: 27 Ross Lane Winnellie NT 0820 Ph: 08 8370 0100 Fax: 08 8370 0101 darwin@alsglobal.com

LAUNCESTON: 38 Kerry Street, Mayfield TAS 7248 Ph: 03 6323 2800 Fax: 03 6323 2898 launceston@alsglobal.com

CLIENT: Parsons Brinckerhoff Australia Pty Limited	**TURNAROUND REQUIREMENTS :** ☒ (Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☐ Non Standard or urgent TAT (List due date):		
OFFICE: Level 5 503 Murray St Perth WA 6000	**ALS QUOTE NO.:** EP737/14		
PROJECT: 2208443A/201402331		**COC SEQUENCE NUMBER (Circle)**	
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	
PROJECT MANAGER: Yamin Ma	**CONTACT PH:** 9217 3279	OF: 1 2 3 4 5 6 7	
SAMPLER: Yamin Ma	**SAMPLER MOBILE:**	**RELINQUISHED BY:** Yamin Ma	**RECEIVED BY:** Joshua Rees
COC emailed to ALS? (YES)	**EDD FORMAT (or default):**	DATE/TIME: 05/04/16	DATE/TIME: 05/04/16 16:53
Email Reports to (will default to PM if no other addresses are listed): Yma@pb.com.au; abeaton@pb.com.au		**RELINQUISHED BY:**	**RECEIVED BY:**
Email Invoice to (will default to PM if no other addresses are listed): APInvoices@pb.com.au		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required). SPOCAS	SCR - EA026	Metals	Additional Information
1	SB01_0.0	9/03/2016	S		1	x	X	X	**Metals - As, Al, Cr(VI), Cd, Fe, Mn, Pb, Zn
2	SB01_0.75	9/03/2016	S		1	x			Reducible chromium - EA025 only
3	SB01_1.50	9/03/2016	S		1	x			
4	SB01_2.25	9/03/2016	S		1	x			
5	SB01_3.25	9/03/2016	S		1	x	X		
6	SB01_4.25	9/03/2016	S		1	x			
7	SB01_5.25	9/03/2016	S		1	x			
8	SB02_0.0	9/03/2016	S		1	x	X		
9	SB02_0.5	9/03/2016	S		1	x			
10	SB02_1.0	9/03/2016	S		1	x			
11	SB02_2.0	9/03/2016	S		1	x	X	X	
12	SB02_3.0	9/03/2016	S		1	x			
13	SB02_4.0	9/03/2016	S		1	x			
14	SB02_5.50	9/03/2016	S		1	x			
15	SB03_0.0	9/03/2016	S		1	x			
16	SB03_0.75	9/03/2016	S		1	x	X	X	
17	SB03_1.75	9/03/2016	S		1	x			
18	SB03_3.0	9/03/2016	S		1	x			
19	SB03_4.25	9/03/2016	S		1	x			
20	SB03_6.0	9/03/2016	S		1	x	X		
21	SB04_0.0	9/03/2016	S		1	x			
22	SB04_1.25	9/03/2016	S		1	x			
23	SB04_2.5	9/03/2016	S		1	x			
24	SB04_3.75	9/03/2016	S		1	x	X	X	
25	SB04_4.50	9/03/2016	S		1	x	X		
26	SB04_5.75	9/03/2016	S		1	x			
27	SB05_0.25	9/03/2016	S		1	x	X		
28	SB05_1.0	9/03/2016	S		1	x			
29	SB05_2.0	9/03/2016	S		1	x			
30	SB05_2.75	9/03/2016	S		1	x			
31	SB05_3.50	9/03/2016	S		1	x			
32	SB05_4.25	9/03/2016	S		1	x	X	X	
33	SB05_5.50	9/03/2016	S		1	x			
34	SB06_0.50	9/03/2016	S		1	x	X	X	
35	SB06_1.75	9/03/2016	S		1	x			
36	SB06_2.75	9/03/2016	S		1	x			
37	SB06_3.75	9/03/2016	S		1	x			
38	SB06_4.75	9/03/2016	S		1	x			
39	SB06_5.75	9/03/2016	S		1	x			
40	SB07_0.25	10/03/2016	S		1	x	X		
41	SB07_2.0	10/03/2016	S		1	x	X	X	
42	SB07_3.0	10/03/2016	S		1	x			
43	SB07_4.0	10/03/2016	S		1	x			
44	SB07_5.25	10/03/2016	S		1	x			
45	SB08_0.0	10/03/2016	S		1	x			
46	SB08_1.0	10/03/2016	S		1	x	X		
47	SB08_2.0	10/03/2016	S		1	x			
48	SB08_3.0	10/03/2016	S		1	x			
49	SB08_4.0	10/03/2016	S		1	x			
50	SB08_5.25	10/03/2016	S		1	x	X	X	
51	SB09_0.25	10/03/2016	S		1	x			
52	SB09_1.0	10/03/2016	S		1	x	X	X	
53	SB09_2.0	10/03/2016	S		1	x			
54	SB09_2.75	10/03/2016	S		1	x			
55	SB09_4.0	10/03/2016	S		1	x			
56	SB09_5.25	10/03/2016	S		1	x	X		
57	SB10_0.25	10/03/2016	S		1	x	X		
58	SB10_1.5	10/03/2016	S		1	x			
59	SB10_3.0	10/03/2016	S		1	x	X	X	
60	SB10_4.0	10/03/2016	S		1	x			
61	SB10_4.75	10/03/2016	S		1	x			
62	SB10_5.75	10/03/2016	S		1	x			
63	SB03_5.0	9/03/2016	S		1	x			
64	SB04_3.50	9/03/2016	S		1	x			
65	SB05_6.0	9/03/2016	S		1	x			
66	SB06_0.0	9/03/2016	S		1	x			
67	SB07_2.25	10/03/2016	S		1	x			
68	SB07_6.0	10/03/2016	S		1	x			
69	SB08_6.0	10/03/2016	S		1	x			
70	SB10_5.25	10/03/2016	S		1	x			
71	QC11	10/03/2016	S		1	x	X		
72	QC9	10/03/2016	S		1	x	X	X	
				TOTAL					

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division
Perth
Work Order Reference
EP1602959

Telephone : + 61-8-9209 7655

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1602959**	Page	: 1 of 7
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Telephone	: 08 9209 7655
Project	: Ex EP1602099, EP1602103, EP1602105 2268443A	Date Samples Received	: 10-Mar-2016
Site	: ----	Issue Date	: 14-Apr-2016
Sampler	: YAMIN MA	No. of samples received	: 72
Order number	: ----	No. of samples analysed	: 72

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: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG005T: Total Metals by ICP-AES	EP1602959--001	SB01_0.0	**Aluminium**	7429-90-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG005T: Total Metals by ICP-AES	EP1602959--001	SB01_0.0	**Iron**	7439-89-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG048: Hexavalent Chromium (Alkaline Digest)	EP1602959--001	SB01_0.0	**Hexavalent Chromium**	18540-29-9	0.168 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **SOIL**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA055: Moisture Content							
80* dried soil							
SB01_0.0, SB03_0.75, SB05_4.25,	SB02_2.0, SB04_3.75, SB06_0.50	----	----	----	07-Apr-2016	23-Mar-2016	**15**
80* dried soil							
SB07_2.0, SB09_1.0, QC9	SB08_5.25, SB10_3.0,	----	----	----	07-Apr-2016	24-Mar-2016	**14**
EG048: Hexavalent Chromium (Alkaline Digest)							
80* dried soil							
SB01_0.0, SB03_0.75, SB05_4.25,	SB02_2.0, SB04_3.75, SB06_0.50	14-Apr-2016	06-Apr-2016	**8**	----	----	----
80* dried soil							
SB07_2.0, SB09_1.0, QC9	SB08_5.25, SB10_3.0,	14-Apr-2016	07-Apr-2016	**7**	----	----	----

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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: **SOIL**

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
EA026 : Chromium Reducible Sulfur							
80* dried soil (EA026)							
SB01_0.0, SB01_3.25, SB02_0.0, SB02_2.0, SB03_0.75, SB03_6.0, SB04_3.75, SB04_4.50, SB05_0.25, SB05_4.25, SB06_0.50	**09-Mar-2016**	**06-Apr-2016**	09-Mar-2017	✓	**12-Apr-2016**	05-Jul-2016	✓
80* dried soil (EA026)							
SB07_0.25, SB07_2.0, SB08_1.0, SB08_5.25, SB09_1.0, SB09_5.25, SB10_0.25, SB10_3.0, QC11, QC9	**10-Mar-2016**	**06-Apr-2016**	10-Mar-2017	✓	**12-Apr-2016**	05-Jul-2016	✓

Matrix: **SOIL**

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
EA029-D: Calcium Values							
80* dried soil (EA029)							
SB01_0.0, SB01_0.75, SB01_1.50, SB01_2.25, SB01_3.25, SB01_4.25, SB01_5.25, SB02_0.0, SB02_0.5, SB02_1.0, SB02_2.0, SB02_3.0, SB02_4.0, SB02_5.50, SB03_0.0, SB03_0.75, SB03_1.75, SB03_3.0, SB03_4.25, SB03_6.0, SB04_0.0, SB04_1.25, SB04_2.5, SB04_3.75, SB04_4.50, SB04_5.75, SB05_0.25, SB05_1.0, SB05_2.0, SB05_2.75, SB05_3.50, SB05_4.25, SB05_5.50, SB06_0.50, SB06_1.75, SB06_2.75, SB06_3.75, SB06_4.75, SB06_5.75, SB03_5.0, SB04_3.50, SB05_6.0, SB06_0.0	**09-Mar-2016**	**06-Apr-2016**	09-Mar-2017	✓	**12-Apr-2016**	05-Jul-2016	✓
80* dried soil (EA029)							
SB07_0.25, SB07_2.0, SB07_3.0, SB07_4.0, SB07_5.25, SB08_0.0, SB08_1.0, SB08_2.0, SB08_3.0, SB08_4.0, SB08_5.25, SB09_0.25, SB09_1.0, SB09_2.0, SB09_2.75, SB09_4.0, SB09_5.25, SB10_0.25, SB10_1.5, SB10_3.0, SB10_4.0, SB10_4.75, SB10_5.75, SB07_2.25, SB07_6.0, SB08_6.0, SB10_5.25, QC11, QC9	**10-Mar-2016**	**06-Apr-2016**	10-Mar-2017	✓	**12-Apr-2016**	05-Jul-2016	✓

Matrix: **SOIL**

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
EA055: Moisture Content							
80* dried soil (EA055-103)							
SB01_0.0, SB02_2.0, SB03_0.75, SB04_3.75, SB05_4.25, SB06_0.50	**09-Mar-2016**	**----**	----	----	**07-Apr-2016**	23-Mar-2016	×
80* dried soil (EA055-103)							
SB07_2.0, SB08_5.25, SB09_1.0, SB10_3.0, QC9	**10-Mar-2016**	**----**	----	----	**07-Apr-2016**	24-Mar-2016	×
EG005T: Total Metals by ICP-AES							
80* dried soil (EG005T)							
SB01_0.0, SB02_2.0, SB03_0.75, SB04_3.75, SB05_4.25, SB06_0.50	**09-Mar-2016**	**12-Apr-2016**	05-Sep-2016	✓	**12-Apr-2016**	05-Sep-2016	✓
80* dried soil (EG005T)							
SB07_2.0, SB08_5.25, SB09_1.0, SB10_3.0, QC9	**10-Mar-2016**	**12-Apr-2016**	06-Sep-2016	✓	**12-Apr-2016**	06-Sep-2016	✓
EG048: Hexavalent Chromium (Alkaline Digest)							
80* dried soil (EG048G)							
SB01_0.0, SB02_2.0, SB03_0.75, SB04_3.75, SB05_4.25, SB06_0.50	**09-Mar-2016**	**14-Apr-2016**	06-Apr-2016	×	**14-Apr-2016**	21-Apr-2016	✓
80* dried soil (EG048G)							
SB07_2.0, SB08_5.25, SB09_1.0, SB10_3.0, QC9	**10-Mar-2016**	**14-Apr-2016**	07-Apr-2016	×	**14-Apr-2016**	21-Apr-2016	✓

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: **SOIL**

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)							
Chromium Reducible Sulphur	EA026	3	21	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055-103	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	8	72	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Reducible Sulphur	EA026	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	4	72	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Reducible Sulphur	EA026	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	4	72	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	11	**9.09**	**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
Chromium Reducible Sulphur	EA026	SOIL	In house: Referenced to Sullivan et al (1998) The CRS method converts reduced inorganic sulfur to H2S by CrCl2 solution ; the evolved H2S is trapped in a zinc acetate solution as ZnS which is quantified by iodometric titration.
Suspension Peroxide Oxidation-Combined Acidity and Sulphate	EA029	SOIL	In house: Referenced to Ahern et al 2004 - a suspension peroxide oxidation method following the 'sulfur trail' by determining the level of 1M KCL extractable sulfur and the sulfur level after oxidation of soil sulphides. The 'acidity trail' is followed by measurement of TAA, TPA and TSA. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Moisture Content	EA055-103	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 103-105 degrees C. This method is compliant with NEPM (2013) Schedule B(3) Section 7.1 and Table 1 (14 day holding time).
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM (2013) Schedule B(3)
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	SOIL	In house: Referenced to USEPA SW846, Method 3060A. Hexavalent chromium is extracted by alkaline digestion. The digest is determined by photometrically by automatic discrete analyser, following pH adjustment. The instrument uses colour development using dephenylcarbazide. Each run of samples is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Alkaline digestion for Hexavalent Chromium	EG048PR	SOIL	In house: Referenced to USEPA SW846, Method 3060A.
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM (2013) Schedule B(3) (Method 202)

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1602959**	Page	: 1 of 32
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Contact	: ShukHui Li
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
Telephone	: +61 08 94899700	Telephone	: 08 9209 7655
Project	: Ex EP1602099, EP1602103, EP1602105 2268443A	Date Samples Received	: 10-Mar-2016 17:20
Order number	: ----	Date Analysis Commenced	: 06-Apr-2016
C-O-C number	: ----	Issue Date	: 14-Apr-2016 18:22
Sampler	: YAMIN MA		
Site	: ----		
Quote number	: ----		
No. of samples received	: 72		
No. of samples analysed	: 72		

NATA Accredited Laboratory 825
Accredited for compliance with
ISO/IEC 17025.

NATA
WORLD RECOGNISED ACCREDITATION

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

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Daniel Fisher	Inorganics Analyst	Perth ASS, Malaga, WA
Indra Astuty	Instrument Chemist	Perth Inorganics, Malaga, WA
Jeremy Truong	Laboratory Supervisor	Perth Inorganics, Malaga, WA

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.

- EG048G (Hexavalent Chromium by Alkaline Digestion and DA Finish): Poor sample matrix spike recovery due to possible sample matrix interference.
- ASS: EA029 (SPOCAS): Retained Acidity not required because pH KCl greater than or equal to 4.5
- ASS: EA029 (SPOCAS): Excess ANC not required because pH OX less than 6.5.
- ASS: EA029 (SPOCAS): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from kg/t dry weight to kg/m3 in-situ soil, multiply reported results x wet bulk density of soil in t/m3.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_0.0	SB01_0.75	SB01_1.50	SB01_2.25	SB01_3.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-001	EP1602959-002	EP1602959-003	EP1602959-004	EP1602959-005
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	**0.041**
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.6**	**5.7**	**5.8**	**6.6**	**5.5**
pH OX (23B)	----	0.1	pH Unit	**3.3**	**5.1**	**5.2**	**5.3**	**3.2**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**5**	**6**	<2	<2	**3**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	<2	**21**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	**17**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	**0.007**	**0.009**	<0.005	<0.005	**0.006**
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	**0.033**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	**0.028**
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	**0.007**
Peroxide Sulfur (23De)	----	0.005	% S	**0.018**	<0.005	<0.005	<0.005	**0.051**
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	**0.016**	<0.005	<0.005	<0.005	**0.044**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	**10**	<5	<5	<5	**28**
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.064**	**0.014**	<0.005	<0.005	**0.009**
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.075**	**0.019**	**0.008**	**0.007**	**0.011**
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.012**	<0.005	<0.005	<0.005	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	**6**	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	**0.010**	<0.005	<0.005	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	**0.005**	<0.005	<0.005	<0.005	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	**0.007**	<0.005	<0.005	<0.005	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_0.0	SB01_0.75	SB01_1.50	SB01_2.25	SB01_3.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-001	EP1602959-002	EP1602959-003	EP1602959-004	EP1602959-005
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.02**	<0.02	<0.02	<0.02	**0.05**
Net Acidity (acidity units)	----	10	mole H+ / t	**15**	<10	<10	<10	**31**
Liming Rate	----	1	kg CaCO3/t	**1**	**1**	<1	<1	**2**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.02**	<0.02	<0.02	<0.02	**0.05**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**15**	<10	<10	<10	**31**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	**1**	<1	<1	**2**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	<1.0	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**1180**	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Iron	7439-89-6	50	mg/kg	**2140**	----	----	----	----
Lead	7439-92-1	5	mg/kg	<5	----	----	----	----
Manganese	7439-96-5	5	mg/kg	**23**	----	----	----	----
Zinc	7440-66-6	5	mg/kg	<5	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_4.25	SB01_5.25	SB02_0.0	SB02_0.5	SB02_1.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-006	EP1602959-007	EP1602959-008	EP1602959-009	EP1602959-010
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	0.005	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.5	5.6	5.0	4.6	5.1
pH OX (23B)	----	0.1	pH Unit	3.1	2.9	3.5	3.2	5.1
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	120	150	27
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	23	56	508	413	14
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	22	55	389	264	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	0.192	0.240	0.043
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.038	0.090	0.815	0.663	0.022
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.036	0.088	0.623	0.422	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	0.006	0.010	0.049	0.036	0.018
Peroxide Sulfur (23De)	----	0.005	% S	0.061	0.118	0.272	0.231	0.042
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.055	0.108	0.224	0.195	0.023
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	34	67	139	122	14
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.011	0.009	0.582	0.384	0.367
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.014	0.014	0.521	0.472	0.354
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	0.005	<0.005	0.088	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	<5	44	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	<0.005	<0.005	0.070	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	<0.005	0.054	0.051	0.076
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	<0.005	0.058	0.057	0.085
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	0.006	0.010
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	8
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	0.005	0.008	0.013
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB01_4.25	SB01_5.25	SB02_0.0	SB02_0.5	SB02_1.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-006	EP1602959-007	EP1602959-008	EP1602959-009	EP1602959-010
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.06	0.11	0.42	0.44	0.07
Net Acidity (acidity units)	----	10	mole H+ / t	35	69	259	272	41
Liming Rate	----	1	kg CaCO3/t	3	5	19	20	3
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.06	0.11	0.42	0.44	0.07
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	35	69	259	272	41
Liming Rate excluding ANC	----	1	kg CaCO3/t	3	5	19	20	3
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	----
Lead	7439-92-1	5	mg/kg	----	----	----	----	----
Manganese	7439-96-5	5	mg/kg	----	----	----	----	----
Zinc	7440-66-6	5	mg/kg	----	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB02_2.0	SB02_3.0	SB02_4.0	SB02_5.50	SB03_0.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-011	EP1602959-012	EP1602959-013	EP1602959-014	EP1602959-015
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.2	6.9	7.8	5.8	5.7
pH OX (23B)	----	0.1	pH Unit	5.6	7.1	8.4	6.5	3.0
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	20	<2	<2	20	8
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	21	103
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	95
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.031	<0.005	<0.005	0.032	0.013
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	0.034	0.165
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	0.152
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	0.010	0.014	0.044	0.019	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.031	0.035	0.279	0.064	0.011
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.021	0.021	0.234	0.045	0.008
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	13	13	146	28	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.402	0.997	1.36	0.707	0.103
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.432	1.01	3.87	0.728	0.110
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.030	0.010	2.51	0.022	0.007
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	15	<5	1250	11	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	0.024	0.008	2.01	0.017	0.006
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.086	0.238	0.196	0.126	0.016
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.090	0.253	0.332	0.136	0.018
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	0.015	0.135	0.010	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	12	111	8	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	0.020	0.178	0.013	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	0.765	5.98	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB02_2.0	SB02_3.0	SB02_4.0	SB02_5.50	SB03_0.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-011	EP1602959-012	EP1602959-013	EP1602959-014	EP1602959-015
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	**153**	**1200**	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	**0.245**	**1.91**	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.05**	<0.02	<0.02	**0.08**	**0.02**
Net Acidity (acidity units)	----	10	mole H+ / t	**32**	<10	<10	**48**	**13**
Liming Rate	----	1	kg CaCO3/t	**2**	<1	<1	**4**	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.05**	**0.02**	**0.23**	**0.08**	**0.02**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**32**	**13**	**146**	**48**	**13**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**2**	**1**	**11**	**4**	**1**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	<1.0	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**6370**	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	**11**	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Iron	7439-89-6	50	mg/kg	**6820**	----	----	----	----
Lead	7439-92-1	5	mg/kg	**7**	----	----	----	----
Manganese	7439-96-5	5	mg/kg	<5	----	----	----	----
Zinc	7440-66-6	5	mg/kg	<5	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB03_0.75	SB03_1.75	SB03_3.0	SB03_4.25	SB03_6.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-016	EP1602959-017	EP1602959-018	EP1602959-019	EP1602959-020
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	0.008
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.3	6.5	6.8	6.6	5.9
pH OX (23B)	----	0.1	pH Unit	3.2	6.3	5.6	5.9	4.1
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	3
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	<2	7
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	4
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	0.006
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	0.011
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	0.006
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.012	0.008	0.010	0.010	0.024
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.009	0.005	0.008	0.008	0.021
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	6	<5	<5	<5	13
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.115	0.058	0.028	0.031	0.026
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.128	0.068	0.034	0.032	0.029
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.013	0.010	0.006	<0.005	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	6	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	0.010	0.008	<0.005	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.017	0.009	<0.005	<0.005	0.009
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.019	0.011	<0.005	<0.005	0.009
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB03_0.75	SB03_1.75	SB03_3.0	SB03_4.25	SB03_6.0
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-016	EP1602959-017	EP1602959-018	EP1602959-019	EP1602959-020
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**0.03**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	**16**
Liming Rate	----	1	kg CaCO3/t	**1**	<1	<1	<1	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**0.03**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	**16**
Liming Rate excluding ANC	----	1	kg CaCO3/t	**1**	<1	<1	<1	**1**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	<1.0	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**490**	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Iron	7439-89-6	50	mg/kg	**2940**	----	----	----	----
Lead	7439-92-1	5	mg/kg	<5	----	----	----	----
Manganese	7439-96-5	5	mg/kg	**23**	----	----	----	----
Zinc	7440-66-6	5	mg/kg	<5	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_0.0	SB04_1.25	SB04_2.5	SB04_3.75	SB04_4.50
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-021	EP1602959-022	EP1602959-023	EP1602959-024	EP1602959-025
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	<0.005	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.5	6.2	6.8	5.9	5.6
pH OX (23B)	----	0.1	pH Unit	3.0	3.3	4.9	4.5	5.0
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	8	<2	<2	7	8
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	129	<2	<2	50	26
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	121	<2	<2	43	18
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.013	<0.005	<0.005	0.011	0.013
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.207	<0.005	<0.005	0.080	0.041
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.194	<0.005	<0.005	0.069	0.028
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.007	<0.005	<0.005	0.024	0.024
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	<0.005	<0.005	0.020	0.022
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	<5	<5	13	14
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.051	0.016	0.009	0.013	0.026
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.057	0.021	0.012	0.016	0.032
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.006	<0.005	<0.005	<0.005	0.006
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.007	<0.005	<0.005	<0.005	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.007	<0.005	<0.005	<0.005	0.006
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_0.0	SB04_1.25	SB04_2.5	SB04_3.75	SB04_4.50
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-021	EP1602959-022	EP1602959-023	EP1602959-024	EP1602959-025
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.02	<0.02	<0.02	0.03	0.03
Net Acidity (acidity units)	----	10	mole H+ / t	11	<10	<10	20	22
Liming Rate	----	1	kg CaCO3/t	1	<1	<1	1	2
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.02	<0.02	<0.02	0.03	0.03
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	11	<10	<10	20	22
Liming Rate excluding ANC	----	1	kg CaCO3/t	1	<1	<1	1	2
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	<1.0	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	4340	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	<5	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	<1	----
Iron	7439-89-6	50	mg/kg	----	----	----	6980	----
Lead	7439-92-1	5	mg/kg	----	----	----	<5	----
Manganese	7439-96-5	5	mg/kg	----	----	----	73	----
Zinc	7440-66-6	5	mg/kg	----	----	----	<5	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	<0.5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_5.75	SB05_0.25	SB05_1.0	SB05_2.0	SB05_2.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-026	EP1602959-027	EP1602959-028	EP1602959-029	EP1602959-030
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**----**	<0.005	**----**	**----**	**----**
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.6**	**7.5**	**7.0**	**7.1**	**6.9**
pH OX (23B)	----	0.1	pH Unit	**4.6**	**6.0**	**4.8**	**5.0**	**5.2**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**18**	<2	<2	<2	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**18**	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.028**	<0.005	<0.005	<0.005	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	**0.028**	<0.005	<0.005	<0.005	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	**0.016**	**0.010**	<0.005	<0.005	**0.008**
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	**0.014**	**0.008**	<0.005	<0.005	**0.005**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	**8**	**5**	<5	<5	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.014**	**0.073**	**0.013**	**0.008**	**0.010**
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.018**	**0.087**	**0.017**	**0.012**	**0.014**
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	**0.014**	<0.005	<0.005	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	**7**	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	**0.011**	<0.005	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	**----**	**----**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB04_5.75	SB05_0.25	SB05_1.0	SB05_2.0	SB05_2.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-026	EP1602959-027	EP1602959-028	EP1602959-029	EP1602959-030
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	15	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	1	<1	<1	<1	<1
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	----
Lead	7439-92-1	5	mg/kg	----	----	----	----	----
Manganese	7439-96-5	5	mg/kg	----	----	----	----	----
Zinc	7440-66-6	5	mg/kg	----	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB05_3.50	SB05_4.25	SB05_5.50	SB06_0.50	SB06_1.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-031	EP1602959-032	EP1602959-033	EP1602959-034	EP1602959-035
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	0.019	----	<0.005	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	6.9	7.0	6.8	5.4	5.6
pH OX (23B)	----	0.1	pH Unit	5.4	4.8	3.6	2.8	2.5
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	8	8
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	6	32	78	165
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	6	32	70	157
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	0.013	0.013
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	0.009	0.052	0.125	0.264
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	0.009	0.052	0.112	0.251
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	0.010	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.010	0.034	0.096	0.028	0.071
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.009	0.030	0.085	0.025	0.068
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	5	19	53	15	42
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.009	0.032	0.041	0.041	0.019
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.012	0.037	0.047	0.048	0.022
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	<0.005	0.006	0.007	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	<0.005	0.005	0.006	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	<0.005	0.006	<0.005	0.007
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	<0.005	0.007	0.006	0.008
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB05_3.50	SB05_4.25	SB05_5.50	SB06_0.50	SB06_1.75
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-031	EP1602959-032	EP1602959-033	EP1602959-034	EP1602959-035
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	0.02	0.06	0.04	0.08
Net Acidity (acidity units)	----	10	mole H+ / t	<10	10	39	24	51
Liming Rate	----	1	kg CaCO3/t	<1	1	3	2	4
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	0.03	0.09	0.04	0.08
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	19	53	24	51
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	1	4	2	4
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	<1.0	----	<1.0	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	1070	----	160	----
Arsenic	7440-38-2	5	mg/kg	----	<5	----	<5	----
Cadmium	7440-43-9	1	mg/kg	----	<1	----	<1	----
Iron	7439-89-6	50	mg/kg	----	5130	----	3800	----
Lead	7439-92-1	5	mg/kg	----	<5	----	<5	----
Manganese	7439-96-5	5	mg/kg	----	52	----	40	----
Zinc	7440-66-6	5	mg/kg	----	<5	----	82	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	<0.5	----	<0.5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_2.75	SB06_3.75	SB06_4.75	SB06_5.75	SB07_0.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-036	EP1602959-037	EP1602959-038	EP1602959-039	EP1602959-040
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.7**	**5.8**	**6.5**	**6.4**	**5.8**
pH OX (23B)	----	0.1	pH Unit	**3.2**	**4.2**	**4.1**	**3.4**	**4.5**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**3**	<2	<2	<2	**16**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**13**	<2	<2	**17**	**105**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**9**	<2	<2	**16**	**89**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	**0.006**	<0.005	<0.005	<0.005	**0.026**
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.021**	<0.005	<0.005	**0.028**	**0.168**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	**0.015**	<0.005	<0.005	**0.026**	**0.142**
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	**0.022**	**0.008**	**0.012**	**0.036**	**0.084**
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	**0.020**	**0.006**	**0.010**	**0.033**	**0.080**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	**13**	<5	**6**	**21**	**50**
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.008**	<0.005	<0.005	<0.005	**0.357**
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.014**	**0.007**	**0.008**	**0.006**	**0.315**
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.005**	<0.005	<0.005	<0.005	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	**0.068**
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	**0.067**
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_2.75	SB06_3.75	SB06_4.75	SB06_5.75	SB07_0.25
			Client sampling date / time	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-036	EP1602959-037	EP1602959-038	EP1602959-039	EP1602959-040
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.03	<0.02	<0.02	0.04	0.11
Net Acidity (acidity units)	----	10	mole H+ / t	16	<10	<10	22	66
Liming Rate	----	1	kg CaCO3/t	1	<1	<1	2	5
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.03	<0.02	<0.02	0.04	0.11
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	16	<10	<10	22	66
Liming Rate excluding ANC	----	1	kg CaCO3/t	1	<1	<1	2	5
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	----
Lead	7439-92-1	5	mg/kg	----	----	----	----	----
Manganese	7439-96-5	5	mg/kg	----	----	----	----	----
Zinc	7440-66-6	5	mg/kg	----	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB07_2.0	SB07_3.0	SB07_4.0	SB07_5.25	SB08_0.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-041	EP1602959-042	EP1602959-043	EP1602959-044	EP1602959-045
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	**0.010**	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**6.2**	**6.4**	**6.1**	**6.0**	**6.5**
pH OX (23B)	----	0.1	pH Unit	**4.1**	**5.0**	**4.7**	**4.3**	**3.2**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**3**	<2	**3**	**2**	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	**2**	**25**	**76**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	**23**	**76**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	**0.006**	<0.005	**0.006**	<0.005	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	**0.041**	**0.121**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	**0.037**	**0.121**
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	**0.006**	<0.005	<0.005	**0.006**	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	**0.062**	**0.027**	**0.036**	**0.057**	**0.009**
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	**0.057**	**0.025**	**0.033**	**0.052**	**0.008**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	**35**	**15**	**21**	**32**	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.153**	**0.066**	**0.036**	**0.034**	**0.084**
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.170**	**0.069**	**0.042**	**0.038**	**0.097**
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.017**	<0.005	**0.007**	<0.005	**0.013**
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	**8**	<5	<5	<5	**6**
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	**0.014**	<0.005	**0.006**	<0.005	**0.010**
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	**0.036**	**0.012**	**0.007**	**0.007**	**0.006**
Peroxide Magnesium (23Tm)	----	0.005	% Mg	**0.039**	**0.012**	**0.009**	**0.009**	**0.008**
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB07_2.0	SB07_3.0	SB07_4.0	SB07_5.25	SB08_0.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-041	EP1602959-042	EP1602959-043	EP1602959-044	EP1602959-045
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	**0.06**	**0.03**	**0.04**	**0.06**	**0.08**
Net Acidity (acidity units)	----	10	mole H+ / t	**39**	**17**	**24**	**34**	**52**
Liming Rate	----	1	kg CaCO3/t	**3**	**1**	**2**	**3**	**4**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.06**	**0.03**	**0.04**	**0.06**	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**39**	**17**	**24**	**34**	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	**3**	**1**	**2**	**3**	<1
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	<1.0	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**11900**	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	<5	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
Iron	7439-89-6	50	mg/kg	**2100**	----	----	----	----
Lead	7439-92-1	5	mg/kg	<5	----	----	----	----
Manganese	7439-96-5	5	mg/kg	**16**	----	----	----	----
Zinc	7440-66-6	5	mg/kg	<5	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_1.0	SB08_2.0	SB08_3.0	SB08_4.0	SB08_5.25
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-046	EP1602959-047	EP1602959-048	EP1602959-049	EP1602959-050
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	----	----	----	<0.005
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.8**	**6.1**	**6.0**	**5.6**	**5.6**
pH OX (23B)	----	0.1	pH Unit	**3.4**	**4.5**	**4.4**	**4.3**	**4.2**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**2**	<2	**2**	**3**	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	<2	**4**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	**3**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	**0.006**	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	**0.007**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	**0.006**
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	**0.010**
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	**0.010**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	<5	<5	<5	**6**
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	<0.005	<0.005	<0.005	<0.005	**0.007**
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.009**	**0.005**	<0.005	**0.006**	**0.012**
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.005**	<0.005	<0.005	**0.006**	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	**0.005**
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	**0.007**
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB08_1.0	SB08_2.0	SB08_3.0	SB08_4.0	SB08_5.25
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-046	EP1602959-047	EP1602959-048	EP1602959-049	EP1602959-050
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	**1**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	**1**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	----	<1.0
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	**520**
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	<5
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	<1
Iron	7439-89-6	50	mg/kg	----	----	----	----	**2160**
Lead	7439-92-1	5	mg/kg	----	----	----	----	<5
Manganese	7439-96-5	5	mg/kg	----	----	----	----	**24**
Zinc	7440-66-6	5	mg/kg	----	----	----	----	<5
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	----	<0.5

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB09_0.25	SB09_1.0	SB09_2.0	SB09_2.75	SB09_4.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-051	EP1602959-052	EP1602959-053	EP1602959-054	EP1602959-055
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	<0.005	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	4.9	4.9	5.2	5.4	5.4
pH OX (23B)	----	0.1	pH Unit	2.8	2.7	2.9	3.1	3.6
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	29	26	7	2	5
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	309	201	106	28	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	280	174	99	26	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.046	0.042	0.011	<0.005	0.007
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.496	0.322	0.170	0.045	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.450	0.280	0.158	0.041	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.012	0.006	0.005	<0.005	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.011	<0.005	0.005	<0.005	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	7	<5	<5	<5	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.080	0.031	0.019	<0.005	<0.005
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.106	0.038	0.026	0.009	0.006
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.026	0.007	0.008	<0.005	0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	13	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	0.021	0.005	0.006	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.022	0.012	0.006	<0.005	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.025	0.014	0.009	<0.005	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB09_0.25	SB09_1.0	SB09_2.0	SB09_2.75	SB09_4.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-051	EP1602959-052	EP1602959-053	EP1602959-054	EP1602959-055
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.06	0.05	0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	36	30	10	<10	<10
Liming Rate	----	1	kg CaCO3/t	3	2	1	<1	1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.06	0.05	0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	36	30	10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	3	2	1	<1	1
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	<1.0	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	<50	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	<1	----	----	----
Iron	7439-89-6	50	mg/kg	----	2370	----	----	----
Lead	7439-92-1	5	mg/kg	----	<5	----	----	----
Manganese	7439-96-5	5	mg/kg	----	26	----	----	----
Zinc	7440-66-6	5	mg/kg	----	<5	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	<0.5	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB09_5.25	SB10_0.25	SB10_1.5	SB10_3.0	SB10_4.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-056	EP1602959-057	EP1602959-058	EP1602959-059	EP1602959-060
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	<0.005	----	<0.005	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.4**	**5.9**	**5.8**	**5.8**	**5.7**
pH OX (23B)	----	0.1	pH Unit	**3.1**	**3.2**	**3.7**	**4.3**	**4.6**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**3**	<2	<2	<2	**2**
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**38**	**60**	<2	<2	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**35**	**58**	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	**0.006**	<0.005	<0.005	<0.005	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.061**	**0.095**	<0.005	<0.005	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	**0.056**	**0.094**	<0.005	<0.005	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	**0.005**	<0.005	<0.005	<0.005	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	<5	<5	<5	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.015**	**0.037**	<0.005	<0.005	<0.005
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.021**	**0.045**	**0.009**	**0.005**	<0.005
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.006**	**0.008**	<0.005	<0.005	<0.005
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	**0.006**	<0.005	<0.005	<0.005
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	**0.005**	<0.005	<0.005	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	**0.006**	**0.008**	<0.005	<0.005	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB09_5.25	SB10_0.25	SB10_1.5	SB10_3.0	SB10_4.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-056	EP1602959-057	EP1602959-058	EP1602959-059	EP1602959-060
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	<1.0	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	<50	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	<5	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	<1	----
Iron	7439-89-6	50	mg/kg	----	----	----	**1350**	----
Lead	7439-92-1	5	mg/kg	----	----	----	<5	----
Manganese	7439-96-5	5	mg/kg	----	----	----	**14**	----
Zinc	7440-66-6	5	mg/kg	----	----	----	<5	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	<0.5	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB10_4.75	SB10_5.75	SB03_5.0	SB04_3.50	SB05_6.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-061	EP1602959-062	EP1602959-063	EP1602959-064	EP1602959-065
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.9**	**5.9**	**7.0**	**5.7**	**6.5**
pH OX (23B)	----	0.1	pH Unit	**5.3**	**4.0**	**6.3**	**4.6**	**3.7**
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	<2	<2	<2	<2	**30**
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	<2	<2	<2	<2	**30**
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	**0.048**
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	<0.005	<0.005	<0.005	<0.005	**0.048**
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	**0.008**
Peroxide Sulfur (23De)	----	0.005	% S	<0.005	<0.005	**0.019**	<0.005	**0.078**
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	<0.005	<0.005	**0.017**	<0.005	**0.069**
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	<5	**11**	<5	**43**
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	<0.005	**0.014**	**0.029**	<0.005	**0.030**
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.008**	**0.019**	**0.048**	<0.005	**0.036**
Acid Reacted Calcium (23X)	----	0.005	% Ca	<0.005	**0.005**	**0.019**	<0.005	**0.006**
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	<5	<5	**10**	<5	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	<0.005	<0.005	**0.015**	<0.005	**0.005**
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	**0.006**
Peroxide Magnesium (23Tm)	----	0.005	% Mg	<0.005	<0.005	**0.007**	<0.005	**0.006**
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	<0.005	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	<0.005	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB10_4.75	SB10_5.75	SB03_5.0	SB04_3.50	SB05_6.0
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]	[09-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-061	EP1602959-062	EP1602959-063	EP1602959-064	EP1602959-065
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	**0.05**
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	**34**
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	**3**
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	<0.02	**0.02**	<0.02	**0.07**
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	<10	**11**	<10	**43**
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	<1	**1**	<1	**3**
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	----
Lead	7439-92-1	5	mg/kg	----	----	----	----	----
Manganese	7439-96-5	5	mg/kg	----	----	----	----	----
Zinc	7440-66-6	5	mg/kg	----	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_0.0	SB07_2.25	SB07_6.0	SB08_6.0	SB10_5.25
			Client sampling date / time	[09-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-066	EP1602959-067	EP1602959-068	EP1602959-069	EP1602959-070
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	----	----	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	5.2	6.1	5.9	5.6	5.9
pH OX (23B)	----	0.1	pH Unit	2.6	5.4	3.9	3.8	4.5
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	24	<2	<2	2	<2
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	294	<2	28	4	<2
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	270	<2	26	2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	0.039	<0.005	<0.005	<0.005	<0.005
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	0.472	<0.005	0.044	0.007	<0.005
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	0.433	<0.005	0.042	<0.005	<0.005
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	<0.005	0.007	<0.005	<0.005
Peroxide Sulfur (23De)	----	0.005	% S	0.035	0.023	0.065	0.021	<0.005
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	0.033	0.022	0.058	0.021	<0.005
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	21	13	36	13	<5
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	0.099	0.063	0.031	0.010	0.015
Peroxide Calcium (23Wh)	----	0.005	% Ca	0.132	0.078	0.037	0.026	0.022
Acid Reacted Calcium (23X)	----	0.005	% Ca	0.033	0.015	0.006	0.015	0.008
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	17	8	<5	7	<5
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	0.027	0.012	<0.005	0.012	0.006
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	0.013	0.013	0.008	<0.005	<0.005
Peroxide Magnesium (23Tm)	----	0.005	% Mg	0.015	0.015	0.009	0.010	<0.005
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	<0.005	<0.005	0.006	<0.005
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	<5	<5	<5
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	<0.005	<0.005	0.008	<0.005
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	SB06_0.0	SB07_2.25	SB07_6.0	SB08_6.0	SB10_5.25
			Client sampling date / time	[09-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]	[10-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602959-066	EP1602959-067	EP1602959-068	EP1602959-069	EP1602959-070
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	0.07	0.02	0.06	0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	45	15	37	15	<10
Liming Rate	----	1	kg CaCO3/t	3	1	3	1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.07	0.02	0.06	0.02	<0.02
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	45	15	37	15	<10
Liming Rate excluding ANC	----	1	kg CaCO3/t	3	1	3	1	<1
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	----	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	----	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	----	----	----	----
Iron	7439-89-6	50	mg/kg	----	----	----	----	----
Lead	7439-92-1	5	mg/kg	----	----	----	----	----
Manganese	7439-96-5	5	mg/kg	----	----	----	----	----
Zinc	7440-66-6	5	mg/kg	----	----	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	QC11	QC9	----	----	----
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit	EP1602959-071	EP1602959-072	--------	--------	--------
				Result	Result	Result	Result	Result
EA026 : Chromium Reducible Sulfur								
Chromium Reducible Sulphur	----	0.005	%	<0.005	**0.008**	----	----	----
EA029-A: pH Measurements								
pH KCl (23A)	----	0.1	pH Unit	**5.0**	**6.1**	----	----	----
pH OX (23B)	----	0.1	pH Unit	**2.8**	**4.2**	----	----	----
EA029-B: Acidity Trail								
Titratable Actual Acidity (23F)	----	2	mole H+ / t	**2**	**3**	----	----	----
Titratable Peroxide Acidity (23G)	----	2	mole H+ / t	**201**	**78**	----	----	----
Titratable Sulfidic Acidity (23H)	----	2	mole H+ / t	**199**	**75**	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.005	% pyrite S	<0.005	**0.006**	----	----	----
sulfidic - Titratable Peroxide Acidity (s-23G)	----	0.005	% pyrite S	**0.322**	**0.126**	----	----	----
sulfidic - Titratable Sulfidic Acidity (s-23H)	----	0.005	% pyrite S	**0.318**	**0.120**	----	----	----
EA029-C: Sulfur Trail								
KCl Extractable Sulfur (23Ce)	----	0.005	% S	<0.005	**0.006**	----	----	----
Peroxide Sulfur (23De)	----	0.005	% S	**0.006**	**0.060**	----	----	----
Peroxide Oxidisable Sulfur (23E)	----	0.005	% S	**0.006**	**0.054**	----	----	----
acidity - Peroxide Oxidisable Sulfur (a-23E)	----	5	mole H+ / t	<5	**34**	----	----	----
EA029-D: Calcium Values								
KCl Extractable Calcium (23Vh)	----	0.005	% Ca	**0.033**	**0.154**	----	----	----
Peroxide Calcium (23Wh)	----	0.005	% Ca	**0.045**	**0.188**	----	----	----
Acid Reacted Calcium (23X)	----	0.005	% Ca	**0.011**	**0.034**	----	----	----
acidity - Acid Reacted Calcium (a-23X)	----	5	mole H+ / t	**6**	**17**	----	----	----
sulfidic - Acid Reacted Calcium (s-23X)	----	0.005	% S	**0.009**	**0.027**	----	----	----
EA029-E: Magnesium Values								
KCl Extractable Magnesium (23Sm)	----	0.005	% Mg	**0.011**	**0.036**	----	----	----
Peroxide Magnesium (23Tm)	----	0.005	% Mg	**0.014**	**0.042**	----	----	----
Acid Reacted Magnesium (23U)	----	0.005	% Mg	<0.005	**0.006**	----	----	----
Acidity - Acid Reacted Magnesium (a-23U)	----	5	mole H+ / t	<5	<5	----	----	----
sulfidic - Acid Reacted Magnesium (s-23U)	----	0.005	% S	<0.005	**0.008**	----	----	----
EA029-F: Excess Acid Neutralising Capacity								
Excess Acid Neutralising Capacity (23Q)	----	0.02	% CaCO3	----	----	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	QC11	QC9	----	----	----
			Client sampling date / time	[10-Mar-2016]	[10-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit	EP1602959-071	EP1602959-072	--------	--------	--------
				Result	Result	Result	Result	Result
EA029-F: Excess Acid Neutralising Capacity - Continued								
acidity - Excess Acid Neutralising Capacity (a-23Q)	----	10	mole H+ / t	----	----	----	----	----
sulfidic - Excess Acid Neutralising Capacity (s-23Q)	----	0.02	% S	----	----	----	----	----
EA029-H: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	**1.5**	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	**0.06**	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	**37**	----	----	----
Liming Rate	----	1	kg CaCO3/t	<1	**3**	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	<0.02	**0.06**	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	<10	**37**	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	<1	**3**	----	----	----
EA055: Moisture Content								
Moisture Content (dried @ 103°C)	----	1	%	----	<1.0	----	----	----
EG005T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	**10200**	----	----	----
Arsenic	7440-38-2	5	mg/kg	----	<5	----	----	----
Cadmium	7440-43-9	1	mg/kg	----	<1	----	----	----
Iron	7439-89-6	50	mg/kg	----	**1650**	----	----	----
Lead	7439-92-1	5	mg/kg	----	<5	----	----	----
Manganese	7439-96-5	5	mg/kg	----	**12**	----	----	----
Zinc	7440-66-6	5	mg/kg	----	<5	----	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	----	<0.5	----	----	----

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

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❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townesville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: WSP | Parsons Brinckerhoff Australia Pty Limited	**TURNAROUND REQUIREMENTS :** ☐ (Standard TAT may be longer for some tests e.g. Ultra Trace Organics) ☒ Non Standard or urgent TAT **(List due date):** 23/03/2016 (3 day turnaround)		**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Level 5 503 Muray St Perth WA 6000			Custody Seal Intact? Yes (No) N/A
PROJECT: 201402331	**ALS QUOTE NO.:** EN008/15 - YM PB - 201402331	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? (Yes) No N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: 24.4 °C
PROJECT MANAGER: Yamin Ma	**CONTACT PH:** 9217 3279	OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Yamin Ma	**SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (YES)	**EDD FORMAT (or default):**	*Yamin Ma*	Brandon
Email Reports to (will default to PM if no other addresses are listed): Yma@pb.com.au		DATE/TIME:	DATE/TIME:
Email Invoice to (will default to PM if no other addresses are listed): APInvoices@pb.com.au		11/3/2016	11·3·16 @ 16:49

RELINQUISHED BY:	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL CONTAINERS	pH, EC	NEPM Metals (W-3)	Nutrients (NT-8)	TRH/BTEXN (W-4)	Analysis from PB quote EP737/14 (ASS groundwater)				Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	MW01	11/03/2016	W		Various	X	X	X		X				Please HOLD the additional 100mL amber vial originally for OC/OP analysis
2	MW02	11/03/2016	W		Various	X	X	X		X				
3	MW03	11/03/2016	W		Various	X	X	X	X	X				NEPM Metals to include: Al, As, Cd, Cu, Fe, Mn, Pb, Hg
4	MW04	11/03/2016	W		Various	X	X	X	X	X				
5	MW05	11/03/2016	W		Various	X	X	X	X	X				
6	MW06	11/03/2016	W		Various					X				
7	MW07	11/03/2016	W		Various					X				
8	MW08	11/03/2016	W		Various					X				
9	MW09	11/03/2016	W		Various					X				
10	QC1	11/03/2016	W		Various	X	X	X	X	X				
11	QC2	11/03/2016	W		Various		X	X		X				
12	QC3	11/03/2016	W		Various			X	X					
				TOTAL		5	5	5	3	11				

Environmental Division Perth
Work Order Reference
EP1602127

Telephone : + 61-8-9209 7655

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1602127**	Page	: 1 of 11
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Contact	: Customer Services EP
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: yma@pb.com.au	E-mail	: ALSEnviro.Perth@alsglobal.com
Telephone	: +61 08 94899700	Telephone	: +61-8-9209 7655
Facsimile	: +61 08 93804060	Facsimile	: +61-8-9209 7600
Project	: 201402331	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 201402331	Date Samples Received	: 11-Mar-2016 16:49
C-O-C number	: ----	Date Analysis Commenced	: 11-Mar-2016
Sampler	: YAMIN MA	Issue Date	: 16-Mar-2016 16:36
Site	: ----		
		No. of samples received	: 12
Quote number	: ----	No. of samples analysed	: 12

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*
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics, Malaga, WA
Efua Wilson	Metals Chemist	Perth Inorganics, Malaga, WA
Jeremy Truong	Laboratory Supervisor	Perth Inorganics, Malaga, WA
Rassem Ayoubi	Senior Organic Chemist	Perth Organics, Malaga, WA

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.

- EK061G/EK067G (TKN/TP): LOR for sample 'MW08' raised due to possible sample matrix interference.
- EG020: It has been confirmed that total element concentration is less than dissolved for samples 'MW08' and 'MW02'.
- TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW01	MW02	MW03	MW04	MW05
			Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602127-001	EP1602127-002	EP1602127-003	EP1602127-004	EP1602127-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.22	5.96	7.16	7.90	6.89
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	480	856	646	727	450
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	432	617	480	576	460
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	166	15	56	169	46
Total Alkalinity as CaCO3	----	1	mg/L	166	15	56	169	46
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	104	98	29	17	46
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	64	87	102	14	109
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	32	230	117	154	58
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	51	24	52	63	37
Magnesium	7439-95-4	1	mg/L	18	15	13	14	13
Sodium	7440-23-5	1	mg/L	35	110	51	67	29
Potassium	7440-09-7	1	mg/L	8	4	6	4	13
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.18	0.51	0.06	0.04	0.52
Arsenic	7440-38-2	0.001	mg/L	<0.001	0.003	<0.001	0.002	0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Barium	7440-39-3	0.001	mg/L	0.028	0.030	0.055	0.098	0.118
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0003	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	0.013	<0.001	0.011	0.002
Chromium	7440-47-3	0.001	mg/L	<0.001	0.002	0.003	0.002	0.003
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.006	0.033	0.034	0.046	0.046
Nickel	7440-02-0	0.001	mg/L	<0.001	0.003	0.001	0.002	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW01	MW02	MW03	MW04	MW05
				Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602127-001	EP1602127-002	EP1602127-003	EP1602127-004	EP1602127-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.012**	**0.014**	**0.029**	**0.005**	**0.008**
Iron	7439-89-6	0.05	mg/L		**0.54**	**15.9**	**0.66**	**4.78**	**1.97**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**2.80**	**11.2**	**1.29**	**8.00**	**3.69**
Iron	7439-89-6	0.05	mg/L		**1.44**	**15.2**	**1.57**	**37.5**	**2.58**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.35**	**0.36**	**0.64**	**0.58**	**0.74**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	**0.03**	**0.01**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.03**	**0.01**	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.8**	**1.4**	**1.1**	**1.2**	**1.8**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.8**	**1.4**	**1.1**	**1.2**	**1.8**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.11**	**0.10**	**0.16**	**0.97**	**0.62**
EK085M: Sulfide as S2-									
Sulfide as S2-	18496-25-8	0.1	mg/L		**1.0**	<0.1	<0.1	<0.1	<0.1
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**5.55**	**8.60**	**6.54**	**8.01**	**4.82**
Total Cations	----	0.01	meq/L		**5.75**	**7.32**	**6.04**	**7.31**	**4.51**
Ionic Balance	----	0.01	%		**1.79**	**8.04**	**4.01**	**4.55**	**3.35**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		----	----	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		----	----	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		----	----	<100	<100	<100

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW01	MW02	MW03	MW04	MW05
				Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602127-001	EP1602127-002	EP1602127-003	EP1602127-004	EP1602127-005
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
C29 - C36 Fraction	----	50	µg/L		----	----	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		----	----	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		----	----	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		----	----	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		----	----	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		----	----	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		----	----	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		----	----	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		----	----	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		----	----	<1	<1	<1
Toluene	108-88-3	2	µg/L		----	----	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		----	----	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	----	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		----	----	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		----	----	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		----	----	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		----	----	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		----	----	**129**	**128**	**129**
Toluene-D8	2037-26-5	2	%		----	----	**95.8**	**97.3**	**99.1**
4-Bromofluorobenzene	460-00-4	2	%		----	----	**102**	**102**	**102**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW06	MW07	MW08	MW09	QC1
			Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]
Compound	CAS Number	LOR	Unit	EP1602127-006	EP1602127-007	EP1602127-008	EP1602127-009	EP1602127-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.54	6.85	6.38	7.01	7.35
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	356	1300	609	471	631
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	332	1020	577	383	474
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	12	78	23	40	72
Total Alkalinity as CaCO3	----	1	mg/L	12	78	23	40	72
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	33	54	42	31	25
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	40	182	122	94	106
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	86	280	116	74	116
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	16	70	22	29	51
Magnesium	7439-95-4	1	mg/L	7	33	23	16	13
Sodium	7440-23-5	1	mg/L	41	124	58	37	49
Potassium	7440-09-7	1	mg/L	6	14	6	4	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.71	0.18	0.46	0.13	0.06
Arsenic	7440-38-2	0.001	mg/L	0.003	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L	----	----	----	----	<0.05
Barium	7440-39-3	0.001	mg/L	----	----	----	----	0.051
Beryllium	7440-41-7	0.001	mg/L	----	----	----	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	----	----	----	----	<0.001
Chromium	7440-47-3	0.001	mg/L	0.002	0.002	0.001	<0.001	0.003
Copper	7440-50-8	0.001	mg/L	----	----	----	----	<0.001
Manganese	7439-96-5	0.001	mg/L	0.026	0.021	0.014	0.006	0.035
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	----	----	----	----	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW06	MW07	MW08	MW09	QC1
				Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602127-006	EP1602127-007	EP1602127-008	EP1602127-009	EP1602127-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		----	----	----	----	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.008**	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L		**1.03**	**0.42**	**1.94**	**0.08**	**0.64**
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**2.72**	**6.46**	**2.12**	**4.43**	**1.19**
Iron	7439-89-6	0.05	mg/L		**1.71**	**1.62**	**0.84**	**0.38**	**1.49**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.10**	**0.99**	**0.55**	**0.66**	**0.58**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.3**	**2.2**	**1.8**	**1.1**	**1.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.3**	**2.2**	**1.8**	**1.1**	**1.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.07**	**0.08**	<0.05	**0.10**	**0.16**
EK085M: Sulfide as S2-									
Sulfide as S2-	18496-25-8	0.1	mg/L		**0.2**	**0.2**	**1.8**	**0.6**	<0.1
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**3.50**	**13.2**	**6.27**	**4.84**	**6.92**
Total Cations	----	0.01	meq/L		**3.31**	**12.0**	**5.67**	**4.48**	**5.90**
Ionic Balance	----	0.01	%		**2.74**	**5.09**	**5.07**	**3.94**	**7.92**
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		----	----	----	----	<20
C10 - C14 Fraction	----	50	µg/L		----	----	----	----	<50
C15 - C28 Fraction	----	100	µg/L		----	----	----	----	<100

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW06	MW07	MW08	MW09	QC1
				Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]	[11-Mar-2016]
Compound	CAS Number	LOR	Unit		EP1602127-006	EP1602127-007	EP1602127-008	EP1602127-009	EP1602127-010
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
C29 - C36 Fraction	----	50	µg/L		----	----	----	----	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		----	----	----	----	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		----	----	----	----	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		----	----	----	----	<20
>C10 - C16 Fraction	----	100	µg/L		----	----	----	----	<100
>C16 - C34 Fraction	----	100	µg/L		----	----	----	----	<100
>C34 - C40 Fraction	----	100	µg/L		----	----	----	----	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		----	----	----	----	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		----	----	----	----	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		----	----	----	----	<1
Toluene	108-88-3	2	µg/L		----	----	----	----	<2
Ethylbenzene	100-41-4	2	µg/L		----	----	----	----	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	----	----	----	<2
ortho-Xylene	95-47-6	2	µg/L		----	----	----	----	<2
^ **Total Xylenes**	1330-20-7	2	µg/L		----	----	----	----	<2
^ **Sum of BTEX**	----	1	µg/L		----	----	----	----	<1
Naphthalene	91-20-3	5	µg/L		----	----	----	----	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		----	----	----	----	**132**
Toluene-D8	2037-26-5	2	%		----	----	----	----	**98.1**
4-Bromofluorobenzene	460-00-4	2	%		----	----	----	----	**103**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QC2	QC3	----	----	----
			Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit	EP1602127-011	EP1602127-012	--------	--------	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	----	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	----	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	----	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	----	----	----	----	----
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	----	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	----	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	----	----	----	----	----
Magnesium	7439-95-4	1	mg/L	----	----	----	----	----
Sodium	7440-23-5	1	mg/L	----	----	----	----	----
Potassium	7440-09-7	1	mg/L	----	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Barium	7440-39-3	0.001	mg/L	<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QC2	QC3	----	----	----
				Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit		EP1602127-011	EP1602127-012	--------	--------	--------
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		----	----	----	----	----
Iron	7439-89-6	0.05	mg/L		----	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	**0.04**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		----	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		<0.1	<0.1	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK085M: Sulfide as S2-									
Sulfide as S2-	18496-25-8	0.1	mg/L		----	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	----	----	----	----
Total Cations	----	0.01	meq/L		----	----	----	----	----
Ionic Balance	----	0.01	%		----	----	----	----	----
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	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QC2	QC3	----	----	----
				Client sampling date / time	[11-Mar-2016]	[11-Mar-2016]	----	----	----
Compound	CAS Number	LOR	Unit		EP1602127-011	EP1602127-012	--------	--------	--------
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons - Continued									
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	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**90.7**	**132**	----	----	----
Toluene-D8	2037-26-5	2	%		**105**	**96.2**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**98.1**	**100.0**	----	----	----

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1602127**	Page	: 1 of 10
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: YAMIN MA	Telephone	: +61-8-9209 7655
Project	: 201402331	Date Samples Received	: 11-Mar-2016
Site	: ----	Issue Date	: 16-Mar-2016
Sampler	: YAMIN MA	No. of samples received	: 12
Order number	: 201402331	No. of samples analysed	: 12

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.**
- **NO Matrix Spike outliers occur.**
- **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 : 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						
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	----	----	----	14-Mar-2016	11-Mar-2016	**3**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Matrix Spikes (MS)					
Total Metals by ICP-MS - Suite A	0	17	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)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	11-Mar-2016	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	08-Apr-2016	✓

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)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	18-Mar-2016	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	25-Mar-2016	✓
ED038A: Acidity							
Clear Plastic Bottle - Natural (ED038)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	25-Mar-2016	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**11-Mar-2016**	08-Apr-2016	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**11-Mar-2016**	08-Apr-2016	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**15-Mar-2016**	08-Apr-2016	✓

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
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1, QC2	**11-Mar-2016**	**----**	----	----	**15-Mar-2016**	07-Sep-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**15-Mar-2016**	07-Sep-2016	✓	**15-Mar-2016**	07-Sep-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F)							
MW01, MW02, MW03, MW04, MW05, QC1, QC2	**11-Mar-2016**	**----**	----	----	**15-Mar-2016**	08-Apr-2016	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**11-Mar-2016**	08-Apr-2016	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
QC2, QC3	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	08-Apr-2016	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**11-Mar-2016**	13-Mar-2016	✓

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
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**11-Mar-2016**	08-Apr-2016	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
QC2, QC3	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	08-Apr-2016	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1, QC2, QC3	**11-Mar-2016**	**14-Mar-2016**	08-Apr-2016	✓	**14-Mar-2016**	08-Apr-2016	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1, QC2, QC3	**11-Mar-2016**	**14-Mar-2016**	08-Apr-2016	✓	**14-Mar-2016**	08-Apr-2016	✓
EK085M: Sulfide as S2-							
Clear Plastic Bottle - Zinc Acetate/NaOH (EK085)							
MW01, MW02, MW03, MW04, MW05, MW06, MW07, MW08, MW09, QC1	**11-Mar-2016**	**----**	----	----	**14-Mar-2016**	18-Mar-2016	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
MW03, MW04, MW05, QC1, QC2, QC3	**11-Mar-2016**	**14-Mar-2016**	18-Mar-2016	✓	**14-Mar-2016**	23-Apr-2016	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber VOC Vial - Sulfuric Acid (EP080)							
MW03, MW04, MW05, QC1, QC2, QC3	**11-Mar-2016**	**14-Mar-2016**	25-Mar-2016	✓	**14-Mar-2016**	25-Mar-2016	✓

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)							
Acidity as Calcium Carbonate	ED038	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	10	**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	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	29	**10.34**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	3	23	**13.04**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acidity as Calcium Carbonate	ED038	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	10	**20.00**	**10.00**	✓	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	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	17	**5.88**	**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*	
Laboratory Control Samples (LCS) - Continued							
Total Phosphorus as P By Discrete Analyser	EK067G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	6	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Alkalinity by PC Titrator	ED037-P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	10	**10.00**	**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	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	6	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	0	17	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	23	**8.70**	**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)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Acidity as Calcium Carbonate	ED038	WATER	In house: Referenced to APHA 2310 B Acidity is determined by titration with a standardised alkali to an end-point pH of 8.3. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. 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 0.45µm 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.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. 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.

Analytical Methods	Method	Matrix	Method Descriptions
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 0.45µm 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)
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)
Sulfide as S2-	EK085	WATER	In house: Referenced to APHA 4500-S2- D. Sulfide species present in water samples are immediately precipitated when collected in pretreated caustic/zinc acetate preserved sample containers. After the supernatant is discarded, the resultant precipitate is then coloured using methylene blue indicator and measured using UV-VIS detection at 664nm. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to 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	In house: Referenced to 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)

Preparation Methods	Method	Matrix	Method Descriptions

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Parsons Brinckerhoff	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	✡ Standard TAT **(List due date):** Standard ☐ Non Standard or urgent TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)** Custody Seal Intact? Yes / No / N/A Free ice / frozen ice bricks present upon receipt? Yes / No / N/A Random Sample Temperature on Receipt: 15 °C Other comments:
OFFICE: Perth			
PROJECT: Mandogalup baseline **PROJECT NO** 2268443A	**ALS QUOTE NO.:** EP-971-16 (WATER)	**COC SEQUENCE NUMBER (Circle)**	
ORDER NUMBER: **PURCHASE ORDER NO.:** 2268443A	**COUNTRY OF ORIGIN:** Australia	COC: 1	
PROJECT MANAGER: Alastair Beaton	**CONTACT PH:** 0892163663	OF: 1	
SAMPLER: Patrick Koo	**SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC Emailed to ALS? (~~YES~~ / NO)	**EDD FORMAT (or default):** XLS/ESDAT	*Patrick Koo*	
Email Reports to (will default to PM if no other addresses are listed): abeaton@pb.com.au; Pakoo@pb.com.au		DATE/TIME: *22/09/2016*	DATE/TIME: 23/9/16 1623
Email Invoice to (will default to PM if no other addresses are listed):abeaton@pb.com.au		**RELINQUISHED BY:** DATE/TIME:	**RECEIVED BY:** DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	EP-971-16								Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	QC1	22/09/2016	w	VARIOUS	X4	X								
2	MW05	22/09/2016	w	VARIOUS	x4	x								
3	MW03	22/09/2016	w	VARIOUS	X4	x								
4	MW06	22/09/2016	w	VARIOUS	X4	x								
														Please analyse as per EP-971-16
				TOTAL	x24									

Environmental Division
Perth
Work Order Reference
EP1609002

Telephone : +61-8-9209 7655

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle**: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane**: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville**: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
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☐ **Perth**: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston**: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Parsons Brinckerhoff	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	✡ Standard TAT **(List due date):**	**Standard**
OFFICE: Perth		☐ Non Standard or urgent TAT **(List due date):**	
PROJECT: Mandogalup baseline — **PROJECT NO** 2268443A	**ALS QUOTE NO.:** EP-971-16 (WATER)	**COC SEQUENCE NUMBER (Circle)**	**FOR LABORATORY USE ONLY (Circle)**
ORDER NUMBER: — **PURCHASE ORDER NO.:** 2268443A	**COUNTRY OF ORIGIN:** Australia	COC: 1	Quotation Call Back: Yes / No
PROJECT MANAGER: Alastair Beaton — **CONTACT PH:** 0892163663		OF: 1	Free of Ice/Ice Packs Present upon receipt: Yes / No / NA
SAMPLER: Patrick Koo — **SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**	Random Sample Temperature on Receipt: °C
COC Emailed to ALS? (~~YES~~ / NO) — **EDD FORMAT (or default):** XLS/ESDAT	*Patrick Koo*		Other comments:
Email Reports to (will default to PM if no other addresses are listed): abeaton@pb.com.au; Pakoo@pb.com.au	DATE/TIME: *28/09/2016*	DATE/TIME: 28/9/16 1140	
Email Invoice to (will default to PM if no other addresses are listed):abeaton@pb.com.au			

RELINQUISHED BY:	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	EP-971-16								Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	QC1	22/09/2016	w	VARIOUS	X4	X								
	MW05	22/09/2016	w	VARIOUS	x4	x								
	MW03	22/09/2016	w	VARIOUS	X4	x								
	MW06	22/09/2016	w	VARIOUS	X4	x								
5	MW01	27/09/2016	w	VARIOUS	X4	x								
6	MW02	27/09/2016	w	VARIOUS	X4	x								
7	MW04	27/09/2016	w	VARIOUS	X4	x								
8	MW07	27/09/2016	w	VARIOUS	X4	x								
9	MW08	27/09/2016	w	VARIOUS	X4	x								
10	MW09	27/09/2016	w	VARIOUS	X4	x								
				TOTAL	x16+x24									

Environmental Division
Perth
Work Order Reference
EP1609002

Telephone : + 61-8-9209 7655

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1609002**	Page	: 1 of 6
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: ALASTAIR BEATON	Contact	: Lauren Biagioni
Address	: LEVEL 5 503 MURRAY STREET PERTH WA, AUSTRALIA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
Telephone	: +61 08 9489 9700	Telephone	: 08 9209 7655
Project	: 2268443A Mandogalup baseline	Date Samples Received	: 23-Sep-2016 16:23
Order number	: 2268443A	Date Analysis Commenced	: 23-Sep-2016
C-O-C number	: ----	Issue Date	: 04-Oct-2016 19:36
Sampler	: PATRICK KOO		
Site	: ----		
Quote number	: ----		
No. of samples received	: 10		
No. of samples analysed	: 10		

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Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Efua Wilson	Metals Chemist	Perth Inorganics, Malaga, WA
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA

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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.
~ = Indicates an estimated value.

- It is recognised that Total Metals (EG020T) is less than Dissolved Metals (EG020F). However, the difference is within experimental variation of the methods.
- EA015H (Total Dissolved Solids): TDS for various samples biasing high due to possible sample matrix interferences.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QC1	MW05	MW03	MW06	MW01
			Client sampling date / time	[22-Sep-2016]	[22-Sep-2016]	[22-Sep-2016]	[22-Sep-2016]	[27-Sep-2016]
Compound	CAS Number	LOR	Unit	EP1609002-001	EP1609002-002	EP1609002-003	EP1609002-004	EP1609002-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.28	5.79	6.54	6.33	6.25
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	453	463	479	436	452
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	317	380	520	306	334
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	21	4	62	22	90
Total Alkalinity as CaCO3	----	1	mg/L	21	4	62	22	90
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	19	30	48	24	60
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	44	135	<1	43	100
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	106	52	124	104	34
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	14	34	33	14	23
Magnesium	7439-95-4	1	mg/L	9	11	9	9	20
Sodium	7440-23-5	1	mg/L	51	30	57	52	42
Potassium	7440-09-7	1	mg/L	4	16	4	4	4
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.31	0.37	0.82	0.29	0.36
Arsenic	7440-38-2	0.001	mg/L	0.001	0.002	0.002	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	0.002	0.004	0.011	0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.014	0.040	0.024	0.013	0.003
Nickel	7440-02-0	0.001	mg/L	<0.001	0.006	0.008	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	0.027	<0.005	0.028	0.035	<0.005
Iron	7439-89-6	0.05	mg/L	1.05	2.45	7.18	1.03	0.96
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.31	1.52	0.68	0.30	0.36
Iron	7439-89-6	0.05	mg/L	0.83	5.16	6.96	0.81	0.77

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QC1	MW05	MW03	MW06	MW01
				Client sampling date / time	[22-Sep-2016]	[22-Sep-2016]	[22-Sep-2016]	[22-Sep-2016]	[27-Sep-2016]
Compound	CAS Number	LOR	Unit		EP1609002-001	EP1609002-002	EP1609002-003	EP1609002-004	EP1609002-005
					Result	Result	Result	Result	Result
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.20**	**0.50**	**0.02**	**0.20**	**0.73**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**3.53**	**0.02**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**3.53**	**0.02**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**1.0**	**1.9**	**4.8**	**1.1**	**1.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**1.0**	**5.4**	**4.8**	**1.1**	**1.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	**0.65**	**0.60**	**0.04**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	**0.25**	**0.53**	**0.02**	<0.01
EK085M: Sulfide as S2-									
Sulfide as S2-	18496-25-8	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**4.32**	**4.36**	**4.74**	**4.27**	**4.84**
Total Cations	----	0.01	meq/L		**3.76**	**4.32**	**4.97**	**3.80**	**4.72**
Ionic Balance	----	0.01	%		**7.00**	**0.45**	**2.41**	**5.76**	**1.23**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW02	MW04	MW07	MW08	MW09
			Client sampling date / time	[27-Sep-2016]	[27-Sep-2016]	[27-Sep-2016]	[27-Sep-2016]	[27-Sep-2016]
Compound	CAS Number	LOR	Unit	EP1609002-006	EP1609002-007	EP1609002-008	EP1609002-009	EP1609002-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.72**	**7.58**	**6.46**	**5.97**	**6.15**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**809**	**716**	**1300**	**367**	**619**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**543**	**469**	**920**	**308**	**470**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**20**	**140**	**86**	**20**	**27**
Total Alkalinity as CaCO3	----	1	mg/L	**20**	**140**	**86**	**20**	**27**
ED038A: Acidity								
Acidity as CaCO3	----	1	mg/L	**98**	**7**	**32**	**26**	**22**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**84**	**20**	**216**	**128**	**110**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**212**	**158**	**286**	**58**	**133**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**21**	**65**	**81**	**13**	**28**
Magnesium	7439-95-4	1	mg/L	**14**	**16**	**34**	**15**	**19**
Sodium	7440-23-5	1	mg/L	**106**	**72**	**133**	**46**	**67**
Potassium	7440-09-7	1	mg/L	**3**	**3**	**20**	**4**	**6**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.85**	**0.02**	**0.08**	**0.59**	**0.21**
Arsenic	7440-38-2	0.001	mg/L	**0.002**	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	**0.001**	<0.001	**0.001**	**0.002**	**0.001**
Manganese	7439-96-5	0.001	mg/L	**0.005**	**0.012**	**0.020**	**0.002**	**0.007**
Nickel	7440-02-0	0.001	mg/L	**0.003**	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Iron	7439-89-6	0.05	mg/L	**15.4**	**1.65**	**0.06**	**1.92**	<0.05
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**1.24**	<0.01	**0.20**	**0.58**	**0.25**
Iron	7439-89-6	0.05	mg/L	**16.8**	**3.59**	**0.07**	**0.35**	<0.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MW02	MW04	MW07	MW08	MW09
				Client sampling date / time	[27-Sep-2016]	[27-Sep-2016]	[27-Sep-2016]	[27-Sep-2016]	[27-Sep-2016]
Compound	CAS Number	LOR	Unit		EP1609002-006	EP1609002-007	EP1609002-008	EP1609002-009	EP1609002-010
					Result	Result	Result	Result	Result
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		0.40	0.51	0.76	0.26	0.46
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		0.8	1.0	1.6	0.9	1.2
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		0.8	1.0	1.6	0.9	1.2
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	3.32	0.05	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	0.14	0.04	<0.01	<0.01
EK085M: Sulfide as S2-									
Sulfide as S2-	18496-25-8	0.1	mg/L		<0.1	<0.1	<0.1	<0.1	<0.1
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		8.13	7.67	14.3	4.70	6.58
Total Cations	----	0.01	meq/L		6.89	7.77	13.1	3.99	6.03
Ionic Balance	----	0.01	%		8.27	0.65	4.17	8.24	4.38

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1609002**	Page	: 1 of 10
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Perth
Contact	: ALASTAIR BEATON	Telephone	: 08 9209 7655
Project	: 2268443A Mandogalup baseline	Date Samples Received	: 23-Sep-2016
Site	: ----	Issue Date	: 04-Oct-2016
Sampler	: PATRICK KOO	No. of samples received	: 10
Order number	: 2268443A	No. of samples analysed	: 10

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							
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	EP1609002--002	MW05	**Nitrite + Nitrate as N**	----	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						
QC1, MW05, MW03, MW06	----	----	----	27-Sep-2016	22-Sep-2016	**5**
Clear Plastic Bottle - Natural						
MW01, MW02, MW04, MW07, MW08, MW09	----	----	----	29-Sep-2016	27-Sep-2016	**2**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Matrix Spikes (MS)					
Total Metals by ICP-MS - Suite A	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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

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)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**27-Sep-2016**	22-Sep-2016	×
Clear Plastic Bottle - Natural (EA005-P)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**29-Sep-2016**	27-Sep-2016	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**27-Sep-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Natural (EA010-P)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**29-Sep-2016**	25-Oct-2016	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**29-Sep-2016**	29-Sep-2016	✓
Clear Plastic Bottle - Natural (EA015H)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**03-Oct-2016**	04-Oct-2016	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**27-Sep-2016**	06-Oct-2016	✓
Clear Plastic Bottle - Natural (ED037-P)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**29-Sep-2016**	11-Oct-2016	✓
ED038A: Acidity							
Clear Plastic Bottle - Natural (ED038)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**03-Oct-2016**	06-Oct-2016	✓
Clear Plastic Bottle - Natural (ED038)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**03-Oct-2016**	11-Oct-2016	✓

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
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**23-Sep-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Natural (ED041G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**28-Sep-2016**	25-Oct-2016	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**23-Sep-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Natural (ED045G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**28-Sep-2016**	25-Oct-2016	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**03-Oct-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Filtered; Lab-acidified (ED093F)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**03-Oct-2016**	25-Oct-2016	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**03-Oct-2016**	21-Mar-2017	✓
Clear Plastic Bottle - Filtered; Lab-acidified (EG020A-F)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**03-Oct-2016**	26-Mar-2017	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**03-Oct-2016**	21-Mar-2017	✓	**03-Oct-2016**	21-Mar-2017	✓
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG020A-T)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**03-Oct-2016**	26-Mar-2017	✓	**03-Oct-2016**	26-Mar-2017	✓

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)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**23-Sep-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**28-Sep-2016**	25-Oct-2016	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**23-Sep-2016**	24-Sep-2016	✓
Clear Plastic Bottle - Natural (EK057G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**28-Sep-2016**	29-Sep-2016	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**23-Sep-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**28-Sep-2016**	25-Oct-2016	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**03-Oct-2016**	20-Oct-2016	✓	**03-Oct-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**03-Oct-2016**	25-Oct-2016	✓	**03-Oct-2016**	25-Oct-2016	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**03-Oct-2016**	20-Oct-2016	✓	**03-Oct-2016**	20-Oct-2016	✓
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**03-Oct-2016**	25-Oct-2016	✓	**03-Oct-2016**	25-Oct-2016	✓

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
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**23-Sep-2016**	24-Sep-2016	✓
Clear Plastic Bottle - Natural (EK071G)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**28-Sep-2016**	29-Sep-2016	✓
EK085M: Sulfide as S2-							
Clear Plastic Bottle - Zinc Acetate/NaOH (EK085)							
QC1, MW05, MW03, MW06	**22-Sep-2016**	**----**	----	----	**29-Sep-2016**	29-Sep-2016	✓
Clear Plastic Bottle - Zinc Acetate/NaOH (EK085)							
MW01, MW02, MW04, MW07, MW08, MW09	**27-Sep-2016**	**----**	----	----	**04-Oct-2016**	04-Oct-2016	✓

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)							
Acidity as Calcium Carbonate	ED038	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	4	34	**11.76**	**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
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	6	54	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	26	**11.54**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acidity as Calcium Carbonate	ED038	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	34	**5.88**	**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
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	3	54	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	26	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							

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							
Alkalinity by PC Titrator	ED037-P	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	34	**5.88**	**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
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	3	54	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	26	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	39	**5.13**	**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
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	0	20	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	39	**5.13**	**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)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Acidity as Calcium Carbonate	ED038	WATER	In house: Referenced to APHA 2310 B Acidity is determined by titration with a standardised alkali to an end-point pH of 8.3. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. 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 0.45µm 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.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. 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.

Analytical Methods	Method	Matrix	Method Descriptions
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)
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)
Sulfide as S2-	EK085	WATER	In house: Referenced to APHA 4500-S2- D. Sulfide species present in water samples are immediately precipitated when collected in pretreated caustic/zinc acetate preserved sample containers. After the supernatant is discarded, the resultant precipitate is then coloured using methylene blue indicator and measured using UV-VIS detection at 664nm. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)



WSP | PARSONS BRINCKERHOFF

APPENDIX 7

DER Correspondence, Confirmation of Decontamination

Government of **Western Australia**
Department of **Environment Regulation**

Your ref	P11562_RPT01_VAR_REV0
Our ref	DER2017/102, DMO8426
Enquiries	Justin Ritchie
Phone	9333 7579
Fax	9333 7575
Email	Justin.Ritchie@der.wa.gov.au

Vanessa Bryant
Senversa Pty Ltd
Level 17, 140 St Georges Terrace,
PERTH, WA 6000

Dear Ms Bryant

PROPOSED RESIDENTIAL SUBDIVISION, MANDOGALUP, WESTERN AUSTRALIA

Thank you for submitting the report "Voluntary Auditor's Report – Proposed Residential Subdivision, Hoffman Road, Mandogalup, Western Australia" (Senversa, 20 December 2016) (the VAR) and supporting consultants' reports to the Department of Environment Regulation (DER). The VAR was received on 21 December 2016.

The VAR was prepared to demonstrate suitability of the site for the proposed residential development prior to the application for subdivision and for DER to classify the site under the *Contaminated Sites Act 2003* (the Act).

DER has reviewed the VAR and provides the following comments.

Based on the information provided, DER concurs with the Auditor's conclusions that investigations for soil, groundwater and surface water contamination and subsequent remediation (including validation of remediation) of all identified contamination at the site, were carried out in accordance with DER's 'Contaminated Sites Guidelines' (2014) and the 'National Environment Protection (Assessment of Site Contamination) Measure 1999' and that all identified soil and groundwater contamination at the site has been successfully remediated. DER agrees with the conclusions of the MAR that the site is free of contamination and is suitable for all land uses and does not appear to be contaminated, as defined by the Act.

As the site has been successfully remediated and is suitable for the proposed residential use, without restriction, the site will be classified *decontaminated* under the Act. Formal notification of the site's classification will follow in due course.

If you have any further queries, please contact Contaminated Sites Officer, Justin Ritchie, on 9333 7579.

Yours sincerely

Andrew Miller
SENIOR MANAGER
CONTAMINATED SITES

15 February 2017

APPENDIX 8

Landscape Masterplan

LEGEND

- EXTENT OF WORKS BOUNDARY
- FOOTPATH NETWORK
- OPEN TURF AREA
- NATIVE PLANTING
- SHELTER AND PICNIC AREA
- PLAYGROUND
- RETAINED TREES
- PROPOSED TREES
- STREET TREES
- INDICATIVE FLOOD STORAGE AREA IN POS
- CONVEYANCE SWALE
- MANDOGALUP SWAMP REGIONAL FLOOD STORAGE AREA



FLORENCE SOUTH, MANDOGALUP
LANDSCAPE MASTERPLAN

DWG **MA-22-01**
REV **B**
DATE **28.05.24**
0 20 40 60 80 100 m
SCALE **1 : 4000 @ A3**

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SYMBOL KEY

- PLAYGROUND
- DRINK FOUNTAIN
- BBQ
- PICNIC SETTING
- RETAINED VEGETATION
- SHELTER
- LOOKOUT
- WALKING TRAIL
- PASSIVE RECREATION
- SWALE / BASIN

PREVIOUSLY APPROVED STRUCTURE PLAN AREA

PEEL MAIN DRAIN

KWINANA FREEWAY

POS 2

POS 10

DBNGP EASEMENT

POS 9

REGIONAL FLOOD STORAGE AREA

POS 13

POS 12

POS 1

POS 11

INDICATIVE FUTURE SCHOOL SITE (SUBJECT TO FURTHER INVESTIGATION)

WESTERN POWER EASEMENT

WESTERN POWER EASEMENT LANDSCAPED AND MAINTAINED TO A PERMANENT LOW THREAT STATE

FLORENCE SOUTH, MANDOGALUP

SPATIAL AMENITY PLAN

DWG MA-22 -02
REV B
DATE 28.05.24

0 20 40 60 80 100 m

SCALE 1 : 4000 @ A3

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LEGEND

STREET TREES



Liquidambar styraciflua
Sweetgum

Eucalyptus torquata
Coral Gum



Eucalyptus sideroxylon rosea
Ironbark

Melaleuca leucadendra
Weeping Paperbark



Eucalyptus victrix
Little Ghost Gum

Melaleuca preissiana
Stout Paperbark



Melaleuca quinquenervia
Broad-leaved Paperbark

Cupaniopsis anarcardioides
Tuckeroo



Melaleuca viridiflora
Broad-leaved Paperbark



FLORENCE SOUTH, MANDOGALUP

STREET TREE MASTERPLAN

DWG **MA-22-03**
REV **B**
DATE **28.05.24**

0 20 40 60 80 100 m

SCALE **1 : 4000 @ A3**

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DBNGP EASEMENT

POS TYPOLOGY

- DBNGP Easement POS

SIZE

- 2.06ha m2 + verge.

DRAINAGE CONSIDERATION

- Swale for conveyance of minor and major stormwater discharge to Regional Flood Storage Area.

CONCEPT & FUNCTION

The DBNGP Easement POS landscape is designed to deliver:

- Passive and active recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Seating areas for rest and recuperation
- Open turf areas for informal sport activities
- Native, waterwise planting
- Clear and easy maintenance access for gas utility providers across entire easement.

** DBNGP Easement POS landscape design to be in accordance with DBNGP land use requirements.







FLORENCE SOUTH, MANDOGALUP

DBNGP EASEMENT POS LANDSCAPE CONCEPT

DWG **MA-22-04**
REV **B**
DATE **28.05.24**
SCALE **1 : 2000 @ A3**
0 10 20 30 40 50 m

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KEY PLAN













POS 1

FLOOD MANAGEMENT AREA H

POS TYPOLOGY

- Neighbourhood POS

SIZE

- 1.12ha + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1800m3

Major Event 1% AEP

TWL Area: 5000m^2

Volume: 4600m3

CONCEPT & FUNCTION

The POS 1 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas in selected locations throughout the POS
- Shelter and picnic node
- Large playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Open lawn/ kick-about space
- Native, water wise planting
- Drainage basin for stormwater management

FLORENCE SOUTH, MANDOGALUP

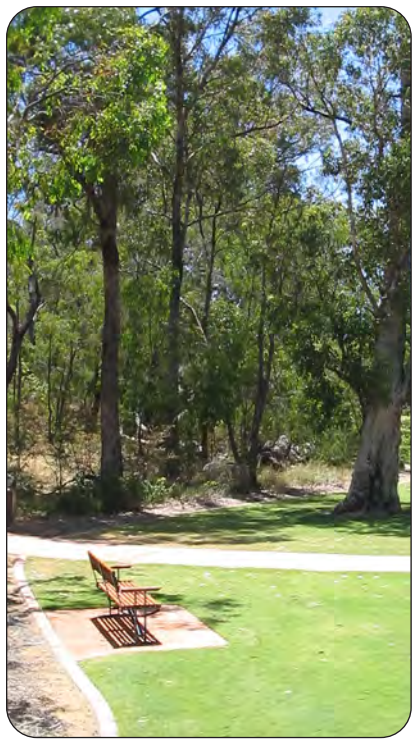
POS 1 LANDSCAPE CONCEPT

DWG **MA-22-05**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
0 5 10 15 20 25 m

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POS 2

FLOOD MANAGEMENT AREA E

POS TYPOLOGY
- Neighbourhood POS

SIZE
- 8507m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1350m3

Major Event 1% AEP

TWL Area: 4900m^2

Volume: 3900m3

CONCEPT & FUNCTION

The POS 2 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing melaleuca trees and understorey vegetation for shade and biodiversity, incorporated into drainage where appropriate.
- Shaded seating areas in selected locations throughout the POS
- Shelter structures with bbq and picnic facilities
- Playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



Fflorence south, mandogalup

POS 2 LANDSCAPE CONCEPT

DWG **MA-22-06**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
0 5 10 15 20 25 m

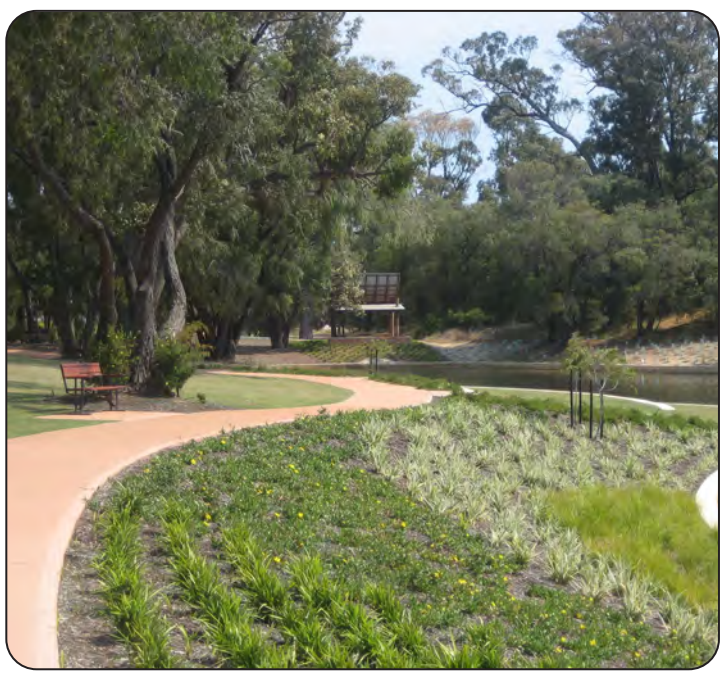
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POS 9

FLOOD MANAGEMENT AREA F

POS TYPOLOGY
Nature Space/ Local Open Space

SIZE
- 8944m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 900m^2

Volume: 340m3

Major Event 1% AEP

TWL Area: 1400m^2

Volume: 1025m3

CONCEPT & FUNCTION

The POS 9 landscape proposals will deliver the following:

- Opportunities for nature-based recreational activities, such as picnicking, bird watching, walking.
- Retention of existing trees and understorey vegetation for shade and biodiversity.
- Shaded seating areas
- Footpath network with access through the POS and to the greater pedestrian path network
- Access into POS from nested lots
- Small open lawn area for informal recreation
- Native, waterwise planting
- Planting designed to maintain a low-fuel state for bushfire managemant purposes
- Drainage basin for stormwater management





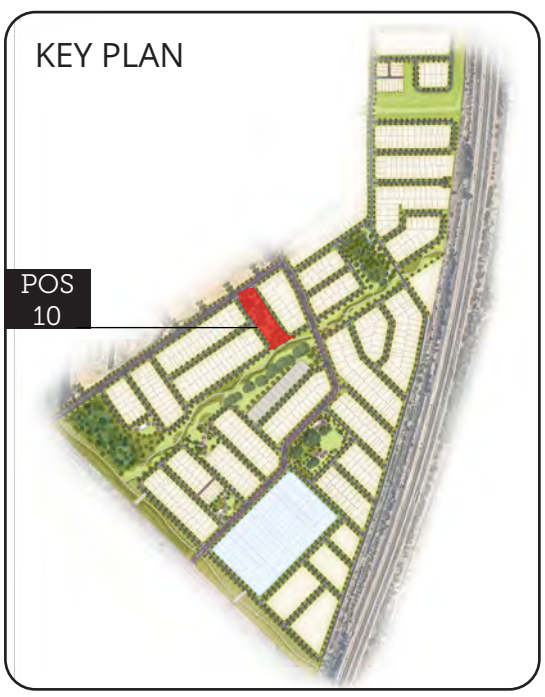
FLORENCE SOUTH, MANDOGALUP
POS 9 LANDSCAPE CONCEPT

DWG **MA-22-07**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 10

FLOOD MANAGEMENT AREA G

POS TYPOLOGY
- Neighbourhood Park

SIZE
- 6715m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 1700m^2

Volume: 380m3

Major Event 1% AEP

TWL Area: 2100m^2

Volume: 1150m3

CONCEPT & FUNCTION

The POS 10 landscape proposals will deliver the following:
- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas
- Shelter structures with bbq and picnic facilities
- Inclusive nature playground with shade sails
- Open lawn areas for informal sports and recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 10 LANDSCAPE CONCEPT

DWG **MA-22-08**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 11

FLOOD MANAGEMENT AREA K

POS TYPOLOGY
Local Park

SIZE
- 3112m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area:1000m^2

Volume: 260m3

Major Event 1% AEP

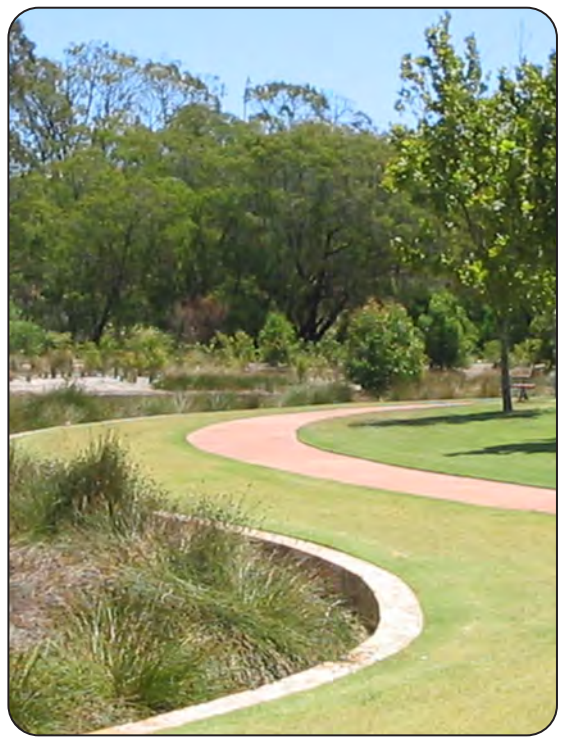
TWL Area:1300m^2

Volume: 700m3

CONCEPT & FUNCTION

The POS 11 landscape proposals will deliver the following:
- Predominantly passive recreation opportunities
- Retention of existing trees for shade and biodiversity
- Shaded seating areas
- Shelter and picnic node
- Open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 11 LANDSCAPE CONCEPT

DWG **MA-22-09**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 12

FLOOD MANAGEMENT AREA J

POS TYPOLOGY

- Local Park

SIZE

- 3941m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 2100m^2

Volume: 735m3

Major Event 1% AEP

TWL Area: 2800m^2

Volume: 2350m3

CONCEPT & FUNCTION

The POS 12 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management

POS 13

FLOOD MANAGEMENT AREA I

POS TYPOLOGY

- Local Park

SIZE

- 4529m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 3600m^2

Volume: 1200m3

Major Event 1% AEP

TWL Area: 4500m^2

Volume: 3400m3

CONCEPT & FUNCTION

The POS 13 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



FLORENCE SOUTH, MANDOGALUP

POS 12 & POS 13 LANDSCAPE CONCEPTS

DWG **MA-22-10**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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WESTERN POWER EASEMENT

POS TYPOLOGY

- High Voltage Powerline Easement

SIZE

- 5.14ha

DRAINAGE CONSIDERATIONS

The Western Power Easement is part of the Mandogalup Swamp Regional Flood Storage Area.

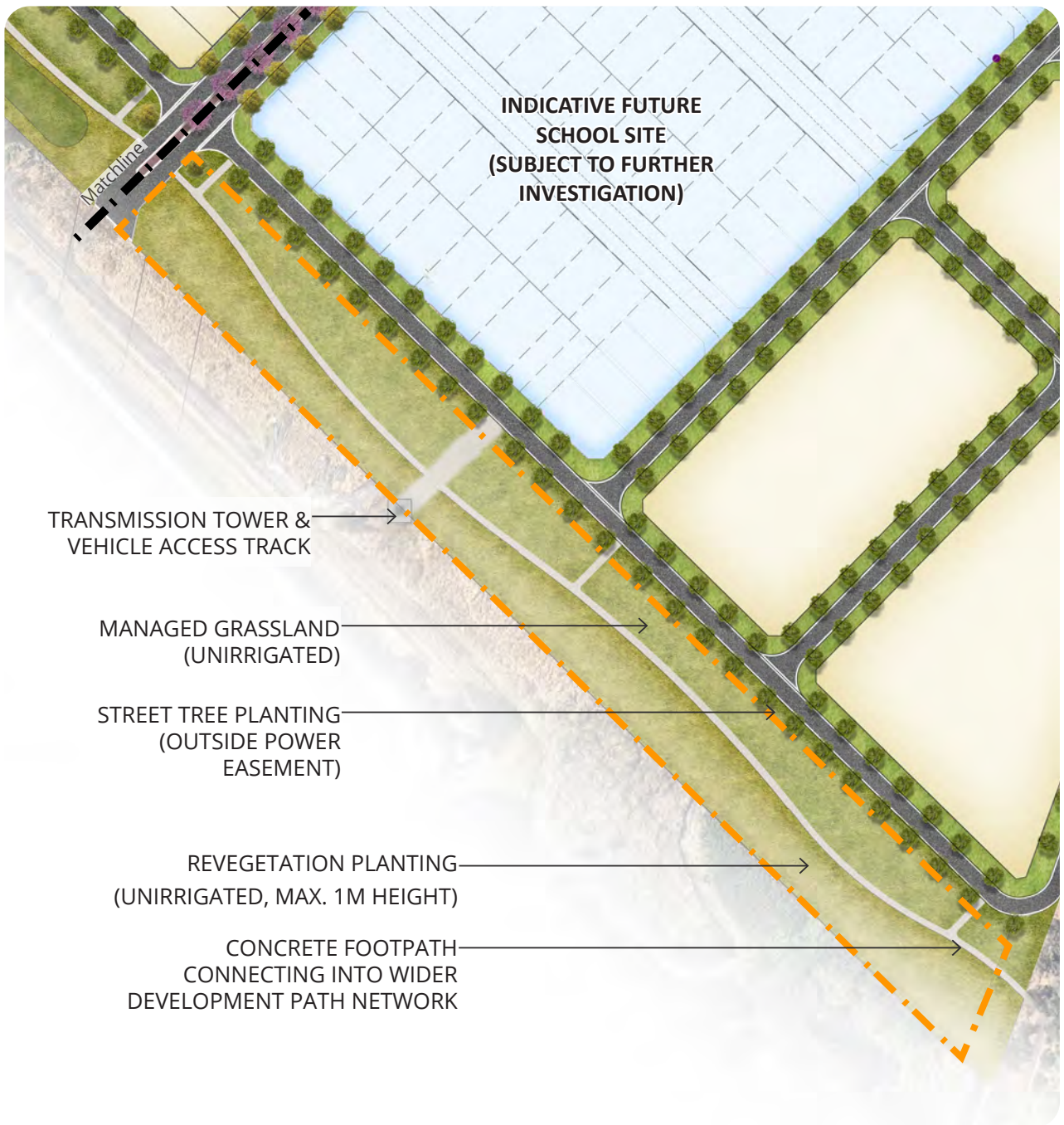
Overland flows from the DBNGP Easement, POS 11 (FMA K), the indicative future school site and FMA M will discharge into the Western Power Easement POS.

CONCEPT & FUNCTION

The Western Power Easement landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Unirrigated, managed grassland planting
- Unirrigated native revegetation planting, to a max. height of 1m.
- Flood storage areas for stormwater management
- Clear and easy maintenance access for power utility providers to transmission towers and across entire easement.

** Western Power Easement landscape design to be in accordance with Western Power easement land use requirements.



FLORENCE SOUTH, MANDOGALUP

WESTERN POWER EASEMENT LANDSCAPE CONCEPT

DWG **MA-22-11**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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APPENDIX 9

Transport Assessment

Engineering a better future for over 20 years!

Mandogalup East

Proposed Amended Local Structure Plan

Revised Transport Impact Assessment

PREPARED FOR:
Satterley Property Group

July 2025

Document history and status

Author	Revision	Approved by	Date approved	Revision type
Mohammad Rasouli	r01	B Bordbar	08/04/2024	Draft
Mohammad Rasouli	r01a	B Bordbar	12/04/2024	Final
Mohammad Rasouli	r01b	B Bordbar	23/05/2024	Minor modification
Mohammad Rasouli	r01c	B Bordbar	09/09/2024	Final
Mohammad Rasouli	r01d	B Bordbar	07/07/2025	Revised Final

File name: t23.273.mr.r01d.docx

Author: Mohammad Rasouli

Project manager: Mohammad Rasouli

Client: Satterley Property Group

Project: Mandogalup East

Document revision: r01d

Project number: t24.076

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1 Introduction and Background

Transcore prepared a revised TIA report for the Mandogalup East Local Structure Plan (MELSP) in November 2017. At the time of preparation of the MELSP TIA report the area to the south of the MELSP was zoned as urban differed and was not included in the MELSP.

The Metropolitan Region Scheme (MRS) has since been amended to rezone land to the south of the MELSP from the Urban Deferred to the Urban zone, as shown in **Figure 1**. Rowe Group has prepared an amended LSP for the MELSP including the urban zone to the south which is the subject of this TIA.

Transcore prepared a TIA in September 2024 for the amended Local Structure Plan (LSP). Following a review by Main Roads WA and the City of Kalamunda, Transcore was commissioned to provide additional information to address the comments from these authorities and update the 2024 TIA. The updates included the following requests from the city:

- Include a safe route to school assessment; and,
- Identify the width of road reserves (access streets) according to the City of Kwinana and Leviable Neighbourhood Guidelines specifications.

Additionally, Transcore separately addressed the comments from Main Roads WA and updated the SIDRA assessments to adjust the peak flow factor at the Rowley Road/Quartermaine Boulevard roundabout.

Both MELSP (referred to as Florence Estate) and MWLSP (referred to as Apsley Estate) **Figure 2**, received endorsement from the Western Australian Planning Commission (WAPC) in March 2018. The approved MELSP and MWLSP aim to deliver a total of 607 and 911 residential lots respectively. Collectively, the approved LSPs are expected to generate a combined total of 1,518 new residential lots. Subdivision for the Florence (MELSP) and Apsley (MWLSP) estates is currently progressing in accordance with the approved structure plans.

Since the preparation of the LSPs, The Western Australian Planning Commission (WAPC) prepared an Improvement Plan (IP47) for the land to the west and south of the LSPs. The IP47 came into effect on 12 April 2019 and following Gazettal of the draft Improvement Scheme, it will provide a framework for future planning and development.

In January 2024, Taylor Burrell Barnett prepared the Improvement Scheme Report for Department of Planning, Lands and Heritage (DPLH) in support of the Mandogalup Improvement Scheme No. 1. A copy of the Mandogalup Improvement Scheme concept plan is provided in **Appendix A**.

The suggested long term access strategy to Hammond Road for the proposed LSPs is generally in line with the access strategy documented in the Mandogalup Improvement Scheme concept plan as shown in Appendix A.

This Revised TIA has been prepared to document the results of the traffic modelling and analysis, and to provide additional information in response to the comments raised by the City of Kwinana in their letter dated August 14, 2024, addressed to Rowe Group.

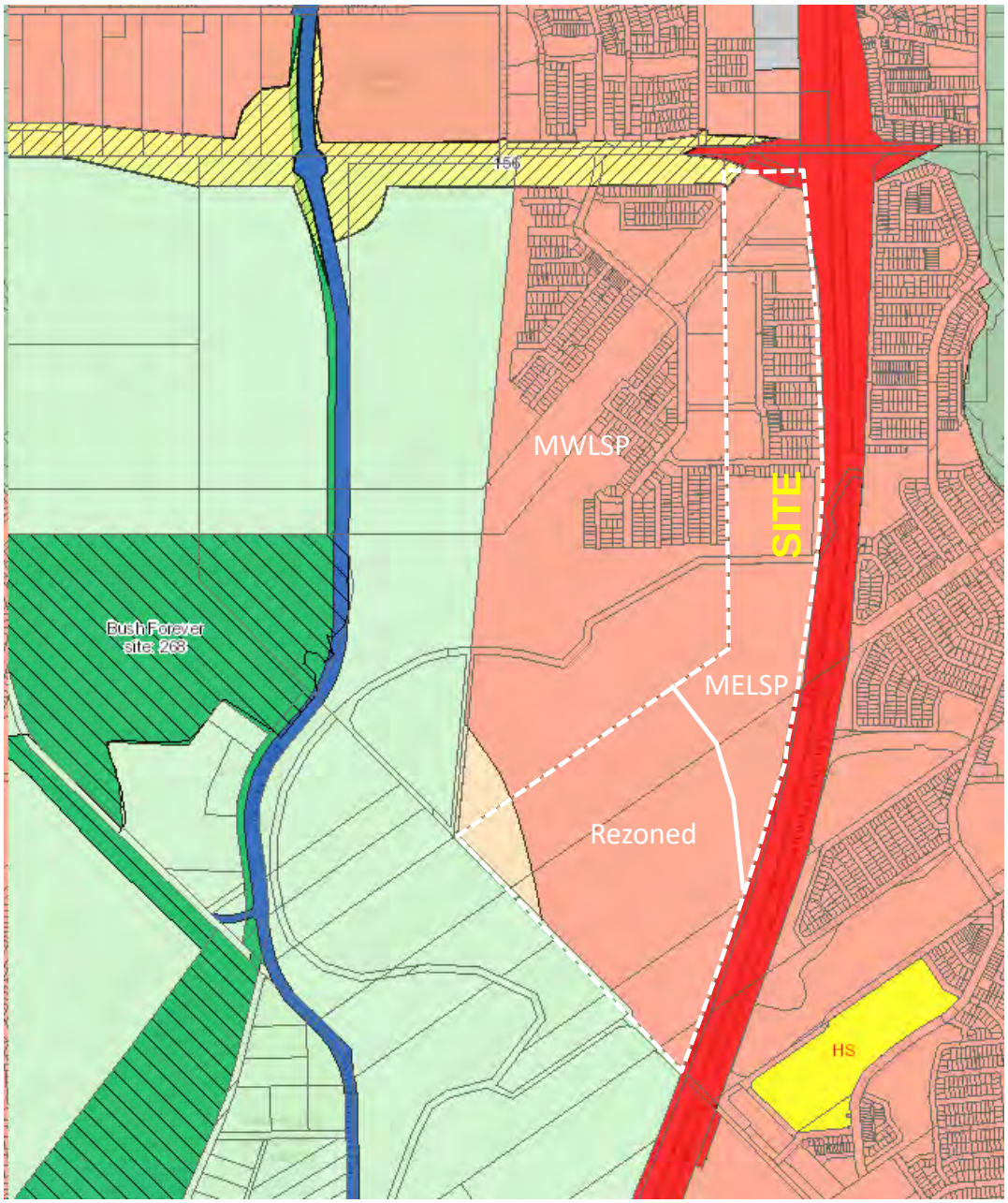


Figure 1: Site location including the land rezoned from Urban Deferred to Urban in the MRS

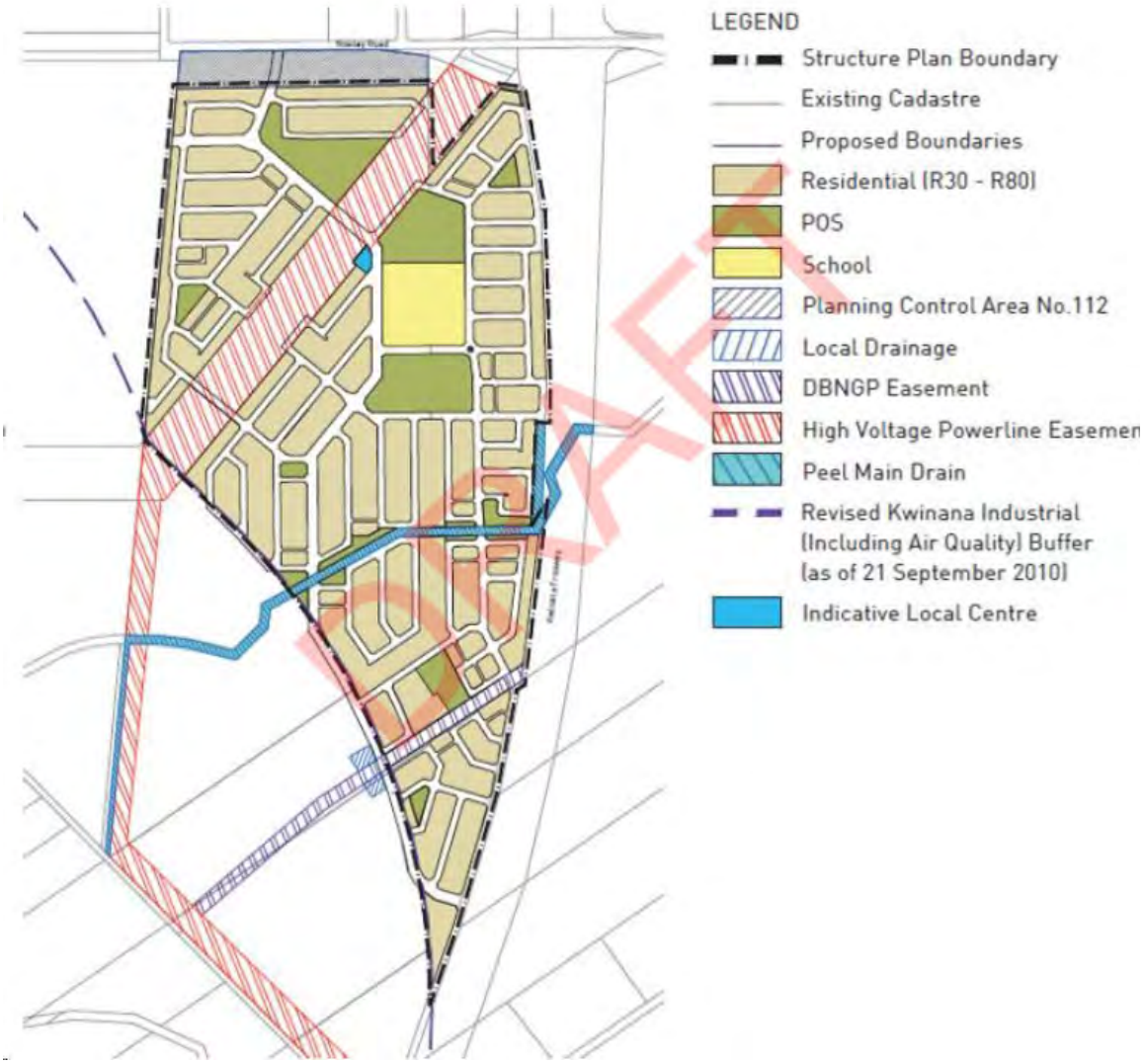


Figure 2: Combined approved Mandogalup East and West Concept Plan

The proposed MELSP and MWLSP areas are located on the western side of the Kwinana Freeway and south of Rowley Road, as shown in **Figure 3**. The subject of this TIA is MELSP. However, the traffic modelling and analysis undertaken in this TIA include the traffic generation of both MELSP and MWLSP.



Figure 3: Location of the Subject Site

2 Proposed Amended Local Structure Plan

The proposed amended Local Structure Plan is shown in **Figure 4**.

Currently, there is an ongoing subdivision development in the northern part of the MWLSP and MELSP area. The amended LSP is currently linked to Rowley Road through a roundabout intersection at Rowley Road/Quartermain Blvd/Irvine Pde.

According to the approved Local Development Plan[1] for Vivente Estate, Irvine Pde (the northern leg of the roundabout intersection on Rowley Road) would be closed after the completion of Vivente subdivision.

Quartermain Blvd serves as the primary north-south spine road within the amended LSP area, and there are plans to extend it southward to connect with Mandogalup Road at the southern end. In addition to the southern connection, two additional connections are proposed for future development. One connection is planned at the southern boundary of the MWLSP area, and another connection is planned through continuation of Goldwyer Drive. These additional connections will provide further access and connectivity within the amended LSP area.

Apart from the approved primary school located in the northern part of the MELSP, the amended LSP indicates the possibility of a school site within the southern part of the amended LSP (as shown in **Figure 4**). However, it should be noted that further investigation is required to confirm the feasibility and suitability of the potential school site in this location.

Furthermore, the amended LSP includes potential development of Lot 11 which is located at the south east corner of the LSP area. Lot 11 would entail 63 residential lots.

The amended LSP would provide approximately 957 residential lots which would reduce to about 869 lots with the potential school site.

[1] 20200304-RIC-HAM-Vivente-Overall-Estate-LDP.pdf

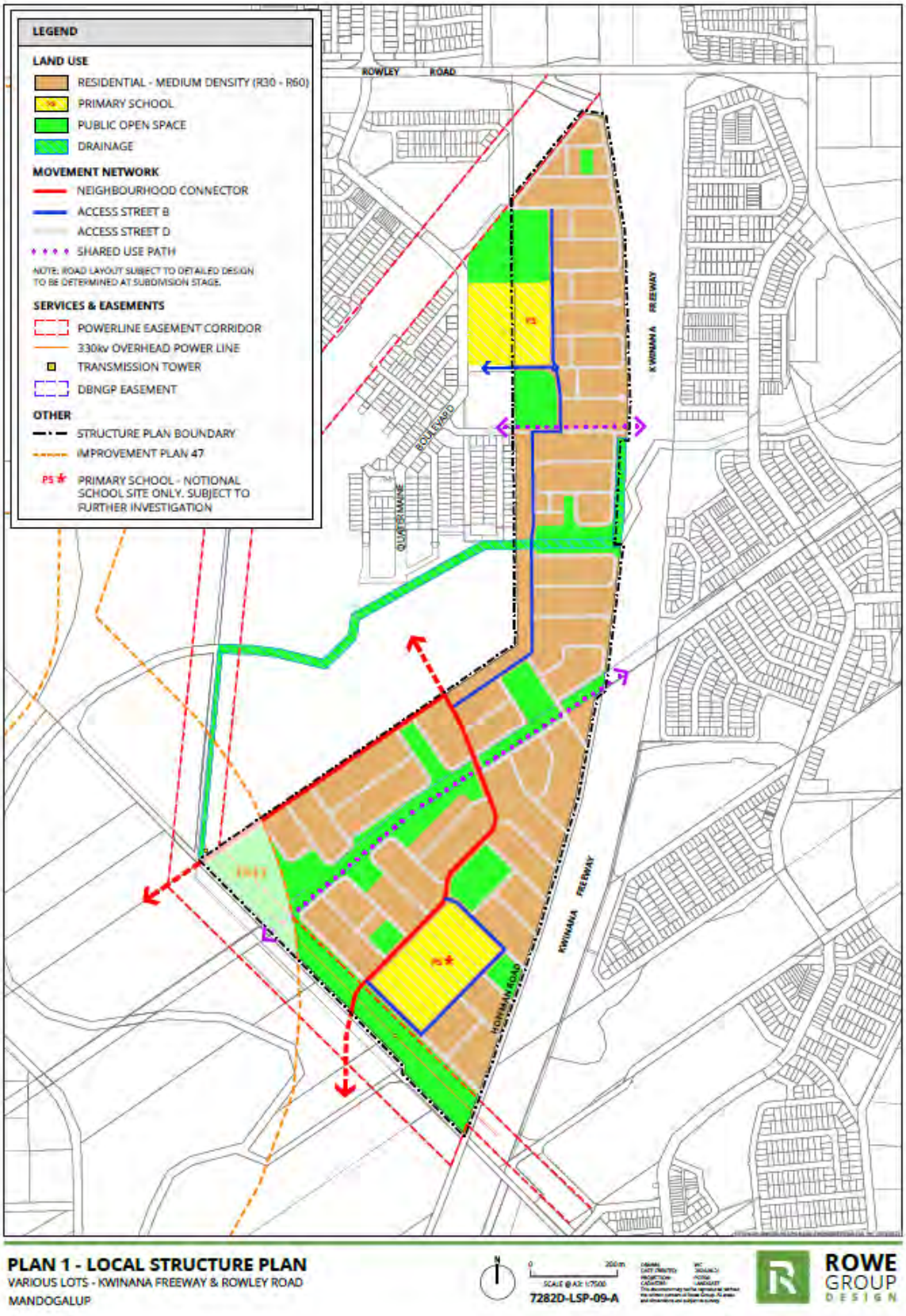


Figure 4: Proposed Amended Local Structure Plan

3 Existing Situation

3.1 Existing Land Use

Currently, there is an ongoing subdivision development in the northern part of the LSPs which is progressing towards south.

3.2 Existing Road Network

The existing road network and its classification in the Main Roads WA functional road hierarchy is illustrated in **Figure 5**.

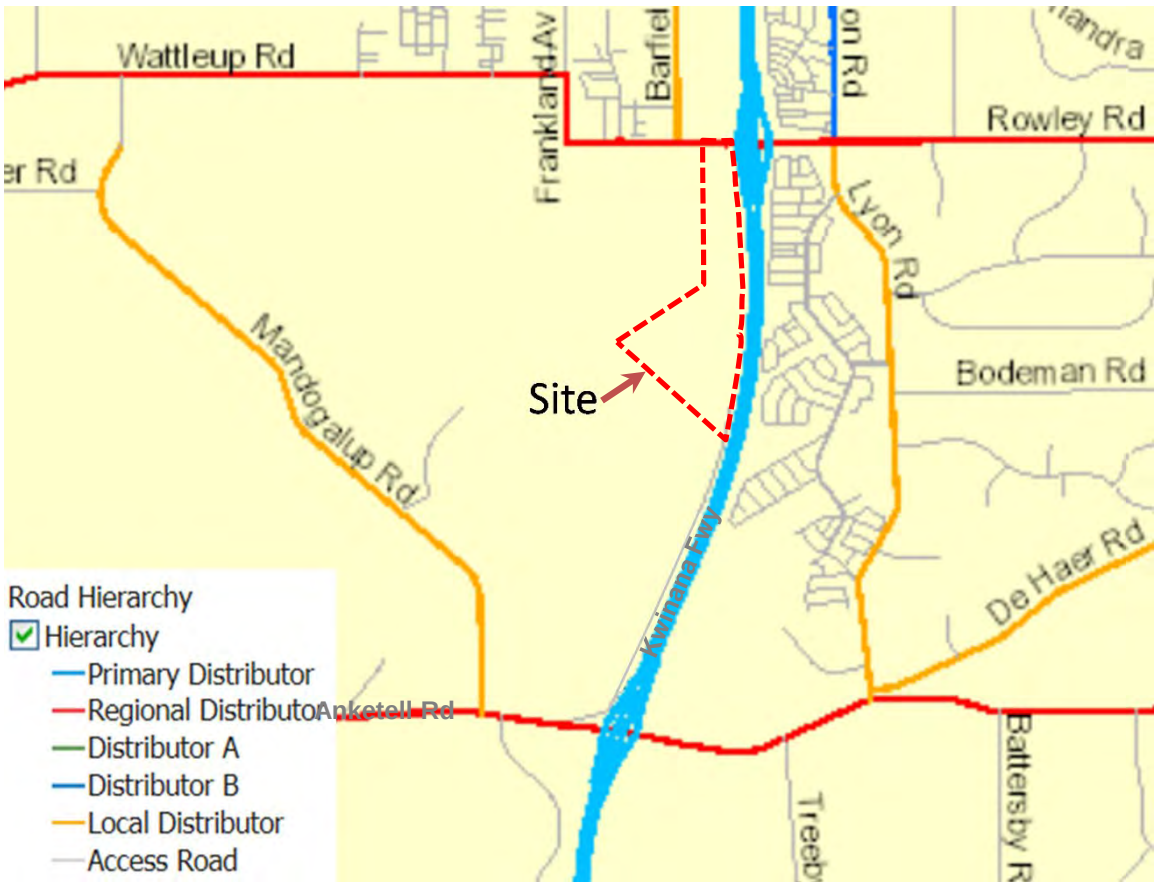


Figure 5: Existing road hierarchy

Rowley Road is classified as a Regional Distributor in the Main Roads WA Functional Road Hierarchy and is currently constructed as a rural standard single carriageway road. Rowley Road provides an east-west connection between South Western Highway (via Eleventh Road in Armadale), Tonkin Highway, Kwinana Freeway and Rockingham Road in Wattleup (via Wattleup Road).

Anketell Road is classified as a Regional Distributor in the Main Roads WA Functional Road Hierarchy and is constructed as a single carriageway road. The existing posted speed limit on Anketell Road (about 150m west of the Hoffman Road intersection) is 80km/h for westbound and 70km/h for eastbound directions.

Anketell Road has been identified as an alternative freight route to the Naval Base / Kwinana Beach industrial areas. Liaison with Department of Planning, Lands & Heritage and Main Roads WA indicates that ultimately a dual divided carriageway standard is planned for Anketell Road.

Mandogalup Road is classed as a Local Distributor primarily running in a north-south direction from Wattleup Road in the north to Anketell Road in the south. The posted speed limit along this road typically varies between 70 and 80 km/h.

Mandogalup Road is constructed as a single carriageway with rural standards, and it occupies a road reserve width of approximately 20 meters. Currently, there is no dedicated infrastructure available for pedestrians or cyclists along this road.

3.3 Existing Traffic Volumes

Existing average weekday traffic (AWT) volumes on surrounding roads have been obtained from Main Roads WA and are illustrated in Figure 6.

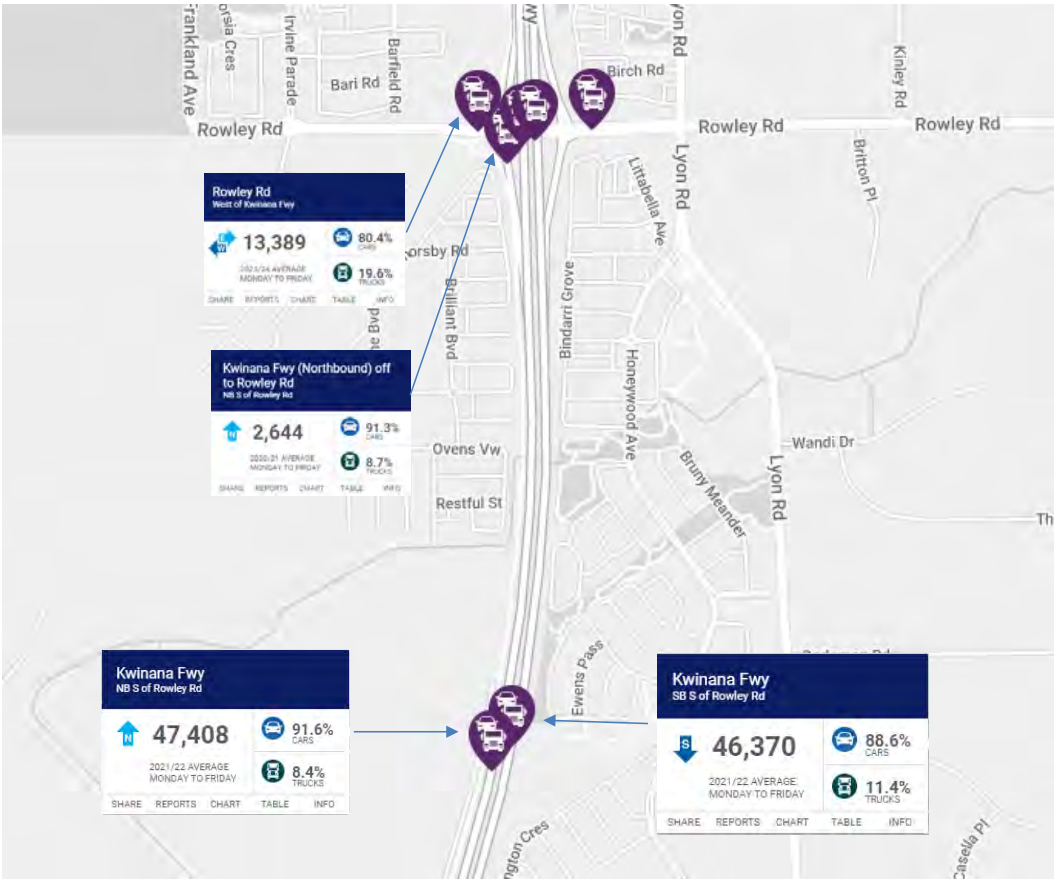


Figure 6: Existing traffic volumes

Anketell Road carried about 22,122vpd in 2023/2024 immediately west of Kwinana Freeway. The existing turning counts at the intersection of Anketell Road/ Mandogalup Road were also sourced from Main Roads WA traffic map (dated Tuesday 27th October 2020). **Figure 7** illustrates the existing traffic counts at the intersection.

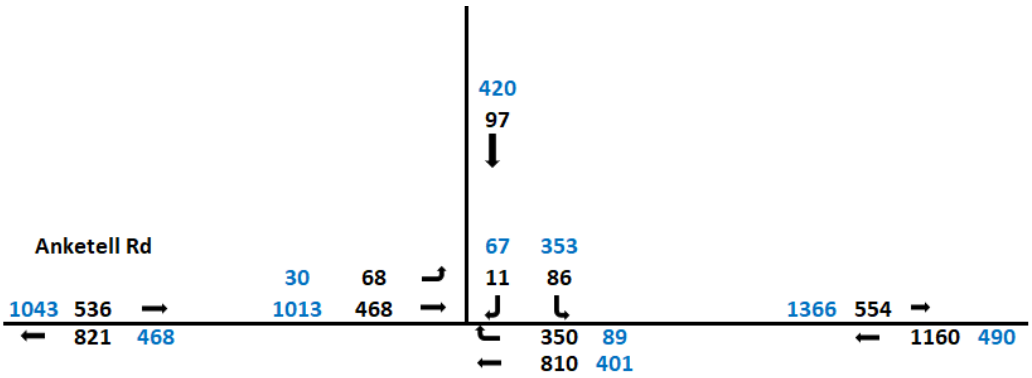


Figure 7: Existing traffic counts at Mandogalup Rd/ Anketell Road intersection AM and PM peak hours

3.4 Public Transport

Currently, there are no bus routes servicing the subject site. The closest existing bus route to the amended LSP is Bus Route No. 527 which traverses through the new developments to the east of the Kwinana Freeway.

Bus routes 525 and 526 are located about 2km to the north of the amended LSP area and terminate north of Gaebler Road, as shown in **Figure 8**. Both of these bus routes are located outside the 400m walking distance to the subject site.

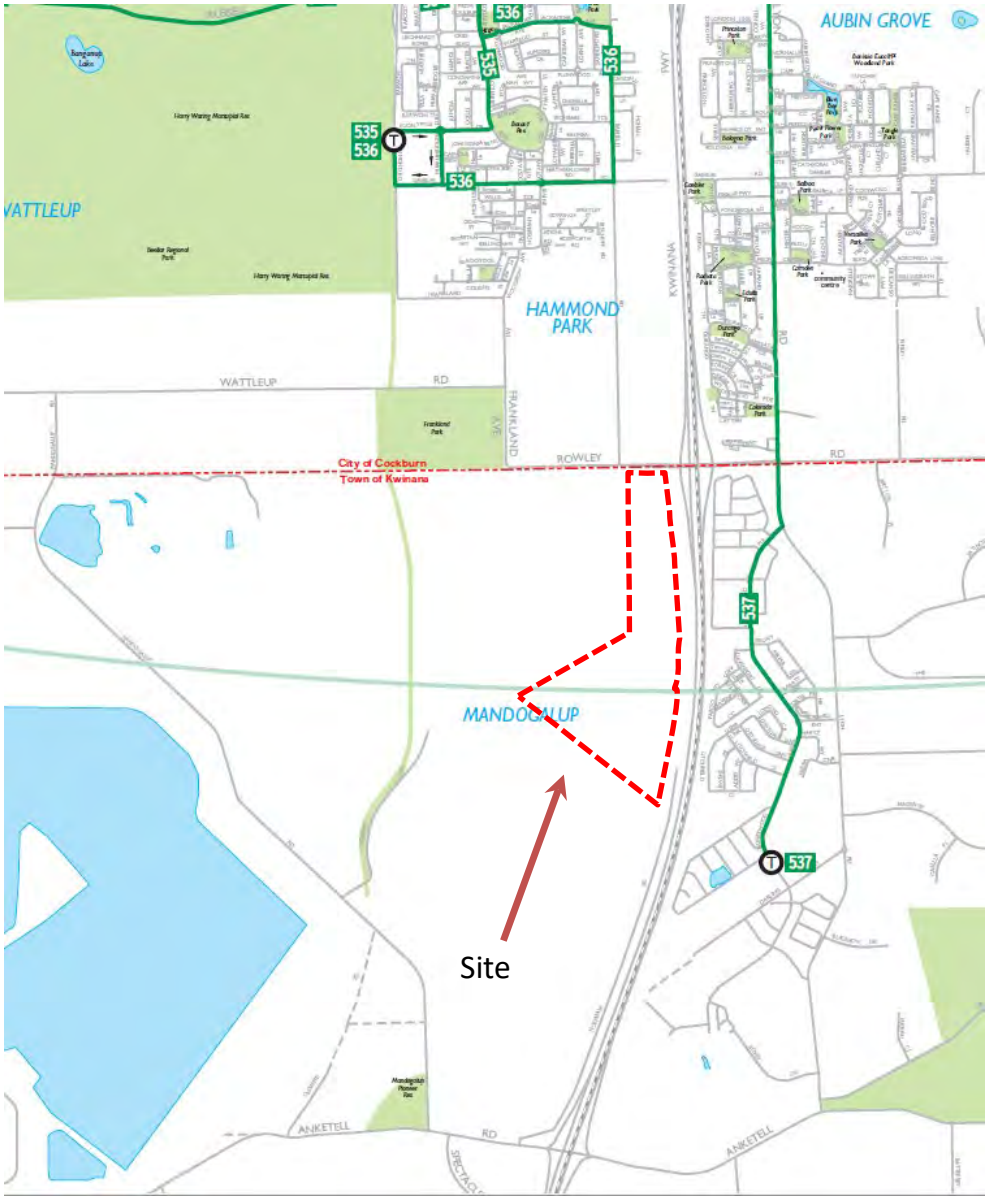


Figure 8: Existing Bus Routes

3.5 Pedestrian and Cyclist Facilities

Currently, there is a 3m Principal Shared Path (PSP) along Kwinana Freeway. The PSP continues north and south along Kwinana Freeway through existing underpasses (under Rowley Road and Anketell Road) immediately west of the Freeway. There is an existing shared path along the south side of Rowley Road which connects to the existing PSP. This shared path terminates immediately east of Barfield Road.

The Department of Transport's Perth Bike Map series (see **Figure 9**) also shows the existing PSP along Kwinana Freeway in the vicinity of the amended LSP area. According to this plan Rowley Road and Barfield Road are considered to be part of the Perth Bicycle Network (PBN) and are nominated as continuous signed routes.

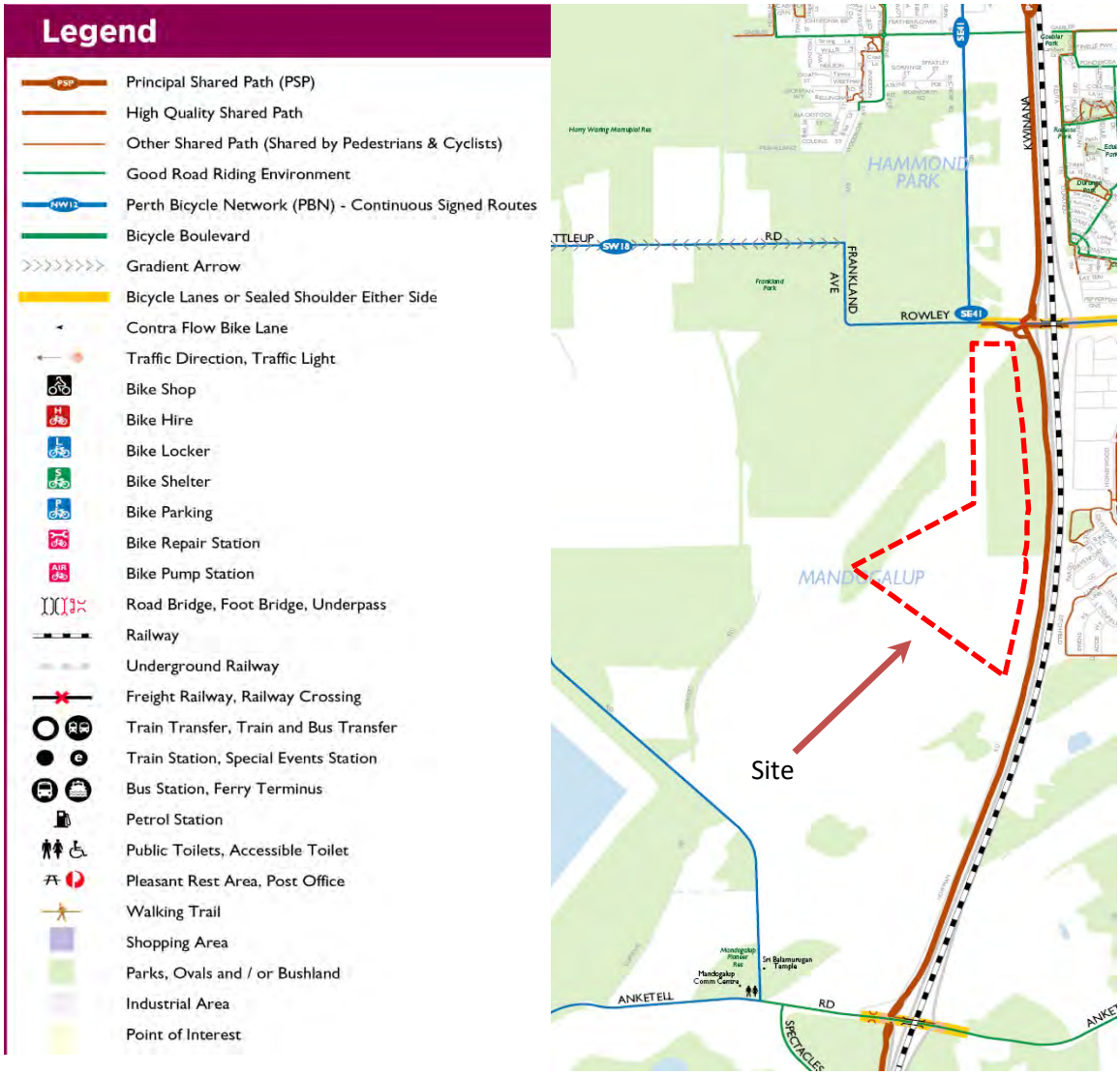


Figure 9: Bike Map

3.6 Changes to the surrounding road network

In June 2015 the Minister for Planning approved the declaration of two Planning Control Areas (PCA) over Rowley Road and Anketell Road west of the Kwinana Freeway.

- PCA 111 is for the protection of the proposed road freight transport access corridor along Anketell Road between the Kwinana Freeway and Rockingham Road.
- PCA 112 is for the protection of the proposed road and rail freight transport access corridor of Rowley Road, between Kwinana Freeway and the coast.

Future road network planning for this part of the Metropolitan area includes the extension of Rowley Road to Rockingham Road. According to the information obtained from Main Roads WA, ultimately Rowley Road is planned to be constructed to four lanes divided standard.

The planned intersection arrangements along Rowley Road to the west of the Kwinana Freeway for the ultimate situation are as follows:

- Barfield Road to be terminated to the north of Rowley Road with no connection on Rowley Road;
- The existing roundabout intersection on Rowley Road would be converted to a 3-leg roundabout intersection by removing the northern leg in the short term. Eventually, the roundabout will be completely removed, and the southern connection will operate as a left-in/left-out access.
- The Frankland Avenue intersection would be downgraded to a left in/ left out intersection;
- Hammond Road would be extended towards the south forming a four-way, grade-separated intersection with Rowley Road and a T-intersection with Anketell Road and Mandogalup LSPs would connect to Hammond Road as per the Draft Mandogalup Improvement Scheme Map shown in **Figure 10**.

According to Main Roads WA, planning is now underway to upgrade Anketell Road between Leath Road and Kwinana Freeway as part of the future Anketell Thomas Road Freight Corridor.

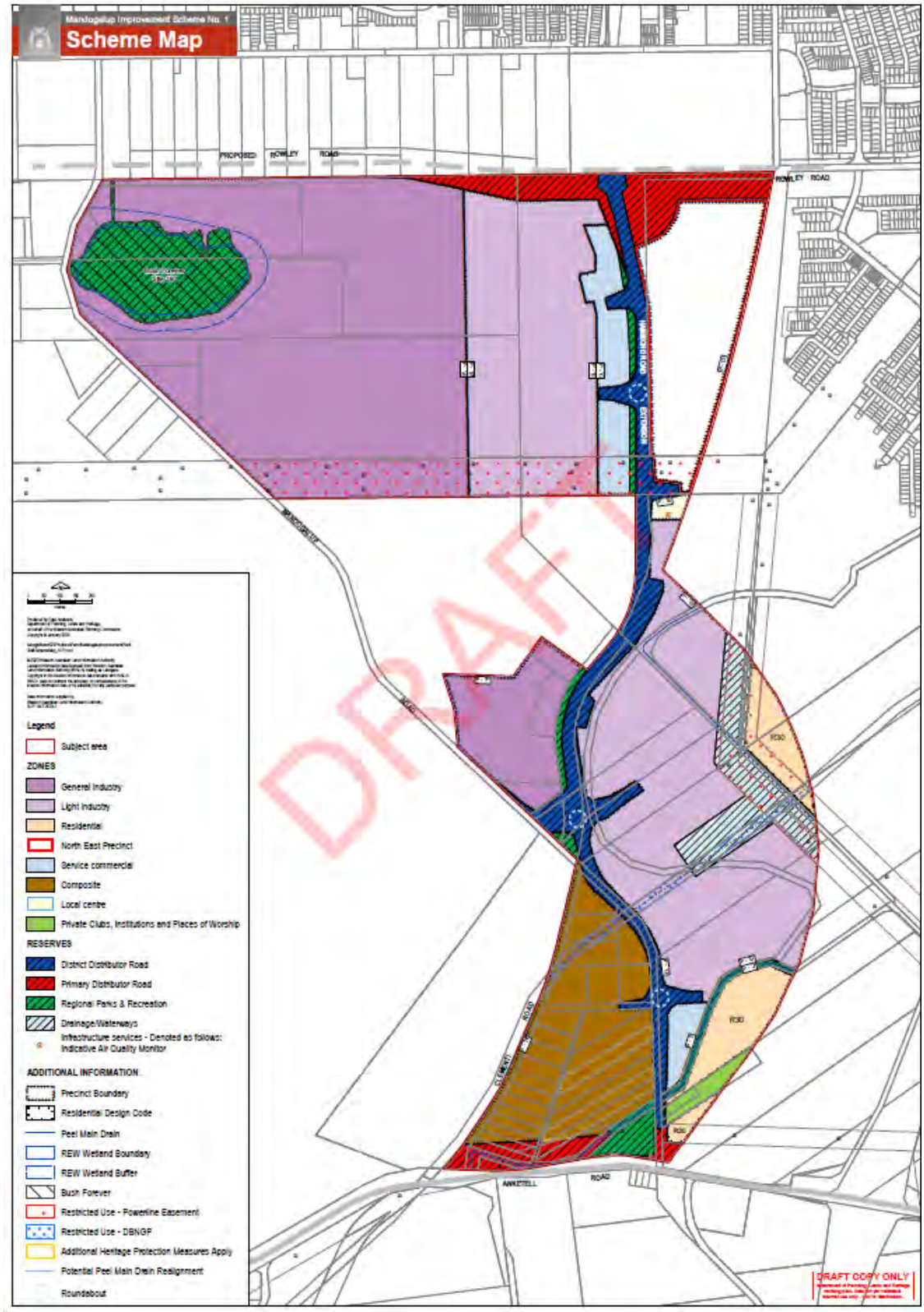


Figure 10: Draft Mandogalup Improvement Scheme Map

3.7 Public Transport Network Planning

According to the information obtained from the Public Transport Authority (PTA), it is anticipated that the area to the west of the Kwinana Freeway would be served by future Bus Routes 535 and 536. These new routes are likely to commence in the near future (subject to the progress of developments and availability of funding) and operate out of Aubin Grove Station. These routes would eventually connect Hammond Park to Mandogalup. **Figure 11** illustrates the proposed bus routes 535 and 536 in this area.



Figure 11: Future Bus Routes in the Vicinity of the subject site

4 Proposed Internal Transport Network

4.1 Road Hierarchy

The proposed hierarchy of roads within the amended LSP area is generally inline with the original approved MELSP and is illustrated in **Figure 12**. The proposed road hierarchy was based on traffic projections and the road classification of the WAPC Liveable Neighbourhoods guidelines (2007).

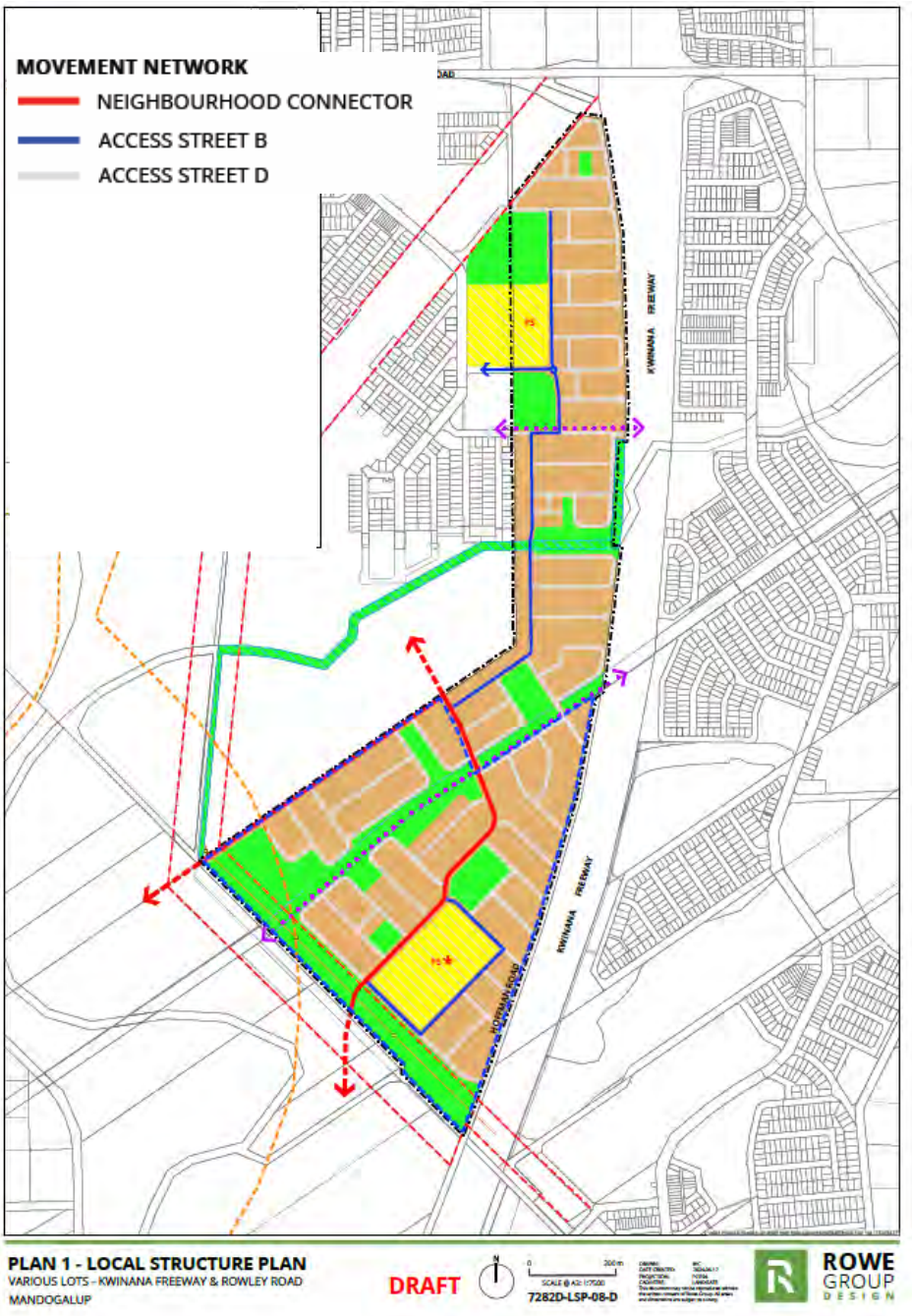


Figure 12: Proposed Road Hierarchy

The road network of the northern part of the proposed amended LSP has already been constructed and it is expected that the same road standard would progress for the future neighbourhood connector and access streets within the amended LSP area.

The majority of the amended LSP internal roads are estimated to carry less than 1,000vpd and according to the LN Guidelines, an Access Street D with a 14.2m road reserve would be sufficient for these roads. However, a wider road reserve of 15.4m, consistent with LN Access Street C, has been adopted to allow for wider verges. Typical cross sections for Access Street C are illustrated in **Figure 13**.

The access streets abutting the approved primary school (to the north of the amended LSP) and the potential primary school (to the south of the amended LSP) are recommended to be constructed to the 17.9-metre Access Street B cross-section standard, which allows for on-street parking on both sides of the street. The access streets around the approved primary school have already been constructed to this standard.

The amended LSP also shows a neighbourhood connector road at the boundary of the Florence and Apsley Estates. This neighbourhood connector road is planned to extend further west through future industrial areas, crossing the existing Peel Main Drain, and ultimately connecting to the future Hammond Road. Cossill and Webley (C&W) Consulting Engineers have prepared a design concept plan for the neighbourhood connector road which is shown in **Figure 14**.

This plan depicts the section of the road on both sides of the existing Peel Main Drain. On the east side of the drain, the road traverses residential subdivisions and connects to the continuation of Quartermain Blvd via a roundabout. The assessments undertaken in this Revised TIA indicates that traffic projections for the proposed neighbourhood connector road would be approximately 5,800 vpd. According to the Liveable Neighbourhoods Guidelines, this road would be classified as a Neighbourhood Connector A road. A typical Neighbourhood Connector A road requires a 24.4m road reserve, which includes 2.1m on-street parking bays indented in the verge and 1.5m on-road cycle lanes.

However, since the proposed neighbourhood connector road will pass through an industrial area to the west, the need for on-road cycle lanes is not warranted. Effective on-road cycling depends on integrated network that connects various routes, and the western section of the road, characterized by industrial zones, poses safety risks for on road cyclists. The presence of heavy vehicle traffic and industrial operations makes it challenging to ensure a safe environment for on-road cycling in this area. Instead, it is recommended that a shared path be provided within the verge of the neighbourhood connector road. This design allows cyclists to travel safely along the verge rather than on the road itself. Therefore, the following cross-section within a 20m road reserve is suggested:

- 2 x 3.5m carriageway, 2m flush median, 2 x 5.5m verge

This configuration allows for lot frontage along the neighbourhood connector road. With respect to the direct lot frontage, the LN Guideline suggests that "*Developments along neighbourhood connector roads with ultimate vehicle volumes over 5000*

vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access. Wider lots with paired driveways and protected reversing areas in the parking lane may be used on streets with up to 7000 vehicles per day."

For those lots that will have direct frontage to the neighbourhood connector road, either wider lots should be designed to facilitate the safe exit of vehicles in a forward direction or a cap road should be provided to facilitate the access/ egress of the residential dwellings through the cap road rather than directly onto the proposed neighbourhood connector road.

The western section of the neighbourhood connector road, located to the west of the Peel Main Drain, will also pass through the industrial area. Therefore, the 20m road reserve will extend through this area, featuring a different cross-section that includes a 9m carriageway suitable for industrial development.

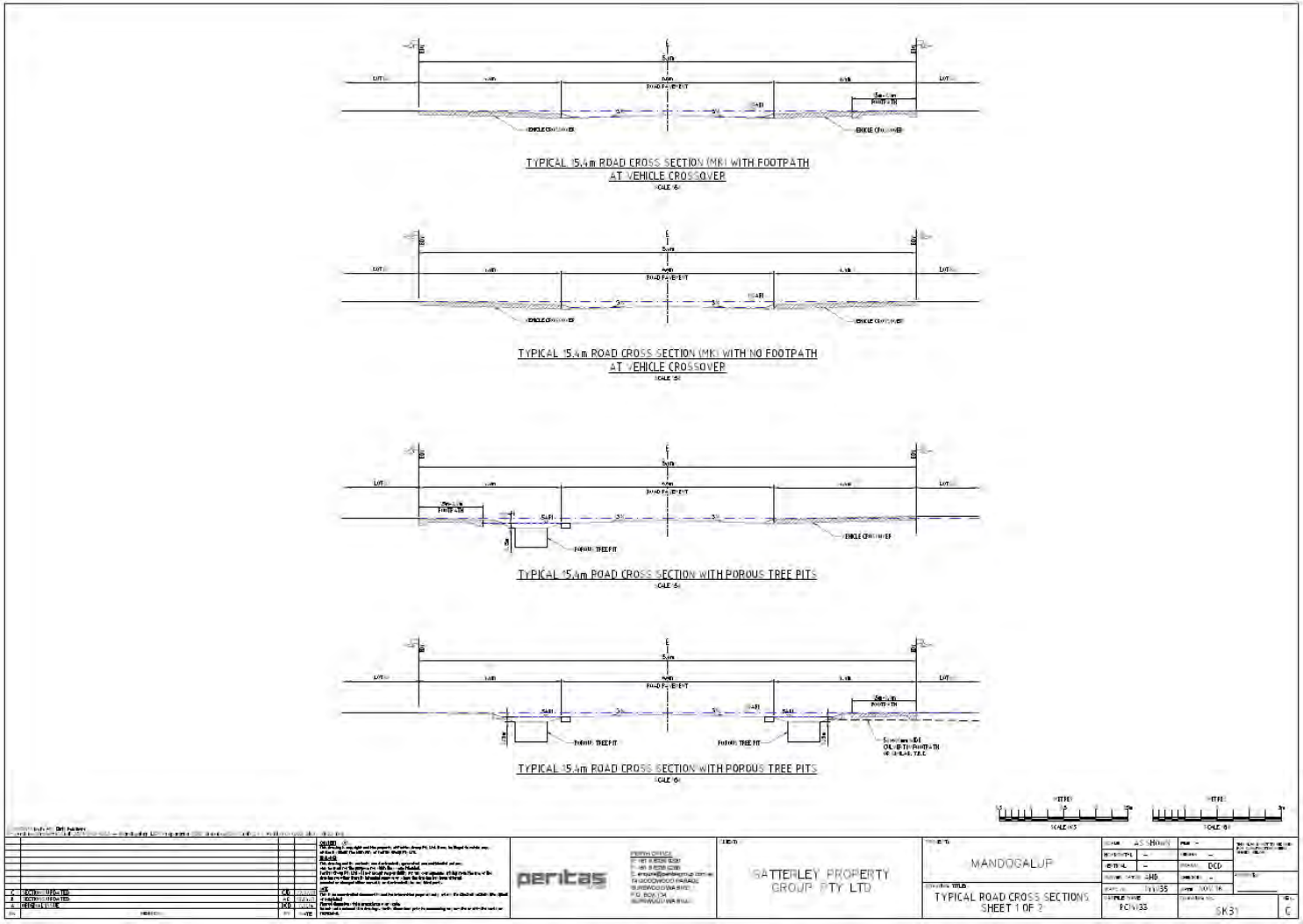


Figure 13: Typical 15.4m cross sections for Access Street C

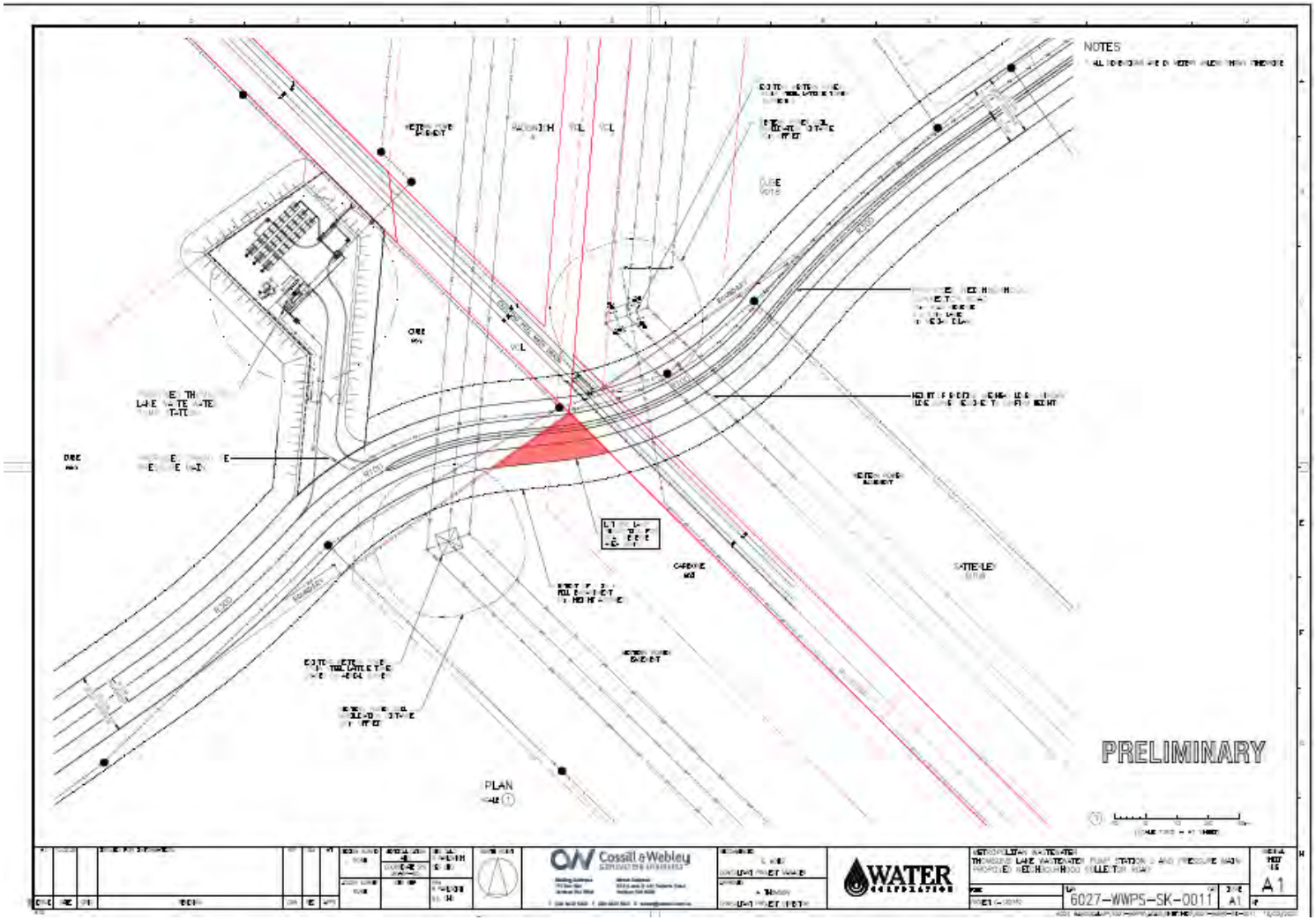


Figure 14: Proposed profile of the neighbourhood connector road at the boundary of the Florence and Apsley Estates

4.2 Public Transport

According to the information obtained from the Public Transport Authority (PTA), it is anticipated that the area to the west of Kwinana Freeway would be served by future bus routes 535 and 536 as outlined in Section 3.7 of this report. It is most likely that route 536 would serve the Mandogalup LSP areas including the proposed amended LSP in future as it operates closest to the Kwinana Freeway on the western side. PTA intention is to run bus route 536 along the north-south spine road within the Mandogalup LSP areas to the south of Rowley Road while maintaining a distance of approximately 500-600m away from the Kwinana Freeway alignment. The proposed bus route is most likely to traverse southbound on Barfield Road from Hammond Park and then across Rowley Road traversing along the north-south spine road. When Barfield Road intersection is terminated, then this bus route is likely to be rerouted to other north-south links such as Hammond Road.

4.3 Pedestrian and Cyclist Facilities

The neighbourhood connector roads within the amended LSP are planned with 2.5m designated cycleways in the verge on one side of the road. The proposed amended LSP also shows indicative cycle accesses to the existing PSP along Kwinana Freeway.

4.4 Integration with Surrounding Area

The proposed land uses within the southern part of the amended LSP are mainly residential and are in line with the approved MELSP. The road network of the amended LSP area is proposed to connect to the neighbouring landholdings at a number of locations to improve permeability and facilitate connection to surrounding regional roads.

5 Analysis of the Transport Network

5.1 Assessment Period

The assessment year that has been adopted for this analysis is for:

Short term Scenario (Say 2031): With the assumption of full development of the approved MWLSP and MELSP areas and the recently rezoned land to the south of both LSPs.

Long term Scenario (say 2041 and 2051): Reference is made to Main Roads WA ROM 24 traffic projections for 2041 daily traffic projections and the transport report prepared by Flyt for the proposed Mandogalup Improvement Scheme which entails long term assessment (2051) after full development of the IP47.

5.2 Traffic generation and distribution

The daily traffic generation rate used for this transport assessment is 8 vehicle trips per day (vpd) per dwelling, which corresponds to peak hour trip generation rates of 0.8vph per dwelling recommended in the Western Australian Planning Commission (WAPC) *Transport Impact Assessment Guidelines* (2016).

The proposed amended MELSP is expected to accommodate approximately 932 lots (869 within Satterley land and 63 in Lot 11), assuming a second school site. The residential component of the amended LSP would generate 6,952 trips per day.

For the proposed primary school, the trip rate used is 1.0 vph (vehicle per hour) per student during before and after school peak periods (typically 8-9am and 3-4pm) and 2vpd (vehicle per day) per student overall. For this assessment the Education Department's standard 540 student primary school design has been assumed, so the two primary schools are assumed to attract traffic flows of 2,160vpd or 1,080vph.

Therefore, the total trip generation of the amended LSP with the potential school site would be approximately 9,112vpd.

In the scenario where there is no school on the south site, the total anticipated yield for the amended LSP would be around 1,020 lots, with 957 lots within Satterley land and 63 lots in Lot 11. The residential component of the amended LSP in this scenario would generate approximately 8,160 trips per day. Additionally, the approved school site would generate about 1,080vpd, resulting in a total trip generation of 9,240vpd.

Review of the total trip generation for the amended LSP under both scenarios (with or without the second school site) indicates that the daily trip generation would not significantly change. Considering that the amended LSP includes the location of the notional school site, for the purpose of the analysis, the school site is included.

Therefore, the overall Mandogalup LSPs are anticipated to accommodate approximately 2,236 dwellings including 932 dwellings for MELSP (including Lot 11) and 1304 dwellings for MWLSP. Therefore, the total trip generation of the residential dwellings of the LSPs are approximately 17,888vpd.

The proposed 750m2 NLA Local Centre within the MWLSP area would also attract approximately 900vpd.

Therefore, total traffic generation of the amended MWLSP and MELSP (including the local centre and two school sites) would be approximately 20,948vpd.

Due to the land use mix within the proposed amended MELSP and MWLSP incidences of multi-purpose trips are anticipated. Accordingly, it is expected that about 20% of the total residential trips would be internal to the LSP area and about 80% of the trips (16,758vpd) would be distributed to the external road network. The potential external road network connections in 2031 are expected to be the existing roundabout intersection on Rowley Road, and a secondary connection to Mandogalup Road.

The transport modelling and analysis undertaken indicates that about 8,000vpd of the total 16,758vpd external trips would be distributed to the roundabout intersection on Rowley Road and the balance of traffic (8,758vpd) would be distributed to the southern connection/s to Mandogalup Road.

5.3 traffic flow forecast on Surrounding roads

5.3.1 Short term scenario:

Figure 14 illustrates the total traffic projections after full development of the amended LSPs before Hammond Road extension (short term scenario). The external connections at this stage are expected to be the 3-leg roundabout intersection on Rowley Road and a secondary connection further south to Mandogalup Road. The location and layout of the proposed secondary connection to Mandogalup Road will need to be investigated further in the subsequent stages of the development of the MWLSP and MELSP.

The Draft Mandogalup Improvement Scheme Map shown in **Figure 10**, shows potential connections to Mandogalup Road further south via two roundabout intersections. One of these connections combined with the future 3-leg roundabout intersection of Rowley Road is expected to be sufficient to accommodate the amended LSPs traffic in 2031.

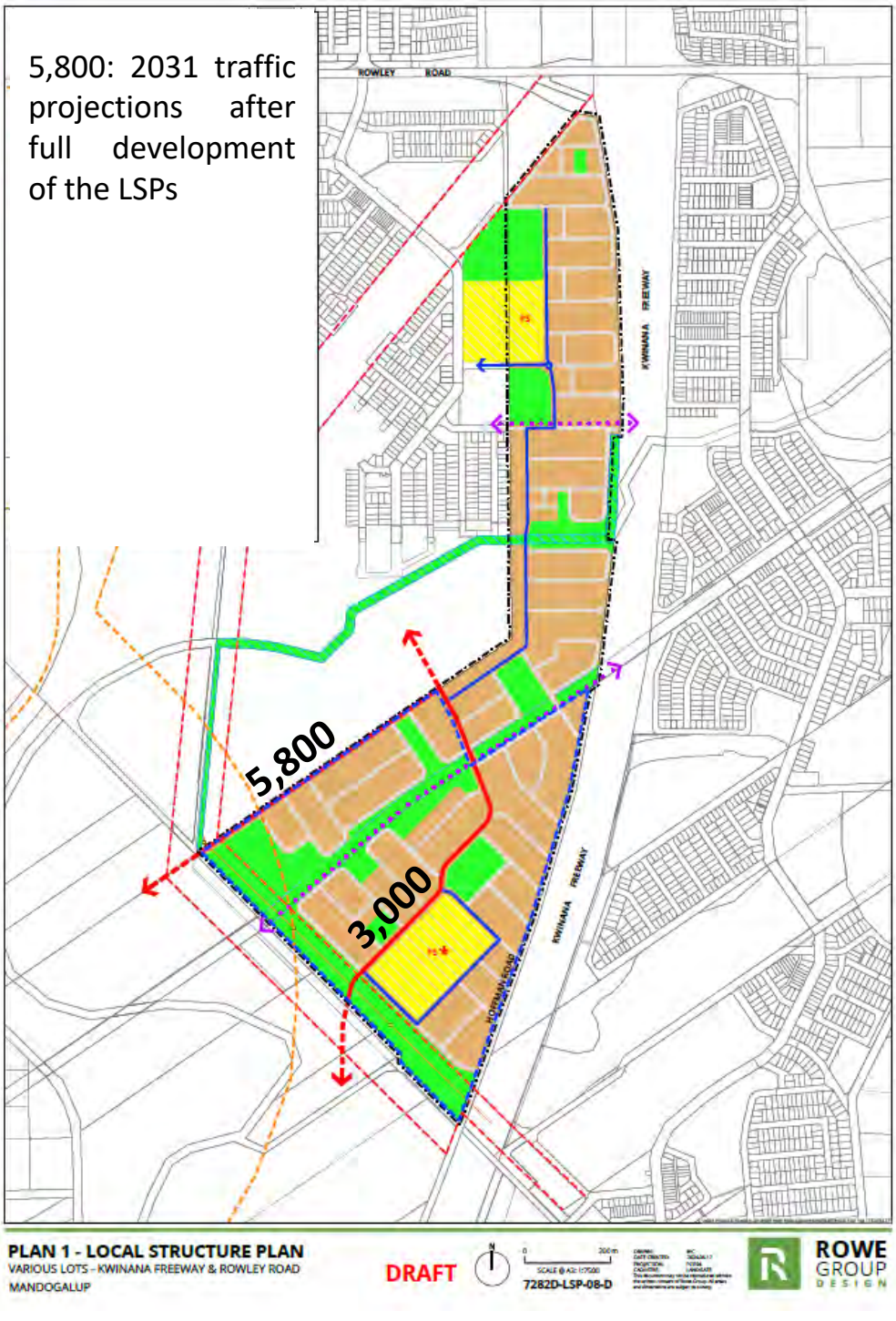


Figure 15: Total (2031) traffic – Weekday AM and PM peak hours

In order to establish the peak hour traffic volumes at the future 3-leg roundabout intersection on Rowley Road, it was assumed that the peak hour traffic would be 10% of the daily traffic and in/ out split would be 30%/ 70% for AM and reverse for PM on LSPs external connections. The total post development traffic for the assessment year of 2031 includes the existing background traffic plus the development traffic. For year 2031 a 2% annual traffic growth was applied to the background traffic on Rowley Road. **Figure 16** illustrates the 2031 peak hour traffic volumes at the intersection.

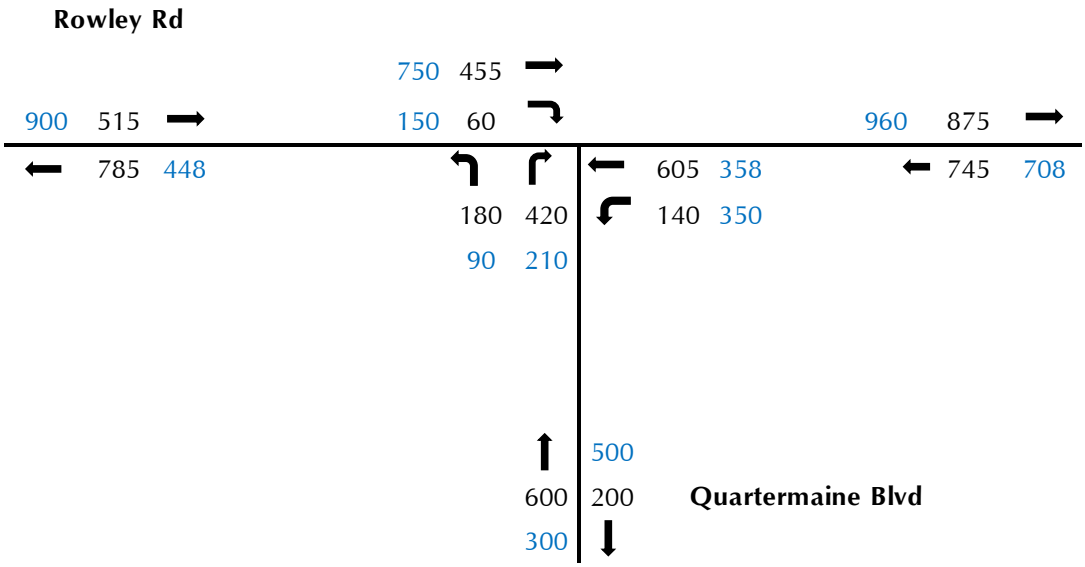


Figure 16: 2031 peak hour traffic volumes AM/ PM peak hour

5.3.2 5.3.2 Long term (2041 and 2051) daily traffic projections:

The transport report for the proposed Mandogalup Improvement Scheme prepared by Flyt (revision 3 dated 16/08/2023) provides ROM24 daily traffic projections for year 2041 which was sourced from Main Roads WA (refer **Appendix B**) and 2051 daily traffic projections based on Flyt assessments (refer **Appendix C**).

The 2041 and 2051 daily traffic projections sourced from Flyt report for the surrounding roads are summarised in **Table 1**. In this table the existing (2021) counts and 2031 traffic projections (by Transcore) are also added for comparison purposes.

Table 1: Traffic projections on surrounding roads

Daily traffic projections				
year	Source	Rowley Rd west of Kwinana Freeway	Anketell Rd west of Kwinana Freeway	Mandogalup Rd north of Anketell Rd
2024	MRWA	13,389	22,122	4,829
2031(interim)	Transcore	16,729	27,155	10,804
2041	MRWA ROM 24	19,300	36,200	10,000
2051	Flyt	41,800	48,500	37,800

5.4 Roads and Intersections

Figure 17 illustrates the existing and proposed intersection controls for key intersections within the amended LSP area. As explained before subdivision development is under progress from the northern part of LSP towards south. Some of the internal roads and intersections shown in Figure 17 are constructed as per the approved 2020 LSP.

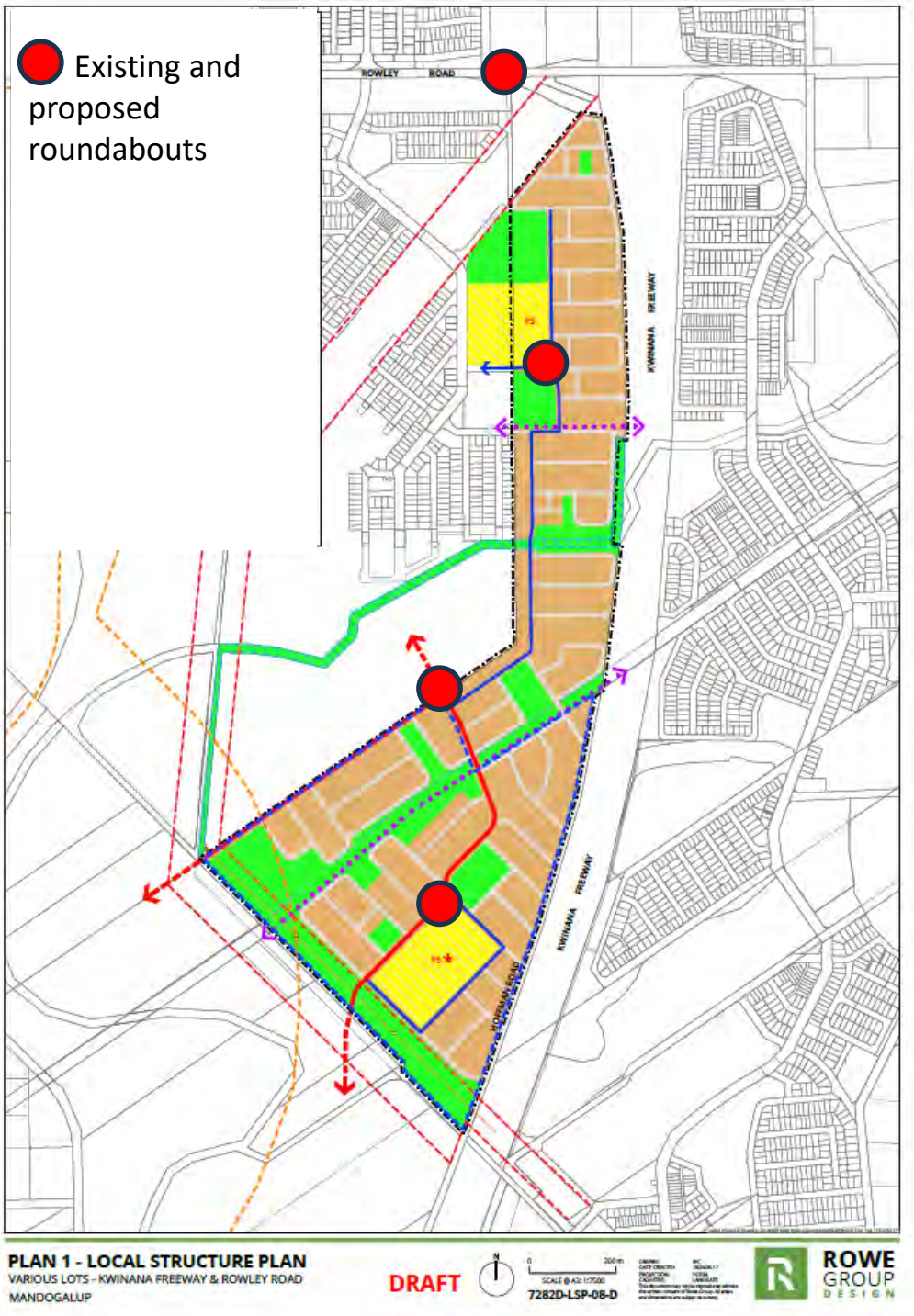


Figure 17: Proposed intersection treatments

The existing roundabout intersection at Rowley Road currently serves both MWLSP and MELSP areas. However, in a longer term when Rowley Road is upgraded to four lanes and Hammond Road is extended south, this roundabout intersection will be downgraded to left in/ left out intersection for the sought leg.

In short term, Irvine Pde (the northern leg of the roundabout intersection on Rowley Road) would be closed after completion of Vivente subdivision or earlier subject to council or Main Roads WA approval.

The closure of the Irvine Pde would provide extra capacity at the roundabout intersection on Rowley Road to support subdivision progress on MELSP and MWLSP. However, at some point in time the secondary connection to Mandogalup Road would be required to facilitate the full development of amended LSPs.

The location and layout of the proposed secondary connection to Mandogalup Road will need to be investigated further in the subsequent stages of the development of the MELSP and MWLSP.

The intersection of Mandogalup Road/ Anketell Road would ultimately operate as a full movement T-intersection in the form of a roundabout or traffic lights.

5.5 Intersection Analysis

The operation of the future 3-leg roundabout intersection on Rowley Road was analysed in SIDRA for the weekday AM and PM peak hours in 2031.

SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- **Degree of Saturation (DoS)**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for varied traffic flow up to one for saturated flow or capacity.
- **Level of Service (LoS)**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- **Average Delay**: is the average of all travel time delays for vehicles through the intersection.
- **95% Queue**: is the queue length below which 95% of all observed queue lengths fall.

The results of the SIDRA analysis are attached in **Appendix C** and briefly discussed in the following paragraphs.

Roundabout intersection on Rowley Road

The existing roundabout intersection would be downgraded to 3-leg roundabout intersection in near future. The removal of the northern leg (Irvine Pde) would provide extra capacity at the roundabout intersection on Rowley Road to support subdivision progress on MELSP and MWLSP. **Figure 17** Illustrates the layout of the roundabout intersection modelled in SIDRA.

The SIDRA analysis results indicate that the 3-leg roundabout intersection on Rowley Road would operate satisfactorily during the future AM and PM peak hours and with minimal queues and delays on all approaches of the intersection.

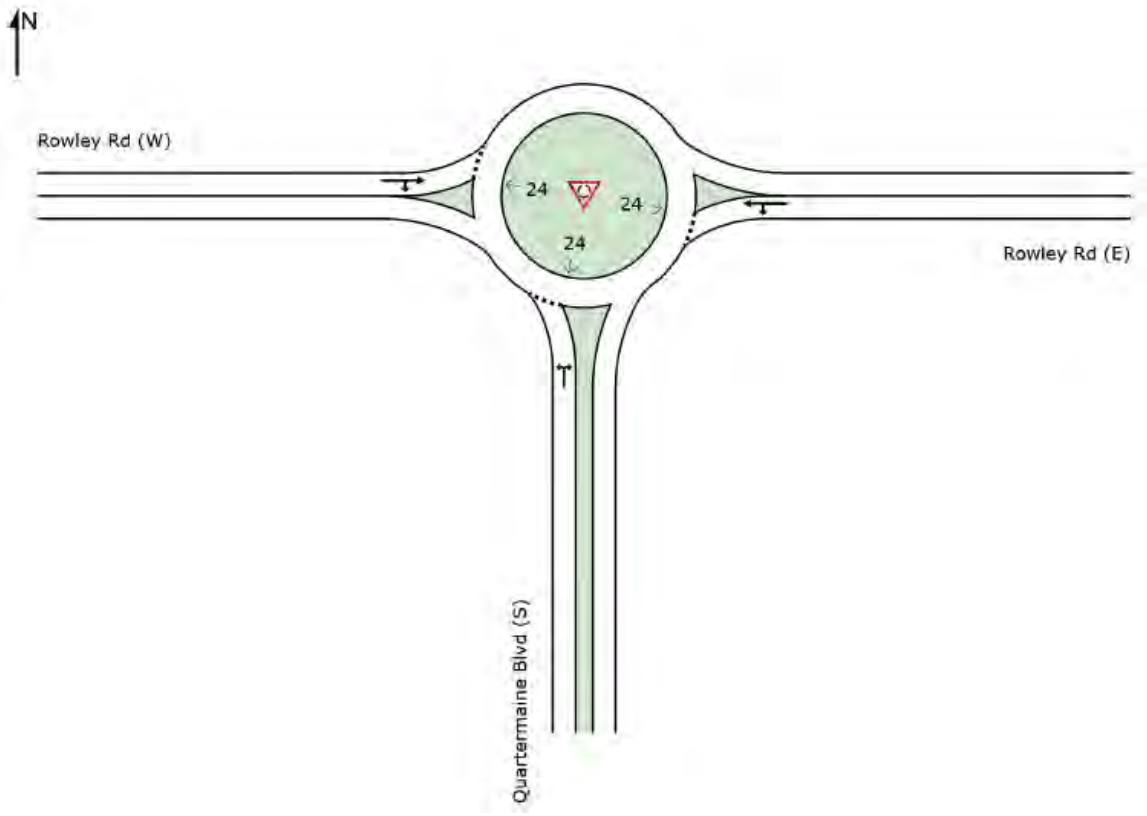


Figure 18: The roundabout intersection on Rowley Road modelled in SIDRA

5.6 Access to Frontage Properties

The WAPC *Liveable Neighbourhoods* policy requires that "Development along integrator B and neighbourhood connector streets with ultimate vehicle volumes over 5000 vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access. Wider lots with paired driveways and protected reversing areas in the parking lane may be used on streets with up to 7000 vehicles per day."

All of the roads within the proposed amended LSP area are expected to carry less than 7,000vpd, so no restriction on vehicular access is required.

For those lots that will have direct frontage to the neighbourhood connector road at the boundary of Florence and Apsley Estates, either wider lots should be designed to facilitate the safe exit of vehicles in a forward direction or a cap road should be provided to facilitate the access/ egress of the residential dwellings through the cap road rather than directly onto the proposed neighbourhood connector road.

5.7 Pedestrian/ Cycle Network

The proposed network of pedestrian and cycle is detailed in the amended LSP which includes shared paths within the amended LSP area that connects to the existing Principal Shared Paths along Kwinana Freeway. This network of cycleways and paths will provide an excellent level of accessibility and permeability for pedestrians and cyclists within the proposed amended LSP area.

5.8 Access to Public Transport

At this stage of the planning process the details of the bus route planning and the location of bus stops are not known. However, in these circumstances the WAPC *Transport Assessment Guidelines for Developments* (2006) suggest that it is desirable for at least 90 per cent of dwellings to be within 400m straight line distance of a bus route. The potential future bus route proposed along the main north-south road would service the majority of the lots within the proposed amended LSP area.

5.9 Safe Route to School

The proposed Florence and Apsley LSPs will be the primary catchment area for the future primary school sites within the LSP areas. Hence all primary students residing in the proximity would need to cross either the *Neighbourhood Connector* or *Access Street* roads separating the schools from the immediately adjacent residential areas on their way to and from the school.

Pedestrian paths on one side and shared paths on the other side are proposed on the perimeter roads. It is recommended that pedestrian crossing facilities in the vicinity of schools be further investigated during the subdivision design stage of the project.

Information from the 2002-2006 *Perth & Regions Travel Survey* (PARTS) indicated that 25.4% of primary school students walk or cycle to school while 26.7% of primary students walk or cycle home from school. Therefore, a 540-student primary school would typically have about 140 students walking or cycling to the school.

Warrant criteria provided on the WA Police website indicate that a *Type A Children's Crossing* may be provided where a minimum of 20 students and 200 vehicle movements occur within the hour immediately before and immediately after school, for a primary school.

The warrants are lower for a *Type B Children's Crossing* at 10 students and 100vph for a primary school. Such facilities can only be applied for by a School Principal or the President/Secretary of the relevant school/parent organisation (e.g., P&C or P&F). The anticipated numbers of students crossing roads around school perimeters around the school sites would potentially meet these warrants in future so it would be expected that the schools would apply for this type of facility if/when future student numbers and movements meet those warrants.

6 Conclusion

The Metropolitan Region Scheme has been recently amended to rezone land to the south of the MELSP from the Urban Deferred to the Urban zone. Rowe Group has prepared an amended LSP for the MELSP including the urban zone to the south which is the subject of this TIA.

This Revised TIA provided addition information regarding the safe route to school, Access Street cross sections and the updated assessment for the Rowley Road roundabout intersection.

Both MELSP and MWLSP received endorsement from the Western Australian Planning Commission (WAPC) in March 2018. Subdivision for the Florence (MELSP) and Apsley (MWLSP) estates is currently progressing in accordance with the approved structure plans.

Since the preparation of the LSPs, The WAPC prepared an Improvement Plan (IP47) for the land to the west and south of the LSPs. The IP47 came into effect in April 2019 and following Gazettal of the draft Improvement Scheme, it will provide a framework for future planning and development.

The suggested long term access strategy to Hammond Road for the proposed amended LSPs is generally in line with the access strategy documented in the IP47.

The neighbourhood connector road between Florence and Apsley Estates is suggested to include a 20m road reserve with the following cross sections:

- Residential area: 2x 3.5m carriageway + 2m flush median + 2x 5.5m verges; and,
- Industrial area: 9m carriageway + 2 x 5.5m verges.

According to the approved Local Development Plan for Vivente Estate, Irvine Pde (the northern leg of the roundabout intersection on Rowley Road) would be closed after the completion of Vivente subdivision.

The transport report prepared by Flyt for the proposed Mandogalup Improvement Scheme entails long term assessment (2051) after full development of the IP47 and identifies the long-term traffic projections and potential connections to Hammond Road.

The assessments undertaken for the short-term scenario (say 2031 and before Hammond Road extension) indicates that in 2031 the combination of the roundabout intersection on Rowley Road (after conversion to 3-leg) and the secondary connection to Mandogalup Road as per the Mandogalup Improvement Scheme would be able to accommodate the traffic generation of the amended MWLSP and MELSP.

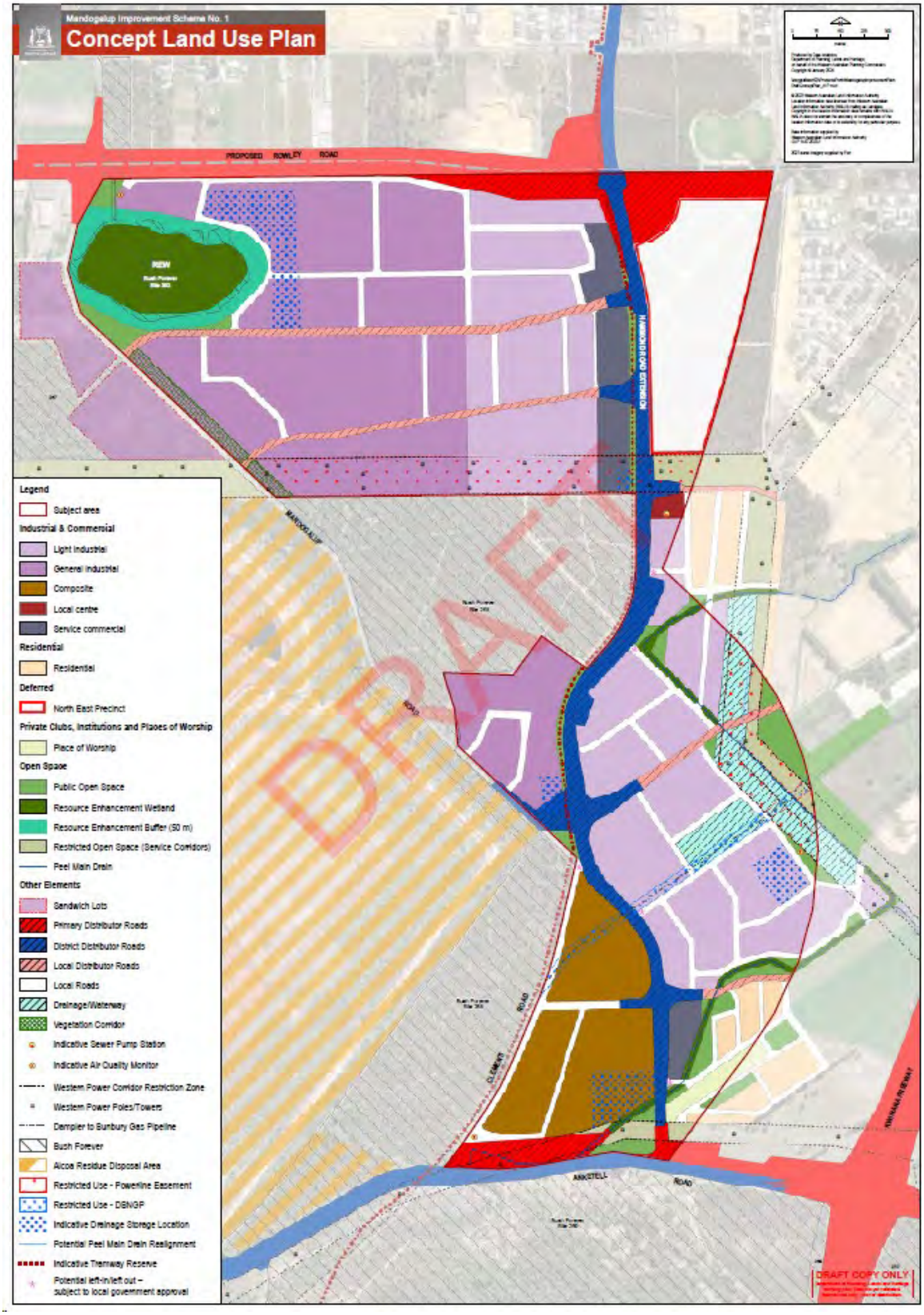
The proposed amended LSP would not change the road hierarchy and standard of the proposed road network for the approved MELSP area.

Appendix A

MANDOGALUP IMPROVEMENT SCHEME CONCEPT PLAN

transcore

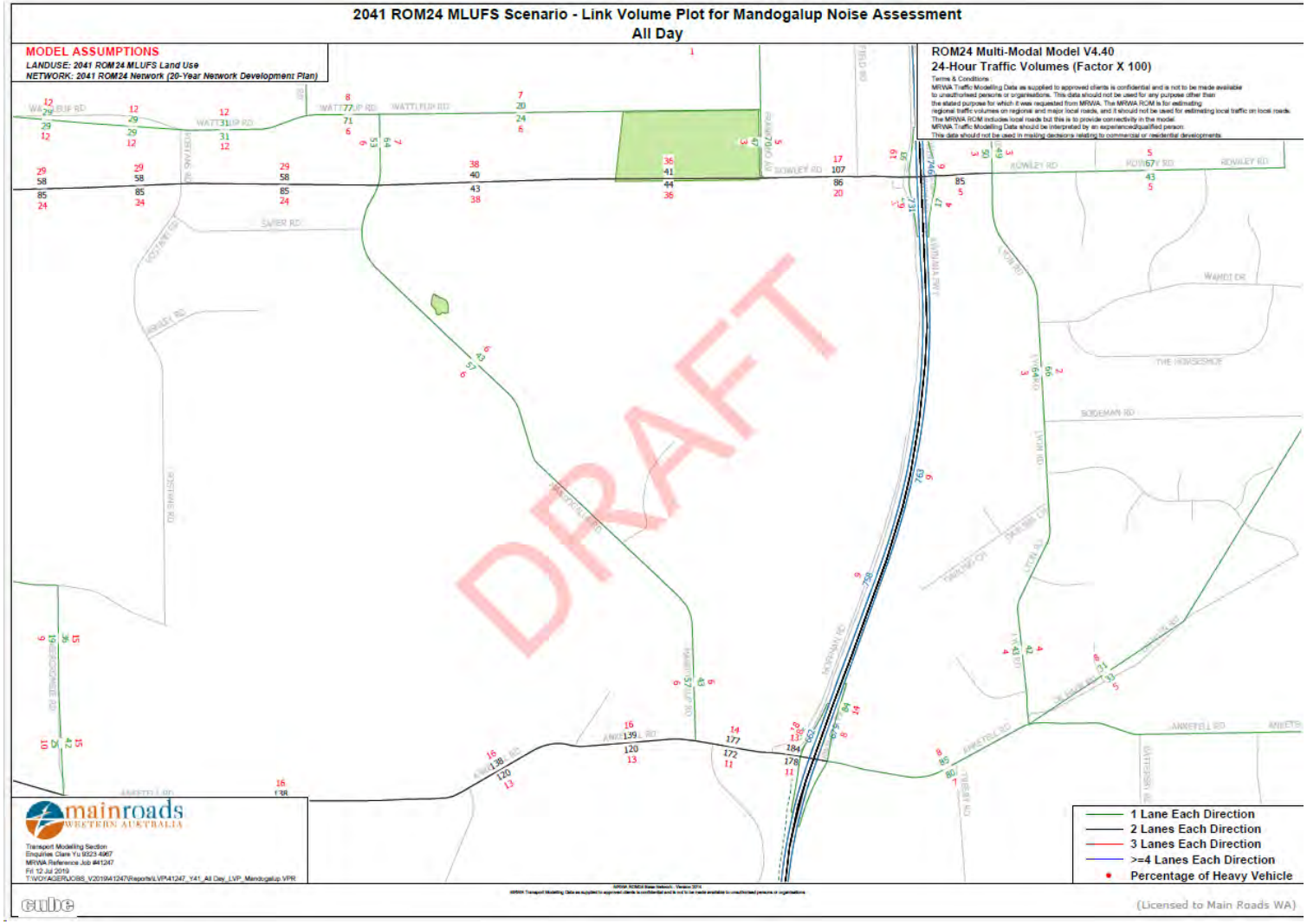
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Mandogalup Improvement Scheme No. 1
Concept Land Use Plan
PROPOSED ROWLEY ROAD
RDW
HAMMOND ROAD EXTENSION
MANDOGALUP
ROAD
CLEMENT
ROAD
ANKETELL
ROAD
DRAFT
DRAFT COPY ONLY
Legend
Subject area
Industrial & Commercial
Light Industrial
General Industrial
Composite
Local centre
Service commercial
Residential
Residential
Deferred
North East Precinct
Private Clubs, Institutions and Places of Worship
Place of Worship
Open Space
Public Open Space
Resource Enhancement Wetland
Resource Enhancement Buffer (50 m)
Restricted Open Space (Service Corridors)
Peel Main Drain
Other Elements
Sandwich Lots
Primary Distributor Roads
District Distributor Roads
Local Distributor Roads
Local Roads
Drainage/Waterway
Vegetation Corridor
Indicative Sewer Pump Station
Indicative Air Quality Monitor
Western Power Corridor Restriction Zone
Western Power Poles/Towers
Dampier to Bunbury Gas Pipeline
Bush Forever
Alcoa Residue Disposal Area
Restricted Use - Powerline Easement
Restricted Use - DBNGP
Indicative Drainage Storage Location
Potential Peel Main Drain Realignment
Indicative Tramway Reserve
Potential left-in/left out –
subject to local government approval

Appendix B

2041 ROM24 PROJECTIONS

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2041 ROM24 MLUFS Scenario - Link Volume Plot for Mandogalup Noise Assessment
All Day
MODEL ASSUMPTIONS
LANDUSE: 2041 ROM24 MLUFS Land Use
NETWORK: 2041 ROM24 Network (20-Year Network Development Plan)
ROM24 Multi-Modal Model V4.40
24-Hour Traffic Volumes (Factor X 100)
DRAFT
mainroads
WESTERN AUSTRALIA
1 Lane Each Direction
2 Lanes Each Direction
3 Lanes Each Direction
>=4 Lanes Each Direction
Percentage of Heavy Vehicle
(Licensed to Main Roads WA)

Appendix C

2051 DAILY TRAFFIC PROJECTIONS (SOURCE: FLYT)

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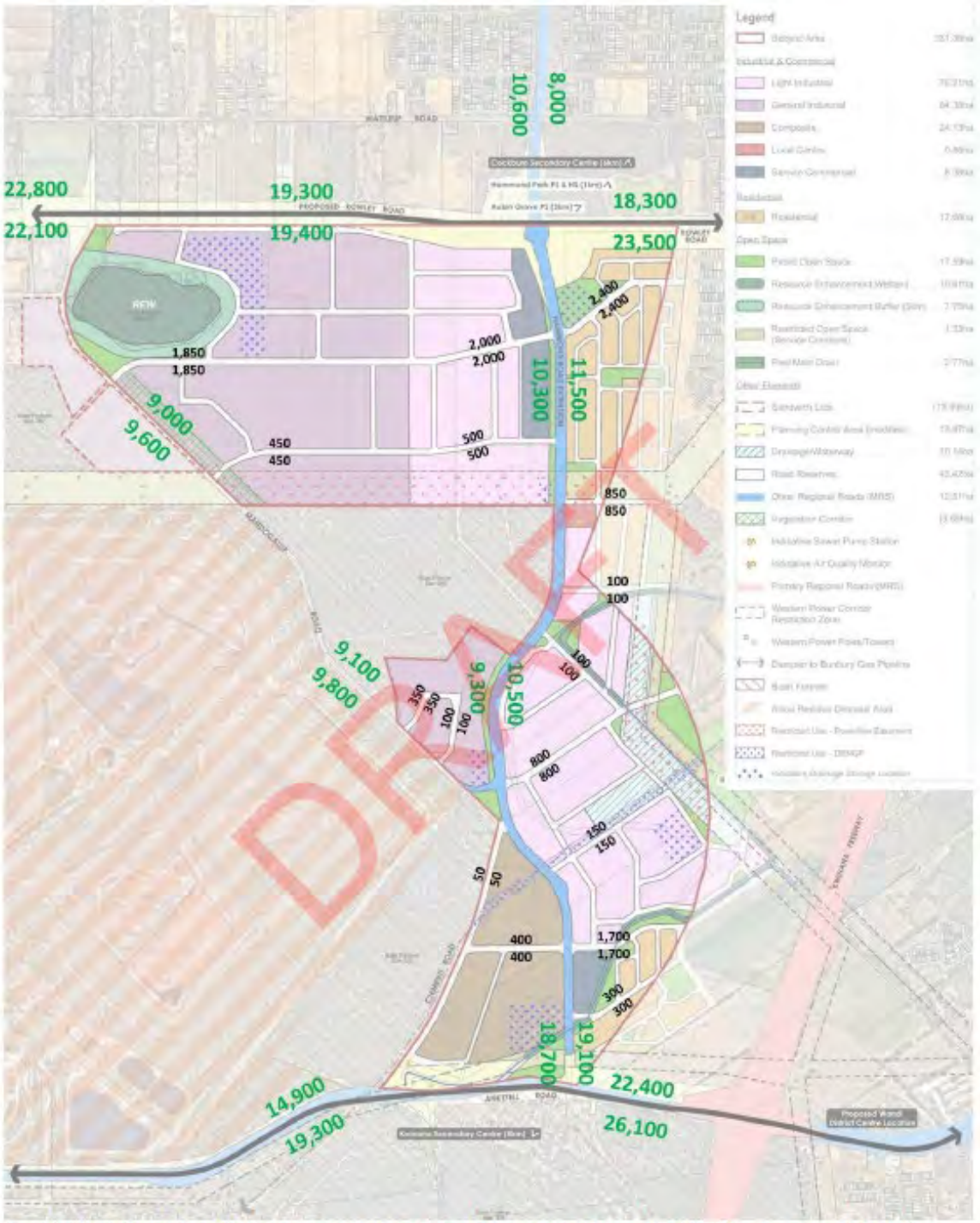


Figure 47 Total 2051 Daily Traffic Volumes Including Final Preferred Scenario Land Uses and Traffic Volumes on Internal Roads (base plan source: TBB)

Appendix D

SIDRA ANALYSIS

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MOVEMENT SUMMARY

Site: [Rowley Rd - AM - 2031 (Site Folder: 2031 - 8000 Veh/ Day)]

Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Quartermaine Blvd (S)														
1	L2	180	2.0	189	2.0	0.874	37.4	LOS D	23.5	178.3	1.00	1.58	2.31	35.7
3	R2	420	2.0	442	2.0	0.874	41.1	LOS D	23.5	178.3	1.00	1.58	2.31	36.2
Approach		600	2.0	632	2.0	0.874	40.0	LOS D	23.5	178.3	1.00	1.58	2.31	36.1
East: Rowley Rd (E)														
4	L2	140	2.0	147	2.0	0.599	5.2	LOS A	7.1	65.2	0.41	0.46	0.41	52.8
5	T1	605	19.9	637	19.9	0.599	6.0	LOS A	7.1	65.2	0.41	0.46	0.41	55.9
Approach		745	16.5	784	16.5	0.599	5.9	LOS A	7.1	65.2	0.41	0.46	0.41	55.3
West: Rowley Rd (W)														
11	T1	455	19.0	479	19.0	0.742	16.3	LOS B	10.3	94.8	1.00	1.08	1.38	49.2
12	R2	60	2.0	63	2.0	0.742	20.2	LOS C	10.3	94.8	1.00	1.08	1.38	48.1
Approach		515	17.0	542	17.0	0.742	16.7	LOS B	10.3	94.8	1.00	1.08	1.38	49.1
All Vehicles		1860	12.0	1958	12.0	0.874	19.9	LOS B	23.5	178.3	0.76	0.99	1.29	45.8

MOVEMENT SUMMARY

Site: [Rowley Rd - PM - 2031 (Site Folder: 2031 - 8000 Veh/ Day)]

Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Quartermaine Blvd (S)														
1	L2	90	2.0	95	2.0	0.346	6.9	LOS A	2.7	20.7	0.74	0.73	0.74	50.3
3	R2	210	2.0	221	2.0	0.346	10.7	LOS B	2.7	20.7	0.74	0.73	0.74	51.2
Approach		300	2.0	316	2.0	0.346	9.5	LOS A	2.7	20.7	0.74	0.73	0.74	50.9
East: Rowley Rd (E)														
4	L2	350	2.0	368	2.0	0.649	6.3	LOS A	7.0	60.5	0.62	0.58	0.62	52.2
5	T1	358	19.9	377	19.9	0.649	7.4	LOS A	7.0	60.5	0.62	0.58	0.62	55.2
Approach		708	11.1	745	11.1	0.649	6.8	LOS A	7.0	60.5	0.62	0.58	0.62	53.6
West: Rowley Rd (W)														
11	T1	750	19.0	789	19.0	0.913	19.2	LOS B	26.1	238.3	1.00	1.01	1.48	47.2
12	R2	150	2.0	158	2.0	0.913	23.3	LOS C	26.1	238.3	1.00	1.01	1.48	46.2
Approach		900	16.2	947	16.2	0.913	19.9	LOS B	26.1	238.3	1.00	1.01	1.48	47.1
All Vehicles		1908	12.0	2008	12.0	0.913	13.4	LOS B	26.1	238.3	0.82	0.81	1.04	49.9

Technical Note: No 1b **Date:** 26/03/2025
Project No: t24.076
Project: Florence and Apsley Local Structure Plans
Subject: Proposed neighbourhood connector road

1 Introduction

Transcore has prepared Transport Impact Assessments (TIAs) for the proposed Amended Local Structure Plans for both Apsley and Florence Estates, for the recently urbanised land located south of Florence and north of Apsley Estates, separated by a neighbourhood connector road highlighted in yellow in **Figure 1**.

This neighbourhood connector road is planned to extend further west through future industrial areas, crossing the existing Peel Main Drain, and ultimately connecting to the future Hammond Road. Cossill and Webley (C&W) Consulting Engineers have prepared a design concept plan for the neighbourhood connector road. Transcore has been commissioned to review this concept plan in relation to the applicable standards, road reserve, and cross-section for the road.



Figure 1: The proposed neighbourhood connector road

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instagram: @transcoreaustralia

2 Proposed design of the neighbourhood connector road

The C&W design concept plan is illustrated in **Figure 2**. This plan depicts the section of the road on both sides of the existing Peel Main Drain. On the east side of the drain, the road traverses residential subdivisions and connects to the continuation of Quartermain Blvd via a roundabout, as shown in **Figure 1**, in line with the suggested intersection treatments in the TIAs for the amended Florence and Apsley Local Structure Plans (LSPs).

The assessments conducted in the TIA for the amended Florence and Apsley LSPs indicated that traffic projections for the proposed neighbourhood connector road would be approximately 5,800 vehicles per day (vpd). According to the Liveable Neighbourhoods Guidelines, this road would be classified as a Neighbourhood Connector A road. A typical Neighbourhood Connector A road requires a 24.4m road reserve, which includes 2.1m on-street parking bays indented in the verge and 1.5m on-road cycle lanes.

However, since the proposed neighbourhood connector road will pass through an industrial area to the west, the need for on-road cycle lanes is not warranted. Effective on-road cycling depends on integrated network that connects various routes, and the western section of the road, characterized by industrial zones, poses safety risks for on road cyclists. The presence of heavy vehicle traffic and industrial operations makes it challenging to ensure a safe environment for on-road cycling in this area. Instead, it is recommended that a shared path be provided within the verge of the neighbourhood connector road. This design allows cyclists to travel safely along the verge rather than on the road itself. Therefore, the following cross-section within a 20m road reserve is suggested:

- 2 x 3.5m carriageway, 2m flush median, 2 x 5.5m verge

This configuration allows for lot frontage along the neighbourhood connector road. With respect to the direct lot frontage, the LN Guideline suggests that "*Developments along neighbourhood connector roads with ultimate vehicle volumes over 5000 vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access. Wider lots with paired driveways and protected reversing areas in the parking lane may be used on streets with up to 7000 vehicles per day.*"

The subdivision plan has been updated on both sides of the proposed neighbourhood connector road to ensure that most of the lots would have frontage on the side roads. For those lots that will have direct frontage to the neighbourhood connector road, either wider lots have been designed to facilitate the safe exit of vehicles in a forward direction or a cap road has been provided to facilitate the access/ egress of the residential dwellings through the cap road rather than directly onto the proposed neighbourhood connector road.

The western section of the neighbourhood connector road, located to the west of the Peel Main Drain, will also pass through the industrial area. Therefore, the 20m

road reserve will extend through this area, featuring a different cross-section that includes a 9m carriageway suitable for industrial development. The profile plan in **Figure 2** illustrates the neighbourhood connector road's profile as it traverses both residential and industrial zones.

3 Conclusion

This technical note is prepared as an addendum to the TIA reports prepared by Transcore for Amended Local Structure Plans for both Apsley and Florence Estates.

The subject of the technical note is the proposed neighbourhood connector road highlighted in yellow in **Figure 1** which is at the boundary of both Apsley and Florence Estates.

The neighbourhood connector road is suggested to include a 20m road reserve with the following cross section as depicted in the design concept plan of this road in **Figure 2**:

- Residential area: 2x 3.5m carriageway + 2m flush median + 2x 5.5m verges; and
- Industrial area: 9m carriageway + 2 x 5.5m verges.

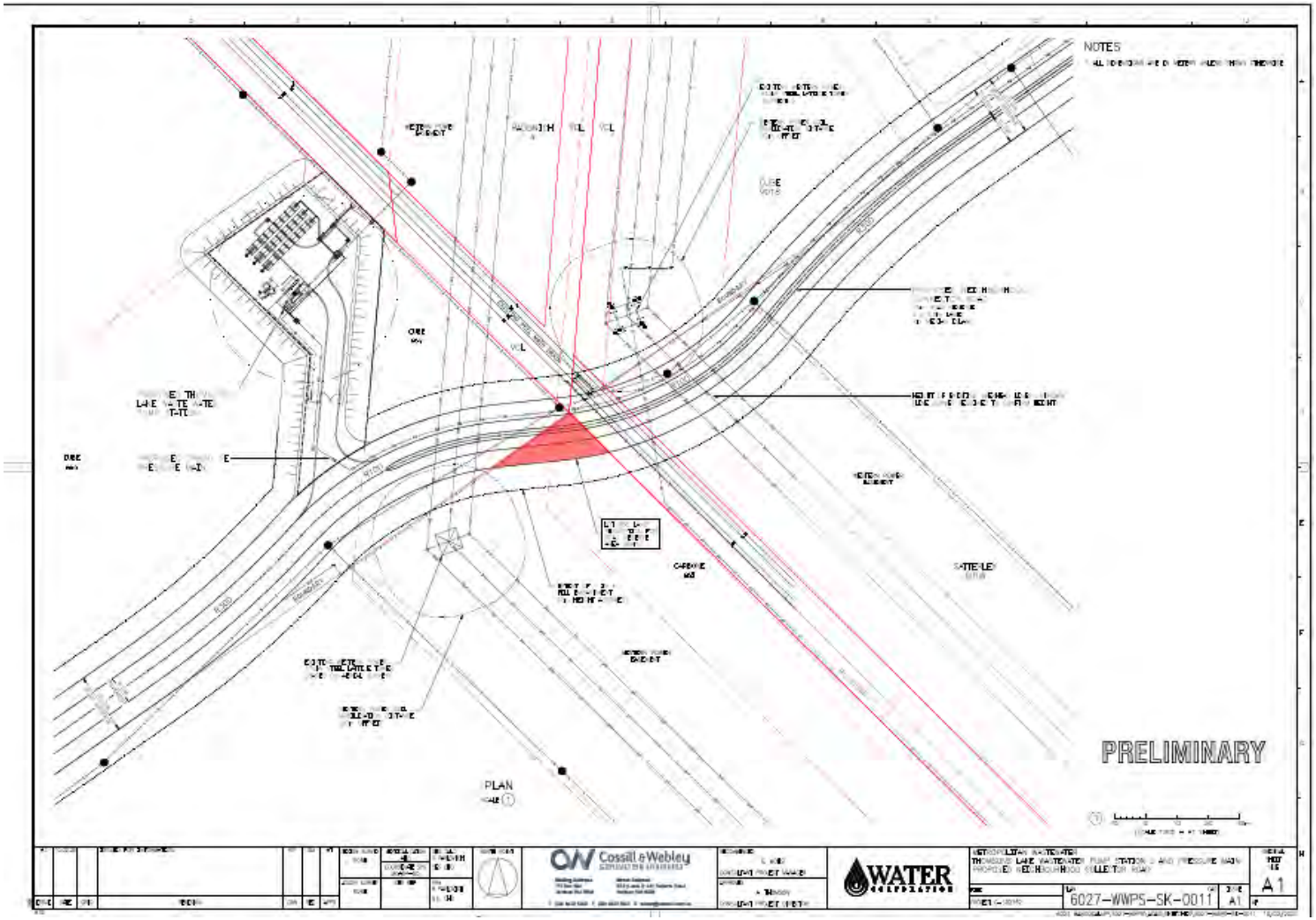


Figure 2: Proposed profile of the neighbourhood connector road

APPENDIX 10

Local Water Management Strategy

Satterley Property Group

Florence Estate, Mandogalup- Stages 12 to 19

Local Water Management Strategy



June 2025

JDA Consultant Hydrologists

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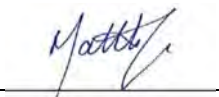
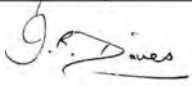
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1. EXECUTIVE SUMMARY

JDA has been engaged by Satterley Property Group to complete a Local Water Management Strategy (LWMS) for an amendment to the previously approved Mandogalup East Local Structure Plan (MELSP).

The Mandogalup East Local Structure Plan [MELSP] covers a total area of 42.67 ha and is comprised of Stages 1 to 11 of Florence Estate. Water management for the MELSP was supported by the approved *"Mandogalup East – Local Water Management Strategy"* (LWMS) (JDA, 2018a) and the LWMS Addendum 1 (JDA, 2021a).

The LSP amendment area covers approximately 45 ha and forms a southern extension to Florence Estate (Stages 12 to 19), herein referred to as the Study Area, Figure 1.

This LWMS has been prepared to support the LSP amendment area, noting the north-east section of the LSP amendment area overlaps a portion of the previously approved MELSP area. This LWMS should be read in conjunction with the existing approved LWMS and Addendum for the balance of the LSP area.

This LWMS provides the framework for the application of total water cycle management to the proposed residential structure within the LSP, consistent with the overarching District Water Management Strategy (JDA, 2011), LWMS (JDA, 2018a), LWMS Addendum 1 (JDA, 2021a), Department of Water and Environmental Regulation's principles of Water Sensitive Urban Design as described in Better Urban Water Management (WAPC, 2008) and the Stormwater Management Manual for Western Australia (DWER, 2022).

Key objectives of the water management strategy are to maintain the application of at-source stormwater infiltration and application of water sensitive urban design practices that are implemented in the LWMS (JDA, 2018a & 2021a) for the northern Stages 1 to 11 of Florence Estate. A summary of the LWMS design principles and objectives is presented in Table 1.

TABLE 1: SUMMARY OF LWMS DESIGN PRINCIPLES AND OBJECTIVES

Key Guiding Principles		
• 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 • To minimise public risk, including risk of injury or loss of life. • Protection of infrastructure and assets from flooding and inundation. • To maintain the total water cycle.		
Category	**DWMS Objectives (JDA, 2011)**	**LWMS Criteria**
Water Conservation and Sustainability	• Ensure that non-potable water supply systems are considered as part of an integrated water supply. • Household target water use of 100 kL/person/year. • Scheme water target use of 40 to 60 kL/person/year. • Use of waterwise landscaping practices both at development and lot scale.	• Consider alternative fit for purpose water sources where appropriate and cost-effective. • Aim to achieve the State Water Plan target for water use of 100 kL/person/yr. • POS areas to be at least 50% native plants. • Buildings are to comply with water efficiency standards in the building code.
Surface Water Management	• At-source retention of small storm events (15 mm). • Infiltration of stormwater runoff on lots, in road reserves and basins in POS areas up to 100 year ARI storm event, with outflows where external catchment connections have been provided in adjacent residential estates. • Water quality treatment systems and water sensitive urban design structures designed in accordance with the Stormwater Management Manual for Western Australia (DoW, 2004-2007) Chapter 9 (Structural Controls) and Australian Runoff Quality (EA, 2006).	• Runoff from the 'small' event or first 15 mm of rainfall is to be treated and infiltrated at-source where possible. • Runoff for events up to the 1% AEP managed by infiltration and detention to external catchment connection within a Flood Management Area [FMA] in the POS. • Manage surface water flows from major events to protect infrastructure from flooding and inundation. • Use of subsoil beneath drainage areas to facilitate adequate drainage of stormwater runoff.
Groundwater Management	• Manage groundwater levels to protect infrastructure and assets. • Maintain groundwater regimes for the protection of groundwater-dependent ecosystems. • Protect the value of groundwater resources. • Adopt nutrient load reduction design objectives for discharges to groundwater.	• Protection of infrastructure and assets from flooding and inundation by high seasonal groundwater levels, perching and/or soil moisture. • Managing and minimising changes in groundwater levels and groundwater quality following development. • Use of subsoil drainage to intercept or capture groundwater with invert levels to be at or above pre-development MGL. Subsoil is to be treated prior to discharge to the downstream system.
Water Quality	• Non-structural measures to reduce applied nutrient loads. • Adopt nutrient load reduction design objectives for stormwater runoff. • Use of amended soils and ephemeral bioretention systems to treat stormwater.	• Use of tree pits and roadside swales with amended soils to treat a minimum of 2% of connected impervious area of road catchments. • Non-structural controls to reduce applied nutrient loads. • Maintain groundwater quality at pre-development levels (median winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.
Monitoring	• Perform monitoring program to inform decisions at LWMS stage. • Post-development monitoring program to ensure water quality targets are met.	• Groundwater monitoring (levels and quality) to allow quantitative assessment of the hydrological impacts of the proposed development.

A number of assumptions have been made in the preparation of this report. Table 2 highlights a few key assumptions. Other assumptions and parameters are more comprehensively documented in this report.

TABLE 2: KEY ASSUMPTIONS AND HYDROLOGICAL PARAMETERS

Parameters/Item	Section	Value or Source
Design Rainfalls	5.2	Bureau of Meteorology (2016)
Rainfall Temporal Patterns	5.2	Australian Rainfall and Runoff (Ball et al., 2019)
Hydraulic Conductivity of Imported Fill	5.2/5.3	Minimum 5 m/day

Australian Rainfall and Runoff (ARR) (Ball et al., 2019) adopts different probability terminology from that used in ARR 1987 (IEAust., 1987). In line with ARR 2019, this report adopts new terminology Exceedances Per Year (EY) and Annual Exceedance Probability (AEP) instead of previous terminology, Average Recurrence Interval (ARI) used in ARR 1987, see conversions below.

- 1 EY is equivalent to 1 Year ARI
- 20% AEP equates to 4.48 Year ARI
  (For simplicity, this report adopts 20% AEP as equivalent to 5 Year ARI)
- 1% AEP is equivalent to 100 Year ARI

2. INTRODUCTION

2.1 Background

This Local Water Management Strategy (LWMS) has been prepared by JDA Consultant Hydrologists on behalf of Satterley Property Group in support of a Local Structure Plan (LSP) amendment to the Mandogalup East Local Structure Plan (MELSP).

Water management for the MELSP was supported by the approved *"Mandogalup East – Local Water Management Strategy"* (LWMS) (JDA, 2018) and the LWMS Addendum 1 (JDA, 2021a). This LWMS should therefore be read in conjunction with the existing approved LWMS and Addendum for the balance of the LSP area.

The LSP amendment area covers approximately 45 ha (Stages 12 to 19), and forms a southern extension of the previously approved Florence Estate (Figure 1). The proposed concept LSP is shown on Figure 2.

This LWMS has been prepared as part of the Better Urban Water Management Framework (WAPC, 2008) to support the LSP amendment area and details stormwater, groundwater and water quality management, at a level of detail suitable for the purpose of the local planning scheme.

2.2 Statutory Framework

2.2.1 District Planning

A Mandogalup District Water Management Strategy (DWMS) was prepared by JDA (2011) and provides guidance on water reuse options, stormwater detention basins, monitoring requirements and structural and non-structural controls for stormwater treatment. The DWMS was approved by City of Kwinana and Department of Water (DoW).

2.2.2 Local Planning

A LWMS (JDA, 2018) was previously prepared and approved to support the MELSP. This document now extends on the surface water and groundwater management strategies presented in the LWMS (JDA, 2018) for the LSP amendment area.

At the subdivision level, an Urban Water Management Plan (JDA, 2021) has been approved for the existing development stages in accordance with the existing approved LWMS, and is being implemented on a staged basis.

Table 3 shows the integrated planning and urban water management documents and their status. A copy of the LWMS checklist from the *Interim: Developing a local water management strategy* (2008) guidelines is show in Appendix A.

TABLE 3: INTEGRATED PLANNING AND URBAN WATER MANAGEMENT

Planning Phase	Planning Document	Urban Water Management Document and Status
District	Mandogalup Development Cell	Mandogalup DWMS (JDA, 2011) *[COMPLETED]*
Local	Mandogalup East Local Structure Plan	Mandogalup East LWMS (JDA, 2018) & Mandogalup East LWMS Addendum 1 (JDA, 2021) *[COMPLETED]*
	Mandogalup East Local Structure Plan Amendment	Florence Estate, Mandogalup - Stages 12-19 LWMS **[THIS DOCUMENT]**
Subdivision	Subdivision Application *[FUTURE PREPARATION]*	Urban Water Management Plans (UWMP) *[FUTURE PREPARATION]*

2.3 Key Design Principles and Objectives

The LWMS employs the following documents to define its content, key principles and objectives:

- Peel Harvey WSUD Local Planning Policy (EPA, 2006)
- Stormwater Management Manual for Western Australia (DoW, 2007)
- Better Urban Water Management (WAPC, 2008)
- Guidelines for Subdivision Development (City of Kwinana, 2008)
- Jandakot Drainage and Water Management Plan – Peel Main Drain Catchment (DoW, 2009)
- Mandogalup District Water Management Strategy (JDA, 2011)

A summary of the key design principles and objectives is provided in Table 1 and summarised below.

2.3.1 Peel Harvey WSUD Local Planning Policy (EPA, 2006)

The Peel Harvey WSUD Local Planning Policy (Peel Development Commission, 2006) was developed through the Federal Governments Coastal Catchments Initiative and endorsed by the Environmental Protection Authority (EPA). It aims to assist local government to help integrate catchment management objectives with land and resource planning in urban landscapes.

The Policy identifies broad policy objectives against which strategic and statutory proposals can be assessed.

Water quantity management principles and objectives are provided based on post-development discharges being maintained relative to predevelopment levels. Criteria are provided for both ecological protection (1 in 1 year events), and flood protection (1 in 100 year events). Water quality management principles and objectives are based on maintaining or improving water quality relative to existing conditions.

Specific water quality guidelines are provided in the document including limitations on developments where average input rates of nutrients exceed 15 kg/phosphorus/ha per annum or 150 kg/nitrogen/ha per annum.

The Policy is consistent with the Decision Process for Stormwater Management in WA (DoE and Swan River Trust, 2005) which is appended to the policy and is consistent with the objectives of the Environmental Protection Policy (Peel Inlet – Harvey Estuary) 1992.

This Policy is stated as holding no legal standing and envisages each local government in the Peel Harvey catchment will customise the model policy to suite its own specific requirements.

2.3.2 Stormwater Management Manual for Western Australia (DWER, 2022)

The Water and Rivers Commission (Department of Water, DoW, 2006-2017; Department of Water and Environmental Regulation, DWER, 2017-present) released *A Manual for Managing Urban Stormwater Quality in Western Australia* in 1998 to define and practically describe Best Management Practices (BMP's) to reduce pollutant and nutrient inputs to stormwater drainage systems. The Manual also aimed to provide guidelines for the incorporation of water sensitive design principles into urban planning and design, which would enable the achievement of improved water quality from urban development.

The document was released to provide a guideline for best planning and management practices and was intended for use by Water and Rivers Commission, but also by other State and Local Government Authorities and sectors of the urban development industry.

In consultation with a working team comprising industry and government representatives a major review of the manual was completed in 2007. The revised manual was officially launched in August 2007.

Principle 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 waterlogging.
- 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.

The manual was reviewed and updated in 2022 from the August 2007 version to ensure all information contained in the document was correct and up-to-date.

2.3.3 Better Urban Water Management (WAPC, 2008)

The guideline document *Better Urban Water Management* (WAPC, 2008) focuses on the process of integration between land use and water planning by specifying the level of investigations and documentation required at various decision points in the planning process. It outlines the requirement for preparation of a Local Water Management Strategy to guide and support water management concepts at the local structure plan level. This LWMS complies with the WAPC (2008) process.

2.3.4 Guidelines for Subdivision Development (City of Kwinana, 2010)

The City of Kwinana (CoK) Guidelines for Subdivision Development (CoK, 2010) provides details of the City's requirements regarding stormwater drainage management. The document provides both general guidelines at the strategic conceptual design level and also more specific detailed criteria for design of drainage systems (grades, subsoil drainage).

At the strategic level key design guidelines are citied as follows:

- Australian Rainfall and Runoff (Institution of Engineers Australia, 1987).
- Stormwater Drainage Design in Small Urban Catchments (J Argue, ARRB Special Report No 34).
- Subsurface Drainage of Road Structures (RJ Gerke, ARRB Special Report No 35).
- Water Sensitive Urban (Residential) Design Guidelines for the Perth Metropolitan Region (Whelans et al, 1993).
- Stormwater Quality Management Manual (Water and Rivers Commission, 1998).

Specific criteria in relation to stormwater/groundwater are detailed as:

- Examine the total drainage catchment area and ensure that any upstream drainage is able to pass through the subdivision.

- Drainage network is designed to 10yr ARI except for arterial drainage and compensating storages to be designed to a 20yr ARI.
- Floor levels minimum 500 mm above 100yr ARI flood level in storages, main drains and watercourses.
- The pre-development AAMGL generally be maintained following development. Where AAMGL is within 1.2m of the design surface level, subsoils will be installed at AAMGL and fill imported. Subsoils are generally provided as a separate system.
- Water Sensitive Urban Design principles incorporated into the design.
- Open Drainage facilities have 1:6 side slopes.
- Nutrient filtration to occur prior to drainage water being released to a Water Corporation Main Drain.

2.3.5 Jandakot Drainage and Water Management Plan (DoW, 2009b)

The Jandakot Drainage and Water Management Plan (DWMP) provides guidance on the management of stormwater in the Peel Main Drain Catchment and was prepared by DoW to support the Jandakot Structure Plan (WAPC, 2007)

The scope of the DWMP is to cover aspects of total water cycle management, including;

- Protection of significant environmental assets within the local structure plan, including meeting their water requirements, managing potential impacts from development and protecting their cultural value.
- Alternative water supply options, opportunities for conservation and demand management measures, and wastewater management.
- Surface runoff, including both peak event (flood) management and the application of water sensitive urban design principles to frequent events.
- Groundwater, including the impact of urbanisation, variation in climate, installation of drainage to manage groundwater levels, potential impacts on the environment and the potential to use groundwater as a resource.
- Water quality management, which includes source control of pollution inputs by catchment management, acid sulphate soil management, control of contaminated discharges from industrial areas and management of nutrient exports from surface runoff and groundwater through structural measures.

2.3.6 Mandogalup District Water Management Strategy (JDA, 2011 & 2018b)

This DWMS was prepared to support rezoning of the Satterley and QUBE landholdings in Mandogalup and demonstrate that the area was capable of supporting the proposed urban zoning.

The aims of the DWMS are to:

1. Define land area requirements for conveyance of flood flows and protection of future development from peak flood events.

2. Propose a drainage design strategy appropriate for local conditions in the strategy area that incorporates best practice water sensitive urban design measures. This strategy should identify Water Sensitive Urban Design (WSUD) practices to be implemented within both private allotments and the public domain, and the legal mechanisms by which all identified practices will be implemented.

3. Prescribe the design criteria for water quantity and water quality for each catchment.

4. Outline the hydrologic and hydraulic framework parameters and subsequently develop the overall drainage network concept.

5. Define an implementation framework for the drainage design objectives; and

6. Recommend monitoring programs for water quantity and water quality pre, during and post development as well as for ensuring hydraulic performance over the lifetime of the drainage structures.

The DWMS (JDA, 2011) supported the rezoning of land from "Urban Deferred" to "Urban" and was approved on 25 February 2014.

A revised DWMS (JDA, 2018b) was then subsequently prepared to support lifting of Urban Deferment for 58.9 ha of land located within the 1.0 km and 1.5 km Kwinana Air Quality Buffer, following Department of Planning Support for the Environmental Protection Authority's advice on the buffer zone.

2.3.7 Mandogalup Improvement Scheme - District Water Management Strategy (JDA, 2023)

The Mandogalup Improvement Scheme DWMS was prepared for Department of Planning, Lands and Heritage for 344 ha of land in the Mandogalup locality proposed for urban zoning. It includes a 331 ha parcel of land gazetted under Improvement Plan 47 (IP47): Mandogalup, and covers a small portion of the south-west corner of the Study Area.

The water management strategy outlined in the Mandogalup Improvement Scheme DWMS defines it's key principles and objectives for water sensitive urban design consistent with the Jandakot Drainage and Water Management Plan (DoW, 2009b) and the Mandogalup DWMS (JDA, 2011 & 2018b).

3. PROPOSED DEVELOPMENT

The Study Area covers 45 ha and is situated within the southern corridor of the Perth Metropolitan Region, approximately 23 km south-east of the Perth CBD. The Study Area is an extension to the previously approved MELSP and partly amends a portion of the area it overlaps. The MELSP, as amended, covers an area of approximately 80 ha.

The proposed concept LSP (Rowe Group, 2025) for the Study Area is shown on Figure 2. It includes a mixture of residential lot sizes with Public Open Space areas integrated with a stormwater management function. There is also an indictive future school site (subject to further investigation) and a powerline easement and Dampier Bunbury Natural Gas Pipeline (DBNGP) easement through the Study Area.

Key elements of the Structure Plan related to urban water management include:

- Use of porous tree pits and rain gardens throughout the estate for detention and treatment of stormwater.
- Retention of the existing DBNGP alignment through the Study Area and integration with Public Open Space.
- Retention of the existing powerline easement along the south-western boundary to maintain the Peel Main Drain PMD and Mandogalup Swamp Regional Flood Storage area.
- Use of higher density urban residential zonings to reduce landscape nutrient input at a domestic scale (e.g. less lawn and garden area corresponds to lower fertiliser application); and
- The extensive use of local native vegetation species in open spaces and streetscapes to reduce nutrient input and conserve water resources.

A breakdown of the land use within the Study Area is presented in Table 4.

TABLE 4: LAND USE BREAKDOWN

Land Use Description	Study Area (ha)
Residential Lots	18.58
Road Reserve	10.31
School	4.00
Public Open Space (POS)	5.30
Powerline Easement	5.14
DBNGP Easement	1.63
Total	**44.96**

4. PRE-DEVELOPMENT ENVIRONMENT

4.1 Existing Land Use

The subject site is currently undeveloped with extensively cleared native vegetation. The land was previously used as market gardens, Figure 3.

4.2 Topography

Topography of the Study Area, Figure 3, indicates slope from east to west, with a high point of 18 mAHD along the north-east boundary to low point of 13 mAHD along the western boundary.

4.3 Climate

The Mandogalup area is characterised by a Mediterranean climate with warm dry summers and cool wet winters.

Rainfall data has been obtained from the Bureau of Meteorology for the nearby *Medina Research Centre r*ain gauge (Site ID. 009194) 5 km south-east of the Study Area, and the *Anketell rain* gauge (Site ID. 009258) 2.67 km south-west, Figure 4.

The average annual rainfall, 1984 to 2017, for Medina Research Centre Aero was 745 mm, with 30-year and 10-year averages of 731 mm and 666 mm, respectively. This represents a 2% (30-year average) and 10% (10-year average) decrease from the average annual rainfall for Mandogalup Area. The long- term and 10-year averages for Anketell were 791 mm and 778 mm, respectively. The general decline in rainfall observed across Medina Research Centre and Anketell rain gauges is consistent with the decreasing rainfall trend across south-west Western Australia (DoW, 2015). The seasonal rainfall distribution has also altered since 1990, with a reduction of average monthly totals in the winter months, but no reduction or increase in the summer months.

Average annual pan evaporation is estimated at 1,900 mm for the Study Area from gridded BoM (2017) 1975-2005 average pan evaporation data, similar to 2022/2023 annual evaporation recorded at the Department of Primary Industries and Regional Development (DPIRD) Wattleup weather station of 1,734.8 mm (2023) and 1,679.6 mm (2022), lower than the estimate of 1,900 mm from Luke *et al.* (1987).

4.4 Geology and Soils

Surface geology mapping by Gozzard (1983) is shown on Figure 5.

The Study Area is situated within the Bassendean Dune system (S8) and is overlaid in places by swamp deposits (Ms5). The thickness of the Bassendean Sands varies and overlies clays of the Guildford Formation. The Bassendean Sands are characterised as “very light at surface, yellow at depth, fine to medium grained, sub-rounded quartz moderately well sorted of Aeolian origin” (Gozzard, 1983).

A geotechnical investigation of 150 ha of proposed land for urban development east and west of Kwinana Freeway by Golder Associates (2008) for Satterley Property Group. This involved the excavation of 40 test pits, of which 10 are located within the Study Area, TP36 to TP44 & TP46.

Sand or Sand/Silty Sand with up to 0.5 m topsoil was encountered in test pits in the north-east of the Study Area (TP36, TP37 and TP40 to TP42). Clayey Sand or Sandy Clay was encountered in the remaining test pits (TP38, TP39, TP43, TP44 & TP46).

Variably cemented soils (uncemented Sand/Silty Sand to moderate cemented “coffee rock”) were encountered in TP43 & TP46 within the centre of the study Area at depths of between 0.7 and 1.1 m and 0.45 and 0.75 m, respectively.

A detailed geotechnical investigation of the Study Area is required prior to subdivision and should include infiltration testing of in-situ soils.

4.5 Acid Sulphate Soils

Mapping published by the DEC (2010) is shown in Figure 5 and indicates the Study Area consists of:

- High to moderate risk of Acid Sulphate Soils (A.S.S.) occurring less than 3 m from surface in the southern portion of the Study Area (associated with Ms5 soils).
- Moderate to low risk of A.S.S occurring less than 3 m from surface in the central to northern portion of the Study Area (associated with S8 soils).

An Acid Sulphate Soil and Dewatering Management Plan (ASSDMP) was prepared by WSP Australia and finalised by Strategen Environmental (2018) for development of Florence Estate in the approved MELSP but which also extended across the Study Area. This ASSDMP has been approved by the Department of Water and Environmental Regulation.

The ASSDMP encompassed the installation of 10 soil cores to up to 6 m depth, collection of soil samples at 0.25 m intervals and analysis of 479 soil samples for various analytes. All soil types contained field pH values above 4, indicative of a lack of actual A.S.S (Strategen Environmental, 2018). All soil types encountered were considered in Strategen Environmental (2018) to have acid generating capacity with a notable number of samples containing field pH after oxidation < 3 and various levels of net acidity, although with one exception, the chromium reducible sulphate complied with the assessment criteria. Clays beneath the investigation area mostly indicated alkaline conditions with net acidity exceeding assessment levels whilst chromium reducible sulphate was below assessment levels suggesting potential acidity likely derived from an organic source.

Management strategies are detailed in Strategen Environmental (2018).

4.6 Groundwater Hydrology

4.6.1 Regional Hydrogeology

Superficial Aquifer

The superficial aquifer in this region is referred to as the Jandakot Mound and covers approximately 522 km^2. The aquifer consists of a thin veneer of Bassendean Sand overlying sandy clays of the Guildford Formation. It has a maximum thickness of 40 m with transmissivities ranging between 600 to 800 m^2/day (Davidson, 1995). It generally contains fresh to slightly brackish groundwater (up to 1,500 mg/L TDS) with slightly acid to neutral pH (5 to 7) (Davidson, 1995). The watertable is shallow, rising in places to the surface during winter, depending upon surface elevation.

The Bassendean Sand consists of fine to coarse grained, moderately sorted, sub-rounded to rounded quartz sand. The sand is highly permeable with horizontal hydraulic conductivity ranging between 10 to 50 m/day.

The base of the Superficial is approximately -18 mAHD and overlies the Kardinya Shale Member of the Osborne Formation which separates the Superficial from the Leederville formation below.

Leederville Aquifer

The Leederville Aquifer is of Cretaceous age and consists of interbedded sandstone, siltstone and shales made up by the Mariginiup, Wanneroo and Pinjar members and the Henley Sandstone Formation. The Leederville Aquifer is a major regional aquifer from which large yields of fresh groundwater can be obtained. The groundwater in the

Leederville Formation is confined with the potentiometric surface in this area at approximately ground level (Davidson, 1995). Base of this aquifer is approximately -350 mAHD.

4.6.2 Groundwater Levels

Pre-development groundwater monitoring was completed in 2007 by JDA (2007 & 2008). Seven monitoring bores (11 to 17) were installed within the Mandogalup Structure Plan area west of Kwinana Freeway. Of these, three were within the Study Area (14, 16 & 17) and were used for pre-development groundwater level monitoring, Figure 6. A site visit on 12 November 2024 did not locate the bores, which have likely been destroyed.

Water quality bores WAM1 to WAM4 (shallow and deep) were installed on 19 October 2004 in the Mandogalup Structure Plan area and monitored to March 2007 (JDA, 2007 & 2008). Bore WAM3 is located within the Study Area.

Bore details and locations are presented in Table 5 and shown in Figure 6.

TABLE 5: DETAILS OF GROUNDWATER MONITORING BORES

Bore ID	GDA 1994 Coordinates		Natural Surface (mAHD)	Total Depth (mbNS)	Top of Casing (mAHD)	Water Level 22/3/2007 (mAHD)	Estimated AAMGL (mAHD)	Depth to AAMGL (mBNS)
	Easting	Northing						
14	391687	6437406	15.98	3	16.98	14.54	15.69	0.29
16	392025	6437114	17.6	3	18.47	14.92	16.07	1.53
17	391527	6436880	13.58	3	14.66	11.34	12.49	1.09
WAM3S	391271	6437128	13.44	5	14.02	-	-	-
WAM3D	391272	6437127	13.44	10	14.09	-	-	-

Notes: m BNS = metres below natural surface; mAHD = metres Australian Height Datum.

Measured groundwater levels were correlated to long-term groundwater monitoring measurements recorded in Department of Water and Environmental Regulation (DWER) monitoring bores JE12C, JM41, JM42, JM49 and SP1-2B.

TABLE 6: LONG-TERM DWER MONITORING BORE SUMMARY

Bore ID	Data Range	Top of casing (mAHD)	Water Level 22 March 2007 (mAHD)	AAMGL (mAHD)	Difference (m)	MGL (mAHD)	Difference (m)
JM42	1975 - 2007	25.8	20.94	22.75	+1.81	23.64	+2.7
JM49	1980 - 2007	26.67	22.96	23.82	+0.86	24.36	+1.4
JE12C	1984 - 2007	37.1	18.82	19.86	+1.04	20.7	+1.88
JM41	1975 - 2007	19.68	11.38	12.63	+1.25	13.72	+2.34
SP1-2B	1995 - 2007	14.9	11	11.79	+0.78	12.07	+1.07
Average					+1.15		+1.88

For each of the DWER monitoring bores an Average Annual Maximum Groundwater Level (AAMGL) was calculated as the average of the winter peak levels over the period of record. Based on the water levels recorded in the DWER bores, Table 6, a correction of +1.15 m was applied to the water levels measured in the JDA bores on the same date to estimate the AAMGL for the JDA bores within the Study Area. AAMGL contours and depth to AAMGL from the existing natural surface are shown on Figure 6 *left*. Note estimated AAMGL contours over Mandogalup Swamp assume partial urban condition (ie. filled with sand), rather than natural surface.

Maximum Groundwater Levels (MGL) for each DWER monitoring bore are presented in Table 6, which is the highest peak water level over the period of record. On average the MGL is 0.73 m above the estimated pre-development

AAMGL. Whilst MGL results in a slighter wider area of surface ponding, it's impact on the remainder of the Study Area is limited due to the steep topographic gradient of the site.

The change in landuse from rural to urban may raise groundwater levels. To prevent this, groundwater will be controlled using sub-soil drainage. Design levels will be determined relative to the controlled post development groundwater level (CGL).

4.6.3 Groundwater Quality

Groundwater quality monitoring of nested (shallow and deep) bore WAM3 was completed monthly by JDA from October 2004 to September 2006 (JDA, 2007). Samples were analysed for physical parameters and nutrients. Groundwater quality results including time series plots are attached as Appendix B.

ANZECC 95% guideline values for wetlands of southwest Australia (ANZECC, 2000) have been used for water quality comparison where no local reference data is available. The Peel Harvey Water Quality Improvement Plan (Peel Harvey WQIP) (EPA, 2008) total phosphorus targets for the rivers and estuary of the Peel-Harvey System have been used in preference to ANZECC 2000 guideline values. A summary of the monitoring results are as follows:

- Average Total Nitrogen (TN) concentrations for all bores were above the ANZECC (2000) TN guideline of 1.2 mg/L with the exception of WAM3 (d).
- Average Total Phosphorus (TP) concentrations varied between bores. WAM3 (d), WAM4(s) and WAM4(d) were above the Peel-Harvey WQIP TP target value of 0.1 mg/L.
- The pH is slightly acidic to neutral (4.5 to 7.1) and below ANZECC guideline values.

The Study Area is characterised by high nutrient concentrations and pH levels generally less than 6.0. Groundwater quality at the water table, within the Bassendean Sand, is naturally acidic due to organic acids generated by decomposition of vegetation in swampy environments. High nitrate and phosphorous levels are present in the superficial aquifer in areas of intensive horticulture as a direct result of fertiliser leaching (Davidson, 1995).

Additional groundwater monitoring should be conducted in support of the UWMP with trigger values in Section 8.5 updated.

4.6.4 Groundwater Resources for Irrigation

The Department of Water and Environmental Regulation manages the groundwater of the State under the Rights in Water and Irrigation Act 1914 (RIWI Act). The Study Area is located within the Mandogalup sub-area of the Jandakot Groundwater Management Area.

The superficial aquifer is the most feasible irrigation supply for the Study Area.

The DWER groundwater allocation limit and water allocations from the superficial aquifer are shown in Table 7 and are based on a Resource Allocation Report from DWER dated 03 June 2025.

TABLE 7: DWER GROUNDWATER RESOURCE ALLOCATION AND LIMIT, JUNE 2025

GW Sub - Area	Aquifer	Allocation Limit Licensable component, (kL/yr)	Allocated & committed (kL/yr)	% Allocated & committed	Additionally Requested (kL/yr)
Mandogalup	Superficial Swan	1,990,000	1,693,620	85.1	185,720

Allocations for the *Perth – Leederville* and *Perth – Yarragadee North* in the Jandakot Groundwater Area are solely held by Water Corporation.

As at 03 June 2025, the superficial aquifer was 85.1 % allocated with 296,380 kL/year or 14.9% of the total allocation still remaining which is sufficient for the additional request of 185,720kl/yr.

A water source is required for the irrigation of streetscapes, establishment and ongoing irrigation vegetated and turfed areas in POS and for the proposed school.

Satterley Property Group Pty Ltd has a Licence to Take Water (GWL169930) issued by DWER which expires 16 February 2034 (Appendix D). The Licence is from the superficial aquifer in the amount of 119,650 kL/year for irrigation of POS (67,500 kL/yr) and earthwork and construction purposes (52,150 kL/yr). An amendment to this licence is required to add school facilities as an authorised activity if the proposed school is confirmed. Details of proposed water use activities and proposed allocations are detailed in Section 5.2.

4.7 Surface Water Hydrology

4.7.1 Existing Surface Drainage

The existing local drainage network is shown on Figure 7.

The Peel Main Drain (PMD) flows east-west through a section of the MELSP just north of the Study Area. This section of the PMD has been approved to be incorporated into public open space as a living stream.

For the Study Area, the PMD flows along the boundary from north-west to south-east, through Mandogalup Swamp and then towards the Spectacles Wetland south of Anketell Rd (Figure 8). The PMD outlets to the Serpentine River which flows to the Peel Harvey Estuary (Figure 7).

The Peel Main Drain was modelled by DoW in the Jandakot DWMP (DoW, 2009). A maximum flood level in the 100 yr ARI upstream of Mandogalup Swamp for the existing system is 13.7 mAHD causing inundation of the Mandogalup Swamp area along the southern boundary of the Study Area.

Further detail on post-development modelling scenarios for Mandogalup Swamp as the Regional Flood Storage area as presented in the Jandakot DWMP (DoW, 2009) is summarised in Section 6.2.2.

4.7.2 Surface water Quality

Surface water quality in the PMD was measured by JDA as part of pre-development monitoring from October 2004 to September 2006 (JDA, 2007). Results indicate the PMD is characterised by high nutrient concentrations and pH levels generally less than 6.8, consistent with other drains in the area and historic land use. Water quality data from locations S1, S2 and S3, Figure 7 is summarised in Table 8 with detailed results provided in Appendix C.

A snapshot sampling event was conducted by JDA on 19 November 2024 at sites S2 and S3 and a new location S4 at the upstream boundary of the Study Area, as shown on Figure 7. Results of this sampling event are summarised in Table 9. Surface water quality at S2 and S3 on 19 November 2024 was generally similar to or better than in previous pre-development monitoring documented in JDA (2007). Nutrients concentrations were highest at site S4, similar to the results from site S2.

TABLE 8: PEEL MAIN DRAIN – MEAN WATER QUALITY RESULTS (JDA, 2007)

Bore	S1	S2	S3
Physico-chemical			
pH	5.6	6.8	6.5
EC (mS/cm)	0.63	0.81	0.47
TDS (mg/L)	446	707	245
Nutrients (mg/L)			
TP	0.40	1.30	0.26

FRP	0.25	0.76	0.11
TN	2.28	5.82	1.04
TKN	2.22	2.46	0.83
NH_4_N	<0.005	0.22	0.05
NO_x_N	0.02	0.12	0.18

TABLE 9: PEEL MAIN DRAIN WATER QUALITY - 19 NOVEMBER 2024 SNAPSHOT

Bore	S2	S3 (D/S boundary)	S4 (U/S boundary)
Physico-chemical			
pH	6.9	7.0	7.2
EC (mS/cm)	0.71	0.50	0.68
TSS (mg/L)	14	<5	160
Nutrients (mg/L)			
TP	0.76	<0.01	0.95
FRP	0.75	<0.05	0.71
TN	3.4	0.93	6.0
TKN	3.4	0.78	6.0
NH_3_N	0.32	0.014	0.16
NO_x_N	<0.05	0.15	<0.05

4.8 Wetlands

The Department of Environment and Conservation Geomorphic Wetlands of the Swan Coastal Plain Wetland mapping shows the boundaries and locations of wetlands in the Study Area (Figure 8). Almost all of the Study Area is classified as Multiple Use dampland.

To the south of the Study Area is the Spectacles Wetland, a Conservation Category Wetland (CCW) which contains significant flora, a number of significant mammal and reptile species and provides an important waterfowl breeding site. The Peel Main Drain contributes approximately 48% of the water entering the Spectacles, with the remainder from groundwater through-flow (DoW, 2009).

4.9 Contaminated Sites

A search of DWER's publicly available Contaminated Site Database (accessed 16 June 2021) indicated no contaminated sites within the Study Area.

JDA notes the publicly available database only identifies 3 of the 7 contaminated sites classifications: *Contaminated – restricted use; Contaminated – remediation required*; *and Remediated for restricted use*. The remaining classifications are *Report not substantiated*; *Possibly contaminated – investigation required*, *Not contaminated – unrestricted use;* and *Decontaminated*.

5. WATER SUSTAINABILITY

5.1 Water Supply & Sewerage

In order to minimise any potential impact on the groundwater resource the development will aim to:

- Use scheme water as the main water supply for residential lots.
- Appropriately manage domestic bore use through structure planning and community education.

Households will be serviced by extension of the scheme water supply and sewer system through a connection from the existing stages of the Florence Estate. Further details are provided in the Peritas Engineering Servicing Report.

5.2 Public Open Space

Use of a non-potable groundwater water supply, such as groundwater abstraction from the superficial aquifer, is the preferred approach to meet POS irrigation requirements.

Satterley Property Group Pty Ltd has a Licence to Take Water (GWL169930) issued by DWER which expires 16 February 2034 (Appendix D). The licence has a groundwater entitlement of 119,650 kL/year from the superficial aquifer for irrigation of POS (67,500 kL/yr) and earthwork and construction purposes (52,150 kL/yr).

Appendix E presents the Concept Landscape Plan for POS. Appendix F outlines a preliminary estimate of water use for various stages of POS, including the potential school site. It indicates the allocation is sufficient to meet the estimated POS irrigation requirement, assuming a reduced application rate of 6,750 kL/ha/year for POS and 7,500 kL/ha/yr for ovals. Note that the water use estimates are preliminary only and subject to change with further detail design.

5.3 Water Efficiency Measures

The objective for water conservation is to minimise use of water and maximise water use efficiency where possible. This objective can be achieved at both the development scale and lot scale and is identified in the State Water Plan (Government of Western Australia, 2007) as a priority item for potable water. The State Water Plan target for household water use is 100 kL/person/year (potable and non-potable water), with a consumption target for scheme water of 40 to 60 kL/person/year (potable water).

Consistent with the State Water Plan, the main objectives for the development are:

- Avoid use of potable water for irrigation in POS areas.
- Reduce household water use to not more than 100 kL/person/year.
- Minimise use of potable water where drinking water quality is not essential, particularly ex-house.
- Household consumption targets for in-house potable water use of 40 to 60 kL/person/year.

Development Scale

Development scale water conservation measures appropriate for the site include:

- Strategic planning (orientation, shape, elevation etc.) of irrigation areas such as pocket parks, active and passive public open space areas, and road reserves to minimise long-term irrigation demand.
- Where possible co-locate facilities with significant irrigation demand.
- Use of non-potable water supply source (groundwater abstraction bore).

- Within irrigation areas, the use of waterwise landscaping practices including hydrozoning, mulching, soil amendments, water retention products and installation of appropriate water efficient irrigation fixtures.

Lot Scale

Lot scale water conservation measures appropriate for the site include:

- Increased residential density, including smaller lots with reduced ex-house irrigation areas.
- Buildings constructed to current 6-star building standards as per the current National Construction Code [NCC]. Note the NCC 2022 was published on 01 October 2022 and incorporates a minimum 7-star energy efficient rating for new dwellings. NCC 2022 was adopted on 01 May 2023 by the WA Government but there will be transitional period in implementation of the new code with the residential energy efficiency provisions mandatory from 01 May 2025 after which all new dwellings are to be 7-star rated.
- Initiatives to encourage waterwise landscaping of residential lots including hydrozoning, mulching, soil amendments, water retention products and installation of appropriate irrigation fixtures.
- Encourage use of non-potable water supply options for ex-house irrigation uses (i.e. Rainwater tanks, greywater recycling, garden bore etc.)

Public Open Spaces

Where appropriate, native species will be used in selected garden bed areas within landscaped Public Open Space. Native species should make up at least 50% of the total plants across the development. The irrigation system, if applicable, will be designed to water wise principles.

6. STORMWATER MANAGEMENT

6.1 Design Overview

Local stormwater management is proposed to be consistent with water sensitive design practices and to meet key objectives and criteria as detailed in Table 1 and the stormwater design approach presented in the DWMS (JDA, 2011). This LWMS continues design elements of the existing approved LWMS for the previous Florence Estate Stages 1 to 6 LWMS (JDA, 2018a), LWMS Addendum 1 (JDA, 2021a) and Stages 1 to 6 Urban Water Management Plan (JDA, 2021b).

The sub-catchments of Study Area will drain to Flood Management Areas (FMA) within POS. The proposed post-development stormwater management strategy catchment and land use is shown on Figure 9.

Stormwater management has been designed according based on small events, minor drainage and major drainage.

Small event management concentrates on the first 15 mm of rainfall (approximately the 1 EY 1 hour event) and comprise lot retention and treatment and retention of stormwater runoff from roads in tree pits and roadside swales.

The minor drainage system is defined as the system of drains, pipes, culverts, kerbs, gutters etc. designed to convey runoff generated by low frequency storms, typically less than the 20% AEP for residential areas to the FMA in the catchment low-point within POS.

The major drainage system is defined as the arrangement of roads, drainage reserves and attenuation areas planned to provide safe passage of stormwater runoff from extreme rainfall events to the FMA in the catchment low point within POS.

Mandogalup Swamp is identified as a regional flood storage area in the Jandakot DWMP (DoW, 2009). Under the DoW (2009) DWMP in the preferred post development Scenario 3, the Dampier Bunbury Natural Gas Pipeline (DBNGP) easement and the High Voltage Powerline (HVP) easement are retained for flood storage.

6.2 District Drainage

6.2.1 Peel Main Drain

The Peel Main Drain (PMD) flows east-west through a section of the MELSP just north of the Study Area. This section of the PMD has been previously approved to be incorporated into public open space as a living stream.

The PMD is located along the Study Area south-west boundary and within the Western Power easement. The PMD flows south from Mandogalup Swamp to the Spectacles Wetland south of Anketell Rd, into the Serpentine River and ultimately to the Peel Harvey Estuary (Figure 7).

The Peel Main Drain was modelled by DoW in the Jandakot DWMP (DoW, 2009). A maximum flood level in the 100 yr ARI upstream of the Mandogalup Swamp for the existing system is 13.7 mAHD causing inundation of the Mandogalup Swamp area along the southern boundary of the Study Area. The balance of the Study Area is not expected to be affected by flooding.

The alignment of the PMD adjacent to the Study Area will be maintained, or be upgraded into an urban Living Stream as part of this development. Minor landscaping works to the PMD interface with the development may be undertaken by the developer.

Peak allowable discharge rates from the development into the PMD are described in Section 6.4.2.

6.2.2 Mandogalup Swamp

Mandogalup Swamp is a highly modified wetland used for market gardens and extends into the western section of the Study Area. The Jandakot DWMP (JDA, 2009) identifies Mandogalup Swamp as a regional flood storage area to assist in reducing post development peak flows to the downstream Spectacles Wetland.

The DWMP assessed four scenarios for post-development land use and associated changes with Mandogalup Swamp. Based on the magnitude of impact of the removal of the Swamp, the DWMP indicated that Department of Water and City of Kwinana have agreed that Mandogalup Swamp can be developed in line with Scenario 3, i.e. Mandogalup Swamp North is partially retained – only the power line and pipeline corridors remain undeveloped. Adoption of Scenario 3 allows for an increase in discharge from pre-development flows and a reduction in storage volume in Mandogalup Swamp. The portion of the Swamp to be retained as storage is represented by DWMP Catchment 17B as shown on Figure 10.

The DWMP water level and volume in Mandogalup Swamp North for 1% AEP storm event with pre- and post-development land use for Scenario 3 is summarised in Table 10.

TABLE 10: WATER LEVEL AND VOLUME IN MANDOGALUP SWAMP NORTH

	Water level (mAHD)		Storage Volume in Mandogalup Swamp (m^3)	Discharge at Mandogalup Road (m^3/s)
	Mandogalup Swamp North	Spectacles Wetland North		
Pre-Development Scenario	13.5	9.4	85,900	1.5
Post-Development Scenario 3	13.7	9.6	68,700	2.0

6.2.3 Dampier Bunbury Natural Gas Pipeline

The DBNGP easement bisects the Study Area along a north-east to south-west alignment. The southern section of the easement is located within Mandogalup Swamp and is inundated to 13.7 mAHD in the post-development 1% AEP event as part of the regional flood storage.

No stormwater management from the subdivision is proposed within the easement. Natural runoff generated within the easement will occur and will continue to flow towards the downstream regional flood storage and into the Peel Main Drain.

6.3 Local Stormwater Drainage

6.3.1 Small Event Management

The following strategies are proposed to meet the criteria for small event management:

- All residential lots are to retain and infiltrate the first 15 mm of rainfall from connected impervious areas. This can be achieved by means of systems such as soakwells and/or other underground storage devices.
- Stormwater runoff from roads will be managed by tree pits and roadside swales. These will be underlain with amended soils and planted with suitable plant species, consistent with *Vegetation Guidelines for Biofilters in South-West Western Australia* (Monash University, 2014). They will also be underlain with subsoil, set as a minimum at AAMGL, to control groundwater levels and prevent waterlogging. Indicative roadside swale locations are shown on Figures 9 and 12.

6.3.2 Minor Drainage

To meet the design criteria for the minor drainage system (for events up to the 20% AEP), the following strategies are proposed:

- Runoff generated within residential lots in excess of lot underground storage devices (e.g. soakwells) will flow overland via driveways or front of lots into the pit-pipe road drainage network. Where proposed lots are less than 350 m^2, underground storage devices (e.g. soakwells) are to be interconnected within the lot.
- Stormwater flow from roads will be conveyed primarily as piped flow to the downstream FMA.
- The FMA located at the catchment low-point in the POS will provide both infiltration and detention of stormwater runoff, with outflow at pre-development rates outlined in the DWMS (JDA, 2011). The FMA will have a minimum side slope of 1:6 (v:h), be planted with appropriate vegetation and have subsoil drainage to prevent waterlogging and ponding of standing water.

6.3.3 Major Drainage

The major drainage system is designed to manage rainfall events greater than the 20% AEP event up to the 1% AEP event. Key points of the major drainage system strategy are as follows:

- Runoff generated within residential lots in excess of lot underground storage devices (e.g. soakwells) will flow overland via driveways or front of lots into the pit-pipe road drainage network.
- Road reserves will provide flood storage and conveyance. In major storm events, the minor drainage pit and pipe system will be full with excess stormwater bypassing the minor drainage structures and flowing overland within the road carriageway, with roads graded towards the downstream FMA located within the POS.
- The FMA will manage up to the 1% AEP flood event via infiltration and detention of stormwater runoff in the POS with outflow at pre-development rates outlined in the DWMS (JDA, 2011).
- Minimum habitable building floor levels will have a 300 mm (0.3 m) clearance from the top water level of the FMA.

6.4 Stormwater Model Parameters

The stormwater management system for the Study Area was modelled using the XP-STORM hydraulic model to estimate maximum water level and peak outflow for the required FMAs and drainage structures.

The design storms modelled were according to the methodology in *Australian Rainfall & Runoff* (AR&R) (Ball et al, 2019). The rainfall temporal pattern was assumed to be spatially uniform across the catchment with storm durations from 10 minutes to 72 hours.

6.4.1 Post Development Catchments

The Study Area is divided in to 10 sub-catchments (E to M and School) for modelling purposes and are shown in Figure 9. The indicative future school site may change to residential during further detail design. Landuse breakdown of each sub-catchment is presented in Table 9.

TABLE 11: POST DEVELOPMENT LWMS CATCHMENT LAND USE BREAKDOWN

Land Use (ha)	E	F	G	H	I	J	K	L	M	School	Total
Standard Residential (> 12.5 m frontage)	4.94	1.12	1.26	5.13	1.24	2.68	3.16	0.48	2.42	0.498	21.02
Compact Residential (< 12.5 m frontage)	0.14	0.09	-	0.27	0.05	0.09	0.21	-	-	-	0.84
Road	2.52	0.84	0.98	3.33	0.92	1.33	1.35	0.76	2.15	0.695	13.02
POS	0.86	0.2	0.53	1.09	-	-	0.31	-	-	-	3.22
School	-	-	-	-	-	-	-	-	-	4.00	4.00
Total Area (ha)	8.45	2.25	2.76	9.82	2.21	4.1	5.03	1.24	4.57	5.193	42.11

6.4.2 Discharge Criteria

Stormwater runoff from the Study Area discharges to the Mandogalup Swamp regional flood storage area. Peak flows determined from the Jandakot DWMP (DoW, 2009) for these drainage catchments are CAT17A, CAT17B and CAT 19 and are shown in Figure 10.

Peak 100yr ARI flow rates from these catchments were presented in the DWMS (JDA, 2011), with allowable peak outflow calculated on a pro-rata basis for the LWMS Study Area presented in Table 12.

TABLE 12: PEAK ALLOWABLE FLOW RATES

Catchment	DWMP Catchment Area (ha)	Peak Outflow (m^3/s)		Area within LWMS (ha)	LWMS Pro-rata Allowable Outflow (m^3/s)[1]	
		20% AEP[1]	1% AEP		20% AEP	1% AEP
CAT19	97.4	0.035	0.1	1.33	0.0005	0.0014
CAT17A	85.2	0.068	0.16	40.32	0.0322	0.0757
CAT17B	31.7	0.035	0.09	3.58	0.0040	0.0102
TOTAL	214.3	0.138	0.35	45.23	0.0366	0.0872

Note: - 20% AEP peak allowable outflow is estimated from 10% and 1% AEP peak allowable outflow (DoW, 2009)

The total allowable flow over the Study Area to the Peel Main Drain/Mandogalup Swamp regional flood storage area for 20% and 1% AEP are estimated to be 0.036 m^3/s and 0.087 m^3/s respectively.

Table 13 presents the allowable outflow for each Study Area sub-catchment.

TABLE 13: LWMS CATCHMENTS AND ALLOWABLE OUTFLOW RATES

LWMS Catchments	Area (ha)	Allowable 20% AEP flow (m^3/s)	Allowable 1% AEP flow (m^3/s)
E	8.44	0.0062	0.0147
F	2.19	0.0017	0.0041
G	2.76	0.0022	0.0052
H	9.5	0.0076	0.0178
I	6.31	0.0053	0.0126
J	4.72	0.0041	0.0099
K	1.55	0.0012	0.0029
L	1.19	0.0012	0.0032
M	4.57	0.0038	0.0092
School	4.00	0.0032	0.0076
Total	45.23	0.0366	0.0872

6.4.3 Loss Model

Rainfall runoff parameters applied to each of the various land uses in the Study Area are presented in Table 14.

'Standard' residential lots (>12.5m Lot frontage) are assumed to have soakwells to manage runoff, with only the front half of the Lot contributing overflow to the street drainage system during major rainfall events.

'Cottage' residential lots (<12.5 m Lot frontage) are assumed to have soakwells to manage runoff, with the entire Lot contributing overflow to the street drainage system during major rainfall events.

The indicative future school site has been modelled assuming school catchment runoff characteristics (50% runoff) but may be revised to residential during detail subdivision design.

TABLE 14: RUNOFF PARAMATERS FOR XP-STORM MODEL

Land Use	Initial Loss (mm)	Continuing Loss (mm/hr)	Proportional Loss (%)
Standard Residential (> $350m^2$)	15	8	-
Cottage Residential (< $350m^2$)	15	8	-
Road		-	10
Drainage	-	-	10
Public Open Space	-	-	90
School	-	-	50

6.5 Modelling Results

For the Small Event (15 mm rainfall), stormwater runoff requiring treatment is only generated from the impervious road catchment area. These volumes will be managed by a combination of tree pits and roadside swales, consistent with the existing theme in the previously approved stages of Florence Estate. Tree pits will generally be installed in front of each Lot, subject to location of services and other restrictions such as driveways. Indicative tree pit design and locations of roadside sales are presented in Figure 11.

For the Minor and Major rainfall events, XP-STORM modelling results for the FMA are presented in Table 15 and shown in Figures 12 and 13. All pipe discharge was modelled with free outfall condition as pipe outlet inverts area above the Mandogalup Swamp regional flood storage 1% AEP top water level of 13.7 mAHD. Total outflow from the development area is within the allowable peak outflow rates.

Concept landscape plans (Appendix E) demonstrate there is sufficient space allocated within the structure plan to integrate drainage area requirements within the allocated POS areas. Indicative concepts of the FMAs are shown on Figures 14 to 21.

Final configuration and exact location of tree pits, roadside swales and flood storage areas will be refined during detailed earthworks, drainage, and road design for the development. Landscaping treatment of areas including plant species and planting density will be determined in consultation with the City of Kwinana.

Further detail design will be performed at the subdivision stage and reported in the future Urban Water Management Plan (UWMP).

TABLE 15: STORMWATER MODELLING RESULTS FOR FLOOD MANAGEMENT AREAS

Flood Management Area	E	F	G	H	I	J	K	L (Swale)	M	School
Subsoil IL (mAHD)	18.3	16	15.5	14.9	13.3	13.8	14.1	N/A	13.8	14.1
FMA Invert (mAHD)	18.8	16.6	16.00	15.4	13.8	14.3	14.6	15.2	14.3	14.6
FMA Base Area (m^2)	3,400	630	1,400	3,300	3,000	1,700	850	500	2,000	1,400
FMA Side Slope	1 in 6	1 in 6	1 in 6	1 in 6	1 in 6	1 in 6	1 in 6	1 in 6	1 in 6	1 in 6
Outlet Pipe Diameter (mm)	300	300	300	300	300	300	300	300	300	300
Bottom Orifice Diameter (mm)	50	20	30	50	40	40	20	30	30	20
Bottom Orifice Invert (mAHD)	18.8	16.6	16	15.4	13.8	14.3	14.6	15.2	14.3	14.6
Top Orifice Diameter (mm)	40	30	40	50	50	40	20	-	40	40
Top Orifice Invert (mAHD)	19.3	17.2	16.5	16	14.3	14.9	15.1	-	14.9	15.2
Minor Event - 20% AEP										
Critical Duration	24	48	24	24	48	24	48	9	24	24
Water Depth (m)	0.42	0.66	0.34	0.55	0.44	0.48	0.45	0.29	0.42	0.55
Water Elevation (mAHD)	19.22	17.26	16.34	15.95	14.24	14.78	15.05	15.49	14.72	15.15
TWL area (m^2)	4,000	1,100	1,800	4,100	3,600	2,200	1,200	970	2,400	1,900
Stored Volume (m^3)	1,550	570	530	2,050	1,450	940	460	210	930	915
Peak Outfall (m^3/s)	0.005	0.002	0.002	0.007	0.004	0.004	0.001	0.002	0.003	0.001
Major Event - 1% AEP										
Critical Duration	9	24	24	24	24	9	24	9	9	24
Water Depth (m)	0.99	1.18	0.73	1.16	0.96	1.10	0.83	0.60	0.98	1.01
Water Elevation (mAHD)	19.79	17.78	16.73	16.56	14.76	15.40	15.43	15.80	15.28	15.61
TWL area (m^2)	4,900	1,600	2,250	5,100	4,500	3,000	1,500	1,650	3,100	2,500
Stored Volume (m^3)	4,100	1,230	1,300	4,800	3,550	2,550	980	610	2,500	1,900
Peak Outfall (m^3/s)	0.013	0.004	0.005	0.017	0.012	0.010	0.002	0.002	0.009	0.005

7. GROUNDWATER MANAGEMENT

7.1 Design Criteria

Groundwater Management for the Study Area has been prepared in line with design criteria presented in the DWMS (JDA,2011), *Water Resource Considerations when Controlling Groundwater Levels in Urban Areas* (DoW, 2013) and the *Stormwater Management Manual for Western Australia* (DWER, 2022):

- Manage groundwater levels to protect infrastructure and assets.
- Maintain groundwater regime for the protection of groundwater-dependent ecosystems.
- Protect the value of groundwater resources.
- Adopt nutrient load reduction design objectives for discharge to groundwater.

7.2 Managing Changes to Groundwater Levels

Groundwater levels across the majority of the Study Area are influenced by the Mandogalup Swamp which covers approximately 40% of the Study Area. Pre-development AAMGLs have been estimated assuming filling of Mandogalup Swamp, Figure 6, and show pre-development AAMGL is at surface across the extent of Mandogalup Swamp within the Study Area and about 0.5 – 1.5 m below natural surface in other areas. A rise in groundwater levels is anticipated due to the clearing of large areas of native bushland within urban development across the Mandogalup locality and locally from a reduction post-development in evapotranspiration losses.

Groundwater management is required to ensure there is a minimum separation of 2 m between finished lots and the estimated pre-development AAMGL (Figure 6) to protect infrastructure from high seasonal groundwater levels, generally achieved through the use of imported sand fill and/or subsoil drainage.

For the Study Area, JDA recommends clean sand fill with a minimum saturated hydraulic conductivity of 5 m/day (Table 2) is used to provide the required separation to the pre-development AAMGL across the Study Area. A lower saturated hydraulic conductivity than 5 m/day would result in a risk of saturation of the soil profile beneath the Study Area.

Post-development, substantial sand fill will be required, particularly around the former extent of Mandogalup Swamp within the Study Area to provide clearance to the Peel Main Drain regional flood storage and local flood management areas. Preliminary earthworks show a general minimum 2 m clearance to the pre-development AAMGL. Consequently, subsoil drainage within road reserves will likely not be required but this should be reviewed during detailed design for the UWMP.

Subsoil drainage will be required beneath FMAs to ensure adequate empty times of POS areas. Subsoils beneath drainage basins will collect treated, infiltrated water and will discharge to the Peel Main Drain. An indicative subsoil layout is shown on Figure 22 with subsoil ILs set 0.5 m below the FMA basin invert and generally at or above the pre development AAMGL. Groundwater levels adjacent to the western Study Area boundary will also be partially controlled by the by the lower-lying Peel Main Drain and regional flood storage in the west.

The post development groundwater level will be determined at the UWMP stage and will account for groundwater rise post development. Groundwater management will be reviewed during detailed design as part of the UWMP with due consideration to final road earthwork levels and finished lot levels.

8. WATER QUALITY MANAGEMENT

8.1 Nutrient Source Controls

The effective implementation of the structural and non-structural controls as part of the urban development will enhance water quality from this site as a result of the land use change.

Non-structural and structural source controls provide a complete treatment train for stormwater movement through the development. The following strategies are proposed:

- Local native plants make up a minimum 50% of the planted areas and streetscape treatments. Any non-local species will be selected for drought tolerance and low fertiliser requirements.
- Maintenance practices such as street sweeping and pit eductions to remove sediment build-up, particularly during the development and construction phase. The UWMP will outline the schedule and cleaning requirements for street sweeping, which will be co-ordinated with the City of Kwinana;
- Use of tree pits and roadside swales to treat road runoff, with amended soils beneath to provide water quality treatment for the 'small event'.

Minimum specifications for the roadside swales are detailed in Table 16.

TABLE 16: MINIMUM SPECIFICATIONS FOR ROADSIDE SWALES

Item	Specification
Amended soil media	• Minimum 300 mm thick. • Hydraulic conductivity >5 m/day. • PRI >10 • Light compaction only. • Total clay and silt fraction <3% in total (w/w). • Organic matter content <5% (w/w). • Phosphorus content <80 mg/kg.
Plant selection, planting density and distribution	• Tolerant of periodic inundation and extended dry periods. • Preferential selection of endemic and local native species (Monash, 2014). • As per Vegetation Guidelines for Stormwater Biofilters in the South-west of Western Australia (Monash, 2014).
Maintenance	• 12 months following initial planting.

FAWB (2009) research specifies that for vegetated systems some clogging will occur in the first few years until the vegetation is established. Once the plants are established, the roots and associated biological activity maintain the conductivity of the soil media over time.

Data currently guiding the design of bio-retention systems is largely based on laboratory testing. Details of plant selection, maintenance and likely nutrient uptake in the Mandogalup environment are not known at this stage. The specifications provided in this document are the best available information at the time. Some flexibility in the specifications will be required as the knowledge base increases.

8.2 Land Use Change Nutrient Impacts

The Study Area pre-development is largely comprised of intensive horticulture. The UNDO (Urban Nutrient Decision Outcomes) decision support tool (DoW, 2016) and associated fact sheets provide detail of nutrient inputs from various land use types.

Intensive horticulture falls under the category of unrestricted *Rural Living* in the UNDO tool which has a nutrient input rate of 70.1 kg/ha/yr TN and 13.2 kg/ha/yr TP. These values are based on median nutrient inputs on land with horses (DoW, 2016b) and are likely an underestimate of the nutrient inputs associated with intensive horticulture across the Study Area. The *Rural Living* fact sheet (DoW, 2016b) summarises median input rates of various land uses from the literature with *Annual horticulture (vegetables)* having a median nutrient input rate of 143 kg/ha/yr TN, 104% higher than *Rural Living*, and 127 kg/ha/yr TP, 860% higher.

The proposed development of the Study Area incorporates road reserves and R30 residential lots. For R30 zoning, lot sizes typically range from 270 m^2 to 420 m^2 with an average of 350 m^2.

The UNDO tool separates residential lots into various ranges based on area, with a nutrient input rate for lots < 400 m^2 of 23.4 kg/ha/yr TN and 6.9 kg/ha/yr TP, and lots between 400 m^2 and 500 m^2 of 65.5 kg/ha/yr TN and 16.7 kg/ha/yr TP. Assume 55% of the lots are less than 400 m^2 and the rest are between 400 m^2 and 500 m^2, the average nutrient input rate from residential lots within the Study Area is 44.3 kg/ha/yr TN and 11.3 kg/ha/yr TP, a 37% reduction in TN and 14% reduction in TP compared to unrestricted *Rural Living*.

Proposed land use change of the Study Area from intensive horticulture to urban results in significant reductions in nutrient inputs post-development.

9. IMPLEMENTATION

9.1 Roles and Responsibilities

Table 17 details the roles and responsibilities to undertake the implementation plan. The operation and maintenance of the stormwater management system will initially be the responsibility of the developer but will ultimately revert to the Local Authority. Preparation of the UWMP will be the responsibility of the developer.

TABLE 17: IMPLEMENTATION RESPONSIBILITIES

IMPLEMENTATION		RESPONSIBILITY	
LWMS Section	Action	Developer	City of Kwinana
6.2	Preparation of an Urban Water Management Plan to support subdivision	✓	
6.4	Construction of stormwater system	✓	
6.4	Stormwater system operation and maintenance Initially Following handover	✓	✓

9.2 Urban Water Management Plan

Processes defined in Better Urban Water Management (WAPC, 2008) require an Urban Water Management Plan (UWMP) at subdivision stage. With an approved LWMS, a UWMP is required as a condition of subdivision and prior to any subdivision activities.

Further items identified for investigation and/or inclusion in the UWMP are:

- Confirm groundwater levels quality d review guideline values for post-development monitoring;
- Design of treatment structures and dry/ephemeral storages as outlined in the Stormwater Management Manual (DWER, 2022);
- Refine the final configuration (storage side slopes etc) and exact location of the flood management areas, dependent on final earthworks, drainage and road design levels for the development;
- Include detailed geotechnical investigation for the Study Area including hydraulic conductivity of in-situ soils at proposed drainage basin locations;
- Confirmation of subsoil location and levels;
- Refinement of Landscape Plans and confirmation of irrigated areas and volumes (establishment and ongoing) in Public Open Space and streetscapes;
- Sizing of subsoil treatment areas once extent of subsoils, specifications of amended soil and current groundwater quality are determined; and
- Peel Main Drain works and maintenance responsibilities. Maintenance responsibilities should be with the City of Kwinana and be similar to the Honeywood Estate development upstream of the Kwinana Freeway. A maintenance agreement between the City of Kwinana and the Water Corporation will be required.

9.3 Construction Management

9.3.1 Dewatering

Dewatering will be required for some elements of subdivision construction. Given the depth of construction, dewatering will only be in the Superficial Aquifer.

Prior to the commencement of any dewatering, the construction contractor will apply for and obtain from DWER a "Licence to Take Water". A licence is not required for dewatering if the pump rate does not exceed 10 L/s over a period of less than 30 days and the volume of water taken over the period does not exceed 25,000 kL.

All dewatering will be carried out in accordance with the conditions of this licence. Where possible, construction will be timed to minimise impacts on groundwater and any dewatering requirement.

Dewatering management strategies including discharge treatment, disposal and monitoring are detailed in Strategen Environmental (2018).

9.3.2 Acid Sulphate Soils

Figure 5 generally shows a high to moderate risk of A.S.S across the Study Area except in locations with sands (moderate to low risk) and Strategen Environmental (2018) found all soil types encountered during site investigations had acid generating capacity and therefore require management.

A.S.S. is to be managed per the strategies detailed in Strategen Environmental (2018) and in accordance with the applicable DWER *Acid Sulphate Guidelines for Identification and Investigation* (DER, 2015a) and *Treatment and Management* (DER, 2015b) of Disturbed Acid Sulphate Soils. Specific methods for treatment and holding times for A.S.S are detailed in Strategen Environmental (2018).

9.4 Stormwater System Operation and Management

The surface and subsoil drainage system will require regular maintenance to ensure correct operation. It is considered that the following operating and maintenance practices will be required periodically:

- Removal of debris to prevent blockages.
- Street sweeping to reduce particulate build up on road surface and gutters.
- Maintenance of vegetation in roadside swales/tree pits as outlined in the UWMP.
- Cleaning of sediment build up and litter layer on the bottom of FMAs as specified in the UWMP.
- Undertake education campaigns regarding source control practise to minimise pollution runoff into stormwater drainage system.
- Checks on subsoil drainage function.

The operating and maintenance schedule required is presented in Table 18.

TABLE 18: MAINTENANCE SCHEDULE FOR DRAINAGE INFRASTRUCTURE

Item	Maintenance Interval		
	Quarterly	Bi-annually	As required
Street Drainage			
Street sweeping to reduce particulate build-up	✓		
Removal of debris to prevent blockages	✓		
Eduction of sediment and rubbish in manholes/GPTs	✓		
Roadside Swales & Tree Pits			
Inspect for erosion + sediment accumulation		✓	
Assess health of vegetation. Remove dead plants and replace where necessary.		✓	
Inspect for standing water 1 day after rainfall events			✓
Removal of sediment and leaf litter layer build up.			✓
Flood Management Area			
Removal of debris from pipe inlets to prevent blockages	✓		
Use of slow release/low Phosphorus fertilisers in turfed areas.		✓	

9.5 Monitoring Program

A post-development monitoring program is required to allow a quantitative assessment of hydrological impacts of the proposed development.

This Program is proposed to operate over a 3-year period. It will be periodically reviewed to ensure suitability and practicality, and the program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area or alter the scope of the programme itself.

The post-development monitoring locations proposed are shown in Figure 23 with Program as follows:

- Monitor groundwater levels in 4 pre-development groundwater sites (14, 16, 17 and WAM3s) for comparison to pre-development data. Guideline values for WAM3s are provided in Table 19.
- Collection of water quality information from WAM3s for comparison to pre-development data. Guideline values provided in Table 19.
- Measure discharge and water quality in the Peel Main Drain from S2 and S3 located at the south western boundaries of the Study Area. This data will be used for comparison to pre-development data. Guideline values provided in Table 19.

The results of the monitoring snapshot of surface water sites on 19 November 2024 were generally consistent with historical data (JDA, 2007) from which guideline values in Table 19 were developed.

A summary of the proposed monitoring program and reporting schedule is shown in Table 20, with the frequency of water quality target review and the contingency action plan detailed in Table 21.

All sampling is to be conducted according to Australian Standards and all water quality sample testing will be conducted by a NATA-approved laboratory. Where the maximum guidelines value (see Table 19) is exceeded for more than two consecutive quarters the contingency actions enlisted in Table 21 should be implemented. Criteria are to be refined and established in the UWMP.

TABLE 19: GUIDELINE VALUES FOR POST-DEVELOPMENT MONITORING

Parameter		Groundwater	Surface Water	
		WAM3s	S2	S3
Water Level (mAHD)	Min	11.12	-	-
	Max	12.65	-	-
	Median	12.35	-	-
pH	Min	6.13	-	-
	Max	7.33	-	-
	Median	6.72	6.8	6.5
EC (ms/cm)	Min	1.08	-	-
	Max	1.89	-	-
	Median	1.37	1.30	0.5
TN (mg/L)	Min	0.8	-	-
	Max	1.9	-	-
	Median	1.4	5.82	1.04
TP (mg/L)	Min	0.01	-	-
	Max	0.19	-	-
	Median	0.03	1.30	0.26

TABLE 20: MONITORING SCHEDULE AND REPORTING

Monitoring Type	Location	Method	Frequency, Timing & Responsibility	Parameter	Reporting
Groundwater Level	4 monitoring sites (14,16,17 and WAM3s)	Data logger and/or Electrical depth probe	Monthly manual measurements or continuous data logger with quarterly verification for 3 years by Developer	Groundwater Level (mAHD)	Annual reports to be provided by the developer for a period of 3 years. Reports will be submitted to DWER/CoK within 3 months of completion of the reporting period.
Surface Water Quantity	Locations S2 & S3 on the PMD.	Continuous logger	Downloaded 3 times per year	Stage (Flow inferred)	
Groundwater Quality	1 monitoring site (WAM3)	Pumped bore samples	Quarterly for 3 years by Developer (Jan, April, July, Oct)	In-situ: pH, EC, temp Lab: TN, TKN, NO_X, Ammonia, TP, FRP, selected metals	
Surface Water Quality	Locations S2 & S3 on the PMD.	Collected grab samples or rising stage sampler	3 times per year while flowing	In-situ: pH, EC, temp Lab: TN, TKN, NO_X, Ammonia, TP, FRP, selected metals, TSS	

TABLE 21: CONTINGENCY PLANNING

Monitoring Type	Criteria for Assessment	Criteria Assessment Frequency	Contingency Action
Groundwater Level	Groundwater levels not to exceed estimated pre-development AAMGL by more than 0.5 m	After monitoring occasion	1. Review design and operation of subsoil and stormwater drainage system. 2. Perform maintenance as required.
Groundwater Quality	Nutrient concentrations in shallow bores not to maximum recorded pre-development level.	Annual review of water quality targets	1. Identify and remove any point sources. 2. Consider reinforcement of Community Education/Awareness program. 3. Review operational and maintenance (e.g. fertilising, cleaning) practices. 4. Consider alterations to POS areas including landscape regimes and soil amendment. 5. Consider modifications to the stormwater system. 6. Consider initiation of community based projects.
Surface Water Level	Extended durations of inundation within the FMA.	After monitoring occasion	1. Review rainfall of storm events to determine rarity. 2. Review design and operation of subsoil and stormwater drainage system. 3. Perform maintenance as required.

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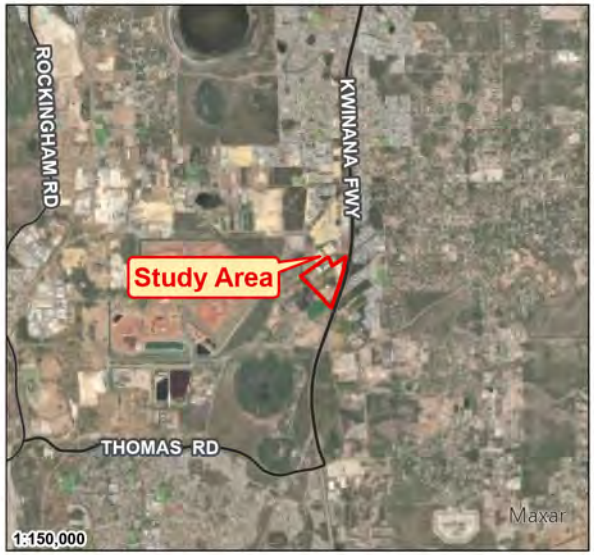
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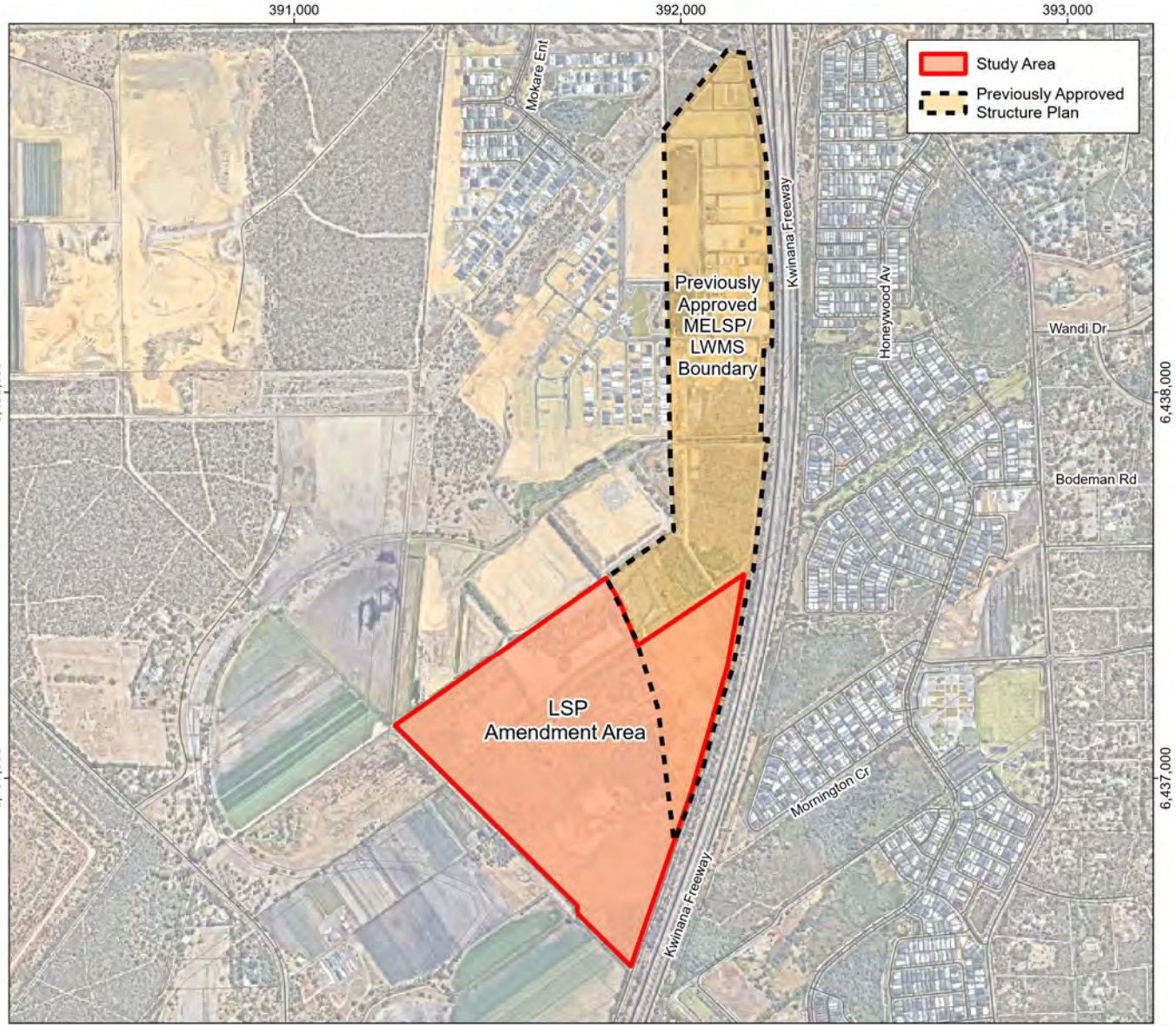
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FIGURES







Data Source: Nearmap (2024) *31 January 2024*.

Coordinate System: GDA 94, Zone 50

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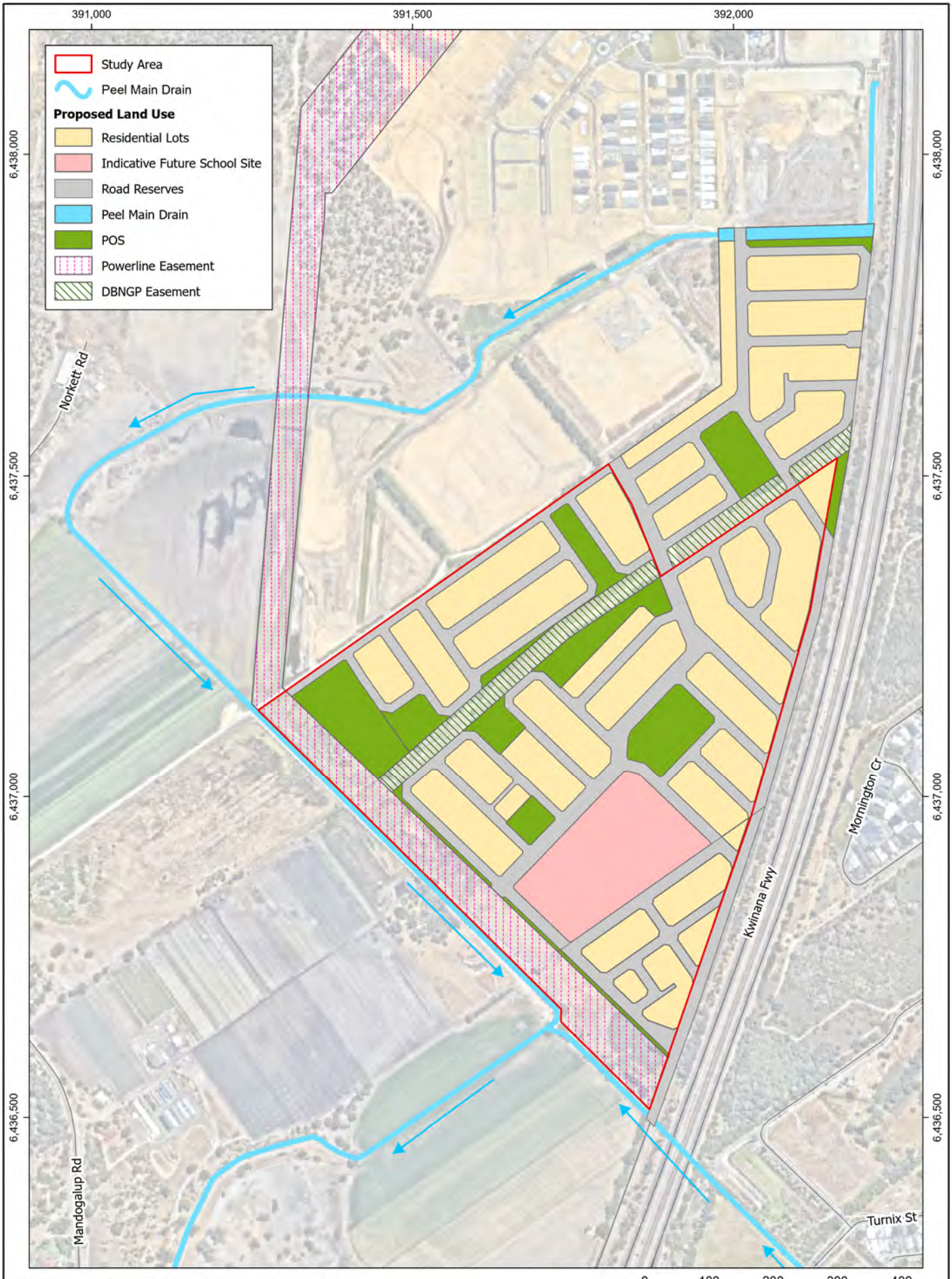
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Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 1: Location Plan



Data Source: NearMaps (2024); Rowe Group (2025).

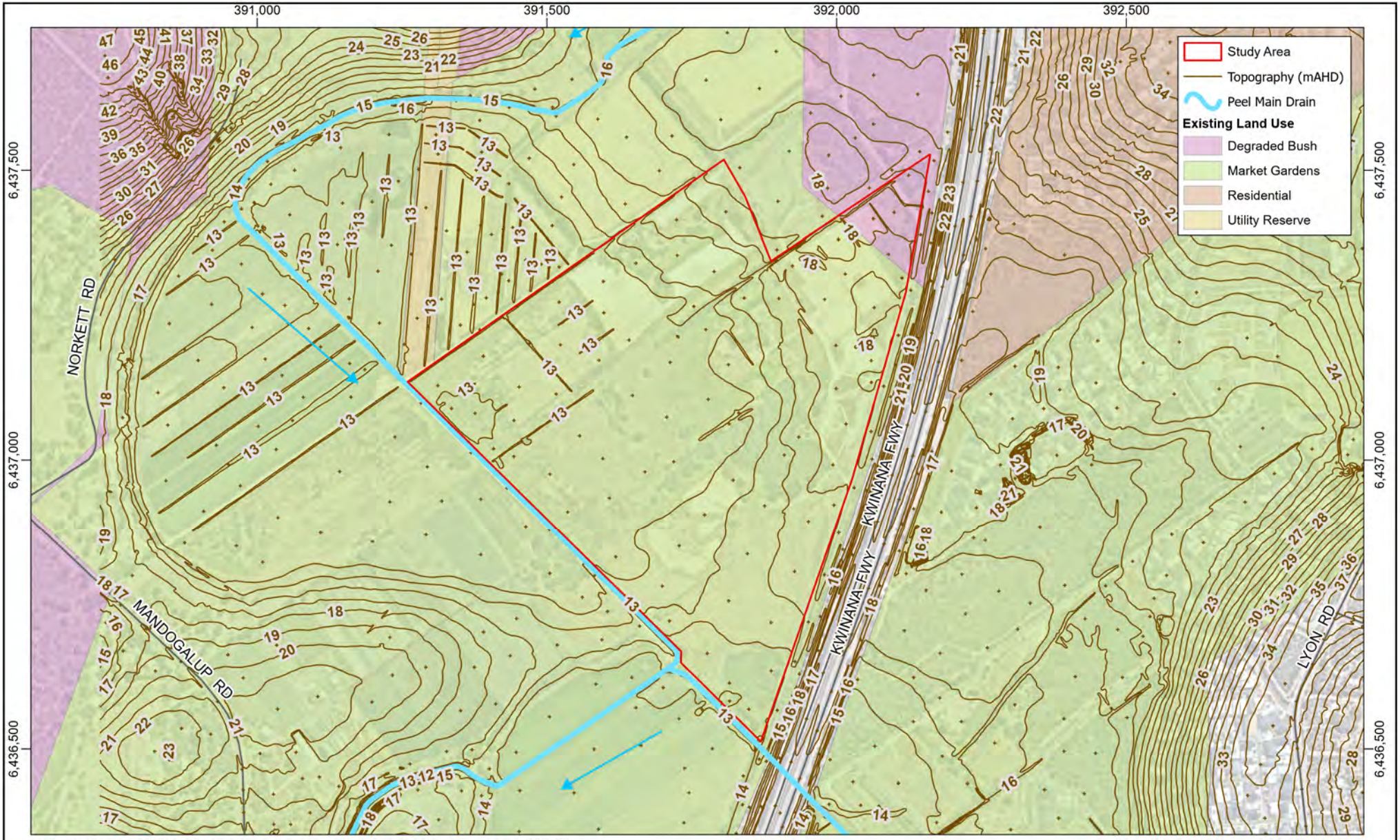
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Figure 2: Concept Structure Plan



Data Source: DoW (2008) *1 m contours generated from LiDAR*, Nearmaps (2024)

Coordinate System: GDA 94, Zone 50

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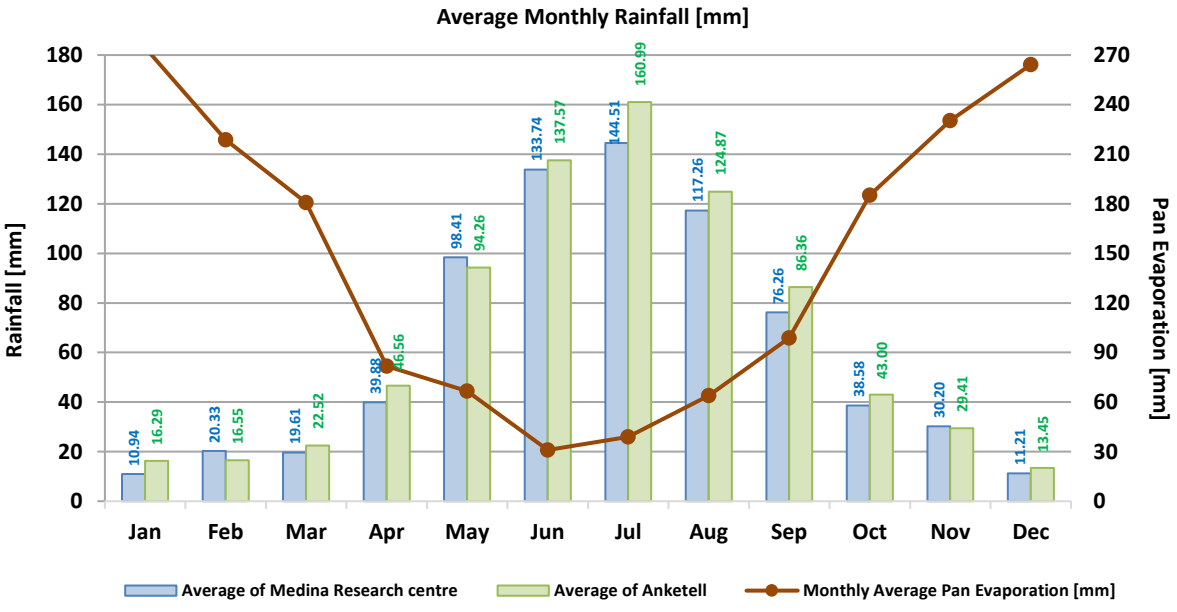
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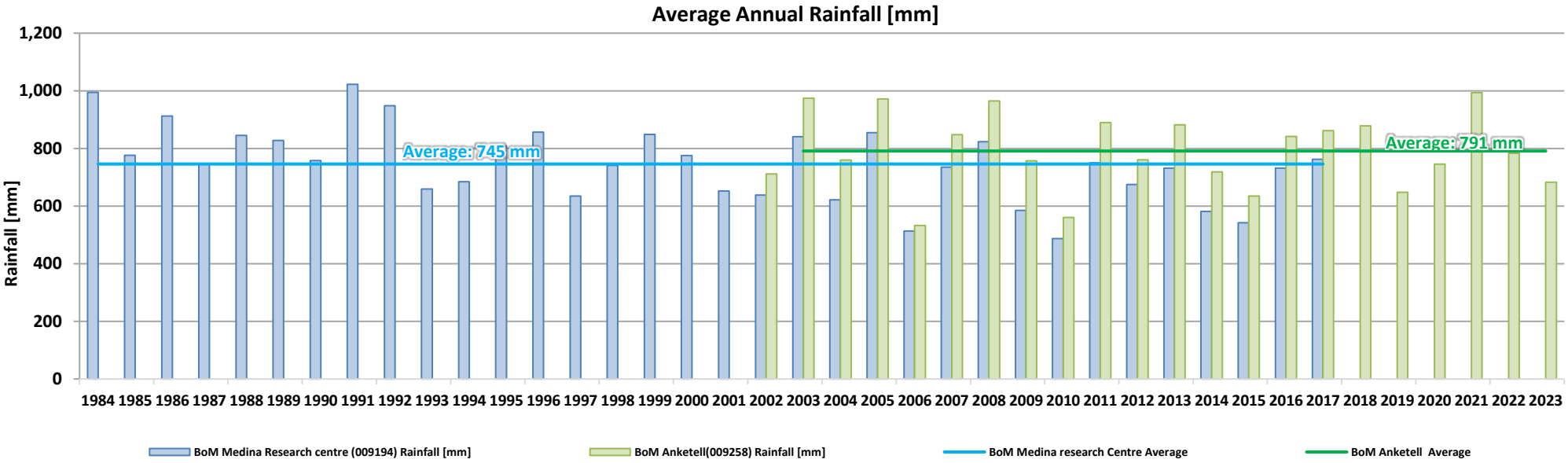
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Figure 3: Existing Land Use and Topography







Data Source: BoM (2023) Climate Data Online - Medina Research Centre (009194) & Anketell (009258); DPIRD (2024 Wattelup (WT001) Pan Evaporation

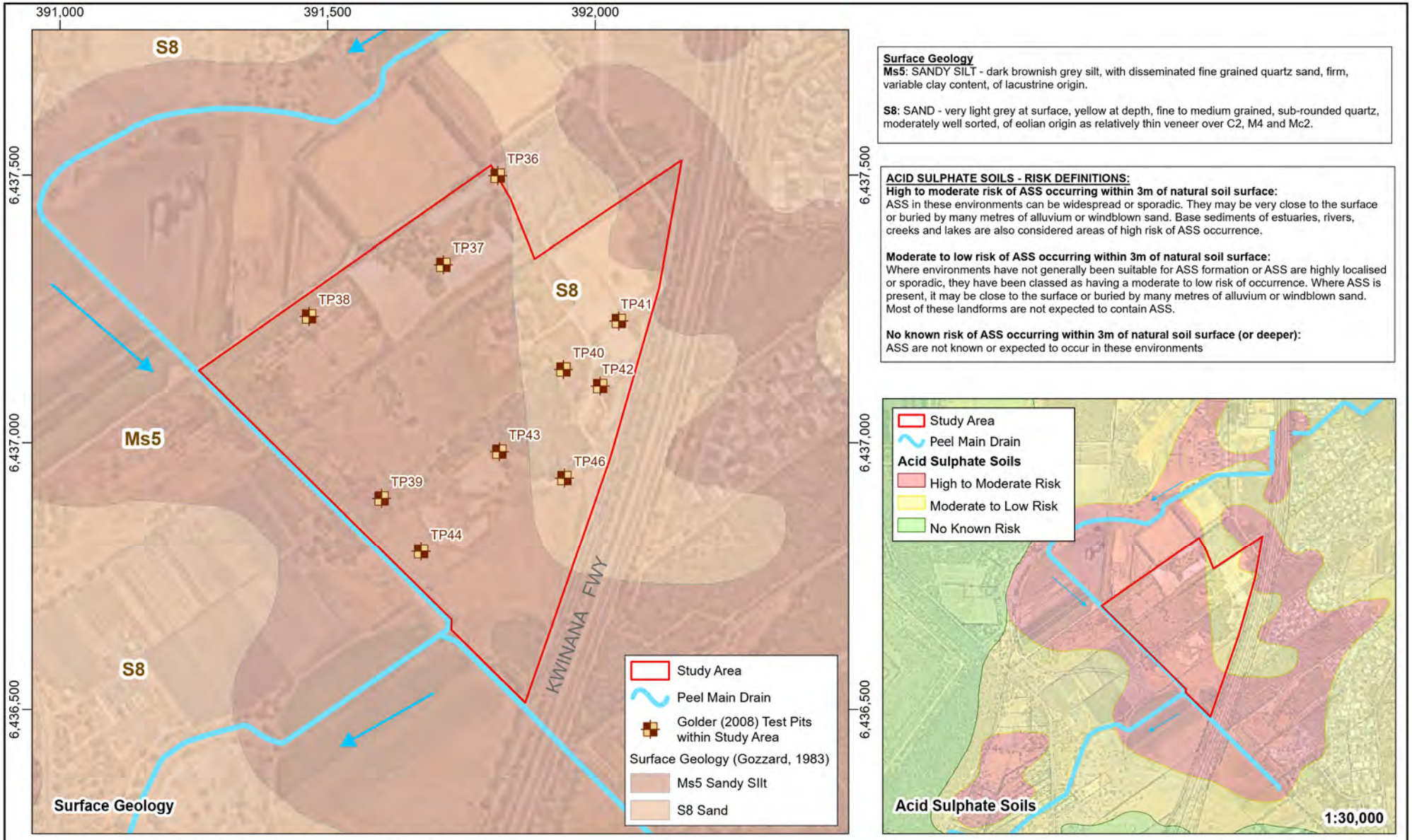
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Figure 4: Rainfall and Evapoation



Data Source: Gozzard (1983), Golder Associates (2008); DEC (2010).

Coordinate System: GDA 94, Zone 50

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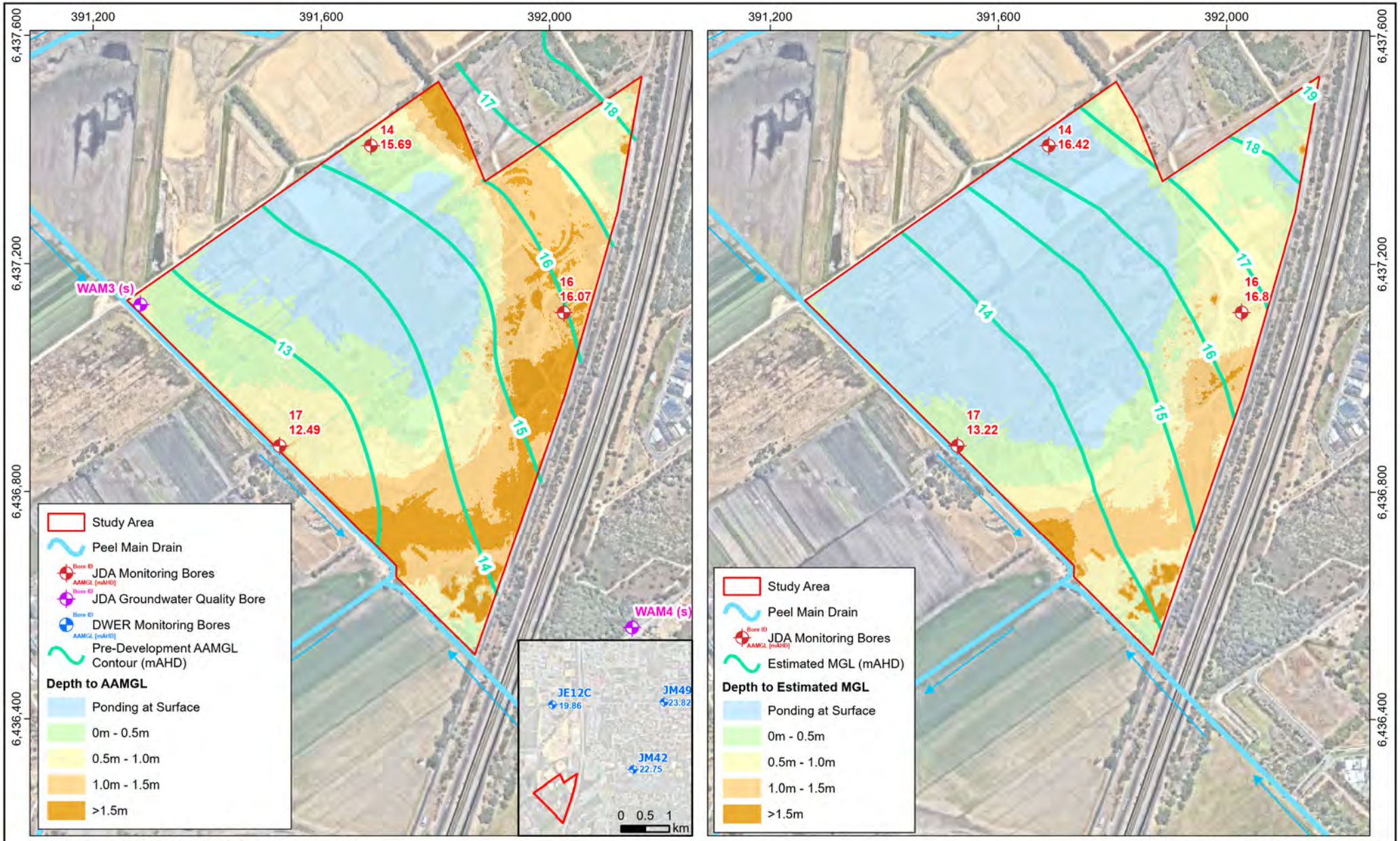
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Figure 5: Surface Geology, Geotechnical and Acid Sulphate Soils



Data Source: JDA (2007; 2008); NearMaps (2024).

Coordinate System: GDA 2020, Zone 50

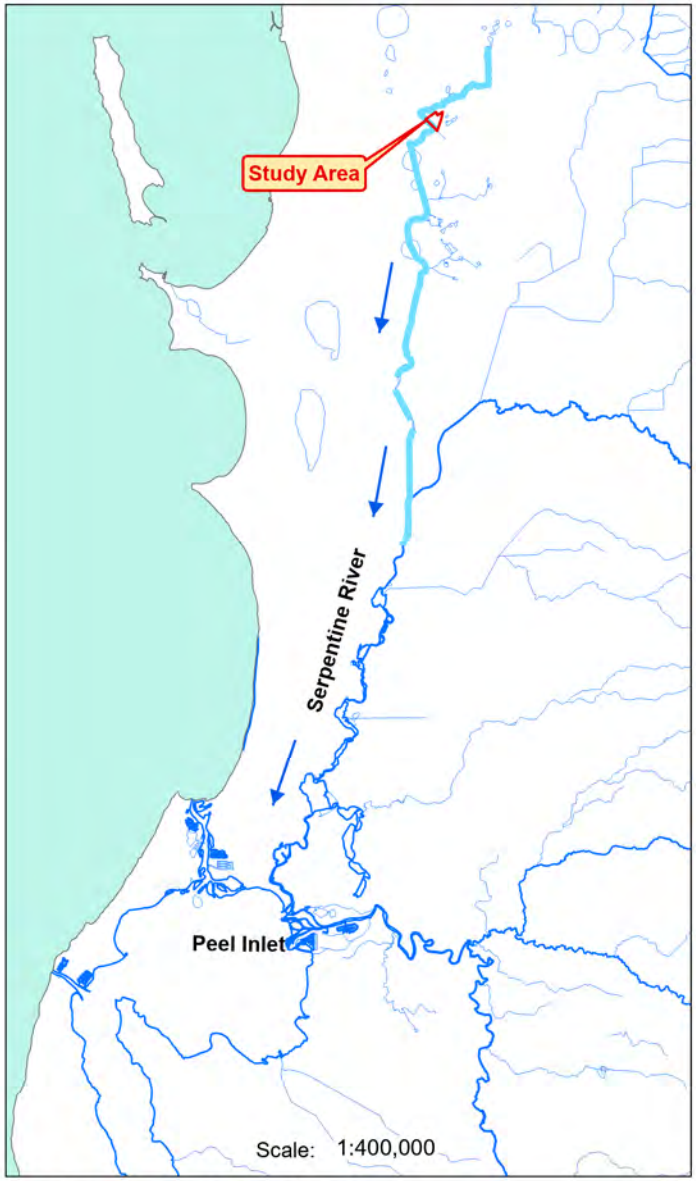
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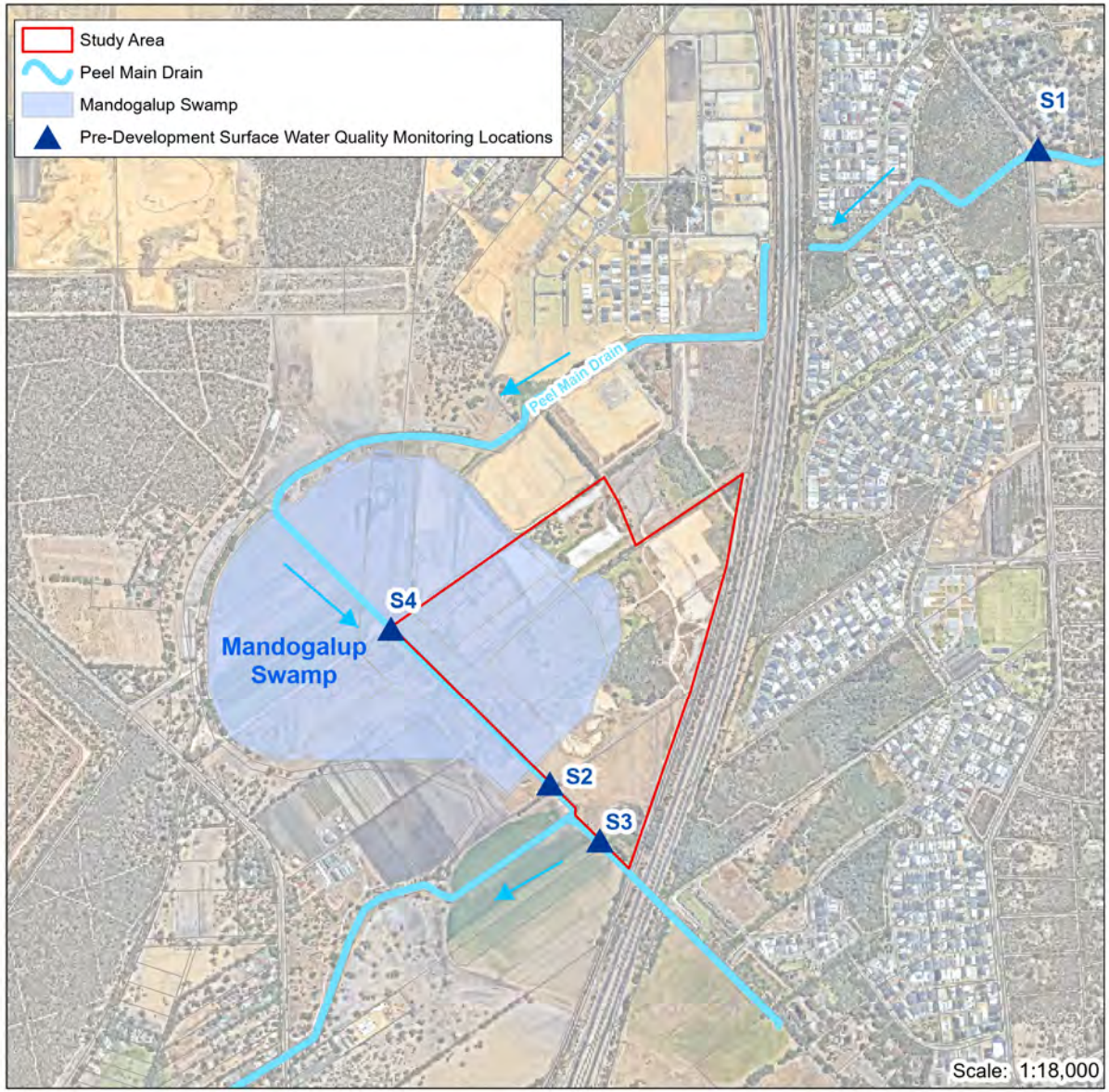
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Figure 6: Groundwater Monitoring Locations and Pre-Development AAMGL & MGL





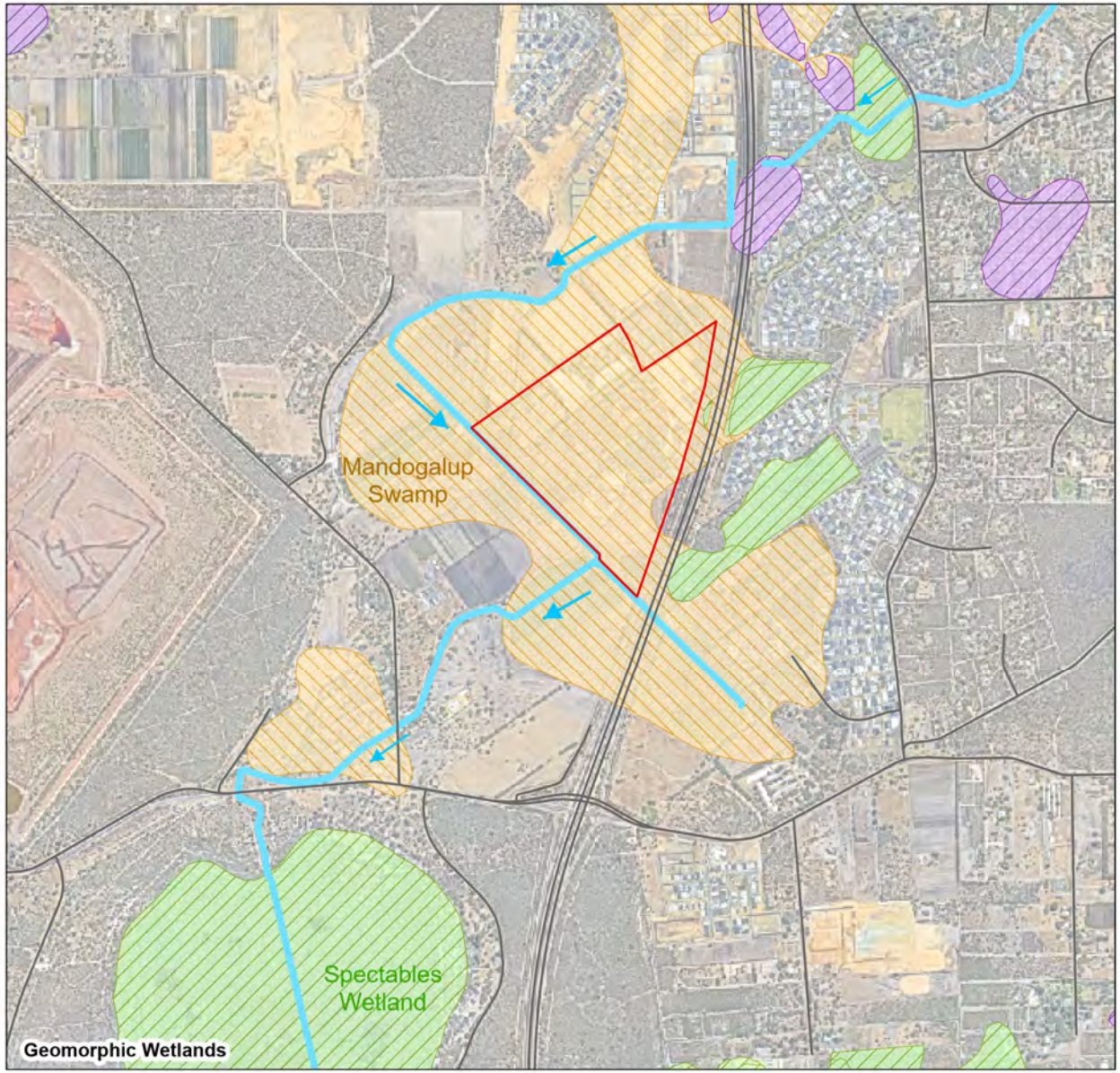
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Figure 7: Existing Surface Drainage



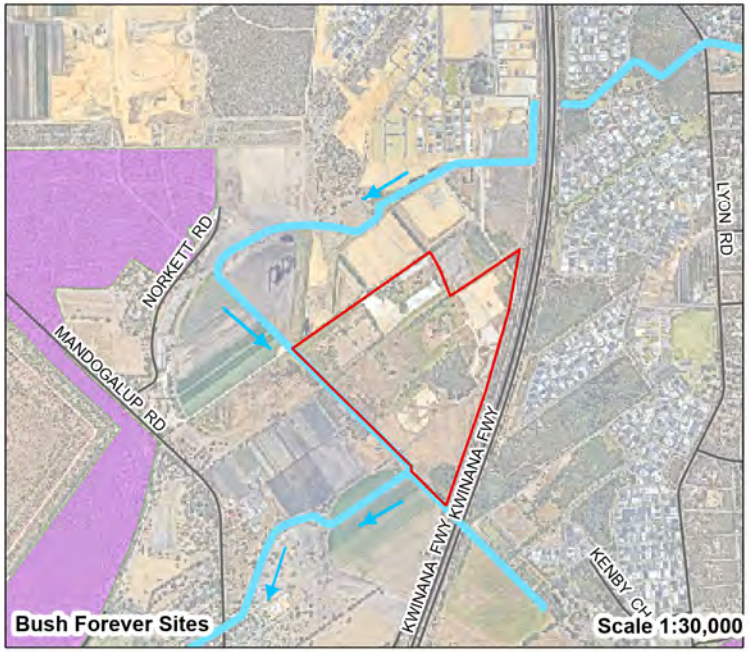
Study Area
Peel Main Drain
Bush Forever Sites

Geomorphic Wetlands (DEC, 2012)

Conservation Category Wetland (CCW)
Resource Enhancement Wetland (REW)
Multiple Use Dampland

WETLAND DEFINITIONS:

Conservation Wetland:
Wetlands that support a high level of ecological attributes and functions.
Resource Enhancement Wetland:
Wetlands which may have been partially modified but still support substantial ecological attributes and functions.
Multiple Use Dampland:
Wetlands with few ecological attributes and functions remaining.



JDA

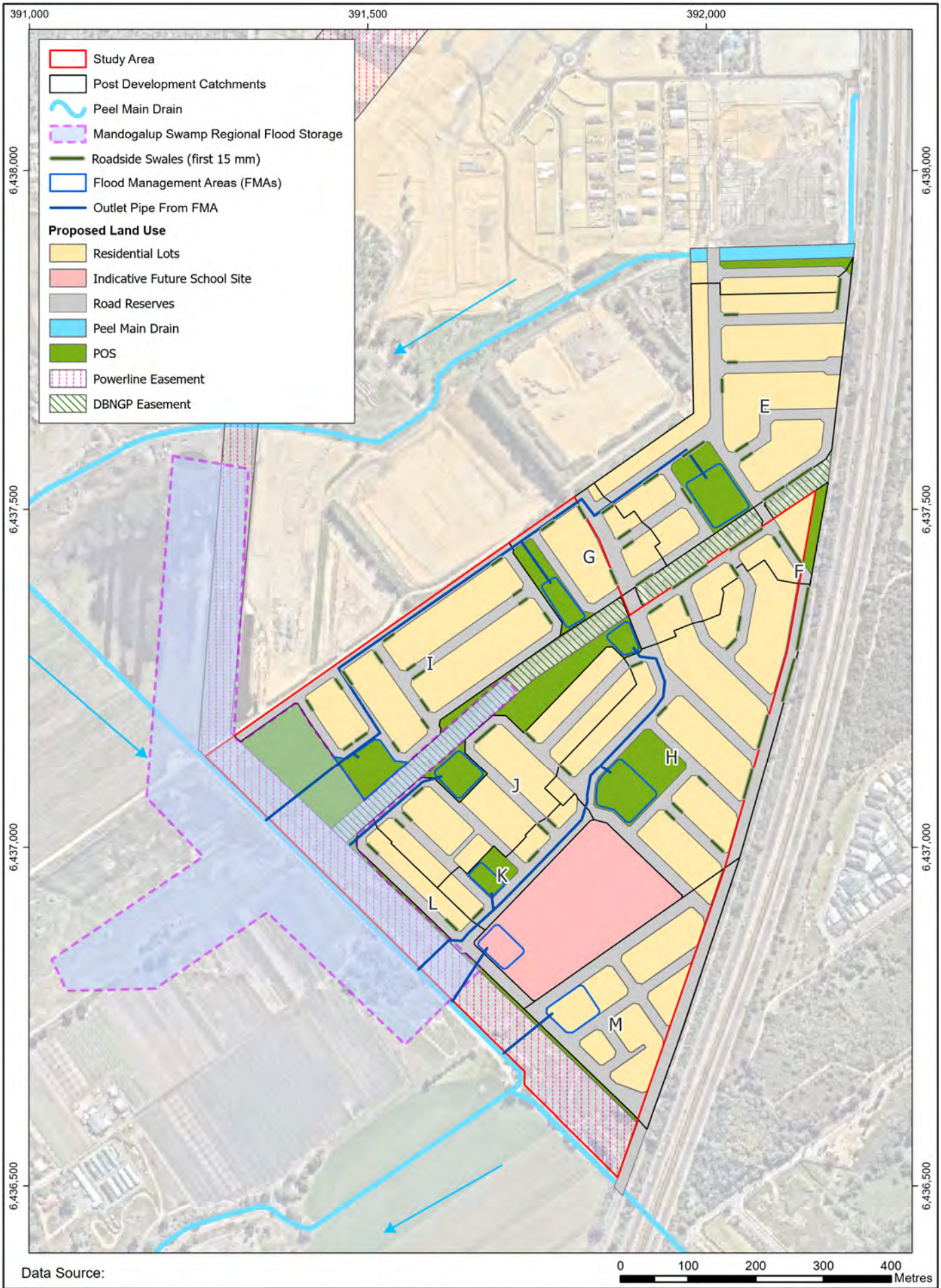
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Figure 8: Wetland Mapping

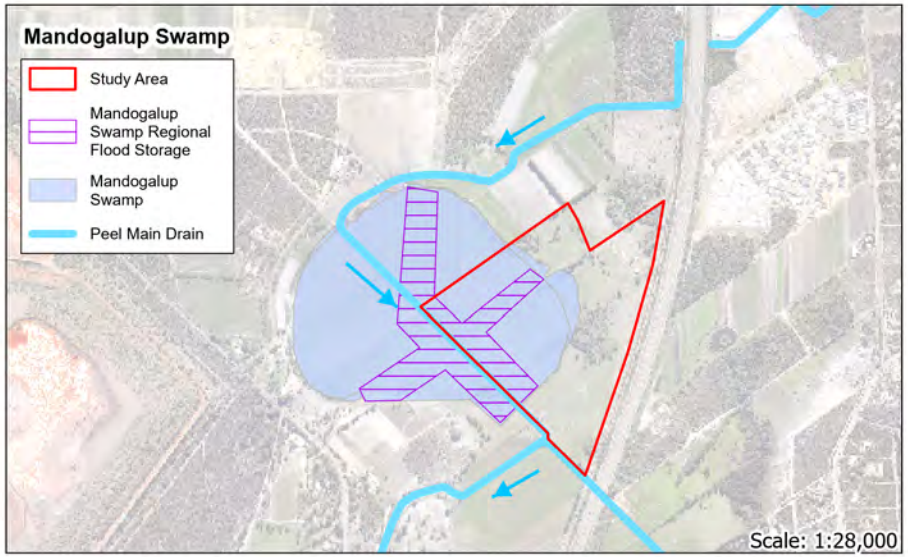


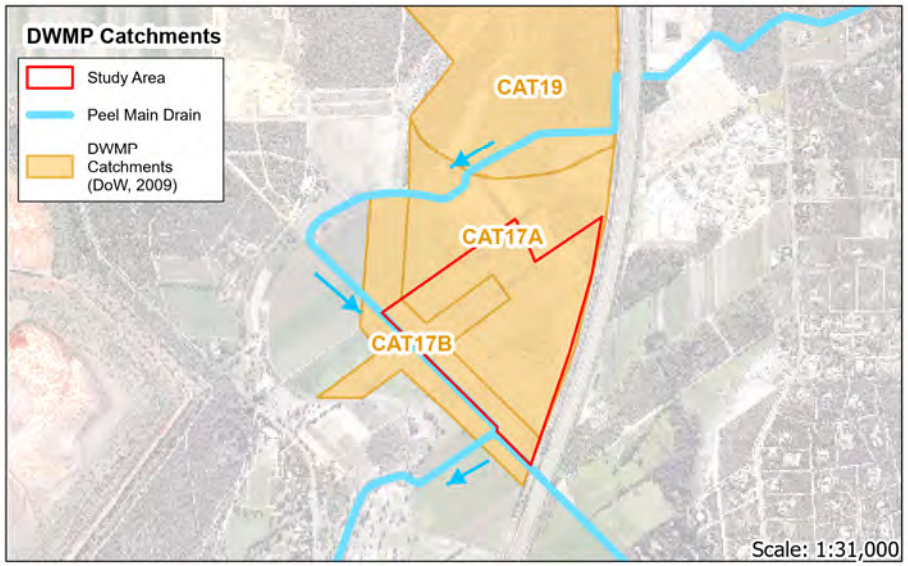
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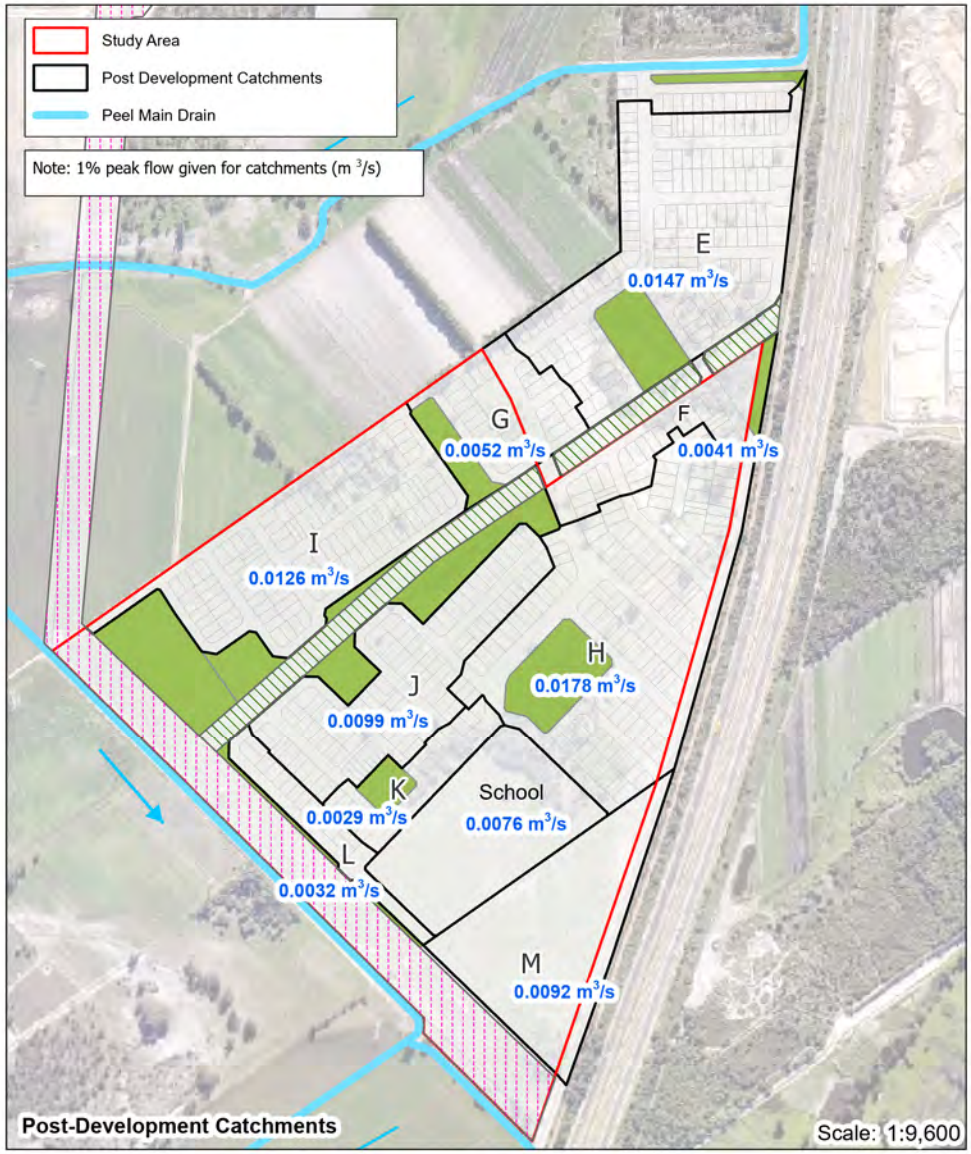
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Satterley Property Group
Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 9: Stormwater Management Plan







Job No. J7502

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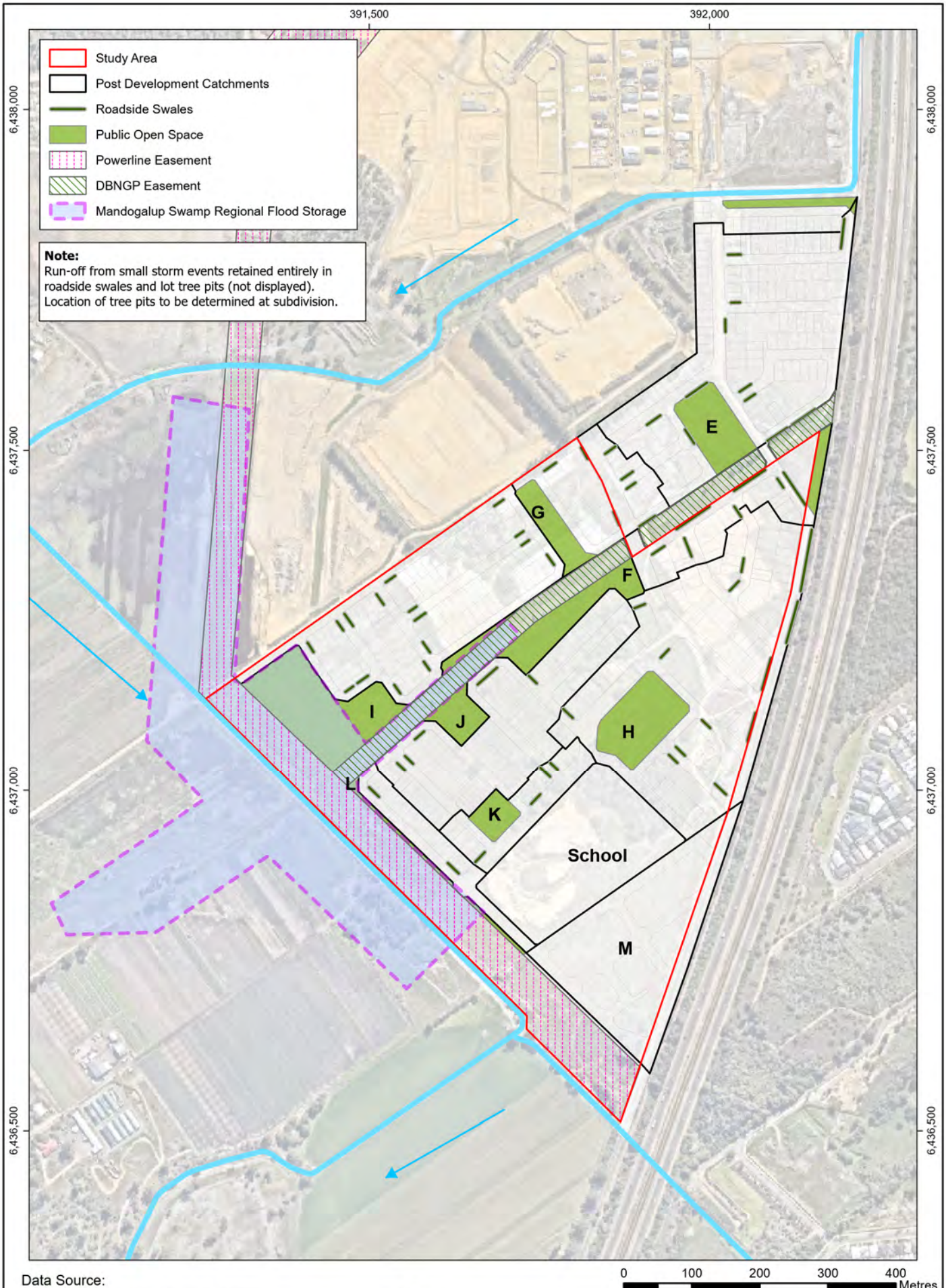
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Satterley Property Group

Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 10: Mandogalup Swamp Regional Flood Storage & Allowable Outflows 1% AEP

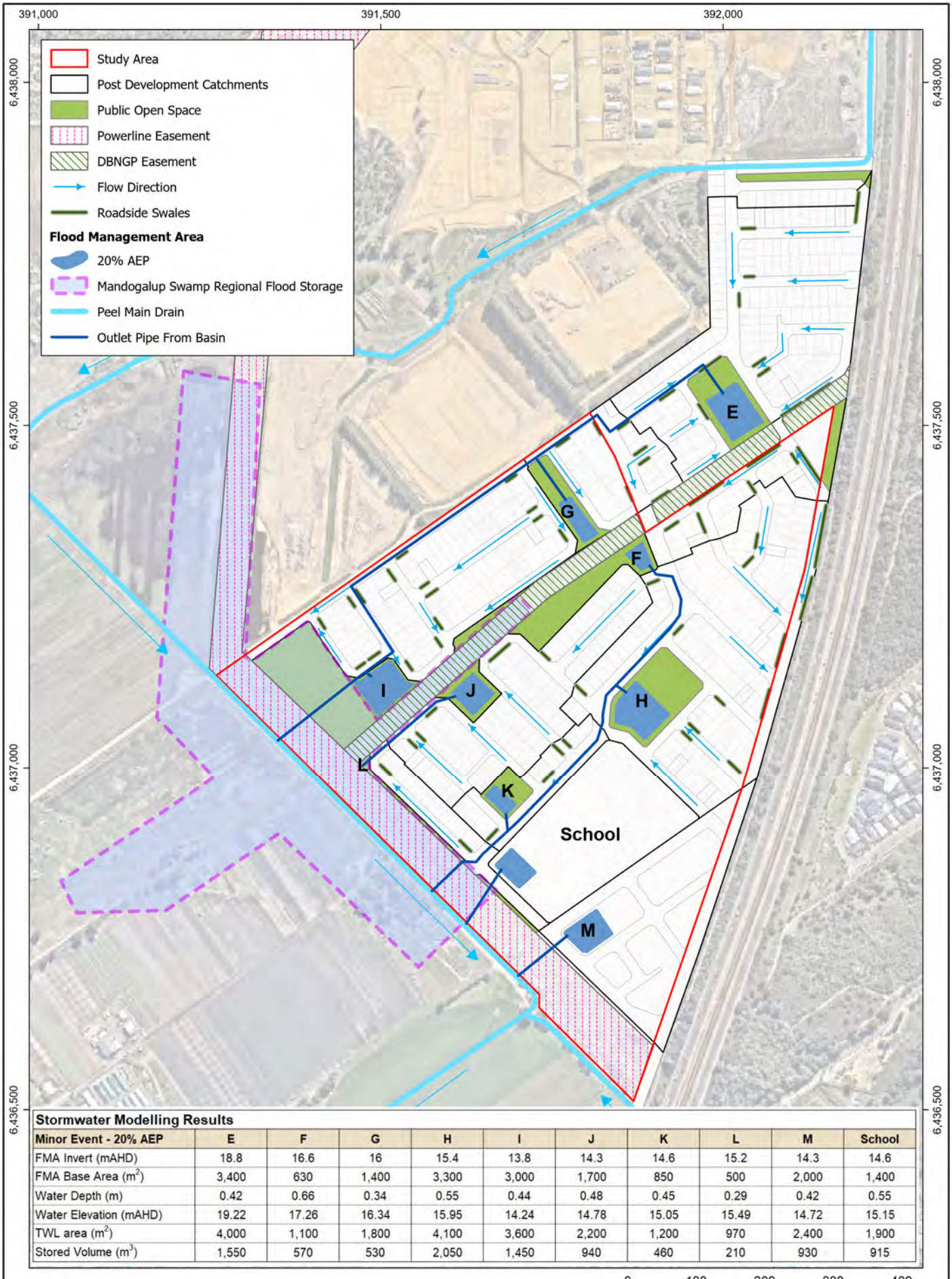


Job No. J7502
Scale: 1:7,500 @A4
Coordinate System: GDA 1994 MGA Zone 50
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Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 11: Small Event Stormwater Event Plan



Stormwater Modelling Results

Minor Event - 20% AEP	E	F	G	H	I	J	K	L	M	School
FMA Invert (mAHD)	18.8	16.6	16	15.4	13.8	14.3	14.6	15.2	14.3	14.6
FMA Base Area (m^2)	3,400	630	1,400	3,300	3,000	1,700	850	500	2,000	1,400
Water Depth (m)	0.42	0.66	0.34	0.55	0.44	0.48	0.45	0.29	0.42	0.55
Water Elevation (mAHD)	19.22	17.26	16.34	15.95	14.24	14.78	15.05	15.49	14.72	15.15
TWL area (m^2)	4,000	1,100	1,800	4,100	3,600	2,200	1,200	970	2,400	1,900
Stored Volume (m^3)	1,550	570	530	2,050	1,450	940	460	210	930	915

Data Source:

0 100 200 300 400 Metres

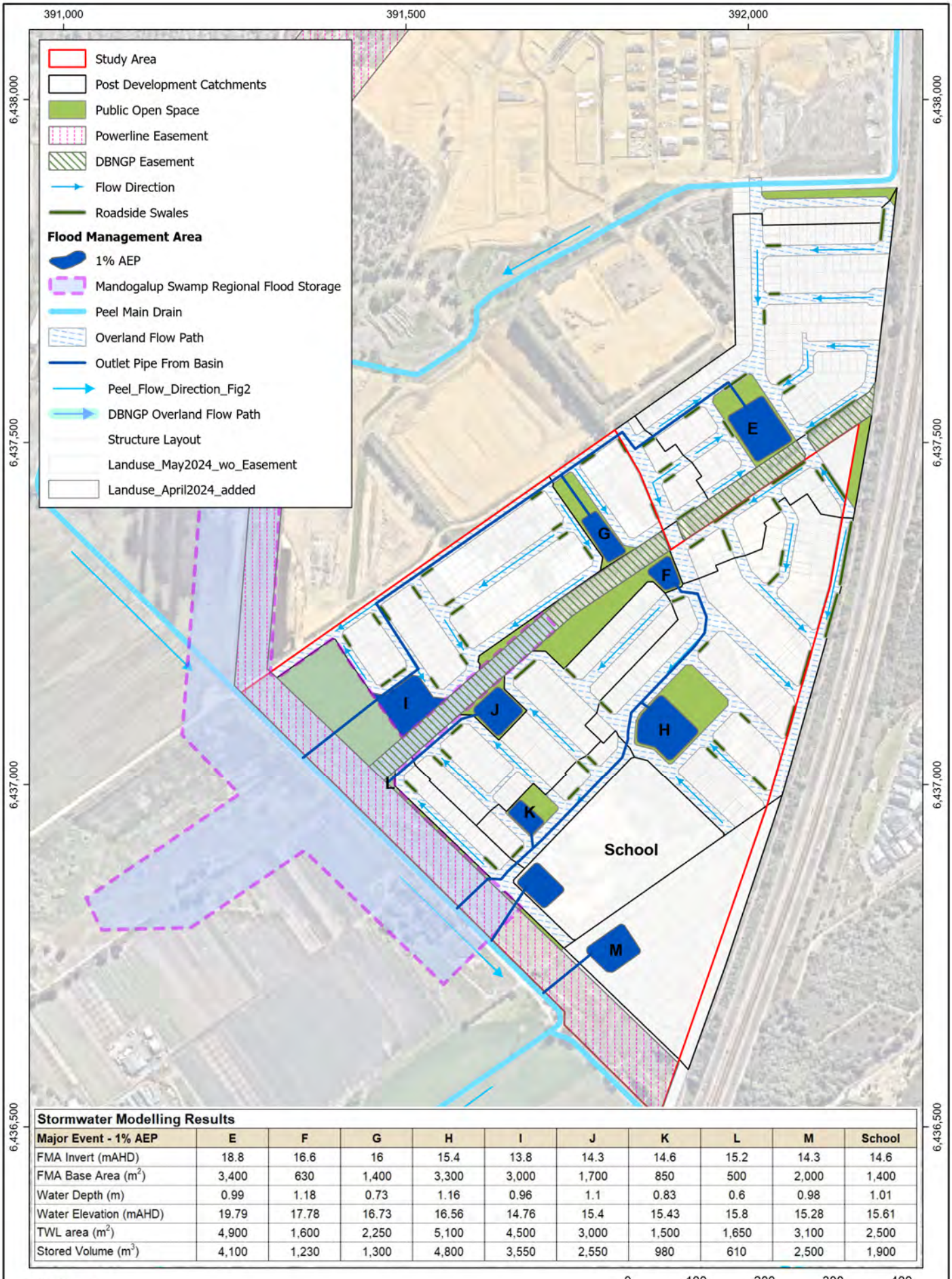
JDA

Job No. J7502
Scale: 1:7,500 @A4
Coordinate System: GDA 1994 MGA Zone 50
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Figure 12: Minor Event Stormwater Event Plan



Stormwater Modelling Results										
Major Event - 1% AEP	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**School**
FMA Invert (mAHD)	18.8	16.6	16	15.4	13.8	14.3	14.6	15.2	14.3	14.6
FMA Base Area (m^2)	3,400	630	1,400	3,300	3,000	1,700	850	500	2,000	1,400
Water Depth (m)	0.99	1.18	0.73	1.16	0.96	1.1	0.83	0.6	0.98	1.01
Water Elevation (mAHD)	19.79	17.78	16.73	16.56	14.76	15.4	15.43	15.8	15.28	15.61
TWL area (m^2)	4,900	1,600	2,250	5,100	4,500	3,000	1,500	1,650	3,100	2,500
Stored Volume (m^3)	4,100	1,230	1,300	4,800	3,550	2,550	980	610	2,500	1,900

Data Source:

0 100 200 300 400 Metres

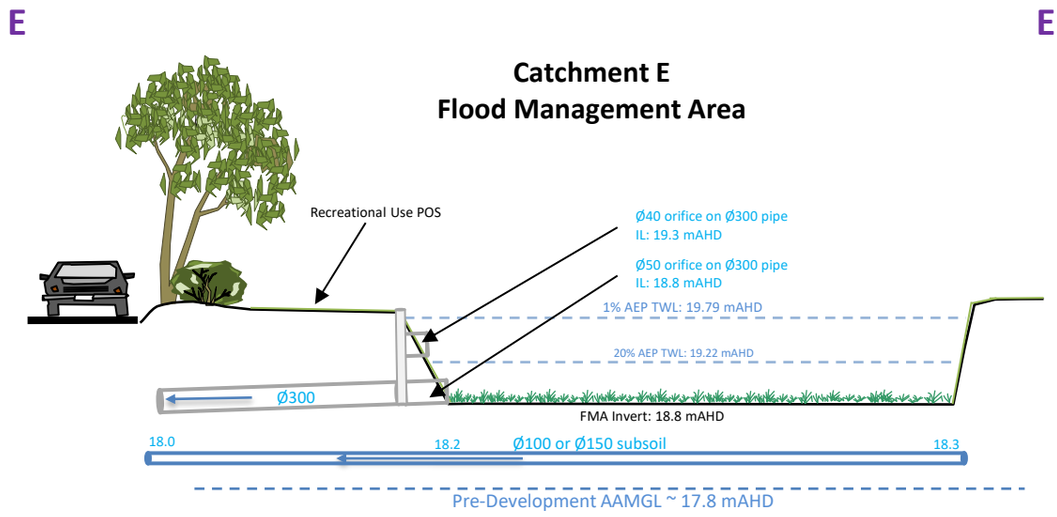
Job No. J7502
Scale: 1:7,500 @A4
Coordinate System: GDA 1994 MGA Zone 50
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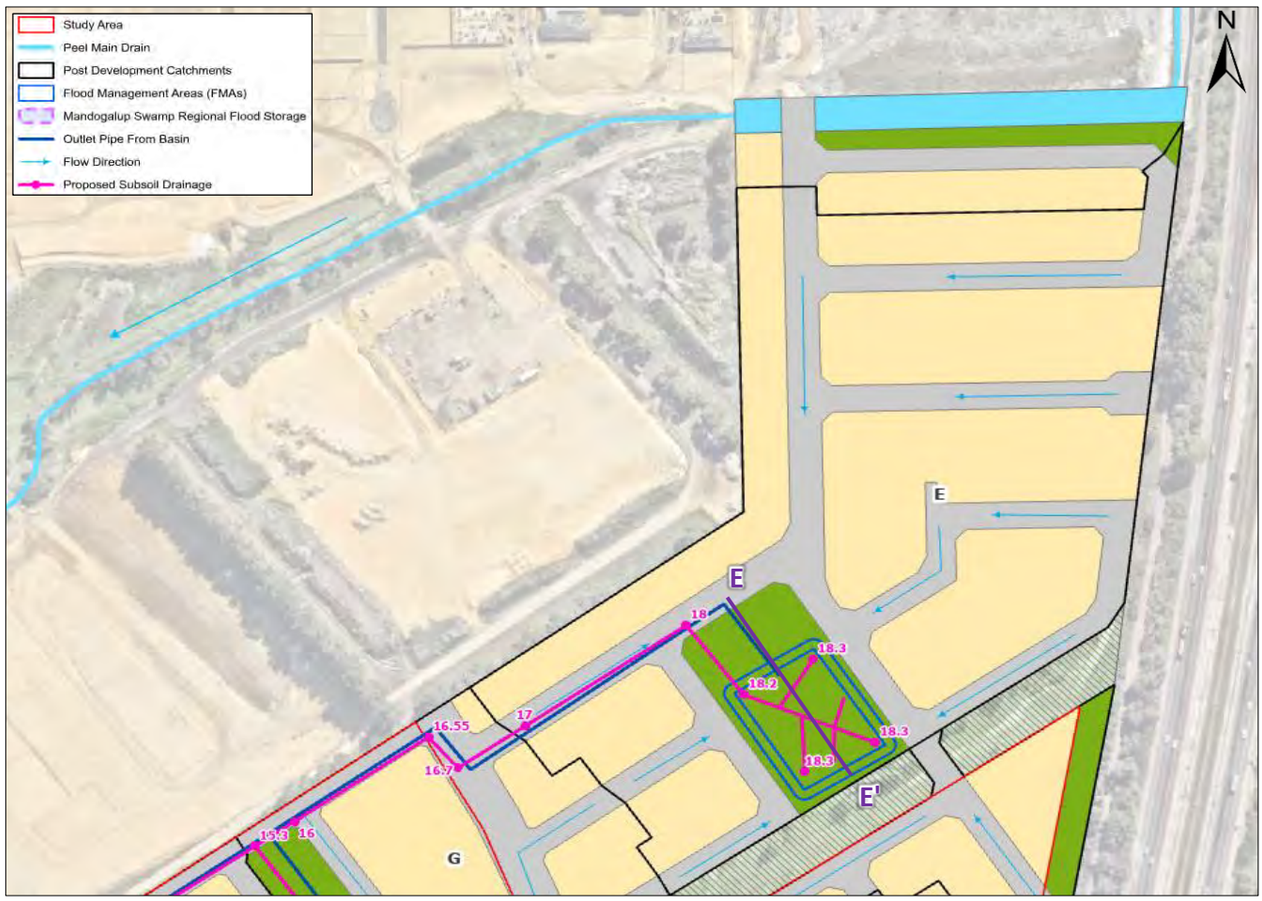
Satterley Property Group
Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 13: Major Event Stormwater Event Plan

Cross-Section

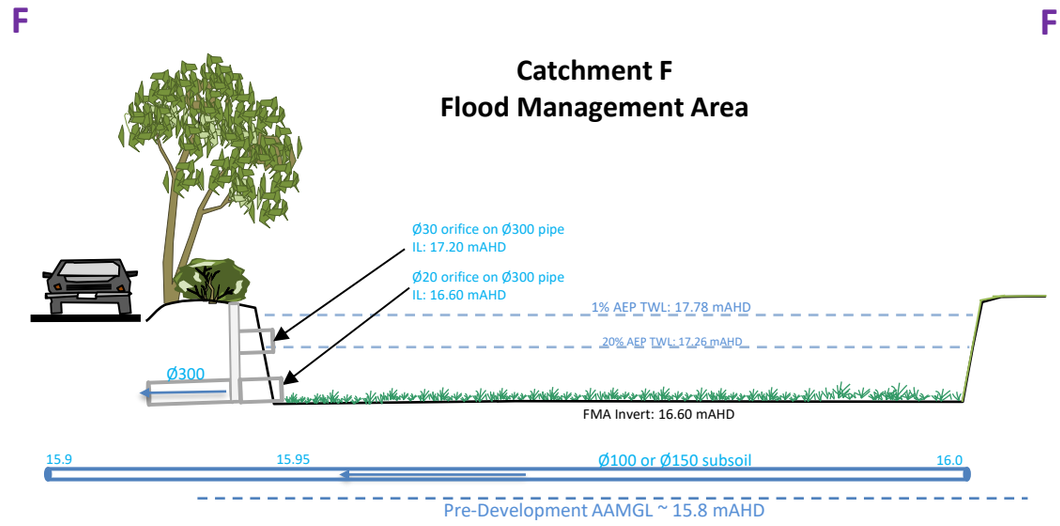


Note: Drawing not to scale



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Cross-Section



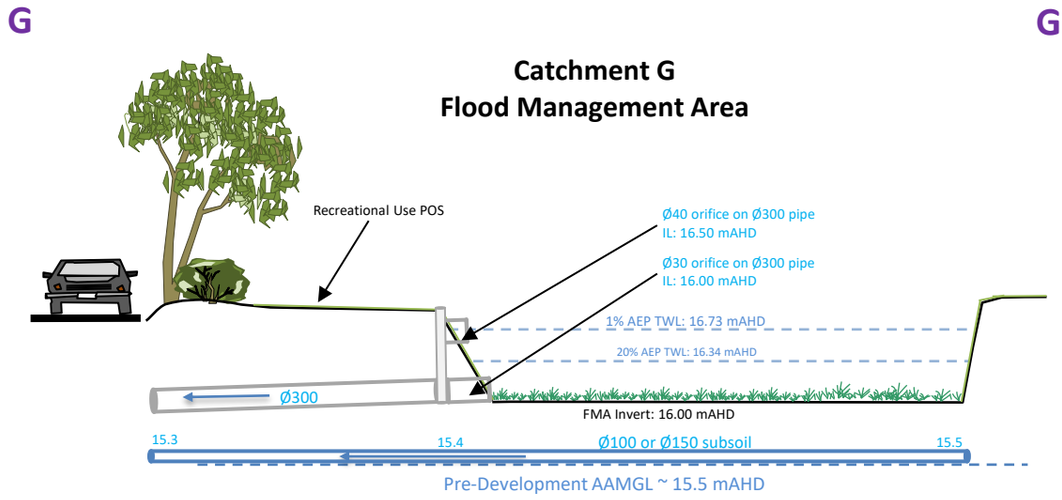
Note: Drawing not to scale



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Florence Estate, Mandogalup – Stages 12 to 19: LWMS
Figure 15: FMA F Concept Cross-Section

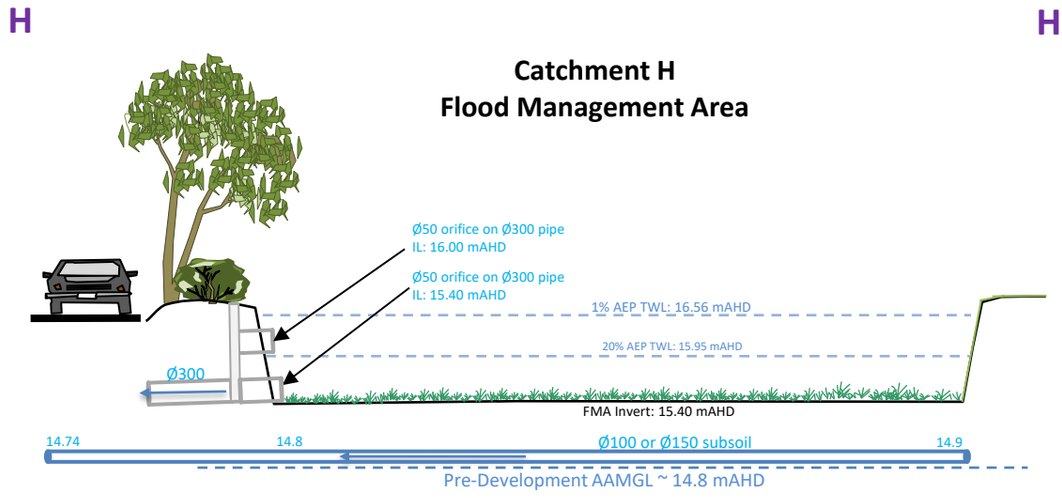
Cross-Section



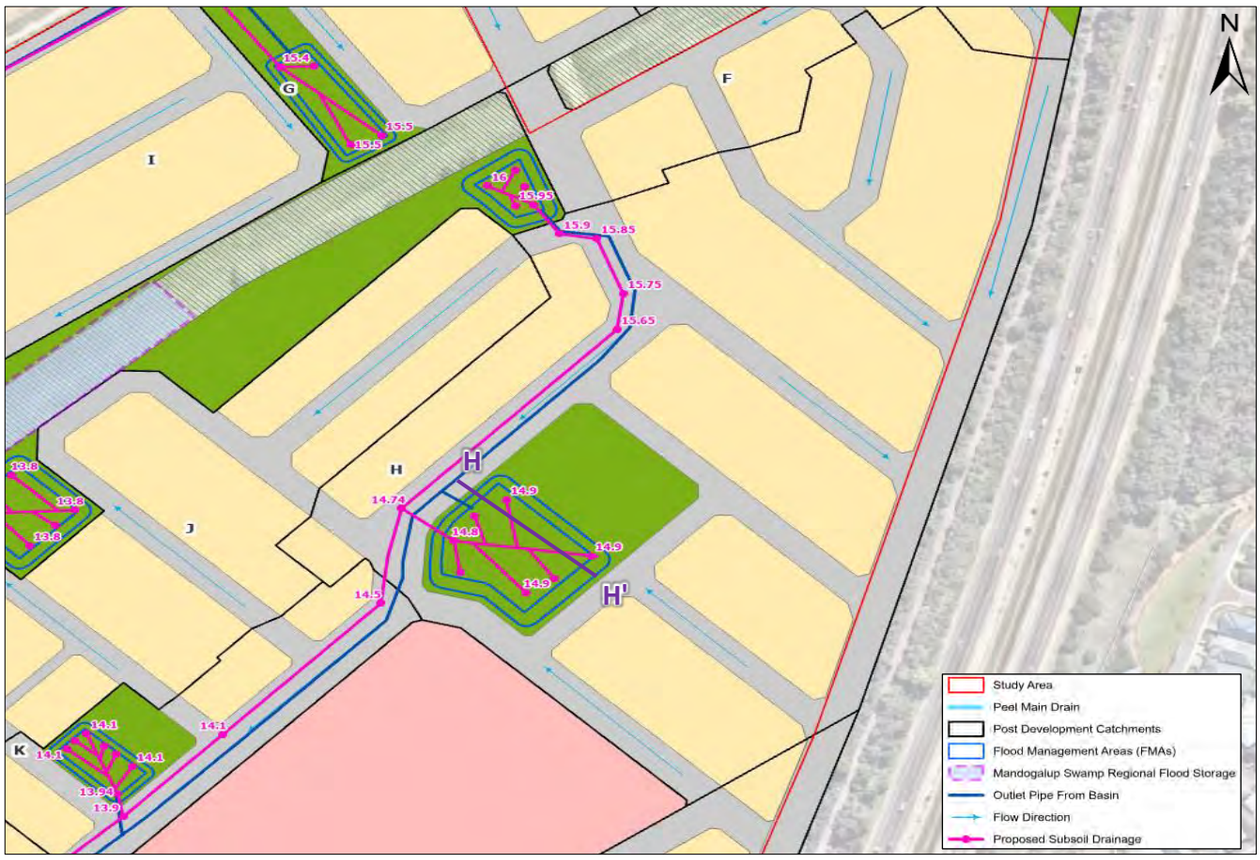
Note: Drawing not to scale



Cross-Section



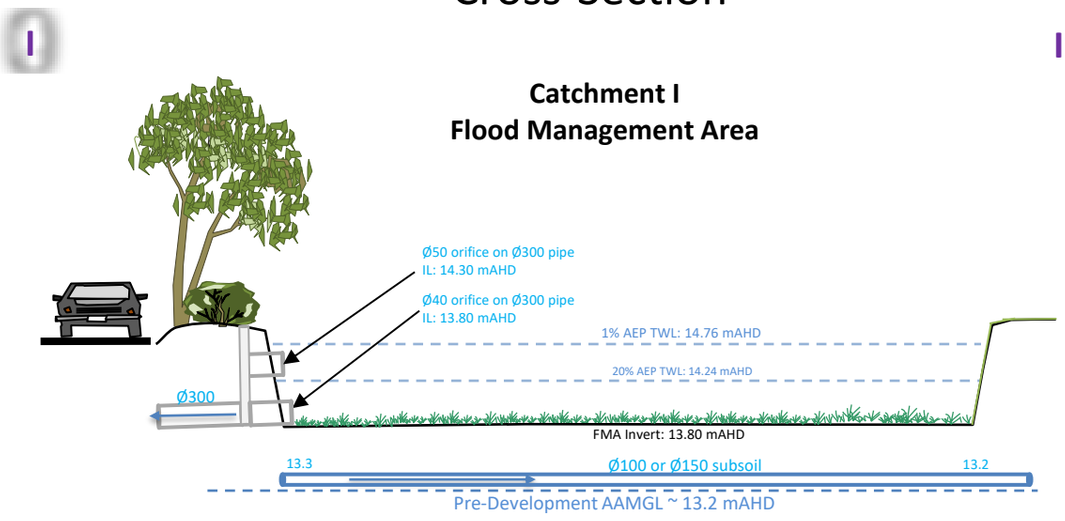
Note: Drawing not to scale



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Florence Estate, Mandogalup – Stages 12 to 19: LWMS
Figure 17: FMA H Concept Cross-Section

Cross-Section



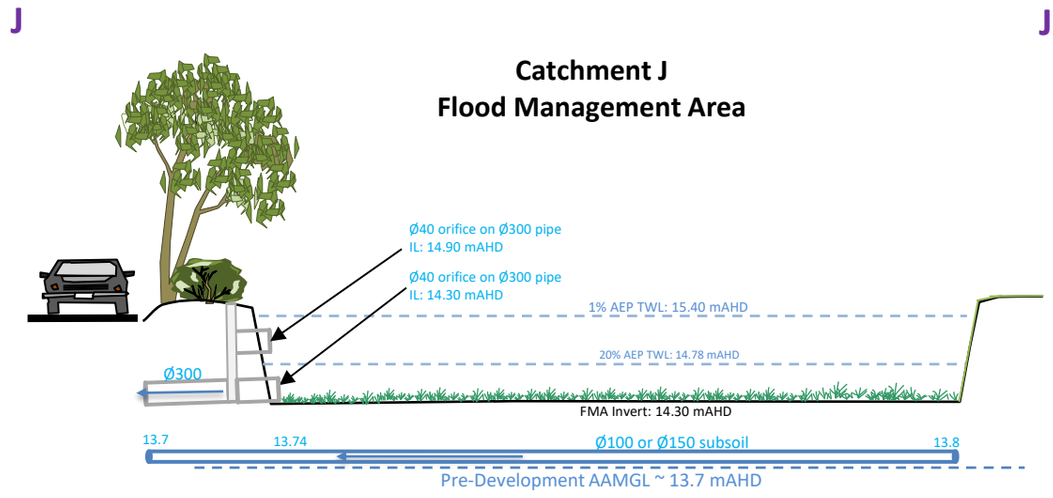
Note: Drawing not to scale



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Florence Estate, Mandogalup – Stages 12 to 19: LWMS
Figure 18: FMA I Concept Cross-Section

Cross-Section



Note: Drawing not to scale



Job No. J7502

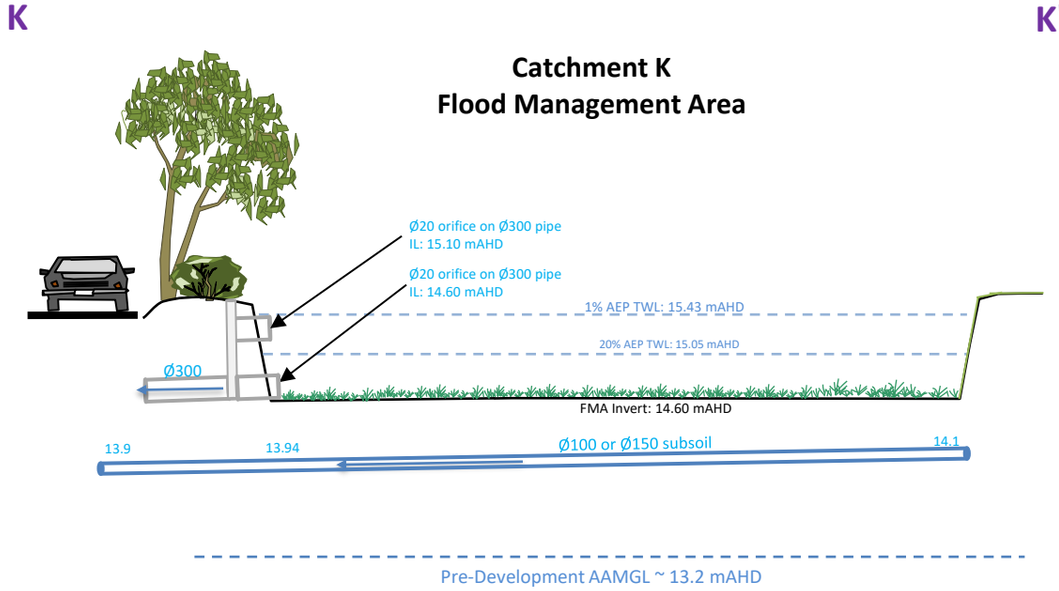
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Satterley Property Group

Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 19: FMA J Concept Cross-Section

Cross-Section



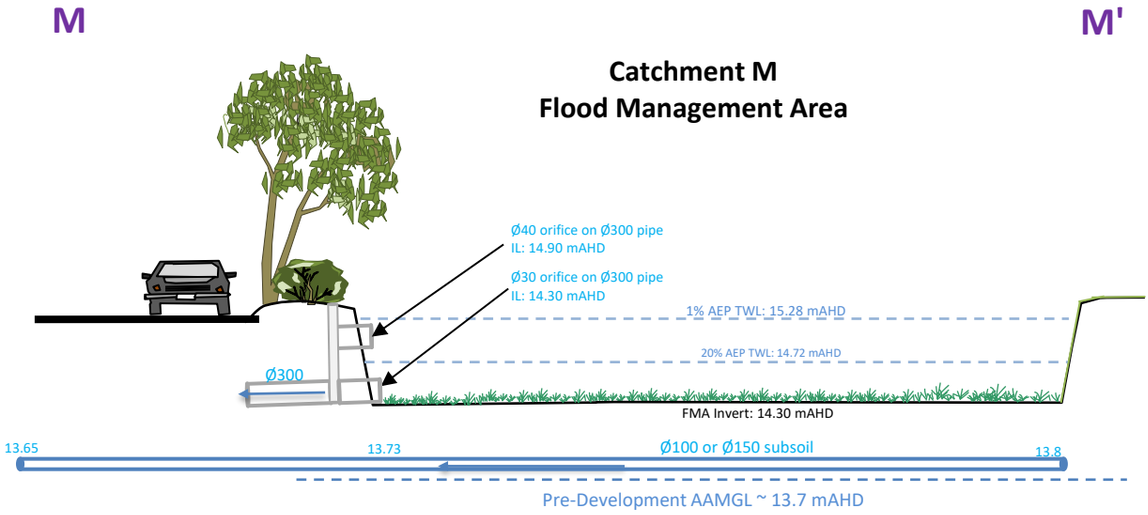
Note: Drawing not to scale



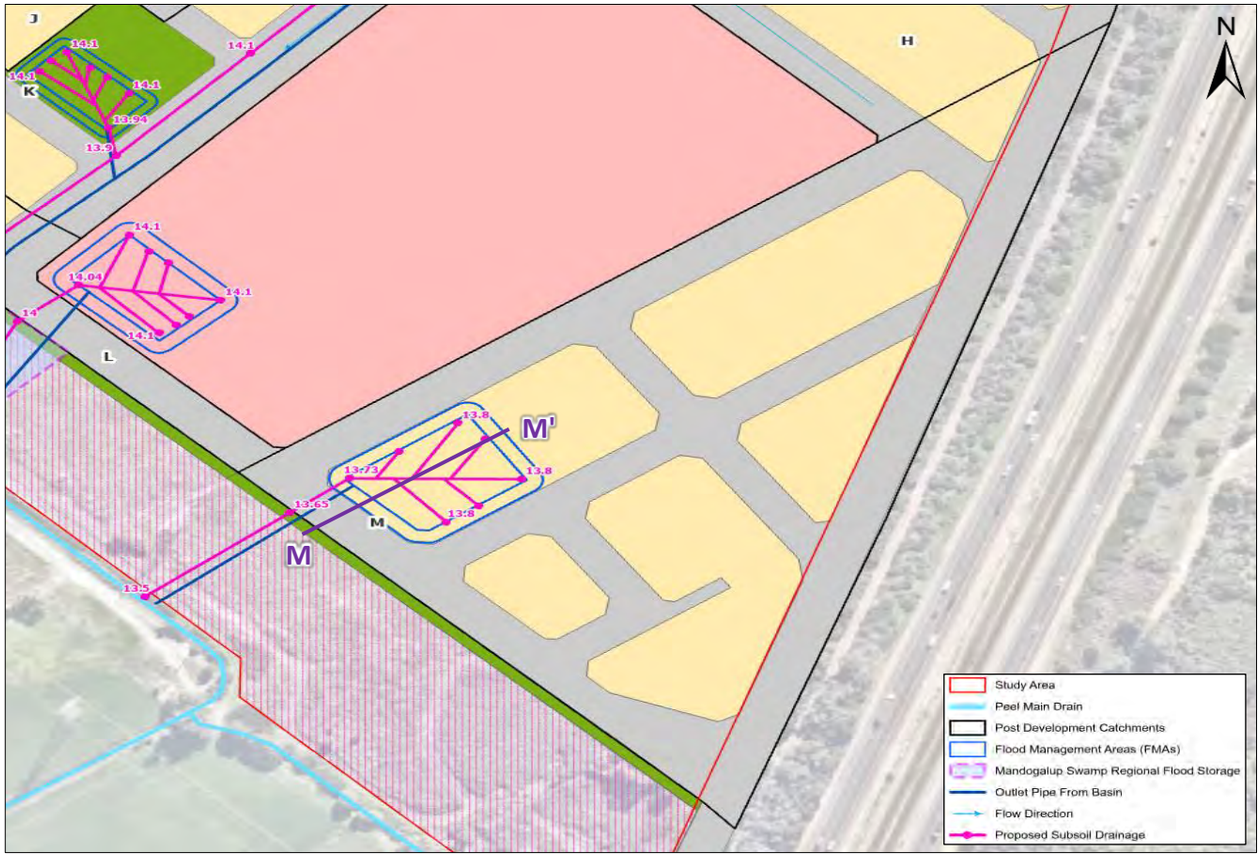
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Florence Estate, Mandogalup – Stages 12 to 19: LWMS
Figure 20: FMA K Concept Cross-Section

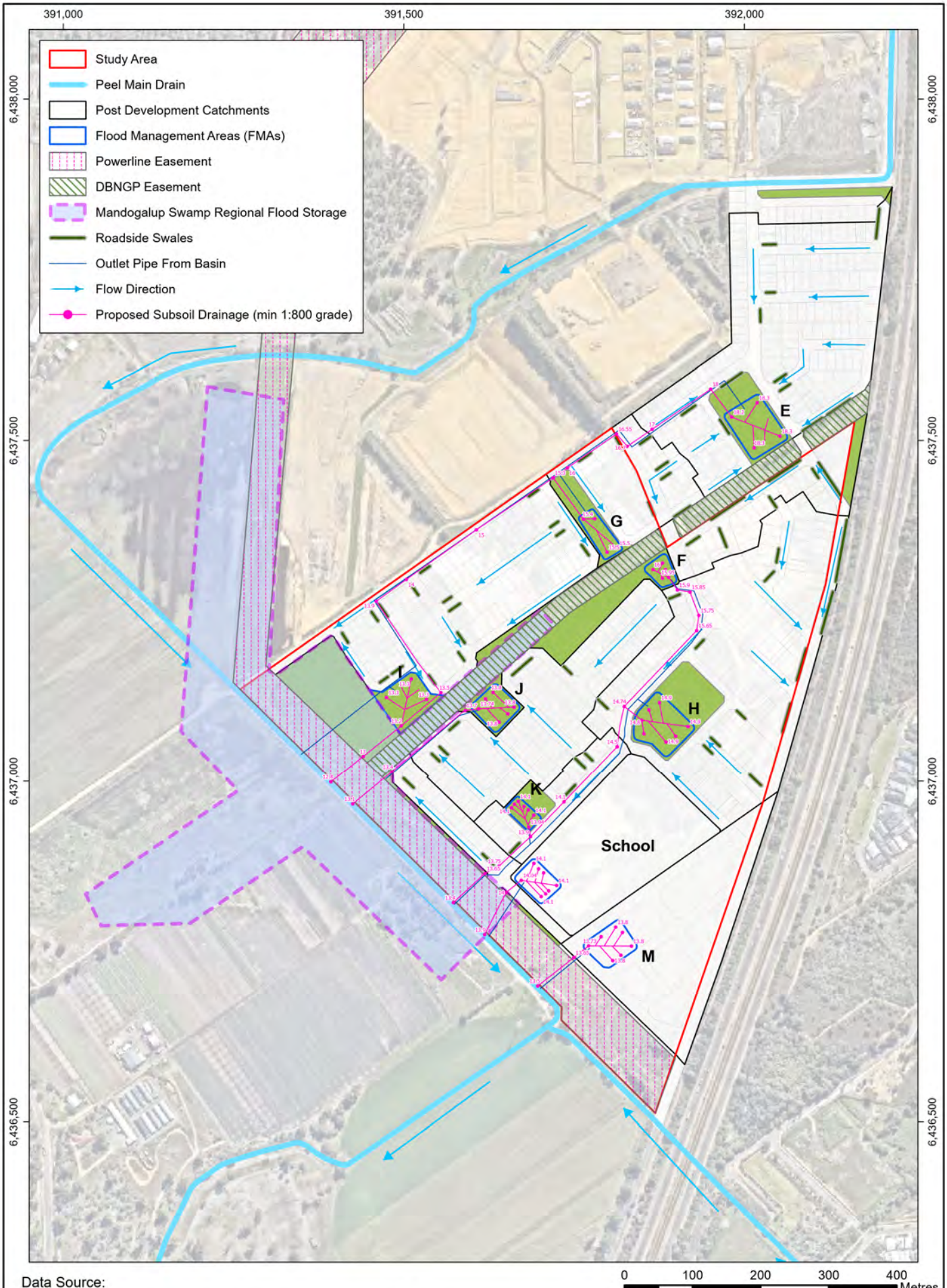
Cross-Section



Note: Drawing not to scale



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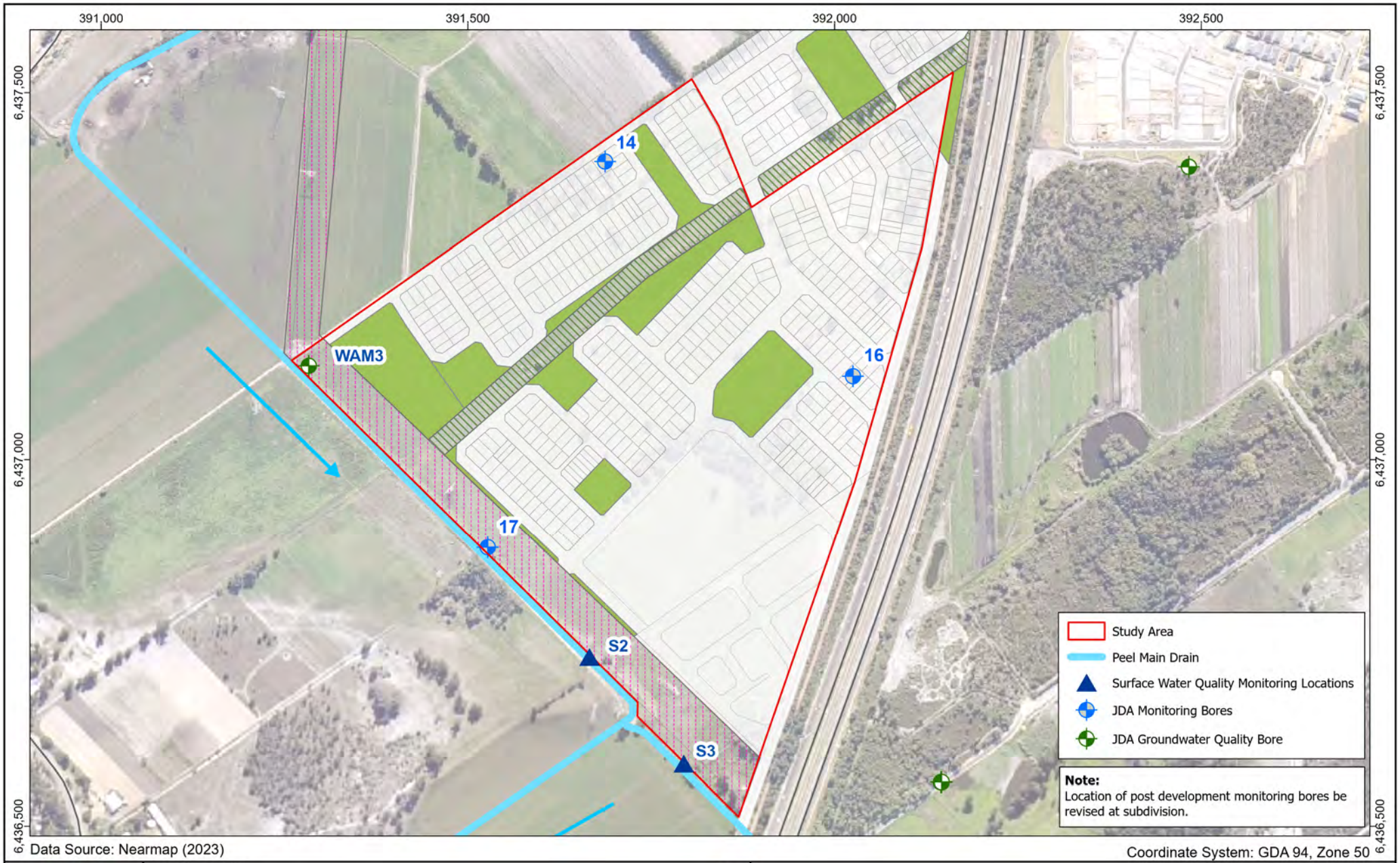
JDA

Job No. J7502
Scale: 1:7,500 @A4
Coordinate System: GDA 1994 MGA Zone 50
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Satterley Property Group
Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 22: Groundwater Management



Data Source: Nearmap (2023)

Coordinate System: GDA 94, Zone 50

JDA

Job No. J7502
Scale: 1:7,000 @A4

0 100 200 300 400 Metres

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Florence Estate, Mandogalup – Stages 12 to 19: LWMS

Figure 23: Post Development Monitoring Locations

APPENDIX A

Local Water Management Strategy:
Checklist for Developers

Local water management strategy item	Deliverable	☑	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: Design elements & requirements for BMPs and critical control points	☑	Page 1- 3
Introduction			
Total water cycle management – principles & objectives Planning background Previous studies		☑	Page 5-9
Proposed development			
Structure plan, zoning and land use. Key landscape features Previous land use	Site context plan Structure plan	☑ ☑	Page 10 Figure 2
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape Plan	☑	Appendix E
Design criteria			
Agreed design objectives and source of objective		☑	Page 2
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	**Page 11**-15
Site Conditions - existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	☑	Page 11 Figure 3
Geotechnical - topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Page 11 Figure 5
Environmental - areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental Plan plus supporting data where appropriate	☑	Page 11 & 15 Figure 5 & 8
Surface Water – topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface Water Plan	☑	Page 14 Figure 7
Groundwater – topography, pre development groundwater levels and water quality, test bore locations	Groundwater Plan plus details of groundwater monitoring and testing	☑	Page 12, 13 Figure 6, Appendix B
Water use sustainability initiatives			
Water efficiency measures – private and public open spaces including method of enforcement		☑	Page 16 & 17
Water supply (fit-for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Page 16
Wastewater management		☑	Page 16
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points,100 year flow paths and 100 year detentions storage areas	100yr event Plan Long section of critical points	☑ N/A	Page 20 Figure 13
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event Plan	☑	Page 20, Figure 12

Local water management strategy item	Deliverable	☑	Comments
Protect ecology – detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1yr event plan Typical cross sections	☑ ☐	Page 19, Figure 11
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoils areas/exclusion zones	Groundwater/subsoil Plan	☑	Page 25, Figure 14
Actions to address acid sulfate soils or contamination		☑	Page 28
The next stage – subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design.		☑	Page 23
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Page 29-30 Figure 14
Implementation			
Developer commitments		☑	Page 27-31
Roles, responsibilities, funding for implementation		☑	Page 27-31
Review		☑	Page 27-31

APPENDIX B

Pre-Development Groundwater Monitoring Data
(JDA, 2007)

EC

Bore	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	0.44	0.30	0.31	1.52	0.30	0.31	0.33	0.27	0.33	0.33	0.43	0.40	1.33	0.39	0.32	0.29	0.3	0.27	0.29	0.27	0.28	1.2	0.51	1.71
WAM1 (d)	1.68	1.56	1.69	0.29	1.59	1.46	1.50	1.55	1.67	1.64	1.47	1.61	0.52	1.43	1.64	1.81	1.74	1.3	1.28	1.7	1.66	2.58	1.89	0.26
WAM2 (s)	1.03	1.05	1.15	0.93	1.07	1.00	1.07	1.15	1.31	1.27	1.13	1.09	0.97	1.10	1.13	1.15	1.08	1	0.95	1.2	1.17	2.09	1.48	1.23
WAM2 (d)	0.94	0.93	0.93	0.70	0.75	0.67	0.51	0.62	0.76	0.77	0.74	0.81	0.74	0.98	0.75	0.95	0.88	0.72	0.79	0.77	0.86	1.57	0.93	0.83
WAM3 (s)	1.80	1.73	1.89	1.33	1.22	1.11	1.22	1.19	1.41	1.37	1.15	1.22	1.08	1.18	1.41	1.77	1.75	1.37	1.25	1.4	1.33	1.5	1.44	
WAM3 (d)	0.63	0.64	0.73	0.56	0.59	0.57	0.59	0.58	0.71	0.69	0.61	0.63	0.62	0.69	0.70	0.71	0.71	0.66	0.62	0.61	0.64	0.14	0.74	
WAM4 (s)	0.28	0.27	0.30	0.23	0.28	0.24	0.24	0.21	0.35	0.47	0.21	0.84	0.19	0.35	0.34	0.33	0.33	0.33	0.31	0.32	0.28	0.89	0.72	0.36
WAM4 (d)	0.74	0.81	0.93	0.77	0.82	0.78	0.81	0.55	0.58	0.87	0.81	0.20	0.78	0.86	0.85	0.40	0.85	0.79	0.75	0.78	0.77	1.36	0.93	0.77

pH

Bore	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	4.68	4.57	4.40	5.61	4.45	4.47	4.91	3.97	4.25	4.30	4.05	4.03	5.00	4.31	4.27	4.73	4.11	4.51	4.37	4.4	4.68	4.75	4.72	5.94
WAM1 (d)	5.70	5.55	5.48	4.66	5.65	5.60	6.15	5.20	5.60	5.25	5.50	5.57	5.02	5.53	5.32	5.53	5.14	5.43	5.24	5.31	5.54	5.39	5.84	4.67
WAM2 (s)	5.27	5.32	5.95	4.85	5.08	4.73	5.85	4.85	5.15	4.90	4.85	5.00	4.92	4.70		4.92	4.58	4.84	5.01	4.5	4.92	4.90	5.23	4.87
WAM2 (d)	5.19	5.21	5.38	5.14	5.17	4.97	6.02	5.11	5.30	4.92	4.62	4.55	4.76	4.97		5.18	4.92	5.1	5.03	4.81	5.24	5.26	5.38	5.01
WAM3 (s)	6.74	6.64	6.20	6.15	6.53	6.82	7.33	6.40	6.93	7.06	6.74	6.13	7.16	6.91		6.67	6.25	6.7	6.53	6.59	6.75	7.27	6.83	
WAM3 (d)	7.21	6.96	6.75	6.82	7.14	6.50	7.91	6.66	6.98	7.23	7.04	6.65	7.42	7.27		7.33	7.07	7.28	7.22	6.95	7.19	6.96	7.37	
WAM4 (s)	3.91	3.77	4.21	3.92	4.18	4.15	4.65	3.70	3.70	3.73	3.70	3.83	4.24	4.05		4.21	3.89	4.22	4.12	3.86	4.39	4.49	3.75	4.01
WAM4 (d)	5.47	5.14	5.59	5.10	5.30	5.42	6.00	4.87	5.10	5.25	5.36	5.34	5.55	5.45		5.47	5.28	5.49	5.22	5.05	5.46	5.14	5.18	5.36

* probe failure

TDS	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	242.00	165.00	170.50	836.00	165.00	170.50	181.50	148.50	181.50	181.50	236.50	220.00	731.50	214.50	176.00	159.50	165	148.5	159.5	148.5	154	660	280.5	940.5
WAM1 (d)	924.00	858.00	929.50	159.50	874.50	803.00	825.00	852.50	918.50	902.00	808.50	885.50	286.00	786.50	902.00	995.50	957	715	704	935	913	1419	1039.5	143
WAM2 (s)	566.50	577.50	632.50	511.50	588.50	550.00	588.50	632.50	720.50	698.50	621.50	599.50	533.50	605.00		632.50	594	550	522.5	660	643.50	1149.50	814.00	676.5
WAM2 (d)	517.00	511.50	511.50	385.00	412.50	368.50	280.50	341.00	418.00	423.50	407.00	445.50	407.00	539.00		522.50	484	396	434.5	423.5	473	863.5	511.5	456.5
WAM3 (s)	990.00	951.50	1039.50	731.50	671.00	610.50	671.00	654.50	775.50	753.50	632.50	671.00	594.00	649.00		973.50	962.5	753.5	687.5	770	731.5	825	792	0
WAM3 (d)	346.50	352.00	401.50	308.00	324.50	313.50	324.50	319.00	390.50	379.50	335.50	346.50	341.00	379.50		390.50	390.5	363	341	335.5	352	77	407	0
WAM4 (s)	154.00	148.50	165.00	126.50	154.00	132.00	132.00	115.50	192.50	258.50	115.50	462.00	104.50	192.50		181.50	181.5	181.5	170.5	176	154	489.5	396	198
WAM4 (d)	407.00	445.50	511.50	423.50	451.00	429.00	445.50	302.50	319.00	478.50	445.50	110.00	429.00	473.00		220.00	467.5	434.5	412.5	429	423.5	748	511.5	423.5

Data Source: JDA(2007)

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Total Kjeldahl Nitrogen_N

LOD [mg/L]																								
	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	5.40	4.40	3.50	3.50	3.50	3.40	3.60	2.70	2.30	2.80	2.40	2.50	2.10	2.4	1.5	3.00	3.40	3.40	3.30	2.30	2.50	2.6	3	2
WAM1 (d)	1.00	1.20	2.10	0.85	1.60	1.80	1.80	1.60	1.30	1.00	1.20	1.30	1.60	1.5	2.7	1.80	1.60	1.60	1.70	1.20	1.70	0.95	1.5	3.7
WAM2 (s)	4.70	0.08	0.09	<0.05	0.25	0.15	30.00	63.00	7.00	8.00	7.00	7.50	22.00	7	1	21.00	7.00	7.00	8.00	5.00	1.00	11	3	0.05
WAM2 (d)	11.00	0.14	0.16	0.06	0.21	0.22	0.61	0.27	0.27	0.23	0.26	0.28	0.45	0.3	0.36	1.90	0.5	0.05	0.28	0.25	0.31	1.4	0.11	1.2
WAM3 (s)	1.30	0.62	1.00	0.96	1.50	1.20	0.78	0.56	0.58	1.04	0.92	1.30	1.20	0.7	1.2	1.50	1.30	0.98	1.20	0.39	1.80	1.8	1.3	
WAM3 (d)	0.44	0.18	0.46	0.08	0.45	0.42	0.62	0.42	0.15	0.28	0.25	0.45	0.42	0.6	0.28	0.65	0.64	0.57	0.61	0.27	0.48	0.47	0.4	
WAM4 (s)	1.60	6.30	6.30	1.40	4.00	4.80	41.00	1.30	4.00	8.00	0.74	1.30	5.50	3.4	3.7	3.80	4.20	3.90	3.90	3.00	4.00	3.3	4.3	5.8
WAM4 (d)	1.90	0.45	1.60	0.47	1.60	1.30	1.40	0.97	0.39	1.40	1.20	6.90	1.40	1.6	1.1	1.80	1.50	1.20	1.00	0.75	1.40	1	1.4	1.6

Total Nitrogen_N

LOD [mg/L]																								
	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	6.90	5.40	4.10	3.60	3.50	3.60	3.70	3.10	2.60	2.90	2.40	2.60	2.10	2.4	1.5	3.10	3.5	3.4	3.3	2.3	2.5	2.6	3.4	2
WAM1 (d)	1.20	1.20	2.20	0.90	1.60	1.90	1.80	1.70	1.40	1.60	1.70	1.60	1.70	1.6	2.8	1.80	1.8	1.6	1.8	1.2	1.9	1.4	1.5	3.7
WAM2 (s)	38.00	32.00	32.00	34.00	34.00	32.00	68.00	100.00	51.00	55.00	49.00	47.00	71.00	49	35	44.00	43	36	33	54	49	65	68	86
WAM2 (d)	33.00	8.00	4.50	2.80	2.90	1.70	0.80	0.40	9.00	1.90	1.00	2.30	0.98	22	1	8.00	11	0.91	4.5	3.8	2.8	14	7.9	7.6
WAM3 (s)	1.80	0.80	1.40	1.20	1.80	1.40	1.10	0.98	1.00	1.30	1.10	1.40	1.20	1.4	1.2	1.50	1.7	1.1	1.4	0.93	1.9	1.8	1.5	
WAM3 (d)	0.60	0.20	0.50	0.20	0.60	0.50	0.60	0.42	0.50	0.43	0.30	0.48	0.45	0.8	0.36	0.66	0.7	0.6	0.75	0.34	0.49	0.47	0.47	
WAM4 (s)	2.20	6.30	6.50	1.40	4.00	4.90	41.00	1.30	4.10	8.00	0.74	1.30	5.50	3.4	3.7	3.80	4.2	3.9	3.9	3	4	3.3	4.3	5.8
WAM4 (d)	2.70	0.50	1.70	0.50	1.70	1.40	1.50	1.00	0.65	1.40	1.00	6.90	1.40	1.6	1.1	1.80	1.5	1.2	1.5	0.92	1.4	1	1.4	1.6

Ammonia_N

LOD [mg/L]																								
Bore	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	0.18	<0.05	0.12	0.07	0.23	0.08	0.61	0.36	0.32	0.34	0.53	0.50	0.49	0.28	0.71	0.27	0.32	0.34	0.41	0.39	0.43	0.41	0.38	0.9
WAM1 (d)	0.93	0.26	0.78	0.22	0.73	0.26	0.80	0.86	0.78	0.32	0.26	0.56	0.80	0.71	0.012	0.78	0.84	0.97	0.85	0.9	0.61	0.57	0.68	0.46
WAM2 (s)	0.08	<0.05	0.09	<0.05	<0.05	<0.05	<0.05	0.02	0.02	0.02	<0.005	<0.005	0.036	<0.005	0.007	0.025	0.005	0.012	0.013	0.08	0.005	0.023	0.016	0.21
WAM2 (d)	0.18	<0.05	<0.05	<0.05	0.06	<0.05	0.08	0.09	0.02	0.01	<0.005	0.007	0.016	<0.005	0.024	0.03	0.024	0.044	0.005	0.005	0.016	0.043	0.017	0.11
WAM3 (s)	<0.05	0.15	0.21	0.26	0.70	0.38	0.26	0.21	0.51	0.54	0.71	0.069	0.73	0.61	0.005	0.38	0.36	0.45	0.23	0.005	0.12	0.072	0.35	
WAM3 (d)	0.40	0.09	0.18	<0.05	0.20	0.08	0.32	0.33	0.14	0.06	0.24	0.23	0.23	0.25	0.005	0.35	0.36	0.41	0.28	0.19	0.22	0.2	0.22	
WAM4 (s)	0.06	0.15	0.10	0.11	<0.05	0.20	0.14	0.09	<.005	<0.005	<0.005	0.47	<0.005	<0.005	0.3	0.05	0.1	0.11	0.062	0.056	0.06	0.11	0.078	0.17
WAM4 (d)	0.38	0.12	0.25	0.14	0.31	0.06	0.45	0.38	0.02	0.46	0.48	<0.005	0.49	0.48	0.14	0.49	0.52	0.47	0.007	0.057	0.45	0.45	0.55	0.58

Nitrate/Nitrite (NOx)_N

LOD [mg/L]																								
Bore	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	1.56	0.97	0.59	0.09	<0.05	0.18	0.07	0.36	0.29	0.01	<0.005	0.012	<0.005	0.061	0.053	0.530	0.041	0.005	0.005	0.005	0.005	0.021	0.38	0.005
WAM1 (d)	0.20	<0.05	0.07	<0.05	<0.05	0.09	<0.05	0.09	0.07	0.55	0.46	0.23	0.016	0.057	0.16	0.013	0.017	0.005	0.11	0.045	0.22	0.44	0.045	0.005
WAM2 (s)	34.00	32.00	32.00	34.00	34.00	32.00	38.00	41.00	44.00	47.00	42.00	40.00	49.00	42	34	23.000	36	29	25	49	48	54	65	86
WAM2 (d)	22.00	7.90	4.30	2.70	2.70	1.50	0.23	0.13	8.70	1.70	0.70	2.00	0.53	22	0.65	6.100	11	1.2	4.2	3.5	2.5	13	7.7	6.4
WAM3 (s)	0.45	0.14	0.35	0.25	0.29	0.16	0.32	0.42	0.42	0.21	0.14	0.085	0.066	0.74	0.027	0.005	0.34	0.11	0.23	0.54	0.06	0.17	0.28	
WAM3 (d)	0.11	<0.05	0.07	0.09	0.11	0.09	<0.05	<0.005	0.35	0.15	0.05	0.027	0.032	0.17	0.081	0.009	0.06	0.029	0.14	0.066	0.009	0.057	0.07	
WAM4 (s)	0.61	<0.05	0.18	<0.05	<0.05	0.07	0.07	<0.005	0.01	<0.005	<0.005	0.008	<0.005	0.005	0.005	0.005	0.005	<0.005	0.005	0.006	0.005	<0.005	0.005	0.008
WAM4 (d)	0.81	<0.05	0.07	<0.05	0.07	0.07	0.09	0.03	0.26	0.02	<0.005	<0.005	<0.005	0.037	0.025	0.005	0.007	<0.005	0.46	0.17	0.014	0.044	0.005	0.032

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Filterable Reactive Phosphorus_P (PO4_P

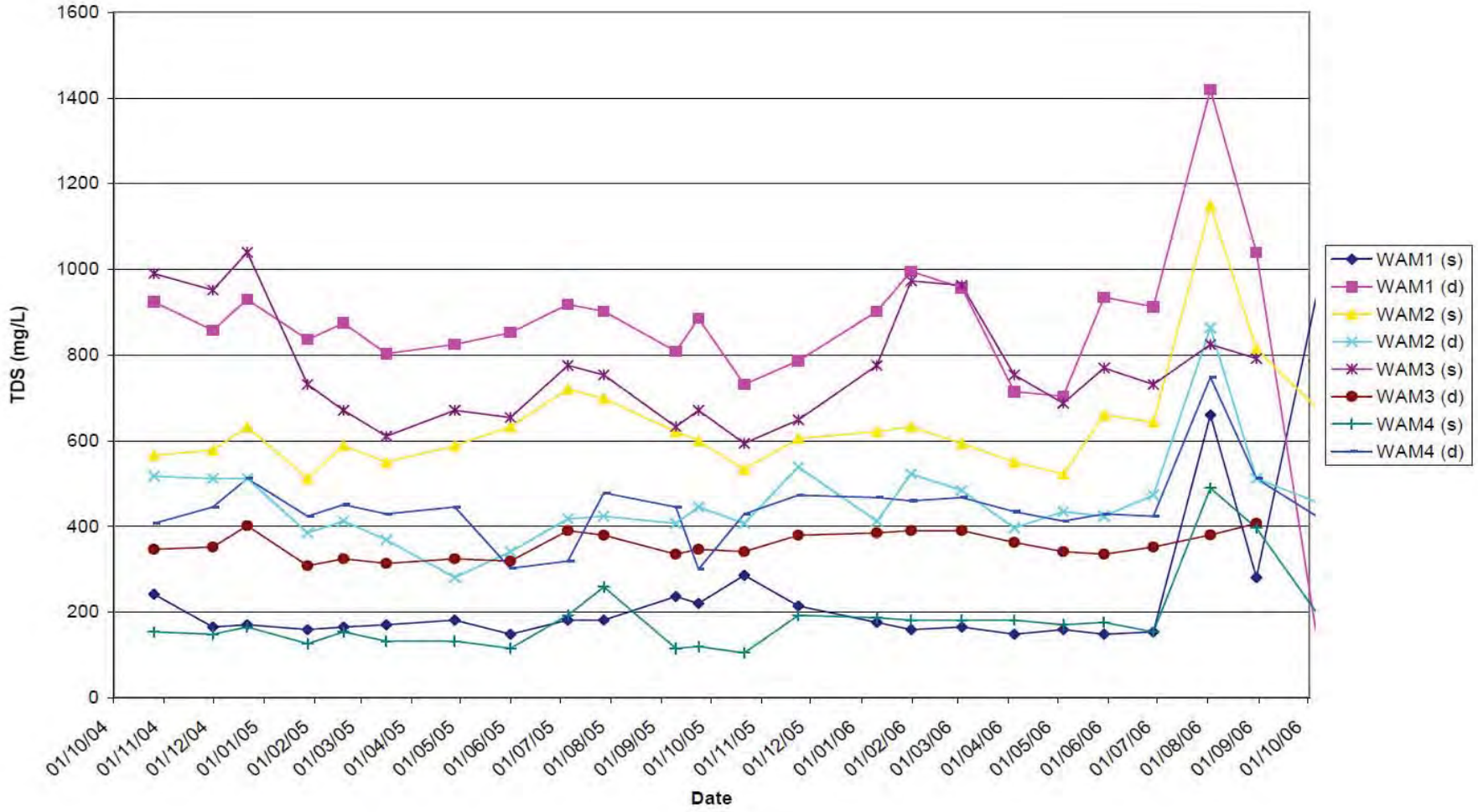
LOD [mg/L]																								
Bore	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2006	2/08/2006	30/08/2006	6/10/2006
WAM1 (s)	0.05	0.03	0.05	0.04	0.03	0.04	0.04	0.04	0.02	0.03	0.02	0.021	0.020	0.02	0.005	0.039	0.047	0.044	0.047	0.062	0.035	0.059	0.031	0.006
WAM1 (d)	<0.01	0.02	0.02	0.02	0.03	0.02	0.03	0.03	0.02	0.05	<0.002	0.014	0.021	0.02	0.005	0.02	0.019	0.021	0.021	0.018	0.005	0.005	0.02	0.033
WAM2 (s)	0.01	<0.01	0.02	0.02	<0.01	<0.01	0.01	0.01	0.00	0.01	<0.002	<0.002	0.006	<0.01	0.006	0.005	<0.005	<0.005	0.005	0.005	0.005	0.005	0.006	0.005
WAM2 (d)	0.20	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01	0.01	0.00	<0.002	<0.002	0.005	<0.01	0.005	0.005	<0.005	<0.005	0.006	0.005	0.005	0.005	0.006	0.005
WAM3 (s)	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	0.01	0.00	0.00	<0.002	<0.002	0.006	<0.01	0.005	0.005	<0.005	<0.005	0.005	0.005	0.005	0.005	0.006	
WAM3 (d)	0.04	0.09	0.09	0.08	0.09	0.03	0.08	0.04	0.05	0.04	0.04	0.052	0.054	0.06	0.075	0.06	0.074	0.053	0.028	0.068	0.06	0.042	0.056	
WAM4 (s)	1.50	0.91	1.00	1.40	3.30	0.38	3.60	4.40	1.20	3.20	2.60	0.009	3.700	3.4	0.005	3.2	3.2	3.3	3.4	3.3	3.7	3.5	4.6	3.3
WAM4 (d)	0.04	0.04	0.01	0.02	0.03	0.02	0.02	0.30	0.60	0.04	0.02	2.00	0.031	0.04	0.005	0.038	0.054	0.035	0.061	0.074	0.015	0.035	0.04	0.022

Total Phosphorus_P

LOD [mg/L]																								
Bore	25/10/04	30/11/04	21/12/04	27/01/05	18/02/05	16/03/05	27/04/05	31/05/05	05/07/05	27/07/05	09/09/05	23/09/05	21/10/05	23/11/05	10/01/06	31/01/06	03/03/06	04/04/06	04/05/06	29/05/06	28/06/06	02/08/06	30/08/06	06/10/06
WAM1 (s)	0.08	0.04	0.05	0.05	0.05	0.05	0.04	0.05	0.15	0.12	0.03	0.02	0.05	0.02	0.05	0.05	0.06	0.05	0.05	0.07	0.03	0.06	0.04	0.09
WAM1 (d)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.11	0.16	<0.01	0.02	0.05	0.02	0.07	0.02	0.04	0.03	0.03	0.02	0.02	0.03	0.03	0.1
WAM2 (s)	0.02	<0.01	0.02	0.01	<0.01	<0.01	0.02	0.01	0.10	0.10	<0.01	<0.01	0.05	0.02	0.16	0.02	0.02	0.01	0.03	0.01	0.01	0.01	0.02	0.08
WAM2 (d)	0.05	<0.01	<0.01	0.02	0.01	0.01	0.03	0.03	0.11	0.81	0.01	<0.01	0.07	0.01	0.04	0.04	0.03	0.01	0.03	0.01	0.02	0.03	0.02	0.08
WAM3 (s)	<0.01	0.05	0.01	0.06	0.05	0.03	0.01	0.01	0.10	0.19	<0.01	<0.01	0.06	<0.01	0.04	0.02	0.02	0.02	0.03	0.01	0.01	0.04	0.02	
WAM3 (d)	0.10	0.10	0.11	0.08	0.09	0.12	0.09	0.10	0.16	0.18	0.07	0.06	0.07	0.27	0.11	0.12	0.09	0.1	0.07	0.12	0.21	0.14	0.08	
WAM4 (s)	3.80	4.40	1.20	3.90	3.50	0.40	3.70	4.90	1.40	4.70	3.00	0.01	4.00	3.8	2.7	3.3	3.4	5.6	3.4	3.7	4	4.3	5.1	0.09
WAM4 (d)	0.09	0.05	0.05	0.03	0.05	0.03	0.03	0.22	0.62	0.22	0.02	2.20	0.16	0.24	0.05	0.05	0.06	0.03	0.06	0.1	0.03	0.06	0.05	0.09

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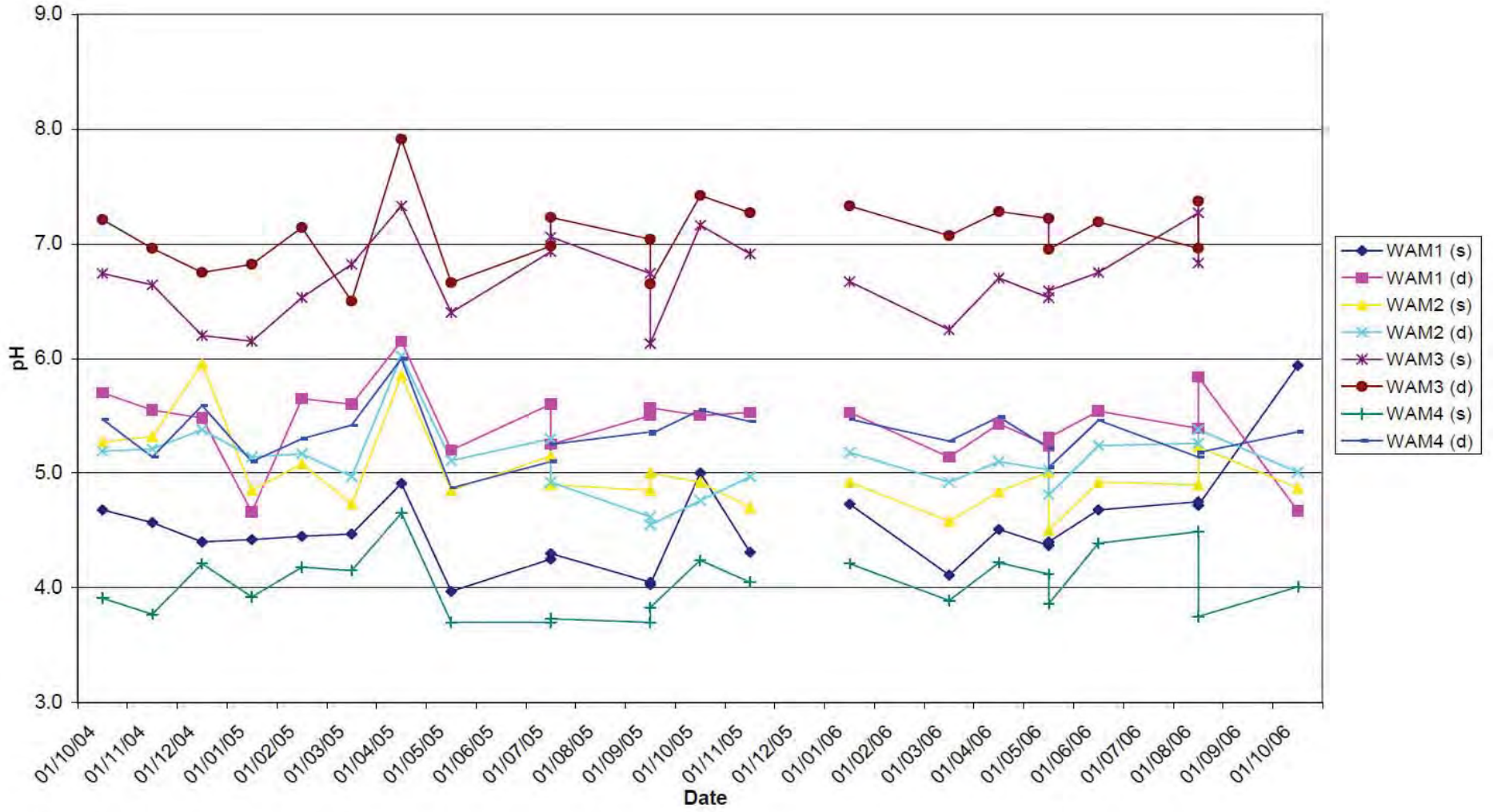


Data Source: JDA(2007)

Job No. J5483

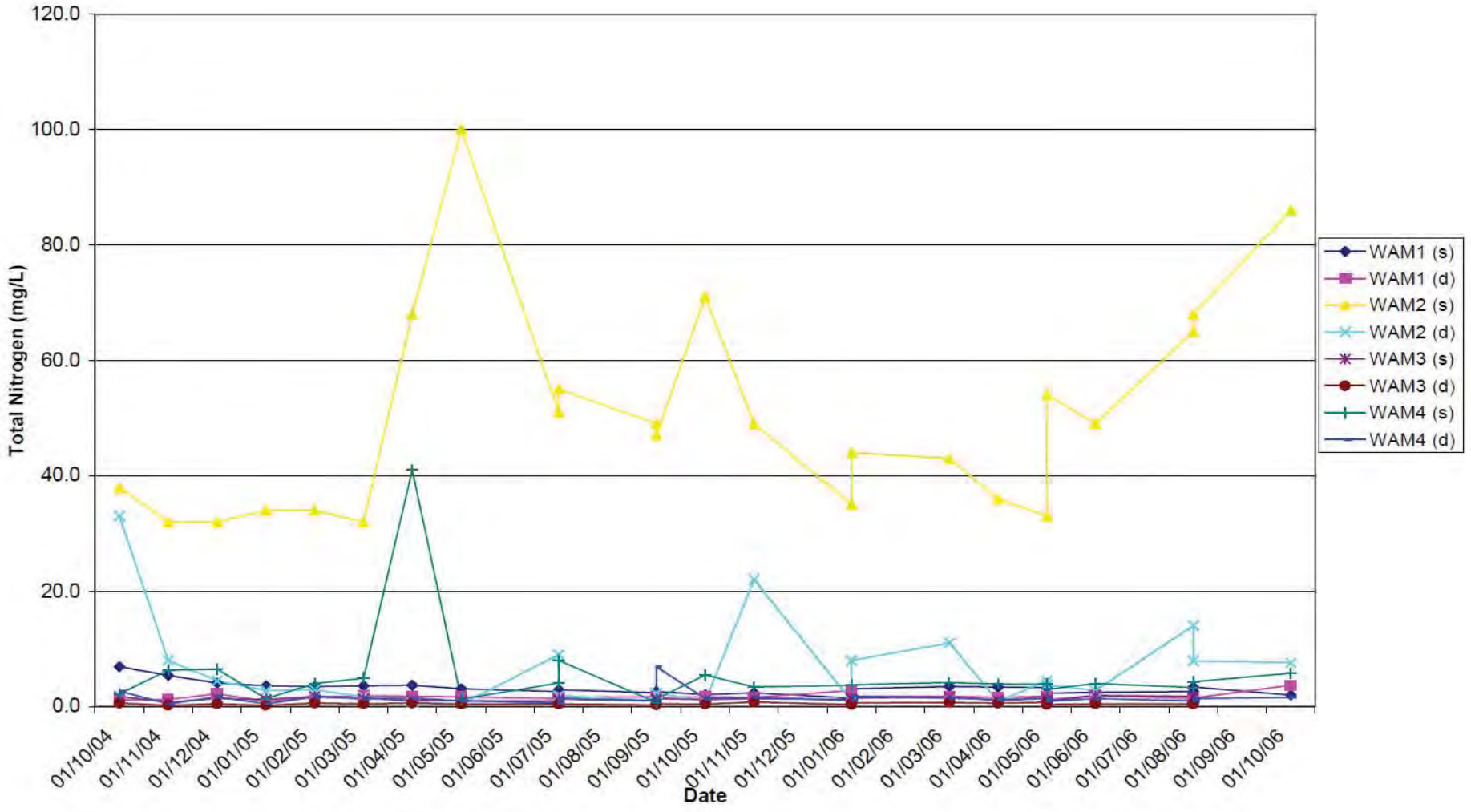
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Appendix D4: Groundwater Monitoring Data



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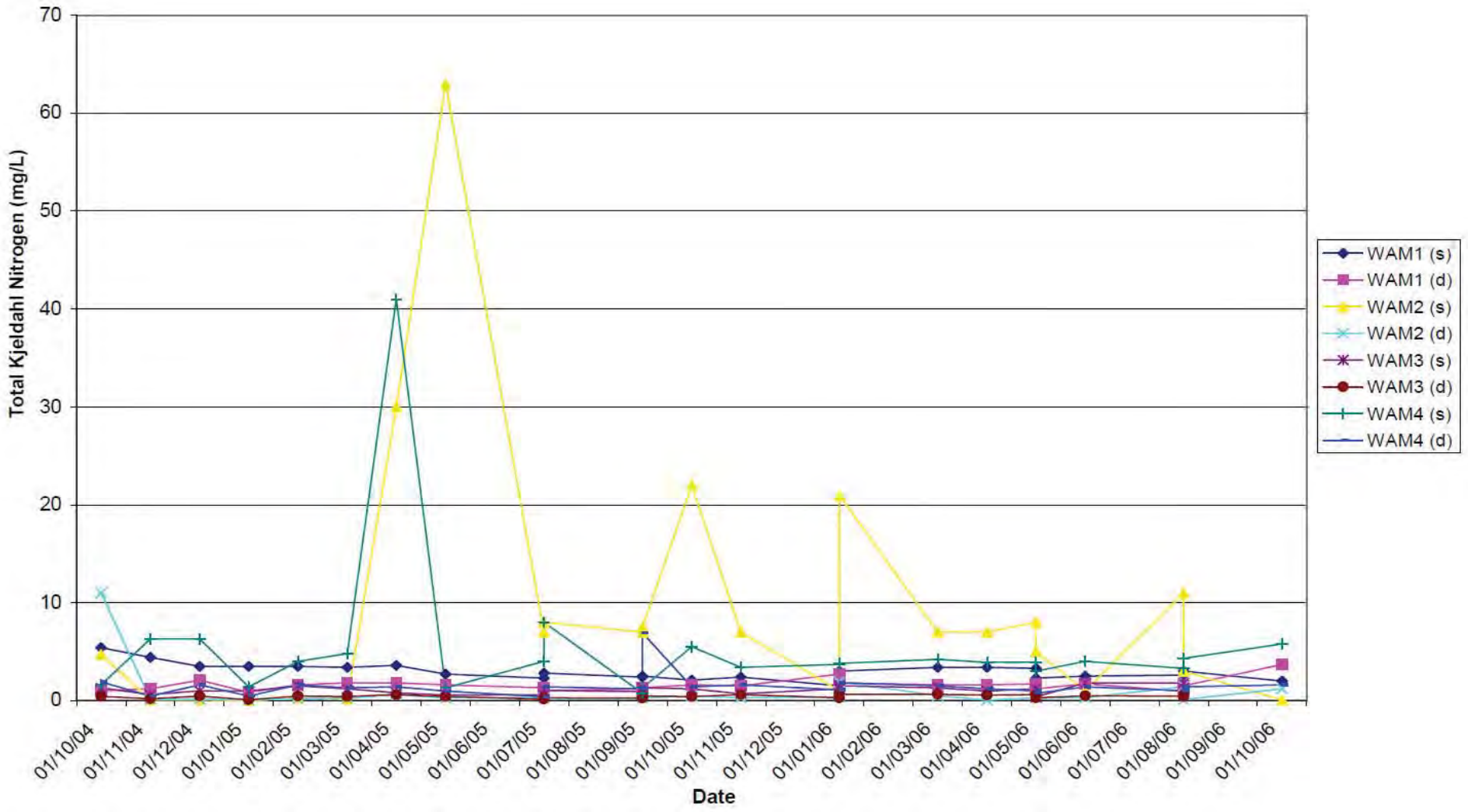


Data Source: JDA(2007)

Job No. J5483

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Mandogalup East LWMS
Appendix D6: Groundwater Monitoring Data

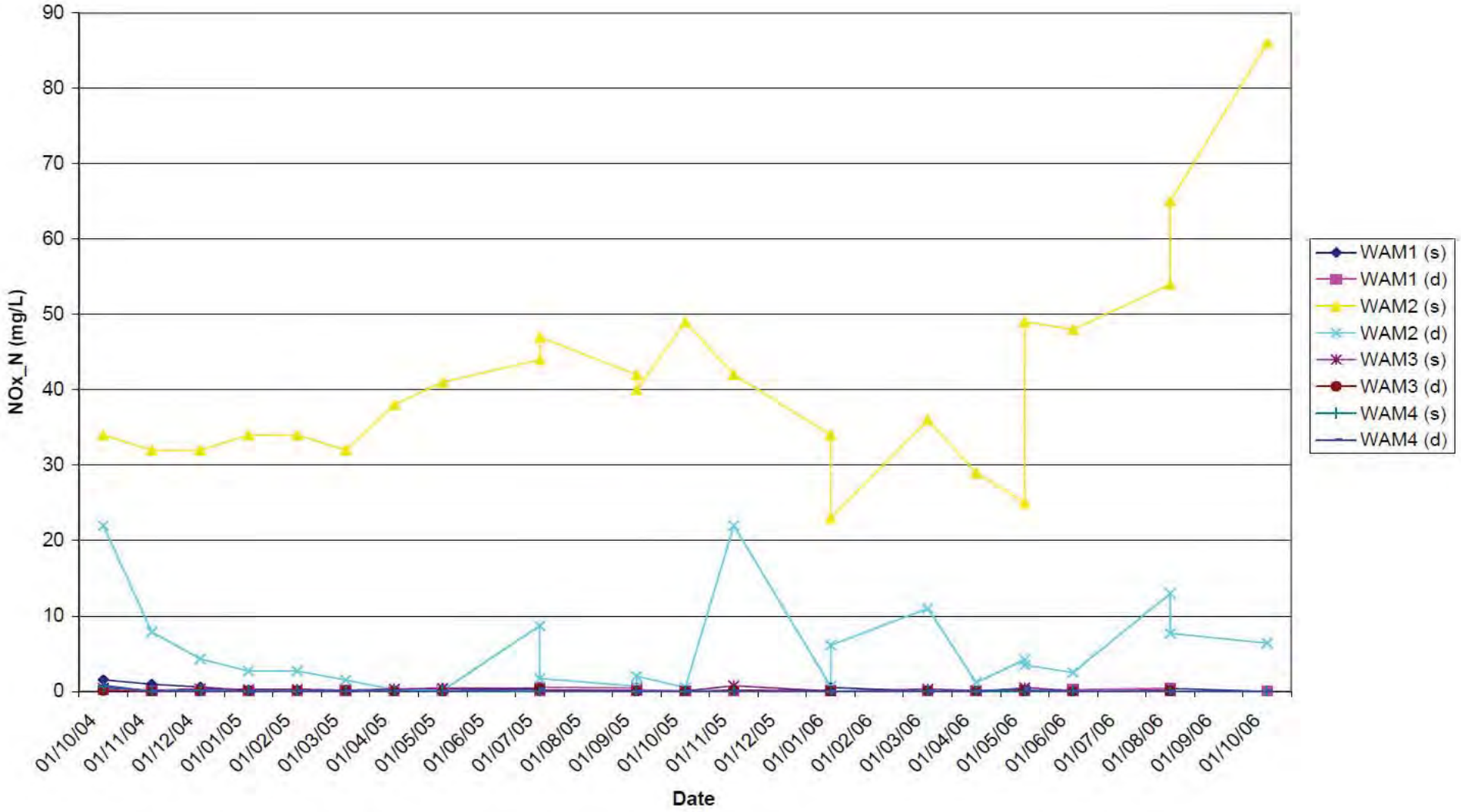


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Mandogalup East LWMS
AppendixD7: Groundwater Monitoring Data

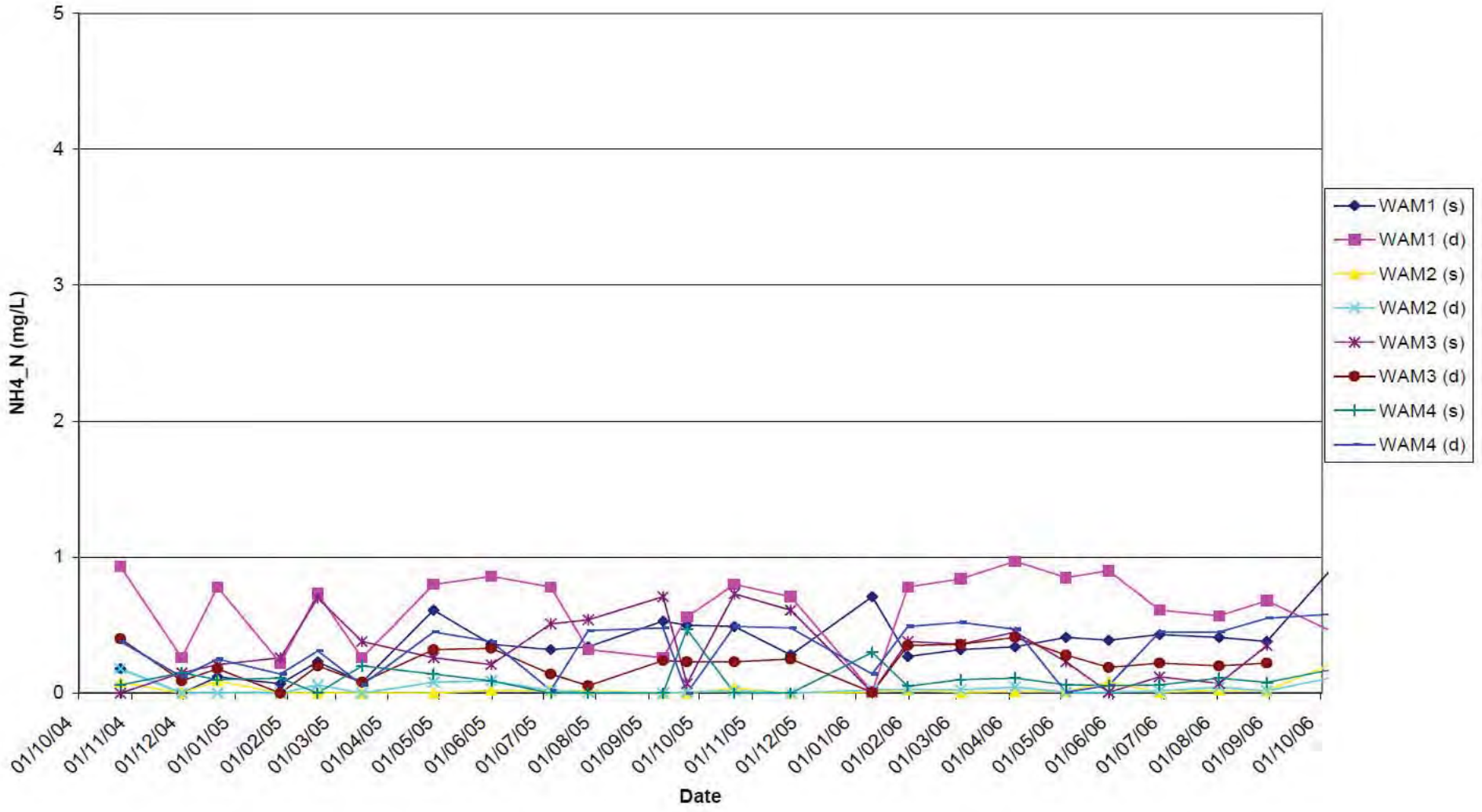


Data Source: JDA(2007)

Job No. J5483

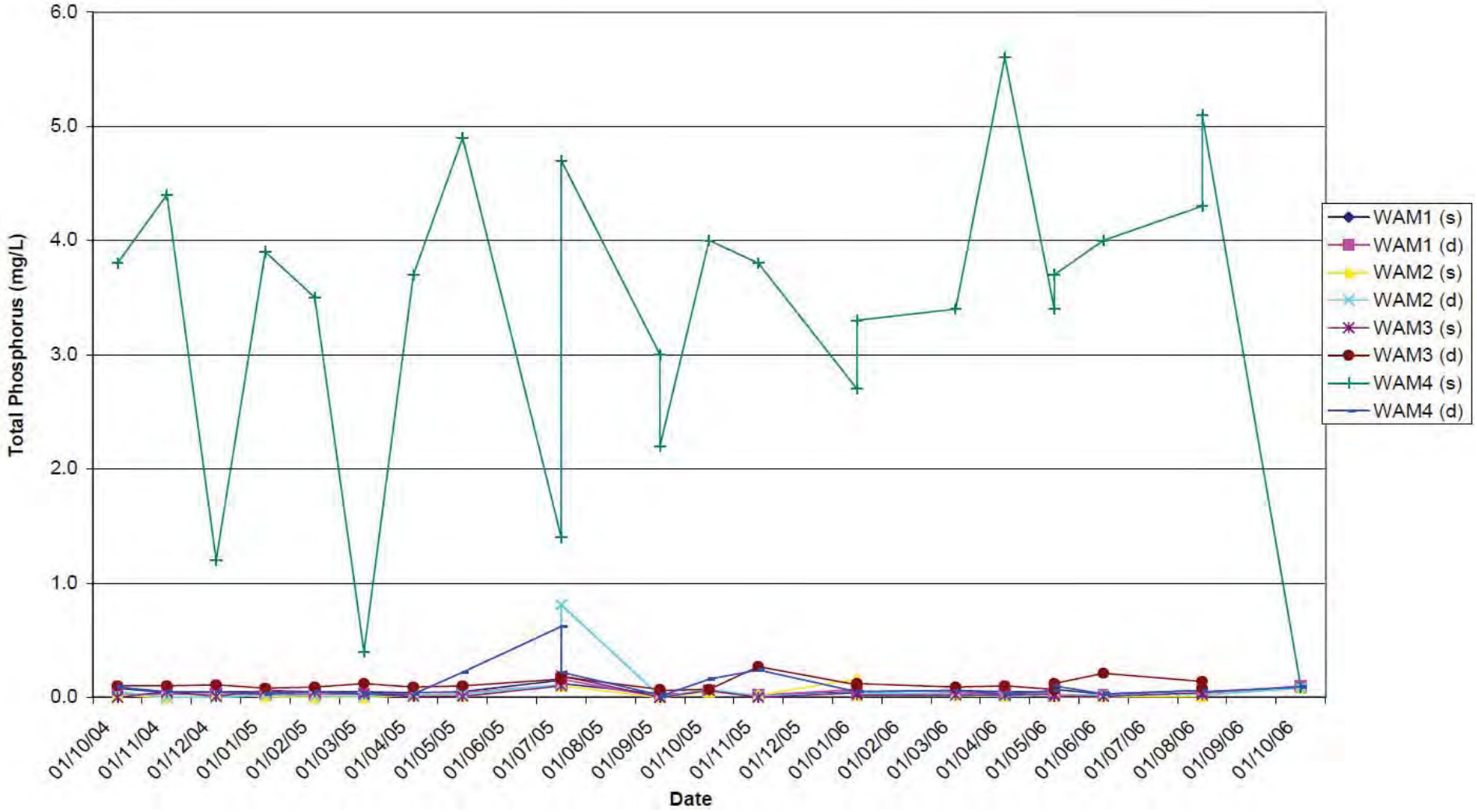
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Mandogalup East LWMS
Appendix D8: Groundwater Monitoring Data



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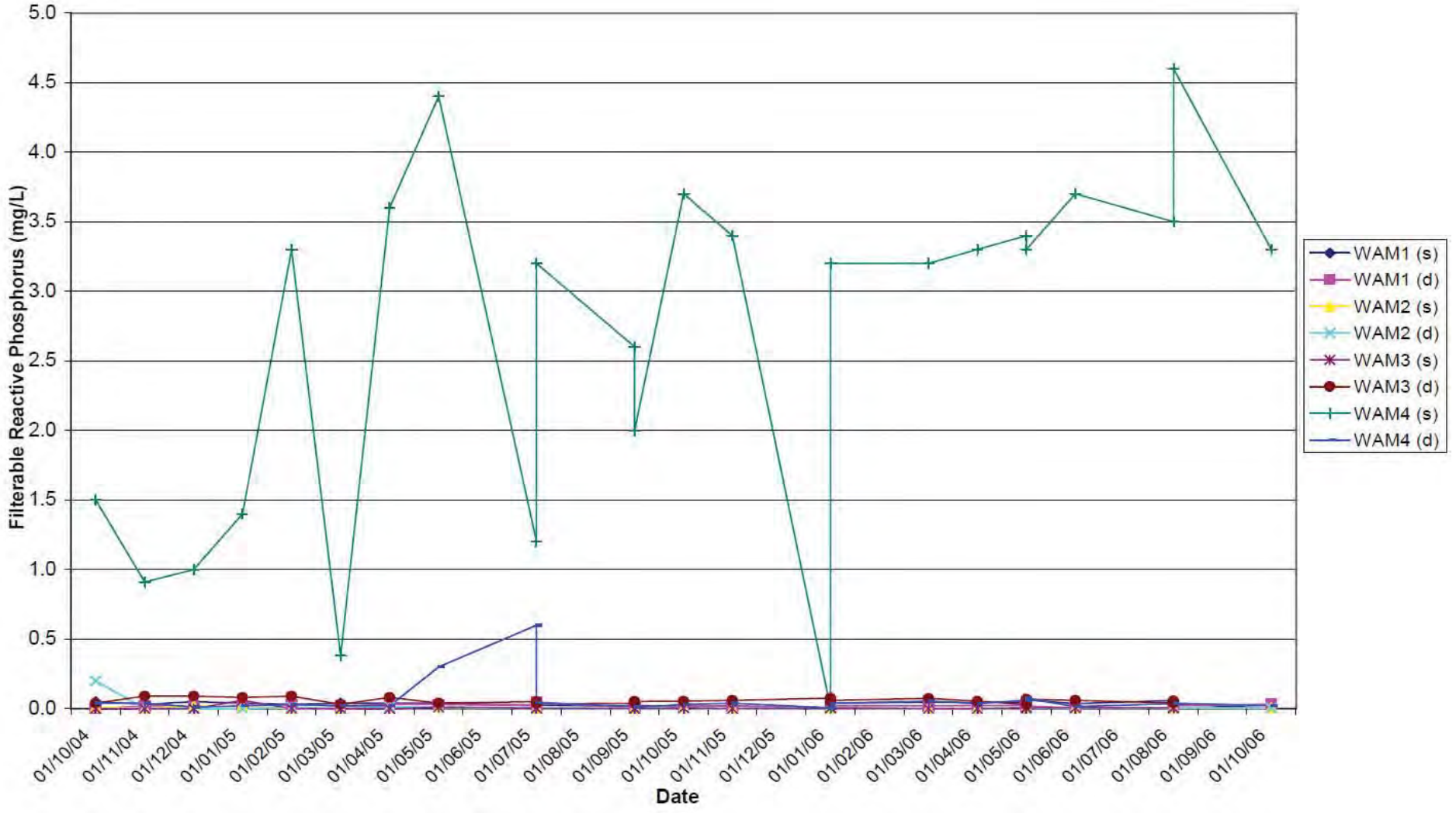


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Mandogalup East LWMS
Appendix D10: Groundwater Monitoring Data



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Appendix D11: Groundwater Monitoring Data

APPENDIX C

Pre-Development Surface Water Monitoring Data
(JDA, 2007)

No flow

Flow [L/s]

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/05	10/01/06	31/01/06	3/03/06	4/04/06	4/05/06	29/05/06	28/06/05	2/08/06	30/08/2006	6/10/2006
Surface Drain 1									20	5	10	50	3	2										
Surface Drain 2									100	40	50	80	10											
Surface Drain 3	8	2	2	2	4	3	2	8	40	20	35	80	15	5	2	2	1	2	3	6	6	5	8	NM

EC

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									1.00	0.92	0.89	0.81	0.63	0.62										
Surface Drain 2									1.56	1.57	1.27	1.22	0.81											
Surface Drain 3	0.38	0.3	0.3	0.33	0.30	0.30	0.27	0.31	0.70	0.66	0.56	0.63	0.43	0.41	0.34	0.38	0.44	0.42	0.27	0.27	0.32	1.45	0.47	

pH

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									5.99	5.80	5.28	5.49	5.55	5.45										
Surface Drain 2									6.95	7.15	6.91	6.51	6.60											
Surface Drain 3	6.72	6.77	6.75	6.75	6.78	6.59	7.74	6.65	7.18	7.15	6.98	6.50	6.85	6.65	0.00	6.76	6.46	6.85	6.68	6.16	6.72	6.60	6.20	

probe failure

TKN

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									1.70	2.60	2.10	2.40	2.10	2.40										
Surface Drain 2									0.90	3.60	2.70	2.90	2.20											
Surface Drain 3	0.81	0.32	0.62	1.10	1.60	1.80	0.57	0.43	0.82	1.30	1.10	1.30	0.83	0.80	0.52	0.73	0.76	0.53	0.46	0.26	0.71	1.10	0.70	

TN

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									1.90	2.70	2.20	2.50	2.10	2.4										
Surface Drain 2									7.80	8.90	5.00	5.10	2.30											
Surface Drain 3	1.30	0.30	1.10	1.10	1.60	2.10	0.60	0.88	1.40	1.70	1.30	1.50	0.94	0.8	0.54	0.74	0.780	0.530	0.62	0.53	1.20	1.10	1.00	

NH4_N

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									0.057	0.079	0.009	0.018	<0.005	<0.005										
Surface Drain 2									0.25	0.38	0.16	0.17	0.15											
Surface Drain 3	0.05	<0.05	<0.05	<0.05	0.08	0.07	<0.05	0.06	0.049	0.041	0.01	0.011	0.022	0.009	0.15	0.11	0.039	0.017	0.013	0.02	0.04	0.10	0.10	

NOx_N

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									0.11	0.10	0.04	0.054	0.02	0.005										
Surface Drain 2									6.90	5.30	2.30	2.20	0.12											
Surface Drain 3	0.47	<0.05	0.47	<0.05	<0.05	0.18	0.07	0.36	0.62	0.48	0.20	0.17	0.01	0.046	0.02	0.01	0.025	0.005	0.16	0.27	0.48	0.53	0.30	

FRP (PO4_P)

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									0.25	0.32	0.20	0.20	0.25	0.34										
Surface Drain 2									0.05	0.68	0.59	0.68	0.76											
Surface Drain 3	0.11	0.10	0.11	0.49	0.22	0.13	0.12	0.10	0.30	0.34	0.28	0.27	0.20	0.22	0.02	0.18	0.08	0.12	0.08	0.12	0.13	0.08	0.13	

TP

	25/10/2004	30/11/2004	21/12/2004	27/01/2005	18/02/2005	16/03/2005	27/04/2005	31/05/2005	5/07/2005	27/07/2005	9/09/2005	23/09/2005	21/10/2005	23/11/2005	10/01/2006	31/01/2006	3/03/2006	4/04/2006	4/05/2006	29/05/2006	28/06/2005	2/08/2006	30/08/2006	6/10/2006
Surface Drain 1									0.28	0.45	0.27	0.22	0.40	0.40										
Surface Drain 2									0.56	1.20	0.73	0.90	1.30											
Surface Drain 3	0.15	0.14	0.15	0.65	0.26	0.42	0.16	0.13	0.34	0.48	0.31	0.27	0.88	0.67	0.31	0.23	0.11	0.14	0.09	0.19	0.20	0.26	0.16	

Data Source: JDA(2007)

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APPENDIX D

Licence to Take Water GWL169930

Government of **Western Australia**
Department of **Water and Environmental Regulation**

LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

Licensee(s)	Satterley Property Group Pty Ltd		
Description of Water Resource	Jandakot Perth - Superficial Swan	**Annual Water Entitlement**	119,650kL
Location of Water Source	Lot 9006 On Plan 70124 - Volume/Folio 2769/846 - Lot 9006 Hoffman Rd Mandogalup LOT 9057 ON PLAN 423167 - Volume/Folio 4041/414 - Lot 9057		

Authorised Activities	**Taking of water for**	**Location of Activity**
	Earthwork and construction purposes	Lot 9002 On Plan 69132 - Volume/Folio 2758/177 - Lot 9002 Hoffman Rd Mandogalup Lot 9006 On Plan 70124 - Volume/Folio 2769/846 - Lot 9006 Hoffman Rd Mandogalup LOT 9057 ON PLAN 423167 - Volume/Folio 4041/414 - Lot 9057
	Irrigation of up to 2.5 ha of public open space	Lot 9006 On Plan 70124 - Volume/Folio 2769/846 - Lot 9006 Hoffman Rd Mandogalup
	Irrigation of up to 3 ha of public open space	Lot 9002 On Plan 69132 - Volume/Folio 2758/177 - Lot 9002 Hoffman Rd Mandogalup
	Irrigation of up to 3.45 ha of public open space	LOT 9057 ON PLAN 423167 - Volume/Folio 4041/414 - Lot 9057
Duration of Licence	From 16 February 2024 to 16 February 2034	

This Licence is subject to the following terms, conditions and restrictions:

1. The annual water year for water taken under this licence is defined as 1 June to 31 May.

2. The licensee shall not use water for public open space between 9 am and 6 pm except for the establishment of newly planted areas. For newly planted areas water may be used within these hours for a period of up to 28 consecutive days, commencing from the date of planting.

3. Between 1 June and 31 August in any year, the licence-holder must not water a lawn, garden, or grass-covered area ("turf") by reticulation, provided always that this restriction shall not apply to watering with a hand held hose; or watering, by way of reticulation: newly planted areas for a period of up to 28 days from the date of planting; for renovating turf; or for maintenance of reticulation systems.

4. The licensee must not, in any water year, take more water than the annual water entitlement specified in this licence.

End of terms, conditions and restrictions

APPENDIX E

Concept Landscape Plan

LEGEND

- EXTENT OF WORKS BOUNDARY
- FOOTPATH NETWORK
- OPEN TURF AREA
- NATIVE PLANTING
- SHELTER AND PICNIC AREA
- PLAYGROUND
- RETAINED TREES
- PROPOSED TREES
- STREET TREES
- INDICATIVE FLOOD STORAGE AREA IN POS
- CONVEYANCE SWALE
- MANDOGALUP SWAMP REGIONAL FLOOD STORAGE AREA



FLORENCE SOUTH, MANDOGALUP
LANDSCAPE MASTERPLAN

DWG **MA-22-01**
REV **B**
DATE **28.05.24**
0 20 40 60 80 100 m
SCALE **1 : 4000 @ A3**

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SYMBOL KEY

- PLAYGROUND
- DRINK FOUNTAIN
- BBQ
- PICNIC SETTING
- RETAINED VEGETATION
- SHELTER
- LOOKOUT
- WALKING TRAIL
- PASSIVE RECREATION
- SWALE / BASIN

PREVIOUSLY APPROVED STRUCTURE PLAN AREA

PEEL MAIN DRAIN

KWINANA FREEWAY

POS 2

POS 10

DBNGP EASEMENT

POS 9

REGIONAL FLOOD STORAGE AREA

POS 13

POS 12

POS 1

POS 11

INDICATIVE FUTURE SCHOOL SITE (SUBJECT TO FURTHER INVESTIGATION)

WESTERN POWER EASEMENT

WESTERN POWER EASEMENT LANDSCAPED AND MAINTAINED TO A PERMANENT LOW THREAT STATE

FLORENCE SOUTH, MANDOGALUP

SPATIAL AMENITY PLAN

DWG MA-22 -02
REV B
DATE 28.05.24

0 20 40 60 80 100 m

SCALE 1 : 4000 @ A3

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LEGEND

STREET TREES



Liquidambar styraciflua
Sweetgum

Eucalyptus torquata
Coral Gum



Eucalyptus sideroxylon rosea
Ironbark

Melaleuca leucadendra
Weeping Paperbark



Eucalyptus victrix
Little Ghost Gum

Melaleuca preissiana
Stout Paperbark



Melaleuca quinquenervia
Broad-leaved Paperbark

Cupaniopsis anarcardioides
Tuckeroo



Melaleuca viridiflora
Broad-leaved Paperbark



FLORENCE SOUTH, MANDOGALUP

STREET TREE MASTERPLAN

DWG **MA-22-03**
REV **B**
DATE **28.05.24**

0 20 40 60 80 100 m

SCALE **1 : 4000 @ A3**

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DBNGP EASEMENT

POS TYPOLOGY

- DBNGP Easement POS

SIZE

- 2.06ha m2 + verge.

DRAINAGE CONSIDERATION

- Swale for conveyance of minor and major stormwater discharge to Regional Flood Storage Area.

CONCEPT & FUNCTION

The DBNGP Easement POS landscape is designed to deliver:

- Passive and active recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Seating areas for rest and recuperation
- Open turf areas for informal sport activities
- Native, waterwise planting
- Clear and easy maintenance access for gas utility providers across entire easement.

** DBNGP Easement POS landscape design to be in accordance with DBNGP land use requirements.







FLORENCE SOUTH, MANDOGALUP

DBNGP EASEMENT POS LANDSCAPE CONCEPT

DWG **MA-22-04**
REV **B**
DATE **28.05.24**
SCALE **1 : 2000 @ A3**
0 10 20 30 40 50 m

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KEY PLAN













POS 1

FLOOD MANAGEMENT AREA H

POS TYPOLOGY

- Neighbourhood POS

SIZE

- 1.12ha + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1800m3

Major Event 1% AEP

TWL Area: 5000m^2

Volume: 4600m3

CONCEPT & FUNCTION

The POS 1 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas in selected locations throughout the POS
- Shelter and picnic node
- Large playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Open lawn/ kick-about space
- Native, water wise planting
- Drainage basin for stormwater management

FLORENCE SOUTH, MANDOGALUP

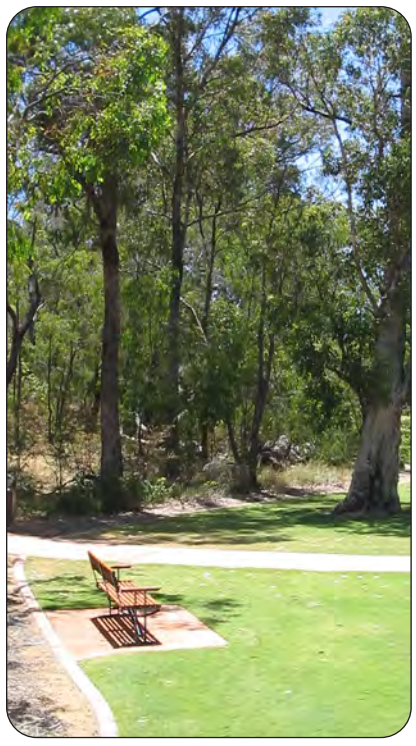
POS 1 LANDSCAPE CONCEPT

DWG **MA-22-05**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
0 5 10 15 20 25 m

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POS 2

FLOOD MANAGEMENT AREA E

POS TYPOLOGY
- Neighbourhood POS

SIZE
- 8507m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales

Minor Event 20% AEP

TWL Area: 4000m^2

Volume: 1350m3

Major Event 1% AEP

TWL Area: 4900m^2

Volume: 3900m3

CONCEPT & FUNCTION

The POS 2 landscape proposals will deliver the following:

- Active and passive recreation opportunities
- Retention of existing melaleuca trees and understorey vegetation for shade and biodiversity, incorporated into drainage where appropriate.
- Shaded seating areas in selected locations throughout the POS
- Shelter structures with bbq and picnic facilities
- Playground with shade sails
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



Fflorence south, mandogalup

POS 2 LANDSCAPE CONCEPT

DWG **MA-22-06**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
0 5 10 15 20 25 m

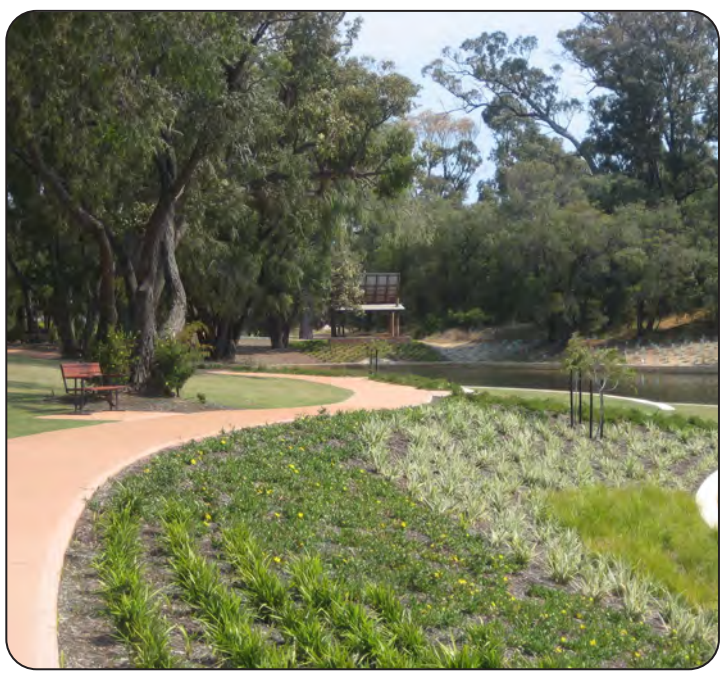
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POS 9

FLOOD MANAGEMENT AREA F

POS TYPOLOGY
Nature Space/ Local Open Space

SIZE
- 8944m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 900m^2

Volume: 340m3

Major Event 1% AEP

TWL Area: 1400m^2

Volume: 1025m3

CONCEPT & FUNCTION

The POS 9 landscape proposals will deliver the following:

- Opportunities for nature-based recreational activities, such as picnicking, bird watching, walking.
- Retention of existing trees and understorey vegetation for shade and biodiversity.
- Shaded seating areas
- Footpath network with access through the POS and to the greater pedestrian path network
- Access into POS from nested lots
- Small open lawn area for informal recreation
- Native, waterwise planting
- Planting designed to maintain a low-fuel state for bushfire managemant purposes
- Drainage basin for stormwater management





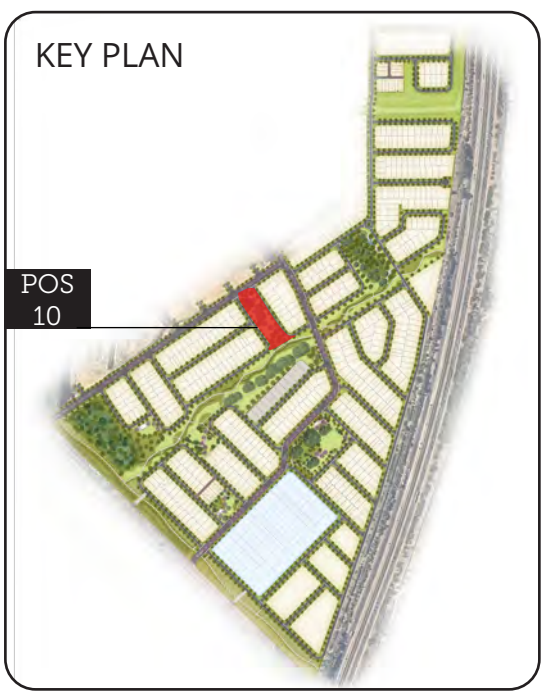
FLORENCE SOUTH, MANDOGALUP
POS 9 LANDSCAPE CONCEPT

DWG **MA-22-07**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 10

FLOOD MANAGEMENT AREA G

POS TYPOLOGY
- Neighbourhood Park

SIZE
- 6715m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 1700m^2

Volume: 380m3

Major Event 1% AEP

TWL Area: 2100m^2

Volume: 1150m3

CONCEPT & FUNCTION

The POS 10 landscape proposals will deliver the following:
- Active and passive recreation opportunities
- Retention of existing trees for shade and biodiversity.
- Shaded seating areas
- Shelter structures with bbq and picnic facilities
- Inclusive nature playground with shade sails
- Open lawn areas for informal sports and recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 10 LANDSCAPE CONCEPT

DWG **MA-22-08**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 11

FLOOD MANAGEMENT AREA K

POS TYPOLOGY
Local Park

SIZE
- 3112m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area:1000m^2

Volume: 260m3

Major Event 1% AEP

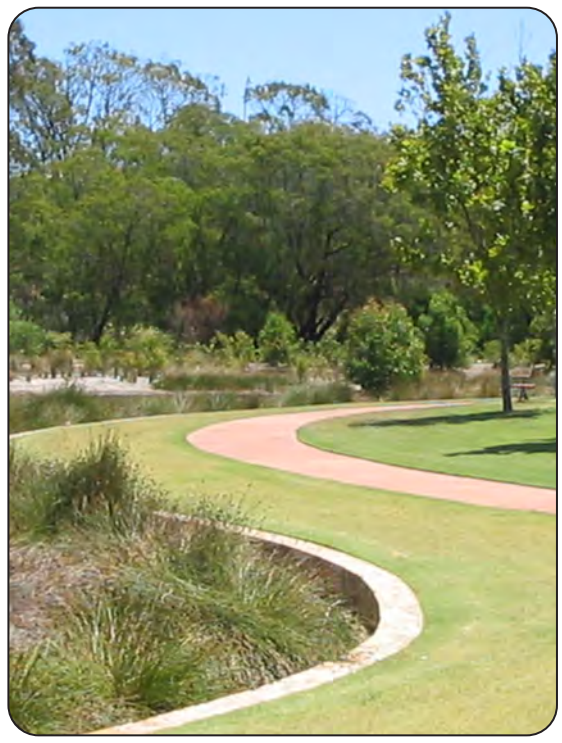
TWL Area:1300m^2

Volume: 700m3

CONCEPT & FUNCTION

The POS 11 landscape proposals will deliver the following:
- Predominantly passive recreation opportunities
- Retention of existing trees for shade and biodiversity
- Shaded seating areas
- Shelter and picnic node
- Open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management





FLORENCE SOUTH, MANDOGALUP
POS 11 LANDSCAPE CONCEPT

DWG **MA-22-09**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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POS 12

FLOOD MANAGEMENT AREA J

POS TYPOLOGY

- Local Park

SIZE

- 3941m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 2100m^2

Volume: 735m3

Major Event 1% AEP

TWL Area: 2800m^2

Volume: 2350m3

CONCEPT & FUNCTION

The POS 12 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management

POS 13

FLOOD MANAGEMENT AREA I

POS TYPOLOGY

- Local Park

SIZE

- 4529m2 + verge.

DRAINAGE CONSIDERATIONS

Small Event - First 15mm

Captured and treated in tree pits and roadside swales.

Minor Event 20% AEP

TWL Area: 3600m^2

Volume: 1200m3

Major Event 1% AEP

TWL Area: 4500m^2

Volume: 3400m3

CONCEPT & FUNCTION

The POS 13 landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Shaded seating areas
- Small open lawn areas for informal recreation
- Footpath network with access through the POS and to the greater pedestrian path network
- Native, waterwise planting
- Drainage basin for stormwater management



FLORENCE SOUTH, MANDOGALUP

POS 12 & POS 13 LANDSCAPE CONCEPTS

DWG **MA-22-10**
REV **B**
DATE **28.05.24**
SCALE **1 : 1000 @ A3**
0 5 10 15 20 25 m

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WESTERN POWER EASEMENT

POS TYPOLOGY

- High Voltage Powerline Easement

SIZE

- 5.14ha

DRAINAGE CONSIDERATIONS

The Western Power Easement is part of the Mandogalup Swamp Regional Flood Storage Area.

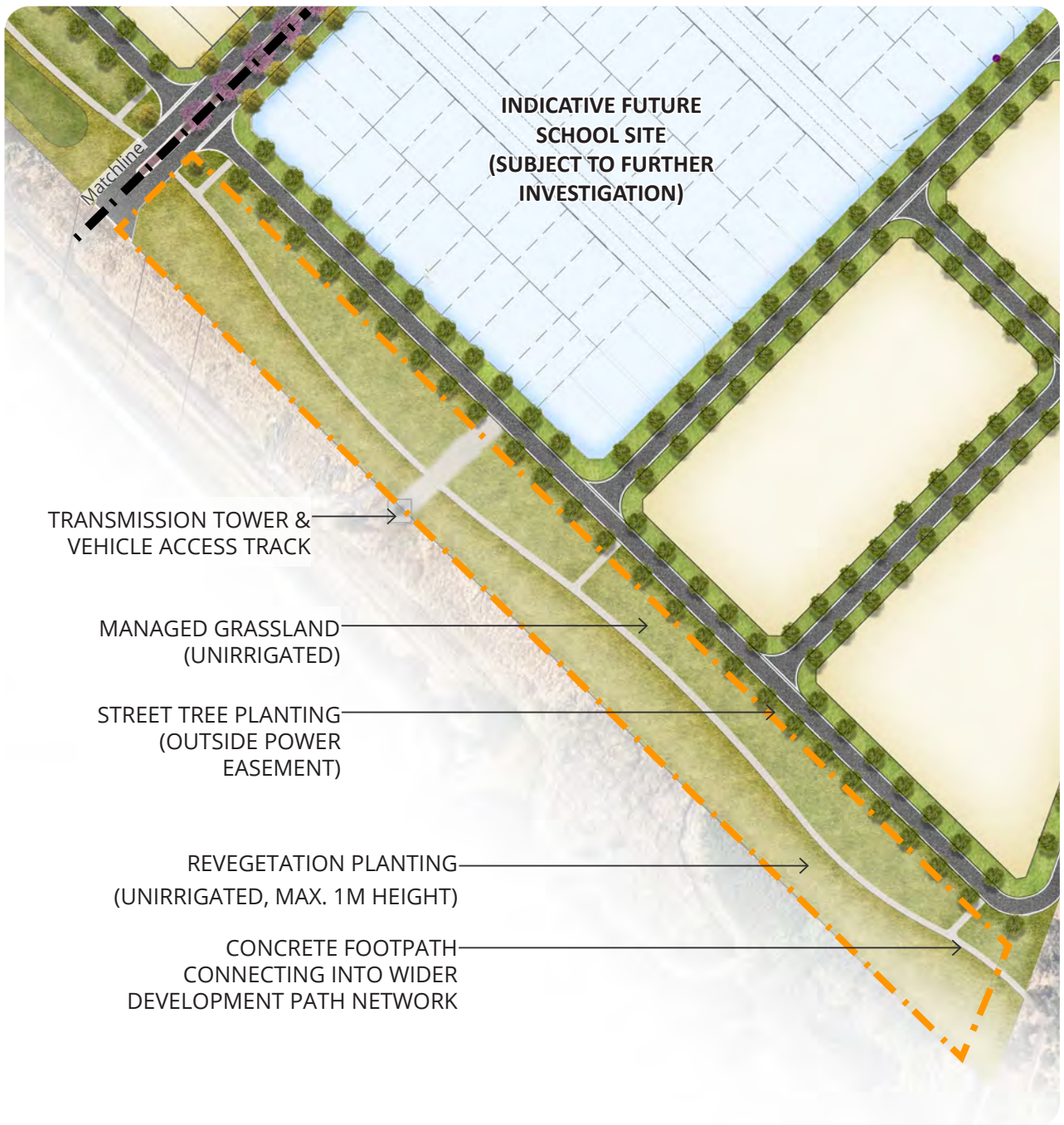
Overland flows from the DBNGP Easement, POS 11 (FMA K), the indicative future school site and FMA M will discharge into the Western Power Easement POS.

CONCEPT & FUNCTION

The Western Power Easement landscape proposals will deliver the following:

- Predominantly passive recreation opportunities
- Path connections to adjoining public open spaces and the wider development path network
- Unirrigated, managed grassland planting
- Unirrigated native revegetation planting, to a max. height of 1m.
- Flood storage areas for stormwater management
- Clear and easy maintenance access for power utility providers to transmission towers and across entire easement.

** Western Power Easement landscape design to be in accordance with Western Power easement land use requirements.



FLORENCE SOUTH, MANDOGALUP

WESTERN POWER EASEMENT LANDSCAPE CONCEPT

DWG **MA-22-11**
REV **B**
DATE **28.05.24**
0 5 10 15 20 25 m
SCALE **1 : 1000 @ A3**

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APPENDIX F

Preliminary Irrigation Estimate
(Emerge, 2025)

Project: Florence, Mandogalup

Client: Satterley

Task: Preliminary Irrigation Estimate for LWMS

Date: 05 May 2025

Item	Location	Total Area (m2)			Area Non-Irrigated (m2)						Water p.a. (kL)
		Area	area x 110%	Area Irrigated	Drainage Basins/Rain Gardens	Living Stream	Retained Trees/veg	Rate	% irrigated	Ha. Irrigated	Ha x 6750
1	Stage 2 Playing Fields	11543	12697.3	13800	0	0	0	7500	108.68%	1.38	10350
2	Stage 3A POS	1641	1805.1	1300	210	0	0	6750	72.02%	0.13	877.5
3	Stage 3B POS	1633	1796.3	1140	840	0	0	6750	63.46%	0.114	769.5
4	Stage 1 & 4 POS 5	12075	13282.5	1595	0	0	8770	6750	12.01%	0.1595	1076.625
5	Stage 6 Peel Main Drain POS North	6808	7488.8	5765	200	0	0	6750	76.98%	0.5765	3891.375
6	Stage 6 Peel Main Drain	8933	9826.3	3350	190	2500	0	6750	34.09%	0.335	2261.25
7	Stage 6 Peel Main Drain POS South	2437	2558.85	1445	20	750	0	6750	56%	0.1445	975.375
8	Stage 8 POS 2	8507	8932.35	1300	120	0	6400	6750	15%	0.13	877.5
9	Stage 10 & 12 Gas Easement POS	9724	10210.2	9100	220	0	0	6750	89%	0.91	6142.5
10	Stage 11 POS 10	6715	7050.75	4400	120	0	1400	6750	62%	0.44	2970
11	Stage 12 &13 POS 9	8944	9391.2	5000	60	0	3100	6750	53%	0.5	3375
12	Stage 13, 14, 15 Gas Easement POS	16300	17115	12850	400	0	1600	6750	75%	1.285	8673.75
13	Stage 17 POS 1	11200	11760	7200	220	0	2600	6750	61%	0.72	4860
14	Stage 15 POS 11	3112	3267.6	2400	120	0	150	6750	73%	0.24	1620
15	Stage 15 POS 12	3941	4138.05	3550	80	0	0	6750	86%	0.355	2396.25
16	Stage 18 POS 13	4529	4755.45	4500				6750	95%	0.45	3037.5
17	Stage 18 Regional Flood Storage	14900	15645	900	13540	0	0	6750	6%	0.09	607.5
18	Western Power Easement	30846	32388.3	3500	0	0	0	6750	11%	0.35	2362.5
19	Southern Land Holding - Verges, RABs & Medians (Neighbourhood Connectors)	2555	n/a	2555	0	0	0	6750	100%	0.2555	1724.625
20	School Site - Oval	10000	11000	10450	0	0	0	7500	95%	1.045	7837.5
21	School Site - Landscaping	30000	33000	8250	0	0	0	6750	25%	0.825	5568.75
	TOTAL (kL per annum)										72255

GWL 169930

Allocation: 67,500kL per annum

Notes

- Irrigation rate used for estimates is 6,750kL per hectare per annum
- Irrigation Rate for playing fields and school oval is 7,500kL per hectare per annum
- Items 1 to 7 based on approved or constructed designs
- Items 5-7 Peel Main Drain POS. Some areas will be unirrigated however establishment irrigation required. This volume is included in annual usage estimate
- Items 8 to 18 based on Structure Plan Concepts
- Items 9 and 12 - DGNBP Easement POS. Irrigated turf is subject to DGNBP Approval
- Item 17 - Regional Flood Storage. Estimate assumes no irrigation to flood storage area. Irrigation allowance is for verge landscaping only (planting and street trees)
- Separate establishment irrigation rate included for Regional Flood Storage Area in case required, however likely delivery is via unirrigated winter planting method.
- Item 18 - Western Power Easement. Inclusion of some areas of irrigated turf is preference of CoK, however is subject to Western Power Approval.
- No allowance for Freeway Road verges
- All irrigation areas for Items 8 to 18 subject to detail design and City of Kwinana approval.
- No allowance included for street trees associated with lots. Assume irrigation for establishment only.

APPENDIX 11

Engineering Services Report

ENGINEERING SERVICES REPORT - MANDOGALUP EAST LOCAL STRUCTURE PLAN (AMENDMENT)

Reference No: PC21209

30 May 2024

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Revision	Description	Author	Checked	Approved	Date
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1	General Revision	SD	OO	OO	09/09/2019
2	Updated Revision	SD	OO	OO	27/05/2024

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EXECUTIVE SUMMARY

Key constraints and recommendations of this report are summarised as follows:

Risk Matrix

Consequence Likelihood	Insignificant	Minor	Moderate	Major	Severe
Remote	Insignificant	Insignificant	Low	Low	Medium
Unlikely	Insignificant	Low	Low	Medium	Medium
Possible	Low	Low	Medium	Medium	High
Likely	Low	Medium	Medium	High	High
Almost Certain	Medium	Medium	High	High	Extreme

Qualitative Measures of Likelihood or Frequency

Scale	Criteria to be used to establish rating
Almost Certain	Will occur. Circumstances or situations are likely to arise often throughout the planning / project period in which provide the opportunity for crystallization of risk. Expect frequent, regular occurrences.
Likely	Likely to occur more than once in the planning period but not an 'everyday' occurrence. Preconditions will arise at times throughout the period.
Possible	Likely to occur at least once but not expected to occur much more than this in the planning period.
Unlikely	Not likely to occur in the planning period. A small, but remote chance of occurrence due to circumstances/situations that could arise.
Remote	Would only occur in highly exceptional circumstances that are unlikely to exist in any planning period. Extremely remote chance of occurrence in planning period. 'Once in a lifetime' event.

Qualitative Measures of Impact – Consequence Severity

Impact	Consequence Criteria
Severe	Near impossible to develop subject site and expected development viability is very low. E.g., Significant Habitat, Major floodway within site etc. Requires comprehensive development viability analysis and specialist input.
Major	Very difficult to develop subject site and expected development viability is low, will involve significant investigations, very expensive major service relocations, many significant trees of excellent health etc. Requires development viability analysis and specialist input as required.
Moderate	Challenging to develop subject site, expected development viability is adequate, will involve further investigations, costly service relocations, many registered trees of excellent health etc. Specialist input as required.
Minor	Relatively simple challenges to develop site, expected development viability is good. Minor upgrades to existing services are required to develop site.
Insignificant	No challenges or risk to program in developing site.

Degree of Risk

Risk Rating	Definition of Risk Rating
Insignificant	Certain development prospect, no foreseeable challenges.
Low	Site is developable with only minor works or investigations required. It is advised to progress to continue the development process.
Medium	Site is developable with significant works or investigations required. It is advised to progress to continue the development process.
High	Site is developable with major works or investigations required. No further investigation recommended without cost benefit analysis first being undertaken.
Extreme	Site is undevelopable or unviable.

Key Site Risks

VEHICULAR ACCESS

Risk Description: The subject site currently obtains vehicular access from Hoffman Road Construction of the internal shared road network for the development, as well as the proximity of the existing intersections (which may need additional treatment) can result in additional costs and possible delay in approvals for the subdivision.

Risk: MEDIUM

Recommendation: Investigation and liaison with the City of Kwinana and Main Roads WA as to the potential access points and temporary access roads during construction for local residence will be required upon realization of the ultimate development layout and access points. Currently the development is progressing from the north side and should provide an access to the area. It is anticipated that the proposed neighbourhood Connector will be delivered by QUBE Developments by 2027.

Refer to **Section 4** for further information.

BUSHFIRE

Risk Description: The current online bushfire mapping listed on the Department of Fire & Emergency Services (DFES) website demonstrates that the subject site is within a Bushfire Prone Area. Additional planning and building requirements will likely apply to the proposed development.

Risk: MEDIUM

Recommendation: Additional planning and building requirements may apply to the proposed subdivisional development in accordance with Schedule 2 Part 10A of the Planning and Development (Local Planning Schemes) Regulations 2015, State Planning Policy 3.7, WA Guidelines for planning in Bushfire Prone Areas, and the Building Code of Australia.

Refer to **Section** Error! Reference source not found. for further information.

SITE GRADING AND EARTHWORKS

Risk Description: Site grading will generally be determined by the proposed building pads, servicing requirements and environmental and geotechnical constraints of the site to ensure a sustainable as well as economic development. Bulk Earthworks will be dictated by building pads and vehicle access point. The

stormwater strategy will need to be confirmed; however, it is likely that stormwater for major storm events will be directed naturally towards the DBNGP easement and Peel Main Drain. To accurately assess stormwater requirements further information is required in regard to the site geotechnical properties. These requirements may incur additional costs and result in potential delays in timeframe for the proposed development.

Risk: MEDIUM

Recommendation: Earthworks on the site will primarily align with sewer reticulation needs, drainage requirements, and geotechnical requirements to achive required separation from existing ground levels to building pads. The site's general topography slopes gently from east to west, with most areas having a gradient of less than 1 in 100. The highest point is in the north of the subject site at approximately 18m AHD and the lowest point over the subject site at approximately 13m AHD at the west side of the subject site. Additionally, a six months preloading is required to achieve Class A site classification, as such it's recommended to schedule earthworks accordingly.

Refer to **Sections 2&0** for further information.

TRAFFIC CONDITIONS

Risk Description: The exact proposed development and total number of residential lots is yet to be confirmed, although this is likely to introduce new traffic flow to the local vicinity, it is unlikely to cause disruption to the existing local traffic network if the proposed development is staged and planned accordingly. The current road network may be able to support the proposed development however is likely to require upgrades.

Risk: MEDIUM

Recommendation: It is anticipated that the proposed development will have an impact on the level of service of the local road network in the immediate vicinity, it is recommended that a Traffic Impact Assessment Report be undertaken. The City of Kwinana will need to be liaised with in regard to development contribution plans at relevant stages of the overall development of Mandogalup West. This will need discussion with the relevant road authorities and may incur additional costs for the development.

Refer to **Section 4** for further information.

SEWER

Risk Description: The subject site is currently does not have a sewer reticlation system. Additional wastewater infrastructure will be required for the development. Based on current sewer planning in the area a Type 180 WWPS may be required to service the area this may incur significant additional costs which will need to be confirmed with Water Corporation over the total Development Plan.

Risk: HIGH

Recommendation: Confirm proposed layout of the development and assess the impact on the existing sewer. Contact Water Corporation to confirm the requirement for works in the vicinity of the existing infrastructure. Verification with the Water Corporation will also be required to confirm serviceability of the site based on the ultimate design of the development. Liaison with WC and QUBE Development will be required to monitor release of the lots in the catchment area to understand the need for WWPS.

Refer to **Sections 0** for further information.

POTABLE WATER

Risk Description: The subject site is currently shown to have no potable water in the area; however, planning for a number of developments north of the subject site and MELSP areas have now resolved supply issues that will enhance the regional network and will also ultimately feed the urban zone that is subject of this application. Potable water requirements of the proposed development will need to be assessed to determine if any additional upgrades in the existing network are required. for the proposed

development. All internal potable water reticulation pipework is to be designed and constructed to the Australian standards and requirements of the Water Corporation of Western Australia.

Risk: **HIGH**

Recommendation: Confirm the existing potable water infrastructure's connection, alignment, and size. Correspondence with Water Corporation has confirmed that the current existing water infrastructure is not sufficient to accommodate the proposed development and it will require upgrades. All internal potable water reticulation pipework is to be designed and constructed to the standards and requirements of the Water Corporation of Western Australia. Standard Water Corporation water headwork charges will apply. Verification with the Water Corporation will also be required to confirm serviceability of the site based on the ultimate design of the development.

Refer to **Sections 7** for further information.

STORMWATER DRAINAGE

Risk Description: The subject site currently has no infrastructure within the site area. Drainage in the area is natural surface flow towards the Peel Main Drain, on-site soakage and drainage corridors. Construction of on-site stormwater drainage infrastructure will be required for the proposed development which may incur additional costs and potential delays in timeframe. There are also potential risks involved with clashes between the drainage corridors and other services that will traverse the local road network, as well as safety issues surrounding the drainage corridor depths.

Risk: **MEDIUM**

Recommendation: Drainage should be constructed in accordance with the Mandogalup Local Water Management Strategy (LWMS) and subsequent Urban Water Management Plans. MRWA safety guidelines should be adhered to for depth and swale slope steepness, the slope must not be greater 1 in 4 and the height must not exceed 1.5m.

Refer to **Sections 5** for further information.

GAS

Risk Description: DBYD information and review of the Atco gas network coverage map shows that there are no reticulated gas services available in the immediate surrounding area, however, planning for a number of developments north of the subject site and MELSP areas have resolved supply issues that will enhance the regional network and will also ultimately feed the urban zone that is subject of this application.

Risk: LOW

Recommendation: Confirm the existing gas service infrastructure's connection, alignment and size.

Refer to **Section** Error! Reference source not found. for further information.

PEDESTRIAN ACCESS

Risk Description: There is currently no existing Pedestrian Path located in the general vicinity of the subject site. The provision of pedestrian infrastructure upgrades or modifications if required may incur additional costs for the development however is likely to be shared over the total development.

Risk: LOW

Recommendation: Peritas recommend undertaking a condition report of the existing bus stops surrounding the site prior to award of the contract to the builder. Any damages during the construction to be rectified by the builder.

Refer to **Section 4** for further information.

ENVIRONMENTAL CONTAMINATION

Risk Description: A contaminated land search on the DWER website indicates the site is within known contaminated sites. Further actions from an environmental contamination perspective are required for the proposed development site. The site overlies both moderate to low and high to moderate risk categories for ASS occurrence. The majority of the site is classed as having a high to moderate risk of ASS occurrence within 3m of the soil surface and is classified as PASS (Potential Acid Sulfate Soils).

Risk: **HIGH**

Recommendation: Further soil investigation may be advantageous along designated infrastructure routes such as sewer lines, to validate specific risks linked with the installation of linear infrastructure. Contingencies are proposed to ensure the implementation of suitable management strategies are in place in the event of encountering Acid Sulfate Soils (ASS). Refer to **Section 2.3**, which outline recommendations from WSP | Parsons Brinckerhoff on additional investigations before commencing each stage.

ELECTRICAL AND STREETLIGHTING

Risk Description: The proposed development currently lacks overhead HV and LV infrastructure in its vicinity. However, HV infrastructure will be extended from the north, while the existing overhead line to the south originates from the same HV feeder connected to the Medina zone substation. Initial communication with Underground Power Development (UPD) indicates that the total load requirement for the site cannot be determined without applications to Western Power (WP) for further detailed assessment. Additionally, UPD cannot ascertain whether additional network reinforcements are necessary, as this determination lies with WP, through a DIP or DCR. The proposed load is expected to connect into the existing aerial network adjacent to the development area, potentially incurring significant additional costs and causing potential delays in the project timeline.

Risk: HIGH

Recommendation: Verify the connection, alignment, and size of the existing electrical service infrastructure. Submit an application to WP through a DIP or DCR process. An EPR/LFI assessment is necessary when installing transformers/switchgear as part of the subdivision process.

Refer to **Section** Error! Reference source not found. for further information.

FLOOD

Risk Description: The primary surface water feature near the subject site is the Peel Main Drain, situated in the southwest area. However, according to advice from the Department of Water and Environmental Regulation (DWER), the general vicinity is not prone to flooding from major surface water bodies.

Risk: MEDIUM

Recommendation: It is recommended to communicate with the City of Cockburn and the Water Corporation to ascertain the drainage capacity available and ensure that the design adheres to standards to prevent potential flooding issues.

Refer to **Section 2.6** for further information.

This Engineering Services Report is for information only. Developers are required to undertake their own assessments of the site prior to forwarding a Development Application to WAPC.

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1. INTRODUCTION

Peritas Consulting was commissioned by Rowe Group on behalf of Satterley Property Group (SPG) to review the engineering constraints and servicing requirements associated with the Mandogalup East Local Structure Plan, currently being amended to included additional landholdings.

The subject site comprises Part Lot 9006 and Lots 9002 and 11, Hoffman Road, with a total area of 34.54 Ha as shown in Figure 1 below. The subject site is bounded by Hoffman Road and Kwinana Freeway to the southeast and by rural lots to the remainder of the site.

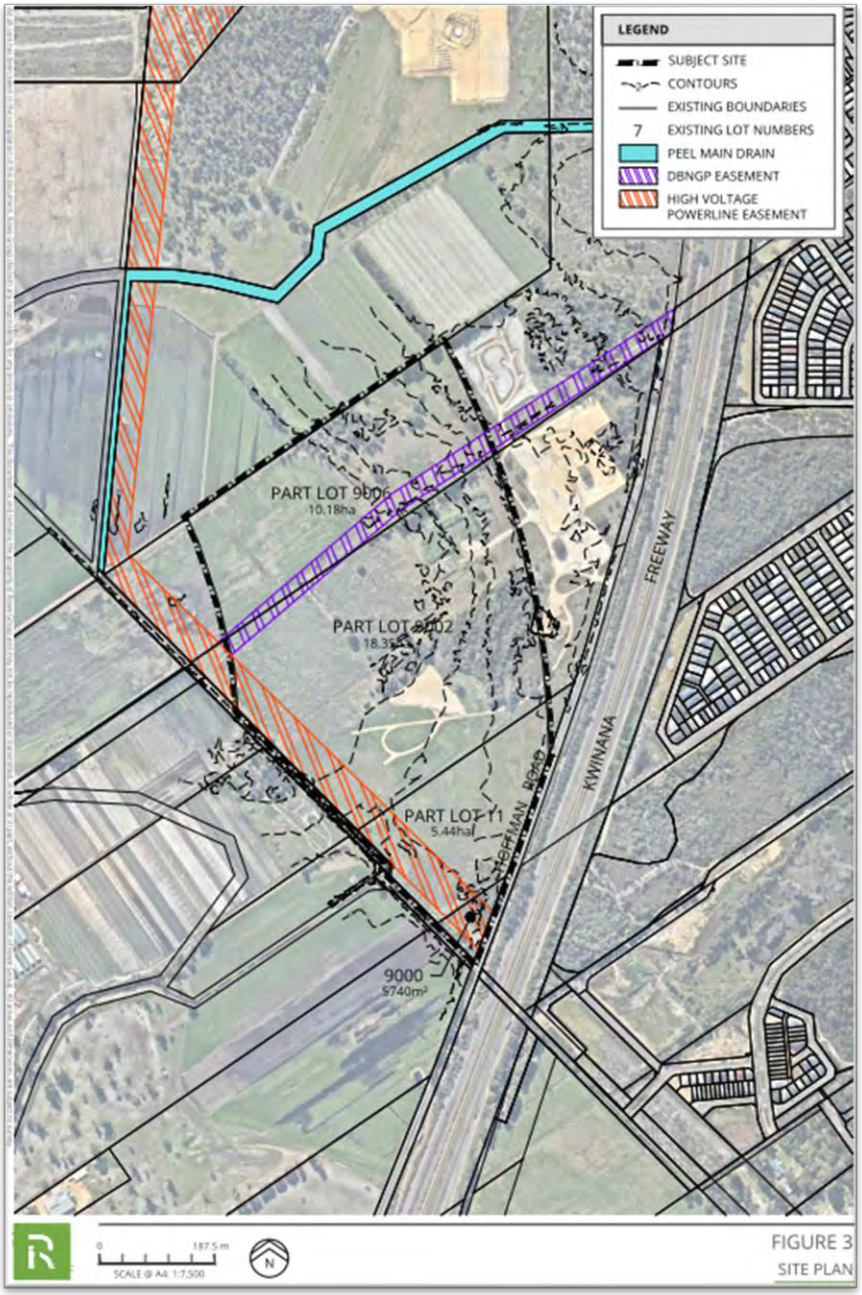


Figure 1 Aerial View

The majority of the site is currently vacant and is generally clear of vegetation and structures. In the past the site was used for rural purposes including grazing hobby farming and the like.

In summary, this report highlights:

- The subject land is capable of sustaining intensive development in keeping with the proposed residential rezoning proposals.
- The land is capable of being connected to and provided with all essential services to sustain residential development (based on current and future service authority planning).
- The proponent's strategy for the subject land will complement the natural landform by careful design of the bulk excavation and site grading and maintaining maximum vegetation.

This report also presents the proponent's commitments regarding further engineering assessment of the site.

This report has been compiled based on the following terms of reference:

- Briefing discussions and regular meetings with the client and the Consultant team.
- Site inspections with the Consultant team after the formulation of the preliminary Local Structure Plan to further refine concepts and development strategies.
- Numerous meetings and discussions with Local Government Agencies.
- Site data and documents included in this report.
- Servicing concepts and Regional Strategic Infrastructure planning by the regulatory authorities.

Peritas Consulting has either been directly involved, or consulted with the relevant consultants, and duly considered the engineering and servicing requirements of the adjoining Mandogalup (East and West) Local Structure Plans (MELSP/MWLSP). We confirm that to our knowledge all conclusions and recommendations are compatible with those for the MELSP and MWLSP at the time of the preparation of the report.

2. SITE EVALUATION

2.1 GENERAL

The subject site exhibits a gradual slope from East to West, spanning from approximately RL 18 m AHD to RL 14 m AHD, with the latter elevation situated roughly at the midpoint of the site. Beyond this midpoint, there is a relatively flat area extending from RL 14 m AHD to RL 13 m AHD, primarily towards the western portion of the site, as depicted in
Figure ***2*** below.

Site gradients range from medium slopes of 1 in 10 to 1 in 15, to gentle slopes of 1 in 500. Greater than 50% of the subject land has gradients less than 1 in 100.

Land with medium gradients dictate that bulk earthworks will be required to regrade the site with retaining walls incorporated in the steeper portions of the site to create level building pads and hence, most of the work will involve reshaping to form level pads where appropriate and to provide infrastructure servicing to the site.

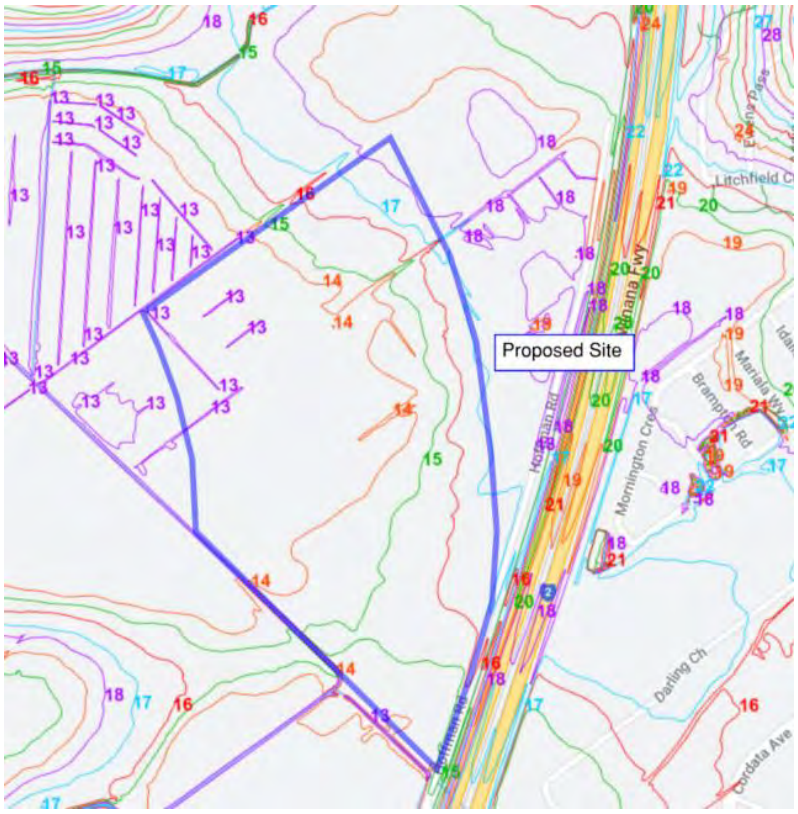


Figure 2 Natural Surface Level Contours (Water Corporation ESInet 24)

2.2 SITE GEOLOGY

The geological characteristics of the development area were initially checked using GeoVIEW, as depicted in **Figure 3** below. Observations revealed the presence of sand and silt within the site. However, a thorough geotechnical investigation was conducted to gain a deeper understanding of the soil conditions, yielding a comprehensive report. A summary of the geotechnical investigation is provided in the following section.

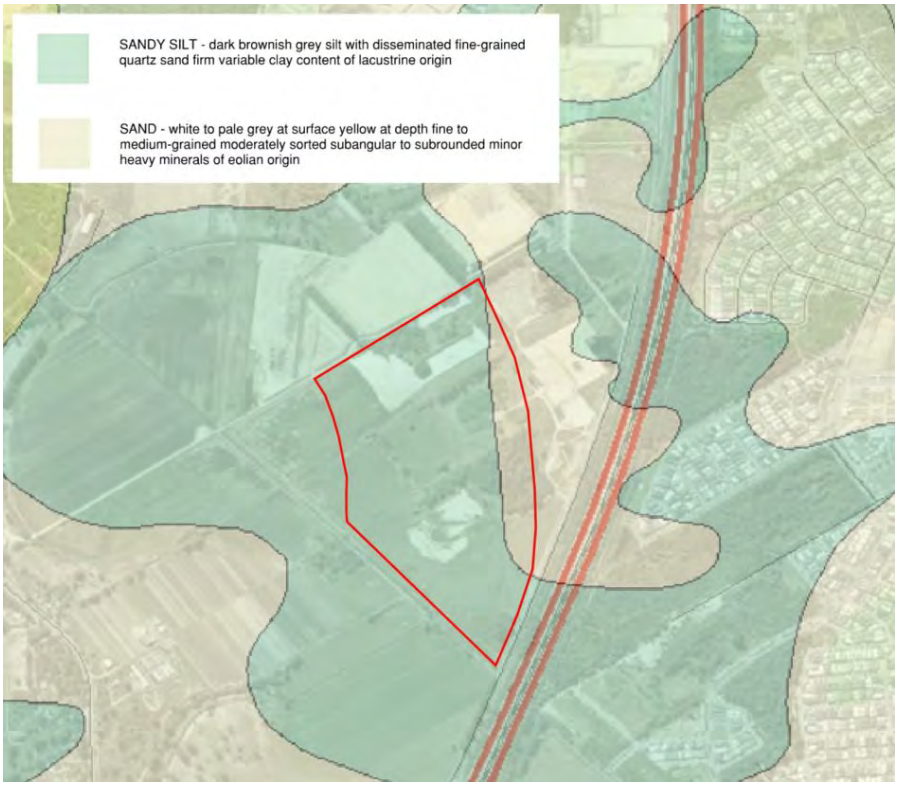


Figure 3 1:50,000 Geology Map of Proposed Development Area

A formal geotechnical investigation was undertaken including a review of the existing Geological Maps by Golder Associates Pty Ltd and presented in their report entitled "Geotechnical Investigation: Proposed Residential Subdivision, Hoffman Road, Mandogalup, July 2014".

Based on the results of the above investigation undertaken by Golder Associates in 2014, surface conditions across the subject area can generally be summarised as:

- **CLAYEY SAND/SANDY CLAY/ORGANIC CLAY/CLAYEY SILT (SC/CL/CI/CH/OH/MH)**, low to high plasticity clay, fine to medium grained sand, typically grey mottled yellow and brown to dark-brown, generally firm to stiff, organic in parts, extending from the surface to depths of between 0.5 and greater than 2.2m; overlying
- **SAND/SILTY SAND (SP/S**M), loose to very dense, extending to the maximum depth investigated of 2.5m.

For further details refer to the Golder Associates Pty Ltd report as noted above.

Further geotechnical investigation was conducted by Galt Geotechnics for settlement monitoring of trial areas in the subject site. Galt Geotechnics' investigation is presented in their report entitled "Settlement Monitoring Southern Part of Florence Estate Lots 9002 and 9006 Hoffman Road Mandogalup, April 2023." Testing locations conducted by Galt Geotechnics are as presented in Figure 4.

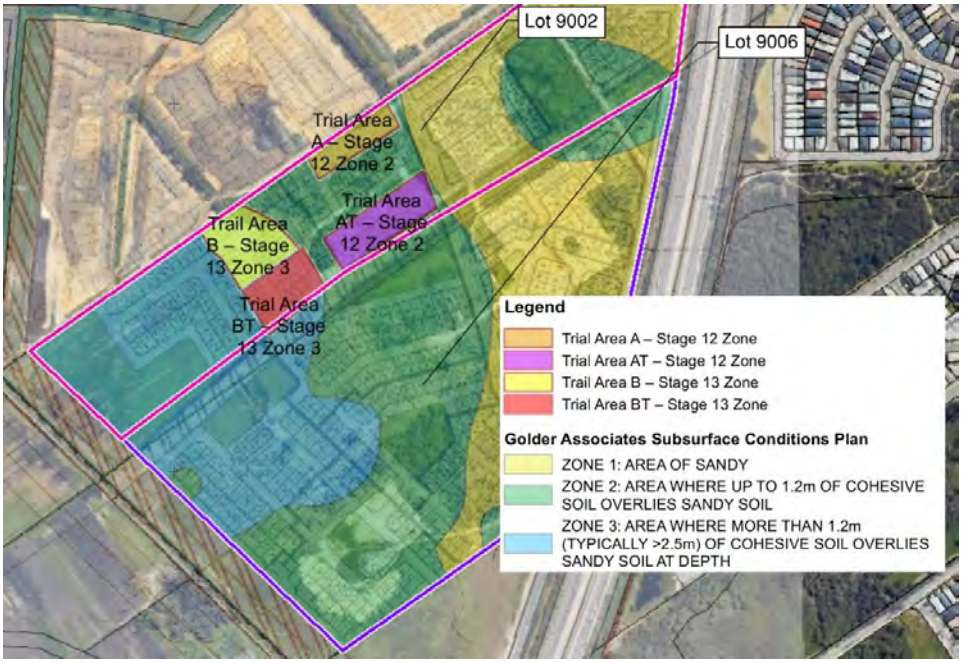


Figure 4 Galt Geotechnics Testing Locations

Based on the results of the investigation undertaken by Galt Geotechnics in 2023, surface soil conditions for each testing locations are presented as follows:

Trial Area A (CPTu03, CPTu04, GTP01 and GTP02)

- Organic SAND (SP-SM) or TOPSOIL: SAND (SP): fine to medium grained, black and dark grey, trace to some fines, moist, loose, extending from the surface to depths ranging from 0.20 m to 0.25 m; overlying.
- SAND (SP): fine to medium grained, sub-angular to sub-rounded, grey, trace fines, moist into wet, loose to about 1.5 m then generally medium dense, extending to the maximum investigated depth of 7.2 m.

Trial Area AT (CPTu01, CPTu02, T36 and T37)

- Peaty Silty CLAY (CH), Peaty CLAY (CI-Pt), Clayey SILT (MH-OH) and Clayey SAND (SC): high plasticity, trace to some fine to medium grained sand, black, trace roots, generally firm, extending from the surface to depths ranging from 0.6 m to 0.75 m; overlying.
- SAND (SP): generally medium dense, extending to maximum investigated depth of 7.2 m

Trial Area B (T33, T40, GTP07, P13, CPTu05 and CPTu06)

- Peaty CLAY (CI-Pt), Peaty Silty CLAY (CH) and Clayey SILT (MH); medium and high plasticity, black, trace roots, extending from the surface to a depth of 0.35 m; overlying.
- Silty CLAY (CI and CH): medium and high plasticity, trace to with fine to medium grained sand, brown/grey, trace construction rubble and gravel, extending to depths ranging from 1.2 m to 2.0 m; overlying.
- CLAY (CH): high plasticity, brown, trace fine grained sand, generally firm to stiff, extending to depths ranging from 3.4 m to 3.5 m; overlying.
- SAND (SP): dense to very dense, extending to the maximum investigated depth of 8.4 m.

Trial Area BT (T45, CPTu07 and CPTu08)

- Peaty Silty CLAY (CH) and Clayey SILT (MH); high plasticity, black, trace roots, firm, extending from the surface to a depth of 0.35 m; overlying.

- Silty CLAY (CI and CH): medium and high plasticity, grey-white, trace fine to medium grained, firm to very stiff, extending to a depth of 1.3 m; overlying.
- CLAY (CH): high plasticity, brown, trace fine grained sand, generally firm with occasional soft layers, extending to depths ranging from 2.1 m to 3.1 m; overlying.
- SAND: dense and very dense, extending to the maximum investigated depth of 7.2 m

In accordance with the geotechnical report received for the Mandogalup land development area, it has been advised that pre-loading is necessary in specific zones identified within the site. Pre-loading is proposed to be implemented in these designated areas to address potential settlement issues and ensure the stability and performance of the ground supporting single and double storey residential homes. The details of the preloading methodology are outlined within the report and are available on the request.

Based on the data available it is not expected that any major difficulties will be experienced during the construction of the development, however, the presence of high ground water will require careful design cinsideratio to ahcive the required site classification.

General definition of Site Classes within the proposed Development Zone

Australian Standard AS 2870 -1996 provides a system of site Classification for residential slabs and footings design as follows:

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground moment from moisture changes
M	Moderately reactive clay or silt sites, which can expect moderate ground movements from moisture changes
H	Highly reactive clay or silt sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement form moisture changes.
A to P	Filled Sites
P	Sites which include: Soft soils, such as soft clays or silts or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive soils subject to abnormal moisture conditions or sites which cannot be classified otherwise.

Table 2-1– General definition of Site Classes

The subject site area soils comprise a range of clayey materials, with varying plasticity and organic contents. A site classification of 'Class P' is considered appropriate for the majority of the subject site in its current form. Modification of the sites is possible to improve foundation conditions and ensure 'Class A' or 'Class S' site conditions for building development across the subject site area.

Earthworks across the subject site area are likely to comprise stripping and disposal of deleterious materials (including organic soils) and replacement with imported clean structural fill. In addition, it is anticipated that filling of the site with import clean structural fill will be required to achieve appropriate site classifications and clearances to groundwater.

Based on the Galt Geotechnics' results, we consider that, after preloading, the following site classifications in accordance with AS 2870-2011 "Residential Slabs and Footings" can be adopted:

- Zones 2 and 3 Areas – Class A where at least 1.8 m of inert granular fill is present over the clay soil.
- Zones 2 and 3 Areas – Class S where less than 1.8 m of inert granular fill is present over the clay soil.

It should be noted that site classifications advised with reference to AS 2870-1996 apply to buildings that are covered by that code being, buildings less than 30m in length and up to 2 stories high. Commercial buildings outside the standard that may be developed within the estate may require specific investigation and footing designs.

Based on the data available it is not expected that any major difficulties will be experienced during the construction of the development from an earthwork and building pad point of view.

2.3 GROUND WATER

The Study Area is within the City of Kwinana and the Peel Main Drain Catchment. It is approximately 23 km south-east of Perth CBD. The boundary of the groundwater study area is approximately 45 ha and is defined based on the catchment hydrology; Mandogalup and Norkett Road to the west, Anketell Road to the south, the Kwinana Freeway to the east and Rowley Rd on the northern boundary.

The results of the studies in the JDA Mandogalup Local Water Management Strategy dated May 2024, indicate that the ground water levels across the site vary from about RL 18m AHD to RL 13m AHD (Based on AAMGL estimated levels). The groundwater contour map which provides details of the AAMGL contours is shown in Figure 5 below.

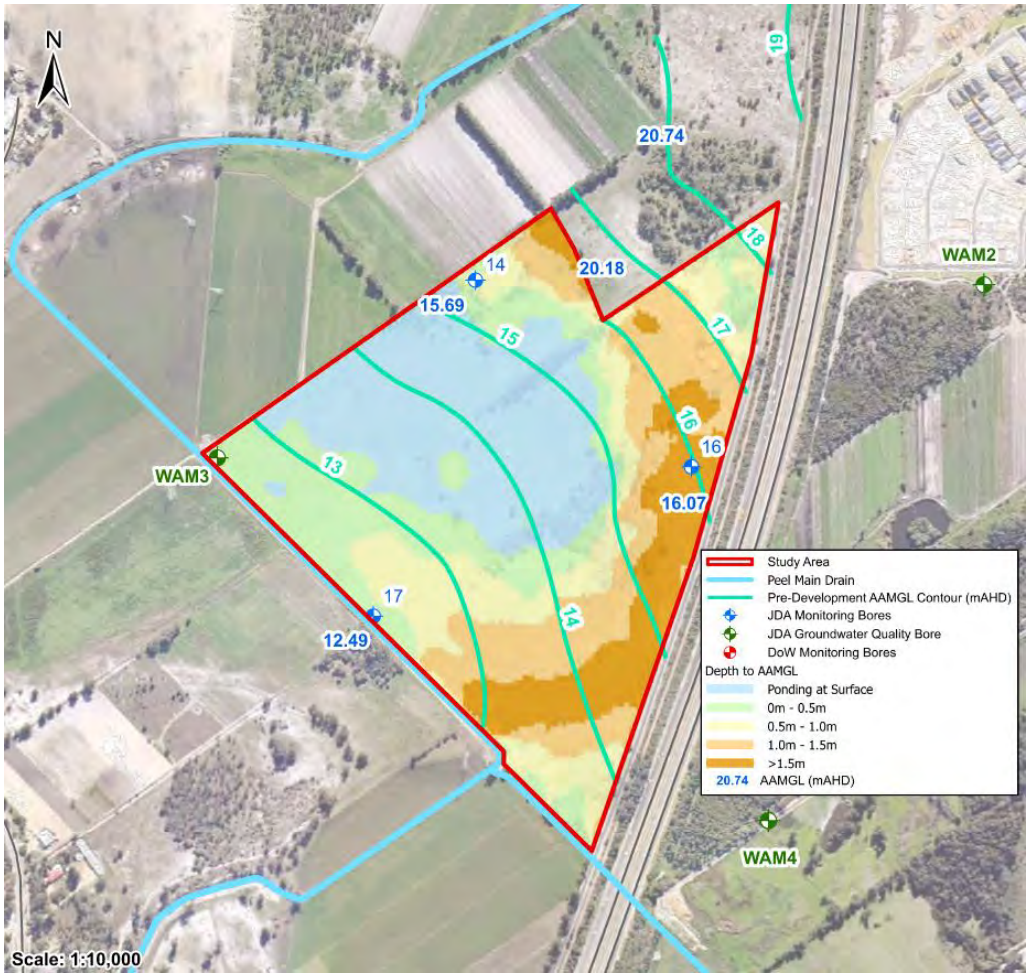


Figure 5 Groundwater Contour Map

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2.4 Acid Sulfate Soil Risk

Based on the information from DWER groundwater database shown in **Figure 6** below there is a high or moderate risk (<3m from the surface) Acid Sulfate Soils (ASS) in the majority of the subject site, therefore additional testing is recommended to be undertaken before siteworks commencement.

Acid Sulfate Soil and Dewatering Management Plan has been prepared by Strategen in 2018, reference SPG17253_01R003 Rev 0. The report cover the entire area of the development.

SPOCAS and CRS results indicated that:

- The SCr concentrations were <LOR in the majority of samples, except sample SB1_3.25 (dark grey sands, SCr value of 0.041% S).
- No sample of light grey to grey sands exceeded assessment criteria, however, 11 samples (0.05%) had pHFOX <3 at depth ranging from 0.15 to 2.75 mBGL.
- Dark grey sands contained SCr <0.03%S in 6 out of 7 samples analysed (one exception of SB01_3.25) and net acidity ranging from <0.02% S to 0.32% S. 24 samples (44%) had pHFOX <3.
- Nearly half (44%) of samples from the LIGHT brown TO brown sands contained pHFOX <3, of which SCr was below assessment criteria and net acidity ranged between <0.02% S and 0.05% S.
- DARK BROWN SILTY SAND / SAND contained pHFOX <3 in 56% of samples and net acidity up to 0.44% S.
- WHITE TO PALE GREY/GREEN SILTY CLAY / CLAY had pHF ranging from 5.3 to 9.4 and contained only one sample (0.02%) with pHFOX <3; 6 of 10 samples from this soil type had net acidity exceeding assessment criteria whilst SCr <LOR in all 3 samples analysed.
- BROWN TO DARK GREY CLAY contained net acidity ranging from <LOR to 0.45% S, exceeding assessment criteria in 5 of 8 samples analysed, and SCr between <LOR and 0.019% S.

Summary of ASS Management strategies

The SPOCAS and CRS results indicated all soil types encountered during the investigation have acid generating capacity, and therefore require management. The ASS management strategies to be applied to the proposed site development works include:

- Infrastructure excavation management.
- Temporary soil stockpiling and limestone pad construction.
- Neutralisation (lime treatment) at the maximum liming rates determined from the SPOCAS testing of different soil types.
- Stockpile monitoring program to validate the lime treatment.

Contingency plans have been developed that will be implemented if nominated targets for soil treatment are exceeded.

Summary of dewatering management strategies

Cone of depression modelling was undertaken using the DWER's cone of depression calculator. The results indicated that the radius of the cone of depression ranges from 31 to 290m for sand and 13 to 19m for clay. Average pumping rate is 22L/s for sand and 3L/s for clay. Time required for establishing a stable drawdown cone would be between 6 and 419 hours.

Based on the modelling, a dewatering management plan has been developed. Water quality and drawdown trigger levels will be determined based on a groundwater monitoring event to be undertaken within two weeks of the commencement of dewatering. If trigger levels are exceeded, various contingency plans will be implemented. Additional modelling may be required for dewatering associated with the installation of a sewer pump station, where drawdown to 7mbgl is expected.

Summary of conclusions

All soil types encountered during this investigation at the site are considered to have acid generating capacity. Therefore, an ASS and dewatering management plan (ASSDMP) has been prepared, herein and must be complied with during site development works. This ASSDMP is provided to the DWER for review and endorsement ahead of an anticipated WAPC condition regarding the assessment and management of Acid Sulfate Soils.



Figure 6 Acid Sulphate Soils

2.5 BUSHFIRE

The current online bushfire mapping listed on the Department of Fire & Emergency Services (DFES) website demonstrates that the subject site is within a Bushfire Prone Area, as shown in **Figure *7*** below. The bushfire mapping is subject to change with the planning of the subdivision. Therefore, additional planning and building requirements may apply to the proposed subdivisional development in accordance with Schedule 2 Part 10A of the Planning and Development (Local Planning Schemes) Regulations 2015, State Planning Policy 3.7, WA Guidelines for planning in Bushfire Prone Areas, and the Building Code of Australia.



Figure 7 DFES Bushfire Prone Map 2024

2.6 FLOOD

Flood DWER was contacted for the 100-year flood level and Floodplain Management Strategy. The following advice was provided by DWER:

"I refer to your enquiry regarding Lots 9002 9006 11 Hoffman Road Mandogalup.
The Department of Water and Environmental Regulation in carrying out its role in floodplain management provides advice and recommends guidelines for development on floodplains with the object of minimising flood risk and damage.

*The general area is not affected by flooding from a major surface water body, refer to attached plan (***Figure 8** below*).*



Figure 8 DWER Flooding Plan

The Water Corporation and the City of Cockburn are responsible for stormwater drainage in the area, and it is recommended that you contact them directly for information on the expected capacity of their networks.

It should be noted that this advice is related to major flooding only and does not take into local drainage. Other planning issues, such as environmental and ecological considerations, may also need to be addressed."

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3. SITE GRADING AND EARTHWORKS

General Principles & Approach

The subject land is a gently sloping site with generally flat terrain in the in the southern and western portions, substantially cleared, incorporating a network of old farm drains, formal branch drains ultimately discharging into the peel main drain along the southern boundary of the subject site.

Site grading and remodelling will be kept to minimum limits wherever possible and will generally be limited to roadworks, building pads for future development and associated works within the following parameters:

- Creation of residential building sites.
- Shaping of siteworks to create interesting features and focal points at each development node keeping within an urban and residential estate theming.
- Contouring of land to suit servicing requirements of the development, sewerage and drainage requirements.
- Creation of sufficient variation in the grading to allow the contouring of public areas with swales and landscaped open spaces along existing natural drainage outfalls.

Site grading will generally be determined by the servicing requirements, geotechnical and environmental constraints of the site to ensure a sustainable as well as economic development of the infrastructure.

Various areas within the subject land contain remnant vegetation cover and every effort should be made to maintain existing significant trees and vegetation by controlling the clearing operations during the earthworks and site grading works, particularly within public areas and at the boundaries of preservation zones.

Therefore clearing, prior to bulk earthworks, will be completed with due regard to selective vegetation preservation and will be restricted to approved areas development and in accordance with planning guidelines to be established.

Peritas Consulting anticipate that the bulk earthwork operations will be completed using material imported to the site. The material will be locally sourced from existing sand mining operations within the locality.

Whilst land gradients are not excessive, steeper cross-gradients within road and residential precincts will require re-grading and stabilisation to ensure building sites are created to take advantage of aspect and location as well as facilitate ease of construction and access.

The natural landform will be reshaped within accepted guidelines and in accordance with the requirements for site servicing and building pad creation, however, natural drainage flow paths will be maintained wherever possible.

Preparatory works prior to earthworking should be limited to the following:

- Removal of fencing and other improvements as necessary, however, retaining as many existing and significant trees and vegetation as possible.
- Stripping and grubbing of areas to be earth worked with due regards to vegetation preservation in selected areas.
- Strip and stockpiling topsoil.
- Cut to fill operations and imported fill to selected areas to improve geotechnical parameters for development.
- Stabilisation of any areas to be landscaped or where topsoil has not been respread on verges and embankments.

Site levels shall be set in accordance with the following parameters:

- Geotechnical and soil parameters to ensure that the site achieves appropriate site classification for its purpose generally Class 'A' for residential purposes.
- Fill levels to provide clearance to groundwater (AAMGL and as prescribed by authority approvals)
- Building pad levels to be designed to ensure that floor levels maintain a clearance of a minimum of 0.5m to the regional 1:100-year flood levels.
- Finished pad levels are to conform to the regional drainage requirements as identified in the published urban stormwater drainage strategies consistent with recent government initiatives for the area.

Upon completion of bulk earthworks, any disturbed areas shall be stabilised either by respreading the stockpiled topsoil from the bulk earthwork operations or via hydro mulching stabilisation as appropriate or in accordance with the requirements of the local authority.

Clearing and Disposal

Wherever possible, cleared vegetative material will be collected and used in soil and land stabilisation, either as 'brush matting' or chipped and used as a mulch. Where approved, rushes will be harvested and used in wetland re-vegetation. Debris from clearing which cannot be re-used will be disposed of in approved land fill sites in accordance with Local Authority policy.

Following clearing, the topsoil will be stripped and stockpiled on site for later use in stabilising verges or topsoiling of embankments and swales.

Land Stabilisation & Dust Suppression

Prior to construction taking place, a construction water supply will be established to provide water for dust suppression, temporary sand stabilisation and irrigation during the construction phases. Water trucks and spray equipment will be on site throughout the construction programme to damp down exposed sand surfaces until the surface is physically stabilised. In the event that adjacent occupied homes or trafficked roads are affected by sand drift, a sand trapping fence will be constructed fronting the affected section of the development.

In the event of strong winds blowing towards adjacent properties that cause blown sand to reach those properties, earthworks, including the stripping or respreading of topsoil, will be temporarily suspended and dust suppression measures immediately implemented.

Stabilisation of the soil surface will be carried out, as required, immediately following topsoil re-spreading and minor regrading.

Soil stabilisation will generally comprise stockpiled topsoil respreading; however, Hydromulch without seed will also be used with Council Approval. Hydromulch with seed, or dry seeding, may also be employed in select locations with due care to utilise wherever possible local and native species.

Soil stabilisation will be maintained until such time as the vegetation cover is sufficient to prevent erosion.

4. ROAD NETWORK & TRAFFIC CONSIDERATIONS

Overview

In the early phases of development, access to the site will be from the North of Rowley Road and along the existing road network within the development.

Internal proposed roads generally consist of asphalted pavements. Minimum recommended carriageway widths will be selected with due reference to local authority (City of Kwinana) and the provisions of Liveable Neighbourhoods.

The design of the road hierarchy and network associated with the proposed Structure Plan has considered the policy document "Liveable Neighborhoods - Community Design Code, Element 2, and Movement Network."

In planning the internal road network for the subject land, the following considerations were taken into account:

- Topographic conditions and existing road networks.
- Retention of the existing trees to comply with City of Kwinana Tree Retention Policy.
- Nature of existing vehicle movements and their major on/off site destinations especially in relation to major regional destinations.
- Compatibility with the proposed land use.
- Relationship to the existing road network and consideration of future potential development and expansion into adjacent areas.
- Separation of through traffic from local traffic.
- Balance accessibility for all the tenants and occupiers to the major proposed public facilities.

Residential streets/minor roads will be designed to remain passable in the 5-year ARI event and defined major arterial roads will be designed to remain passable in the 100-year ARI event.

In residential areas, generally road truncations may be reduced from 6mx6m to 3mx3m in the following situations (although they will be subject to more detailed design at subdivision stage):

- On roads that intersect with a 20m road reserve and wider (i.e. 15m road onto a 20m road reserve or wider). 15m roads onto a 15m road will not work and for anything below this other than at laneways (see below).
- On road bends (and for reserve widths greater than 12m) where the angle is greater than 120 degrees in deviation. 90-degree bends will not work other than as noted above and as noted for laneways below.
- On laneways (6m reserve width) that intersect at right angles to roads that have a reserve width 12m and greater (i.e. 6m laneway onto a 12m, 15m etc. road reserve).
- In some odd intersection situations where the roads come in at differing angles (see examples below).

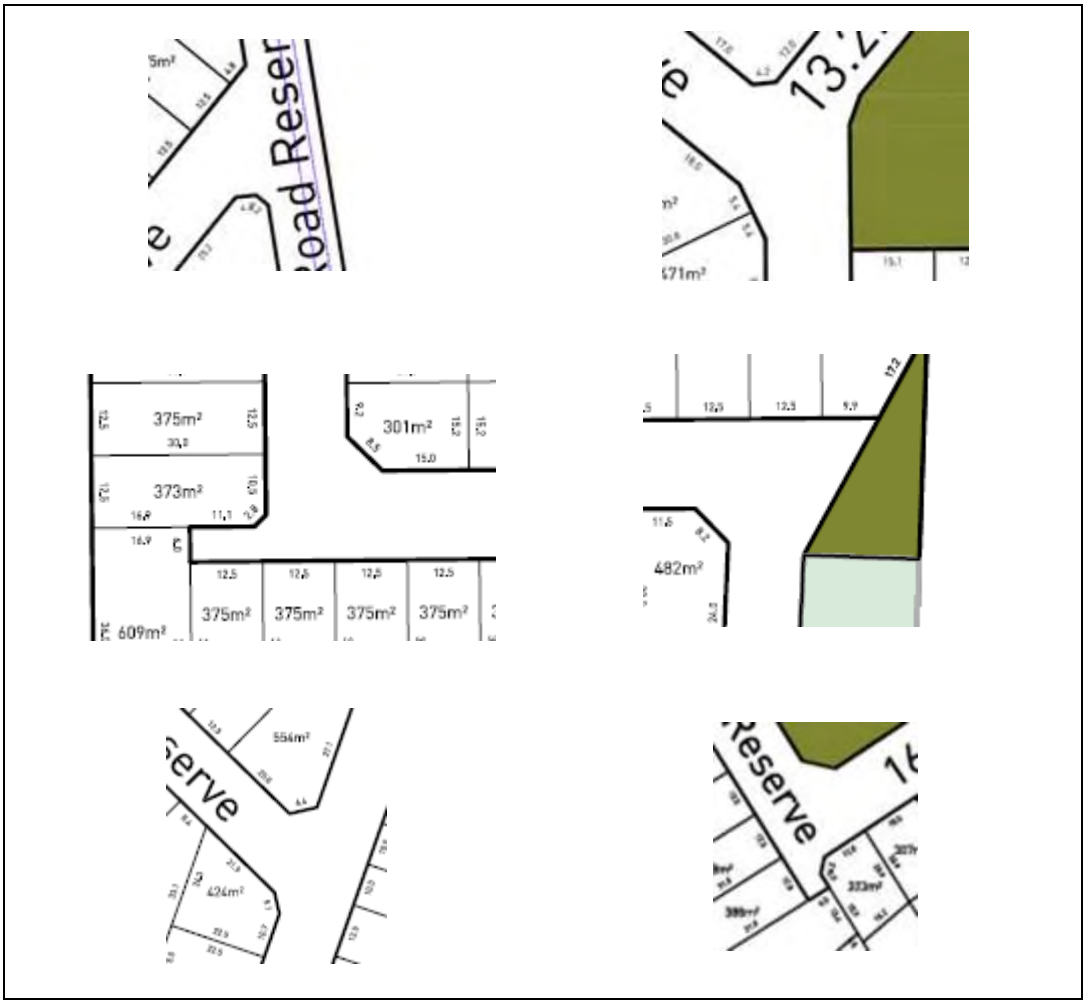


Figure 1. Examples of truncations 3mx3m in particular intersection situations.

Road Hierarchy

The road network design achieves its objectives to separate non-local traffic from the minor road network. The design focuses on a structured road hierarchy which is self-regulating, creating road environments compatible with the traffic needs of land use.

The road network in the northern part of the proposed amended LSP has already been constructed, and it is expected that the same road standard would progress for the future neighbourhood connector and access streets within the amended LSP area.

The proposed hierarchy of roads within the Development Zone, MELSP area was established through transport modeling undertaken by Transcore Pty Ltd for both LSPs and is presented in Transcore`s traffic assessment report (reference t23.273.mr01, April 2024).

The proposed road hierarchy was based on traffic projections and the classification of the WAPC Liveable Neighborhoods guidelines (2007) and illustrated in **Figure 9**.



Figure 9 Proposed Road Hierarchy by Transcore

The network is flexible, allowing a staged implementation of the major road network as development of the subject land progresses. The road network of the amended LSP area is proposed to connect to the neighbouring landholdings at a number of locations to improve permeability and facilitate connection to surrounding regional roads. In particular, the needs of commercial vehicles, public transport, pedestrians and cyclists have been considered in the design of appropriate road cross sections. In this way, design features are integrated to provide streetscapes which serve all road users efficiently.

There are inbuilt opportunities for further expansion, which will not compromise the operation or aesthetics of the network for any road user group.

Any development plan for the area will incorporate a structured road network which includes a range of traffic control and regulating devices including roundabouts, road medians and convenient turning areas, both for council refuse truck use and local industrial vehicular traffic. The road network would be complemented by pedestrian links and landscaping treatments to enhance the verges and streetscapes in keeping with a green park theme.

According to the information obtained from the Public Transport Authority (PTA), it is anticipated that the area to the west of Kwinana Freeway would be served by future bus routes 535 and 536 as outlined in Section 3.7 of Transcore`s traffic assessment report.

The focus of traffic management and road network design within the development is to create a legible, functional road hierarchy which will be safe for all road users with a self-enforcing speed environment achieved through the use of:

- A hierarchy compatible with land use.
- Appropriate road construction widths and standards.
- Appropriate intersection control treatments and midblock traffic management.
- Property access control (where appropriate).
- Optimized intersection location, spacing and interaction.

Some key characteristics of relevant road classifications have been summarised below:

i) Neighborhood Connectors

Neighborhood connectors link neighborhoods and towns, are carefully designed to calm traffic and facilitate pedestrian use and have frequent local street connections. The neighborhood connector should not attract substantial long distance through traffic, but provide for safe and convenient local travel to and from arterial routes.
The neighbourhood connector roads within the amended LSP are planned with 2.5m designated cycleways in the verge on one side of the road.
The number of median breaks will need to be controlled to ensure reasonable levels of traffic speed and flow, limiting delays and potential traffic conflict points.

Neighborhood connectors spread local traffic loads and reduce intersection loadings, act as bus routes and support the location and viability of neighborhood centres.

ii) Access Streets

The access street is the most common street in residential subdivisions designed under Liveable Neighborhoods. The environment of the abutting land use dominates, traffic speed and volumes are low, and pedestrian and bike movements are facilitated by the streetscape and traffic behavior. Vehicle speeds will be constrained by street length, on-street parking intensity, variation in width and alignment of the road, the presence of street trees, and type of road construction.

The majority of both LSP internal roads are classified as Access Street Type D roads with an indicative volume of traffic being less than 1,000 vpd. Access Street D typical cross section entails 4.7m verges on both sides, with embayed parking provided in the verges as appropriate.

The access streets to the east and south of the approved primary school site are recommended to be constructed as Access Street Type B with a 17.9m road reserve width that will allow for on-street parking on both sides of the road. The access streets around the approved primary school have already been constructed to this standard.

All roads would be provided to residential street standards, providing local access between properties and the distribution network in a low speed, low volume environment pavement widths to accommodate on-street parking help control vehicle speeds without the need for restrictive traffic control devices. In this way, street environments can be created where shared vehicle-pedestrian areas can exist and in corporate/enterprise areas to optimize the use of available road space for parking and service vehicle access.

Traffic Management

Appropriate intersection control is key to regulating traffic speeds and creating a self-enforcing road environment.

Significant levels of internal and external traffic are expected to be generated by the improved connectivity to the major regional road network. The standard of road treatments and hierarchy has been specifically addressed to cater not only for internally generated traffic, but to recognize the importance of the subject land road system within the context of a wider regional network.

Four-way intersections will be proposed within the Development Zone on low traffic volume access streets. These intersections will be constructed as priority-controlled intersections with Give Way control on the minor road approaches as suggested in Liveable Neighborhood document. Appropriate entry treatments will be implemented on side roads to help to alert road users about the presence of the intersection and that traffic on the major road has priority.

5. STORMWATER DRAINAGE

Preliminary discussions with City of Kwinana indicate that the design philosophy for drainage in the area is to ensure that downstream discharges are limited to existing discharge flows. An excess of stormwater is to be compensated on site using alternative measures to an end of pipe solution.

To achieve this, a combination of median swales, linear rain gardens/swales and porous tree pits will be required prior to surface water being allowed to overflow into the adjacent drainage network and into compensation basins downstream.

Stormwater collection disposal strategies will incorporate storage and flood attenuation prior to discharge to existing outfalls including the proposed regional drainage system.

All road reserves will be drained. It is proposed however, that where soakage is possible porous tree pits, and linear rain gardens/swales in roadsides would be installed to allow for appropriate infiltration in addition to a conventional piped drainage system (consisting of collector pits, manholes, and controlled outfalls). These nutrient stripping zones and infiltration would incorporate water sensitive design and quality principles.

The stormwater concepts are proposed to meet the key criteria defined by JDA Mandogalup District Water Management Strategy report May 2024;

- The 1-year 1-hour ARI event shall be retained on site through the use of retention (soakwell) or storage devises. Chapter 9 of the Stormwater Management Manual for Western Australia (DoW, 2007) details suitable devices and appropriate design of retention system for the soil type of the site.

- A range of flows from 1 in 1 year to the areas required for flood management to be determined based on stormwater modelling for the 100yr ARI. These areas will be allocated in the local structure plan.

- Public open space (POS) and retention basins should operate as dry basins with a clearance of 0.5m (or alternative level agreed with the city) between the controlled groundwater level and the invert of the basin.

- Defined major arterial roads should remain passable in the 100-year ARI event.

- Water quality treatment systems and water sensitive urban design structure must be designed in accordance with the Stormwater Management Manual for Western Australia (Department of Water & Swan River Trust, 2007) Chapter 9 (Structural Controls) and Australian Runoff Quality (Engineers Australia, 2006).

- All minor rainfall events will be infiltrated at source (porous tree pits, rain gardens or road swales) wherever possible, consistent with DWMP design criteria.

- The surface water management strategy to be guided by the DWMP, Stormwater Management Manual and follows Water Sensitive Urban Design principles.

Based on recent stormwater modeling results, additional information regarding the drainage strategy has been obtained. Refer to the Stormwater modelling results in **Appendix J** and **Figure 10** below.

The modeling assumptions include:

- Small Event (15 mm) runoff is contained in a 0.3 m high vertical walled bio-retention area. It is infiltrated through amended soil and collected by an underlying subsoil drainage system that discharges into the district flood storage area.

- Minor Drainage, Runoff generated within residential lots in excess of lot underground storage devices (e.g., soakwells) will flow overland via driveways or front of lots into the pit-pipe road drainage network. Where proposed lots are less than 350 m2, underground storage devices (e.g., soakwells) are to be interconnected within the lot. Stormwater flow from roads will be conveyed primarily as piped flow to the downstream FMA.

- Major Drainage, Runoff from residential lots in excess of storage devices flows overland to the pit-pipe road drainage network. Roads provide flood storage and conveyance. Major event (1% AEP) runoff is contained in a basin with 1:6 side slopes, with outflow at prescribed rates into the district flood storage area.

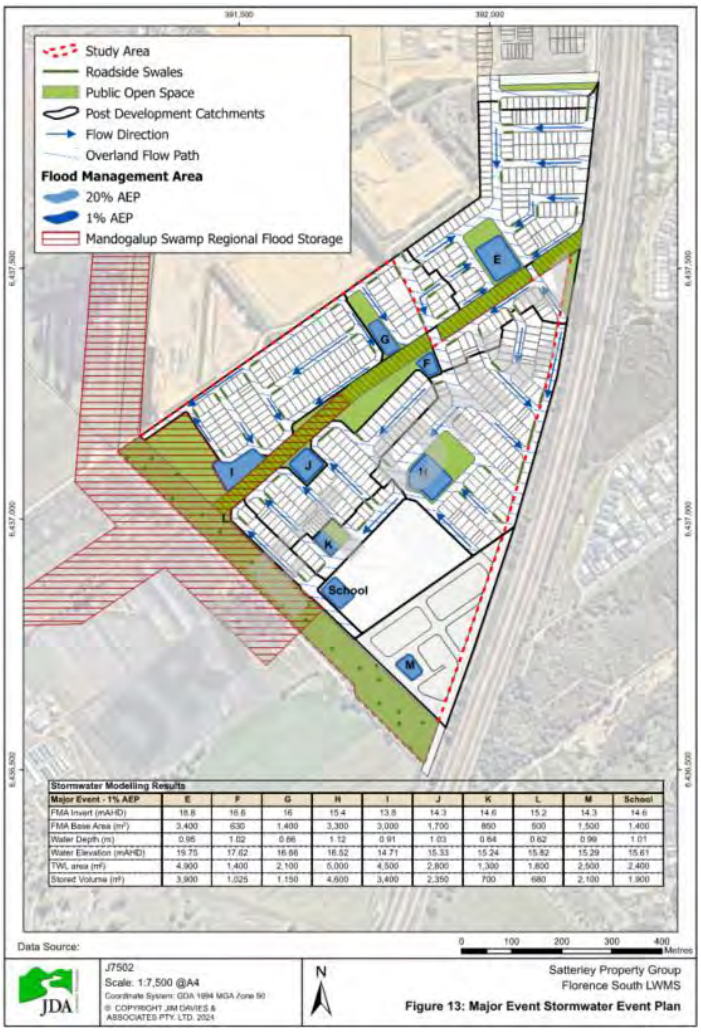


Figure 10 Major Stormwater Event Plan

It is expected that DBNGP corridor would contain a small meandering swale through its center with mulching around it. The basins around it would discharge via a headwall at the boundary of the corridor to the flow into the central swale. The DBNGP corridor could potentially serve as a conduit for minor and major flood storage. Further investigation is required to ascertain its viability.

These considerations have been factored into the stormwater drainage plan, ensuring comprehensive management of runoff while addressing engineering and environmental concerns. Further coordination and refinement will be undertaken as the project progresses.

Refer to the JDA Mandogalup Local Water Management Strategy report May 2024, Reference J7502a for further details of Stormwater Drainage Strategy**.**

6. WASTEWATER DISPOSAL

Preliminary information from of Water Corporation (WC) indicates that there is no service network in the area, however, planning has been underway for a number of developments in the area and have now resolved supply issues adjacent to development that will enhance the regional network. The preliminary discussion with Water Corporation also addressed the concept for ultimate discharge from the proposed Mandogalup development area inclusive of Mandogalup East Local Structure Plan and Mandogalup West Local Structure Plan areas.

The Water Corporation have indicated that the planning and disposal strategies that we have outlined below are in accordance with their wastewater planning proposals. Peritas Consulting has also been engaged to design and document the proposed sewer network and sewer pumping station that will service Mandogalup development area.

Please refer to **Appendix E** for plans showing the proposed sewer configuration and the location of the proposed sewer pumping station.

The Development Zone will be served in accordance with preliminary Water Corporation Sewage Planning as shown in **Appendix F**.

This sewer planning identifies the need for a prefunded WWPS (Thompsons Lake Pump Station J) with a long-term pumping rate of approximately 190 litres / sec.

A series of plans have been developed by Peritas that propose a staged approach to use the existing Honeywood (Thompsons Lake Pump Station J) by diverting flow under the freeway from the southern corner of the Mandogalup precinct and upgrading the existing pump station for the increased flow conditions.

This may be a temporary or an interim measure until such time as the Mandogalup catchment develops to its full extent and as the MWLSP land comes on stream in later stages. The Water Corporation may consider allowing the early stages of the MELSP land to gravitate to that catchment to save construction of the major infrastructure necessary for the Mandogalup catchment to stall the major expenses within the Capital works for the Mandogalup area.

7. POTABLE WATER SUPPLY

Overview

Preliminary information from Water Corporation indicates that there is no service network in the area, however, planning has been underway for a number of developments to the north of the subject site and MELSP areas that have now resolved supply issues that will enhance the regional network that will also ultimately feed the urban zone that is subject of this application.

The Development Zone and MELSP area will be served in accordance with current Water Corporation Water Supply Planning and generally by extension of the proposed water mains as identified on attached sketch plan in **Figure 11.**

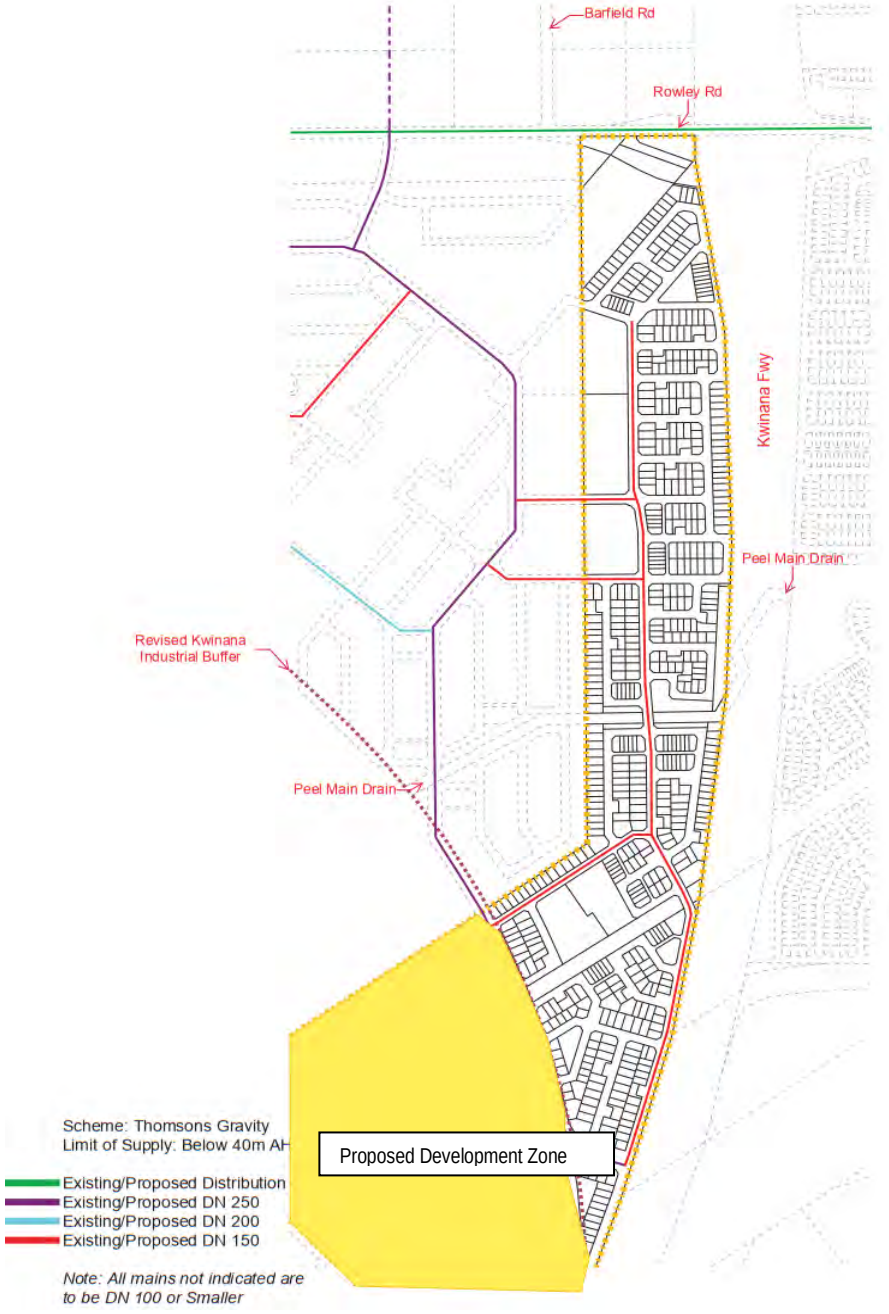


Figure 11 Water Supply Planning Capital Works

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The Water Corporation has indicated that the water distribution mains along Brushwood Boulevard and Russell Road were completed and that the 500DN extension southwards along Hammond Road/Frankland Avenue would be completed in the near future.

This would leave a section of distribution main to be completed in order to connect the northern end of the MELSP area to water supply. This infrastructure would require the construction of a combination of 375DN and possibly 900DN or 700DN water mains southwards along Frankland Avenue to the intersection of Rowley Road.

It is unclear at this stage what size mains the Water Corporation would select for the prefunded works sections of the water supply extension. The Corporation has advised that they are currently reviewing water supply generally in the Mandogalup and adjacent precincts due to the increased demand for development land in the area.

Current indications are that the mains constructed under a prefund arrangement would terminate at the intersection of future Hammond Road/Rowley Road and from there the developer (whomsoever developed first) would need to extend a minimum 250DN distribution main along Rowley Road to service the northern end of the Mandogalup precinct.

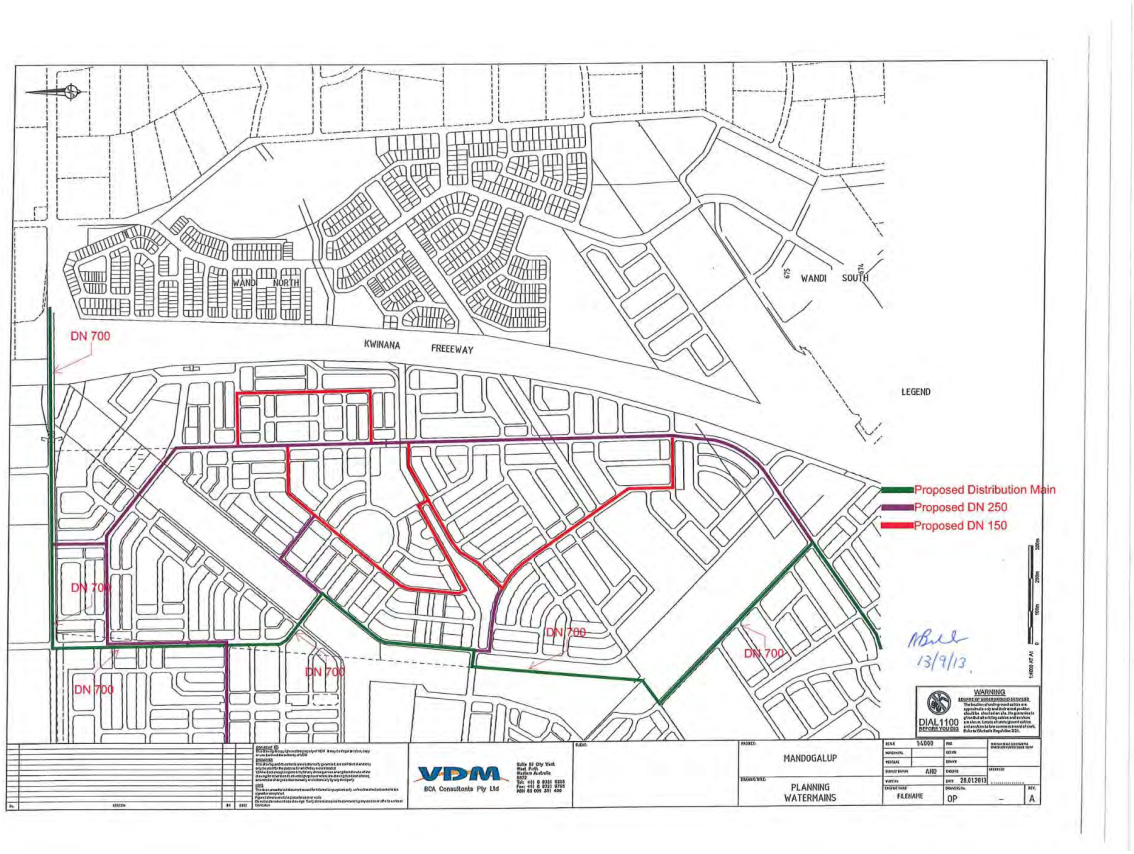


Figure 12 From Water Corporation Email – 23/02/2024

The strategy for this area as advised by the Water Corporation involves enabling developers to progressively extend large water mains (250mm) southward in phases to cater to subdivision stages. The Corporation is actively monitoring water pressure at strategic high points within the Hammond Park area, located north of Rowley Rd, to effectively time the extension of sizable distribution mains as required.

Presently, a project is underway to construct a 1.7km extension of the DN600 steel distribution main southward along Hammond Rd, aiming to intersect with the 250P mains at the intersection of Frankland Rd.
Further development stages of the distribution network are planned to proceed from the western corner of Frankland Ave, proceeding east along Frankland, and then south along Frankland up to Rowley Rd. Ultimately, this distribution main is envisaged to extend further southward as a 700mm mainline through the western perimeter of the Mandogalup development zone.

The reticulation layout plan, provided in the attached documentation, has been utilized to direct the developments of QUBE and Satterley towards the northern region.

Water Supply Reticulation System

All internal water reticulation pipework will be designed and constructed to the standards and requirements of the Water Corporation of Western Australia.

A ring main feeder system will distribute water along the major arterial roads. Internal reticulation will then proceed from this ring main into the various collector roads and cul-de-sacs.

Standard Water Corporation water headwork charges will apply.

8. POWER, TELECOMMUNICATION & GAS

8.1 WESTERN POWER

The proposed development is currently surrounded by overhead HV infrastructure ranging from local distribution network capacity lines of 22kV right up to major kV distribution lines with a capacity of 330kV. The lower order distribution network can be utilised to supply power to the development.

There are currently two options for the provision of the power infrastructure to service the development as follows:

Option 1 – Power Extension from Rowley Road.

The current Apsley Estate and Florence Estate developments in the area have extended power supply from Rowley Road`s feeder and would provide a working end for Satterley Group to utilise during the development of their futurefirst stages. The HV cable will be extended south as the development progresses until the existing power feeder reached the capacity. Some intermediate upgrades might be required during the development and will depend on development activity in the area.

Option 2 – Power supply from Anketell Road

Satterley Property Group has engaged Western Power to undertake a preliminary feasibility study to establish the capacity of the current network and its ability to serve the MESLP area (including the proposed Development Zone). The study undertaken by Western Power has indicated that the existing power network in the vicinity of MELSP area has insufficient capacity to accommodate the whole development and provided recommendations on possible network extensions that would be required to deliver power services to the estate. The copy of the feasibility study is attached in **Appendix G**.

The Development Zone will have to be served with underground power. The cost of upgrades and extensions to the existing network will need to be met in full by the developer.

Standard Western Power requirements will apply including cost for headworks upgrades and exclusions to serve the site.

Pad mount sites will be required throughout the Development Zone, however, it is not envisaged that there will be a problem in providing the sites strategically located to meet both Western Power design requirements and the requirements of the developer.

The street lighting throughout the development shall provide effective illumination for both pedestrian and vehicles.

The following criteria was used as a basis for the street lighting design.

1. Street lighting shall be provided to the entire development.
2. Lighting levels will vary from major to minor roads.

Roadway lighting will generally be at low elevations however high mast lighting will still be necessary to accomplish high illumination levels required for fast moving or heavy traffic areas.

Low height luminaires up to 6 metres high are generally used on all minor roadways and these also provide general amenity lighting to pedestrian pathways. Lighting should be suitably designed to co-ordinate with other streetscape elements such as roads, pathways, landscape, street furniture etc.

8.2 TELECOMMUNICATION SERVICES

It is anticipated that all lots within the proposed development will be served with Telecommunication services provided by an external private supply provider such as Opticomm.

The selected provider will install telecommunication facilities to the proposed subdivision, subject to the developer providing at his cost, trenching for cable laying.

Alternatively, where cable routes match Western Power underground power supply routes, the communications provider will wherever possible use the Western Power trenches in lieu of the developer providing additional trenching.

Headwork charges for Telecommunication services extensions are anticipated.

8.3 GAS SUPPLY

ATCO Gas has advised that reticulated gas services are available in the surrounding area.

ATCO Gas may provide road crossing conduits for future use; however, this is subject to cost allocations and budgets being approved by the gas authorities.

No developer contributions to provide for future reticulated gas supplies are anticipated.

8.4 DAMPIER BUNBURY NATURAL GAS PIPELINE

The Dampier – Bunbury Natural Gas Pipeline (DBNGP), as shown in Figure 13 below, traverses the subject site, and as was the case in Honeywood Estate, Wandi, earthworks in this corridor are not permitted with adjacent land being graded to maintain access and to maintain existing gas corridor levels.



Figure 13 Dampier to Bunbury Natural Gas Pipeline (DBNGP)

Services that require to cross the pipeline reserve or at road crossing locations across the reserve will need to be negotiated with DBP (Dampier Bunbury Pipeline Authority) regulation and designed to accommodate their requirements in full.

The preliminary advice received from DBP indicates that a Qualitative Risk Assessment may be required at the subdivision approval stage (as a condition of subdivision approval) to develop a pipeline protection plan which will identify the risk and mitigation measures to be implemented as part of the future development. Upon referral of relevant subdivision application, DBP will confirm whether a qualitative risk assessment is required.

Any works within DBNGP corridor area will require prior approval from the DBNGP Land Access Minister. This, however, will not provide any major technical challenges and the contracts established with the DBP regulatory authority during adjacent development will ensure streamlined approvals for any local development or infrastructure proposals associated with the subject land. The formal response from DBP and follow up email are attached in **Appendix I.**

9. CONCLUSIONS & RECOMMENDATIONS

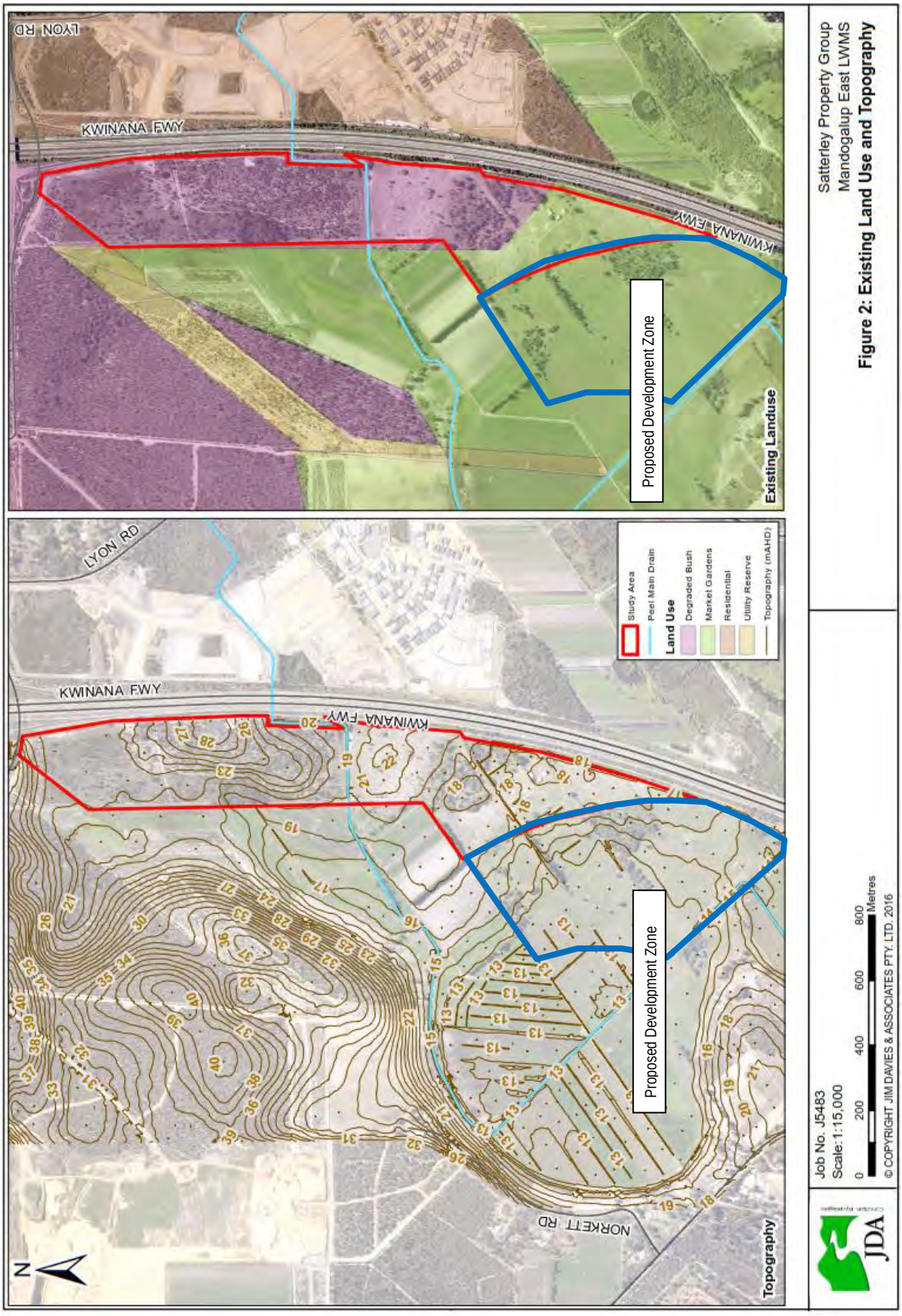
Peritas Consulting does not envisage any major servicing constraints for the proposed development and has allowed appropriate costs for major servicing infrastructure based on a stand-alone site development of the subject land.

The site is capable of being serviced with all essential services, has known soil conditions that based on completed geotechnical investigations can be treated and remediated where applicable to be consistent with expected building requirements. With careful and considered design, it is anticipated that the resulting works will be a high-quality development.

It is recommended that additional detailed work be undertaken in conjunction with the regulatory authorities and service provider to determine the land requirements associated with the necessary infrastructure as envisaged by the Water Corporation and other service authorities, and to ensure any major works are incorporated on Water Corporation capital works program that will assist in the timely delivery of the major infrastructure items detailed in this report.

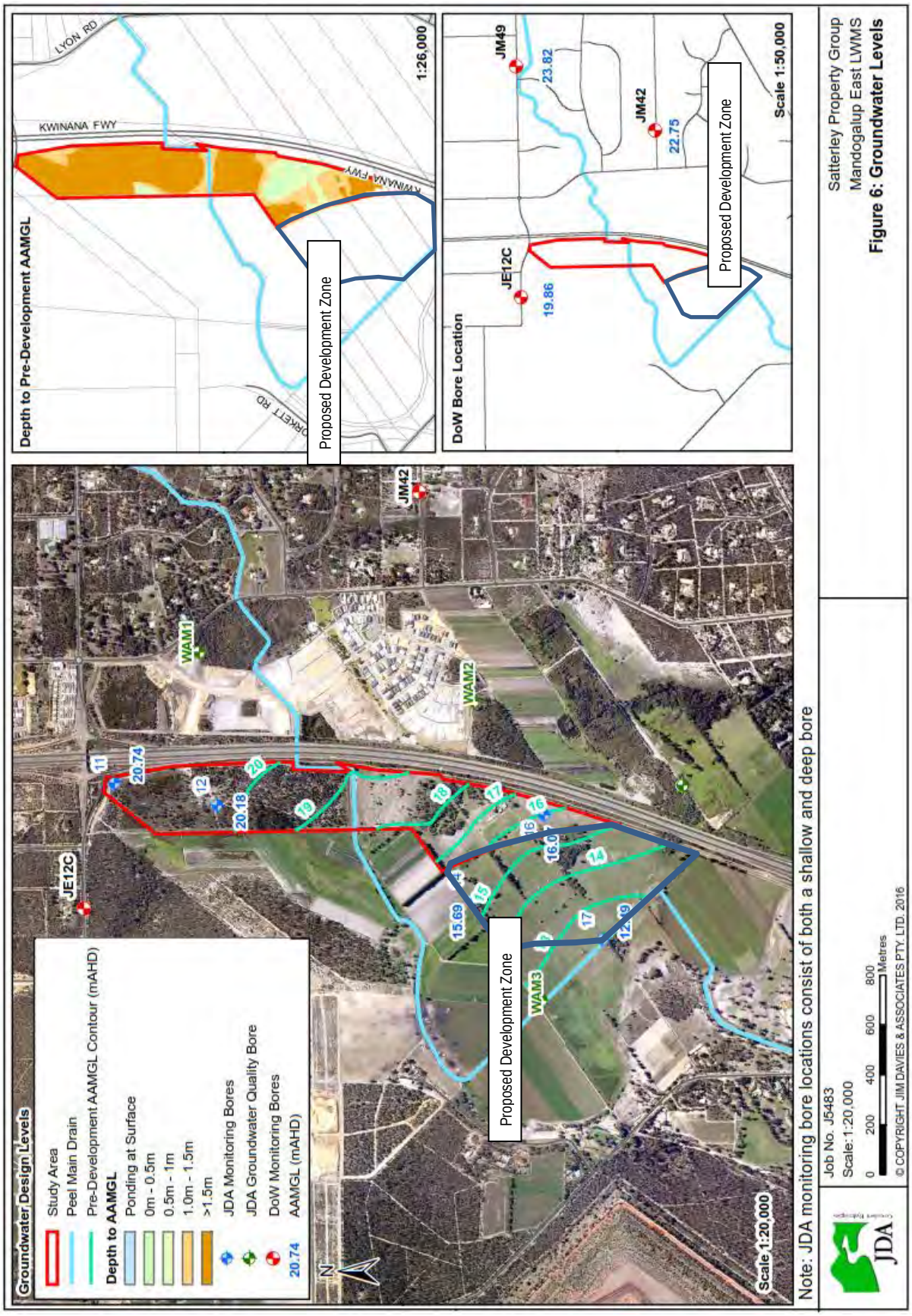
Additionally, the major service authorities should again be approached to formally confirm further details of any upgrade requirements based on the staged development of the site so that the early planning major infrastructure can be undertaken, and forward work construction programmed.

APPENDIX A - TOPOGRAPHICAL FEATURES PLAN



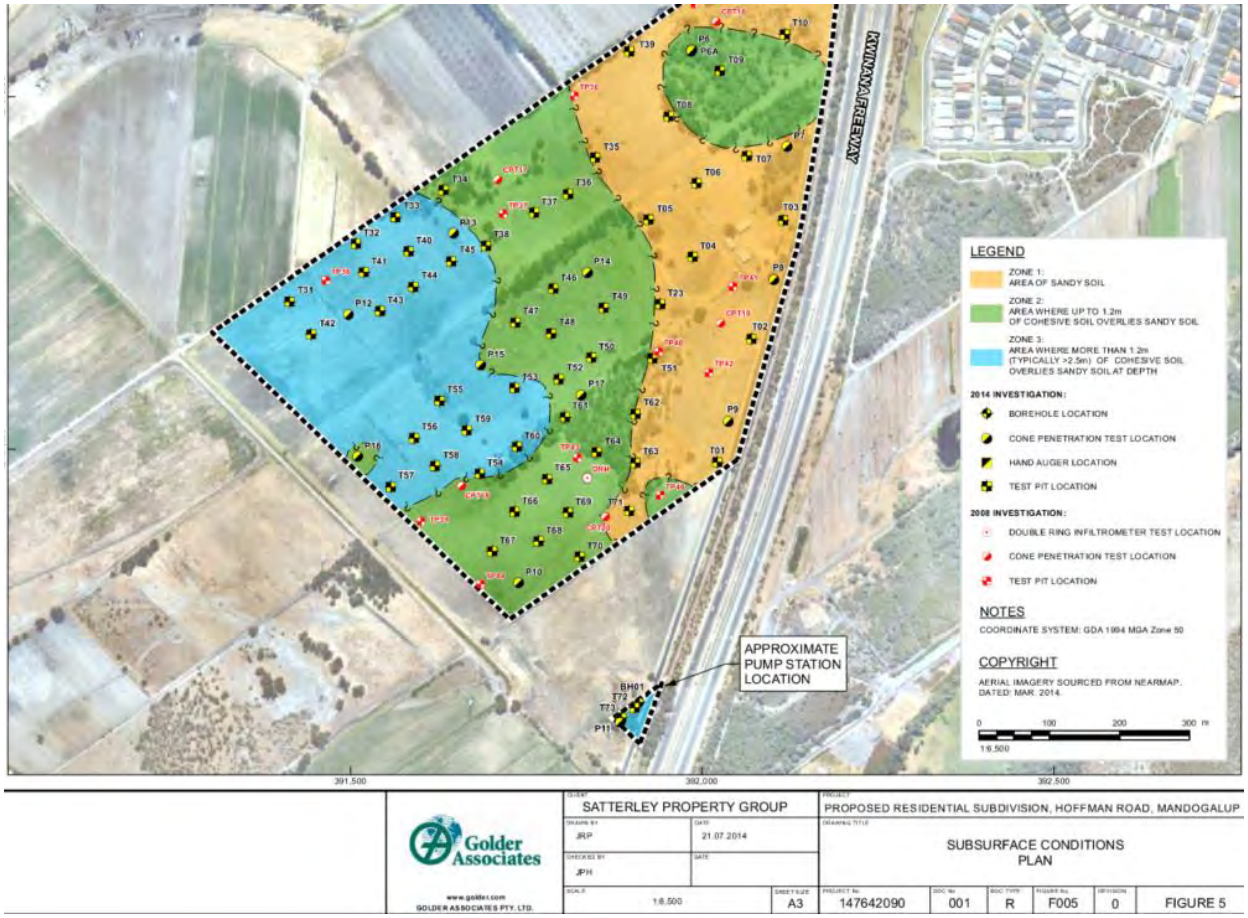
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APPENDIX B - AAMGL CONTOURS & GROUNDWATER LEVELS



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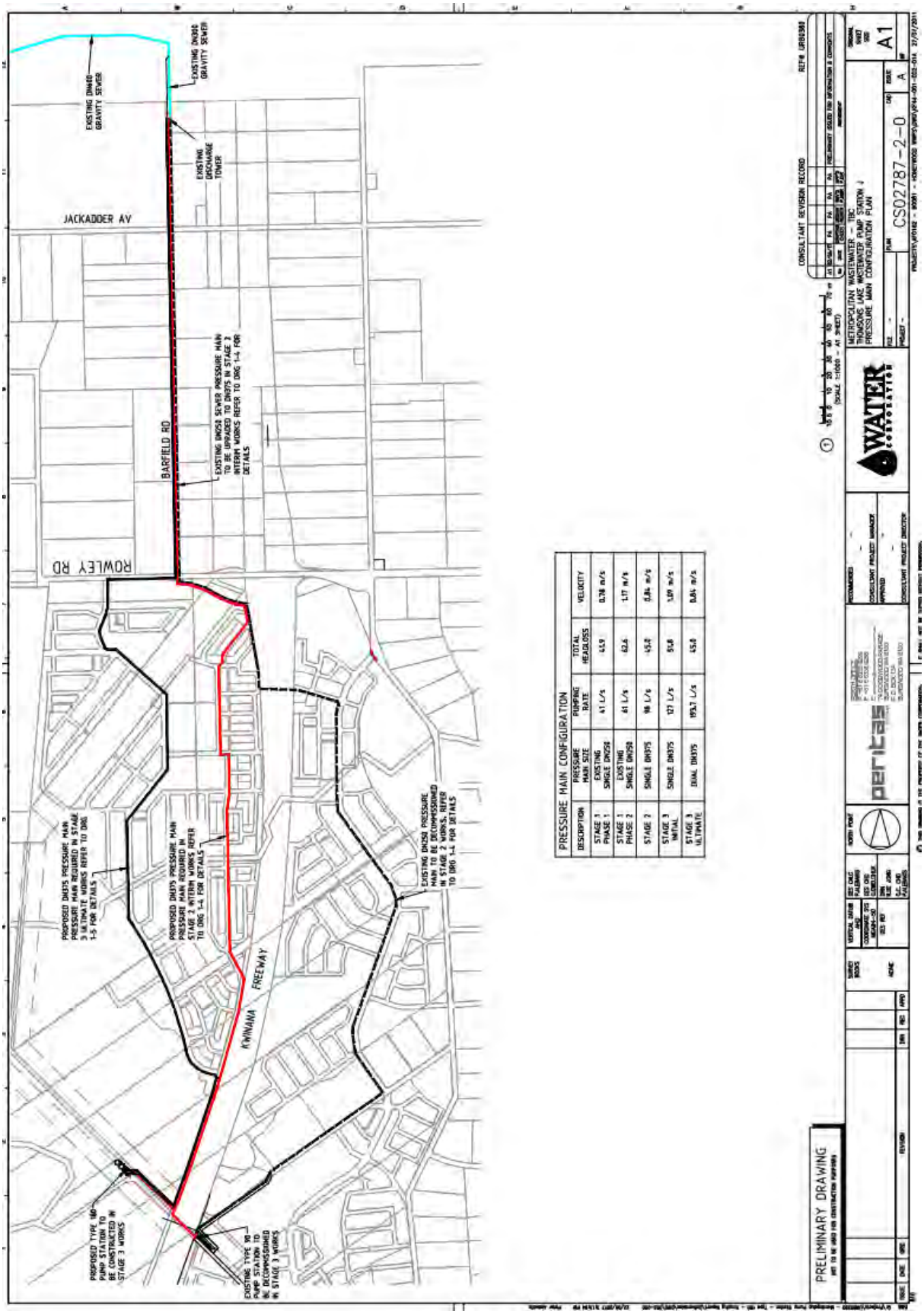
APPENDIX C – GEOTECHNICAL SITE INVESTIGATION



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APPENDIX D – DBYD SERVICES

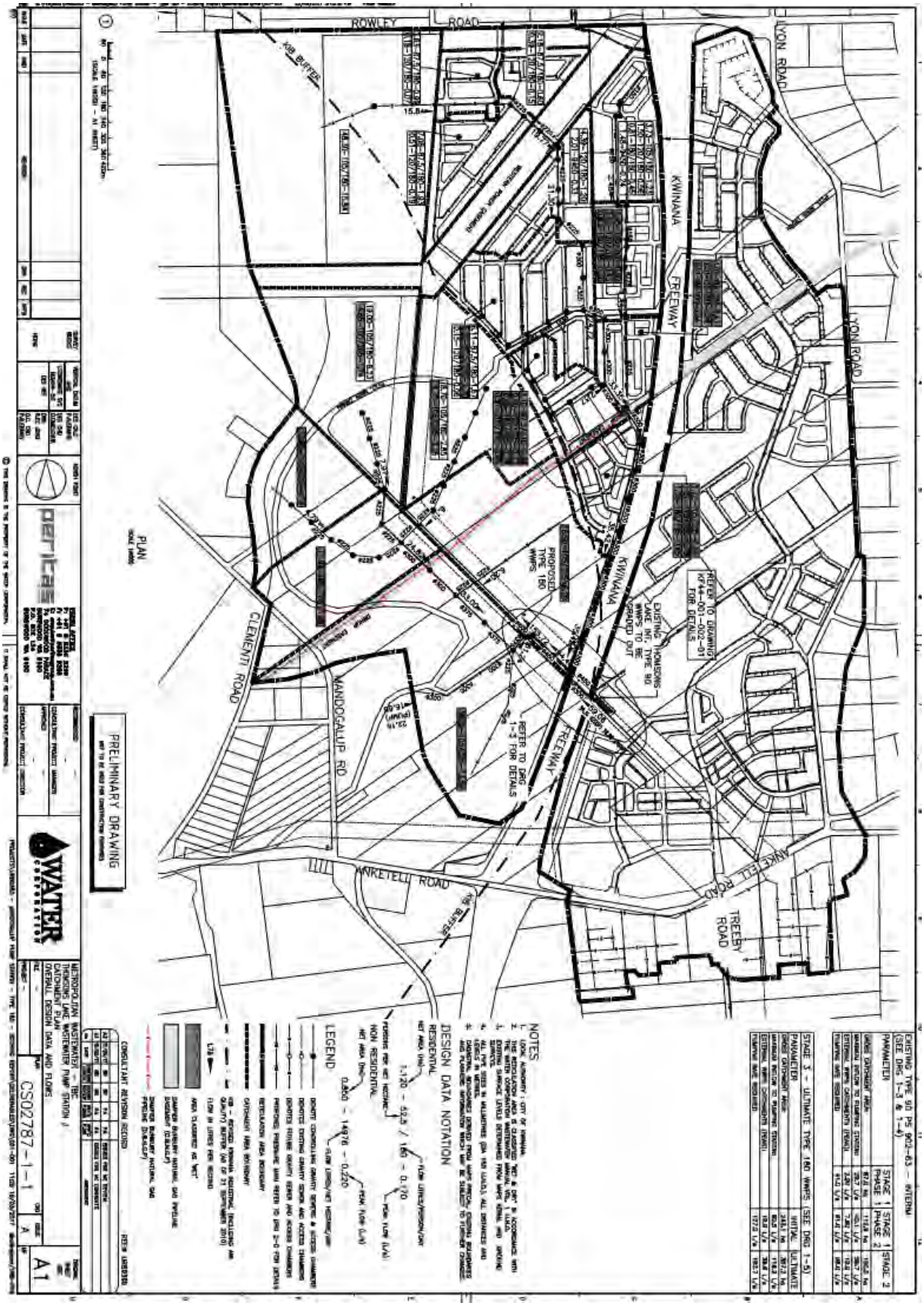
APPENDIX E - SEWAGE DISPOSAL CONCEPT PLAN



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APPENDIX F - OVERALL SEWER CATCHMENT PLAN



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APPENDIX G – WESTERN POWER FEASIBILITY STUDY

Feasibility Report

MF010540 – 4.61MVA, Mandogalup

Large Residential Development - DIP

29/06/2016

Document release information

Client	UPD
Project name	MF010540
Document number	DM#40256853
Document title	4.61MVA Mandogalup
Revision status	A

Document prepared by:

Western Power
ABN 18540492861

71 Ewing Street, Bentley 6102

Prepared by:	Reviewed by:
Aden Hoddy	Ryan Shaw
Distribution Design Network Officer	Distribution Design Coordinator

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1 Introduction

1.1 Background

Satterley Property Group Pty Ltd is planning a large freehold residential subdivision bordered by the Kwinana Fwy in Mandogalup. The development consists of 11 stages requiring an estimated 4.61MVA of network capacity. The subdivision will be released in stages with most expected to be completed by the end of 2018. The customer is seeking Western Power's advice on available network capacity to accommodate the new residential development and if there are any constraints from a Western Power perspective that would impact on the proposed development.

1.2 Purpose

The purpose of this study is to determine whether there is sufficient capacity available on the Medina (MED) HV network to accommodate the proposed residential development in Mandogalup.

The proposed outcomes from the feasibility study are:

- Determine if there is sufficient capacity available on the HV distribution network to accommodate the 4.61MVA residential development; network capacity to be assessed for all 11 stages.
- Determine the Western Power head works (if required) to reinforce the HV distribution network.
- Advise on any potential issues in relation to the proposed development.

1.3 Scope of Study

The activities that will be undertaken to achieve the specified outcomes are:

1. Network Configuration Assessment
2. Network Impact Assessment
3. Network Capacity Assessment

2 Study Activities

2.1 Activity 1 – Network Configuration Assessment

The proposed development site is adjacent to the Kwinana Fwy as shown in Figure 1 below. There are two 22kV feeders (MED504 and MED526) in the vicinity which may be used to connect the proposed subdivision.



Figure 1 - Surrounding Western Power Network

2.2 Activity 2 – Network Impact Assessment

There are currently only two 22kV HV feeders (MED504 and MED524) near the proposed development site. The model is based on the existing network plus upcoming customer loads and with the addition of a 4.61MVA load increase at the customer location.

The planning study demonstrates that the MED526 feeder has insufficient capacity to service the entire development. There does however appear to be sufficient capacity on the MED504 feeder network based on the existing feeder utilisation levels.

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3 Technical Evaluation

3.1 Network Capacity Assessment

3.1.1 Overview

Based on the existing feeder utilisation on the MED526 feeder, there is insufficient capacity available to connect the proposed development. This subdivision is to be connected to the MED504 feeder backbone by extending this feeder using 400mm2 XLPE 22kV cable. It is estimated that approximately 6.0kM of 400mm2 XLPE 22kV cable will be required to make a power supply available on the south-east boundary (near stage 11A) of the proposed development site.

3.1.2 Site Map



Figure 2 - Proposed Western Power Scope of Works

3.1.3 Western Power Works

The proposed network interface works is to install approximately 6.0km of 400mm2 HV XLPE cable from the 'Alcoa 2' RMU to the development site boundary.

3.1.4 Customer Contribution for Western Power Works

With reference to the interface works identified in section 3.1.3 the estimated customer contribution towards the Western Power works approximately is **$1,600,000** +/-30%.

Please note this estimate based on a desktop review of the required Western Power works associated with implementing this option. This estimate is non-binding and could be subject to change at completion of the Access Offer.

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3.1.5 Assumptions

The customer contribution and scope of works are dependent on the following assumptions;

- No other connection requests and changes to network conditions prior to the formal application for this connection.
- Potential environmental permits and approvals can be obtained.
- Third party approvals that may apply are granted.
- No allowance for rock excavation or rock drilling.
- Specific cable route has not been considered.
- Transmission line and transformer capacity has not been considered.
- Existing overhead network that may be impacted by the development site has not been considered.

3.1.6 Application Requirements

Developers are responsible to engage Electrical Consultants to produce the UDS subdivisions electrical reticulation designs in accordance with the Underground Distribution Scheme manual.

Western Power will:

- Provide the Designer Organisations with a Design Information Package (DIP) appropriate to the developments and their locations.
- Audit the UDS designs certified by Engineers on random basis to ensure they conform to Western Power's design requirements, planning criteria and construction practices.

For more information on the DIP process, please refer to section 4.3 of the UDS manual. The Western Power scope of works detailed in section 3.1.3 of this document will be resolved during the DIP process and will need to be completed prior to WAPC approval.

Reference of this feasibility study should be included within the formal DIP submission to Western Power.

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4 Conclusions and Recommendations

Network Planning network analysis has identified there is insufficient capacity available on the nearby HV feeder and the recommendation is to extend the MED504 feeder to the development site to provide the supply.

A transmission capacity clearance has not been conducted as part of this planning study.

There is an existing overhead transmission line to the south of the development site which is within close proximity to several residential stages. Consideration should be noted in relation to the transmission easement restriction zones.

If you would like further information about easements or to check whether you have an easement registered on your Certificate of Title please contact us on the details below.

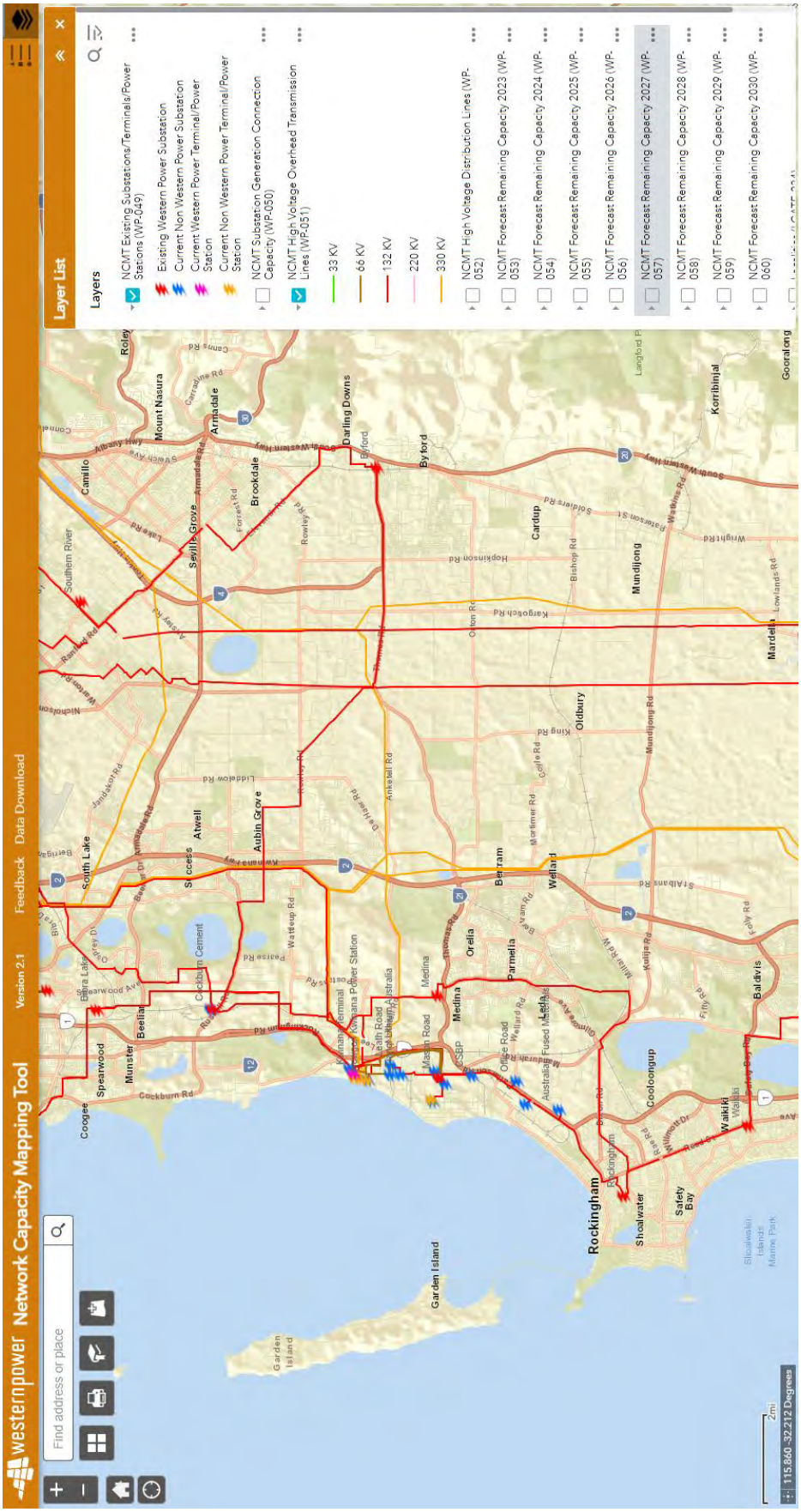
Email: enquiry@westernpower.com.au, Phone: 13 10 87

Please take note that the information herein is provided in good faith and is accurate at the time of issue. Power systems are dynamic in nature, due to the connection of new users and changes in consumer behaviour. As such, Western Power's distribution electricity networks will change over time - this may have a bearing on the amount of reinforcement required to accommodate new developments.

As capacity cannot be reserved, it is possible that requirements will also be altered, resulting in a significant variation in power infrastructure requirements. There may be other competing application for new loads or upgrades which may use the available spare capacity.

Applicants need to be aware that Western Power's response may become out-of-date, resulting in a significant variation in power infrastructure requirements. To provide a firm connection proposal and cost, a formal application to Western Power will need to be made, in accordance with current connection policies.

APPENDIX H – WESTERN POWER TRANSMISSION LINES



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APPENDIX I – DAMPIER BUNBURY PIPELINE`S ADVICE

Your Ref: East Mandogalup LSP
Our Ref: LM/Works; Dec 2016
Contact: Neil Parry
Telephone: 08 9223 4944

DBNGP (WA) Nominees Pty Limited
ABN 78 081 609 289
Level 6, 12-14 The Esplanade
Perth WA 6000
Postal Address
PO Box Z5267
Perth St Georges Tce WA 6831
Telephone: +61 8 9223 4300
Facsimile: +61 8 9223 4301

12 December 2016

Rebecca Cummings
Designer, Rowe Group
Level 3, 369 Newcastle Street
Northbridge WA 6003

Dear Rebecca

PROPOSED MANDOGALUP EAST LOCAL STRUCTURE PLAN

I refer to the email correspondence in recent weeks to Kathryn Chick at DBP regarding the amended East Mandogalup Local Structure Plan (LSP).

I note and acknowledge that the LSP has undergone some beneficial amendments since we commented last in August 2015. As such I can confirm and advise that DBP is supportive of the proposed LSP subject to being able to fully consider and input into future subdivisional plans that flow through in the future.

Some relevant comments and advice notes are provided below.

- The plan proposes residential at a density less than R80 in close proximity to the DBNGP which is in line with the current land use classification and design basis of the pipe at that location.
- A comprehensive Qualitative Risk Assessment will be required at the subdivision approval stage to develop a pipeline protection plan which will identify the risk and the mitigation measures that need to be implemented as part of future development.
- Pursuant to section 41 of the *Dampier to Bunbury Pipeline Act 1997*, restrictions apply to the DBNGP corridor and any works within the corridor area requires prior approval from the DBNGP Land Access Minister.
- DBP will require a notification to be placed on the titles of the newly created lots adjacent to the DBNGP corridor advising of the existence of the DBNGP.

Should you have any questions in relation to DBP's comments, please do not hesitate to contact me on the number above.

Yours sincerely

Neil Parry
Manager, Land Management
Dampier Bunbury Pipeline

PN

Wed 22/03/2017 3:06 PM

Parry, Neil <Neil.Parry@dbp.net.au>

RE: Mandogalup East Development Project (Satterly) - Pipeline Risk Assessment Workshop (Dampier to Bunbury Natural Gas Pipeline)

To Rob Thornton

Cc Rebecca Cumming; Chick, Kathryn

Rob,

We have relooked at the conditions associated with the East Mandogolup Structure Plan and note the following.

We have requested a QRA at the subdivision stage. If undertaken now any changes that are made between now and the sub division application being lodged may give rise to the need to repeat the process which is not desirable. Looking at the latest design which incorporated our comments in relation to the proposed school etc, , and with the demise of PB 87 as an instructive document it may well be that a risk assessment is not require and we are happy to make that decision at the subdivision stage.

If a risk assessment is not require the works can be managed under the normal Section 41 application and approval process.

Thanks

Neil Parry
Manager, Land Management
System Design and Operations
DBP
Level 7, 12-14 The Esplanade, Perth WA 6000
Telephone: (08) 9223 4944 | Facsimile: (08) 9223 4322 | Mobile: 045 75 19191
neil.parry@dbp.net.au
www.dbp.net.au

APPENDIX J – STORMWATER MODELLING RESULTS

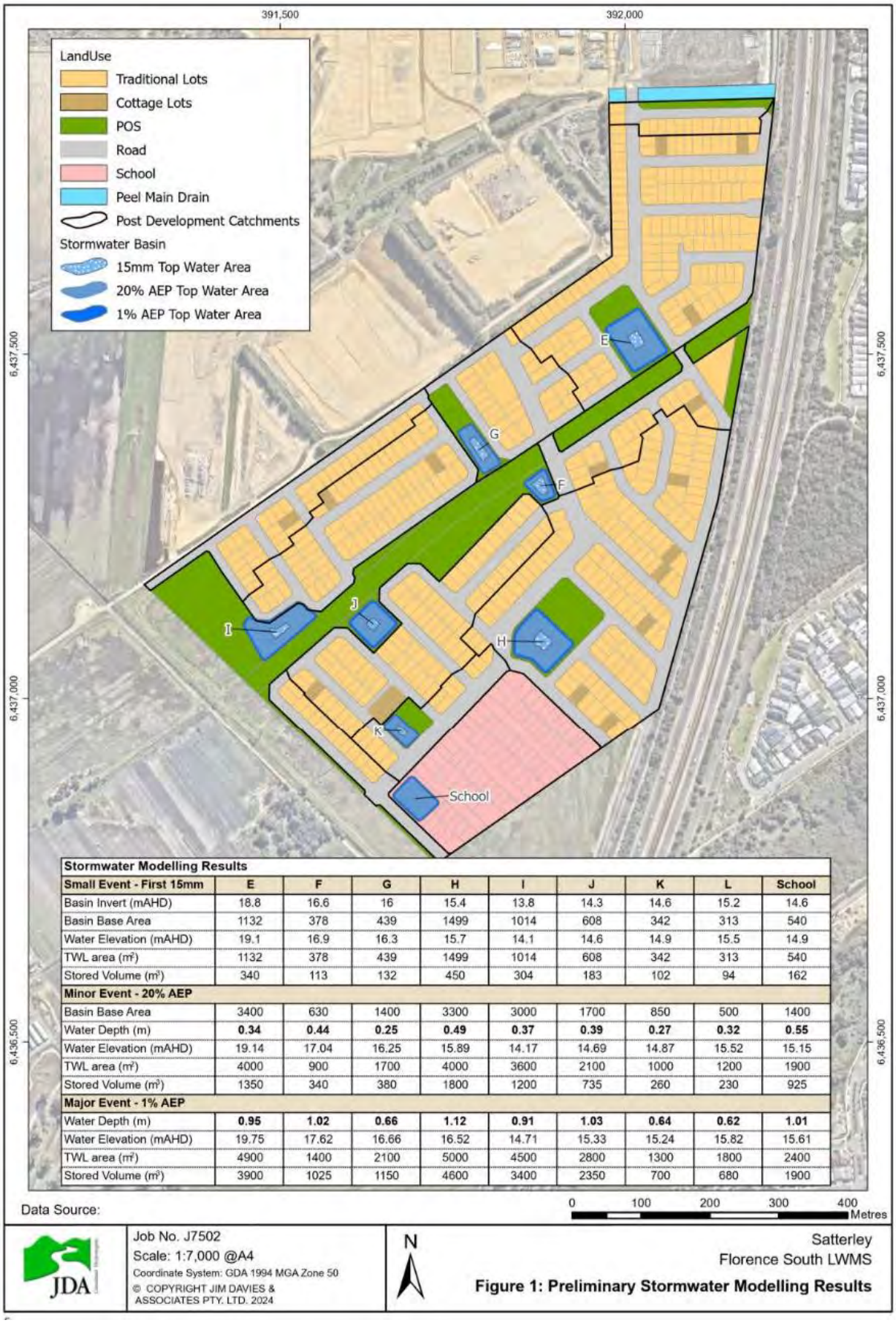
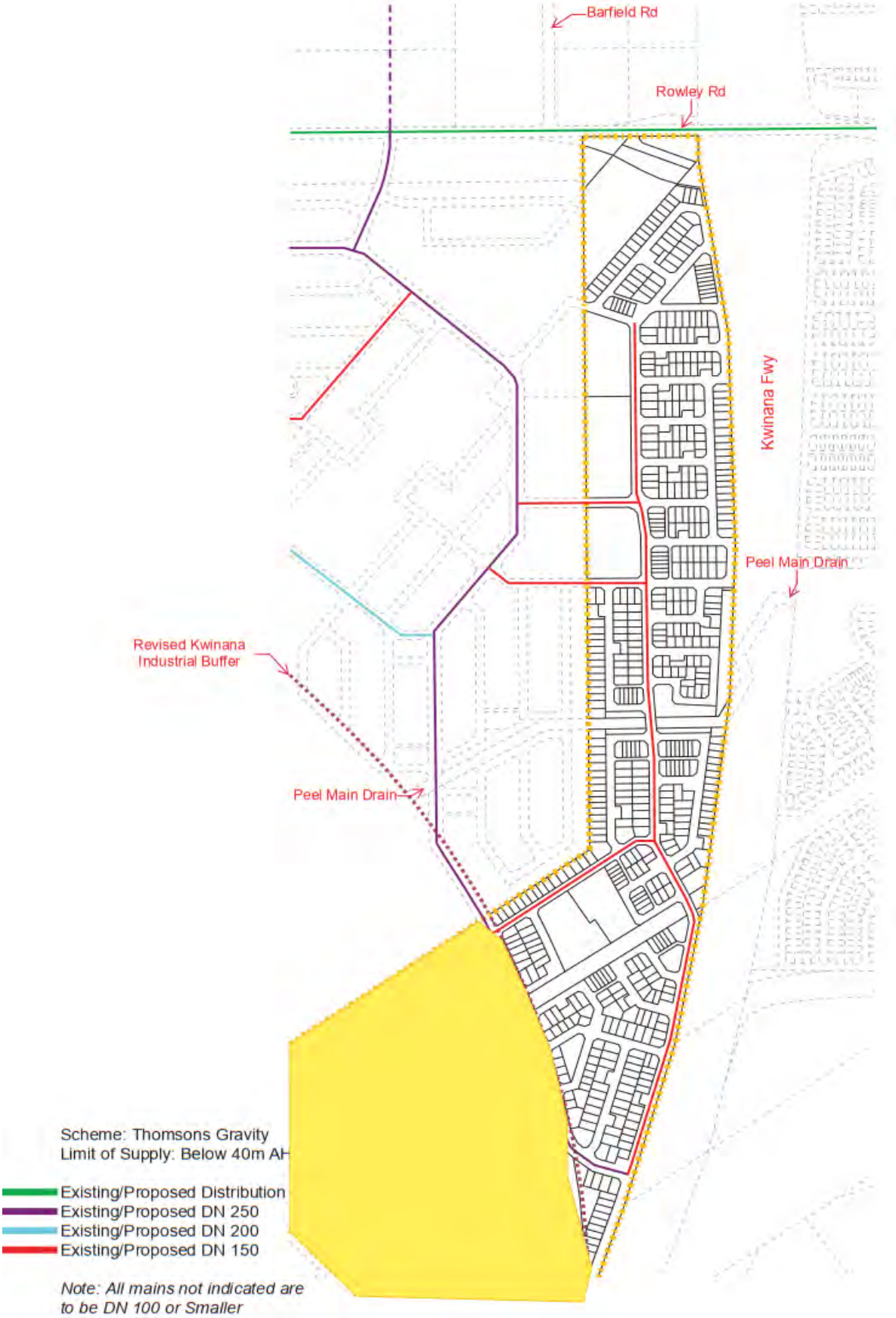


Figure 1: Preliminary Stormwater Modelling Results

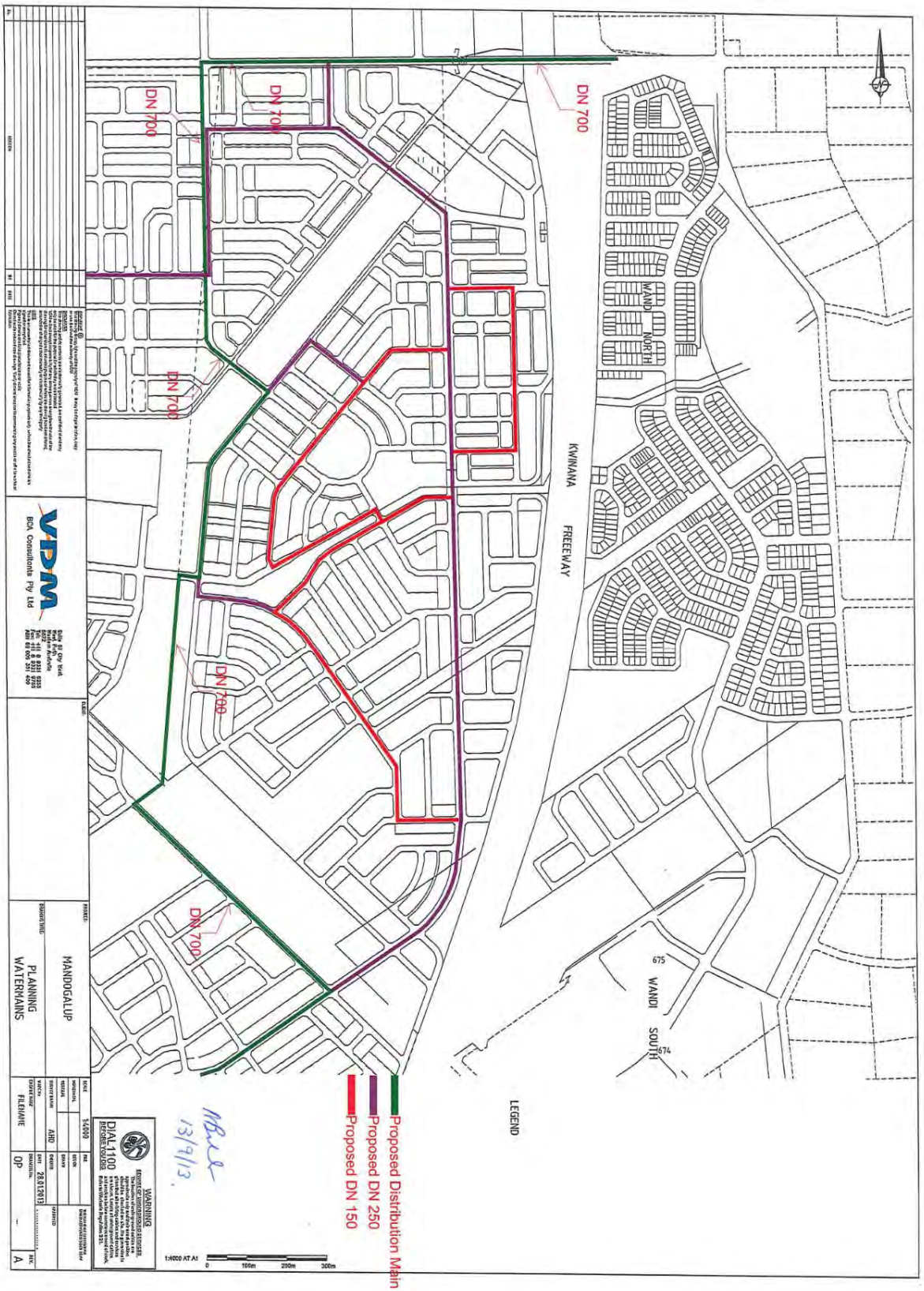
Stormwater Modelling Results									
Small Event - First 15mm	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**School**
Basin Invert (mAHD)	18.8	16.6	16	15.4	13.8	14.3	14.6	15.2	14.6
Basin Base Area	1132	378	439	1499	1014	608	342	313	540
Water Elevation (mAHD)	19.1	16.9	16.3	15.7	14.1	14.6	14.9	15.5	14.9
TWL area (m²)	1132	378	439	1499	1014	608	342	313	540
Stored Volume (m³)	340	113	132	450	304	183	102	94	162
Minor Event - 20% AEP									
Basin Base Area	3400	630	1400	3300	3000	1700	850	500	1400
Water Depth (m)	**0.34**	**0.44**	**0.25**	**0.49**	**0.37**	**0.39**	**0.27**	**0.32**	**0.55**
Water Elevation (mAHD)	19.14	17.04	16.25	15.89	14.17	14.69	14.87	15.52	15.15
TWL area (m²)	4000	900	1700	4000	3600	2100	1000	1200	1900
Stored Volume (m³)	1350	340	380	1800	1200	735	260	230	925
Major Event - 1% AEP									
Water Depth (m)	**0.95**	**1.02**	**0.66**	**1.12**	**0.91**	**1.03**	**0.64**	**0.62**	**1.01**
Water Elevation (mAHD)	19.75	17.62	16.66	16.52	14.71	15.33	15.24	15.82	15.61
TWL area (m²)	4900	1400	2100	5000	4500	2800	1300	1800	2400
Stored Volume (m³)	3900	1025	1150	4600	3400	2350	700	680	1900

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APPENDIX K – STORMWATER MODELLING RESULTS



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