EAST ROSELEA STRUCTURE PLAN

VARIOUS LANDHOLDINGS

BALCATTA

ROWE GROUP DESIGN

DOCUMENT CONTROL

Printed 8 March 2021 8686_21mar01R_rd

VERSION	FILE NAME	PREPARED BY	APPROVED BY	DATE
1	8686_18feb01R_rd	Reyne Dial	George Hajigabriel	23/02/2018
2	8686_18feb02R_rd	Reyne Dial	George Hajigabriel	21/05/2018
3	8686_18jul01R_rd v3	Reyne Dial	George Hajigabriel	17/08/2018
4	8686_20nov01R_rd	Reyne Dial	George Hajigabriel	21/12/2020
5	8686_21jan01R_gh	Rebecca Thompson	George Hajigrabiel	14/01/2021
6	8686_21jan02R_ rd.docx	Reyne Dial	George Hajigrabiel	10/02/2021
7	8686_21mar01R_ rd.docx	Reyne Dial	George Hajigrabiel	08/03/2021

This report has been authorised by;

George Hajigabriel	Reyne Dial	Jamie Baxter
General Manager	Senior Urban Planner	Quality Control

CONTACT PERTH OFFICE

p 9221 1991 **e** info@rowegroup.com.au **w** rowegroup.com.au
a 3/369 Newcastle Street, Northbridge 6003

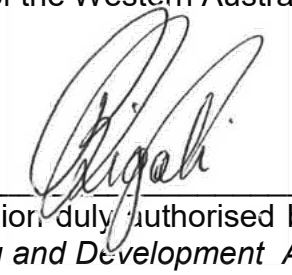
Although all care has been taken on the compilation of this document Greg Rowe Pty Ltd and all parties associated with its preparation disclaim any responsibility for any errors or omissions. The right is reserved to change this document at any time. This document does not constitute an invitation, agreement or contract (or any part thereof) of any kind whatsoever. Liability is expressly disclaimed by Greg Rowe Pty Ltd for any loss or damage which may be sustained by any person acting on this document.

© 2021 Greg Rowe Pty Ltd All Rights Reserved. Copyright in the whole and every part of this document belongs to Greg Rowe Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Greg Rowe Pty Ltd.

This structure plan is prepared under the provisions of the City of Stirling Local Planning Scheme No. 3.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON: **29 APRIL 2021**

Signed for and on behalf of the Western Australian Planning Commission



_____

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

_____ Witness

29 APRIL 2021 Date

29 APRIL 2031 Date of Expiry

TABLE OF AMENDMENTS

AMENDMENT NO.	SUMMARY OF THE AMENDMENT	AMENDMENT TYPE	DATE APPROVED BY WAPC

EXECUTIVE SUMMARY

This Structure Plan addresses the land known as East Roselea, comprising various landholdings generally bound by Grindleford Drive, Karrinyup Road and Albert Street in Balcatta. The subject site is herein referred to as the East Roselea Structure Plan (the 'Structure Plan'). The Structure Plan comprises a total of 29.7 hectares of land which is zoned 'Urban' under the *Metropolitan Region Scheme* and is zoned 'Development' under the *City of Stirling Local Planning Scheme No. 3*.

The site is situated approximately 7.5 kilometres north-west of the Perth Central Area and approximately 3.8 kilometres from the Karrinyup Shopping Centre. The site presently accommodates a number of existing land uses, including residential development along Albert Street, the Chung Wah Association function centre and associated facilities within Lot 63, the Macedonian Club sporting complex within Lot 153, the Sicilian Club within Lot 51, a newly redeveloped Local Centre within Lots 150 – 151 and 139 and areas of recreational open space.

This Structure Plan seeks to facilitate the subdivision and development of the land for a mix of residential, civic use and commercial land uses in a manner that interacts appropriately with the existing urban environment in this locality. Specifically, the Structure Plan will provide for:

- Residential lots with the applicable density codes ranging from 'R30' to 'R80';
- A 'Special Use' comprising the existing Chung Wah Association's facility will allow for the future expansion of the facility in accordance with the Association's development aspirations;
- 'Additional Uses' over the Siciliani Association of WA Inc. landholding and the City of Stirling's northernmost land parcel to allow for the continued operation of the respective club premises.
- A Local Centre comprising the existing medical centre and associated consulting rooms and newly developed shopping centre; and
- Public Open Space, which has been designed and located to accommodate the City of Stirling's development aspirations to provide for a mix of uses such as playing fields, club rooms, playgrounds and other such active and passive uses.

This Structure Plan has therefore been prepared in accordance with the requirements of the *City of Stirling Local Planning Scheme No. 3* to facilitate the subdivision and development of the site. The purpose of the Structure Plan is to provide a plan for the coordination of future zoning and subdivision of the subject site to facilitate development for residential purposes, complementary to its 'Urban' zoning under the *Metropolitan Region Scheme*.

The preparation of the Structure Plan has been undertaken in consultation with the City of Stirling and other relevant stakeholders.

STRUCTURE PLAN SUMMARY

ITEM	DATA	SECTION NUMBER REFERENCED IN PART 2 OF REPORT
Total area covered by the Structure Plan	29.7 hectares	1.2
Area of each land use proposed:		4
Zones Residential Local Centre Special Use **Reserves** Road Reserves Park Recreation and Drainage (Proposed) Park Recreation (Existing)	 11.55 hectares 2.8 hectares 3 hectares 6.1 hectares 2.89 hectares 3.4 hectares	
Total estimated lot yield	500 lots	4.3
Estimated number of dwellings	528 dwellings	4.3
Estimated residential site density	35 dwellings per site hectare 17 dwelling per gross urban hectare	4.3
Estimated population	1,150 people based on 2.3 persons per household	4.3
Number of high schools	N/A	4.6
Number of primary schools	N/A	4.6
Estimated commercial floor space	0.56 hectares, comprising: - 0.36 hectares proposed; - 0.20 hectares existing.	4.7
Estimated area and percentage of public open space given over to:		4.2
- Playing Fields (Existing) - Neighbourhood parks - Drainage Swale	3.38 hectares (11.4%) 1 park 1.62 hectares (5.5%) 3 parks 1.26 ha (4.2%) 5 parks	
Estimate percentage of natural area	Nil	3.1, 4.2

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

CONTENTS

DOCUMENT CONTROL i

RECORD OF ENDORSEMENT ii

TABLE OF AMENDMENTS iii

EXECUTIVE SUMMARY iv

STRUCTURE PLAN SUMMARY v

PART ONE **1**

1. STRUCTURE PLAN AREA 2

2. OPERATION 2

3. STAGING 2

4. SUBDIVISION & DEVELOPMENT REQUIREMENTS 2

4.1. PUBLIC OPEN SPACE 2

4.2. RESIDENTIAL DENSITIES AND DEVELOPMENT STANDARDS 3

5. LOCAL DEVELOPMENT PLANS 3

6. OTHER REQUIREMENTS 3

6.1. EARTHWORKS 3

6.2. NOTIFICATIONS ON TITLES 3

6.3. PUBLIC OPEN SPACE CONTRIBUTION 4

7. ADDITIONAL INFORMATION 4

PART TWO **6**

1. PLANNING BACKGROUND 7

1.1. INTRODUCTION AND PURPOSE 7

1.2. LAND DESCRIPTION 7

1.2.1. LOCATION 7

1.2.2. AREA AND LAND USE 10

1.2.3. LEGAL DESCRIPTION AND OWNERSHIP 12

2. PLANNING FRAMEWORK 15
2.1. ZONING AND RESERVATIONS 15
2.1.1. METROPOLITAN REGION SCHEME 15
2.1.2. CITY OF STIRLING LOCAL PLANNING SCHEME NO. 3 15
2.2. SUB-REGIONAL STRUCTURE PLAN 18
2.2.1. PERTH AND PEEL @ 3.5 MILLION / CENTRAL SUB-REGIONAL PLANNING FRAMEWORK 18
2.3. PLANNING STRATEGIES 18
2.3.1. BALCATTA AND STIRLING LOCAL AREA PLAN 18
2.4. POLICIES 19
2.4.1. LIVEABLE NEIGHBOURHOODS 19
2.4.2. STATE PLANNING POLICY 5.4 – ROAD AND RAIL NOISE 19
2.4.3. DEVELOPMENT CONTROL POLICY 2.3 – PUBLIC OPEN SPACE IN RESIDENTIAL AREAS 20
2.4.4. LOCAL PLANNING POLICIES 21
3. SITE CONDITIONS & CONSTRAINTS 22
3.1. BIODIVERSITY AND NATURAL AREA ASSETS 22
3.1.1. FLORA AND VEGETATION 22
3.1.2. FAUNA 22
3.1.3. WETLANDS 22
3.2. LANDFORM AND SOILS 22
3.2.1. ACID SULPHATE SOILS 23
3.2.2. CONTAMINATION 23
3.3. BUSHFIRE RISK 24
3.4. GROUNDWATER AND SURFACE WATER 24
3.4.1. GROUNDWATER 24
3.4.2. SURFACE WATER 25
3.5. HERITAGE 25
3.6. NOISE MANAGEMENT 25
3.7. OTHER LAND USE CONSTRAINTS & OPPORTUNITIES 26
3.7.1. CHUNG WAH ASSOCIATION 26
3.7.2. MACEDONIA CLUB 28
3.7.3. SICILIAN CLUB 28
3.7.4. DRAINAGE SWALE / ROAD WIDENING 28
3.7.5. EASEMENT 29

4. LAND USE AND SUBDIVISION REQUIREMENTS 30
4.1. LAND USE 30
4.2. PUBLIC OPEN SPACE 33
4.2.1. CITY OF STIRLING PUBLIC OPEN SPACE STRATEGY 38
4.2.2. DRAINAGE SWALE 39
4.2.2.1. CITY OF STIRLING OWNED LAND 40
4.2.2.2. COORDINATION OF PUBLIC OPEN SPACE WORKS 40
4.2.2.3. BUILT-FORM OUTCOMES 40
4.2.2.4. MAINTENANCE 41
4.2.3. COMMUNITY PURPOSE SITE 41
4.2.4. CASH IN LIEU ARRANGEMENTS 42
4.3. RESIDENTIAL 43
4.3.1. LOCAL DEVELOPMENT PLANS 45
4.4. MOVEMENT NETWORKS 46
4.4.1. EXISTING ROAD NETWORK 46
4.4.1.1. KARRINYUP ROAD 46
4.4.1.2. GRINDLEFORD DRIVE 46
4.4.1.3. ALBERT STREET 46
4.4.2. PROPOSED ROAD NETWORK 47
4.4.2.1. PEDESTRIAN AND CYCLE NETWORK 49
4.4.3. PUBLIC TRANSPORT 49
4.5. WATER MANAGEMENT 50
4.5.1. LOCAL WATER MANAGEMENT STRATEGY 50
4.5.2. PROPOSED STORMWATER MANAGEMENT STRATEGY 50
4.5.2.1. LOT STORAGE 50
4.5.2.2. VEGETATED SWALES 51
4.5.2.3. BIO-RETENTION AREAS 51
4.5.2.4. FLOOD STORAGE AREAS 51
4.5.2.5. DISCHARGE TO EXTERNAL STORMWATER NETWORKS 52
4.5.3. GROUNDWATER MANAGEMENT 52
4.5.4. URBAN WATER MANAGEMENT PLAN 53
4.6. EDUCATION FACILITIES 54
4.7. ACTIVITY CENTRES AND EMPLOYMENT 54
4.7.1. SECONDARY CENTRES 54

4.7.2. DISTRICT CENTRES 54
4.7.3. NEIGHBOURHOOD / LOCAL CENTRE 55
4.7.4. COMMUNITY FACILITIES 55
4.8. INFRASTRUCTURE COORDINATION, SERVICING AND STAGING 60
4.8.1. WATER SUPPLY 60
4.8.2. SEWERAGE 60
4.8.3. NATURAL GAS 60
4.8.4. ELECTRICITY 60
4.8.5. TELECOMMUNICATIONS 60
4.8.6. EARTHWORKS 61
4.8.7. STAGING 62
4.9. DEVELOPER CONTRIBUTION ARRANGEMENTS 63

PART THREE 65

TECHNICAL APPENDICES

APPENDIX NUMBER	DOCUMENT TITLE	NATURE OF DOCUMENT	REFERRAL/APPROVAL AGENCY	APPROVAL STATUS AND MODIFICATIONS
1	Certificates of Title	Supporting	-	
2	Acoustic Report	Approval Required	Main Roads WA / City of Stirling	
3	Environmental Assessment Report	Supporting	Department of Parks and Wildlife	
4	Chung Wah Association Submission	Supporting	-	
5	Macedonian Club Submission	Supporting	-	
6	Sicilian Club Submission	Supporting	-	
7	Landscape Masterplan	Supporting	City of Stirling	
8	Transport Impact Assessment	Supporting	Main Roads WA / City of Stirling	
9	Local Water Management Strategy	Approval Required	Department of Water and Environmental Regulation	
10	Retail Sustainability Assessment	Supporting	City of Stirling	
11	Engineering Services Report	Supporting	-	

FIGURES

PLAN 1. ROSELEA EAST LOCAL STRUCTURE PLAN 5

1. REGIONAL LOCATION 8
2. LOCAL LOCATION 9
3. SITE PLAN 11
4. LANDOWNERSHIP PLAN 14
5. METROPOLITAN REGION SCHEME ZONING 16
6. CITY OF STIRLING LOCAL PLANNING SCHEME NO. 3 ZONING 17
7. INDICATIVE RESIDENTIAL LAYOUT – CHUNG WAH ASSOCIATION LANDHOLDING 27
8. INDICATIVE ZONING AND RESIDENTIAL DENSITY CODE PLAN 32
9. PUBLIC OPEN SPACE PLAN 35
10. PUBLIC OPEN SPACE SCHEDULE 36
11. COMMUNITY AMENITY CATCHMENT – PEDSHED ANALYSIS 37
12. INDICATIVE SUBDIVISION LAYOUT 44
13. INDICATIVE MOVEMENT NETWORK 48

TABLES

1. TABLE 1: PROJECT TEAM 7
2. TABLE 2: LOT DETAILS 13
3. TABLE 3 - LAND USE SUMMARY TABLE 31
4. TABLE 4: ROAD CLASSIFICATIONS 47
5. TABLE 5 - ASSESSMENT OF PUBLIC OPEN SPACE AND COMMUNITY FACILITIES 57

PART ONE

IMPLEMENTATION

ROWE GROUP DESIGN

1. STRUCTURE PLAN AREA

This Structure Plan applies to Lots 50, 86, 88, 109, 114, 129, 400 and 801 Grindleford Drive, Lots 30, 49, 52, 66, 89, 108, 128, 141, 151 and 153 Albert Street, Lots 87, 139, 150, and 350 Karrinyup Road, Lot 51 Sicilia Place, and Lot 64 Radalj Place, Balcatta, comprising the land identified within the inner edge of the line denoting the Structure Plan boundary on the Structure Plan map (refer Plan 1).

2. OPERATION

This Structure Plan comes into effect on the day it is approved by the Western Australian Planning Commission.

3. STAGING

Given the fragmented ownership of the Structure Plan, initial stages of development will likely be undertaken by the current active landowner being, ABN Development No. 1 Pty Ltd, representing Lots 30 and 39 Albert Street and Lots 86, 88 and 129 Grindleford Drive. The expansion of the local centre and public open space delivery is also likely to be undertaken as part of the initial development stages.

The balance of residential development will be undertaken in due course upon progression of detailed design by the relevant landowners.

Given the siting and location of the Structure Plan, access and servicing is generally readily available to all existing lots and therefore staging of development in a coordinated manner is not necessary to ensure the appropriate delivery of infrastructure in accordance with the Local Structure Plan.

4. SUBDIVISION & DEVELOPMENT REQUIREMENTS

The Structure Plan identifies land use zones and reserves applicable within the Structure Plan area in accordance with the zones and reserves listed in the local planning scheme.

4.1. PUBLIC OPEN SPACE

The Structure Plan is to provide for a minimum of ten per cent (10%) of the gross subdivisible area as public open space in accordance with Western Australian Planning Commission's *Liveable Neighbourhoods*. Public open space should be provided generally in accordance with Plan 1.

4.2. RESIDENTIAL DENSITIES AND DEVELOPMENT STANDARDS

Dwelling Targets

It is anticipated that the Structure Plan area will accommodate approximately 528 dwellings, with an average of at least:

a) 35 dwellings per site hectare across the structure plan area; and

b) 17 dwellings per gross urban hectare across the structure plan area.

Residential Density

Plan 1 sets out the residential density codes that apply to the structure plan area.

5. LOCAL DEVELOPMENT PLANS

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

a) Lot 63 (Chung-Wah Association owned land) is substantially redeveloped, to ensure that development occurs in a coordinated manner and preserves the potential extension of the north-south spine road through the site in the future;

b) Lots abutting public open space;

c) Lots abutting the drainage swale; and

d) Lots subject to quiet house design requirements.

6. OTHER REQUIREMENTS

6.1. EARTHWORKS

With respect to applications for subdivision approval, landowners/applicants within the structure plan area are advised that, where the local government has identified particular sub-soil conditions, the WAPC will engage a suitably qualified practitioner, at the expense of the landowner/applicant, to:

a) Provide an independent review report in respect to any drainage, geotechnical or earthworks requirements associated with any conditions of subdivision approval; and

b) Certify that the conditions of subdivision approval have been satisfied prior to endorsement of the deposited plan

6.2. NOTIFICATIONS ON TITLES

Notifications may be placed on the Certificate of Title for each affected lot to advise of:

a) Transport noise for lots that are the subject of noise levels exceeding the noise target as per *State Planning Policy 5.4 – Road and Rail Noise*; and

b) Lots where a Local Development Plan is applicable.

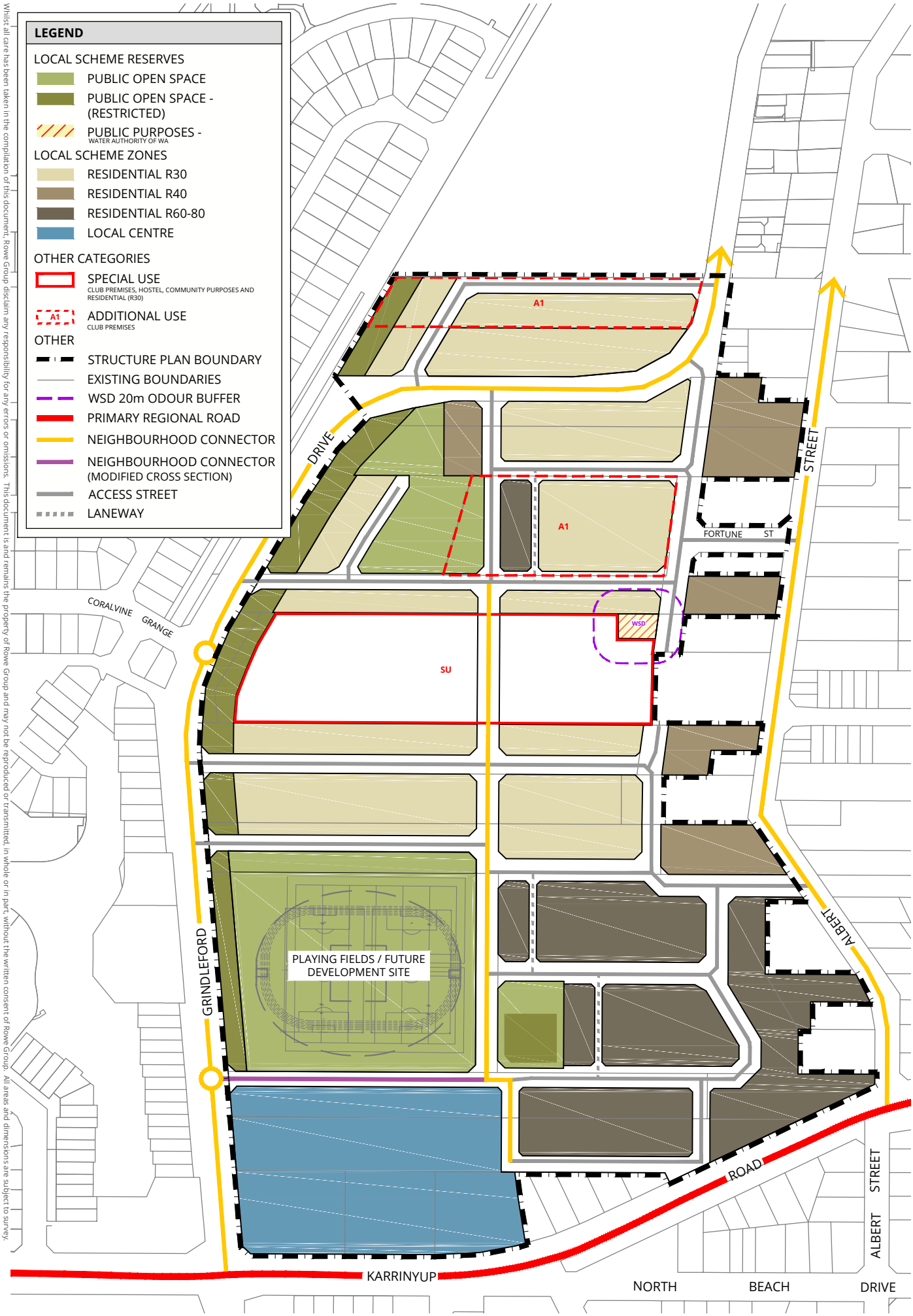
6.3. PUBLIC OPEN SPACE CONTRIBUTION

Where public open space is required to be provided by subdividing landowners at a minimum rate of 10% of the gross subdivisible area, comprising a minimum of 8% unrestricted open space, and public open space is not identified for that landholding under the Structure Plan (as identified on Plan 1), a cash in lieu contribution will be payable to the City of Stirling for any shortfall in public open space.

Public open space contributions shall be implemented through conditions of subdivision approval.

7. ADDITIONAL INFORMATION

ADDITIONAL INFORMATION	APPROVAL STAGE	CONSULTATION REQUIRED
BUILT FORM		
Street Activation and Built-form Guidelines for the Neighbourhood Centre	Prior to lodgement of a Subdivision or Development Application (may be prepared as a Local Development Plan).	City of Stirling
Development Guidelines for those lots abutting the Drainage Swale along Grindleford Drive.	Prior to lodgement of a Subdivision or Development Application (may be prepared as a Local Development Plan).	City of Stirling
CONTAMINATION		
Preliminary Site Investigation	Condition of Subdivision Approval.	Department of Water and Environmental Regulation



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.08

8686_LSP02N_20210308 Balcatta (LSP PLAN 1) - DRAWN:WILLIAM CLEMENTS - DATE CREATED: 2021.03.08 - PROJECTION: PCG94 - CADASTRE: LANDGATE -

0 100 m

SCALE @ A4: 1:4000

N

STRUCTURE PLAN - PLAN 1

EAST ROSELEA

PART TWO

EXPLANATORY SECTION

ROWE GROUP DESIGN

1. PLANNING BACKGROUND

1.1. INTRODUCTION AND PURPOSE

The purpose of this Structure Plan is to facilitate the development of the Urban zoned land comprising Lots 50, 86, 88, 109, 114, 129, 400 and 801 Grindleford Drive, Lots 30, 49, 52, 66, 89, 108, 128, 141, 151 and 153 Albert Street, Lots 87, 139, 150, and 350 Karrinyup Road, Lot 51 Sicilia Place, and Lot 64 Radalj Place, Balcatta, herein referred to as the 'East Roselea Structure Plan' or the 'Structure Plan'.

The Structure Plan will guide future land use and development over the subject site and provide a framework for more detailed planning at subdivision. The following sections provide further detail and explanation for the Structure Plan Part 1 provisions.

PROJECT TEAM

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

DISCIPLINE	CONSULTANT
Acoustic	Herring Storer Acoustics
Civil Engineering	Pritchard Francis
Environmental	Galt Environmental
Geotechnical	Structerre
Hydrological	Emerge Associates
Landscape Architecture	LD Total
Retail	MacroPlan Dimasi
Town Planning and Design	Rowe Group
Traffic	Donald Veal Consultants

Table 1: Project Team

Rowe Group is the primary point of contact for all matters relating to the Structure Plan submission.

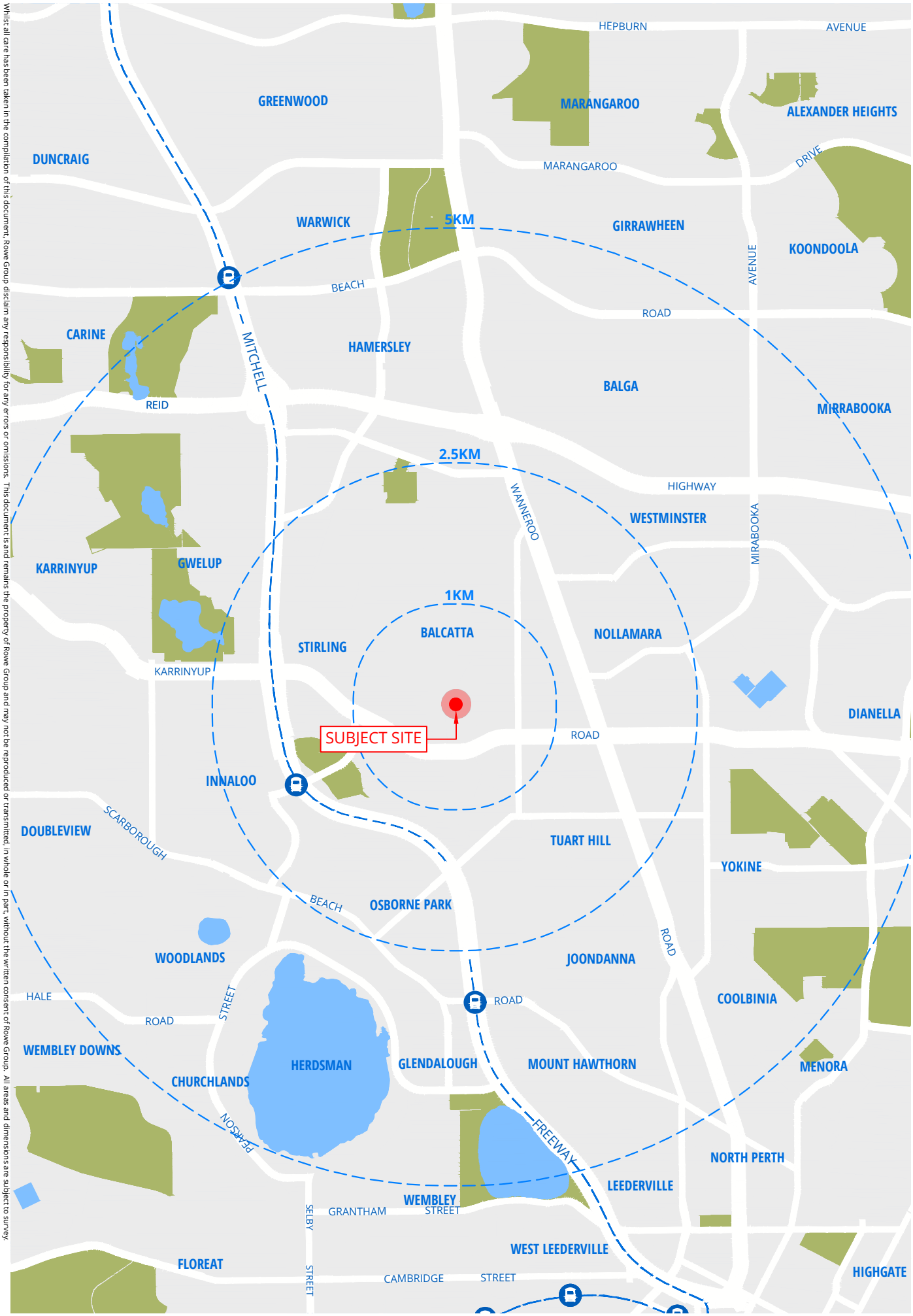
1.2. LAND DESCRIPTION

1.2.1. LOCATION

The Structure Plan area is located within the central metropolitan region, within the municipality of the City of Stirling, and approximately 7.5 kilometres north-west of the Perth Central Area.

The subject site is generally bound by Karrinyup Road to the south, Grindleford Drive to the west, Albert Street to the east, and an existing parks and recreation reserve to the north.

Refer to **Figure 1 – Regional Context** and **Figure 2 – Local Location.**



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD · ADAM GLASKIN · 2020.12.21

8686_FIG03E_20201211 Balcatta (Regional) · DRAWN:ADAM GLASKIN · DATE CREATED: 2020.12.11 · PROJECTION: MGA50 GDA94 · CADASTRE: LANDGATE ·

0 1250 m

SCALE @ A4: 1:50,000

N

FIGURE 1

REGIONAL CONTEXT

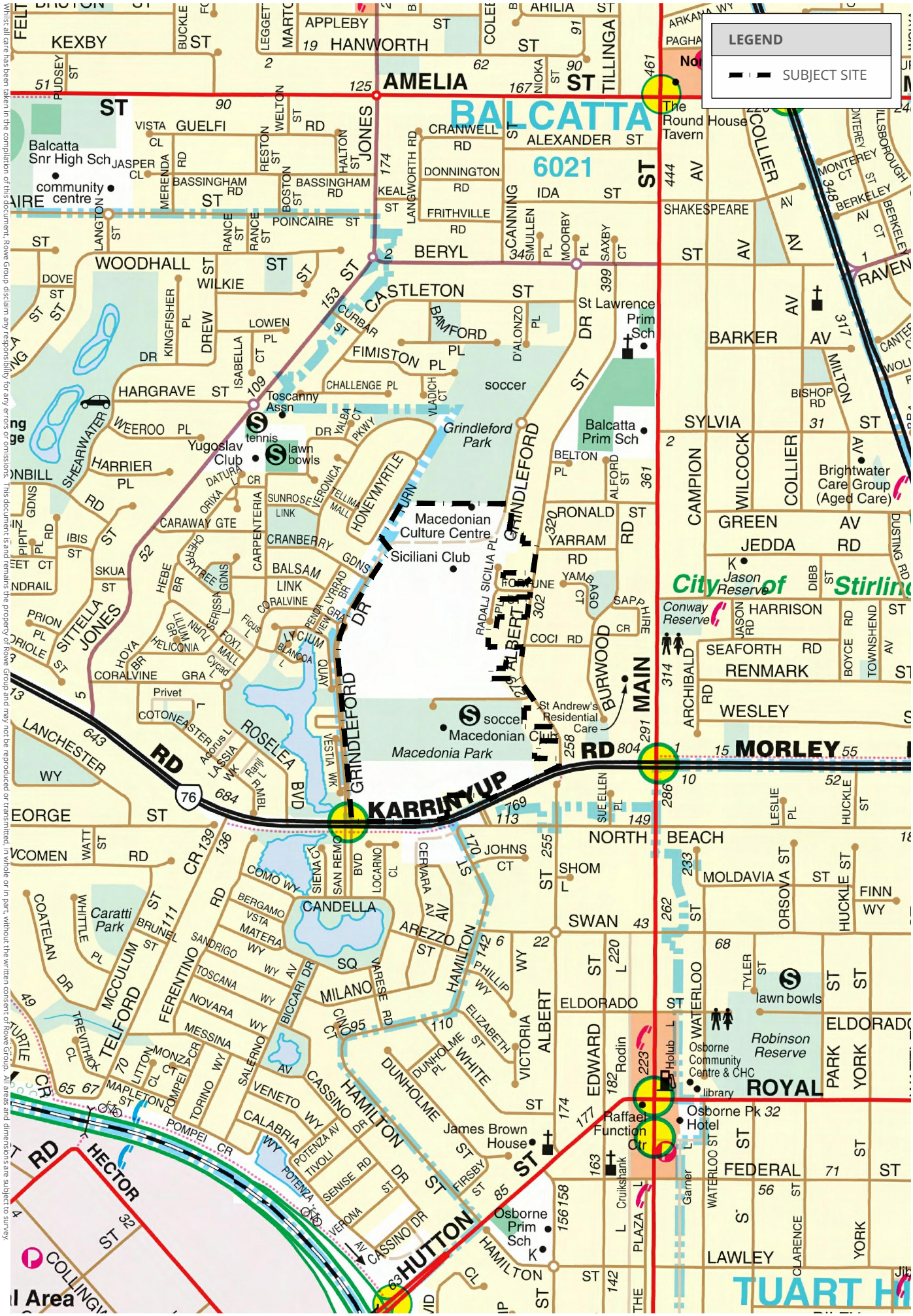


FIGURE 2

LOCAL LOCATION

1.2.2. AREA AND LAND USE

The Structure Plan comprises approximately 29.7 hectares of land situated in Balcatta. The site is currently primarily accessed via Grindleford Drive and Karrinyup Road, which connects to the Mitchell Freeway in the west. Secondary access is also provided via Albert Street which forms portions of the eastern structure plan boundary.

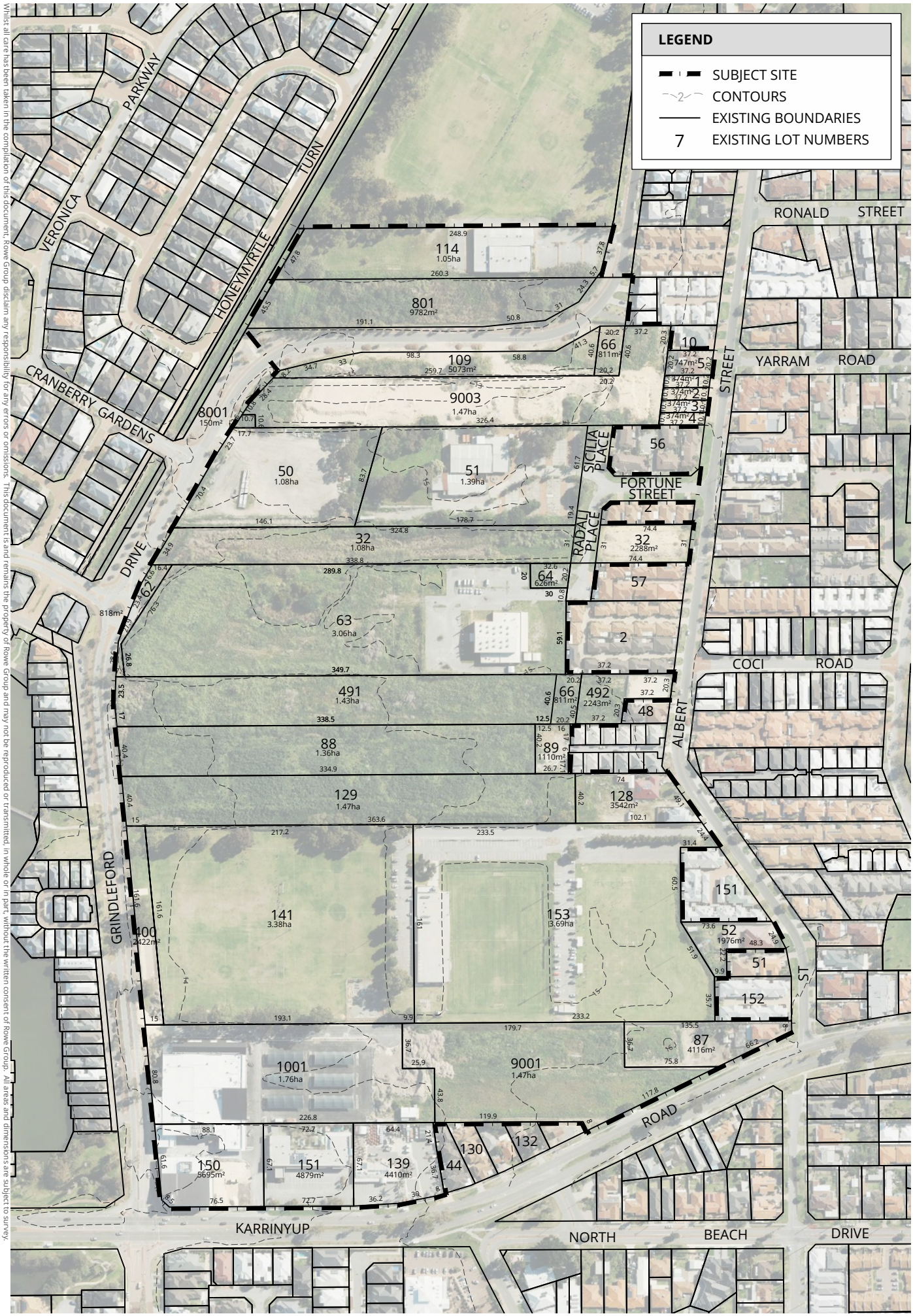
Historically, the subject site has primarily been used for market gardening purposes. It is noted that there is existing development over parts of the site, the majority of which is intended to remain in the medium to long term. The Structure Plan area therefore comprises a number of existing land uses, generally summarised as follows:

- The eastern boundary of the Structure Plan comprises existing residential development, generally located along the majority of the Albert Street frontage.
- Lot 63 Grindleford Drive is occupied by the Chung Wah Association. It is noted that the Chung Wah Association has expressed its intentions to remain at this location for the foreseeable future and in this regard, the Structure Plan accommodates this through identifying the land for 'Special Use' purposes as discussed further within this report.
- There is an existing facility (club rooms and sporting fields) situated on Lot 153, associated with the Macedonian Community. Whilst this facility is intended to be retained in the short term, the Macedonian Community are currently reviewing the need for their facilities at this site and may look to redevelop the land for residential purposes in the future. The Structure Plan therefore facilitates the future use of the site (in the long term) for residential purposes.
- There is an existing commercial centre situated in the south of the site fronting Karrinyup Road, which is intended to be retained and expanded as part of the development of the site. Existing facilities within the centre include a child care centre, physiotherapy clinic and hire equipment facility, with a new shopping centre having recently been developed at the corner of Karrinyup Road and Grindleford Drive.
- Lot 64 contains an existing Waste Water Pump Station which is intended to remain as part of the ultimate development of the site.
- Lot 141 comprises an existing area of recreational open space owned by the City of Stirling. Whilst this area of open space is currently under the management and ownership of the City of Stirling, the land is not currently reserved for public open space purposes. Notwithstanding, given its current and anticipated future function, the Structure Plan proposes to retain this area as public open space albeit in a slightly expanded form to accommodate the City of Stirling development aspirations for playing fields and associated facilities such as clubrooms, car parking and play areas.

It is anticipated that funds raised through cash-in-lieu contributions will be used to fund the redevelopment of the open space area.

It is noted that those parts of the site not comprising existing development typically contain some vegetation cover comprising winter grasses, shrubs and scattered trees.

Refer to **Figure 3 - Site Plan**.



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD · ADAM GLASKIN · 2020.12.21

8686_FIG05G_20201112 Balcatta (Site) · DRAWN:ADAM GLASKIN · DATE CREATED: 2020.12.11 · PROJECTION: MGA50 GDA94 · CADASTRE: LANDGATE ·

0 100 m

SCALE @ A4: 1:4000

N

FIGURE 3

SITE PLAN

1.2.3. LEGAL DESCRIPTION AND OWNERSHIP

The Structure Plan comprises 31 land parcels, legally described as follows.

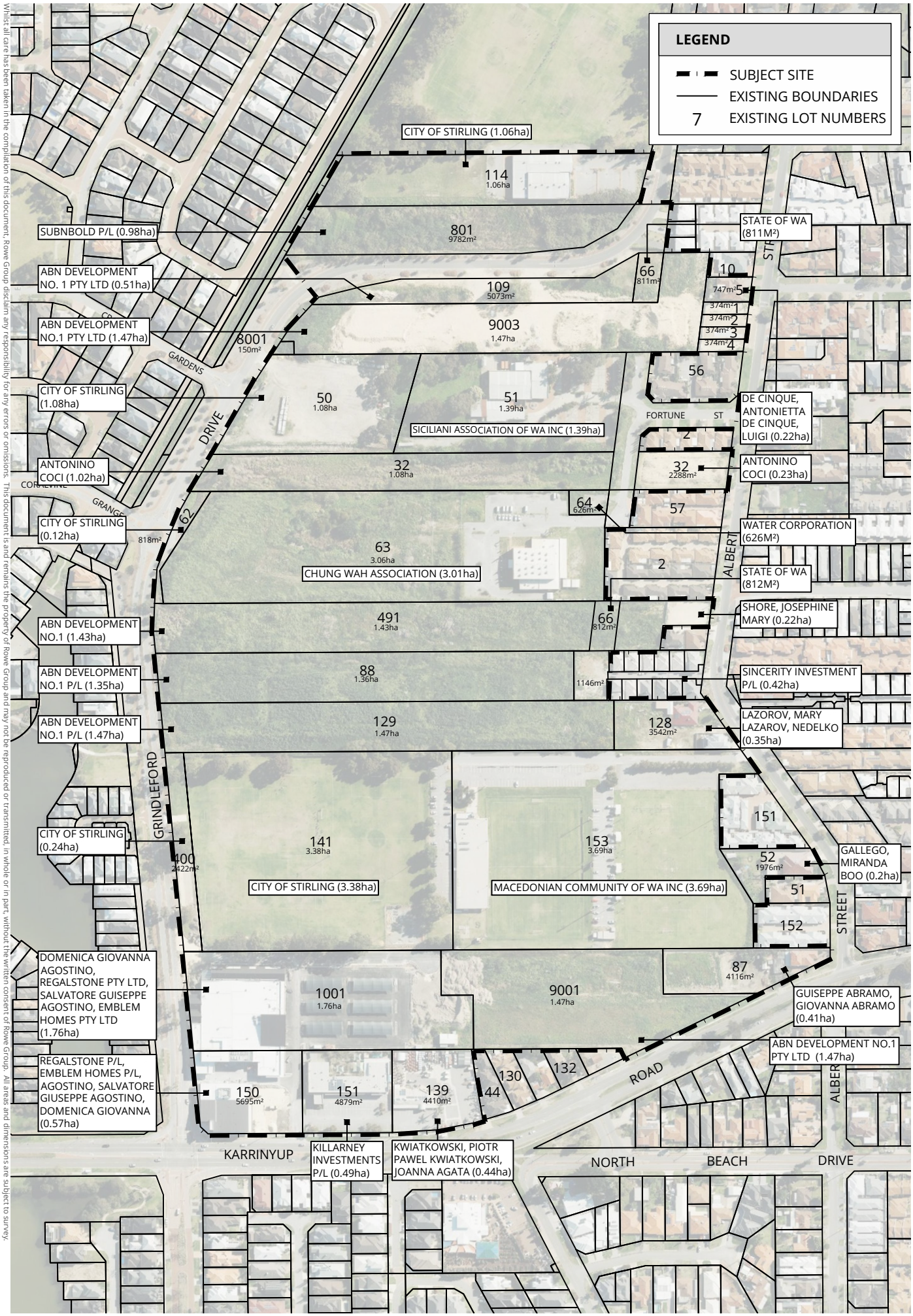
LOT NUMBER	STREET ADDRESS	PLAN/ DIAGRAM NO.	VOL./FOLIO	PROPRIETOR(S)
30 (Part Lot)	309 Albert St	D15403	1314 / 510	ABN Development No.1 Pty Ltd
49(W)	281a Albert St	D47083	1385 / 66	JM. Shore
49 (E)	281a Albert St	D47083	1385 / 66	JM. Shore
52	263 Albert St	D70756	1744 / 665	MB. Gallego
89	279 Albert St	P27769	2590 / 704	Sincerity Investment Pty Ltd
108	311 Albert St	D61726	1619 / 166	A & L De Cinque
128	275 Albert St	P27343	2222 / 470	M & N Lazorov
141	273a Albert St	D67731	1744 / 538	City of Stirling
153	273 Albert St	P37311	2545 / 171	Macedonian Community of WA Inc
32	299 Albert St	D18698	1194 / 816	Antonino Coci
30	309 Albert St	D15403	1314 / 510	ABN Development No. 1 Pty Ltd
50	90 Grindleford Dr	P13824	1702 / 417	City of Stirling
62	100 Grindleford Dr	D67317	1683 / 605	City of Stirling
86	120 Grindleford Dr	P27768	2222 / 468	ABN Development No. 1 Pty Ltd
88	104 Grindleford Dr	P27769	2590 / 703	ABN Development No. 1 Pty Ltd
109	80 Grindleford Dr	D61726	1619 / 167	City of Stirling
114	71 Grindleford Dr	D62707	1614 / 491	City of Stirling
129	108 Grindleford Dr	P27343	2222 / 471	ABN Development No. 1 Pty Ltd
400	114 Grindleford Dr	P37616	2225 / 770	City of Stirling
801	75 Grindleford Dr	P39999	2226 / 243	Sunbold Pty Ltd
87	774 Karrinyup Rd	P27768	2222 / 469	G & G Abramo
139	736 Karrinyup Rd	D61999	1713 / 923	JA & PP Kwiatkowski
150	732 Karrinyup Rd	D93196	2119 / 104	Regalstone Pty Ltd; Emblem Homes Pty Ltd; SG & DG Agostino

151	734 Karrinyup Rd	D93196 / S33238		Regalstone Pty Ltd; Emblem Homes Pty Ltd; SG & DG Agostino
350	764 Karrinyup Rd	D74913	2009 / 910	Regalstone Pty Ltd; Emblem Homes Pty Ltd; SG & DG Agostino
63	18 Radalj Pl	D67317	1683 / 606	Chung Wah Association Inc
64	12 Radalj Pl	D67317	1683 / 607	Water Corporation
51	1 Sicilia Pl	P13824	1854 / 918	Siciliani Association of WA Inc.
66	-	D61726	2748 / 63	State of WA
66	-	D47083	550 / 171	State of WA

Table 2: Lot Details

The Structure Plan area comprises a total of approximately 29.7 hectares of land.

Refer to **Figure 4 – Landownership Plan** and **Appendix 1 – Certificates of Title.**



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - ADAM GLASKIN - 2021.02.08

8686_FIG02E_20210114 Balcatta (Land Ownership) - DRAWN: **ADAM GLASKIN** - DATE CREATED: **2021.01.14** - PROJECTION: **MGA50** GDA94 - CADASTRE: LANDGATE -

0 100 m

SCALE @ A4: 1:4000

N

FIGURE 4

LAND OWNERSHIP PLAN

2. PLANNING FRAMEWORK

2.1. ZONING AND RESERVATIONS

2.1.1. METROPOLITAN REGION SCHEME

The subject site is zoned 'Urban' in accordance with the provisions of the *Metropolitan Region Scheme* ('MRS').

Refer to **Figure 5 – Metropolitan Region Scheme Zoning**.

2.1.2. CITY OF STIRLING LOCAL PLANNING SCHEME NO. 3

The land the subject of the Structure Plan is zoned 'Development' under the provisions of the *City of Stirling Local Planning Scheme No. 3* ('LPS 3'). There is also a small area of land (Lot 64) which is zoned for 'Public Purposes' as this portion of land contains an existing Waste Water Pump Station land use.

The objectives of the Development Zone, as stated in LPS 3, are:

- *To provide for coordinated development through the application of a comprehensive structure plan to guide subdivision and development.*
- *To avoid the development of land for purposes likely to compromise its future development for purposes, or in a manner likely to detract from the amenity or integrity of the area.*

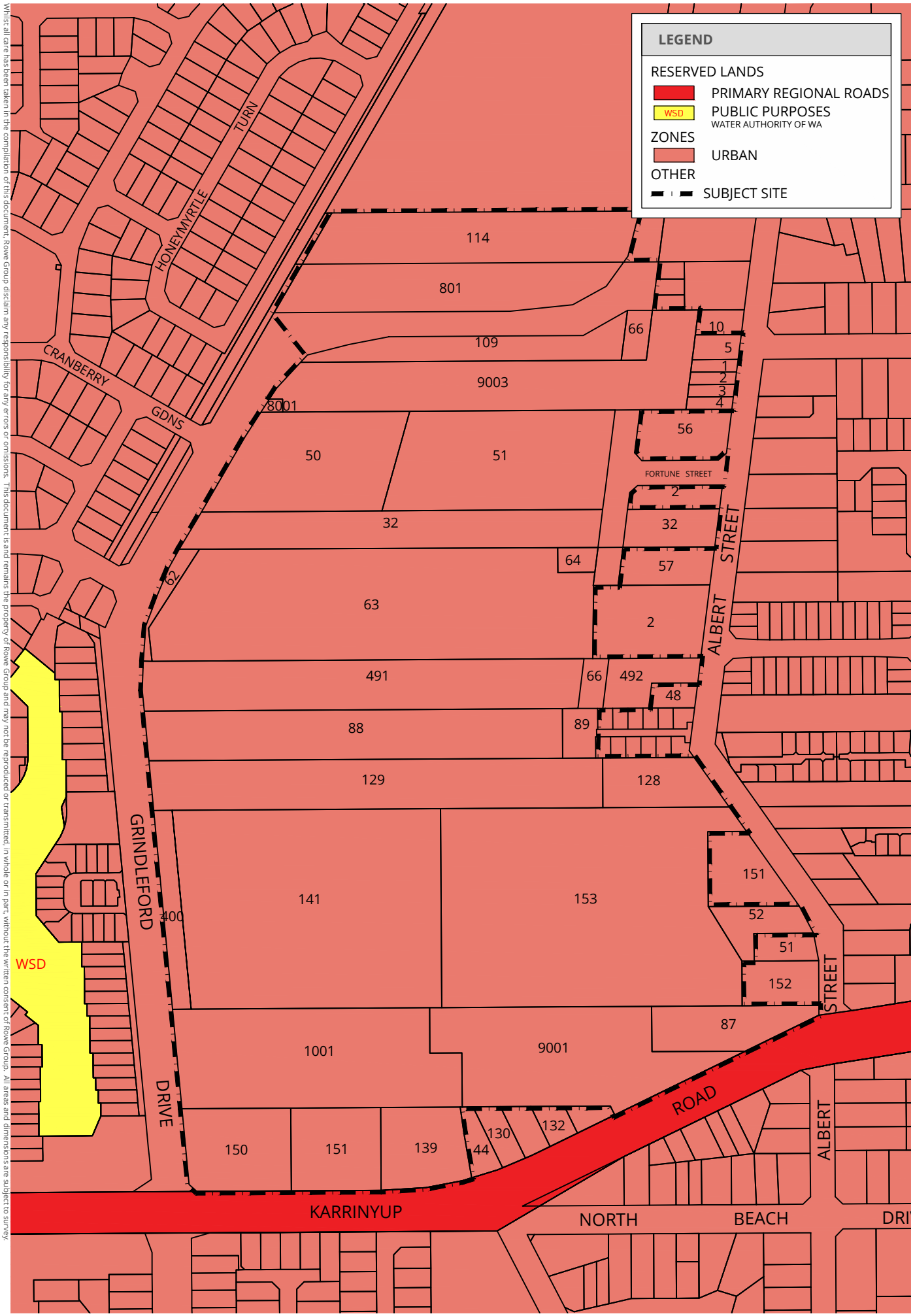
The site is also within the 'East Roselea – Development (Structure Plan) Area', the purpose of which is:

> *"To facilitate development within the East Roselea Balcatta Structure Plan Area of a variety of medium to high density residential lots, public open space and a Neighbourhood Centre in the south western corner of the Structure Plan Area."*

The Structure Plan has therefore been prepared in a manner which is consistent with these objectives and which provides a framework for further subdivision and development within the structure plan area.

Further, the zoning as depicted under the Structure Plan seeks to retain the existing ' 'Public Purpose' zoning of the site to ensure consistency with LPS 3.

Refer to **Figure 6 – City of Stirling Local Planning Scheme No. 3 Zoning.**



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - ADAM GLASKIN - 2020.12.21

8686_FIG06D_20201216 Stirling (MRS) - DRAWN:**ADAM GLASKIN** - DATE CREATED: **2020.12.16** - PROJECTION: **MGA50** GDA94 - CADASTRE: LANDGATE -

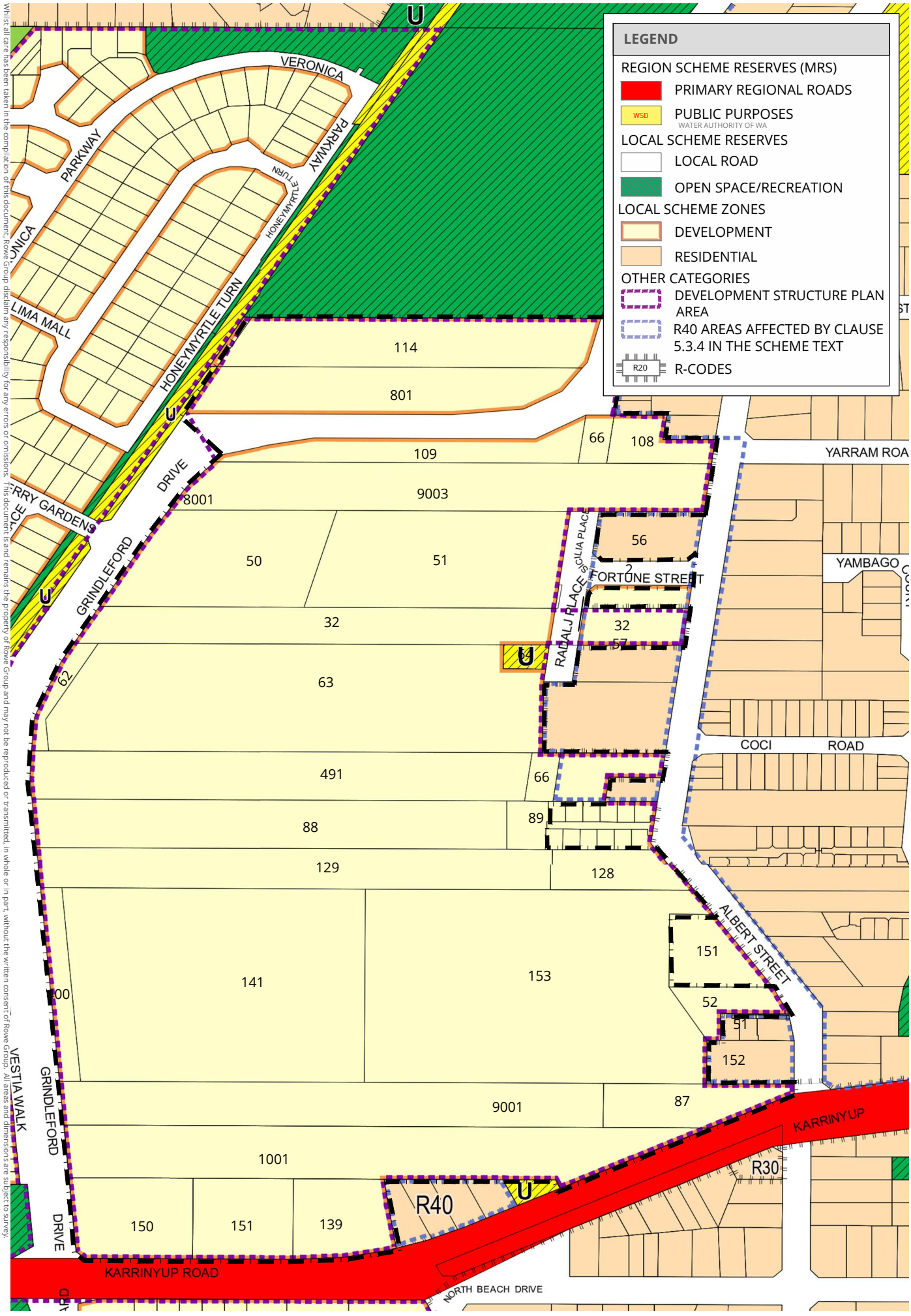
0 100m

SCALE @ A4: 1:4000

N

FIGURE 5

METROPOLITAN REGION SCHEME ZONING



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.08

8686_FIG07E_20210308 Balcatta (Local Planning Scheme No3) - DRAWN:WILLIAM CLEMENTS - DATE CREATED: 2021.03.08 - CADASTRE: LANDGATE -

SCALE @ A4: N.T.S

N

FIGURE 6

CITY OF STIRLING LOCAL PLANNING SCHEME No. 3 ZONING

2.2. SUB-REGIONAL STRUCTURE PLAN

2.2.1. PERTH AND PEEL @ 3.5 MILLION / CENTRAL SUB-REGIONAL PLANNING FRAMEWORK

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 suite of documents also includes four draft sub-regional planning frameworks for the Central, North-West, North-East and South Metropolitan Peel sub-regions. The four draft sub-regional planning frameworks detail where future homes and employment should be located, and where important environmental assets should be avoided and protected.

The subject site is situated within the Central Sub-Regional Planning Framework (the 'Framework'). The Urban infill target for the City of Stirling is 60,400 dwellings of which the Structure Plan will contribute towards reaching the specified urban infill targets.

The Framework aims for the majority of all new infill residential development, being approximately 75%, to occur within urban consolidation areas of activity centres, and broadly assumes that 25% of all new infill in the Central Sub-Region will occur as a result of incremental infill growth in existing built up areas within traditional suburban streets. The Structure Plan is not situated within an urban consolidation area and therefore will contribute to the latter 25% infill target. The Structure Plan is therefore considered to be consistent with the objectives of the Framework through facilitating a mix of medium to high density residential development within an existing infill area.

2.3. PLANNING STRATEGIES

2.3.1. BALCATTA AND STIRLING LOCAL AREA PLAN

The City of Stirling adopted a Local Area Plan for the Balcatta and Stirling areas in 2007 which identifies the community's visions for the area. The key objectives of the Local Area Plan are identified as:

- To review key planning issues, policies and forces acting on local areas within the City and develop a coordinated response to these;
- To identify specific 'opportunities' and 'constraints' within each local area and develop strategies to address these;
- To develop a commonly embraced 'vision' for each local area which recognises areas of local significance and key attributes contributing to each area's sense of place;
- To identify issues of priority to the local community and work with them to developing practical solutions to these, within the context of a regional framework;
- To foster open lines of communication between the City and the community;
- To create a sound and comprehensible statutory and strategic planning framework for each local area to allow delivery of the vision and plan; and
- To help ensure that each local area operates in a sustainable way and in balance with surrounding precincts and other areas of influence.

It is noted that the Balcatta Local Area references the "increased interest" of the community in developing the East Roselea area which is achieved by way of this Structure Plan. The Local Area Plan also makes reference to ensuring any development is "well designed and coordinated". The Structure Plan provides for a well-designed and coordinated design response to the East Roselea area, therefore satisfying the requirements of the Local Area Plan.

2.4. POLICIES

2.4.1. LIVEABLE NEIGHBOURHOODS

Liveable Neighbourhoods represents the WAPC's primary policy to guide the design and assessment of structure plans and subdivision for new urban development of residential communities in Western Australia. The underlying objective is to create quality neighbourhoods with site responsive identity supportive of local community that reduce dependency on private vehicles and are more energy and land efficient. As such, *Liveable Neighbourhoods* focuses on an urban structure based on walkable mixed-use neighbourhoods with interconnected street patterns. It functions by drawing together key policy aspects into a single 'integrated planning and assessment policy' to provide for a performance-based approach to planning assessment.

It does so according to a range of considerations including:

- Community;
- Movement;
- Lot Layout;
- Urban Water Management;
- Public Open Space; and
- Schools.

Liveable Neighbourhoods identifies a series of Objectives and Requirements for Structure Plans that, when met, demonstrate compliance with the overall outcomes sought by *Liveable Neighbourhoods*. These objectives and requirements relate to items such as road layout, relationship of housing to open space and schools, school location/distribution, POS layout and location and housing densities.

The Structure Plan has been prepared to satisfy the various objectives and requirements of *Liveable Neighbourhoods* to ensure that more detailed proposals at subdivision stage are also capable of satisfying the relevant criteria.

2.4.2. STATE PLANNING POLICY 5.4 – ROAD AND RAIL NOISE

The general objectives of *State Planning Policy 5.4 - Road and Rail Noise* ('SPP 5.4') are to ensure people are protected from unreasonable levels of transport noise and to ensure new development is compatible with existing transport corridors and freight operations. As Karrinyup Road is identified as a 'Primary Regional Road' reserve under the *Metropolitan Region Scheme* and abuts the site's southern boundary, the provisions of SPP 5.4 are to be taken into consideration as part of the development.

In this regard and in accordance with SPP 5.4, an acoustic assessment has been prepared to inform the Structure Plan. The acoustic assessment provided at Appendix 2 of this Structure Plan report.

The acoustic modelling and assessment considers the potential noise impacts from Karrinyup Road within a planning horizon to year 2031 and indicates that vehicle noise from Karrinyup Road is likely to cause noise impacts above the prescribed criteria under SPP 5.4 for residential lots within relatively close proximity to Karrinyup Road. On this basis, varying degrees of 'Quiet House Design' treatment options are required to achieve compliance with SPP 5.4, as specified under the Acoustic Assessment. The suggested mitigation measures apply to single storey dwellings.

Should multiple storey dwellings be proposed, further specialist acoustic advice will be required for the upper floors to determine the appropriate construction requirements for noise mitigation.

Refer **Appendix 2 - Acoustic Report**

2.4.3. DEVELOPMENT CONTROL POLICY 2.3 – PUBLIC OPEN SPACE IN RESIDENTIAL AREAS

The WAPC's *Development Control Policy 2.3 – Public Open Space in Residential Areas* ('DCP 2.3') seeks to ensure that all residential development in the State is complemented by adequate, well-located areas of public open space that will enhance the amenity of the development and provide for the recreational needs of local residents. The provisions of DCP 2.3 generally require a 10% public open space contribution to be made as part of the preparation of a Structure Plan, or application to subdivide land. In this regard, the provisions of DCP 2.3 are relevant to the Structure Plan which seeks to create more than five (5) residential lots.

As previously outlined within this report, the Structure Plan delivers in excess of 10% public open space, with those landowners with no public open space identified within their landholdings being required to pay a cash-in-lieu contribution to the City of Stirling. In this regard, DCP 2.3 identifies a number of situations where cash-in-lieu of public open space may be required or accepted by the local government and / or WAPC. Such situations include:

- The land is such that a 10% contribution would be too small to be of practical use.
- There may already be sufficient public open space in the locality.
- Public open space is planned in another location by way of a town planning scheme of local structure plan.

The abovementioned situations are applicable to the subject site, as follows:

- The Structure Plan area comprises highly fragmented landownership which would otherwise result in an inefficient and inappropriate use of land should each landowner be required to deliver 10% of their gross subdivisible area as public open space.
- There is already a substantial amount of public open space within the locality, with a total of 14 parks being identified within 800m of the site, as summarised in Section 4.2 of this report.
- The City of Stirling Lot 141 is currently used for local playing fields, however this land is privately owned by the City and is not a formal open space reserve.

2.4.4. LOCAL PLANNING POLICIES

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

- LPP 3.13: Roselea Estate Design Guidelines – whilst this policy is applicable to the land on the western side of Grindleford Drive, it will likely have some relevance for implementation within the Structure Plan.
- LPP 4.1: Reserves and Other Zones Design Guidelines – applicable to the public open space and Civic uses on site.
- LPP 4.2: Mixed Use and Commercial Centre Design Guidelines –applicable to the Local Centre site.
- LPP 6.6: Landscaping – applicable to the Local Centre site and any grouped or multiple dwelling proposals involving 5 or more units.
- LPP 6.7: Parking and Access – applicable across the various land uses of the Structure Plan.
- LPP 6.11: Trees and Development – applicable across the Structure Plan.

3. SITE CONDITIONS & CONSTRAINTS

The following provides a summary of the environmental site conditions and constraints. For further information the Environmental Assessment Report is provided in **Appendix 3**.

3.1. BIODIVERSITY AND NATURAL AREA ASSETS

3.1.1. FLORA AND VEGETATION

Due to historic clearing activities which have been undertaken across the site, as well as the existing land uses on site, the Structure Plan does not contain any flora or vegetation of ecological significance. Given the lack of remnant vegetation, a flora and vegetation survey was not undertaken as part of the preparation of the Structure Plan.

A desktop assessment undertaken by Galt Environmental identified no Threatened Ecological Communities as being likely to occur on site, nor is there any species protected under the *Environment Protection and Biodiversity Conservation Act 1999* likely to occur.

There are also no Bush Forever sites identified within or within close proximity to the Structure Plan.

In accordance with Department of Biodiversity, Conservation and Attractions ('DBCA') mapping, the site is not identified as an environmentally sensitive area ('ESA'). The nearest ESA is situated approximately two kilometres southwest of the Structure Plan and is therefore not impacted upon as part of this Structure Plan.

3.1.2. FAUNA

Given the lack of significant vegetation across the site, it is unlikely that any significant habitat exists for native fauna within the Structure Plan area. A fauna assessment has therefore not been undertaken as part of the preparation of the Structure Plan.

3.1.3. WETLANDS

There is a Multiple-Use ('MU') category wetland mapped over the majority of the Structure Plan area (UFI 8177). DoBC mapping indicates the wetland extends well beyond the Structure Plan boundary and is characterised as a sumpland. The Environmental Assessment Report prepared by Galt Environmental considers that wetland UFI 8177 is capable of development and is therefore not considered to be adversely impacted upon as a result of the proposed Structure Plan.

3.2. LANDFORM AND SOILS

The soil profiles of the Structure Plan vary across the site, primarily due to existing filling and historical remedial site works undertaken across the site.

The central portion of the site is typically characterised as:

- Fill (Sand) – some organics, typically dark brown with some fines and organic fines, approximately 4m thick in the west of the northern part of the site, becoming thinner to the east to approximately 1 metre in the central parts of the site, and not present on the east of the site. Very loose, typically dry and becoming moist at depth, overlying;

- Fill (Peaty sand) – fine to coarse grained, brown to black, very loose. Typically dry and becoming most, with varying proportions of fines and organics, typically to approximately 2.5m to 7m depths, including sand or limestone layers, overlying.
- Peat – typically black, stiff or firm to stiff, with varying proportions of sand, present in a layer typically 1-2 metres thick below Unit C, present to between 6 and 8 metre depths, overlying.
- Sand – fine to coarse grained, brown becoming grey, typically dense, wet, present to the maximum investigated depth of approximately 10 metres.
- The northern and southern portions of the site are typically characterised as:
- Fill (Peaty sand) – fine to coarse grained, brown to black, very loose. Typically, dry and becoming most, with varying proportions of fines and organics, typically to approximately 2.5m to 7m depths, including sand or limestone layers, overlying.
- Peat – typically black, stiff or firm to stiff, with varying proportions of sand, present in a layer typically 1-2 metres thick below Unit C, present to between 6 and 8 metre depths, overlying.
- Sand – fine to coarse grained, brown becoming grey, typically dense, wet, present to the maximum investigated depth of approximately 10 metres.

The northern and southern portions of the site are typically characterised as:

- Uncontrolled Fill (Sand) – with deleterious and inert inclusions. Typically, a mixture of concrete rubble, brick rubble, steel and general rubbish. Typically comprising between 10% and 60% of inert and deleterious fill, in a matrix of sand, fine to coarse grained, very loose, with some non-plastic fines, trace roots, rootlets and wood pieces. Very loose, present from the surface to depths varying between 1 metre and more than 3 metres, underlying.
- Peat – typically black, very soft to soft, generally 0.3 metres to approximately 2.5 metres thick. Present at depths of between 1.8 metres and 4.5 metres across most of the site, overlying.
- Sand – fine to coarse grained, typically dense, wet. Present to the maximum investigated depth of approximately 9 metres.

The underlying peaty soils situated within Lot 350 have been partially remediated (excavated and replaced) over majority of the lot.

3.2.1. ACID SULPHATE SOILS

The Department of Water and Environmental Regulation Acid Sulphate Soil Risk Mapping identifies the site as having 'high to moderate risk of acid sulphate soils occurring within 3m of the natural surface'.

Given the high quantities of Peat on site, it is anticipated an Acid Sulphate Soils Management Plan will be required as a condition of subdivision approval.

3.2.2. CONTAMINATION

The Department of Water and Environmental Regulation Contaminated Sites Database does not list the site as being a known or suspected contaminated site.

Notwithstanding, the proponent recognises that further investigations with regard to contamination are required to be undertaken prior to development, particularly with regard to the potential presence of asbestos. This process will be appropriately dealt with at the subdivision stage, whereby Model Subdivision Condition EN9 would be imposed on any future approval, which states:

Prior to commencement of subdivision works, investigation for soil and groundwater contamination is to be carried out to determine if remediation is required.

If required, remediation, including validation of remediation, of any contamination identified shall be completed prior to the issuing of titles to the satisfaction of the Western Australian Planning Commission on advice from the Department of Water and Environmental Regulation, to ensure that the lots created are suitable for the proposed use.

Investigations and remediation are to be carried out in compliance with the Contaminated Sites Act 2003 and current Department of Water and Environmental Regulation Contaminated Sites Guidelines.

Clause 7 of Part 1 of the Structure Plan therefore includes a notation alerting to the requirement for further investigation with regard to contamination to be undertaken prior to subdivision works occurring on-site.

3.3. BUSHFIRE RISK

The Structure Plan is not situated within or adjacent to an area identified as bushfire prone by the Department of Fire and Emergency Services. A Bushfire Management Plan is therefore not required to support the submission of a Structure Plan.

In this regard, it should be noted that the nearest identified "bushfire prone area" is situated approximately 1.5 kilometres southwest of the site and is therefore not considered to present as a constraint to the proposed development of the Structure Plan.

3.4. GROUNDWATER AND SURFACE WATER

3.4.1. GROUNDWATER

The *Perth Groundwater Atlas* (1997) shows the maximum historical groundwater levels at the subject site to be an approximate relative level ('RL') of 15 metres AHD along the eastern boundary, falling to approximately RL 11.5 metres AHD in the west. This is identified as being within 1-1.5 metres of the mapped ground surface.

Site investigations undertaken by Galt Environmental encountered groundwater at varying depths between the existing surface level up to greater than 2.5 metres below ground surface. Where groundwater is at, or near the surface, this is identified as being a perched groundwater level over peaty soils.

There are a number of existing registered bores located within and surrounding the subject site, however, none of these are currently used for irrigation purposes. Any dewatering occurring at the site will have potential to disrupt registered and unregistered bore users with the hydraulic influence of the site.

A groundwater quality assessment was undertaken by Strategen Environmental in 2015 which noted the following conditions:

- The pH values were generally above 6.5 across the site;
- Low levels of inherent acidity and high levels of alkalinity indicate that groundwater has high levels of buffering capacity;
- The concentrations of aluminium, iron and arsenic are consistent with groundwater conditions previous identified for peaty sites; and
- The pH and alkalinity values indicate groundwater has not been adversely impacted by the presence of actual and potential acid sulphate soils in the vicinity of the site.

3.4.2. SURFACE WATER

There are no surface water features within the site.

3.5. HERITAGE

A search of the Department of Aboriginal Affairs Aboriginal Heritage Inquiry System identified no registered sites within the Structure Plan area or immediate surrounds. The closest site of aboriginal significant is "Dog Swamp (ID 3738) about 2.5 kilometres south-east of the site.

A search of the Western Australian Register of Heritage Places identified no sites of State heritage significance within the Structure Plan area or immediate surrounds.

A search of the City of Stirling's Municipal Heritage Inventory identified no sites of local historic significance within the Structure Plan area or immediate surrounds.

3.6. NOISE MANAGEMENT

As noted in Section 2.4.2 of this report, Karrinyup Road abuts the Structure Plan on its southern boundary. In this regard, an acoustic assessment has been prepared to inform the Structure Plan, provided at Appendix 2 of this structure plan report. As summarised in the Acoustic Assessment, whilst some dwellings may be subject to vehicular noise as a result of traffic along Karrinyup Road, appropriate mitigation measures are able to be implemented to provide for suitable levels of amenity to residential land uses.

3.7. OTHER LAND USE CONSTRAINTS & OPPORTUNITIES

3.7.1. CHUNG WAH ASSOCIATION

The Chung Wah Association (the 'Association') occupies Lot 63 (No. 18) Radalj Place which is used as a community purpose building for various events, as well as providing for temporary accommodation for monks and other members of the Association travelling interstate. The Chung Wah Association was founded in 1909 and is the largest and most established Chinese organisation in Western Australia, with a total of 140,000 members.

The Executive of the Chung Wah Association have confirmed that they do not wish to be included within any future subdivision or development proposal for residential development. The Association intends on occupying the site for the long term and therefore does not wish to be restricted through land use allocation or movement networks. The Chung Wah Association has also engaged a local architect and is in the process of preparing an Application for Development Approval for the expansion of their existing facility, including the construction of Chinese gardens within the western portion of their landholding.

In this regard, the Chung Wah Association has been designated as 'Special Use – Club Premises, Hostel, Community Purposes and Residential (R30)' under the Structure Plan to allow for the continued use of the site by the Chung Wah Association, whilst also "futureproofing" the outcomes of the Structure Plan. The Chung Wah Association is recognised by the Federal, State and local governments as the spokesperson for the Chinese community in Western Australia. In this regard, it is considered that the land use is more appropriately defined as 'Community Purpose' rather than a private club, given the Association is registered as an "organisation" and provides for facilities and services for the Chinese community within Western Australia.

The use of the land by the Chung Wah Association is considered to be compliant with the objectives of the "Civic" zone given the facilities provided are compatible with the surrounding development (i.e. will not have an undue impact on the adjoining residential areas) and are of a scale which is consistent with that of the surrounding development.

A copy of the submission provided by the Association to the proponent is provided at **Appendix 4**.

An Indicative Residential Layout has also been prepared over the Chung Wah Association's landholding demonstrating how the property may be developed for residential purposes and how the land would integrate with the surrounding development. It is noted that the Structure Plan currently provides for a total of 13.93% public open space (not including Lot 141), with the Chung Wah landholding being identified as 'Special Use'. Should the Chung Wah landholding be developed for residential purposes a provision of 10% public open space will be required to be provided within the site as is required under *Liveable Neighbourhoods and Development Control Policy 2.3*.

Refer **Figure 7 - Indicative Subdivision Layout (Chung Wah Association Landholding)** and **Appendix 4 - Chung Wah Association Submission to Parcel Property.**

Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.10

8686_FIG18F_20210310 Balcatta (chun wah indicative layout) - DRAWN:WILLIAM CLEMENTS - DATE CREATED: 2021.03.10 - PROJECTION: MGA50 GDA94 - CADASTRE: LANDGATE -

0 100 m

SCALE @ A4: 1:4000

N

FIGURE 7

INDICATIVE RESIDENTIAL LAYOUT - CHUNG WAH

3.7.2. MACEDONIA CLUB

The Macedonia Club owns and occupies Lot 153 (No. 273) Albert Street, Balcatta which comprises a sporting complex with associated licensed facilities. Whilst the Macedonia Club has no short – medium term development aspirations for its landholding, the Macedonia Community may, in the future, elect to develop the land for a mix of medium to high density residential land uses given its close proximity to public open space and the future local centre.

In this regard, the land use and zoning allocation of the Macedonia Club landholding under the Structure Plan has been undertaken in consultation with the Macedonian Club, which supports the design in its current form. The land use and zoning allocation of the Structure Plan allows the Macedonian Club to continue to operate its sporting complex as is, until such time as it chooses to redevelop the land.

Refer **Appendix 5 – Macedonian Club Submission to Parcel Property.**

3.7.3. SICILIAN CLUB

The Sicilian Association is the landowner and occupier of Lot 51 (No. 1) Sicilia Place which is currently used as a community facility to serve members of the Sicilian community and other interested participants in the associations' activity. The centre is often used for events and cultural gatherings. The Sicilian Association has advised that whilst is welcomes the urban front, the current use of the property is not envisaged to change for a considerable period of time.

The Sicilian Association has indicated its general support for the Structure Plan proposal to the proponent. Notwithstanding, the Sicilian Association has provided its support with the following amendments to the Structure Plan, for consideration by the City of Stirling and Western Australian Planning Commission:

1. That no proposed use or approved change of use in the Structure Plan impacts on the current use or the value of the property owned and occupied by the Sicilian Association.

2. The Sicilian Association land be coded R60 – R80 to permit the use of the land in the future for multiple dwellings; and

3. The future use of the land to include the opportunity for retirement living and aged care.

4. The proposed road reserve at the rear of the Sicilian Association be relocated in the plan to sit on the boundary between associations Lot 51 and Lot 50 and the land allocated for the road reserve be equally shared with the City of Stirling.

Refer **Appendix 6 – Sicilian Club Submission**.

3.7.4. DRAINAGE SWALE / ROAD WIDENING

It is noted that portions of land adjacent to Grindleford Drive have historically been acquired by the City of Stirling for the intended future road widening of Grindleford Drive. This has occurred on Lot 141 and Lot 63 whereby between 10 – 15 metres of land has been ceded.

Notwithstanding, it is understood that the plans to widen Grindleford Drive are no longer current and therefore it is intended to utilise the "road widening" area for drainage purposes in the form of a vegetated drainage swale. This is discussed in further detail at **Sections 4.2.2 and 4.6** of this report.

3.7.5. EASEMENT

There is an existing Water Corporation sewerage easement which traverses through Lot 153 Albert Street (i.e. the Macedonian Club landholding) and Lot 9001 Karrinyup Road. It is understood that the landowner will be required to realign the existing sewer line at the time when the subject lots are developed for urban residential purposes.

4. LAND USE AND SUBDIVISION REQUIREMENTS

4.1. LAND USE

The Structure Plan sets out land use, residential densities, public open space, vehicle and pedestrian access and servicing requirements.

The Structure Plan is proposed to comprise residential development with densities ranging from R30 to R80, as well as areas comprising special and additional uses and the local centre. The Structure Plan also comprises public open space in accordance with the requirements of *Liveable Neighbourhoods*.

The following describes the design response proposed under the Structure Plan and addresses the relevant elements of *Liveable Neighbourhoods*. Please refer to the land use summary table provided within the Executive Summary on Page iii of this report.

Please also refer to **Plan 1 – Structure Plan**, and **Figure 8 - Indicative Zoning and Residential Density Code Plan**.

A land use area breakdown table has also been prepared detailing the area of land allocated to each lot within the structure plan area (i.e. extent of public open space, road reserves, etc) and the associated public open space requirement arising from each lot. A copy of this table has been included on Page 31 of this report.

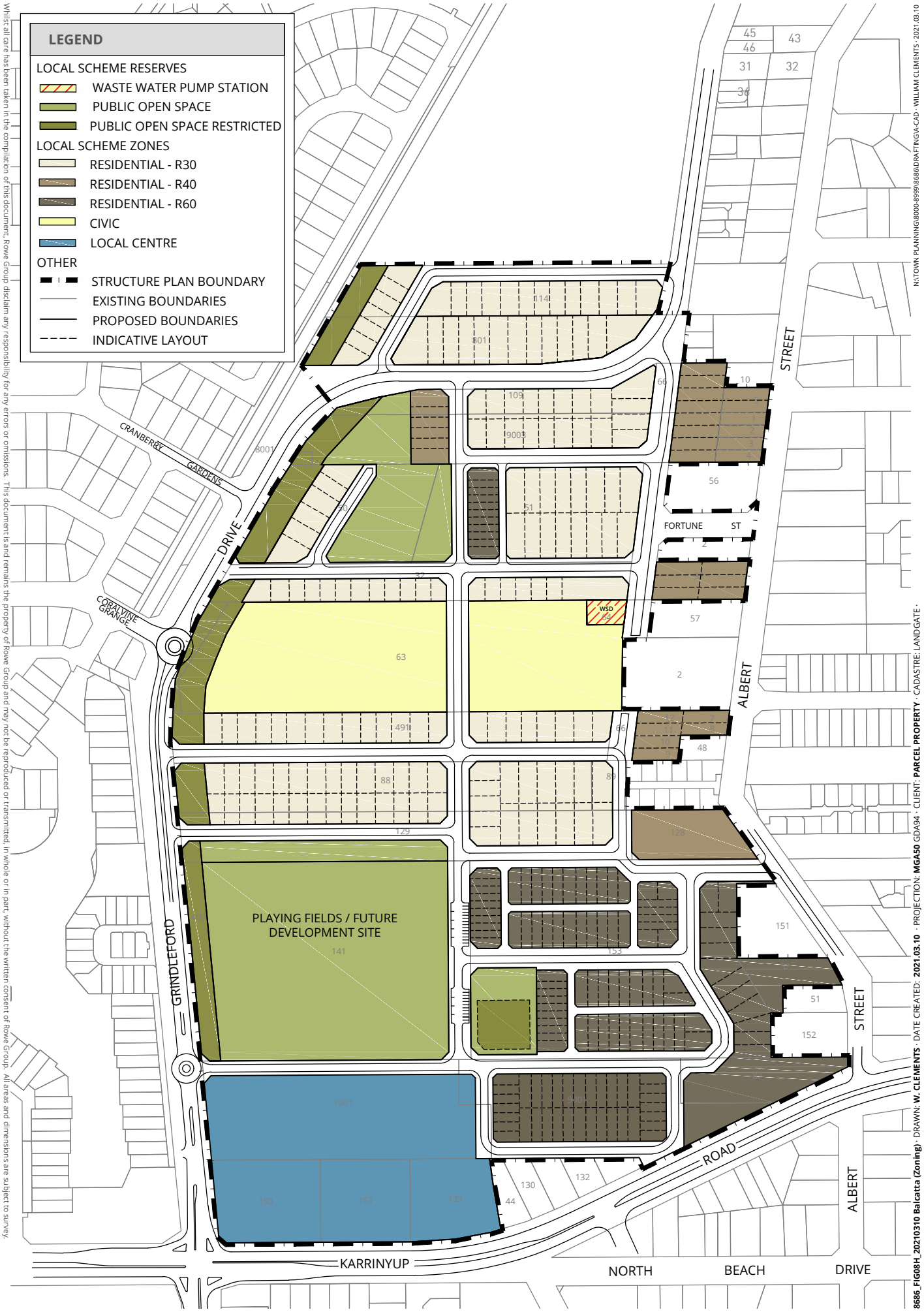
Refer **Table 3 - Land Use Summary Table**.

Table 3 - Land Use Summary Table

EAST ROSELEA STRUCTURE PLAN – LAND USE AREA SUMMARY TABLE

LANDOWNER		LOT NUMBER	TOTAL LOT AREA (m²)	LOCAL CENTRE AREA (m²)	POS REQUIREMENT (m²)	TOTAL POS REQUIREMENT (m²)	POS PROVIDED (m²)	TOTAL POS PROVIDED (m²)	ROAD RESERVE AREA (m²)
ABN DEVELOPMENT NO. 1		109	5,073	-	507	7,822	787	9,759	348
		9003	14,706	-	1471		3340		3177
		Lots 1 - 4	1,496	-	150		150		-
		491	14,292	-	1429		621		5929
		88	13,540	-	1354		968		757
		129	14,702	-	1470		3893		5698
		9001	14,733	327	1441		0		5365
CITY OF STIRLING		114	10,551	-	1.055	1,078	900	10,145	3,191
		50	10,770	-	1,077		6,822		1,432
		141	33,823	-	0		0		2,900
		400	2,423	-	0		2,423		0
Siciliani Association		51	13,886	-	1,389	1,389	1,676	1,676	2,562
Coci		32 (Grouped Housing)	2,288	-	229	1,251	*	483	0
		32	10,215	-	1,022		483*		4,337
Macedonian Club of WA		153	36,878	-	3,688	3,688	3,730	3,730	10,405
Sunbold Pty Ltd		801	9,787	-	979	979	859*	859	732
ALBERT STREET GROUPED HOUSING	Gallego	52	1,796	-	180		*	Nil: cash-in-lieu contribution payable at subdivision.	0
	State of WA	66 (North)	620	-	0		Nil		620
	State of WA	66 (South)	811	-	0		Nil		811
	Abrama	87	4,117	-	412		*		660
	Sincerity Investment	89 (Strata Lot 13)	1,146	-	114.6		*		616
	De Cinque	5	748	-	74.8		*		0
	Lazorov	128	3,542	-	354		*		33
	Shore	492	2,244	-	224		*		0
LOCAL CENTRE	Regalstone Pty Ltd	1001	17,597	13,406	47.23	47.23	*	*	3,717
	Kwiatkowski	139	4,411	3,248	Nil	Nil - commercial zoned land.	-	Nil - commercial zoned land.	1,163
	Regalstone Pty Ltd	150	5,697	5,697	Nil		-		0
	Killarney Investments	151	4,879	4,879	Nil		-		0
CHUNG WAH		63	30,083	-	Nil	Nil	Nil	Nil	Nil
WATER CORPORATION		64	626	-	Nil	Nil	Nil	Nil	Nil

*Notes: * denotes cash-in-lieu contribution required.*



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.10
8686_FIG08H_20210310 Balcatta (Zoning) · DRAWN: W. CLEMENTS · DATE CREATED: 2021.03.10 · PROJECTION: MGA50 GDA94 · CLIENT: PARCEL PROPERTY · CADASTRE: LANDGATE ·

0 100 m
SCALE @ A4: 1:4000

N

FIGURE 8
INDICATIVE ZONING AND RESIDENTIAL DENSITY CODE PLAN

4.2. PUBLIC OPEN SPACE

There is an existing area of recreational open space situated within the Structure Plan, measuring approximately 3.38 hectares in area. Whilst this area is not currently reserved for parks and recreation under the *Metropolitan Region Scheme* or LPS 3, it is under the management and ownership of the City of Stirling and functions as public open space (specifically, playing fields). Given its existing function and use, the Structure Plan proposes to retain this land as public open space, however, with slightly extended boundaries to accommodate larger playing fields, as well as car parking and club rooms, in line with the City of Stirling's development aspirations. This area of public open space equates to approximately 11.4% of the Structure Plan gross subdivisible area, providing for in excess of the minimum 10% public open space requirement under *Liveable Neighbourhoods*.

Notwithstanding the above, preliminary discussions with the City of Stirling's Administration indicates that the City's aspiration for Lot 141 have not yet been formalised and therefore, Lot 141 has been treated as a deduction from the overall gross subdivisible area on the basis that the land may be more appropriately defined as District Open Space, subject to a formal determination on the desired use of the land.

The Structure Plan therefore proposes a total of seven (7) areas of public open space comprising a total of 12.57% public open space (comprising 7.58% unrestricted and 4.99% restricted), as follows:

- POS Area 1: comprises a total area of 1,752m² and form part of the linear drainage swale along the western boundary of the site.

- POS Area 2: comprises a total land area of 9,105m² and provides for a "Neighbourhood Park" for the northern portion of the Structure Plan area. The area of public open space is intended to accommodate passive and active recreational uses. A number of direct frontage lots are proposed along the north-eastern interface with the lots anticipated to be elevated above the finished level of the public open space to provide a clear delineated between the public and private realm which will improve privacy within residential courtyard spaces. Major openings and visually permeable fencing are also anticipated to be provided to the public open space interface to improve passive surveillance.

- POS Area 3: comprises a land area of 3,430m² and acts as a continuation to the potential District Playing Fields which may be developed on Lot 141 in accordance with the City's development aspirations. Should the City not proceed with the development of Lot 141 for playing fields purposes, it is anticipated that a linear area of public open space consistent with that provided within Lot 129 would be provided, creating an aesthetically pleasing entry statement into the Structure Plan area which may also serve active and passive recreation purposes (i.e. walking trails, small play equipment, etc).

- POS Area 4: comprises a land area of 3,730m² and has been designed to a "Neighbourhood Park" standard, located centrally within south-eastern precinct of the Structure Plan area. The area of public open space also incorporates a number of direct frontage rear-loaded laneway lots which are provided on the eastern boundary of the public open space which provide surveillance and activation of the open space. The public open space area will provide for a range of passive and active recreational type uses, providing for a range of amenity benefits to local residents. In addition, a portion of POS Area 4 is required for drainage purposes which will be integrated into the design and functionality of the public open space area.

- POS Areas 5 – 7: comprise a total combined area of 10,869m² and form the balance of the linear drainage swale along the western boundary of the site.

The Structure Plan has therefore been designed such that all of lots are situated within 400 metres public open space This is achieved through the location of the existing open space within the Structure Plan, which is further complemented by the surplus of existing open space reserves within the immediate walkable catchment of the subject site.

Given the site is situated within an established urban residential area, there is significant provision of existing areas of public open space within close proximity to the subject site, serving a range of functions including both passive and active recreation purposes. Such open space reserves within close proximity to the site include, but are not limited to:

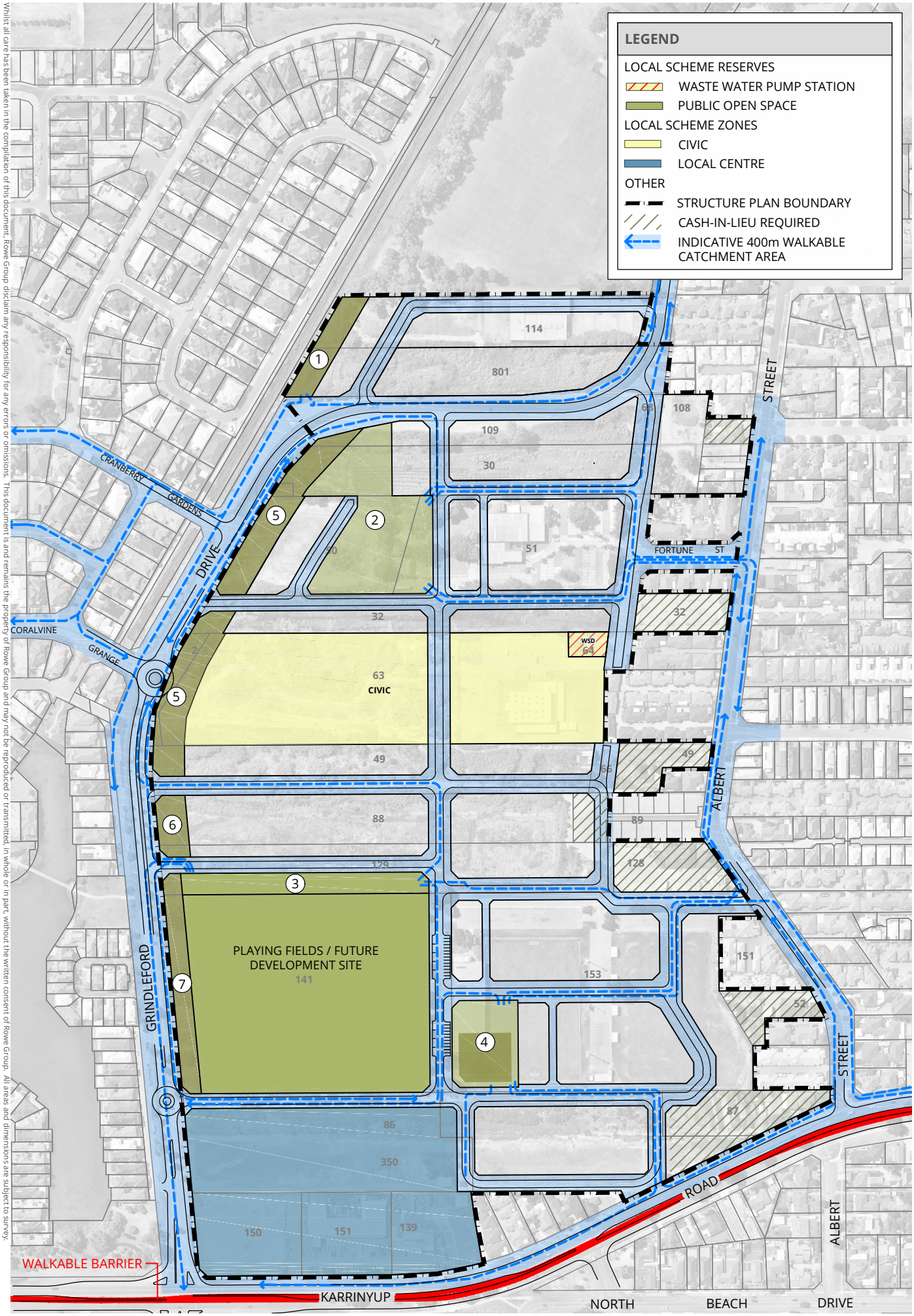
- Grindleford Reserve (150m);
- Burswood South Reserve (150m);
- Como Reserve (150m);
- Roselea Reserve (175m);
- Carpenteria Cranberry Reserve (180m);
- Burswood Reserve (200m);
- Balcatta Primary School Playing Fields (300m);
- Cherrytree Gardens (350m);
- Cadella Biccari Reserve (400m);
- Conway Reserve (450m);
- Castleton Bamford Reserve (550m);
- Castleton D'Alorzo Reserve (600m);
- Keith Clarke Reserve (620m); and
- Salerno Reserve (800m).

Based on the provision of existing and proposed public open space, all of the proposed lots are situated within 300 metres of an existing area of public open space. The proposed Structure Plan is therefore consistent with the parkland requirements of *Liveable Neighbourhoods* with all of the proposed lots being within safe walking distance to public open space.

With regard to landscaping, opportunities for tree transplanting will be explored and implemented at the subdivision stage, where possible. More detailed investigations would be undertaken at the subdivision stage, as detailed design work progresses across the site.

Further, it should be noted that in accordance with the Landscape Masterplan, street trees will be planted by the developer at a rate of one tree per lot which will significantly increase tree density above that of the existing conditions.

Refer to **Figure 9 - Public Open Space Plan, Figure 10 - Public Open Space Schedule** and **Figure 11 – Community Amenity Catchment – Pedshed Analysis.**



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.08

8686_FIG09M_20210308_Balcatta (POS) · DRAWN:WILLIAM CLEMENTS · DATE CREATED: 2021.03.08 · PROJECTION: MGA50 GDA94 · CADASTRE: LANDGATE ·

0 100 m

SCALE @ A4: 1:4000

N

FIGURE 9

PUBLIC OPEN SPACE PLAN

East Roselea Structure Plan (As Modified) – Public Open Space Schedule

08.03.21				
Site Area (Structure Plan Boundary)				29.69
Less				
Waste Water Pump Station		0.06		
Total			0.06	
Deductions				
Community Purpose Site - Chung Wah Association		2.98		
City of Stirling Playing Fields (Lot 141)		3.38		
Local Centre		2.84		
Drainage (1:1 year) - *refer below**		0.45		
Total			9.65	
				19.98
POS @10%				2.00
Public Open Space Contribution				
May comprise:				
Min 80% unrestricted POS			1.60	
Min 20% restricted use POS			0.40	
Total Required POS				**2.00**

POS Reference Number *(Catchment Boundary as per LWMS, October 2020)*	**Total POS Area (m²)**	**1:1 Year Drainage** **Deduction from Net Area*	**Unrestricted Urban POS sites (m^2)**	**Restricted Urban POS sites - Dedicated Drainage (m²)**
1 - *Swale Ct-01*	1752	1750	0	2
2	9105	0	9105	0
3	3430	0	3430	0
4 - *BRA CT-06*	3730	910	2173	647
5 - *Swale CT-03, Swale CT-04 & Swale CT-05 US*	7031	1440	0	5591
6 - *Swale CT-05 DS*	1190	0	0	1190
7 - *Swale CT-06a & Swale CT-07*	2648	388	0	2260
Total	**28886**	**4488**	**14708**	**9690**
	2.89	**0.4**	**1.47**	**0.97**
Percentage of gross subdivisible area	**14.46%**	**2.25%**	**7.36%**	**4.85%**
			Total Public Open Space	**12.21%**
Additional Deductions				
Restricted Open Space Surplus		0.57		
Revised Gross Subdivisible Area				**19.41**
Revised POS @ 10%				1.94
Revised Public Open Space Contribution				
May comprise:				
Min 80% unrestricted POS			1.55	
Min 20% restricted use POS			0.39	
Total Required POS				**1.94**
Total POS Provided	**28886**	**4488**	**14708**	**9690**
	2.89	**0.4**	**1.47**	**0.97**
	14.88%	**2.31%**	**7.58%**	**4.99%**
			Total Public Open Space	**12.57%**
			Total Unrestricted POS Shortfall	**0.08**

Notes:

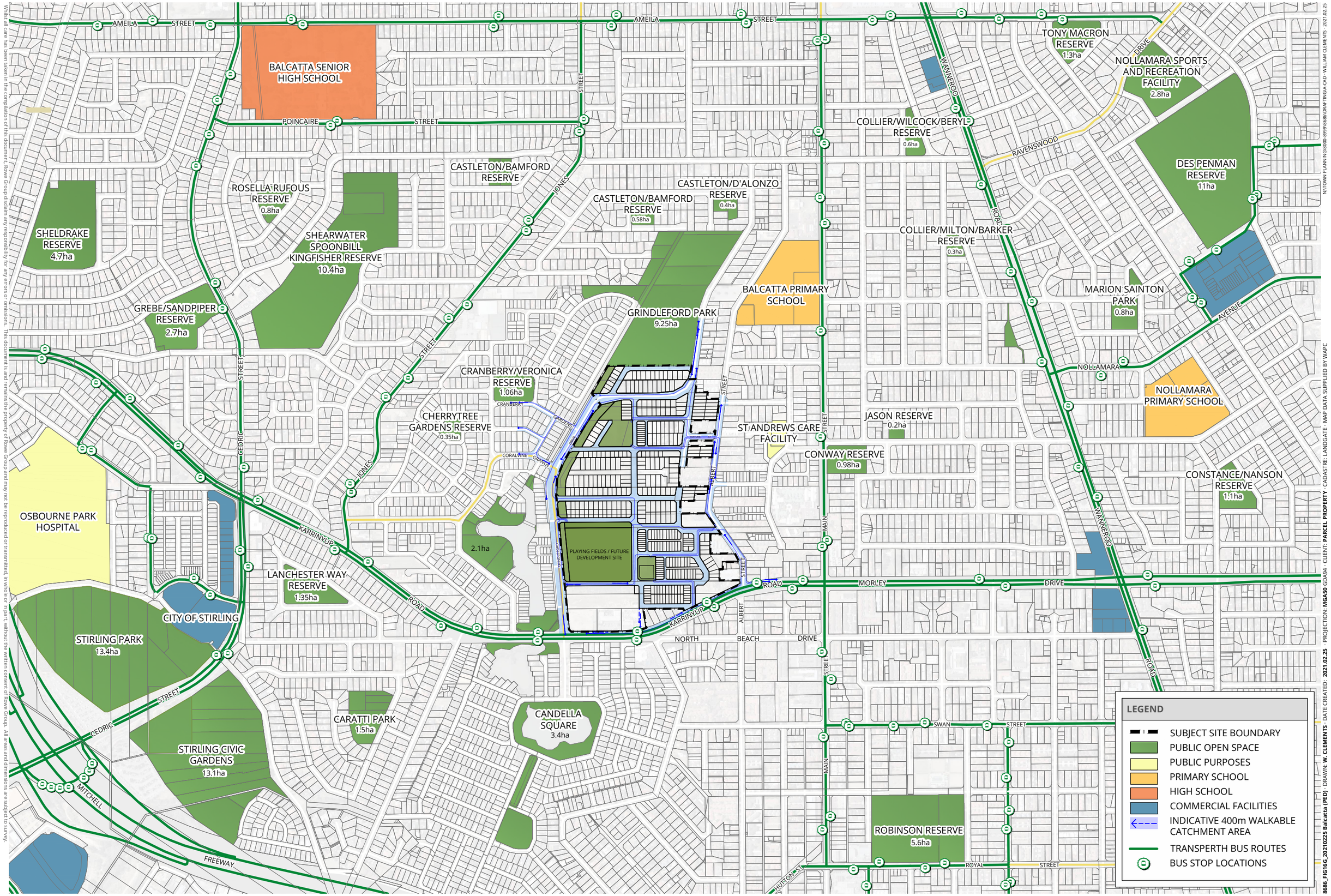
1. This Public Open Space Schedule is based on the Local Structure Plan prepared by Rowe Group (Plan ID: 8686- LSP*-02-L).*

2. This Public Open Space Schedule is based on the December 2020 LWMS prepared by Emerge Associates

FIGURE 10

PUBLIC OPEN SPACE SCHEDULE

Whilst all care has been taken in the compilation of this document, Rowe Group disclaims any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.



LEGEND

- SUBJECT SITE BOUNDARY
- PUBLIC OPEN SPACE
- PUBLIC PURPOSES
- PRIMARY SCHOOL
- HIGH SCHOOL
- COMMERCIAL FACILITIES
- INDICATIVE 400m WALKABLE CATCHMENT AREA
- TRANSPERTH BUS ROUTES
- BUS STOP LOCATIONS

0m 250m
SCALE:1:10,000 @ A3
N

8686_FIG16G_20210225 Balcatta (PED) - DRAWN: **W. CLEMENTS** - DATE CREATED: **2021.02.25** - PROJECTION: **MGA50** GDA94 - CLIENT: **PARCEL PROPERTY** - CADASTRE: **LANDGATE** - MAP DATA SUPPLIED BY **WAPC**

NITTOWN PLANNING|8000 8959 8686|DRAFTING|A-CAD - WILLIAM CLEMENTS - 2021.02.25

FIGURE 11

COMMUNITY AMENITY CATCHMENT - PEDSHED ANALYSIS

4.2.1. CITY OF STIRLING PUBLIC OPEN SPACE STRATEGY

The future population is considered to be well serviced by the existing public open space network located within walking distance of the structure plan area, as demonstrated on Figure 11. The site has access to a range of public open space areas, including areas which can be used for both passive and active recreation purposes. It is considered that the creation of small "pocket parks" would not result in a good urban design outcome for the locality and rather, it is understood that the local community's preference would be for any surplus funds to be spent on upgrading existing public open space areas within the Balcatta-Stirling locality, as noted within the City's Public Open Space Strategy.

In this regard, the increased population proposed as a result of the new residential development will not have a negative impact on the totality of public open space within the vicinity of the site, on the basis that the site is well serviced by the existing open space network within the Balcatta-Stirling locality.

Should the City's Lot 141 be developed for district playing fields purposes, the appropriate classification under the City's Public Open Space Strategy as would be "District Open Space", due to the intended use of the open space for formal sport and recreation activities. The linear area of open space which contains the drainage swale is more appropriately classified as "Local Open Space" under the strategy given is provides "green relief" from the built form whilst also serving a local drainage function.

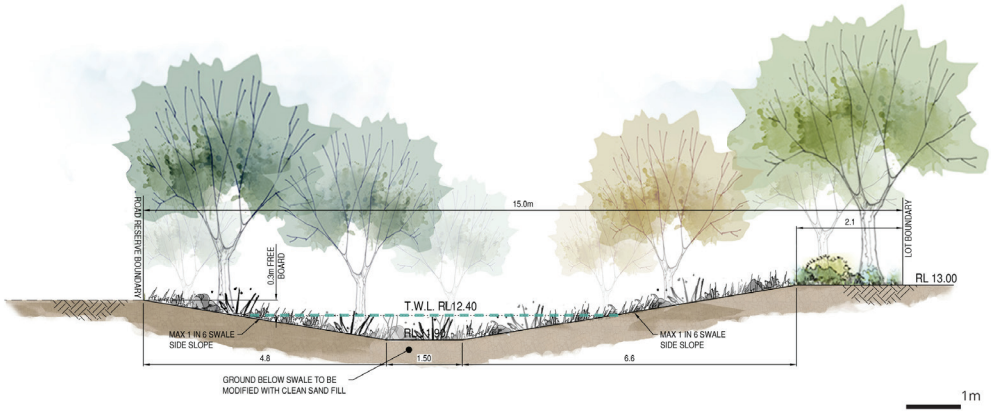
It is also noted that the City's Public Open Space Strategy states that at the conclusion of the community forums, the top priority or preference for the "Balcatta-Stirling" local area was "improving parks and reserves", indicating that there is a preference to focus on the quality as opposed to the quantity of public open space in the area. Further, the Central locality which contains the "Balcatta-Stirling" community, indicated that 57% of residents would rather dispose of most small pocket parks, with the proceeds to be used to upgrade other local parks.

In this regard, it is considered that the proposed allocation of public open space and the cash-in-lieu methodology is consistent with the community's aspirations to improve its current parks and reserves.

4.2.2. DRAINAGE SWALE

The Structure Plan identifies a linear vegetated drainage swale along the majority of the western interface with Grindleford Drive which comprises approximately 1.27 hectares or 4% of the site. In accordance with the Local Water Management Strategy, vegetated drainage swales will be utilised to treat and retain runoff within the western boundary of the site. The drainage swales are typically proposed at 25m in width (with the exception of Lot 400 adjacent to the City's Playing Fields). A number of indicative cross sections have been prepared and included within the Landscape Masterplan at **Appendix 7** of this report.

Section A-A



Section B-B

In terms of the interface to Grindleford Drive, the drainage swale will predominantly present as a vegetated area, to be landscaped as development progresses across the Structure Plan area. The drainage swale will be integrated into the landscape and civil design response to meet best practice urban design standards and will not be fenced to preclude access. The location of the drainage swale does not restrict or prevent vehicular access, with lots able to be accessed from the internal road network proposed under the Structure Plan.

Development of lots which abut the drainage swale will be guided by a Local Development Plan, to be imposed by way of a condition of subdivision approval. It is anticipated dwellings will be required to provide major openings and portions of visually permeable fencing adjacent to the drainage swale to provide for passive surveillance and an improved streetscape aesthetic along the western boundary of the site.

4.2.2.1. CITY OF STIRLING OWNED LAND

Portions of the proposed linear drainage swale are provided on City of Stirling owned land, specifically Lot 50 and Lot 400 (located adjacent to the playing fields). The use of the City's land for drainage purposes was adopted by Council at its Ordinary Council Meeting dated 20 November 2018 as part of its resolution to recommend approval of the Structure Plan.

The proponent will seek further agreement from the City of Stirling at the implementation stage with regard to any construction / staging related matters (including access and undertaken works on the City's land). The agreement should ensure that the detailed design, construction and ongoing maintenance of the drainage swale are to the City of Stirling's satisfaction.

4.2.2.2. COORDINATION OF PUBLIC OPEN SPACE WORKS

Where public open space is provided over two different landholdings, there will be a need for the landowners to enter into an agreement with regard to the coordination of landscape design and construction works.

The agreement between landowners should consider:

- Landscape design and treatment;
- Coordination of works;
- Timing for works; and
- Site access requirements (during construction).

Such agreements would be entered into as part of the implementation of any subdivision approvals of the respective landholdings.

4.2.2.3. BUILT-FORM OUTCOMES

In accordance with Clause 5 of Part 1 of the Structure Plan report, Local Development Plans will be required to guide the development of those lots abutting public open space, inclusive of the vegetated drainage swale along Grindleford Drive.

It is envisioned that the Local Development Plans will address the following matters, to ensure an appropriate built-form outcome is provided:

- **Vehicular Access:** those lots abutting the proposed drainage swale shall take access from the internal road network, with access from Grindleford Drive generally not permitted.
- **Fencing:** those lots which back on to the drainage swale are to provide visually permeable fencing to the boundary of the drainage swale, with the exception of any areas of minor screening required to provide privacy to any outdoor living areas.
- **Dwelling Orientation:** dwellings shall generally be designed such that passive surveillance over the drainage swale can be achieved (i.e. dwellings should be designed such that major openings are provided fronting Grindleford Drive and the drainage swale).

The abovementioned requirements are subject to further detailed design at the subdivision stage to ascertain the most appropriate built-form response for the subject lots.

4.2.2.4. MAINTENANCE

With regard to the maintenance of the drainage swale, the appointed Landscape Architect LD Total has confirmed that the drainage swales will not require more than the normal amount of maintenance of public open space. Maintenance of the drainage swale will include the standard public open space rubbish removal, replacement or removal of vegetation and top up of mulch (organic mulch or stone mulch) as required throughout the drainage swales and public open space.

Construction of the drainage swale will be undertaken by each of the applicable landowners however the proponent is prepared to fund the construction of the drainage swale, which occurs on land either owned by the proponent or the City of Stirling (which achieves 75% of the total storage basin required). The land and infrastructure required for the drainage swale will be delivered as part of the proponent's application to subdivide their land.

The construction per square meter rate of the drainage swale anticipated to be consistent with the of standard areas of public open space. The linear drainage swale will also cater for the City's existing upstream drainage catchment which currently discharges within the Structure Plan area. The provision of the drainage swale within the City's landholdings is therefore considered to address a pre-existing issue for the City of Stirling and therefore should be supported.

Refer **Appendix 7 - Landscape Masterplan.**

4.2.3. COMMUNITY PURPOSE SITE

Lot 63 is currently under the ownership of Chung Wah Association, which is used as a community purpose building for various events, as well as providing for temporary accommodation for monks and other members of the Association travelling interstate.

In accordance with the submission received from the Chung Wah Association, this parcel of land is to be used for community purposes and therefore, the land has been identified within the "Civic" zone to reflect the current and future intentions for the site.

Given the current and future intentions for the site and at the request of the Chung Wah Association, no road connections are proposed through Lot 63. It is understood that the Chung Wah Association has development aspirations for Lot 63, which include the construction of Chinese gardens and the expansion of the existing facility.

This landholding has therefore been included as a deduction under the Public Open Space Schedule.

4.2.4. CASH IN LIEU ARRANGEMENTS

Given the fragmented ownership across the site, it is considered an inefficient and inappropriate use of land to require each subdividing landowner to deliver 10% of their gross subdivisible area as public open space. The provision of a higher functioning and consolidated parcel of open space to serve the community, as opposed to fragmented smaller areas of open space dispersed across the site, is considered to be more in keeping with the interests of orderly and proper planning, as well as providing for a more efficient public open space network for the locality.

Therefore, upon subdivision of land by individual land owners, a cash-in-lieu payment for public open space equivalent to 10% of their gross subdivisible area will be required to be paid to the City of Stirling.

Given there is no existing development contribution scheme in place for the Structure Plan, nor is one intended to be prepared, this will be required to be implemented through conditions of subdivision approval.

Cash-in-lieu funds collected by the City through the process outlined under the *Planning and Development Act 2005* should be used to formally acquire Lot 50 from the City and transfer the land to the Crown as a formal public open space reserve (noting Lot 50 is currently denoted as public open space on the structure plan map). Ultimately, how the City chooses to expend the funds collected through the cash-in-lieu arrangements will be determined by the City and guided by the WAPC's *Development Control Policy 2.3 and Planning Bulletin 21 – Cash-in-lieu of Public Open Space.*

The responsibility and funding for the development of Public Open Space would occur through the cash-in-lieu process, as detailed in Development Control Policy 2.3. Similarly, the on-going maintenance of the drainage swale would be undertaken by the local authority (i.e. the City of Stirling), as per the standard subdivision process as detailed under the *Planning and Development Act 2005*.

4.3. RESIDENTIAL

An indicative subdivision layout has been prepared for the site, identifying a yield of approximately 528 dwellings, comprising a mix of freehold and grouped housing lots. It should be noted that indicative dwelling calculations have assumed the construction of freehold and grouped housing lots only. Should portions of the site be developed for multiple dwellings (i.e. in proximity to the local centre), the total dwelling yield calculation would be expected to increase.

Based on applying the "gross dwellings per urban hectare" calculation of the WAPC's *Directions 2031*, the site is anticipated to deliver approximately 500 lots, based on a calculation of 15 dwellings per gross urban hectare multiplied by the site area (i.e. 29.7 hectares). As noted above, however, the number of freehold lots may be less than the estimated value, on the presumption that portions of the land are more conducive to grouped housing and multiple dwelling type developments.

In this regard, and based on an indicative dwelling yield of 528, the site achieves a density of approximately 35 dwellings per residential site hectare, and 17 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 new subdivision areas.

For reference, an Indicative Plan of Subdivision is provided at Figure 10. Indicative dwelling yields as provided on Figure 10 have been based on the relevant average lot size requirements of the *Residential Design Codes of WA* (the 'R-Codes'). It should be noted that this figure has been provided for explanatory purposes only, and is subject to further review and detailed design at the subdivision stage.

Residential density codes have been allocated across the site and have been used in the preparation of indicative subdivision layouts and density calculations. The Structure Plan allocates a base density of R30, with areas of R40 adjacent to Albert Street consistent with current LPS 3 mapping. The Structure Plan also proposes density codes between R60 and R80 within proximity to the local centre, public open space and Karrinyup Road.

The density code range also facilitates 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 built form outcomes consistent with the development intent of the site.

Refer to **Figure 12 – Indicative Subdivision Layout**.

Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.10

8686_FIG12F_20210310 Stirling (Indicative Subdivision) - DRAWN:WILLIAM CLEMENTS - DATE CREATED: 2021.03.10 - PROJECTION: MGA50 GDA94 - CADASTRE: LANDGATE -

0 100 m

SCALE @ A4: 1:4000

N

FIGURE 12

INDICATIVE SUBDIVISION LAYOUT

4.3.1. LOCAL DEVELOPMENT PLANS

A Local Development Plan is required in the following circumstances:

- Lot 63 (Chung-Wah Association owned land) is substantially redeveloped, to ensure that development occurs in a coordinated manner and preserves the potential extension of the north-south spine road through the site in the future;
- Lots abutting POS;
- Lots abutting the drainage swale; and
- Lots subject to quiet house design requirements.

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

- Dwelling orientation;
- Type of fencing;
- Location of carports/ garages and vehicular access;
- Surveillance;
- Setback variations;
- Solar Orientation; and
- Requirements for dwelling construction compliant with an approved Noise Management Plan.

It is anticipated that where a Local Development Plan is required in accordance with the abovementioned criteria, a condition of approval will be imposed by the WAPC requiring the preparation and approval of a Local Development Plan.

4.4. MOVEMENT NETWORKS

The following provides a summary of the proposed movement network. For further information, refer to the Transport Impact Assessment included at **Appendix 8**.

4.4.1. EXISTING ROAD NETWORK

4.4.1.1. KARRINYUP ROAD

Karrinyup Road adjoins the Structure Plan on its southern boundary and provides a connection to the Mitchell Freeway via Cedric Street, as well to the Stirling railway station. Karrinyup Road is reserved as a "Primary Regional Road" under the MRS and classified as a "Primary Distributor Road" under the Main Roads WA Functional Road Hierarchy.

It is noted that Karrinyup Road is currently constructed as a 4-lane dual carriageway where it adjoins the site.

Daily traffic volumes for Karrinyup Road in the vicinity of the Structure Plan indicate approximately 23,772 vehicle movements per day.

4.4.1.2. GRINDLEFORD DRIVE

Grindleford Drive adjoins the Structure Plan on its western boundary and connects with Karrinyup Road in the south and Beryl Street in the north. Grindleford Drive is classified as a "Local Distributor Road" under the Main Roads WA Functional Road Hierarchy.

Grindleford Drive is currently constructed to a 2-lane dual carriageway, with a 4.5 metre pavement width in each direction, south of Coralvine Grange. North of Coralvine Grange, Grindleford Drive is constructed to a single carriageway with a 7.5 metre pavement width.

Existing traffic volumes along Grindleford Drive vary from 1,864 vpd in the south to 1,027 vpd in the north, and 834 vpd generally centrally to the site.

4.4.1.3. ALBERT STREET

Albert Street adjoins the Structure Plan on its eastern boundary and connects with Karrinyup Road in the south and Beryl Street in the north. Albert Street is classified as an "Access Road" under the Main Roads WA Functional Road Hierarchy.

Albert Street is currently constructed to a 2-lane access road, with a 7-metre pavement width and traffic calming devices.

Existing traffic volumes along Albert Street are indicated at approximately 1,610 vehicle movements per day.

4.4.2. PROPOSED ROAD NETWORK

The proposed road hierarchy for the Structure Plan (refer **Figure 13 - Indicative Movement Network**) has been determined from modelling based on the indicative subdivision layout and provides for simple and efficient vehicle movements through the site.

The location of the road reserves has generally been designed to ensure that each lot can be developed independently of one another (i.e. to prevent lots becoming "land locked". In the event that minor road realignments are required in order to facilitate access, it is considered that these variations may be dealt with as an "inconsequential" variation at the subdivision stage. Should any such road realignment be major in nature, an amendment to the Structure Plan may be required, at the discretion of the WAPC.

The movement network reflects an east-west and north-south modified grid configuration, with a number of direct connections to the existing surrounding road network. 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	INDICATIVE UPPER TRAFFIC VOLUME	INDICATIVE ROAD RESERVE WIDTH
Neighbourhood Connector A	>3,000 vpd	25 metres
Neighbourhood Connector B	<3,000 vpd	18 metres
Access Road B	<3,000 vpd	18 metres
Access Street C	<3,000 vpd	15 metres
Access Street D	<1,000 vpd	15 metres

Table 4: Road Classifications

The proposed road hierarchy primarily consists of access streets, with higher order roads surrounding the local centre and providing a north-south spine road through the site, terminating at the community purposes site.

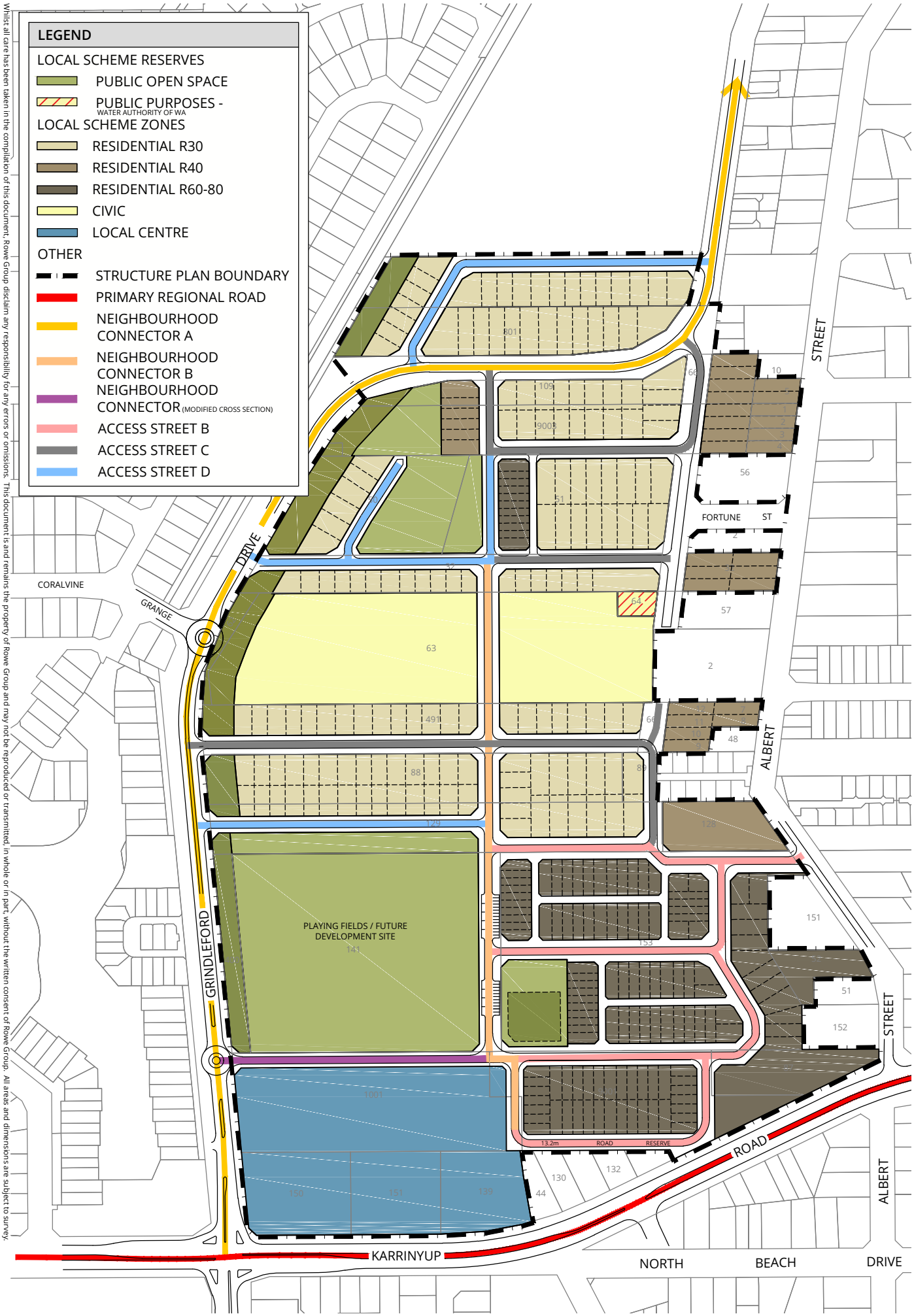
The access streets are proposed to primarily consist of Access Street type D roads, designed to a 15 metre cross-section. Where services are only required to one side of the road, such as adjacent to public open space or backing on to commercial development, a reduced Access Street D cross-section of 12 to 13.2 metres is proposed.

Access Street type B roads are provided within the higher density areas (i.e. areas with a density code of between R60 – R80) in proximity to the local centre to provide for additional on-street embayment car parking. The widened Access Streets will provide for improved vehicular access and egress within proximity to the local centre and support a pedestrian friendly environment.

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 Structure Plan area estimates the completed development will generate in the order of approximately 13,000 vehicle movements per day, with approximately 66% of those generated by the local centre.

Refer **Figure 13 - Indicative Movement Network**.



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD - WILLIAM CLEMENTS - 2021.03.10
8686_FIG13F_20210310 Balcatta (Modified Movement Network) - DRAWN:WILLIAM CLEMENTS - DATE CREATED: 2021.03.10 - PROJECTION: MGA50 GDA94 - CADASTRE: LANDGATE -

FIGURE 13
INDICATIVE MOVEMENT NETWORK

4.4.2.1. PEDESTRIAN AND CYCLE NETWORK

In accordance with the requirements of *Liveable Neighbourhoods*, footpaths will be provided on at least one side of every street, with a number of roads proposed to have footpaths on both sides.

Given the relatively low traffic volumes anticipated, no designated cycle paths are proposed within the Structure Plan. It is, however, recommended that on-street cycle lanes are provided along the Neighbourhood Connector, as well as cycle facilities (by way of a 2.5m shared path) along the north south spine road, providing connections from the local centre to Grindleford Drive and Karrinyup Road.

The Department of Transport's Bike Map for Stirling identifies Albert Street, running along the eastern boundary of the site, as being part of the Perth Bicycle Network (NE2). In addition, the western end of Karrinyup Road adjacent to the Structure Plan is also shown as a shared path.

4.4.3. PUBLIC TRANSPORT

The Structure Plan area is currently serviced by bus routes 402, 998 and 999 along Karrinyup Road, adjoining the site's southern boundary. Bus route 402 services the Stirling railway station and connects to the Perth Bus Depot on Wellington Street. Routes 998 and 999 are circle routes that also service the Stirling railway station. There are also a number of other bus routes servicing the local roads within relatively close proximity to the site, primarily the 414 east of Albert Street.

Given that the neighbourhood centre and the majority of the residents in Roselea East have good access to bus routes on Karrinyup Road, it is considered unlikely that any new routes would be introduced through the site.

It is also noted that the Stirling Station is situated approximately 2 kilometres to the south-west of the Structure Plan.

4.5. WATER MANAGEMENT

4.5.1. LOCAL WATER MANAGEMENT STRATEGY

A Local Water Management Strategy ('LWMS') has been prepared in support of this Structure Plan and is provided as **Appendix 9**.

The LWMS addresses the Structure Plan area, and provides a refinement of flood modelling, the surface water management strategy and the groundwater management strategy to a local scale. The LWMS has been prepared in accordance with the water sensitive urban design practices as described in the *Stormwater Management Manual* of WA and the WAPC's *Better Urban Water Management (2008).*

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 defined under the LWMS.

4.5.2. PROPOSED STORMWATER MANAGEMENT STRATEGY

The stormwater management strategy for the site is to retain, treat and infiltrate stormwater runoff as close to source as possible. The strategy for the site requires residential lots up to the R60 density classification to retain the small event (first 15 mm) on site. Residential lots of density R60 and above will retain the major (1% AEP) event onsite.

The proposed stormwater management approach is outlined in further detail below.

4.5.2.1. LOT STORAGE

Rainfall on lots will either infiltrate directly at-source (i.e. garden areas) or will be directed to soakwells from roofs and paved surfaces where it will infiltrate into the underlying soil and ultimately to groundwater. Infiltration of runoff through the underlying soils will provide treatment through adsorption of nutrients to sand particles.

Residential lots of density up to R60 will utilise soakwells sized to retain runoff from the small event (i.e. first 15 mm) from lot. Residential lots of density R60 and above will use a combination of strategies to retain up to the major event onsite, which will be detailed in future Urban Water Management Plans ('UWMPs').

Additionally, soakwells will have the ability to overflow to a lot connection for discharge to either of the proposed subsoil or stormwater networks, with the intent of ensuring that the lot-scale detention measures continue to function as intended.

4.5.2.2. VEGETATED SWALES

As described in **Section 5.2.2**, vegetated swales will be utilised to treat and retain runoff within the western boundary of the site. These will be located within a 25 m wide drainage reserve immediately adjacent to Grindleford Drive.

Vegetated swales are designed to treat runoff received from the small event or first flush (i.e. first 15 mm), and to retain up to the major (1% AEP) storm event from the road network plus discharge from lots in excess of the small event.

The swales will have a maximum top width of 25 m and typically have 1:6 side slopes (with the exception to swales Ct-01 and Ct-05 DS where vertical sidewalls are proposed). Swale inverts will be set 300 mm above the 50% AEP predicted groundwater level to facilitate infiltration and prevent prolonged wet conditions. The swales are designed to have a top water level ('TWL') in the major event that will be below the level of Grindleford Drive.

Wherever practical individual swales shall be interconnected by culverts across proposed roads to enable water levels to balance throughout the system and optimise storage and infiltration. Where invert levels vary between adjacent swales a high level overflow outlet structure may be incorporated at the swale having the higher invert level.

Infiltration of runoff through the underlying soils of the swales will provide treatment through adsorption of nutrients to sand particles. The swales can potentially be lined with high Phosphorus Retention Index (PRI > 10) media to improve phosphorus uptake. Nutrient stripping vegetation will be planted densely in the swales to assist in the uptake of nutrients.

4.5.2.3. BIO-RETENTION AREAS

Runoff generated by the small event on road reserves will be captured and retained in a vegetated bio-retention area ('BRA'), located in the public open space within catchment Ct-06 (POS Area 4).

The BRA will be designed with side slopes no greater than 1:3 and a maximum depth of 300 mm. BRAs will be densely vegetated with species known to uptake nutrients, potentially controlling access to these areas. BRA inverts will maintain a minimum 300 mm clearance from MGL.

The BRA is sized to cover an area of ~4.6 % of the total connected impervious area, thus exceeding the 2% of connected impervious area requirement.

4.5.2.4. FLOOD STORAGE AREAS

A flood storage area ('FSA') will be utilised in catchment Ct-06 to detain and infiltrate major event flows, supporting the pre-development hydrological regime. Collocated with the BRA, surface runoff above the small event, up to and including the major event, will be detained within the FSA located within the Ct-06 POS area. During the major event the FSA will discharge via a high level overflow to the swale in catchment Ct-06A, however no off-site discharge will result. The City of Stirling's requirements will be incorporated into the final detailed design at future design stages.

The FSA will be designed with side slopes no greater than 1:6 and an overall maximum depth of 1.2 m (inclusive of the BRA depth). The FSA invert will maintain a minimum 300 mm clearance from MGL to ensure they are able to adequately drain following a rainfall event. The FSA will also be designed to maintain a 300 mm clearance from finished floor levels ('FFLs') to the major event TWL. Clearance from MGL and FFLs will be demonstrated upon lodgement of civil engineering drawings.

4.5.2.5. DISCHARGE TO EXTERNAL STORMWATER NETWORKS

Stormwater discharged onto site from the external upstream stormwater networks, including runoff generated from the mostly developed catchment Ct-02, will continue to be collected via the existing stormwater network and will be conveyed through the site via extended pipework for final discharge to the Albert Street Branch Drain. The Structure Plan therefore does not need to make any spatial provision for the management of runoff from the upstream catchments.

Water Corporation has provided approval in principle for the extension of the existing DN900. Water Corporation has also advised that no additional connections from the structure plan area will be permitted, including no additional connections to the proposed DN900 pipe drain extension.

Rainfall on the 'Local Centre' is assumed to be retained up to the major (1% AEP) event in accordance with City of Stirling's Development Services requirements.

4.5.3. GROUNDWATER MANAGEMENT

The primary objective for groundwater level management is to ensure the final lot levels are at least 1.2 m above the 50% AEP predicted 'wet' scenario.

The historical Maximum Groundwater Level ('MGL') for the site ranges between 11.6 mAHD and 15.5 mAHD lifting to the east. This is generally reflected in the 2021 predicted groundwater levels along the western boundary, with groundwater predicted to be at 11 mAHD - 12.5 mAHD in this part of the site. Concept earthwork levels for the residential lots are designed between 13.5 mAHD and 17.8 mAHD, giving a minimum clearance to the 50% AEP of 1.2 m

The inverts of the swales, BRAs and FSAs will provide a minimum clearance to the 50% AEP of 300 mm.

Free draining sands will be provided to an appropriate depth below lots, typically a minimum of 2.3 m. The earthworks currently proposed indicates that in some locations these sands will be underlain by a limestone raft that will provide a geotechnically stable platform over the underlying peaty soils.

The base of the swales will also be excavated to remove the peat, and these areas will be backfilled with free draining sand. This will assist in ensuring that groundwater levels are maintained to an acceptable level.

Subsoil drains are proposed beneath some road reserves to protect road pavement. These do not seek to control the existing groundwater levels, however, will control rise of locally infiltrated stormwater beneath lots to mitigate against potential waterlogging, and will protect road pavement integrity in the post-development environment. Subsoil inverts will discharge to the swales along Grindleford Drive at least 150 mm above the swale inverts, which would still be above post-development groundwater if this were to rise.

A connection will be provided so that private residences can install subsoil drains at either side or rear boundaries of properties.

4.5.4. URBAN WATER MANAGEMENT PLAN

Consistent with the requirements of the LWMS and the Better Urban Water Management framework, an UWMP will be required as a condition of subdivision approval. The UWMP will refine and implement the proposed drainage network/system, as defined under the LWMS.

While strategies have been provided within this LWMS that address planning for water management within the site, it is a logical progression that future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification within future UWMPs include:

- Drainage calculations
- WSUD configuration
- Staging considerations
- Irrigation Schedule
- Water Balance
- Water Conservation Strategy
- Subdivision earthworks
- Groundwater licensing
- Acid sulphate soil investigations
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction management strategy.

4.6. EDUCATION FACILITIES

Given the infill nature of the proposed development, the site is well catered for with existing public education facilities within the surrounding areas. The Structure Plan therefore does not propose any primary, secondary or tertiary education facilities. Preliminary discussions with the Department of Education indicate that there is sufficient capacity within the existing schools within the vicinity of the site, which will be formally confirmed during the Structure Plan advertising process.

The site currently falls within the intake area for Balcatta Primary School (0.9km from the site), however is also within relatively close proximity to the following other public schools.

- Osborne Primary School (1.4km);
- Nollamara Primary School (1.7km);
- West Balcatta Primary School (2km);
- Balcatta Senior High School (1.6km);
- Dianella Secondary College (3.3km);
- Churchlands Senior High School (4.5km); and
- Balga Senior High School (4.6km).

There are also a number of private education facilities accessible from the subject site.

In accordance with *Liveable Neighbourhoods* criteria, the anticipated lot yield does not trigger the need for provision of any additional primary or high school facilities within the subject site.

4.7. ACTIVITY CENTRES AND EMPLOYMENT

4.7.1. SECONDARY CENTRES

Consistent with *State Planning Policy 4.2: Activity Centres for Perth and Peel* ('SPP 4.2'), the closest secondary centres to the Structure Plan area are Karrinyup (approximately 3.8 kilometres to the north-west) and the Mirrabooka Centre (approximately 4.0 kilometres to the north-east).

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

4.7.2. DISTRICT CENTRES

Northlands and Main Street (Osborne Park) are the two closest district centres to the subject site.

These centres provide for a mix of smaller scale every day uses, including food and beverage outlets, retail shops, offices and other complementary uses including warehouse / showroom type uses. These centres support the larger scale secondary centre and provide further economic and employment opportunities for future residents.

4.7.3. NEIGHBOURHOOD / LOCAL CENTRE

There is an existing local centre situated in the south-west corner of the site, at the intersection of Grindleford Drive and Karrinyup Road. It is proposed to retain the local centre and expand its facilities and offerings as part of the Structure Plan. The existing centre includes a medical centre ('Stirling Lakes Medical Centre'), a child care centre ('Stirling Child Care Centre') and a tool hire shop ('The Hire Guys'). The local centre has recently been redeveloped, which now also comprises a Woolworth supermarket of approximately 3,600m² in size, approximately 220 car parking bays and other commercial retail, food and beverage outlets.

There is also an existing garden centre and cafe ('Waldecks') located on the opposite side of Karrinyup Road, outside the Structure Plan boundary.

A Retail Sustainability Assessment was prepared in support of the proposed expansion of the centre and delivery of a supermarket at the site. A copy of the Retail Sustainability Assessment is provided at **Appendix 10**. The assessment concludes there is a clear need and demand for a supermarket of this size in this locality, as well as identifying the economic and social benefits to the local community.

Subject to detailed design and sizing of the site, there may also be an opportunity to include additional uses within the local centre.

Refer **Appendix 10 - Retail Sustainability Assessment**.

4.7.4. COMMUNITY FACILITIES

The subject site is located in an existing and well-developed urban area which is serviced by a broad range of existing community facilities. In this regard, the population increase proposed as a result of the Structure Plan is not considered to result in a requirement to provide additional community services and facilities. By way of example, the following community facilities are located in close proximity to the site:

- Stirling Community Centre – WK Moir – Balcatta;
- The Stirling Community Centre;
- Colin Moore Community Resource Centre;
- Osborne Park Community Centre;
- Stirling Leisure Centres – Karrinyup;
- Stirling Community Centres – Karrinyup;
- Stirling Community Men's Shed;
- Tuart Hill Community Centre;
- Osborne Library – City of Stirling; and
- Karrinyup Library.

The site is also well serviced from an aged care perspective with the following facilities being located in close proximity to the site:

- Juniper Saint Andrew's;
- St Andrew's Care Facility;
- Bethanie Geneff;
- MYVISTA; and
- Mount La Verna Retirement Village.

In this regard, the Structure Plan area is considered to be well serviced in terms of existing community facilities and therefore, does not require the provision of additional facilities as a result of the proposed population increase.

An assessment again the key criteria of the Community Facilities Guidelines published by Parks and Leisure Australia has been included in Table 5 on Page 59 of this report.

Refer **Table 5 - Assessment of Public Open Space and Community Facilities**.

Table 5 - Assessment of Public Open Space and Community Facilities

USE	POPULATION CATCHMENT	STRUCTURE PLAN RESPONSE
(Organised Sport) – Sports Space	1 : 4,000 – 5,000	The structure plan will provide for a population of approximately 1,150 people, representing 20% over the overall "demand" for an organised sports space. It is noted that Balcatta currently comprises a total population of 10,382 people, with the proposed structure plan providing for approximately a 10% increase in the overall total population. The structure plan is not considered to warrant the need for any additional organised sports spaces for reasons as follows: • It is understood that the City of Stirling is exploring a number of development options for Lot 141, including a concept for District Playing Fields which will provide a multi-functional area of open space capable of accommodating rectangular sports field (such as hockey, rugby and soccer) and also a full sized Australian Football League ('AFL') oval. • Further, there are existing rectangular playing fields located to the north of the structure plan area, within Grindleford Park, which abuts the northernmost edge of the structure plan area. • With regard to AFL and cricket facilities, Jones Paskin Reserve is located approximately 1 kilometre north of the structure plan area, which caters for these facilities, with Richard Guelfi Reserve being located approximately 2 kilometres from the subject site. On the basis of a total forecast population of approximately 11,500 people for the suburb of Balcatta (inclusive of the structure plan area), a total of two (2) organised sports spaces are required. As summarised above, there is in excess of two (2) existing organised sports spaces within the suburb of Balcatta and therefore, the existing facilities within the locality are sufficient for the forecast population growth.
Child's Play) – Play Space	Neighbourhood: 1 : 2,000 District: 1 : 8,000 – 10,000 Regional: 1 : 50,000	**Neighbourhood:** Opportunities for children's play spaces to be incorporated within the structure plan area will be reviewed at the detailed design stage, once further information regarding the treatment of the internal areas of public open space is known. Notwithstanding, it should also be noted that there are at least five (5) existing reserves within 200 to 500 metres of the structure plan area which provide for children's play equipment, including: • Carpentenia Cranberry Reserve (200 metres); • Burwood Reserve (250 metres); • Roselea Reserve (300 metres); • Cherrytree Gardens (350 metres); and • Conway Reserve (500 metres). **District:** It is understood that the City of Stirling is exploring a number of potential development scenarios over Lot 141, one of which would include the redevelopment of the land for District Playing Fields, which would incorporate children's play equipment of a "regional" standard. Taking the City's development aspirations into consideration and further, given the proposed population increase arising as a result of the structure plan represents only 10% of the overall need for district level facilities, it is not considered that further district facilities need to be provided for as a result of the East Roselea Structure Plan. **Regional:** Given Balcatta comprises a population which is significantly less than 50,000 people and further, given the proposed structure plan population represents 2.3% of the overall requirement for a regional play space for children, the requirement for regional facilities is not triggered by this structure plan application.

USE	COMMUNITY BUILDING	POPULATION CATCHMENT	STRUCTURE PLAN RESPONSE
Playgroup	Community Centre	1 : 4,000 – 6,000	The "Balcatta Playgroup" located at Jones Paskin Reserve is located approximately 1.0 kilometre north of the structure plan area. The proposed population increase (as a result of the Structure Plan) represents between approximately 20 – 25% of the overall demand for a "playgroup" facility which therefore, is not considered to warrant the provision of any additional playgroup facilities. Further, in accordance with ABS Census data, of the 10,382 people residing in Balcatta, there are 2,684 families. The ratio of families to total people therefore equates to approximately 25% of the overall total population. Assuming the ratio of families to total population remains consistent and factoring in the proposed increase in population arising as a result of the structure plan, the total number of families would equate to 2,883 families, being an increase of approximately 200 families. Based on the above assumptions and following a review of the 2016 Census data, it is considered that existing community facilities with regard to playgroups within the Balcatta locality is sufficient to accommodate the current for future forecast population and therefore, no additional community facilities in this regard are required.
Seniors Space	Community Centre	1 : 20,000 – 30,000 for a District level facility.	The proposed population increase of 1,150 as a result of the Structure Plan represents approximately 4 – 6% of the overall population catchment for a "Seniors Space" community centre building. In this regard, the resultant population increase as a result of this structure plan does not trigger the need for a "Seniors Space".
Sports Clubs	Sports Pavilion	1 : District Sporting Space	There are a number of existing district sporting spaces within Balcatta (which include sports pavilions), including the Richard Guelfi Reserve which is home to the Balcatta Baseball Club as is also capable of accommodating most senior sporting activities. Further, it is understood that the City of Stirling is exploring the potential to develop Lot 141 for District Playing Fields which will provide a multi-functional area of open space capable of accommodating rectangular sports field (such as hockey, rugby and soccer) and also a full sized Australian Football League oval and include clubrooms and spectator facilities. In this regard, as there are already a number of district sporting spaces within Balcatta (which include sports pavilions) and further, given the City's development aspirations for Lot 141, the provision of further sports clubs and sports pavilions as a result of this structure plan application is not required.

USE	COMMUNITY BUILDING	POPULATION CATCHMENT	STRUCTURE PLAN RESPONSE
*Outside School Hours Care	Community Centre	1 : 4,000 – 6,000	There are three (3) after school care facilities already existing within Balcatta, including: • A Club for Kids (386 Albert Street); • Balcatta Kids Clubs (5 Rickman Street); and • Maragon Early Learning Centre (219 Cedric Street). The existing after school care / child care facilities within Balcatta equate to a ratio of 1 : 3,844 (inclusive of the forecast structure plan population) which is in excess of the minimum requirements for these facilities. In this regard, there is no demand / need for the structure plan to provide any additional facilities to cater for the population.
*Maternal & Child Health Service	Community Centre	1 : 30,000 – 50,000	The proposed population increase of 1,150 as a result of the Structure Plan represents approximately 2.5 – 4% of the overall population catchment for a "Maternal and Child Health Service" community centre building and is therefore, on a standalone basis not considered to trigger the requirement for the provision of such a service. Further, when viewed in context of the total population of Balcatta, it is noted that the current and forecast population of the suburb only generate approximate one third of the requirement for a maternal and child health service. On the basis of the above, it is therefore considered appropriate to consider that such a service would be provided across a number of adjoining suburbs, and in this regard, it is noted that the Tuart Hill Child Care Centre is located approximately 950m southeast of the structure plan area. The Australian Bureau of Statistics QuickStats identifies a total population of 11,895 people for the Tuart Hill – Joondana locality. The combined population of Tuart Hill – Joondana and Balcatta (inclusive of the forecast population for the structure plan area) equates to approximately 23,650 people, meaning that the ratio of 1 Maternal and Child Health Service per 30,000 – 50,000 people is achieved across the suburbs of Balcatta and Tuart Hill - Joondana. In this regard, the structure plan does not require the provision of additional community services to cater for material and child health services.

Note: The above-mentioned ratio are as per Parks & Leisure Australia Community Facilities Guidelines.

4.8. INFRASTRUCTURE COORDINATION, SERVICING AND STAGING

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

4.8.1. WATER SUPPLY

There are existing 150mm diameter water reticulation mains along Grindleford Drive, which are considered adequate to service the proposed development of the subject site.

4.8.2. SEWERAGE

There is an existing waste water pump station situated within the Structure Plan on Lot 64 (No. 12) Radalj Place. This site is currently operated by the Water Corporation and is reserved for such purposes under LPS 3. The Water Corporation have confirmed the pump station services the Structure Plan area.

There are existing 225mm diameter gravity sewers running along the east of the site, which are of sufficient depth to accommodate the proposed development and the anticipated finished levels.

4.8.3. NATURAL GAS

There are existing gas mains situated on the western side of Grindleford Drive, currently servicing the adjacent subdivision. The existing mains are 63mm diameter HP and may require upgrading to service the future development of the Structure Plan. Atco Gas has advised the main pressure line has capacity to service 700 standard domestic customers at the subject site via a mains extension of DN150PVC in Karrinyup Road.

4.8.4. ELECTRICITY

The subject site is currently serviced by two separate zone substations, being Balcatta to the north-west and Yokine to the south-east, both of which are located approximately 3 - 4 kilometres from the site. Both substations have greater than 10MVA of spare capacity and therefore sufficient capacity to service the proposed development.

There are existing HV and LV network cables, both underground and aerial, surrounding the subject site from which multiple connection points may be obtained.

4.8.5. TELECOMMUNICATIONS

There are existing telecommunications services within the Structure Plan area, serviced from the Telstra Tuart Hill Exchange. There is an existing P100 conduit running from Tuart Hill to the eastern boundary of the site. This conduit has some capacity and may be able to support hauling of additional optic cable. Limited copper cable exists to the east and west of the site.

The Structure Plan is situated within the National Broadband Company's ('NBN Co') fixed line footprint, in which NBN Co deliver FTTP technology. NBN Co plan to convert connections within Balcatta (comprising the subject site) to broadband in the first half of 2018 and will likely provide FTTN to existing dwellings. Beyond March 2018, NBN Co is required to accept the development of the subject site should application be made by the developer to that effect.

4.8.6. EARTHWORKS

Earthworks for this site would be completed in accordance with standards AS3798 – 2007- "Earthworks for Residential and Commercial Developments" and specific Geotechnical Investigations and recommendations provided by Registered Geotechnical Engineers.

There have been a number of geotechnical investigations completed on various portions of the site to date, where it is clearly noted that there are challenging conditions pertaining to silts and peat areas across most of the site, along with several areas of uncontrolled fill, whose extent is not clearly defined or quantified. Advice from Geotechnical Engineers is that the site is suitable for residential development, provided that any site preparation and earthworks is completed to alleviate any risk posed by natural conditions.

The Geotechnical recommendation for remedial earthworks for the site as prepared by Structerre Consulting Engineers – Geotechnical, is provided within the Engineering services report and describes general earthworks practices that are likely to be employed across the development.

Given the variable nature of the site, and different stockpiles present, it is expected that earthworks will be highly dynamic. For this reason, it is proposed that any construction works will be accompanied by thorough and ongoing geotechnical assessment and sign off, where each successive phase of earthworks shall not proceed until preceding works are deemed to be geotechnical compliant. In this manner, development lots are proposed to achieve a classification suitable for residential development, and as verified by the registered Geotechnical Engineer.

Due to existing conditions, it is anticipated there will be certain quantities of uncontrolled fill and peat to be removed from site, where these quantities would be subject to further detailed design and assessment, and confirmation on site during construction. At this stage, the earthworks aims to minimise any disturbance or removal of in-situ underlying peat material by employing a limestone raft and geogrid methodology overlain by considerable free draining sand fill as described further in Structerre's remedial earthworks summary. Indicative finished lot development levels are also provided within the Engineering Services report, which will guide overall earthworks and fill quantities. Additional surcharge material is expected to be allowed to achieve any consolidation of the peat material under the limestone raft and free draining fill prior to building construction. Settlement monitoring pegs are expected to be implemented to assist with assessing this process and timeframes for removal of any surcharge material. As indicated, earthworks will be subject to confirmation on site and detailed design, where some areas will not contain underlying peat and therefore will not be subject to the same remedial methodology, and a more traditional approach can be adopted.

Earthworks will also be completed to assist with stormwater management for the site with levels generally grading from east to west. Subsoil drainage shall be employed to assist in managing groundwater.

4.8.7. STAGING

A staging plan for drainage infrastructure cannot be reasonably completed at this stage of the structure planning process, as infrastructure construction will be largely guided by proposed development staging and areas, and particularly follow earthworks progress. The proposed drainage strategy would be in accordance with the Local Water Management Strategy as prepared by Emerge Associates and to the requirements of the City of Stirling and the Water Corporation.

The general drainage concept is shown in Engineering Plans, Proposed Swale Details Sheets 1 and 2. As shown in the Local Water Management Strategy, it would be proposed to

- Retain the first 15mm of rainfall on site as close to source as practicably possible for all lots.
- Convey the 20% Annual Exceedance Probability (AEP) storm within the piped road network
- Contain the 1% AEP within the road reserve.
- Ensure properties are 500mm above the 1% AEP flood level within adjacent stormwater detention systems
- Detention of the 20% to 1% AEP events so that the post development peak discharge is comparable to the predevelopment peak discharge.

As shown in the Local Water Management Strategy drainage concept plans, the site generally consists of east-west drainage catchments. These generally also correlate with the building development cells for the site. From this, it would be assumed that construction staging will likely occur in a similar manner, where east-west cells may occur independently. Should this be the case, it would be expected that associated infrastructure for each stage would be constructed, including road pavements and piped drainage. The road drainage system would be designed to accommodate the 20% AEP short duration storm, and convey this, as shown in concept plans, to vegetate swales to the west of the site along Grindelford Drive, which will aim to detain stormwater to control peak discharge from the site to predevelopment conditions for the 20% to 1% AEP events.

Should greater areas of development occur, then it would be intended to construct more of this system and additional vegetated detention swales to allow for correct detention for the areas being developed to limit discharge to predevelopment conditions.

Due to the fragmented land ownership and the uncertainty regarding development staging, temporary drainage storage/infiltration basins may be necessary at certain locations to allow staged development to proceed. Where temporary basins are required they shall be constructed and fenced to the satisfaction of the City of Stirling and shall be protected by easements granted in favour of the City of Stirling. Costs associated with the basin construction, legal issues including creation of easements, and ultimate removal of the basin and associated infrastructure shall be the responsibility of the developer upon whose land the temporary basin is located.

4.9. DEVELOPER CONTRIBUTION ARRANGEMENTS

The Structure Plan is not subject to a development contribution scheme under LPS 3. Given the nature of the proposed development, no shared infrastructure and facilities of regional or district significance are proposed, and therefore it is not anticipated a development contribution scheme will be required to be prepared for the Structure Plan. The Structure Plan design has been carefully considered in context of the fragmented landownership to ensure each respective landowner can develop their land independent of one another, with none of the landowners being "land locked".

The provision of any local infrastructure and public open space cash-in-lieu arrangements can be appropriately dealt with through standard conditions of subdivision approval.

Furthermore, there are no road reserves proposed over and above that of a standard subdivision road. The proponent is prepared to fund the construction of the drainage swale, which occurs on land either owned by the proponent or the City of Stirling (which achieves 75% of the total storage basin required). The land and infrastructure required for the drainage swale will be delivered as part of the proponent's application to subdivide their land.

With regard to the small portion of the drainage swale which is located in privately owned land, it is noted that the drainage swale has been designed in a manner which does not rely on this portion of land for drainage purposes. By way of example, the private landowner cannot develop his landholding first, as there is not enough storage within the portion of drainage swale to accommodate residential development in isolation of the remaining swale basin. As the proponent has committed to delivering the remainder of the basin, it is considered that sufficient measures have been implemented through the LWMS to support the Structure Plan, with further details to follow at the detailed design stage.

PART THREE

TECHNICAL APPENDICES

ROWE GROUP DESIGN

APPENDIX 1

CERTIFICATES OF TITLE

ROWE GROUP DESIGN

WESTERN AUSTRALIA

REGISTER NUMBER	
801/DP39999	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	27/3/2009

VOLUME 2226 FOLIO 243

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 801 ON DEPOSITED PLAN 39999

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SUNBOLD PTY LTD OF 9 STRINGYBARK COURT, STRATHDALE, VICTORIA
(A I789368) REGISTERED 20/2/2004

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

1. K873683 MORTGAGE TO KALGOORLIE MINE MANAGEMENT PTY LTD REGISTERED 9/3/2009.
2. *K873690 CAVEAT BY CITY OF STIRLING LODGED 9/3/2009.
3. *L174420 PROPERTY (SEIZURE AND SALE) ORDER (COURT REF NO. PER/GCLM/798/2009) REGISTERED 16/12/2009.
4. *L176049 MEMORIAL. TAXATION ADMINISTRATION ACT 2003, SECTION 76 (LAND TAX) REGISTERED 17/12/2009.
5. *N153184 PROPERTY (SEIZURE AND SALE) ORDER (COURT REF NO:PER/GCLM/4303/2015) REGISTERED 20/10/2015.
   *N294484 ORDER EXTENDING SALE PERIOD REGISTERED 6/4/2016.
6. *N653251 PROPERTY (SEIZURE AND SALE) ORDER (COURT REF NO: PER/GCLM/2710/2017) REGISTERED 21/6/2017.

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP39999
PREVIOUS TITLE:	2189-105
PROPERTY STREET ADDRESS:	75 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:11 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
114/D62707	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1614 FOLIO 491

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 114 ON DIAGRAM 62707

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CITY OF STIRLING OF HERTHA ROAD, STIRLING

(T C326561) REGISTERED 23/3/1982

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

1. TITLE EXCLUDES THE LAND SHOWN ON PLANS 17954 AND 17955.
2. *H076794 CAVEAT BY BANK OF WESTERN AUSTRALIA LTD AS TO PORTION ONLY. LODGED 12/4/1999.
3. *L595003 THE PORTION OF THE WITHIN LAND NOW COMPRISED IN LOT 302 ON PLAN 17955 HEREIN INCLUDED IN VOL. 2766 FOL.958. THIS TITLE IS NOW "PARTIALLY CANCELLED". NO DUPLICATE ISSUED. REGISTERED 5/4/2011.

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: 1614-491 (114/D62707)
PREVIOUS TITLE: 459-42
PROPERTY STREET ADDRESS: 71 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY: CITY OF STIRLING

NOTE 1: A000001A PENDING SURVEYS PLAN 17954 & PLAN 17955.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:18 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
63/D67317	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	**N/A**

RECORD OF CERTIFICATE OF TITLE

VOLUME **1683** FOLIO **606**

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 63 ON DIAGRAM 67317

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

THE CHUNG WAH ASSOCIATION INC OF 128 JAMES STREET, PERTH
(T D236149) REGISTERED 22 APRIL 1986

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

1. *D236150 CAVEAT BY CITY OF STIRLING LODGED 22.4.1986.

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: 1683-606 (63/D67317).
PREVIOUS TITLE: 1683-604.
PROPERTY STREET ADDRESS: 18 RADALJ PL, BALCATTA.
LOCAL GOVERNMENT AREA: CITY OF STIRLING.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:26 2015 JOB 46736667

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
64/D67317	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1683 FOLIO 607

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 64 ON DIAGRAM 67317

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

WATER CORPORATION OF 629 NEWCASTLE STREET, LEEDERVILLE

(A G163535) REGISTERED 30/4/1996

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.
* 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:	1683-607 (64/D67317)
PREVIOUS TITLE:	1683-604
PROPERTY STREET ADDRESS:	12 RADALJ PL, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING
RESPONSIBLE AGENCY:	WATER CORPORATION

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:18 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
51/P13824	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1854 FOLIO 918

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 51 ON PLAN 13824

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SICILIANI ASSOCIATION OF WESTERN AUSTRALIA INC OF 1 SICILIA PLACE, BALCATTA
(A E236697) REGISTERED 17/11/1989

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

1. D052255 EASEMENT BURDEN SEE SKETCH ON VOL 1854 FOL 918. REGISTERED 26/6/1985.
2. G200952 MORTGAGE TO WESTPAC BANKING CORPORATION REGISTERED 13/6/1996.

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: 1854-918 (51/P13824)
PREVIOUS TITLE: 1697-818
PROPERTY STREET ADDRESS: 1 SICILIA PL, BALCATTA.
LOCAL GOVERNMENT AUTHORITY: CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:03 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

58Q
Perth Batch
N161034

WESTERN AUSTRALIA

REGISTER NUMBER	
30/D15403	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	3/11/2015

DUPLICATE CERTIFICATE OF TITLE

VOLUME 1314 FOLIO 510

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 30 ON DIAGRAM 15403

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ABN DEVELOPMENT NO.1 PTY LTD OF PO BOX 389 OSBORNE PARK
(T N161034) REGISTERED 29 OCTOBER 2015

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

1. TITLE EXCLUDES THE LAND SHOWN ON PLAN 17952.

Warning: A current search of the certificate of title held in electronic form should be obtained before dealing on this land. Lot as described in the land description may be a lot or location.

----------END OF DUPLICATE 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:	1314-510 (30/D15403).
PREVIOUS TITLE:	1132-538.
PROPERTY STREET ADDRESS:	309 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AREA:	CITY OF STIRLING.

58Q
Perth Batch
N169846

WESTERN AUSTRALIA

REGISTER NUMBER	
88/DP27769	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	27/11/2015

VOLUME 2590 FOLIO 703

DUPLICATE 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 88 ON DEPOSITED PLAN 27769

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ABN DEVELOPMENT NO.1 PTY LTD OF 133 HASLER ROAD OSBORNE PARK
(TP N169846) REGISTERED 9 NOVEMBER 2015

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

Warning: A current search of the certificate of title held in electronic form should be obtained before dealing on this land.
Lot as described in the land description may be a lot or location.

----------END OF DUPLICATE 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:	DP27769.
PREVIOUS TITLE:	1242-400.
PROPERTY STREET ADDRESS:	104 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AREA:	CITY OF STIRLING.

WESTERN AUSTRALIA

REGISTER NUMBER	
87/DP27768	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	12/8/2003

VOLUME 2222 FOLIO 469

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 87 ON DEPOSITED PLAN 27768

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

GIUSEPPE ABRAMO
GIOVANNA ABRAMO
BOTH OF 774 KARRINYUP ROAD, BALCATTA
AS JOINT TENANTS

(T I574645) REGISTERED 31/7/2003

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.
* 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:	2222-469 (87/DP27768)
PREVIOUS TITLE:	721-8
PROPERTY STREET ADDRESS:	774 KARRINYUP RD, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:53 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
350/D74913	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	27/7/2004

VOLUME 2009 FOLIO 910

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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

REGISTRAR OF TITLES

LAND DESCRIPTION:

LOT 350 ON DIAGRAM 74913

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SALVATORE GIUSEPPE AGOSTINO
DOMENICA GIOVANNA AGOSTINO
AS JOINT TENANTS IN 33/100 SHARE
EMBLEM HOMES PTY LTD
IN 50/100 SHARE
REGALSTONE PTY LTD
IN 17/100 SHARE
ALL OF 164 CEDRIC STREET STIRLING WA 6021
AS TENANTS IN COMMON

(T N666242) REGISTERED 5/7/2017

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

1. E207518 EASEMENT TO THE WATER AUTHORITY OF WESTERN AUSTRALIA. SEE SKETCH ON VOL 2009 FOL 910. REGISTERED 9/10/1989.
2. *N666243 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 5/7/2017.

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

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

STATEMENTS:

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

SKETCH OF LAND:	2009-910 (350/D74913)
PREVIOUS TITLE:	1851-589
PROPERTY STREET ADDRESS:	764 KARRINYUP RD, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

END OF PAGE 1 - CONTINUED OVER

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:46 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

REGISTER NUMBER: 350/D74913 VOLUME/FOLIO: 2009-910 PAGE 2

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

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:46 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
139/D61999	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	1/4/2008

VOLUME 1713 FOLIO 923

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 139 ON DIAGRAM 61999

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

PIOTR PAWEL KWIATKOWSKI
JOANNA AGATA KWIATKOWSKI
BOTH OF PO BOX 357, HILLARYS
AS JOINT TENANTS

(T K928411) REGISTERED 4/5/2009

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

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS OF THE LOT DESCRIBED ABOVE EXCEPT THAT PORTION SHOWN IN THE SKETCH OF THE SUPERSEDED PAPER VERSION OF THIS TITLE. VOL 1713 FOL 923.
2. *K928412 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 4/5/2009.

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: 1713-923 (139/D61999)
PREVIOUS TITLE: 1605-407
PROPERTY STREET ADDRESS: 736 KARRINYUP RD, BALCATTA.
LOCAL GOVERNMENT AUTHORITY: CITY OF STIRLING

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING K928412

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:46 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
150/D93196	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	14/3/2014

VOLUME 2119 FOLIO 104

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 150 ON DIAGRAM 93196

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

SALVATORE GIUSEPPE AGOSTINO
DOMENICA GIOVANNA AGOSTINO
AS JOINT TENANTS IN 33/100 SHARE
EMBLEM HOMES PTY LTD
IN 50/100 SHARE
REGALSTONE PTY LTD
IN 17/100 SHARE
ALL OF 164 CEDRIC STREET, STIRLING
AS TENANTS IN COMMON

(TP M524541) REGISTERED 17/1/2014

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

1. EASEMENT BURDEN CREATED UNDER SECTION 27A OF T. P. & D. ACT - SEE DIAGRAM 93196.
2. EASEMENT BURDEN - SEE DIAGRAM 93196.
3. RESTRICTIVE COVENANT BURDEN - SEE DIAGRAM 93196 AND INSTRUMENT G630182.
4. *M639494 MORTGAGE TO NATIONAL AUSTRALIA BANK LTD REGISTERED 16/5/2014.

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:	2119-104 (150/D93196)
PREVIOUS TITLE:	2064-433
PROPERTY STREET ADDRESS:	732 KARRINYUP RD, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

END OF PAGE 1 - CONTINUED OVER

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:46 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

NOTE 1: I598796 SECTION 138D TLA APPLIES TO CAVEAT I453058
NOTE 2: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING M639494

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:46 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
108/D61726	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	28/3/2002

VOLUME 1619 FOLIO 166

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 108 ON DIAGRAM 61726

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LUIGI DE CINQUE
ANTONIETTA DE CINQUE
BOTH OF 311 ALBERT STREET, BALCATTA
AS JOINT TENANTS

(T I047578) REGISTERED 19/3/2002

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.
* 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:	1619-166 (108/D61726)
PREVIOUS TITLE:	1543-811
PROPERTY STREET ADDRESS:	311 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:11 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
30/D15403	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	3/11/2015

VOLUME 1314 FOLIO 510

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 30 ON DIAGRAM 15403

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ABN DEVELOPMENT NO.1 PTY LTD OF PO BOX 389 OSBORNE PARK

(T N161034) REGISTERED 29/10/2015

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

1. TITLE EXCLUDES THE LAND SHOWN ON PLAN 17952.

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: 1314-510 (30/D15403)
PREVIOUS TITLE: 1132-538
PROPERTY STREET ADDRESS: 309 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY: CITY OF STIRLING

NOTE 1: A000001A PENDING SURVEYS PLAN 17952 & PLAN 17953.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:03 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

26903/59

Transfer 10352/1956 (4949)

Application

From Volume	Folio
959	91

25336/56

INDEXED

REGISTER BOOK.

Vol. 1194 Fol. No. 816

D63812
D65442
D67317
P16363
P16364

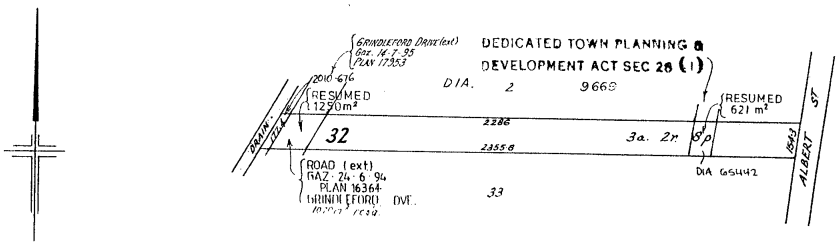
WESTERN AUSTRALIA.

Certificate of Title

under "The Transfer of Land Act, 1893" (56 Vic., 14. Sch. 5).

Antonino Cocì of Albert Street, Osborne Park, Market Gardener, is now the proprietor of an estate in fee simple subject to the easements and encumbrances notified hereunder in all that piece of land delineated and coloured green on the map hereon containing three acres two roods and eight perches or thereabouts, being portion of Perthshire Location A[u] and being Lot 32 on Diagram 18698.

CT 1194 0816 F



Scale: 5 chains to an inch

Dated the seventh day of August One thousand nine hundred and fifty-six.

Registrar of Titles.

PUBLIC WORKS ACT 1902-1953
Gaz. 10:2:84 DIA Plan 65442
portion resumed and vested in City of Stirling
Registrar of Titles

PUBLIC WORKS ACT 1902-1953
In the portion resumed Gaz. 10:2:84 the right to mines of coal or other minerals is resumed and revested in Her Majesty as of her former estate.
Registrar of Titles

PUBLIC WORKS ACT 1902-1953
Gaz. 29.12.89 Plan 16363
Portion resumed and vested in City of Stirling
E273135 Registrar of Titles

PUBLIC WORKS ACT 1902-1953
In the portion resumed Gaz. 29.12.89 the right to mines of coal or other minerals is resumed and revested in Her Majesty as of her former estate.
Registrar of Titles

As to Plan 16364
SUNDRY DOC. F669301
INCLUDED IN VOL. 2010 FOL. 676
REGISTERED 31-8-94 at 14.49 hrs

80358/8/55—24m.—11/o.

For encumbrances and other matters affecting the land see back.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:26 2015 JOB 46736667

Landgate
www.landgate.wa.gov.au

EASEMENTS AND ENCUMBRANCES REFERRED TO

Instrument stamped £3·7·6
Mortgage 7151/1956 Antonino Cocì to James Peter Pianta, Retired Farmer and Frank Corser, Solicitor both of care of Corser & Corser Solicitors, 36 & 39 Padbury Buildings, Forrest Place, Perth. Registered 7th August 1956 at 9·44 a.m.

ASST REGISTRAR OF TITLES

Discharge 6851/1959 of Mortgage 7151/1956. Registered 4th August 1959 of 9·33 a.m.

ASSISTANT REGISTRAR OF TITLES

PUBLIC WORKS ACT 1902-1955 SEC. 17 (5)
NOTICE OF INTENTION TO RESUME
AS TO PORTION ONLY
R.D. 8/83 GOVT. GAZ. 11-2-83
SCHEDULE 8 PAGE 489
ITEM 1
ASSISTANT REGISTRAR OF TITLES

PUBLIC WORKS ACT 1902-1955 SEC. 17 (5)
NOTICE OF INTENTION TO RESUME
AS TO PORTION ONLY
R.D. 1/84 GOVT. GAZ. 6.1.84
SCHEDULE 1 PAGE 15
ITEM 1
ASSISTANT REGISTRAR OF TITLES

~~TRANSFER~~ / APPLICATION H632944
~~Registered~~ 27th December, 2000 at 13·13 hrs.
As to Diagram 65442
To Vol. 2207 Fol. 805

CT 1194 0816 B

CERTIFICATE OF TITLE

Vol. 1194 Fol.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:26 2015 JOB 46736667
Landgate
www.landgate.wa.gov.au

26903/59

Transfer 10352/1956 (4949)

Application

From Volume Folio

959 91

25336/56

INDEXED

REGISTER BOOK.

Vol. 1194 Fol. No. 816

D63812
D65442
D67317
P16363
P16364

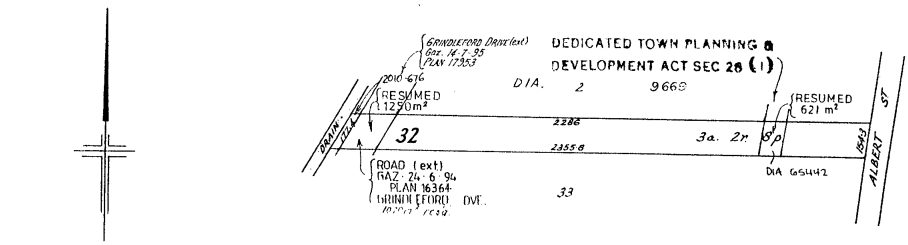
WESTERN AUSTRALIA.

Certificate of Title

under "The Transfer of Land Act, 1893" (56 Vic., 14. Sch. 5).

Antonino Cocì of Albert Street, Osborne Park, Market Gardener, is now the proprietor of an estate in fee simple subject to the easements and encumbrances notified hereunder in all that piece of land delineated and coloured green on the map hereon containing three acres two roods and eight perches or thereabouts, being portion of Perthshire Location A[u] and being Lot 32 on Diagram 18698.

CT 1194 0816 F



Scale: 5 chains to an inch

Dated the seventh day of August One thousand nine hundred and fifty-six.

Registrar of Titles.

PUBLIC WORKS ACT 1902-1953
Gaz. 10:2:84 DIA Plan 65442
portion resumed and vested in City of Stirling
Registrar of Titles

PUBLIC WORKS ACT 1902-1953
In the portion resumed Gaz. 10:2:84 the right to mines of coal or other minerals is resumed and revested in Her Majesty as of her former estate.
Registrar of Titles

PUBLIC WORKS ACT 1902-1953
Gaz. 29.12.89 Plan 16363
Portion resumed and vested in City of Stirling
E273135 Registrar of Titles

PUBLIC WORKS ACT 1902-1953
In the portion resumed Gaz. 29.12.89 the right to mines of coal or other minerals is resumed and revested in Her Majesty as of her former estate.
Registrar of Titles

As to Plan 16364
SUNDRY DOC. F669301
INCLUDED IN VOL. 2010 FOL. 676
REGISTERED 31-8-94 at 14.49 hrs

80358/8/55—24m.—11/o.

For encumbrances and other matters affecting the land see back.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:00 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

EASEMENTS AND ENCUMBRANCES REFERRED TO

Instrument stamped £3·7·6
Mortgage 7151/1956 Antonino Cocì to James Peter Pianta, Retired Farmer and Frank Corser, Solicitor both of care of Corser & Corser Solicitors, 36 & 39 Padbury Buildings, Forrest Place, Perth. Registered 7th August 1956 at 9·44 a.m.

A/T REGISTRAR OF TITLES

Discharge 6851/1959 of Mortgage 7151/1956. Registered 4th August 1959 of 9·33 a.m.

ASSISTANT REGISTRAR OF TITLES

PUBLIC WORKS ACT 1902-1955 SEC. 17 (5)
NOTICE OF INTENTION TO RESUME
AS TO PORTION ONLY
R.D. 8/83 GOVT. GAZ. 11-2-83
SCHEDULE 8 PAGE 489
ITEM 1
ASSISTANT REGISTRAR OF TITLES

PUBLIC WORKS ACT 1902-1955 SEC. 17 (5)
NOTICE OF INTENTION TO RESUME
AS TO PORTION ONLY
R.D. 1/84 GOVT. GAZ. 6.1.84
SCHEDULE 1 PAGE 15
ITEM 1
ASSISTANT REGISTRAR OF TITLES

~~TRANSFER~~ / APPLICATION H632944
~~Registered~~ 27th December, 2000 at 13·13 hrs.
As to Diagram 65442
To Vol. 2207 Fol. 805

CT 1194 0816 B

CERTIFICATE OF TITLE

Vol. 1194 Fol.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:00 2018 JOB 56098683
Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
49/D47083	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	11/5/2017

VOLUME 1385 FOLIO 66

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

Subject to Dealing

LAND DESCRIPTION:

LOT 49 ON DIAGRAM 47083

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

JOSEPHINE MARY SHORE OF CORNER OF JONES AND HARGRAVES STREETS STIRLING
(T B664089) REGISTERED 15/2/1979

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

1. *TITLE EXCLUDES THE LAND SHOWN ON PLAN 16364
2. *N605714 MEMORIAL. TAXATION ADMINISTRATION ACT 2003, SECTION 76 (LAND TAX) REGISTERED 21/4/2017.

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

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

STATEMENTS:

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

SKETCH OF LAND:	1385-66 (49/D47083)
PREVIOUS TITLE:	550-171
PROPERTY STREET ADDRESS:	281A ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Jun 19 16:28:45 2017 JOB 54162572

*** SUBJECT TO DEALING *** *** SUBJECT TO DEALING ***

Landgate
www.landgate.wa.gov.au

ORIGINAL – NOT TO BE REMOVED FROM OFFICE OF

CT 1385 0066 F

Application A856433 WESTERN AUSTRALIA

Volume 550 Folio 171

VOL. 1385 FOL. 066

D63813 I240854 (CANCELLED)
P 16363
P 16364

CERTIFICATE OF TITLE

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

Page 1 (of 2 pages) VOL. 1385 FOL. 066

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

DATED 1st August, 1974

ACTING REGISTRAR OF TITLES

ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Perthshire Location A[u] and being Lot 49 on Diagram 47083, delineated and coloured green on the map in the Third Schedule hereto.

FIRST SCHEDULE (continued overleaf)

~~Skopek Investments Pty. Ltd. of 151 The Boulevard, Floreat Park.~~

SECOND SCHEDULE (continued overleaf)

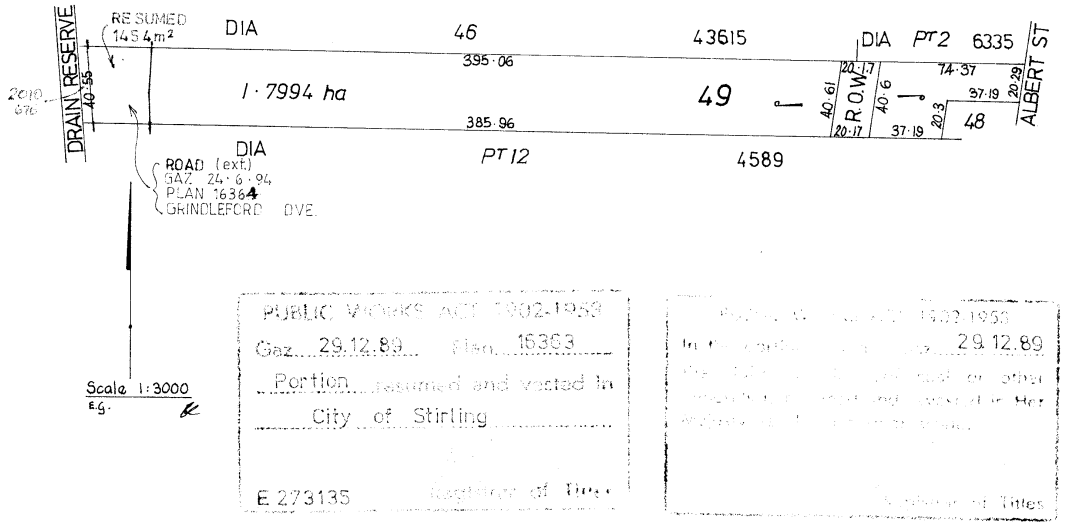
~~1. MORTGAGE A379264 to Herbert Ernest Black of 28B Rankin Way, Booragoon, Retired Farmer. Registered 10.3.71 at 9.18 o'c.~~ Discharged (B295622, 24.2.77)

~~2. EXTENSION A856431 of Mortgage A379264. Registered 1.8.74 at 9.57 o'c.~~ Mortgage Discharged (B295622, 24.2.77)

ACTING REGISTRAR OF TITLES

THIRD SCHEDULE

As to Plan 16364
SUNDRY DOC. F660301
INCLUDED IN VOL. 2010 FOL. 676
31-8-94 at 14.49 hrs.



PUBLIC WORKS ACT 1902-1953
Gaz 29.12.89 Plan 16363
Portion assumed and vested in City of Stirling
E 273135 Registrar of Titles

29.12.89

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

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

30267/8/73–30M–O/SOL

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:26 2015 JOB 46736667

Landgate
www.landgate.wa.gov.au

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:26 2015 JOB 46736667

LT. 37

FIRST SCHEDULE (continued)

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

REGISTERED PROPRIETOR	INSTRUMENT NATURE	INSTRUMENT NUMBER	REGISTERED	TIME	SEAL	INITIALS
~~Palmo Betti, Bricklayer and Caterina Betti, Married Woman both of 8 Alexander Street, Balcatta, as joint tenants.~~	Transfer	~~B295623~~	~~24.2.77~~	9.33		
Josephine Mary Shore of corner Jones and Hargraves Streets, Stirling, Upholsteress.	Transfer	B664089	15.2.79	9.06		

SECOND SCHEDULE (continued)

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

INSTRUMENT NATURE	INSTRUMENT NUMBER	PARTICULARS	REGISTERED	TIME	SEAL	INITIALS	CANCELLATION	NUMBER	REGISTERED OR LODGED	SEAL	INITIALS
Caveat	D637898	As to portion only: Lodged 23.12.1987 at 14.52 hours.					Withdrawn	F739197	25.11.94		

CERTIFICATE OF TITLE VOL. 1385 066

Landgate www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
128/DP27343	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 2222 FOLIO 470

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 128 ON DEPOSITED PLAN 27343

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

NEDELKO LAZOROV
MARY LAZOROV
BOTH OF 275-277 ALBERT STREET, BALCATTA
AS TENANTS IN COMMON IN EQUAL SHARES

(A I326252) REGISTERED 13/12/2002

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

1. G753308 MORTGAGE TO PRIORITY ONE FINANCIAL SERVICES LTD REGISTERED 31/3/1998.
H288552 TRANSFER OF MORTGAGE G753308, MORTGAGEE NOW AMP BANK LTD REGISTERED 23/11/1999.

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:	2222-470 (128/DP27343)
PREVIOUS TITLE:	913-108
PROPERTY STREET ADDRESS:	275 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:58 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
141/D67731	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	10/9/2003

RECORD OF CERTIFICATE OF TITLE

VOLUME 1744 FOLIO 538

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 141 ON DIAGRAM 67731

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CITY OF STIRLING OF CIVIC PLACE, STIRLING

(A D350656) REGISTERED 29 OCTOBER 1986

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

1. D323855 EASEMENT BENEFIT SEE SKETCH ON VOL 1744 FOL 538. REGISTERED 16.9.1986.

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: 1744-538 (141/D67731).
PREVIOUS TITLE: 1744-535.
PROPERTY STREET ADDRESS: 273A ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AREA: CITY OF STIRLING.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:27 2015 JOB 46736667

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
153/DP37311	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
2	7/10/2009

VOLUME 2545 FOLIO 171

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 153 ON DEPOSITED PLAN 37311

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MACEDONIAN COMMUNITY OF WA INC OF 51 ALBERT STREET, NORTH PERTH
(AF I594446) REGISTERED 18/8/2003

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

1. D323855 EASEMENT BURDEN SEE SKETCH ON DEPOSITED PLAN 37311. REGISTERED 16/9/1986.
2. EASEMENT BURDEN CREATED UNDER SECTION 27A OF T. P. & D. ACT - SEE DEPOSITED PLAN 37311 CREATED ON DIAGRAM 67731.
3. H771996 LEASE TO LUCENT TECHNOLOGIES AUSTRALIA PTY LTD OF LEVEL 4, 6-10 TALAVERA ROAD, NORTH RYDE, NEW SOUTH WALES AS TO PORTION ONLY.. EXPIRES: SEE LEASE. REGISTERED 8/6/2001.
   I260526 TRANSFER OF LEASE H771996, LESSEE NOW HUTCHISON 3G AUSTRALIA PTY LTD OF LEVEL 3, 504 PACIFIC HIGHWAY, ST. LEONARDS, NEW SOUTH WALES REGISTERED 10/10/2002.
4. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER, SEWERAGE OR DRAINAGE PURPOSES TO WATER CORPORATION SEE DEPOSITED PLAN 37311
5. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR UNDERGROUND ELECTRICITY PURPOSES TO WESTERN POWER CORPORATION SEE DEPOSITED PLAN 37311.
6. *I594447 CAVEAT BY CITY OF STIRLING LODGED 18/8/2003.
7. *L670534 CAVEAT BY VODAFONE HUTCHISON AUSTRALIA PTY LTD AS TO PORTION ONLY LODGED 30/6/2011.

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.

END OF PAGE 1 - CONTINUED OVER

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:54 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

REGISTER NUMBER: 153/DP37311 VOLUME/FOLIO: 2545-171 PAGE 2

SKETCH OF LAND:	DP37311
PREVIOUS TITLE:	1744-534
PROPERTY STREET ADDRESS:	273 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

NOTE 1: G620590 SECTION 138D TLA APPLIES TO CAVEAT D323856.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:54 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
151/DP37311	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	29/12/2003

VOLUME 2545 FOLIO 169

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 151 ON DEPOSITED PLAN 37311

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

KILLARNEY INVESTMENTS PTY LTD OF SUITE 23, 350 CAMBRIDGE STREET, WEMBLEY
(T I669796) REGISTERED 22/10/2003

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

1. *K207494 MEMORIAL. RETIREMENT VILLAGES ACT 1992. LODGED 29/5/2007.
2. *L148873 CAVEAT BY CITY OF STIRLING LODGED 24/11/2009.

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: DP37311
PREVIOUS TITLE: 1744-534
PROPERTY STREET ADDRESS: 271 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY: CITY OF STIRLING

NOTE 1: G620590 SECTION 138D TLA APPLIES TO CAVEAT D323856.
NOTE 2: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING K207497

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:24 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
52/D70756	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	11/8/2009

VOLUME 1744 FOLIO 665

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 52 ON DIAGRAM 70756

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

MIRANDA BOO GALLEGO OF 263 ALBERT STREET, BALCATTA

(T D346483) REGISTERED 22/10/1986

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.
* 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:	1744-665 (52/D70756)
PREVIOUS TITLE:	1486-179
PROPERTY STREET ADDRESS:	263 ALBERT ST, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:18 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
86/DP27768	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	14/1/2016

VOLUME 2222 FOLIO 468

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 86 ON DEPOSITED PLAN 27768

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ABN DEVELOPMENT NO.1 PTY LTD OF PO BOX 389 OSBORNE PARK

(T N182472) REGISTERED 23/11/2015

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

1. *H820178 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. LODGED 25/7/2001.
2. EASEMENT BURDEN CREATED UNDER SECTION 27A OF T. P. & D. ACT - SEE DEPOSITED PLAN 27768.
3. *N182474 CAVEAT BY CITY OF STIRLING LODGED 23/11/2015.

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP27768
PREVIOUS TITLE:	721-8
PROPERTY STREET ADDRESS:	120 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:52 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
400/DP37616	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

RECORD OF CERTIFICATE OF TITLE

VOLUME 2225 FOLIO 770

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 400 ON DEPOSITED PLAN 37616

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CITY OF STIRLING OF CIVIC PLACE, STIRLING

(XA I635116) REGISTERED 22 SEPTEMBER 2003

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

1. D323855 EASEMENT BENEFIT SEE SKETCH IN VOL 1744 FOL 539. REGISTERED 16.9.1986.

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: DP37616.
PREVIOUS TITLE: 1744-539.
PROPERTY STREET ADDRESS: 114 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AREA: CITY OF STIRLING.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Mon Feb 2 12:33:38 2015 JOB 46736667

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
129/DP27343	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
3	14/1/2016

VOLUME 2222 FOLIO 471

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 129 ON DEPOSITED PLAN 27343

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ABN DEVELOPMENT NO.1 PTY LTD OF PO BOX 389 OSBORNE PARK

(T N182472) REGISTERED 23/11/2015

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

1. *H735099 NOTIFICATION CONTAINS FACTORS AFFECTING THE WITHIN LAND. LODGED 1/5/2001.
2. *N182473 CAVEAT BY CITY OF STIRLING LODGED 23/11/2015.

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

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

STATEMENTS:

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

SKETCH OF LAND:	DP27343
PREVIOUS TITLE:	913-108
PROPERTY STREET ADDRESS:	108 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:31:58 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
62/D67317	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1683 FOLIO 605

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 62 ON DIAGRAM 67317

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CITY OF STIRLING OF CIVIC PLACE, STIRLING

(A C924637) REGISTERED 20/12/1984

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

1. TITLE EXCLUDES THE LAND SHOWN ON SEE PLAN 16364

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: 1683-605 (62/D67317)
PREVIOUS TITLE: 1683-604
PROPERTY STREET ADDRESS: 100 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY: CITY OF STIRLING

NOTE 1: L111818 PLANS 16363 AND 16364

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:24 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
50/P13824	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1702 FOLIO 417

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 50 ON PLAN 13824

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CITY OF STIRLING OF CIVIC PLACE, STIRLING

(A D090234) REGISTERED 16/8/1985

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

1. D052255 EASEMENT BENEFIT SEE SKETCH ON VOL 1702 FOL 417. REGISTERED 26/6/1985.
2. TITLE EXCLUDES THE LAND SHOWN ON PLAN 17952.

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:	1702-417 (50/P13824)
PREVIOUS TITLE:	1697-817
PROPERTY STREET ADDRESS:	90 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

NOTE 1: A000001A PENDING SURVEYS PLAN 17952 & PLAN 17953.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:03 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

WESTERN AUSTRALIA

REGISTER NUMBER	
109/D61726	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	N/A

VOLUME 1619 FOLIO 167

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 109 ON DIAGRAM 61726

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

CITY OF STIRLING OF HERTHA ROAD, STIRLING

(T C359457) REGISTERED 18/5/1982

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

1. TITLE EXCLUDES THE LAND SHOWN ON PLAN 17952.

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:	1619-167 (109/D61726)
PREVIOUS TITLE:	1543-811
PROPERTY STREET ADDRESS:	80 GRINDLEFORD DR, BALCATTA.
LOCAL GOVERNMENT AUTHORITY:	CITY OF STIRLING

NOTE 1: A000001A PENDING SURVEY - PLAN 17953.

LANDGATE COPY OF ORIGINAL NOT TO SCALE Tue Feb 27 10:32:11 2018 JOB 56098683

Landgate
www.landgate.wa.gov.au

APPENDIX 2

ACOUSTIC REPORT

ROWE GROUP DESIGN

HERRING STORER ACOUSTICS

PROPOSED RESIDENTIAL DEVELOPMENT

EAST ROSELEA STRUCTURE PLAN
BALCATTA

NOISE ASSESSMENT

NOVEMBER 2017

OUR REFERENCE: 22508-1-17225

Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
HERRING STORER ACOUSTICS
P.O. Box 219, Como, W.A. 6952
(08) 9367 6200
hsa@hsacoustics.com.au

DOCUMENT CONTROL PAGE

NOISE ASSESSMENT

BALCATTA

Job No: 17225

Document Reference: 22508-1-17225

FOR

PROGRESS DEVELOPMENTS

DOCUMENT INFORMATION			
Author:	Geoffrey Harris	**Checked By:**	Tim Reynolds
Date of Issue :	15 November 2017		

REVISION HISTORY

Revision	Description	Date	Author	Checked

DOCUMENT DISTRIBUTION

Copy No.	Version No.	Destination	Hard Copy	Electronic Copy
1	1	Parcel Property Attn: Matt Craven-Kelly Email: mckelly@parcelproperty.com.au		✓

CONTENTS

1.	INTRODUCTION		1
2.	SUMMARY		1
3.	ACOUSTIC CRITERIA		2
	3.1	WAPC Planning Policy	2
	3.2	Appropriate Criteria	4
4.	MEASUREMENTS AND OBSERVATIONS		4
5.	MODELLING		5
6.	ASSESSMENT		6

APPENDICES

A	Development Plans
B	Noise Monitoring
C	Noise Contour Plots
D	Noise Amelioration & “Quiet House” Design Requirements

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Parcel Property to undertake a road traffic noise assessment for the proposed "Rosella East" development bordered by Karrinyup Road, Gridelford Drive and Albert Street in Balcatta.

The purpose of this assessment was to assess noise received within the development from vehicles travelling along Karrinyup Road and if exceedance with the stated criteria were determined, establish the required attenuation measures to control noise intrusion to acceptable levels. The traffic noise assessment has been carried out in accordance with the WAPC State Planning Policy 5.4 *"Road and Rail Transportation Noise and Freight Consideration in Land Use Planning"*.

As part of the study, the following was carried out:

- Monitor existing noise received from vehicles travelling along Karrinyup Road.
- For future traffic flows, determine noise that would be received at residences within the development from vehicles travelling on Karrinyup Road.
- Assess the predicted noise levels for compliance with the appropriate criteria.
- If exceedances are predicted, comment on possible noise amelioration options for compliance with the appropriate criteria.

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 Transport Noise and Freight Considerations in Land Use Planning"* (SPP5.4), we believe that the appropriate criteria for assessment for this development are as listed below for "Noise Limits".

EXTERNAL

$L_{Aeq(Day)}$ of 60 dB(A); and
$L_{Aeq(Night)}$ of 55 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).

Noise received at the residences in close proximity Karrinyup Road would, as shown by the noise contour plot attached as Figure C1 in Appendix C exceed the Policies "Noise Limits". As of such, varying degrees of "Quiet House Design" are required to achieve compliance with SPP 5.4. Appendix D highlights the various lots affected by noise and the requisite amelioration for each, including lots requiring notification on the title.

If there is a requirement for multiple storey houses to be constructed, specialist acoustic advice is to be sought for the upper floors.

For information, "Quiet House" requirements are attached in Appendix D.

3. ACOUSTIC CRITERIA

3.1 WAPC PLANNING POLICY

The Western Australian Planning Commission (WAPC) released on 22 September 2009 State Planning Policy 5.4 *"Road and Rail Transport Noise and Freight Considerations In Land Use Planning"*. Section 5.3 – Noise Criteria, which outlines the acoustic criteria, states:

"5.3 - NOISE CRITERIA

Table 1 sets out the outdoor noise criteria that apply to proposals for new noise-sensitive development or new major roads and railways assessed under this policy.

These criteria do not apply to –

- *proposals for redevelopment of existing major roads or railways, which are dealt with by a separate approach as described in section 5.4.1; and*
- *proposals for new freight handling facilities, for which a separate approach is described in section 5.4.2.*

The outdoor noise criteria set out in Table 1 apply to the emission of road and rail transport noise as received at a noise-sensitive land use. These noise levels apply at the following locations—

- *for new road or rail infrastructure proposals, at 1 m from the most exposed, habitable façade of the building receiving the noise, at ground floor level only; and*
- *for new noise-sensitive development proposals, at 1 m from the most exposed, habitable façade of the proposed building, at each floor level, and within at least one outdoor living area on each residential lot.*

Further information is provided in the guidelines.

Table 1 - Outdoor Noise Criteria

Time of day	*Noise Target*	*Noise Limit*
Day (6 am–10 pm)	$L_{Aeq(Day)}$ *= 55 dB(A)*	$L_{Aeq(Day)}$ *= 60 dB(A)*
Night (10 pm–6 am)	$L_{Aeq(Night)}$ *= 50 dB(A)*	$L_{Aeq(Night)}$ *= 55 dB(A)*

The 5 dB difference between the outdoor noise target and the outdoor noise limit, as prescribed in Table 1, represents an acceptable margin for compliance. In most situations in which either the noise-sensitive land use or the major road or railway already exists, it should be practicable to achieve outdoor noise levels within this acceptable margin. In relation to greenfield sites, however, there is an expectation that the design of the proposal will be consistent with the target ultimately being achieved.

Because the range of noise amelioration measures available for implementation is dependent upon the type of proposal being considered, the application of the noise criteria will vary slightly for each different type. Policy interpretation of the criteria for each type of proposal is outlined in sections 5.3.1 and 5.3.2.

The noise criteria were developed after consideration of road and rail transport noise criteria in Australia and overseas, and after a series of case studies to assess whether the levels were practicable. The noise criteria take into account the considerable body of research into the effects of noise on humans, particularly community annoyance, sleep disturbance, long-term effects on cardiovascular health, effects on children's learning performance, and impacts on vulnerable groups such as children and the elderly. Reference is made to the World Health Organization (WHO) recommendations for noise policies in their publications on community noise and the Night Noise Guidelines for Europe. See the policy guidelines for suggested further reading.

5.3.1 Interpretation and application for noise-sensitive development proposals

In the application of these outdoor noise criteria to new noise-sensitive developments, the objective of this policy is to achieve –

- *acceptable indoor noise levels in noise-sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and*
- *a reasonable degree of acoustic amenity in at least one outdoor living area on each residential lot[1].*

If a noise-sensitive development takes place in an area where outdoor noise levels will meet the noise target, no further measures are required under this policy.

In areas where the noise target is likely to be exceeded, but noise levels are likely to be within the 5dB margin, mitigation measures should be implemented by the developer with a view to achieving the target levels in a least one outdoor living area on each residential lot[1]. Where indoor spaces are planned to be facing any outdoor area in the margin, noise mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces. In this case, compliance with this policy can be achieved for residential buildings through implementation of the deemed-to-comply measures detailed in the guidelines.

In areas where the outdoor noise limit is likely to be exceeded (i.e. above $L_{Aeq(Day)}$ of 60 dB(A) or $L_{Aeq(Night)}$ of 55 dB(A)), a detailed noise assessment in accordance with the guidelines should be undertaken by the developer. Customised noise mitigation measures should be implemented with a view to achieving the noise target in at least one outdoor living or recreation area on each noise-sensitive lot or, if this is not practicable, within the margin. Where indoor spaces will face outdoor areas that are above the noise limit, mitigation measures should be implemented to achieve acceptable indoor noise levels in those spaces, as specified in the following paragraphs.

For residential buildings, acceptable indoor noise levels are $L_{Aeq(Day)}$ of 40 dB(A) in living and work areas and $L_{Aeq(Night)}$ of 35 dB(A) in bedrooms[2]. For all other noise-sensitive buildings, acceptable indoor noise levels under this policy comprise noise levels that meet the recommended design sound levels in Table 1 of Australian Standard AS 2107:2000 Acoustics—Recommended design sound levels and reverberation times for building interiors.

1 For non residential noise-sensitive developments, (e.g. schools and child care centres) consideration should be given to providing a suitable outdoor area that achieves the noise target, where this is appropriate to the type of use.
2 For residential buildings, indoor noise levels are not set for utility spaces such as bathrooms. This policy encourages effective "quiet house" design, which positions these non-sensitive spaces to shield the more sensitive spaces from transport noise (see guidelines for further information).

These requirements also apply in the case of new noise-sensitive developments in the vicinity of a major transport corridor where there is no existing railway or major road (bearing in mind the policy's 15-20 year planning horizon). In these instances, the developer should engage in dialogue with the relevant infrastructure provider to develop a noise management plan to ascertain individual responsibilities, cost sharing arrangements and construction time frame.

If the policy objectives for noise-sensitive developments are not achievable, best practicable measures should be implemented, having regard to section 5.8 and the guidelines."

The Policy, under Section 5.7, also provides information regarding "Notifications on Titles".

3.2 APPROPRIATE CRITERIA

Based on the above, the following criteria are proposed for this development:

External	
Day	Maximum of 60 dB(A) L_{Aeq}
Night	Maximum of 55 dB(A) L_{Aeq}
Outdoor Living Areas*	Maximum of 50 dB(A) $L_{Aeq\ (night\ period)}$
Internal	
Sleeping Areas	35 dB(A) $L_{Aeq(night)}$
Living Areas	40 dB(A) $L_{Aeq(day)}$

*This is a suggested noise level; noise is to be reduced as far as practicably possible.

4. MEASUREMENTS AND OBSERVATIONS

To determine the existing acoustic environment at the proposed development, a noise data logger was located adjacent to Karrinyup Road, with data collected from 27 September to 1 October 2017.

The automatic noise data logger records sound pressure levels in accordance with Australian Standard 2702-1984: *Acoustics - Method For Measurement of Road Traffic Noise.* The logger used records statistical noise level data, of which the L_{A1}, L_{A10}, L_{Aeq} and L_{A90} levels are reported. These are defined below:

- L_{A1} The noise level exceeded for 1% of the time (in this instance, the noise level exceeded for 36 seconds in each 1-hour period).
- L_{A10} The noise level exceeded for 10% of the time (in this instance, the noise level exceeded for 6 minutes in each 1-hour period).
- L_{Aeq} The energy equivalent noise level for the 1-hour period. A single number value that expresses the time-varying sound level for the 1-hour period as though it were a constant sound level with the same total sound energy as the time-varying level.
- L_{A90} The noise level exceeded for 90% of the time (in this instance, the noise level exceeded for 54 minutes in each 1-hour period).

The results of the noise logging are summarised in Table 4.1. The results are also shown graphically on Figure B1, attached in Appendix B.

TABLE 4.1 - SUMMARY OF MEASURED NOISE LEVELS (KARRINYUP ROAD)

Parameter	Measured Level dB(A)*	Difference between $L_{10(18hour)}$ and $L_{Aeq(parameter)}$ dB(A)
$L_{A10\ (18\ hour)}$	66.9	N/A
$L_{Aeq,\ day\ (6am\ to\ 10pm)}$	64.2	= $L_{A10\ (18\ hour)}$ – 2.7
$L_{Aeq,\ night\ (10pm\ to\ 6am)}$	56.5	= $L_{A10(18\ hour)}$ – 10.4

* It is normal practice to quote decibels to the nearest whole number. Fractions are retained here to minimise any cumulative rounding error.

5. MODELLING

Modelling of noise received within the subdivision from Karrinyup Road was carried out using SoundPlan, using the Calculation of Road Traffic Noise (CoRTN) algorithms. The input data for the model included:

- Increased traffic volume, assuming 2% growth over 20 years.
- Other traffic data as listed in Table 4.1.
- A +2.5 dB adjustment to allow for façade reflection.
- A -1.5 dB adjustment for the change in road surface from chip seal to dense graded asphalt.

The traffic data currently available on the Main Roads web site are as listed in Table 5.1. Table 5.1 also lists the percentage heavy vehicles and the calculated future traffic flows.

TABLE 5.1 - SUMMARY OF TRAFFIC DATA

Parameter	Karrinyup Road
Current Traffic Flow (vpd)	29600
Future Traffic Flow (vpd)	39200
Percentage Heavy Vehicles (%)	5%
Speed (km/hr)	70

For the noise modeling for future traffic it has been assumed that the percentage of future heavy vehicles remains the same as for the current traffic flows.

We note that with the difference between the $L_{Aeq,8hr}$ and the $L_{Aeq,16hr}$ being less than 5 dB(A), achieving compliance with the night period criteria will also result in achieving compliance with the day period criteria.

Noise modelling was undertaken for the following scenarios:

A 2031 traffic flows, without any noise amelioration.

The noise contour plot for the day period is attached in Appendix C.

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 "East Roselea" Balcatta, from vehicles travelling on Karrinyup Road has been undertaken.

In accordance with the Policy, the following would be the acoustic criteria applicable to this project:

External

Day	Maximum of 60 dB(A) L_{Aeq}
Night	Maximum of 55 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).

Noise received at the residences in close proximity Karrinyup Road would, as shown by the noise contour plot attached as Figure C1 in Appendix C exceed the Policies "Noise Limits". As of such, varying degrees of “Quiet House Design” are required to achieve compliance with SPP 5.4. Appendix D highlights the various lots affected by noise and the requisite amelioration for each including lots requiring notification on the title.

An example of a suitable notice, as provided within the Guidelines is:

> *This lot is situated in the vicinity of Karrinyup Road and is currently affected, and / or may in the future be affected by transport noise.*

If there is a requirement for multiple storey houses to be constructed, specialist acoustic advice is to be sought for the upper floors.

For information, “Quiet House” requirements are attached in Appendix D.

Notes: It is noted that the “Quiet House” design packages attached in Appendix D, are “Deemed to Satisfy” constructions and alternative constructions would be acceptable provided they are supported by an acoustic report prepared by a suitably qualified acoustic consultant.

APPENDIX A

DEVELOPMENT PLAN

LEGEND

- STRUCTURE PLAN BOUNDARY
- 7 EXISTING LOT NUMBERS
- EXISTING BOUNDARIES
- PROPOSED BOUNDARIES
- EASEMENT
- LOCAL CENTRE
- RESIDENTIAL R30
- RESIDENTIAL R40-60
- RESIDENTIAL R60-80
- PUBLIC OPEN SPACE
- COMMUNITY FACILITY
- WASTE WATER PUMP STATION

13.2m ROAD RESERVE
114
801
108
109
30
15m ROAD RESERVE
ROAD RESERVE
20m ROAD RESERVE
50
51
FORTUNE ST
32
WWPS
64
63
49
66
49
ALBERT STREET
15m ROAD RESERVE
10m ROAD WIDENING
88
129
89
128
15m ROAD RESERVE
141
PUBLIC OPEN SPACE
RESERVE ROAD
15m ROAD RESERVE
153
151
52
18m ROAD RESERVE
15m ROAD RESERVE
87
86
LOCAL CENTRE
350
12m ROAD RESERVE
150
151
139
CRANBERRY GARDENS DRIVE
GRANGE
GRINDLEFORD
ALBERT ROAD
KARRINYUP
NORTH BEACH DRIVE
DRAFT

Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD\8686_LSP01A_20170926 BALCATTA (LOCAL STRUCTURE PLAN)
8686_LSP01A_20170926 Balcatta (Local Structure Plan) | DRAWN: WILLIAM CLEMENTS | PLOT DATE: 2017.09.22 | PROJECTION: MGA50 GDA94 | CLIENT: LANDCORP | CADASTRE SUPPLIED BY LANDGATE

ROWEGROUP DESIGN
P: 9221 1991 W: www.rowegroup.com.au

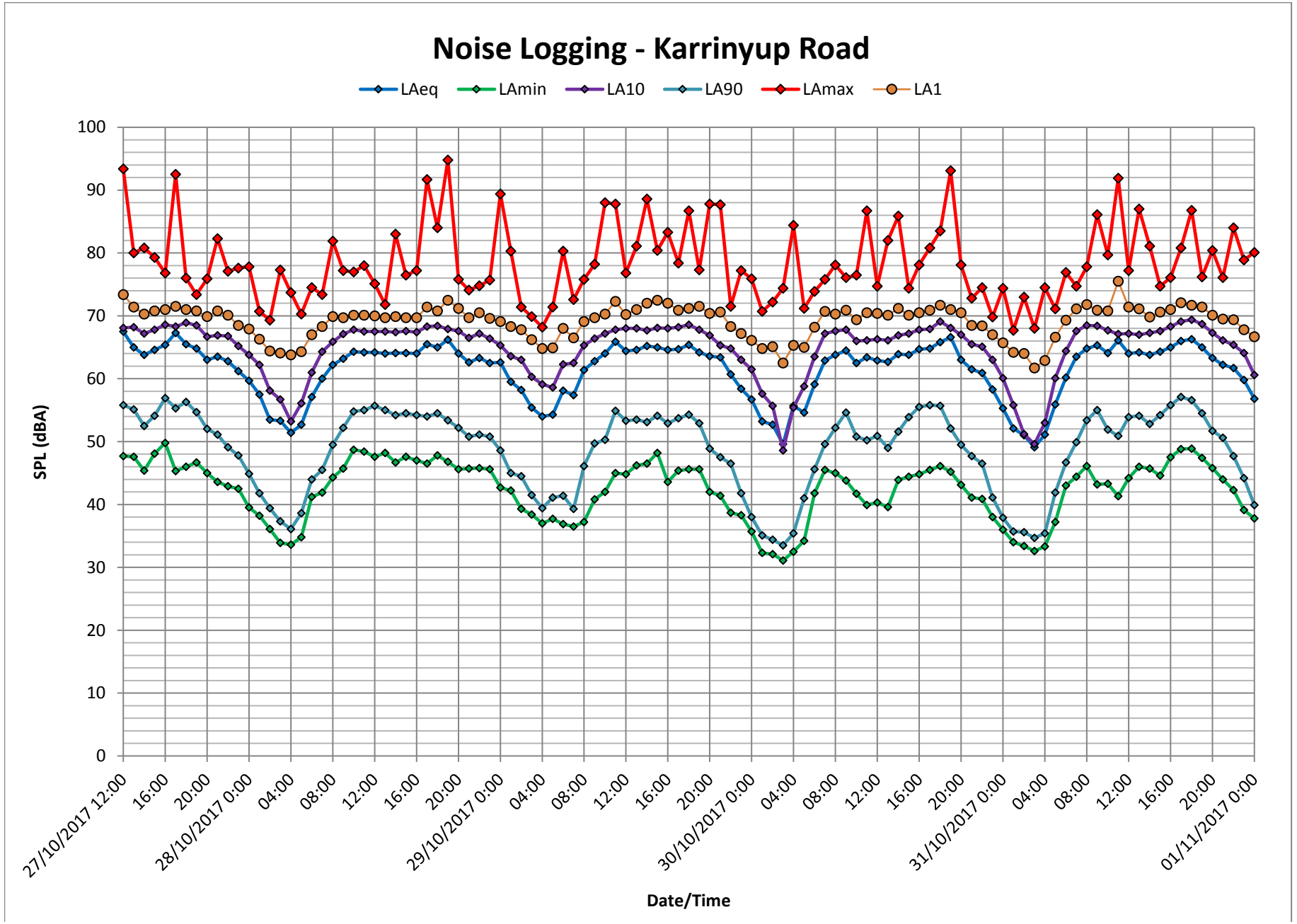
0 62.5 M
SCALE @ A3: 1:2500
8686-LSP-01-A
NORTH

ROSELEA EAST STRUCTURE PLAN

BALCATTA - PLAN 1

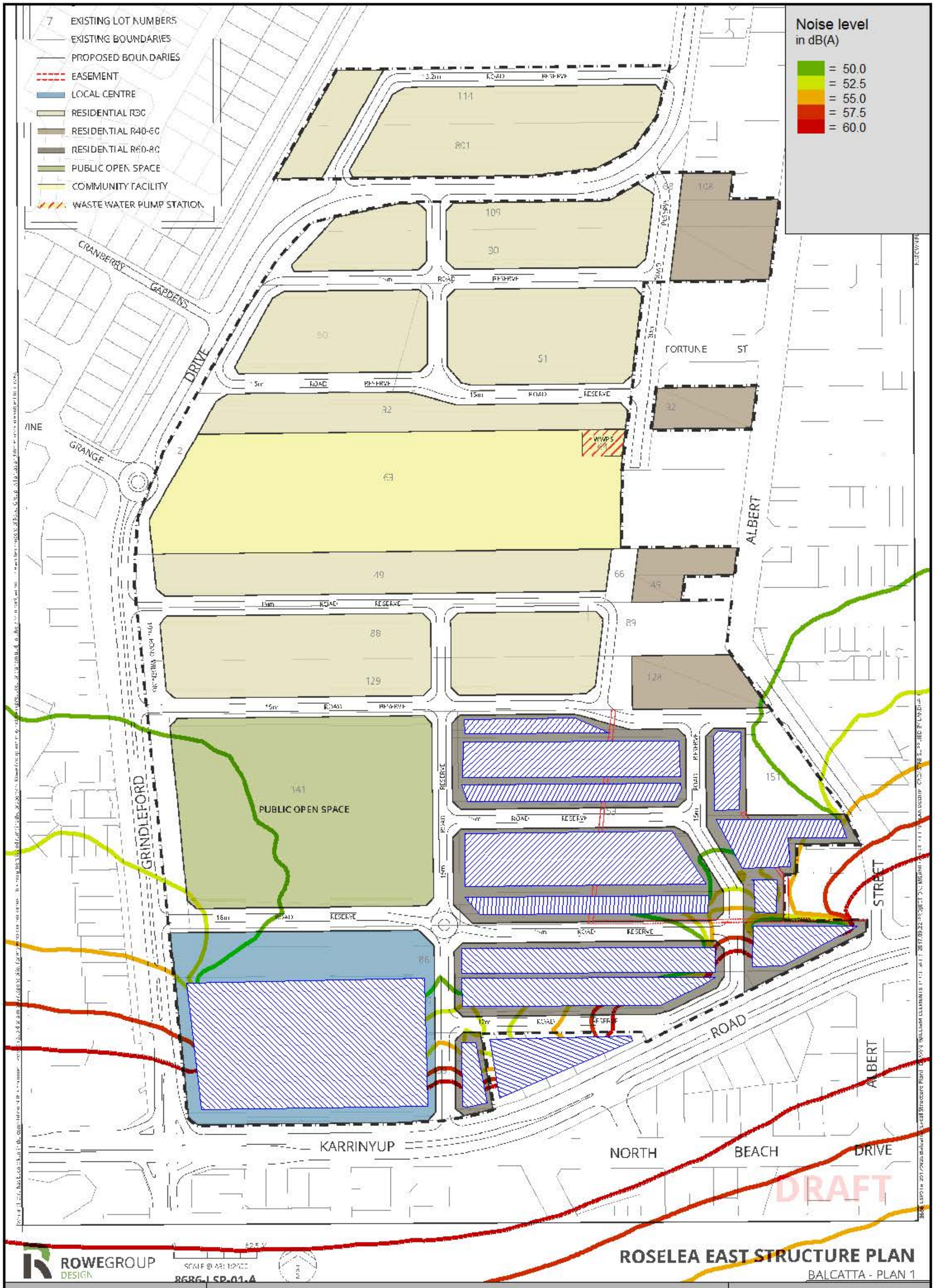
APPENDIX B

NOISE MONITORING


Noise Logging - Karrinyup Road
LAeq
LAmin
LA10
LA90
LAmax
LA1
SPL (dBA)
100
90
80
70
60
50
40
30
20
10
0
27/10/2017 12:00
16:00
20:00
28/10/2017 0:00
04:00
08:00
12:00
16:00
20:00
29/10/2017 0:00
04:00
08:00
12:00
16:00
20:00
30/10/2017 0:00
04:00
08:00
12:00
16:00
20:00
31/10/2017 0:00
04:00
08:00
12:00
16:00
20:00
01/11/2017 0:00
Date/Time

APPENDIX C

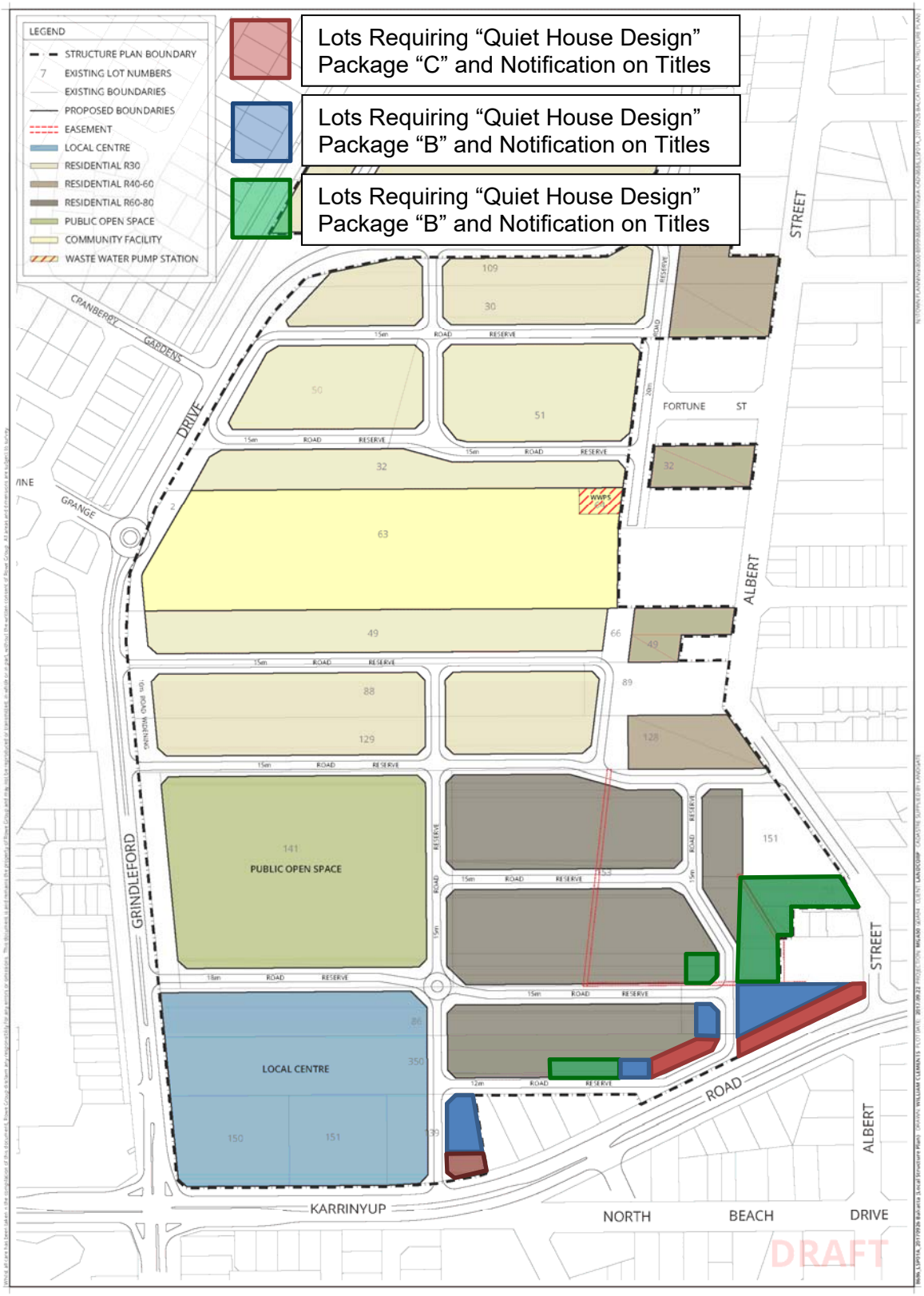
NOISE CONTOUR PLOTS



Herring Storer Acoustics 17225	**Parcel Property** **Rosella East LSP** **Day Time Road Traffic Noise Contours**	Appendix C

APPENDIX D

NOISE AMELIORATION &
"QUIET HOUSE" DESIGN REQUIREMENTS



ROWEGROUP DESIGN

SCALE @ A3: 1:2500

8686-LSP-01-A

ROSELEA EAST STRUCTURE PLAN

BALCATTA - PLAN 1

QUIET HOUSE DESIGN PACKAGES FOR RESIDENCE

Area	Orientation to road or rail corridor	Package A L_{Aeq},Day up to 60dB L_{Aeq},Night up to 55dB	Package B L_{Aeq},Day up to 63dB L_{Aeq},Night up to 58dB	Package C L_{Aeq},Day up to 65dB L_{Aeq},Night up to 60dB
Bedrooms	Facing	• Walls to R_w+C_{tr} 45dB • Windows and external door systems: Minimum R_w+C_{tr} 28dB (Table 6.4), total glazing area up to 40% of room floor area. [if R_w+C_{tr} 31dB: 60%] [if R_w+C_{tr} 34dB: 80%] • Roof and ceiling to R_w+C_{tr} 35dB (1 layer 10mm plasterboard) • Mechanical ventilation as per Section 6.3.1	• Walls to R_w+C_{tr} 50dB • Windows and external door systems: Minimum R_w+C_{tr} 31dB (Table 6.4), total glazing area up to 40% of room floor area. [if R_w+C_{tr} 34dB: 60%] • Roof and ceiling to R_w+C_{tr} 35dB (1 layer 10mm plasterboard) • Mechanical ventilation as per Section 6.3.1	• Walls to R_w+C_{tr} 50dB • Windows and external door systems: Minimum R_w+C_{tr} 34dB (Table 6.4), total glazing area limited to 40% of room floor area [if 20% of floor area or less, R_w+C_{tr} 31dB] • Roof and ceiling to R_w+C_{tr} 40dB (2 layers 10mm plasterboard) • Mechanical ventilation as per Section 6.3.1
	Side-on	•As above, except glazing Rw+Ctr values for each package may be 3dB less, or max % area increased by 20%		
	Opposite	• No requirements	• As per Package A 'Side On'	• As per Package A 'Facing'
Indoor living and work Areas	Facing	• Walls to Rw+Ctr 45dB • Windows and external door systems: Minimum Rw+Ctr 25dB (Table 6.4), total glazing area limited to 40% of room floor area. [if Rw+Ctr 28dB: 60%] [if Rw+Ctr 31dB: 80%] • External doors other than glass doors to Rw+Ctr 26dB (Table 6.4) • Mechanical ventilation as per Section 6.3.1	• Walls to Rw+Ctr 50dB • Windows and external door systems: Minimum Rw+Ctr 28dB (Table 6.4), total glazing area up to 40% of room floor area. [if Rw+Ctr 31dB: 60%] [if Rw+Ctr 34dB: 80%] • External doors other than glass doors to Rw+Ctr 26dB (Table 6.4) • Mechanical ventilation as per Section 6.3.1	• Walls to R_w+C_{tr} 50dB • Windows and external door systems: Minimum R_w+C_{tr} 31dB (Table 6.4), total glazing area up to 40% of room floor area. [if R_w+C_{tr} 34dB: 60%] • External doors other than glass doors to R_w+C_{tr} 30dB (Table 6.4) • Mechanical ventilation as per Section 6.3.1
	Side-on	• As above, except the glazing R_w+C_{tr} values for each package may be 3dB less, or max % area increased by 20%		
	Opposite	• No requirements	• As per Package A 'Side On'	• As per Package A 'Facing'
Other indoor areas	Any	• No requirements	• No requirements	• No requirements
Outdoor living areas	Any (Section 6.2.3)	• As per Package C, 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	• As per Package C, 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	• At least one outdoor living area located on the opposite side of the building from the transport corridor

APPENDIX 3

ENVIRONMENTAL ASSESSMENT REPORT

ROWE GROUP DESIGN

Report on

ENVIRONMENTAL ASSESSMENT
ROSELEA EAST STRUCTURE PLAN AREA
GRINDLEFORD DRIVE, BALCATTA

Submitted to:
Parcel Property
131 Hasler Road
OSBORNE PARK WA 6017

www.galtenv.com.au
50 Edward Street
OSBORNE PARK WA 6017
T: +61 (8) 6272-0200

J1702012 002 R Rev2

23 November 2017

TABLE OF CONTENTS

1. Introduction 1

2. Site Description and Proposed Development 1

3. Project Objectives 1

4. Previous Studies 1

5. Site Conditions 2

5.1 Geology 2

5.2 Subsurface Conditions 2

5.3 Groundwater 3

5.4 Acid Sulfate Soils 4

5.5 Contaminated Sites 4

5.6 Geomorphic Wetlands 4

5.7 Environmentally Sensitive Areas 4

5.8 Bush Fire Risk 4

5.9 Vegetation and Flora 5

5.10 Fauna 5

5.11 Historical Aerial Imagery 5

6. Preliminary Environmental Assessment 6

7. Further Work 7

8. Closure 8

TABLES

Table 1: Summary of Historical Aerial Photograph Review 5

Table 2: Preliminary Environmental Assessment 6

FIGURES

Figure 1: Site and Location Plan

Figure 2: Geological Mapping

Figure 3: Groundwater Contours and WIN Sites

Figure 4: Acid Sulfate Soil Risk Mapping

Figure 5: Contaminated Sites

Figure 6: Geomorphic Wetlands

Figure 7: Environmentally Sensitive Areas

Figure 8: Bushfire Prone Areas

Figure 9a-9h: Historical Aerial Photographs

APPENDICES

APPENDIX A: INDICATIVE SUBDIVISION CONCEPT PLAN

APPENDIX B: UNDERSTANDING YOUR REPORT

1. INTRODUCTION

This report presents the findings of Galt Environmental Pty Ltd's (Galt's) environmental assessment of the Roselea East Structure Plan Area located on Grindleford Drive, Balcatta (the site). The site relative to the surrounding area is shown on Figure 1.

The work was authorised by Jeremy Cordina from Parcel Property via an email dated 13 July 2017.

This report supersedes our report ref. J1702012 002 R Rev0, dated 26 September 2017.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

Based on the supplied information, Structure Plan Area (SPA) is irregular in shape and approximately 29 hectares in size. The site is bounded by Grindleford Drive to the west, Grindleford Park to the north, Albert Street to the east and Karrinyup Road to the south.

Publicly available topographic data indicates that the elevation ranges from RL 13 m to RL 15 m AHD across the site. However, we note that most lots within the SPA have been earthworked in the past and therefore these elevations (from circa 1997) may no longer be accurate.

We understand that the proposed development involves subdivision of the existing lots into residential and commercial lots, public open space and associated access roads. An indicative subdivision concept plan for the Roselea East area is included in Appendix A - Indicative Structure Plan Area.

We understand that a structure plan is to be lodged with the Western Australian Planning Commission for approval and requires the support of a geotechnical study report indicating that the land is suitable for the proposed development.

This environmental assessment is based on studies conducted at the site by us and other consultants, with no additional intrusive works conducted as part of this current package of works.

3. PROJECT OBJECTIVES

The objectives of the desk study are to:

- review the existing environmental data available for the site;
- assess and provide comment on environmental constraints that may impact on the proposed development;
- assess and provide comment whether the site is suitable for the proposed development; and
- provide recommendations for further studies that may be required to support the proposed development.

4. PREVIOUS STUDIES

The following studies have previously been conducted within the SPA, and have been reviewed as part of this environmental assessment:

- Galt Geotechnics Pty Ltd, *Geotechnical Desktop Study –Roselea East Structure Plan Area, Grindleford Drive, Balcatta* Ref: J1707022 001 R Rev2, dated 23 November 2017;
- Galt Geotechnics Pty Ltd, *Due Diligence Geotechnical and Environmental Study, Proposed Residential Development, 49 Albert Street, Balcatta*, Ref: J1601060 001 R Rev0, dated 6 May 2016;
- Galt Geotechnics Pty Ltd, *Geotechnical Study, Proposed Residential Development, Lots 86, 88 & 129 Grindleford Drive, Balcatta*, Ref: J1401266 004 R Rev0, dated 16 February 2016;

- Infra Tech Pty Ltd, *Seismic Investigation Report Lots 88, 129 141, and 86 Grindleford Drive, Balcatta*, Ref: 804-PO-ENG-RPT-001, dated 27 March 2015;
- Douglas Partners Pty Ltd, *Preliminary Geotechnical Investigation - 309 Albert Street, Balcatta, WA*, Ref: 76430, dated 3 October 2012;
- Douglas Partners Pty Ltd, *Preliminary Site Investigation - 309 Albert Street, Balcatta, WA*, Ref: 76430, dated 5 October 2012;
- Merit Consulting Group Pty Ltd, *Methodology and Cost Assessment 309 Albert Street, Balcatta,* dated 3 July 2015;
- Galt Geotechnics Pty Ltd, *Due Diligence Investigation, Proposed Display Home Development, Lots 150 Karrinyup Road, Balcatta*, Ref: J1101001 001 R Rev0, dated 24 January 2011;
- Coffey Geosciences Pty Ltd, Geotechnical Review, *Subdivision - Lots 350 Grindleford Drive, Stirling,* Ref: P2963/1-AC, dated 25 November 2002;
- Strategen Environmental Pty Ltd, *Grindleford Drive – Groundwater and Surface Water Monitoring Results*, Ref: ABN15334.01 dated 3 December 2015; and
- Strategen Environmental Pty Ltd, *Grindleford Drive – Stockpile Assessment,* Ref: ABN15339.01 dated 4 December 2015.

5. SITE CONDITIONS

5.1 Geology

The Perth sheet of the 1:50,000 scale Environmental Geology series maps indicate that the entire development area is underlain by:

- PEAT – *black, clayey in part, saturated fibrous organic soil.*

Geological mapping is shown on Figure 2.

5.2 Subsurface Conditions

The typical subsurface profiles differ slightly across the SPA, mainly based on the filling history and remedial works undertaken. However, the profiles underlying the individual lots are relatively consistent.

Central Portion (Lots 88 & 129)

The site surface in the central portion of the site (Lots 88 & 129) has been raised by around 4 m to 5 m above the natural surface level. These lots are understood to have been raised with peaty fill from the adjacent residential development to the west between 2000 and 2001.

The lots are underlain by:

- FILL: SAND with some organics, typically dark brown, with some fines and organic fines (typical estimated organic content about 5% and total fines content about 10% to 15%), about 4 m thick in the west of the northern site, becoming thinner to the east to about 1 m thickness in the middle of the site and not present in the east of the site, very loose, typically dry becoming moist at depth, overlying
- FILL: Peaty SAND / PEAT (Pt), fine to coarse grained, brown to black, very loose, typically dry becoming moist, with varying proportions of fines and organics, typically to about 2.5 m to 7 m depth (deeper in the east and west, shallower in the middle of the site), including sand or limestone layers in the lower part of this layer (inferred working platforms placed during placement of the peat fill), overlying

- PEAT (Pt), typically black, stiff or firm to stiff, with varying proportions of sand (typically 70% to 80% of dry weight), present in a layer typically 1 m to 2 m thick below Unit C (not present in parts), present to between 6 m and 8 m depth, overlying
- SAND (SP), fine to coarse grained, brown becoming grey, typically dense, wet, present to the maximum investigated depth of about 10 m).

Northern and Southern Portions

The northern and southern lots within the SPA are generally at or close to the natural surface level and are underlain by:

- UNCONTROLLED FILL: SAND (SP) with deleterious and inert inclusions – Typically a mixture of concrete rubble, brick rubble, steel and general rubbish (evidently from construction/demolition site clean-ups), typically comprising between 10% to 60% of the inert and deleterious fill, in a matrix of sand, fine to coarse grained, very loose, with some non-plastic fines, trace roots, rootlets and wood pieces, very loose, present from the surface to depths varying between about 1 m and more than 3 m, overlying
- PEAT (Pt), typically black, very soft to soft, generally 0.3 m to about 2.5 m thick, present to between 1.8 m and 4.5 m depth across most of the site, overlying
- SAND (SP), fine to coarse grained, typically dense, wet, present to the maximum investigated depth of about 9 m.

We note that the underlying peaty soils in Lot 350 have been partially remediated (excavated and replaced) over most of the lot footprint.

5.3 Groundwater

The Perth Groundwater Atlas (1997) shows the maximum historical groundwater level to be around RL 15 m AHD along the eastern boundary of the SPA, falling to around RL 11.5 m AHD along the western boundary. This is within about 1 m to 1.5 m of the mapped ground surface. Regional groundwater contours for the development area are shown on Figure 3.

Groundwater was encountered during the various investigations at depths between the existing surface level and greater than 2.5 m below ground surface. Where groundwater is at or near surface, this appears to be a perched groundwater level over peaty soils.

The water information network (WIN) indicates that there are a number of registered groundwater bores located on and surrounding the site. Based on our review of the available WIN sites data, none of the bores within the SPA are currently used for irrigation purposes.

We note that the soccer fields located in the southern portion of the site may be irrigated with groundwater abstracted from the site. Furthermore, there are number of registered groundwater bores surrounding the SPA. As such, any dewatering at the site as part of construction or ground improvement works, has the potential to disrupt registered and unregistered bore users within the hydraulic influence of the site.

A groundwater quality assessment was undertaken by Strategen Environmental in 2015 and the following conditions were noted:

- the pH values were generally above 6.5 across the site;
- low levels of inherent acidity and high levels of alkalinity indicate that groundwater has high levels of buffering capacity;

- the concentrations of aluminium, iron and arsenic are consistent with groundwater conditions previously identified at sites with peat; and
- the pH and alkalinity values indicate that groundwater has not been adversely impacted by the presence of actual and potential ASS in the vicinity of the site.

Groundwater contours and registered WIN sites are shown on Figure 3.

5.4 Acid Sulfate Soils

The Department of Water and Environmental Regulation (DWER) acid sulfate soil (ASS) risk mapping indicates that the entirety of the site is located in an area mapped as having high to moderate risk of ASS occurrence at depth less than 3 m below the existing surface. The mapping is consistent with the findings of preliminary ASS studies that have been conducted at the site.

ASS risk mapping is shown on Figure 4.

5.5 Contaminated Sites

The publicly available DWER contaminated sites database was searched for known contaminated sites (sites classified as Contaminated-restricted use, Remediated for restricted use or Contaminated-remediation required) in proximity to the study site.

The results of the search indicate that there are no known contaminated sites within the Structure Plan Area.

Surrounding contaminated sites are shown on Figure 5.

5.6 Geomorphic Wetlands

The Department of Parks and Wildlife (DPaW) geomorphic wetland database indicates that the site is located in an area mapped as being a 'Multiple Use' wetland with unique feature identifier (UFI) 8177. The wetland boundary extends well beyond the proposed SPA and is characterised as a 'Sumpland'. The presence of this wetland is consistent with the pre-development environment in the Stirling and Balcatta area. We do not consider that the presence of the wetland will adversely impact on the proposed development.

The geomorphic wetland mapping is shown on Figure 6.

5.7 Environmentally Sensitive Areas

The site is not classified as an environmentally sensitive area (ESA) based on the DPaW mapping. The nearest ESA is located approximately 2 km to the southwest of the site.

The ESA mapping is shown on Figure 7.

5.8 Bush Fire Risk

The is not classified as a bush fire prone area by the Department of Fire and Emergency Services (DFES). The nearest bush fire prone area is located approximately 1.5 km to the southwest and is unlikely to impact on the proposed development.

Bush fire risk mapping is shown on Figure 8.

5.9 Vegetation and Flora

Remnant vegetation is protected in Western Australia under the EP Act, and clearing of native vegetation requires a Clearing Permit, unless subject to subdivision approval.

Threatened ecological communities (TECs) can be listed under the *Environment Protection and Biodiversity Conservation Act* 1999 (Commonwealth) (EPBC Act) and the *Wildlife Conservation Act* 1950 (WA) (WC Act), while priority ecological communities (PECs) are listed by DPaW.

Native flora species are protected under the EPBC Act and the WC Act. Flora species protected under the EPBC Act are referred to as Matters of National Environmental Significance (MNES) and include rare, threatened and migratory species. Flora species may also be listed for protection under the WC Act or listed as priorities by DPaW. Listed threatened and priority flora are also considered during the assessment of clearing permit applications.

The majority of SPA has either been cleared for other purposes (sports grounds, clubs etc) or not planned to be developed. A desktop assessment has confirmed that there are no Bush Forever sites within the SPA.

5.10 Fauna

Native fauna species are protected under the EPBC Act and WC Act. Fauna species protected under the EPBC Act are referred to as Matters of National Environmental Significance (MNES) and include rare, threatened and migratory species. Fauna species may also be listed for protection under the WC Act or listed as priorities by DPaW. Important fauna habitats are also considered during the assessment of clearing permit applications.

Under the environmental assessment provisions of the EPBC Act, 'actions' (such as this development) that are considered likely to have a significant impact to one or more MNES protected under the EPBC Act are subject to an assessment and approvals process by DotE. 'Actions', including clearing, that may significantly impact upon MNES are required to be referred to DotE. An action that is considered to have a significant impact is deemed a 'controlled action' and will require formal assessment by DotE.

The SPA is largely devoid of remnant vegetation, having been previously cleared or developed. It is unlikely that any significant habitat exists for native fauna within the project area, based on the desktop assessment.

5.11 Historical Aerial Imagery

Historical aerial photographs were reviewed to develop an understanding of previous land uses at the site and adjacent sites.

A summary of the historical photograph review is presented in Table 1 with the historical aerial photographs shown on Figures 9A to 9H.

Table 1: Summary of Historical Aerial Photograph Review

Year	Observations
1953	Entire site in use as market gardens
1965 - 1979	Site unchanged
1981	Earthworks along eastern boundary and southern portion of site
1985	Extensive filling in central lots.

Year	Observations
1995	Construction of Grindleford Drive along western boundary and existing cultural centres and sports facilities in north, centre and south portions of site.
2000	Site Unchanged
2001	Extensive earthworks in area to west of site. Filling of Lots 88 and 129 with dark, peaty material.
2006-2015	Site Unchanged
2016	Extension of Grindleford Drive through northern portion of site.
2017	Site Unchanged

6. PRELIMINARY ENVIRONMENTAL ASSESSMENT

A summary of the key environmental constraints to development determined from the desktop assessment is presented in Table 2.

Table 2: Preliminary Environmental Assessment

Factor	Potential Constraint To Development	Justification	Potential Management Measures and Further Work Required
Conflicts with current land uses	No	The SPA and surrounds incorporate existing residential developments, public open space and commercial developments. The proposed Structure Plan is consistent with the surrounding land use.	Consideration will need to be given to surrounding land owners which will require sufficient notification and liaison to be undertaken by the developer during key stages of development, such as construction.
Geology and subsurface conditions	No	A review of geotechnical studies previously conducted at the site indicated that the site would be suitable for the proposed development with appropriate ground improvement.	Additional intrusive geotechnical studies will be required prior to the commencement of the development.
Groundwater	No	Groundwater at the site is considered to be moderately degraded and unsuitable for irrigation purposes. However, pH and alkalinity values indicate that groundwater has not been adversely impacted by the oxidation of ASS in the vicinity of the site. Future works at the site will not further impact groundwater quality.	A comprehensive groundwater monitoring program will be implemented during all ground disturbing works. A detailed management plan will be developed prior to commencement of construction.
Acid Sulfate Soils	Yes	ASS material has been identified at the site and will required treatment and/or management during ground disturbing works.	It is recommended that a detailed ASS management plan be prepared prior to the commencement of any ground disturbing works.

Factor	Potential Constraint To Development	Justification	Potential Management Measures and Further Work Required
Contaminated Sites	Yes	Historical and current land use of the site has included market gardening which may have resulted in some form of contamination through the use of chemicals, pesticides. Additionally, uncontrolled fill has been identified at the site.	To determine the likely status of contamination of the project area, it is recommended that a preliminary site investigation (PSI) is undertaken to assess the presence of contaminants. The PSI would include recommendations for removal and treatment of contaminants if required.
Bushfire Risk	No	The project is not considered to be located within an extreme bush fire risk area.	Bush fire is not considered to be a significant risk to development; however it is recommended that a Bush fire Management Plan is prepared to support the subdivision application.
Vegetation and Flora	No	The project area comprises mostly cleared vegetation, with a small number of remnant trees, primarily introduced species. The remainder of the site is comprised of existing buildings, community centres and sports grounds	Given the lack of native species within the project area and the weedy areas associated with the wetland it is unlikely that a flora and vegetation survey is required.
Fauna	No	The project area is largely devoid of remnant vegetation, having been previously cleared. It is unlikely that any significant habitat exists for native fauna within the project area, based on the desktop assessment.	It is unlikely that significant fauna habitat occurs within the swamp area.

7. FURTHER WORK

This desktop environmental study is intended to identify the general conditions at the site including conditions that may adversely impact residential development. We consider it necessary to conduct further studies to confirm the following:

- nature and extent of ASS material across the site;
- nature and extent of potential contaminants at the site; and
- baseline groundwater monitoring to establish existing groundwater quality.

These further studies would supplement existing reports already prepared for the site.

8. CLOSURE

We draw your attention to Appendix B of this report, "Understanding Your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

Yours Faithfully,

GALT ENVIRONMENTAL PTY LTD

Brad Palmer

Environmental Scientist

O:\Jobs\2017\J1702012 - Parcel Property SI Balcatta\03 Correspondence\J1702012 002 R Rev2.docx

Figures

Legend

Site Boundary

N

0 60 120 180 240 300

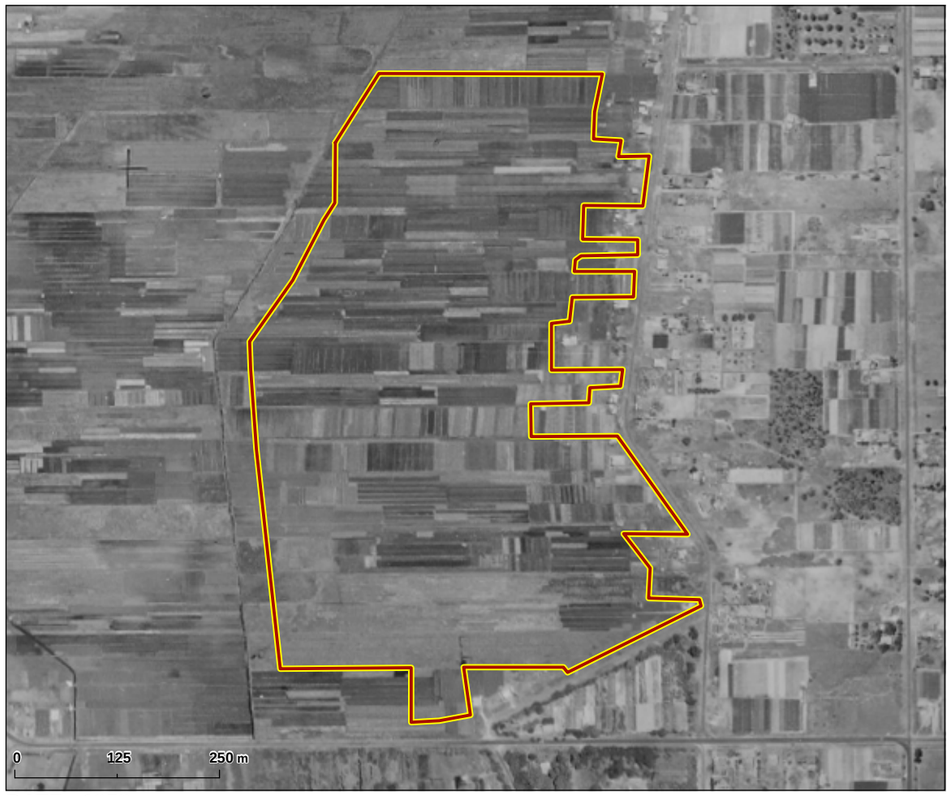
Meters

SCALE	1:4,000	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	03/08/2017	
PROJECTION	GDA 1994 MGA Zone 50	

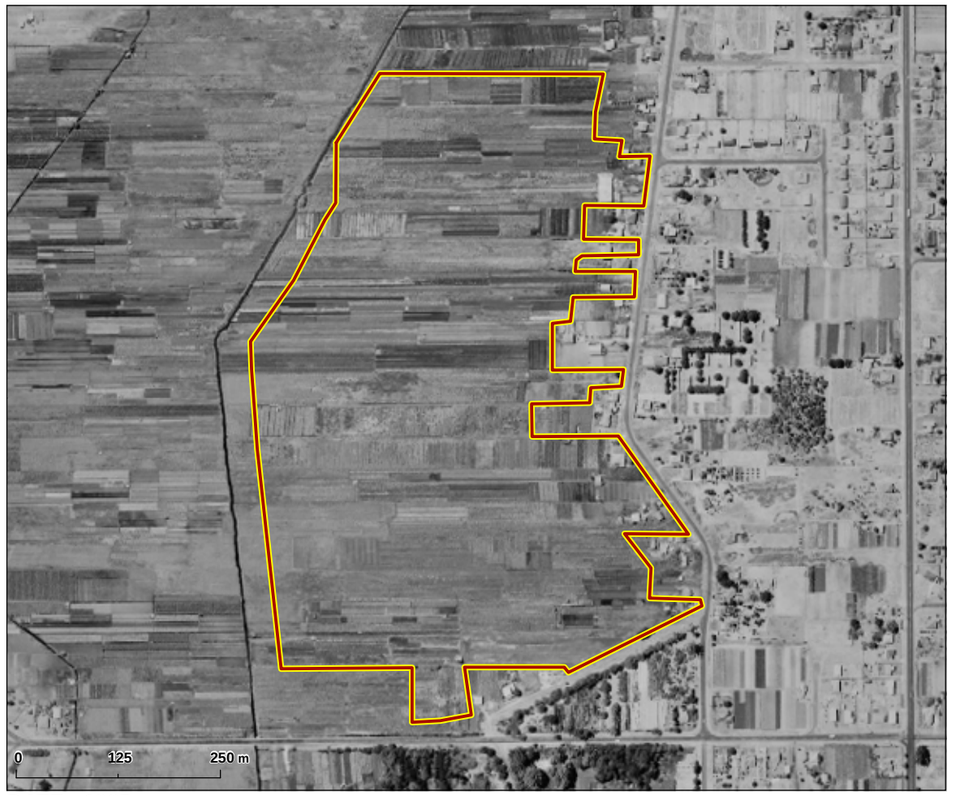
Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

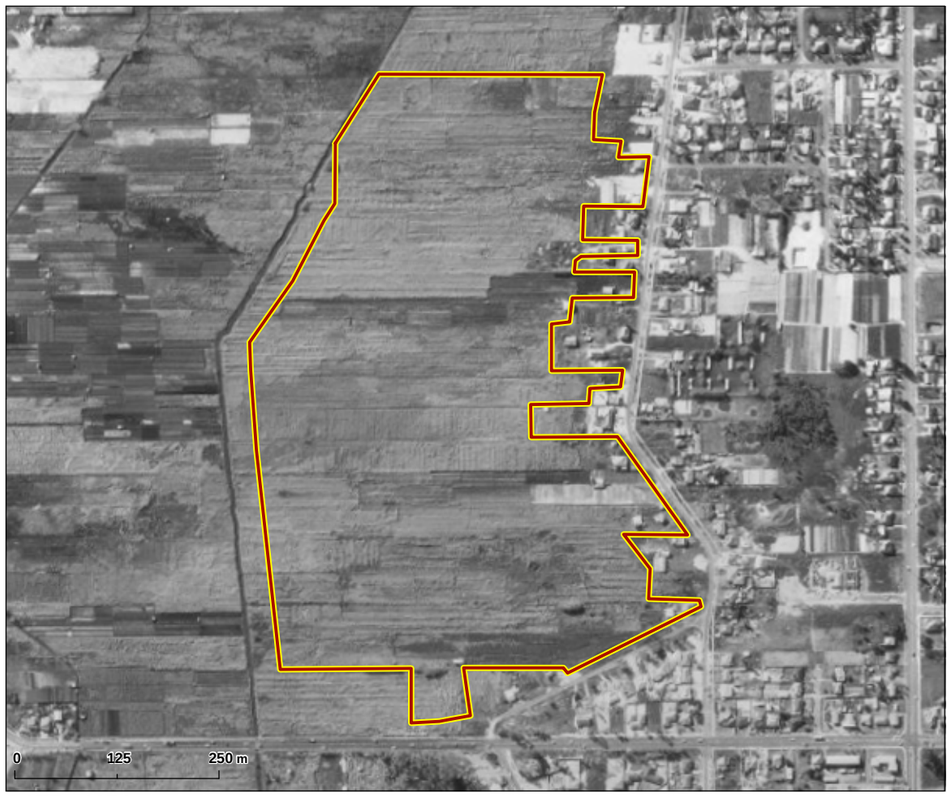
CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA BALCATTA
TITLE	SITE & LOCATION PLAN
Job No	J1702012-EDS
Fig No	FIGURE 1
Rev	**A**



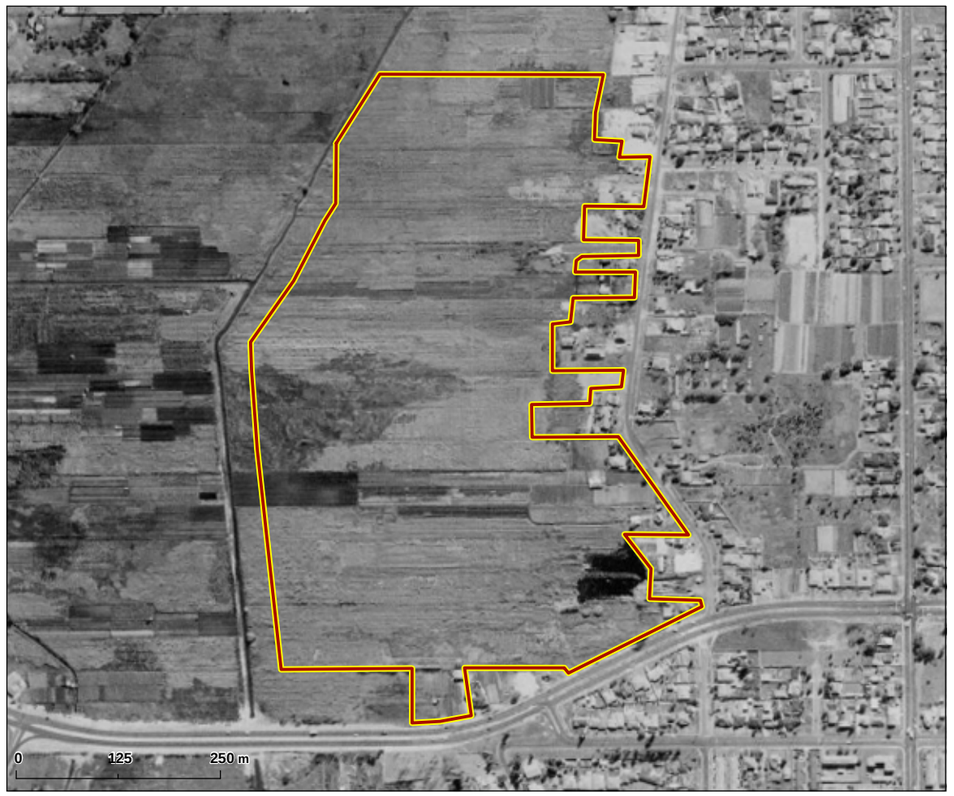
DATE - 1953



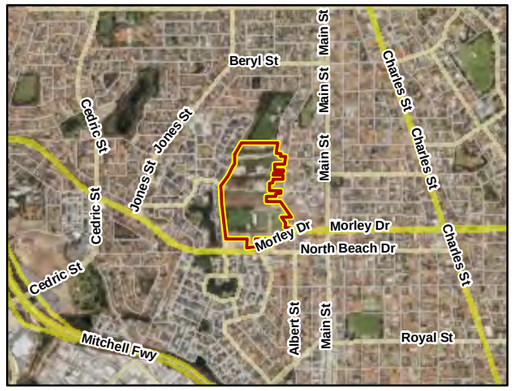
DATE - 1965



DATE - 1974



DATE - 1979



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500 (A3)
DRAWN	DAC
DATE DRAWN	3/08/2017
CHECKED	BP
DATE CHECKED	3/04/2017
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

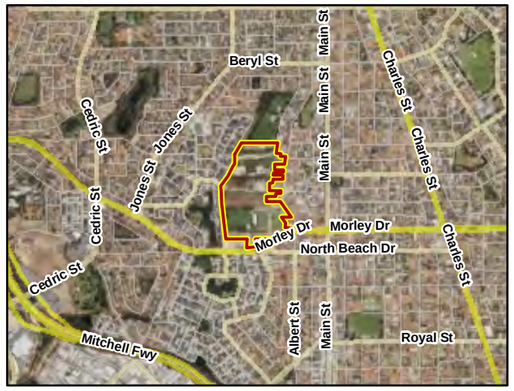
CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (1953 - 1979)
Job No	J1702012-GDS
Fig No	FIGURE 2A
Rev	**A**

DATE - 1981

DATE - 1985

DATE - 1995

DATE - 2000



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (1981 - 2000)

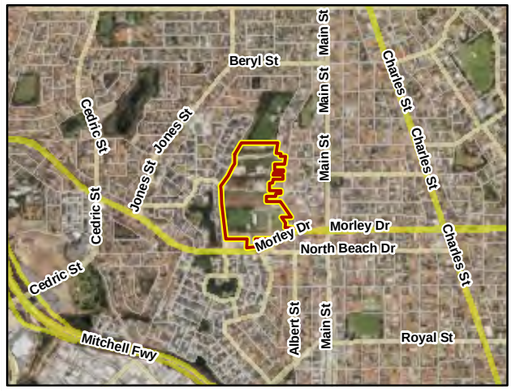
Job No	J1702012-GDS	Fig No FIGURE 2B	Rev **A**

DATE - 2001

DATE - 2002

DATE - 2003

DATE - 2004



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address: U2, 39 Flynn Street, Wembley, WA, 6014

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (2001 - 2004)

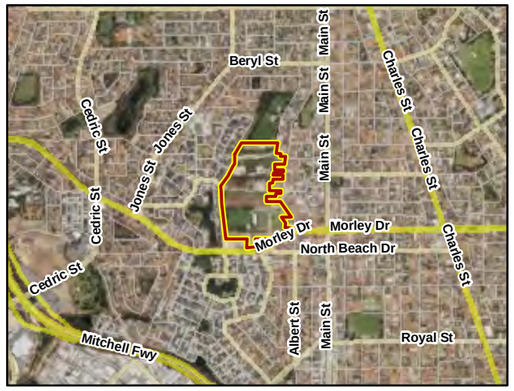
Job No	J1702012-GDS	Fig No FIGURE 2C	Rev **A**

DATE - 2005

DATE - 2006

DATE - 2007

DATE - 2008



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

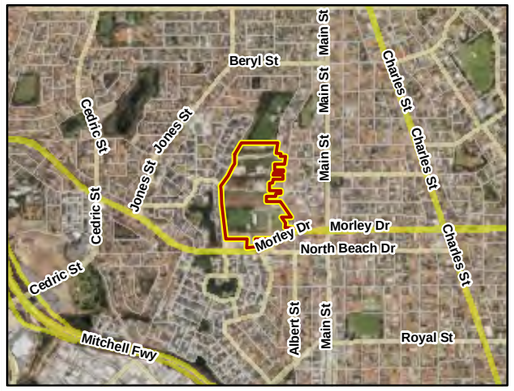
CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (2005 - 2008)
Job No	J1702012-GDS
Fig No	FIGURE 2D
Rev	**A**

DATE - 2009

DATE - 2010

DATE - 2011 SUMMER

DATE - 2011 WINTER



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

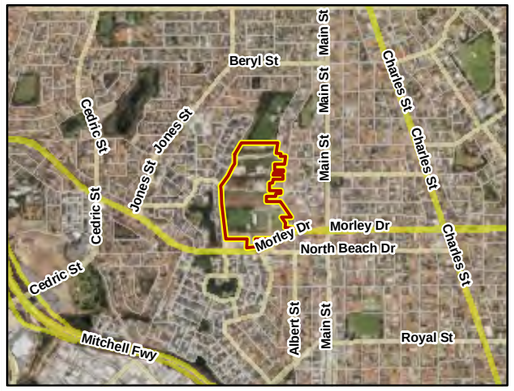
CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (2009 - 2011 WINTER)
Job No	J1702012-GDS
Fig No	FIGURE 2E
Rev	**A**

DATE - 2012 SUMMER

DATE - 2012 WINTER

DATE - 2013 SUMMER

DATE - 2013 WINTER



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (2012 SUMMER - 2013 WINTER)

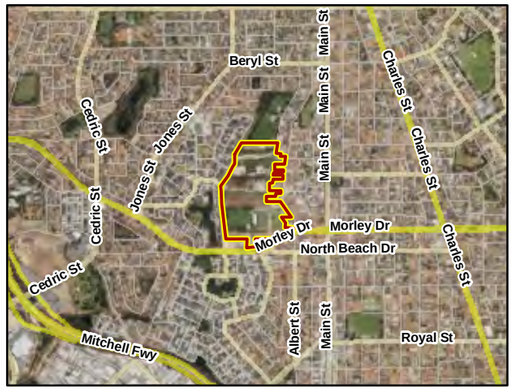
Job No	J1702012-GDS	Fig No FIGURE 2F	Rev **A**

DATE - 2014 SUMMER

DATE - 2014 WINTER

DATE - 2015 SUMMER

DATE - 2015 WINTER



LEGEND

Site Boundary

N

0 110 220 330 440 550

Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (2014 SUMMER - 2015 WINTER)
Job No	J1702012-GDS
Fig No	FIGURE 2G
Rev	**A**

DATE - 2016 SUMMER

DATE - 2016 WINTER

DATE - 2017 SUMMER

LEGEND

Site Boundary

N

0 110 220 330 440 550

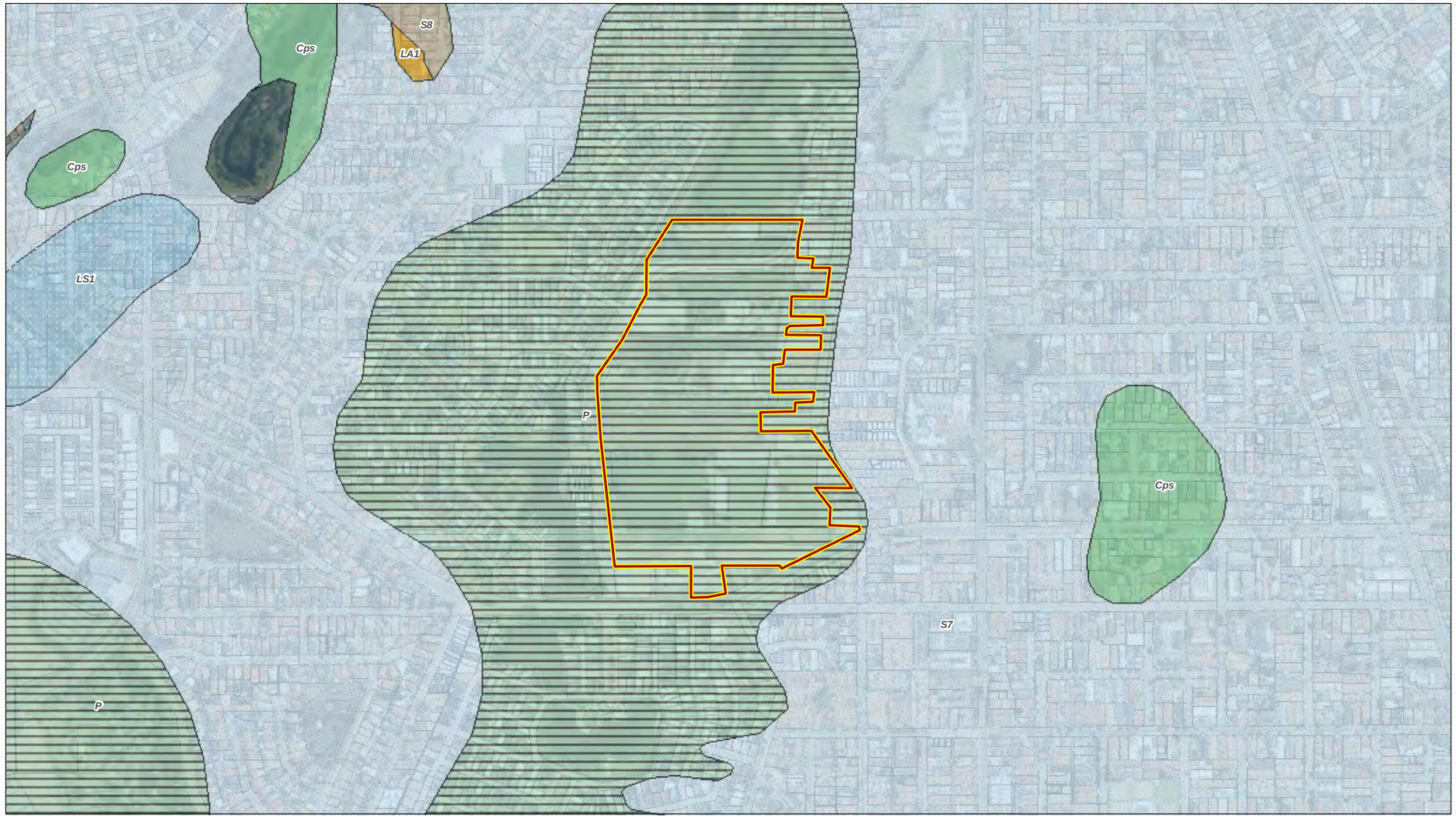
Meters

SCALE	1:7,500	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	3/04/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: U4, 15 Walters Drive
Osborne Park WA
6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	HISTORICAL AERIAL IMAGERY (2016 SUMMER - 2016 WINTER)
Job No	J1702012-GDS
Fig No	FIGURE 2H
Rev	**A**



GEOLOGY MAP

PERTH:20342 CODE, NARRATIVE

- **Cps** Cps: PEATY CLAY - dark grey and black with variable sand content of lacustrine origin [Swamp Deposits (Qhw)]
- **LA1** LA1: LATERITE - massive and cemented, occasionally vesicular, up to c. 4 m in thickness, overlies a zone of mottled and/or pallid clays and saprolite [Laterite (Ql)]
- **LS1** LS1: LIMESTONE - light, yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin [Tamala Limestone (Qtl)]
- **P** P: PEAT - black, clayey in part, saturated fibrous organic soil [Swamp Deposits (Qhw)]
- **S7** S7: SAND - pale and olive yellow, medium to coarse-grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin [Sand Derived from Tamala Limestone (Qts)]
- **S8** S8: SAND - very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted of eolian origin [Bassendean Sand (Qpb)]

GEOLOGY MAP LEGEND

Legend

Site Boundary

N

0 160 320 480 640 800

Meters

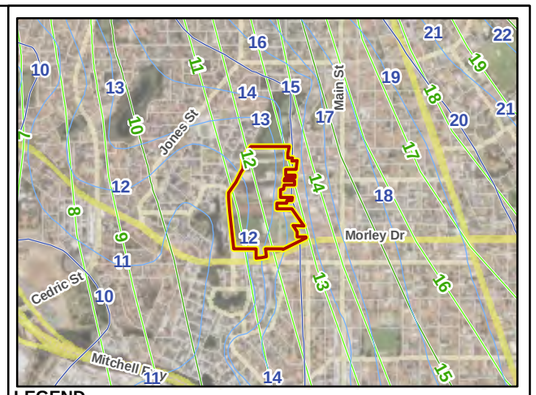
SCALE	1:10,000	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	03/08/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA BALCATTA
TITLE	GEOLOGY

Job No	Fig No	Rev
J1702012-EDS	FIGURE 2	**A**



LEGEND

- Site Boundary

Ground Water Contours (Max)

- 5
- 1

Ground Water Contours (Min)

- 5
- 1

WINSITES

- Ground, Borehole or Well
- Other

0 70 140 210 280 350

Meters

N

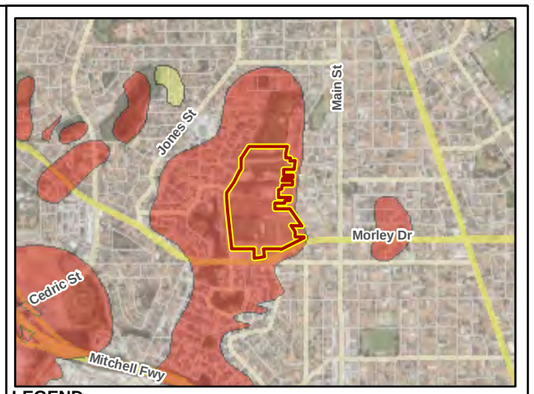
SCALE	1:5,000 (A3)
DRAWN	DAC
DATE DRAWN	3/08/2017
CHECKED	BP
DATE CHECKED	03/08/2017
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA BALCATTA
TITLE	GROUNDWATER
JOB NO	J1702012-EDS
Fig No	FIGURE 4
Rev	**A**

388,000
388,500
389,000
6,472,000
6,471,500
6,471,000



LEGEND

Site Boundary

Acid Sulfate Soil Risk

High to moderate risk

Moderate to low risk

0 70 140 210 280 350

Meters

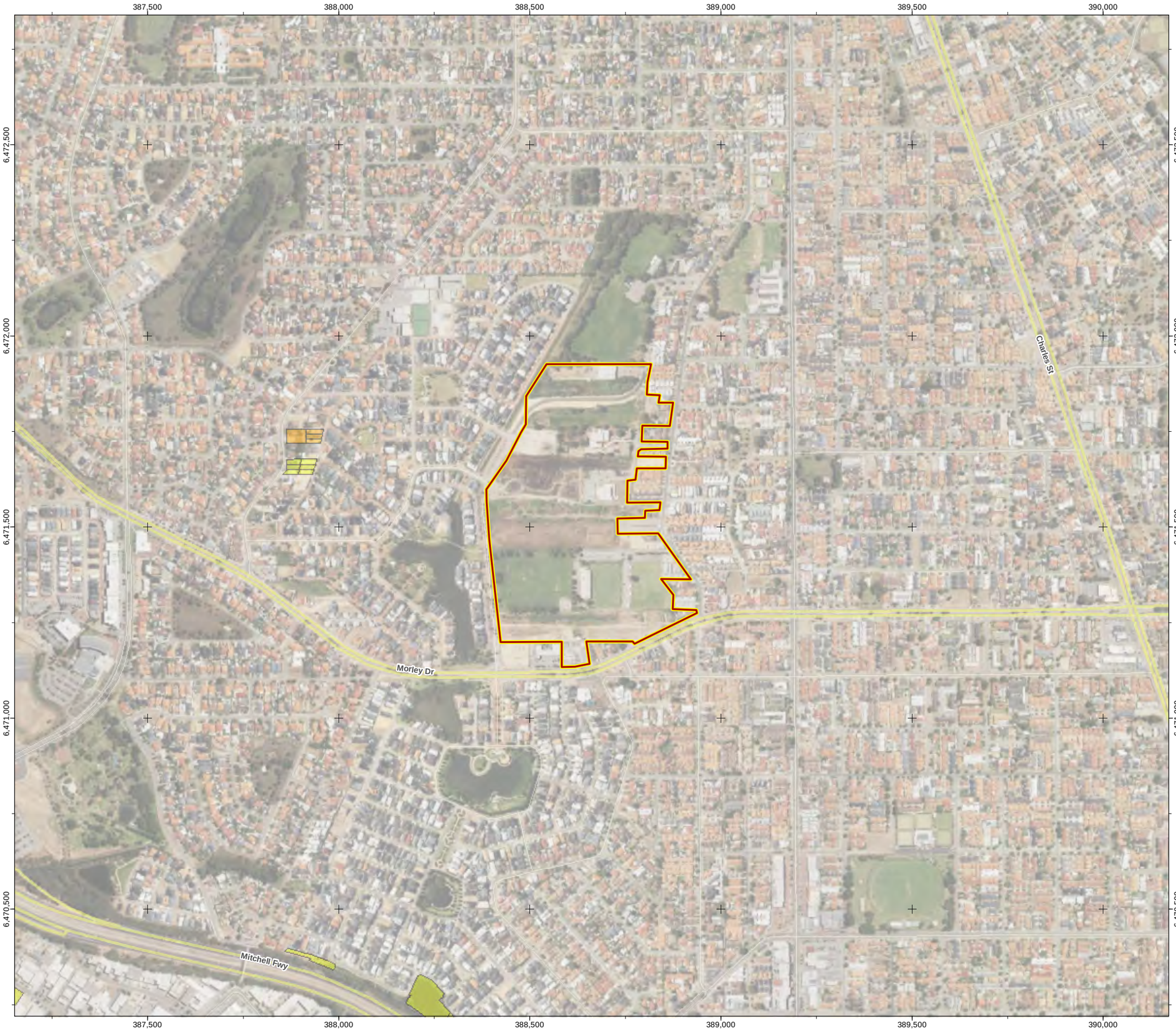
N

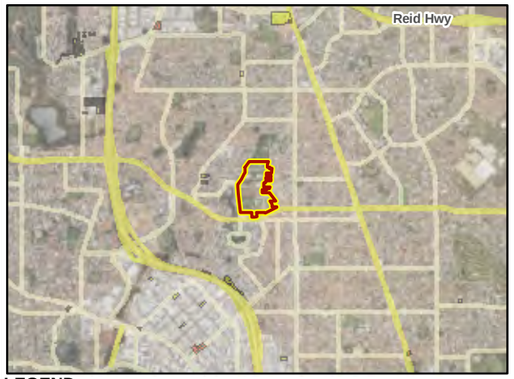
SCALE	1:5,000 (A3)
DRAWN	DAC
DATE DRAWN	3/08/2017
CHECKED	BP
DATE CHECKED	03/08/2017
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	ACID SULFATE SOIL RISK MAPPING
JOB NO	J1702012-EDS
Fig No	FIGURE 5
Rev	**A**





LEGEND

Site Boundary

Contaminated Sites

- Contaminated - remediation required
- Contaminated - restricted use
- Remediated for restricted use

Contaminated sites information is taken from the publicly availably Department of Environment Regulation (DER) Contaminated Sites Database. Only sites classified as 'Contaminated – remediation required', 'Contaminated – restricted use' and 'Remediated – restricted use' are shown. Sites with other classifications under the Contaminated Sites Act 2003 are identified through a basic or detailed summary of records search request though DER.

N

0 150 300 450 600 750

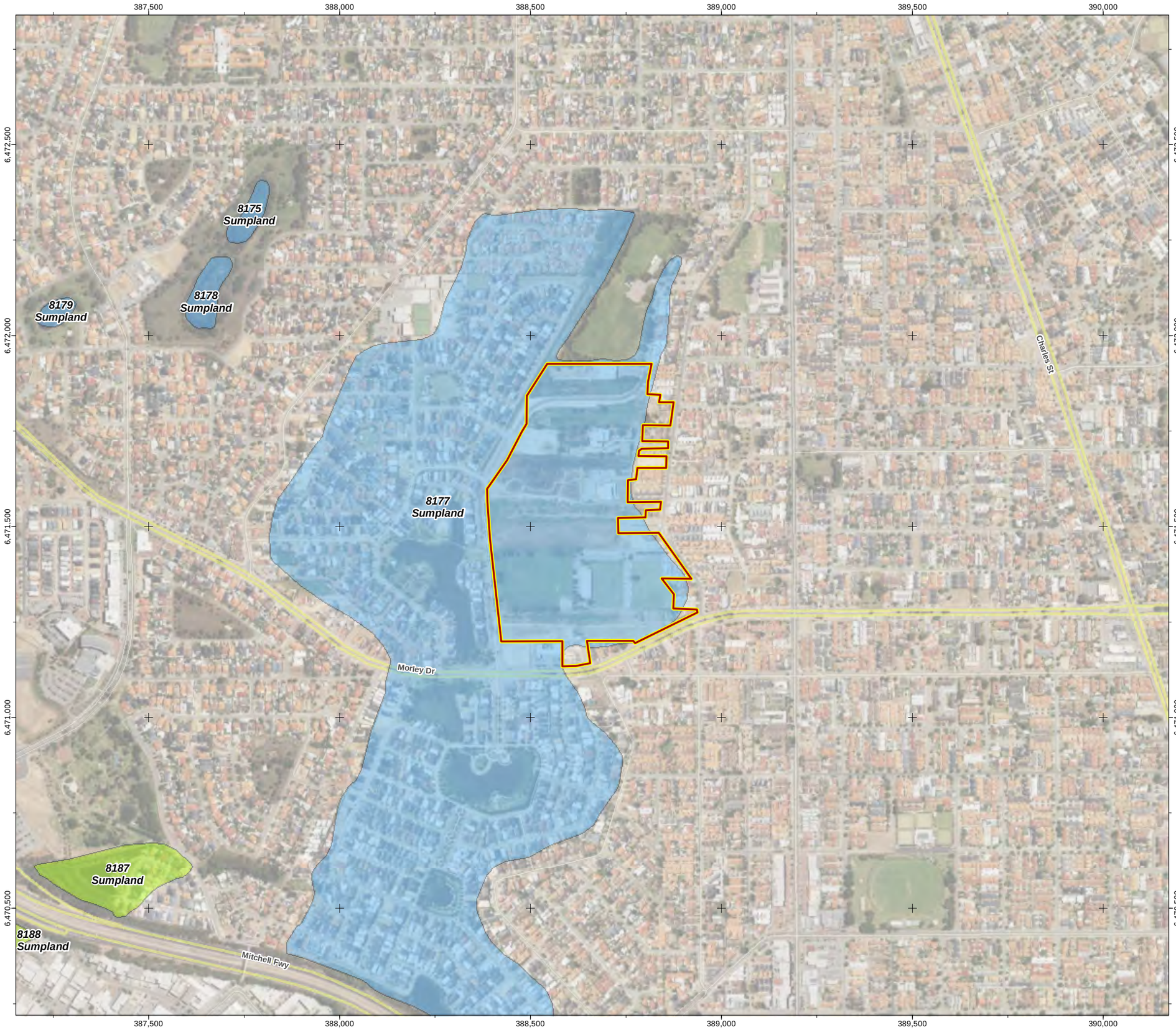
Meters

SCALE	1:10,000 (A3)
DRAWN	DAC
DATE DRAWN	3/08/2017
CHECKED	BP
DATE CHECKED	03/08/2017
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	CONTAMINATED SITES
JOB NO	J1702012-EDS
Fig No	FIGURE 6
Rev	**A**



LEGEND

Site Boundary

Geomorphic Wetlands, Swan Coastal

Multiple Use

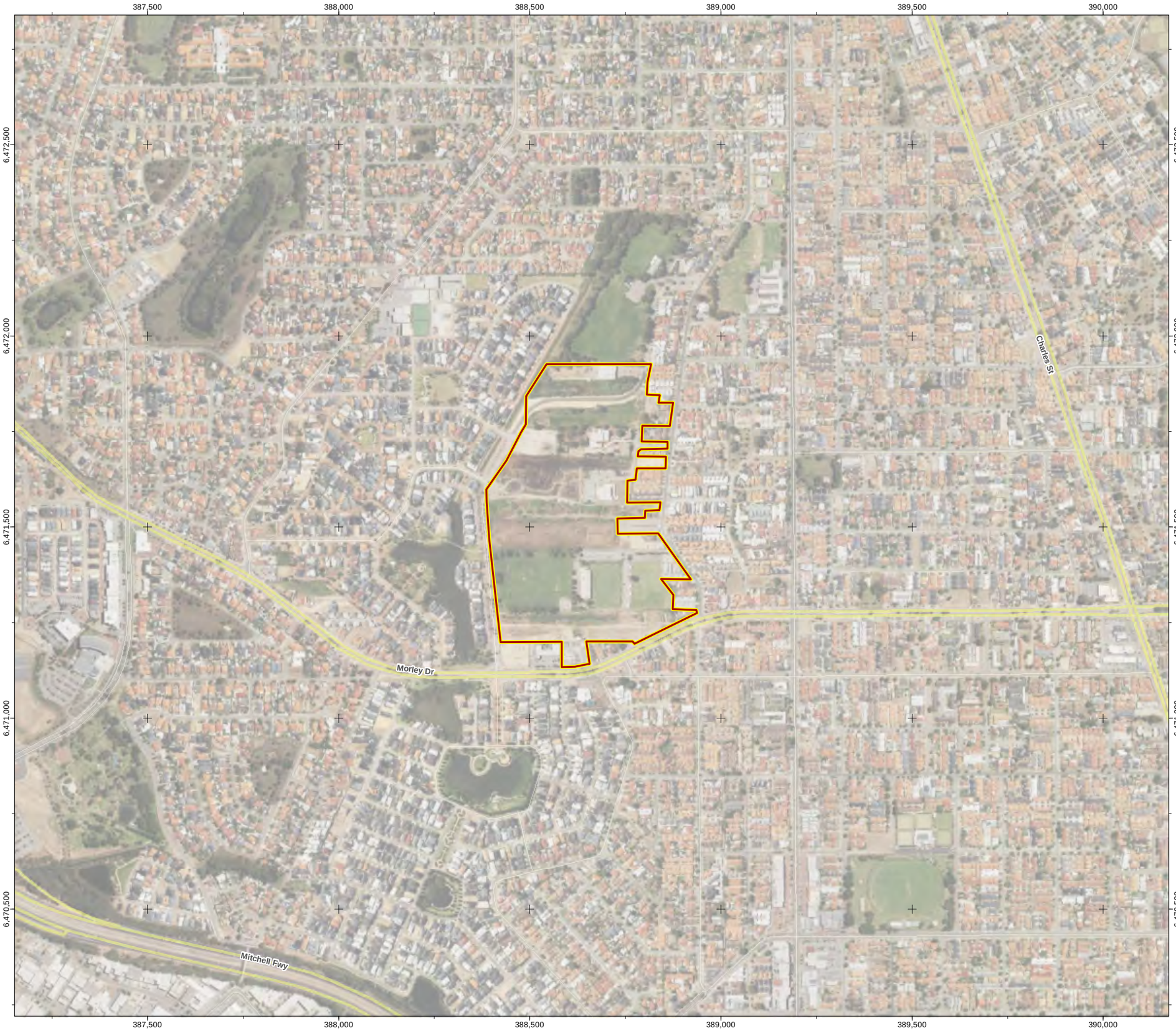
Resource Enhancement

SCALE	1:10,000	(A3)
DRAWN	DAC	
DATE DRAWN	3/08/2017	
CHECKED	BP	
DATE CHECKED	03/08/2017	
PROJECTION	GDA 1994 MGA Zone 50	

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	GEOMORPHIC WETLANDS
JOB NO	J1702012-EDS
Fig No	FIGURE 7
Rev	**A**



LEGEND

Site Boundary

Environmentally Sensitive Areas

Environmentally Sensitive Area

DPAW Managed Land & Waters

0 150 300 450 600 750

Meters

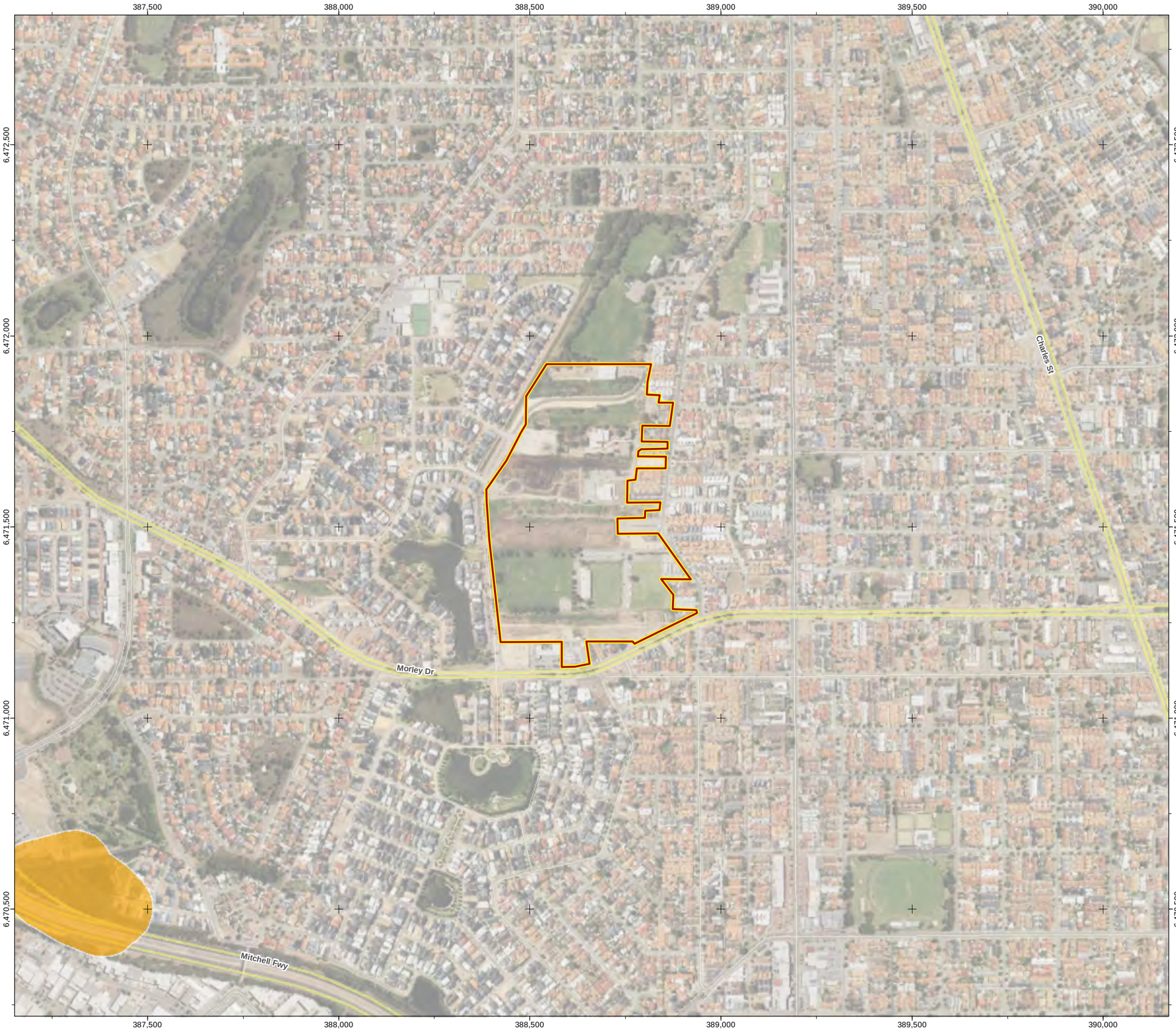
N

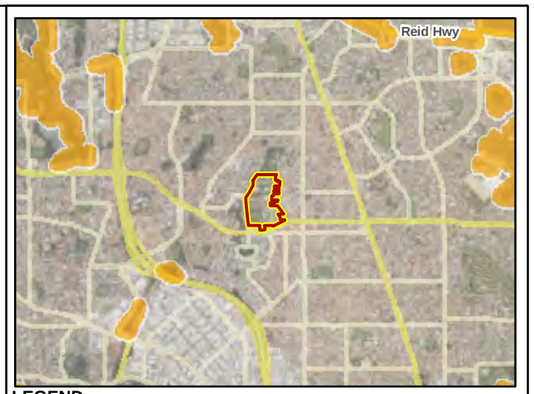
SCALE	1:10,000 (A3)
DRAWN	DAC
DATE DRAWN	3/08/2017
CHECKED	BP
DATE CHECKED	03/08/2017
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	ENVIRONMENTALLY SENSITIVE AREAS
JOB NO	J1702012-EDS
Fig No	FIGURE 8
Rev	**A**





LEGEND

- Site Boundary
- Bush Fire Prone Area

0 150 300 450 600 750

Meters

N

SCALE	1:10,000 (A3)
DRAWN	DAC
DATE DRAWN	3/08/2017
CHECKED	BP
DATE CHECKED	03/08/2017
PROJECTION	GDA 1994 MGA Zone 50

Galt Environmental Pty Ltd
ACN : 161 708 998
Tel : +61 (0)8 6272-0200
Address: Unit 4, 15 Walters Drive
Osborne Park WA 6017

COPYRIGHT © 2017 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT ENVIRONMENTAL PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	**PARCEL PROPERTY**
PROJECT	STRUCTURE PLAN ENVIRONMENTAL ASSESSMENT
LOCATION	PROPOSED ROSELEA EAST STRUCTURE PLAN AREA
TITLE	BUSH FIRE PRONE AREAS
JOB NO	J1702012-EDS
Fig No	FIGURE 9
Rev	**A**

Appendix A: Indicative Subdivision Concept Plan

www.galtenv.com.au
50 Edward Street OSBORNE PARK WA 6017
ABN: 96 520 810 622

LEGEND

- DEVELOPMENT ZONE
- DEVELOPMENT CONTRIBUTION BOUNDARY
- CONTOURS
- EXISTING LOT NUMBERS
- EXISTING BOUNDARIES
- PROPOSED BOUNDARIES
- INDICATIVE LAYOUT
- EASEMENT
- LOCAL CENTRE
- COMMUNITY FACILITY
- RESIDENTIAL R30
- RESIDENTIAL R40-60
- RESIDENTIAL R60-80
- PUBLIC OPEN SPACE

INDICATIVE SUBDIVISION CONCEPT

ROSELEA EAST - STRUCTURE PLAN AREA

BALCATTA

SCALE @ A3: 1:2500

0 62.5 M

ROWEGROUP DESIGN
P: 9221 1991 W: www.rowegroup.com.au E: info@rowegroup.com.au

REF: 8686-CON-02-A DATE: 13.7.2017 DRAWN: WC

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\A-CAD\8686_CON02A_20170713 STIRLING (INDICATIVE SUBDIVISION CONCEPT).DWG
William Clements

Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

Appendix B: Understanding Your Report

www.galtenv.com.au
50 Edward Street OSBORNE PARK WA 6017
ABN: 96 520 810 622

UNDERSTANDING YOUR REPORT

GALT FORM PMP29 Rev1

1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

APPENDIX 4

CHUNG WAH ASSOCIATION SUBMISSION

ROWE GROUP DESIGN

The Chung Wah Association Inc.

Admin Office: 128 James Street, Northbridge WA 6003, Australia
Mailing Address: P O Box 73, Northbridge WA 6865, Australia
Tel: (61-8) 9328 8657 Fax: (61-8) 9227 5694
Email: chungwah@chungwah.org.au Website: www.chungwah.org.au

ABN 31 621 821 100

founded in 1909
100 Years
中華會館
Chung Wah Association

22nd February 2018

Mr Jeremy Cordina
General Manager - Land Development
Parcel Property
Ground Floor, 131 Hasler Road
Osborne Park WA 6017

Dear Jeremy

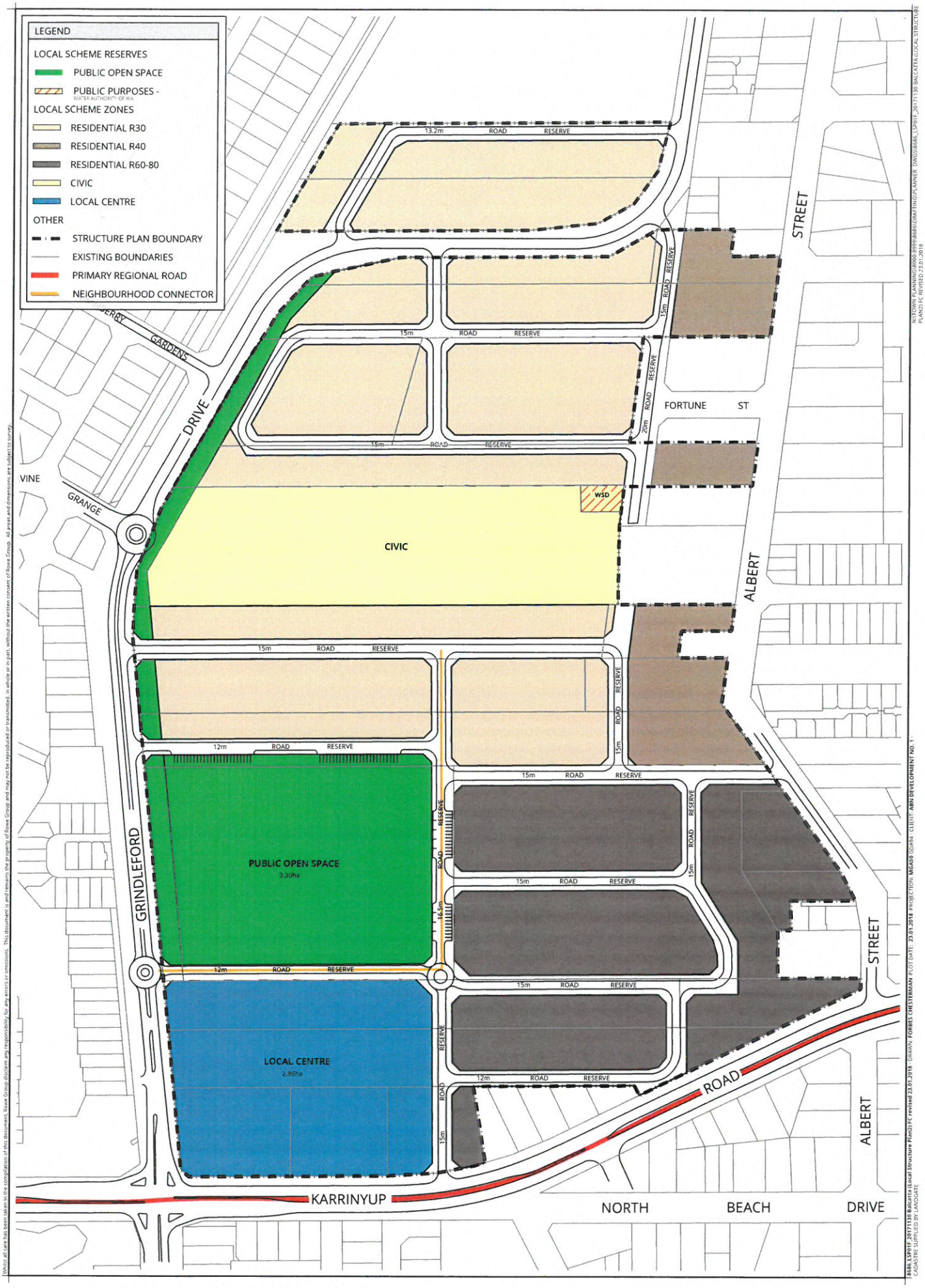
On behalf of the owners of lot 63 Grindleford Drive (Chung Wah Association), I would like to confirm that we support the Local Structure Plan prepared by Parcel Property and specifically the community use for the Chung Wah site.

I would also like to confirm that we do not support a public road through our site.

Thank you.

Kind Regards

Ding Shao Ping
President
Chung Wah Association



Whilst all care has been taken in the compilation of this document, Rowe Group disclaims any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8600-8699\8686\DRAFTING\PLANNER DWGS\8686_LSP01_20171130 BALCATTA LOCAL STRUCTURE PLAN21 FC REVISED 23.01.2018

8686_LSP01_20171130 Balcatta Local Structure Plan21 FC revised 23.01.2018 | DRAWN: FORBES CHESTERMAN | PLOT DATE: 23.01.2018 | PROJECTION: MGA50 | DATUM: | CLIENT: ABN DEVELOPMENT NO. 1
CADASTRE SUPPLIED BY LANDGATE

ROWEGROUP DESIGN
P: 9221 1991 W: www.rowegroup.com.au

0 62.5 M
SCALE @ A3: 1:2500

8686-LSP-01-F

LOCAL STRUCTURE PLAN

ROSELEA EAST, BALCATTA

APPENDIX 5

MACEDONIAN CLUB SUBMISSION

ROWE GROUP DESIGN

Macedonian Community of W.A. Inc.

(Est 1942)

Macedonian Orthodox Church of St Nikola

W.A. Macedonian Club Inc.

Stirling Lions Soccer Club

PO Box 12, North Perth WA 6906 Cnr Albert St and Macedonia Place North Perth Western Australia
Macedonia Park 273 Albert Street Balcatta WA 6021
Tel 08 9328 7852 email: admin@macedoniawa.com.au web: www.macedoniawa.com.au

City of Stirling Civic Place Stirling WA 6021 21 February 2018

LOCAL STRUCTURE PLAN – ROSALIE EAST

The Macedonian Community is the owner of Lot 153 Number 273 (3.69ha) within the Local Structure Plan of Rosalie East.
We are in receipt of plans and information pertaining to the East Rosalie Local Structure Plan.
The Local Structure Plan as prepared by The Rowe Group on behalf of Parcel Property and was done in consultation and discussions with the Macedonian Community.
The Local Structure Plan is one the Community supports and believes it represents good planning outcomes keeping in mind the requirements of Government and WAPC in fill targets and also the required public open space requirements have been met and as identified on Lot 141.
Furthermore, it is our view that the Local Structure Plan shows a good balance of Residential densities, moving from higher densities located closer to Karrinyup Road (access to transport links and local centre facilities) to lesser densities moving towards and adjacent to the existing suburb development and sub divisions.
We can confirm that the Macedonian Community is reviewing its requirements for the private facility it has at Balcatta, which has been utilised over the past years as a sporting complex.
To that end, the East Rosalie Local Structure Plan has been designed in a way that allows the use of the current facility by the Macedonian Community (albeit for a timeframe yet to be determined) and most importantly, allowing until such time it chooses to redevelop the land.

We conclude by again confirming that the Macedonian Community supports the East Rosalie Local Structure Plan as prepared by The Rowe Group and presented by Parcel Property.

Yours Sincerely

George Naoum
Management Committee – Building and Projects
M: 0411 691692
Email: george@ecorp.net.au

Trayn Andonovski
Management Committee - President

APPENDIX 6

SICILIAN CLUB SUBMISSION

ROWE
GROUP
DESIGN

IQ
Property & Projects

5th March 2018

Parcel Property Group
131 Hasler Road
Osborne Park WA 6017

Attention: **Jeremy Cordina, General Manager Land Development.**

RE: Sicilian Association Perth, 1 Sicilia Place Balcatta WA &
Proposed East Roselea Structure Plan.

I.Q. Property & Projects (IQPP) is an authorized consultant of the Sicilian Association in Perth and supports the proposed Roselea East Structure Plan, with some amendments noted in this letter, which will be lodged with the City of Stirling in March 2018 (appendices 1). IQPP has met with the Rowe Group. The RESP have been clearly explained and other than some minor changes to the proposal, the Sicilian Association supports the plan when such changes have been adopted.

The Sicilian Association is the owner of the land at 1 Sicilia Place Balcatta WA which is within the RESP area. The property is in the area which is generally bound by Grindleford Drive, Karrinyup Road and Albert Street in Balcatta.

Sicilian Association of WA Inc.	
Address	1 Sicilia Place Balcatta WA 6021
Lot	51
Plan	013824
Volume	1854
Folio	918
Area	13,886 square metres
LGA	City of Stirling
Zoned	LPS3 – Development Zone
Use	Club - Sicilian Association of WA Inc.

Commencing its association in 1972, in 2018 the club will celebrate its 46th year of service to the community and other interested participants in the associations activity. The Sicilian Association property which is used as a community facility, constructed the club and reception centre in 1986, to serve members of the Sicilian community. It is a place where the Australian Sicilians and other Italians can gather for events and cultural gatherings.

The association presently resides in an area with a variety of existing land uses, including residential development along Albert Street, other community-based groups including the Chung Wah and Macedonian Club, sporting clubs and community recreational open space.

The proposed RESP will guide future land use and development over the subject site and provide a framework for more detailed planning and future uses. This structure plan proposes to encourage the development of the land for a mix of residential, civic use and commercial land uses in a manner that interacts appropriately with the existing urban environment in this locality.

The Sicilian Association has been a long term owner occupier of the property and the current building was constructed for its community by the membership. The and use of the property is not envisaged to change for a considerable period. Since commencement of the associations work, there is no doubt that the urban front has encroached on the quiet and secluded area in Balcatta. That urban front is welcomed by the Sicilian Association, but it is not yet prepared to change its use or occupancy of the site. The activity of the association is very well supported and the central location to a large number of its membership is important to the associations ongoing viability. The current office holders within the committee understand that this may not always be the thoughts of future leaders of the Sicilian Association and it is possible that the land may be used for other purposes in years to come.

The RESP provides for a residential zoning on the Sicilian Association land. A residential use of the land is most likely to provide the future decision makers with the greatest flexibility and the highest and best financial outcome. A residential zoning also provides for the potential future plan of the Sicilian Association to develop the property themselves or develop retirement living units for its membership. The RESP proposal is also supported because it preserves the land value and provides the Sicilian Association with flexible outcomes in the future.

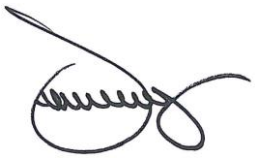
Conclusion.

The Sicilian Association committee supports the RESP as proposed by the Rowe Group and Parcel Property Group with the following amendments as reflected in the attached plan:

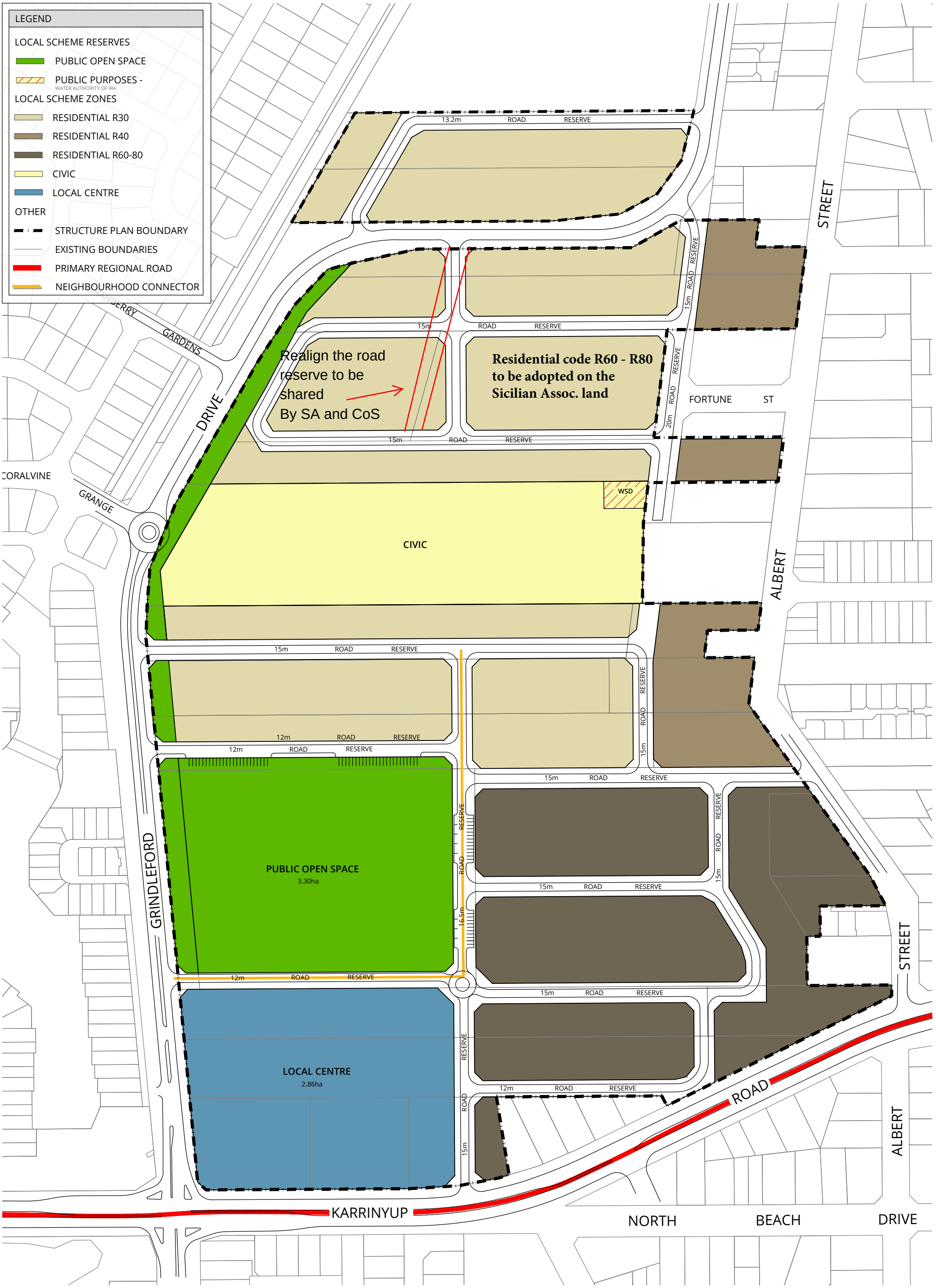
1. That no proposed use or approved change of use in the RESP impacts on the current use or the value of the property owned and occupied by the Sicilian Association.
2. The Sicilian Association land be coded R60 – R80 to permit the use of the land in the future for multiple dwellings; and

3. The future use of the land to include the opportunity for retirement living and aged care.
4. The proposed road reserve at the rear of the Sicilian Association be relocated in the plan to sit on the boundary between associations Lot 51 and Lot 50 and the land allocated for the road reserve be equally shared with the City of Stirling.

Yours Sincerely,



Nick Di Lello
Director & Licensee
Mobile: 0422 230 230
Email: nick.dilello@iqproperty.net.au



Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8000-8999\8686\DRAFTING\DELIVERABLES-DATA OUT\8686_LSP01G_20180130 BALCATTA (LOCAL STRUCTURE PLAN- FC)

8686_LSP01G_20180130 Balcatta (Local Structure Plan- FC) - DRAWN: **WILLIAM CLEMENTS** - PLOT DATE: **2018.01.30** - PROJECTION: **MGA50** GDA94 - CLIENT: **ABN DEVELOPMENT NO. 1** - CADASTRE SUPPLIED BY LANDGATE

ROWEGROUP DESIGN
P: 9221 1991 W: www.rowegroup.com.au

0 62.5 M
SCALE @ A3: 1:2500

8686-LSP-01-G

NORTH

LOCAL STRUCTURE PLAN

ROSELEA EAST, BALCATTA

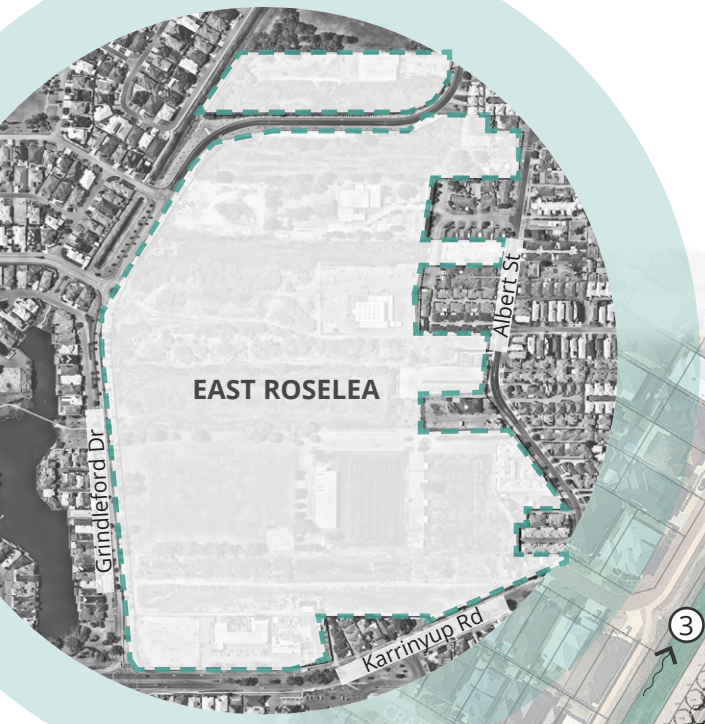
APPENDIX 7

LANDSCAPE MASTERPLAN

ROWE
GROUP
DESIGN

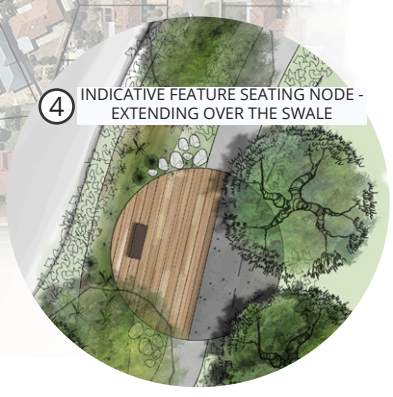
EAST ROSELEA, BALCATTA

LANDSCAPE MASTER PLAN



Note:
- Road reserve boundary, existing road and existing trees to be confirmed with additional feature survey
- POS Design subject to water allocation

15m



Legend

1. Public Open Space / Playing Fields @ 3.40ha
2. Proposed Linear Drainage Swale POS along Grindleford Drive (swale, potential for cantilevered feature seating and exercise nodes, where practical)
3. Existing Water Corporation Drain
4. Feature seating nodes
5. Chung Wah Site: Autumn Centre and Community Facility with short stay accomodation - *subject to further approval*
6. Public Purpose Reserve - Water Authority of WA
7. Public Open Spaces
8. Inundation area

A A Typical Section - refer to page 2 & 3

Existing trees - retain where possible in detailed design

Indicative feature seating node - extending over swale

Indicative exercise node location - linear exercise trail

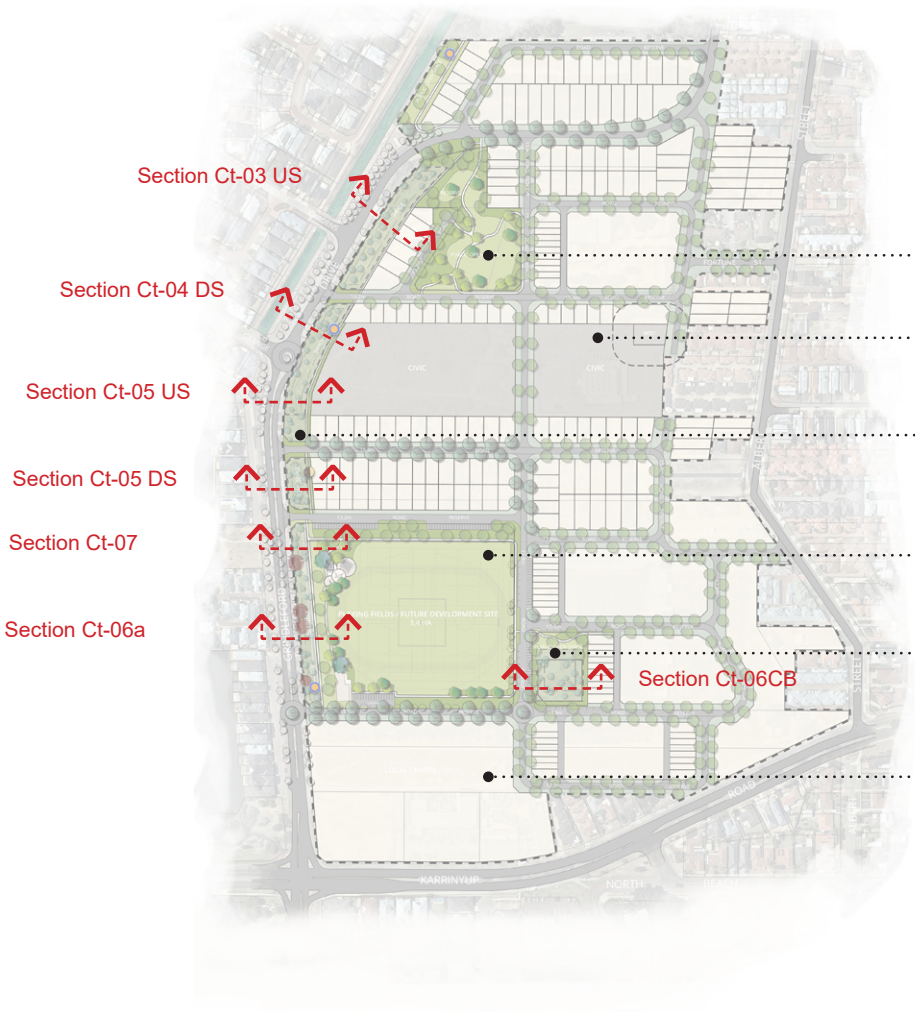
LD TOTAL
LEADERS IN LANDSCAPING
172 BURSWOOD ROAD, BURSWOOD, WA, 6100
T +61 8 6436 1111
F +61 8 9367 2034

EAST ROSELEA, BALCATTA
LOCAL STRUCTURE PLAN

20TH JANUARY 2021 **REV I**

EAST ROSELEA, BALCATTA

LANDSCAPE MASTER PLAN



Proposed POS
with shelter and kick-about area

Chung Wah Site
- subject to further approval

Proposed Linear Drainage Swale POS
(swale, potential for cantilevered feature seating and exercise nodes, where practical)

Proposed POS
with playing fields and playground area

Proposed POS
with drainage basin

Proposed Local Centre

Note:
- Road reserve boundary, existing road and existing trees to be confirmed with additional feature survey
- POS Design subject to water allocation

Key Plan NTS

Proposed Planting Selection to swale

Trees:
Eucalyptus rudis
Melaleuca rhaphiophylla
Melaleuca preissiana
Banksia littoralis

Shrubs:
Melaleuca lateritia
Melaleuca viminea
Hakea varia
Hypocalymma angustifolium
Taxandria linearifolia
Euchilopsis linearis
Eremaea pauciflora
Anigozanthos flavidus

Herbs:
Dampiera linearis
Dianella revoluta
Patersonia occidentalis

Rushes and sedges:
Ficinia nodosa
Juncus krausii
Baumea juncea
Meeboldina roycei

EAST ROSELEA, BALCATTA

LANDSCAPE MASTER PLAN

Key Plan NTS

Legend

- 1a Proposed feature shelter node
- 1b Proposed Playground
- 1c Indicative location of Club house
- 1d Indicative car park/ parking bays
- 1e Soccer field
- 1f 400mm running track
- 1g AFL oval 165x135m
- 1h Rugby field
- 1i Proposed garden beds (organic pattern planting with native trees and concrete kerb edging)
- 1j Proposed concrete footpath
- 1k Proposed drainage swale and existing trees to remain where possible
- 1l Proposed exercise node

Note:
- Road reserve boundary, existing road and existing trees to be confirmed with additional feature survey
- POS Design subject to water allocation

Proposed feature shelter node

Retained vegetation

Themed play area

Playing fields

Proposed feature planting

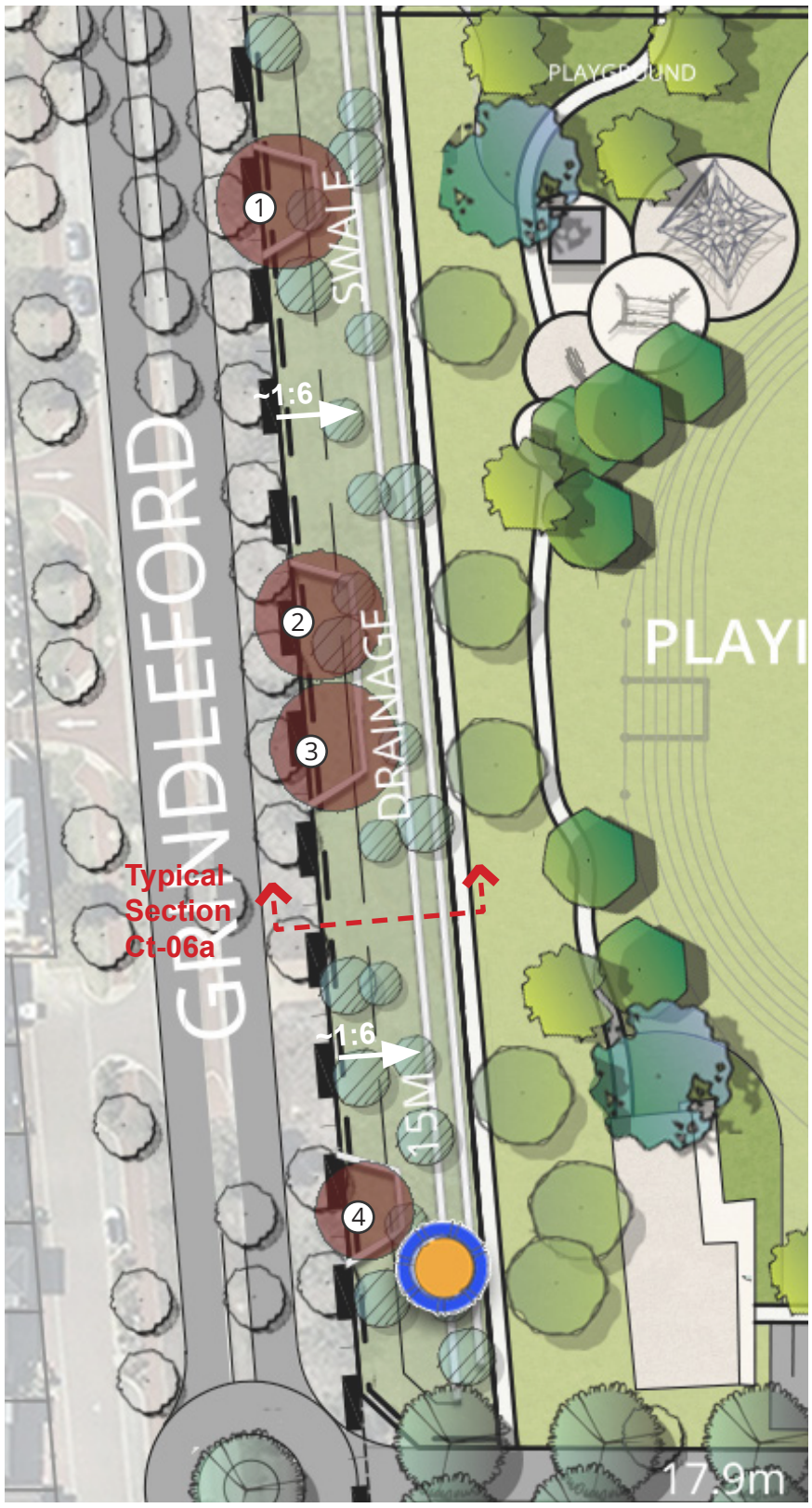
Character Images

LD TOTAL
LEADERS IN LANDSCAPING
172 BURSWOOD ROAD,
BURSWOOD, WA, 6100
T +61 8 6436 1111
F +61 8 9367 2034

EAST ROSELEA, BALCATTA

LANDSCAPE MASTER PLAN

Existing tree from survey and base plan

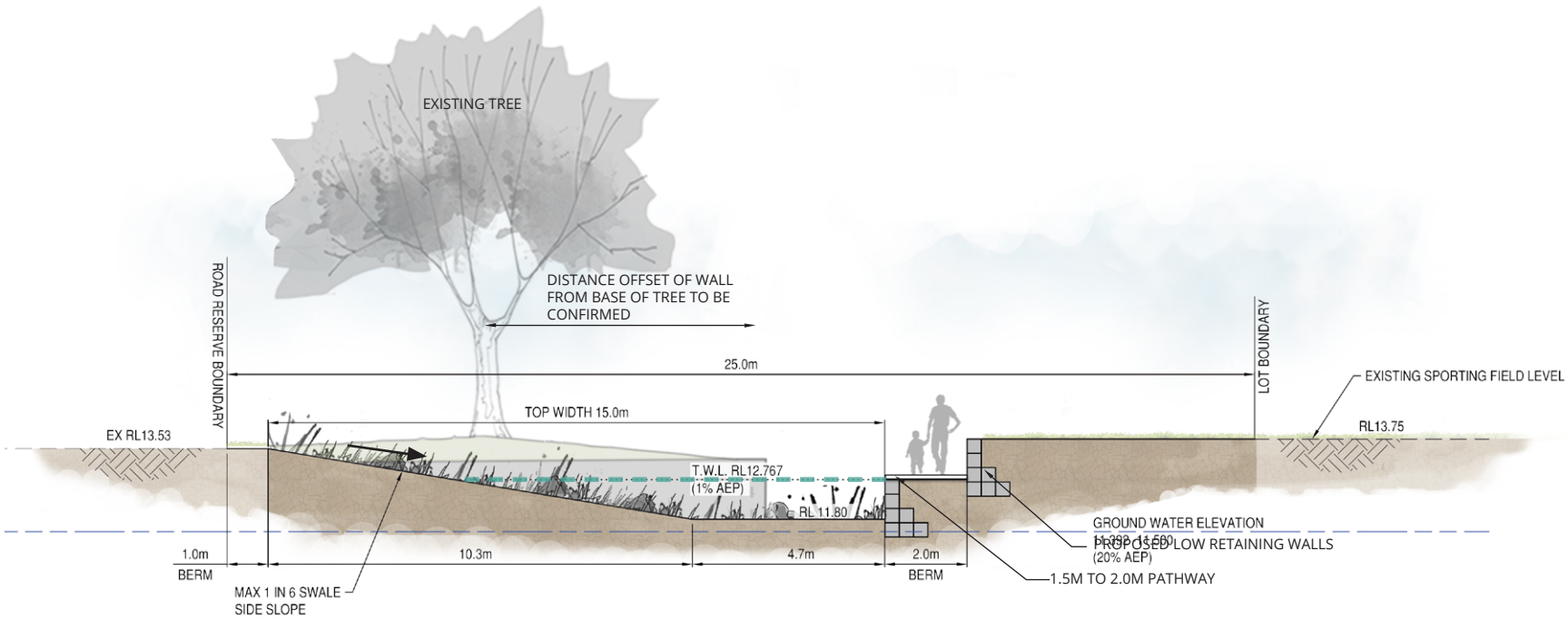


Key Plan - Grindleford Swale NTS

All species identified

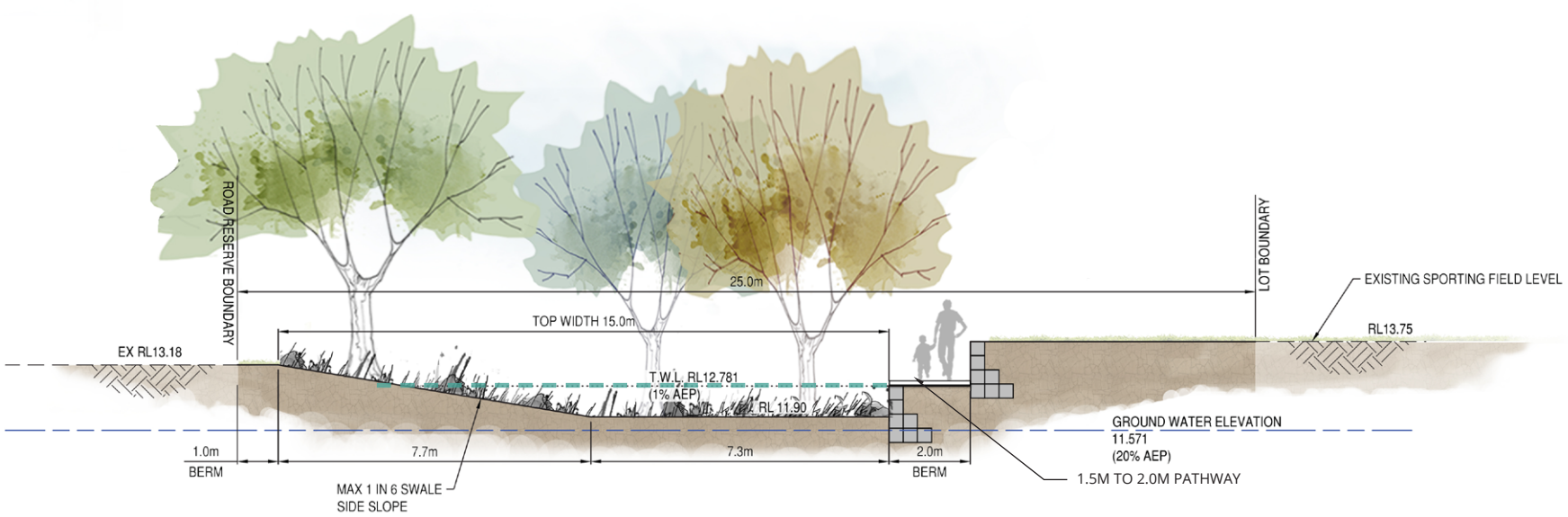
1. *Eucalyptus gradis*
2. *Eucalyptus grandis*
3. *Eucalyptus grandis*
4. *Corymbia ficifolia*

Panoramic of existing trees to remain

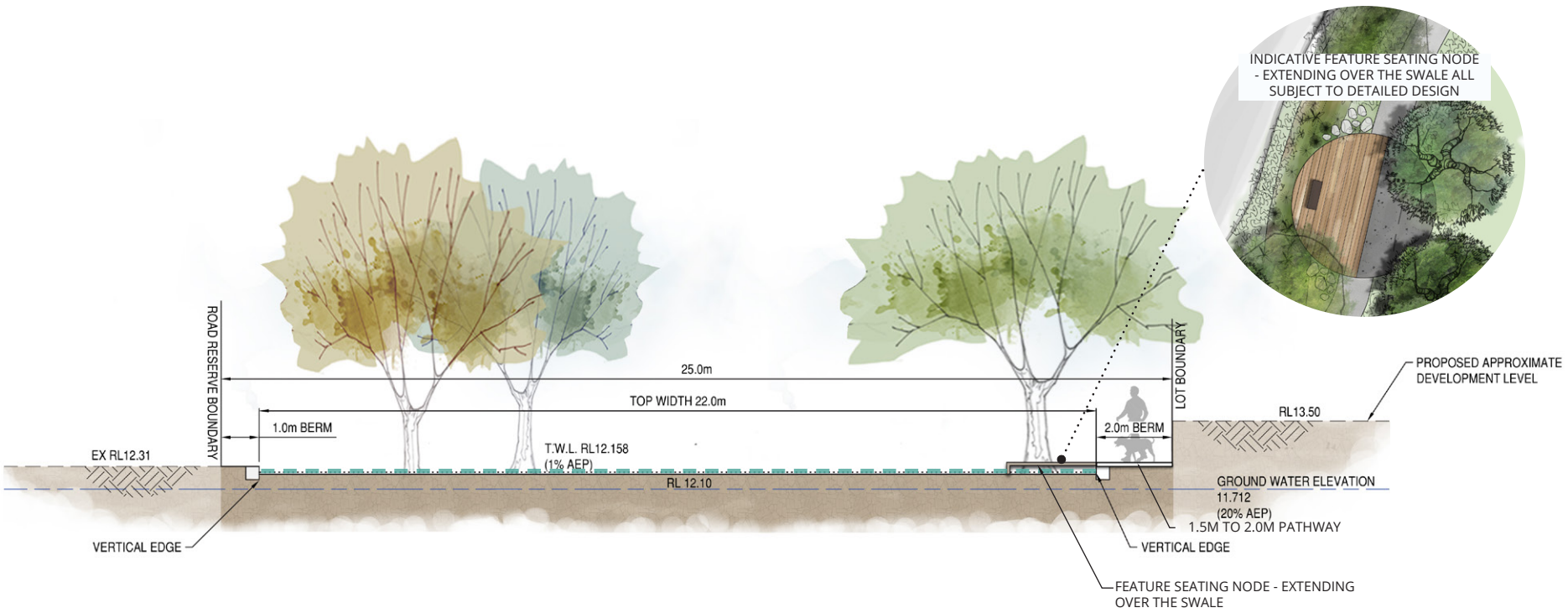


Typical Section Ct-06a - Low Walls to Existing Retain Tree NTS

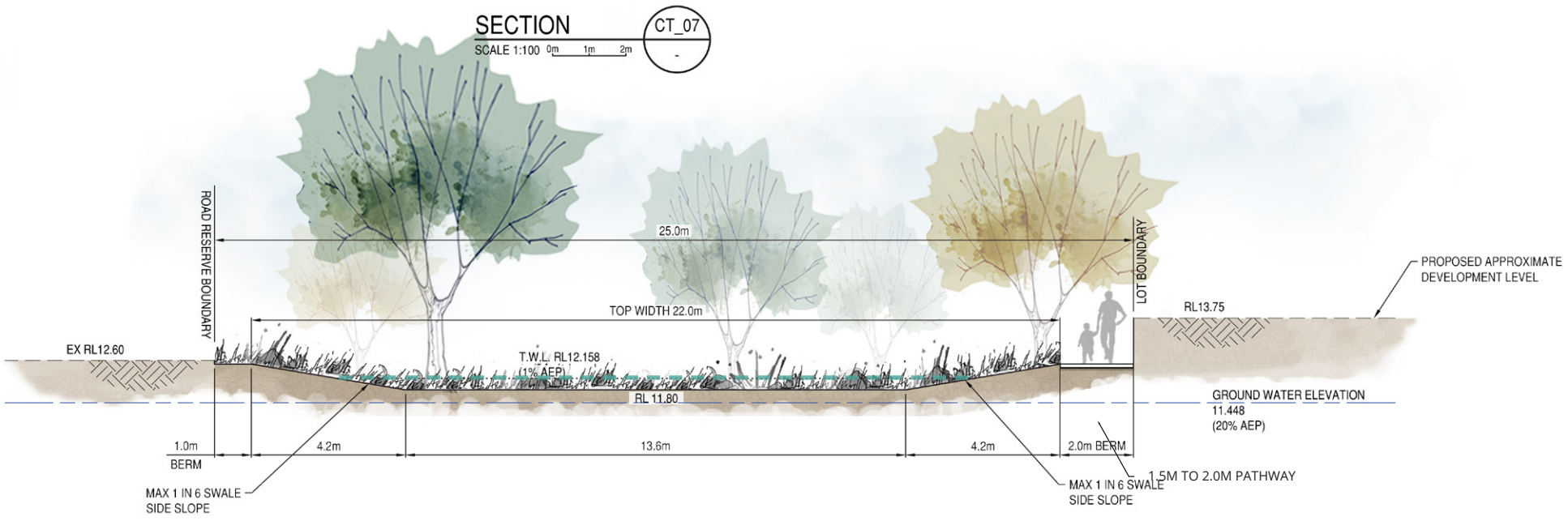
Note:
All trees to remain where possible and low retaining walls are proposed to retain levels around base of tree and surrounding area. The walls around the trees shown indicatively and will be offset as far as possible to tree base (trunk) into swale area based on further advice from Arborists.
Wall/ vertical edges specification and swale volume/shape to be reviewed and confirmed in the detailed design phase (noting 15m wide swale excluding berms is achieved, and 1:4/1:6 slope to be maintained).



Section Ct-07

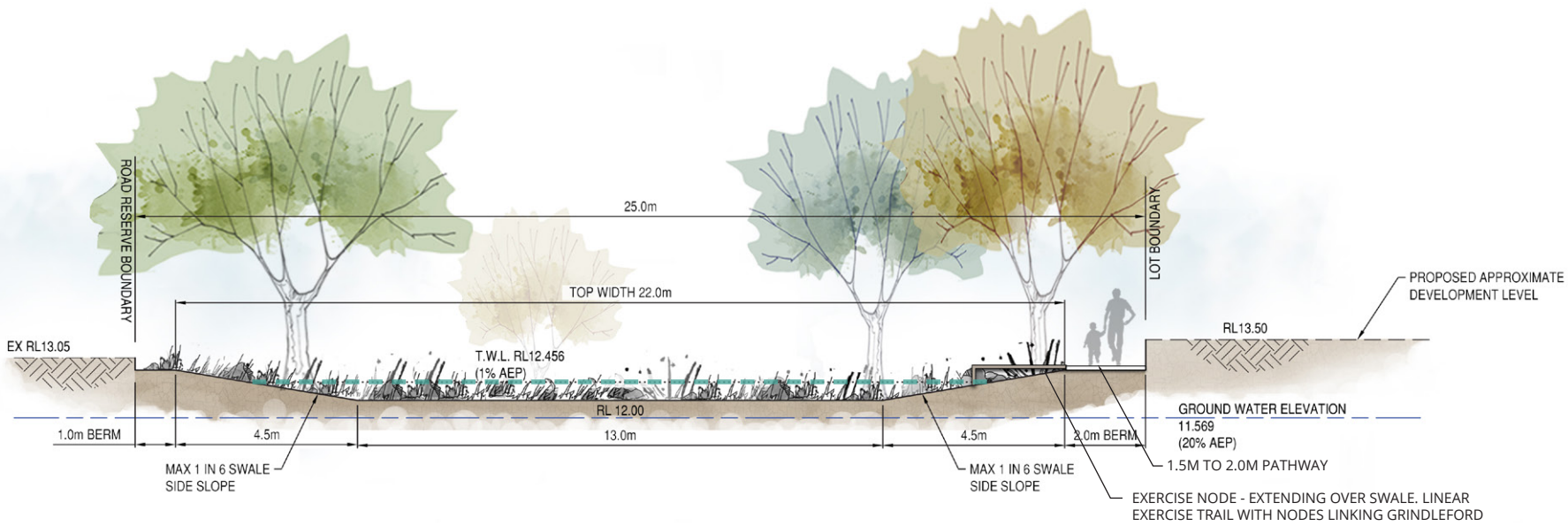


Section Ct-05 DS

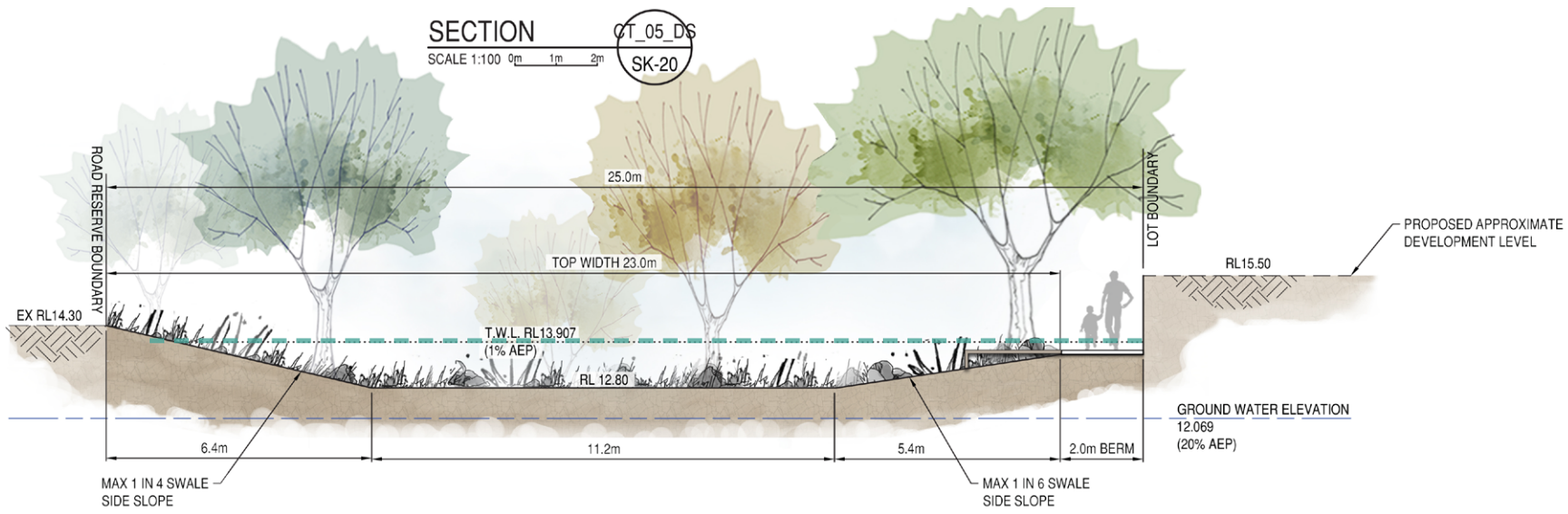


Section Ct-05 US

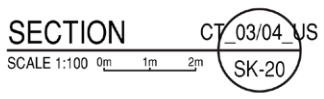
2m

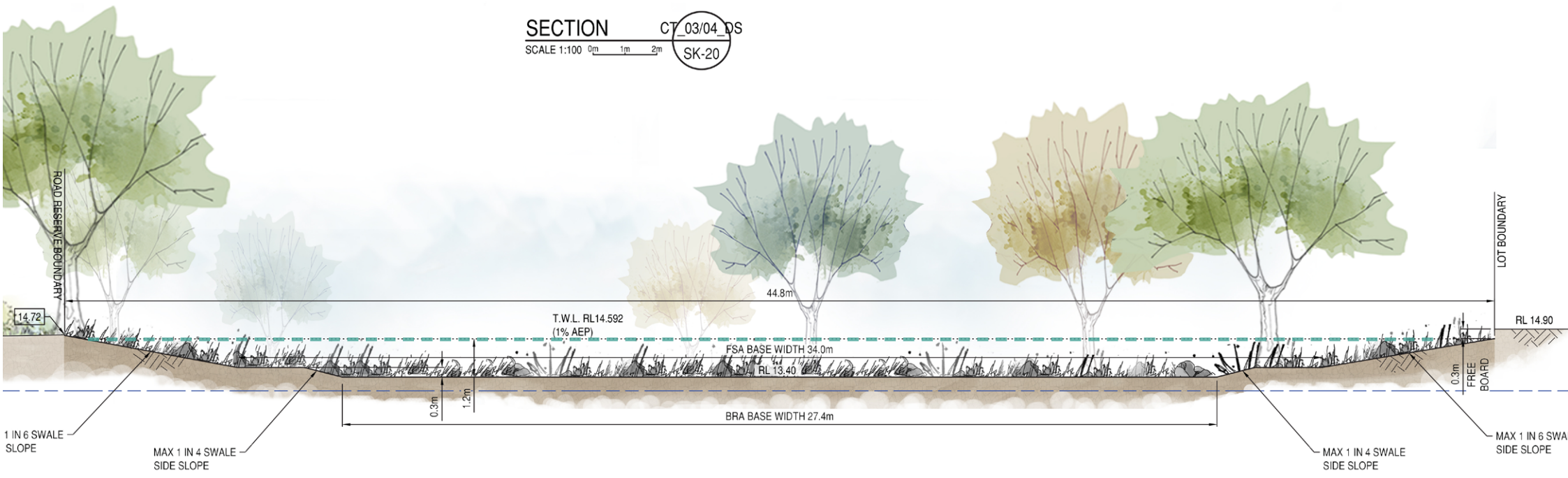


Section Ct-04 DS



Section Ct-03 US





Section Ct-06 CB

2m

APPENDIX 8

TRANSPORT IMPACT ASSESSMENT

ROWE GROUP DESIGN

December 2020

Final Rev 3

East Roselea Structure Plan

Prepared For:

Parcel Property Pty Ltd

Transport Impact Assessment Report

T: +61 8 9274 7076

E: Admin@dvcworld.com

6 Burgess St Midland WA 6056
PO Box 5060 Midland WA 6056
www.dvcworld.com

DOCUMENT ISSUE AUTHORISATION

Issue	Rev	Date	Description	Author	Checked By	Approved By
0	0	1/09/2017	DRAFT Report	CS	DNV	DNV
1	0	27/09/2017	Final Report	CS	DNV	DNV
2	0	5/02/2018	Final Report –Rev Structure Plan Base	CS	DNV	DNV
2	2	23/04/2018	Final Report - Including Response to City Queries	CS	DNV	DNV
2	3	18/12/2020	Revised to include Modified Structure Plan (Scenario 3)	CS	DNV	DNV

The information contained in this document is solely for the use of the client identified for the purpose for which it has been prepared. It is not to be used by any third party and no responsibility is undertaken to any third party. All photographs remain the copyright of Donald Veal Consultants and are included for illustration only.

Donald Veal Consultants Pty Ltd

TABLE OF CONTENTS

PAGE

1 INTRODUCTION 1

1.1 BACKGROUND 1
1.2 SITE LOCATION 1
1.3 SCOPE OF ASSESSMENT 2
1.4 REFERENCES 2

2 STRUCTURE PLAN PROPOSAL 3

2.1 STRUCTURE PLAN CONTEXT 3
2.2 PROPOSED LAND USES 3

3 EXISTING ROAD NETWORK 7

3.1 EXISTING ROAD INFRASTRUCTURE 7
3.2 ROAD HIERARCHY CLASSIFICATION 8
3.3 TRAFFIC VOLUMES 10

4 ROAD NETWORK PROPOSALS 13

4.1 SCENARIO 1 - INTERNAL ROAD NETWORK 13
4.1.1 Road Reserve Widths 13
4.2 SCENARIO 1 - INTERNAL ROAD NETWORK INTERSECTION CONTROLS 16
4.3 SCENARIO 2 - INTERNAL ROAD NETWORK 17
4.4 SCENARIO 3 – FINAL INTERNAL ROAD LAYOUT 17
4.5 EXTERNAL ROAD NETWORK 20
4.5.1 Changes proposed as part of the Structure Plan 20

5 ANALYSIS OF TRANSPORT NETWORKS 21

5.1 ASSESSMENT PARAMETERS 21
5.2 TRAFFIC GENERATION, DISTRIBUTION AND ASSIGNMENT 21
5.3 THROUGH TRAFFIC 33
5.4 ANALYSIS OF ROADS 33
5.5 ANALYSIS OF INTERSECTIONS 34
5.5.1 Intersections internal to the development 34
5.5.2 Scenario 1 - External intersections 34
5.5.3 Scenario 2 - External Intersections 39
5.5.4 Scenario 3 – External Intersections 42

6 PUBLIC TRANSPORT ACCESS 43

6.1 BUS ROUTES 43
6.2 PEDESTRIAN AND CYCLING FACILITIES 45
6.3 EXISTING FACILITIES 46
6.4 PROPOSED FACILITIES 46

7 SUMMARY AND RECOMMENDATIONS 49

APPENDIX A: 2021 OPENING AND 2031 DESIGN YEAR BACKGROUND TRAFFIC VOLUMES (NO DEVELOPMENT) 52

APPENDIX B: SCENARIO 1 FULL DEVELOPMENT TRAFFIC FOR 2021 AND 2031 59
APPENDIX C: SCENARIO 2 FULL DEVELOPMENT TRAFFIC FOR 2021 AND 2031 66
APPENDIX D: DVC TRAFFIC COUNTS 73
APPENDIX E: SIDRA RESULTS 86

1 INTRODUCTION

1.1 BACKGROUND

This Transport Impact Assessment has been prepared by Donald Veal Consultants (DVC) on behalf of Parcel Property Pty Ltd, with regard to the proposed Structure Plan of East Roselea, Stirling. The Structure Plan comprises of residential lots with a range of densities, public open space and a neighbourhood centre. The residential densities include R30, R40-60 and R60-80.

The neighbourhood centre land is currently owned and being further developed by others. Similarly, there are two other significant land holdings within the structure plan area that are owned by others and these are currently zoned as Community Facilities. However, the neighbourhood centre and the community land have been included in this assessment to provide a complete Structure Plan for the area.

1.2 SITE LOCATION

The site lies within the City of Stirling, in the suburb of Stirling. It is located approximately 1.6 km as the crow flies to the north east of the City of Stirling offices, the Stirling Rail Station on the Northern Line, and the Mitchell Freeway interchange with Cedric Street. The site abuts Karrinyup Road to the south and is two blocks away from Main Street to the east. Approximately 2 km north of the site Main Street joins Wanneroo Road with access to Reid Highway being a further 1km to the north. **Figure 1.1** shows the location of the site in a regional context.

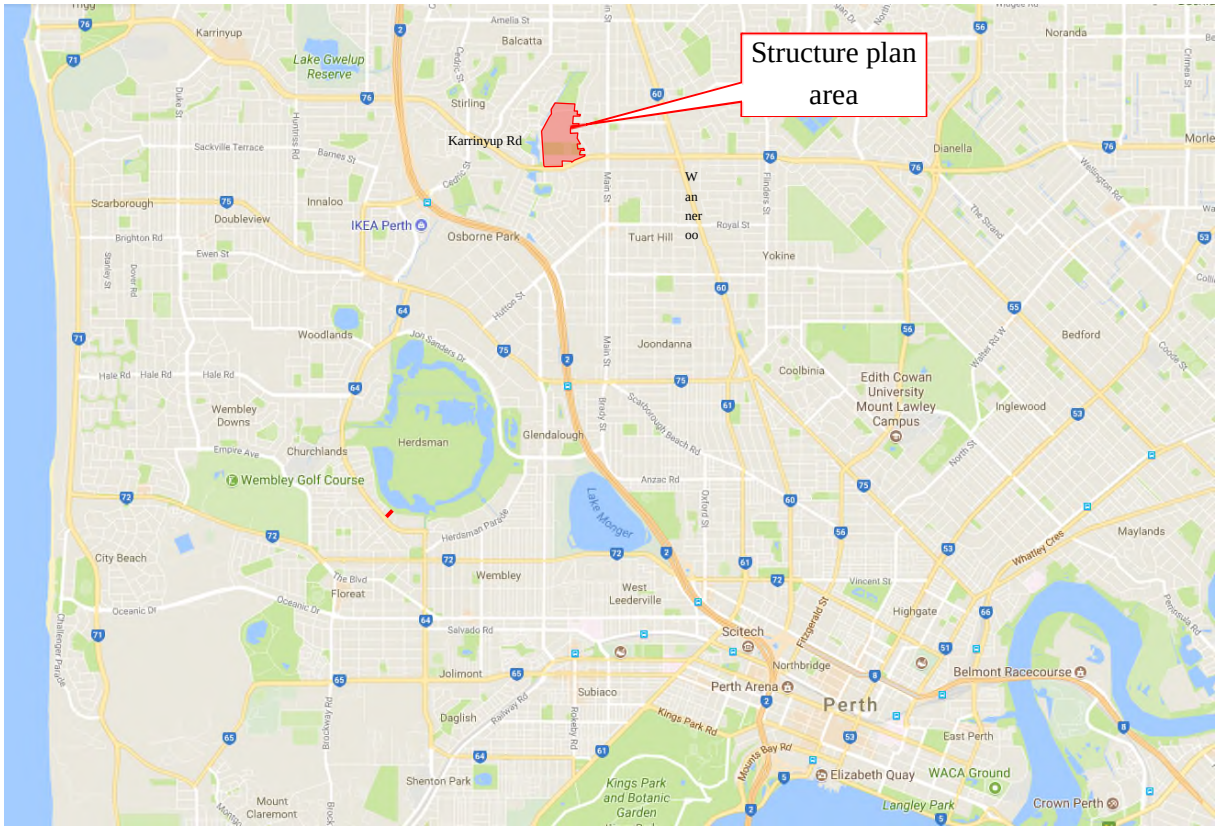


Figure 1.1: Site location

Source: Nearmap

1.3 SCOPE OF ASSESSMENT

This Transport Impact Assessment (TIA) has been prepared in accordance with the Western Australian Planning Commission's (WAPC's) *Transport Assessment Guidelines for Developments Volume 2 Structure Plans* (August 2016). Its intent is to provide the approving authority with sufficient traffic information to confirm that the proponent has adequately considered the traffic aspects of the development and that it would not have an adverse traffic impact on the surrounding area.

1.4 REFERENCES

The following documents are referred to in this report:

- **Liveable Neighbourhoods*, January 2009, WAPC and Department of Planning and Infrastructure;
- *Transport Impact Assessment Guidelines for Developments Volume 2 Planning Schemes, Structure Plans and Activity Centre Plans*, August 2016, WAPC;
- *Transport Impact Assessment Guidelines for Developments Volume 4 Individual Developments*, August 2016, WAPC;
- *Transport Impact Assessment Guidelines Volume 5 Technical Guidance* August 2016, WAPC;
- *Guide to Traffic Generating Developments*, October 2002, NSW Roads and Traffic Authority;
- *Residential Design Code (R-Codes) Amendments 2015*, WAPC; and
- *Austroads Guide to Road Design Part 4A Unsignalised and Signalised Intersections, 2009*.

*A *Draft Liveable Neighbourhoods 2015* is available, however, for the purposes of this report, the current 2009 version has been utilised.

2 STRUCTURE PLAN PROPOSAL

2.1 STRUCTURE PLAN CONTEXT

The subject area is largely undeveloped or underdeveloped land; Macedonia Park is home to the Stirling Lions football (soccer) pitch and club rooms. The Chung Wah Cultural Grounds contain a Cultural Centre building and large informal Gardens. The Sicilian Association of WA has a large clubhouse and extensive parking. The existing commercial development on Karrinyup Road to the south comprises a medical centre with individual GP, Dentist, Physiotherapy and Child Care rooms, and a tool hire business. The remainder of the site is open land with vestiges of market garden activity. **Figure 2.1** shows an aerial view of the subject site and its immediate surrounds and puts its location into a local context.

Figure 2.1: Structure Plan Location in a Local Context

Source: Nearmap

2.2 PROPOSED LAND USES

Figure 2.2 shows the Concept Plan and the range of residential densities envisaged. For the R30 land the lot size is typically between 375m^2 and 465m^2. The R40-60 land has an average lot size of approximately 285m^2, whilst the R60-80 land has an average lot size of approximately 165m^2.

The neighbourhood centre will comprise a mixture of retail and residential development, to be constructed in two stages. In total the centre will include some 7,200m^2 of retail and mixed used space. The existing medical centre will be retained. **Figure 2.3** shows the proposed layout of the neighbourhood centre.

Table 2.1 shows the proposed land uses within the subject site.

Table 2.1: East Roselea Lot Yield

Land Uses	Residential Lots	Area
Residential R30	261	
Residential R40-60	46	
Residential R60-80	279	
Open Space		2.72Ha
Neighbourhood Centre*	50	9,485m^2
Total	642	

Source: Rowe Group 13.7.2107 (based on REF 8686-CON-02A) and Hames Sharley

** Ultimate Scenario*

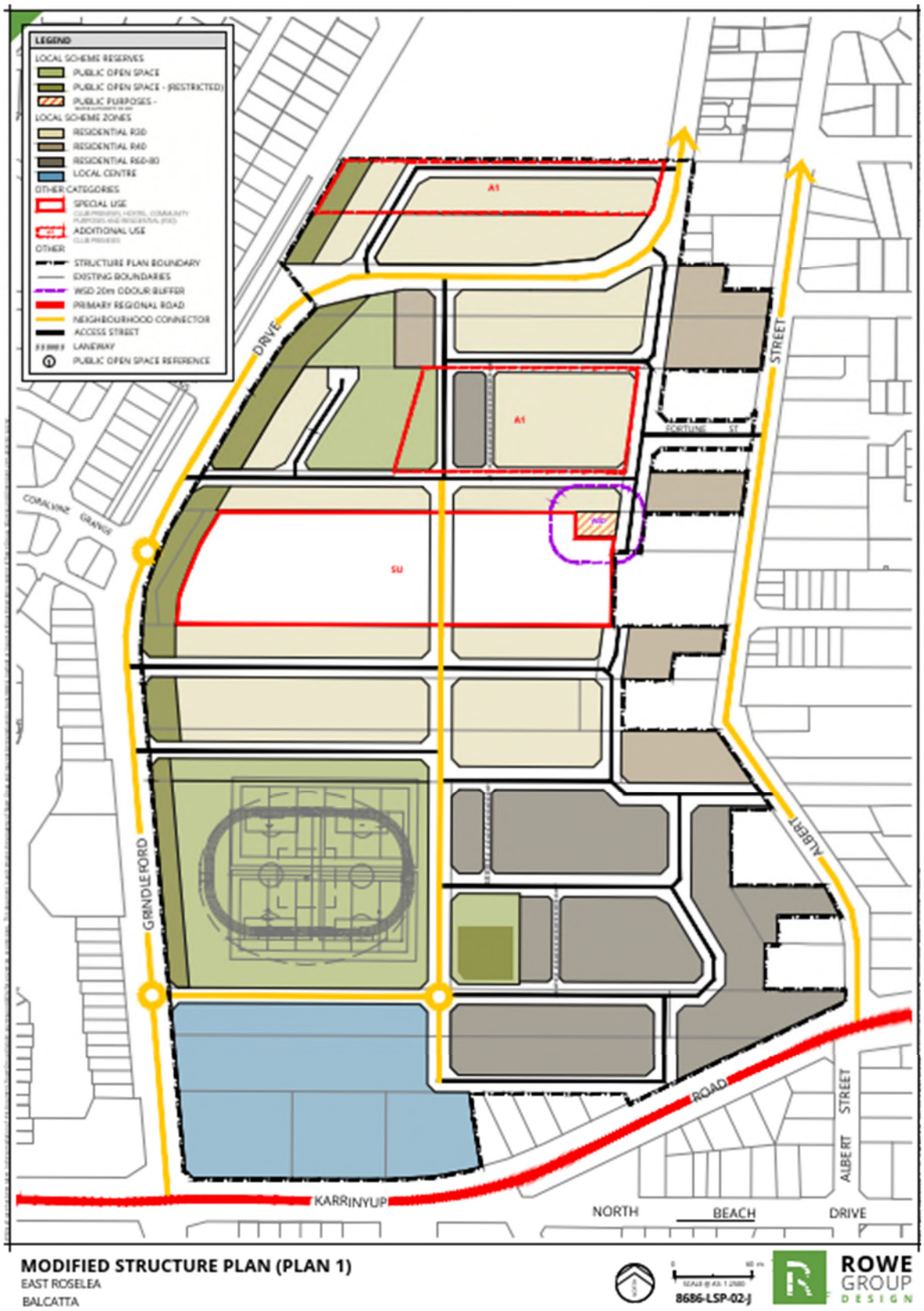


Figure 2.2: East Roselea Local Structure Plan

Source: Rowe Group

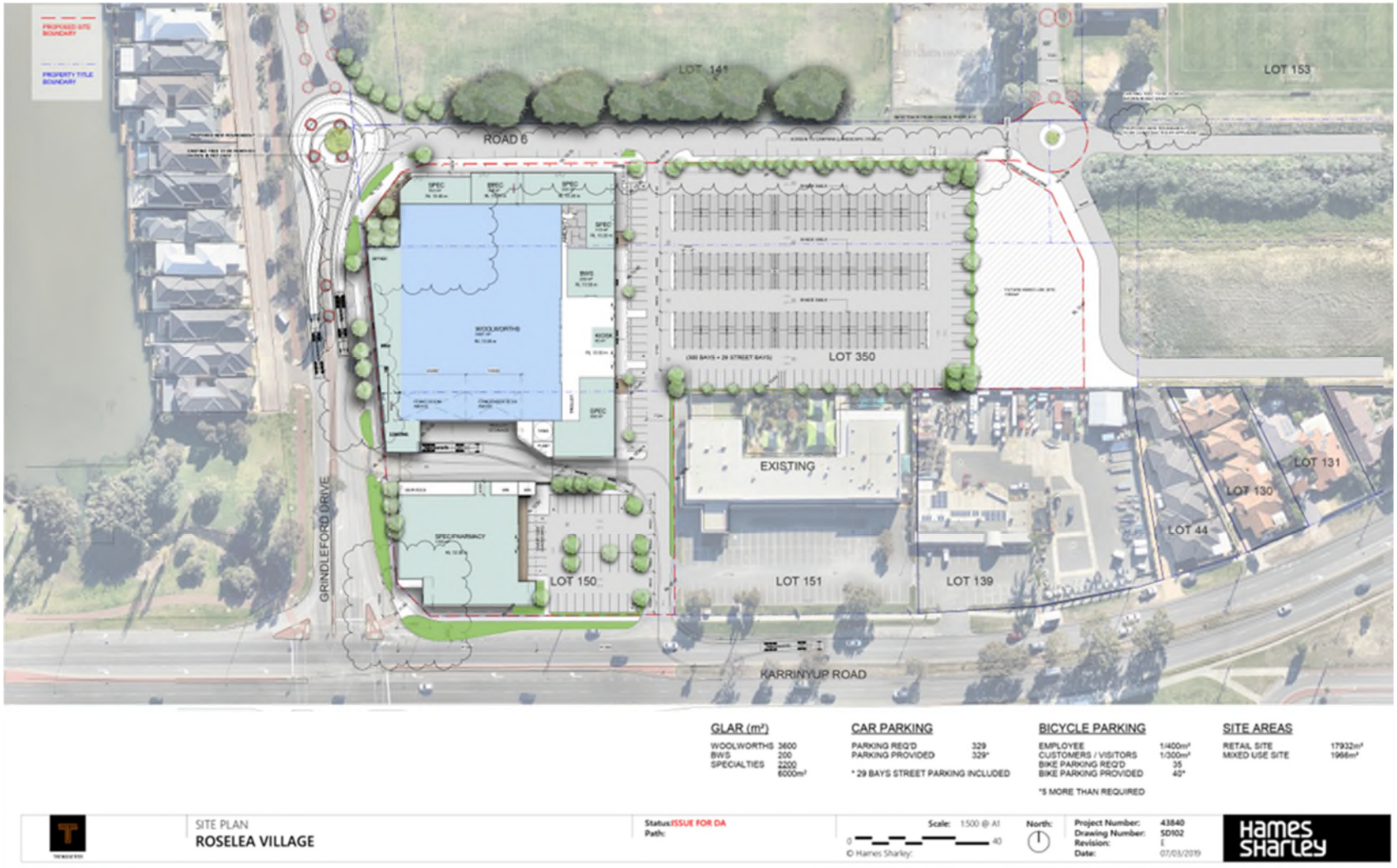


Figure 2.3: East Roselea Neighbourhood Centre Concept Plan

Source: Hames Sharley

3 EXISTING ROAD NETWORK

3.1 EXISTING ROAD INFRASTRUCTURE

The site is bounded to the south by Karrinyup Road which is a 4-lane dual carriageway road in this vicinity. Karrinyup Road connects to Jones Street and Cedric Street to the west of the site with Cedric Street providing a link to the Stirling Rail Station on the Northern rail line. Cedric Street also links to the Mitchell Freeway and into the northern part of Osborne Park via Ellen Stirling Boulevard. Karrinyup Road itself continues west to the Mitchell Freeway and ultimately to West Coast Highway and the coast at Trigg Beach. Karrinyup Road has a 70km/h speed limit. **Figure 3.1** illustrates the road network servicing the subject site.

Figure 3.1: Existing road network
Source: Google Maps

Karrinyup Road to the east of the site crosses Main Street and then continues east as Morley Drive.

The site is bounded to the east by Albert Street which is a 7m wide, 2-lane access road with speed cushions and numerous property frontages. It terminates at Karrinyup Road in the south and at Beryl Street to the north. It has a 50km/h posted speed limit with 40km/h school restrictions adjacent to the Balcatta Primary School and St Lawrence School at the northern end.

Further to the east (approximately two blocks) and parallel to Albert Street is Main Street. Main Street is a key north-south distributor with 2-lanes in each direction on an undivided carriageway. It links to Wanneroo Road to the north and Scarborough Beach Road to the south.

Immediately to the west of the site is Grindleford Drive, which also terminates at Beryl Street to the north and Karrinyup Road to the south. Until fairly recently Grindleford Drive had a northern section and a southern section but were joined when the central section was constructed north of Coralvine Grange. South of the intersection with Coralvine Grange, Grindleford Drive is a 2-lane, dual carriageway with a 4.5m carriageway in each direction. North of Coralvine Grange, Grindleford Drive is a single carriageway road about 7.5 m wide. On the newly constructed section of Grindleford Drive, the City of Stirling has constructed speed cushions to manage speeds. There is a 2.2m wide footpath on the northern/western side of Grindleford Drive.

Beryl Street is an east-west road linking Main Street (priority give-way intersection) and Jones Street (roundabout intersection).

3.2 ROAD HIERARCHY CLASSIFICATION

Karrinyup Road is classified as a Primary Distributor road under Main Roads Western Australia's (MRWA's) Functional Road Hierarchy. This classification is applied to roads that:

"…Provide for major regional and inter-regional traffic movement and carry large volumes of generally fast moving traffic. Some are strategic freight routes and all are State Roads. They are managed by Main Roads Western Australia." (MRWA).

Main Street to the east of the site is classified as a District Distributor A under MRWA's Functional Road Hierarchy. This classification is applied to roads that:

"Carry traffic between industrial, commercial and residential areas and generally connect to Primary Distributors. These are likely to be truck routes and provide only limited access to adjoining property. They are managed by local government." (MRWA).

Beryl Street, Coralvine Grange, Jones Street and Grindleford Drive (south of Coralvine Grange) are all classified as Local Distributors under MRWA's Functional Road Hierarchy. This classification is applied to roads that:

"…carry traffic within a cell and link District Distributors or Primary Distributors at the boundary, to access roads. The route of Local Distributors should discourage through traffic so that the cell formed by the grid of higher order distributor roads, only carries traffic belonging to, or serving the area. Local Distributors should accommodate buses, but discourage trucks... Local Distributors are managed by the local government." (MRWA).

Other roads abutting or terminating at the site boundary are classified as *Access Roads*. These include Albert Street (north of Karrinyup Road) and Grindleford Drive (north of Coralvine Grange). This classification is applied to roads that:

"..provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function. These roads are bicycle and pedestrian friendly. They are managed by the local government." (MRWA).

Figure 3.2 outlines the road hierarchy classification of the surrounding road network.

Figure 3.2: Road Hierarchy of surrounding road network

Source: MRWA Functional Road Hierarchy, Road Info Mapping

3.3 TRAFFIC VOLUMES

The latest available traffic counts for the surrounding road network were sourced from counts undertaken by DVC, the City of Stirling and MRWA. These counts were used as the basis, in Section 5 of this report, to determine the extent to which the East Roselea development traffic will impact on the operation of the respective roads. **Table 3.1** summarises the available data.

Table 3.1: Existing Daily Traffic Flows for the Surrounding Road network

Location	Date	AWT(vpd)
Beryl Street, west of Albert Street	07/2013	3,114
Beryl Street, east of Jones Street	07/2013	1,781
Albert Street, south of Beryl Street	10.2014	1,610
Grindleford Drive, north of Vestia Walk	05/2017	1,864
Grindleford Drive, south of Castleton Street	06/2017	1,027
Grindleford Drive, north of Cranberry Garden	05/2017	834
Coralvine Grange, north of Blacoa Lane	10/2016	499
Karrinyup Road, west of Albert Street	2014/2015	23,772
Main Street, north of Karrinyup Road	2013/2014	21,041

Source: City of Stirling and MRWA

Additional traffic counts were undertaken by DVC in August 2017 and are included as **Appendix A**. Intersection turning movements for Karrinyup Road/Grindleford Drive and Main Street/Beryl Street are summarised below as **Figures 3.3 and 3.4**. These figures include both the am and pm peak hour turning movements.

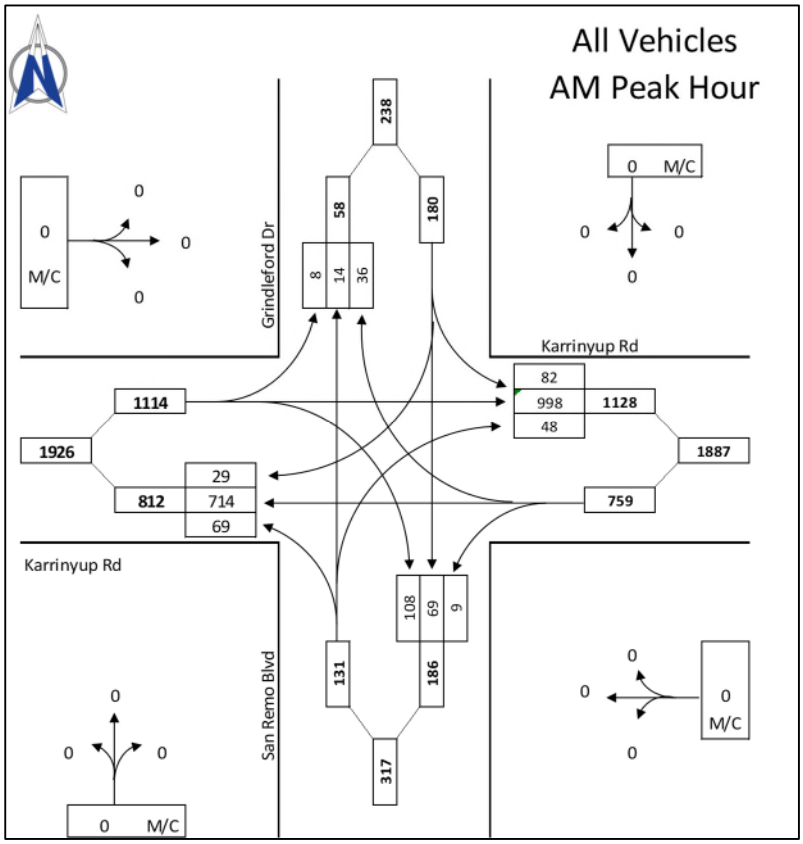


Figure 3.3a: Karrinyup Road/Grindleford Drive AM Peak Hour Turning Movements (August 2017)

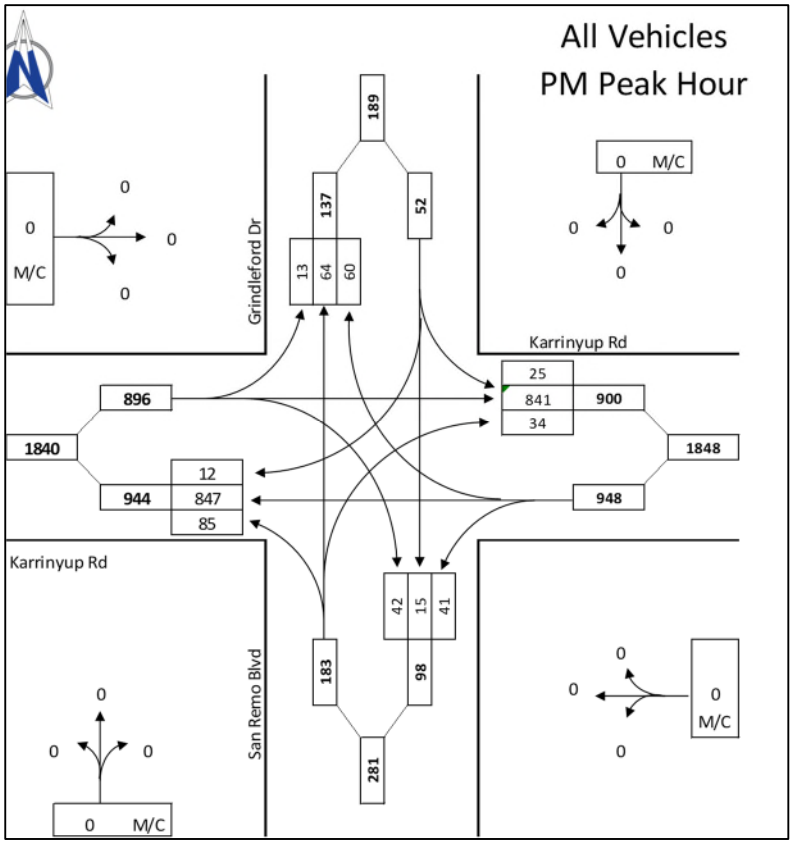


Figure 3.3b: Karrinyup Road/Grindleford Drive PM Peak Hour Turning Movements (August 2017)

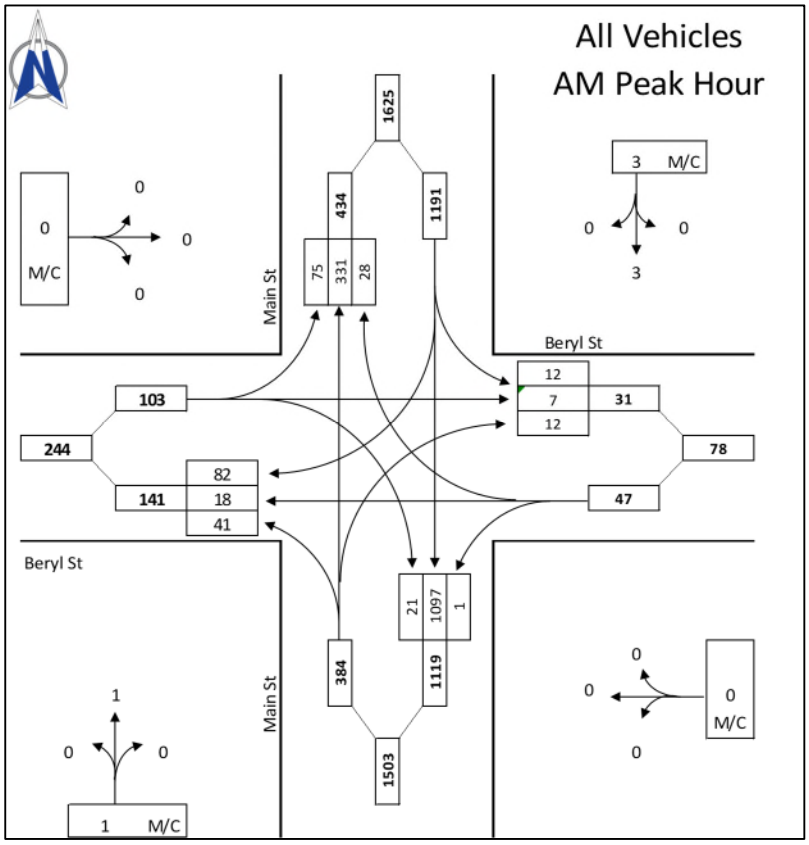


Figure 3.4a: Main Street/Beryl Street AM Peak Hour Turning Movements (August 2017)

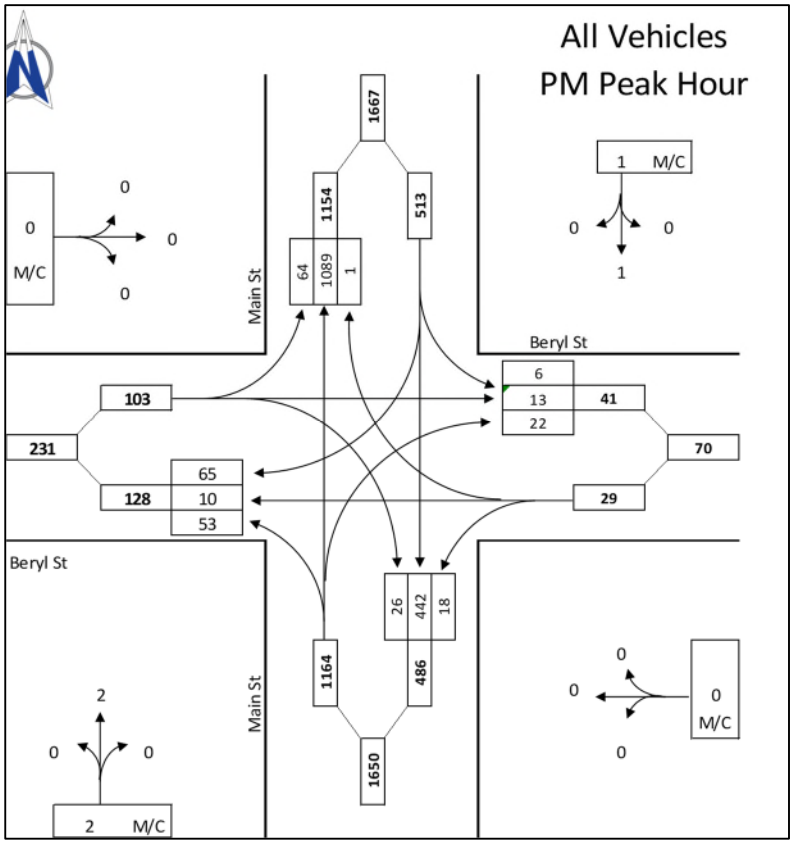


Figure 3.4b: Main Street/Beryl Street PM Peak Hour Turning Movements (August 2017)

4 ROAD NETWORK PROPOSALS

Two road network scenarios were initially tested for this study: the first (Scenario 1), assumed that a central north-south internal road (Spine Road) links Grindleford Drive to the north to Karrinyup Road to the south. The intersection with Karrinyup Road permited left-in/left-out traffic movements only. The Chung Wah Association which owns the large portion of land in the centre of the Structure Plan area, advised that they wished to be considered as a Community Use in the Structure Plan, and do not want any roads passing through their property. A second network scenario was developed to reflect this. Scenario 2 assumed that the Spine Road was not continuous through the Chung Wah Association land and did not intersect with Karrinyup Road in the south.

Further minor modifications were made to the Structure Plan during 2020 which are included in this report as Scenario 3. Scenario 3 is very similar to Scenario 2 with the exception of the inclusion of the Spine Road through the Chung Wah Association land and other minor changes. Because of its similarity to Scenario 2, no explicit traffic modelling was undertaken for Scenario 3.

4.1 SCENARIO 1 - INTERNAL ROAD NETWORK

The proposed road network is shown in **Figure 4.1**. As the proposed roads are yet to be named, the identifying names as per **Figure 4.1** have been adopted for use in this assessment.

4.1.1 Road Reserve Widths

The indicative road reserve widths of the proposed internal road network are shown in **Figure 4.1** and are mostly 15m or 18m. Indicative cross sections for each road are discussed further below.

Access Road Type B - 18m Road Reserve

Access Road type B roads are proposed for the higher density residential areas in the south east corner of the site as shown. **Figure 4.2** shows a sample cross section for an Access Road B as outlined in *Liveable Neighbourhoods* (WAPC 2009). Access Road B allows for higher parking demand on-street usually associated with higher density living.

Figure 4.1: Scenario 1 - Internal road network

Source: Rowe Group

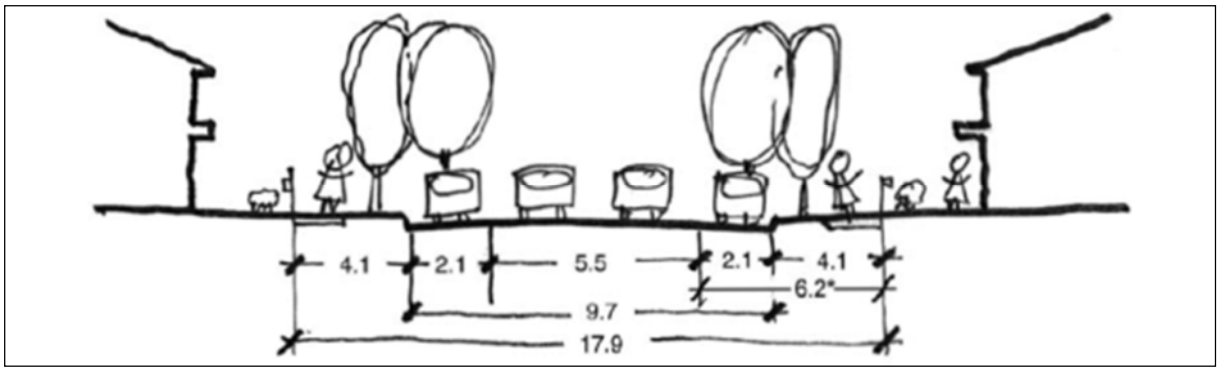


Figure 4.2: Sample Road Cross Section, Access Street B, 40km/h < 3,000vpd
Source: Liveable Neighbourhoods WAPC (2009)

Access Road Type D - 15m Road Reserve

Figure 4.3 shows a sample cross section for an Access Road D as outlined in *Liveable Neighbourhoods*. Type D roads have a low target speed, allow staggered parking on both sides of the road, and carry typically less than 1,000 vpd. Type D roads are recommended for Roads 1, 2, 3, 4 and 5 in the development site.

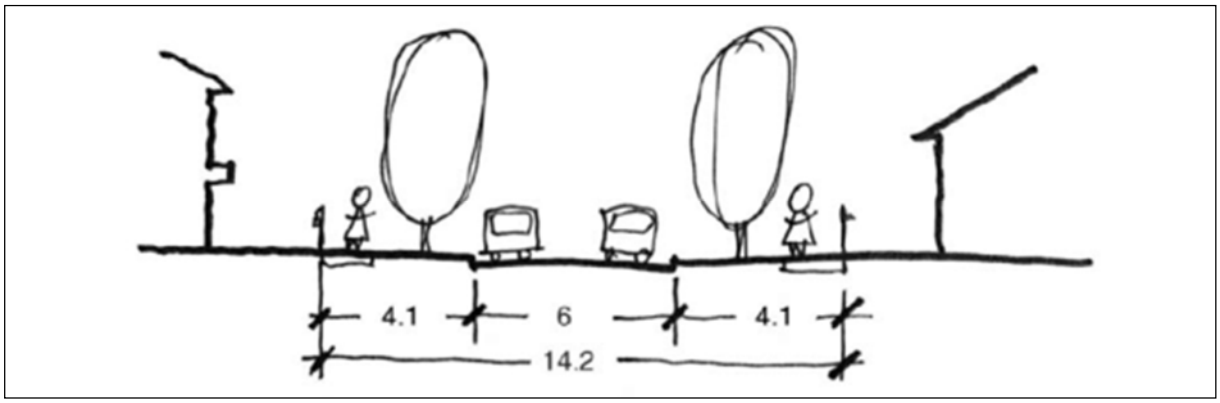


Figure 4.3: Sample Road Cross Section, Access Street D - Narrow Yield Access Street, 40km/h, <1,000vpd
Source: Liveable Neighbourhoods WAPC (2009)

Neighbourhood Connector B - 18m Road Reserve

Figure 4.4 shows a sample cross section for a Neighbourhood Connector B road as outlined in *Liveable Neighbourhoods.* This is proposed for the Spine Road from Road 3 south to the neighbourhood centre to accommodate higher traffic volumes. Parallel parking embayments adjacent to the centre will service both the neighbourhood centre and the residential area to the east.

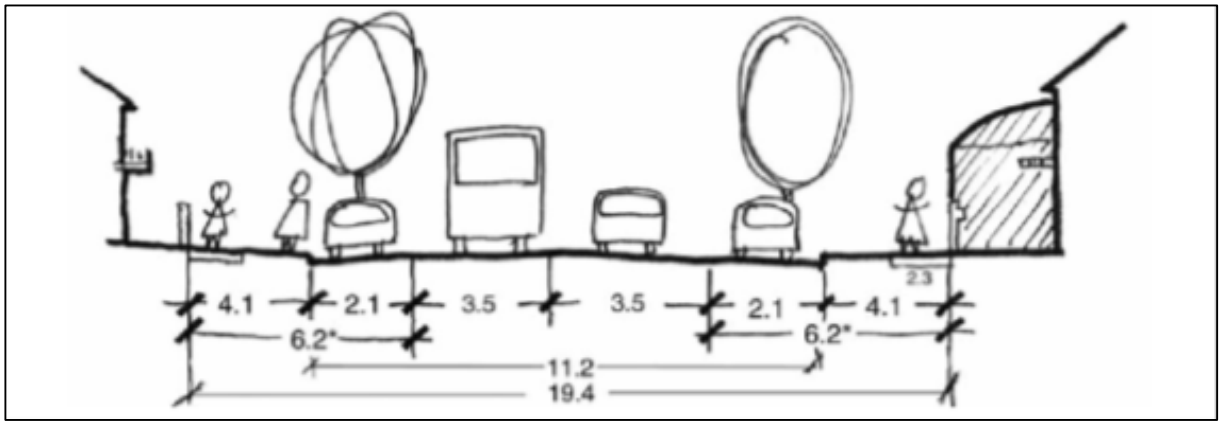


Figure 4.4: Sample Road Cross Section, Neighbourhood Connector B, 50km/h (<3,000vpd)
Source: Liveable Neighbourhoods WAPC (2009)

Neighbourhood Connector A - 25m Road Reserve

Road 6 adjacent to the neighbourhood centre was originally proposed as a Neighbourhood Connector A as shown in **Figure 4.5** to accommodate higher traffic volumes associated with the Neighbourhood Centre.

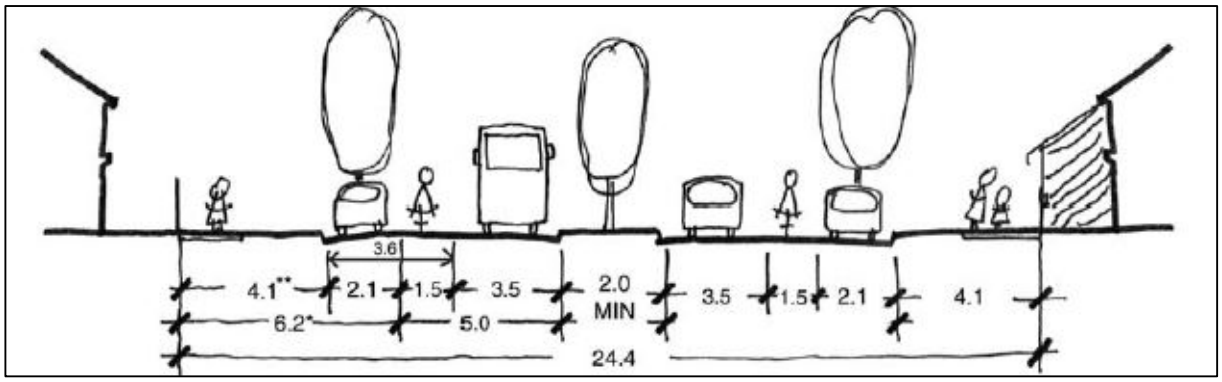


Figure 4.5: Sample Road Cross Section, Neighbourhood Connector A, 50km/h (>3,000vpd)

In Scenario 3 (the final internal road layout for the Structure Plan area), Road 6 is shown as a 12m road reserve. DVC understands this reserve width reflects a negotiated outcome between the Neighbourhood Centre proponents and the City. This was due to the difficulties of locating a road which functions as a Neighbourhood Connector in a situation impacted by a number of constraints, including site irregularity and critical dimensions, fragmented land tenure, the protection of an existing row of mature trees and the functionality of the City's playing fields land which abuts the Neighbourhood Centre to the immediate north.

4.2 SCENARIO 1 - INTERNAL ROAD NETWORK INTERSECTION CONTROLS

The majority of the intersections within the proposed internal road network are indicated on the Structure Plan drawings as being T- intersections. The exceptions to this are the intersections with the Spine Road which are shown as crossroads.

Liveable Neighbourhood permits the use of four-way intersections for a limited proportion of intersections within a development and recommends that the presence of a four-way intersection is highlighted.

The intersection of Roads 2, 3, 4 and 5 with the Spine Road are envisaged as 4-way priority-controlled intersections (i.e. give-way control). The forecast traffic volumes at these intersections are all well below the recommended threshold in *Liveable Neighbourhoods*.

The intersection of Spine Road with the extension of Coralvine Grange is envisaged as a mini-roundabout mainly to control speed along Spine Road. A roundabout is also envisaged to control the larger volumes of traffic at the intersection of Spine Road and Road 6 at the neighbourhood centre. The intersection controls are shown in **Figure 4.1** for Scenario 1.

4.3 SCENARIO 2 - INTERNAL ROAD NETWORK

The Scenario 2 road network and intersection controls are shown in **Figure 4.6.** The internal road reserves, proposed cross-sections and intersection controls are the same for Scenario 2 as for Scenario 1 except that the central section of Spine Road is no longer present and there is no intersection with the extension of Coralvine Grange. Also, the Spine Road does not connect to Karrinyup Road in Scenario 2.

4.4 SCENARIO 3 – FINAL INTERNAL ROAD LAYOUT

In December 2020 a revised internal road network was confirmed which took into account some requirements of the local water management plan and negotiations around property access. The Scenario 3 - Final Internal Road Network is shown in **Figure 4.7**.

The final road layout is similar to Scenario 2 in that there is no extension of the Spine Road south to connect to Karrinyup Road and there is no eastwards extension of Coralvine Grange into the structure plan area. It differs to Scenario 2 in that the Spine Road is connected through the Chung Wah Association land and Road 3 is connected to Grindleford Drive to the west. There are also minor road discontinuities in the northwest section of the structure plan.

The intersections of Spine Road and Roads 3 and 4 are proposed as 4-way priority controlled intersections.

Figure 4.6: Scenario 2 - Internal Road Network

Source: Rowe *Group*

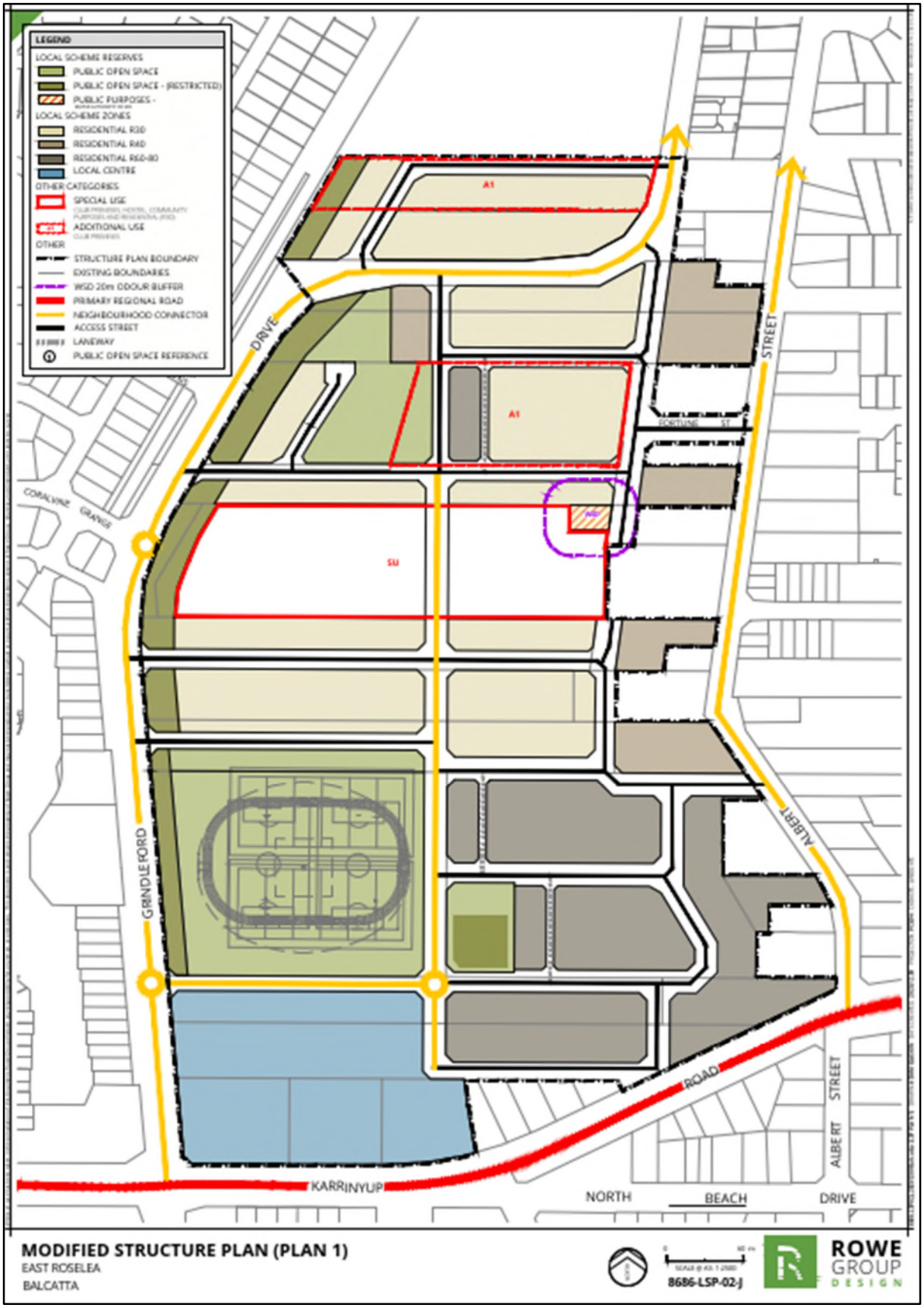


Figure 4.7: Scenario 3 – Final Internal Road Network

Source: Rowe *Group*

4.5 EXTERNAL ROAD NETWORK

4.5.1 Changes proposed as part of the Structure Plan

There are no major road changes to the external road network proposed by the Structure Plan except for connections onto the surrounding road network. A new three-leg roundabout is proposed at the intersection of Grindleford Drive and Road 6 to control the higher volumes of traffic associated with the neighbourhood centre.

Currently, left-in left-out access from Karrinyup Road is permitted to the medical centre and it is proposed that as a minimum the left-turn in is retained when the neighbourhood centre is developed. A new left-in left-out access from Karrinyup Road is proposed for the Spine Road (Scenario 1).

5 ANALYSIS OF TRANSPORT NETWORKS

5.1 ASSESSMENT PARAMETERS

This transport assessment has been undertaken assuming full development of the Structure Plan, which includes numerous residential lots, and a neighbourhood centre with mixed use retail and residential apartments.

The opening of the residential component was expected to be completed by 2021. In the neighbourhood centre it was estimated that development of Stage 1 would be complete by 2019 with Stage 2 following progressively after 2022. For the purposes of the analysis, the development has been assumed to be fully completed by 2021, with analysis undertaken for ten years post completion, being 2031. Any staging of the development would result in a slower build-up of traffic, and the need for any network improvements being delayed.

5.2 TRAFFIC GENERATION, DISTRIBUTION AND ASSIGNMENT

In order to determine the traffic generation for the proposed development, trip generation rates for the residential lots were sourced from the *Guide to Trip Generating Developments*, NSW Road Traffic Authority (2002). The breakdown of inbound and outbound trips for the peak hours has been taken from those suggested in the WAPC *Transport Impact Assessment Guidelines Volume 5 Technical Guidance* (2016).

The total daily, am and pm peak hour trip generation are shown in **Table 5.1**. The proposed development is estimated to generate approximately 13,000 vehicle trips per day (vpd), with about 66% of those generated by the neighbourhood centre. In the PM peak hour approximately 1,220 trips will be generated, again mostly due to the neighbourhood centre. Trip generation for the neighbourhood centre excludes the current commercial activity there, as this traffic is already on the road network and not additional to the area.

There is strong evidence to show that generated trips to new retail areas are not all new trips to the road network. For developments which front busy roads with good direct access this effect is particularly important. Research by the TRICS Consortium in the UK and published in 1995 indicated that the proportion of trips generally accepted to come from passing traffic is 30%. More recent research by them suggests that this figure is low due to a number of factors including the increase in on-line shopping.

To account for the passing traffic and internal trips on the network generated by the neighbourhood centre, a conservative factor of 20% passing traffic has been applied, i.e., 20% of trips to the neighbourhood centre are already on the movement network.

In addition, the traffic model developed for this study makes no allowance for residential trips within the subdivision travelling to and from the neighbourhood centre. It assumes that all residential trips travel via the subdivision roads to external zones, which provides a conservative and possibly a slight overestimate of traffic forecast on the road network and key intersections.

The development site was divided into eight internal zones, seven residential and the remaining being the neighbourhood centre. Each zone was then given a trip directional distribution to the north, west, east and south considering likely attractors. To the south and south west is Perth City and Osborne Park industrial area. To the north are Joondalup and the industrial areas such as Balcatta and Wangara. To the east are Morley Galleria and the Bayswater Industrial area. By far the largest attractor is expected to be Perth City.

Based on the proposed internal road network of the Concept Structure Plan, the trips were then assigned the likely routes taken to and from each of the zones to respective destinations. The product of the lot yield for each zone and the trip assignment exercise results in the forecast design flows generated by the development.

Figures 5.1, 5.2 and **5.3** show the additional traffic daily, during the am peak and pm peak hours, respectively on the internal and surrounding road network for Scenario 1. **Figures 5.4, 5.5** and **5.6** show the additional traffic from Scenario 2 (and Scenario 3).

Explicit modelling was not undertaken for Scenario 3 – Final Internal Road Network. However, the traffic assessment is similar to that of Scenario 2, with minor differences pertaining to where traffic joins Grindleford Drive from Road 3 and Road 4.

Figures 5.7, 5.8 and **5.9** show the 2017 existing daily, am and pm traffic. Note that the am and pm traffic is derived from traffic count data while the daily traffic is estimated by multiplying the sum of the am and pm traffic by 5.

Appendix A shows the 2021 opening year and 2031 design year background traffic volumes. **Appendix B** shows the full development and background traffic at 2021 and 2031 for Scenario 1; whilst **Appendix C** shows the full development and background traffic at 2021 and 2031 for Scenario 2.

Table 5.1: Traffic Generation Rates and Distribution

			FORECAST UNITS	Rate per UNIT		Peak Hour Distribution (WAPC)				FORECAST Trips per Peak Hour & Daily				
Land Use	**UNITS**	**sq m**	**DWELLINGS**	**Source**	**Daily**	**AM in**	**AM out**	**PM in**	**PM out**	**AM in**	**AM out**	**PM in**	**PM out**	**Daily**
Residental R30 & R40-60	per dwelling		307	RTA	9	0.2	0.6	0.5	0.3	61	184	154	92	2763
Residential R60-80	per dwelling		329	RTA	5	0.2	0.6	0.5	0.3	66	197	165	99	1645
Retail	GFA	7108		RTA	121	2.0	0.5	5.0	5.0	142	36	355	355	8601
										269	**417**	**673**	**546**	**13009**
										687		**1220**		

(Note: the retail GFA is net of the existing Hire Guys and includes the Passing Traffic Factor)

Scenario 1 Daily Traffic

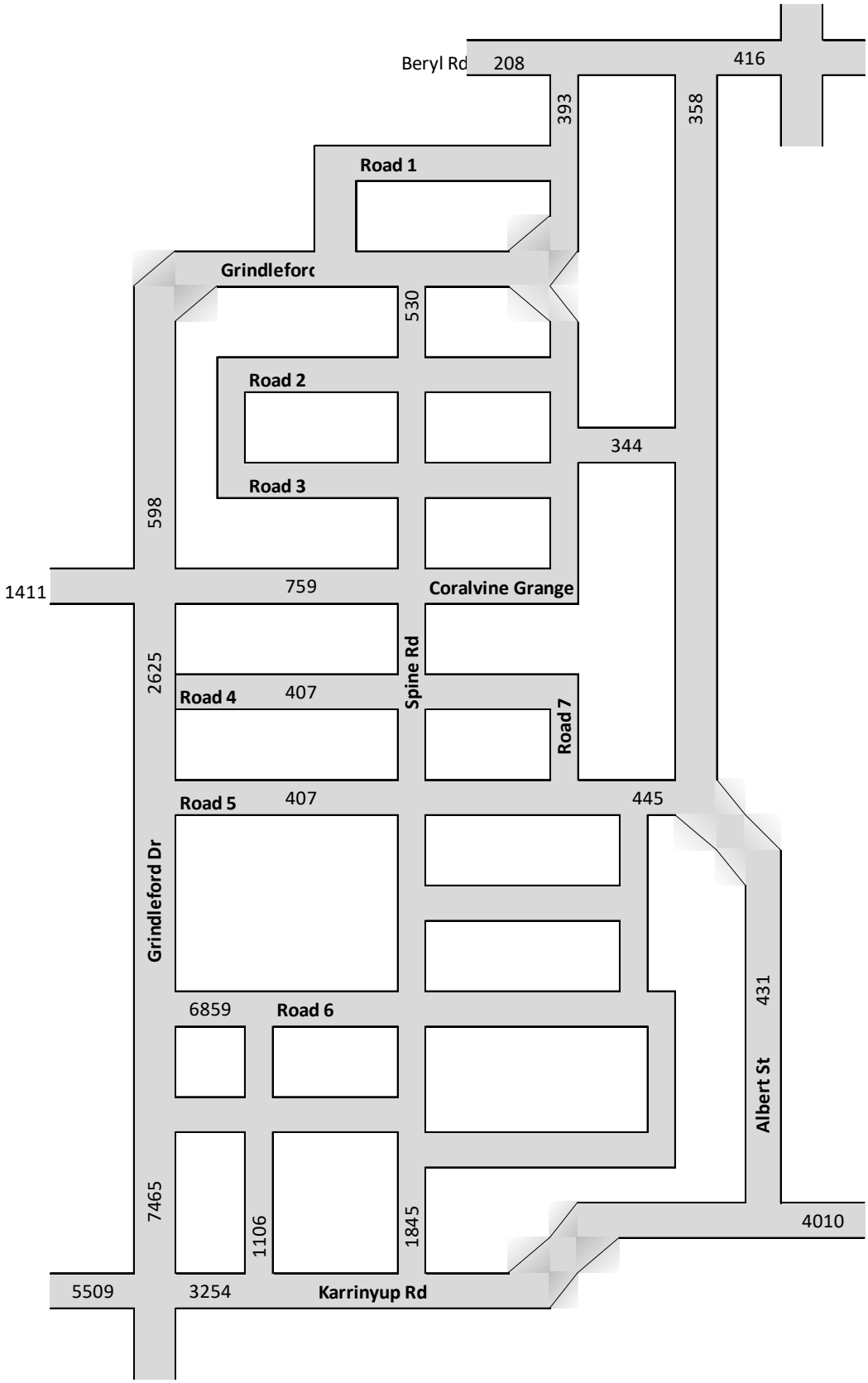


Figure 5.1: Scenario 1 Forecast Daily additional trips from the development

Scenario 1 AM Peak

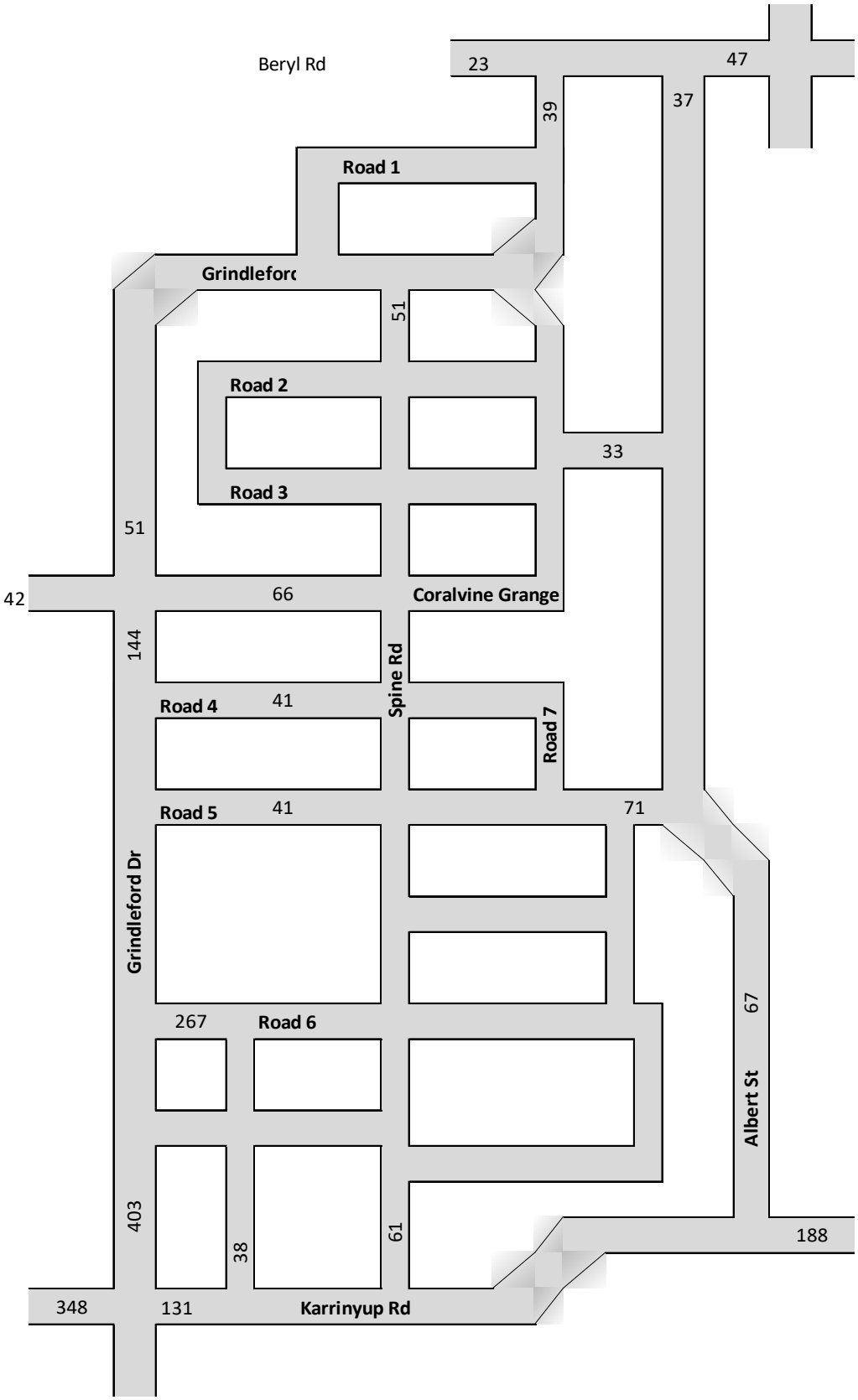


Figure 5.2: Scenario 1 Forecast additional AM Peak Hour trips from the development

Scenario 1 PM Peak

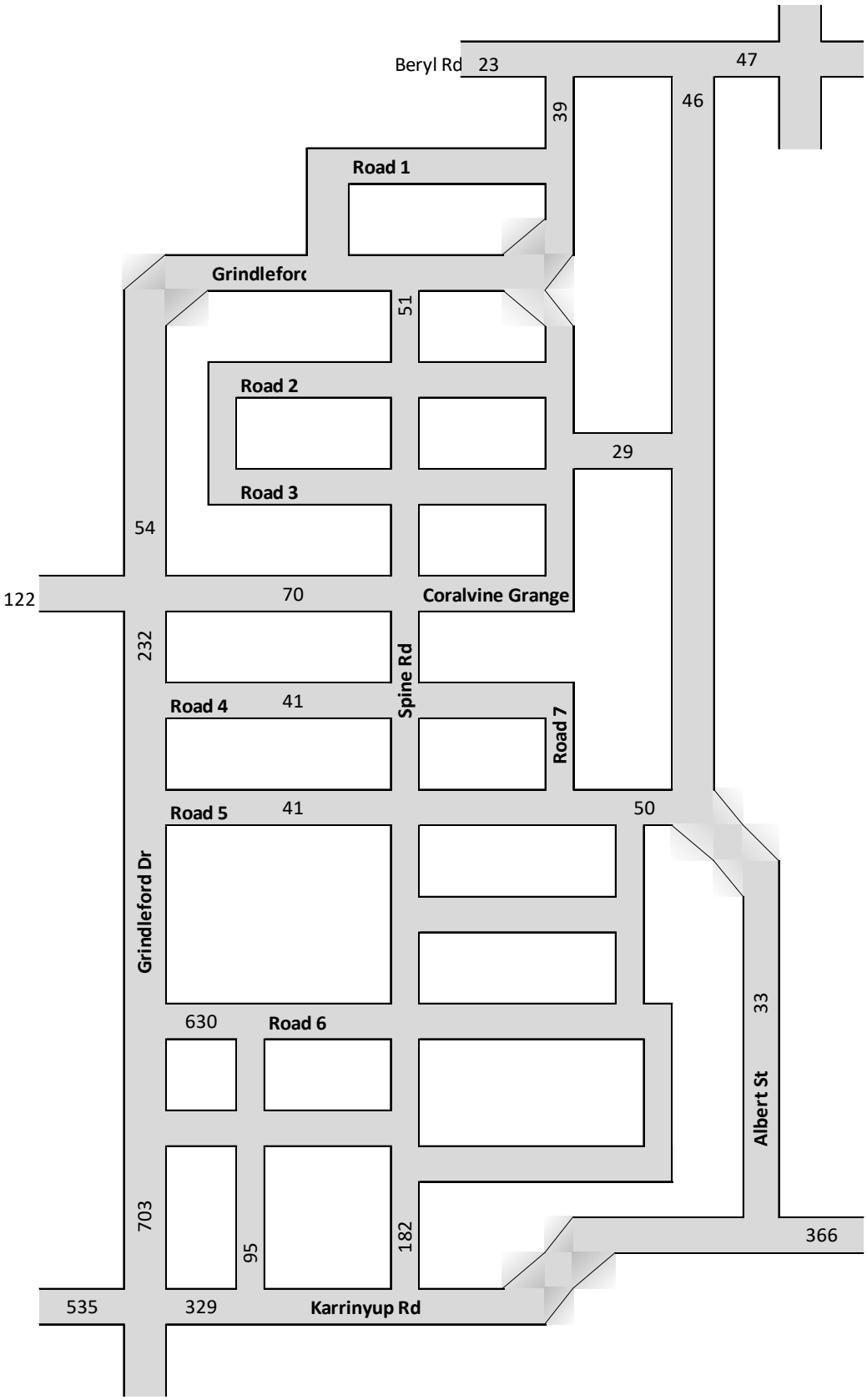


Figure 5.3: Scenario 1 Forecast additional PM Peak Hour trips from the development

Scenario 2 Daily

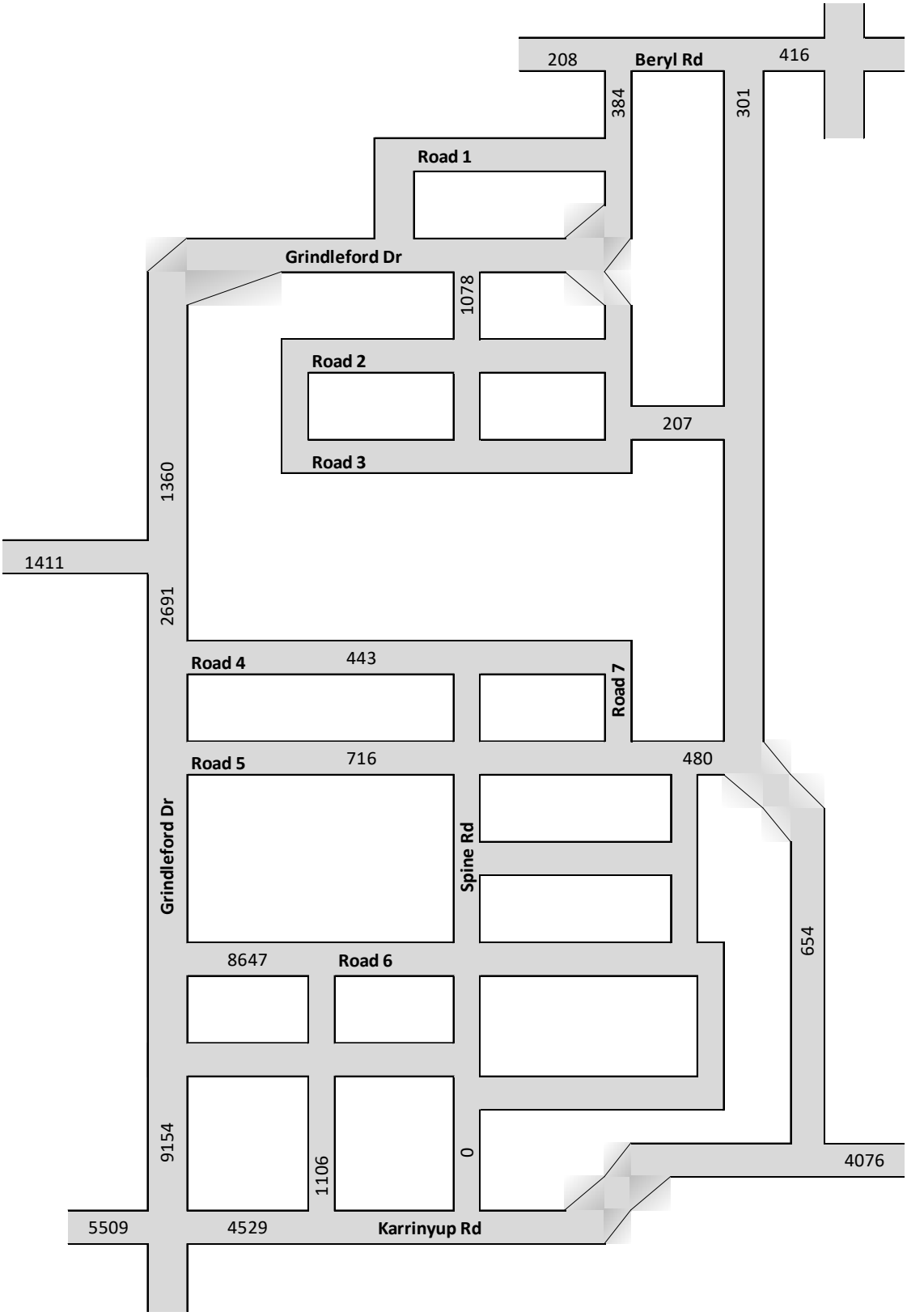


Figure 5.4: Scenario 2 Forecast Daily additional trips from the development

Scenario 2 AM Peak

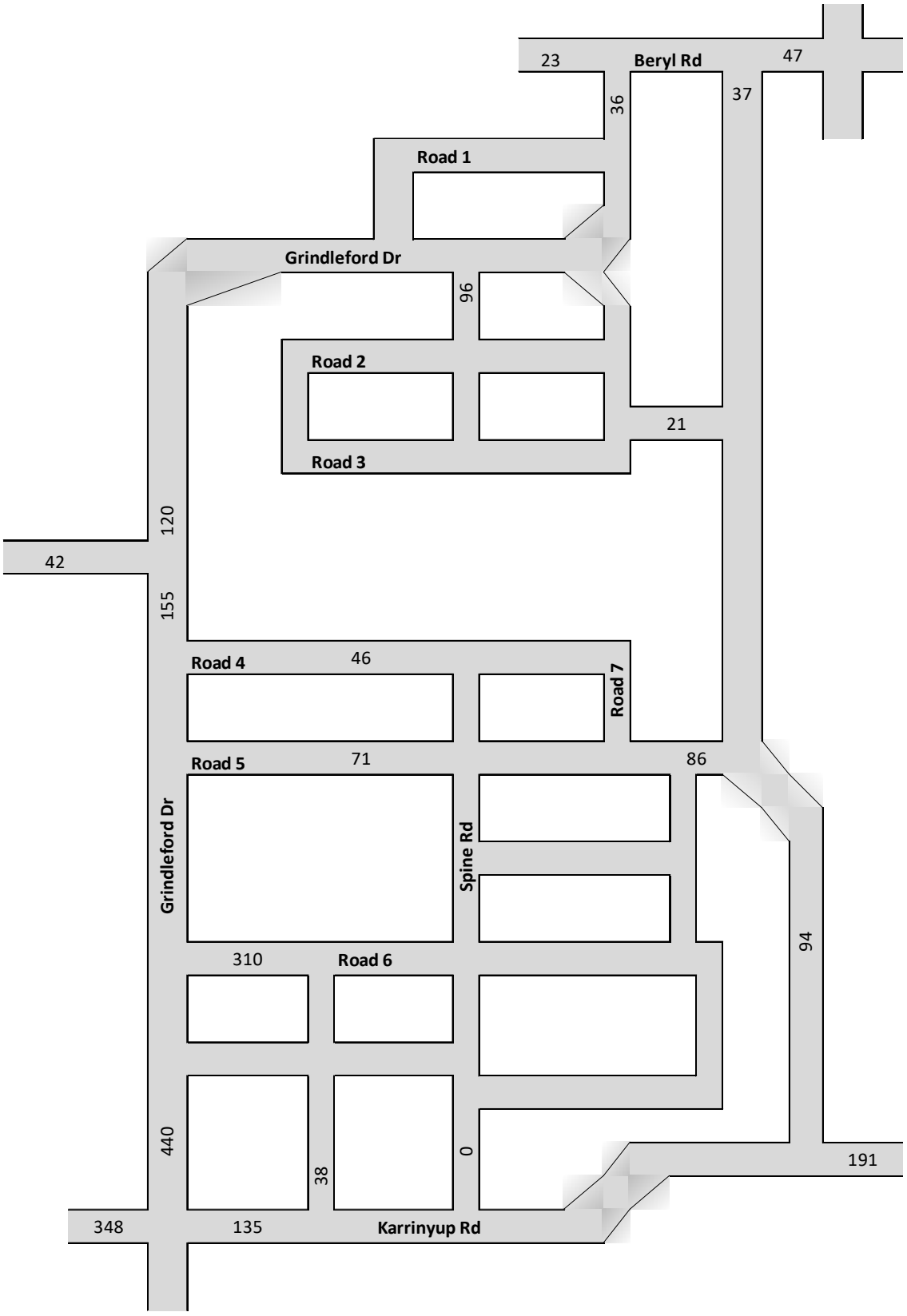


Figure 5.5: Scenario 2 Forecast additional AM Peak Hour trips from the development

Scenario 2 PM Peak

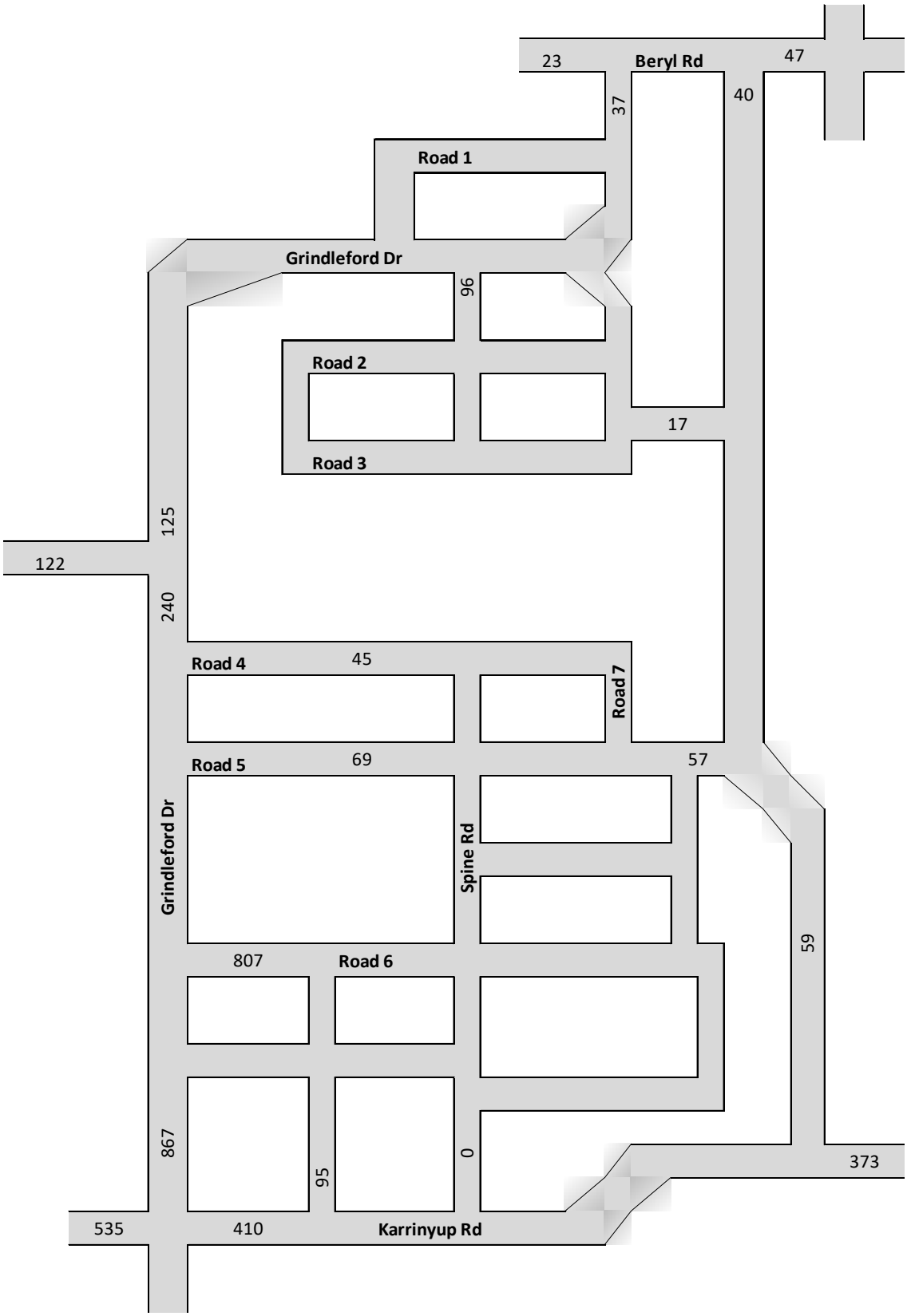


Figure 5.6: Scenario 2 Forecast additional PM Peak Hour trips from the development

2017 Daily Background Traffic

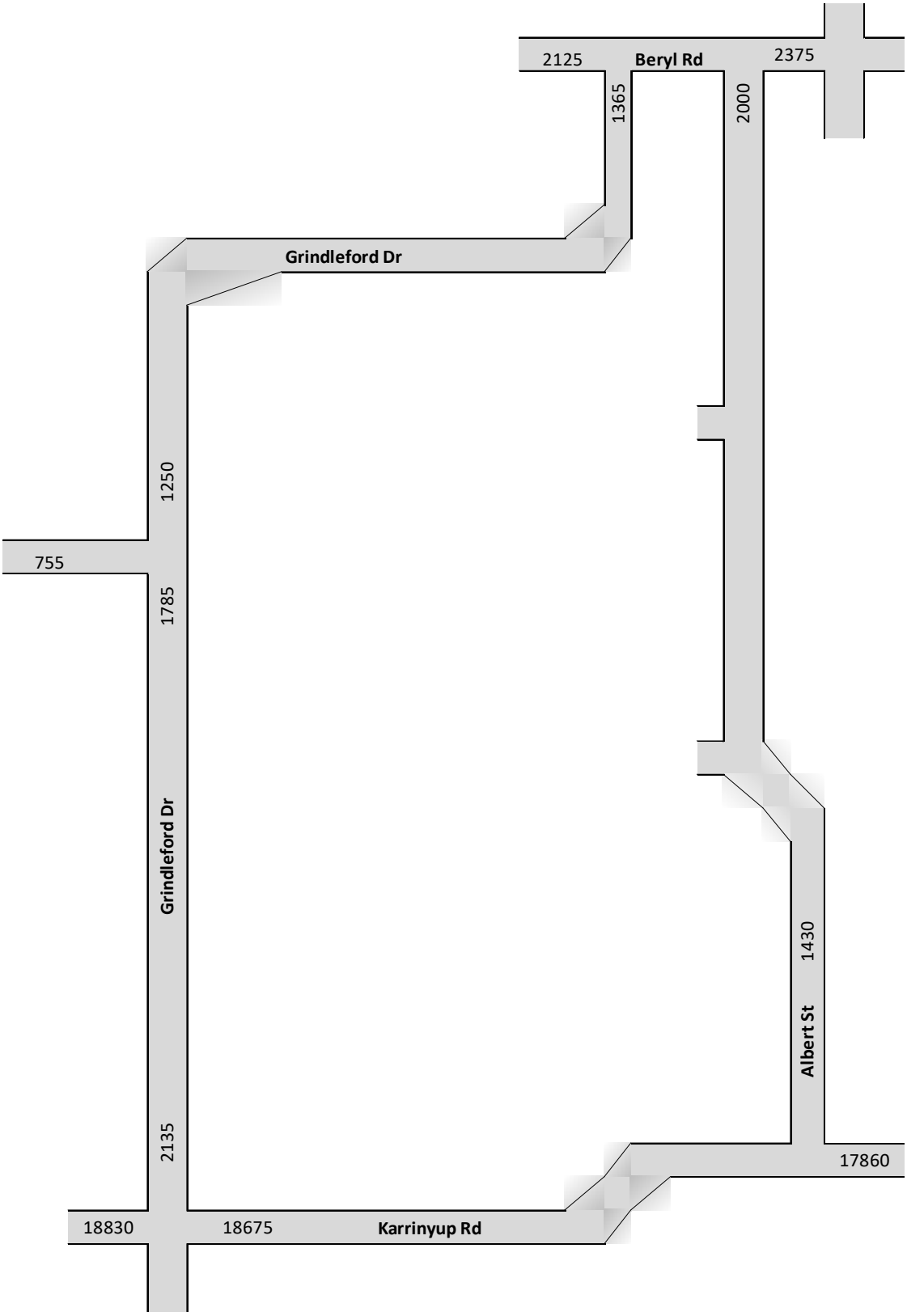


Figure 5.7: 2017 Daily Background Traffic (no development)

2017 AM Background Traffic

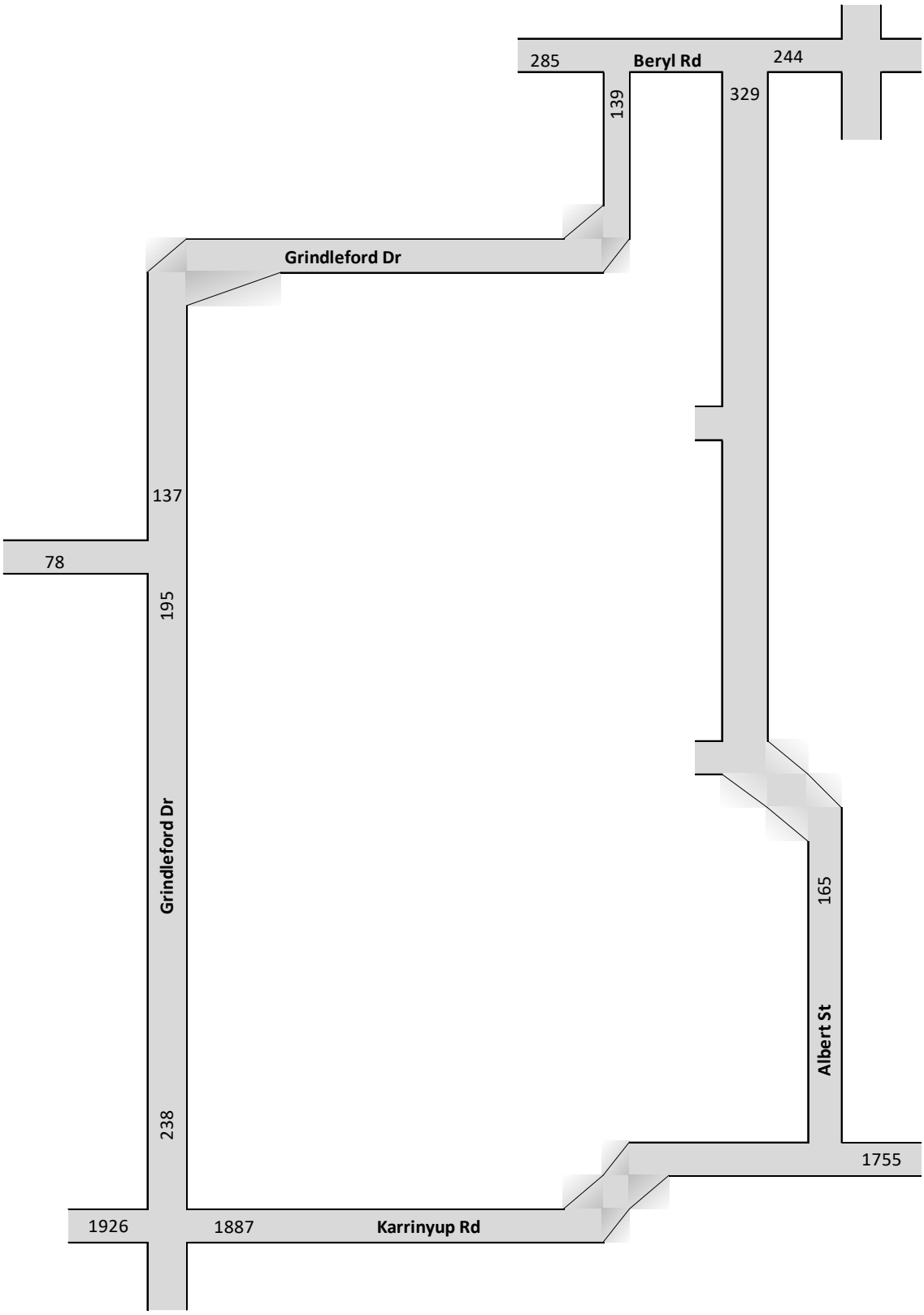


Figure 5.8: 2017 AM Peak Hour Background Traffic (no development)

2017 PM Background Traffic

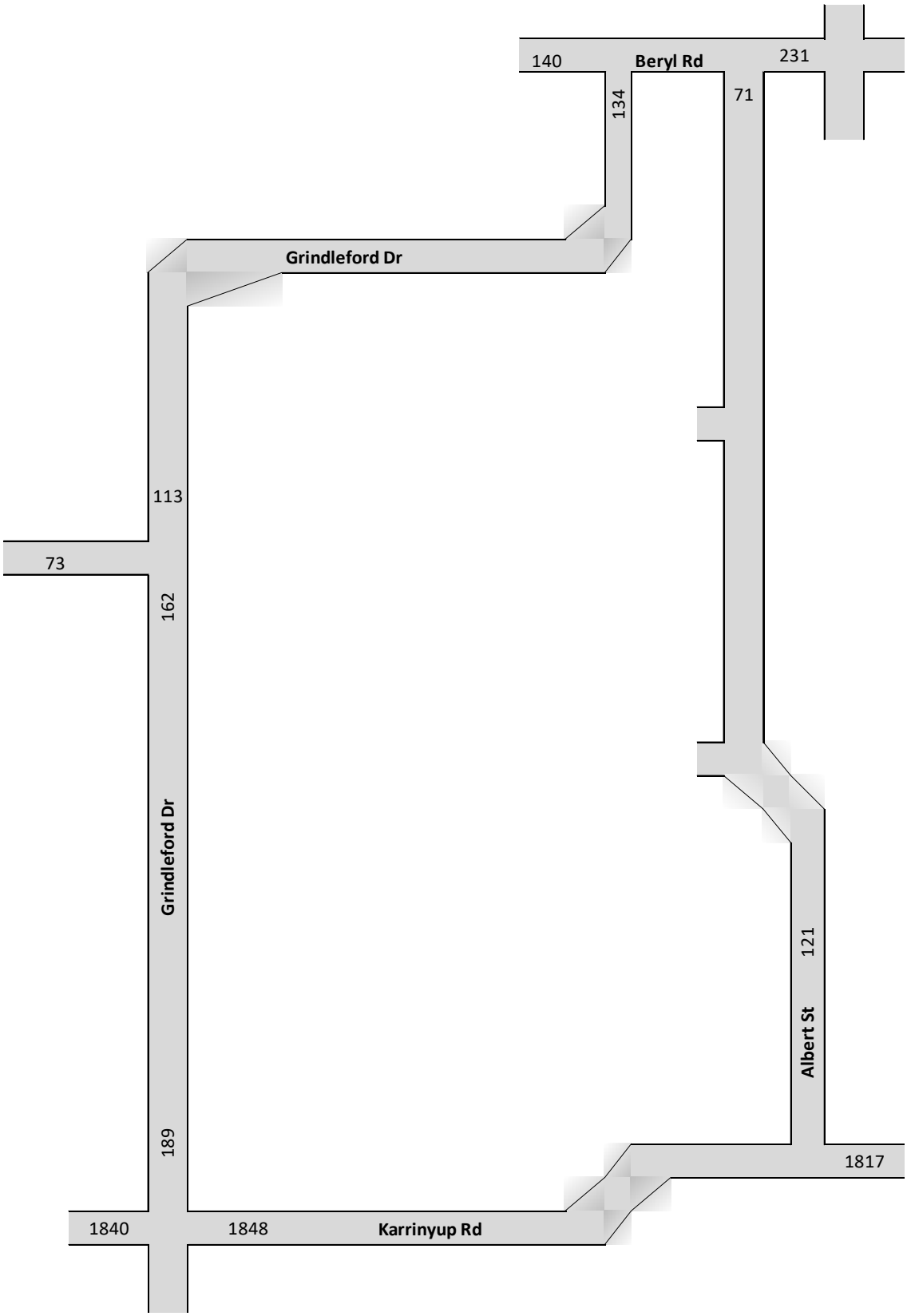


Figure 5.9: 2017 PM Peak Hour Background Traffic (no development)

5.3 THROUGH TRAFFIC

The road network surrounding the development site provides good access for through trips from neighbouring suburbs without needing to use the new subdivision roads.

From north to south access is provided by Grindleford Drive and Albert Street, with Grindleford Drive providing excellent access to the neighbourhood centre. Grindleford Drive also provides excellent access for traffic from the neighbouring suburb of Roselea. Both Grindleford Drive north of Coralvine Grange and Albert Street are only classified as Access Roads.

The east-west movements are well catered for via Karrinyup Road, a Primary Distributor road, and to a lesser extent Beryl Street, which is classified as a Local Distributor road.

The level of non-subdivision traffic expected to pass through the Structure Plan area is therefore minimal and the resultant impact on the proposed intersections would be negligible.

5.4 ANALYSIS OF ROADS

The Structure Plan area is expected to generate approximately 13,000 vpd in total and this traffic will be distributed over several accesses. According to *Liveable Neighbourhoods, (WAPC 2009),* the indicative maximum volume of traffic suitable for an access street varies from 3,000 vpd based on a pavement width of at least 7.2m to 1,000 vpd based on a pavement width of 5.5-6m.

The proposed internal road layouts were discussed in **Section 4.1**. All internal roads except those adjacent to the neighbourhood centre carry low volumes of traffic (less than 1,000 vpd) and are all classified as Access Roads.

Austroads *Guide to Traffic Management* provides advice on the capacity of unsignalised intersections. For minor roads where there are relatively low volumes of turning traffic, capacity considerations are usually not significant and capacity analysis is unnecessary. Intersection volumes, below which capacity analysis is unnecessary, are indicated in **Table 5.2**. It can be seen that for a two-lane major road, when the flow on the major road is 650 vehicles per hour (vph) or less, the crossroads would easily accommodate up to 100vph.

Table 5.2: Intersection Volumes below which Capacity Analysis is unnecessary (Austroads 2009)

Type of road	**Light cross and turning volumes maximum design hour volumes (vehicles per hour (two-way))**		
Four lane major road	1000	1500	2000
Crossroads	100	50	25
Two lane major road	400	500	650
Crossroads	250	200	100

After discussions with the City of Stirling, MRWA and the Department of Transport, a background traffic growth rate of 1% per annum has been applied to existing 2017 traffic flows, for growth between

2017 and 2021 (opening) and between 2021 and 2031. This rate of growth equates to an overall increase of 4.1% by 2021, and 15% by 2031.

The midblock capacity of the surrounding roads i.e. Grindleford Drive, Beryl Street, Albert Street and Karrinyup Road is not exceeded by the forecast increases to 2031, inclusive of the forecast subdivision traffic. Capacity along these roads (especially Karrinyup Road) is dictated by their capacity at intersections, although as is shown in the following **Section 5.5**, intersection capacity too is not exceeded by the proposed development.

5.5 ANALYSIS OF INTERSECTIONS

5.5.1 Intersections internal to the development

It can be seen from **Figures 5.1** and **5.2** and reference to **Table 5.2** that there is sufficient capacity at the proposed intersections within the development. Minor road peak hour volumes are mostly less than 100 vph, and the major roads are well below the 650 vph threshold.

5.5.2 Scenario 1 - External intersections

Traffic counts undertaken for this study are summarised in **Appendix D**. Forecast traffic at 2031 was calculated by factoring background traffic volumes for growth and adding the forecast development traffic volumes. SIDRA analyses were undertaken for a number of the key external intersections; analysis at two intersections, Karrinyup Road/Grindleford Drive and Main Street/Beryl Street, are discussed in the body of the report. Other intersection analysis for the morning peak is shown in **Appendix E**.

SIDRA is an intersection-modelling tool commonly used by traffic engineers for all types of intersection analysis. 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: 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.

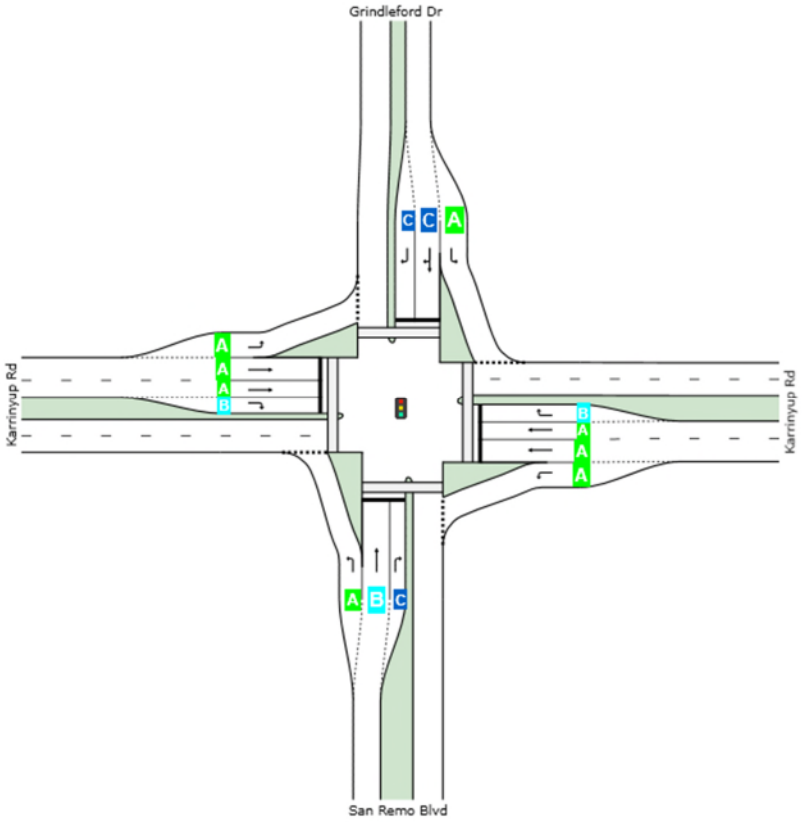
Level of Service (LoS): is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free 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 passing through the intersection.

95% Queue: is the queue length below which 95% of all observed queue lengths fall.

The intersections were modelled at the 2031 horizon year assuming that if the intersection performed adequately then, it would perform adequately at the opening year 2021.

A SIDRA analysis was undertaken for the intersection of Karrinyup Road with Grindleford Drive and the model output is shown in **Figure 5.10** and **Figure 5.11** for the AM and PM peak hours, respectively.

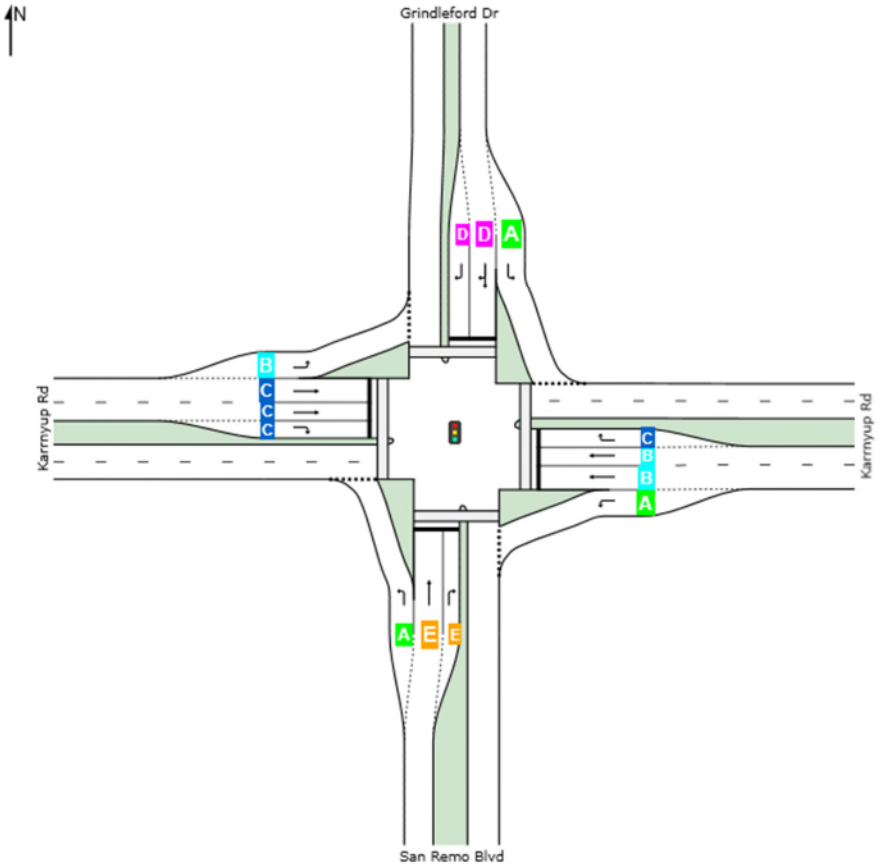


Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: San Remo Blvd											
1	L2	83	2.0	0.132	7.9	LOS A	0.5	3.7	0.58	0.65	50.0
2	T1	17	2.0	0.046	15.4	LOS B	0.3	2.0	0.86	0.59	38.1
3	R2	58	2.0	0.211	21.8	LOS C	1.1	7.6	0.91	0.73	39.1
Approach		158	2.0	0.211	13.8	LOS B	1.1	7.6	0.73	0.67	44.0
East: Karrinyup Rd											
4	L2	11	5.0	0.010	8.7	LOS A	0.1	0.4	0.44	0.63	52.3
5	T1	864	5.0	0.419	6.4	LOS A	5.4	39.4	0.65	0.56	62.4
6	R2	124	5.0	0.485	19.6	LOS B	2.2	15.8	0.84	0.79	44.9
Approach		999	5.0	0.485	8.0	LOS A	5.4	39.4	0.67	0.59	59.5
North: Grindleford Dr											
7	L2	99	20.0	0.168	8.7	LOS A	0.8	6.9	0.61	0.67	46.2
8	T1	83	2.0	0.627	18.6	LOS B	3.7	26.5	0.97	0.85	35.1
9	R2	274	2.0	0.627	23.6	LOS C	3.7	26.5	0.98	0.85	41.7
Approach		456	5.9	0.627	19.4	LOS B	3.7	26.5	0.90	0.81	41.6
West: Karrinyup Rd											
10	L2	92	5.0	0.083	8.9	LOS A	0.5	3.9	0.47	0.68	51.3
11	T1	1253	5.0	0.608	7.3	LOS A	9.0	65.6	0.75	0.66	61.4
12	R2	131	5.0	0.369	16.5	LOS B	1.9	14.2	0.74	0.76	45.0
Approach		1475	5.0	0.608	8.2	LOS A	9.0	65.6	0.73	0.67	59.4
All Vehicles		3087	5.0	0.627	10.1	LOS B	9.0	65.6	0.74	0.66	55.3

Figure 5.10: Scenario 1 SIDRA Results for Karrinyup Road and Grindleford Drive (AM Peak Hour)

The future lane configuration for the intersection of Karrinyup Road and Grindleford Drive was determined by the PM peak hour demand. The relatively high right-turn from Grindleford Drive north onto Karrinyup Road indicated that additional capacity was required. This can be achieved simply by changing the through-movement (southbound) lane marking to a right and through movement as shown in **Figure 5.11**. The overall intersection LoS is B in the AM and LoS C in the PM.

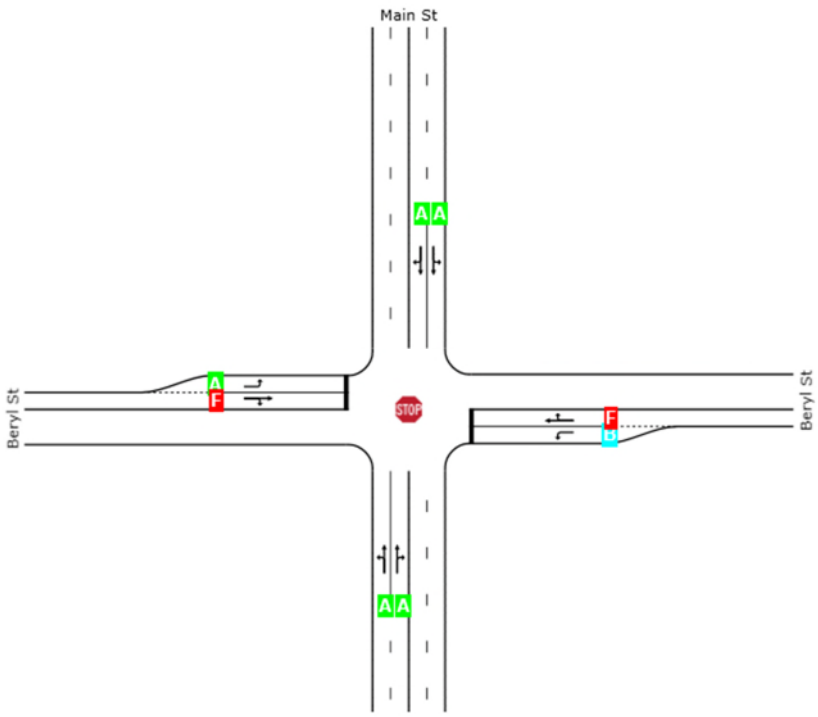


Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: San Remo Blvd											
1	L2	103	2.0	0.092	8.4	LOS A	1.5	10.5	0.33	0.60	49.4
2	T1	78	2.0	0.637	63.6	LOS E	4.8	34.0	1.00	0.80	21.9
3	R2	41	2.0	0.353	66.3	LOS E	2.4	17.4	1.00	0.73	23.0
Approach		222	2.0	0.637	38.5	LOS D	4.8	34.0	0.69	0.69	29.8
East: Karrinyup Rd											
4	L2	49	5.0	0.034	7.1	LOS A	0.2	1.4	0.13	0.61	54.1
5	T1	1025	5.0	0.402	10.5	LOS B	14.3	104.3	0.51	0.46	58.4
6	R2	275	5.0	0.667	25.9	LOS C	7.9	57.4	0.95	0.85	41.7
Approach		1349	5.0	0.667	13.5	LOS B	14.3	104.3	0.59	0.54	53.8
North: Grindleford Dr											
7	L2	31	2.0	0.031	9.5	LOS A	0.5	3.6	0.35	0.59	48.9
8	T1	18	2.0	0.474	42.7	LOS D	7.1	50.4	0.96	0.78	25.7
9	R2	258	2.0	0.474	47.7	LOS D	7.1	50.4	0.96	0.79	32.6
Approach		306	2.0	0.474	43.6	LOS D	7.1	50.4	0.90	0.77	33.4
West: Karrinyup Rd											
10	L2	221	5.0	0.208	12.3	LOS B	3.4	25.0	0.47	0.71	49.1
11	T1	1018	5.0	0.671	28.6	LOS C	23.7	172.8	0.83	0.74	45.4
12	R2	51	5.0	0.083	28.5	LOS C	1.7	12.7	0.63	0.71	36.9
Approach		1289	5.0	0.671	25.8	LOS C	23.7	172.8	0.76	0.73	45.7
All Vehicles		3167	4.5	0.671	23.2	LOS C	23.7	172.8	0.70	0.65	45.9

Figure 5.11: Scenario 1 SIDRA Results for Karrinyup Road and Grindleford Drive (PM Peak Hour)

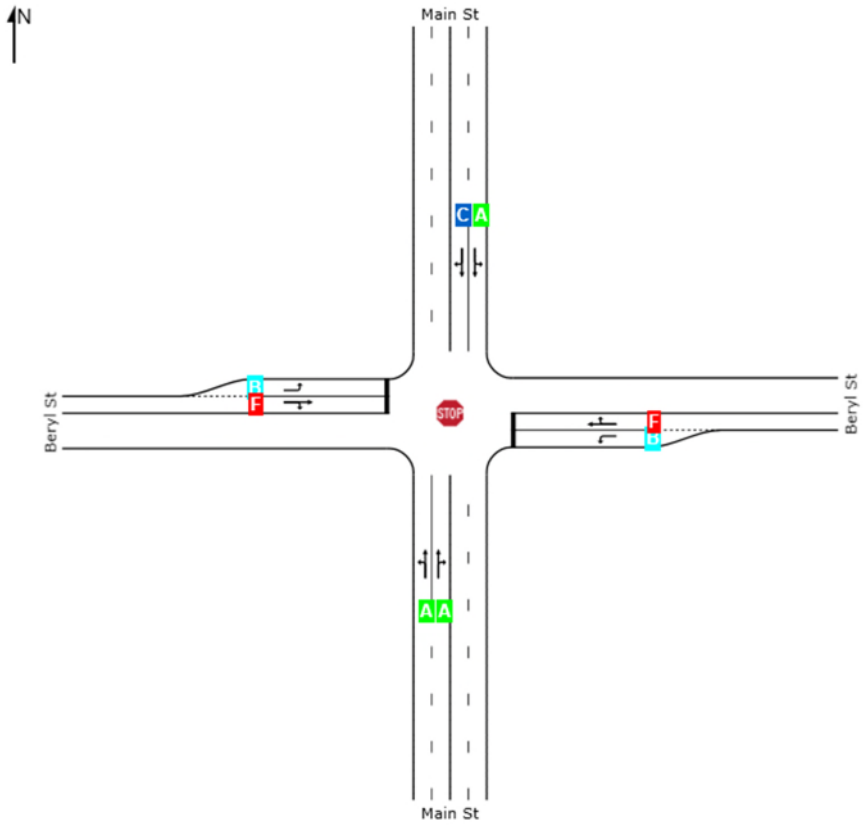
The results of the SIDRA Analysis for the Main Street/Beryl Street intersection are shown in **Figures 5.12** and **5.13** for the AM and PM peak hours, respectively.



Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Main St											
1	L2	49	5.0	0.145	5.6	LOS A	0.0	0.0	0.00	0.11	55.7
2	T1	400	5.0	0.145	1.6	LOS A	0.7	5.4	0.13	0.08	57.2
3	R2	15	5.0	0.145	18.9	LOS C	0.7	5.4	0.29	0.05	50.6
Approach		464	5.0	0.145	2.6	NA	0.7	5.4	0.12	0.09	56.8
East: Beryl St											
4	L2	1	2.0	0.002	13.2	LOS B	0.0	0.1	0.63	0.82	45.0
5	T1	22	2.0	2.126	1153.1	LOS F	24.4	173.9	1.00	2.03	1.8
6	R2	34	2.0	2.126	1187.6	LOS F	24.4	173.9	1.00	2.03	2.4
Approach		57	2.0	2.126	1152.5	LOS F	24.4	173.9	0.99	2.01	2.2
North: Main St											
7	L2	15	5.0	0.422	5.6	LOS A	0.0	0.0	0.00	0.01	57.6
8	T1	1327	5.0	0.422	0.6	LOS A	2.0	14.3	0.11	0.06	58.7
9	R2	112	5.0	0.422	9.3	LOS A	2.0	14.3	0.25	0.12	51.9
Approach		1454	5.0	0.422	1.3	NA	2.0	14.3	0.12	0.06	58.3
West: Beryl St											
10	L2	126	2.0	0.133	8.7	LOS A	0.5	3.6	0.35	0.89	44.9
11	T1	8	2.0	1.102	365.2	LOS F	6.1	43.5	1.00	1.38	5.2
12	R2	25	2.0	1.102	399.1	LOS F	6.1	43.5	1.00	1.38	5.7
Approach		160	2.0	1.102	89.1	LOS F	6.1	43.5	0.48	1.00	17.0
All Vehicles		2135	4.7	2.126	38.8	NA	24.4	173.9	0.17	0.19	33.4

Figure 5.12: Scenario 1 SIDRA Results for Beryl Street and Main Street (AM Peak Hour)



Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Main St											
1	L2	64	5.0	0.387	5.6	LOS A	0.0	0.0	0.00	0.05	56.2
2	T1	1318	5.0	0.387	0.2	LOS A	0.6	4.7	0.04	0.04	59.3
3	R2	26	5.0	0.387	10.4	LOS B	0.6	4.7	0.08	0.02	53.6
Approach		1408	5.0	0.387	0.7	NA	0.6	4.7	0.04	0.04	59.0
East: Beryl St											
4	L2	22	2.0	0.034	10.8	LOS B	0.1	0.8	0.51	0.91	46.3
5	T1	12	2.0	0.426	164.2	LOS F	1.2	8.6	0.99	1.03	10.8
6	R2	1	2.0	0.426	226.9	LOS F	1.2	8.6	0.99	1.03	13.6
Approach		35	2.0	0.426	68.5	LOS F	1.2	8.6	0.68	0.95	24.3
North: Main St											
7	L2	7	5.0	0.290	5.6	LOS A	0.0	0.0	0.00	0.01	57.6
8	T1	535	5.0	0.290	0.0	LOS A	0.0	0.0	0.00	0.01	59.8
9	R2	109	5.0	0.425	23.8	LOS C	1.5	11.0	0.90	1.02	34.6
Approach		652	5.0	0.425	4.1	NA	1.5	11.0	0.15	0.18	55.1
West: Beryl St											
10	L2	95	2.0	0.179	12.8	LOS B	0.6	4.5	0.62	1.00	41.9
11	T1	16	2.0	1.932	1006.2	LOS F	19.7	140.2	1.00	1.89	2.0
12	R2	32	2.0	1.932	1034.6	LOS F	19.7	140.2	1.00	1.89	2.2
Approach		142	2.0	1.932	350.3	LOS F	19.7	140.2	0.75	1.30	5.5
All Vehicles		2237	4.8	1.932	24.9	NA	19.7	140.2	0.13	0.17	39.6

Figure 5.13: Scenario 1 SIDRA Results for Beryl Street and Main Street (PM Peak Hour)

During the traffic surveys, short queues were observed on the Beryl Street approaches for vehicles crossing Main Street and turning right. This is expected as turning vehicles need to cross 4 lanes of traffic which in this case carry high volumes of traffic. At the 2031 horizon the modelled delays increase significantly as turning demand and opposing flows increase. In reality drivers will not tolerate lengthy

queues and delays and will find alternative routes where the turning movements are controlled by traffic signals or a roundabout.

It is worth noting that in this case traffic from East Roselea is not affected by the delays nor does it contribute to them. The demand from East Roselea is to and from the north and both of these movements experience only moderate delays in 2031.

5.5.3 Scenario 2 - External Intersections

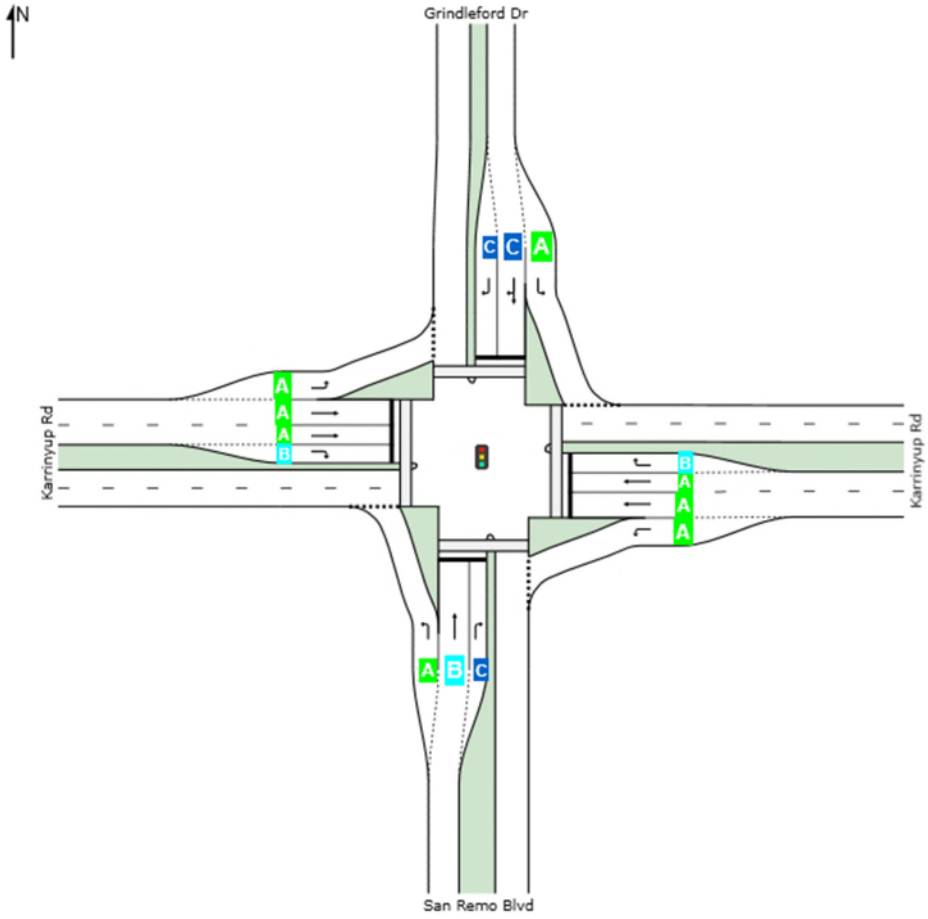
Scenario 2 models changes to the road network which reflect the different development timelines for the different land owners within the structure plan area.

The changes to the network are:

- No Spine Road through the central section of the area, specifically through the land currently owned by the Chung Wah Association; and

- No Spine Road connection to Karrinyup Road. The left-in to the neighbourhood centre is retained, although no left-out is permitted. This is considered a worst-case scenario as all east-bound traffic from the neighbourhood centre would need to exit via Grindleford Drive.

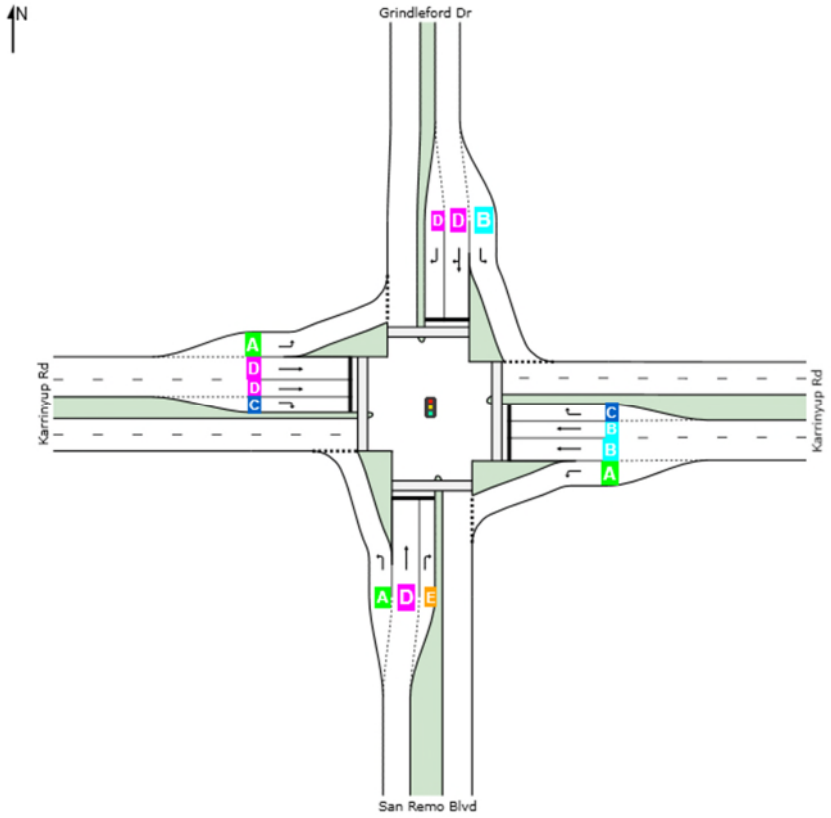
The changes to the network have little or no impact on the northern parts of the movement networks. Intersection analysis results are unchanged from Scenario 1 for the Beryl Street/Main Street intersection. In the south, the revised traffic volumes for the Karrinyup Road/Grindleford Drive intersection were modelled and the results shown below in **Figure 5.14** and **5.15** for the AM and PM peaks, respectively. The double right turn from Grindleford Drive has been modelled and again acceptable levels of delay are expected. Similarly, the intersection of Grindleford Drive/Road 6 was modelled and again showed ample capacity.



Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: San Remo Blvd											
1	L2	83	2.0	0.132	7.9	LOS A	0.5	3.7	0.58	0.65	50.0
2	T1	17	2.0	0.046	15.4	LOS B	0.3	2.0	0.86	0.59	38.1
3	R2	58	2.0	0.211	21.8	LOS C	1.1	7.6	0.91	0.73	39.1
Approach		158	2.0	0.211	13.8	LOS B	1.1	7.6	0.73	0.67	44.0
East: Karrinyup Rd											
4	L2	11	5.0	0.010	8.7	LOS A	0.1	0.4	0.44	0.63	52.3
5	T1	864	5.0	0.419	6.4	LOS A	5.4	39.4	0.65	0.56	62.4
6	R2	124	5.0	0.485	19.6	LOS B	2.2	15.8	0.84	0.79	44.9
Approach		999	5.0	0.485	8.0	LOS A	5.4	39.4	0.67	0.59	59.5
North: Grindleford Dr											
7	L2	123	20.0	0.210	8.8	LOS A	1.1	8.9	0.63	0.69	46.1
8	T1	83	2.0	0.627	18.6	LOS B	3.7	26.5	0.97	0.85	35.1
9	R2	274	2.0	0.627	23.6	LOS C	3.7	26.5	0.98	0.85	41.7
Approach		480	6.6	0.627	18.9	LOS B	3.7	26.5	0.89	0.81	41.8
West: Karrinyup Rd											
10	L2	109	5.0	0.099	9.0	LOS A	0.6	4.7	0.47	0.68	51.2
11	T1	1253	5.0	0.608	7.3	LOS A	9.0	65.6	0.75	0.66	61.4
12	R2	131	5.0	0.369	16.5	LOS B	1.9	14.2	0.74	0.76	45.0
Approach		1493	5.0	0.608	8.2	LOS A	9.0	65.6	0.73	0.67	59.3
All Vehicles		3129	5.1	0.627	10.1	LOS B	9.0	65.6	0.73	0.67	55.2

Figure 5.14: Scenario 2 SIDRA Results for Karrinyup Road and Grindleford Drive (AM Peak Hour)



Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: San Remo Blvd											
1	L2	103	2.0	0.095	8.6	LOS A	1.4	9.8	0.37	0.61	49.2
2	T1	78	2.0	0.620	53.4	LOS D	4.0	28.5	1.00	0.80	24.0
3	R2	41	2.0	0.335	56.2	LOS E	2.0	14.6	0.99	0.73	25.3
Approach		222	2.0	0.620	33.1	LOS C	4.0	28.5	0.71	0.70	31.9
East: Karrinyup Rd											
4	L2	49	5.0	0.033	7.2	LOS A	0.2	1.4	0.15	0.61	54.0
5	T1	1025	5.0	0.435	11.5	LOS B	13.7	100.1	0.58	0.52	57.5
6	R2	275	5.0	0.691	32.1	LOS C	8.4	61.5	0.97	0.87	39.0
Approach		1349	5.0	0.691	15.5	LOS B	13.7	100.1	0.65	0.59	52.3
North: Grindleford Dr											
7	L2	166	2.0	0.162	12.1	LOS B	3.3	23.7	0.47	0.64	47.3
8	T1	18	2.0	0.422	33.4	LOS C	5.7	40.8	0.93	0.77	28.5
9	R2	258	2.0	0.422	38.4	LOS D	5.7	40.8	0.94	0.78	35.6
Approach		442	2.0	0.422	28.3	LOS C	5.7	40.8	0.76	0.73	39.0
West: Karrinyup Rd											
10	L2	264	5.0	0.214	9.8	LOS A	2.8	20.6	0.39	0.69	50.8
11	T1	1087	5.0	0.916	50.3	LOS D	32.8	239.3	0.98	1.07	35.8
12	R2	51	5.0	0.102	30.9	LOS C	1.7	12.3	0.72	0.72	35.6
Approach		1402	5.0	0.916	42.0	LOS D	32.8	239.3	0.86	0.99	37.9
All Vehicles		3416	4.4	0.916	29.2	LOS C	32.8	239.3	0.75	0.78	42.4

Figure 5.15: Scenario 2 SIDRA Results for Karrinyup Road and Grindleford Drive (PM Peak Hour)

5.5.4 Scenario 3 – External Intersections

As noted previously, Scenario 3 traffic has not been modelled explicitly as there are only minor changes to the road network in Scenario 2. The changes are:

- Road 3 intersects with Grindleford Drive and no longer forms a closed internal loop with Road 2;
- The Spine Road is continuous through the Chaung Wah Association property thus linking the northern and southern sections of the Structure Plan area; and
- Rear laneways are provided to the parcels of land directly east of the playing field open space area.

The continuity of the Spine Road does provide increased accessibility for northern residents to access the neighbourhood centre whereas previously they might have used Grindleford Drive. Also, some residents travelling to the Karrinyup Road/Grindleford Drive intersection may choose to join Grindleford Road further south i.e., via Roads 4, 5 or 6. However, given the additional connection of Road 3 to Grindleford Drive, these volumes are likely to be small. In any event the traffic demand through the Karrinyup Road/Grindleford Drive intersection remains unchanged from Scenario 2.

6 PUBLIC TRANSPORT ACCESS

The City of Stirling's Integrated Transport Strategy identifies a number of desirable outcomes when planning for the future, including;
- Public Transport;
- Land use and Transport Integration;
- Pedestrian amenity; and
- Cycling Amenity.

East Roselea directly addresses these desired outcomes which are discussed in the context of Bus Routes and land use/transport integration (see Section 6.1) and Pedestrian and Cycle Facilities (see Section 6.2).

6.1 BUS ROUTES

The bus routes in the vicinity of the East Roselea development site are shown in **Figure 6.1**. The bus routes along Karrinyup Road (402, 998 and 999) are the most accessible to the southern portion of the site. Karrinyup Road is approximately 400m (i.e., walkable distance) from Coralvine Grange which is proposed to extend east west through the site in Scenario 1. Route 402 links Stirling Station on the Northern rail line to the underground Perth Bus Depot on Wellington Street. This gives excellent access both to the rail line for travel north and south and directly into the Perth CBD, and is especially relevant to residents in the southern half of the site i.e., the R60-80 density areas. There are four eastbound and four westbound bus stops on Karrinyup Road close to the development site. These bus stops and those on Main Street and Jones Street are shown in **Figure 6.2**.

Routes 998 and 999 are the Circle Routes which also pass Stirling Station and along Karrinyup Road to the south of the site.

Figure 6.1: Bus Routes

Source: Transperth

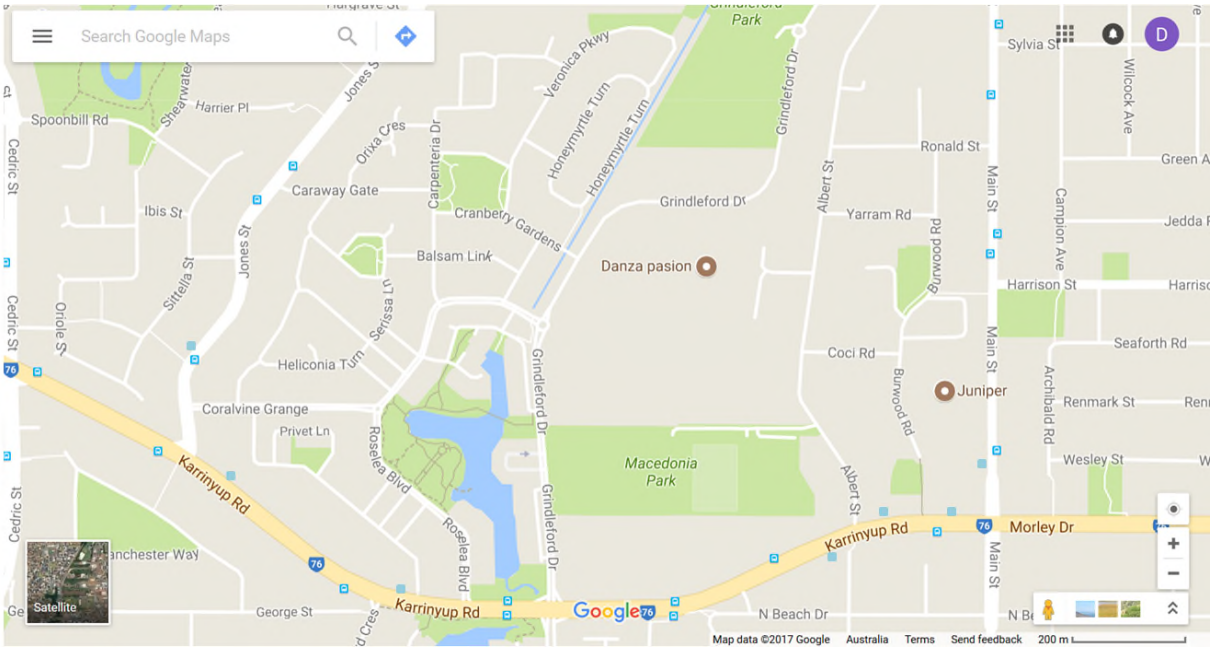


Figure 6.2: Bus Stop Locations along Karrinyup Road, Main Street and Jones Street

Source: Google

Route 414 passes along Main Street approximately 330m east of Albert Street (the site's eastern boundary) and also along Jones Street to the west. Some residents may access Main Street via Fortune Street, Albert Street and Roland Street or the footpath adjacent to Sapphire Crescent which is about an 800m walk to the stop after Harrison Street. Jones Street is about 630m to the west of Grindleford Drive, the western boundary of the site.

According to the City's Integrated Transport Strategy, major public transport corridors are proposed in the immediate vicinity. Karrinyup Road is proposed as a Major Public Transport Route linking the Stirling City Centre (and railway station) in the west to the Morley activity centre in the east. The residential density, especially in the southern half of East Roselea, is within easy walkable access to Karrinyup Road and strongly supports the desired strategic outcomes of integrated land use and transport planning. High frequency public transport services require patronage to make them viable and the location of East Roselea will contribute strongly to that success as the corridor is developed in future.

Similarly, Main Street is also identified in the City of Stirling Integrated Transport Strategy as a Major Public Transport Route. While Main Street is not a direct interface with East Roselea, parts of it are considered to be within a walkable catchment, and again support the future development of Main Street as a public transport corridor.

The proximity of major future public transport routes to the Structure Plan area also provides the opportunity to reduce parking across the City. The increased density of East Roselea contributes to the growth of public transport ridership which in turn provides the opportunity to relax parking supply requirements of future developments, both locally and in other areas of the City.

Given the proximity of East Roselea to existing bus routes on Karrinyup Road and therefore connectivity to the Northern rail line and future Major Public Transport Corridors, it is considered unlikely that any new routes would be introduced through the site. It is important however that walking and cycling facilities link the site to these corridors.

6.2 PEDESTRIAN AND CYCLING FACILITIES

The City's Integrated Transport Strategy identifies desired outcomes for pedestrian and cycling amenity. At a structure plan level these translate as providing footpaths on at least one side of all streets in the City and safe, convenient cycle movements which have priority over the movement of vehicles and with minimum impediment from traffic and pedestrians. For cycling this is supported further by the City's Integrated Cycling Strategy which advises that bike facilities in the City will '*no longer be provided on a piecemeal basis but will consist of developing a complete route that will have a defined function from start to end*'.

6.3 EXISTING FACILITIES

A 2.5m wide shared path exists on the west side of Grindleford Drive and a 1.2m wide footpath on the east side of Albert Street. There is a 1.2m wide footpath on either side of Karrinyup Road adjacent to the development site.

Figure 6.3 shows the Department of Transport's Bike Map for Stirling. Albert Street is designated as part of the Perth Bicycle Network (Route NE2). The western end of Karrinyup Road adjacent to the site is shown as a shared path.

On the south side of Karrinyup Road, George Street and Telford Crescent are shown as streets with a good riding environment and which provide excellent links to the Principle Shared Path (PSP) which runs along the Mitchell Freeway and is popular with commuter cyclists to the Perth CBD.

The Shared Path on the west side of Grindleford Drive is not shown on this map.

6.4 PROPOSED FACILITIES

Typical road cross sections as discussed in **Section 4.1** indicate footpaths are proposed on at least one side of the road within the development, with the majority of the roads having footpaths on both sides of the road. These will provide a safe network for pedestrians within the structure plan area.

Liveable Neighbourhoods suggests *'in residential areas where projected forecast volume is less than 3,000 vehicles per day, cycling should generally be on street shared with cars'*. Forecast volumes, as discussed in **Section 5.2**, reveal that no forecast traffic flows on the internal road network would exceed 3,000 vpd, except adjacent to the neighbourhood centre. Hence, on-street cycle lanes are not proposed in general within the internal road network. The Integrated Cycling Strategy notes '*Unless, or until suburban speeds are reduced (or these facilities are subject to lower speed limits), the least experienced cyclists will still need to be accommodated on the adjacent paths'*.

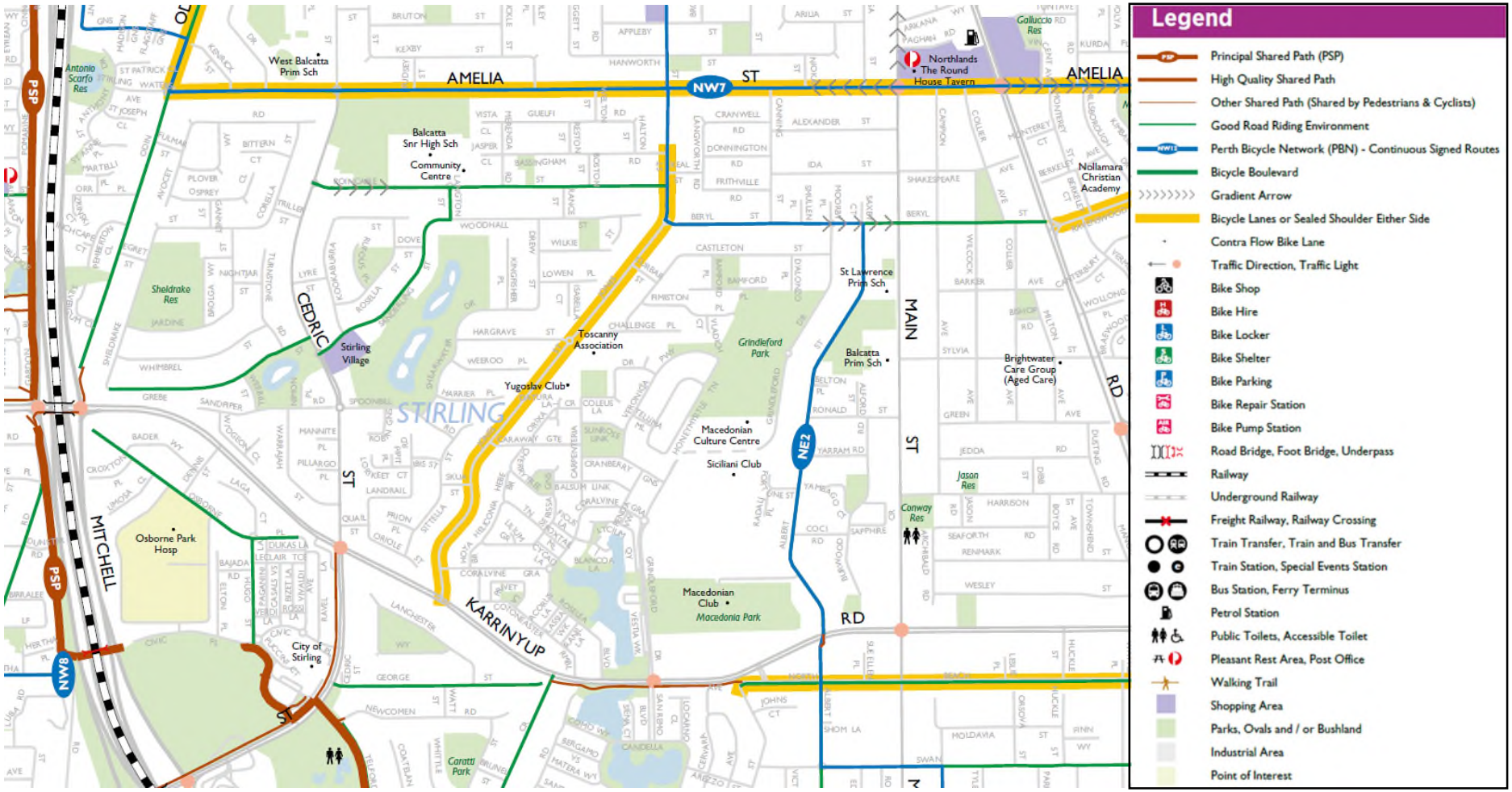
Most of the pedestrian and cycle demand is expected to gravitate to the south west corner of the development site, to the neighbourhood centre itself or to bus stops, signalised pedestrian crossings at the intersection of Grindleford Drive and Karrinyup Road or to routes further south. While some of this pedestrian and cycle traffic will access this via Grindleford Drive north of the neighbourhood centre, most users are likely to travel further south internally along the Spine Road to the neighbourhood centre (Scenarios 1 and 3).

To safely integrate cyclists and vehicles along the Spine Road, consideration should be given to introducing the Bike Boulevard concept there. While increasing the appeal of the road to cyclists, it has the added benefit of providing speed and volume management for vehicles. This should be done in conjunction with the City's own planning in the vicinity or as part of the Strategic Footpath Program. Any further consideration for the Spine Road should be part of the City's separate Bike Route Development Plan. Until then it is recommended that Group A cyclists (See Page 80 of the Integrated Cycling Plan) use the footpaths i.e., cyclists are not fully integrated onto the Spine Road.

Alternatively, the section of the Spine Road between Karrinyup Road and Road 3 should safely cater for cyclists and pedestrians by providing a 2.5m wide shared path on one side. This provision accords with the advice in the City's Integrated Cycling Strategy and the Liveable Neighbourhoods Guidelines; on roads with higher traffic volumes segregation between vehicles and cyclist is desirable.

In the absence of a continuous Spine Road connection more pedestrians and cyclists are expected to use the footpath adjacent to Grindleford Drive. Hence, a 2.5m wide shared path should be provided along the east side of Grindleford Drive to connect residential development with the neighbourhood centre. This is in keeping with current infrastructure i.e., the 2.5m shared path on the western side of Grindleford Drive.

Road 6 between the POS and neighbourhood centre is proposed as a 12m road reserve as discussed previously. The need to protect the row of mature trees located up to 4 m from the property boundary (and therefore 5m off the proposed northern kerb of Road 6) including their canopy on the northern side, creates a de facto northern verge of up to 10m and (and therefore a de facto road reserve of up to 22m) which can accommodate a shared path either side of the trees. Therefore, bike lanes are not required within the carriageway of Road 6 and nor is on-street parking on the northern side.


Legend
Principal Shared Path (PSP)
High Quality Shared Path
Other Shared Path (Shared by Pedestrians & Cyclists)
Good Road Riding Environment
Perth Bicycle Network (PBN) - Continuous Signed Routes
Bicycle Boulevard
Gradient Arrow
Bicycle Lanes or Sealed Shoulder Either Side
Contra Flow Bike Lane
Traffic Direction, Traffic Light
Bike Shop
Bike Hire
Bike Locker
Bike Shelter
Bike Parking
Bike Repair Station
Bike Pump Station
Road Bridge, Foot Bridge, Underpass
Railway
Underground Railway
Freight Railway, Railway Crossing
Train Transfer, Train and Bus Transfer
Train Station, Special Events Station
Bus Station, Ferry Terminus
Petrol Station
Public Toilets, Accessible Toilet
Pleasant Rest Area, Post Office
Walking Trail
Shopping Area
Parks, Ovals and / or Bushland
Industrial Area
Point of Interest
AMELIA
NW7
MAIN
CEDRIC
MITCHELL
KARRINYUP
STIRLING
NE2
NW8
PSP
West Balcatta Prim Sch
Balcatta Snr High Sch
Community Centre
Northlands
The Round House Tavern
Nollamara Christian Academy
St Lawrence Prim Sch
Balcatta Prim Sch
Brightwater Care Group (Aged Care)
Toscanny Association
Yugoslav Club
Macedonian Culture Centre
Siciliani Club
Macedonian Club
Macedonia Park
Grindleford Park
Stirling Village
Sheldrake Res
Osborne Park Hosp
City of Stirling
Caratti Park
Jason Res
Conway Res
Gallucio Res
Antonio Scarfo Res

7 SUMMARY AND RECOMMENDATIONS

The proposed East Roselea Structure Plan area includes approximately 635 residential lots with a range of densities including R30, R40-60 and R60-80. Most of the higher density lots are located in the southern portion of the area, immediately north of Karrinyup Road.

Also included in the southern part of the Structure Plan area is a neighbourhood centre which is an extension to the existing commercial outlets that include a medical centre and tool hire business. The total neighbourhood centre comprises approximately 7,200m^2 of retail and mixed use land use. For the purpose of this traffic study analysis, the existing commercial land use has been excluded.

The area has good connection to the surrounding movement network. Karrinyup Road to the south is a Primary Distributor route carrying 24,000 vpd, with direct connection to the Mitchell Freeway at Karrinyup Road interchange and indirectly via Cedric Street. Karrinyup Road also caters for a significant number of bus routes to and from the Stirling Station on the northern rail line.

Two blocks to the east of the site is Main Street; a major north/south arterial classified as a District Distributor A road carrying 21,000 vpd.

Directly to the west of the site is Grindleford Drive (1,900 pd) which previously existed as two separate parts, north and south. It has now been joined and links Beryl Street to the north to Karrinyup Road in the south. The intersection with Karrinyup Road is signalised. There are speed cushions on the new central section of Grindleford Drive, which is currently classified as an Access Road.

Immediately to the east of the site is Albert Street, which is also classified as an Access Road. It links Beryl Street to the north with Karrinyup Road to the south. Only left-in left-out movements are permitted at Karrinyup Road. Albert Street also has speed cushions.

Three road network scenarios were tested as part of this assessment. Scenario 3 has emerged as the Final Internal Road Network and the summary of results provided below relates to Scenario 3. Traffic was not specifically modelled for Scenario 3 as it is very similar to the modelling undertaken for Scenario 2. Complete traffic modelling results for Scenarios 1 and 2 are contained in the body of this report.

Traffic generated by the residential lots and neighbourhood centre has been distributed to the major external attractions (e.g. Perth City, Osborne Park, Joondalup etc.) and assigned to the internal and external roads in the surrounding movement network. The site is forecast to generate some 4,500 residential trips plus 8,600 retail/commercial trips per day.

All internal roads are forecast to carry less than 1,000 vpd and are classified as Access Roads. In the lower density northern parts of the site an Access Road Type D (15m road reserve or 13m against POS), as defined in Liveable Neighbourhoods is appropriate for this level of traffic. The north-south Spine Road is classified as a Neighbourhood Connector B (18m) with embayed on-street parking. In the higher density southern sections, Access Road B (18m) is considered appropriate to accommodate higher on-street parking demand associated with higher density living.

Adjacent to the neighbourhood centre, Spine Road is classified as a Neighbourhood Connector B (18m) to accommodate higher traffic volumes, pedestrian movements and on-street (embayed) parking. Road 6 to the north of the neighbourhood centre was originally classified as a Neighbourhood Connector A to accommodate neighbourhood centre traffic and on-street parking. However, DVC understands that a 12m road reserve has been negotiated between the Neighbourhood Centre proponents and the City. This was due to the difficulties of locating a road which functions as a Neighbourhood Connector in a situation impacted by a number of constraints, including site irregularity and critical dimensions, fragmented land tenure, the protection of an existing row of mature trees and the functionality of the City's playing fields land which abuts the Neighbourhood Centre to the immediate north.

As all internal road traffic volumes are forecast to be less than 1,000 vpd, most internal road intersections are either T-junctions or four-way, priority-controlled intersections. Roundabouts are proposed at the intersection of Spine Road and Road 6. A roundabout is also recommended at the intersection of Grindleford Drive and Road 6 to manage the forecast higher traffic volumes.

SIDRA intersection analysis was undertaken of all the key external road intersections. All have adequate spare capacity under both tested network scenarios at the ultimate forecast year (2031).

The intersection of Karrinyup Road and Grindleford Drive is forecast to experience some pressure especially during the PM peak hour in 2031. A SIDRA analysis of the intersection shows that if the existing southbound through lane from Grindleford Drive is repainted as a shared right turn and through lane, then traffic delay is acceptable. This would only be required when the neighbourhood centre is fully developed and after further growth in the existing background traffic. The intersection should be monitored to determine when this is needed. The overall 2031 forecast Level of Service at this intersection is LoS B in the AM peak hour and LoS C in the PM peak hour.

The intersection of Beryl Street and Main Street is also expected to experience some delay, especially at the 2031 forecast year. However, this delay is only experienced by vehicles on Beryl Street wishing to cross all four lanes of Main Street traffic. This is not related to traffic generated by the East Roselea Structure Plan area. In practice, vehicles experiencing this level of delay will find alternative routes with controlled intersections.

The East Roselea Structure Plan area is well served by sustainable transport modes. Karrinyup Road is 400m from the centre of the structure plan area and thus within walkable catchment of the public transport routes that travel along it. Importantly, the higher density areas in the southern portion of the site are all within easy walking distance of public transport routes.

Footpaths are proposed on at least one side of all internal access roads and traffic volumes are forecast to be sufficiently low to encourage on-street bicycle use. Albert Street is designated as part of the Perth Bicycle Network and Grindleford Drive has a 2.5m wide shared path along its western side. There is also a 1.2m wide footpath on either side of Karrinyup Road. Further south of Karrinyup Road there are excellent pedestrian and cycle links to the Principal Shared Path along the Mitchell Freeway.

A 2.5m wide shared path should be established along the east side of Grindleford Drive to connect the residential development with the neighbourhood centre in the absence of a link through the Chung Wah

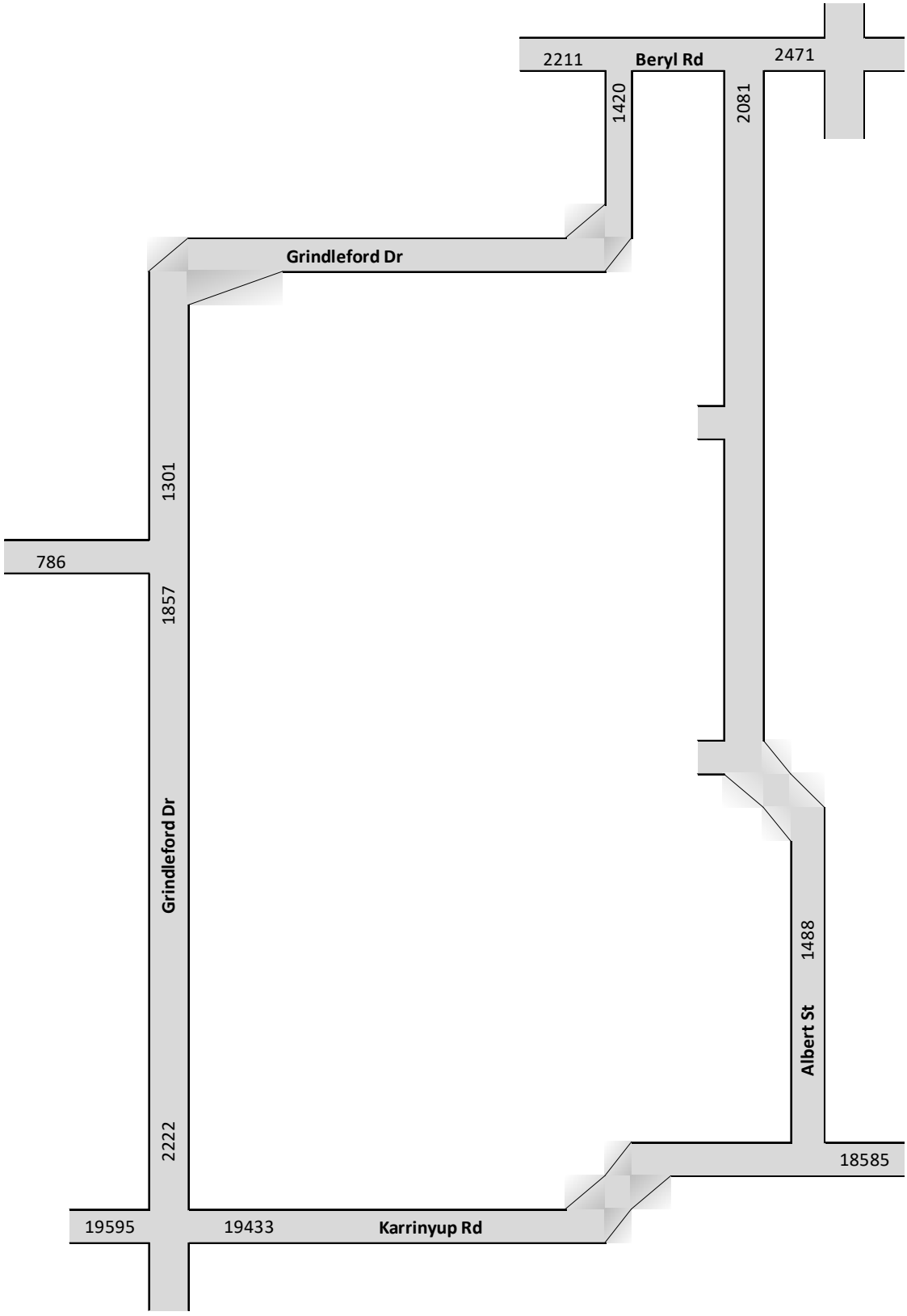
Association land. Additionally, the section of the Spine Road between Karrinyup Road and Road 3 should cater for cyclists and pedestrians by providing a 2.5m wide shared path on one side. Consideration should be given to creating a Bicycle Boulevard facility along the Spine Road, but only in conjunction with area wide planning of bike facilities by the City.

An additional pedestrian crossing (pedestrian ramps and paved median) of Karrinyup Road is proposed midblock between Albert Street and the neighbourhood centre to support public transport usage.

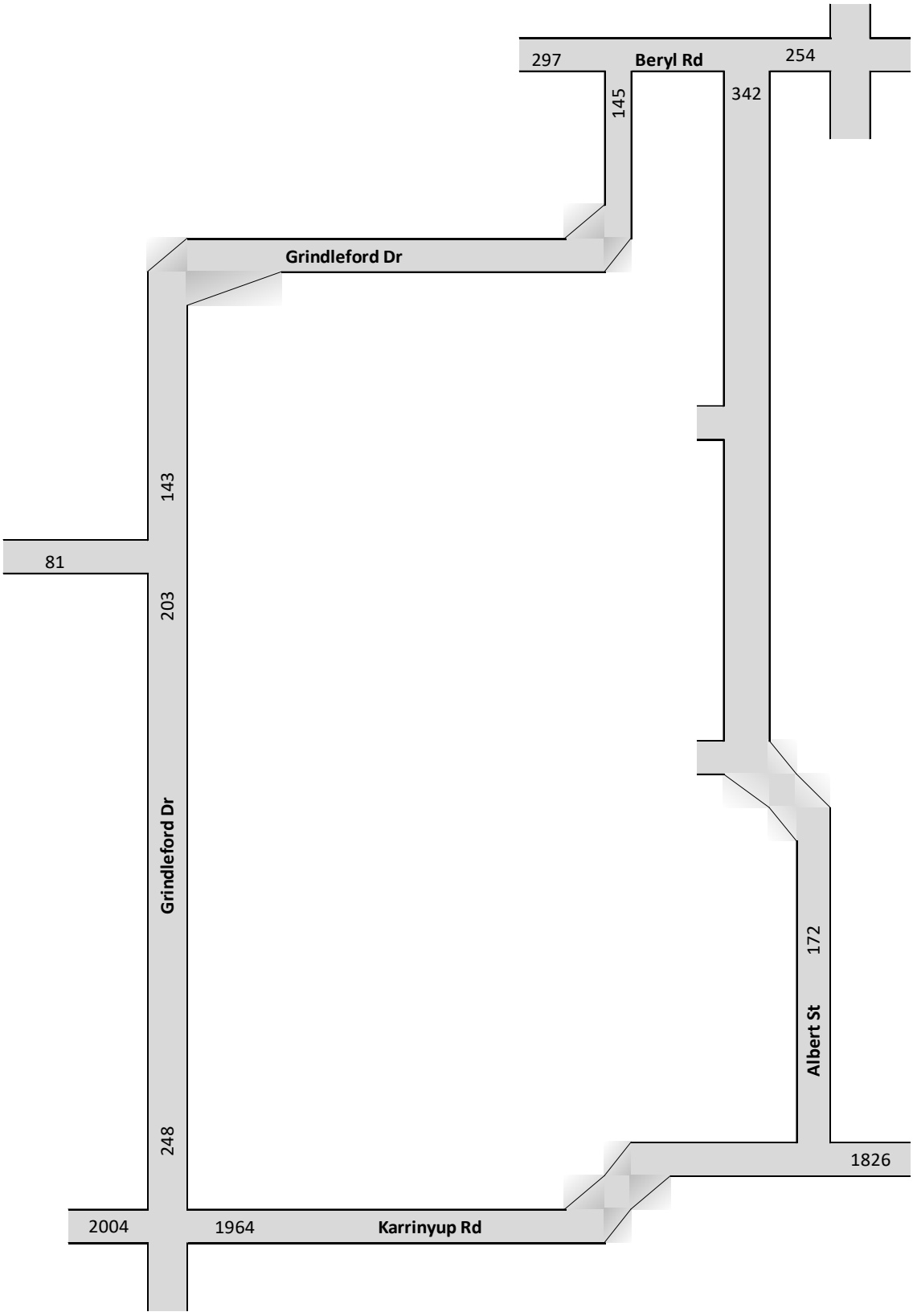
In conclusion, the structure plan development has appropriately and adequately considered the transport impact aspects and, as demonstrated in this report, are forecast to have an acceptable level of transport impact on the surrounding area. We therefore support the structure plan proposal from a traffic operational and road safety perspective.

APPENDIX A: 2021 OPENING AND 2031 DESIGN YEAR BACKGROUND TRAFFIC VOLUMES (NO DEVELOPMENT)

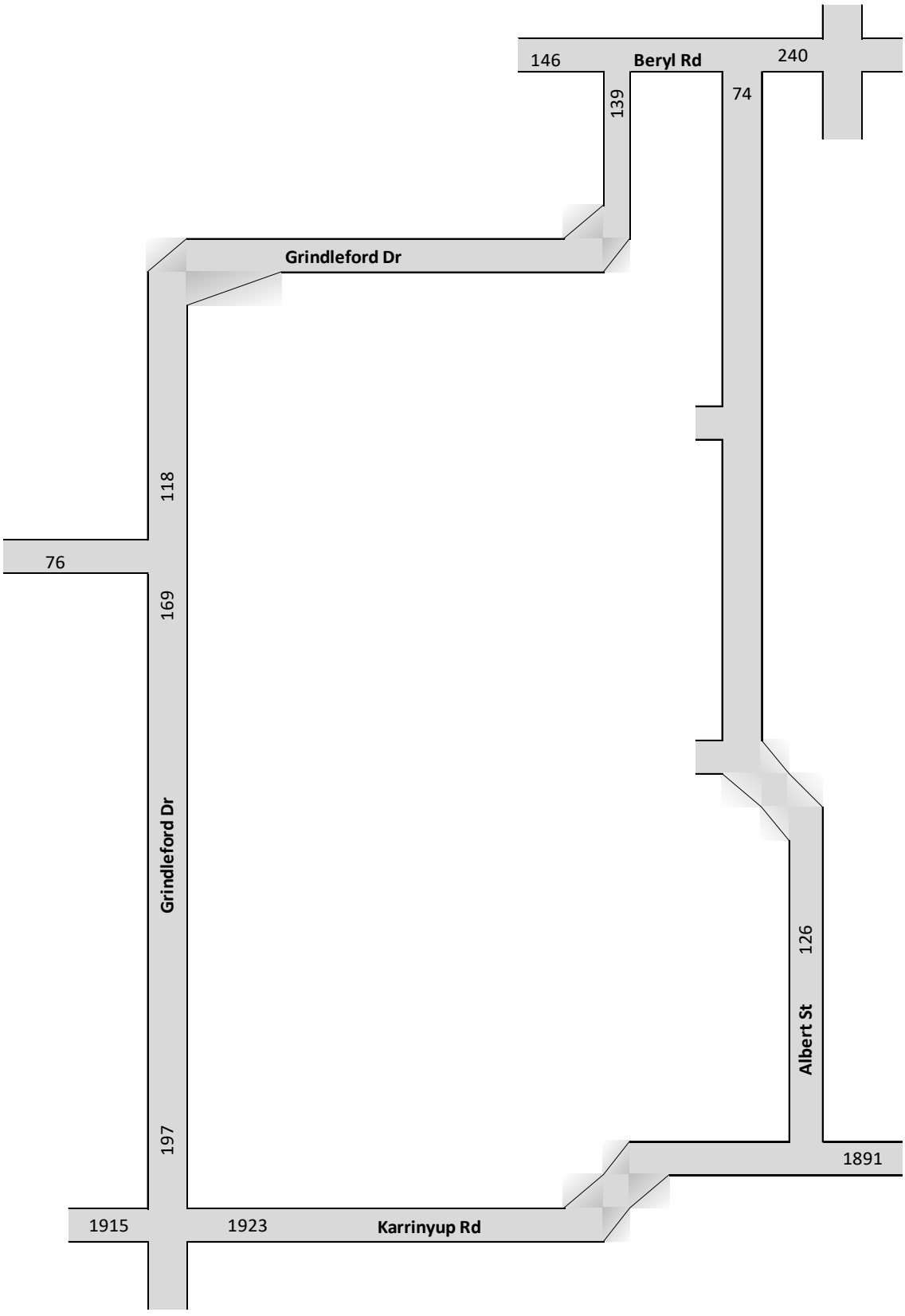
2021 Daily Background Traffic



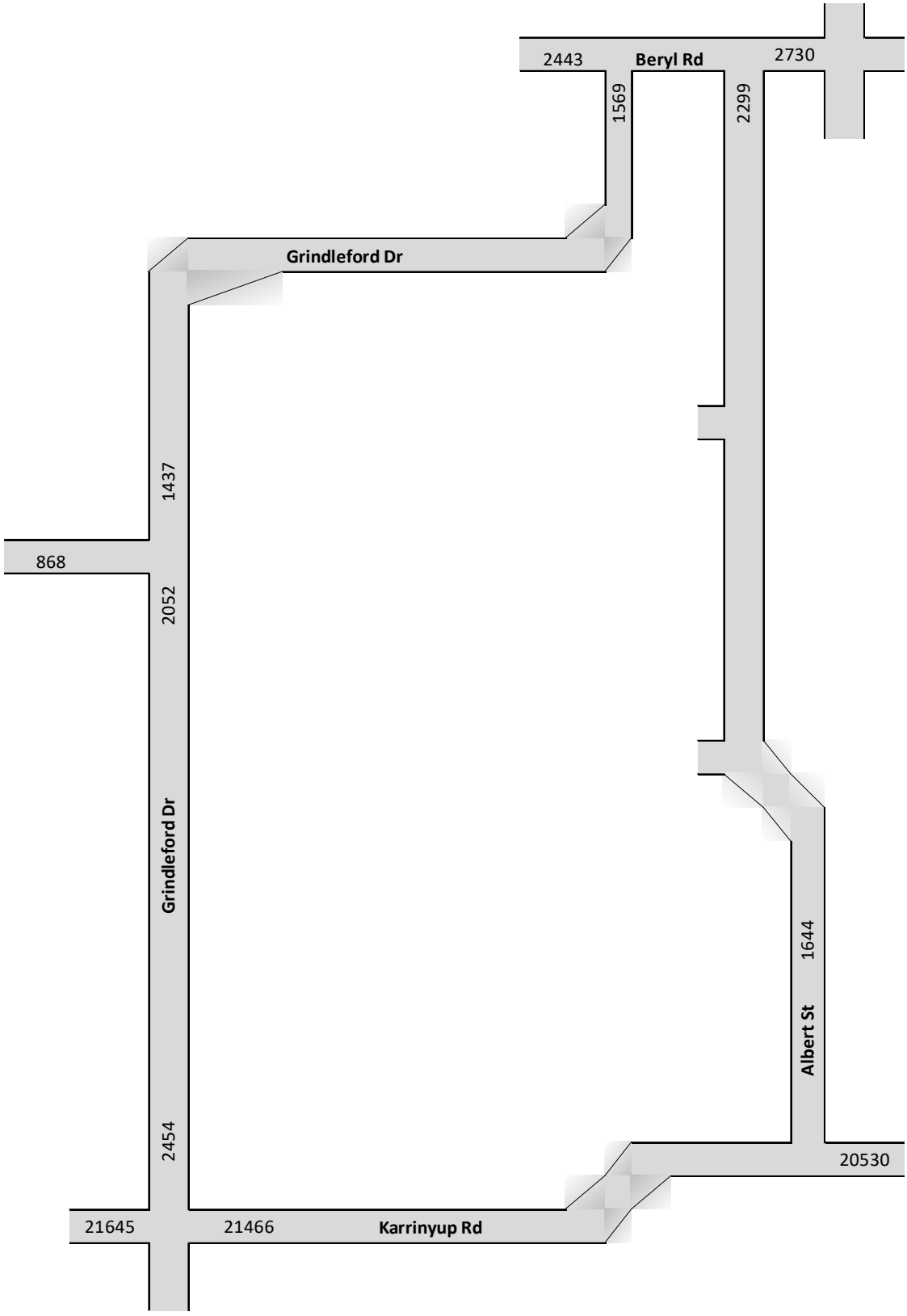
2021 AM Background Traffic



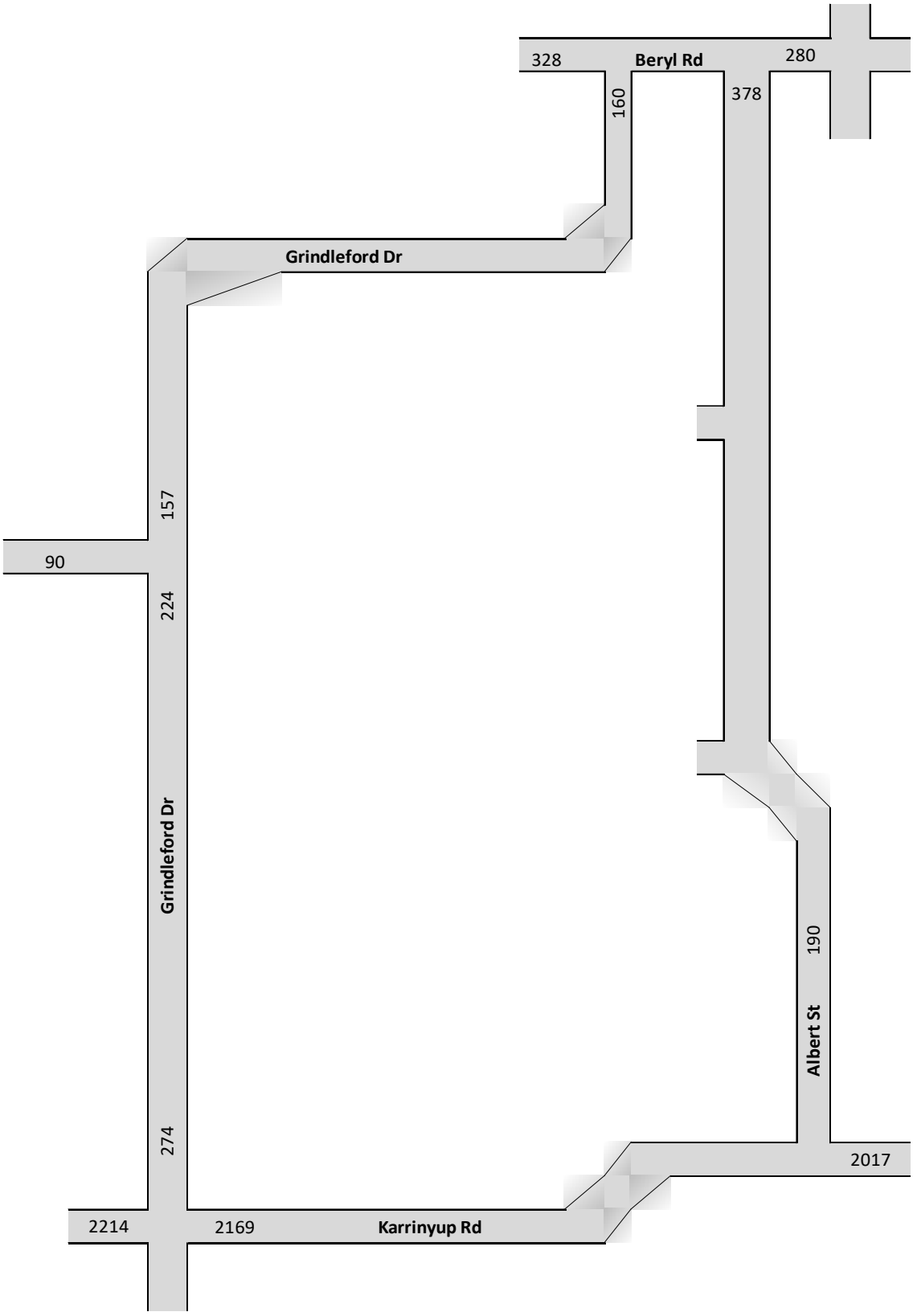
2021 PM Background Traffic



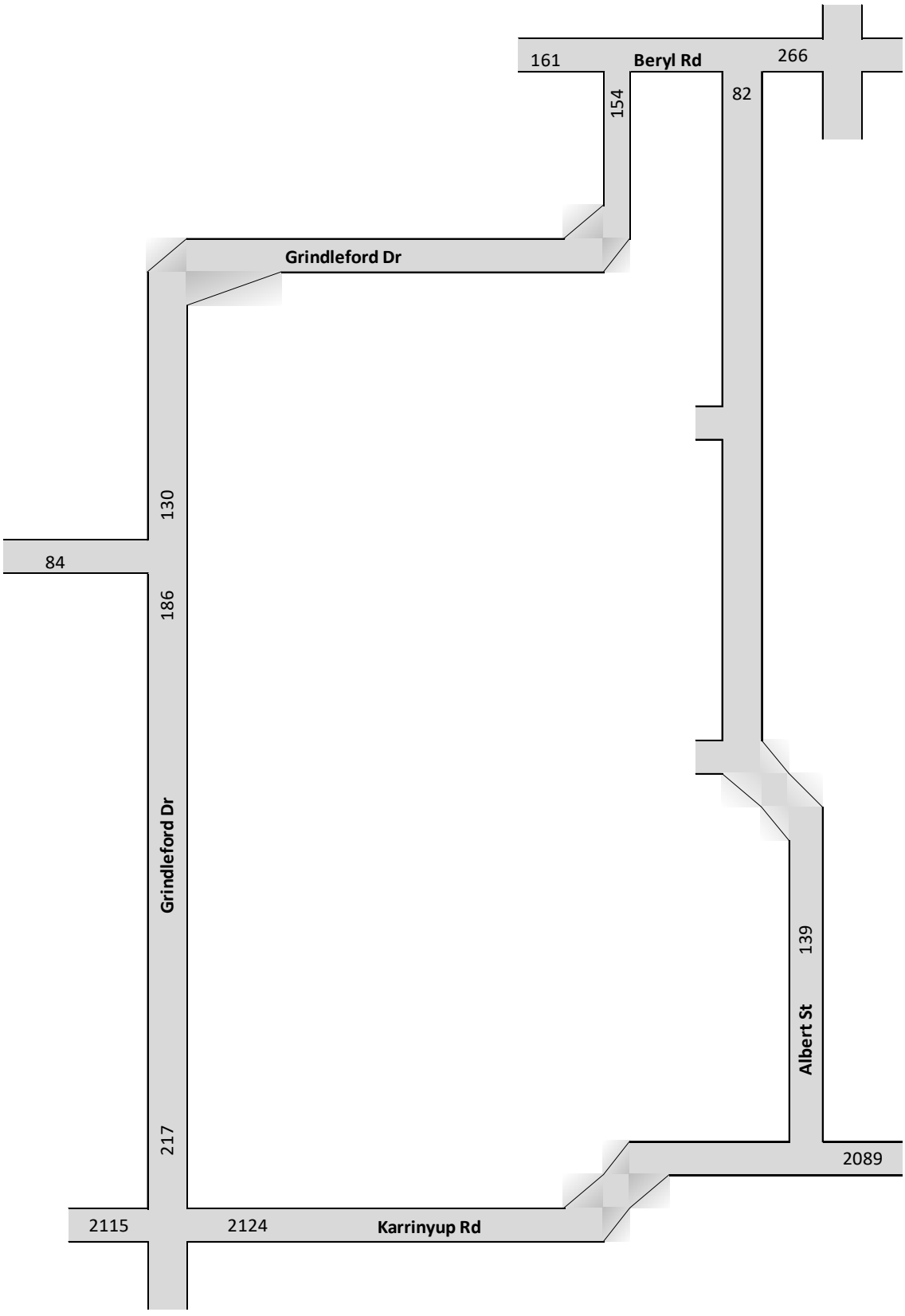
2031 Daily Background Traffic



2031 AM Background Traffic

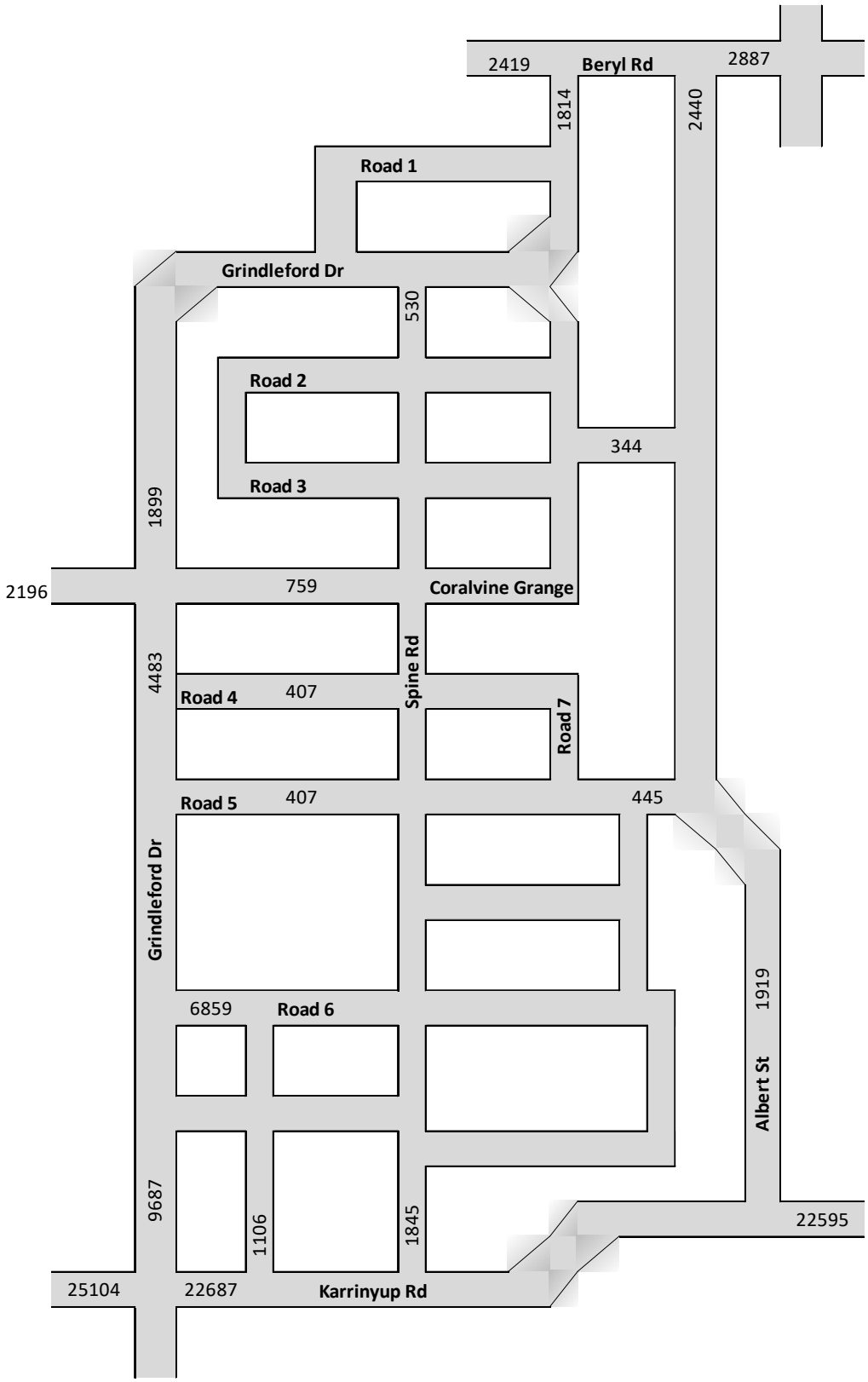


2031 PM Background Traffic

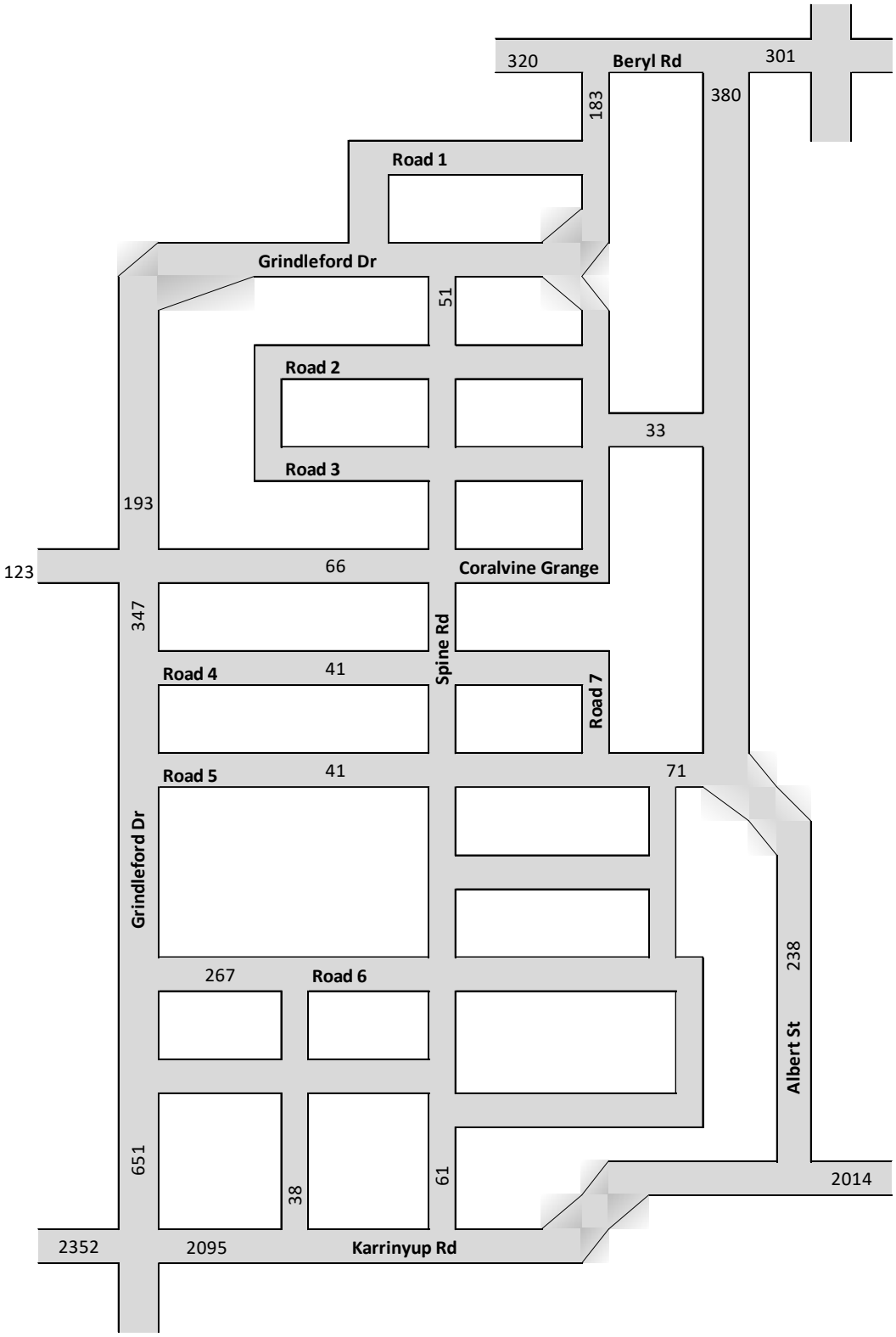


APPENDIX B: SCENARIO 1 FULL DEVELOPMENT TRAFFIC FOR 2021 AND 2031

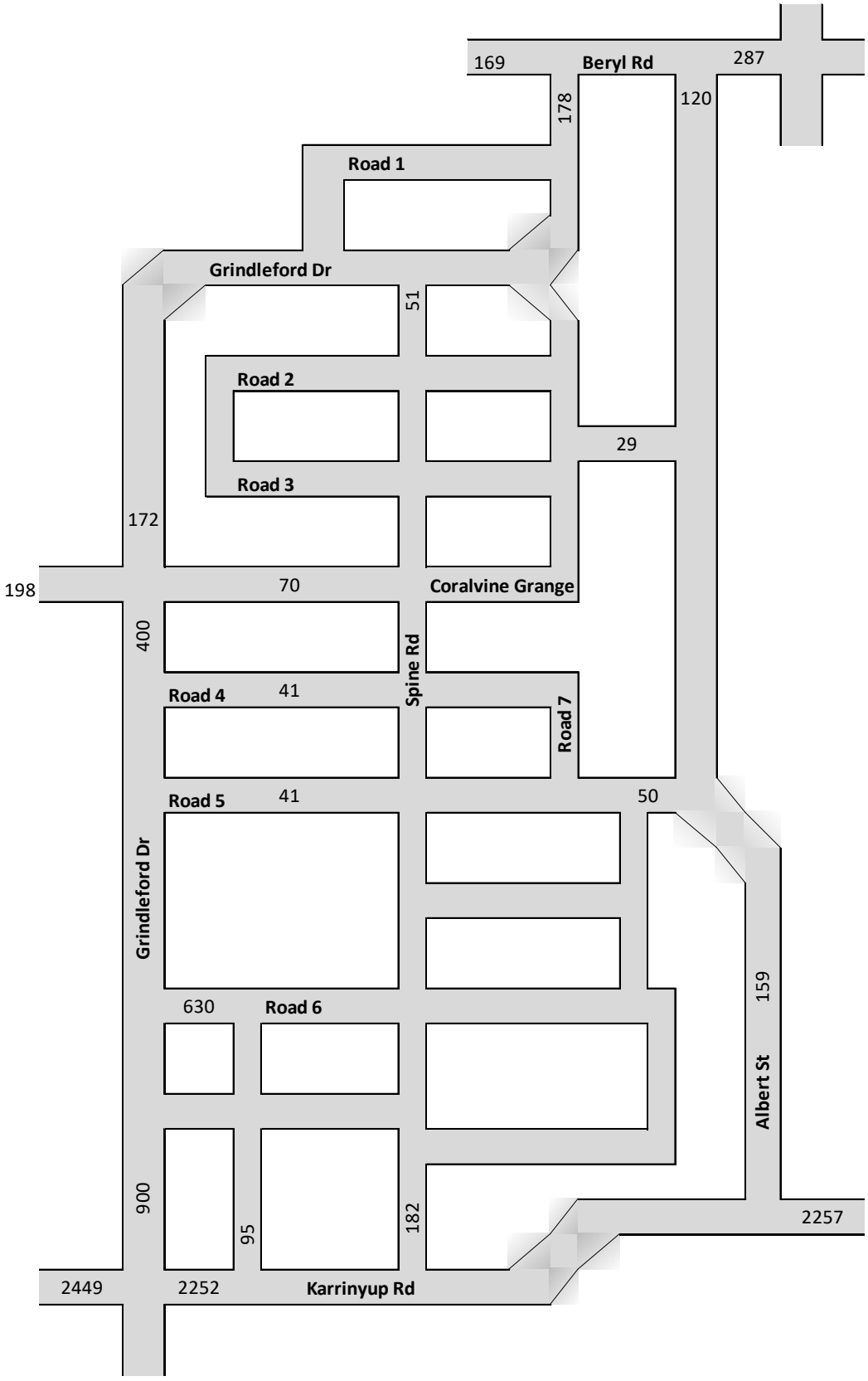
2021 Daily Development & Background Traffic



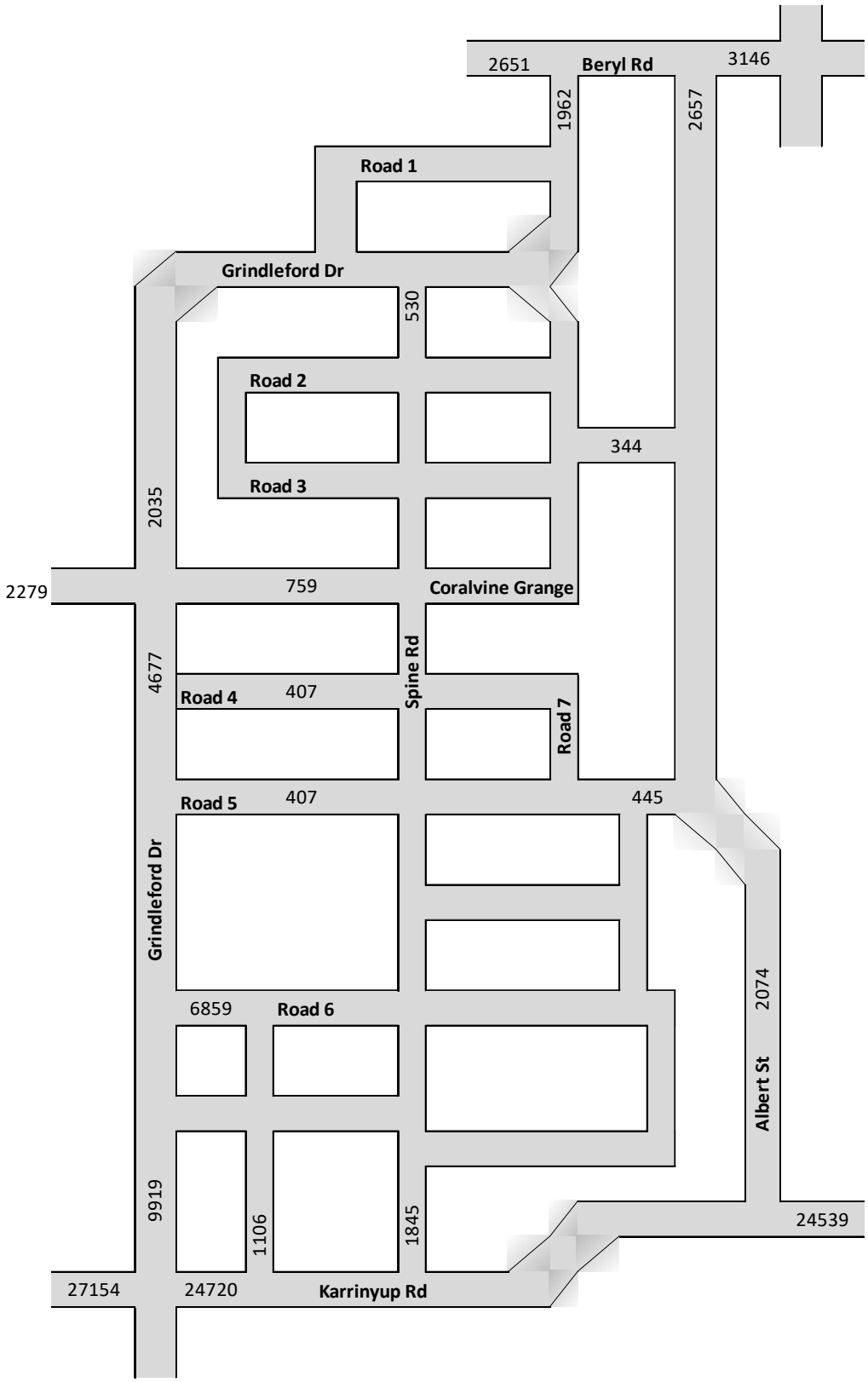
2021 AM Development & Background Traffic



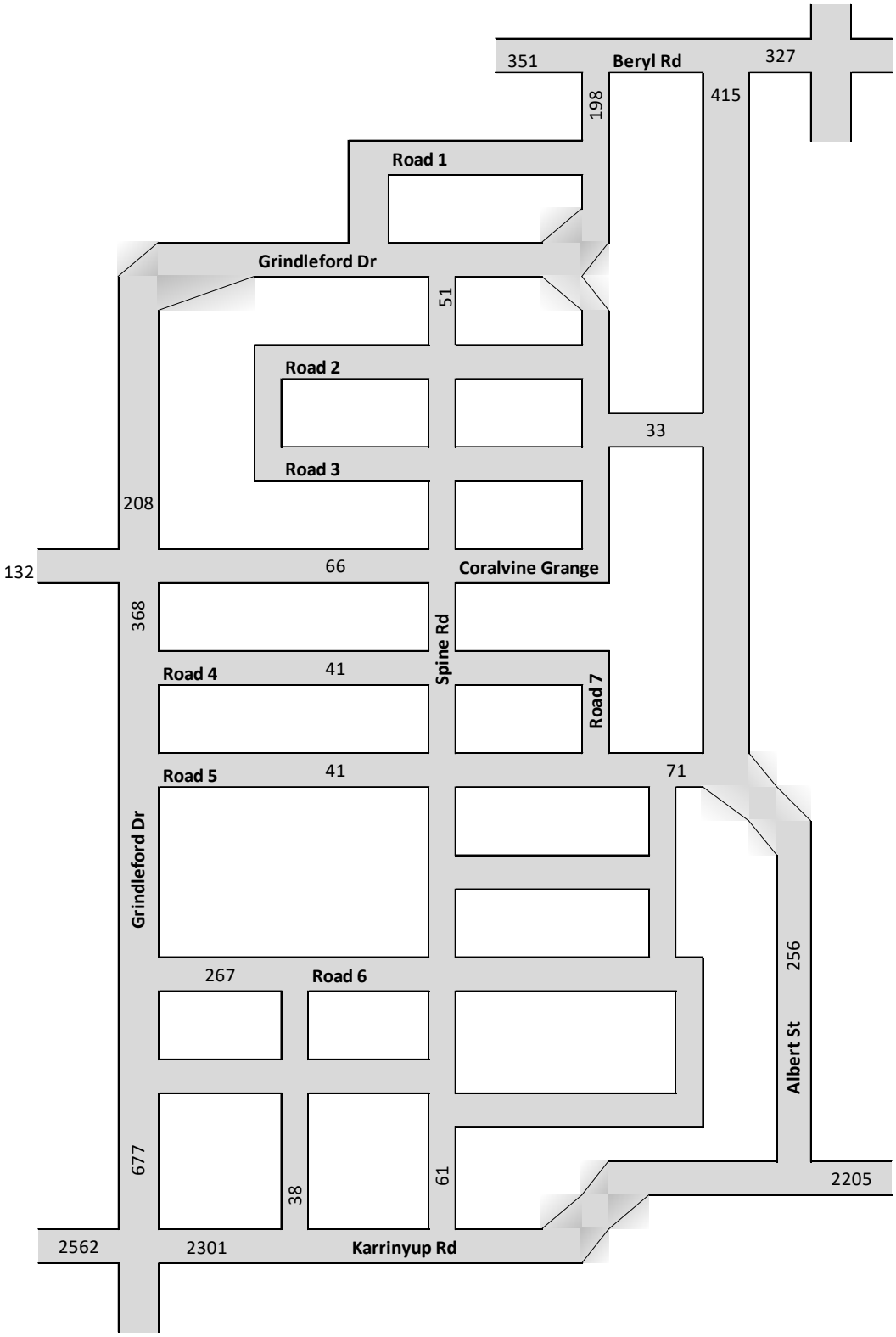
2021 PM Development & Background Traffic



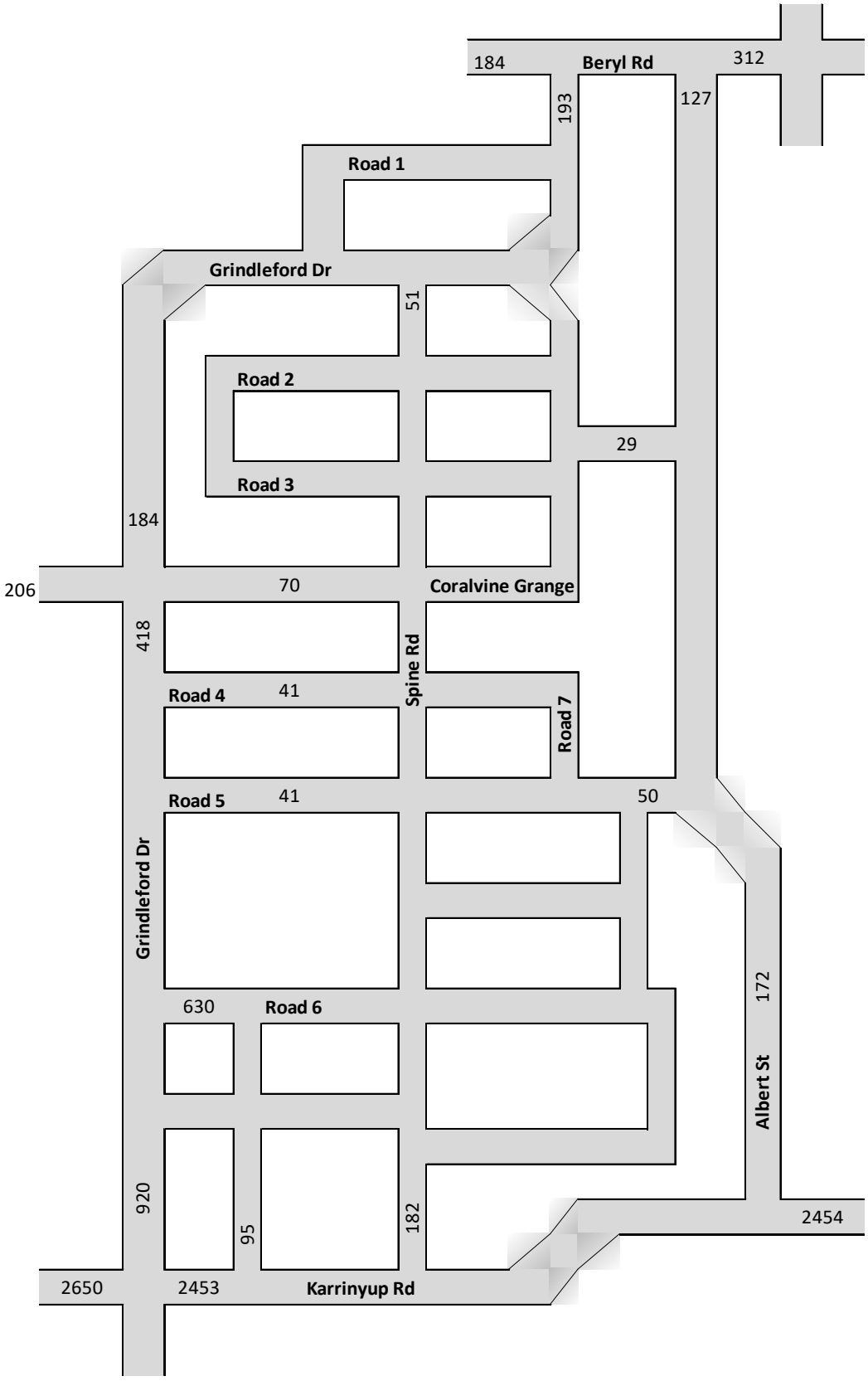
2031 Daily Development & Background Traffic



2031 AM Development & Background Traffic

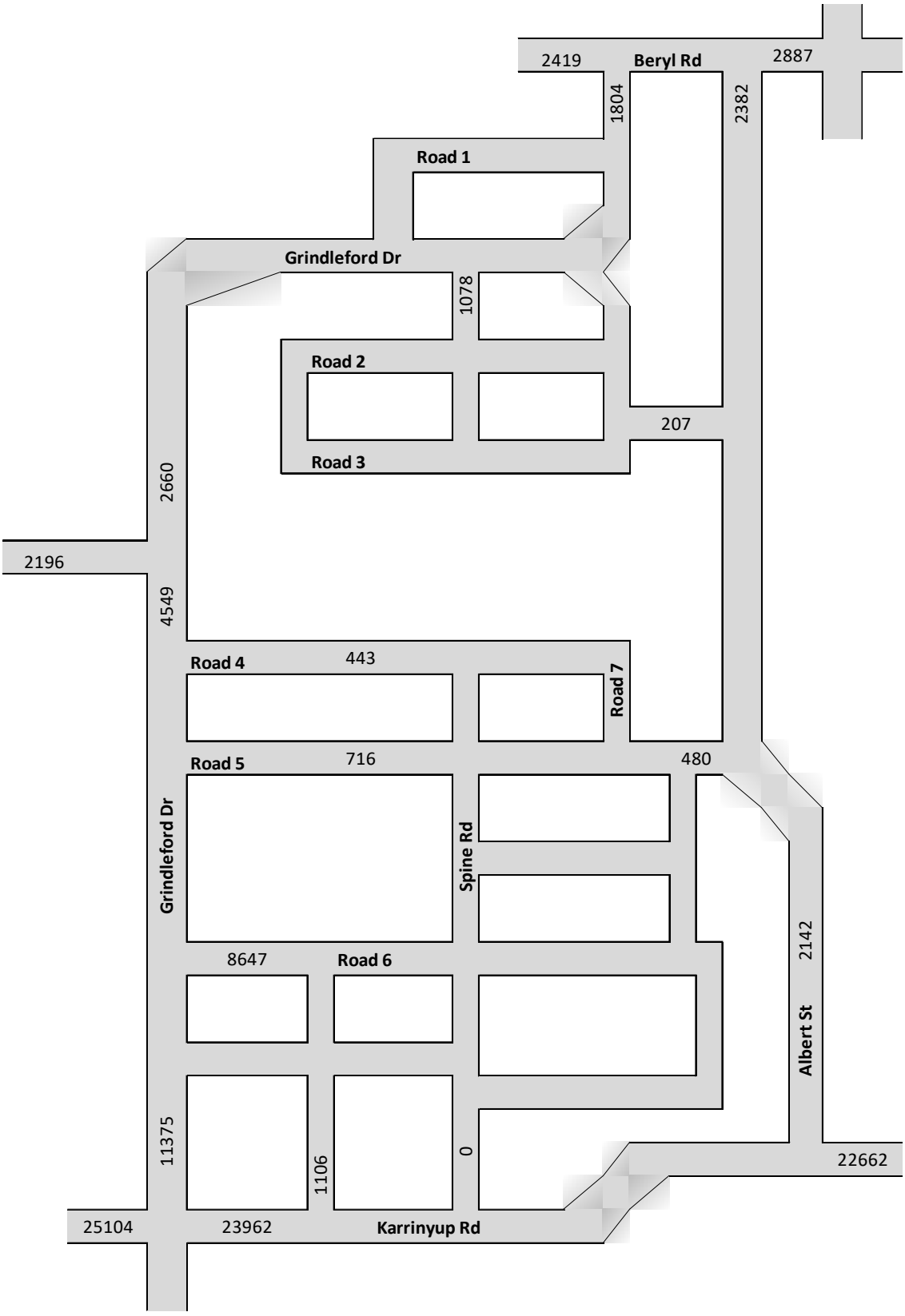


2031 PM Development & Background Traffic

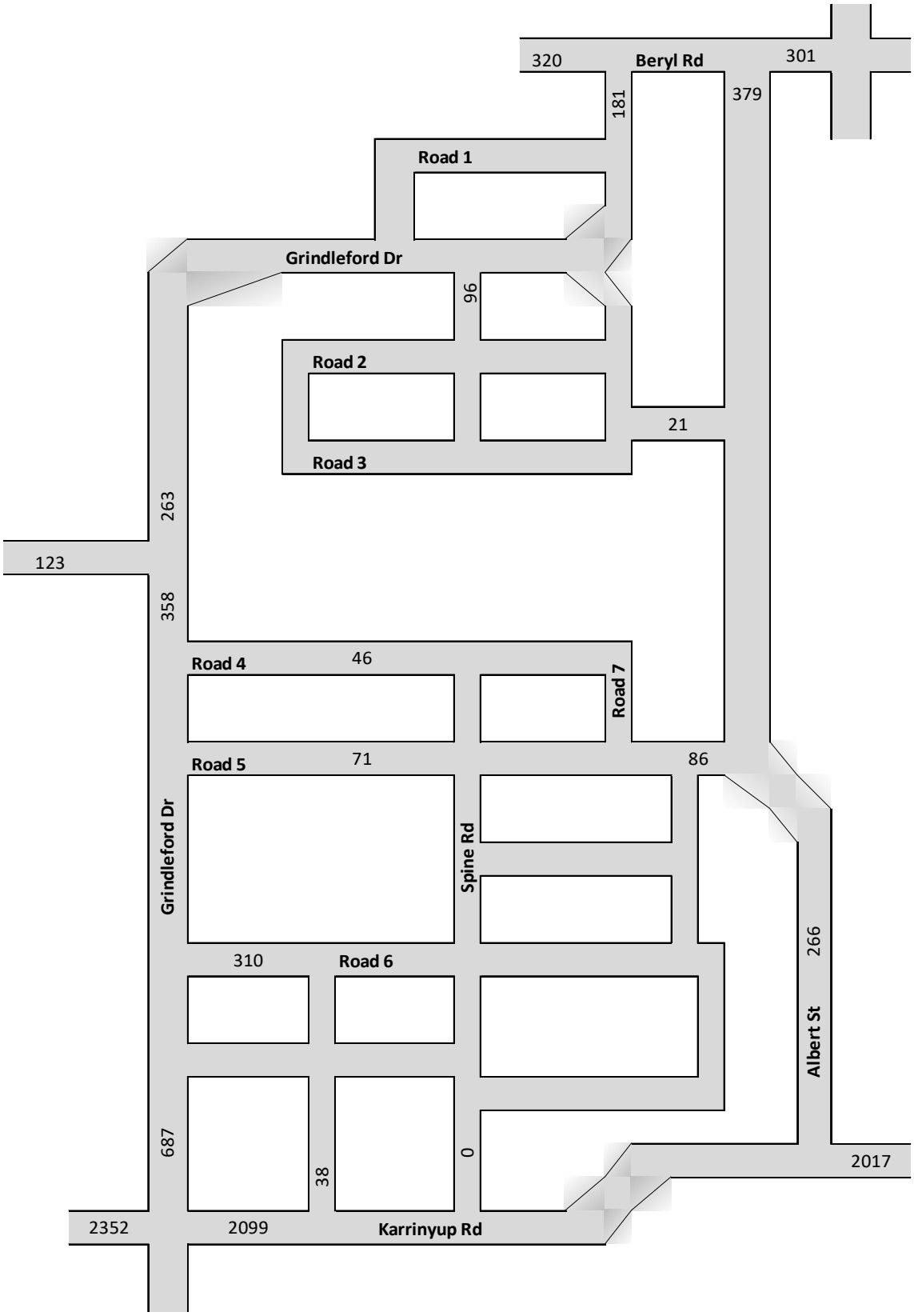


APPENDIX C: SCENARIO 2 FULL DEVELOPMENT TRAFFIC FOR 2021 AND 2031

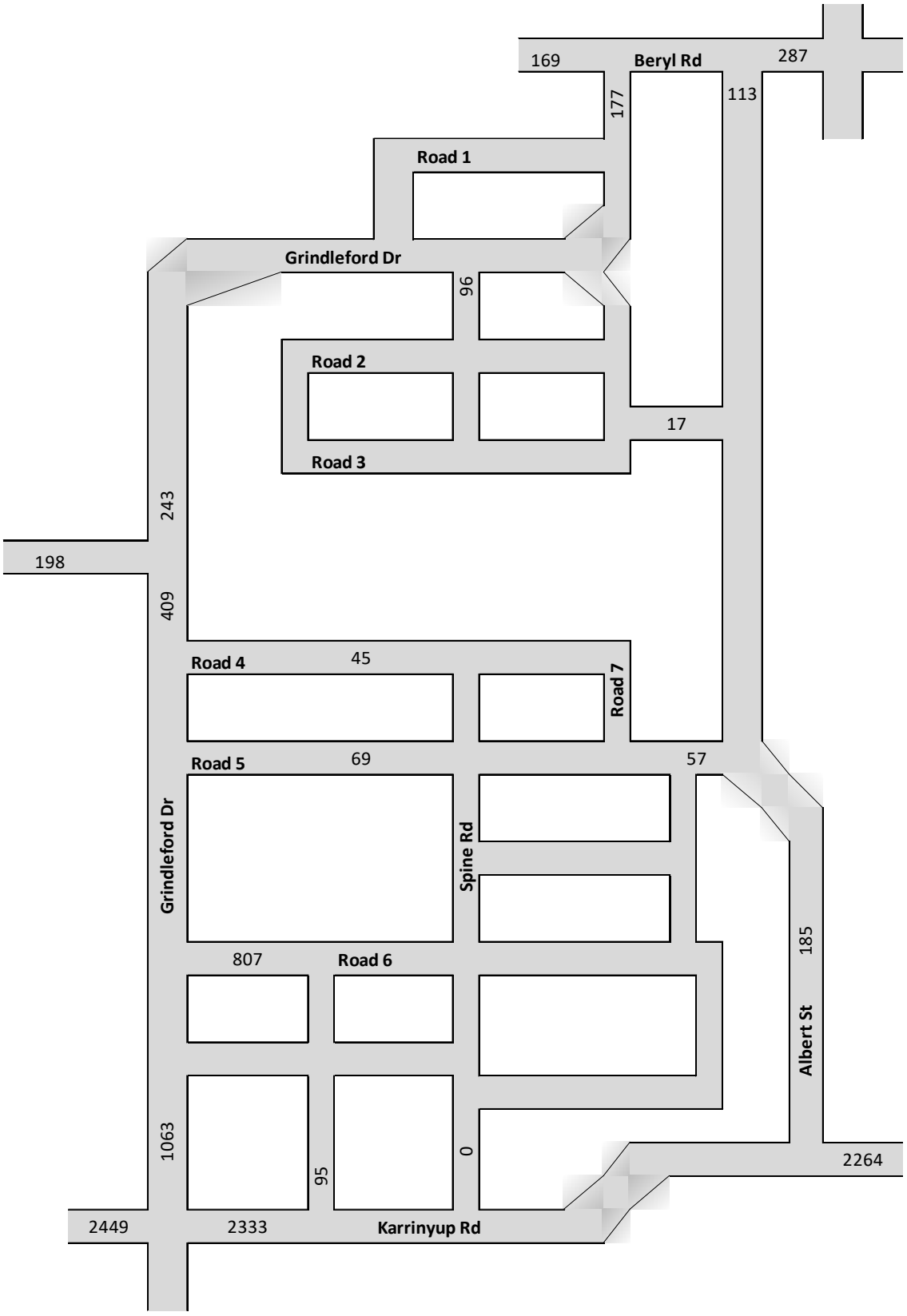
2021 Sc2 Daily Development & Background Traffic



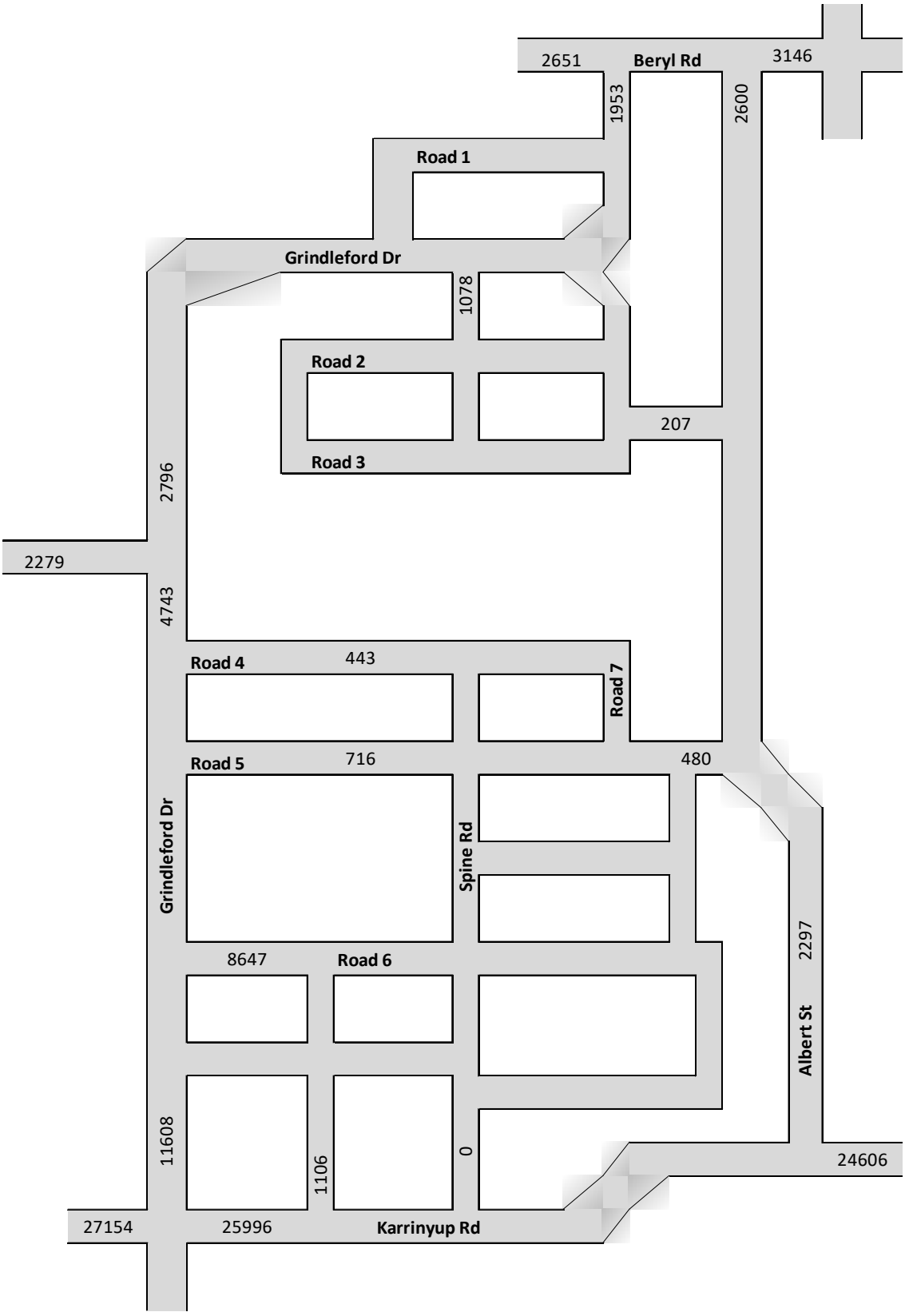
2021 Sc2 AM Development & Background Traffic



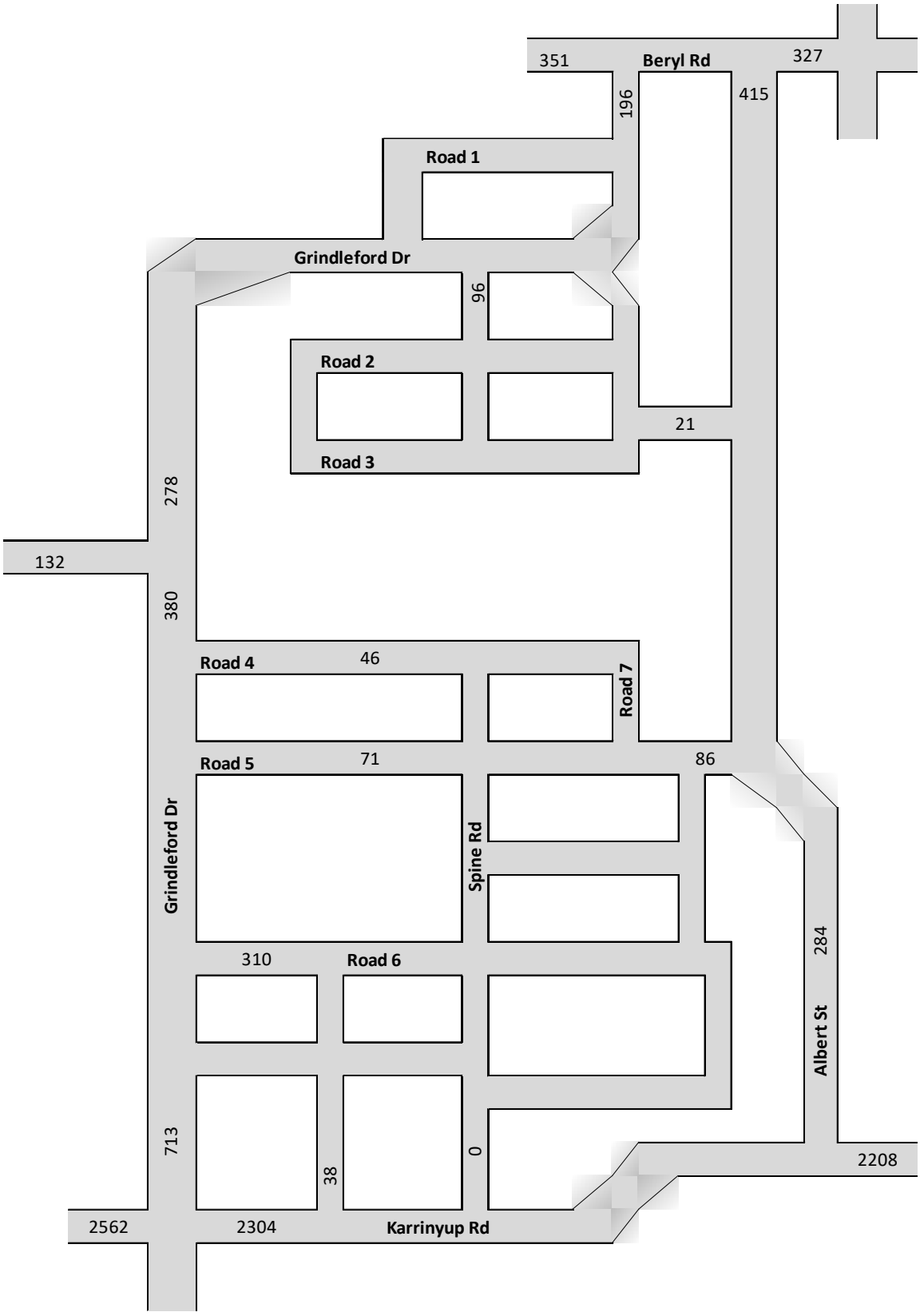
2021 Sc2 PM Development & Background Traffic



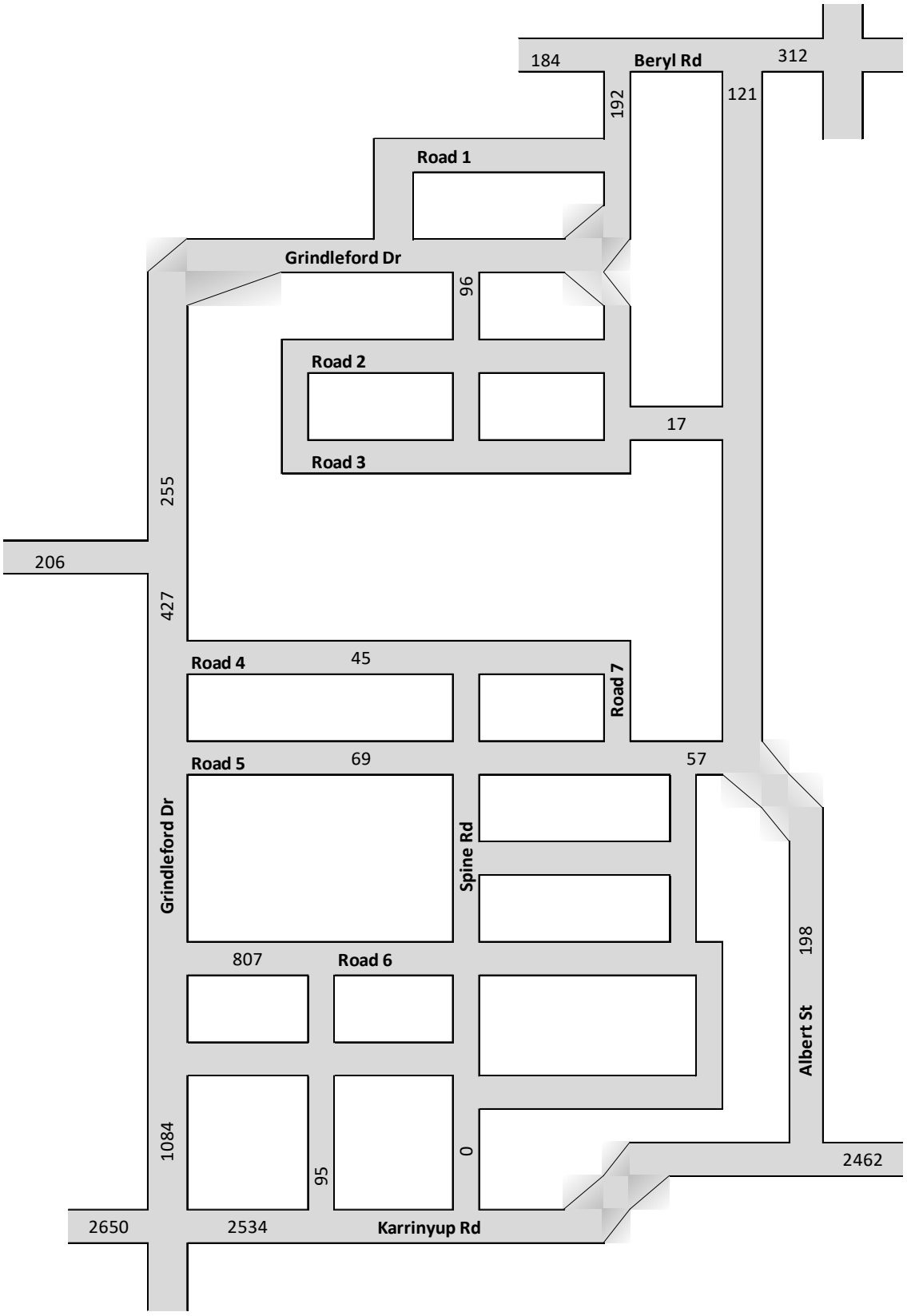
2031 Sc2 Daily Development & Background Traffic



2031 Sc2 AM Development & Background Traffic



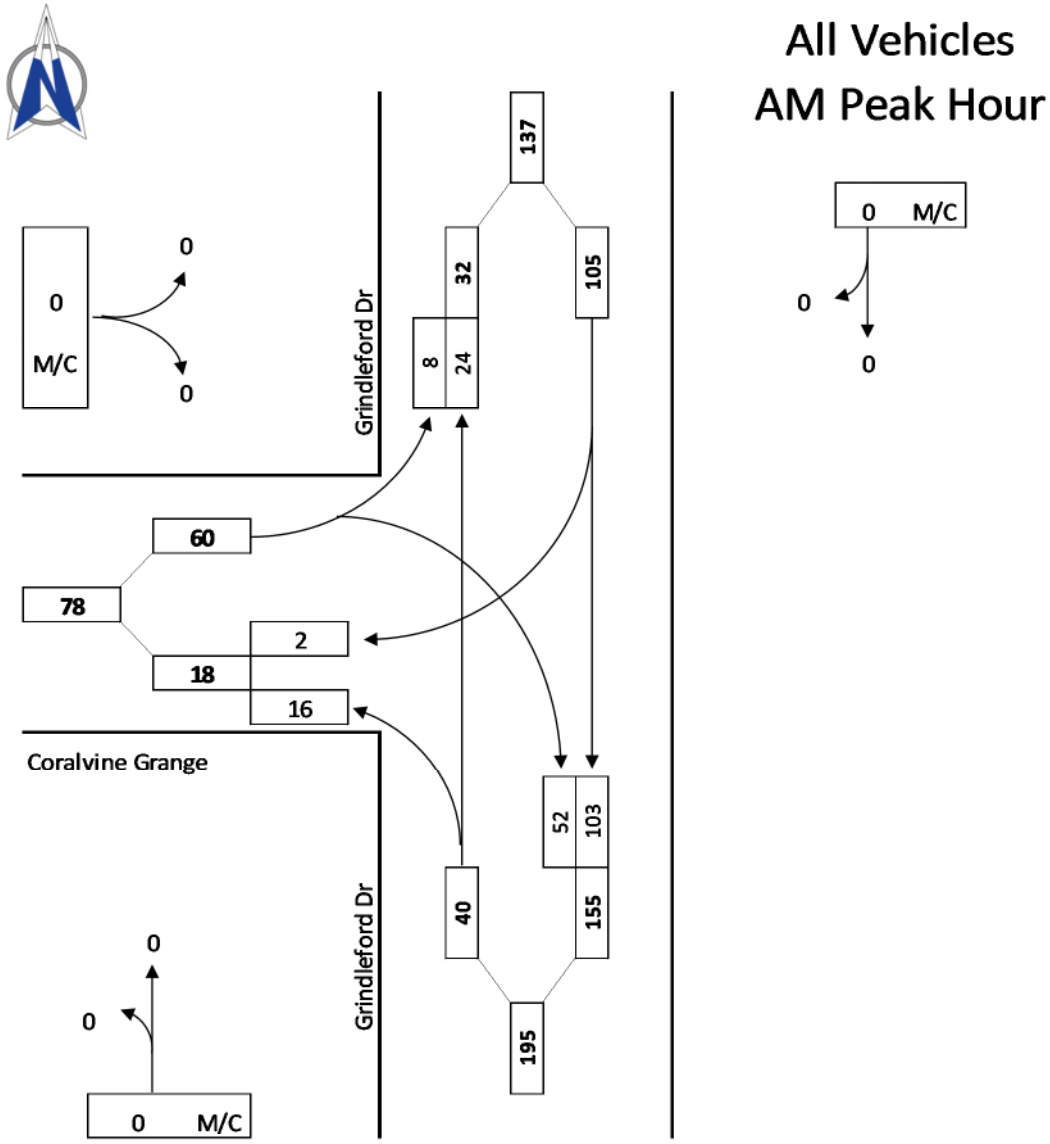
2031 Sc2 PM Development & Background Traffic



APPENDIX D: DVC TRAFFIC COUNTS

All traffic counts were conducted on
Wednesday 9th August 2017
AM peak hour: 0800 – 0900
PM Peak hour 1630 - 1730

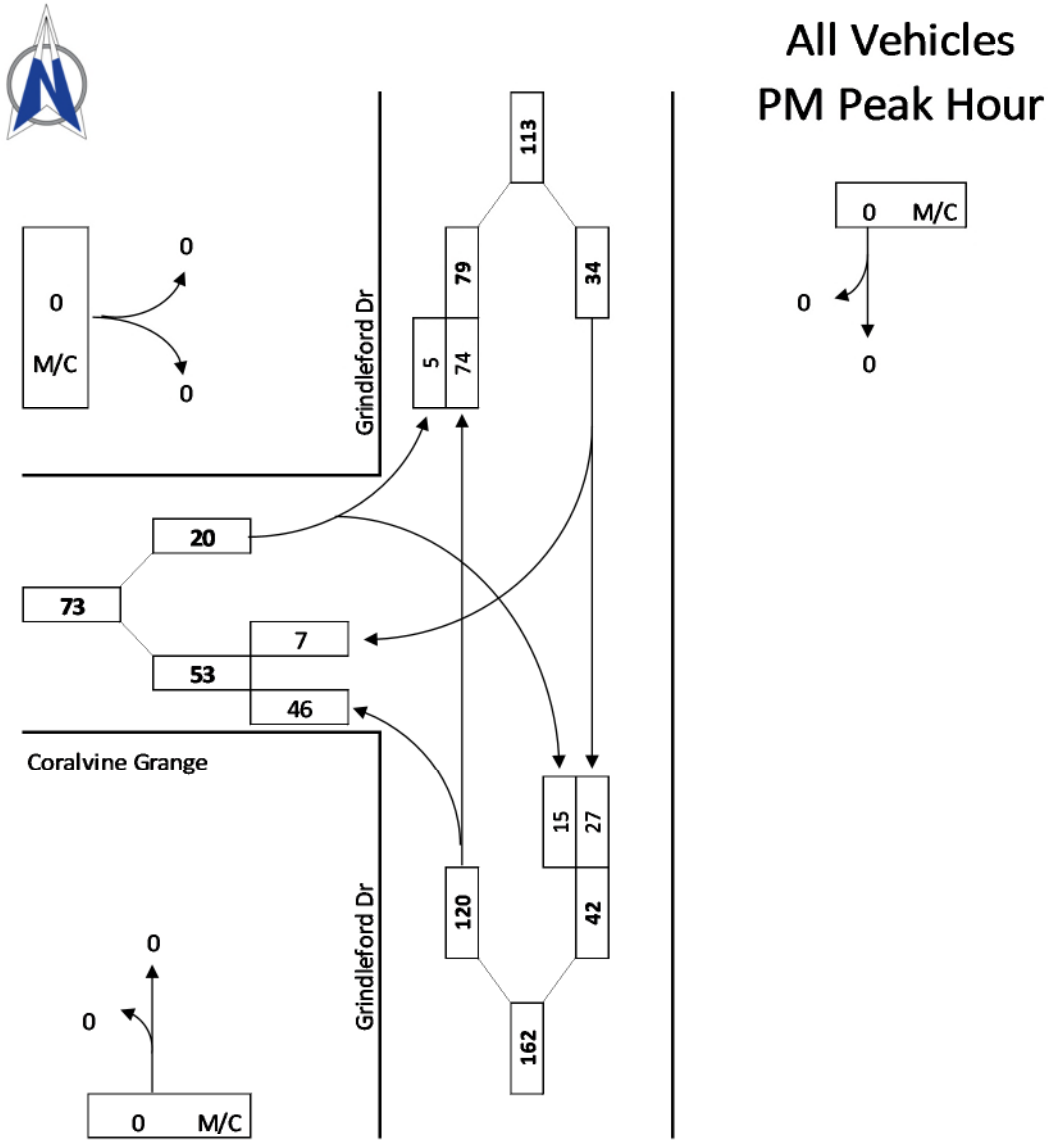
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Grindleford Dr & Coralvine Grange		Balcatta
Site 1	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	3 -Way	
	Duration:	0800 -0900	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	103	2	**105**
From E	0	0	0	0	**0**
From S	24	0	0	16	**40**
From W	8	0	52	0	**60**
Total	**32**	**0**	**155**	**18**	**205**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

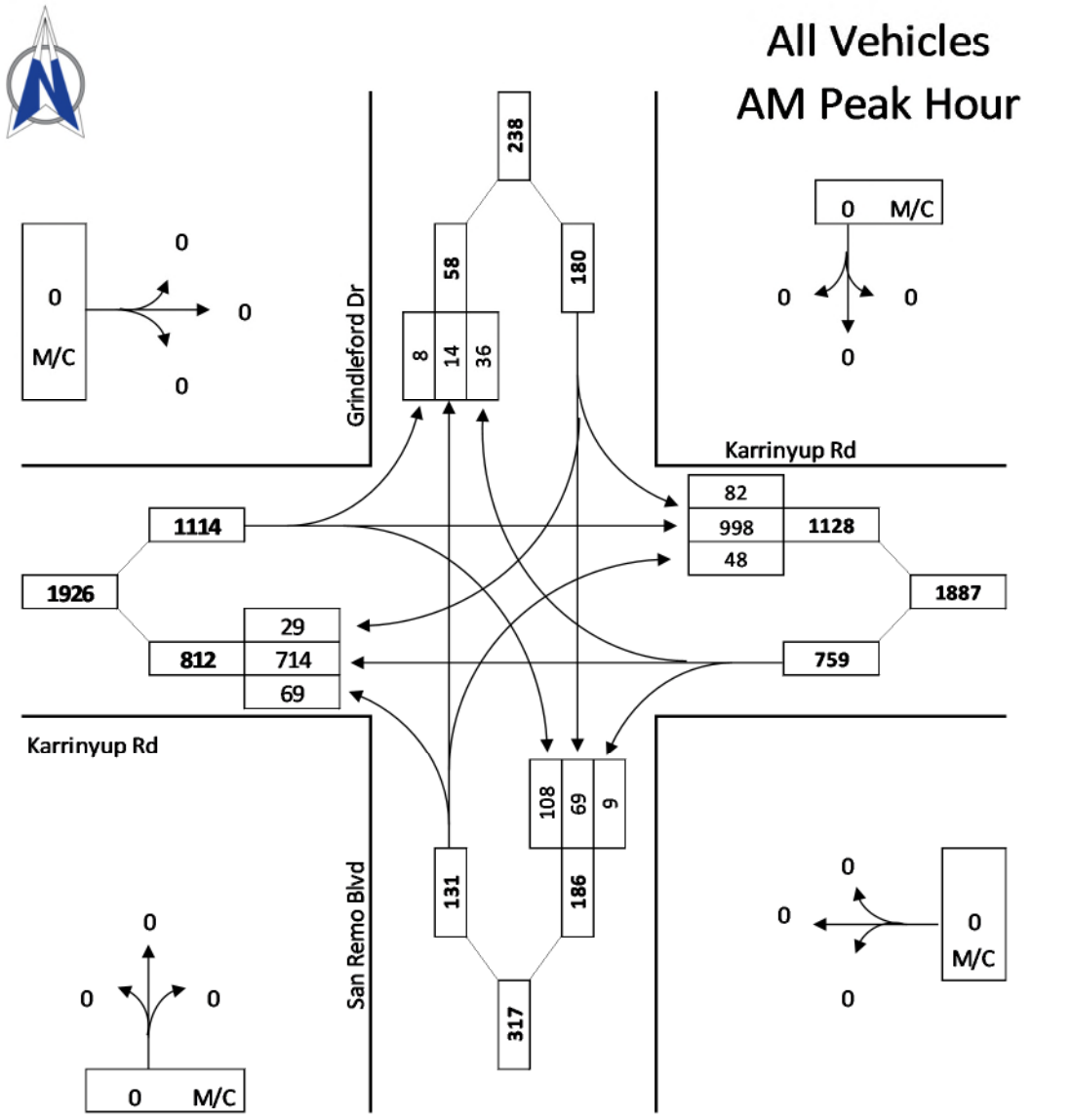
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Grindleford Dr & Coralvine Grange		Balcatta
Site 1	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	3 -Way	
	Duration:	1630 - 1730	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	27	7	**34**
From E	0	0	0	0	**0**
From S	74	0	3	46	**120**
From W	5	0	15	0	**20**
Total	**79**	**0**	**42**	**53**	**174**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

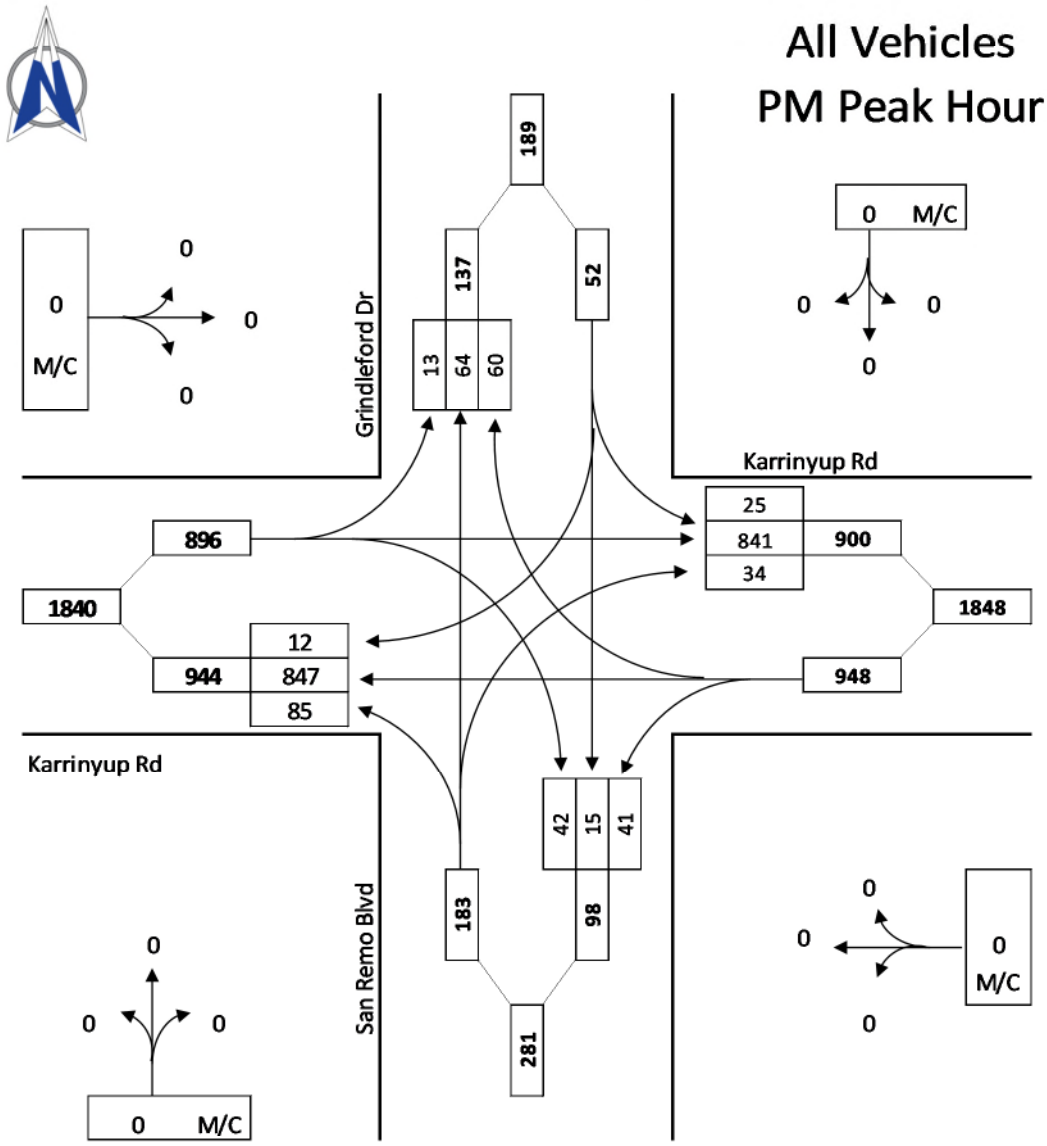
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Grindleford Dr, San Remo Blvd & Karrinyup Rd		Balcatta
Site 6	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	0800 -0900	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	82	69	29	**180**
From E	36	0	9	714	**759**
From S	14	48	0	69	**131**
From W	8	998	108	0	**1114**
Total	**58**	**1128**	**186**	**812**	**2184**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

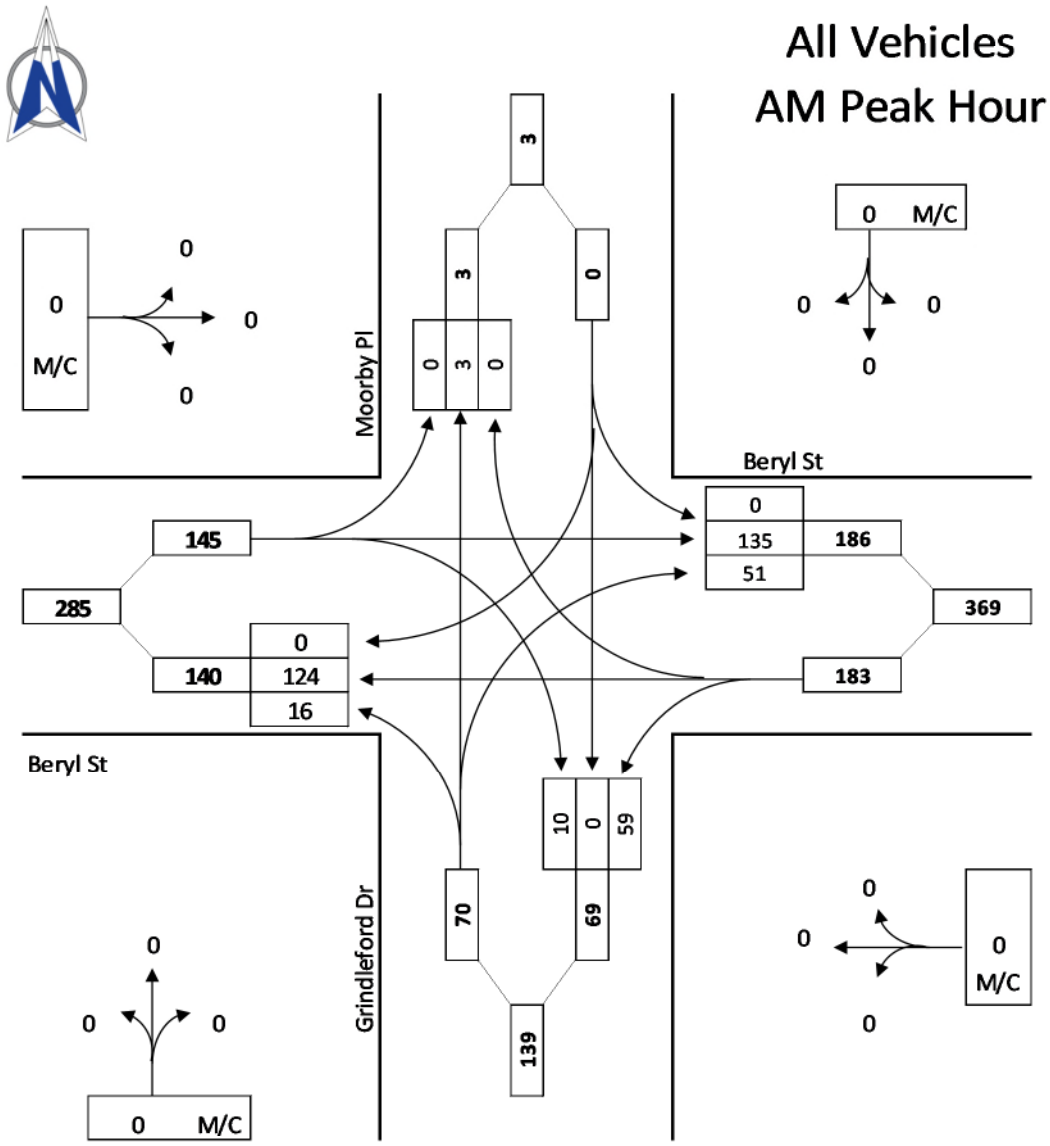
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Grindleford Dr, San Remo Blvd & Karrinyup Rd		Balcatta
Site 6	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	1630 - 1730	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	25	15	12	**52**
From E	60	0	41	847	**948**
From S	64	34	0	85	**183**
From W	13	841	42	0	**896**
Total	**137**	**900**	**98**	**944**	**2079**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

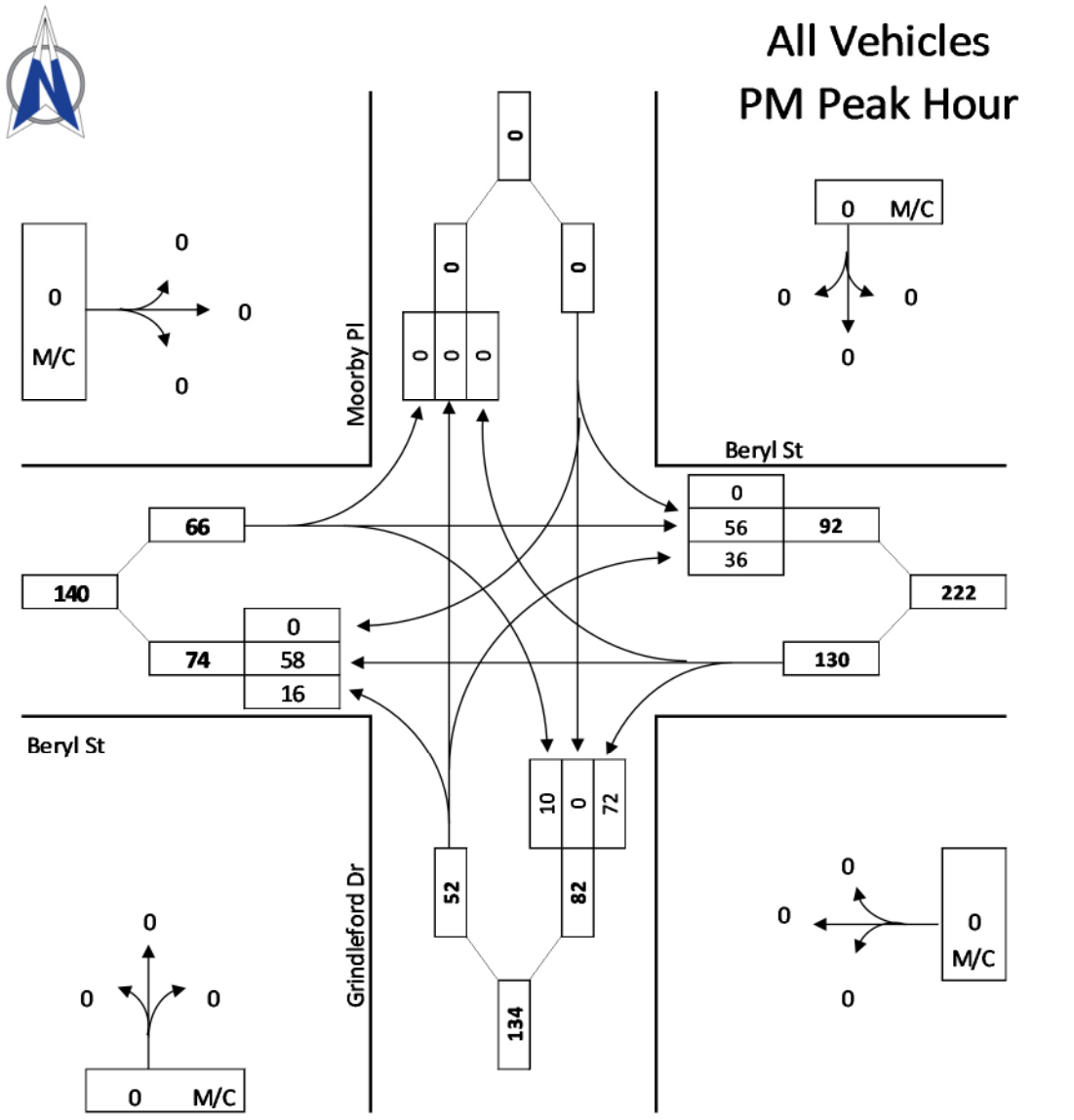
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Grindleford Dr, Moorby Pl & Beryl St		Balcatta
Site 2	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	0800 -0900	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	59	124	**183**
From S	3	51	0	16	**70**
From W	0	135	10	0	**145**
Total	**3**	**186**	**69**	**140**	**398**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

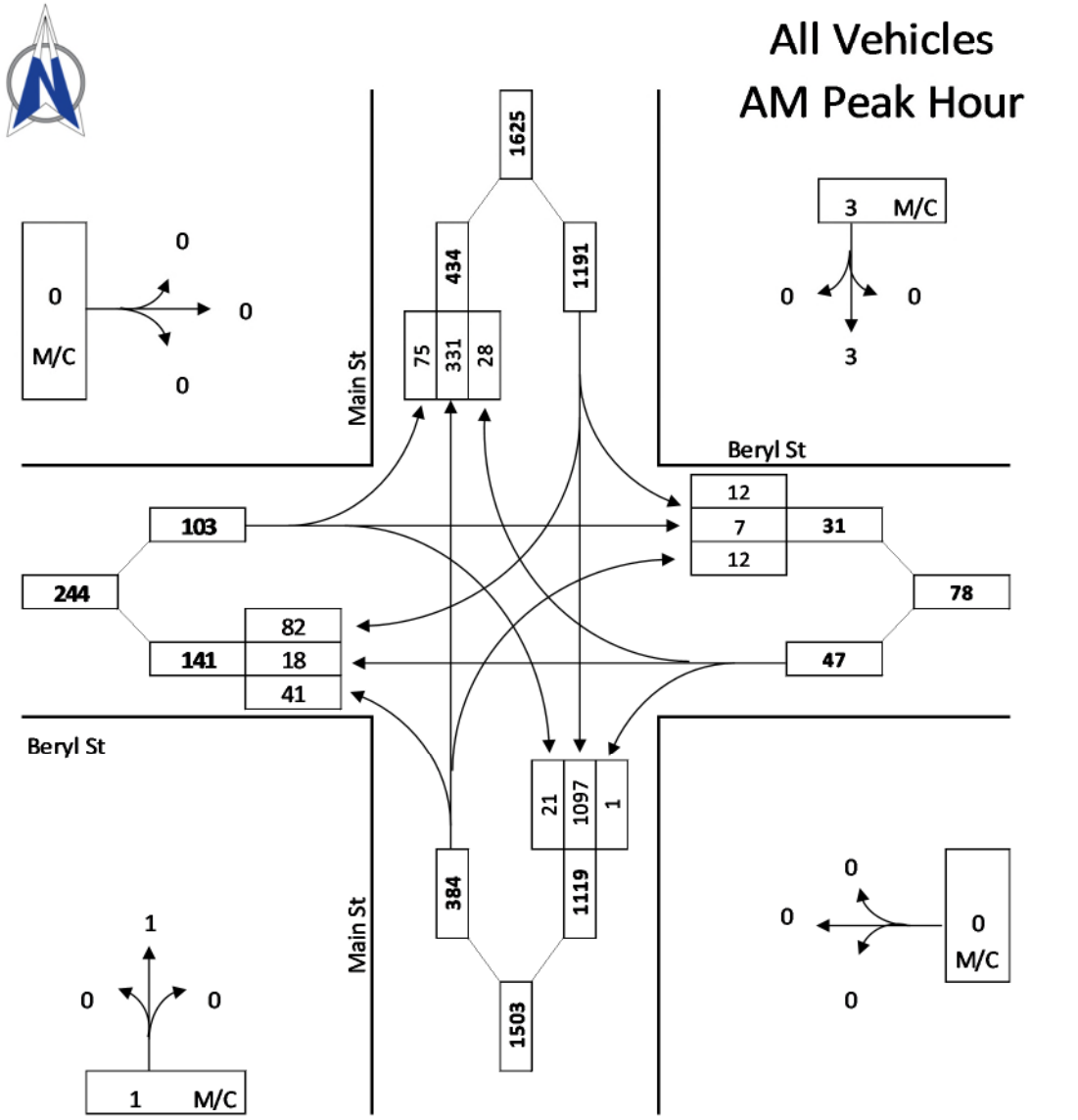
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Grindleford Dr, Moorby Pl & Beryl St		Balcatta
Site 2	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	1630 - 1730	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	72	58	**130**
From S	0	36	0	16	**52**
From W	0	56	10	0	**66**
Total	**0**	**92**	**82**	**74**	**248**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

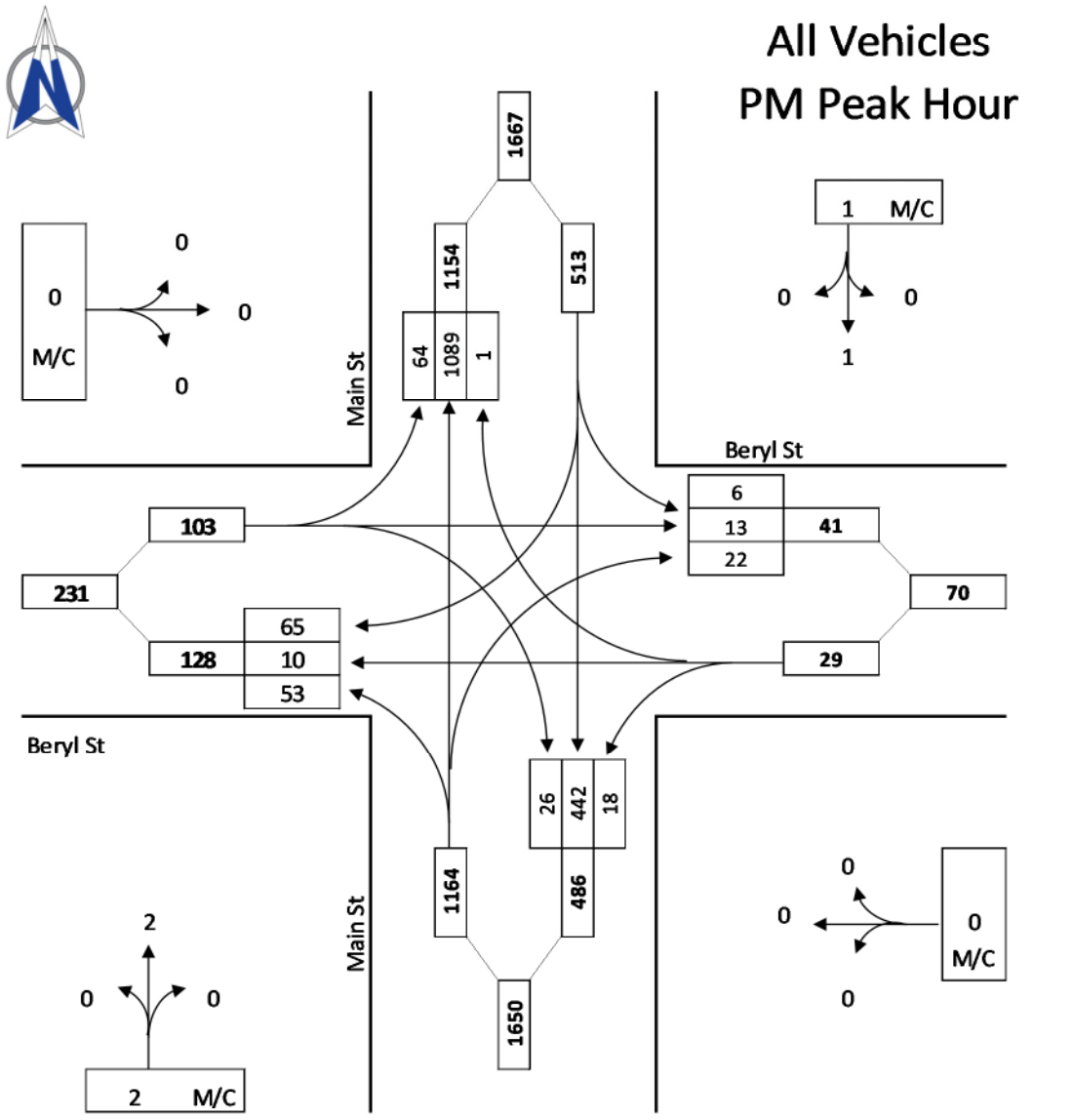
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Main St & Beryl St		Balcatta
Site 4	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	0800 -0900	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	12	1097	82	**1191**
From E	28	0	1	18	**47**
From S	331	12	0	41	**384**
From W	75	7	21	0	**103**
Total	**434**	**31**	**1119**	**141**	**1725**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	3	0	**3**
From E	0	0	0	0	**0**
From S	1	0	0	0	**1**
From W	0	0	0	0	**0**
Total	**1**	**0**	**3**	**0**	**4**

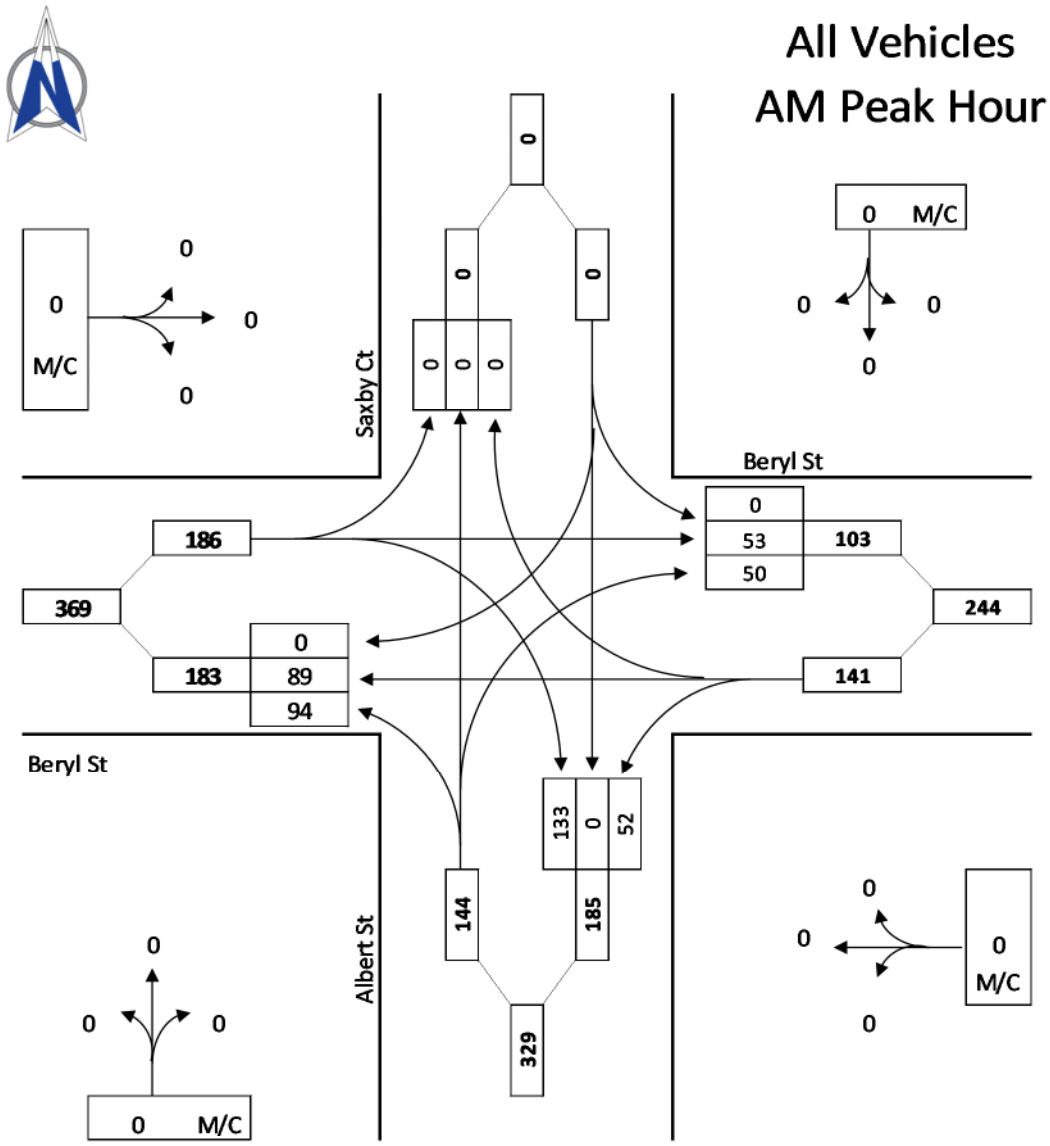
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Main St & Beryl St		Balcatta
Site 4	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	1630 - 1730	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	6	442	65	**513**
From E	1	0	18	10	**29**
From S	1089	22	0	53	**1164**
From W	64	13	26	0	**103**
Total	**1154**	**41**	**486**	**128**	**1809**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	1	0	**1**
From E	0	0	0	0	**0**
From S	2	0	0	0	**2**
From W	0	0	0	0	**0**
Total	**2**	**0**	**1**	**0**	**3**

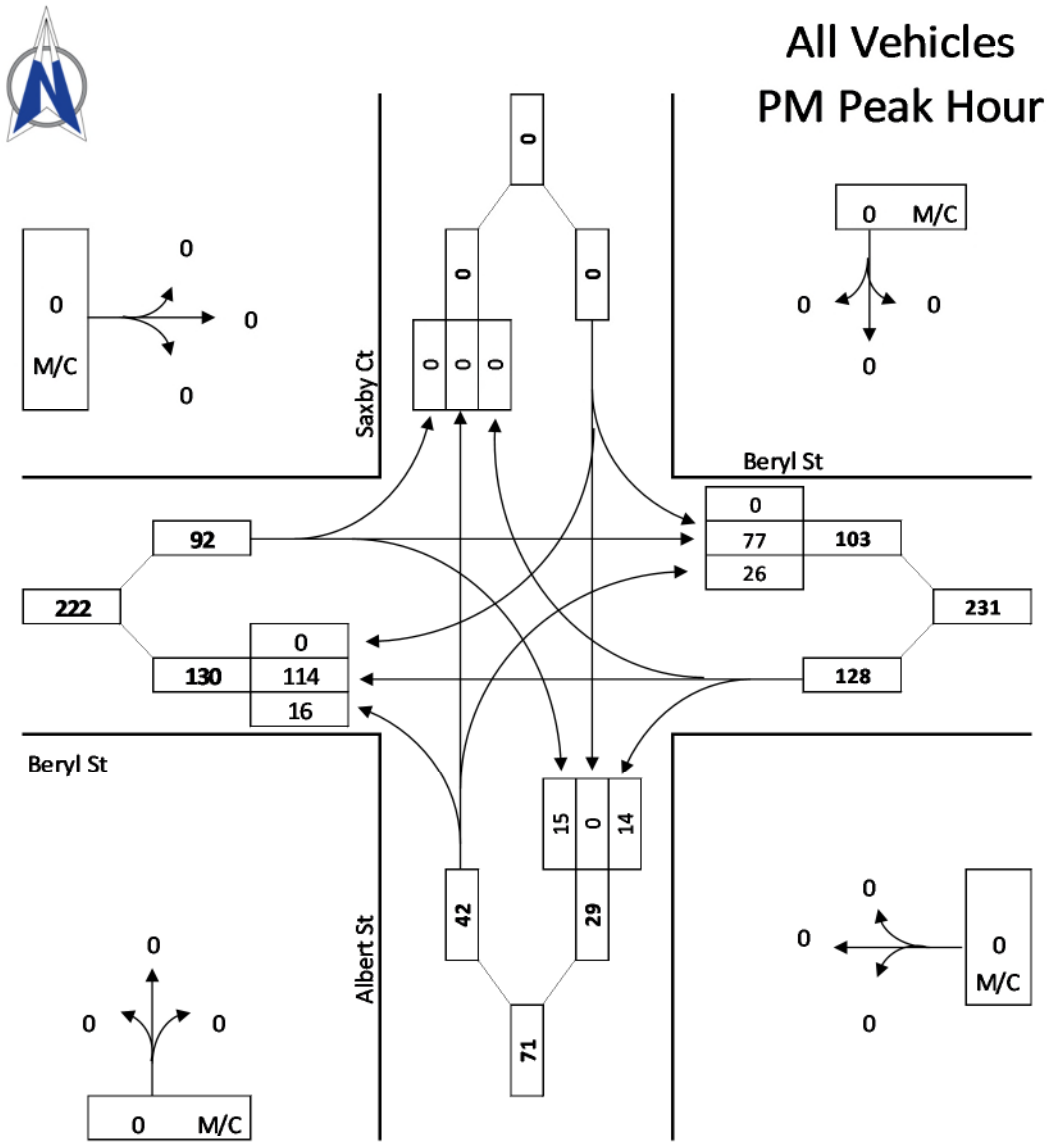
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Albert St, Saxby Ct & Beryl St		Balcatta
Site 3	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	0800 -0900	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	52	89	**141**
From S	0	50	0	94	**144**
From W	0	53	133	0	**186**
Total	**0**	**103**	**185**	**183**	**471**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

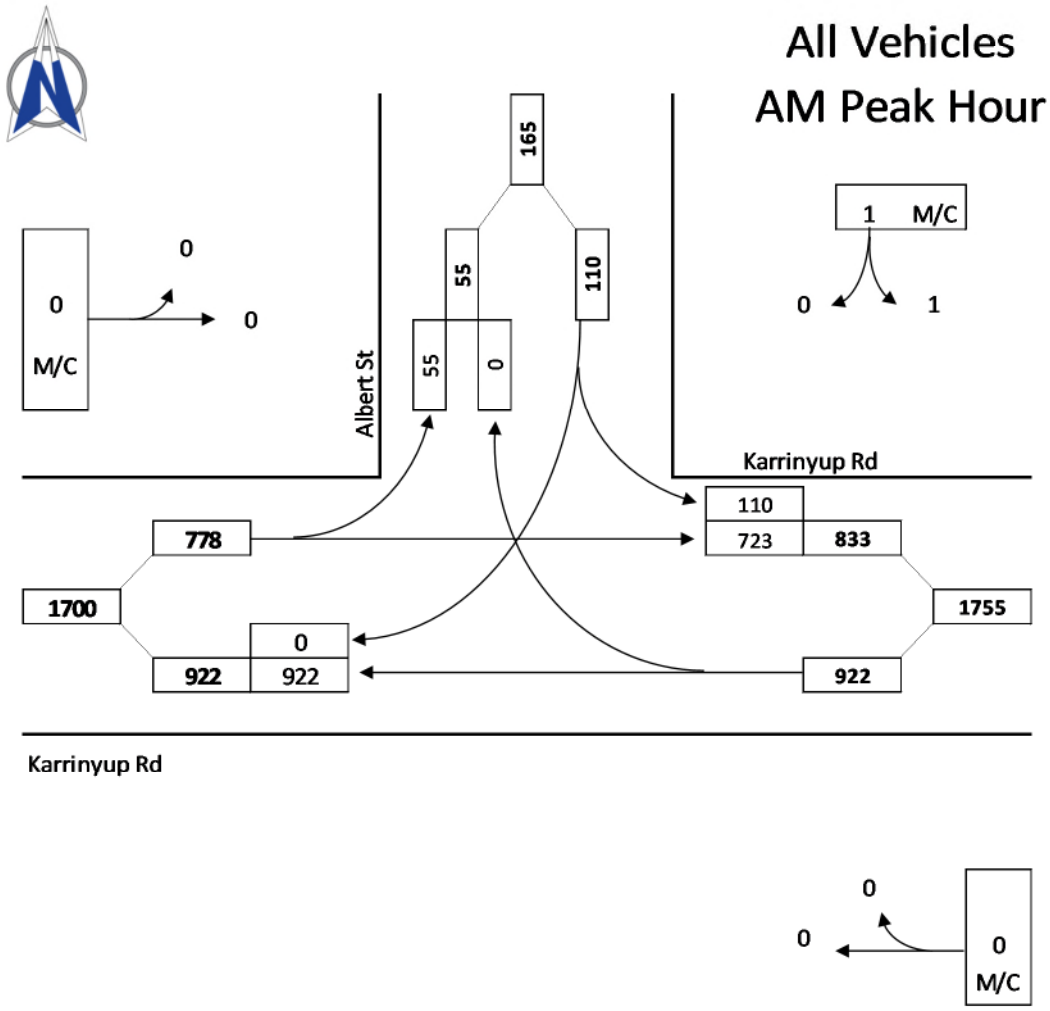
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Albert St, Saxby Ct & Beryl St		Balcatta
Site 3	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	4 -Way	
	Duration:	1630 - 1730	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	14	114	**128**
From S	0	26	0	16	**42**
From W	0	77	15	0	**92**
Total	**0**	**103**	**29**	**130**	**262**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

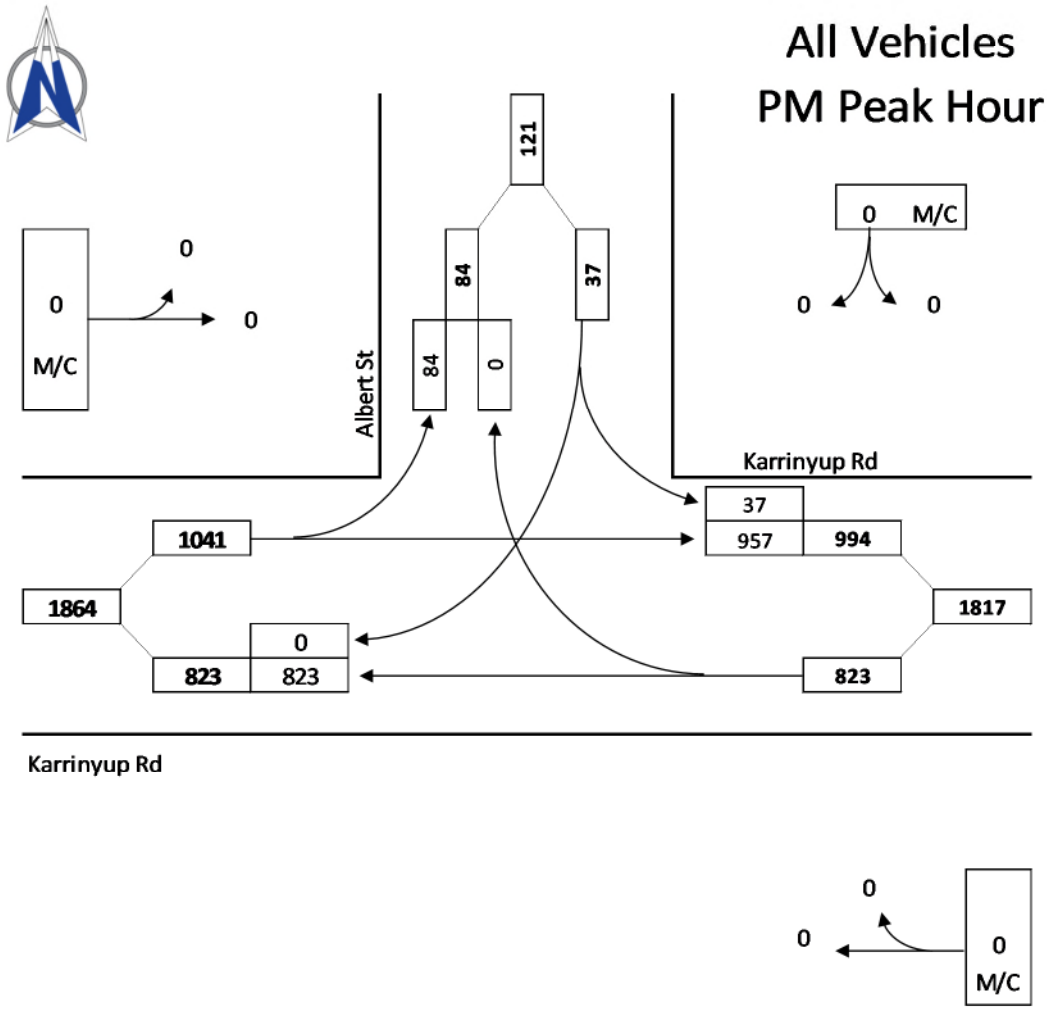
Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Albert St & Karrinyup Rd		Balcatta
Site 5	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	3 -Way	
	Duration:	0800 -0900	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	110	0	0	**110**
From E	0	0	0	922	**922**
From S	0	0	0	0	**0**
From W	55	723	0	0	**778**
Total	**55**	**833**	**0**	**922**	**1810**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	1	0	0	**1**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**1**	**0**	**0**	**1**

Parcel Property	Day	Date	Weather
	Wednesday	09/08/17	Cloudy
Vehicle Volumes	**Location**		**Suburb**
East Roselea Structure Plan Manual Counts	Albert St & Karrinyup Rd		Balcatta
Site 5	**Job No.**	**Intersection Type:**	
Donald Veal Consultants	Z565	3 -Way	
	Duration:	1630 - 1730	



Vehicles Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	37	0	0	**37**
From E	0	0	0	823	**823**
From S	0	0	0	0	**0**
From W	84	957	0	0	**1041**
Total	**84**	**994**	**0**	**823**	**1901**

M/C Entering Intersection					
Count	To N	To E	To S	To W	Total
From N	0	0	0	0	**0**
From E	0	0	0	0	**0**
From S	0	0	0	0	**0**
From W	0	0	0	0	**0**
Total	**0**	**0**	**0**	**0**	**0**

APPENDIX E: SIDRA RESULTS

MOVEMENT SUMMARY

Site: 101 [Grindleford Dr & Beryl St AM Peak 2031]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: RoadName											
1	L2	35	2.0	0.096	5.0	LOS A	0.5	3.4	0.32	0.60	51.9
2	T1	1	2.0	0.096	5.3	LOS A	0.5	3.4	0.32	0.60	46.9
3	R2	77	2.0	0.096	9.2	LOS A	0.5	3.4	0.32	0.60	46.6
Approach		113	2.0	0.096	7.8	LOS A	0.5	3.4	0.32	0.60	48.7
East: RoadName											
4	L2	77	2.0	0.152	4.3	LOS A	0.8	5.9	0.10	0.45	51.3
5	T1	151	2.0	0.152	4.6	LOS A	0.8	5.9	0.10	0.45	53.0
6	R2	1	2.0	0.152	8.4	LOS A	0.8	5.9	0.10	0.45	20.3
Approach		228	2.0	0.152	4.5	LOS A	0.8	5.9	0.10	0.45	52.3
North: RoadName											
7	L2	1	0.0	0.003	3.8	LOS A	0.0	0.1	0.39	0.51	36.5
8	T1	1	0.0	0.003	4.2	LOS A	0.0	0.1	0.39	0.51	51.9
9	R2	1	0.0	0.003	7.8	LOS A	0.0	0.1	0.39	0.51	51.5
Approach		3	0.0	0.003	5.3	LOS A	0.0	0.1	0.39	0.51	49.0
West: RoadName											
10	L2	1	0.0	0.139	4.6	LOS A	0.8	5.3	0.24	0.47	32.1
11	T1	163	0.0	0.139	4.9	LOS A	0.8	5.3	0.24	0.47	33.5
12	R2	17	0.0	0.139	8.7	LOS A	0.8	5.3	0.24	0.47	54.4
Approach		181	0.0	0.139	5.2	LOS A	0.8	5.3	0.24	0.47	35.4
All Vehicles		525	1.3	0.152	5.5	LOS A	0.8	5.9	0.20	0.49	44.2

MOVEMENT SUMMARY

Site: 101 [Grindleford Dr & Road 6 AM Peak 2031]

Grindleford & Road 6
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Grindleford											
2	T1	71	2.0	0.127	4.8	LOS A	0.7	5.2	0.08	0.59	50.4
3	R2	121	2.0	0.127	8.1	LOS A	0.7	5.2	0.08	0.59	43.8
Approach		192	2.0	0.127	6.9	LOS A	0.7	5.2	0.08	0.59	47.0
East: Road 6											
4	L2	124	2.0	0.129	5.8	LOS A	0.7	4.9	0.41	0.59	43.4
6	R2	12	2.0	0.129	9.2	LOS A	0.7	4.9	0.41	0.59	51.1
Approach		136	2.0	0.129	6.1	LOS A	0.7	4.9	0.41	0.59	44.4
North: Grindleford											
7	L2	24	2.0	0.202	5.3	LOS A	1.1	7.8	0.31	0.50	50.4
8	T1	218	2.0	0.202	5.4	LOS A	1.1	7.8	0.31	0.50	51.2
Approach		242	2.0	0.202	5.4	LOS A	1.1	7.8	0.31	0.50	51.1
All Vehicles		569	2.0	0.202	6.1	LOS A	1.1	7.8	0.26	0.55	48.6

MOVEMENT SUMMARY

Site: 104 [Karrinyup Rd & Albert St]

Existing T-junction
Giveway / Yield (Two-Way)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
North: Albert St											
7	L2	116	0.0	0.100	6.0	LOS A	0.4	3.0	0.43	0.61	46.4
Approach		116	0.0	0.100	6.0	LOS A	0.4	3.0	0.43	0.61	46.4
West: Karrinyup Rd											
10	L2	58	5.0	0.229	6.5	LOS A	0.0	0.0	0.00	0.08	63.8
11	T1	819	5.0	0.229	0.0	LOS A	0.0	0.0	0.00	0.04	69.2
Approach		877	5.0	0.229	0.4	NA	0.0	0.0	0.00	0.04	68.7
All Vehicles		993	4.4	0.229	1.1	NA	0.4	3.0	0.05	0.11	65.1

APPENDIX 9

LOCAL WATER MANAGEMENT STRATEGY

ROWE GROUP DESIGN

emerge ASSOCIATES
Integrated Science & Design

Local Water Management Strategy

East Roselea

Project No: EP18-114(02)

Prepared for Parcel Property
December 2020

Document Control

Doc name:	Local Water Management Strategy East Roselea				
Doc no.:	**EP18-114(02)--003E JRT**				
Version	**Date**	**Author**		**Reviewer**	
1	March 2019	Justin Temmen	JRT	Dave Coremans	DPC
A	July 2019	Justin Temmen	JRT	Dave Coremans	DPC
B	September 2019	Dave Coremans	DPC	Aisha Chalmers	ASC
	Updated following meeting with DWER				
C	November 2019	Dave Coremans	DPC	Aisha Chalmers	ASC
	Updated following final comments from DWER				
D	October 2020	Marley Butler	MB	Dave Coremans	DPC
	Updated to include groundwater modelling and recent agency feedback				
E	December 2020	Marley Butler	MB	Dave Coremans	DPC
	Updated to address final City of Stirling comments				

© 2020 Emerge Associates All Rights Reserved. Copyright in the whole and every part of this document belongs to Emerge Associates and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Emerge Associates.

Executive Summary

Parcel Property proposes to develop lots adjacent to Grindleford Drive in Balcatta, within the East Roselea development (referred to herein as 'the Site') for mixed use commercial and residential purposes. The site is approximately 8 km northwest of the Perth central business district, within the City of Stirling (CoS).

The site is zoned 'Urban' under the Metropolitan Region Scheme (MRS) (WAPC 2017) and 'Development' under the Local Planning Scheme 3 (LPS No. 3) (CoS 2018).

A draft local water management strategy (LWMS) was previously prepared by 360 Environmental, however this has been updated and is replaced by this LWMS, which is intended to support the development of the site in consideration of the objectives and principles detailed in *Better Urban Water Management*, *State Planning Policy 2.9 Water Resources* and *Planning Bulletin 92 Urban Water Management*. Water will be managed using an integrated water cycle approach, which has been developed using philosophies and design approaches described in the *Stormwater Management Manual for Western Australia* (DoW 2007).

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems. In summary, the environmental investigations conducted to date indicate that:

- The site receives 733.2 mm of average annual rainfall with the majority of rainfall received between May and September.
- Topography within the site ranges from approximately 12 m Australian height datum (AHD) at a natural low point along the western central boundary to 16 m AHD on the eastern boundary.
- The site is underlain by peat, sandy gravel and sands.
- Permeability testing along the western site boundary of the site within fill sand ranges from 1.1 to 3.7 m/day.
- Permeability of the underlying natural peat and fill peat ranges between 3.5 x 10^{-3} m/day to 4.5 x 10^{-4} m/day, which is effectively impermeable.
- Acid sulfate soil (ASS) risk mapping classifies the site as having a high to moderate risk of ASS occurring within 3 m of the natural surface.
- There are no classified wetlands within the site. Lake Gwelup is located approximately 2.2 km to the west of site.
- No natural surface water features are present on site.
- No formal surface water drainage features are identified on site; runoff from a relatively large upstream catchment is discharged to the central northern portion of site via a piped network.
- The site is located within a Priority 3 public drinking water source area (P3 PDWSA) and has two identified wellhead protection zones (WHPZs).
- Groundwater levels measured beneath the site range from 11.2 and ~15.5 m AHD with similar historical maximums (MGL). The depth to groundwater therefore ranges from ~0.4 to ~2.3 m below ground level (BGL).
- Groundwater underlying the site flows west towards the Indian Ocean.

- Nutrient concentrations in groundwater are slightly elevated in comparison to the ANZECC and ARMCANZ guidelines.

The site covers an area of approximately 29.5 ha with the proposed residential development incorporating 12.5 ha of residential lots over a range of lot densities (R30, R40, and R60-80), and approximately 5.7 Ha of public open space (POS) including drainage reserve.

The overall objective for integrated water cycle management is to minimise the use of potable water, to appropriately manage groundwater and protect groundwater resources, and to appropriately manage stormwater quantity and quality within the site. The design objectives seek to deliver best practice outcomes using a water sensitive urban design (WSUD) approach, including detailed management objectives for:

- Water conservation
- Stormwater management
- Groundwater management

The criteria proposed within this LWMS are based on the characteristics of the existing environment and a contemporary best-practice approach to integrated water cycle management.

The overall approach to water conservation is to reduce the amount of scheme water required within the development at both a lot and estate scale. Within lots, potable water consumption will be reduced by promoting water efficient fixtures and appliances (WEFA) and water wise gardening (WWG) principles within lot gardens. On an estate scale, groundwater will be utilised for irrigation of landscaped areas within POS which will also utilise WWG principles.

Stormwater management focuses on stormwater runoff quantity and quality. The principle behind the stormwater management strategy is to maintain the existing hydrology by retaining surface flows and to infiltrate stormwater runoff as close to source as possible. The site will retain all runoff up to the major (1% Annual Exceedance Probability - AEP) event within the site. Small event (first 15 mm) runoff will be retained as close to source as possible using a combination of soakwells in lots, vegetated swales, and bio-retention areas (BRA) within POS. Runoff from events greater than the small event will be conveyed through site via a combination of pipe and surface flow. Major event (i.e. 1% AEP) runoff will be retained within flood storage areas (FSA) within POS and the drainage swale along Grindleford Drive, where it will infiltrate to groundwater.

Surface water quality will be addressed using a treatment train approach, which incorporates the principles discussed above. Additional non-structural measures will also be adopted and will be detailed in future urban water management plans (UWMP).

Groundwater level management focusses on protecting properties from flooding, and preventing damage to infrastructure within road reserves, due to inundation by groundwater. The low clearance to groundwater in the western portion of the site means that some lots will need to be filled to achieve a minimum clearance to groundwater. Subsoil drains will be utilised, however given the fill levels proposed these will be to ensure that lots maintain an appropriate clearance above low permeability soil conditions, and are not needed to achieve a clearance above the predicted

groundwater level. The future groundwater conditions have been modelled, and the 50% AEP predicted groundwater level (under a future 'wet' scenario) is used as the design datum for infiltration infrastructure.

The main objective of the management of groundwater quality is to maintain or improve the existing groundwater quality. This will be achieved by reducing total nutrient loads originating from the development, treating surface water runoff as close to source as possible, and using high nutrient uptake soils and vegetation within drainage infrastructure. Measures to address groundwater quality are consistent with those proposed for surface water quality.

The proposed criteria and the manner in which they are proposed to be achieved are presented in **Table E1**. This table provides a readily auditable summary of the required outcomes which can be used in the future detailed design stage to demonstrate that the agreed objectives for water management across the site have actually been achieved.

This LWMS demonstrates that by following the recommendations detailed in the report the site is capable of being developed.

Table E1: *Water management criteria and compliance*

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Water Conservation	WC1	Use fit for purpose water source	Groundwater to be used for irrigation of POS and widened road verges	Proponent	Landscape implementation
			Harvested rainwater used for irrigation of lot gardens and in lot use for suitable built form	Lot owner	Post-house construction
	WC2	Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water	Provide contemporary lot sizes with less room for garden	Proponent	Subdivision design
			Provide advice to lot owners regarding water conservation measures	Proponent	Point of sale
			Use of rainwater tanks within lots where suitable	Lot owner	Post-house construction
			Promotion of waterwise gardening principles in lots	Proponent	Point of sale
			Use of waterwise gardening principles in lots	Lot owner	Post-house construction
			Use of waterwise gardening principles in POS	Proponent	Landscape design
				Landscape contractor	Landscape implementation
			Promotion of water efficient appliances	Proponent	Point of Sale
			Use of water efficient appliances	Lot owner	Post-house construction
			Mandate water efficient fittings	Proponent/City of Stirling	Building approval
	WC3	Minimise use of water at an estate scale	Use of waterwise gardening principles in POS	Proponent	Landscape design

Table E1: *Water management criteria and compliance - continued*

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Groundwater management	GW1	Lots to have a clearance to 50% AEP groundwater level of at least 1.2 m	Preliminary earthworks strategy presented in Appendix F confirms lots achieve a minimum of 1.2 m clearance to 50% AEP groundwater level.	Proponent	During detailed drainage design
	GW2	Drainage basin (BRA and FSA) inverts will be set 300 mm above 50% AEP groundwater level	Swales inverts are set at or above 50% AEP groundwater level. Basin inverts are set at least 300 mm above 50% AEP groundwater level	Proponent	During detailed drainage design
	GW3	Groundwater quality leaving the site will be maintained or improved	Removal or reduction of high nutrient land use (i.e. market gardening, sporting grounds)	Proponent	Sub-division design
			BRA and vegetated swales to provide treatment of surface water runoff through infiltration, uptake of nutrients by vegetation, and adsorption of nutrients to soil media	Landscape contractor	Landscape implementation
			Provision of educational material to lot owners in relation to minimising fertiliser use and plant species selection	Proponent	Point of sale
	GW4	Use water sensitive urban design approaches to recharge the superficial aquifer	Vegetated swales and BRA designs utilise WSUD principles to treat small event and first flush runoff from catchments prior to infiltration	Proponent	During detailed drainage design
	GW5	Subsoil drainage will be set at or above the 50% AEP groundwater level, with discharge to swales at least 150 mm above the swale inverts	Conceptual designs have assumed subsoils discharge at least 150mm above swale inverts. Detailed design of swales and subsoil drains will be provided in the future UWMP. Inverts will be set at or above the modelled 50% AEP groundwater level, with subsoil discharge to swales set at least 150 mm above swale inverts	Proponent	During detailed drainage design

Table E1: *Water management criteria and compliance - continued*

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
Stormwater management	SW1	Retain and infiltrate all runoff from the small event (first 15mm) as close to source as possible (on lot) and 100% of the major event on site.	Residential lots to retain small event in soakwells and garden areas	Lot owner	Construction
			High density lots to retain 100% of runoff up to the major event utilising strategies including soakwells	Proponent / Lot owner	Construction
			Road runoff and excess runoff from lots will be retained within BRA and FSA within POS and drainage reserve	Proponent	During detailed drainage design
	SW2	Finished floor levels of lots shall have a minimum 300 mm clearance to the major storm event top water level in FSA	Preliminary earthworks strategy presented in the concept civil engineering designs within **Appendix F** confirms that lots adjacent to FSAs will be at least 300 mm above the major storm event top water level	Proponent	During detailed drainage design
	SW3	Provide stormwater flow pathways for runoff from the major storm event	Preliminary earthworks strategy presented in **Appendix F** confirms that the road network will be graded towards POS and drainage reserve areas, providing a flow path for major storm event runoff to reach FSAs	Proponent	During detailed drainage design
	SW4	Minor roads are to be designed to remain passable in the minor (20% AEP) storm event.	The piped drainage network will be designed to convey the minor storm event (20% AEP) which will ensure roads remain passable	Proponent	During detailed drainage design
	SW5	Trapped low points within minor roads are to be provided with a piped drainage outlet designed for major 1% AEP with limited inundation and minimum freeboard to design floor levels of 300 mm.	The pipe network will be sized to convey the minor event to stormwater infrastructure. Appropriate freeboard from the road spill crest will be allowed for flows via the road network in the major event.	Proponent	During detailed drainage design
	SW6	Design infiltration areas to avoid creating mosquito habitat	FSA drain times will comply with recommended emptying times	N/A	N/A
	SW7	Size BRAs to (at least) 2% of the connected impervious	BRAs are sized to 4.4% of the connected impervious area	Proponent	During detailed drainage design

Table E1: *Water management criteria and compliance - continued*

Management Aspect	Criteria Number	Criteria Description	Manner in which compliance will be achieved	Responsibility for implementation	Timing of implementation
	SW8	Apply appropriate non-structural measures to reduce nutrient loads	Minimise use of fertilisers within POS and road verges	Proponent	Landscape implementation
			Use of drought tolerant turf species that require minimal water and nutrients	Landscape contractor	Landscape implementation
			Use of nutrient absorbing vegetation species within estate drainage reserves and treatment infrastructure	Landscape contractor	Landscape implementation
			Maintenance of POS and drainage areas	Landscape contractor	Landscape implementation
			Education of residents regarding responsible nutrient application	Proponent	Point of sale

Table of Contents

Abbreviations Tables xiii

1 Introduction 1

1.1 Background 1
1.2 Planning context 1
1.3 Policy framework 1
1.4 Previous studies 2
1.4.1 Roselea East, Balcatta – Draft Local Water Management Strategy (360 Environmental 2018) 2
1.4.2 Preliminary flood modelling analysis of East Roselea structure planning area and upstream catchments (Emerge Associates 2018) 2
1.5 LWMS objectives 3

2 Proposed Development 4

3 Existing Environment 5

3.1 Climate 5
3.2 Geotechnical conditions 5
3.2.1 Topography 5
3.2.2 Geology and soils 5
3.2.3 Soil permeability 5
3.2.4 Acid sulfate soils 6
3.2.5 Contaminated sites 6
3.3 Existing and historical land use 6
3.3.1 Aboriginal heritage 6
3.4 Surface water 7
3.4.1 Wetlands 7
3.4.2 Existing drainage network 7
3.4.2.1 Surface water features 7
3.4.2.2 City of Stirling stormwater drainage 7
3.4.2.3 Water Corporation drainage 7
3.5 Groundwater 8
3.5.1 Groundwater levels 8
3.5.1.1 Regional groundwater level data 8
3.5.1.2 Site specific groundwater level data 8
3.5.2 Groundwater quality 8
3.5.3 Public Drinking Water Source Areas 9
3.6 Summary of existing environment 9

4 Design Criteria and Objectives 10

4.1 Integrated water cycle management 10
4.2 Water conservation 10
4.3 Stormwater management 11
4.4 Groundwater management 11

5 Water Conservation Strategy 12

5.1 Fit for purpose water use 12
5.1.1 Scheme water supply 12
5.1.2 Groundwater supply 12
5.1.3 Rainwater harvesting 12
5.1.4 Alternative water supply 13

5.2 Water conservation measures....13
5.2.1 Water efficient fixtures and appliances....13
5.2.2 Water wise gardens....13
5.2.3 Community awareness and education programs....13
5.3 Water balance....14
5.4 Estate scale water usage....14
5.5 Wastewater management....15
5.6 Water conservation criteria compliance summary....15

6 Stormwater Management Strategy....16

6.1 Stormwater management approach....16
6.1.1 Lot storage....16
6.1.2 Vegetated swales....16
6.1.3 Bio-retention areas....18
6.1.4 Flood storage areas....19
6.1.5 Discharge to external stormwater networks....20
6.2 Non-structural stormwater management measures....20
6.3 Stormwater criteria compliance summary....21

7 Groundwater Management Strategy....22

7.1 Groundwater modelling assessment....22
7.2 Groundwater level management....23
7.3 Groundwater quality management....24
7.4 Groundwater criteria compliance summary....25

8 Matters to be addressed in the UWMP....26

8.1 Drainage calculations....26
8.2 WSUD configuration....26
8.3 Staging considerations....27
8.4 Irrigation schedule....27
8.5 Water balance....27
8.6 Water conservation strategy....27
8.7 Subdivision earthworks....27
8.8 Groundwater licensing....28
8.9 Acid sulphate soil investigations....28
8.10 Non-structural water quality improvement measures....28
8.11 Management and maintenance requirements....28
8.12 Construction management strategy....28

9 Monitoring Program....29

9.1 Condition monitoring....29
9.2 Groundwater monitoring....29
9.3 Temporary infrastructure....29
9.4 Reporting....30

10 Implementation Plan....31

10.1 Roles and responsibility....31
10.2 Funding....31
10.3 Review....31

11 References....32

11.1 General references....32
11.2 Online references....34

List of Tables

Table 1: Water conservation criteria compliance....15
Table 2: Swale treatment and storage requirement in small, minor and major storm events....17
Table 3: Small event treatment requirements....19
Table 4: Minor and major storm event detention requirements....19
Table 5: Stormwater criteria compliance summary....21
Table 6: 50% AEP groundwater levels, inverts and top water levels....24
Table 7 Groundwater management criteria compliance....25

Figures

Figure 1: Location Plan and Site Boundary
Figure 2: Topographical Contours
Figure 3: Regional Geological Mapping and Geotechnical Investigations
Figure 4: Acid Sulfate Soil Risk Mapping
Figure 5: Wetlands and Hydrological Features
Figure 6: Historical Maximum Groundwater Elevations
Figure 7: Public Drinking Water Source Area and Wellhead Protection Zones
Figure 8: Stormwater Management Strategy
Figure 9: Small (first 15 mm) Event Inundation Areas
Figure 10: Minor (20% AEP) Event Inundation Areas
Figure 11: Major (1% AEP) Event Inundation Areas
Figure 12: Pre-development and Post Development Groundwater Contours

Appendices

Appendix A

East Roselea Local Structure Plan

Appendix B

Geotechnical Investigation

Appendix C

Preliminary Flood Modelling of East Roselea

Appendix D

Groundwater Monitoring Results

Appendix E

Modelling Assumptions Report

Appendix F

Civil Engineering Designs

Appendix G

Conceptual Landscape Designs

Appendix H

Groundwater Modelling Report (CDM Smith)

Appendix I

Annual Exceedance Probability analysis

Abbreviations Tables

Table A1: *Abbreviations – General terms*

General terms	
ABS	Australian Bureau of Statistics
AEP	Annual exceedance probability
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASS	Acid sulfate soils
CCW	Conservation category wetland
FSA	Flood storage area
IWSS	Integrated water supply scheme
LWMS	Local Water Management Strategy
MGL	Maximum groundwater level
NWQMS	National Water Quality Management Strategy
RWT	Rainwater tanks
TN	Total nitrogen
TP	Total phosphorous
TWL	Top water level
UWMP	Urban Water Management Plan
WSUD	Water sensitive urban design
WWG	Water wise gardens

Table A2: *Abbreviations – Organisations*

Organisations	
BoM	Bureau of Meteorology
DAA	Department of Aboriginal Affairs
DBCA	Department of Biodiversity Conservation and Attractions
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
CoS	City of Stirling
WAPC	Western Australian Planning Commission
WC	Water Corporation of Western Australia

Table A3: *Abbreviations – units of measurement*

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre
m^2	Square metre
m AHD	Metres in relation to the Australian height datum
mm	Millimetre
°C	Degrees Celsius
mg/L	Milligrams per litre
mS/cm	Millisiemens per centimetre
µS/cm	Microsiemens per centimetre

1 Introduction

1.1 Background

East Roselea, referred to herein as 'the site', is located approximately 8 km northwest of the Perth central business district, within the City of Stirling (CoS). The site is predominantly located to the east of Grindleford Drive and is bounded by Karrinyup Road to the south and Albert Street to the west. Parcel Property proposes to develop the site for mixed use commercial and residential properties.

The site is approximately 29.5 ha. The majority of site is currently undeveloped, with the exception of small commercial premises to the southern boundary, and community clubs and cultural centers along with parks and recreation areas through the centre and northern parts of the site. The location of the site is shown in **Figure 1**, including an aerial photograph illustrating the cadastral boundaries and current condition of the site.

A (draft) Roselea East, Balcatta LWMS was prepared for Parcel Property in March 2018 by 360 Environmental, and outlines a strategy for supporting the proposed land uses within the development, being mixed commercial and residential. This LWMS provides an update to the previous *draft LWMS*, providing additional detail not available at the time and includes information requested by the CoS following review of the *draft LWMS*.

1.2 Planning context

The East Roselea site is currently zoned 'Urban' under the Metropolitan Region Scheme (MRS) (WAPC 2017) and as 'Development' under the Local Planning Scheme 3 (LPS No. 3) (CoS 2018).

1.3 Policy framework

There are a number of Local and State Government policies of relevance to the development. These policies include:

- *A State Water Strategy for Western Australia* (Government of WA 2003)
- *State Water Plan* (Government of WA 2007)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *Liveable Neighbourhoods Edition 4 (Update 2) (WAPC 2009a)*
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009b)
- *Bush Forever* (Government of WA 2000)

In addition to the above policies, there are a number of published guidelines and standards available that provide direction regarding the water discharge characteristics that developments should aim to achieve. These are key inputs that relate either directly or indirectly to the development and include:

- *Australian Rainfall and Runoff (Engineers Australia 2016)*
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Better Urban Water Management* (WAPC 2008)
- *Developing a Local Water Management Strategy* (DoW 2008a)
- *Decision Process for Stormwater Management in Western Australia (DWER 2017b)*
- *National Water Quality Management Strategy* (NWQMS) (ANZECC and ARMCANZ 2000)
- *Stormwater Management Manual for Western Australia* (DoW 2007)

The guidance documents listed indicate a need for accurate baseline data prior to urban development. This will ensure that any future development is able to fulfil the water management requirements of Department of Water and Environmental Regulation (DWER) and engineering standards specified by the CoS, and will also ensure that realistic water management criteria that are practically achievable are adopted.

1.4 Previous studies

1.4.1 Roselea East, Balcatta – Draft Local Water Management Strategy (360 Environmental 2018)

The (Draft) *Roselea East, Balcatta LWMS* was prepared for Parcel Property in March 2018 by 360 Environmental, and outlines a strategy for supporting the proposed land uses within the development, being mixed commercial and residential. The strategy outlined within the Draft LWMS is consistent with the major objectives presented in **Section 1.5**, and the design criteria proposed therein forms the basis for the criteria proposed in this LWMS.

Due to changes in the proposed structure plan, elements of the approach to stormwater management and groundwater management have changed, particularly in light of the progression of civil conceptual designs for the development. Whereas previously, the lowering of existing groundwater levels through the use of subsoil drains was proposed, revised earthworks and civil engineering designs now propose to control the level of perched groundwater above a layer (raft) of limestone which is to be installed above the peat soils found on site. The stormwater management plan now adopts the approach of retaining all runoff generated across the development up to the major storm event.

1.4.2 Preliminary flood modelling analysis of East Roselea structure planning area and upstream catchments (Emerge Associates 2018)

The *Preliminary flood modelling analysis of East Roselea structure planning area and upstream catchments* is a high level investigation into the external upstream catchment discharge to the development. The report details a desktop review of the upstream catchment and structure plan site flood storage, and determines;

- A substantial inflow to the site from the external upstream catchment via existing City stormwater network assets (further detailed in **Section 3.4.2**)
- An estimate of the magnitude of pre-development site storage
- A preliminary plan for stormwater management.

1.5 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in the *Better Urban Water Management* (WAPC 2008). It is intended to support the development within the East Roselea site and is based on the following major objectives:

- Provide a broad level stormwater management framework to support future urban development.
- Provide sufficient land in which to manage major event runoff volumes
- Incorporate appropriate best management practices (BMPs) into the drainage systems that address the environmental and stormwater management issues identified.
- Minimise development construction costs, which will result in reduced land costs for future home owners.
- Minimise ongoing operation and maintenance costs for the land owners and CoS.
- Develop a water conservation strategy for the site that will accommodate existing groundwater allocation constraints for the area.
- Gain support from DWER and CoS for the proposed method to manage stormwater within the site and potential impacts on downstream areas.

Detailed objectives for water management within the site are further discussed in **Section 4**.

2 Proposed Development

Roselea East is designed to be a focal point for the local and wider community integrating residential and commercial areas to provide a multi-functional, mixed use centre. The Structure Plan includes a total land area of approximately 29.5 hectares, and proposed land uses include:

- 3.1 ha of retained Public Open Space (POS)
- 1.2 ha of new POS and 1.4 ha of drainage reserve
- 6.9 ha of R30 residential lots
- 1.3 ha of R40 residential lots
- 4.3 ha of R60-R80 residential lots
- 3.0 ha of civic centre
- 2.8 ha of mixed use commercial (local centre)
- 5.6 ha of local road network

It is proposed that the Chung Wah Chinese Cultural centre area is to remain, along with the Macedonia Park sports ground on Lot 114 Grindleford Drive. The East Roselea Local Structure Plan is provided in **Appendix A**.

The development proposes to fully retain the 1% AEP event within the site. This is achieved within a flood storage area (FSA) for the central portion of the site and within a 15 m – 25 m infiltration swale located along the western boundary of the site. These features will have bioretention areas (BRAs) incorporated into the base to provide a positive water quality outcome for surface and groundwater.

3 Existing Environment

3.1 Climate

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. An average of 733.2 mm of rainfall is recorded annually at the Perth Metro weather station (Station ID: 009225), located approximately 6.6 km from site. Average monthly rainfall of 100 mm or greater is recorded between the months of June and August (BoM 2019).

Average daily evaporation in the region is 5.7 mm per day, equating to an average annual evaporation of 2,082 mm (Perth Airport weather station, Station ID: 009021) (BoM 2019).

3.2 Geotechnical conditions

3.2.1 Topography

The topography of the site slopes generally east to west, ranging in elevation from approximately 16 m Australian height datum (AHD) along the eastern site boundary, to a low of 12 mAHD along the central western boundary.

Historic stockpiling of uncontrolled fill immediately north of the Macedonia Park has resulted in a high point in the centre of site to be at a maximum elevation of ~ 20.8 mAHD, with the bulk of the stock pile ranging in elevation from approximately 16.5 mAHD and 18.5 m AHD (McMullen Nolan Group (MNG) 2019).

Topographic contours are shown on **Figure 2**.

3.2.2 Geology and soils

Regional geological mapping indicates that the site is underlain by peat (P), described as black, fibrous organic and sometimes clayey soil across the entirety of site. Calcareous and siliceous sands associated with Tamala Limestone (S_7) (Gozzard 1986) of the Quindalup and Spearwood coastal dunal systems are located just beyond the eastern site boundary, as shown in **Figure 3**.

An intrusive soil investigation was conducted by Galt Geotechnics (Galt Geotechnics 2017). The soil types encountered were generally consistent with the regional geological mapping (Gozzard 1986) but showed dense sands underlying the site starting at a depth of approximately 10 m. The Geotechnical Report is provided in **Appendix B**.

Karst formations have not been identified as a potential risk. Regional geological mapping shows the nearest potential karst formations to be approximately 1 km to the west of site, and none were reported to be encountered by the geotechnical investigations.

3.2.3 Soil permeability

Infiltration testing of the shallow soil profile was undertaken (Galt Geotechnics 2017) along the western boundary of the site during the geotechnical investigation. Permeability results indicate a range between 1.1 m/day and 3.7 m/day with an average permeability of 2.73 m/day.

Additional permeability testing was also undertaken by Galt Geotechnics in 2020 to confirm the permeability of the underlying peat layers, and to determine if compacting these peat layers would form an additional impediment to vertical or horizontal movement of water within this soil layer. The peat was classified in to Natural Peat and Fill Peat. The infiltration testing and subsequently recommended design horizontal permeability (k) values are:

- Natural Peat – 4.5 x 10^{-4} m/day
- FILL: Peat – 3.5 x 10^{-3} m/day

The approximate permeability test locations are shown on **Figure 3** and **Appendix B**. The Geotechnical Report is provided in **Appendix B**.

3.2.4 Acid sulfate soils

The Acid Sulfate Soil (ASS) Regional Risk Mapping (DWER 2017a) classifies the site as having a high to moderate risk of ASS occurring within 3 m of the natural surface. ASS mapping is shown in **Figure 4**.

A site specific ASS investigation is proposed for the site, and will be undertaken to support future subdivision.

3.2.5 Contaminated sites

According to the Reported Contaminated Sites Database (DWER 2019a) the site has no record of a contaminated site classification. Two reported sites, classified as “Contaminated – Restricted Use” and “Remediated – Restricted Use”, lay 500 m to the west of site.

3.3 Existing and historical land use

The majority of the site is currently undeveloped, with the exception of community cultural centers (the Macedonian Cultural Centre to the northern boundary, the Chung Wah Chinese Cultural Centre and a dance studio to the centre of site) and a small commercial precinct at the southern boundary. Sporting fields and associated parking is situated on the southern half of the site.

Historic aerial photography (Landgate 2019) dated from the 1950’s shows that the site was originally used for agricultural purposes. Clearing occurs by 1985 and sports fields and the northern cultural centre are observed by 1995. The central cultural premises and the commercial district at the south of site appear by 2000. Uncontrolled fill is stockpiled on the site between 2000 and 2015 whilst the remainder of the site is undeveloped.

3.3.1 Aboriginal heritage

There are no sites of Aboriginal or European heritage within the site; a search of the Department of Aboriginal Affairs (DAA) Aboriginal Heritage Inquiry System (AHIS) indicates that the nearest site of significance is located in Dog Swamp (ID 3738), approximately 2.5 km to the southeast of site (DAA 2014).

3.4 Surface water

3.4.1 Wetlands

The *Geomorphic Wetlands Swan Coastal Plain dataset* (DBCA 2018) classifies the entirety of site as a multiple use sumpland, (UFI #8177). Nearby wetlands classified as conservation category wetlands (CCW) include;

- UFI #8176 - Lake Gwelup and associated Bush Forever Site (BF312), located approximately 2.2 km to the west of site.
- UFI #8192 - Herdsman Lake and associated Bush Forever Site (BF281), located approximately 2.8 km to the south west of site.
- UFI # 8146 – Dog Swamp located approximately 3.0 km south of site.

UFI #8177 is shown in relation to the site on **Figure 5**.

3.4.2 Existing drainage network

3.4.2.1 Surface water features

There are no formal drainage related surface water features within the site.

3.4.2.2 City of Stirling stormwater drainage

The CoS Intramaps (CoS 2018) shows an existing discharge location on to site. A 900 mm diameter drainage pipe is shown to discharge stormwater from the upstream road network catchment onto Lot 50.

The volume of stormwater received by the site from the discharge from upstream networks has been estimated (Emerge Associates 2018), and is included in **Appendix C.** It is understood that the City have obtained permission from the Water Corporation to discharge this water beyond the site to the Albert Street Branch Drain (ASBD), west of Grindleford Drive. The management of this volume of stormwater is therefore not required to be considered in this LWMS.

CoS intramaps also show a 525 mm diameter pipe apparently connecting to Lot 86 in the south of the site. The extent to which the site drains to this pipe is unknown, however localised topographical contours suggest that the discharge is localised and generally restricted to Lot 86.

The approximate alignment of the CoS infrastructure and the ASBD are shown on **Figure 5**.

3.4.2.3 Water Corporation drainage

The ASBD is an open Water Corporation drainage asset flowing northeast-southwest along the northern section of Grindleford Drive, west of and adjacent to the site. The ASBD is designed to convey major event flows, and connects via pipe to the Roselea Estate Lake west of the southern and central portion of site, before returning to open drain south of Karrinyup Road (CoS 2018).

3.5 Groundwater

3.5.1 Groundwater levels

3.5.1.1 Regional groundwater level data

The *Water Register* (DWER 2019b) indicates that groundwater beneath the site is a multi-layered system comprised of the following aquifers within the Gwelup groundwater subregion:

- Perth – Superficial Swan unconfined aquifer
- Perth – Mirrabooka unconfined aquifer
- Perth – Leederville confined aquifer
- Perth – Yarragadee North confined aquifer.

The historic maximum groundwater contours (MGL) dataset provided in the Perth Groundwater Map (DWER 2018) shows groundwater levels across the site ranging between 11.2 m and ~15.5 m AHD (between ~0.4 m and ~2.3 m below the ground surface level), suggesting that groundwater flows in a westerly direction towards the coast.

3.5.1.2 Site specific groundwater level data

The draft LWMS (360 Environmental 2018) records that eight monitoring bores were installed across the site in 2016 to measure groundwater levels and quality. In August 2017, 360 Environmental assumed custody of the bores and continued water level and quality monitoring until November 2017. 360 Environmental presented this data in the Draft Local Water Management Strategy (360 Environmental 2018). Bores were then re-monitored until November 2018.

A review of the full monitoring data set revealed outliers that had skewed the contours presented in the draft LWMS. Following review, maximum groundwater levels were found to be generally consistent with the DWER regional MGL dataset (2018) across the site during the observation period.

A calibration of the revised site specific measured MGLs to three nearby DWER bores was undertaken, however these bores were found to be not representative of the site and do not produce a reasonable calibration (as MGL was predicted well above natural surface). As MGLs are typically at or close to the surface and are generally aligned with the regional contours, the site specific measured MGLs are deemed an appropriate benchmark for the site.

A collated summary of the full groundwater level data set (360 Environmental 2018) is attached in **Appendix D**. Site specific measured MGLs are shown against the DWER regional contours, along with borehole locations, on **Figure 6**.

3.5.2 Groundwater quality

Groundwater quality monitoring was completed in October 2016 and September 2017 (360 Environmental 2018) for select boreholes across the site. Results show that average ammonia (NH_4), nitrite + nitrate (NOx), total nitrogen (TN), and total phosphorus (TP) levels are elevated in comparison to ANZECC and ARMCANZ criteria for background groundwater nutrient concentrations.

An extract of the groundwater quality data (360 Environmental 2018) is presented in **Appendix D**. The locations of boreholes are shown on **Figure 6**.

3.5.3 Public Drinking Water Source Areas

The site is located within a Priority 3 Public Drinking Water Source Area (PDWSA) (DWER 2018). Two public drinking water production bores are identified in proximity to the southern boundary of the site. A 300 m radius wellhead protection zone (WHPZ) is required around each production bore. PDWSA and WHPZs are shown on **Figure 7**.

Priority 3 classification areas are defined to '*manage the risk of pollution*' to the water source from catchment activities. Protection of P3 areas is achieved through guided or regulated environmental risk management for land use activities.

Land uses considered to have significant pollution potential are opposed or constrained (DoE 2004). All of the land uses proposed under the East Roselea development are classified as '*Acceptable*' within these areas (DoE 2004).

3.6 Summary of existing environment

In summary, the environmental investigations conducted to date indicate that:

- The site receives 733.2 mm of average annual rainfall with the majority of rainfall received between May and September.
- Topography within the site ranges from approximately 12 m AHD at a natural low point along the western central boundary to 16 m AHD on the eastern boundary.
- The site is underlain by peat, and sandy gravel and sands.
- Permeability testing along the western site boundary of the site within fill sand ranges from 1.1 to 3.7 m/day.
- Permeability of the underlying natural peat and fill peat ranges between 3.5 x 10^{-3} m/day to 4.5 x 10^{-4} m/day, which is effectively impermeable.
- ASS risk mapping classifies the site as having a high to moderate risk of ASS occurring within 3 m of the natural surface.
- There are no classified wetlands within the site. Lake Gwelup is located approximately 2.2 km to the west of site.
- No natural surface water features are present on site.
- No formal surface water drainage features are identified on site; runoff from a relatively large upstream catchment is discharged to the central northern portion of site via a piped network.
- The site is located within a P3 PDWSA and has two identified WHPZs.
- Groundwater levels beneath the site range from 11.2 and ~15.5 m AHD with similar historical MGL. The depth to groundwater therefore ranges from ~0.4 to ~2.3 m BGL across the site.
- Groundwater underlying the site flows west towards the Indian Ocean.
- Nutrient concentrations in groundwater were found to be slightly elevated in comparison to the ANZECC and ARMCANZ guidelines.

4 Design Criteria and Objectives

4.1 Integrated water cycle management

The *State Water Strategy* (Government of WA 2003) and *Better Urban Water Management* (WAPC 2008) endorse the promotion of integrated water cycle management and application of WSUD principles to provide improvements in the management of stormwater, and to increase the efficient use of other existing water supplies. The key principles of integrated water cycle management include:

- Considering all water sources, including wastewater, stormwater and groundwater.
- Integrating water and land use planning.
- Allocating and using water sustainably and equitably.
- Integrating water use with natural water processes.
- Adopting a whole of catchment integration of natural resource use and management.

Integrated water cycle management addresses not only physical and environmental aspects of water resource use and planning, but also integrates other social and economic concerns. Water management design objectives should therefore seek to deliver best practice outcomes in terms of:

- Potable water consumption,
- Flood mitigation,
- Stormwater quality management,
- Groundwater management.

The first step in applying integrated water cycle management in urban catchments is to establish agreed environmental values for receiving environments. The existing environmental context of the East Roselea site has been discussed in **Section 3** of this document. Guidance regarding environmental values and criteria is provided by a number of federal and state government policies and guidelines, and site specific studies that are detailed in **Section 1.3** and **Section 1.4**.

The design criteria discussed in the following sections are based on the assessment of the existing environment within the site, and with the aim of achieving the integrated water cycle outcomes discussed above.

4.2 Water conservation

The water conservation design criteria proposed are consistent with the guidelines presented in *Better Urban Water Management* (WAPC 2008) and *Developing a Local Water Management Strategy* (DoW 2008a). This LWMS proposes the following water conservation criteria:

Criteria WC1 Use fit for purpose water sources.

Criteria WC2 Consumption target for water of 100 kL/person/year, including not more than 40-60 kL/person/year scheme water.

Criteria WC3 Minimise use of water at an estate scale.

The manner in which this objective will be achieved is further detailed in **Section 5**.

4.3 Stormwater management

The principle behind stormwater management for Stage 1 is to mimic the existing hydrological conditions, as described in **Sections 3.4** and **3.5**. This principle and the guidance documents discussed in **Section 1** have guided the stormwater management criteria which include:

Criteria SW1 Retain and infiltrate all runoff from the small (first 15mm) rainfall event as close to source as possible (on lot) and 100% of the major (1% AEP) storm event on site.

Criteria SW2 Finished floor levels of lots shall have a minimum 300 mm clearance to the major storm event top water level in FSAs.

Criteria SW3 Provide stormwater conveyance pathways for runoff in the major storm event.

Criteria SW4 Minor roads are to be designed to remain passable in the minor (20% AEP) storm event. Trapped low points within minor roads are to be provided with a piped drainage outlet designed for major 1% AEP with limited inundation and minimum freeboard to design floor levels of 300 mm.

Criteria SW5 Design infiltration areas to avoid creating mosquito habitat.

Criteria SW6 Bio-retention areas (BRAs) to be sized to a minimum of 2% of the connected impervious area.

Criteria SW7 Apply appropriate non-structural measures to reduce nutrient loads.

The manner in which these objectives will be achieved is further detailed in **Section 6**.

4.4 Groundwater management

The principle behind the groundwater management strategy is to maintain (at minimum) the existing groundwater hydrology. This LWMS proposes the following groundwater management criteria:

Criteria GW1 Provide separation distance of finished floor levels to the 50% AEP groundwater level of at least 1.2 m.

Criteria GW2 Drainage basin inverts will be set 300 mm above the 50% AEP groundwater level.

Criteria GW3 Maintain or improve groundwater quality onsite.

Criteria GW4 Use water sensitive urban design approaches to recharge the superficial aquifer.

Criteria GW5 Subsoil drainage will be set at or above the 50% AEP groundwater level, with discharge to swales at least 150 mm above the swale inverts.

The manner in which these objectives will be achieved is further detailed in **Section 7**.

5 Water Conservation Strategy

5.1 Fit for purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted.

5.1.1 Scheme water supply

The East Roselea site will be serviced by the Water Corporation Integrated Water Supply Scheme (IWSS) which supplies scheme water for potable and some limited non-potable uses. The proposed development is capable of being serviced by the existing potable water infrastructure located along Grindleford Drive (Pritchard Francis 2017).

Scheme water will not be used for permanent irrigation of POS within the East Roselea site, however pending availability of groundwater licences it may be required for establishment period irrigation for 'dry parks'.

5.1.2 Groundwater supply

The POS in the development includes retained sports playing fields (approximately half of the existing area), which has ongoing irrigation requirements. There is some new POS proposed within the LSP area and the retention of existing sports playing fields within the development is expected to minimise water usage as establishment of additional planting is minimised.

An allocation of 37,500 kL/annum is available for the irrigation of existing and proposed new POS. If the groundwater licences were to be unavailable for the irrigation of POS or drainage reserves, a 'dry park' response would be taken, and any irrigation would be undertaken temporarily during establishment period, in which case the source of the water would likely be scheme water.

The irrigation requirement for street scaping as may be applicable will be investigated at the time of the Urban Water Management Plan (UWMP).

The above measures will assist in achieving **Criteria WC2** and **WC3**.

5.1.3 Rainwater harvesting

Collection of runoff from roof surfaces can be undertaken, with this water stored within rainwater tanks (RWT) for later use. This water is of high quality, however in urban environments this water is considered non-potable. Stored rainwater may be used for some irrigation requirements however this will need to be supplemented with scheme water during the lower rainfall months. During the higher rainfall months the majority of the stored rainwater can be used to supplement internal building non-potable uses. The water efficiency strategy recommends that rainwater is used in washing machines, toilets and hot water systems.

RWTs will not be mandated for the site however they will be promoted by the proponent at point of sale by providing educational literature regarding the benefits of their use.

The above measures will assist in achieving **Criteria WC1** and **WC2**.

5.1.4 Alternative water supply

Due to the location of a P3 PDWSA and respective WHPZ (**Section 3.5.3**) within the site, alternative water supply options are not feasible.

5.2 Water conservation measures

The development will utilise water wise garden (WWG) principles (WC 2003) for lot scale gardens and within estate landscaping and water efficient fixtures and appliances (WEFA) to ensure that the development minimises the use of water. These measures are further discussed in the following Sections.

5.2.1 Water efficient fixtures and appliances

Significant reductions in in-house water uses can be achieved with the use of WEFA. The water conservation strategy proposes that all dwellings use WEFA. Water efficient fittings are mandated as part of the building approvals process, while uptake of water efficient appliances can be encouraged by state and local government rebates, as well as education from the proponent at point of sale.

The above measures will assist in achieving **Criteria WC1** and **WC2**.

5.2.2 Water wise gardens

Reductions in water use for irrigation by employing water efficiency measures can significantly reduce the total water usage (WC 2003). The following water efficiency measures will be used:

- Where required, soil shall be improved with soil conditioner certified to Australian Standard AS4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- Garden beds to be mulched to 75 mm with a product certified to Australian Standard AS4454.
- Implementation of hydrozoning design practices, which will group plant species with similar / same irrigation requirements.
- Irrigation systems will have emitters which disperse coarse droplets to minimise losses to evaporation.
- Irrigation will not be utilised during winter months and rain sensors will be utilised.
- The adoption of xeriscaped gardens (garden beds are landscaped using ‘waterwise plants’, which are local native species that require less water).
- Minimising turf areas where possible.
- Educating the community to increase awareness of water conservation.

WWG principles will be utilised within POS, drainage reserves and road reserves with an average irrigation rate of 7,500 kL/ha/year maintained. Uptake of WWG practices for lot landscaping can be encouraged by the proponent at point of sale of lots.

The above measures will assist in achieving **Criteria WC1** and **WC2**.

5.2.3 Community awareness and education programs

Lot owners can be provided with reference material covering the following topics:

- Water conservation in the home
- Waterwise gardening
- On-lot erosion and sediment control.

5.3 Water balance

A water balance analysis has been undertaken to demonstrate the effectiveness of the water conservation strategy. Due to the level of detail available at this planning stage, assumed rates at which the water conservation measured are implemented are based on data from the Australian Bureau of Statistics (ABS) (ABS 2013b).

The water balance analysis has been based on the rates and calculation methodology presented in the Water Corporation spreadsheet *AltWaterSupply_Water_Use_Model.xls* (WC 2011). The water balance analysis assumes an average of 1.8 people per lot for single dwellings, a value calculated from data provided by the ABS for new housing developments in Perth (ABS 2013a). This spreadsheet has been adapted to model the effects of using RWT, WWG and WEFA.

The results of the water balance indicate that on average, if households in the development adopt the proposed water conservation measures at typical uptake rates, they will use 43.1 kL of potable water per year, per person.

This achieves the state water consumption target of no more than 100 kL/year/person and the *Better Urban Water Management* aspirational goal of 40-60 kL/year/person, and satisfies **Criteria WC1.**

5.4 Estate scale water usage

The water usage at the estate scale has been determined by the amount of POS provided and any additional areas which will require irrigation. There is approximately 4.3 ha of POS (including verges adjacent to POS), with 3.1 ha being established sporting grounds.

The existing POS is predominantly turf with some established trees on the periphery. The new POS areas should incorporate native shrub planting and turf spaces for informal recreational purposes.

The drainage reserve could potentially require irrigation to establish plants and turf within the proposed drainage reserves (approximately 1.4 ha), however this use is expected to be temporary.

The estate scale water usage will be designed to approximately 37,500 kL/annum for the site during establishment and upkeep. This volume is expected to reduce once water wise plants are established. Additionally, street trees may be incorporated in the estate landscape during future design, however individual trees may be watered by water cart/scheme water during their establishment period. A detailed irrigation schedule will be provided in future UWMPs and/or landscape concept designs.

A temporary allocation for dust suppression may also be required for construction purposes, the total of which will be confirmed at UWMP stage, and for the relevant construction area.

The above measures will assist in achieving **Criteria WC2**.

5.5 Wastewater management

The site will be connected to the Water Corporation deep sewer network. The site is proposed to be serviced by connection to an existing reticulation sewer located on Grindleford Drive (Pritchard Francis 2017).

5.6 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria and how these are addressed within the site is provided in **Table 1**.

Table 1: Water conservation criteria compliance

Criteria Number	Criteria Description	Manner in which compliance will be achieved
WC1	Use fit for purpose water sources	Potable water supplied by scheme
		Development scale POS irrigation by groundwater
		On-lot non-potable water using RWTs
WC2	Consumption target of 100 kL/person/year with no more than 40-60 kL/person/year of scheme water	Mandated use of water efficient fittings
		Promotion of WEFA
		Promotion of RWTs in lot
		Use of WWG in POS and road reserve
		Promotion of WWG principles to lot owners
WC3	Minimise use of water at an estate scale	Use of WWG in POS and road reserve
		Maximum irrigation rate of 7,500 kL/ha/annum
		Retention of predevelopment established POS area

6 Stormwater Management Strategy

The stormwater management strategy for the site is to retain, treat and infiltrate stormwater runoff as close to source as possible. The overall approach to managing stormwater within the site is consistent with the integrated water cycle management approach described in **Section 4.1**.

The strategy for the site requires residential lots up to the R60 density classification to retain the small event (first 15 mm) on site. Residential lots of density R60 and above will retain the major (1% AEP) event onsite.

The following stormwater management strategy is illustrated in **Figure 8**, which shows stormwater catchment areas and related management infrastructure detailed in **Section 6.1**, below.

6.1 Stormwater management approach

The development drainage system has been designed to achieve the objectives and criteria stated in **Section 4.3**. Surface runoff modelling undertaken using XPSWMM has been used to inform the design of stormwater infrastructure as detailed below. Modelling assumptions are provided in **Appendix E**.

6.1.1 Lot storage

Rainfall on lots will either infiltrate directly at-source (garden areas) or will be directed to soakwells from roofs and paved surfaces where it will infiltrate into the underlying soil and ultimately to groundwater. Infiltration of runoff through the underlying soils will provide treatment through adsorption of nutrients to sand particles.

Residential lots of density up to R60 will utilise soakwells sized to retain runoff from the small event (i.e. first 15 mm) from lot. Residential lots of density R60 and above will use a combination of strategies to retain up to the major event onsite, which will be detailed in future UWMPs. As these strategies are at this stage undefined this information will inform the UWMP.

Additionally, soakwells will have the ability to overflow to a lot connection for discharge to either of the proposed subsoil or stormwater networks, with the intent of ensuring that the lot-scale detention measures continue to function as intended. Subsoil networks are discussed in **Section 7.1**.

The use of soak wells will assist in achieving **Criteria SW1** and **SW7**.

6.1.2 Vegetated swales

Vegetated swales will be utilised to treat and retain runoff within the western boundary of the site. These will be located within a 25 m wide drainage reserve immediately adjacent to Grindleford Drive. Concept civil engineering designs are provided in **Appendix F**.

Vegetated swales are designed to treat runoff received from the small event or first flush (i.e. first 15 mm), and to retain up to the major (1% AEP) storm event from the road network plus discharge from lots in excess of the small event. Swale locations are indicated on **Figure 8**. Inundation from the small, minor and major events are shown in **Figure 9**, **Figure 10** and **Figure 11** respectively.

The design details of the vegetated swales are presented in **Table 2**.

Table 2: Swale treatment and storage requirement in small, minor and major storm events

Swales	Length (m)	Small Event (first 15 mm)				Minor Event (20% AEP)				Major Event (1% AEP)			
		Depth (m)	Top width (m)	Volume (m^3)	TWL surface area (m^2)	Depth (m)	Top width (m)	Volume (m^3)	TWL surface area (m^2)	Depth (m)	Top width (m)	Volume (m^3)	TWL surface area (m^2)
Ct_01	70	0.016	25.0	28	1,750	0.092	25.0	160	1,750	0.320	25.0	560	1,750
Ct_03	110	0.108	8.9	98	979	0.549	14.2	658	1,561	1.107	20.9	1,734	2,297
Ct_04	63	0.000	0.0	0.0	0	0.008	13.1	6.2	825	0.456	18.5	452	1,164
Ct_05 US	66	0.011	6.9	8	461	0.127	15.1	121	1,005	0.311	17.3	320	1,153
Ct_05 DS	37	0.000	0.0	0.0	0	0.011	22.0	9	814	0.058	22.0	47	814
Ct_06 (treatment*)	7	0.303	4.7	8	33	0.350	5.0	10	35	0.967	8.7	39	61
Ct 06 (flood storage*)	84	0.000	0.0	0.0	0	0.115	3.6	31	301	0.967	8.7	471	731
Ct_07	65	0.077	6.0	29	388	0.302	7.3	126	475	0.759	10.1	384	654
Total	502			170	3,611			1,121	6,766			4,008	8,624

Note that swale Ct06 is reported in **Table 2** as two swales, however it will actually be a single swale; only a small portion is required for water quality treatment. This will be separated from the broader swale by a 300 mm bund /weir.

The swales will have a maximum top width of 25 m and typically have 1:6 side slopes (exception to swales Ct-01 and Ct-05 DS where vertical sidewalls are proposed). Swale inverts will be set 300 mm above the 50% AEP predicted groundwater level (see **Section 7.2**) to facilitate infiltration and prevent prolonged wet conditions. The swales are designed to have a top water level (TWL) in the major event that will be below the level of Grindleford Drive.

Wherever practical individual swales shall be interconnected by culverts across proposed roads to enable water levels to balance throughout the system and optimise storage and infiltration; this information will inform the UWMP. Where invert levels vary between adjacent swales a high level overflow outlet structure may be incorporated at the swale having the higher invert level.

Infiltration of runoff through the underlying soils of the swales will provide treatment through adsorption of nutrients to sand particles. The swales will be lined with high Phosphorus Retention Index (PRI > 10) media to improve phosphorus uptake. Nutrient stripping vegetation will be planted densely in the swales to assist in the uptake of nutrients.

Note that some of the swales that are linked will not receive runoff in response to a 15mm rainfall event. For these it will be appropriate for them to be turfed of have another permeable treatment that can provide additional amenity to the area.

The construction staging of swales and adjacent subdivisions has been considered, in that swales are generally allocated at the western end of each landholding. If a landholding is proposed to be developed and the downstream swale is not available, temporary drainage structures (e.g. basins) may be required.

Modelling assumptions pertaining to the verge swales are detailed in the modelling report, attached in **Appendix E**.

The use of vegetated swales will assist in achieving **Criteria SW1** through **SW7** respectively.

6.1.3 Bio-retention areas

Runoff generated by the small event on road reserves will be captured and retained in a vegetated BRA, located in the POS within catchment Ct-06. **Figure 8** shows the indicative location of the BRA.

The BRA will be designed with side slopes no greater than 1:3 and a maximum depth of 300 mm. BRAs will be densely vegetated with species known to uptake nutrients, potentially controlling access to these areas. BRA inverts will maintain a minimum 300 mm clearance from MGL as shown in the civil engineering designs provided in **Appendix F**, and the concept landscape plans provided in **Appendix G**.

The BRA is sized to cover an area of ~4.6 % of the total connected impervious area, thus exceeding the 2% of connected impervious area requirement.

The design requirements of the BRA for treatment of the small event are provided in **Table 3**, with the associated inundation area shown in **Figure 9**.

Table 3: Small event treatment requirements

BRA	Small Event (first 15 mm)			
	Depth (m)	Bottom surface area (m^2)	Surface area (m^2)	Volume (m^3)
Ct-06	0.227	835	910	197

Infiltration of runoff through the underlying soils of the BRA will provide treatment through adsorption of nutrients to sand particles. The BRA will also be lined with high PRI (PRI > 10) media to improve phosphorus uptake.

Modelling assumptions pertaining to the BRA are detailed in the modelling report, attached in **Appendix E**.

The use of a BRA in catchment Ct-06 will assist in achieving **Criteria SW1** through **SW7**.

6.1.4 Flood storage areas

A FSA will be utilised in catchment Ct-06 to detain and infiltrate major event flows, supporting the pre-development hydrological regime. Collocated with the BRA (see **Section 6.1.3**), surface runoff above the small event, up to and including the major event, will be detained within the FSA located within the Ct-06 POS area. During the major event the FSA will discharge via a high level overflow to the swale in catchment Ct-06A, however no off-site discharge will result. The City of Stirling's requirements will be incorporated into the final detailed design at future design stages. The indicative location of the collocated basin and the high level overflow is shown in **Figure 8**.

The preliminary earthworks strategy shown in the civil engineering designs presented in **Appendix F** shows that the road network will be graded towards POS and drainage reserve areas, providing a flow path for the major storm event runoff to reach the FSA.

The FSA will be designed with side slopes no greater than 1:6 and an overall maximum depth of 1.2 m (inclusive of the BRA depth). The FSA invert will maintain a minimum 300 mm clearance from MGL to ensure they are able to adequately drain following a rainfall event. The FSA will also be designed to maintain a 300 mm clearance from finished floor levels (FFLs) to the major event top water level (TWL). Clearance from MGL and FFLs are shown in the conceptual civil engineering designs provided in **Appendix F**, and the concept landscape plans provided in **Appendix G**.

The design requirement of the FSA for detention of the minor and major storm events are provided in **Table 4** with associated inundation areas shown in **Figure 10** and **Figure 11** respectively.

Table 4: Minor and major storm event detention requirements

FSA	Minor Event (20% AEP)			Major Event (1% AEP)		
	Depth (m)	Volume (m^3)	TWL surface area (m^2)	Depth (m)	Volume (m^3)	TWL surface area (m^2)
Ct_06	0.7	833	1,557	1.192	1,688	2,041

Modelling assumptions pertaining to the FSA are detailed in the modelling report, attached in **Appendix E**.

The use of an FSA in catchment Ct-06 will assist in achieving **Criteria SW1** through **SW7** respectively.

6.1.5 Discharge to external stormwater networks

Stormwater discharged onto site from the external upstream stormwater networks, as identified in **Section 3.4.2**, including runoff generated from the mostly developed catchment Ct-02 shown in **Figure 8**, will continue to be collected via the existing stormwater network and will be conveyed through the site via extended pipework for final discharge to the ASBD. The Structure Plan therefore does not need to make any spatial provision for the management of runoff from the upstream catchments.

Water Corporation has provided approval in principle for the extension of the existing DN900 (Pers. Comms., Mike Grove, 23/01/2019). Water Corporation has also advised that no additional connections from the structure plan area will be permitted, including no additional connections to the proposed DN900 pipe drain extension (Pers. Comms., Mike Grove, 23/01/2019).

Rainfall on the 'Local Centre' (see **Appendix A**) is assumed to be retained up to the major (1% AEP) event in accordance with City of Stirling's Development Services requirements.

6.2 Non-structural stormwater management measures

The structural measures proposed within the site provide both a storage and treatment function to stormwater runoff, as detailed in **Section 6.1**. A number of non-structural measures will also be implemented across the site to help reduce nutrient loads within stormwater runoff. These measures include:

- Minimising fertiliser use to establish and maintain vegetation within POS areas and road verges.
- Use of nutrient absorbing vegetation species within estate drainage reserves and treatment infrastructure.
- Use of drought tolerant turf species that require minimal water and nutrients.
- Maintenance of POS and drainage areas to remove sediments and excess vegetation debris
- Education of residents regarding fertiliser use and nutrient absorbing vegetation species within lots.

These measures will assist in achieving **Criteria WC1, SW7** and **GW1**.

6.3 Stormwater criteria compliance summary

A summary of the proposed stormwater design criteria and how these are addressed for the site are shown in **Table 5**.

Table 5: Stormwater criteria compliance summary

Criteria Number	Description	Manner in which compliance is achieved
SW1	Retain and infiltrate all runoff from the small event (first 15mm) as close to source as possible (on lot) and 100% of the major storm event on site.	All lots will retain at least the small event on lot in soak wells, with lots greater than R60 retaining up to the major event
		Runoff from road reserves will be retained and treated in BRA within POS and swales for storms up to the small (first 15 mm) event
		All runoff up to the major (1% AEP) storm event will be retained in swales located within the boundaries of the structure plan area
SW2	Finished floor levels of lots shall have a minimum of 300 mm clearance above the major event flood levels in drainage infrastructure	Finished floor levels will have a minimum clearance of 300 mm above the major event flood levels within swales, FSAs and BRAs
SW3	Ensure pathways for stormwater conveyance in the major event	The road network is designed to convey the major event to stormwater infrastructure
SW4	Minor roads are to be designed to remain passable in the minor (20% AEP) storm event.	The pipe network will be sized to convey the minor event to stormwater infrastructure.
SW5	Trapped low points within minor roads are to be provided with a piped drainage outlet designed for major 1% AEP with limited inundation and minimum freeboard to design floor levels of 300 mm.	The pipe network will be sized to convey the minor event to stormwater infrastructure. Appropriate freeboard from the road spill crest will be allowed for flows via the road network in the major event.
SW6	Ensure infiltration areas are designed to prevent creating mosquito	FSA drain times to comply with recommended emptying times
SW7	Ensure bio-retention areas are sized to (at least) 2% of the connected impervious area	Surface area of BRA is >2% of connected impervious surface area (impervious road pavement)
SW8	Reduce nutrient loads by applying appropriate non-structural measures	Minimising fertiliser use to establish and maintain vegetation within POS areas and road verges
		Use of nutrient absorbing vegetation species within estate drainage reserves and treatment infrastructure
		Use of drought tolerant turf species that require minimal water and nutrients
		Maintenance of POS and drainage areas
		Education of residents regarding fertiliser use and nutrient absorbing vegetation species within lots

7 Groundwater Management Strategy

The development drainage system has been designed to achieve the groundwater management objectives and criteria stated in **Section 4.4**.

7.1 Groundwater modelling assessment

In order to understand the potential for changes to groundwater to occur as a result of development of the East Roselea LSP area, a numerical groundwater model was developed using Modflow-USG/Groundwater Vistas to represent the potential changes to the groundwater levels beneath and surrounding the site as a result of the development. The modelling was undertaken by CDM Smith following the recommendations of the Australian Groundwater Modelling Guidelines (Barnett et al 2012) and the full modelling report is provided in **Appendix H**.

In summary, the approach taken for the pre-development/calibration groundwater model has included:

- Soil profiles within the site as determined by geotechnical test-pitting. This has resulted in a three-layer model to represent the predominant soil types (infill/sand, peat, deeper dense sand).
- Permeability of the layers within the site was determined by measurement by Douglas Partners (2012) and Galt (2020). These range between 2.5 m/day for sand to 0.0015 m/day for peat (vertical) and have been adopted in the model.
- The model domain/extents/boundaries are approximately 1.5 km from the site boundary, extended to include DWER long-term reference bores (61610143, 61610163, 61610142 and 61615012) for calibration purposes.
- Recharge (40%) and evapotranspiration (100% measured, 1 m extinction depth) has been applied over the entire model domain.
- Soil profiles in the surrounding domain taken from regional soil mapping.
- Measured groundwater levels within the site and from the DWER reference bores were used to calibrate the pre-development results.
- We have used recent rainfall records which coincide with site measurements to undertake the calibration.

The results of the pre-development groundwater model and calibration hydrographs are contained in **Appendix H**. Pre-development modelled groundwater contours are shown on **Figure 6**.

The approach to representing the post development environment has built on the pre-development groundwater model, with the following additions/changes:

- Finished surface levels were based on the earthworks model provided by project team engineers (as shown in **Appendix F**).
- Model/soil Layer 2 represents the peat and proposed limestone raft as a combined layer, with permeability of 0.0015 m/day as per pre-development assumptions.

- Depth of permeable sand (Layer 1) over the limestone raft/peat (Layer 2) is 2.3 m (i.e. the limestone raft is 2.3 m below the finished surface); this is an increase from the previous approach which proposed 1.5 m – 1.8 m of fill over the limestone raft.
- In order to assist infiltration capacity of the swales/FSA, the low permeability limestone/peat layer (Layer 2) at the base of these features has been removed and replaced with permeable sand with 2.5 m/day permeability (this is an update to previously proposed approaches and the earthworks concept now reflects this).
- Recharge was modified for the site but unaltered for the remainder of the domain. Site recharge ranges between 75% - 95% to represent the infiltrate at source approach being taken.
- A 30 year SILO rainfall data record provided by DWER was used to simulate future rainfall years; the model was run to simulate 'dry', 'median' and 'wet'' scenarios.
- Annual peak groundwater levels were used to determine the 50% AEP by deriving a probability distribution fitted to the predicted elevations. The probability distribution utilised is the Generalized Extreme Value (GEV) distribution, which was fitted to the Annual Maximum Series (AMS) using L-moments (see detailed summary of the AEP analysis in **Appendix I**). The analysis indicated that the 50% AEP is very closely (i.e. peak levels 0-39 mm beneath infiltration areas) represented by the peak groundwater levels predicted for 2021.

The results of the post-development groundwater modelling and predicted hydrographs are contained in the groundwater modelling report in **Appendix H**. Post-development/predicted groundwater modelling contours and design surface levels are shown on **Figure 12**. The use of the 2021 'wet' scenario predicted groundwater contours provide a conservative datum for use in designing the stormwater management system and for assessing clearance from groundwater levels.

The groundwater model has also considered the recently recorded (current) rainfall and applied this to the proposed development scenario. This analysis shows that the resulting groundwater level is typically reduced in comparison to those experienced at the current site under recent rainfall by between 100 mm to 600 mm (see **Appendix H**). The model also shows that as soon as peak rainfall events are over the groundwater levels would recede and where groundwater could intersect swales (i.e. in unusually high in peak years) these will not stay permanently wet.

The groundwater model has not simulated the use of subsoil drains, as the combination of increased fill levels above the low permeability layer and increased connectivity beneath the swales and FSA result in sufficient clearance between the predicted 50% AEP maximum and the finished level being achieved across the development.

7.2 Groundwater level management

The primary objective for groundwater level management is to ensure the final lot levels are at least 1.2 m above the 50% AEP predicted 'wet' scenario.

As described in **Section 3.5.1**, the historical MGL for the site ranges between 11.6 mAHD and 15.5 mAHD lifting to the east. This is generally reflected in the 2021 predicted groundwater levels along the western boundary, with groundwater predicted to be at 11 mAHD - 12.5 mAHD in this part of the site. Concept earthwork levels for the residential lots are designed between 13.5 mAHD and 17.8 mAHD (provided in **Appendix F**), giving a minimum clearance to the 50% AEP of 1.2 m

As discussed in **Section 6.1**, the inverts of the swales, BRAs and FSAs will provide a minimum clearance to the 50% AEP of 300 mm as summarised in **Table 6** and shown in **Appendices F** and **G**.

Table 6: 50% AEP groundwater levels, inverts and top water levels

Swale/storage name	20% AEP Groundwater elevation	Invert (mAHD)	1% AEP TWL (mAHD)	Grindleford Drive elevation (mAHD)
Ct01	13.5	13.8	14.120	N/A
Ct04	11.569	12.0	12.456	13.05
Ct03	12.069	12.8	13.907	14.3
Ct05DS	11.712	12.1	12.158	12.31
Ct05US	11.448	11.8	12.111	12.60
Ct06	11.392 -11.5	11.8	12.767	13.53
Macedonian Basin Ct06CB	12.967	13.4	14.592	N/A
Ct07	11.571	11.9	12.659	13.18

Free draining sands will be provided to an appropriate depth below lots, typically a minimum of 2.3 m. The earthworks currently proposed indicates that in some locations these sands will be underlain by a limestone raft that will provide a geotechnically stable platform over the underlying peaty soils.

The base of the swales will also be excavated to remove the peat, and these areas will be backfilled with free draining sand. This will assist in ensuring that groundwater levels are maintained to an acceptable level and as indicted in **Table 6**.

Subsoil drains are proposed beneath some road reserves to protect road pavement. These do not seek to control the existing groundwater levels, however will control rise of locally infiltrated stormwater beneath lots to mitigate against potential waterlogging, and will protect road pavement integrity in the post-development environment. Preliminary subsoil inverts are shown in the civil engineering designs and subsoil inverts will discharge to the swales along Grindleford Drive at least 150 mm above the swale inverts (see **Appendix F**), which would still be above post-development groundwater if this were to rise.

A connection will be provided so that private residences can install subsoil drains at either side or rear boundaries of properties.

It is acknowledged that design levels and subsoil drainage requirements shown in **Appendix F** are indicative only and are subject to change at subdivision design stage to provide the minimum separation distances required. The above measures will ensure that **Criteria GW1** and **GW2** are achieved.

7.3 Groundwater quality management

The main objective for the management of groundwater quality is to maintain or improve the existing groundwater quality. This can be achieved by reducing the total nutrient load into

groundwater from the development, including treatment of stormwater runoff and management of landscape and garden maintenance practices. Groundwater quality will be managed through;

- Improving stormwater quality prior to infiltration
- Use of slow release fertiliser
- Use of native species and xeriscaping (which in turn reduces the need for fertilisers)
- Minimising new turf areas.

As discussed in **Section 6.1**, surface water runoff will be treated by retaining and infiltrating water through underlying soil media. Removal of nutrients will occur through vegetative uptake and by adsorption to soil particles prior to reaching groundwater. Education of residents in appropriate fertiliser use and plant selection will also assist in reducing nutrient input to surface water runoff and groundwater.

The mobilising of legacy nutrients within the soil profile has been considered. Inverts of subsoils are set at or above the 50% AEP groundwater level, and therefore no mobilisation is expected. Preliminary subsoil inverts are shown in the civil engineering designs and subsoil inverts will discharge to the swales along Grindleford Drive at least 150 mm above the swale inverts (see **Appendix F**). The above measures will assist in achieving **Criteria GW2** and **GW3**.

7.4 Groundwater criteria compliance summary

A summary of the proposed groundwater management design criteria and how these are addressed within the site are provided in **Table 7**.

Table 7: Groundwater management criteria compliance

Criteria Number	Criteria description	Manner in which compliance will be achieved
GW1	Lots to have a clearance to the 50% AEP of at least 1.2 m	Conceptual civil engineering designs presented in **Appendix F** confirm that lots will be a minimum 1.2 m above the 50% AEP groundwater level
GW2	Drainage basin inverts will be set 300 mm above the 50% AEP groundwater level	Concept design of swales, BRAs and FSAs confirm that inverts will be set 300 mm above the 50% AEP groundwater level
GW3	Groundwater quality leaving the site will be maintained or improved	Removal or reduction of high nutrient land use (i.e. market gardening, sporting grounds)
		Treatment of surface water via infiltration, uptake by vegetation, and adsorption to soil media
		Provision of educational material to lot owners in relation to minimising fertiliser use and plant species selection
GW4	Use water sensitive urban design approaches to recharge the superficial aquifer.	BRA and swales designs will treat small event and first flush runoff from catchments prior to infiltration
GW5	Subsoil drainage will be set at or above the 50% AEP groundwater level, with discharge to swales at least 150 mm above the swale inverts.	Detailed design of swales and subsoil drains will be provided in the future UWMP. Inverts will be set at or above the 50% AEP, with subsoil discharge to swales set at least 150 mm above swale inverts

8 Matters to be addressed in the UWMP

The requirement to prepare more detailed water management plans to support subdivision is generally imposed as a condition of subdivision. The development of any future UWMP should follow the guidance provided in Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision **Conditions** (DoW 2008b).

While strategies have been provided within this LWMS that address planning for water management within the site, it is a logical progression that future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification within future UWMPs include:

- Drainage calculations
- WSUD configuration
- Staging considerations
- Irrigation Schedule
- Water Balance
- Water Conservation Strategy
- Subdivision earthworks
- Groundwater licensing
- Acid sulphate soil investigations
- Non-structural water quality improvement measures
- Management and maintenance requirements
- Construction management strategy.

These are further detailed in the following sections.

8.1 Drainage calculations

It is acknowledged that the drainage strategies documented in this LWMS are based upon broad-scale assumptions and regional data. These assumptions are considered adequate for development of the proposed drainage strategy and are of an appropriate level of detail. However, verification of proposed subdivision drainage designs within the LSP area will be undertaken once the specific road and basin (BRA and FSA) designs are confirmed.

8.2 WSUD configuration

It is acknowledged that the drainage strategies documented in this LWMS are subject to possible design amendments following review and stakeholder feedback.

Drainage features will be specified within future UWMPs, including geometry and specific location. WSUD will be designed to a level that provides detailed cross-sections and storage areas, detained volumes, grades, inverts, culverts and so forth as relevant. The UWMP will also detail changes to the approach outlined in this LWMS.

8.3 Staging considerations

Due to the fragmented land ownership and the uncertainty regarding development staging, temporary drainage storage/infiltration basins may be necessary at certain locations to allow staged development to proceed. Where temporary basins are required they shall be constructed and fenced to the satisfaction of the CoS and shall be protected by easements granted in favour of the CoS. Costs associated with the basin construction, legal issues including creation of easements, and ultimate removal of the basin and associated infrastructure shall be the responsibility of the developer upon whose land the temporary basin is located.

8.4 Irrigation schedule

An irrigation schedule is currently under development. This schedule will be further developed to support each stage of the subdivision and provided within future UWMPs.

8.5 Water balance

Future UWMPs will address any potential changes to the water balance due to refinements in lot yield, POS area, or changes to fit for purpose water supply.

8.6 Water conservation strategy

The water conservation strategies, such as those detailed in this LWMS, will be confirmed as measures to be employed within the UWMP. Estate scale landscape design measures to be incorporated will be further detailed, and the manner in which the proponent intends to address water conservation measures with lot owners will also be further detailed.

8.7 Subdivision earthworks

Future UWMPs will contain detailed civil designs accompanied by a geotechnical report which confirms that the proposed approach will meet an appropriate site classification.

There are a number of possible approaches that could be taken to address the uncontrolled fill that is found on site, as discussed in **Section 3.2**. The approach being considered for some portions of the site involves raking and compaction of the uncontrolled fill. Where the fill has been identified as peat material compaction will be followed by overlaying of a limestone raft and top dressed with 2.3 m of free draining sands.

Douglass Partners (2012) addresses the preliminary Geotechnical Investigation of the northern section of site, and recommends that *peat should be considered impervious for drainage applications* (Douglas Partners 2012). Given the existing low measured permeability of the peaty material, it is not expected that compaction will have any significant reduction on permeability.

Given permeability will not be significantly affected it is unlikely to impact upon the broadscale movement of groundwater within the underlying shallow superficial aquifer which is approximately 35 m in thickness beneath the site, and therefore localised groundwater flow and levels are not

anticipated to be significantly affected by the proposed earthworks approach. The geotechnical report is provided in **Appendix B**.

8.8 Groundwater licensing

Groundwater requirements and licensing provisions for construction, estate irrigation, and dewatering will be addressed within the UWMP, including measures proposed for conforming to licence obligations and transfers upon completion of construction and maintenance periods.

8.9 Acid sulphate soil investigations

Future UWMPs will address the results and required actions of the site specific ASS investigation proposed for the site, undertaken to support future subdivision of the site.

8.10 Non-structural water quality improvement measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007). Some measures will be more appropriately implemented at a local government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the subdivision. It is expected that the future UWMP will provide reference to measures such as public education (through measures such as signage that may be implemented to raise awareness).

8.11 Management and maintenance requirements

The management measures to be implemented to address surface water quality, such as the use of BRAs will require ongoing maintenance.

It is therefore expected that future UWMPs will provide detailed management and maintenance plans that will set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions).

Given that approval from the CoS will be sought for the proposed measures, it is anticipated that consultation with CoS will be undertaken and referral will be made to guiding policies and documents.

8.12 Construction management strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. sediments, erosion, dust, surface runoff, noise, traffic, etc.). The management measures undertaken for construction management will be addressed either in the future UWMP or a separate Construction Management Plan (CMP).

9 Monitoring Program

9.1 Condition monitoring

It is proposed that the overall condition of the development will be monitored on a bi-annual basis. This monitoring will be implemented after the completion and handover of the civil and landscaping works and will continue for a period of two years.

A visual assessment will be undertaken to monitor the overall condition of the development, with the aim to ascertain that the maintenance activities are achieving the overall management objectives for the development. The parameters that will be monitored include:

- Nutrients and Water quality
- Gross pollutants
- Terrestrial weeds
- Irrigation
- Vegetation density
- Drainage infrastructure
- Paths, benches, walkways and other infrastructure.

The management and maintenance objectives will be detailed within future UWMPs along with details of the corresponding groundwater monitoring program.

9.2 Groundwater monitoring

Water quality will be monitored by the developer post completion to determine the effectiveness of the WSUD approach at managing nutrients, and to guide the future management actions that have the potential to influence water quality beneath the site. Groundwater quality will be used as an analytical tool to determine the success of the overall development (i.e. as compared to pre-development monitoring).

Monitoring of groundwater nutrient concentrations and physio-chemical parameters is proposed close to pre-development bore locations (see **Figure 6**) if these locations can be retained. Where they cannot be retained they will be reinstalled as close as practicable. Monitoring of groundwater quality and levels will be conducted quarterly for a period of two years from practical completion of the drainage swales and the FSA. Groundwater bores installed for this monitoring program will be left in place after the monitoring period, and handed over to the CoS.

9.3 Temporary infrastructure

If temporary infrastructure (e.g. drainage basins) are required these will be monitored and maintained by the proponent until such time as the temporary measures are removed and relocated to the ultimate location.

9.4 Reporting

A post-development monitoring report will be prepared on conclusion of the two year monitoring period, and will be provided to the CoS. Interim results (spreadsheet) can be provided to CoS on request during the monitoring program.

10 Implementation Plan

The LWMS is a key supportive document for the Structure Plan. The development of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur consistent with an integrated water cycle management approach. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of the future UWMPs.

10.1 Roles and responsibility

The LWMS provides a framework that the proponent can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations, are consistent with relevant State Government and CoS policies and have been endorsed by the CoS The responsibility for working within the framework established within the LWMS rests with the developer, although it is anticipated that future UWMPs will be developed in consultation with the CoS and in consideration of other relevant policies and documents.

The design and implementation of lot retention infrastructure (i.e. soakwells) for minor event runoff within lot will be the responsibility of the individual lot owner/lot developer.

10.2 Funding

The East Roselea development constitutes several land holdings; therefore management strategies outlined in this LWMS will be implemented and funded by the developers as and when each land parcel is developed.

Funding for lot drainage infrastructure (i.e. soakwells) will be the responsibility of the lot owner.

10.3 Review

It is not anticipated that this LWMS will be reviewed, unless the Structure Plan undergoes significant change following the finalization of the LWMS. If the LSP is substantially modified, surface runoff modelling undertaken for this LWMS will need to be reviewed and the criteria proposed revised to ensure that all are still appropriate.

11 References

11.1 General references

Australian Bureau of Statistics (ABS) 2013a, *4130.0 - Housing Occupancy and Costs 2011-12*, Canberra. 2011.

Australian Bureau of Statistics (ABS) 2013b, *4602.0.55.003 - Environmental Issues: Water Use and Conservation, March 2013*, Canberra.

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

Barnett B, Townley LR, Post V, Evan RE, Hunt RJ, Peeters L, Richardson S, Werner AD, Knapton A & Boronkay A, 2012. Australian Groundwater Modelling Guidelines. Published by National Water Commission, Canberra.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018, *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)*.

Department of Environment (DoE) 2004, *Land use compatibility in Public Drinking Water Source Areas*, Perth.

Department of Water (DoW) 2007, *Stormwater Management Manual for Western Australia*, Perth.

Department of Water (DoW) 2008a, *Interim: Developing a local water management strategy*, Department of Water, Government of Western Australia, Perth.

Department of Water (DoW) 2008b, *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions*, Perth.

Department of Water and Environmental Regulation (DWER) 2017a, *Acid Sulfate Soil Risk Map, Swan Coastal Plain (DWER-055)*.

Department of Water and Environmental Regulation (DWER) 2017b, *Decision Process for Stormwater Management in Western Australia*, Government of Western Australia, Perth.

Engineers Australia 2006, *Australian Runoff Quality: A guide to Water Sensitive Urban Design*, National Committee for Water Engineering, Engineers Australia, Canberra.

Engineers Australia 2016, *Australian Rainfall and Runoff*, National Committee for Water Engineering, Canberra.

Environmental Protection Authority (EPA) 2008, *Guidance Statement No. 33. Environmental Guidance for Planning and Development*, Perth.

Galt Geotechnics 2017, *Report on Geotechnical Desktop Study East Roselea Structure Plan Area Grindleford Drive, Balcatta*

Government of WA 2000, *Bush Forever, Volume 2: Bush Forever Site Descriptions*, Perth.

Government of WA 2003, *A State Water Strategy for Western Australia*, Perth.

Government of WA 2007, *State Water Plan*, Perth.

Gozzard, J. R. 1986, *Perth Metropolitan Region* Geological Survey of Western Australia, Perth.

Laio, F., Porporato, A., Ridolfi, L. and Rodriguez-Iturbe, I. 2001, *Plants in water-controlled ecosystems: active role in hydraulic processes and response to water stress II*. Probabilistic soil moisture dynamics, Advances in Water Resources, 24(7): 707-723.

Western Australian Planning Commission (WAPC) 2006, *State Planning Policy 2.9: Water Resources*, Gazetted in December 2006, Perth.

Western Australian Planning Commission (WAPC) 2008, *Better Urban Water Management*, Perth.

Western Australian Planning Commission (WAPC) 2009b, *Planning Bulletin No. 64 Acid Sulfate Soils*, January 2009, Perth.

Western Australian Planning Commission (WAPC) 2017, *Metropolitan Region Scheme*, Perth.

Water Corporation (WC) 2003, *Domestic Water Use Study in Perth, Western Australia 1998-2001*, Perth.

Water Corporation (WC) 2011, *AltWaterSupply_Water_Use_Model.xls*, Perth.

11.2 Online references

Bureau of Meteorology (BoM) 2019, *Climate Averages*, accessed January 2019 <http://www.bom.gov.au/climate/data/>.

City of Stirling (CoS) 2018, *City Intramaps*, accessed September-October 2018, February 2019 <https://maps.stirling.wa.gov.au/intramaps80/>

Department of Aboriginal Affairs (DAA) 2019, *Aboriginal Heritage Inquiry System*, accessed February 2019 <https://maps.daa.wa.gov.au/AHIS/>

Department of Water and Environmental Regulation (DWER) 2018, Perth Groundwater Map, accessed September-October 2018 <http://www.water.wa.gov.au/maps-and-data/maps/perth-groundwater-atlas>

Department of Water and Environmental Regulation (DWER) 2019a, *Contaminated Sites Database*, accessed February 2019 <https://dow.maps.arcgis.com/apps/webappviewer/>

Department of Water and Environmental Regulation (DWER) 2019b, *Water Register*, accessed February 2019 <http://water.wa.gov.au/maps-and-data/maps/water-register>

Landgate 2019, Online Aerial Photography, accessed January 2019 <https://www0.landgate.wa.gov.au/maps-and-imagery/imagery/aerial-photography/aerial/>

Figures

Figure 1: *Location Plan and Site Boundary*

Figure 2: *Topographical Contours*

Figure 3: *Regional Geological Mapping and Geotechnical Investigations*

Figure 4: *Acid Sulfate Soil Risk Mapping*

Figure 5: *Wetlands and Hydrological Features*

Figure 6: *Historical Maximum Groundwater Elevations*

Figure 7: *Public Drinking Water Source Area and Wellhead Protection Zones*

Figure 8: *Stormwater Management Strategy*

Figure 9: *Small (first 15 mm) Event Inundation Areas*

Figure 10: *Minor (20% AEP) Event Inundation Areas*

Figure 11: *Major (1% AEP) Event Inundation Areas*

Figure 12: *Pre-development and Post Development Groundwater Contours*

Figure 1: **Location Plan and Site Boundary**

Project:	Local Water Management Strategy East Roselea
Client:	Parcel Property

Plan Number:
EP18-114(02)--F01

Drawn:	KNM
Date:	01/03/2019
Checked:	JRT
Approved:	DPC
Date:	06/03/2019

N

0 100 200
Metres

Scale: 1:7,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

Figure 2: Topographical Contours

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number:
EP18-114(02)--F02

Drawn:	KNM
Date:	01/03/2019
Checked:	JRT
Approved:	DPC
Date:	06/03/2019

N

0 50 100
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

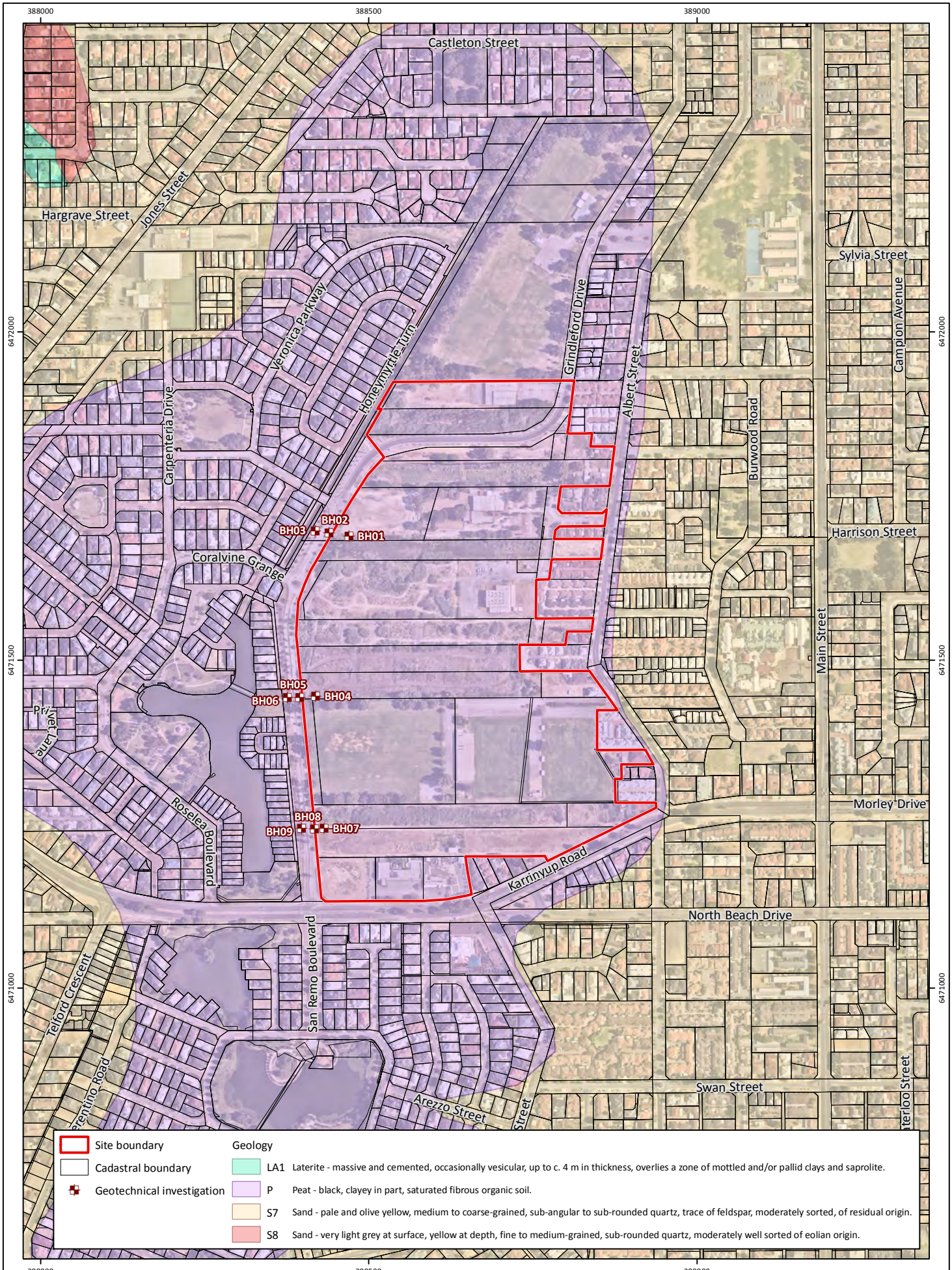


Figure 3: **Regional Geological Mapping and Geotechnical Investigations**

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number:
EP18-114(02)--F03

Drawn:	KNM
Date:	01/03/2019
Checked:	JRT
Approved:	DPC
Date:	06/03/2019

N

0 100 200
Metres

Scale: 1:7,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

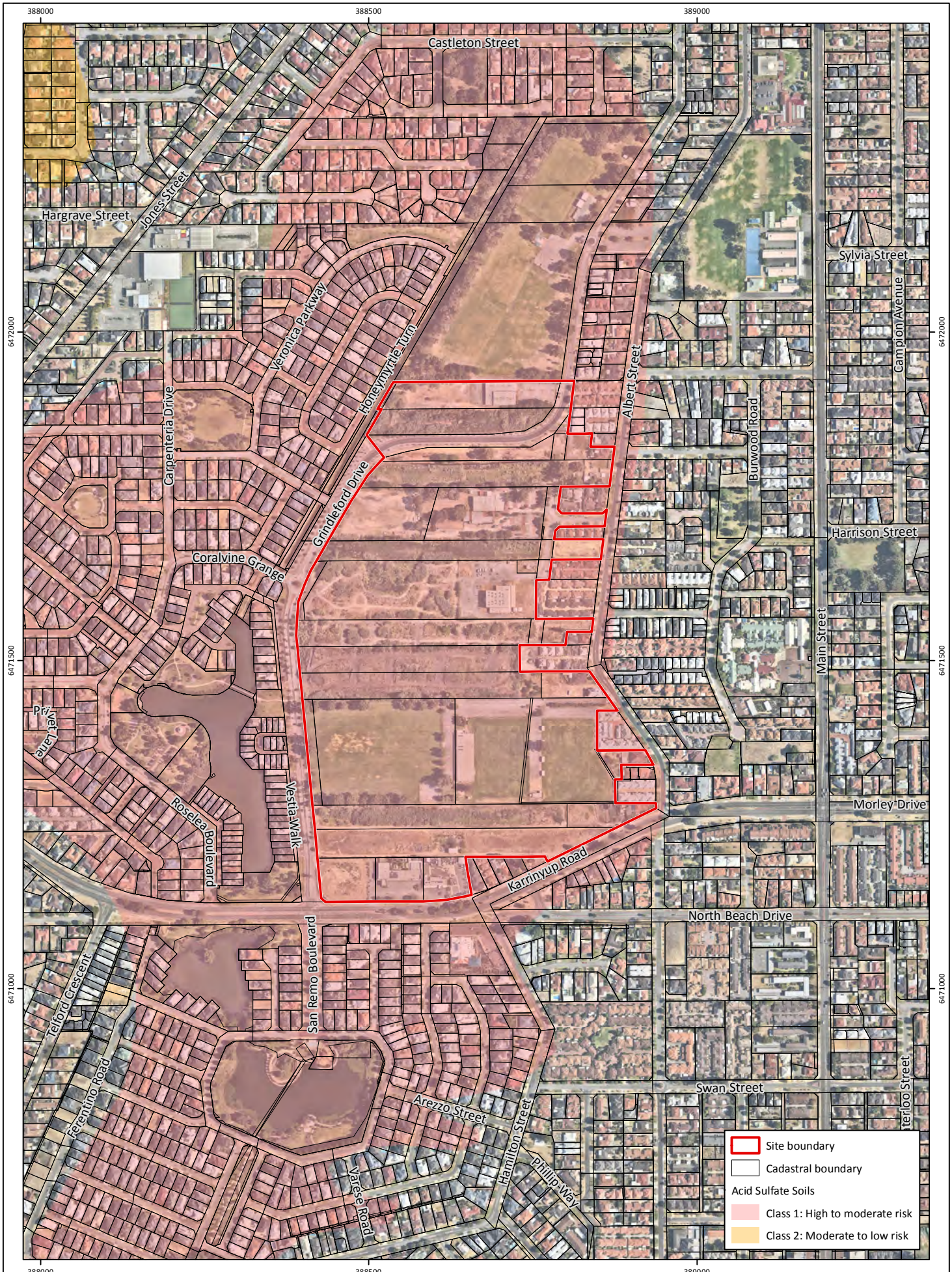


Figure 4: **Acid Sulfate Soil Risk Mapping**

Project:	Local Water Management Strategy East Roselea
Client:	Parcel Property

Plan Number:
EP18-114(02)--F04

Drawn:	KNM
Date:	01/03/2019
Checked:	JRT
Approved:	DPC
Date:	06/03/2019

N

0 100 200
Metres

Scale: 1:7,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

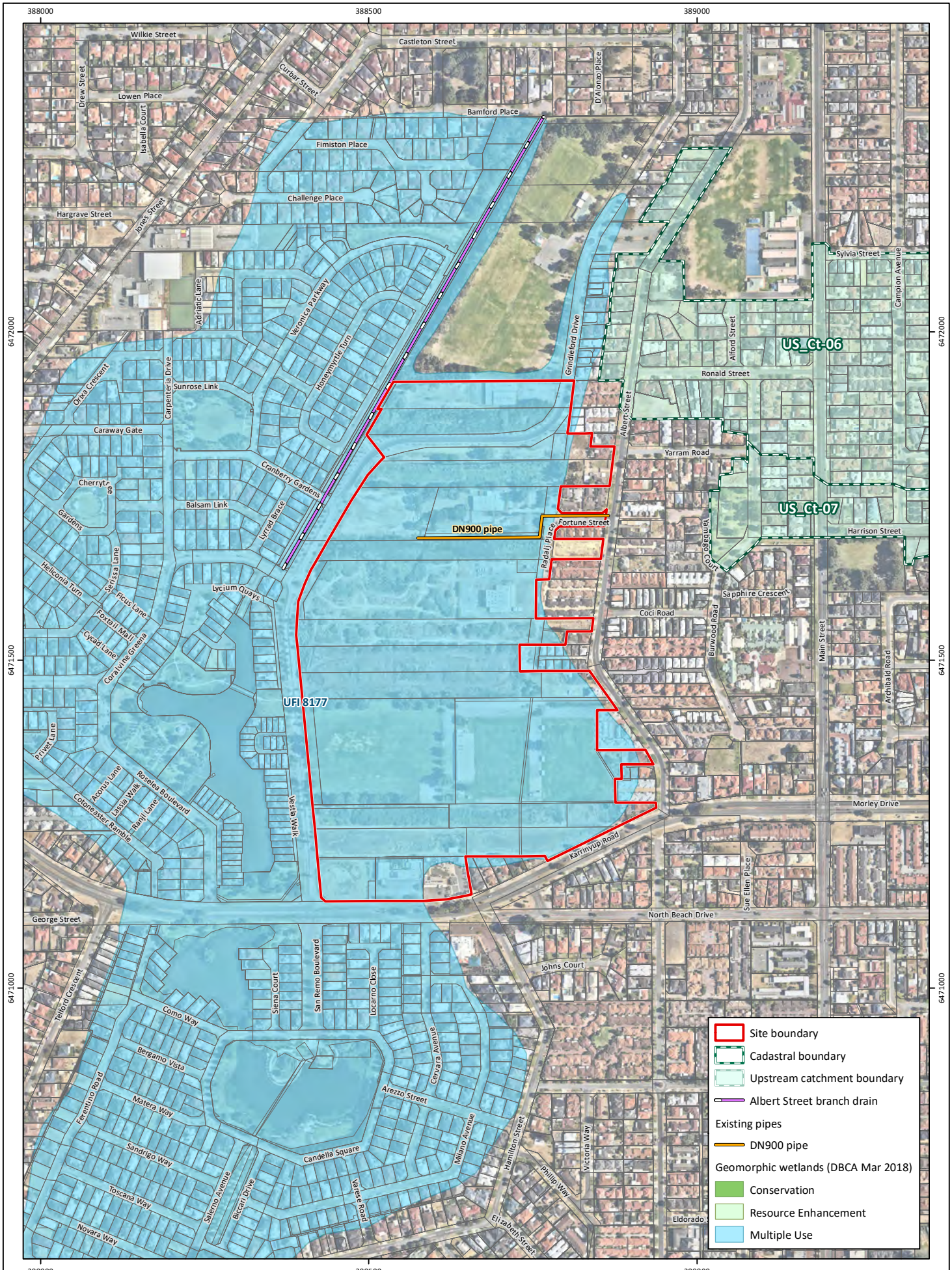


Figure 5: Wetlands and Hydrological Features

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number:
EP18-114(02)--F05a

Drawn:	KNM
Date:	01/03/2019
Checked:	DPC
Approved:	DPC
Date:	14/12/2020

N

0 100 200
Metres

Scale: 1:7,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

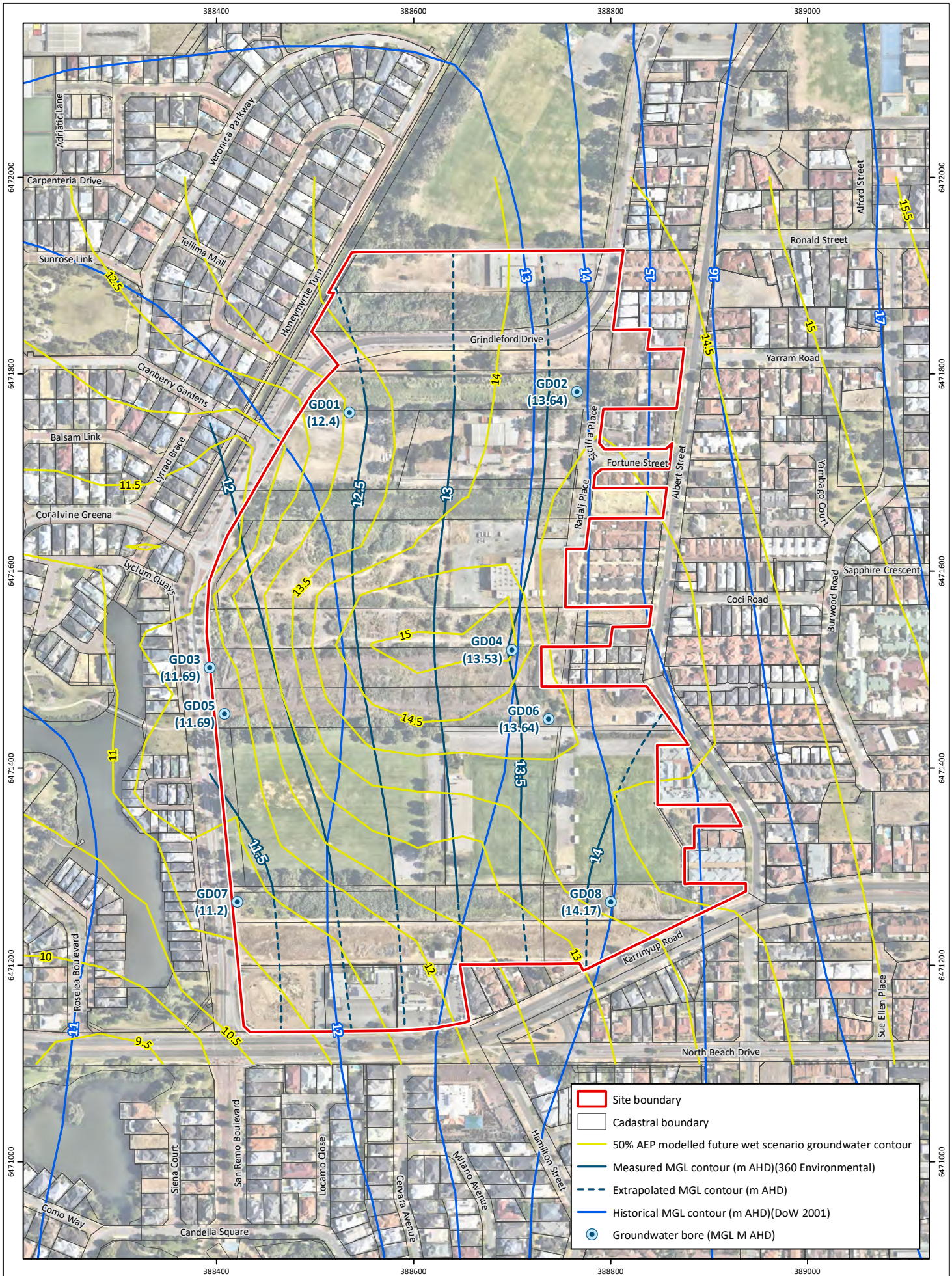


Figure 6: Historical Maximum Groundwater Elevations

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number: EP18-114(02)--F06d

Drawn:	AFF
Date:	7/10/2020
Checked:	DPC
Approved:	DPC
Date:	7/10/2020

N

0 50 100
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

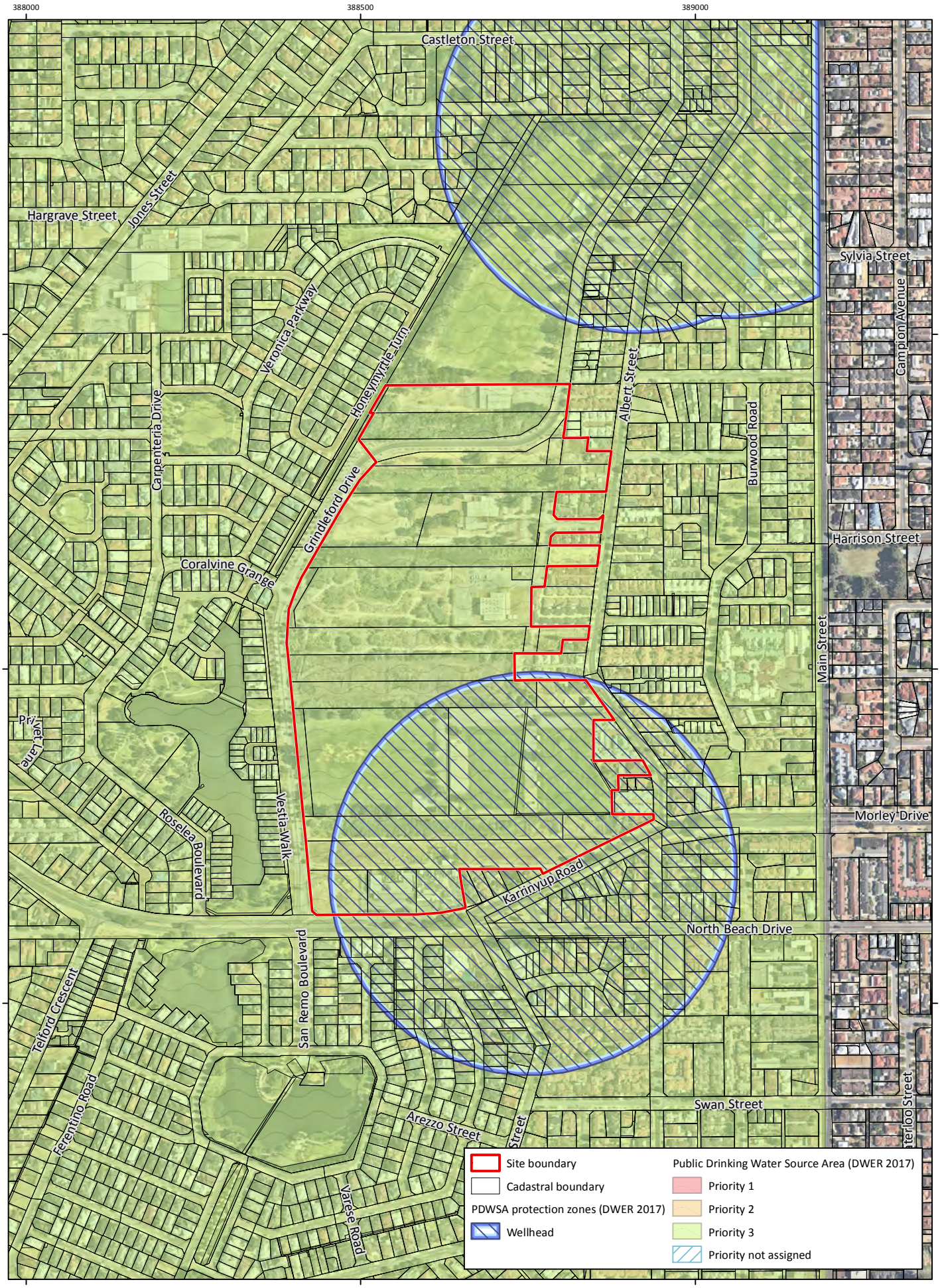


Figure 7: **Public Drinking Water Source Area and Wellhead Protection Zone**

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number: EP18-114(02)--F07

Drawn:	KNM
Date:	01/03/2019
Checked:	JRT
Approved:	DPC
Date:	07/03/2019

N

0 100 200
Metres

Scale: 1:7,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

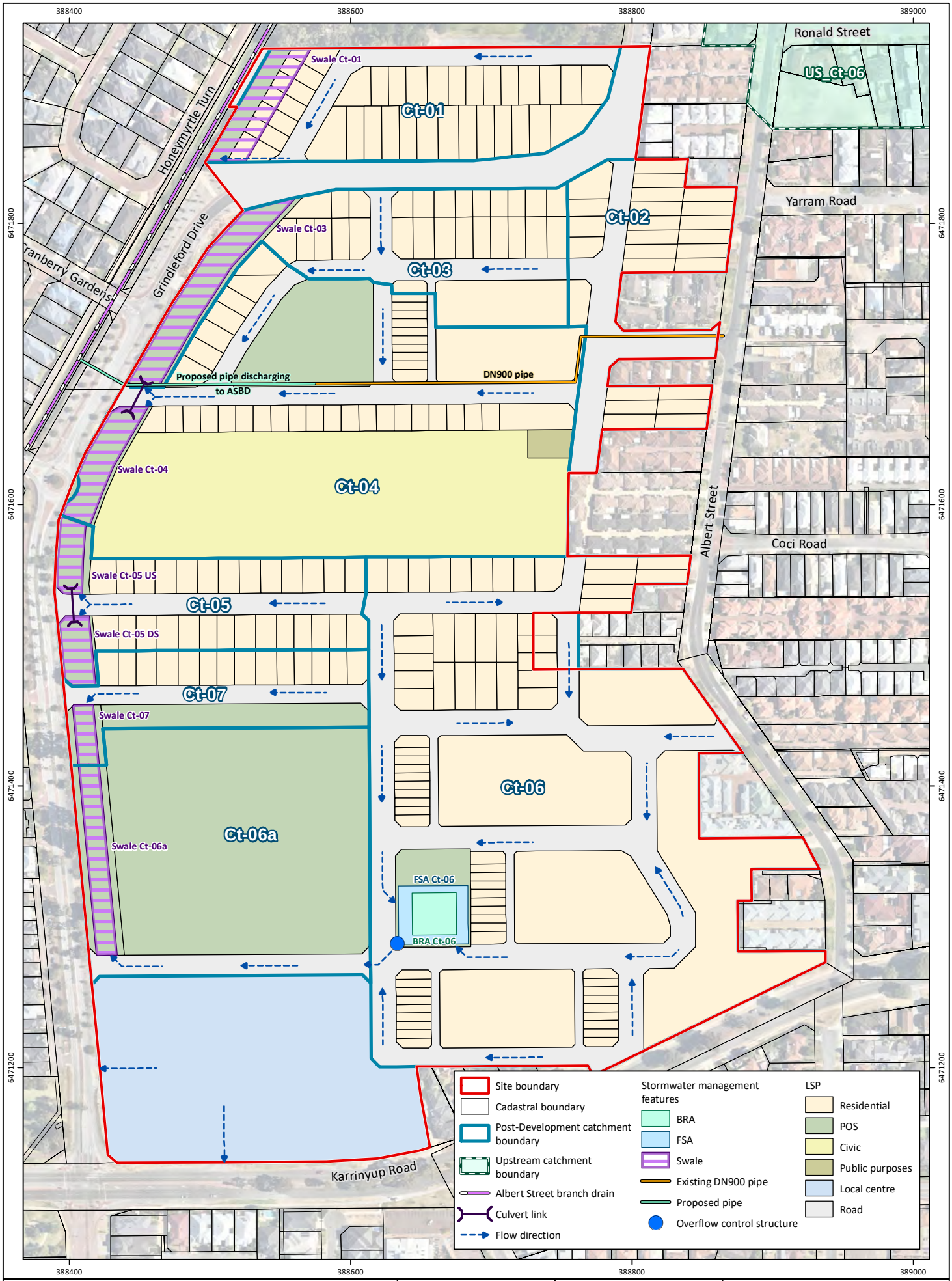


Figure 8: Stormwater Management Plan

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number: EP18-114(02)--F08c

Drawn:	AFF	
Date:	15/12/2020	
Checked:	MGB	
Approved:	DPC	
Date:	15/12/2020	

N

0 40 80
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

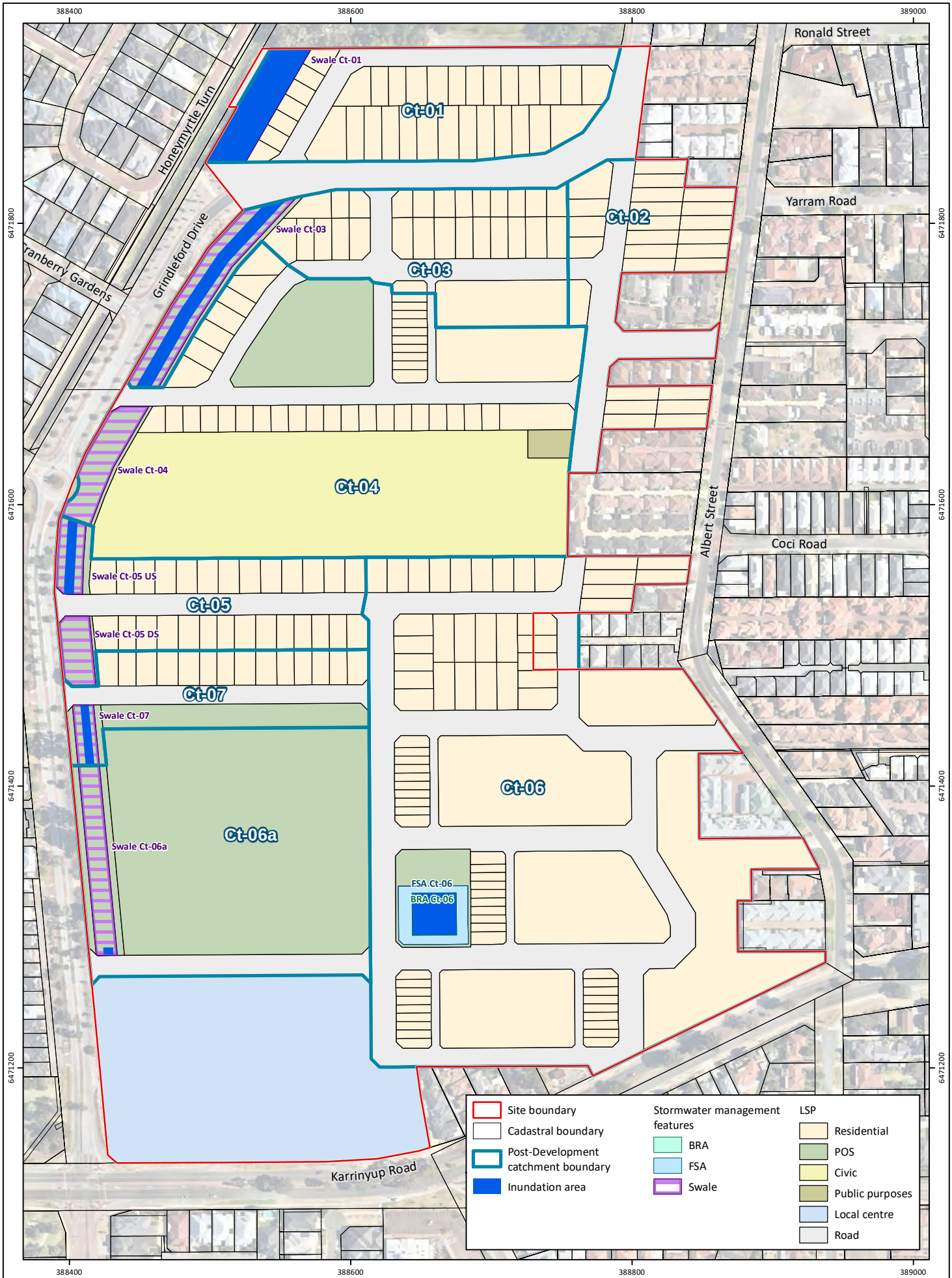


Figure 9: **Small (first 15mm) Event Inundation Areas**

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number: EP18-114(02)--F09b

Drawn:	AFF	
Date:	9/10/2020	
Checked:	MGB	
Approved:	DPC	
Date:	9/10/2020	

N

0 40 80
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

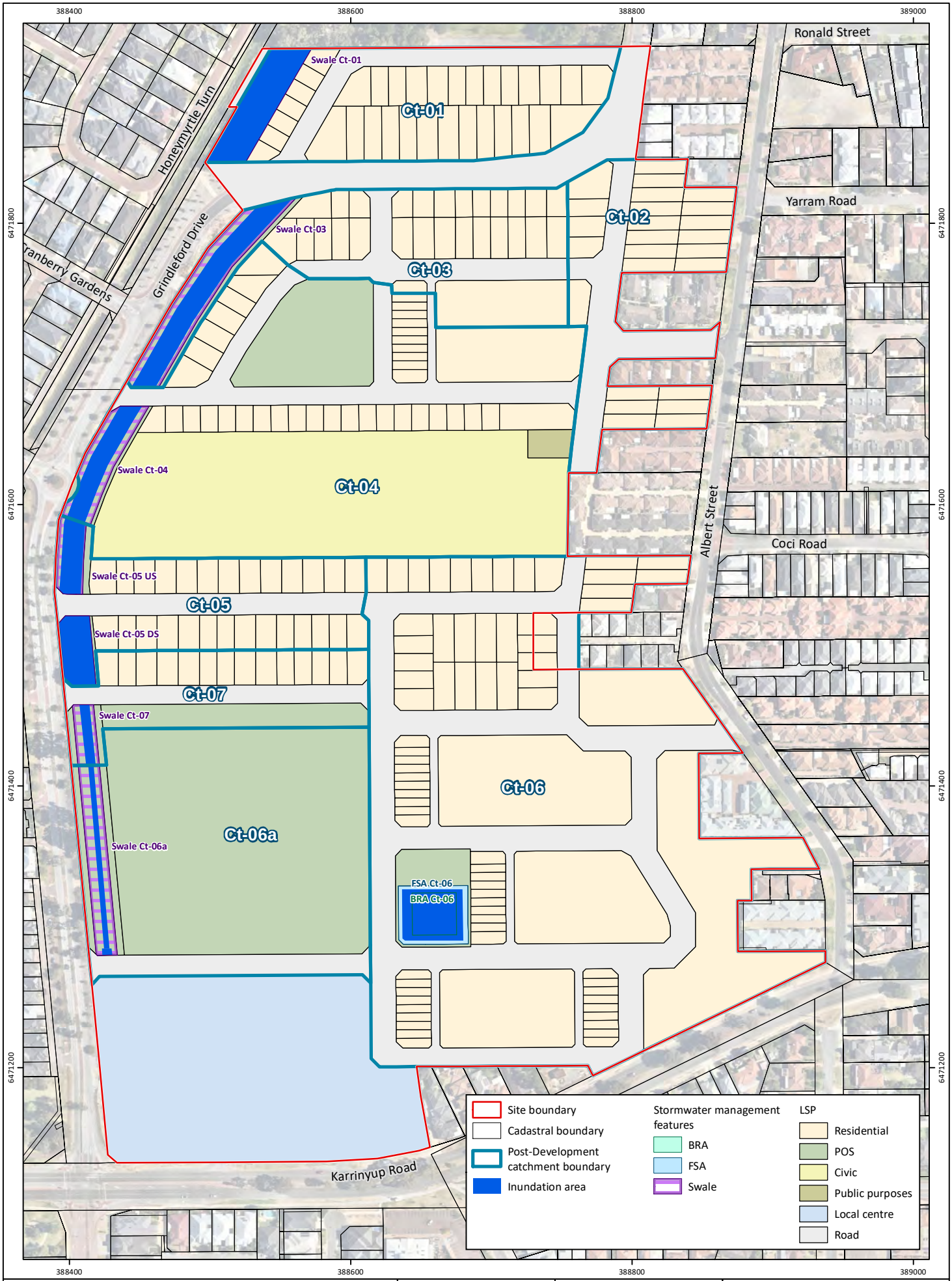


Figure 10: Minor (20% AEP) Event Inundation Areas

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number: EP18-114(02)--F10b

Drawn:	AFF	
Date:	9/10/2020	
Checked:	MGB	
Approved:	DPC	
Date:	9/10/2020	

N

0 40 80
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

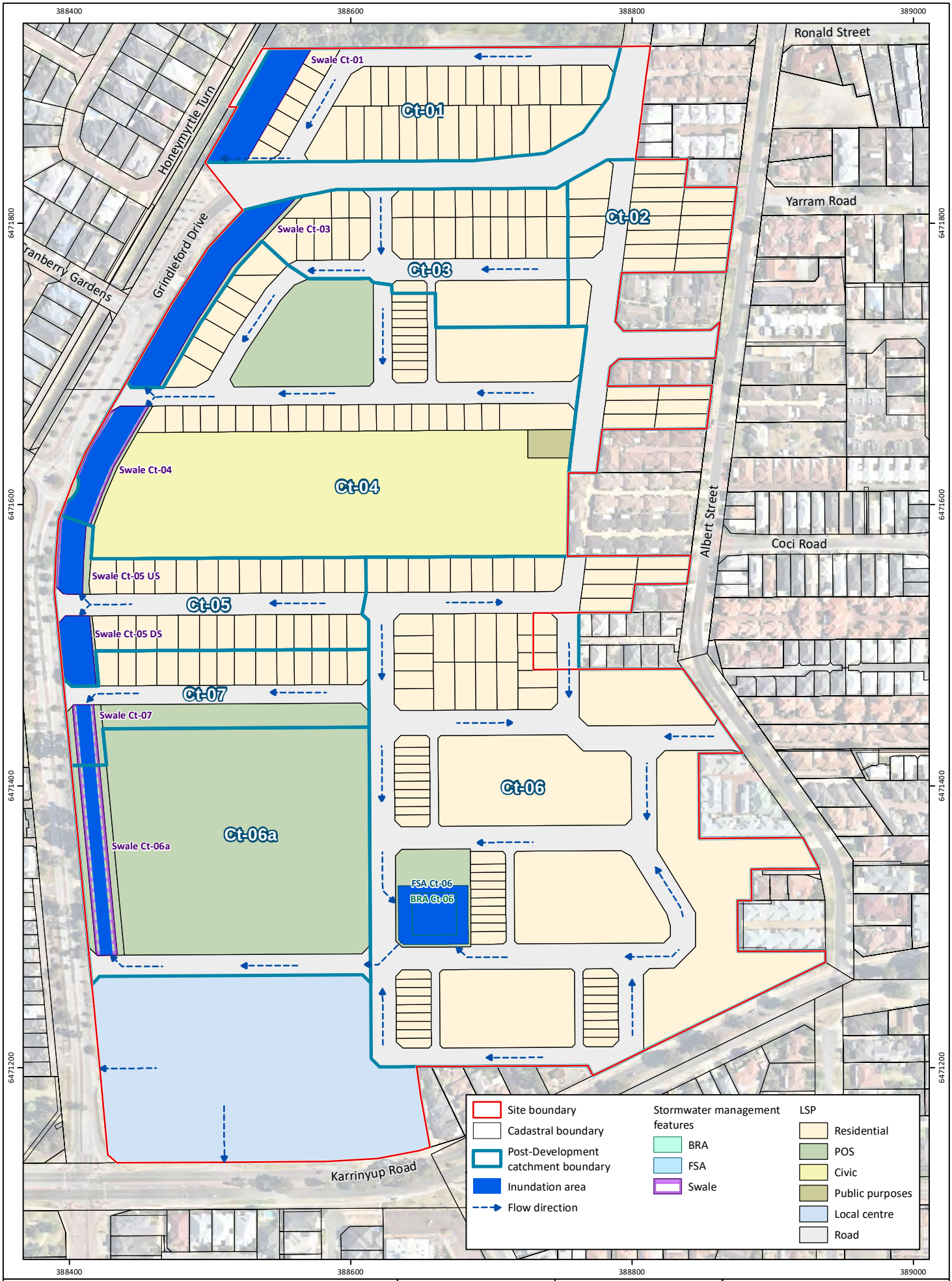


Figure 11: **Major (1% AEP) Event Inundation Areas**

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number: EP18-114(02)--F11b

Drawn:	AFF	
Date:	9/10/2020	
Checked:	MGB	
Approved:	DPC	
Date:	9/10/2020	

N

0 40 80
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

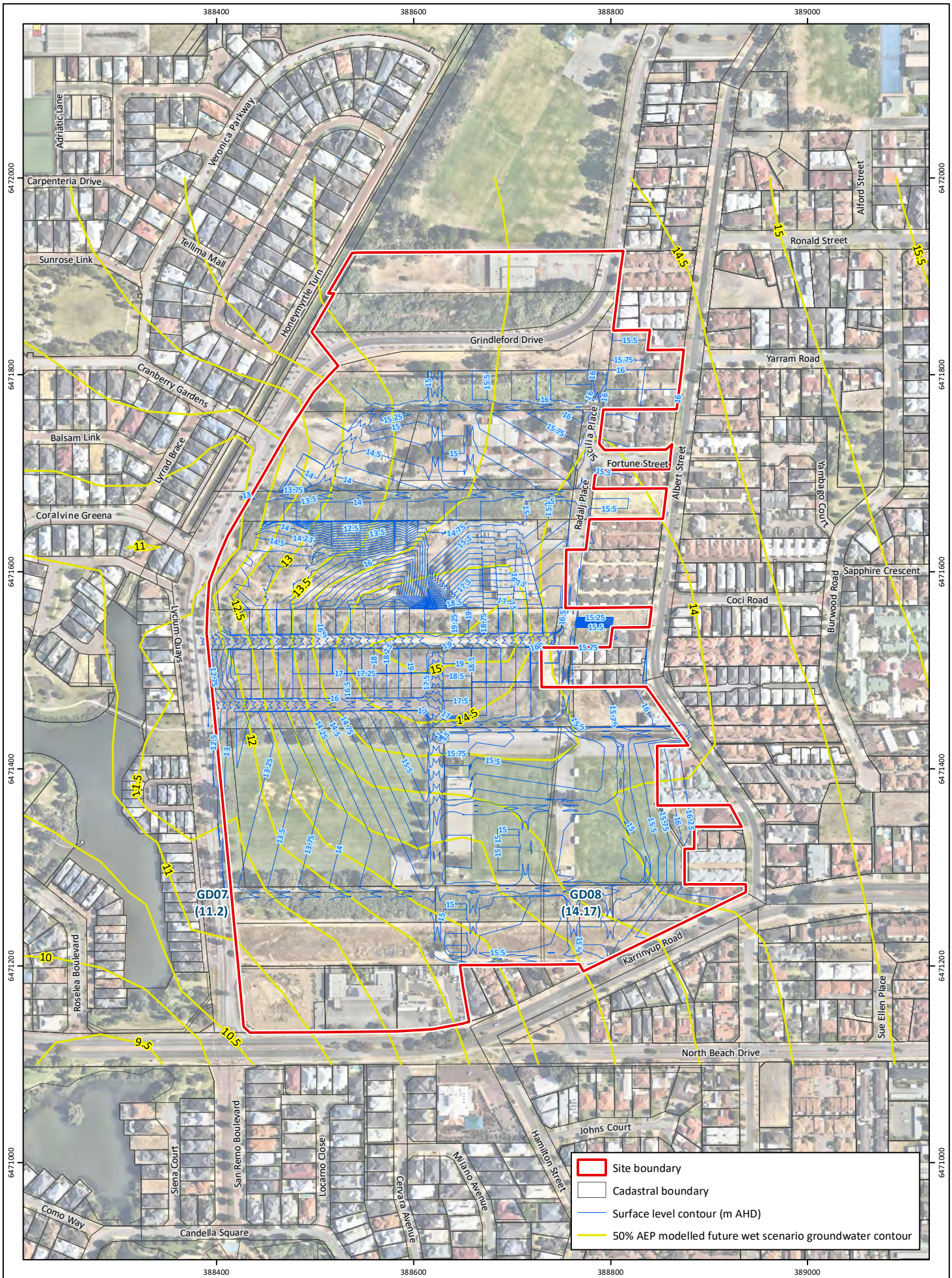


Figure 12: **Design Surface and Predicted 50% AEP Groundwater Levels**

Project: Local Water Management Strategy
East Roselea

Client: Parcel Property

Plan Number:
EP18-114(02)--F12

Drawn:	AFF
Date:	22/10/2020
Checked:	DPC
Approved:	DPC
Date:	28/10/2020

N

0 50 100
Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used

Appendix A

East Roselea Local Structure Plan

MODIFIED STRUCTURE PLAN

ROSELEA EAST

BALCATTA

NORTH

0 62.5 m

SCALE @ A3: 1:2500

8686-CON-07-L

ROWE GROUP DESIGN

Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.

N:\TOWN PLANNING\8600-8999\8686\DRAFTING\A-CAD - FORBES.CHESTERMAN - 2019.03.13

8686_CON07L_20190312 Balcatta (structure plan concept) DRAWN: A. GLASKIN - DATE CREATED: 2019.03.12 - PROJECTION: MGA50 GDA94 - CADASTE: LANDGATE

Appendix B

Geotechnical Investigation

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Preliminary Geotechnical Investigation

309 Albert Street
Balcatta, WA

Prepared for
Estate of Cono Santoro

Project 76430
October 2012

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	76430	Document No.	1
Document title	Report on Preliminary Geotechnical Investigation		
Site address	309 Albert Street, Balcatta		
Report prepared for	Estate of Cono Santoro		
File name	P:\76430 Balcatta, 309 Albert Street\Docs\76430 Report on Preliminary Geotechnical Investigation, 309 Albert Street, Balcatta.doc		

Document status and review

Revision	Prepared by	Reviewed by	Date issued
1	B. Divilly	M.J. Thom	3 October 2012

Distribution of copies

Revision	Electronic	Paper	Issued to
1	1	1	Ms Maria Priolo

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

	Signature	Date
Author	BD:	3 October 2012
Reviewer		3 October 2012

NCB INTERNATIONAL CERTIFIED QUALITY MANAGEMENT SYSTEM

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

Table of Contents

Page

1. Introduction 1
2. Site Description 1
3. Field Work Methods 2
4. Field Work Results 3
   4.1 Ground Conditions 3
   4.2 Groundwater 3
   4.3 Permeability Testing 3
5. Laboratory Testing 4
6. Comments 4
   6.1 Proposed Development 4
   6.2 Site Classification 5
   6.3 Site Preparation 5
      6.3.1 Ground Improvement 5
      6.3.2 Surface Compaction 6
      6.3.3 Foundation Design 6
   6.4 Pavement Design Parameters 7
   6.5 Soil Permeability 7
7. References 7
8. Limitations 8

Appendix A: About this Report
Location of Tests
Results of Field Work
Appendix B Geotechnical Laboratory Testing

Report on Geotechnical Investigation
Proposed Residential Development
309 Albert Street, Balcatta, WA

1. Introduction

This report presents the results of a geotechnical investigation undertaken by Douglas Partners Pty Ltd (DP) for a proposed residential development at 309 Albert Street in Balcatta, Western Australia. The investigation was commissioned in an email dated 6 August 2012, by Ms Maria Priolo on behalf of the Estate of Cono Santoro, and was undertaken in accordance with DP's proposal dated 26 June 2012.

The purpose of the geotechnical investigation was to determine the subsurface conditions across the site and thus:

- Provide the appropriate classification in accordance with the requirements of AS 2870-2011.
- Provide recommendations on site preparation.
- Provide recommendations on appropriate foundation system(s) for the proposed buildings, including an allowable bearing pressure and an estimate of likely settlements.
- Provide parameters for pavement design, including indicative external pavement CBR.
- Comment on the suitability of the site for on-site stormwater disposal using soakwells, including the assessment of permeability.
- Assess the groundwater level beneath the site at the time of investigation.

The investigation included the excavation of eight test pits, six cone penetration tests, one in-situ permeability test and laboratory testing of selected samples.

Details of the field work and the results of the investigation are presented in this report together with recommendations on the issues listed above.

2. Site Description

The site comprises an approximately rectangular shaped area of 1.5 ha and is identified as 309 Albert Street in Balcatta, Western Australia. It is bounded by the future Grindleford Drive to the north and west, Albert Street to the east, and residential lots and the Sicilian Club to the south.

At the time of the investigation the site was occupied with a residential building and a tin shed on the eastern end of the lot. Some machinery, old car bodies and other waste materials were scattered around the shed. The remainder of the site comprised a vineyard. Several drainage sumps were present across the vineyard area. Vegetation on the site consisted of medium length grasses, vines and some large trees to the west of the house.

The ground surface level generally falls to the west from a high point adjacent to Albert Street of approximately RL 17 m AHD (Australian Height Datum), to approximately RL 13 m near the western boundary of the site.

The Perth 1:50 000 Environmental Geology sheet indicates that the shallow subsurface conditions at the site consist of swamp deposits comprising peat.

3. Field Work Methods

Field work was carried out on 13 and 17 August 2012 and comprised the excavation of eight test pits with adjacent Perth sand penetrometer (PSP) tests, six cone penetration tests (CPT) and one in situ permeability test.

The test pits (TP1 to TP8) were excavated to depths of between 2.3 m and 3 m using a 5 tonne Kobelco excavator equipped with a 400 mm wide toothed bucket and were logged in general accordance with AS1726-1993 by a suitably experienced engineer from DP. Soil samples were recovered from selected locations for subsequent laboratory testing.

The CPTs (CPT9 to CPT14) were carried out to depths of between 10.2 m and 12.2 m by using a 36 mm diameter instrumented cone with a following 130 mm long friction sleeve attached to rods of the same diameter, pushed continuously at a rate of 20 mm/sec into the soil by hydraulic thrust from a ballasted truck mounted rig. Strain gauges in the cone and sleeve measure resistance to penetration and friction along the sleeve. This data is recorded on a computer and analysed to allow the assessment of the type, properties and condition of the materials penetrated.

The PSP tests were carried out in accordance with AS 1289.6.3.3 to assess the in situ density of the shallow soils.

One in-situ permeability test was carried out using the falling head method adjacent to TP1 at a depth of 0.7 m.

Test locations were determined using both site features and a handheld GPS and are marked on Drawing 1.

4. Field Work Results

4.1 Ground Conditions

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

- **Filling (Sand)** – very loose to medium dense, dark grey, grey and yellow-brown, sand filling with some silt to depths of between 0.5 m and 2 m at TP1, TP2, TP5 to TP8 and CPT9 to CPT14. Some demolition rubble, including bricks, concrete, pipe and tiles were observed within the sand filling at some of the test pits locations.
- **Peat** – very soft and soft, black and dark grey-brown, fibrous peat from depths of between 0 m to 1.8 m extending to depths of 1.6 m and 3.3 m at TP2 to TP8 and CPT10 to CPT14.
- **Sand –** medium dense to dense, grey, white and light brown, fine to coarse grained sand with some silt underlying the peat to termination depths between 3 m and 12.2 m at all test locations.

4.2 Groundwater

Groundwater was encountered at between surface level and a depth of 2.8 m in all of the test pits and CPT holes at the time of the fieldwork. All test pits were immediately backfilled following sampling, which precluded longer-term monitoring of groundwater levels.

The Perth Groundwater Atlas indicates that the groundwater level was at between RL 12 m AHD and RL 13 m AHD , i.e. approximately 1 m below the lowest surface level in May 2003.

4.3 Permeability Testing

One in situ permeability test using the falling head method was carried out at a depth of 0.7 m at TP1. A field permeability value was estimated using Hvorslev's method (1951). A permeability value was also derived using grading results (refer to Section 5) and Hazen's formula which applies to sand in a loose state. Results of the permeability analysis are summarised in Table 1.

Table 1: Summary of the Permeability Analysis

Test	Depth (m)	Measured Permeability (m/s) [1]	Derived Permeability (m/s) [2]	Material
TP1	0.7	4.1×10^{-4}	2.9×10^{-4}	Filling (Sand)
TP2	2.2	-	2.6×10^{-4}	Sand
TP6	0.5	-	2.3×10^{-4}	Filling (Sand)
TP8	0.5	-	2.3×10^{-4}	Filling (Sand)

Notes: [1]: Hvorslev's method.
[2]: Hazen's method.

5. Laboratory Testing

A geotechnical laboratory testing programme was carried out by a NATA registered laboratory and comprised the determination of the particle size distribution of four samples and the organic content of two samples. Detailed test report sheets are given in Appendix B and the results are summarised in Table 2.

Table 2: Results of Geotechnical Laboratory Testing

Test	Depth (m)	Fines (%)	d_{10} (mm)	d_{60} (mm)	OC (%)	Material
TP1	0.7	5	0.17	0.49	-	Sand filling with a trace of gravel and silt.
TP2	2.2	5	0.16	0.41	-	Sand with a trace of silt.
TP3	1.0	-	-	-	45.4	Peat.
TP5	2.6	-	-	-	26.2	Peat.
TP6	0.5	8	0.15	0.45	-	Sand filling with some silt and a trace of gravel.
TP8	0.5	7	0.15	0.42	-	Sand filling with some silt and a trace of gravel.

Notes for Table 2
- The % fines is the amount of particles smaller than 75 µm.
- A d_{10} of 0.17 mm means that 10% of the sample particles are finer than 0.17 mm.
- A d_{60} of 0.44 mm means that 60% of the sample particles are finer than 0.44 mm.
- OC: organic content.

6. Comments

6.1 Proposed Development

It is understood that proposed development consists of a residential subdivision.

6.2 Site Classification

Results of the investigation indicate that the ground conditions across the site generally comprise uncontrolled filling with some demolition debris, overlying soft peat. Medium dense sand underlies the peat at depths of between 1.6 m and 3.3 m below surface level.

Based on the results of the investigation, a classification of 'P' in accordance with AS2870 should be applied to this site. Significant site preparation would be required in order to allow development on the site. Discussions and recommendations regarding possible ground improvement options are given in Section 6.3 of the report.

6.3 Site Preparation

The proposed structures should not be built on shallow footing systems unless ground improvement is carried out. General recommendations regarding possible ground improvement are given in this section based on the available results.

The extent of site preparation will depend on the footing system chosen for the proposed building. There are two alternative strategies that could be adopted for the development of the site namely:

- remove the existing filling and peat and replace it with engineered fill so that it is suitable to support shallow footings; or
- surface compact the existing filling and then use a pile foundation for the support of the proposed structures.

Details of both options are provided below.

6.3.1 Ground Improvement

Uncontrolled filling extends to depths of between 0.5 m and 2.0 m at the investigated locations. This material is of varying density and includes a variable quantity of demolition debris and does not form a suitable structural layer in its current condition. If this option is chosen, it is recommended that the existing filling be stripped from the site and stockpiled for treatment and reuse. The unsuitable deleterious materials could possibly be screened from this filling, with the sand fraction reused as structural fill. It is anticipated that the filling extends below the groundwater level across part of the site, and thus excavation will be limited to the material above the groundwater level unless the groundwater level beneath the site is lowered. Also, suitable compaction of the submerged uncontrolled filling is unlikely to be achieved using conventional compaction equipment.

Peat was encountered underlying the uncontrolled filling and from surface to depths of between 1.6 m and 3.3 m. Peat is a highly compressible organic material which will decay and consolidate over time, and thus is not a suitable structural material. It is recommended that the peat is excavated and removed from site and replaced with structural filling material. The peat extends below the groundwater level across the site, and thus groundwater control will be required during this excavation.

It is recommended that imported structural filling comprise less than 5% per weight of particle less than 75 microns and no material with a nominal size greater than 150 mm. The filling should be placed close to its optimum moisture content and compacted to achieve a dry density ratio of not less than 95% of standard maximum dry density.

Owing to the unknown nature of possible imported filling, it is recommended that compaction control of imported sand filling be carried out using PSP in accordance with AS1289.6.3.3 only after the relationship between the sand dry density and the PSP blow counts is established. Alternatively, conventional compaction control testing with a nuclear density meter will be required.

6.3.2 Surface Compaction

If a pile foundation system is used, it would be feasible to simply compact the existing filling over the peat layer to provide support for pavements. The procedures for this option are:

- remove the existing filling to 0.5 m below proposed pavement level;
- proof roll the exposed surface with a roller of about 10 tonne static weight. Non vibratory rolling is recommended to avoid problems with the shallow groundwater and underlying peat;
- screening the excavated material to remove any unsuitable material; and
- replace excavated material or imported filling as indicated in Section 6.3.1.

This site preparation would be suitable for pavements subjected to loads from passenger vehicles and light commercial vehicles only. It would not have any impact on the peat layer and hence there is likely to be ongoing settlement of the soft compressible material due to the weight of the filling and pavement. For example it is estimated that the long term settlement of the peat could be up to about 100 mm as a result of the imposed loads. Assuming that site levels are not raised above the current levels or substantial filling is contemplated, much higher settlements could occur. Settlement will also be ongoing for the entire life of structures erected on the site.

6.3.3 Foundation Design

Owing to the occurrence of uncontrolled filling and soft peat material encountered to depths up to 3.3 m, buildings founded on shallow foundation systems would experience unacceptable settlements if no specific site improvement is carried out.

Thus, if no specific site improvement is carried out, buildings should be supported on piles, founded within the medium dense sand underlying the peat which was encountered at depths of between 1.6 m and 3.3 m at the test locations. The depth of piles would need to be assessed based on the design loads of the proposed structure, when available.

Proposed structures could be built on shallow foundation systems provided suitable site improvement is carried out, as discussed in Section 6.3.1. Such site preparation should include the treatment of both the surficial uncontrolled filling and the soft peat materials encountered to depths up to 3.3 m below existing ground level.

Shallow foundation systems comprising slab, pad and strip footings should be suitable to support the proposed structures. Footings of buildings covered by AS 2870-2011 should be designed to satisfy the requirements of this standard for 'Class A' conditions, provided that site preparation is carried out as detailed in Section 6.3.1.

AS 2870-2011 applies to single houses, townhouses and the like classified as Class 1 and 10a under the Building Code of Australia. For buildings not covered by AS 2870-2011, a presumptive allowable bearing pressure of 200 kPa is suggested for foundation design of strip and pad footings founded at a minimum depth of 0.5 m in medium dense or denser sand. This should ensure that total and differential settlements will in the order of 5 mm to 10 mm.

6.4 Pavement Design Parameters

Based on field observations, it is recommended that a subgrade CBR of 10% be used for the design of flexible pavements on sand subgrade encountered at this site and for sand filling imported to the site, provided that such subgrade is compacted to achieve a dry density ratio of not less than 95% relative to modified compaction, as determined by AS 1289.5.2.1.

6.5 Soil Permeability

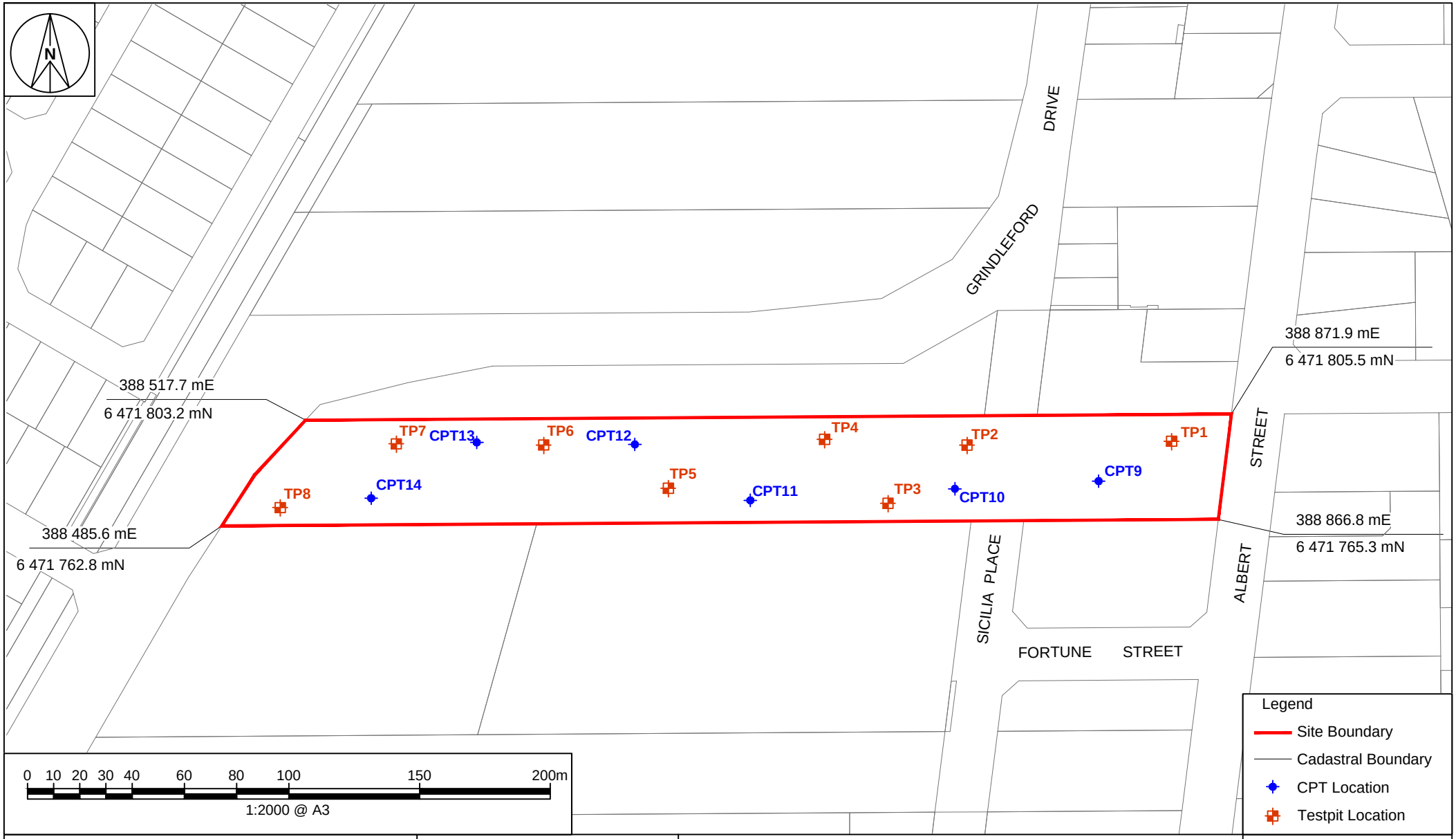
The shallow soil conditions beneath the site generally comprise sand filling overlying peat. It is therefore considered that stormwater disposal using sumps should be feasible in areas where shallow peat does not exist. Peat should be considered impervious for drainage applications.

Results of the analyses shown in Table 1 indicate permeability values of between 2.3×10^{-4}m/s and 4.1×10^{-4} m/s for the sand filling and sand encountered at this site. A design permeability of 2×10^{-4} m/s is suggested.

A lower permeability than that indicated may be appropriate for a long-term design value which takes into account bio build-up, siltation from surface infiltration, and increased compaction of the soils due to possible earthworks.

7. References

1. Australian Standard AS 1289-2000, Methods of Testing Soils for Engineering Purposes.
2. Australian Standard AS 1289.6.3.3-1999, Soil Strength and Consolidation Tests-Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test.
3. Australian Standard AS 1726-1996, Geotechnical Site Investigation.
4. Australian Standard AS 2870-2011, Residential Slabs and Footings
5. Australian Standard AS 3798-1996, Guidelines on Earthworks for Commercial and Residential Developments.
6. Department of Environment, Perth Groundwater Atlas, Second Edition, December 2004.



Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Estate of Cono Santoro
OFFICE: Perth
DATE: 4.09.2012

Proposed Residential Development
309 Albert Street, Balcatta, WA

PROJECT No: 76430
DRAWING No: 1
REVISION: A

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 17 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP1
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
17		FILLING (SAND) - medium dense, yellow-brown, fine to coarse grained sand filling with a trace of silt and a trace of fine to medium sized gravel.		B	0.4				
				D	0.7				
16	1	- becoming grey-brown with some bricks and cobbles of limestone from 0.8 m depth.							1
	1.3	SAND - medium dense, dark grey, fine to coarse grained sand with some silt, moist.							
		- becoming grey from 1.5 m depth.							
15	2			D	2.0				2
		- becoming light brown and white from 2.8 m depth.						13-08-12	
14	3								3
	3.0	Pit discontinued at 3.0m (Target depth)							

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at 2.8 m depth.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 14 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP2
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
14	0	FILLING (SAND) - very loose, dark grey, fine to coarse grained sand with some rootlets and some silt, moist.		D	0.4				
	0.5	PEAT - soft, black and dark grey-brown, slightly sandy fibrous peat with some rootlets.		D	0.8			13-08-12 ▼	
13	1								1
	1.6	SAND - light grey, fine to coarse grained sand with a trace silt, wet.		D	2.2				
12	2								2
	2.3	Pit discontinued at 2.3m (Test pit collapse)							
11	3								3

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

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at 0.6 m depth.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 14 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP3
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
14		PEAT - soft, black, fibrous peat with some rootlets.						13-08-12 ▼	
13	1			D	1.0				1
	1.6	SAND - grey, fine to coarse grained sand, wet.							
12	2	- becoming light grey from 2.5 m depth.		D	2.8				2
11	3	3.0 Pit discontinued at 3.0m (Target depth)							3

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at surface.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 14 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP4
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per mm)
14	0	PEAT - soft, black, fibrous peat with some rootlets.						13-08-12 ▼	5 10 15 20
		- drainage pipe observed from 0.4 m depth.		D	0.8				
13	1								1
12	2								2
	2.8	SAND - grey, fine to coarse grained sand with some silt, wet.							
11	3	3.0 Pit discontinued at 3.0m (Target depth)							3

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at surface.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics / Environment / Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 14 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP5
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
14		FILLING (SAND) - medium dense, dark grey, fine to coarse grained sand with some rootlets, silt and gravel, moist.							
	0.4	FILLING (SAND) - medium dense, grey and yellow-brown, fine to coarse grained sand filling with some silt.		D	0.6				
13	1	- with many large pieces of concrete, pieces of tile, brick and rootlets from 0.8 m depth.						13-08-12	1
	1.5	PEAT - soft, black, fibrous peat with some rootlets.							
12	2			D	2.6				2
11	3	3.0 Pit discontinued at 3.0m (Target depth)							3

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at 0.8 m depth.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics | Environment | Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 13 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP6
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
13	0	FILLING (SAND) - medium dense, dark grey, fine to coarse grained sand with some rootlets, some silt and a trace of fine to medium sized gravel, moist.		D	0.5			13-08-12 ▼	
		- a pipe found at 0.6 m depth.							
	0.6	PEAT - soft, black, fibrous peat with some rootlets.							
12	1								1
11	2								2
	2.3	SAND - grey, fine to coarse grained sand with some silt, saturated.							
10	3								3
	3.0	Pit discontinued at 3.0m (Target depth)							

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

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at surface.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 13 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP7
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
13		FILLING (SAND) - medium dense, dark grey, fine to coarse grained sand filling with some silt, bricks and pieces of concrete.							
		- becoming loose from 0.45 m depth.							
		- a large pipe found at 0.6 m depth.						13-08-12	
12	1	1.0 PEAT - soft, black, fibrous peat with some rootlets.							1
11	2	2.3 SAND - grey, fine to coarse grained sand with some silt, saturated.		D	2.5				2
		- becoming white and light brown with depth.							
10	3	3.0 Pit discontinued at 3.0m (Target depth)							3

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

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at 0.8 m depth.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics I Environment I Groundwater

TEST PIT LOG

CLIENT: Estate of Cono Santoro
PROJECT: 309 Albert Street
LOCATION: Balcatta, WA

SURFACE LEVEL: 14 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

PIT No: TP8
PROJECT No: 76430
DATE: 13/8/2012
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Dynamic Penetrometer Test (blows per 150mm)
14		FILLING (SAND) - medium dense, dark grey, fine to coarse grained sand filling with some silt, a trace of fine to medium sized gravel, some bricks and large pieces of concrete, plastic, styrofoam and rootlets, moist.		D	0.5				
13	1							13-08-12	1
	1.3	PEAT - soft, black, fibrous peat with some rootlets.							
	1.9	SAND - grey, fine to coarse grained sand with some silt, wet.							
12	2	- becoming light brown with depth.		D	2.8				2
11	3								3
	3.0	Pit discontinued at 3.0m (Target depth)							

RIG: Kobelco 5 tonne excavator with a 400 mm wide toothed bucket.
LOGGED: BD
SURVEY DATUM:

WATER OBSERVATIONS: Groundwater observed at 1.0 m depth.

REMARKS: *Surface level obtained from Google Earth.

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

SAMPLING & IN SITU TESTING LEGEND

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

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Estate of Cono Santoro

PROJECT: 309 Albert Street

LOCATION: Balcatta, WA

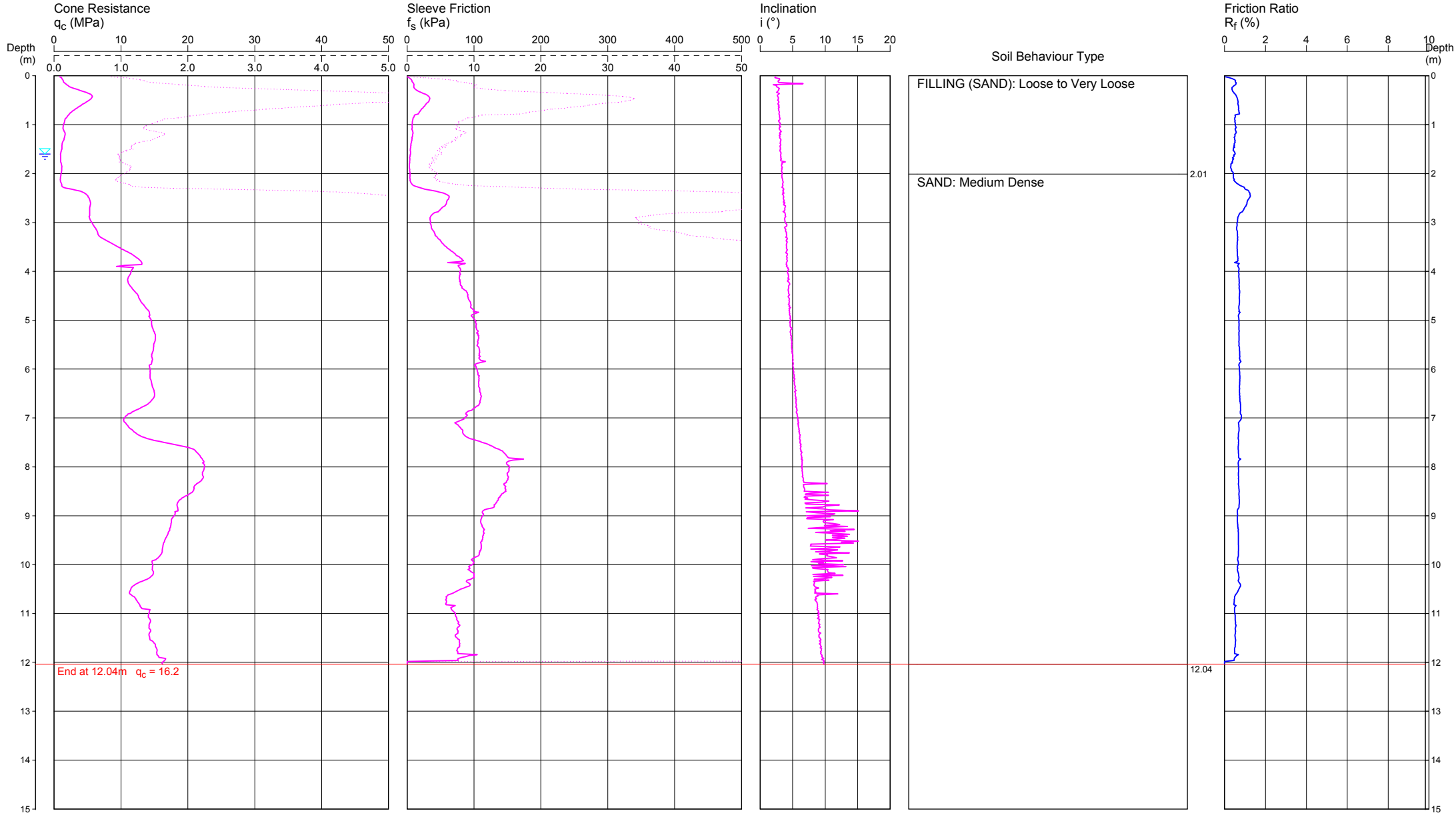
REDUCED LEVEL: 14 m AHD*

COORDINATES:

CPT9

DATE 17/08/2012

PROJECT No: 76430



REMARKS: *Surface level obtained from Google Earth.

Water depth after test: 1.60m depth (measured)

File: P:\76430 Balcatta, 309 Albert Street\Field\CPT9.CP5
Cone ID: Probedrill **Type:** EC23GM

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Estate of Cono Santoro

PROJECT: 309 Albert Street

LOCATION: Balcatta, WA

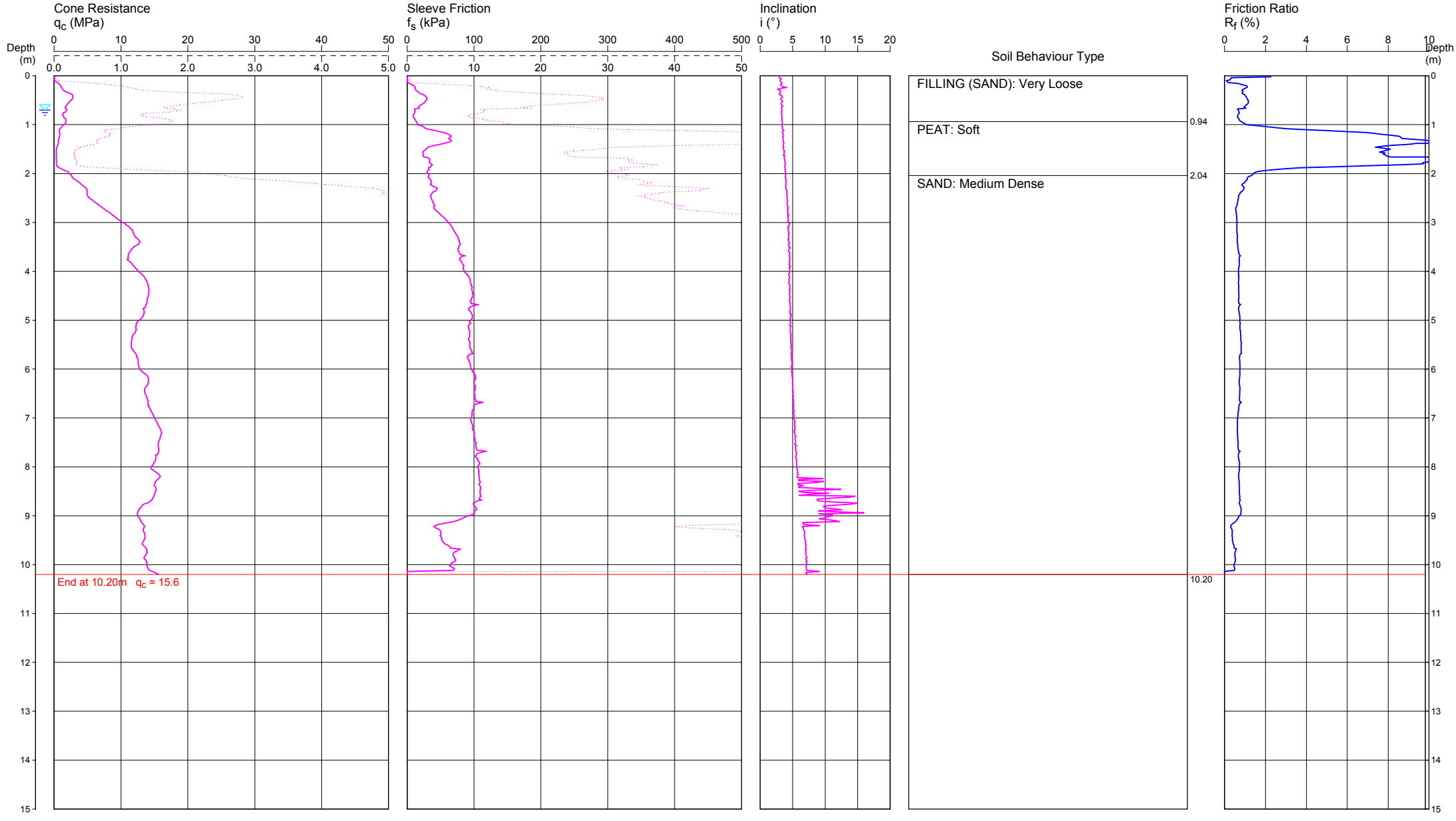
REDUCED LEVEL: 14 m AHD*

COORDINATES:

CPT10

DATE 17/08/2012

PROJECT No: 76430



REMARKS: *Surface level obtained from Google Earth.

Water depth after test: 0.70m depth (measured)

File: P:\76430 Balcatta, 309 Albert Street\Field\CPT10.CP5
Cone ID: Probedrill **Type:** EC23GM

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Estate of Cono Santoro

PROJECT: 309 Albert Street

LOCATION: Balcatta, WA

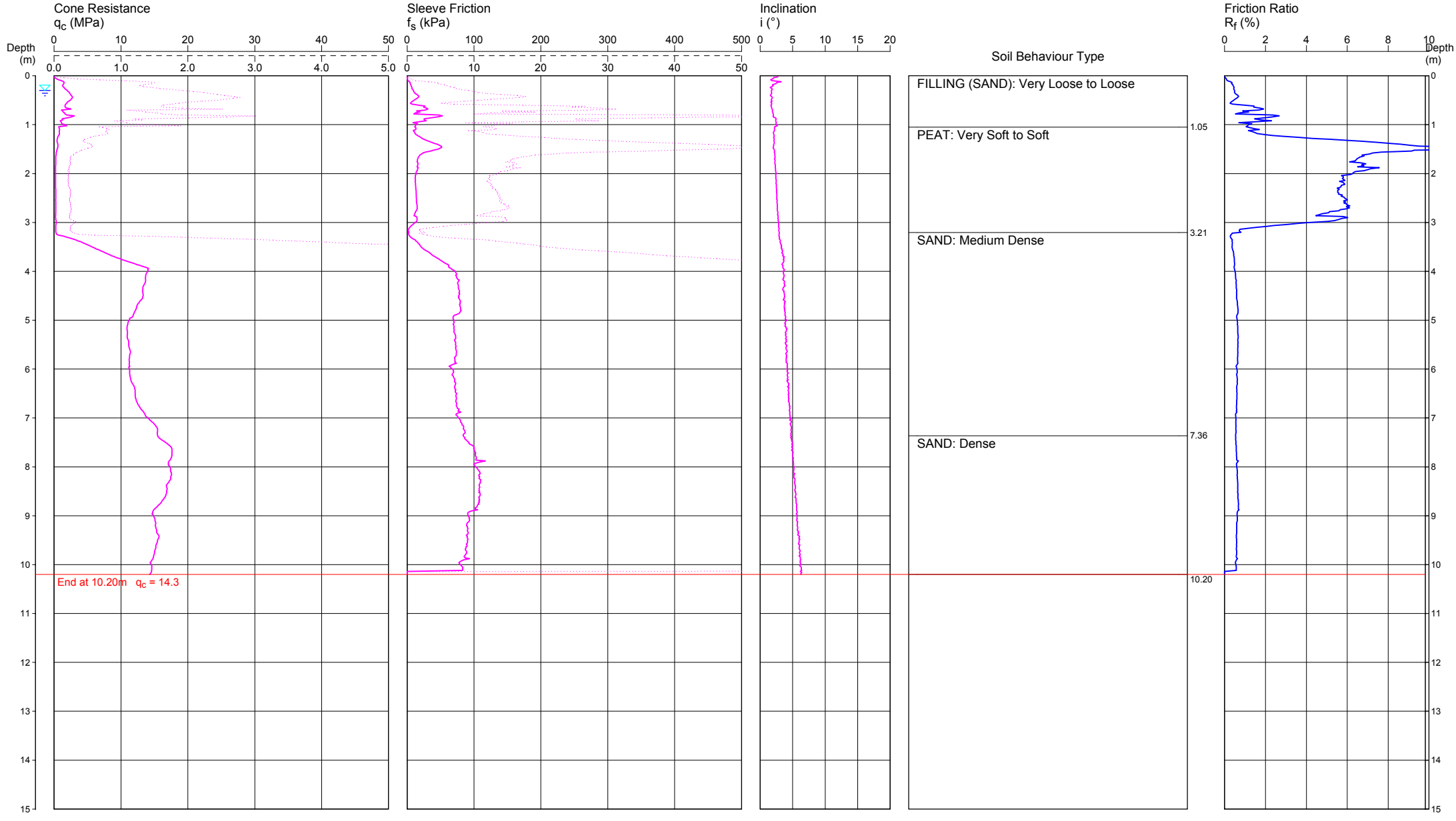
REDUCED LEVEL: 14 m AHD*

COORDINATES:

CPT11

DATE 17/08/2012

PROJECT No: 76430



REMARKS: *Surface level obtained from Google Earth.

Water depth after test: 0.30m depth (measured)

File: P:\76430 Balcatta, 309 Albert Street\Field\CPT11.CP5
Cone ID: Probedrill **Type:** EC23GM

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Estate of Cono Santoro

PROJECT: 309 Albert Street

LOCATION: Balcatta, WA

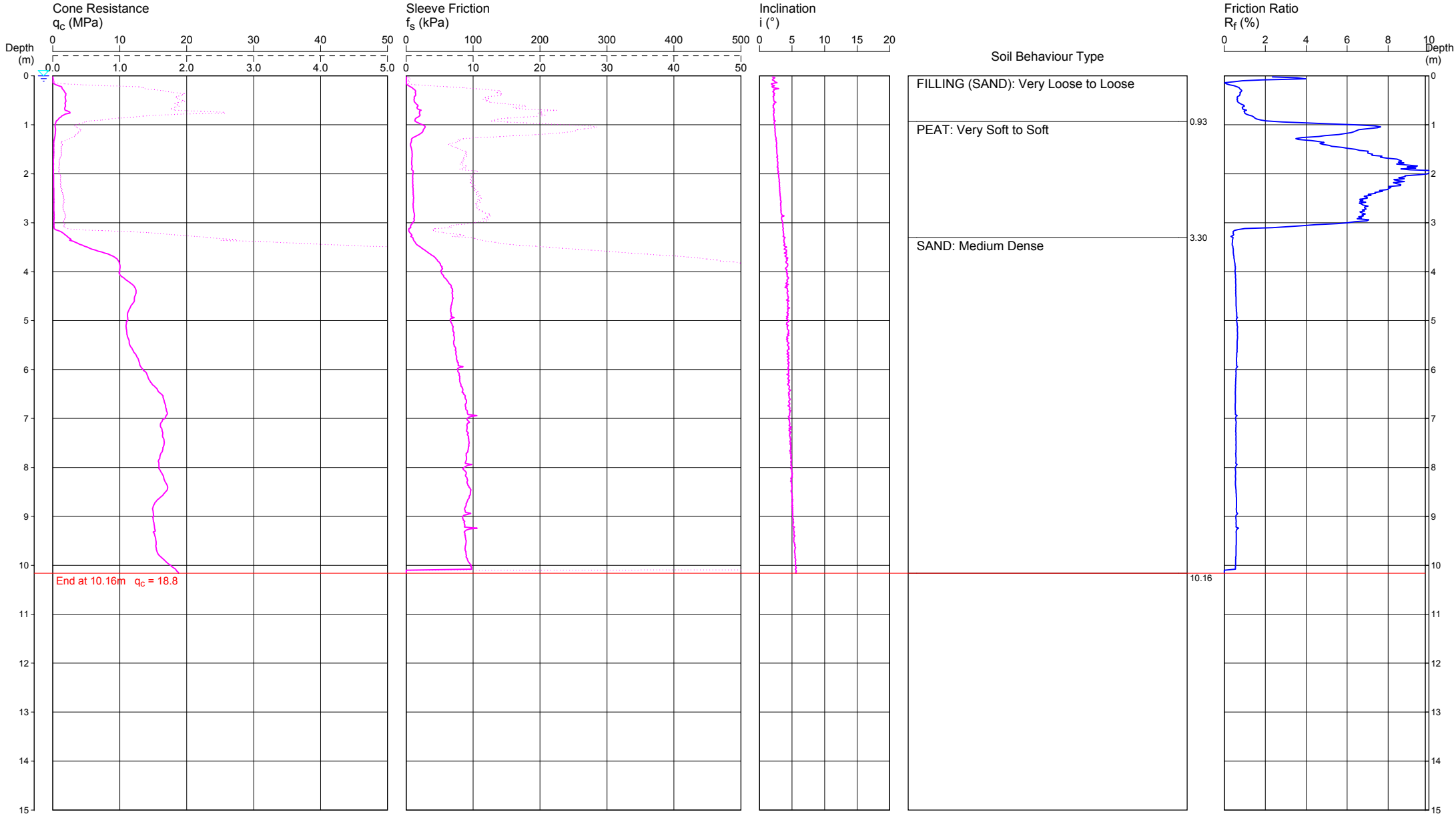
REDUCED LEVEL: 13 m AHD*

COORDINATES:

CPT12

DATE 17/08/2012

PROJECT No: 76430



REMARKS: *Surface level obtained from Google Earth.

Water depth after test: 0.00m depth (measured)

File: P:\76430 Balcatta, 309 Albert Street\Field\CPT12.CP5
Cone ID: Probedrill **Type:** EC23GM

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Estate of Cono Santoro

PROJECT: 309 Albert Street

LOCATION: Balcatta, WA

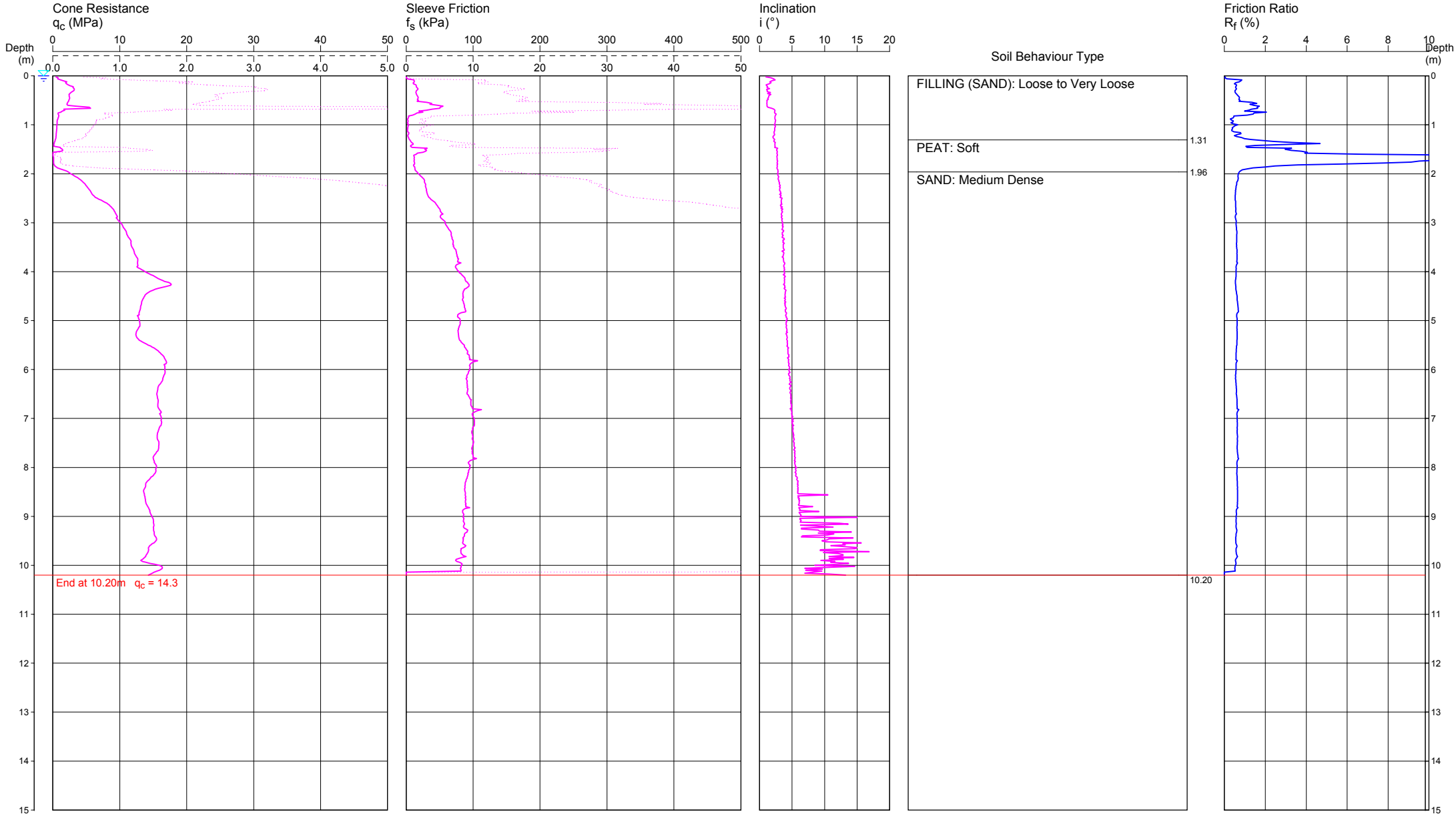
REDUCED LEVEL: 13 m AHD*

COORDINATES:

CPT13

DATE 17/08/2012

PROJECT No: 76430



REMARKS: *Surface level obtained from Google Earth.

Water depth after test: 0.00m depth (measured)

File: P:\76430 Balcatta, 309 Albert Street\Field\CPT13.CP5
Cone ID: Probedrill **Type:** EC23GM

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics | Environment | Groundwater

CONE PENETRATION TEST

CLIENT: Estate of Cono Santoro

PROJECT: 309 Albert Street

LOCATION: Balcatta, WA

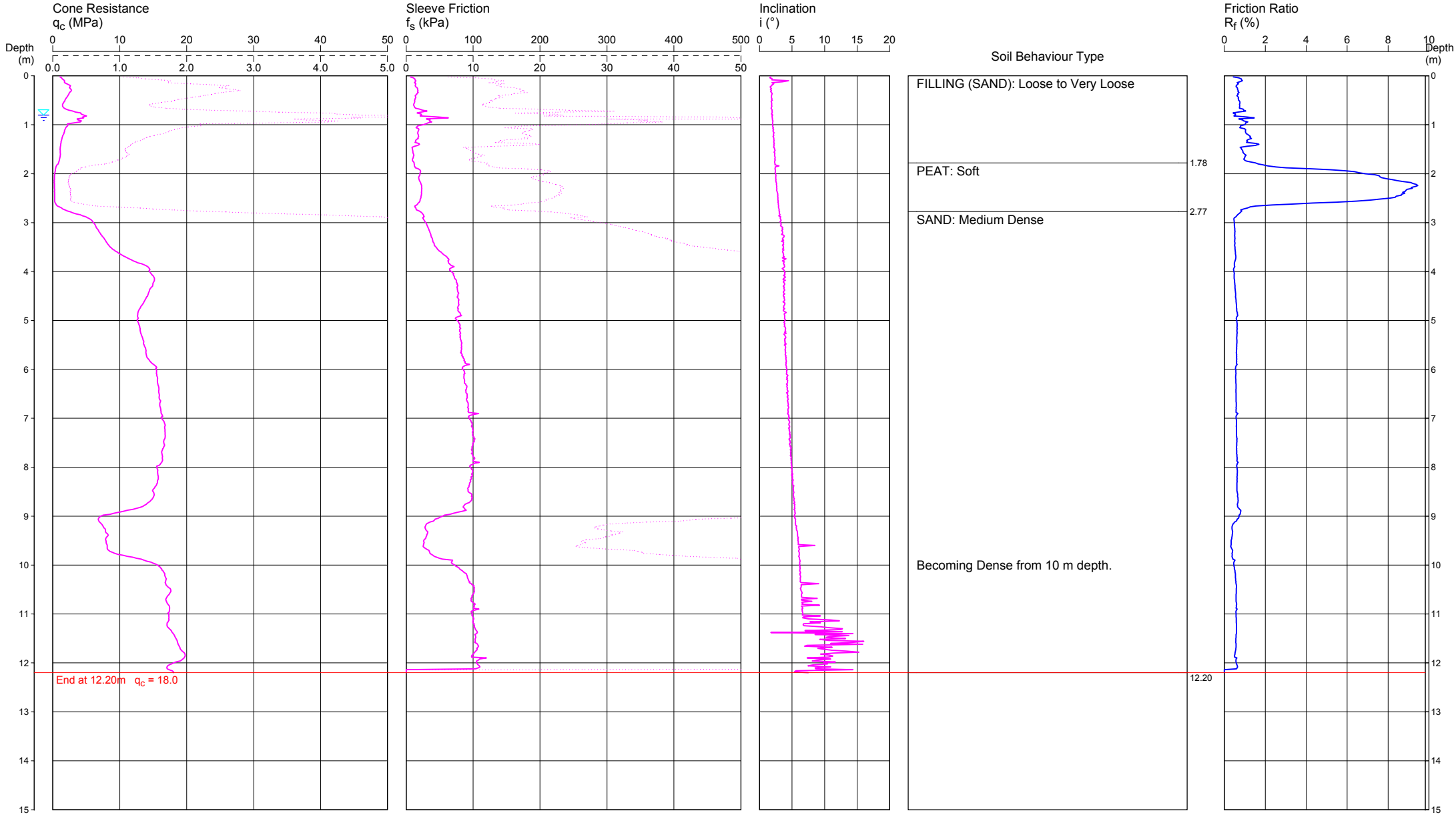
REDUCED LEVEL: 14 m AHD*

COORDINATES:

CPT14

DATE 17/08/2012

PROJECT No: 76430



REMARKS: *Surface level obtained from Google Earth.

Water depth after test: 0.80m depth (measured)

File: P:\76430 Balcatta, 309 Albert Street\Field\CPT14.CP5
Cone ID: Probedrill **Type:** EC23GM

ConePlot Version 5.9.2
© 2003 Douglas Partners Pty Ltd

Douglas Partners
Geotechnics | Environment | Groundwater

Appendix B

Geotechnical Laboratory Testing

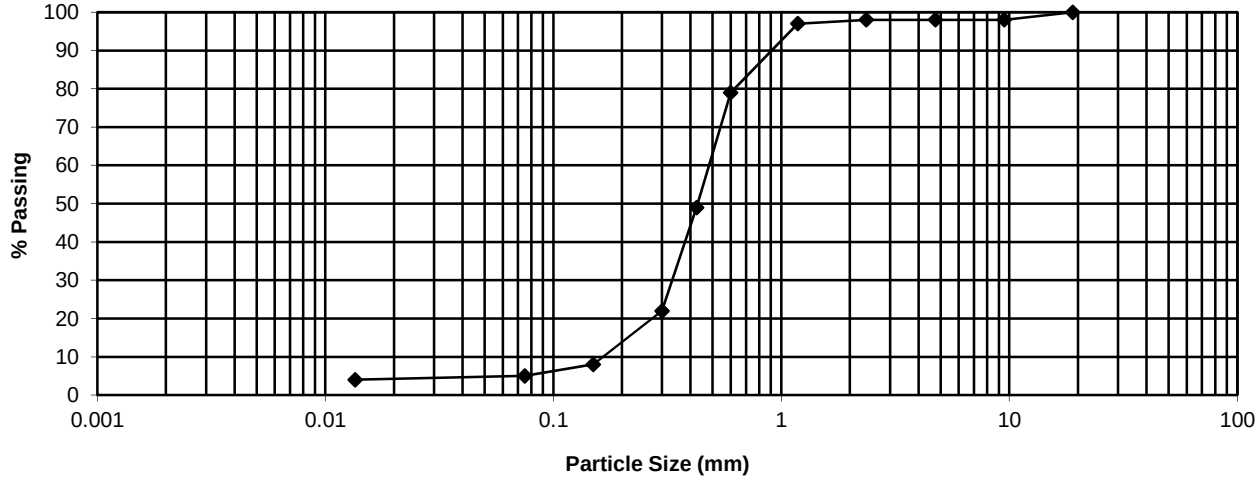
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P12/2811**
Sample No:	**P12/2811**
Issue Date:	**18 August 2012**

Client: **Estate of Cono Santoro**
Project: **309 Albert Street**
Location: **Balcatta**

Sample Location: **TP 1**
Depth (m): **0.7**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	98
4.75	98
2.36	98
1.18	97
0.600	79
0.425	49
0.300	22
0.150	8
0.075	5
0.0135	4

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

NATA WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements. This Document may only be reproduced in full. Accreditation No 15545

Approved signature

Kevin M Jones

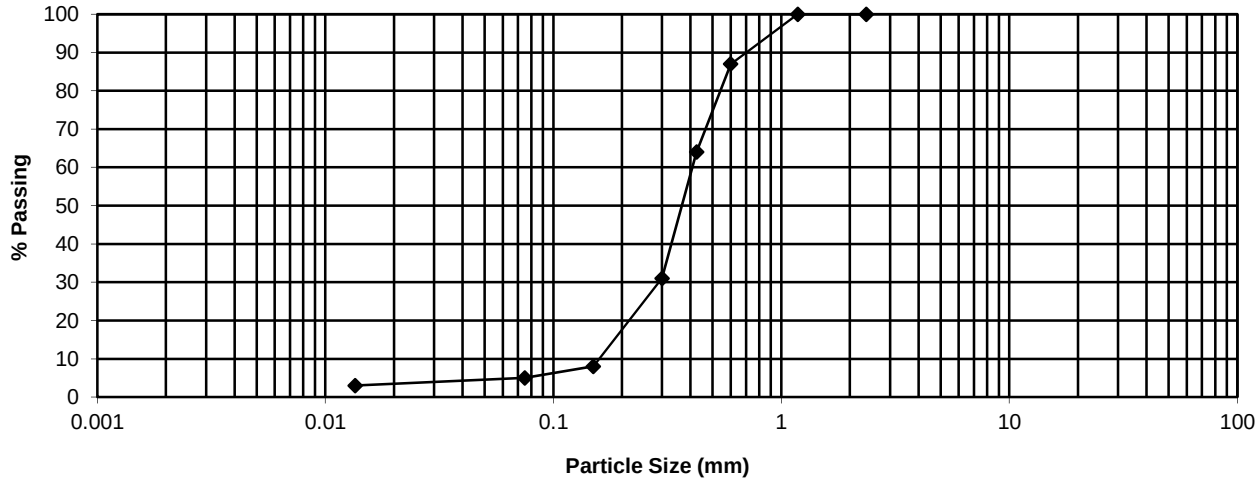
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P12/2812**
Sample No:	**P12/2812**
Issue Date:	**18 August 2012**

Client: **Estate of Cono Santoro**
Project: **309 Albert Street**
Location: **Balcatta**

Sample Location: **TP 2**
Depth (m): **2.2**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	100
0.600	87
0.425	64
0.300	31
0.150	8
0.075	5
0.0135	3

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

NATA WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements. This Document may only be reproduced in full. Accreditation No 15545

Approved signature

Kevin M Jones

Mining & Civil Geotest Pty Ltd

Ph (08) 9414 8022 Fax (08) 9414 8011

Email kevin@mcgeotest.com.au

Unit 1/1 Pusey Road, JANDAKOT WA 6164

Organic content of Soils ASTM: D 2974-07a Test Method C

Job No: 60017

Report No: 60017-P12/2813

Date of issue: 18 August 2012

Client:	Estate of Cono Santoro	Date tested:	16 August 2012
Project:	309 Albert Street	Tested by:	M Carmichael
Location:	Balcatta	Checked:	K M Jones

Sample Number	Sample Identification & Depth (m)	Ash content %	Organic content %
P12/2813	TP 3, 1.0	54.6	45.4
P12/2814	TP 5, 2.6	73.8	26.2
Tested as received	Furnace temperature 440^{oc}		

Client address: 36 O'Malley St, Osborne Park

Organic content April 2009

Approved Signature Kevin M Jones

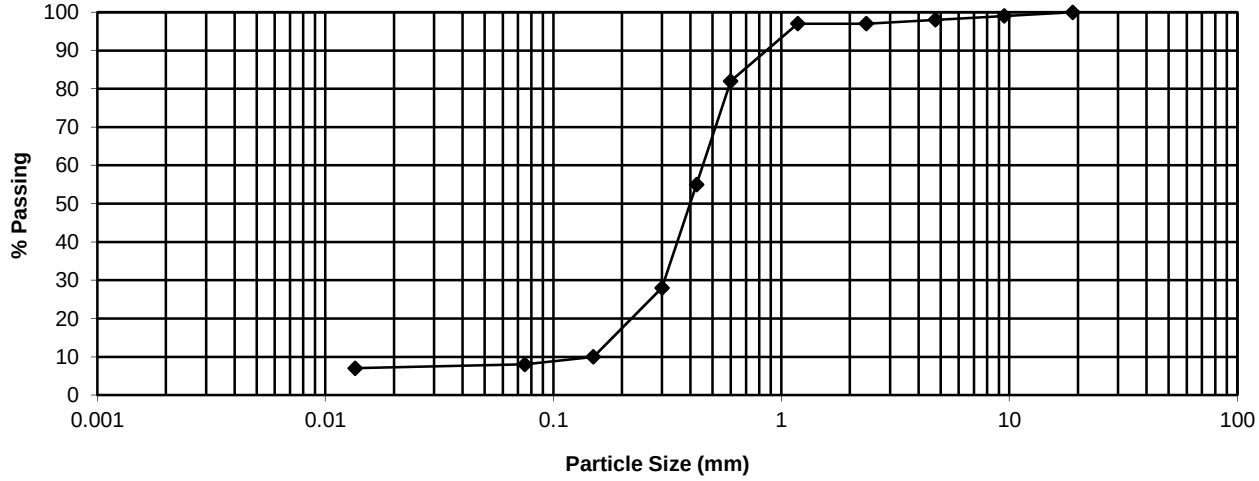
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P12/2815**
Sample No:	**P12/2815**
Issue Date:	**18 August 2012**

Client: **Estate of Cono Santoro**
Project: **309 Albert Street**
Location: **Balcatta**

Sample Location: **TP 6**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	99
4.75	98
2.36	97
1.18	97
0.600	82
0.425	55
0.300	28
0.150	10
0.075	8
0.0135	7

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

Sampling Procedure: Tested as received

NATA WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements. This Document may only be reproduced in full. Accreditation No 15545

Approved signature

Kevin M Jones

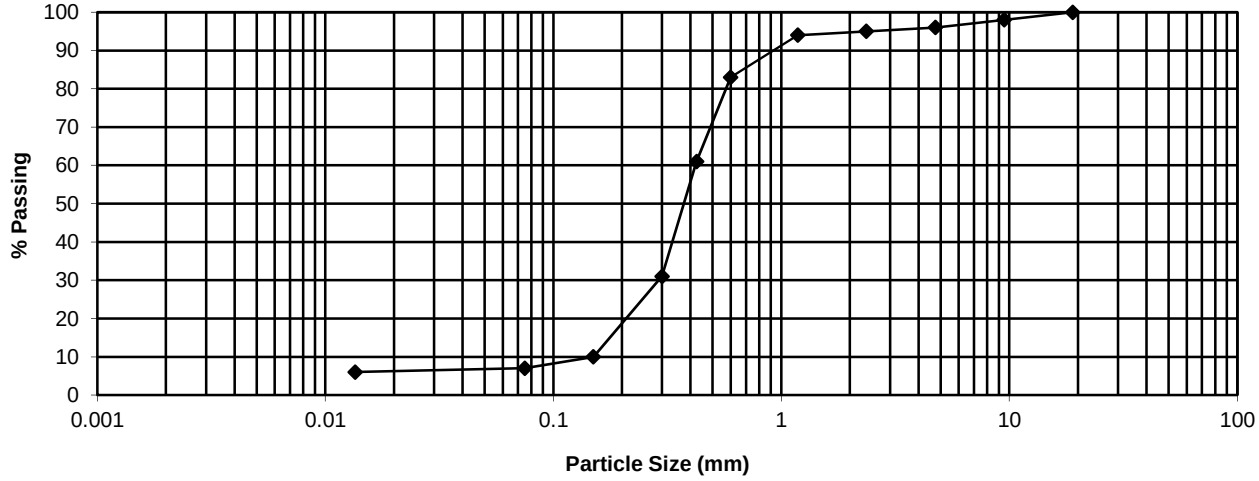
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: kevin@mcgeotest.com.au

Job No:	**60017**
Report No:	**60017-P12/2816**
Sample No:	**P12/2816**
Issue Date:	**18 August 2012**

Client: **Estate of Cono Santoro**
Project: **309 Albert Street**
Location: **Balcatta**

Sample Location: **TP 8**
Depth (m): **0.5**



SIEVE ANALYSIS WA 115.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	98
4.75	96
2.36	95
1.18	94
0.600	83
0.425	61
0.300	31
0.150	10
0.075	7
0.0135	6

Plasticity index tests
Australian Standard 1289.

Liquid limit 3.1.1	na	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client address: 36 O'Malley Street, Osborne Park

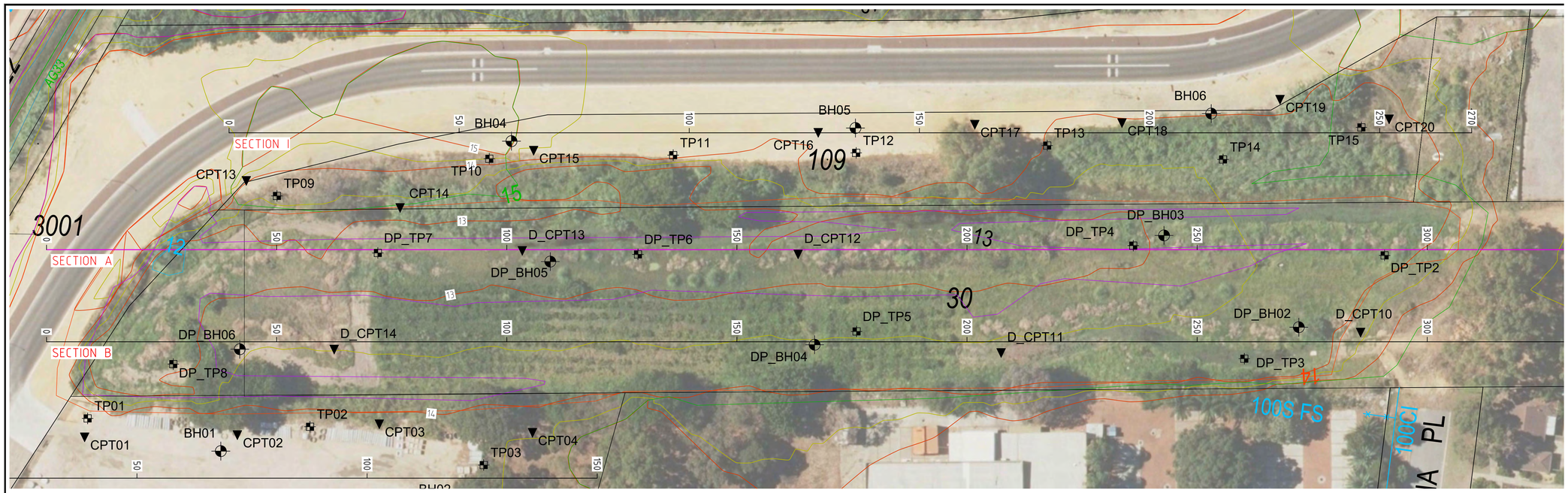
Sampling Procedure: Tested as received

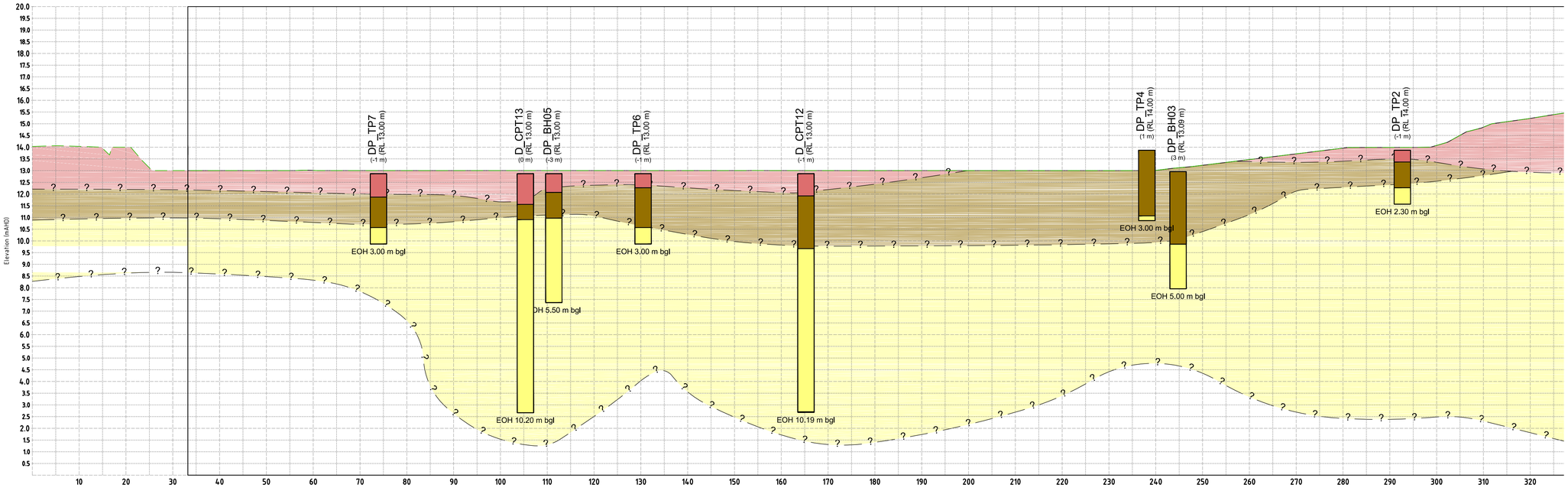
NATA WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements. This Document may only be reproduced in full. Accreditation No 15545

Approved signature

Kevin M Jones





GEOLOGY UNIT

- 1 — FILL: SAND WITH SOME ORGANICS
- 2 — FILL: PEATY SAND
- B — UNCONTROLLED FILL
- C — FILL: PEAT
- D — PEAT (NATURAL)
- E — SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m): 0 5 10 20 40

VERTICAL SCALE (m): 0 1 2 4 8

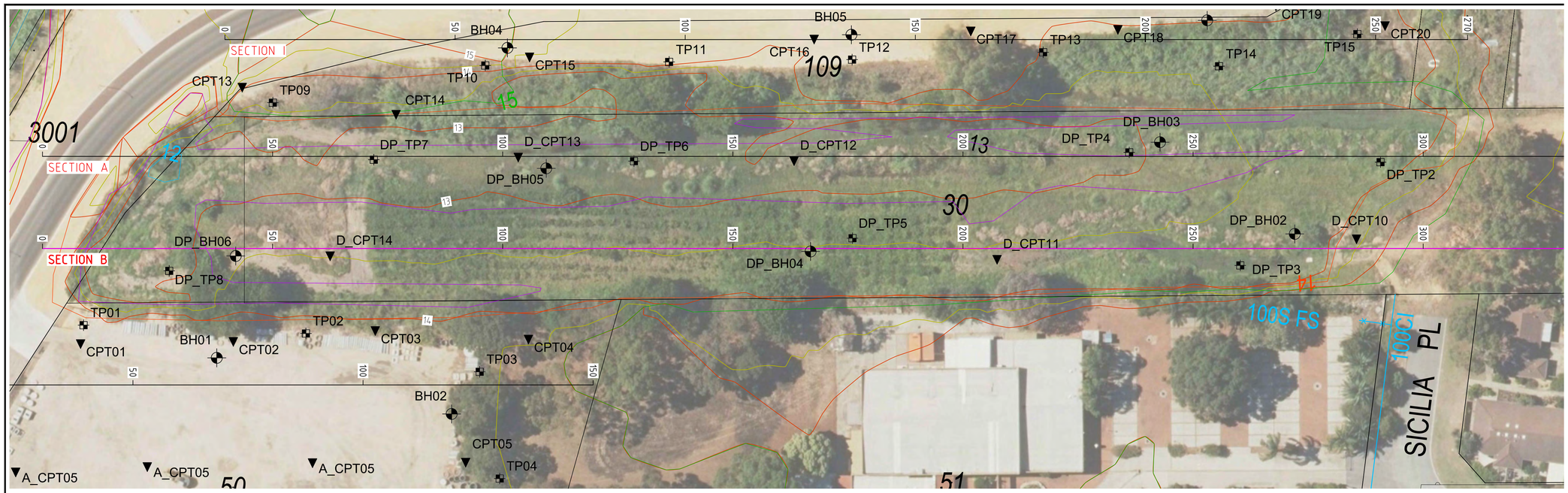
REV	DESCRIPTION	DATE	CHK

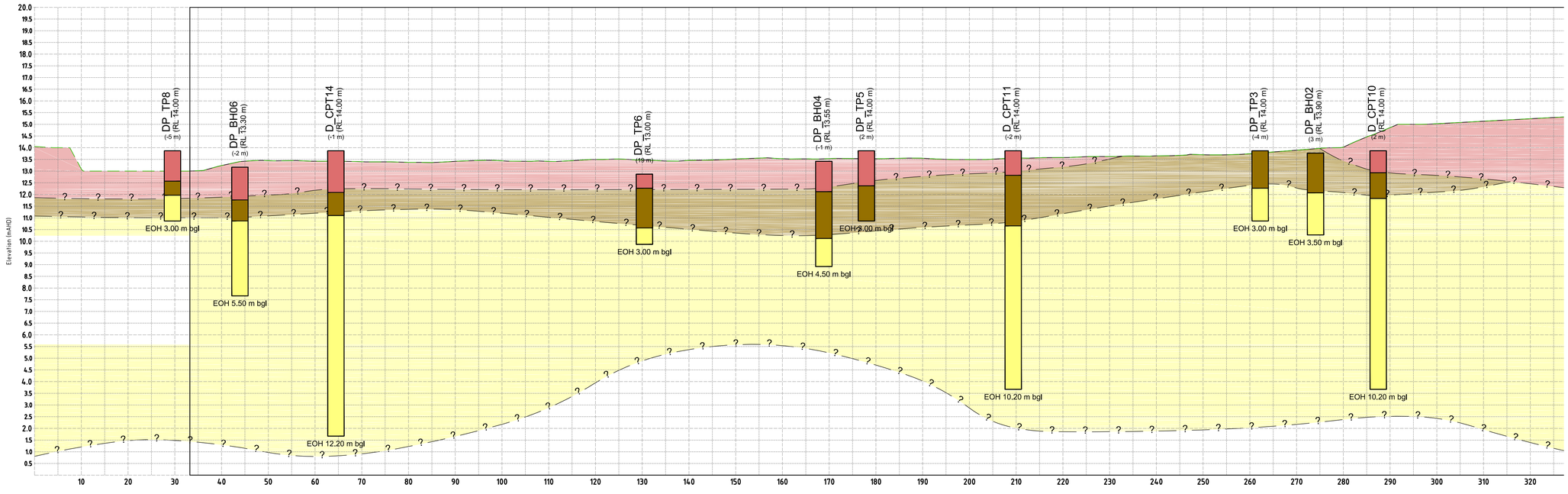
SCALE: 1 : 500(@A1)
DRAWN: DAC
DATE DRAWN: 18/12/2017
CHECKED: PCW
DATE CHECKED: 18/12/2017

Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIEN
PROJ
LOCA
TITLE
OBJ





GEOLOGY UNIT

1	FILL: SAND WITH SOME ORGANICS
2	FILL: PEATY SAND
B	UNCONTROLLED FILL
C	FILL: PEAT
D	PEAT (NATURAL)
E	SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m) 0 5 10 20 40

VERTICAL SCALE (m) 0 1 2 4 8

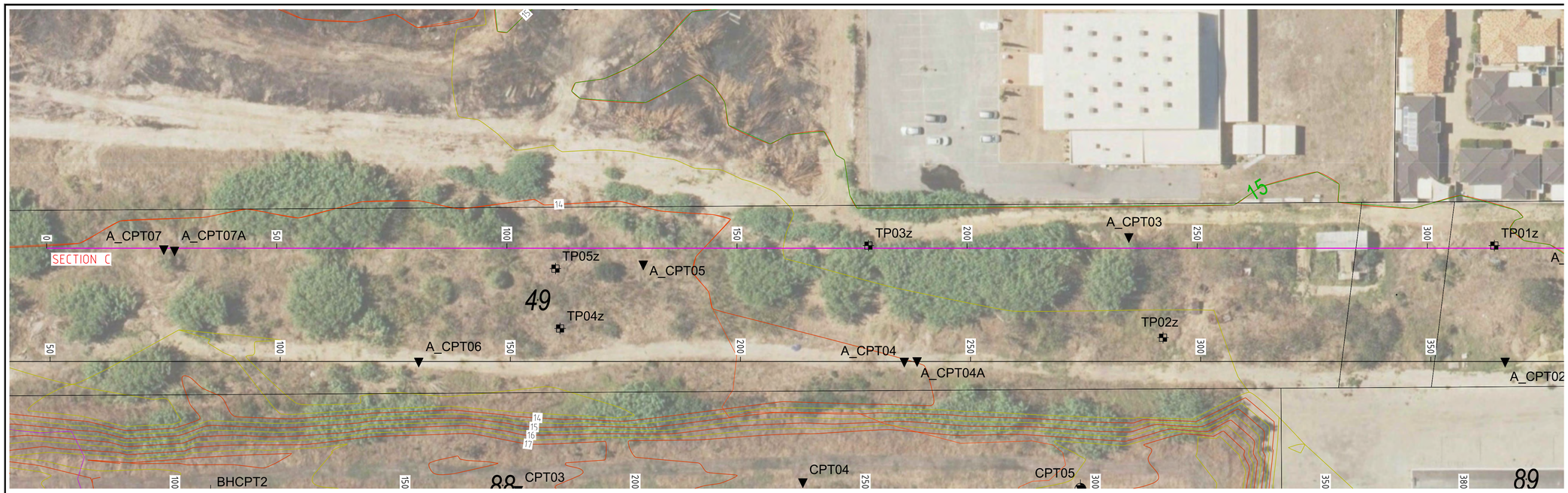
REV	DESCRIPTION	DATE	CHK

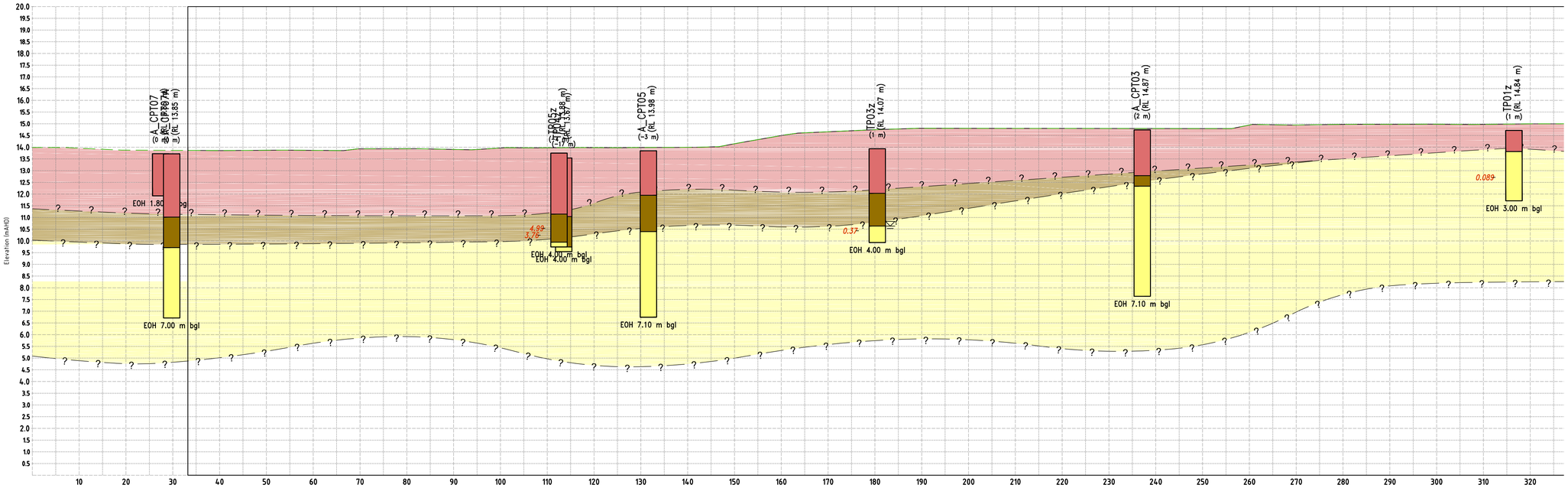
SCALE 1 : 500(@A1)
DRAWN DAC
DATE DRAWN 18/12/2017
CHECKED PCW
DATE CHECKED 18/12/2017

Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIENT:
PROJECT:
LOCATION:
TITLE:
JOB No:





GEOLOGY UNIT

1 — FILL: SAND WITH SOME ORGANICS	C — FILL: PEAT
2 — FILL: PEATY SAND	D — PEAT (NATURAL)
B — UNCONTROLLED FILL	E — SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m): 0 5 10 20 40

VERTICAL SCALE (m): 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

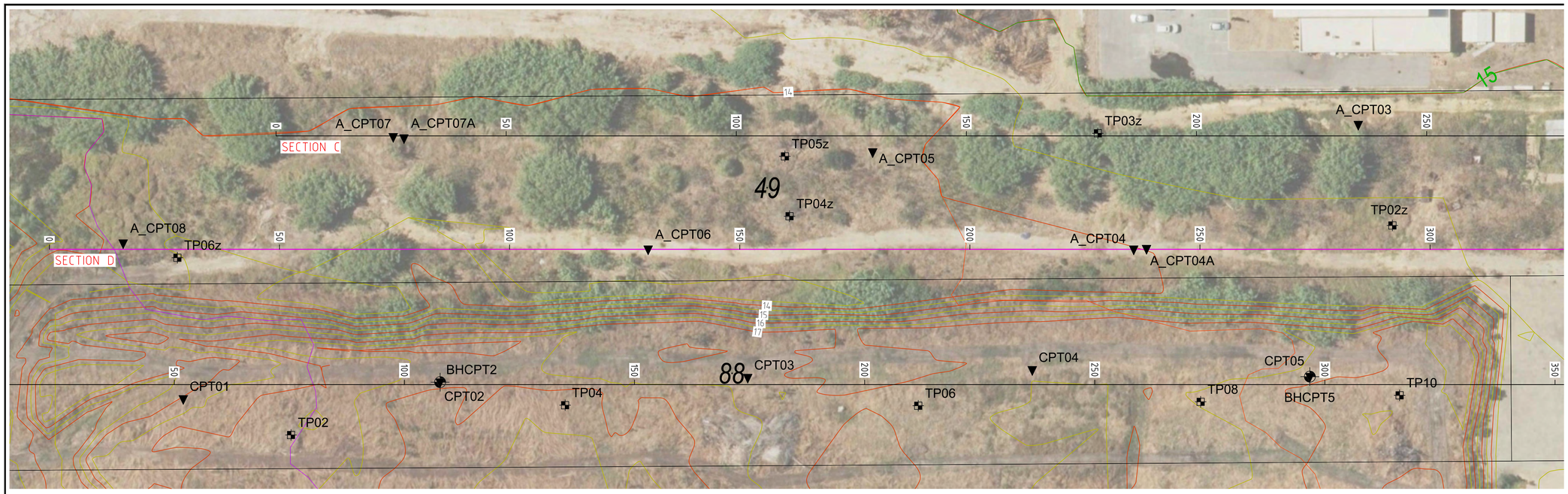
SCALE	1 : 500(@A1)
DRAWN	DAC
DATE DRAWN	18/12/2017
CHECKED	PCW
DATE CHECKED	18/12/2017

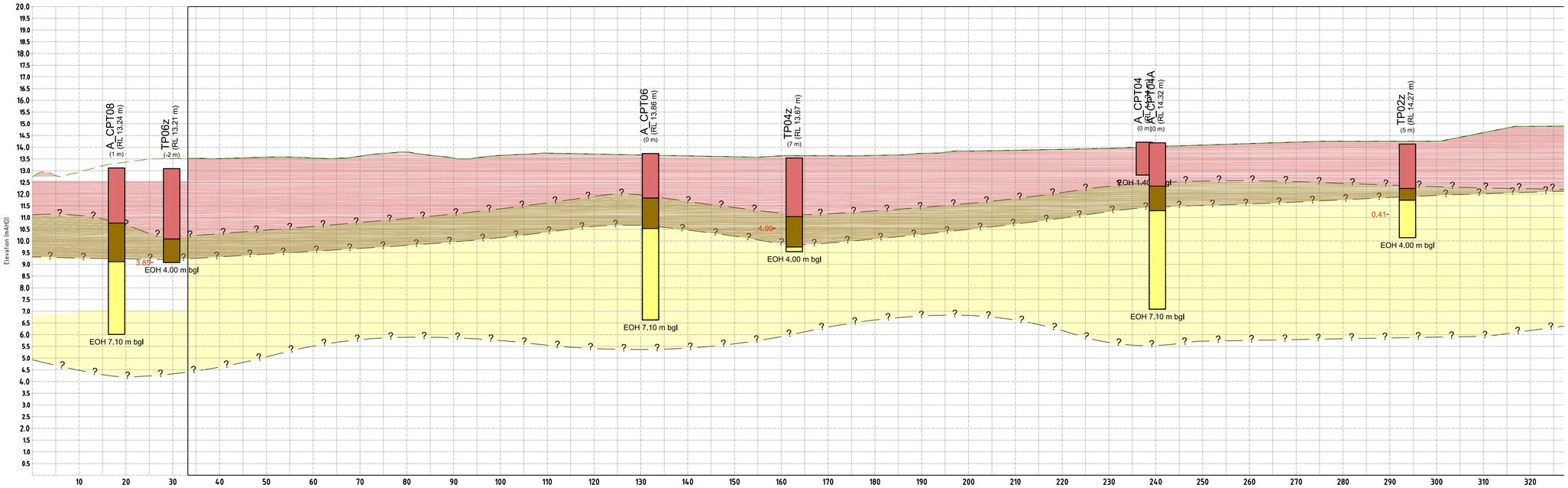
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIENT
PROJECT
LOCATION
TITLE
JOB No

O:\Jobs\2017\J1702012 - Parcel Property St Balcatta\05 CAD\DWG\J1702012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]





GEOLOGY UNIT

1 — FILL: SAND WITH SOME ORGANICS	C — FILL: PEAT
2 — FILL: PEATY SAND	D — PEAT (NATURAL)
B — UNCONTROLLED FILL	E — SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m): 0 5 10 20 40

VERTICAL SCALE (m): 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

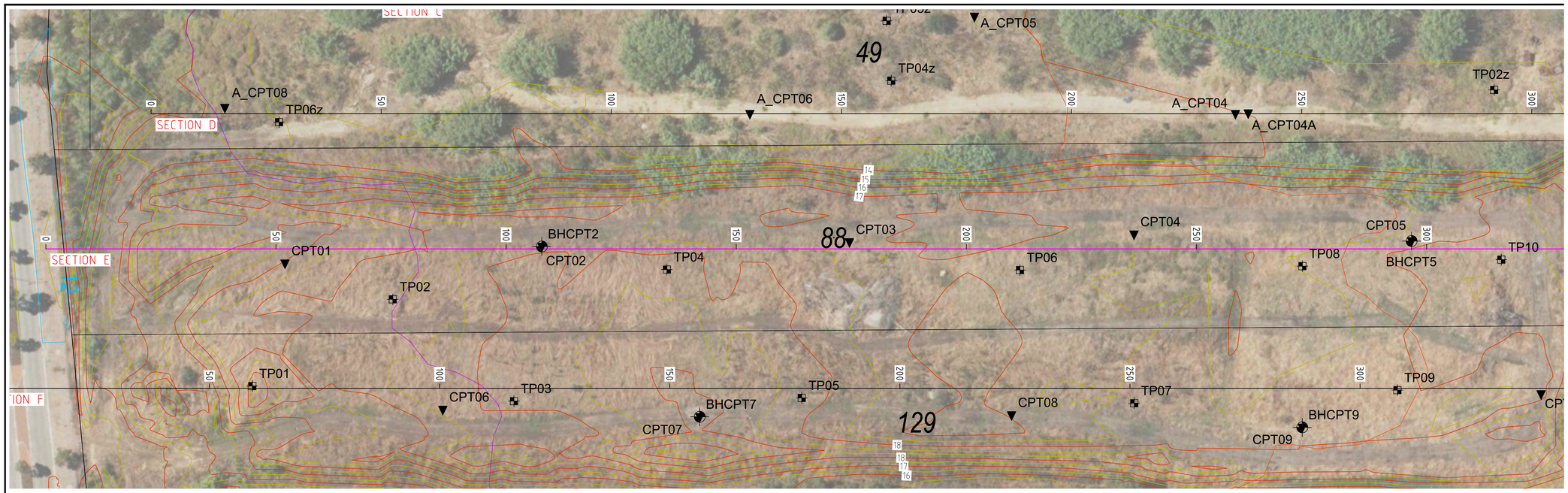
SCALE: 1 : 500(@A1)
DRAWN: DAC
DATE DRAWN: 18/12/2017
CHECKED: PCW
DATE CHECKED: 18/12/2017

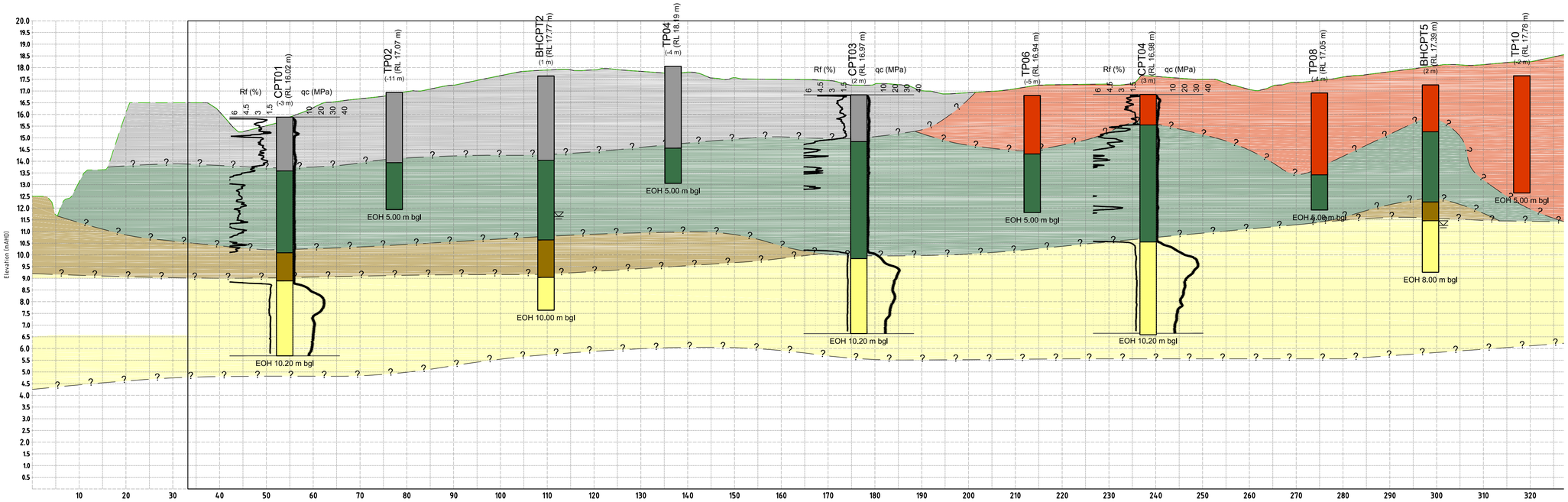
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIEN
PROJ
LOCA
SITE E
JOB N

D:\Jobs\2017\JT02012 - Parcel Property SI Balcatta\05 CAD\DWG\JT02012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]





GEOLOGY UNIT

1	FILL: SAND WITH SOME ORGANICS	C	FILL: PEAT
2	FILL: PEATY SAND	D	PEAT (NATURAL)
B	UNCONTROLLED FILL	E	SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m) 0 5 10 20 40

VERTICAL SCALE (m) 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

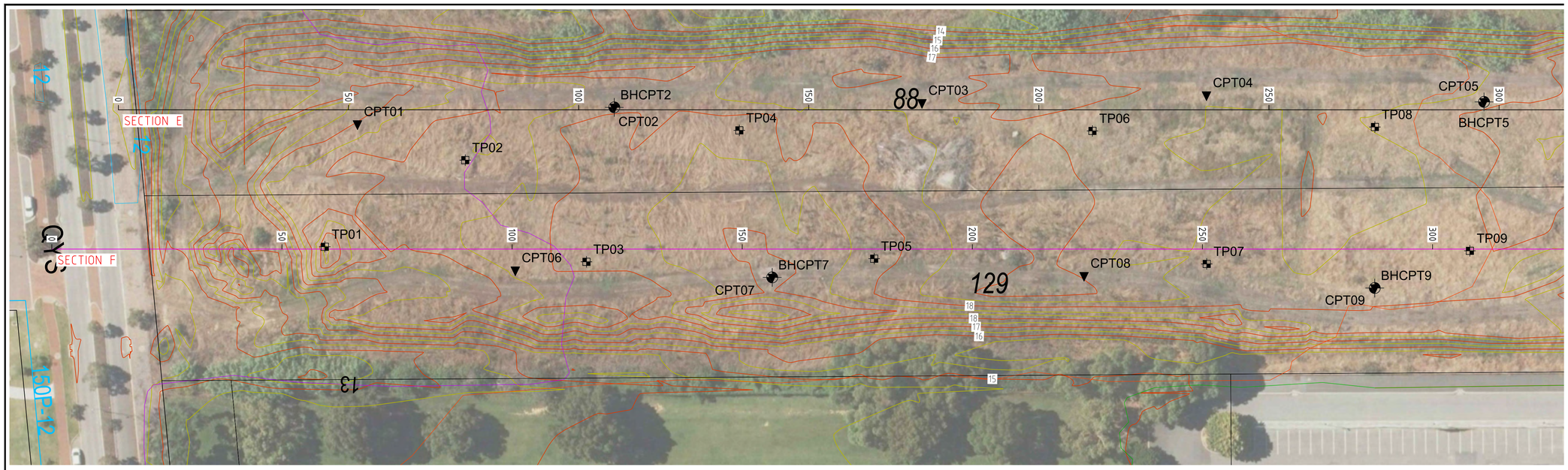
SCALE 1 : 500(@A1)
DRAWN DAC
DATE DRAWN 18/12/2017
CHECKED PCW
DATE CHECKED 18/12/2017

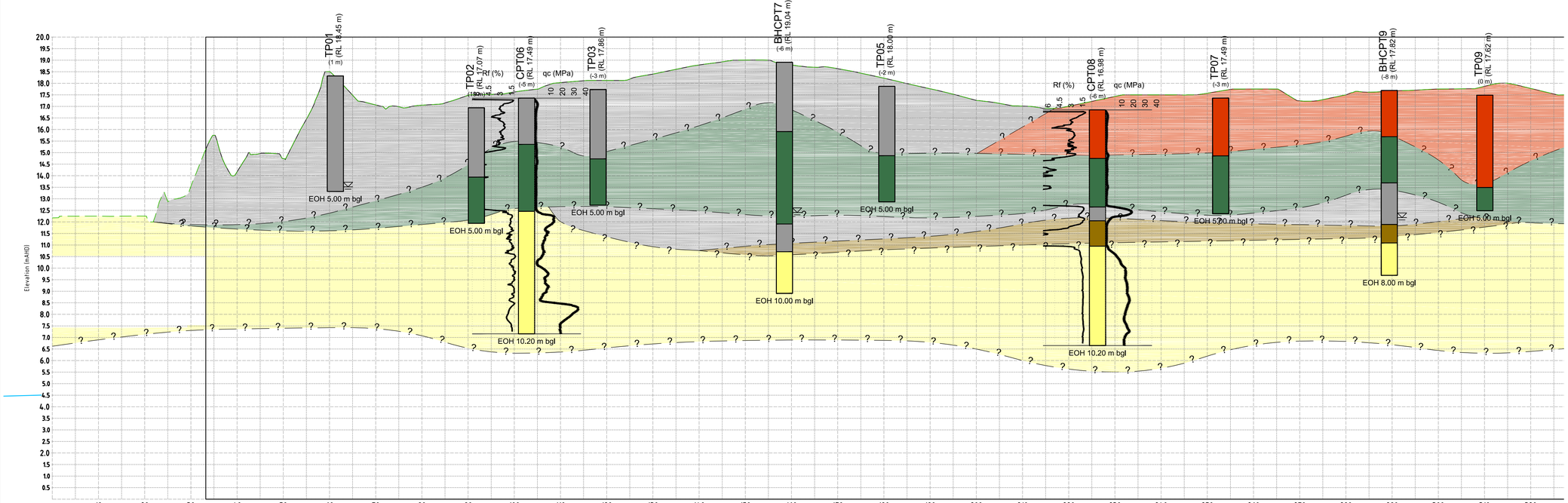
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIEN
PRO:
LOCA
TITLE
OBM

O:\Jobs\2017\J1702012 - Parcel Property SI Balcatta\05 CAD\DWG\J1702012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]





GEOLOGY UNIT

- 1 — FILL: SAND WITH SOME ORGANICS
- 2 — FILL: PEATY SAND
- B — UNCONTROLLED FILL
- C — FILL: PEAT
- D — PEAT (NATURAL)
- E — SAND, TYPICALLY DENSE

sdfdsf

HORIZONTAL SCALE (m): 0 5 10 20 40

VERTICAL SCALE (m): 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

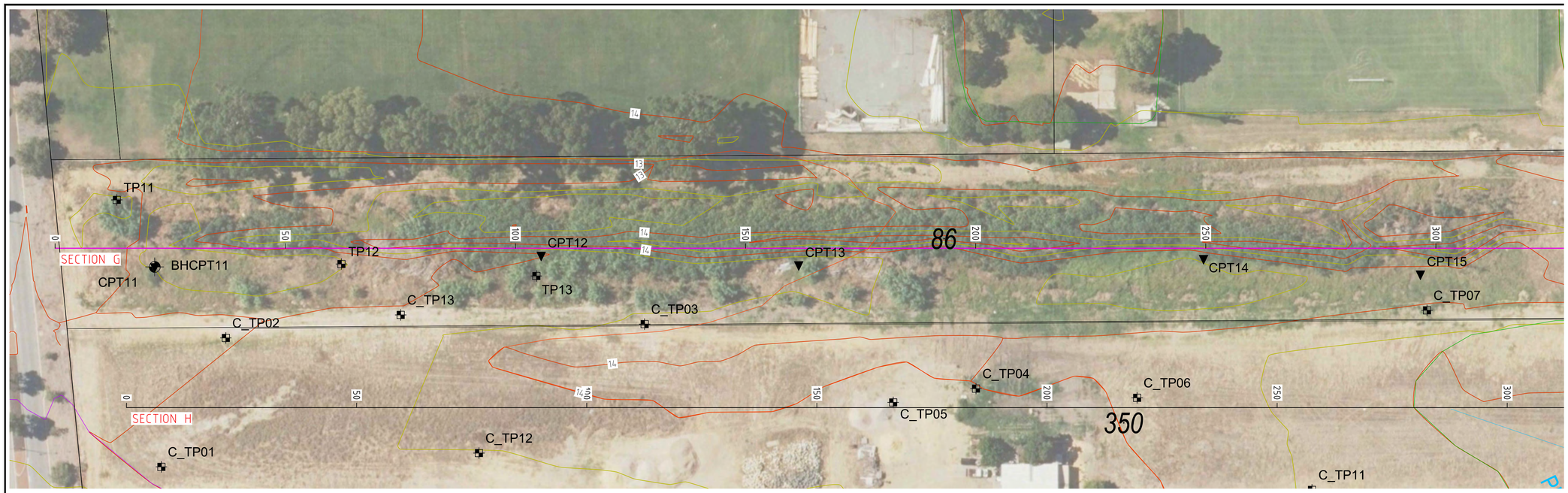
SCALE: 1 : 500(@A1)
DRAWN: DAC
DATE DRAWN: 18/12/2017
CHECKED: PCW
DATE CHECKED: 18/12/2017

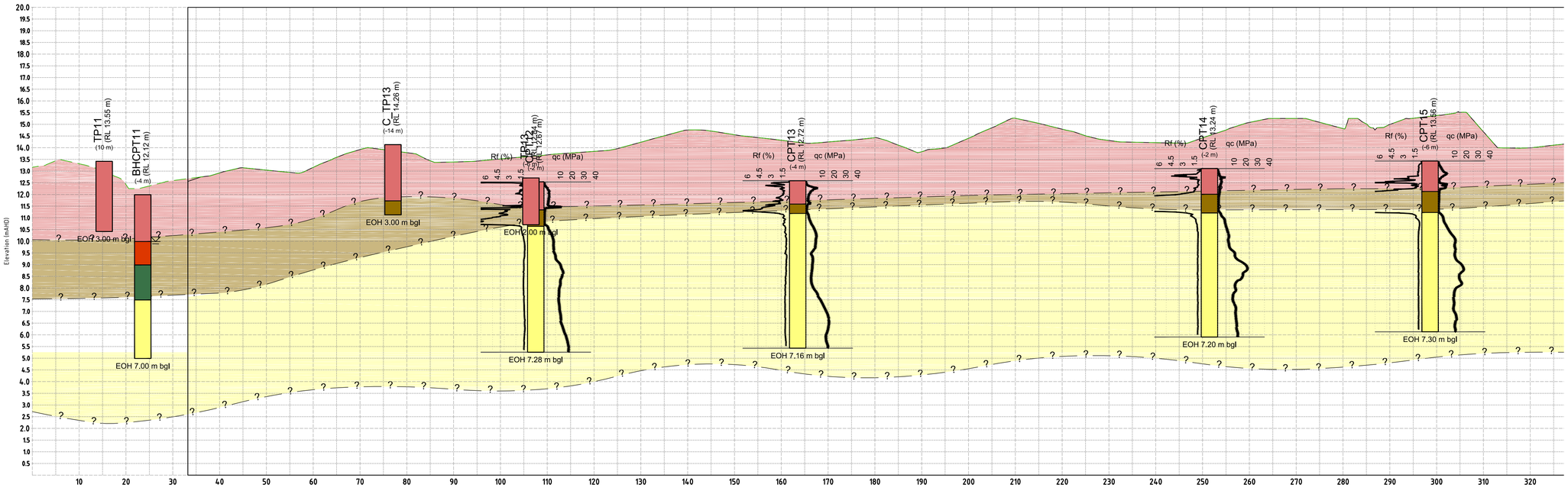
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

JC REF
PROJ
LOCA
TITLE
OBN

O:\Jobs\2017\J1702012 - Parcel Property St Balcatta\05 CAD\DWG\J1702012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]





GEOLOGY UNIT

- 1 — FILL: SAND WITH SOME ORGANICS
- 2 — FILL: PEATY SAND
- B — UNCONTROLLED FILL
- C — FILL: PEAT
- D — PEAT (NATURAL)
- E — SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m) 0 5 10 20 40

VERTICAL SCALE (m) 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

SCALE	1 : 500(@A1)
DRAWN	DAC
DATE DRAWN	18/12/2017
CHECKED	PCW
DATE CHECKED	18/12/2017

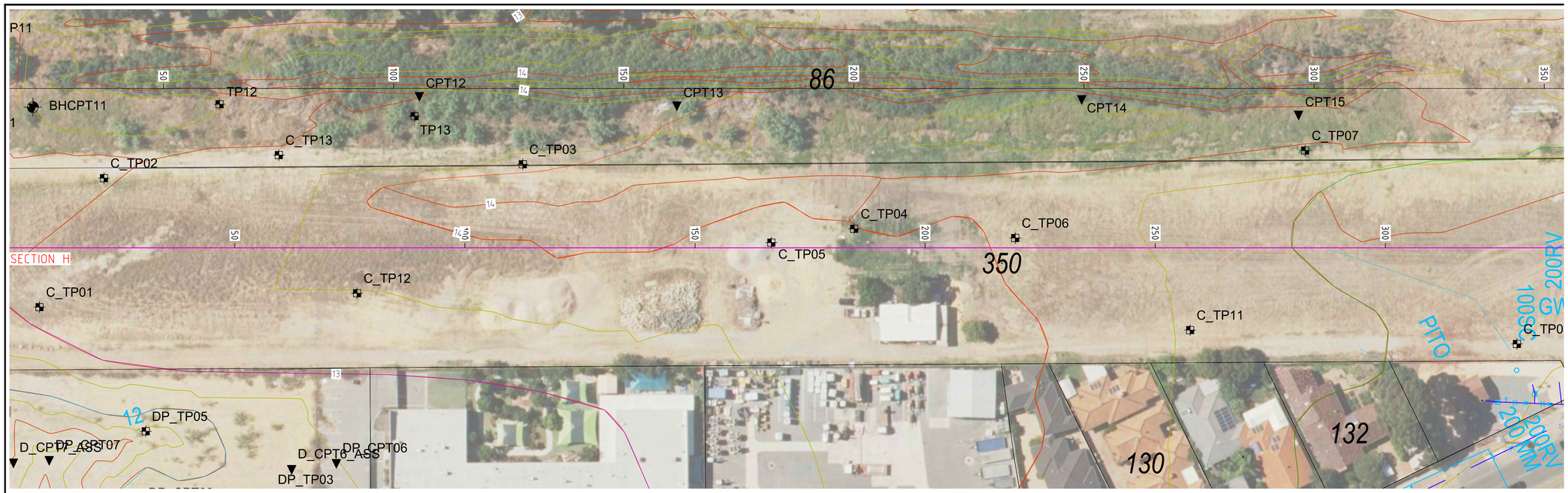
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

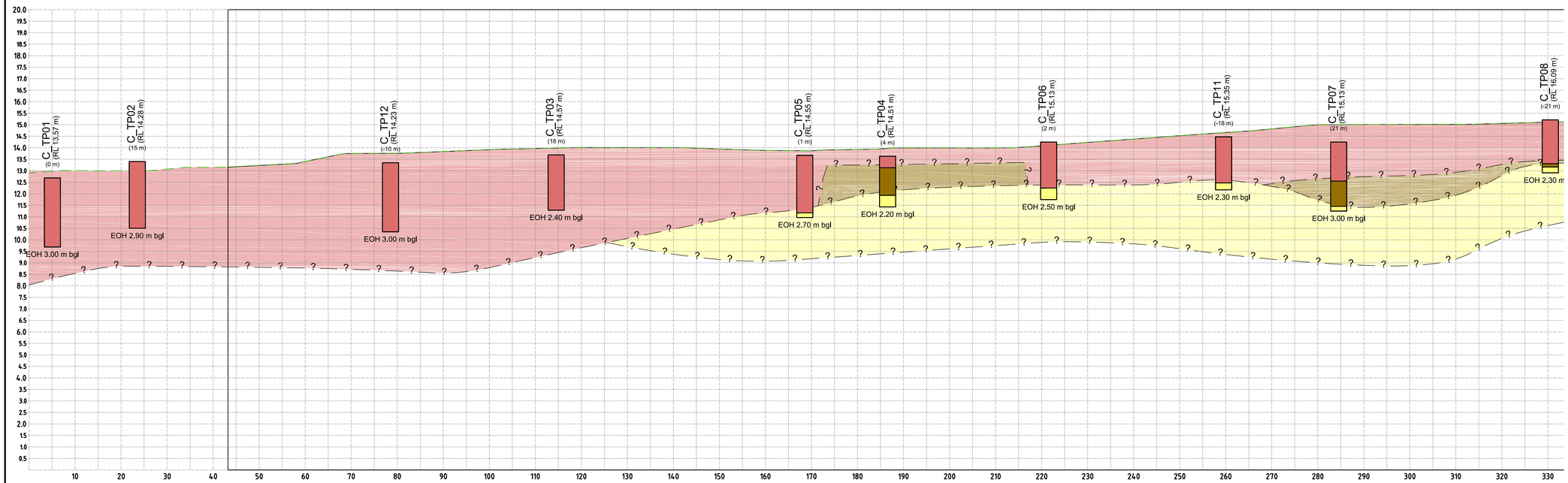
Galt GEOTECHNICS

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIENT:
PROJECT:
LOCATION:
TITLE:
JOB No:

O:\Jobs\2017\J1702012 - Parcel Property St Balcatta\05 CAD\DWG\J1702012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]





GEOLOGY UNIT

1 — FILL: SAND WITH SOME ORGANICS	C — FILL: PEAT
2 — FILL: PEATY SAND	D — PEAT (NATURAL)
B — UNCONTROLLED FILL	E — SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m): 0 5 10 20 40

VERTICAL SCALE (m): 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

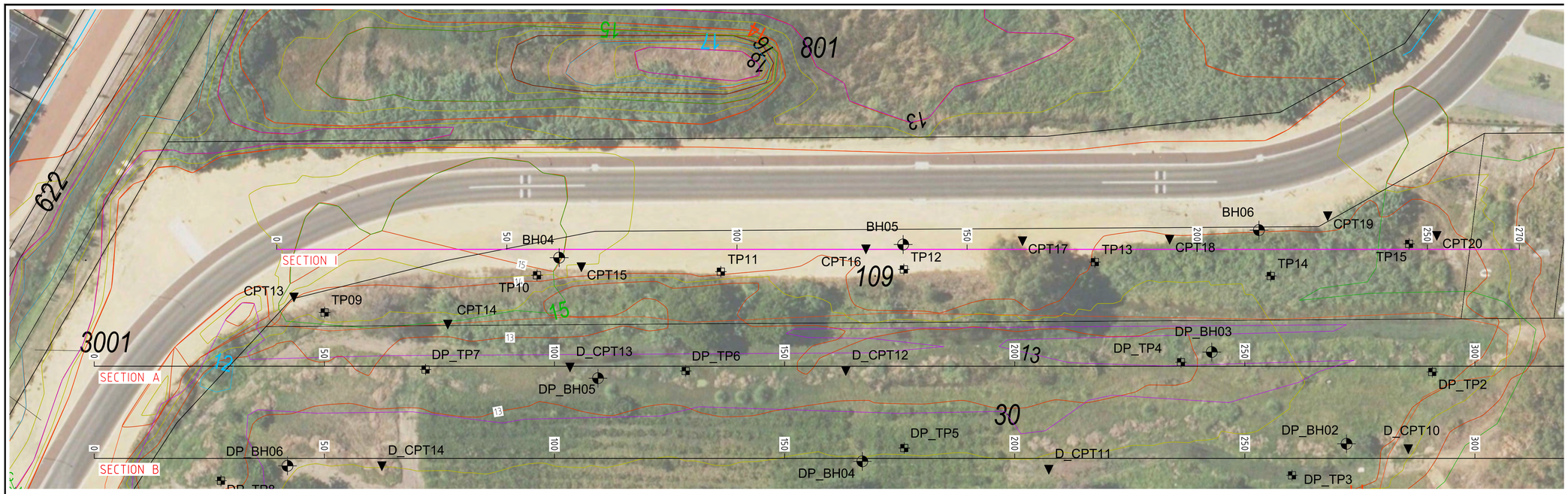
SCALE: 1 : 500(@A1)
DRAWN: DAC
DATE DRAWN: 18/12/2017
CHECKED: PCW
DATE CHECKED: 18/12/2017

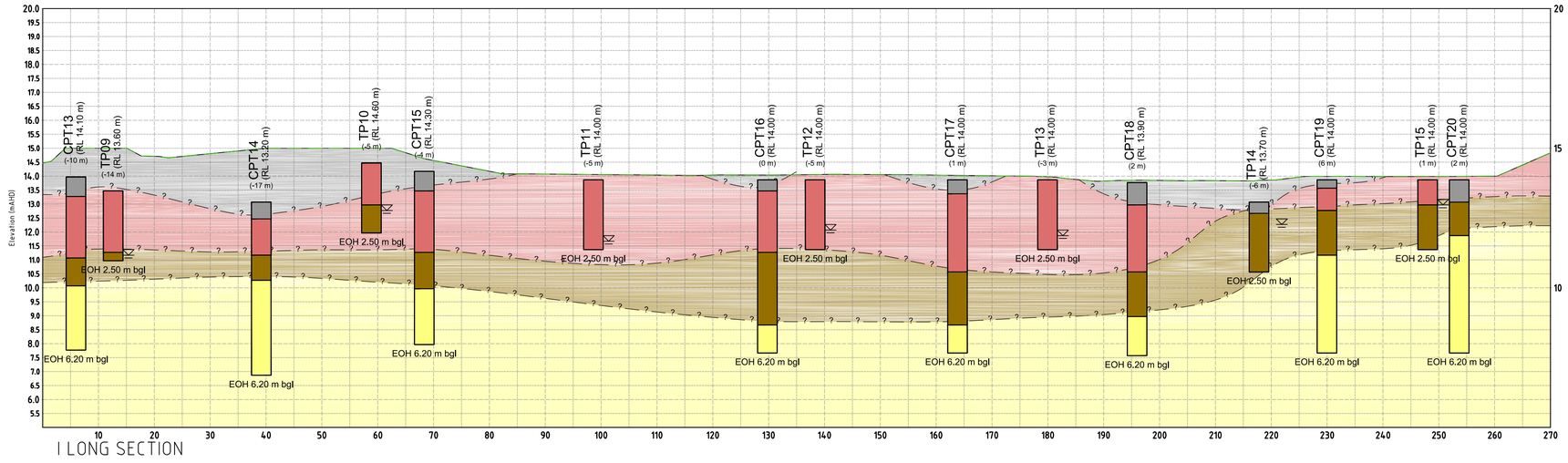
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIENT
PROJ
LOCA
TITLE
JOB N

O:\Jobs\2017\J1702012 - Parcel Property St Balcatta\05 CAD\DWG\J1702012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]





GEOLOGY UNIT

- 1 — FILL: SAND WITH SOME ORGANICS
- 2 — FILL: PEATY SAND
- B — UNCONTROLLED FILL
- C — FILL: PEAT
- D — PEAT (NATURAL)
- E — SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m) 0 5 10 20 40

VERTICAL SCALE (m) 0 1 2 4 8

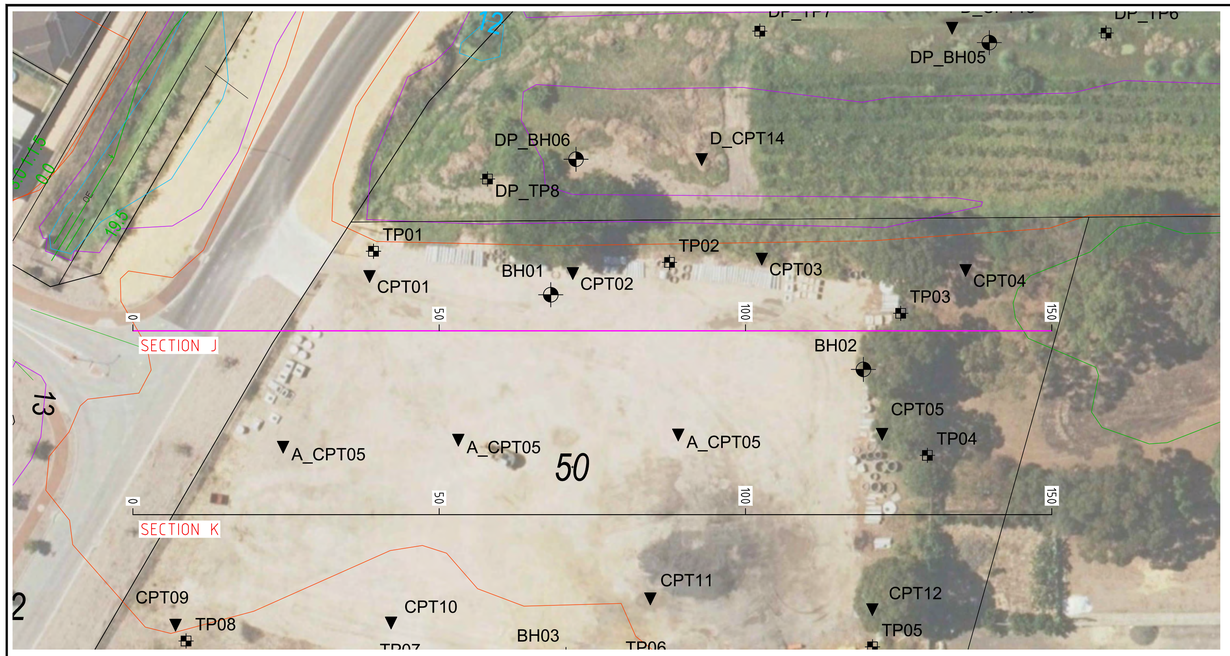
REV	DESCRIPTION	DATE	CHK

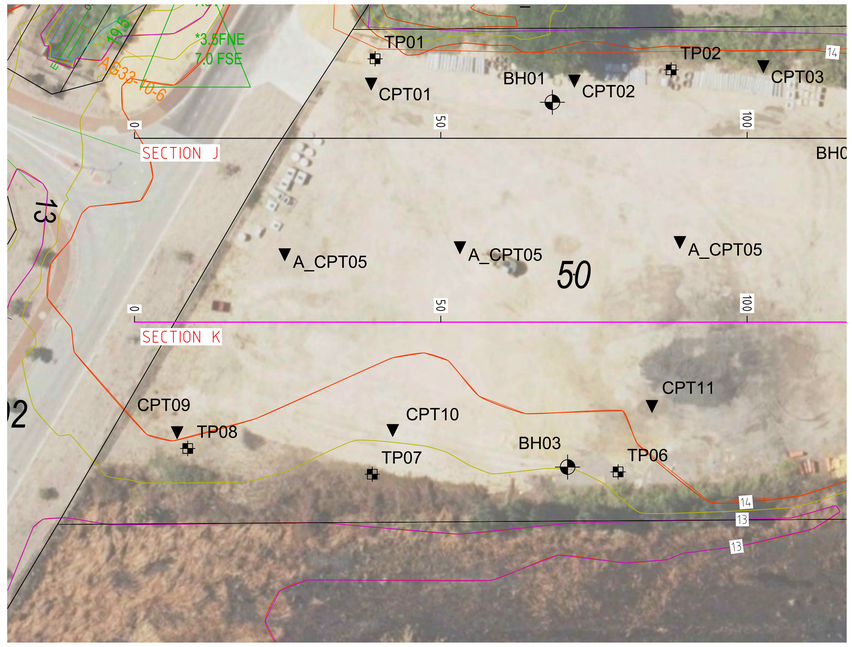
SCALE 1 : 500(@A1)
DRAWN DAC
DATE DRAWN 18/12/2017
CHECKED PCW
DATE CHECKED 18/12/2017

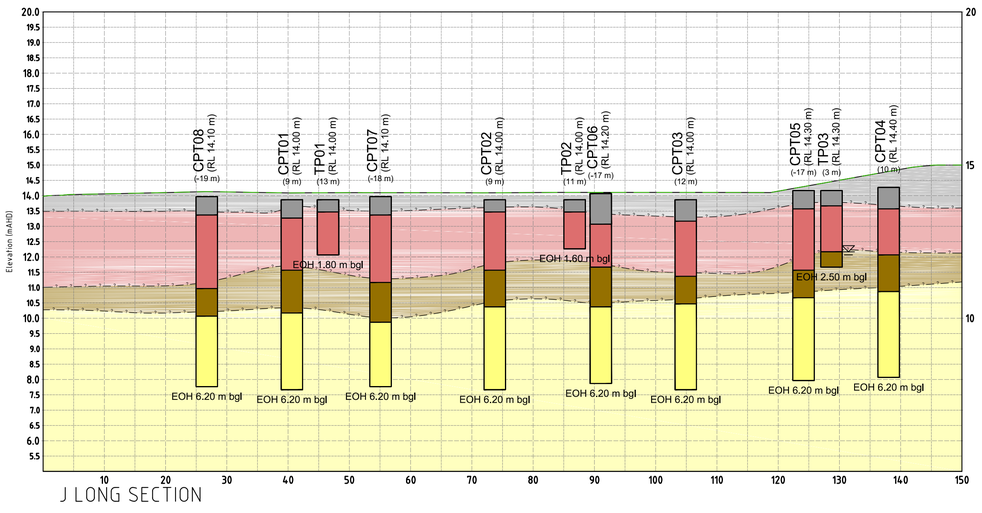
Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

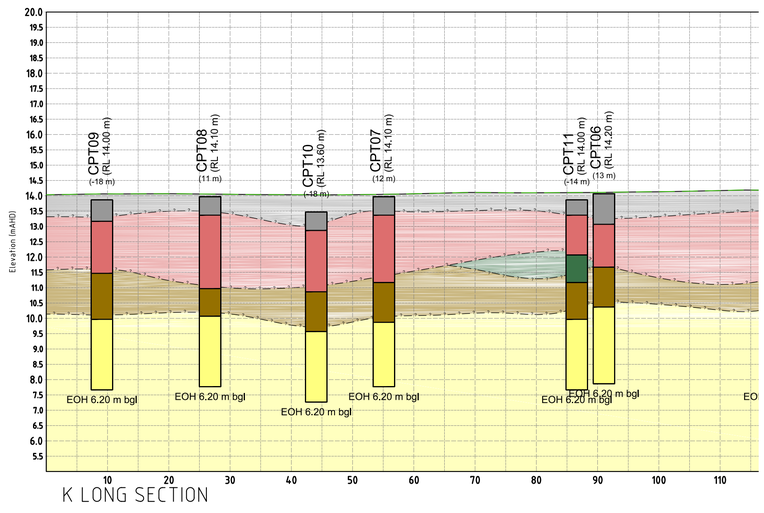
Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

C: IEN
PROJ
LOCA
TITLE
JOB N









GEOLOGY UNIT

1	FILL: SAND WITH SOME ORGANICS
2	FILL: PEATY SAND
B	UNCONTROLLED FILL
C	FILL: PEAT
D	PEAT (NATURAL)
E	SAND, TYPICALLY DENSE

HORIZONTAL SCALE (m) 0 5 10 20 40

VERTICAL SCALE (m) 0 1 2 4 8

REV	DESCRIPTION	DATE	CHK

SCALE 1 : 500(@A1)
DRAWN DAC
DATE DRAWN 18/12/2017
CHECKED PCW
DATE CHECKED 18/12/2017

Copyright © 2017 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Address : Unit 4, 15 Walters Drive, OSBORNE PARK, WA, 6017

CLIEN
PROJ
LOCA
TITLE
JOB N

O:\Jobs\2017\JT702012 - Parcel Property SI Balcatta\05 CAD\DWG\JT702012-001.dwg [DAMON CLARK [18/12/2017 1:28 PM]]

Report on

PROPOSED RESIDENTIAL DEVELOPMENT LOTS 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA

Submitted to:

ABN Group
Ground Floor, 131 Hasler Road
OSBORNE PARK WA 6017

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6 014
T: +61 (8) 6272-0200
F: +61 (8) 9285-8444

J1401266 004 R Rev0

16 February 2015

TABLE OF CONTENTS

1. Introduction 1
2. Site Description and Proposed Development 1
3. Ground Conditions and Inferred Filling History 1
3.1 Lots 88 & 129 2
3.2 Lot 86 2
4. Project Objectives 2
5. Fieldwork 3
6. Laboratory Test Results 5
7. Site Conditions 6
7.1 Geology 6
7.2 Acid Sulfate Soils 6
7.3 Subsurface Conditions 6
7.4 Groundwater 7
8. Geotechncial assessment 8
8.1 Suitability For Development 8
8.2 Lots 88 & 129 8
8.2.1 Excavate and Replace 8
8.2.2 Pile All Structures 10
8.2.3 Ground Improvement 10
8.3 Lot 86 11
8.3.1 Uncontrolled Fill 11
8.3.2 Peat 12
9. Environmental encumbrances 13
10. Conclusion 14

TABLES (WITHIN TEXT)

Table 1: Summary of Tests 3

Table 2: Summary of Laboratory Test Results 5

FIGURES

FIGURE 1: SITE AND LOCATION PLAN

FIGURE 2: GEOLOGICAL SECTION A – LOTS 88 & 129

FIGURE 3: GEOLOGICAL SECTION B – LOT 86

APPENDICES

APPENDIX A: PHOTOGRAPHS

APPENDIX B: CONE PENETRATION TEST RESULTS

APPENDIX C: BOREHOLE AND TEST PIT REPORTS

APPENDIX D: LABORATORY TEST RESULTS

APPENDIX E: UNDERSTANDING YOUR GEOTECHNICAL ENGINEERING REPORT

1. INTRODUCTION

This report presents the outcomes of a due-diligence level geotechnical assessment of the proposed residential development of Lots 86, 88 & 129 Grindleford Drive, Balcatta (collectively, "the site"). The assessment was requested by Jeremy Cordina of ABN Group.

The study undertaken was for assessment of purchaser risk and comprised a relatively detailed due-diligence level study (given the known risk of peat and other poor soils in the area), but is not adequate for full detailed design of the development, as noted in our proposal for the study.

This report supersedes previously issued emails and technical memoranda.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site comprises three undeveloped lots in the immediate vicinity of the Macedonian Community facility (MCF, Lot 141 Grindleford Drive). Lots 88 & 129 lie to the north of the MCF and Lot 86 lies to the south.

LOTS 88 & 129 ("Northern Site")

Lot 88 covers 1.354 ha in plan area and Lot 129 covers 1.470 ha (total: 2.824 ha). Each lot is rectangular in shape and about 40 m wide by 300 m to 330 m long. The lots are undeveloped. Anecdotal evidence suggests that peat was excavated from this area and replaced with a large volume of uncontrolled fill. The surface level appears to have been raised about 3 m to 5 m above the surrounding area over a rectangular block covering most of the northern site. Publicly available contour mapping shows the northern site surface level to be between RL 13 m and RL 14 m AHD, but this is likely to be prior to filling.

During a site walkover, we noted that the fill is relatively regular across the northern site, with a ramped access from Grindleford Drive in the southwest. The surficial fill appears to be sandy.

Extensive vegetation (shrubs, small trees and grass) is present across the northern site.

LOT 86 ("Southern Site")

Lot 86 covers 1.417 ha in plan area and is about 36 m by 400 m in plan. The lot level shown on published contour mapping appears to be relatively flat at about RL 13 m AHD. It appears that Lot 86 has also been subjected to earthworks, including some filling.

A review of historical aerial photography shows that the Lot was used as a market garden until the 1960s and then lay fallow until the present day. Some filling may have taken place in about 2007, however this is not clear from the aerial photography.

PROPOSED DEVELOPMENT

The proposed development is to comprise built houses on single residential lots, similar to the nearby Roselea Estate. Lots will be around 400 m^2 to 500 m^2 in plan area. Buried services and access roads will also be constructed.

3. GROUND CONDITIONS AND INFERRED FILLING HISTORY

The following descriptions take into account a desktop review, a surface walkover (prior to intrusive testing) and the results of the intrusive investigation undertaken during the course of this study.

3.1 Lots 88 & 129

A review of historical aerial photography shows that the lots were previously developed as a market garden (until the 1960s-1970s), evidently laying fallow until the late 1990s. An aerial photograph in 2001 appears to show extensive excavations across the lots, as surface water (probably an expression of the groundwater table) is present in a number of locations. Extensive filling had occurred by about 2007 (possibly started as early as 2003, although the filling was not completed until about 2007), with the lots appearing relatively unchanged from 2007 to the present day. This aerial photograph review supports the anecdotal evidence of the filling history.

We note that the far eastern end of Lot 129 does not appear to have been filled.

Our interpretation of the filling history is as follows:

- The original vegetation and some surface peat from the northern site was removed, probably to about 2 m below the original ground level and probably corresponding with summer groundwater levels (i.e. about 5 m to 6 m below the current surface levels). This may have been an initial attempt to improve the northern site to a standard for development.
- Following this, a filling campaign commenced on the northern site. Probably to improve traffickability of the *in situ* peat, up to about 1.5 m of generally sandy fill (but including some gravel, brick fragments, etc – likely 'hardcore' to improve the traffickability) was placed on parts of the northern site, primarily on Lot 129.
- The filling included substantial amounts of peat (probably from other developments in the area), finishing with less peaty sand in the upper 1 m to 3 m.
- The site has lain unattended for the last 7 years or so.

3.2 Lot 86

It appears that the southern site was partly excavated prior to filling, based on 1997 contour data (this excavation is not obvious from online aerial photography). A substantial amount of construction debris has been placed loose on the site. This is almost certainly derived from clean-ups from construction and demolition projects in the area and includes bricks, concrete pieces and rubble, car parts and parts of car bodies, metal pieces (to about 2 m length at the test locations), wood, asbestos containing material (ACM) (mainly broken fence and Hardiflex fragments). The fill thickness is the greatest to the west (up to about 3 m) and least to the east (as little as about 1 m), overlying apparently *in situ* peaty soils, which in turn overlie natural sand.

The uncontrolled fill at the test locations contained about 30% sand, 60% inert debris and 10% putrescible/deleterious material (such as steel, wood and other organic matter).

4. PROJECT OBJECTIVES

The objectives of the due diligence study were to:

- Broadly assess subsurface soil and groundwater conditions across the site, with a particular emphasis on:
  - The thickness, level and consistency of peaty soils present on the site
  - The thickness, composition and density of any fill present on the site
  - The presence and level of groundwater as may influence the development;
- provide preliminary recommendations on suitable footing systems for the proposed development;
- provide a preliminary site classification(s) in accordance with AS 2870-2011 "Residential Slabs and Footings";
- provide recommendations and geotechnical design parameters for earth retaining structures;
- assess the appropriate site subsoil class for the site in accordance with AS 1170.4-2007;
- recommend appropriate site preparation procedures including compaction criteria;

- assess the permeability of the soils at the site for potential on-site disposal of stormwater by infiltration;
- provide a subgrade California bearing ratio (CBR) value for pavement thickness design by others; and
- recommend further geotechnical studies to progress the project to detailed design, if required.

5. FIELDWORK

Fieldwork for the study was undertaken between 12 and 16 January 2015 and comprised:

- track clearing to create access for the investigation;
- cone penetration testing (CPTs) at 16 locations, extending to depths of 10.2 m (10 tests on Lots 88 & 129) and 7.2 m to 8.7 m (6 tests on Lot 86);
- drilling of geotechnical boreholes at 5 locations using a dual tube percussive sampler, extending to depths of 8 m to 10 m (4 tests on Lots 88 & 129) and 7 m (1 test on Lot 86); and
- excavation of test pits using a 9 tonne backhoe at 10 locations within Lots 88 & 129 and 3 locations within Lot 86 (total 13 test pits), extending to depths of between 1.5 m and 5 m.

A sketch plan showing approximate test locations is included as Figure 1. A summary of the tests is presented in Table 1. Interpreted geological cross sections are shown on Figure 2 (Section A – Lots 88 & 129) and Figure 3 (Section B – Lot 86).

Table 1: Summary of Tests

Test Name	Lot Number	Test Depth (m)	Thickness (m) of Natural Peat and Fill Over Sand			Depth to Natural Sand (m)	Depth to Groundwater (m)	Notes
			Construction Debris	Peaty Sand	Peat			
CPT01	88	10.2	0.0	2.1	5.0	7.1	DT[1] 6.5	
CPT02	88	10.2	0.0	3.5	4.5	8.0	DT 5.5	
CPT03	88	10.2	0.0	1.8	5.0	6.8	DT 6.0	
CPT04	88	10.2	0.0	1.3	5.0	6.3	DT 5.0	
CPT05	88	10.2	0.0	1.5	4.3	5.8	DT 6.0	
CPT06	129	10.2	0.0	2.2	2.7	4.9	DT 6.0	Possible sand fill 4.9-8.6 m
CPT07	129	10.2	0.0	2.0	6.5	8.5	DT 5.5	Sand layer 6.8-7.8 m (probably fill)
CPT08	129	10.2	0.0	2.0	4.0	6.0	DT 5.0	Sand layer 4.2-5.0 m (probably fill)
CPT09	129	10.2	0.0	1.8	4.7	6.5	DT 4.5	Sand layer 4.3-5.8 m (probably fill)
CPT10	129	10.2	0.0	1.6	4.4	6.0	DT 6.0	
CPT11	86	8.7	2.0	0.0	2.6	4.6	DT 1.2	
CPT12	86	7.2	1.2	0.0	0.6	1.8	DT 0.5	
CPT13	86	7.2	1.0	0.0	0.4	1.4	DT 0.3	

Test Name	Lot Number	Test Depth (m)	Thickness (m) of Natural Peat and Fill Over Sand			Depth to Natural Sand (m)	Depth to Groundwater (m)	Notes
			Construction Debris	Peaty Sand	Peat			
CPT14	86	7.2	1.0	0.0	0.9	1.9	DT 0.5	
CPT15	86	7.2	1.2	0.0	1.0	2.2	DT 0.3	
CPT16	86	7.2	1.0	0.0	0.7	1.7	DT 0.2	
TP01	129	5.0	0.0	2.0	>3.0	>5.0	4.8	
TP02	88	5.0	0.0	3.0	>2.0	>5.0	NE[2]	
TP03	129	5.0	0.0	3.0	>2.0	>5.0	NE	
TP04	88	5.0	0.0	3.5	>1.5	>5.0	NE	
TP05	129	5.0	0.0	3.0	>2.0	>5.0	NE	
TP06	88	5.0	0.0	2.5	>2.5	>5.0	NE	
TP07	129	5.0	0.0	2.5	>2.5	>5.0	NE	
TP08	88	5.0	0.0	3.5	>1.5	>5.0	NE	
TP09	129	5.0	0.0	4.0	>1.0	>5.0	NE	
TP10	88	5.0	0.0	>5.0	NE	>5.0	NE	
TP11	86	3.0	>3.0	NE	NE	>3.0	NE	Terminated due to presence of ACM
TP12	86	1.5	>1.5	NE	NE	>1.5	NE	
TP13	86	2.0	>2.0	NE	NE	>2.0	NE	
TP14	86	Not Done						Proposed boreholes not done due to presence of ACM and very dusty conditions
TP15	86	Not Done						
TP16	86	Not Done						
BHCPT2	88	10.0	0.0	3.6	5.0	8.6	6.0 A[3]	
BHCPT5	88	8.0	0.0	2.0	3.8	5.8	6.0	Hole collapse at 8 m
BHCPT7	129	10.0	0.0	3.0	6.0	9.0	6.5 A	
BHCPT9	129	8.0	0.0	2.0	4.6	6.6	5.5 A	Sand layer 4.0-5.8 m, probable fill
BHCPT11	86	7.0	2.0	1.0	1.6	4.6	2.0 A	

Notes:

1. 'DT' 6.5 indicates that after completion of the CPT, the probe was extracted and water level dipped, however collapse of the probe hole had occurred and the hole was 'dry to' this depth (i.e. groundwater can be expected at some level below this).
2. NE: Not encountered within the excavated depth
3. A: Approximate depth to groundwater based on soil moisture and drilling conditions
4. Ground conditions inferred from CPTs are based on correlations contained in Robertson et al (1986)[1].

[1] Robertson, P.K., Campanella, R.G., Gillespie, D. and Grieg, J. (1986) "Use of Piezometer Cone Data". Proceedings of the ASCE Speciality Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, pp 1263-80, American Society of Civil Engineers (ASCE)

Cone Penetration Tests

Cone penetration tests were carried out by Probedrill Pty Ltd using a 19 tonne track mounted CPT rig. The tests were carried out in accordance with AS1289.6.5.1. The results of the CPTs are presented in Appendix B along with a method of interpretation proposed by Robertson et al (1986).

Test Pits

Test pits were excavated using a 9 tonne backhoe fitted with a 600mm toothed bucket. Test pit reports are presented in Appendix C along with a method of soil description and a list of explanatory notes and abbreviations used in the reports.

Boreholes

Boreholes were drilled using a percussive sampler pushed by the CPT pushing frame. 50 mm diameter samples were recovered in acrylic liners through the full depth of each borehole (except where sample was lost or no sample was recovered through uncontrolled fill on Lot 86).

Borehole reports are presented in Appendix C. The same method of soil description and list of explanatory notes apply as for the test pit reports.

6. LABORATORY TEST RESULTS

Geotechnical laboratory testing was undertaken by Mining and Civil Geotest in their NATA accredited laboratory. The testing comprised determination of:

- particle size distribution on 2 samples;
- organic content on 6 samples; and
- moisture content on 6 samples.

The laboratory test results along with the test methods followed are presented in Appendix D and the test results are summarised in Table 2.

Table 2: Summary of Laboratory Test Results

Test Location	Sample Depth (m)	Gravel (%)	Sand (%)	Fines (%)	OC (%)	MC (%)	Soil Description
TP02-1	3.5	-	-	-	5.4	61.5	PEAT with some fine to coarse grained sand
TP05-1	0.5	2	82	16	-	-	SAND with pockets of Peaty SAND (10-15% organic fines, up to 30% total fines)
TP08-1	0.5	1	68	31	-	-	Peaty SAND, up to 30% organic fines
TP08-2	4.5	-	-	-	14.1	95.6	PEAT with some fine to coarse grained sand
BHCPT2-1	5.0-5.5	-	-	-	11.2	61.1	Sandy PEAT (fill)
BHCPT2-2	7.5-8.0	-	-	-	28.0	252.3	PEAT
BHCPT5-1	5.0-5.5	-	-	-	27.8	140.2	PEAT
BHCPT11-1	3.5-4.0	-	-	-	47.4	590.9	PEAT

NOTES: **OC:** Organic Content **MC:** Moisture Content

7. SITE CONDITIONS

7.1 Geology

The Perth sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by peat, described as *black, clayey in part, saturated fibrous organic soil*. Extensive peat deposits are known in the area.

Extensive filling is also present across Lots 88 & 129 and filling has taken place on Lot 86.

The expected geology is in accordance with the site conditions, however the filling history of the site is also relevant (refer to Section 3).

7.2 Acid Sulfate Soils

The site is in an area mapped by the CSIRO (http://asris.csiro.au) as having high risk of encountering acid sulfate soils. Peats and organic soils are known high-risk ASS units. We consider that any development done on the site must consider the presence of ASS and deal with it accordingly. An ASS assessment is beyond the scope of this study, however a brief further commentary is presented in Section 9.

7.3 Subsurface Conditions

The typical subsurface profiles differ between the northern site and the southern site, mainly based on the filling history. However, the profiles underlying the individual sites are relatively consistent.

Northern Site: Lots 88 & 129

The site surface at Lots 88 & 129 has been raised by around an estimated 4 m to 5 m above the natural surface level (with the exception of the far eastern end of Lot 129, which appears to be at around natural surface level). An interpreted geological section through Lot 129 is presented as Section A in Figure 2. We note that the site surface levels are based on a limited number of discrete points picked up using a dGPS with an accuracy of about +/- 0.2 m in the X, Y and Z directions. A site survey by a licenced surveyor would provide more accurate and detailed surface contours.

The lots are underlain by:

- **Unit A1: FILL: SAND** with some organics, typically dark brown, with some fines and organic fines (typical estimated organic content about 5% and total fines content about 10% to 15%), about 4 m thick in the west of the northern site, becoming thinner to the east to about 1 m thickness in the middle of the site and not present in the east of the site, very loose, typically dry becoming moist at depth, overlying
- **Unit A2: FILL: Peaty SAND**, fine to coarse grained, brown to dark brown, very loose, typically dry becoming moist, with varying proportions of fines and organics but typically 10% to 15% organics and 20% to 30% organic fines, present below Unit A1 (or from surface in the east of the northern site), typically to about 2.5 m to 5 m depth (deeper in the east and west, shallower in the middle of the site), overlying
- **Unit B: FILL: Mixed rubble, rubbish and SAND** – not present on northern site (Lots 88 & 129).
- **Unit C: FILL: PEAT**, typically black, stiff, with varying proportions of sand (typically 70% to 80% of dry weight, however noting that most of the volume of the soil comprises organic matter with a very high moisture content), present to between 3 m and 7 m depth (typically more than 5 m depth), including sand or limestone layers in the lower part of this layer (inferred working platforms placed during placement of the peat fill, mainly on Lot 129), overlying

- **Unit D: PEAT**, typically black, stiff or firm to stiff, with varying proportions of sand (typically 70% to 80% of dry weight), present in a layer typically 1 m to 2 m thick below Unit C (not present in parts), present to between 6 m and 8 m depth, overlying
- **Unit E: SAND**, fine to coarse grained, brown becoming grey, typically dense, wet, present to the maximum investigated depth of about 10 m).

Southern Site: Lot 86

The site surface at Lot 86 appears to have been lowered relative to the original ground level. An interpreted geological section is presented as Section B in Figure 3. We note that the site surface levels are based on a limited number of discrete points picked up using a dGPS as for the northern site.

The lots are underlain by:

- **Unit A1: FILL: SAND** – not present on southern site (Lot 86).
- **Unit A2: FILL: Peaty SAND** – not present on southern site.
- **Unit B: FILL: Mixed rubble, rubbish and SAND** – a mixture of concrete rubble, brick rubble, steel and general rubbish (evidently from construction/demolition site clean-ups), typically comprising 50% to 60% of the mixed fill, in a matrix of sand, fine to coarse grained, very loose, with some non-plastic fines, trace roots, rootlets and wood pieces, very loose, present from the surface to depths varying between about 1.2 m (east) and more than 3 m (west) (generally 1 m to 1.5 m except parts of the west of the site), overlying
- **Unit C: FILL: PEAT** – not present on southern site
- **Unit D: PEAT**, typically black, very soft to soft, generally 0.3 m to 1 m thick across most of the centre and east of the site, but up to about 2.5 m thick in the west, present to between 1.8 m and 2.0 m depth across most of the site (to about 4.5 m depth in the west), overlying
- **Unit E: SAND**, fine to coarse grained, typically dense, wet, present to the maximum investigated depth of about 8.8 m.

7.4 Groundwater

Accurate groundwater level measurements could not be measured with the techniques used on site. However some estimates have been made and are discussed below.

The Perth Groundwater Atlas (1997) shows the maximum groundwater level to be around RL 12 m to RL 13 m AHD. This is within about 1 m of the natural surface.

Northern Site: Lots 88 & 129

The approximate groundwater level on the northern site was between 5.5 m and 6.5 m below ground surface, or about RL 11.5 m to RL 12.5 m AHD. The peat and peat fill are relatively impermeable and significant inflow did not occur in test pits and boreholes, therefore the groundwater levels are estimated based on drilling characteristics and where moisture content changes were noted in recovered soils.

Southern Site: Lot 86

The approximate groundwater level on the southern site was about 2 m below ground surface in the west, or about RL 10 m AHD (no measurements could be made in the east).

Note: The above groundwater levels were generally below historical maxima on both sites, particularly on Lot 86.

8. GEOTECHNCIAL ASSESSMENT

8.1 Suitability For Development

We consider that neither site is suitable for the proposed residential development in its current condition. This is due to:

- The presence of peat, which although locally firm to stiff, is highly organic and will be susceptible to substantial ongoing settlements over the next 50-100 years, particularly when loaded further by structural fill, houses, etc. This settlement could easily total hundreds of millimetres or more.
- The presence of uncontrolled fill, mainly on the southern site, which is both very loose and also contains putrescible/deleterious material and will be subject to substantial and irregular settlements on loading.

We consider that it will be possible (albeit expensive) to improve both sites to a sufficient standard for the proposed residential development. Concepts for doing this are discussed below.

8.2 Lots 88 & 129

The principal geotechnical encumbrance on the northern site is the presence of up to about 9 m of peaty soil, which will be subject to substantial settlements over time, damaging infrastructure, houses, etc.

The options for dealing with this are discussed below.

8.2.1 Excavate and Replace

Under this option, all of the peat (and other peaty soils) would be removed down to the underlying dense sand. This is likely to require substantial dewatering as the excavation would be expected to extend to around 2 m below current (late summer) groundwater levels.

The dewatering is required to dry out the excavation and facilitate re-filling of the site up to the required levels (we assume that around 3 m or more of filling will be required above the cut levels to remove the peaty soils.

If sand fill is used, we consider that dewatering will be unavoidable. However, an option of a 'wet dig' may be considered (given that the underlying sand is generally dense), based on the following:

- Excavation to be done at the driest time of the year (February to May).
- Trafficking of the subgrade to cease no lower than 1 m above target level (probably 2 m to 2.5 m is preferable based on water levels).
- Last peat to be excavated down to sand level by an excavator using a flat-edged bucket, loading out to trucks at a higher level.
- No further disturbance of sand permitted (i.e. it will stay dense if trimmed with a flat edged bucket and not otherwise disturbed – if trafficked, it will loosen and liquefy).
- If possible - place a geotextile separator layer (Bidim A24 or similar) and a layer of geogrid (Tensar SS20 or similar biaxial geogrid) across the sand layer (hand placement only). This may be difficult or impossible to achieve, and may be omitted if not achievable. The purpose of the geotextile is to separate underlying sand from the overlying Coarse Fill and to prevent mingling of the two materials. The geogrid is intended to stiffen the bottom of the Coarse Fill layer. The incorporation of these elements is not essential.
- Backfill excavation with Coarse Fill (see below) to at least 1 m thick, or to above groundwater level, whichever requires more fill. Fill to be placed in layers not more than 0.5 m thick and track rolled with a bulldozer or

other tracked machine (e.g. a Caterpillar D6 or similar). Minimum 4 passes across the entirety of each layer, with overlapping track passes (at least 30% of track width).

- Place a geotextile separator (Bidim A24 or similar) and a further layer of geogrid (Tensar SS20 or similar) onto the top of the coarse fill.
- Commence sand filling with imported sand fill (or blended sand fill, refer below). Sand to be placed and compacted in loose layers not more than 500 mm thick, and compacted to a minimum dry density ratio (DDR) of 95% MMDD (modified maximum dry density) for the full layer thickness.

Coarse Fill

Coarse Fill shall be a no-fines product of hard, durable particles. There should not be more than 10% by weight passing the 2.36 mm sieve (i.e. less than 10% sand and fines). The maximum particle size should be 300 mm. Possible sources include:

- Construction/demolition debris (bricks, concrete, limestone rubble, etc, but excluding any steel or putrescible waste) – possibly crushed or otherwise sorted.
- 10 mm to 300 mm rock fill sourced from a hard rock quarry.
- 50 mm to 300 mm limestone spalls.

The coarse grading is intended to allow wet placement of the layer which will require relatively little compactive effort to produce a relatively stiff, strong layer. The inclusion of a significant proportion of sand and fines will not allow this to occur. A geotextile separator is necessary on the top (and, ideally, the bottom) of this fill to prevent sand mixing from above and below.

Blended Sand Fill

The use of blended sand fill may be considered to maximize the use of existing on-site materials. The 'Unit A1' sand with some organics has a sufficiently low organic content (about 5%) and fines content (about 10% to 15%) to be considered for inclusion in a blended sand fill for structural purposes. This sand could be blended at a ratio of 2 parts clean sand fill (<5% fines, <1% organics) to 1 part sand with some organics to produce a blend with about 5% fines and less than 2% organics.

There may be bulk organics (grass, rootlets, etc) in parts of the Unit A1 fill and therefore screening of this material (with a screening plant, over a 50 mm or finer aperture screen) may be necessary prior to blending. Blending through the screen (i.e. 1 scoop sand with some organics followed by 2 scoops of clean sand) should be an effective means of blending. Other mechanical means are possible and we should be consulted if this is considered.

Prior to the use of blended sand fill being adopted, we must be consulted to discuss permeability requirements and testing needed of the blended fill.

We do not consider that the 'Unit A2' peaty sands are suitable for blending as a very high ratio of clean sand would be needed, given the elevated peat and fines content in this sand (probably 5 or 6 parts clean sand to 1 part peaty sand).

Site Classification

If the 'excavate and replace' option is adopted and properly implemented, we consider that a 'Class A' site classification could be achieved in accordance with AS2870-2011. Careful geotechnical engineering oversight is needed, particularly in the late stages of excavation and early stages of filling.

We consider this to be a geotechnically good, robust option following straightforward site improvement techniques. The principal hindrances would be dealing with the ASS and dewatering during earthworks, as well as disposal of the peat (either treated or untreated).

8.2.2 Pile All Structures

In this option, all settlement-sensitive infrastructure would be placed on piles (extending into dense sand) and roads, landscaping, etc would be built over the peaty soil (probably with a layer of high-quality fill over the weak soils, say 1 m to 1.5 m of sand fill with a separator geotextile and geogrid below).

This option would still require removal of at least 2 m of the peaty sand to lower site surface levels. This has potential for being a relatively low-cost option, however legacy issues are highly likely, with driveways, gardens, services, etc, potentially settling relative to houses as the peat consolidates and rots.

A 'Class P' site classification would apply to this option.

We can provide further advice on this option if required but, from early discussions on this option, we understand it is not preferred.

We do not recommend this option due to the legacy issues of settlement of roads, driveways, gardens, etc relative to the houses.

8.2.3 Ground Improvement

We consider there are two options for ground improvement, primarily of the peat layer:

- Partial addition/replacement of material (e.g. stone columns, controlled modulus columns or similar); or
- Mass stabilization.

8.2.3.1 Addition/Replacement of Material

This is an established method which would supplement the weak, compressible peaty soils with rigid or stiff inclusions. Typically, this would comprise stone columns (installed using a vibrofloat, displacing the peat horizontally) or controlled modulus columns/soil mix columns (amendment of the in-situ material with addition of cement or similar to stiffen it).

The advantage of this method is that the existing soil can be treated (and not removed from site) and the settlement performance of the site can be significantly improved.

A capping layer of around 0.5 m to 1.0 m of sandy soil would be used (probably with a geogrid and a geotextile separator) over the treated soil. This is intended to be an easily excavatable layer (for construction of houses and installation of services) that will also support the growth of gardens.

However, the method does not stop all settlement of the site surface. We therefore expect that a site classification of the equivalent of a "Class M" (possibly "Class S") would apply after ground improvement is completed.

We do not recommend this option as it is likely to be relatively expensive but less effective than other methods. We note also that there is likely to be a significant excess of peaty soil on the northern site that will still require disposal.

8.2.3.2 Mass Stabilisation

If this option were adopted, a mechanical mixer (mounted on a large, tracked excavator) would be used to stir the soils at depths of up to 7 m and add a dry or wet admixture (probably cement, possibly with gypsum or similar added also). The admixture is intended to dry the peaty soil and chemically stabilize it, effectively forming a soilcrete mass that is significantly stiffer and stronger than the original parent material.

Given the very poor nature of the peaty soils on the site, we expect that a high blend ratio would be required (probably 100 kg or more cement per cubic metre of treated soil). This ratio would need to be established with site-specific laboratory testing (this program would take several months to complete).

This option has the advantage of not requiring disposal of the on-site soils off-site and therefore also not needing new soil to be brought in to replace the peat. It is likely that the stiffness of the peat can be improved to a point where effectively no further consolidation would occur. This would result in a 'Class A' site classification.

As for the previous option, a capping layer of sand (plus a geogrid and a geotextile separator) would be needed, probably 0.5 m to 1.0 m thick. This would be to bridge any irregularities in the mass stabilized soil, particularly the upper surface.

We consider this to be a geotechnically acceptable option with the advantage that the peat is left in place.

8.3 Lot 86

Lot 86 is encumbered both by 1 m to 3 m of uncontrolled fill and by the presence of peaty soils (thickest in the west, thinnest in the east). These issues are considered below.

8.3.1 Uncontrolled Fill

8.3.1.1 Processing Uncontrolled Fill to Produce Structural Fill

We consider that the uncontrolled fill could be processed to form a suitable structural fill for deep burial (critically noting that it is contaminated with asbestos containing material, ACM, and this process may not be approvable by government authorities). Failing that, it would need to be removed off site to achieve a robust engineered outcome.

The treatment would involve:

- removal of all steel and other metal (small pieces, say less than 100 mm long, could remain) – possibly done with an electromagnet, or by hand picking;
- removal of large organics (sticks, roots, timber, etc), probably by hand picking; and
- removal or crushing of oversize particles (>250 mm) – this could be done using a 'grizzly' to screen out oversize or a jaw crusher or similar to break it down.

Following such treatment, the processed uncontrolled fill (PUF) could be placed, moisture conditioned and compacted similar to a mixed rock/sand fill (such as limestone rubble), probably with a method specification that could be determined using field trials. Depending on the sand content, it may also be possible to compact the PUF below the water table by track rolling or similar (we expect that <10% sand would be needed to do this). Alternatively, crushed oversize PUF could be used in lower lifts and then general PUF including a larger proportion of sand could be used above groundwater.

We expect that this process would be subjected to close scrutiny by regulators.

If this were done in conjunction with full removal (or mass stabilization) of the peat, a 'Class A' site classification could be achieved. The PUF would be overlain by compacted sand fill, probably 0.5 m to 1.0 m thick.

8.3.1.2 Treating Uncontrolled Fill In-situ

Another option for treating uncontrolled fill, possibly well aligned with mass stabilization of underlying peat (refer to Section 8.3.2), would be to treat it in-situ with a similar mass stabilization technique as discussed in 8.2.3.2. A wet

admixture (cement slurry) could be used, mechanically blended with the uncontrolled fill to produce a stabilized uncontrolled fill (SUF) soilcrete. The largely inert uncontrolled fill should be relatively easily stabilized. The inclusion of some steel pieces and organics in the SUF should not be detrimental to its overall performance as decay occurs.

The SUF would be overlain by compacted sand fill, probably 0.5 m to 1.0 m thick. A 'Class A' site classification could be achieved with stabilization of the peat and the uncontrolled fill.

The biggest single hindrance to the proposed treatment is the nature of the uncontrolled fill. The inclusion of large, very hard particles, including steel waste, may be difficult or impossible for the mechanical mixers to process.

We consider this to be a relatively good option to deal with the conditions on the southern site, particularly if overall treatment of peat and the overlying uncontrolled fill could be done in one operation with cement admixtures (possibly with cross-mixing of the peaty soil and the uncontrolled fill, plus addition of admixtures.

8.3.1.3 Minimal Treatment of Uncontrolled Fill

Clearly, it would be preferable (from an environmental and cost perspective) to leave the uncontrolled fill in place and not disturb it or remove it from site. It is very loose and heterogeneous and contains deleterious inclusions. Unless it is processed (such as suggested in Section 8.3.1.1 above), it will never have the strength and settlement performance of an engineered fill. However, the client may wish to consider a 'minimal treatment' option. This would probably comprise:

- Stripping of topsoil, vegetation, etc.
- Extensive wetting of the uncontrolled fill to wet it to depth.
- Impact rolling or other high-energy compaction techniques to compact the uncontrolled fill as much as possible to its full depth, to produce compacted uncontrolled fill (CUF).
- Placement of a geotextile separator and a geogrid across the compacted surface.
- Filling with about 0.3 m to 0.5 m of compacted limestone fill (<75 mm 'all in' crushed limestone would be satisfactory).
- Filling with sand fill to the required level.
- Possibly, preloading or surcharging to improve the peat layer (refer to Section 8.3.2).

The geogrid and limestone fill are intended to help reduce the effect of differential settlements in the CUF (this would not entirely remove such differential settlements).

The CUF would not perform as well as the PUF or SUF discussed in the preceding sections. However, the cost of this approach is likely to be significantly lower and the regulatory approvals would probably be easier to obtain.

This will not address the issue of consolidation of the peat, however the peat is thinner in parts of the site and could potentially be left in place with some sort of settlement-tolerant solution (such as piling houses to the dense sand and founding roads, gardens, driveways etc on the soil). This may be also adopted as a hybrid solution, with this method used where peat is relatively thin and a mass stabilization or excavate and replace method adopted where it is thicker.

We expect that the site classification resulting from this method will be 'Class P'.

8.3.2 Peat

The peat is significantly softer (soft to firm) on the southern site and is likely to be all *in situ* (i.e. not fill). The peat will be subject to significant consolidation on loading. Notably, however, the peat is generally much thinner on the southern site than the northern site (on the southern site it is predominantly 0.3 m to 1.0 m thick across the eastern two-thirds, but up to about 2.5 m thick in the western third).

We consider that where the peat is thick, the same issues and treatment methods apply as discussed for the northern site. We prefer excavation and replacement or mass stabilization as improvement techniques. If the uncontrolled fill is removed, the peat could also be removed (there is far less on the southern site than the northern site) and the site improved to 'Class A' with the importation, placement and compaction of sand fill. This would require substantial dewatering. However, we note that the thickest peat also coincides with the thickest (and thus hardest to deal with) uncontrolled fill.

There are a number of potential ways to deal with this issue (thick peat and thick uncontrolled fill) that are variations on the methods already discussed in this report. We recommend that this be workshopped with the client and civil engineers for the project to develop a suitable method.

Where the peat is relatively thin (probably less than 0.5 m thick, but possibly up to 1.0 m thick), it may be possible to leave the peat in place and surcharge the site prior to construction to remove primary consolidation in the peat (noting that ongoing secondary consolidation and creep will occur on an ongoing basis, both from water expulsion and decay of the peat). It may be possible to achieve a classified site (probably equivalent of 'Class H1' although possibly 'Class M') by this method. This could only be achieved where the peat is relatively thin.

It may also happen that part of the peat is relatively sandy (which has not been assessed so far due to difficulties in carrying out investigations through the ACM-containing uncontrolled fill). Peaty sand would be far less prone to settlement/consolidation than true peat. This should be considered when detailed investigations are conducted.

9. ENVIRONMENTAL ENCUMBRANCES

An environmental assessment was beyond the scope of our study, however, it is clear to us that both sites are substantially environmentally encumbered. Particularly:

- The peat fill on the northern site (and the natural peat) is an acid sulfate soil (ASS) with a very high acid generating potential. Substantial quantities of peat are present well above the water table and are likely to be generating acid and releasing it into the surrounding environment even without any further disturbance or development.
- The groundwater is likely to be degraded and require substantial treatment when dewatering is done. Furthermore, substantial dewatering will be needed for any major earthworks campaign to excavate the peat.
- Dewatering of the peat will have its own environmental impacts (e.g. oxidization of the ASS, acidic effluent, etc) that need to be addressed and managed.
- The uncontrolled fill on the southern site contains asbestos and almost certainly other contaminants. It is very dry and dusty. There are sensitive receptors in the area, most notably a child care centre about 50 m from the site on Karrinyup Road. The handling and treatment of the uncontrolled fill is likely to attract significant scrutiny from various government departments and require onerous management.

The above is a basic assessment only which we have provided to raise client awareness about the site. We can provide further advice through Galt Environmental, if required.

10. CONCLUSION

We draw your attention to Appendix E of this report, Understanding your Geotechnical Engineering Report. The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with groundworks for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

Owen Woodland CPEng

Geotechnical Engineer

O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\03 Correspondence\J1401266 004 R Rev0.docx

Figures

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

Appendix A: Photographs

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

Photograph 1: Typical spoil on northern site, typical surface conditions (heavy grass, dense bamboo and shrubs in part)

Photograph 2: CPT Rig on Lot 129

Photograph 3: Typical uncontrolled fill on southern site (TP11)

Photograph 4: Old car parts, machinery and similar in uncontrolled fill (this is at TP12)

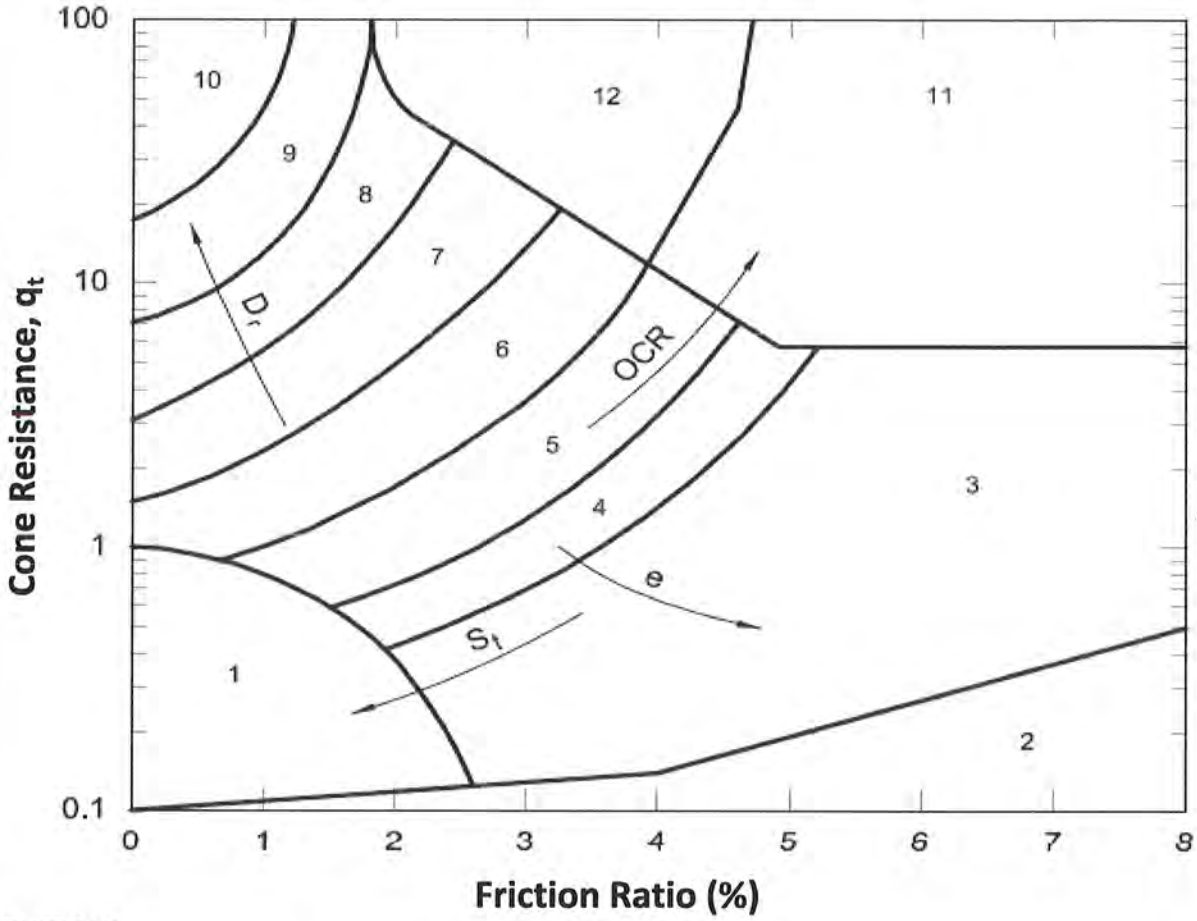
Photograph 5: Typical surface conditions at southern site – spoil heaps, dense bamboo in parts, heavy grass

Photograph 6: Edge of spoil heap on northern site

Appendix B: Cone Penetration Test Results

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155



DEFINITIONS

q_t : Cone tip resistance corrected for pore water pressure
S_t : Sensitivity
e : Void ratio
D_r : Relative density
OCR : Overconsolidation ratio
OC : Overconsolidated

SOIL BEHAVIOUR TYPE ZONES

1. Sensitive fine grained
2. Organic material
3. Clay
4. Silty clay to clay
5. Clayey silt to silty clay
6. Sandy silt to clayey silt
7. Silty sand to sandy silt
8. Sand to silty sand
9. Sand
10. Gravelly sand to sand
11. Very stiff fine grained material (OC/cemented)
12. Sand to clayey sand (OC/cemented)

NOTES

A. Some overlap in type zones is expected
B. Local correlations are preferred and may indicate soil type boundaries that are different from those shown above

Reference: Robertson, P.K., Campanella, R.G., Gillespie, D. and Grieg, J. (1986) "Use of Piezometer Cone Data". Proceedings of the ASCE Speciality Conference In Situ '86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, pp 1263-80, American Society of Civil Engineers (ASCE)

Galt GEOTECHNICS

CONE PENETRATION TESTING (CPT) SOIL TYPE INTERPRETATION

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

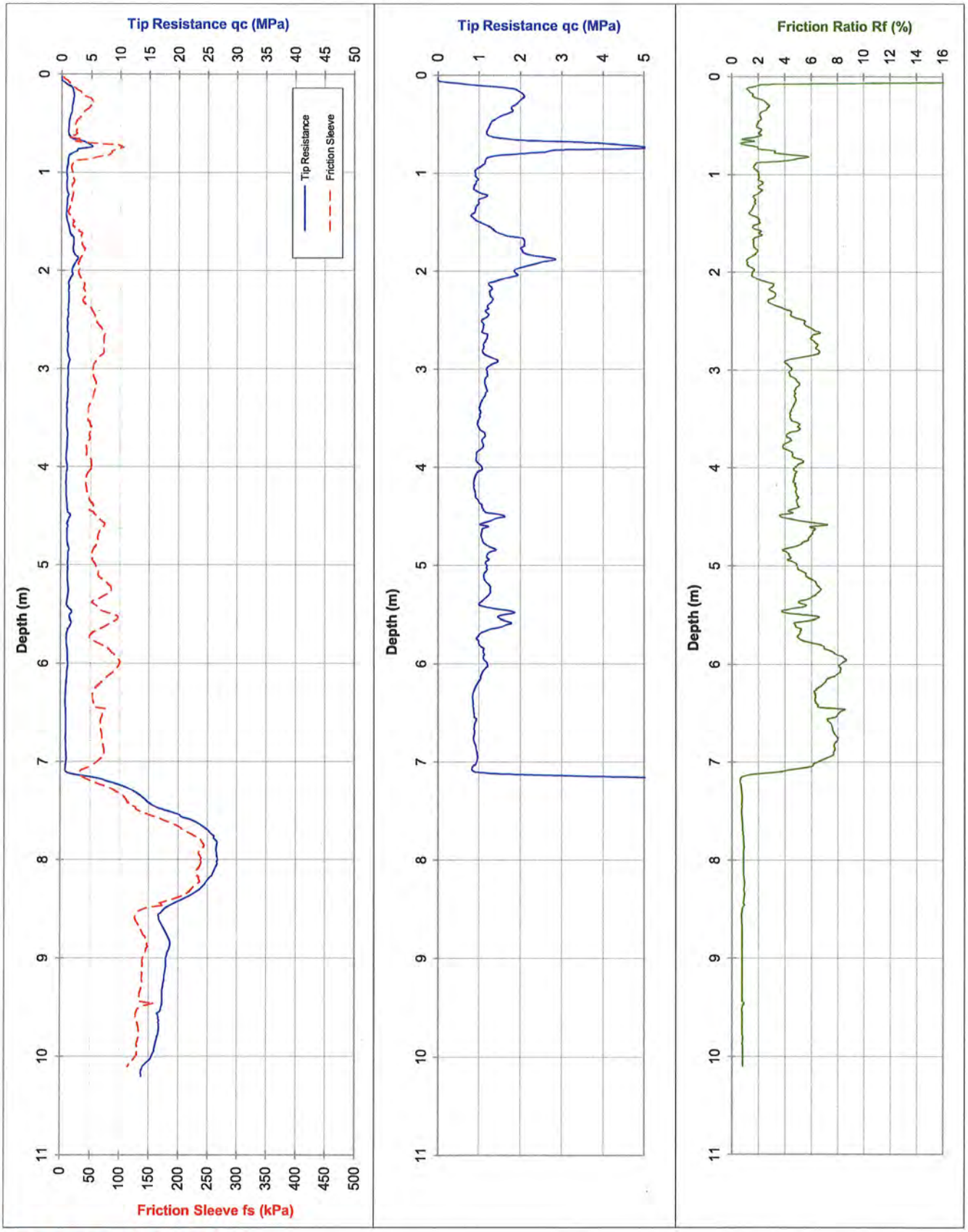
Probe No.: CPT 1

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 6.50

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0284M3

Cone I.D. : EC43

Dummy probe to (m):

19 tonne track mounted CPT Rig (M3)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

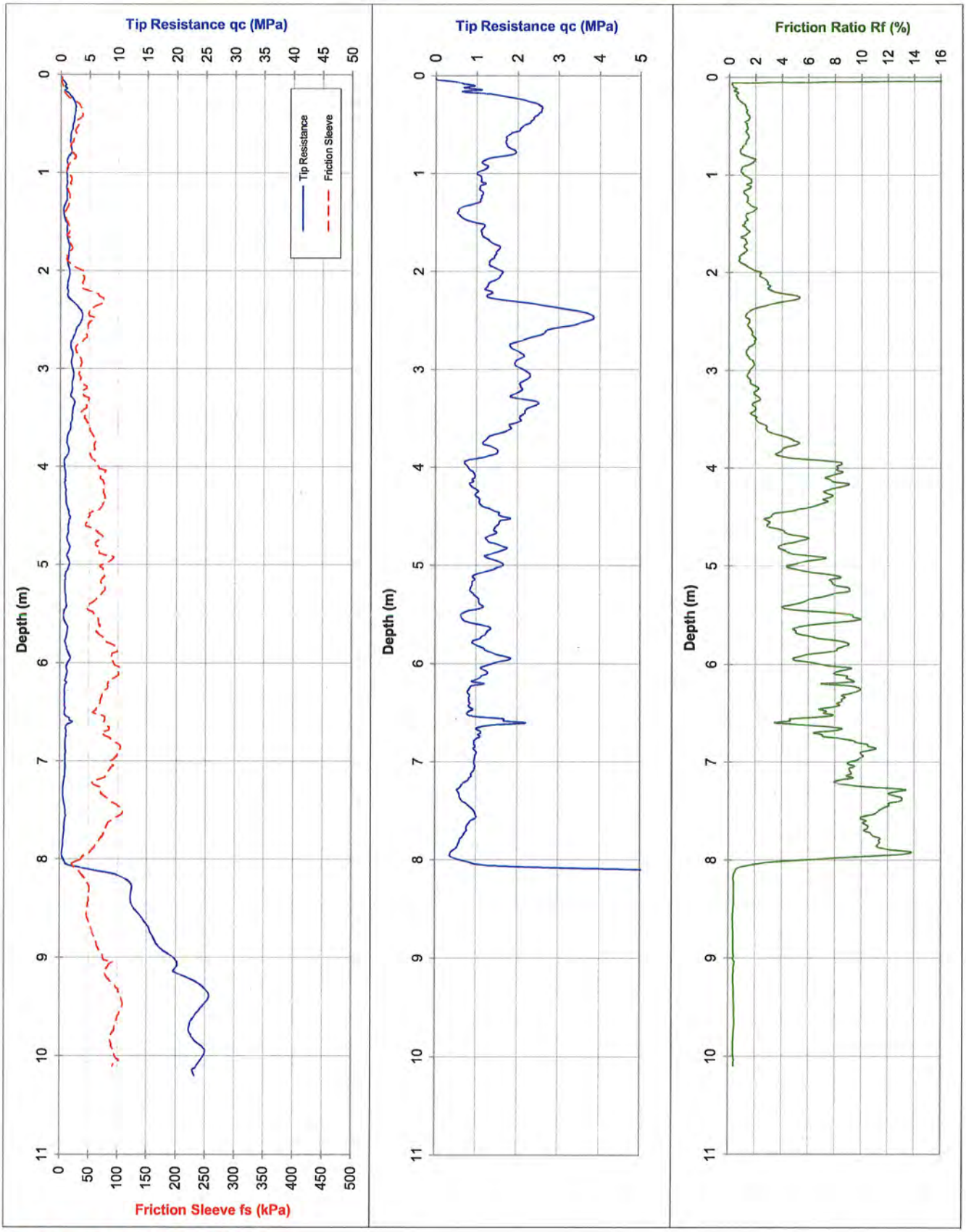
Probe No.: CPT 2

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 5.50

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0625M

Cone I.D. : EC21

Sample at (m): 0 - 9.0

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

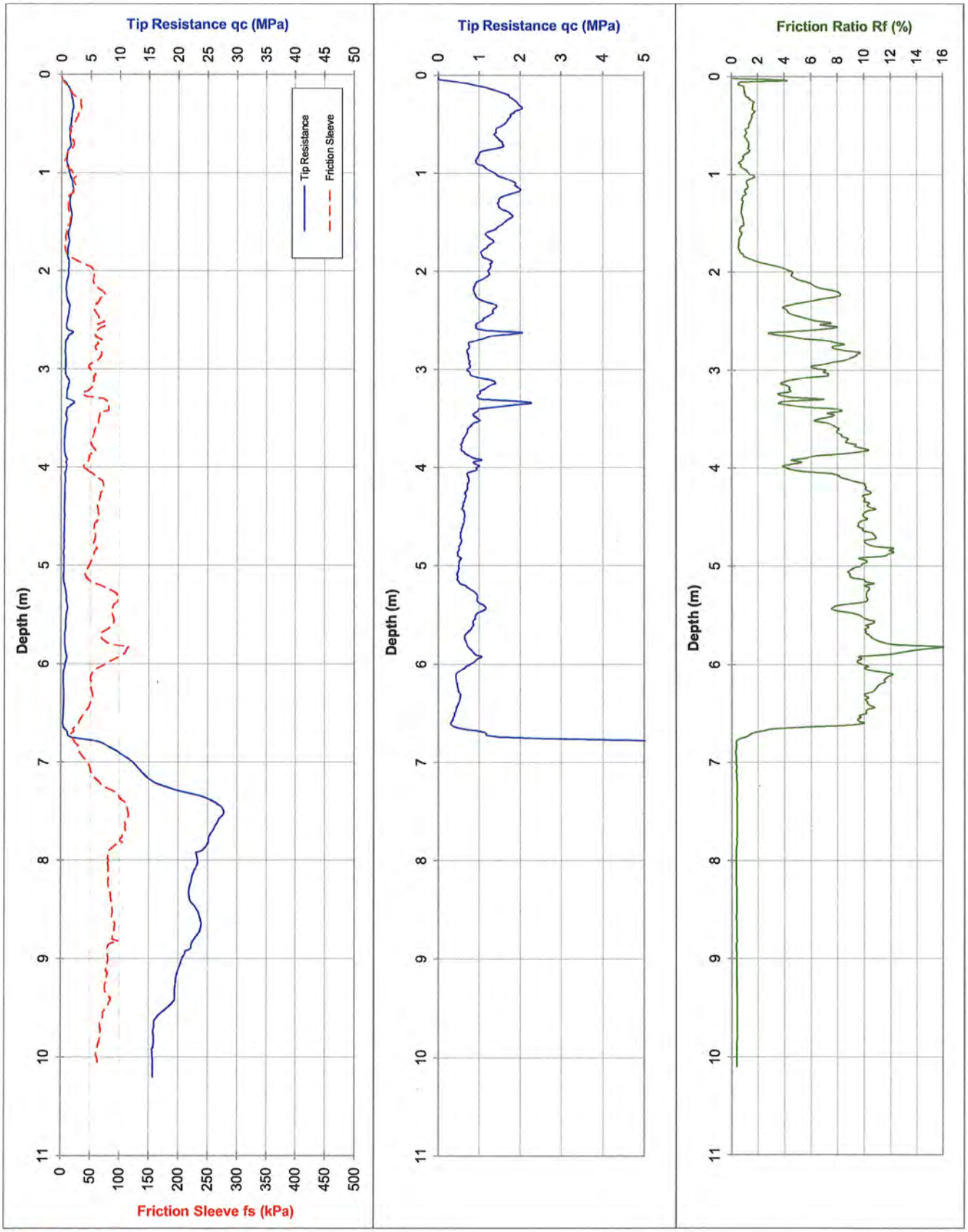
Probe No.: CPT 3

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 6.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0626M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

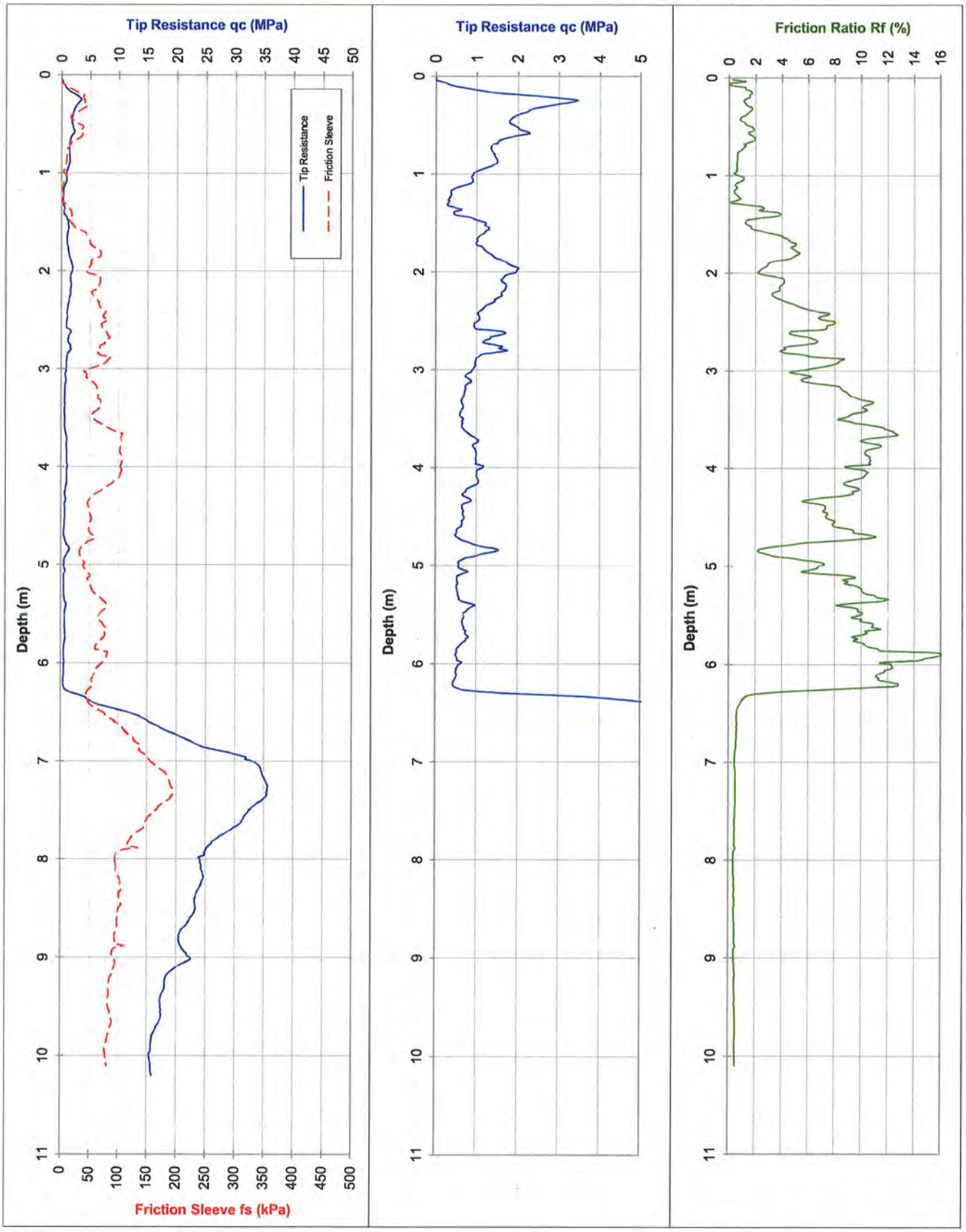
Probe No.: CPT 4

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 5.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0627M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

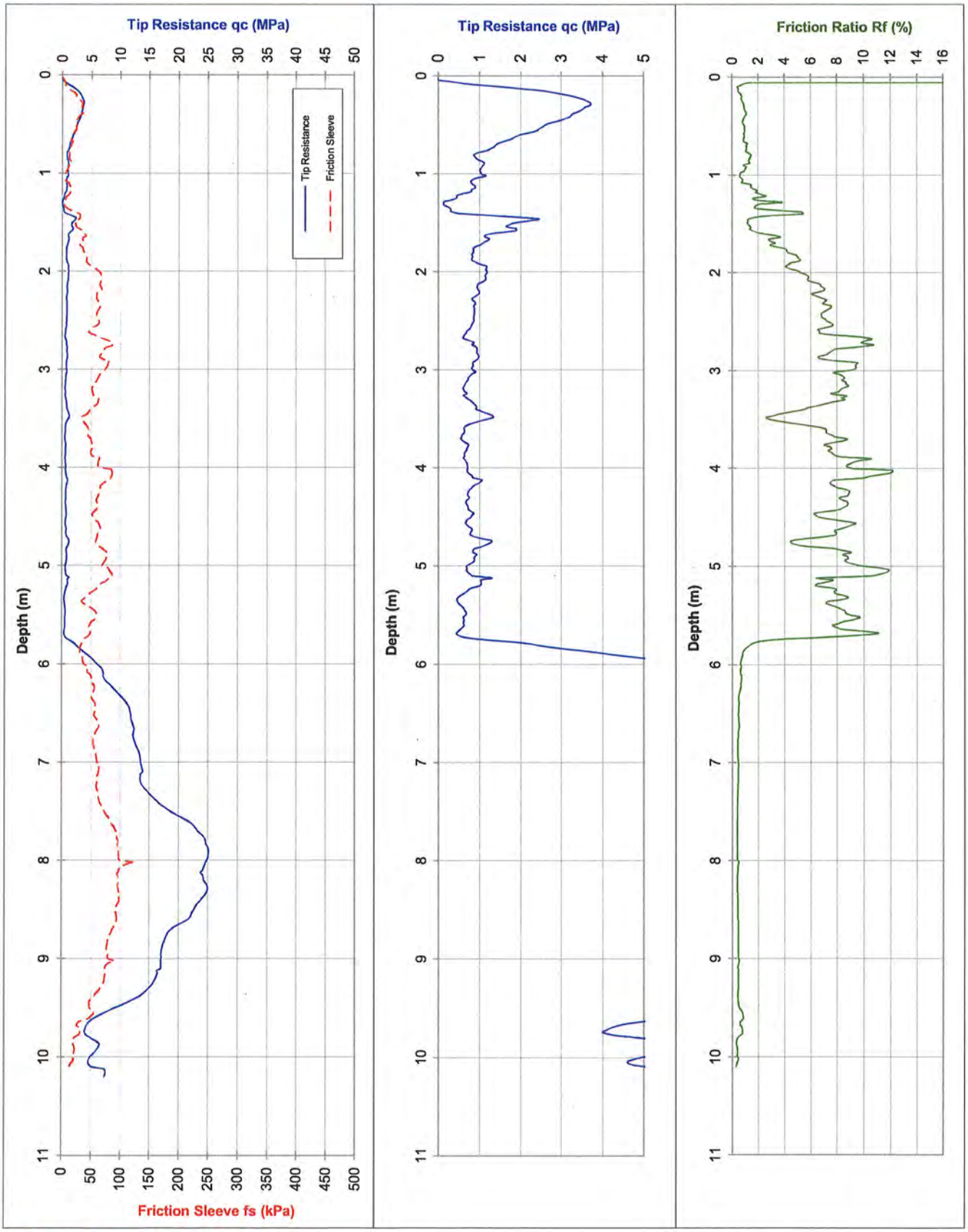
Probe No.: CPT 5

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 6.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0628M

Cone I.D. : EC21

Sample at (m): 0 - 8.0

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Thursday, 15 January 2015

PROJECT: Proposed Residential Development

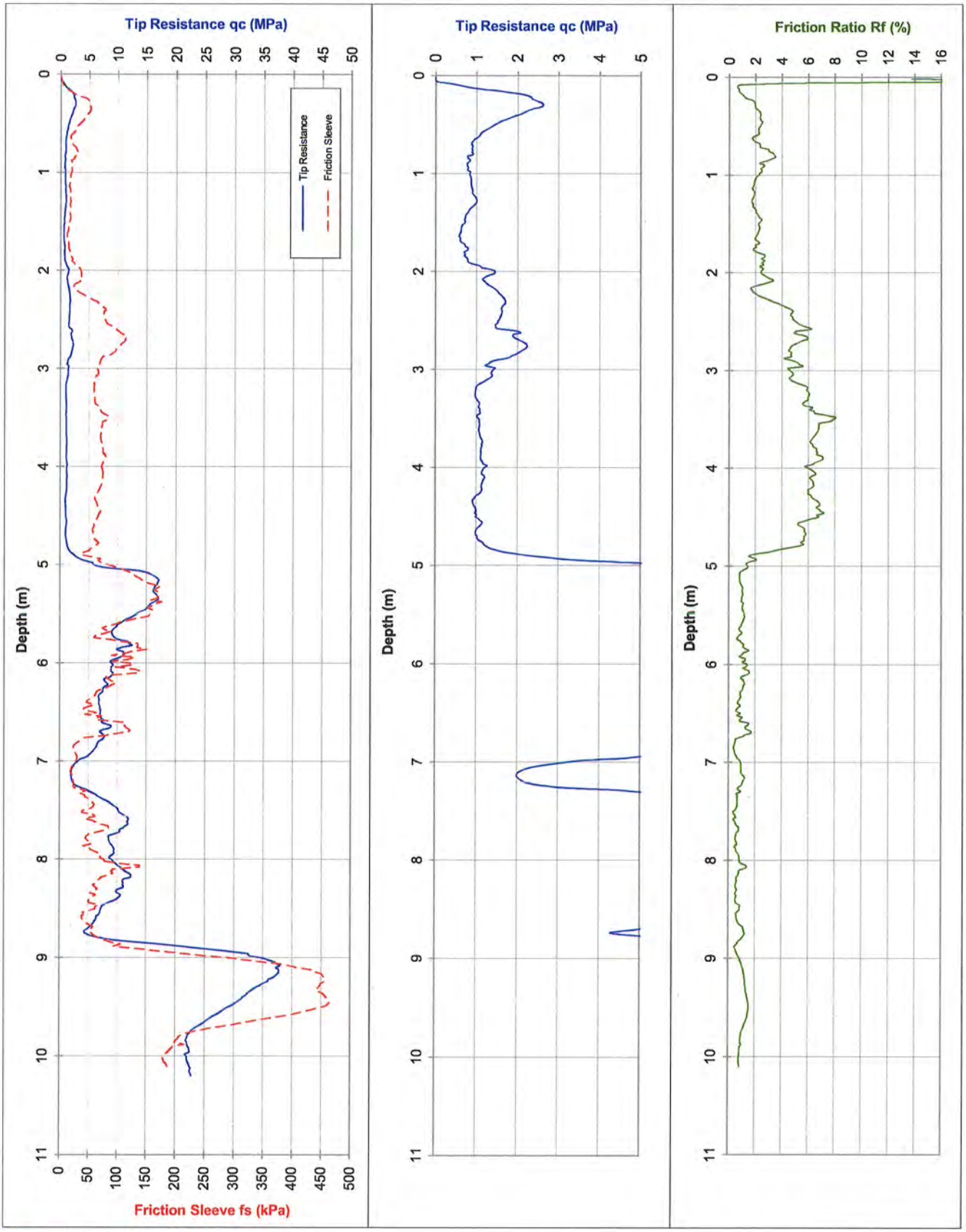
Probe No.: CPT 6

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 6.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0288M3

Cone I.D. : EC43

Dummy probe to (m):

19 tonne track mounted CPT Rig (M3)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Thursday, 15 January 2015

PROJECT: Proposed Residential Development

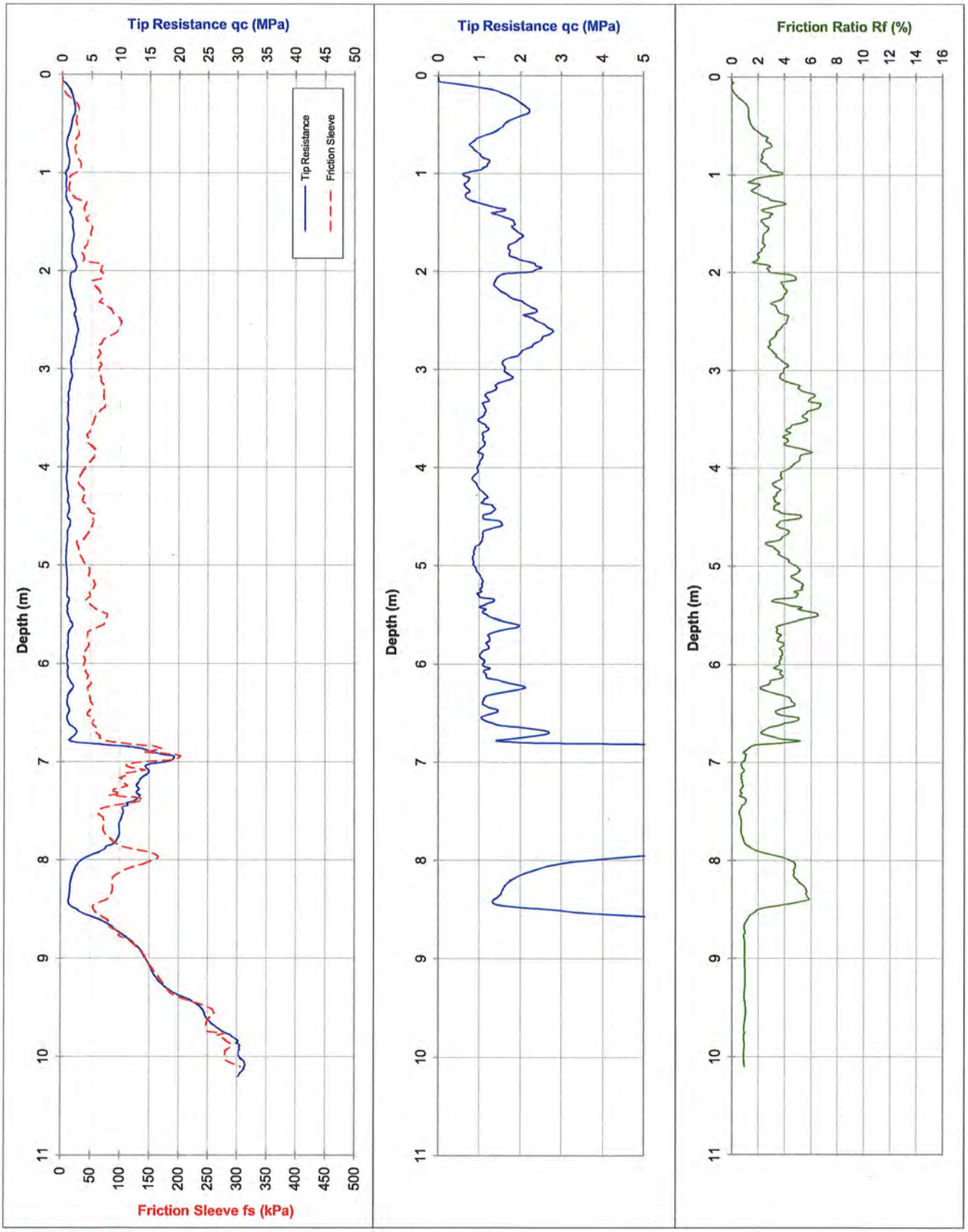
Probe No.: CPT 7

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 5.50

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0289M3

Cone I.D. : EC43

Sample at (m): 1.0 - 10.0

19 tonne track mounted CPT Rig (M3)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

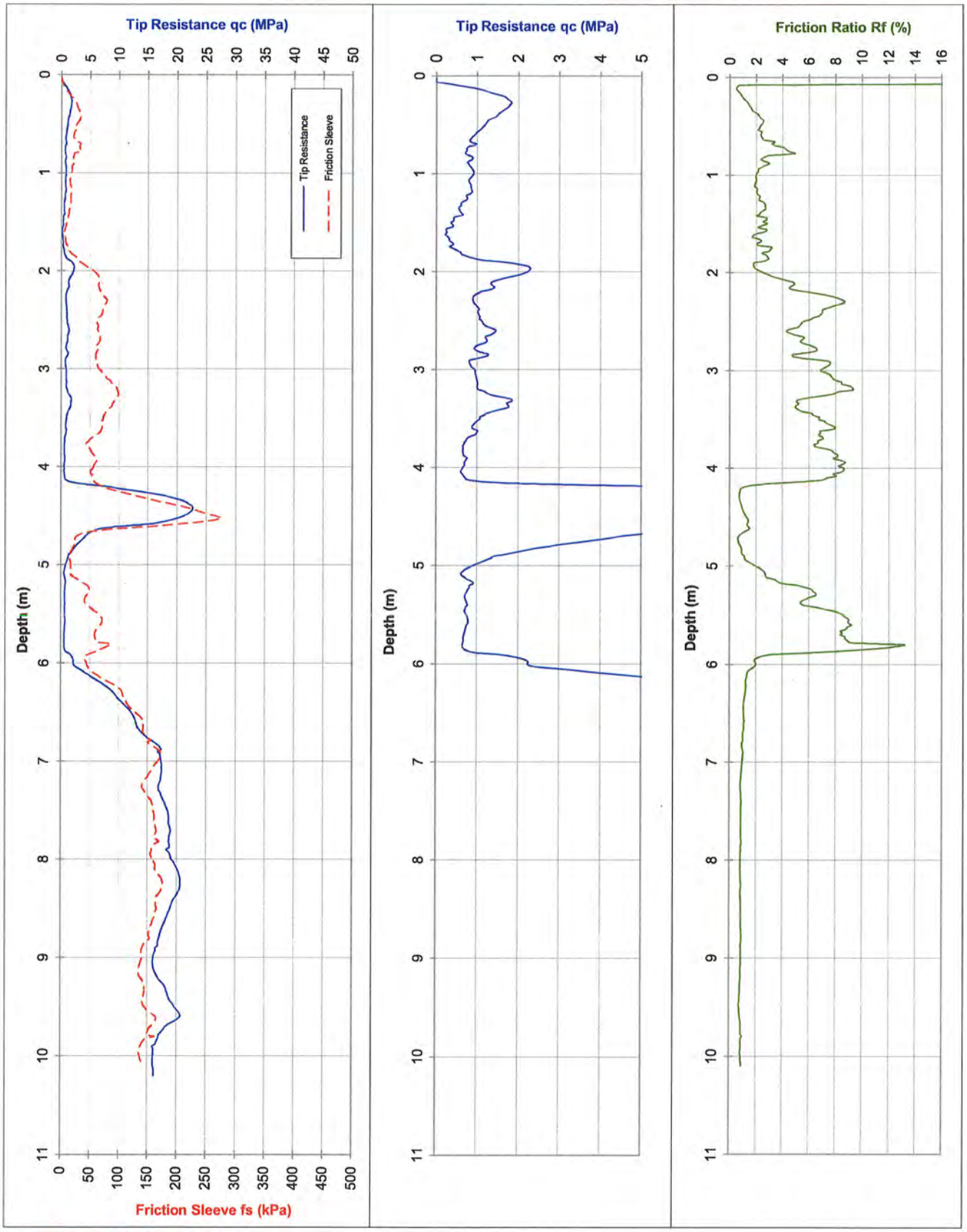
Probe No.: CPT 8

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 5.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0287M3

Cone I.D. : EC43

Dummy Probe to (m):

19 tonne track mounted CPT Rig (M3)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

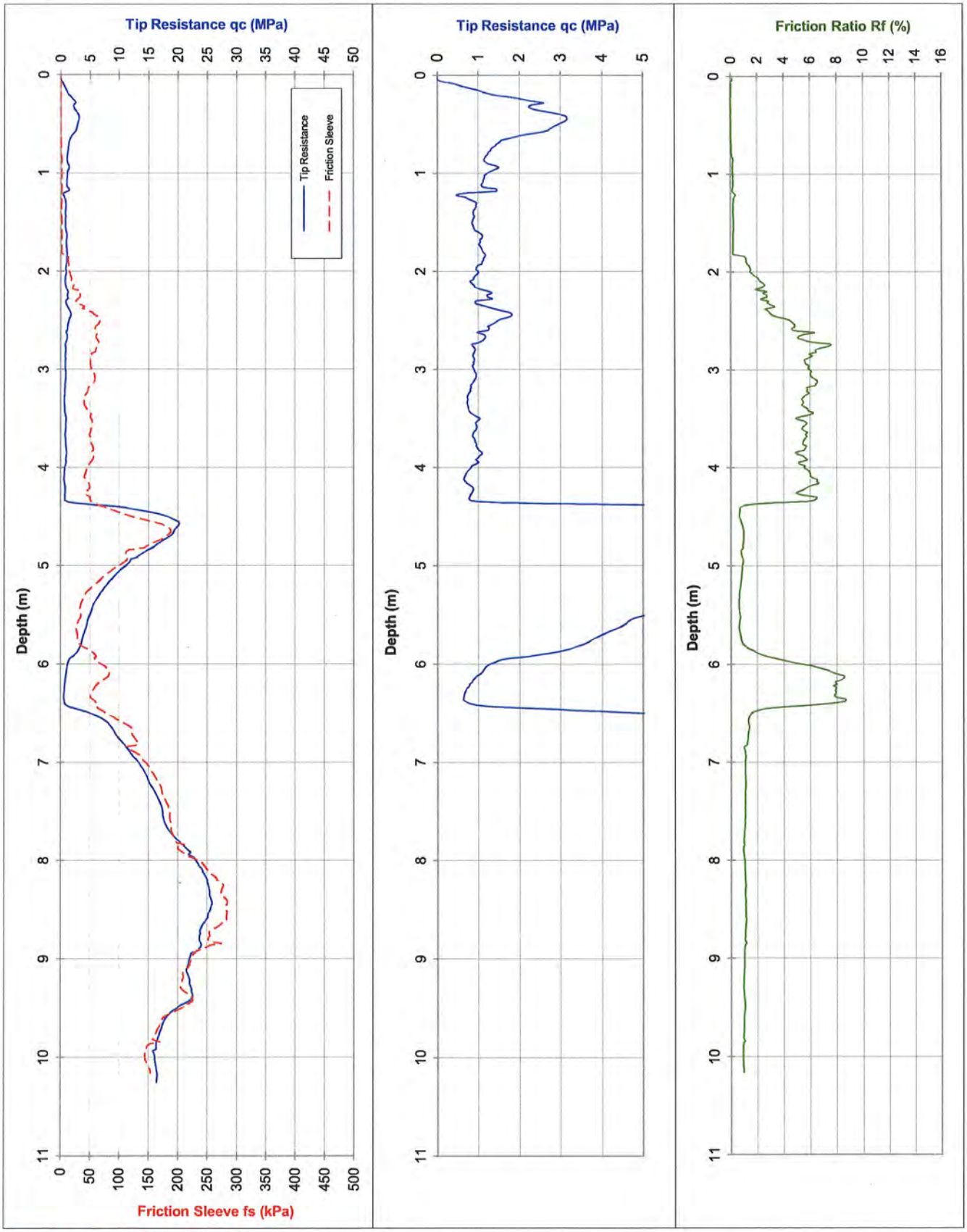
Probe No.: CPT 9

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 4.50

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0286M3

Cone I.D. : EC43

Sample at (m): 0 - 8.0

19 tonne track mounted CPT Rig (M3)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Wednesday, 14 January 2015

PROJECT: Proposed Residential Development

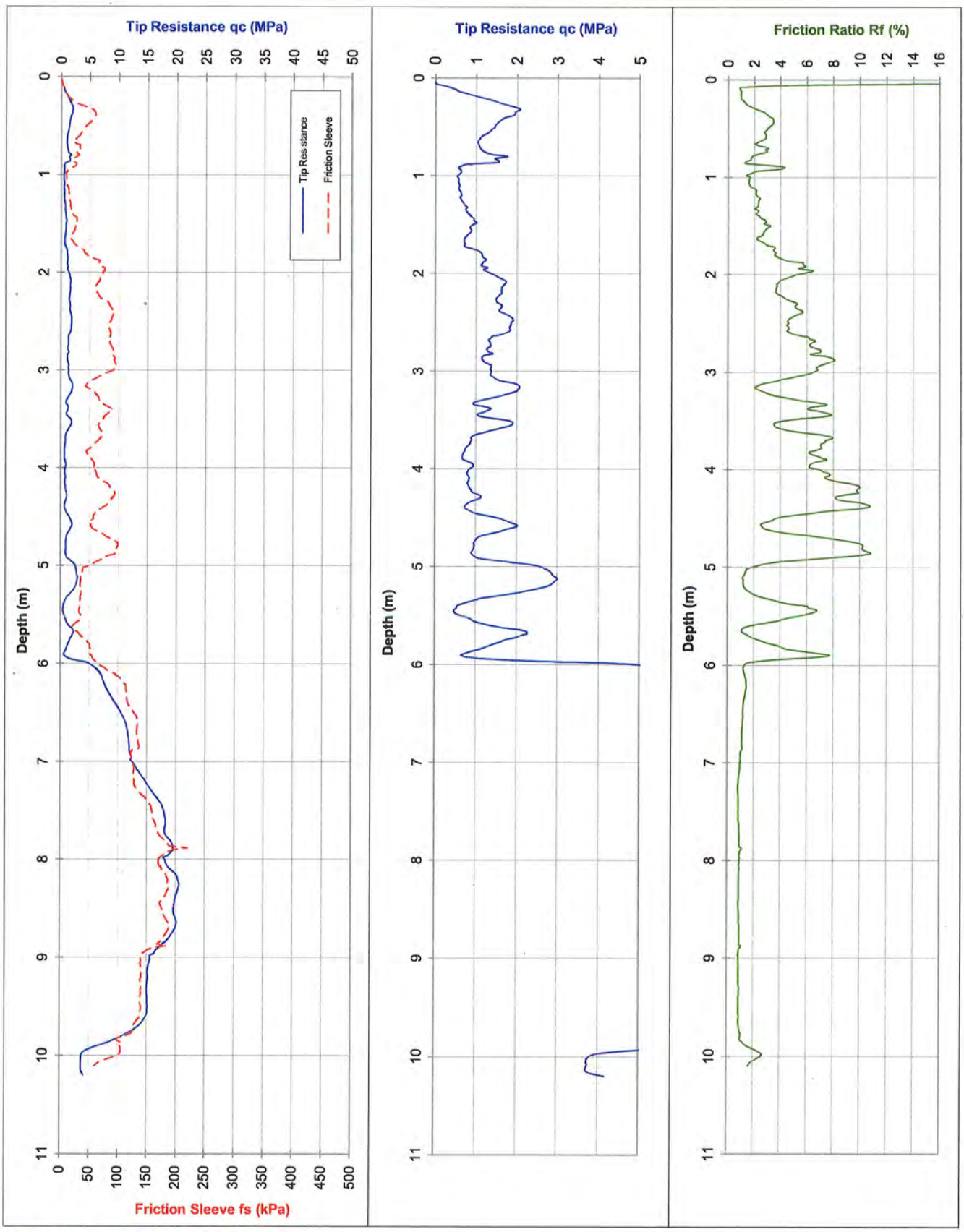
Probe No.: CPT 10

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 6.0

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0285M3

Cone I.D. : EC43

Dummy probe to (m):

19 tonne track mounted CPT Rig (M3)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Friday, 16 January 2015

PROJECT: Proposed Residential Development

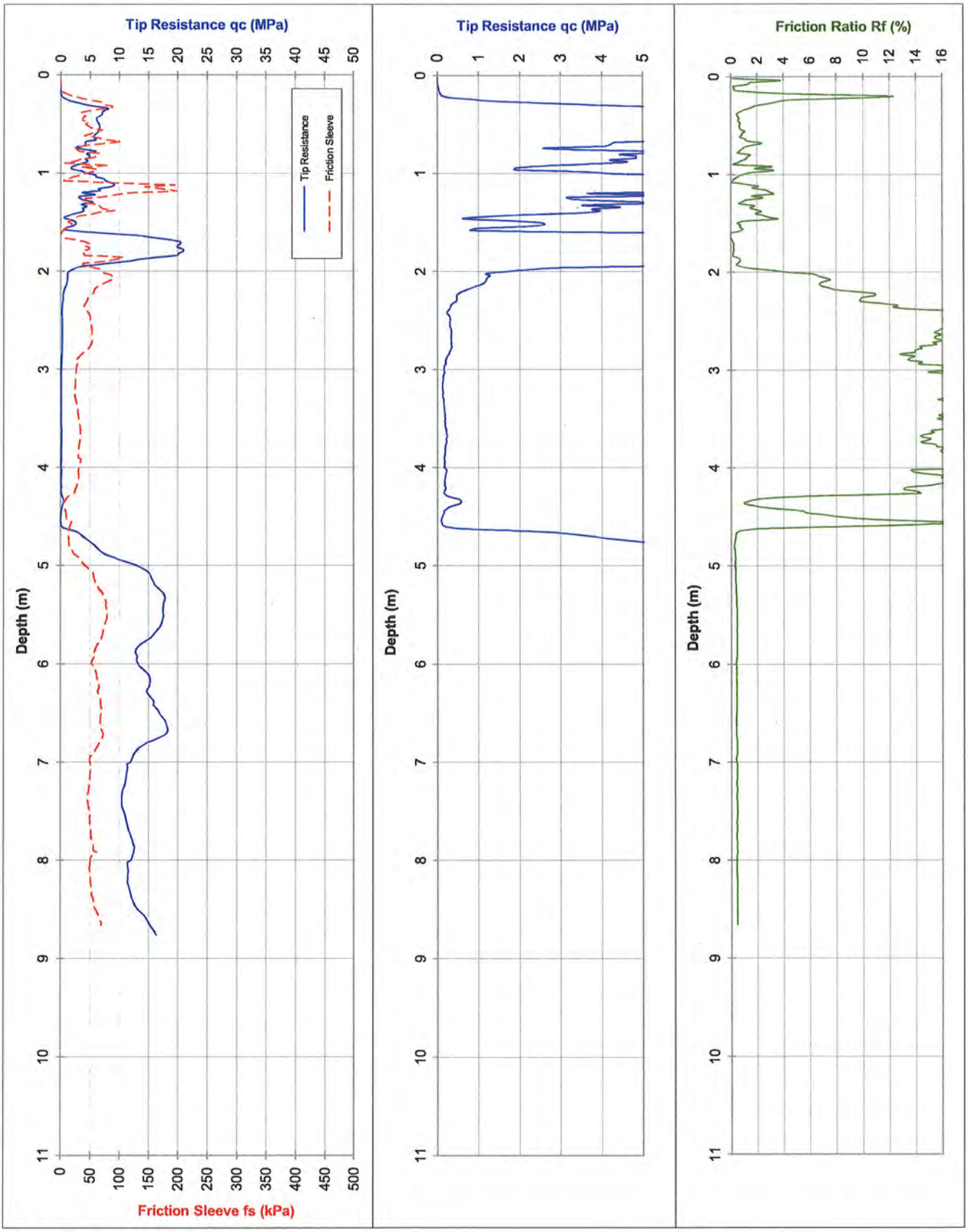
Probe No.: CPT 11

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 1.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0629M

Cone I.D. : EC21

Sample at (m): 3.0 - 7.0

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

PROJECT: Proposed Residential Development

LOCATION: Grindleford Drive, Balcatta

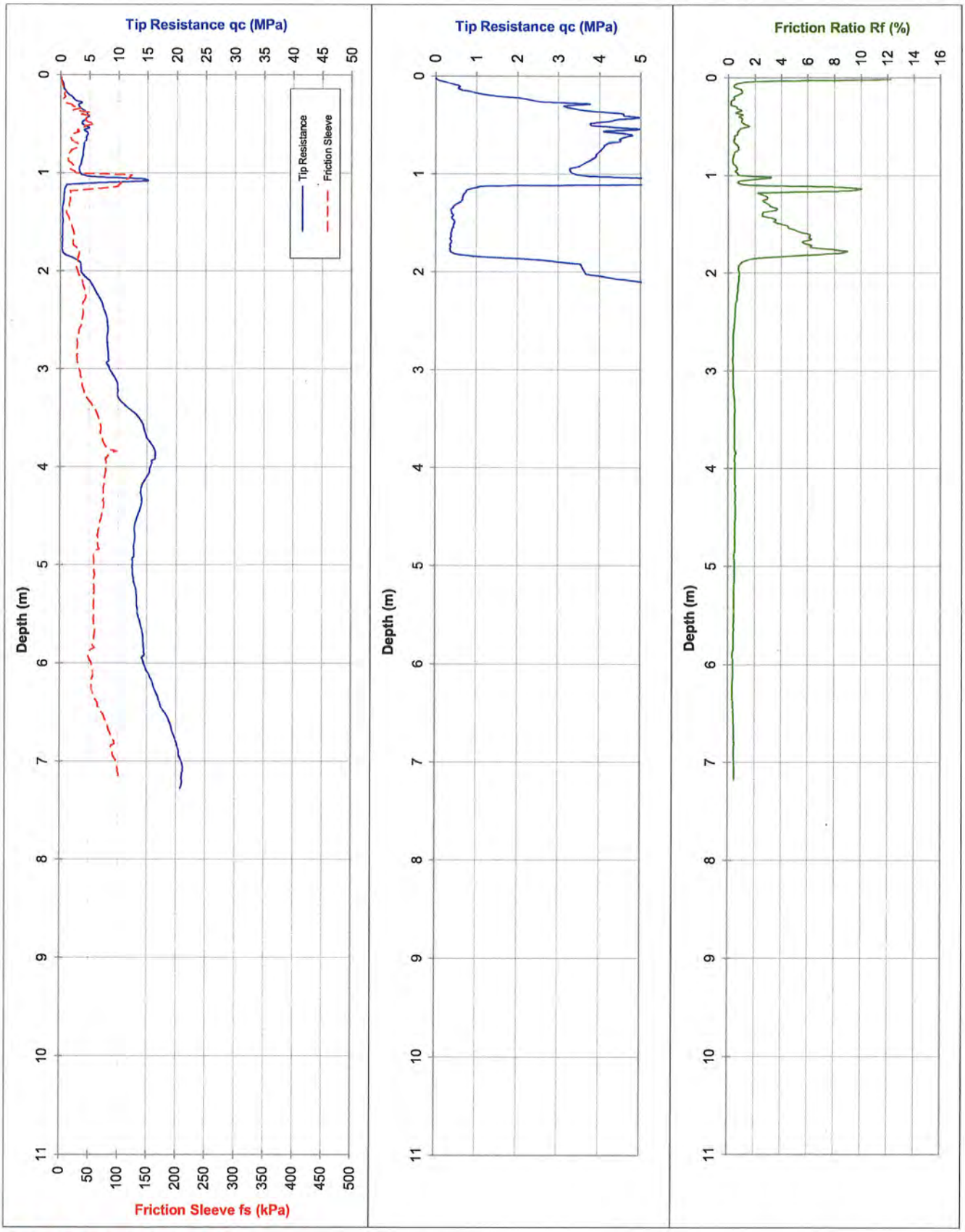
RL (m):

Date: Friday, 16 January 2015

Probe No.: CPT 12

Job Number: J1401266

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 0.5

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0630M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Friday, 16 January 2015

PROJECT: Proposed Residential Development

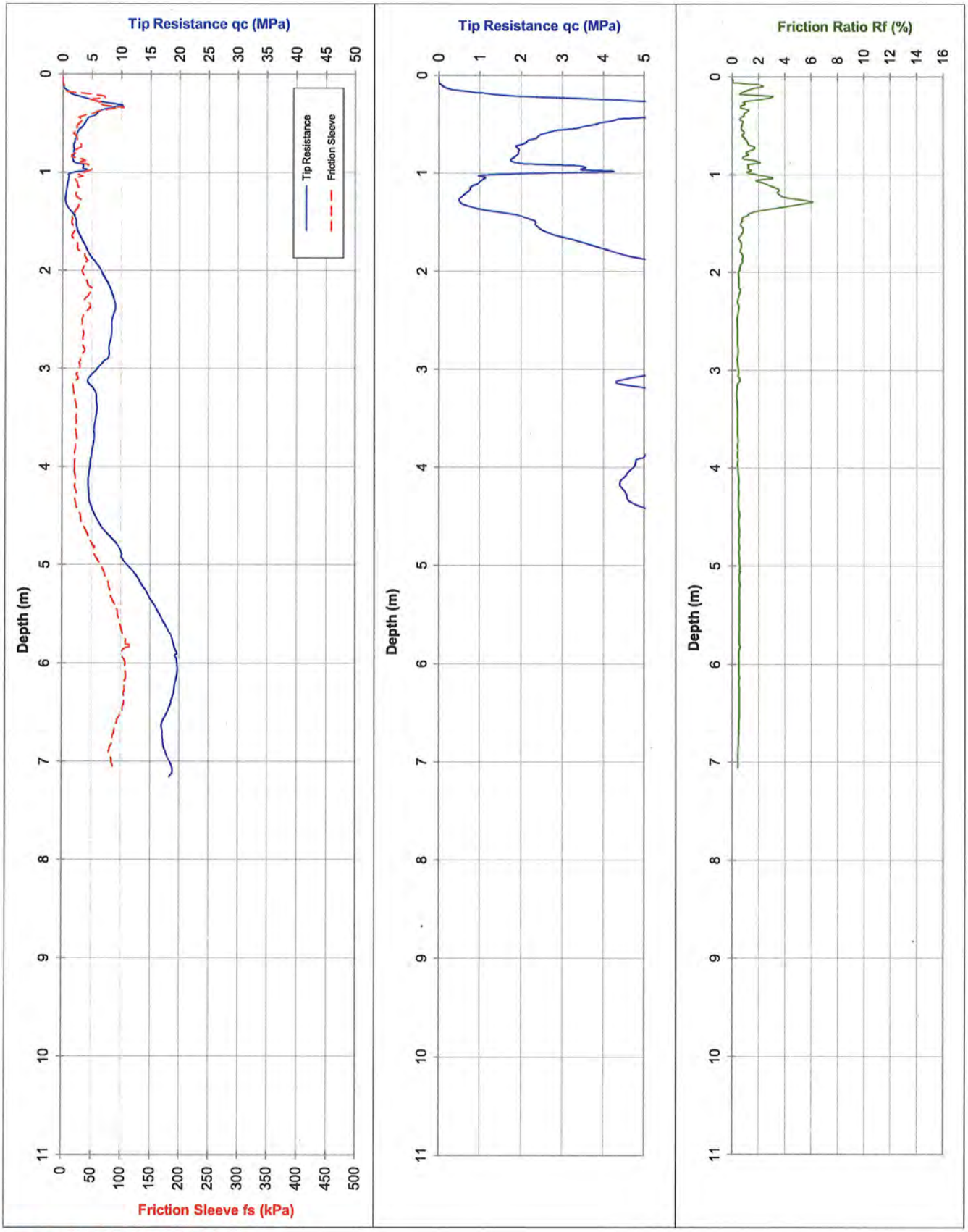
Probe No.: CPT 13

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 0.3

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0631M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Friday, 16 January 2015

PROJECT: Proposed Residential Development

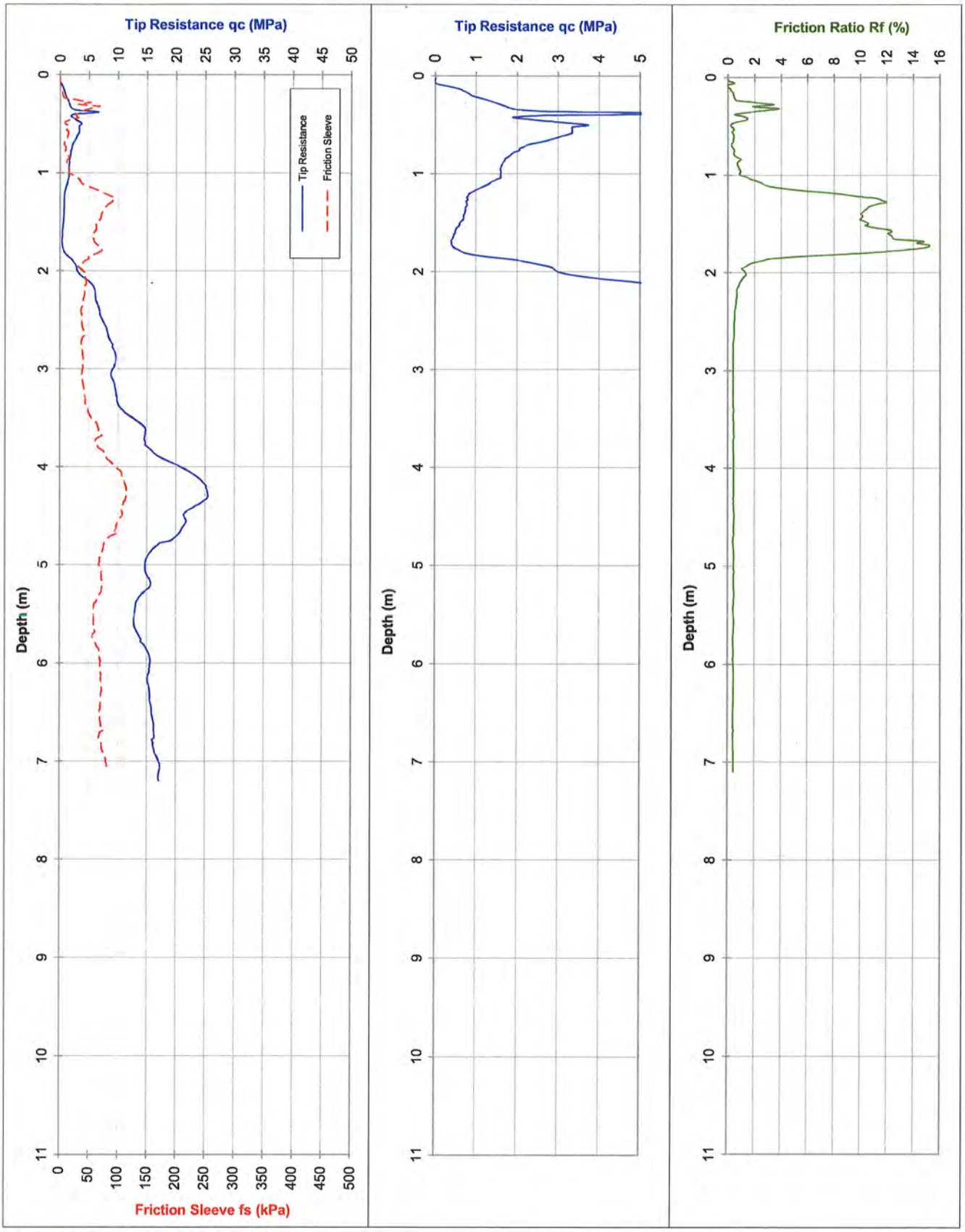
Probe No.: CPT 14

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 0.5

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0632M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Friday, 16 January 2015

PROJECT: Proposed Residential Development

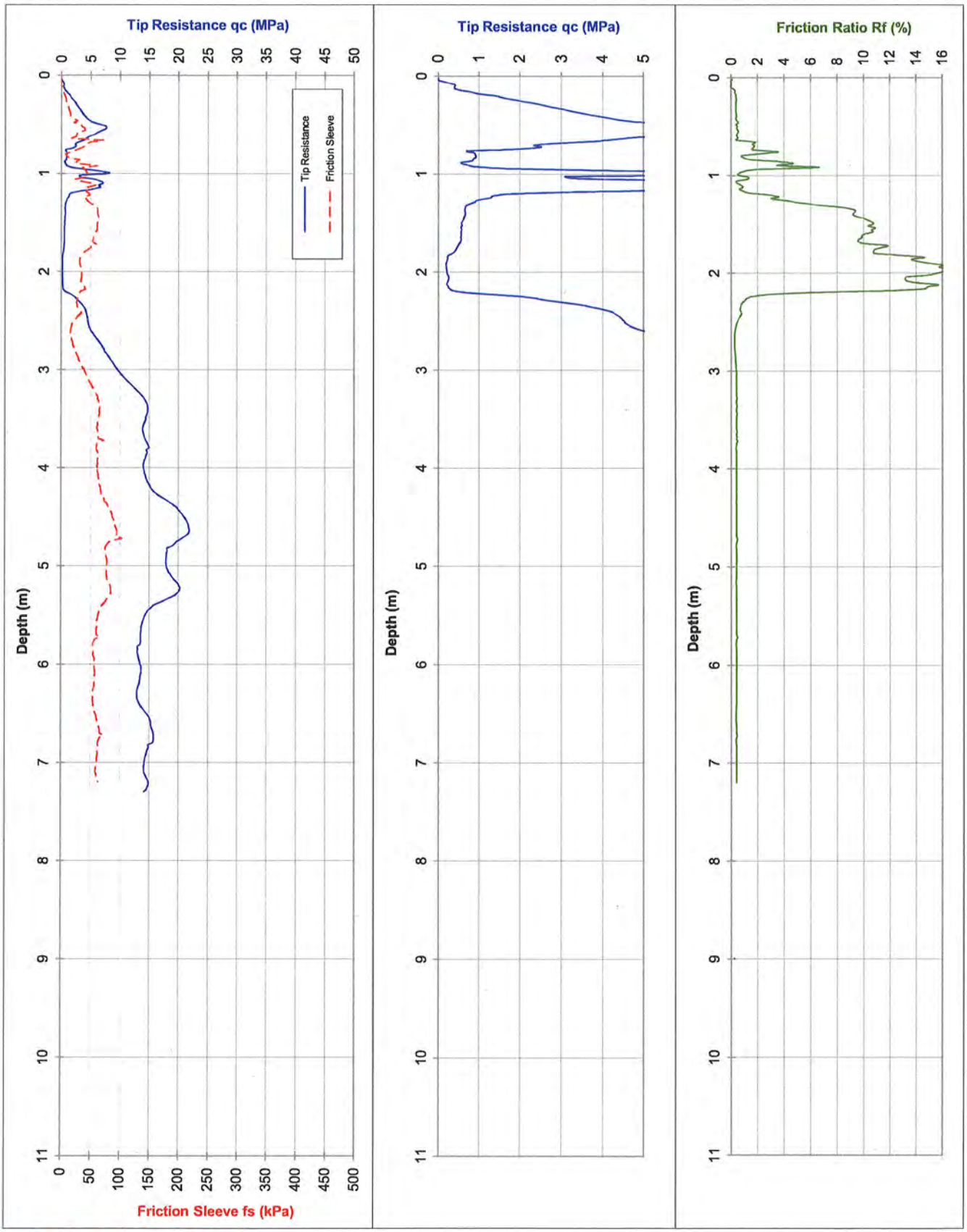
Probe No.: CPT 15

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 0.3

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0633M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

ELECTRIC FRICTION-CONE PENETROMETER

CLIENT: ABN Group

Date: Friday, 16 January 2015

PROJECT: Proposed Residential Development

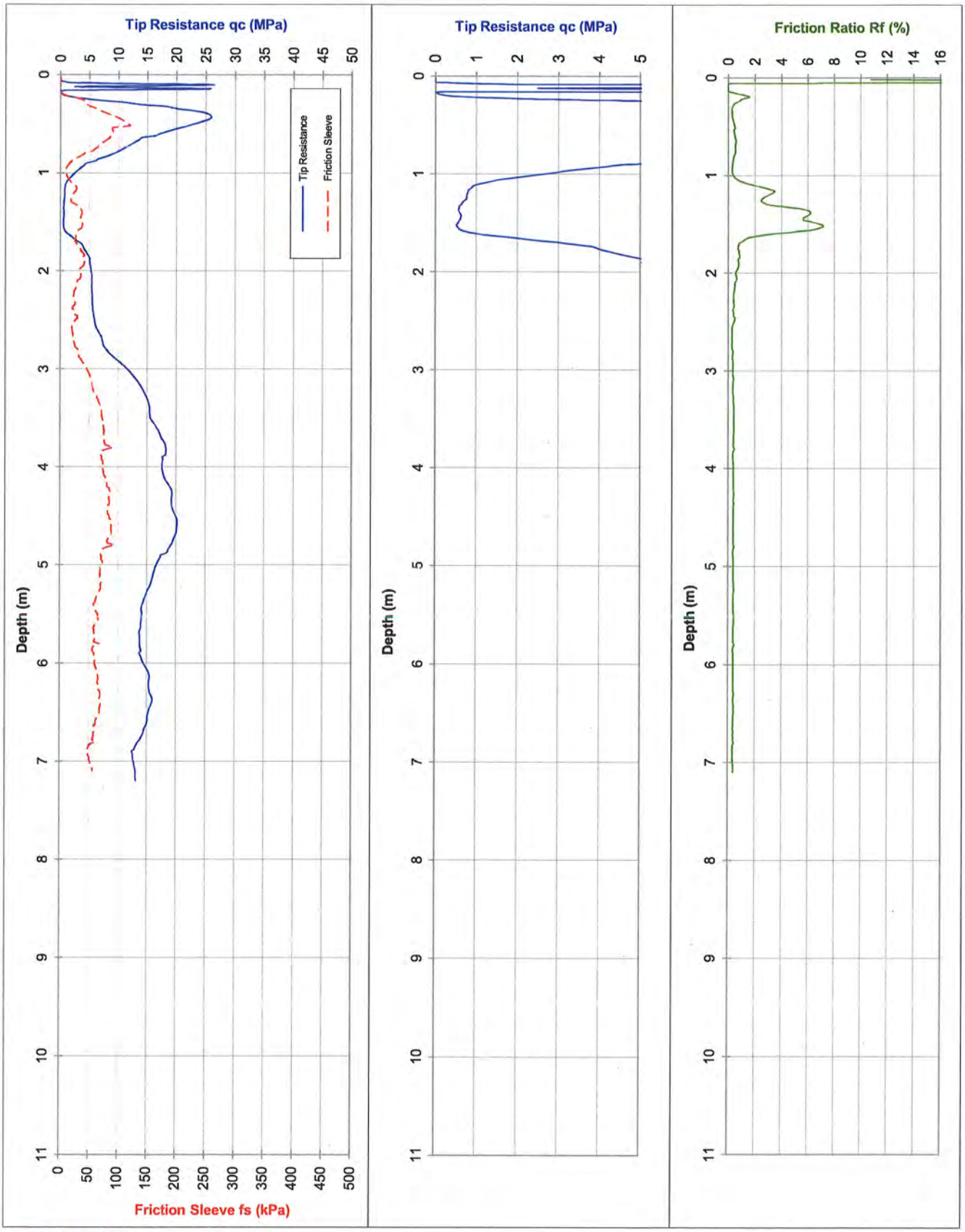
Probe No.: CPT 16

LOCATION: Grindleford Drive, Balcatta

Job Number: J1401266

RL (m):

Co-ordinates:



PROBEDRILL GEOTECHNICAL SURVEY

Water (m): Dry to 0.2

Refusal:

Tested in accordance with AS 1289.6.5.1 - 1999 and IRTP 2001 for friction reducer

File: GL0634M

Cone I.D. : EC21

Dummy probe to (m):

12 tonne track mounted CPT Rig (M1)

Appendix C: Borehole and Test Pit Reports

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

Galt GEOTECHNICS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

SCR = Solid Core Recovery (%) $= \frac{CCR}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Recovered Length of Core
CCR	Total Length of Cylindrical Pieces of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES
		BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

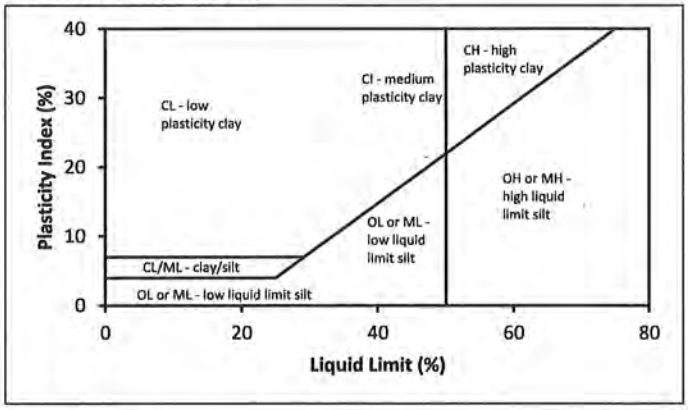
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-1993, Appendix A. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993 and HB160-2006

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100 mm
VS	Very Soft	0 to 12	0 to 2	<1
S	Soft	12 to 25	2 to 4	<1
F	Firm	25 to 50	4 to 8	1 to 2
St	Stiff	50 to 100	8 to 15	3 to 4
VSt	Very Stiff	100 to 200	15 to 30	5 to 10
H	Hard	>200	>30	>10

Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100 mm	PSP Blows per 300 mm
VL	Very Loose	<15	0 to 4	<1	0 to 2
L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VD	Very Dense	>85	>50	>8	>15

Note: PSP correlations only valid to 450 mm depth

Consistency and density may also be inferred from excavation performance and material behaviour.

TEST PIT: TP01

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width:	3 m **Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E	▼	0.0						SP	FILL: SAND, dark brown, with some organic fines, sticks, roots, traces of limestone cobbles, localised pockets of high organic fines (5-15%), overall organic content approximately 5-10%	D	VL	
			0.5										
			1.0										
			1.5										
			2.0		B(TP01-01)								
			2.5								M		
			3.0										
			3.5										
			4.0										
			4.5								W		
			5.0							Hole terminated at 5.00 m Target depth Groundwater encountered at 4.8m			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFiles>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP02

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	m		0.0						SP	FILL: SAND, fine to coarse grained, dark brown, with some organic fines (5-15%), sticks, roots, trace limestone gravel	D	VL	
			3.0						Pt	FILL: PEAT, black with some fine to coarse grained sand	M	St	
			3.5		B(TP02-01)								
			5.0							Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP03

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width:	3 m **Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, brown, with some organic fines (5-15%)	D	VL	
			0.5										
			1.0		ES-TP03/1.00-TP03-1								
			1.5										
			2.0		ES-TP03/2.00-TP03-1								
			2.5										
			3.0		ES-TP03/3.00-TP03-1				Pt	PEAT: black, with some fine to coarse grained sand	M	St	
			3.5										
			4.0		ES-TP03/4.00-TP03-1								
			4.5										
			5.0		ES-TP03/5.00-TP03-1					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP04

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	m		0.0						SP	FILL: SAND, dark brown, with some organic fines (5-15%), roots, sticks	D	VL	
			0.5										
			1.0		ES-TP04/1.00-*TP04-1*								
			1.5										
			2.0		ES-TP04/2.00-*TP04-1*								
			2.5										
			3.0		ES-TP04/3.00-*TP04-1*								
			3.5						Pt	PEAT: black, with some fine to coarse grained sand	M	S - F	
			4.0		ES-TP04/4.00-*TP04-1*								
			4.5										
			5.0		ES-TP04/5.00-*TP04-1*					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFiles>> 03/02/2015 13:13 8.30.003 Daigel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP05

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, brown, with some organic fines, sticks, roots	D	VL	
			0.5		B(TP05-01)					Pockets of Peaty SAND (up to approximately 30% fines, estimated 10-15% organic fines)			
			1.0		ES-TP05/1.00-TP05-1								
			1.5										
			2.0		ES-TP05/2.00-TP05-1								
			2.5										
			3.0		ES-TP05/3.00-TP05-1				Pt	FILL: PEAT, black, with some fine to coarse grained sand	M	St	
			3.5										
			4.0		ES-TP05/4.00-TP05-1 B(TP05-02)								
			4.5										
			5.0		ES-TP05/5.00-TP05-1					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD_CPT_Photo_Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP06

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	FILL: SAND, fine to coarse grained, brown, with some organic fines (5-10%), trace limestone gravel, pockets of high organic content (25-30%) organics	D	VL	
			0.5										
			1.0		ES-TP06/1.00-TP06-1								
			1.5										
			2.0		ES-TP06/2.00-TP06-1								
			2.5						Pt	FILL: PEAT, black, with some fine to coarse grained sand	M	St	
			3.0		ES-TP06/3.00-TP06-1								
			3.5										
			4.0		ES-TP06/4.00-TP06-1								
			4.5										
			5.0		ES-TP06/5.00-TP06-1					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

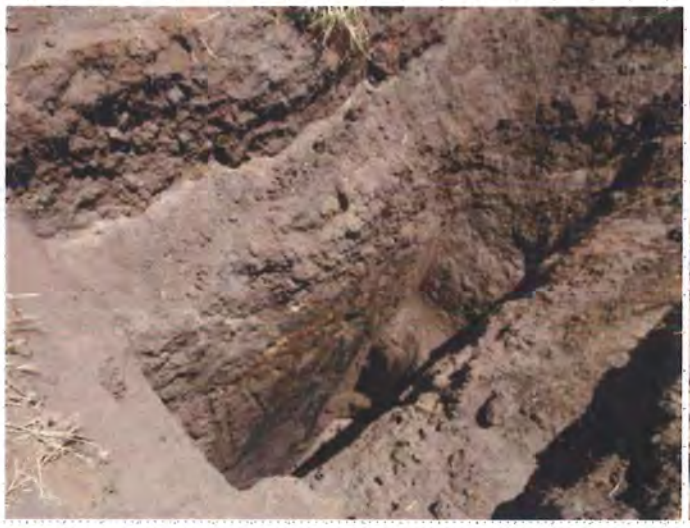
TEST PIT: TP07

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width. 3 m	**Length.** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0							FILL: SAND, brown, with some organic fines (5-10%), trace sticks, roots			
			0.5							Pockets of Peaty SAND (up to approximately 30% fines and organic fines)			
			1.0		ES-TP07/1.00-*TP07-1*				SP-SM		D	VL	
			1.5										
			2.0		ES-TP07/2.00-*TP07-1*								
			2.5							FILL: PEAT, black, with some fine to coarse grained sand			
			3.0		ES-TP07/3.00-*TP07-1*								
			3.5						Pt		M	F - St	
			4.0		ES-TP07/4.00-*TP07-1*								
			4.5										
			5.0		ES-TP07/5.00-*TP07-1*					Traces of limestone gravel at 5.0 m			
			5.5							Hole terminated at 5.00 m Target depth Groundwater not encountered			

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP08

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SM	FILL: Peaty SAND, fine to coarse grained, with up to 30% organic fines	D	VL	
			0.5		B(TP08-01)								
			1.0		ES-TP08/1.00-*TP08-1*								
			1.5										
			2.0		ES-TP08/2.00-*TP08-1*								
			2.5										
			3.0		ES-TP08/3.00-*TP08-1*								
			3.5						Pt	FILL: PEAT, black, with some fine to coarse grained sand	M	F - St	
			4.0		ES-TP08/4.00-*TP08-1*								
			4.5		B(TP08-02)								
			5.0		ES-TP08/5.00-*TP08-1*					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP09

Job Number: J1401266
Client: ABN Group
Project: Proposed Residential Subdivision
Location: Lot 86, 88 and 129 Grindleford Drive, Balcatta

Contractor: Allwest Plant Hire
Machine: 600 mm toothed
Operator: Derrick
Bucket: 600 mm toothed
Width: 3 m **Length:** 3 m

Date: 14/01/2015
Logged: ST
Checked Date: 02/02/2015
Checked By: ORW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SM	FILL: Peaty SAND, brown, with up to approximately 30% organic fines, trace sticks, roots	D	VL	
			0.5										
			1.0		ES-TP09/1.00-TP09-1								
			1.5										
			2.0		ES-TP09/2.00-TP09-1								
			2.5										
			3.0		ES-TP09/3.00-TP09-1								
			3.5										
			4.0		ES-TP09/4.00-TP09-1				Pt	FILL: PEAT, black, with some fine to coarse grained sand	M	F - St	
			4.5										
			5.0		ES-TP09/5.00-TP09-1					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGE, CPT, Photo, Monitoring Tabs | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP10

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0							FILL: Peaty SAND, fine to coarse grained, brown, with up to 30% organic fines, trace gravel in top 0.5 m			
			0.5										
			1.0		ES-TP10/1.00-TP10-1								
			1.5										
			2.0		ES-TP10/2.00-TP10-1					Pockets of PEAT, black			
			2.5						SM		D	VL	
			3.0		ES-TP10/3.00-TP10-1								
			3.5										
			4.0		ES-TP10/4.00-TP10-1								
			4.5										
			5.0		ES-TP10/5.00-TP10-1					Hole terminated at 5.00 m Target depth Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP11

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	Uncontrolled FILL: SAND, fine to coarse grained, pale brown, with building rubble (bricks, concrete, metal, tiles, plastic, timber, garden hose, old shoes, carpets, plastic bottles, polystyrene), estimated 50% SAND, 50% rubbish/rubble	D	L	
			0.5										
			1.0										
			1.5										
			2.0										
			2.5										
			3.0							Asbestos fence panel fragments			
			3.5							Hole terminated at 3.00 m Test pit collapsing Groundwater not encountered			
			4.0										
			4.5										
			5.0										
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP12

Job Number:	J1401266	**Contractor:**	Allwest Plant Hire	**Date:**	14/01/2015
Client:	ABN Group	**Machine:**	600 mm toothed	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Operator:**	Derrick	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta	**Bucket:**	600 mm toothed	**Checked By:**	ORW
		Width: 3 m	**Length:** 3 m		

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	m		0.0						SP	Uncontrolled FILL: SAND, fine to coarse grained, pale brown, with building rubble (bricks, metal, asbestos fragments, garden hose, plastic, bottles, timber, carpet), approximately 40-50% SAND, 50-60% rubble/rubbish	D	L	
			1.5							Hole terminated at 1.50 m Terminated due to presence of asbestos Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP13

Job Number: J1401266
Client: ABN Group
Project: Proposed Residential Subdivision
Location: Lot 86, 88 and 129 Grindleford Drive, Balcatta

Contractor: Allwest Plant Hire
Machine: 600 mm toothed
Operator: Derrick
Bucket: 600 mm toothed
Width: 3 m **Length:** 3 m

Date: 14/01/2015
Logged: ST
Checked Date: 02/02/2015
Checked By: ORW

Excavation					Sampling			Field Material Description					
METHOD	EXCAVATICN RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
BH	E		0.0						SP	Uncontrolled FILL: SAND, with building rubble (bricks, tiles, metal, bottles, asbestos, car parts with oil, glass), approximately 40-50% SAND, 50-60% rubble/rubbish	D	L	
			2.0							Hole terminated at 2.00 m Terminated due to presence of asbestos Groundwater not encountered			
			5.5										

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1401266.GPJ <<DrawingFile>> 03/02/2015 13:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BHCPT2

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Probedrill	**Date:**	16/01/2015
Client:	ABN Group	**Drill Rig:**	M3	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Inclination:**	-90°	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta			**Checked By:**	ORW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PP		▼	0						SP-SM	FILL: SAND with some organic fines/Peaty SAND, fine to coarse grained, pale brown, estimated 5-15% organic fines, total fines content 15-30%	D	VL	
			1										
			2							Becoming black-grey			
			3										
			4						Pt	FILL: Sandy PEAT, black, fine to coarse grained sand	M	St	
			5		B(BHCPT2-01)								
			6								W		
			7						Pt	PEAT: black, trace sand fines, fibrous organics present		F - St	
			8		B(BHCPT2-02)								
			9						SP	SAND: fine to coarse grained, grey		D	
			10							Hole terminated at 10.00 m Target depth Groundwater encountered at 6m			

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_NON_CORED J1401266.GPJ <<DrawingFile>> 03/02/2015 13:16 8.30.003 Datgel DGD, CPT, Photo, Maintaining Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BHCPT5

Job Number:	J1401266	**Contractor:**	Probedrill	**Date:**	16/01/2015
Client:	ABN Group	**Drill Rig:**	M3	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Inclination:**	-90°	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta			**Checked By:**	ORW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PP	E		0						SM	FILL: Peaty SAND, fine to coarse grained, brown, 20-30% organic fines	D	VL	
			1										
			2						Pt	FILL: PEAT, black with some fine to coarse grained sand	M	St	
			3										
			4										
			5		B(BHCPT5-01)				Pt	PEAT: black, trace fine to coarse grained sand, fibrous organics present	W	F - St	
		▼	6						SP	SAND: fine to coarse grained, brown becoming grey, trace fines		D	
			7										
			8							Hole terminated at 8.00 m Sand collapse Groundwater encountered at 6m			
			9										
			10										

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_NON_CORED J1401266.GPJ <<DrawingFile>> 03/02/2015 13:16 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BHCPT7

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Probedrill	**Date:**	16/01/2015
Client:	ABN Group	**Drill Rig:**	M3	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Inclination:**	-90°	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta			**Checked By:**	ORW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PP	E	▼	0						SM	FILL: Peaty SAND, brown becoming black, fine to coarse grained sand, estimated 5-15% organic fines, total 15-30% fines	D		
			3						Pt	FILL: PEAT, black, trace limestone gravel, with some fine to coarse grained sand	M	St	
			7						SP	FILL: SAND, fine to coarse grained, brown, trace organic fines	W	MD	
			8						SP	SAND: fine to coarse grained, brown becoming grey, trace fines		D	
			10							Hole terminated at 10.00 m Target depth Groundwater encountered at 6.5m			

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_NOW_CORED J1401266.GPJ <<DrawingFiles>> 03/02/2015 13:16 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Plt: GALT 1.01 2013-02-21

BOREHOLE: BHCPT9

Job Number:	J1401266	**Contractor:**	Probedrill	**Date:**	16/01/2015
Client:	ABN Group	**Drill Rig:**	M3	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Inclination:**	-90°	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta			**Checked By:**	ORW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PP	E	▼	0						SM	FILL: Peaty SAND, fine to coarse grained, brown, 20-30% organics, estimated 5-15% organics	D	VL	
			1										
			2						Pt	FILL: PEAT, black, with some fine to coarse grained sand	M	St	
			3										
			4						SP	FILL: SAND, fine to coarse grained, brown-grey, trace organic fines		MD	
			5									L	
			6						Pt	PEAT: black, trace sand	W	F	
	F		7						SP	SAND: fine to coarse grained, brown becoming grey, trace fines		D	
			8							Hole terminated at 8.00 m Sand collapse Groundwater encountered at 5.5m			
			9										
			10										

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_NON_CORED J1401266.GPJ <<DrawingFiles>> 03/02/2015 13:16 8.30.003 Datgel DGE, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

BOREHOLE: BHCPT11

Sheet 1 OF 1

Job Number:	J1401266	**Contractor:**	Probedrill	**Date:**	16/01/2015
Client:	ABN Group	**Drill Rig:**	M3	**Logged:**	ST
Project:	Proposed Residential Subdivision	**Inclination:**	-90°	**Checked Date:**	02/02/2015
Location:	Lot 86, 88 and 129 Grindleford Drive, Balcatta			**Checked By:**	ORW

Drilling					Sampling			Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	ACID SULPHATE SAMPLE	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
PP		▼	0						SP	Uncontrolled FILL: SAND, with building rubble, metal, asbestos, tiles, etc	D		No sample taken in uncontrolled fill, description inferred from adjacent test pit and surface observations.
			1										
			2						SM	Peaty SAND: fine to coarse grained, black, 20-30% organics	M	MD - D	2.00-2.70: Soil loss 2.0-2.7 m: tube blocking with root matter
			3		B(BHCPT11-01)				Pt	PEAT: black, trace sand, fines	W	VS - S	3.70-3.70: Soil loss 3.0-3.7 m
			4										
			5						SP	SAND: fine to coarse grained, grey-brown, trace fines		D	
			6										
			7							Hole terminated at 7.00 m Target depth Groundwater encountered at 2m			
			8										
			9										
			10										

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_NON_CORED J1401266.GPJ <<DrawingFile>> 03/02/2015 13:16 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

Appendix D: Laboratory Test Results

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

Mining & Civil Geotest Pty Ltd

Ph (08) 9414 8022 Fax (08) 9414 8011

Email matt@mcgeotest.com.au

Unit 1/1 Pusey Road, JANDAKOT WA 6164

Moisture Content AS 1289.2.1.1

Job No: 60083

Report No: 60083-P15/309

Date of issue: 27 January 2015

Client:	Galt Geotechnics (J1401266)	Date tested:	23 January 2015
Project:	Proposed Residential Development	Tested by:	P Culverston
Location:	Balcatta	Checked:	M van Herk

Sample Number	Sample Identification		
P15/309	TP2-1 3.5m	61.5	%
P15/312	TP8-2 4.5m	95.6	%
P15/313	BH-CPT11-1 3.5-4.0m	590.9	%
P15/314	BH-CPTU2-1 5.0-5.5m	61.1	%
P15/315	BH-CPT2-2 7.5-8.0m	252.3	%
P15/316	BH-CPTU5-1 5.0-5.5m	140.2	%
Tested as received	Furnace temperature 440^{oc}		

Organic content April 2009

Approved Signature Matthew van Herk

Mining & Civil Geotest Pty Ltd

Ph (08) 9414 8022 Fax (08) 9414 8011

Email matt@mcgeotest.com.au

Unit 1/1 Pusey Road, JANDAKOT WA 6164

Organic content of Soils ASTM: D 2974-07a Test Method C

Job No: 60083

Report No: 60083-P15/309

Date of issue: 27 January 2015

Client:	Galt Geotechnics (J1401266)	Date tested:	23 January 2015
Project:	Proposed Residential Development	Tested by:	P Culverston
Location:	Balcatta	Checked:	M van Herk

Sample Number	Sample Identification	Ash content %	Organic content %
P15/309	TP2-1 3.5m	94.6	5.4
P15/312	TP8-2 4.5m	85.9	14.1
P15/313	BH-CPT11-1 3.5-4.0m	52.6	47.4
P15/314	BH-CPTU2-1 5.0-5.5m	88.8	11.2
P15/315	BH-CPT2-2 7.5-8.0m	72.0	28.0
P15/316	BH-CPTU5-1 5.0-5.5m	72.2	27.8
Tested as received	Furnace temperature 440^{oc}		

Organic content April 2009

Approved Signature Matthew van Herk

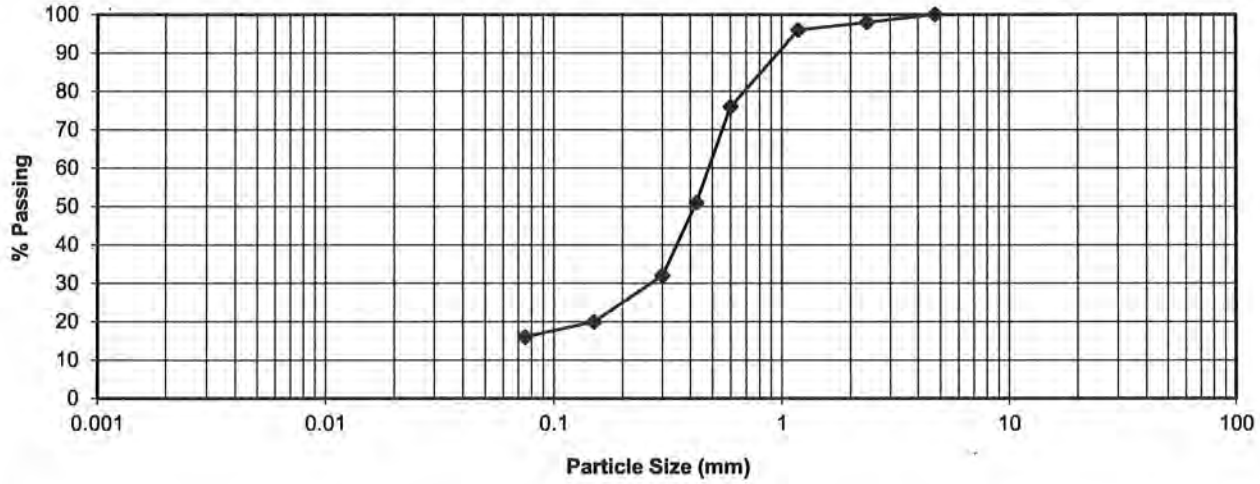
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60083
Report No:	60083-P15/310
Sample No:	P15/310
Issue Date:	27 January 2015

Client: Galt Geotechnics (J1401266)
Project: Proposed Residential Development
Location: Balcatta

Sample location: TP5-1
Sample Depth (m): 0.50



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	98
1.18	96
0.600	76
0.425	51
0.300	32
0.150	20
0.075	16

Plasticity index tests
AS 1289

Liquid limit 3.1.1	NA	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client Address: 2/39 Flynn Street, Wembley WA

Sampling Procedure: Tested as received

NATA
WORLD RECOGNISED ACCREDITATION

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

Approved signature

Matthew van Herk
AS PSDPI May 2009

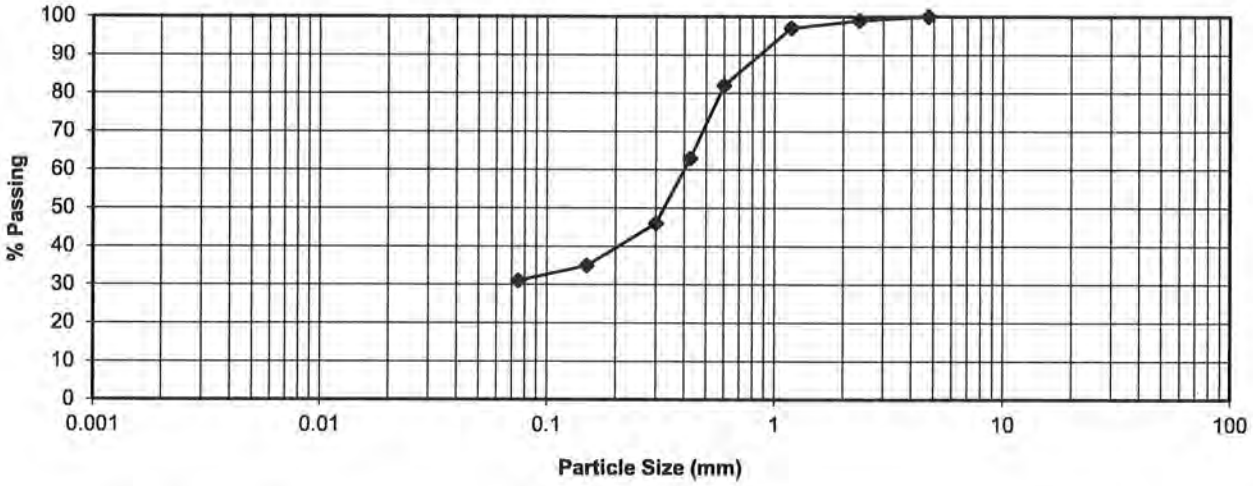
Particle Size Distribution & Plasticity Index tests

Mining & Civil
Geotest Pty Ltd
unit1/1 Pusey Road, Jandakot, WA 6164
Ph (08) 9414 8022 Fax (08) 9414 8011
Email: matt@mcgeotest.com.au

Job No:	60083
Report No:	60083-P15/311
Sample No:	P15/311
Issue Date:	27 January 2015

Client: Galt Geotechnics (J1401266)
Project: Proposed Residential Development
Location: Balcatta

Sample location: TP8-1
Sample Depth (m): 0.50



SIEVE ANALYSIS AS 1289.3.6.1

Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	97
0.600	82
0.425	63
0.300	46
0.150	35
0.075	31

Plasticity index tests
AS 1289

Liquid limit 3.1.1	NA	%
Plastic limit 3.2.1		%
Plasticity index 3.3.1		%
Linear shrinkage 3.4.1		%

Cracked ☐

Curled ☐

Client Address: 2/39 Flynn Street, Wembley WA

Sampling Procedure: Tested as received

NATA
WORLD RECOGNISED ACCREDITATION

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

Approved signature

Matthew van Herk
AS PSDPI May 2009

Appendix E: Understanding Your Geotechnical Engineering Report

www.galtgeo.com.au
2/39 Flynn St, WEMBLEY WA 6014

ABN: 73 292 586 155

UNDERSTANDING YOUR GEOTECHNICAL ENGINEERING REPORT

GALT FORM PMP11 Rev1

1. EXPECTATIONS OF A GEOTECHNICAL ENGINEERING REPORT

This document has been prepared to clarify what is and is not provided in your geotechnical report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with geotechnical conditions.

Geotechnical engineering is a less exact science than other engineering disciplines. We include this information to help you understand where our responsibilities as geotechnical engineers begin and end, to help the client recognise his responsibilities and risks. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of geotechnical problems and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following :

- The project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this geotechnical report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your geotechnical engineering report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the design team and by being able to review work produced by other members of the design team which relies on geotechnical information provided in our report.

3. GEOTECHNICAL ENGINEERING LOGS

Our reports often include logs of intrusive and non-intrusive geotechnical investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party as a consequence of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The geotechnical recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including as a result of anthropogenic events (such as construction on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

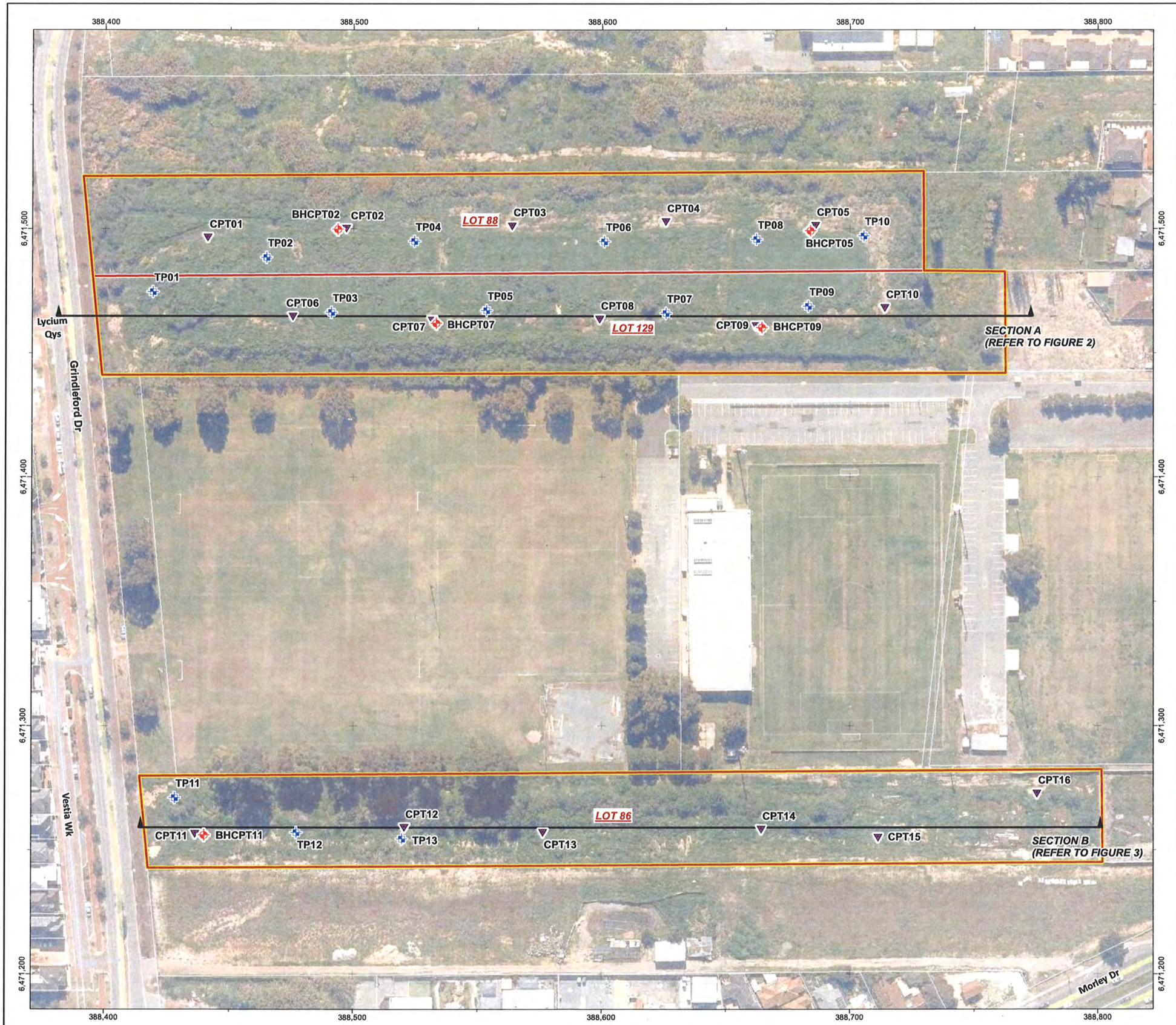
Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use engineering judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from engineering judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not included. The investigation techniques used by us in developing our report differ from those for an environmental investigation. Our report was not prepared with environmental considerations in mind and it is the client's responsibility to satisfy himself that environmental considerations have been taken into account for the site. If you require guidance on how to proceed on evaluating environmental risk at the site, we can provide further information and contacts.

O:\Administration\Standard Forms and Documents\PMP11 Understanding your Geotechnical Engineering Report.docx



Legend

- Site Boundary
- Lot Boundary

Test Locations

- Borehole
- Cone Penetration Test
- Test Pit
- Geological Section Line

N

0 20 40 60 80 100
Meters

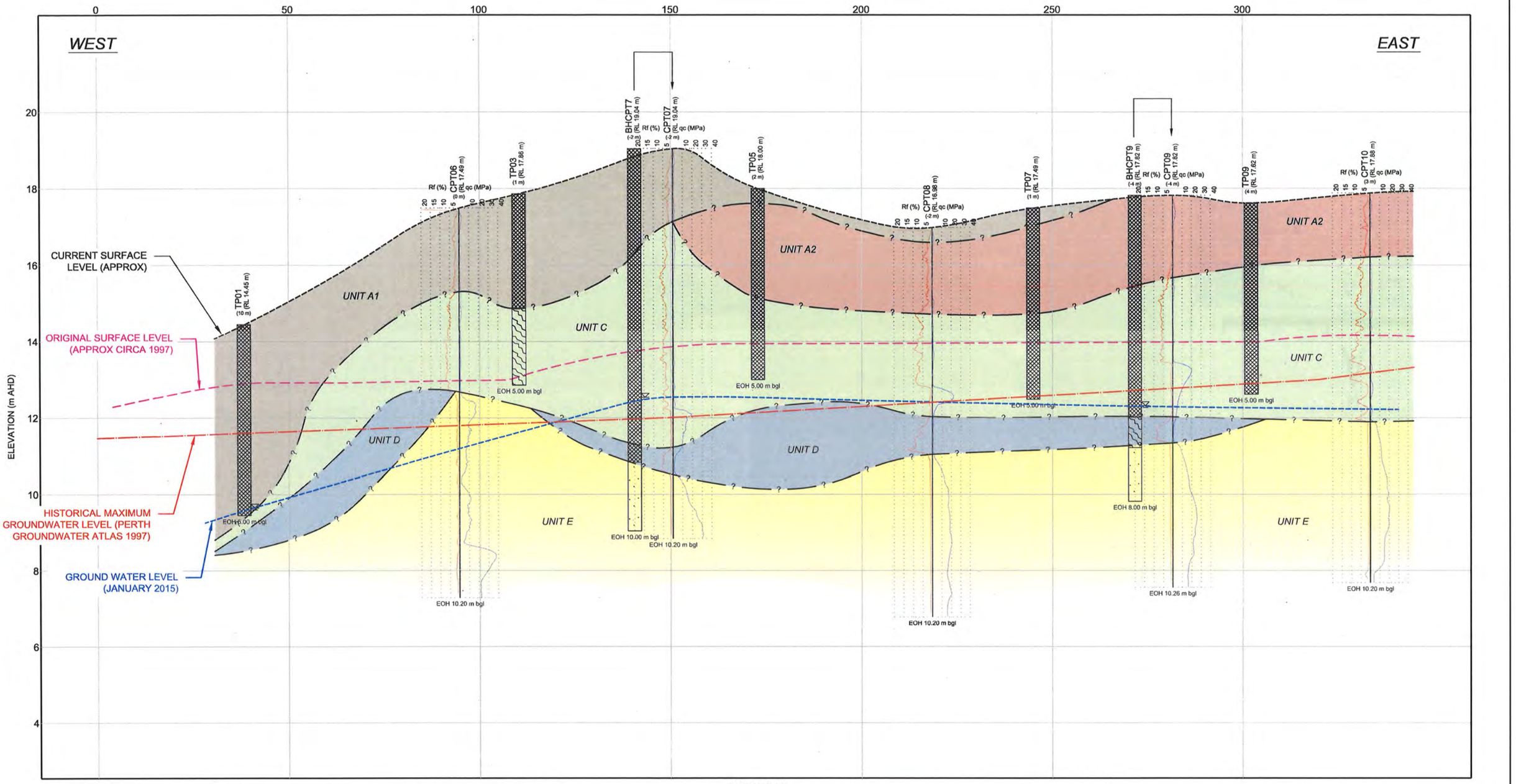
SCALE	1:1,500 (A3)
DRAWN	DAC
DATE DRAWN	16/02/2015
CHECKED	ORW
DATE CHECKED	16/02/2015
PROJECTION	GDA 1994 MGA Zone 50

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address : U2, 39 Flynn Street, Wembley, WA, 6014

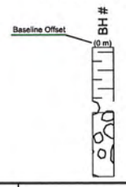
COPYRIGHT © 2015 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT GEOTECHNICS PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	ABN GROUP
PROJECT	PROPOSED RESIDENTIAL DEVELOPMENT
LOCATION	LOTS 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA
TITLE	SITE & LOCATION PLAN
Job No	J1401266
Fig No	FIGURE 1
Rev	A

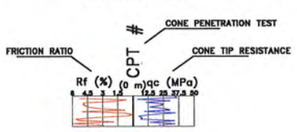
O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\09 GIS\04 MXD\J1401266-001.mxd (damonclark) 16/02/2015 1:48:06 PM



POST LEGEND



CPT DETAILS



MATERIAL GRAPHIC

- FILL
- PEAT
- Poorly-graded SAND
- Organic SAND

SOIL UNIT

A1	FILL: SAND WITH SOME ORGANICS
A2	FILL: PEATY SAND
B	UNCONTROLLED FILL (RUBBLE / RUBBISH / SAND)
C	FILL: PEAT
D	PEAT (NATURAL)
E	SAND, TYPICALLY DENSE

NOTES:

1. Groundwater level data may be inaccurate due to the presence of low permeability fill layers and the nature of the intrusive investigation techniques used. Long-term groundwater monitoring is recommended prior to finalising any earthworks plans
2. Historical maximum groundwater levels taken from the Perth Groundwater Atlas (1997)

H 1:1000
0 10 20 30 40 50m
V 1:100
0 1 2 3 4 5m
Coord.System: MGA94 Zone 50 Height Datum: AHD

REV	DESCRIPTION	DATE	CHK

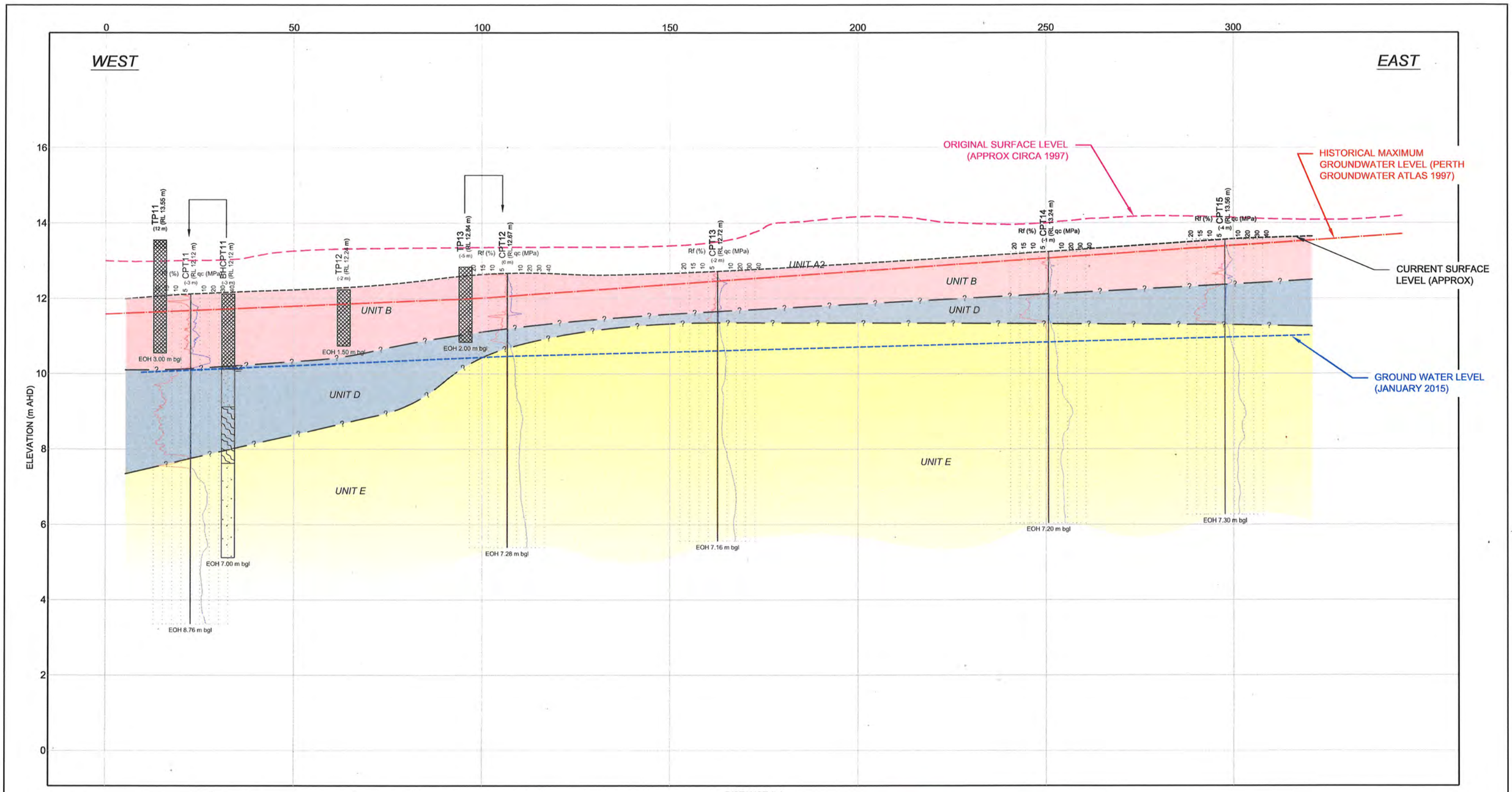
Copyright © 2015 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

SCALE	H 1:1000 V 1:100
DRAWN	DAC
DATE DRAWN	16/02/2015
CHECKED	ORW
DATE CHECKED	16/02/2015

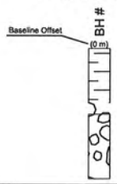
Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address : UNIT 2 39 Flynn Street, Wembley, WA, 6014

CLIENT	ABN GROUP
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	LOT 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA
TITLE	GEOLOGICAL SECTION A
JOB NO.	J1401266
FIGURE	FIGURE 2

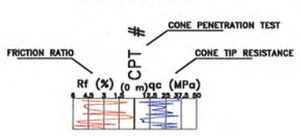
O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\05 CAD\J1401266-SECTIONS.dwg



POST LEGEND



CPT DETAILS



MATERIAL GRAPHIC

- FILL
- PEAT
- Poorly-graded SAND
- Organic SAND

SOIL UNIT

A1	FILL: SAND WITH SOME ORGANICS
A2	FILL: PEATY SAND
B	UNCONTROLLED FILL (RUBBLE / RUBBISH / SAND)
C	FILL: PEAT
D	PEAT (NATURAL)
E	SAND, TYPICALLY DENSE

NOTES:

1. Groundwater level based on one point only (BHCPT11) and may be inaccurate. Long-term groundwater monitoring is recommended prior to finalising any earthworks plans
2. Historical maximum groundwater levels taken from the Perth Groundwater Atlas (1997)

H 1:1000
0 10 20 30 40 50m
V 1:100
0 1 2 3 4 5m
Coord.System: MGA94 Zone 50 Height Datum: AHD

REV	DESCRIPTION	DATE	CHK

Copyright © 2015 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

SCALE	H 1:1000 V 1:100
DRAWN	DAC
DATE DRAWN	16/02/2015
CHECKED	ORW
DATE CHECKED	16/02/2015

Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address : UNIT 2 39 Flynn Street, Wembley, WA, 6014

CLIENT	ABN GROUP
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	LOT 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA
TITLE	GEOLOGICAL SECTION B
JOB NO.	J1401266
FIGURE	FIGURE 3

O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\05 CAD\J1401266-SECTIONS.dwg

Appendix C

Preliminary Flood Modelling of East Roselea

PERTH OFFICE
Suite 4, 26 Railway Road
Subiaco
Western Australia 6008

P +61 8 9380 4988
F +61 8 9380 9636
emergeassociates.com.au

Emerge Environmental Services Pty Ltd ABN 57144772510 trading as Emerge Associates

Document Reference: EP18-118(01)--002A DPC

Emerge Associates contact: Dave Coremans

1 November 2018

Attention: Matt Craven-Kelly
Parcel Property

Delivered by email to: mckelly@parcelproperty.com.au

Dear Matt

PRELIMINARY FLOOD MODELLING ANALYSIS OF EAST ROSELEA STRUCTURE PLANNING AREA AND UPSTREAM CATCHMENTS

At your request, Emerge Associates have undertaken review of the Local Water Management Strategy and associated flood modelling prepared to support the Structure Plan for the East Roselea site in Balcatta, with a view to providing additional information potential runoff which could enter the site from upstream catchments. This letter documents the outcome of the preliminary hydrological assessment undertaken by Emerge Associates.

Upstream catchment review

Emerge Associates have determined the extent up upstream catchments which could potentially discharge into the site. This was based on analysis of the City of Stirling's intramaps information, which shows pipe sizes and flow directions (however we note does not provide pipe invert levels). The extent of the catchment analysed is shown in **Plate 1**.

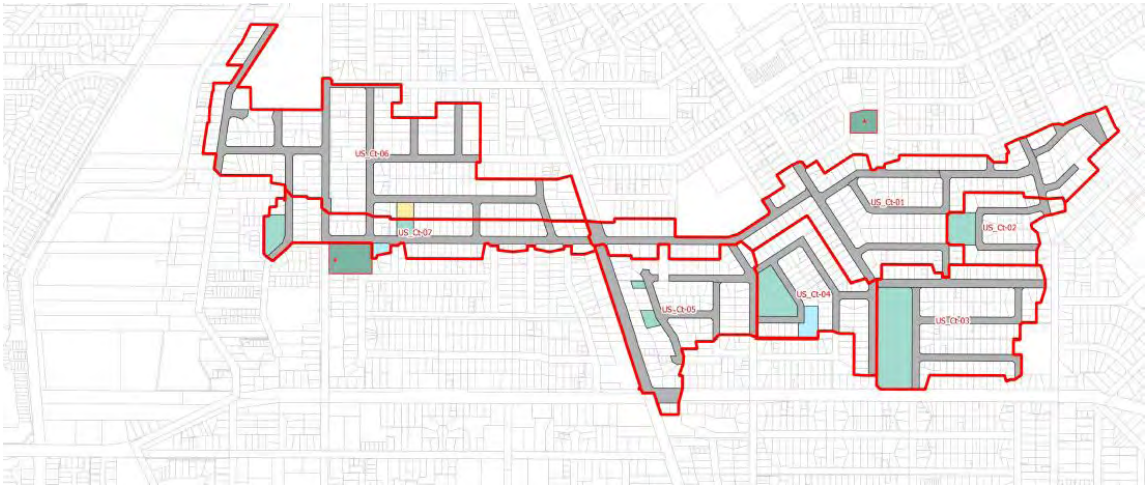


Plate 1: upstream catchments potentially contributing to East Roselea

The potential runoff from these catchments was modelled using XPSWMM software. We assumed that the first 15 mm of runoff from roads is able to be addressed at source, and that there was no restrictions to runoff moving across the catchment. The potential runoff from these catchments in a 1% AEP event was 9.98 m^3/s.

In reality however, we know that there are a number of storage areas within public open space (POS) and losses/storage in road reserves and the pipe network. Further, the topographical contours do not indicate that there are significant surface flow pathways. On this basis it is reasonable to assume that flow which enters the site is via the concrete piped network. The City's intramaps indicate that there is a 750 mm pipe leading from Radalj Place road reserve into the site. The pipe infrastructure which enters and which could potentially convey runoff from the LSP area is shown in **Plate 2**.

Plate 2: Stormwater infrastructure into and out of the LSP area (from City of Stirling Intramaps)

The discharge pipe widens to a 900 mm pipe and discharges in to Lot 90. When the 750 mm pipe flow restriction is added the potential flow into the site is reduced to 0.65m^3/s

Outflow from the site potentially occurs from a single 525 mm pipe which passes under Grindleford Drive.

The inverts of these pipes is not available, and it is therefore not possible to undertake a detailed peak flow analysis to determine the potential storage provided within the site. However, preliminary analysis of site contours suggests that runoff entering Lot 90 flows southward into the adjacent Lot 299. In absence of an outflow (i.e. via the 525 mm pipe) inundation would need to reach approximately 1 m depth before it could sheet flow southwards towards the intersection of Grindleford Drive and Coralvine Grange. The 1 m site contours in this area are shown in **Plate 3**, and suggest that there could be approximately 1,500 m^3 of storage provided in this area

Plate 3: Site topographical contours

While this analysis is based on first principles, it demonstrates that

- There is an inflow from an upstream catchment (of substantial size)
- There is a potential outflow which could regulate the amount of flood storage
- Runoff entering the site in to Lot 90 would migrate south in to Lot 299, which is at a lower elevation
- The magnitude of storage could be in the order of 1,500 m^3

In order to provide greater certainty to the amount of flood storage being provided by the site additional information regarding pipe inverts, site contours and tailwater conditions in the Albert Street Branch Drain would be required, and this information would inform a more detailed runoff modelling analysis.

Roselea East Structure Plan flood storage review

The LWMS provided flood modelling of the LSP area, however it was based on a now outdated plan, assumed an allowable pre-development outflow from the site and used lot-retention/losses that the City have since advised are not acceptable. Emerge Associates have therefore undertaken revised runoff modelling of the LSP area using the following assumptions:

- All lots retain the first 15 mm of runoff
- Road reserves are 60% impervious, and pervious portions have reduced infiltration to account for footpaths, cross overs, etc.)
- Storage swales achieve 2.5 m/day of infiltration
- Local Centre does not contribute runoff to the LSP area (i.e. deals with its own drainage)
- Runoff from the minor northern portion of the LSP area (north of Grindleford Drive) is accommodated within the POS area proposed
- Runoff from the majority (remainder) of the LSP area is accommodated within the Grindleford Drive swale, located along the western boundary of the LSP area
- Flood storage areas have 1:6 side slopes

Infiltration losses are summarised in **Table 1**.

Land type	Initial loss (mm)	Continual loss (mm/hr)	Manning's number (n)
Road surface (impervious)	1	0.1	0.02
Road verge (pervious)	9	1.5	0.05
Lot roof (impervious)	15	0.1	0.02
Lot hardscape (impervious)	1	0.1	0.02
Lot softscape (pervious)	25	3.5	0.05
Turf	22.5	3	0.05
Bushland	37	5	0.05

Table 1: infiltration losses within the LSP area.

The results of the LSP runoff analysis which shows flood storage volumes areas and assumptions are shown in **Table 2**.

Catchment	Storage type	Side slope	Length (m)	Depth (m)	TWL surface area (m^2)	Volume (m^3)
Ct_01 (north of Grindleford Drive)	Basin	1/6	-	1.2	740	500
Ct_02 (south and east of Grindleford Drive)	Swale	1/6	450.0	1.0	9,000	6,300
Total					9,740	6,800

Table 2: results of LSP runoff analysis

The results of the runoff analysis of the LSP area indicate that the Grindleford Drive swale would need to be 20 m wide, assuming that 450 m of the approximately 600 m can be utilised for drainage. The swale may require provision for integration into the surrounding land and presume that this could be resolved at detailed designs stage.

Summary and closing

The analysis of the LSP area and contributing catchments has been undertaken commensurate with the level of detail available regarding existing drainage infrastructure. The analysis of upstream catchments confirms that there are some flows entering the site from upstream catchments, though this is constricted by the size of the pipe network immediately upstream of the site. Given site levels it is likely that some measure of detention storage of upstream flows is currently provided within the site – to refine the estimates provided in this letter would require additional site information (pipe inverts, detailed site contours, tailwater conditions within the downstream drain). The revised LSP proposes approximately 6,000 m^2 of POS at the location of discharge in to the site, which would provide sufficient room to achieve detention of upstream flows as currently occurs.

The analysis undertaken of the LSP area indicates that the major event flood retention could be achieved by combination of a minor basin (for the land north of Grindleford Drive) and a flood retention swale along and immediately east of Grindleford Drive (for the land south and east of Grindleford Drive). The runoff modelling undertaken indicates that the swale would need to be a minimum of 20 m wide, assuming that 75% of the swale length can be utilised for flood storage.

Should you have any queries or concerns regarding the analysis undertaken, please do not hesitate to contact the undersigned.

Yours sincerely
Emerge Associates

Dave Coremans
DIRECTOR, PRINCIPAL ENVIRONMENTAL CONSULTANT - HYDROLOGY

cc: none

Encl: none

Appendix D

Groundwater Monitoring Results

Note: Locations of monitoring bores are given in Figure 6.

Table 6: Summary of Mean Groundwater Quality Analysis

Parameter	Limit of Reporting	ANZECC Trigger Levels (mg/L)	GD02	GD03	GD06	GD07
Temperature (°C)	-	-	18.80	17.4	20.5	19.2
Dissolved Oxygen (mg/L)	-	-	0.82	2.07	0.95	1.75
Specific Conductivity (µs/cm)	-	-	1147.0	1388.5	675.5	1648.0
Salinity (g/L)	-	-	0.64	0.89	0.37	1.02
pH	-	Lower limit: 6.5 Upper limit: 8.0	6.73	7.13	6.20	6.55
Redox (mV)	-	-	3.0	-21.0	30.9	-70.2
NH_4 (Ammonia as N)	0.01	0.08	0.14	0.28	0.19	1.07
Nitrite + Nitrate (NOx)	0.01	0.15	1.31	0.09	0.60	-
Total Kjeldahl Nitrogen (TKN)	0.1	-	1.75	1.9	1.4	1.9
Total Nitrogen (TN)	0.1	1.2	3.05	2	2	1.9
Total Phosphorus (TP)	0.01	0.065	0.57	1.17	2.31	0.52

Groundwater field parameters and nutrients are presented in Table 6. Groundwater ranged from 17.4 to 20.5 °C and was characterised as slightly acidic to neutral. Groundwater salinity was marginal across the site, with the exception of GD06 in the central-eastern portion of the site, which reported fresh conditions. Groundwater ranged from anaerobic to aerobic, with the greatest concentrations of dissolved oxygen located along the western site boundary. Reducing groundwater conditions were reported in the western portion of the site, whilst oxidising conditions were reported in the east.

Nutrients were detected at each sampled location and exceeded the ANZECC and ARMCANZ (2000) criteria for lowland rivers for ammonia as N (0.08 mg/L), nitrogen oxides as N (0.15 mg/L), total nitrogen (1.2 mg/L) and total phosphorus (0.065 mg/L) across the site.

Appendix D – Groundwater Monitoring Data (Reviewed by Emerge Associates, May 2019).

Table 1: Groundwater level monitoring data summary (2016 - 2018 monitoring periods)

Well ID	Easting	Northing	Number Monitoring Occasions	Minimum Watertable Height (mAHD)	Maximum Watertable Height (mAHD)	Depth to Groundwater Minimum (mBGL)	Depth to Groundwater Maximum (mBGL)
GD01	388531.37	6471758.19	10	11.78	12.40	2.21	1.59
GD02*	388767.98	6471781.31	10	13.33	13.64	0.97	0.66
GD03	388392.47	6471500.99	10	11.11	11.69	1.34	0.76
GD04	388699.02	6471520.26	11	12.69	13.53	1.60	0.76
GD05	388450.15	6471453.92	11	11.41	11.69	1.04	0.76
GD06	388736.98	6471452.43	10	13.00	13.64	2.57	1.93
GD07**	388418.90	6471262.61	9	10.93	11.20	2.55	2.28
GD08	388799.31	6471263.20	10	13.03	14.17	1.53	0.39

* Outlier data point removed from 2018 dataset

** Outlier data point removed from 2017 dataset

Table 2: Measured MGL and clearance from predevelopment surface

Well ID	Surface Level (mAHD)	Measured MGL (2017-18) (mAHD)	Clearance from MGL (m)
GD01	13.98	12.40	1.59
GD02	14.29	13.64	0.66
GD03	12.45	11.69	0.76
GD04	14.29	13.53	0.76
GD05	12.45	11.69	0.76
GD06	15.57	13.64	1.93
GD07	13.49	11.20	2.28
GD08	14.56	14.17	0.39

Appendix E

Modelling Assumptions Report

Modelling Assumptions Report

East Roselea

Project No: EP18-114(02)

Prepared for Parcel Properties

October 2020

Document Control

Doc name:	Modelling Assumptions Report East Roselea				
Doc no.:	**EP18-114(02)--004B JRT**				
Version	**Date**	**Author**		**Reviewer**	
1	March, 2019	Justin Temmen	JRT	Dave Coremans	DPC
	Appendix to LWMS				
A	July, 2019	Justin Temmen	JRT	Dave Coremans	DPC
	Appendix to LWMS				
B	October 2020	Marley Butler	MB	Dave Coremans	DPC
	Appendix to LWMS				

© 2020 Emerge Associates All Rights Reserved. Copyright in the whole and every part of this document belongs to Emerge Associates and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Emerge Associates.

Table of Contents

1 Modelling Assumptions....1

2 Upstream Pre-development Model....2

3 Post-development Model....3

3.1 Catchment hydrology....3
3.2 Post-development model results....5

4 References....6

List of Tables

Table 1: East Roselea post-development parameters....3
Table 2: East Roselea post-development catchment areas....3

1 Modelling Assumptions

This report is an appendix of the East Roselea Local Water Management Strategy (LWMS) and details the assumptions and calculations made in the hydrological modelling developed in support of the development.

XPSWMM hydrologic and hydraulic modelling software (v18.1) was used to calculate the surface water runoff volumes within the East Roselea development, as well as an external catchment located to the east of the development.

The hydrologic component of the software uses the Laurenson non-linear runoff-routing method to simulate runoff from design storm events. Key assumptions regarding the hydrologic model include:

- Runoff is proportional to slope, area, infiltration and percentage of imperviousness of a catchment.
- Development sub-catchment areas and slopes are determined from surveyed topographical data and earthworks plans.
- Upstream catchment areas and existing stormwater infrastructure are determined from publicly available online maps (Landgate 2018) and the City of Stirling (CoS) online Intramap (CoS 2018).
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions, and in consultation with Pritchard Francis Consulting Engineers.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Generally, assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given the length of 10 m and slope of 0.05 to minimise the lag time of conveying the water from a sub-catchment node to a ‘storage’ node, a ‘dummy intermediate’ node or a conduit/link.
- Links between sub-catchment storages act as conveyance channels (e.g. sheet flow within roads in a 1% annual exceedance probability (AEP) event). These links are given lengths and slopes that are representative of the site conditions and actual pathway lengths between catchments.
- All channels are designed with a width of 5 m, roughness of 0.014 (Manning’s n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Where relevant, swales, bio-retention areas (BRAs), and flood storage areas (FSAs) are modelled as nodal-reservoirs with infiltration depth-rating curves to account for differential infiltration rates with changing depth.

2 Pre-development Model

2.1 Upstream catchments

A 1D pre-development hydrological model was developed using the XPSWMM software to characterise the external, upstream catchments and estimate the runoff volumes that have historically been routed to the East Roselea site for infiltration along the natural low lying areas of the eastern portion of site, adjacent to Grindleford Drive.

The model was constructed to be consistent with the upstream catchment areas in order to determine the requirement for flood storage. Preliminary modelling and analysis was undertaken (Emerge Associates 2018) providing an overview of the potential runoff flows and volumes received by the site. This analysis has not been revised as upstream flows will be routed through the site to connect with the Water Corporation drainage asset that runs alongside the western side of Grindleford Drive.

2.2 Site runoff

Analysis was undertaken of the potential for runoff to leave the site to determine if there are any existing pre-development discharge flows.

- A DN900 pipe discharges onto the northern portion of site; it is proposed that flows will be re-routed ultimately connecting to the Albert Street Branch Drain (ABSD), the management of this volume of stormwater is therefore ignored.
- The southern DN525 pipe will drain a small part of Lot 86, and it is assumed that any post development discharge will meet the pre development flows.
- Grindleford Drive is higher than the downstream end of the site.

3 Post-development Model

A 1D post-development hydrological model was developed using the XPSWMM software to characterise the internal catchments and estimate runoff volumes from the East Roselea site for treatment and infiltration.

3.1 Catchment hydrology

The post-development model uses an "initial loss - continual loss" infiltration model. The post-development catchment area and land types were informed by the Structure Plan (provided in Appendix A of the LWMS). The loss parameters used within the post-development model are summarised in **Table 1**.

Table 1: East Roselea post-development parameters

Land type	Initial loss (mm)	Continual loss (mm)	Roughness
Road Surface	1	0.1	0.02
Road Verge	9	1.5	0.05
Lot Impervious (roof, paved)	15	0.1	0.02
Lot Pervious (gardens)	25	3.5	0.05
POS	20	2.5	0.05

A summary of post-development catchment information is provided in **Table 2** with the catchment plan and basin locations shown in Figure 8 of the LWMS (Emerge Associates 2020).

Table 2: East Roselea post-development catchment areas

Sub-catchment	Slope	Area (ha)								
		Total catchment area	Total road reserve	Road pavement	Road verge	Total Lot Roof	Total Lot Hardscape	Total Lot Softscape	POS	Drainage
Ct-01	0.01	2.05	0.39	0.32	0.08	0.92	0.31	0.31	0.00	0.12
Ct-02	0.01	1.54	0.60	0.48	0.12	0.64	0.19	0.11	0.00	0.00
Ct-03	0.01	2.14	0.39	0.31	0.08	0.80	0.27	0.26	0.00	0.41
Ct-04	0.01	5.89	0.75	0.60	0.15	0.87	0.27	0.26	0.60	0.17
Ct-05	0.01	1.62	0.34	0.28	0.07	0.59	0.20	0.20	0.00	0.30
Ct-06	0.01	8.65	2.43	1.95	0.49	4.38	0.96	0.50	0.38	0.00
Ct-06A	0.01	3.67	0.31	0.25	0.06	0.00	0.00	0.00	3.08	0.29
Ct-07	0.01	1.15	0.36	0.29	0.07	0.29	0.10	0.10	0.24	0.10

Due to the nature of existing stormwater infrastructure at the north and east of site, runoff from catchment Ct-02 is assumed to accumulate and discharge via pipework to the Water Corporation asset along with runoff generated within the external upstream catchment detailed in **Section 2**.

The following characteristics further define the East Roselea post development catchment model:

- Critical storm event analysis
  - Major (1% AEP) storm event – 6 hour duration.
  - Minor (20% AEP) storm event – 6 hour duration.
- Lot assumptions
  - Lots of different densities are assumed to have an impervious to pervious ratio (Roof : Hardscape : Softscape) as follows;
    - R30 – 60 : 20 : 20
    - R40 – 70 : 20 : 10
    - R60 (and over) – 80 : 15 : 5
  - Lot impervious areas retain the small (first 15 mm) event only.
  - The Civic area retains 100% of runoff, up to and including the major storm event.
- Road reserve assumptions
  - Road reserves within catchments are, on average, 80% impervious surface and 20% pervious verge allowing for crossovers, hardscape verge treatments, and paths.
  - Roads, pavements and driveways do not infiltrate runoff. However, some minor absorption storage losses are accounted for in the initial and continuing loss rates as summarised in **Table 1**.
- POS assumptions
  - POS is assumed to be 100% pervious.
  - POS will likely contain dense vegetation or turf over a sand-based landscape mix.
  - The playing field in Ct-06A is assumed to retain runoff up to the major storm event for the entire surface area, except for a 20 m corridor adjacent to drainage areas (~0.4 ha) assumed to discharge directly to the adjacent swale.
  - Four trees alongside Grindleford roadside reserve are to be retained. Swale design has been modelled accordingly. Further detail is provided in Appendix G of the LWMS (Emerge Associates 2019).
- Storage assumptions
  - All Catchments (except Ct-06)
    - Treatment and storage swales retain 100% of runoff from roads up to and including the major (1% AEP) storm event, and runoff from lots above the small (first 15 mm) storm event.
  - Catchment Ct-06
    - A bio-retention area (BRA) retains the first 15mm from road reserves in Ct-06.
    - A flood storage area (FSA) retains the majority of the major storm event discharged from roads and lots within Ct-06.
    - Additional storage is provided in the Ct-06a swale for relief during the major storm event.
- Storage infiltration assumptions
  - Swale inverts of Ct-03 and Ct-06 have been set at least 300 mm above the modelled 50% AEP future groundwater level.
  - An infiltration rate of 2.5 m/day has been allowed as this is consistent with the modelled excavation of peat material below the invert of swales and the basin.
  - Infiltration through base area and side slopes of the swales, BRA and FSA is considered in the infiltration rating curves for this infrastructure.

- Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and since the duration of the model run was comparatively short. XPSWMM default evapotranspiration assumptions are therefore used.

3.2 Post-development model results

The model for the East Roselea post-development catchments was designed to test treatment and storage requirements for each sub-catchment (see **Table 2**). The small (first 15mm) rainfall event is assumed treated within swales and a BRA. The minor (20% AEP) and major (1% AEP) storm events are likewise stored in swales and a FSA.

Runoff from the external eastern external catchment and catchment Ct_02 is assumed hydraulically linked to Water Corporation drainage infrastructure as discussed in **Section 3.1**.

Proposed design requirements and locations of treatment and flood storage for each sub-catchment are shown in Figure 8 of the LWMS.

4 References

Bureau of Meteorology (BoM) 2018, *Design Rainfalls - IFD*, viewed October-November 2018 <http://www.bom.gov.au/water/designRainfalls/ifd/>

City of Stirling 2018, Stirling Intramaps, accessed October-November 2018 <https://maps.stirling.wa.gov.au/intramaps80/>

Department of Water 2008, *LiDAR Elevation Dataset*, Swan Coastal Plain

Emerge Associates 2018, *Preliminary flood modelling analysis of East Roselea structure planning area and upstream catchments*, Subiaco 2018

Emerge Associates 2020, *East Roselea Local Water Management Strategy*, Subiaco 2020

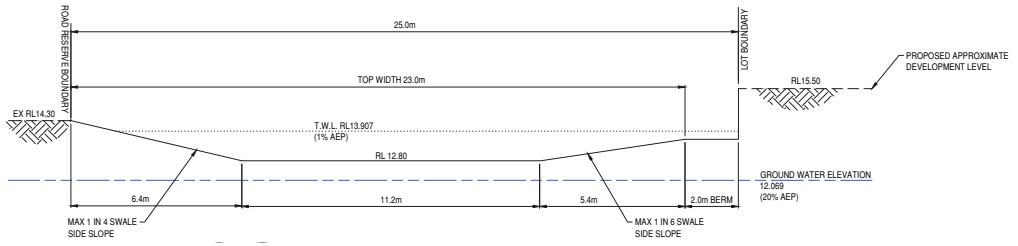
Landgate 2018, Landgate Map Viewer, accessed October-November 2018 <https://maps.landgate.wa.gov.au/maps-landgate/registered/>

Appendix F

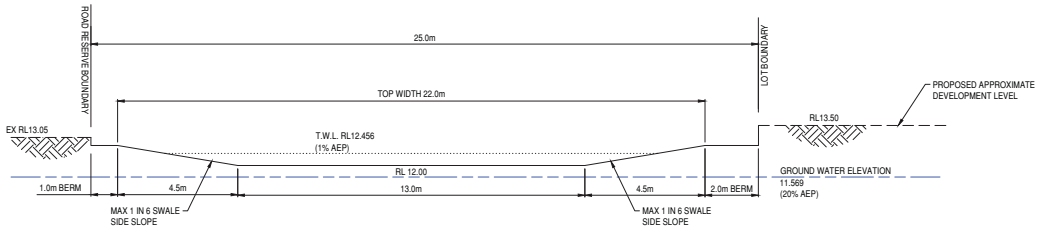
Civil Engineering Designs

NORTH

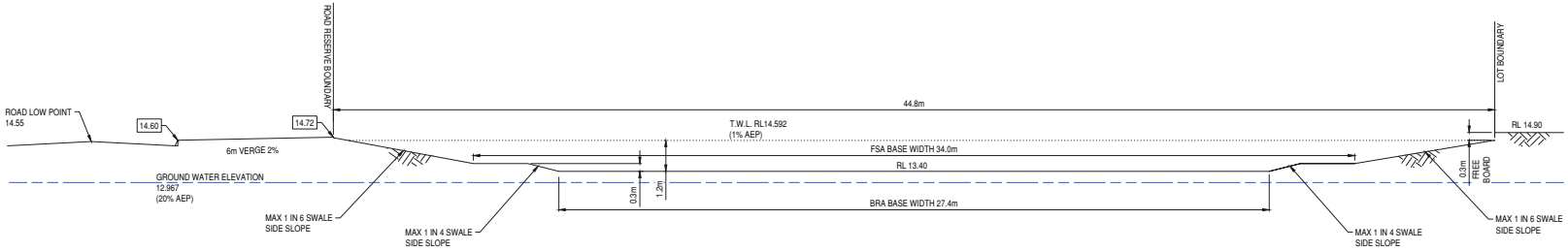
NOTE:
REFER TO LANDSCAPE ARCHITECT DRAWINGS FOR TREE PROTECTION DETAILS



SECTION CT_03/04_US
SCALE 1:100 0m 1m 2m
SK-20



SECTION CT_03/04_DS
SCALE 1:100 0m 1m 2m
SK-20



SECTION Ø1_06_CB
SCALE 1:100 0m 1m 2m
SK-20

DIAL BEFORE YOU DIG
www.1100.com.au
Three Essential First Steps.

REV	DATE	DESCRIPTION	BY	CHKR
F	08/10/20	BASE AND TWLs REVISED	JS	FO
E	15/07/19	BERMS ADDED	JS	FO
D	12/07/19	SECTIONS REVISED	JS	FO
C	15/04/19	LEVELS AMENDED	LL	FO
B	12/04/19	SECTION Ct_06_CB ADDED	LL	JS
A	05/04/19	INITIAL ISSUE	LL	JS

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
APRIL 2019	PCG94	AHD

DESIGNED	DRAWN	CHECKED	APPROVED
FO	LL	JS	FO .... / ...

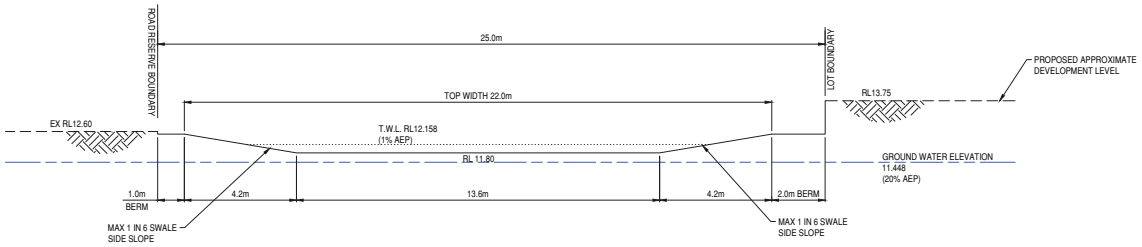
W.A.P.C. N/A
SCALE U.N.O. AS SHOWN @ A1
SHEET SIZE
DRG No. 15029-C9-SK-22
REVISION F

CLIENT & JOB
PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

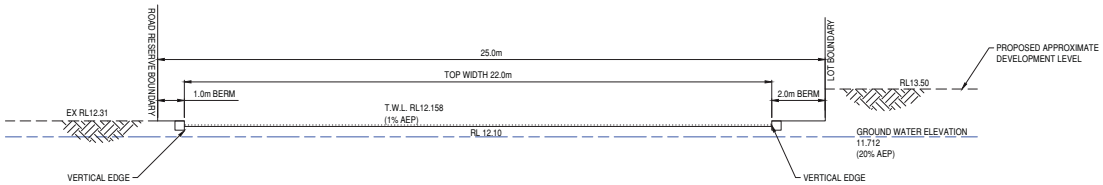
TITLE
PROPOSED SWALE DETAILS
SHEET 3 OF 3

NORTH

NOTE:
REFER TO LANDSCAPE ARCHITECT DRAWINGS FOR TREE PROTECTION DETAILS



SECTION CT_05_US
SCALE 1:100 0m 1m 2m
SK-20



SECTION CT_05_DS
SCALE 1:100 0m 1m 2m
SK-20

DIAL BEFORE YOU DIG
www.1100.com.au
Three Essential First Steps.

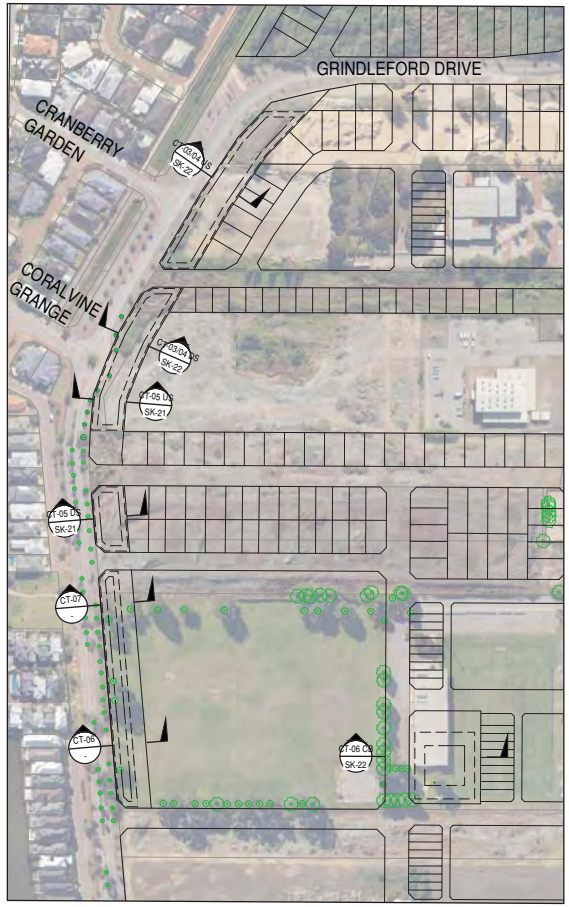
REV	DATE	DESCRIPTION	BY	CHKR
E	08/10/20	BASE AND TWLs REVISED	JS	FO
D	15/07/19	BERMS ADDED	JS	FO
C	12/07/19	SECTIONS REVISED	JS	FO
B	09/04/19	SECTION Ct_05_US AMENDED	JS	FO
A	05/04/19	INITIAL ISSUE	LL	JS

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

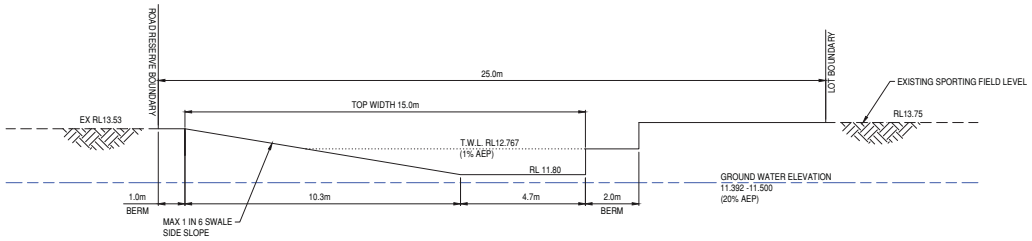
DRAWING STATUS: NOT FOR CONSTRUCTION
DATE: APRIL 2019
GRID: PCG94
DATUM: AHD
DESIGNED: FO
DRAWN: LL
CHECKED: JS
APPROVED: FO
W.A.P.C.: N/A
SCALE U.N.O.: AS SHOWN @ A1
CLIENT & JOB: PARCEL PROPERTY GRINDLEFORD DRIVE, BALCATTA
TITLE: PROPOSED SWALE DETAILS SHEET 2 OF 3
SHEET SIZE: A1
DRG No.: 15029-C9-SK-21
REVISION: E

NORTH

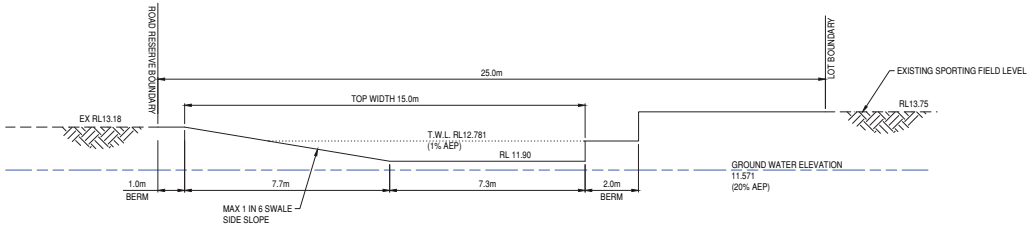
NOTE:
REFER TO LANDSCAPE ARCHITECT DRAWINGS FOR TREE PROTECTION DETAILS



LOCALITY PLAN
SCALE 1:2000 0m 40m 80m



SECTION CT_06
SCALE 1:100 0m 1m 2m



SECTION CT_07
SCALE 1:100 0m 1m 2m

NOTE:

EXISTING GRINDLEFORD DRIVE ROAD RESERVE LEVELS ARE SUBJECT TO CONFIRMATION BY DETAILED SURVEY. FEATURE SURVEY DOES NOT COVER THE FULL EXTENT OF THIS PLAN, SOME LEVELS ARE TAKEN FROM SURVEY WHILST OTHERS ARE BASED OFF PUBLIC DATABASE CONTOUR INFORMATION AND MAY NOT BE ACCURATE. TO BE CONFIRMED DURING SUBSEQUENT DESIGN.

ROAD RESERVE BOUNDARY AND EXISTING ROAD TO BE CONFIRMED WITH ADDITIONAL FEATURE SURVEY

DIAL BEFORE YOU DIG www.1100.com.au Three Essential First Steps.

REV	DATE	DESCRIPTION	BY	CHKR
E	08/10/20	BASE AND TWLs REVISED	JS	FO
D	17/07/19	SECTIONS AMENDED	JS	FO
C	15/07/19	BERMS ADDED	JS	FO
B	12/07/19	SECTIONS REVISED	JS	FO
A	05/04/19	INITIAL ISSUE	LL	JS

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
APRIL 2019	PCG94	AHD

DESIGNED	DRAWN	CHECKED	APPROVED
FO	LL	JS	FO ...../ ..../ ....

W.A.P.C. N/A | SCALE U.N.O. AS SHOWN @ A1

CLIENT & JOB: PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

TITLE: PROPOSED SWALE DETAILS
SHEET 1 OF 3

SHEET SIZE: A1 | DRG No. 15029-C9-SK-20 | REVISION E

NORTH

NOTES

1. EXISTING SURVEY INFORMATION IS PROVIDED BY MNG SURVEY, AS CONSOLIDATED IN JAN 2019. THE SURVEY DOES NOT COVER THE ENTIRE SITE AND WILL NEED TO BE VERIFIED IN THE FUTURE.
2. THIS CONCEPT DRAWING SHOULD BE READ IN CONJUNCTION WITH THE LOCAL WATER MANAGEMENT STRATEGY AND ASSOCIATED PLANS AS PREPARED BY EMERGE ASSOCIATES.
3. PROPOSED ROAD AND FINISHED LOT LEVELS ARE INDICATIVE ONLY AND SUBJECT TO FURTHER DESIGN DEVELOPMENT, STAKEHOLDER AND AUTHORITY COORDINATION.
4. MINIMUM SWALE INVERT LEVELS ARE AS ADVISED BY EMERGE ASSOCIATES AND LARGELY RELATE TO ESTIMATED MAXIMUM GROUNDWATER LEVELS.
5. SUBSOIL DRAINAGE LAYOUT AND LEVELS ARE SUBJECT TO DESIGN DEVELOPMENT, COORDINATION WITH OTHER SERVICES, GEOTECHNICAL AND EARTHWORKS PREPARATION REQUIREMENTS.
6. OVERLAND FLOW PATHS AREA DIRECTED TOWARDS COMPENSATING BASINS AND SWALE AREAS. DUE TO OVERALL LEVEL DIFFERENCES, THERE ARE SOME AREAS OF SAW-TOOTH ROAD PROFILES REQUIRED TO ACHIEVE FLOOD ROUTING.
7. SUBSOIL DRAINAGE IS INTENDED TO BE SLOTTED PVC DRAINAGE PIPE IN ACCORDANCE WITH AS2439. SIZE, LAYOUT, LEVELS, TRENCH DETAILS AND THE LIKE ARE SUBJECT TO FURTHER DESIGN AND SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS AND TO THE SATISFACTION OF THE CITY OF STIRLING.
8. A SEPARATION OF 1.2m IS INTENDED BETWEEN SUBSOIL LEVELS, ROAD LEVELS AND LOT LEVELS. HOWEVER THIS MAY NOT BE ACHIEVABLE IN ALL AREAS, SUCH AS ROAD CONNECTIONS TO EXISTING LEVELS IN GRINDLEFORD DRIVE.
9. TREES TO BE PROTECTED AS BEST AS POSSIBLE.
10. THE SITE IS NOTED TO HAVE HIGH GROUNDWATER LEVELS AND NATURALLY OCCURRING UNDERLYING PEAT MATERIAL. EARTHWORKS METHODOLOGIES ARE INTENDED TO CONSIDER THESE GEOTECHNICAL CONDITIONS AND PROVIDE SUITABLE REMEDIATION STRATEGIES TO ACHIEVE LOTS SUITABLE FOR RESIDENTIAL DEVELOPMENT IN ACCORDANCE WITH AS3798. INDICATIVE LOT LEVELS CONSIDER ADEQUATE SEPARATION TO GROUNDWATER AND PEAT, HOWEVER ARE SUBJECT TO FURTHER DESIGN.
11. EARTHWORKS AND ANY MODIFICATION TO THE EXISTING PEAT LAYER, IF AND AS REQUIRED, IS NOT SHOWN ON THIS PLAN AND IS SUBJECT TO MORE DETAILED DESIGN.

LEGEND

- SITE BOUNDARY
- EXISTING SURFACE CONTOUR
- 50% AEP MODELLED GROUNDWATER CONTOURS - WET SCENARIO (EMERGE AND ASSOCIATES 2020)
- 6.80 — INDICATIVE DESIGN ROAD CENTRELINE LEVEL
- 6.80 — INDICATIVE DESIGN LOT LEVEL
- 6.80 — INDICATIVE EXISTING SURFACE LEVEL
- 6.80 — INDICATIVE SUBSOIL DRAINAGE INVERT LEVEL
- OVERLAND FLOW DIRECTION
- SAG POINT
- CREST POINT
- SS — INDICATIVE SUBSOIL DRAIN AND FLOW DIRECTION
- TOP OF DRAINAGE BASIN
- BOTTOM OF DRAINAGE BASIN

REV	DATE	DESCRIPTION	BY	CHKR
C	08/10/20	GROUND WATER CONTROUS AMENDED	JS	FO
B	12/07/19	LEVELS AMENDED AND SUBSOIL ADDED	JS	FO
A	27/03/19	INITIAL ISSUE	JS	MRI

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2100
Subiaco WA 6904
Telephone: (08) 9382 5111

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE: MARCH 2019 | GRID: PCG94 | DATUM: AHD

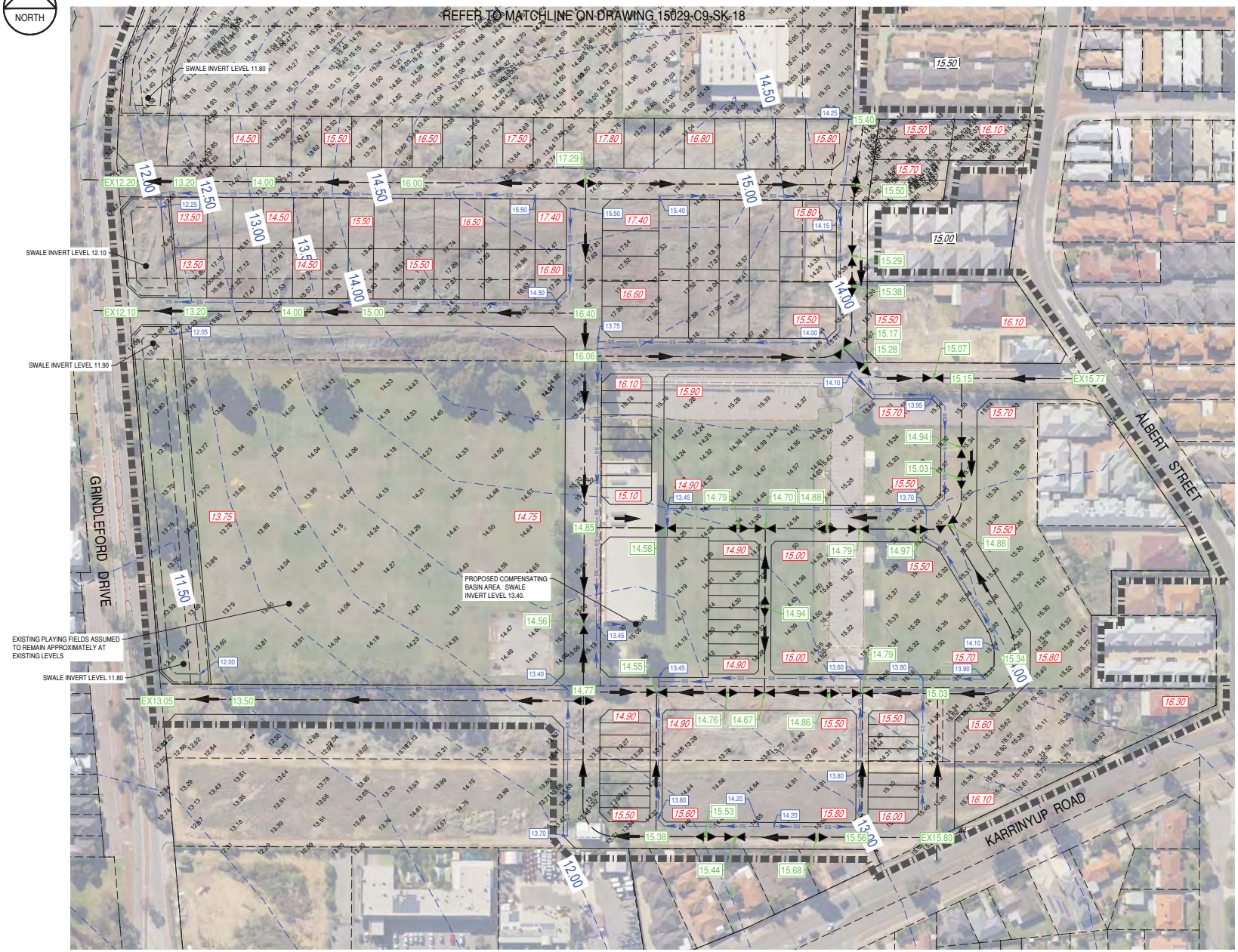
DESIGNED: JS | DRAWN: JS | CHECKED: MRI | APPROVED: MRI .... / ...

W.A.P.C.: N/A | SCALE U.N.O.: 1:1000 @ | SHEET SIZE: A1

CLIENT & JOB: PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

TITLE: STRUCTURE PLAN, CONCEPT FINISHED LEVELS, OVERLAND FLOW AND SUBSOIL DRAINAGE PLAN SHEET 2 OF 2

DRG No.: 15029-C9-SK-18 | REVISION: C



NOTES

1. EXISTING SURVEY INFORMATION IS PROVIDED BY MNG SURVEY, AS CONSOLIDATED IN JAN 2019. THE SURVEY DOES NOT COVER THE ENTIRE SITE AND WILL NEED TO BE VERIFIED IN THE FUTURE.
2. THIS CONCEPT DRAWING SHOULD BE READ IN CONJUNCTION WITH THE LOCAL WATER MANAGEMENT STRATEGY AND ASSOCIATED PLANS AS PREPARED BY EMERGE ASSOCIATES.
3. PROPOSED ROAD AND FINISHED LOT LEVELS ARE INDICATIVE ONLY AND SUBJECT TO FURTHER DESIGN DEVELOPMENT, STAKEHOLDER AND AUTHORITY COORDINATION.
4. MINIMUM SWALE INVERT LEVELS ARE AS ADVISED BY EMERGE ASSOCIATES AND LARGELY RELATE TO ESTIMATED MAXIMUM GROUNDWATER LEVELS.
5. SUBSOIL DRAINAGE LAYOUT AND LEVELS ARE SUBJECT TO DESIGN DEVELOPMENT, COORDINATION WITH OTHER SERVICES, GEOTECHNICAL AND EARTHWORKS PREPARATION REQUIREMENTS.
6. OVERLAND FLOW PATHS AREA DIRECTED TOWARDS COMPENSATING BASINS AND SWALE AREAS. DUE TO OVERALL LEVEL DIFFERENCES, THERE ARE SOME AREAS OF SAW-TOOTH ROAD PROFILES REQUIRED TO ACHIEVE FLOOD ROUTING.
7. SUBSOIL DRAINAGE IS INTENDED TO BE SLOTTED PVC DRAINAGE PIPE IN ACCORDANCE WITH AS2439. SIZE, LAYOUT, LEVELS, TRENCH DETAILS AND THE LIKE ARE SUBJECT TO FURTHER DESIGN AND SHALL BE IN ACCORDANCE WITH RELEVANT STANDARDS AND TO THE SATISFACTION OF THE CITY OF STIRLING.
8. A SEPARATION OF 1.2m IS INTENDED BETWEEN SUBSOIL LEVELS, ROAD LEVELS AND LOT LEVELS. HOWEVER THIS MAY NOT BE ACHIEVABLE IN ALL AREAS, SUCH AS ROAD CONNECTIONS TO EXISTING LEVELS IN GRINDLEFORD DRIVE.
9. TREES TO BE PROTECTED AS BEST AS POSSIBLE.
10. THE SITE IS NOTED TO HAVE HIGH GROUNDWATER LEVELS AND NATURALLY OCCURRING UNDERLYING PEAT MATERIAL. EARTHWORKS METHODOLOGIES ARE INTENDED TO CONSIDER THESE GEOTECHNICAL CONDITIONS AND PROVIDE SUITABLE REMEDIATION STRATEGIES TO ACHIEVE LOTS SUITABLE FOR RESIDENTIAL DEVELOPMENT IN ACCORDANCE WITH AS3798. INDICATIVE LOT LEVELS CONSIDER ADEQUATE SEPARATION TO GROUNDWATER AND PEAT, HOWEVER ARE SUBJECT TO FURTHER DESIGN.
11. EARTHWORKS AND ANY MODIFICATION TO THE EXISTING PEAT LAYER, IF AND AS REQUIRED, IS NOT SHOWN ON THIS PLAN AND IS SUBJECT TO MORE DETAILED DESIGN.

LEGEND

- SITE BOUNDARY
- EXISTING SURFACE CONTOUR
- 50% AEP MODELLED GROUNDWATER CONTOURS - WET SCENARIO (EMERGE AND ASSOCIATES 2020)
- 6.80 INDICATIVE DESIGN ROAD CENTRELINE LEVEL
- 6.80 INDICATIVE DESIGN LOT LEVEL
- 6.80 INDICATIVE EXISTING SURFACE LEVEL
- 6.80 INDICATIVE SUBSOIL DRAINAGE INVERT LEVEL
- OVERLAND FLOW DIRECTION
- SAG POINT
- CREST POINT
- INDICATIVE SUBSOIL DRAIN AND FLOW DIRECTION
- TOP OF DRAINAGE BASIN
- BOTTOM OF DRAINAGE BASIN

REV	DATE	DESCRIPTION	BY	CHKR
D	08/10/20	GROUND WATER CONTROUS AMENDED	JS	FO
C	12/07/19	LEVELS AMENDED AND SUBSOIL ADDED	JS	FO
B	01/04/19	LEVELS AMENDED	CJD	FO
A	27/03/19	INITIAL ISSUE	JS	MRI

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2100
Subiaco WA 6904
Telephone: (08) 9382 5111

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE: MARCH 2019 | GRID: PCG94 | DATUM: AHD

DESIGNED: JS | DRAWN: JS | CHECKED: MRI | APPROVED: MRI

W.A.P.C.: N/A | SCALE U.N.O.: 1:1000 @ | SHEET SIZE: A1

CLIENT & JOB: PARCEL PROPERTY GRINDLEFORD DRIVE, BALCATTA

TITLE: STRUCTURE PLAN, CONCEPT FINISHED LEVELS, OVERLAND FLOW AND SUBSOIL DRAINAGE PLAN SHEET 1 OF 2

DRG No.: 15029-C9-SK-17

REVISION: D

Appendix G

Conceptual Landscape Designs

Appendix H

Groundwater Modelling Report (CDM Smith)

Parcel Property

East Roselea Groundwater Modelling

20 November 2020

CDM Smith

Revision Summary

Following the submission of the original report (Rev A) groundwater model had to revised to accommodate comments from the regulator (DWER) and recent site investigation results.

Main comments that this model (Rev B) had to address were:

1. "Rainfall recharge and evapotranspiration have not been applied to the entire model domain. This can significantly impact the model results and groundwater could be more variable and problematically higher."
2. "An analysis of available groundwater information in the surrounding area should be undertaken to provide an understanding of the sensitivity of existing properties and infrastructure to the predicted groundwater level changes."

To accommodate these two requirements model domain was extended further in all directions to include several available monitoring bores (61610142, 61610143, 61610163 and 61615012). Also, recharge and evapotranspiration have been applied across the entire model domain.

In addition to the above, Parcel Properties have engaged Galt Geotechnics to undertake additional permeability testing of the natural and imported peat layers across the site. Infiltration testing indicated measured horizontal permeability of between 0.02 m/d and 0.0012 m/d, which renders this unit effectively impermeable. Rev A model considered permeability of the peat layer of 1 m/d horizontal and 0.1 m/d vertical. Reducing this parameter in the model by three magnitudes had an impact on other model parameters as well and the model had to be recalibrated from scratch. For the same reasons some structural changes had to be adopted in the post-development model. Direct hydraulic connection between the infill material in model layer 1 and sand below the peat in model layer 3 had to be established under the proposed basin and swales by removing peat at those locations to allow for drainage of the swales and basin. Thickness of the infill material above the peat was increased by further removing peat in some areas of the site to allow for minimum thickness of the infill material of 2.3m. Top elevations of the infill material remained consistent with the Rev A model.

All major changes described above and other minor changes have been discussed in details in the following sections of this report.

Executive Summary

A numerical groundwater model has been developed in support of the Local Water Management Strategy and Structure Plan for the proposed East Roselea project.

The development of the groundwater model for this site follows the recommendations of the Australian Groundwater Modelling Guidelines and Specification for separation distances for groundwater-controlled urban development. The numerical model is a groundwater flow model developed using the Modflow-USG code operating under the Groundwater Vistas graphical interface.

Results of the calibrated model parameters (hydraulic conductivity, specific yield, recharge, evapotranspiration, boundary elevations and conductancies) were consistent with background ranges determined mainly from the available groundwater data, soil investigation reports and literature. Model convergence and the model water balance were within guideline target criteria.

The transient model calibration provided a good match between the measured and predicted groundwater levels within the site domain and outside of the site at “regional” monitoring bore locations. The model had acceptable qualitative performance with modelled groundwater levels in reasonable agreement with observed values.

A predictive scenario, which represents the proposed Structure Plan and earthworks approach proposed for the site, was modelled to investigate post development impact on groundwater levels and throughflow in and around the site. Subsoil drains associated with the development at East Roselea have not been simulated. This is because even without the subsoil drains the model estimates that post development water levels within the site would stay below the post-development ground levels. Predictive post-development impacts on groundwater levels at East Roselea used Wet, Median and Dry climate scenarios. The simulated climate change scenarios are consistent with the “Selection of future climate projections for Western Australia” report by Department of Water WA. The model estimates that water levels within the site would stay below the post-development ground levels. Prediction results suggest that short term peaks in projected rainfall for June peak years would result in groundwater levels being at or less than 0.2 m higher than the bottom of the swale at Swale 1 north and Swale 2 only for the Wet climate scenario, and below the invert levels of Swale 1 south, Swale 3 north and south, Swale 4, Basin and throughout the site.

The model estimates that outside of the immediate site area proposed development at East Roselea would not cause any drawdown or drawup outside of the site.

This report is a full record of the model development and predictive simulations. It includes descriptions of the hydrogeological conceptualisation, model construction and calibration, predictive simulations and results, and predictive uncertainty analysis in the form of climate change scenarios.

Table of Contents

Revision Summary ..... **ii**

Executive Summary ..... **iii**

Section 1 Introduction **4**

Section 2 Site physical setting **6**

2.1 Climate 6

2.2 Topography 6

2.3 Hydrology 8

2.4 Geology and soils 8

2.5 Hydrogeology 8

Section 3 Groundwater Model **12**

3.1 Model Setup 12

3.2 Model Calibration 18

3.3 Adopted hydraulic properties and boundary conditions 21

Section 4 Predictive simulations **22**

4.1 Development scenario setup 22

4.2 No Development Scenario 30

4.3 Development scenario results 31

Section 5 Conclusions ..... Error! Bookmark not defined.

Section 6 References **44**

Figures

Figure 1-1 Proposed Development Plan 5

Figure 2-1 Measured Rainfall and Evapotranspiration (Perth Metro weather station ID: 009225) 6

Figure 2-2 Site Topography 7

Figure 2-3 Site Geology 9

Figure 2-4 Bore locations and measured maximum pre-development groundwater levels 10

Figure 3-1 Hydraulic conductivity distribution in model layer 1 13

Figure 3-2 Hydraulic conductivity distribution in model layer 2 14

Figure 3-3 Hydraulic conductivity distribution in model layer 3 15

Figure 3-4 Boundary conditions in the model 17

Figure 3-5 Steady state scatter plot 19

Figure 3-6 Calibration Hydrographs (Bores within the site boundaries) 20

Figure 3-7 Calibration Hydrographs (“Regional” bores) 21

Figure 4-1 Post development ground levels (northern parts of East Roselea development) 23

Figure 4-2 Post development ground levels (southern parts of East Roselea development) 24

Figure 4-3 Post development ground levels (southern parts of East Roselea development) 25

Figure 4-4 Top elevation of peat and limestone raft layer in the model 26

Figure 4-5 Bottom elevation of peat and limestone raft layer in the model 27
Figure 4-6 Model cross-sections (White = Infill, Brown = Peat/Limestone, Blue = Sand) 28
Figure 4-7 Development plan 29
Figure 4-8 Predicted water levels for Wet, Median and Dry scenarios (Swales 1 and 2) 31
Figure 4-9 Predicted water levels for Wet, Median and Dry scenarios (Swales 3, 4 and Basin) 32
Figure 4-10 Predicted water levels for Wet, Median and Dry scenarios (site locations away from swales and basin) 33
Figure 4-11 Location of the monitoring points 34
Figure 4-12 Predicted groundwater levels (Blue = Post-development scenario, Red = No development scenario) 35
Figure 4-13 Predicted groundwater levels (Blue = Post-development scenario, Red = No development scenario) 36

Tables

Table 2-1 Summary of the Soil Permeability Analysis 8
Table 2-2 Summary of the Saturated Zone Permeability Analysis 11
Table 3-1 Model coordinates (MGA94 Zone 50) 12
Table 3-2 Model layers 12
Table 3-3 Steady state calibration statistics 18
Table 3-4 Steady State Water Balance 18
Table 3-5 Estimated model parameters 21
Table 4-1 Adopted recharge rates in the model 22

Appendices

Appendix 1 – Emerge Technical Memo “The methodology utilised to determine the 50% AEP”

Document history & status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
Rev0	25 May 2020	D Bringemeier D Coremans	M Pavlovic	15 May 2020	Final
Rev1	20 November 2020	P Howe D Coremans	M Pavlovic	25 September 2020	Final

Distribution of copies

Version	Date issued	Quantity	Electronic	Issued to
Rev0	25 May 2020	2	2	M Craven-Kelly D Coremans
Rev1	19 November 2020	2	2	M Craven-Kelly D Coremans

Last Saved:	15 December 2020
File Name:	CDMSmith-1000741-East Roselea Groundwater Modelling Report-Rev 1 (19112020).docx
Author:	Milos Pavlovic
Project Manager:	Milos Pavlovic
Client:	Parcel Property
Document Title:	**East Roselea Groundwater Modelling**
Document Version:	B
Project Number:	1000741

Section 1 Introduction

Parcel Property proposes to develop lots adjacent to Grindleford Drive in Balcatta (Figure 1-1), within the East Roselea development (referred to herein as 'the Site') for mixed use commercial and residential purposes. The site is approximately 8 km northwest of the Perth central business district, within the City of Stirling.

The site is zoned 'Urban' under the Metropolitan Region Scheme (MRS) (WAPC 2017) and 'Development' under the Local Planning Scheme 3 (LPS No. 3, CoS 2018).

The site covers an area of approximately 29.5 ha with the proposed residential development incorporating 12.5 ha of residential lots over a range of lot densities (R30, R40, and R60-80), and approximately 5.7 Ha of public open space (POS) including drainage reserve.

The overall project comprises multiple aspects, one of them being "Groundwater level management" which focusses on protecting properties from flooding, and preventing damage to infrastructure within road reserves, due to inundation by groundwater. The shallow depth to groundwater in the western portion of the site means that some lots will need to be filled to achieve a minimum depth to groundwater. Subsoil drains will be utilised, however given the fill levels proposed these will be to ensure that lots maintain an appropriate clearance above low permeability soil conditions (Peat) and are not needed to achieve a clearance above the measured MGL.

The objective of this groundwater modelling study is aligned with the groundwater level management aspects proposed in the Local Water Management Strategy (LWMS) (Emerge Associates 2019). There are two main objectives that this groundwater model had to address:

1. Assess if the proposed development at East Roselea will impact groundwater levels in and around the site causing them to rise above the pre-development levels
2. Assess if the proposed development at East Roselea will impact groundwater throughflow in and around the site and what impact that might have to the overall hydrogeology of the area.

Figure 1-1 Proposed Development Plan

Section 2 Site physical setting

2.1 Climate

Perth experiences a Mediterranean climate of hot dry summers and cool wet winters. Rainfall and evapotranspiration records from October 2016 to November 2018 at Perth Metro weather station ID: 009225 are presented in Figure 2-1.

Average annual rainfall for the Perth metropolitan area is around 733 mm (Perth Metro weather station ID: 009225), located approximately 6.6 km from site. Average monthly rainfall of 100 mm or greater is recorded between the months of June and August (BoM 2019). The climate data indicate evaporation rates exceed rainfall rates during all but the winter months of June through August.

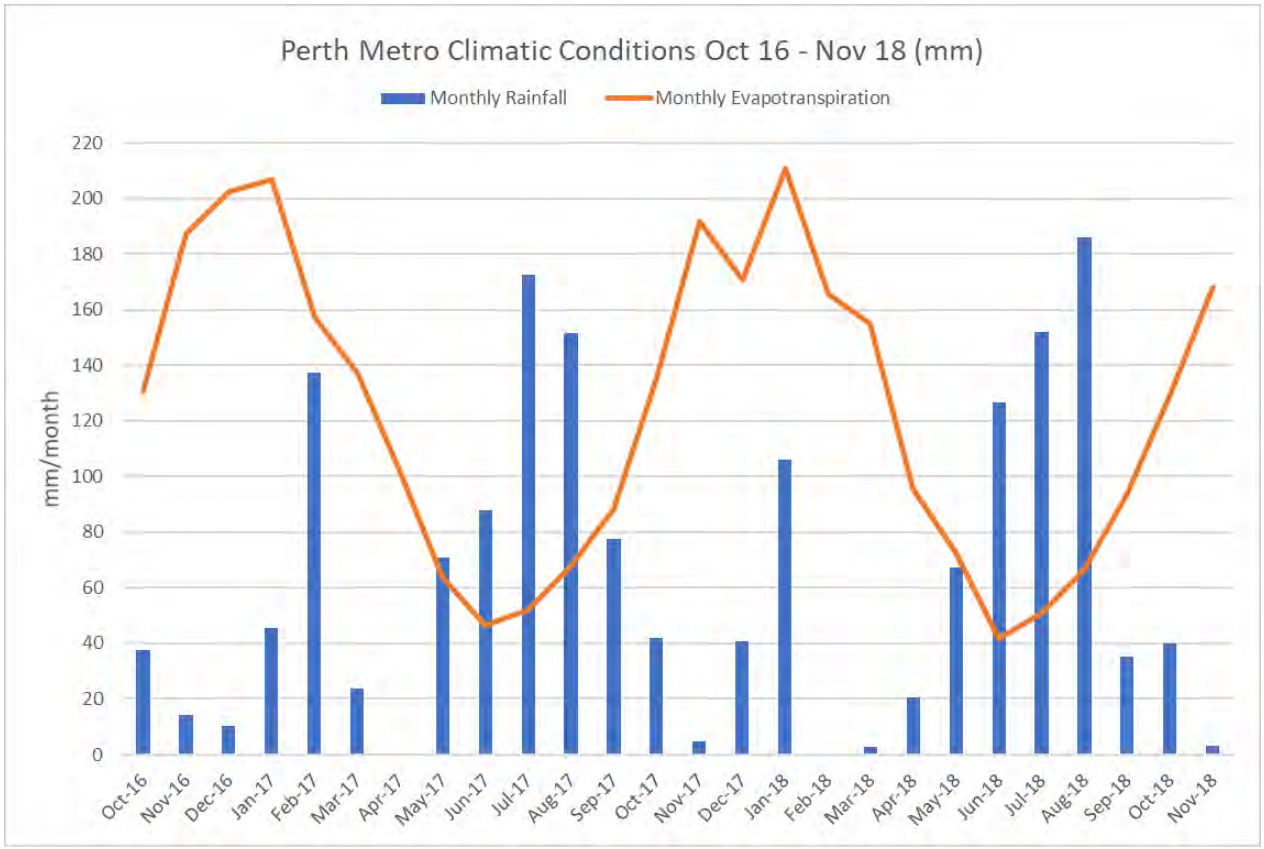


Figure 2-1 Measured Rainfall and Evapotranspiration (Perth Metro weather station ID: 009225)

2.2 Topography

The topography of the site slopes generally east to west, ranging in elevation from approximately 16 m Australian height datum (AHD) along the eastern site boundary, to a low of 12 mAHD along the central western boundary.

Historic stockpiling of uncontrolled fill immediately north of the Macedonia Park has resulted in a high point in the centre of site to be at a maximum elevation of approximately 20.8 mAHD, with the bulk of the stock pile ranging in elevation between approximately 16.5 mAHD and 18.5 m AHD (McMullen Nolan Group (MNG 2019). Topographic contours are shown on Figure 2-2.

Figure 2-2 Site Topography

2.3 Hydrology

On the western side of the site an open Water Corporation drainage asset is located flowing northeast-southwest along the northern section of Grindleford Drive, west of and adjacent to the site. The ASBD is designed to convey major event flows, and connects via pipe to the Roselea Estate Lake west of the southern and central portion of site, before returning to an open drain south of Karrinyup Road (CoS 2018). Also, to the west and south west there are two surface pools/lakes potentially capturing some of the throughflow in the immediate site area to the west.

2.4 Geology and soils

Regional geological mapping indicates that the site is underlain by peat (P), described as black, fibrous organic and sometimes clayey soil across the entirety of site. Calcareous and siliceous sands associated with Tamala Limestone (S7) (Gozzard 1986) of the Quindalup and Spearwood coastal dunal systems are located just beyond the eastern site boundary, as shown in Figure 2-3.

An intrusive soil investigation was conducted by Galt Geotechnics (Galt Geotechnics 2017). The soil types encountered were generally consistent with the regional geological mapping (Gozzard 1986) but showed dense sands underlying the site starting at a depth of approximately 10 m below ground level (bgl). The geotechnical report is provided in the East Roselea LWMS (Project No: EP18-114(02), Emerge Associates 2019). Karst formations have not been identified as a potential risk. Regional geological mapping shows the nearest potential karst formations to be approximately 1 km to the west of site, and none were reported to be encountered by the geotechnical investigations.

Soil permeabilities have been reported in the "Preliminary Geotechnical Investigation" by Douglas Partners, 2012. Out of eight test pits around the site four have been sampled and sample tested in the laboratory. One in situ permeability test using the falling head method was carried out at a depth of 0.7 m bgl at TP1. Results of the permeability analysis are summarised in **Error! Reference source not found.**.

Table 2-1 Summary of the Soil Permeability Analysis

Test	Depth (m)	Measured Permeability (m/s)	Derived Permeability (m/s)	Material
TP1	0.7	4.1×10^{-4}	2.9×10^{-4}	Filling (Sand)
TP2	2.2	-	2.6×10^{-4}	Sand
TP6	0.5	-	2.3×10^{-4}	Filling (Sand)
TP8	0.5	-	2.3×10^{-4}	Filling (Sand)

2.5 Hydrogeology

Eight monitoring bores were installed across the site in 2016 to measure groundwater levels and quality. Bores were monitored until November 2018. Bore locations and site specific measured maximum groundwater levels are shown on Figure 2-4. Also, four "regional" monitoring bores have been included in the model as presented in Figure 3-4. The interpreted general direction of throughflow is east to west, consistent with topography.

Additional permeability testing was undertaken of the natural and imported peat layers across the site. The results are summarised in Table 2-2.

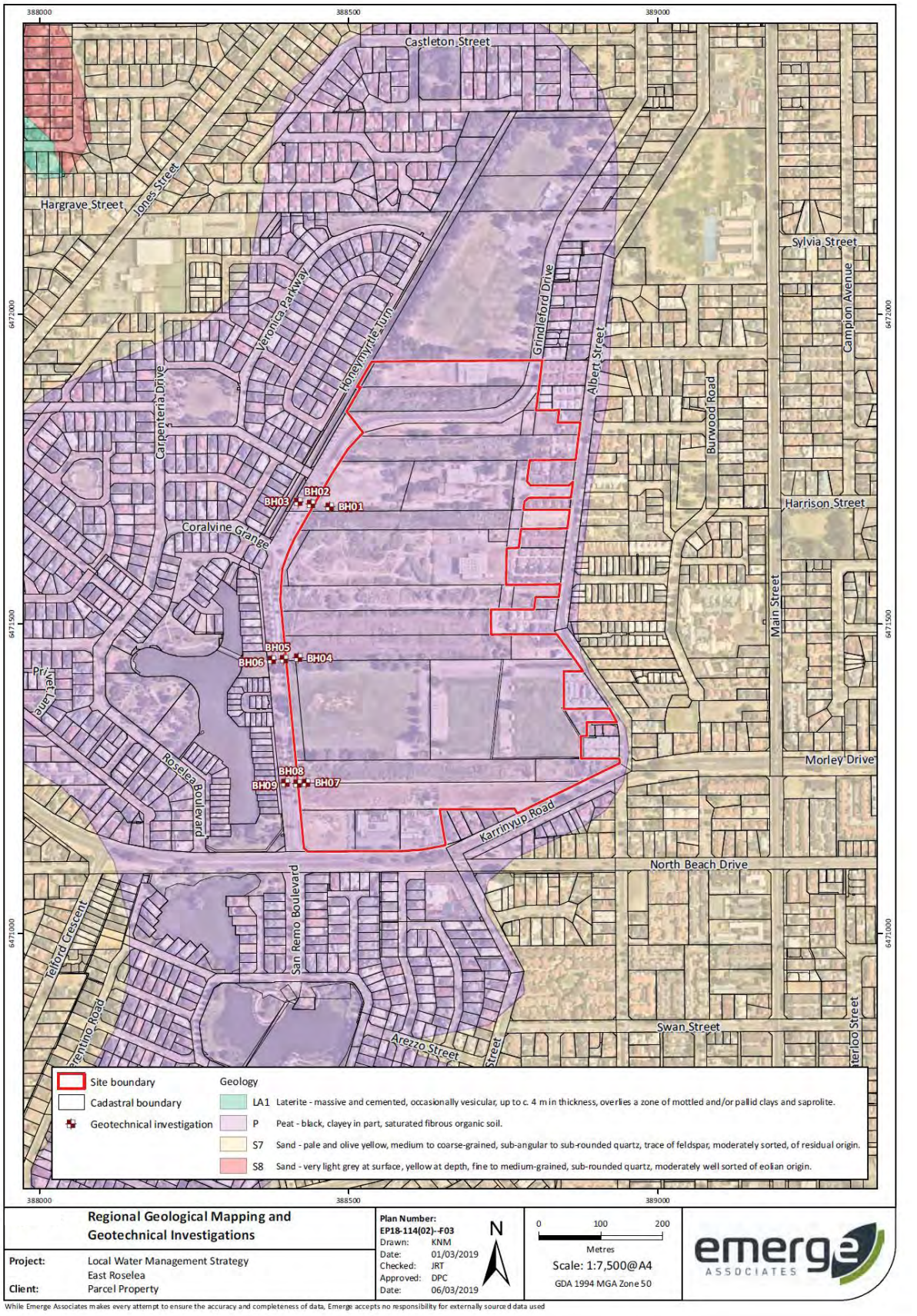


Figure 2-3 Site Geology

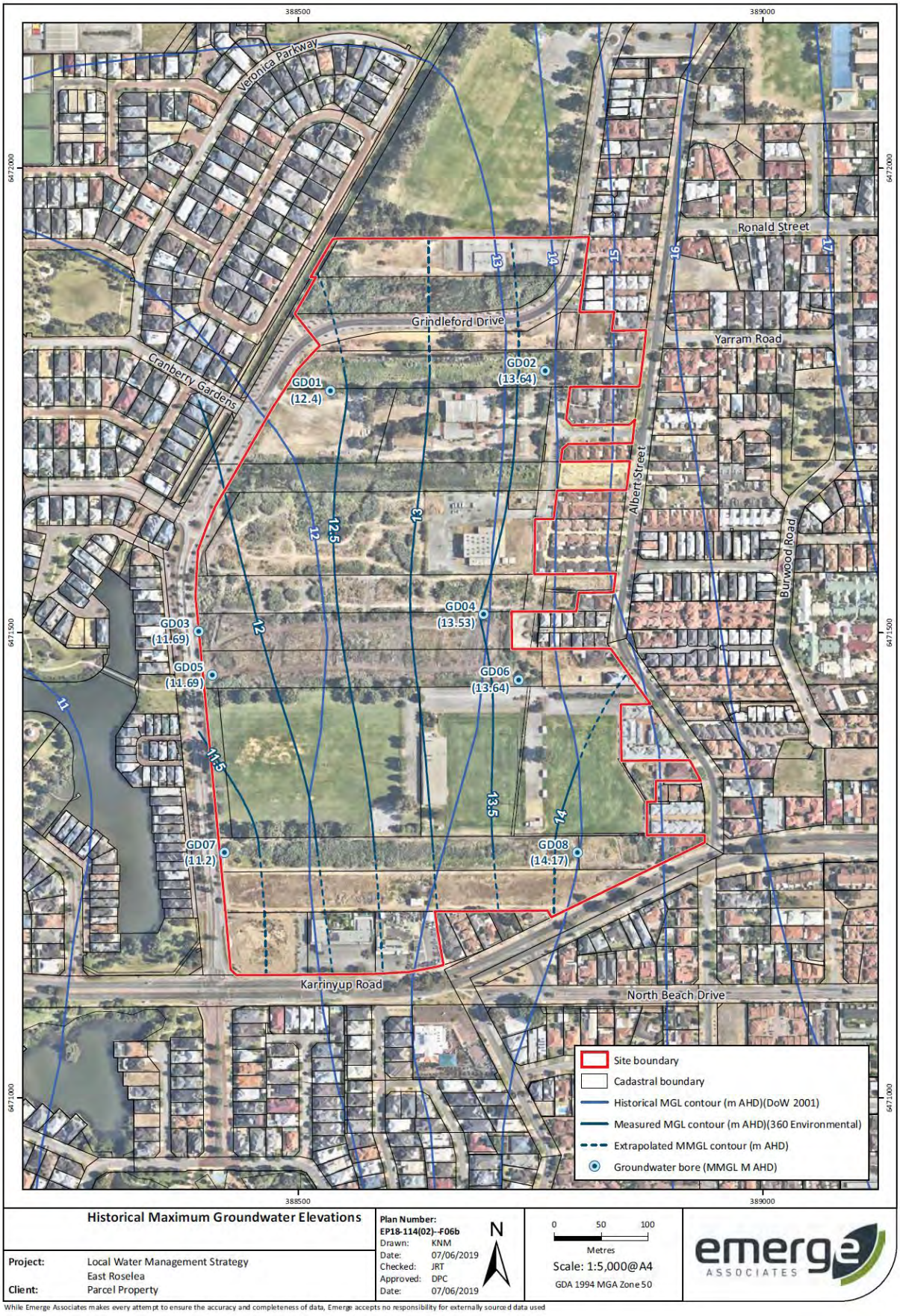


Figure 2-4 Bore locations and measured maximum pre-development groundwater levels

Table 2-2 Summary of the Saturated Zone Permeability Analysis

Test Location	Description	Depth (m)	Depth to Groundwater (m)	Test Type	Average Conductivity (m/d)
CPT02	Natural Peat	7.55	6.1	Saturated Falling Head	3.4×10^{-2}
				Saturated Rising Head	
CPT02A	Fill: Peat	4.0	NE	Unsaturated Falling Head	2×10^{-2}
CPT03A	Fill: Peat	3.8	NE	Unsaturated Falling Head	1.2×10^{-3}
CPT07	Natural Peat	4.6	1.2	Saturated Falling Head	3.1×10^{-3}
				Saturated Rising Head	

Infiltration testing indicates the peat has a horizontal permeability of between 0.001 and 0.02 m/d. The previous approach taken (Rev A of this report) had represented both the peat and limestone raft layers (in the post-development) as a single layer with a permeability of 0.1 m/d vertical and 1m/d horizontal. Tested hydraulic conductivity of peat being three magnitude of order lower renders this unit impermeable.

Section 3 Groundwater Model

3.1 Model Setup

The purpose of this work is to provide an assessment of the potential impacts on groundwater levels and aquifer throughflow as a result of the proposed development of East Roselea. The assessment was undertaken using a 3D numerical groundwater modelling approach which also involved building a conceptual hydrogeological model of the broader site area consistent with available geological, hydrogeological and hydrological data.

The model was built to capture relevant details in the immediate site area and extends 4.6 km east-west and 5 km north-south. Model coordinates are presented in Table 3-1.

Table 3-1 Model coordinates (MGA94 Zone 50)

Easting (minimum)	Easting (maximum)	Northing (minimum)	Northing (maximum)
386,420	391,020	6,469,500	6,474,500

The model comprises three layers (Figure 3-1, Figure 3-2 and Figure 3-3) capturing the site geology from the soil investigation reports “Preliminary Geotechnical Investigation” by Douglas Partners, 2012 and “Proposed Residential Development Lots 86, 88 and 129, Gindleford Drive, Balcatta” by Galt Geotechnics, 2015.

Table 3-2 Model layers

Model Layer	Material	Description
Layer 1	Infill (Sand)	Very loose to medium dense, dark grey, grey and yellow-brown, sand fill with some silt to depths of between 0.5 m and 2 m bgl. Some demolition rubble, including bricks, concrete, pipe and tiles were observed within the sand fill at some of the test pit locations
Layer 2	Peat	Very soft and soft, black and dark grey-brown, fibrous peat from depths of between 0 to 1.8 m bgl extending to depths of 1.6 m and 3.3 m bgl
Layer 3	Sand	Medium dense to dense, grey, white and light brown, fine to coarse grained sand with some silt underlying the peat to termination depths between 3 m and 12.2 m bgl at all test locations

Topography in the model was taken from the available survey data (Figure 2-2) and publicly available Lidar data (Geoscience Australia).

The model was built using the Groundwater Vistas graphical interface. The selected code was Modflow-USG for its capability of providing very fine grid discretisation in the immediate area of interest while keeping the rest of the grid coarse. This way the number of cells in the model could be significantly reduced reducing the model run times. With the provision of simulating subsoil as part of the predictive assessments the grid was refined down to 6.25 x 6.25 m in the immediate site area, up to 50 x 50 m grid outside of the site resulting in 58,800 active cells in the model.

Inflow from the east and outflow to the west were simulated using the General Head Boundary (GHB) as shown in Figure 3-4. Boundary elevations and conductancies were tested during the model calibration to ensure that there were little to no impacts from the boundaries on the results and predicted water levels and in order to have the boundaries providing only an inflow and outflow mechanism in the model.

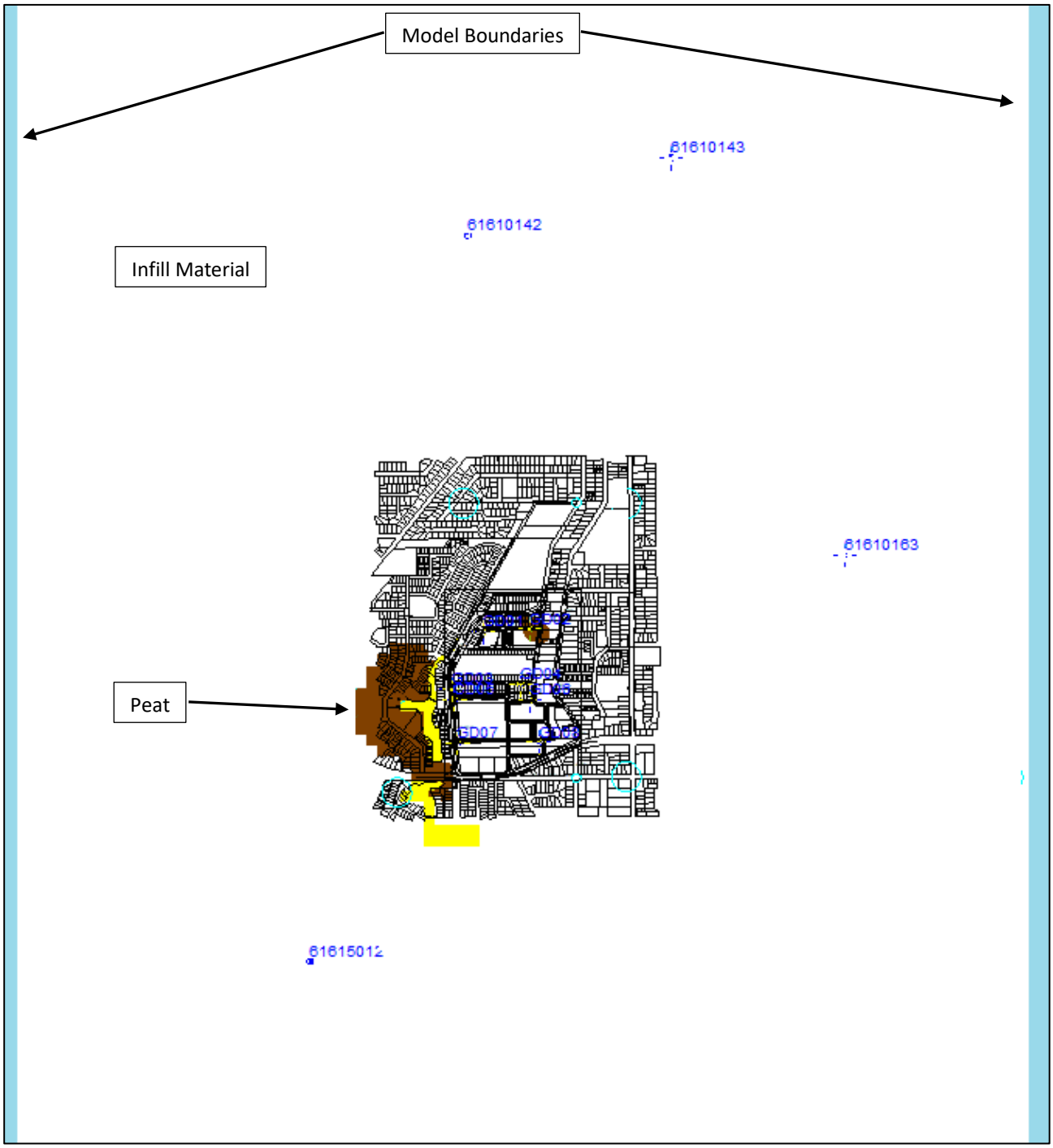


Figure 3-1 Hydraulic conductivity distribution in model layer 1

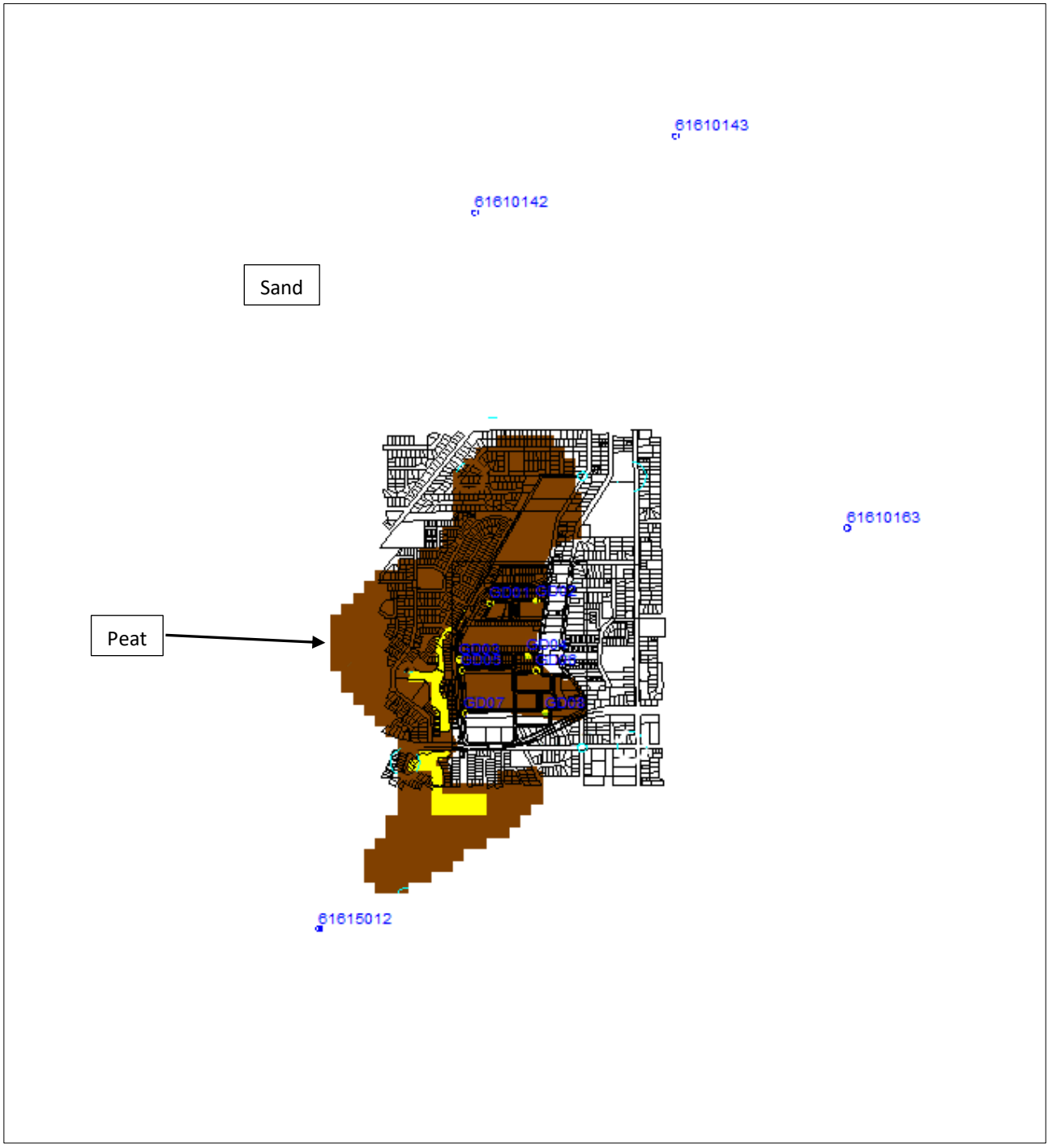
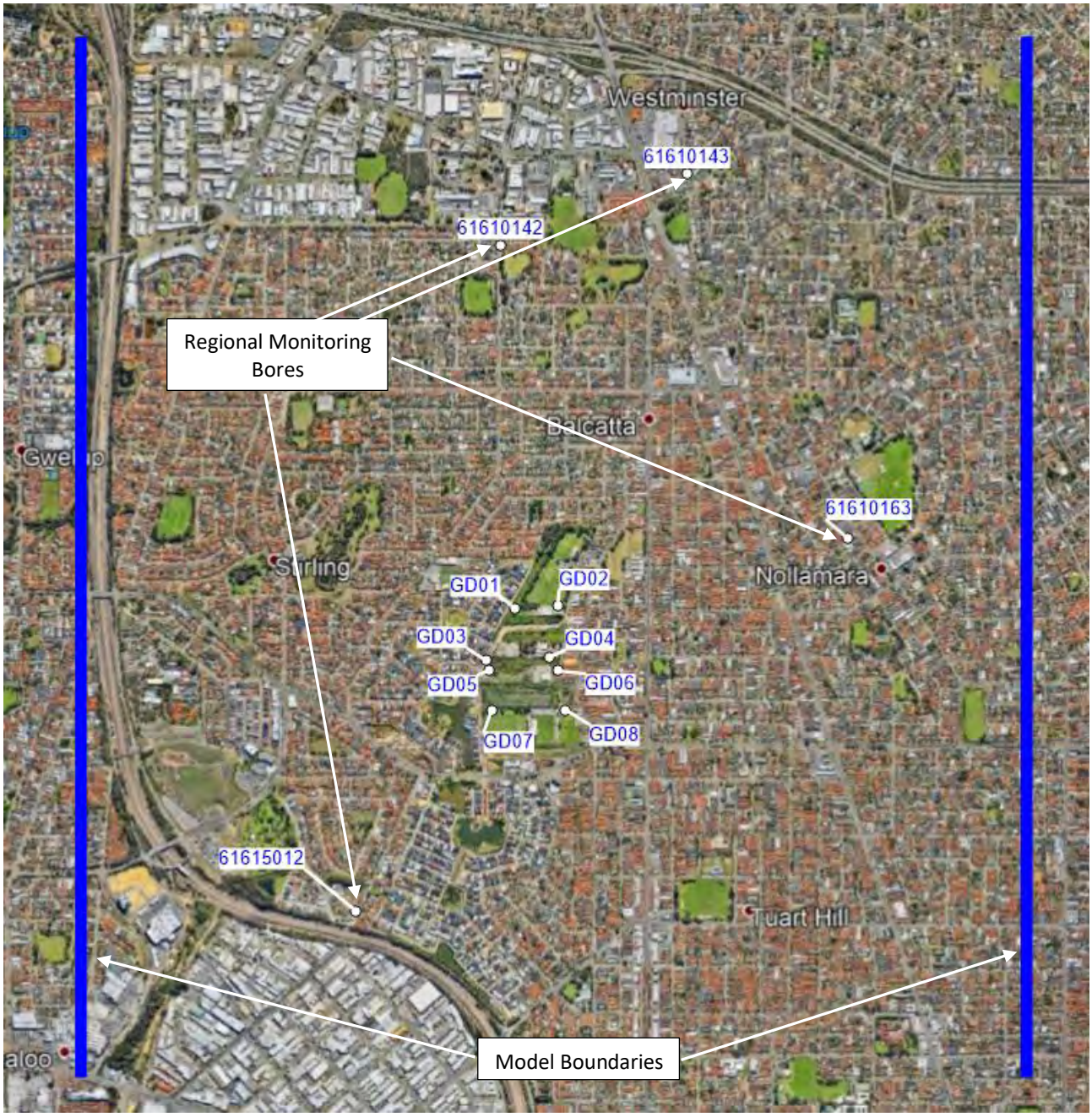


Figure 3-2 Hydraulic conductivity distribution in model layer 2

Figure 3-3 Hydraulic conductivity distribution in model layer 3

Another inflow component of the model water balance was inflow from rainfall recharge. Percentage of measured rainfall applied in the model as recharge was tested during the model calibration. Recharge was applied across the entire model domain



(Zoomed in version of this figure is presented on the next page)

Figure 3-4 Boundary conditions in the model

One of the outflow components in the model was evapotranspiration. Based on the vegetation profile around the site (Crops = Turf and Bushes, Crop Factor = 65%, Root Depth ~ 50 cm) percentage of measured evaporation and extinction depth applied in the model as evapotranspiration were tested during the model calibration. Spatially evapotranspiration was applied across the entire model domain.

Three surface water ponds/lakes in the model on the western and south-western side of the site also represent outflow components of the overall water balance (Figure 3-4). They were simulated using the Drain package (DRN) in the model. Lake elevations were set based on available survey data. The lake west of the site was assigned an elevation of 11 m AHD and the other two lakes to the south-west of the site 9 m AHD. Drain conductancies were

tested during the model calibration. Water Corporation drain has been assigned on the western side of the Grindleford Drive. The elevation of this drain was sourced from the publicly available data published by Water Corporation.

3.2 Model Calibration

As described in Section 2 of this report, eight monitoring bores have been installed on site (Figure 3-4) providing monitoring records since October 2016. The monitoring program stopped in November 2018. For that reason, the period comprising 26 months (Oct 2016 – Nov 2018) was selected for the long term transient model calibration. The model domain also incorporates four "regional" monitoring bores (Figure 3-4) to assist model calibration outside of the site.

Transient stress periods were simulated in monthly time increments with five time steps assigned to every stress period. Effectively, the model provides predicted water levels every 5 to 6 days. Steady state calibration was addressed in the same model run. A single steady state period was set at the start of the model followed by 26 monthly stress periods. All model layers are assigned as type 1 (unconfined).

Steady state calibration statistics are presented in Table 3-3 and Table 3-4. Both the SRMS and modelled water balance are with the expected range recommended by the Groundwater Modelling Guidelines with SRMS error being less than 10% and water balance error being less than 1%.

Table 3-3 Steady state calibration statistics

Parameter	Value
Residual Sum of Squares	2.91
RMS Error	0.54
Scaled RMS	0.069

Table 3-4 Steady State Water Balance

Water Balance Component	Inflow (kL/d)	Outflow (kL/d)
Inflow from upstream GHB	250	-
Outflow through downstream GHB	-	12,205
Rainfall recharge	19,940	-
Evapotranspiration	-	525
Lakes/ponds and drains (DRN package)	-	7,460
TOTAL	**20,190**	**20,190**

Figure 3-5 is a graph comparing the measured water table elevations at monitoring bores to their predicted pre-development water levels under the long-term average conditions (steady state).

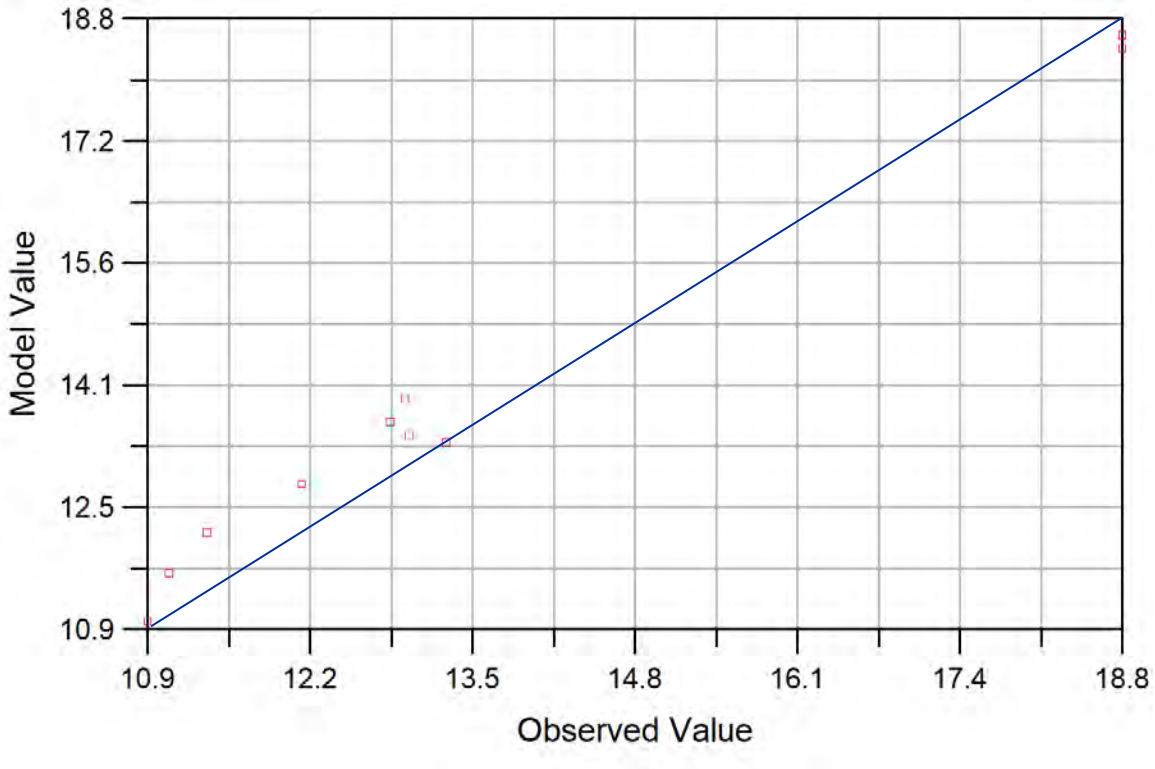


Figure 3-5 Steady state scatter plot

Transient model calibration involves changing parameters in the model until a reasonable match is achieved between measured and modelled water levels. At some locations measurements show abnormally high water levels (i.e. GD01 in September 2018) or abnormally low water levels during the peak rainfall (i.e. GD04 in August 2017). All measured water levels have been plotted on the charts but those abnormalities haven't been taken into account and no attempt has been made to calibrate the model against those abnormalities. Of the four "regional" monitoring bores, bore 61615012 located south-west of the site was producing reasonable measurements until 1996. The logger started drifting soon afterwards with latest monitoring results (from 2001 onwards) being negative values. Also, monitoring at bore 61610142 stopped in 2005. From examining the groundwater monitoring records before 2005 it was evident that bore 61610142 is only monitoring seasonal fluctuations and that past records could be used for model calibration. Therefore, those past monitoring records have been moved 20 years forward. Calibration hydrographs are presented in Figure 3-6 and Figure 3-7.

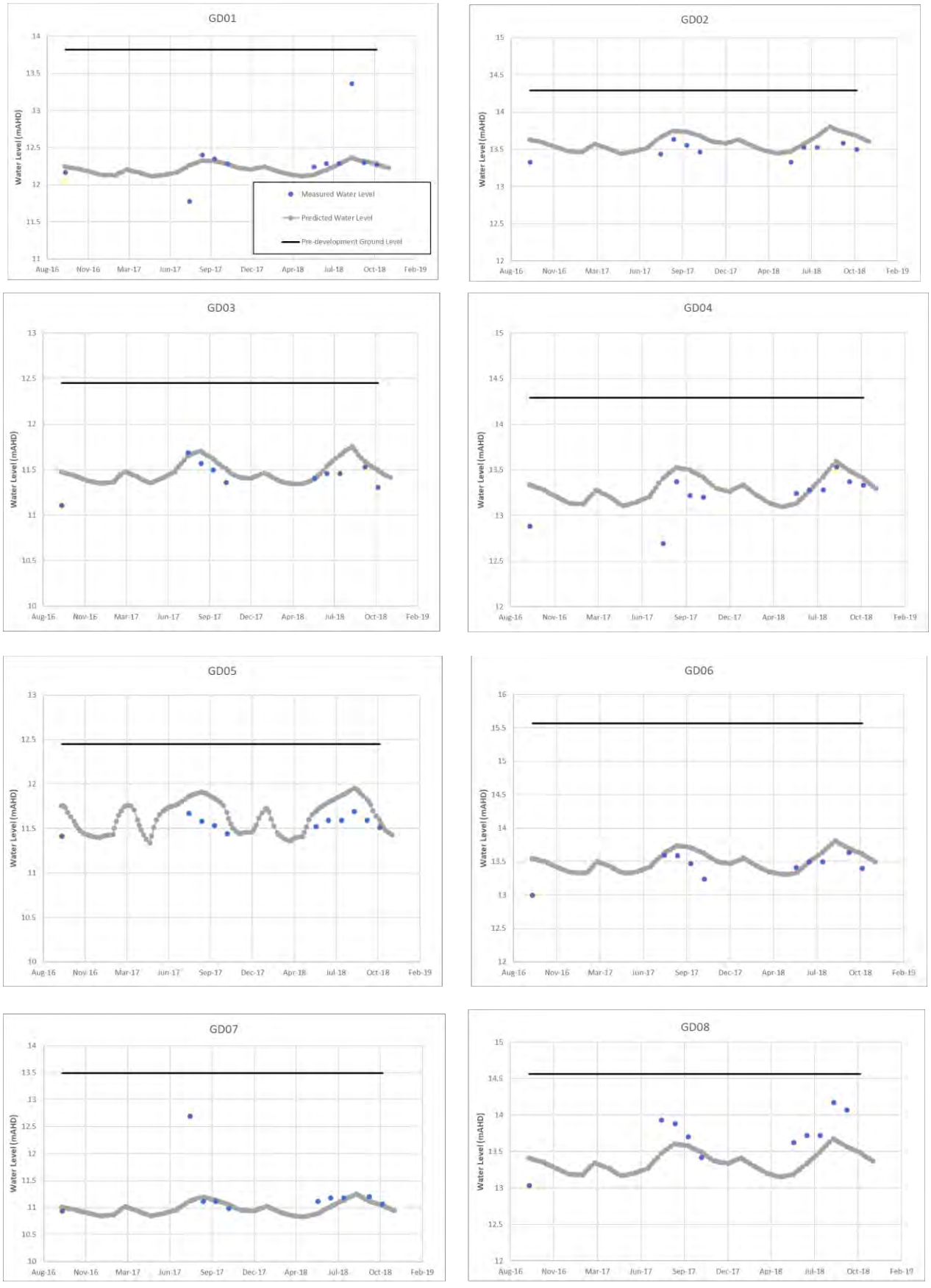


Figure 3-6 Calibration Hydrographs (Bores within the site boundaries)

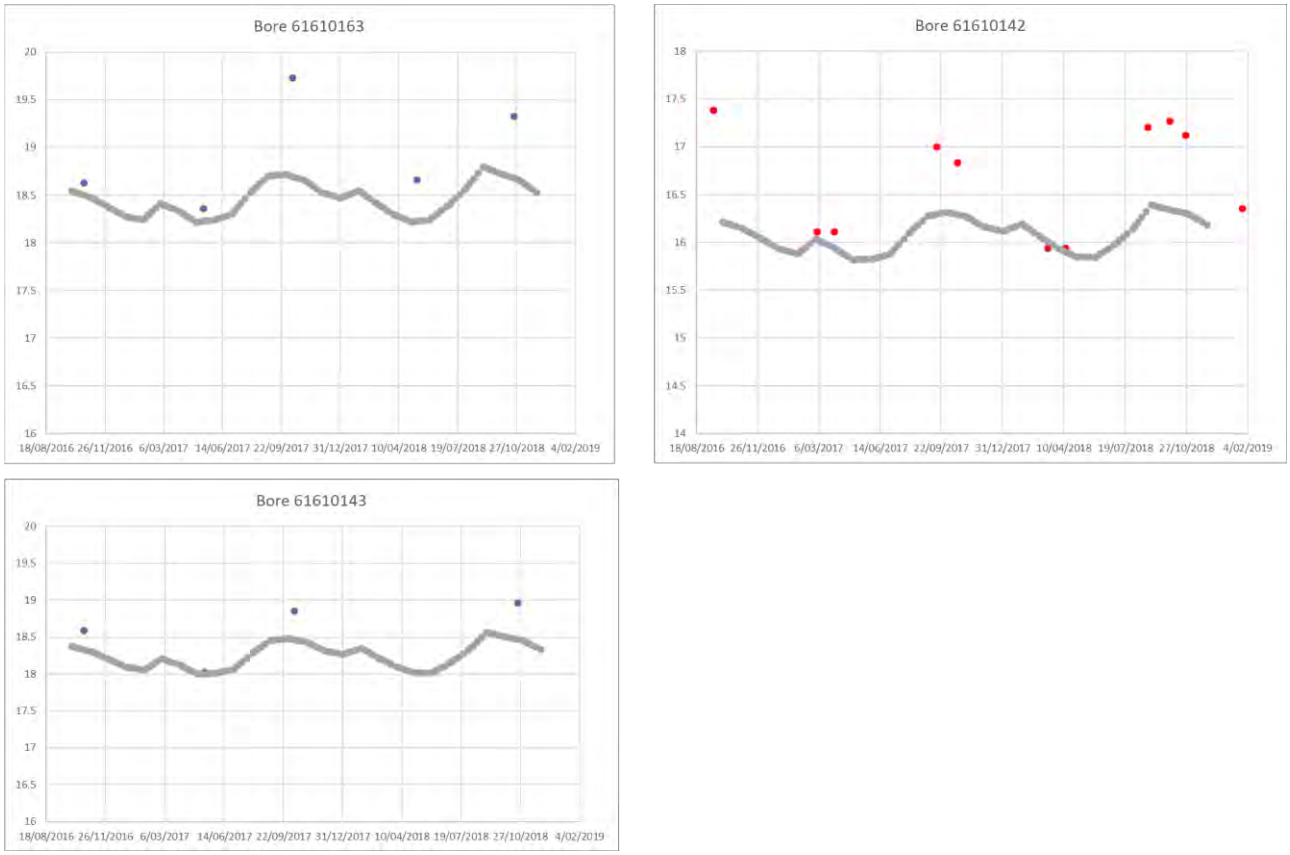


Figure 3-7 Calibration Hydrographs ("Regional" bores)

3.3 Adopted hydraulic properties and boundary conditions

Calibration datasets are provided in Table 3-5.

Table 3-5 Estimated model parameters

Parameter	Infill	Peat	Sand
Horizontal hydraulic conductivity (m/d)	25	0.003	10
Vertical hydraulic conductivity (m/d)	2.5	0.0003	1
Unconfined storage (%)	20	1	10
Recharge	40% measured rainfall		
Evapotranspiration	100% measured evapotranspiration, 1 m extinction depth		
Inflow General Head Boundary	Head = 19 mAHD, Conductance = 35 m^2/d		
Outflow General Head Boundary	Head = 5 mAHD, Conductance = 50 m^2/d		
Western Pond/Lake	Head = 11 mAHD, Conductance = 2,500 m^2/d		
South Western Pond/Lake	Head = 9 mAHD, Conductance = 2,500 m^2/d		

Section 4 Predictive simulations

4.1 Development scenario setup

The proposed development at East Roselea would alter the pre-development ground surface. The top of model layer 1 was revised consistent with the provided CAD construction drawings (Figure 4-1, Figure 4-2 and Figure 4-3). Based on the proposed earthworks approach and civil engineering designs a layer (raft) of limestone is to be installed above the peat soils found on site. The limestone raft and peat have been simulated as one unit in the model. Hydraulic conductivity of the limestone/peat layer in the model was 0.003 m/d horizontal and 0.0003 m/d vertical which renders them both as an effectively impermeable unit in the model. The top and bottom of the peat layer have been modified accordingly to incorporate this plan. Top and bottom elevations of the peat/limestone layer are presented in Figure 4-4, Figure 4-5 and Figure 4-6. The minimum thickness of infill was set to 2.3 m. This was enforced by removing additional volumes of peat in some areas of the site while the proposed final site elevations remain consistent with the site plan. To improve drainage of the proposed swales and basin peat underneath the swales and basin has been removed which establishes a direct hydraulic connection between the swales (and basin) and sandy aquifer underneath the peat. Also, to improve drainage of the swales, swales 1 and 2 and swales 2 and 3 have been laterally connected.

Surface water and groundwater plans involve installation of the subsoil drains above the measured pre-development groundwater levels. Subsoil drains are proposed to discharge into the swales on the western side of the site and a proposed drainage basin in the southern portion of the site (Figure 4-7). Figure 4-7 also shows that the peat has been modelled to be excavated at some road connections along western boundary of the site.

The post-development model was setup in line with the "Specification for separation distances for groundwater-controlled urban development" guidelines published by Institute of Public Works Engineering Australia. Rainfall recharge rates have been assigned in the model consistent with the guidelines (Table 4-1).

Table 4-1 Adopted recharge rates in the model

Area	Rate
Lots	89% measured rainfall
Civic Area	75% measured rainfall
Local Centre	95% measured rainfall
Roads	20% measured rainfall other 80% that falls onto roads assigned to swales (or drainage basin)

Compared to the pre-development recharge, development at East Roselea would increase aquifer recharge by 30%.

Subsoil drains have not been included in the model as a measure of controlling the water level rise, and therefore this model setup is conservative in that respect (i.e. it does not rely on subsoil drains to control groundwater level rise).

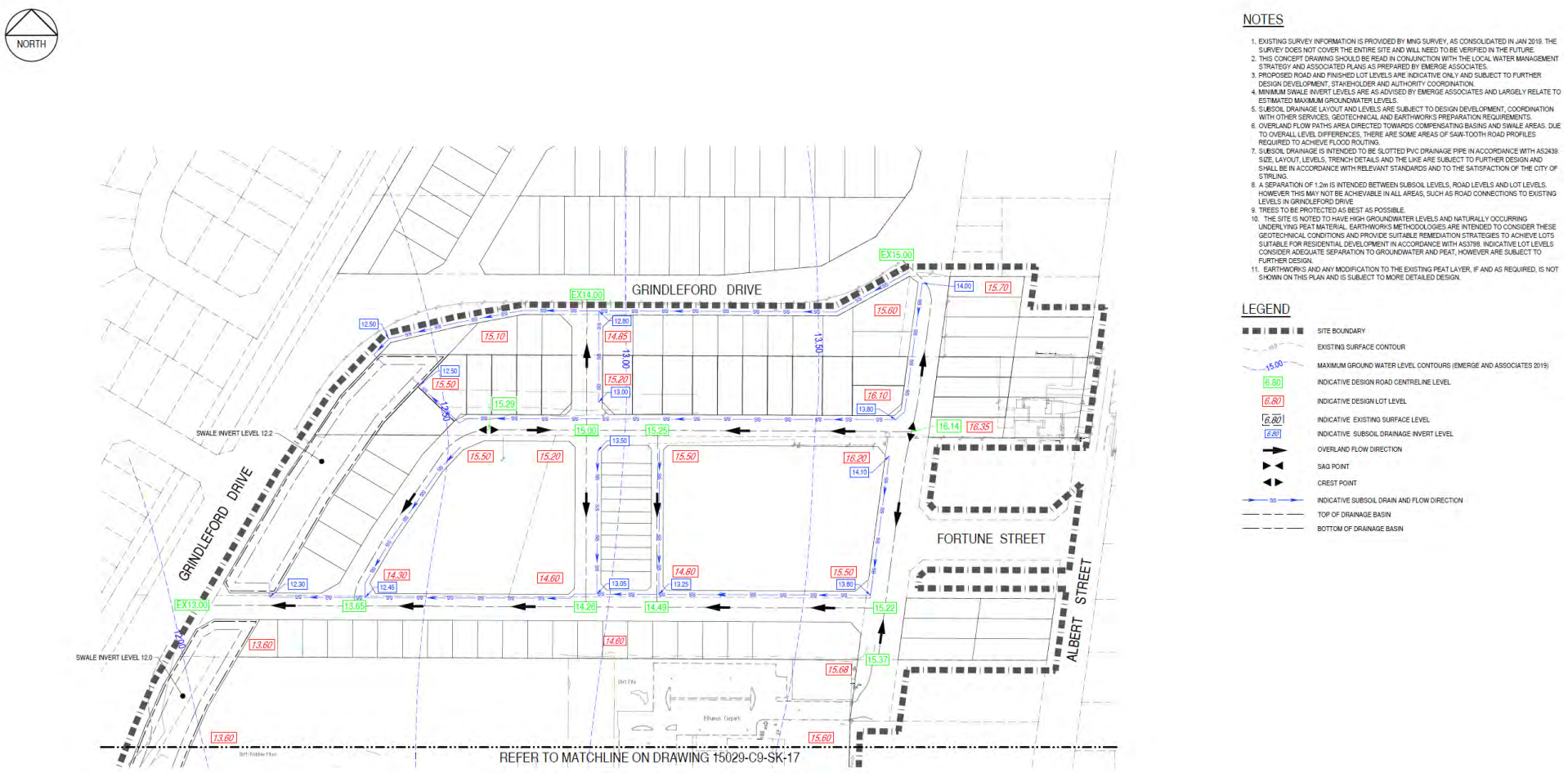


Figure 4-1 Post development ground levels (northern parts of East Roselea development)

Figure 4-2 Post development ground levels (southern parts of East Roselea development)

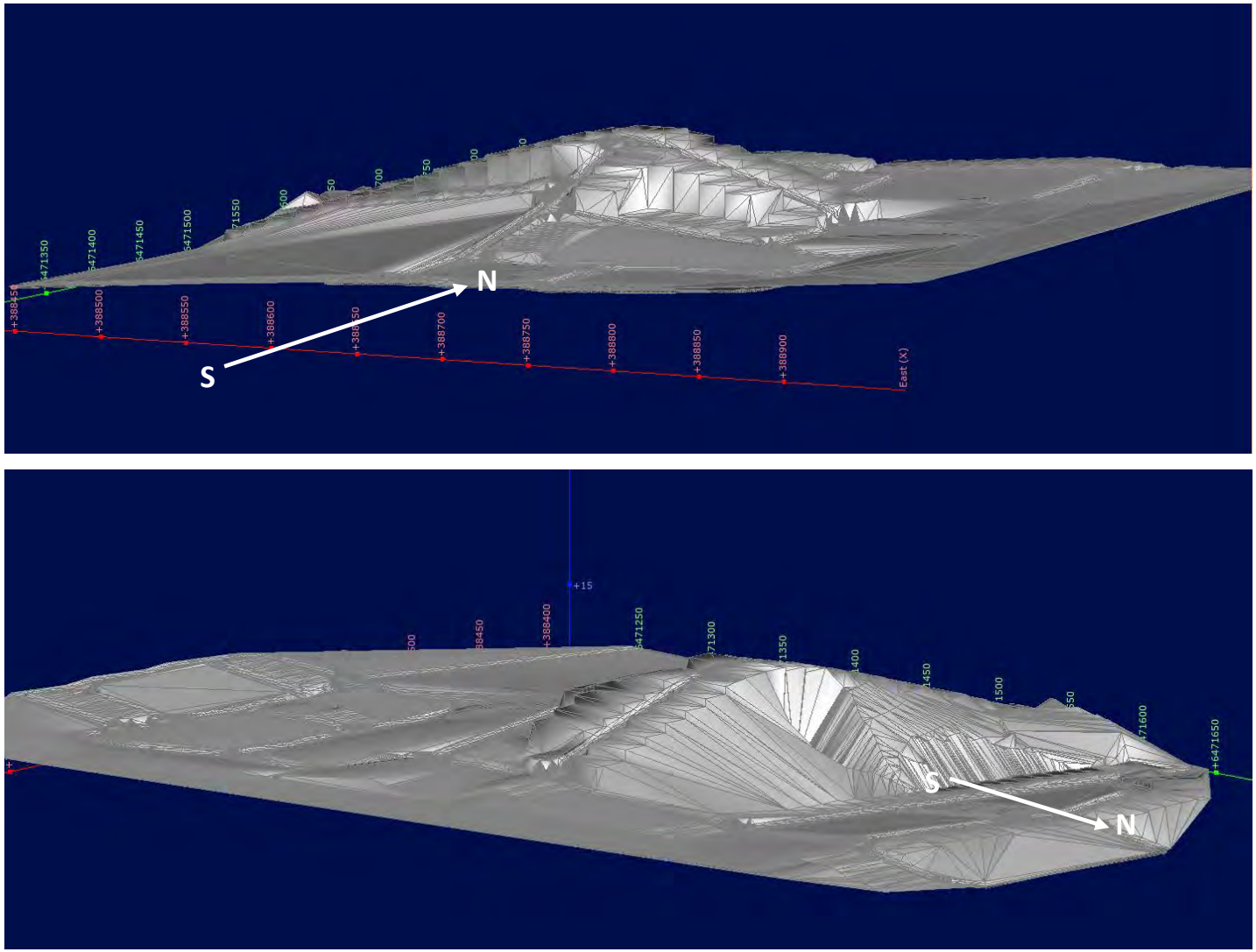


Figure 4-3 Post development ground levels (southern parts of East Roselea development)

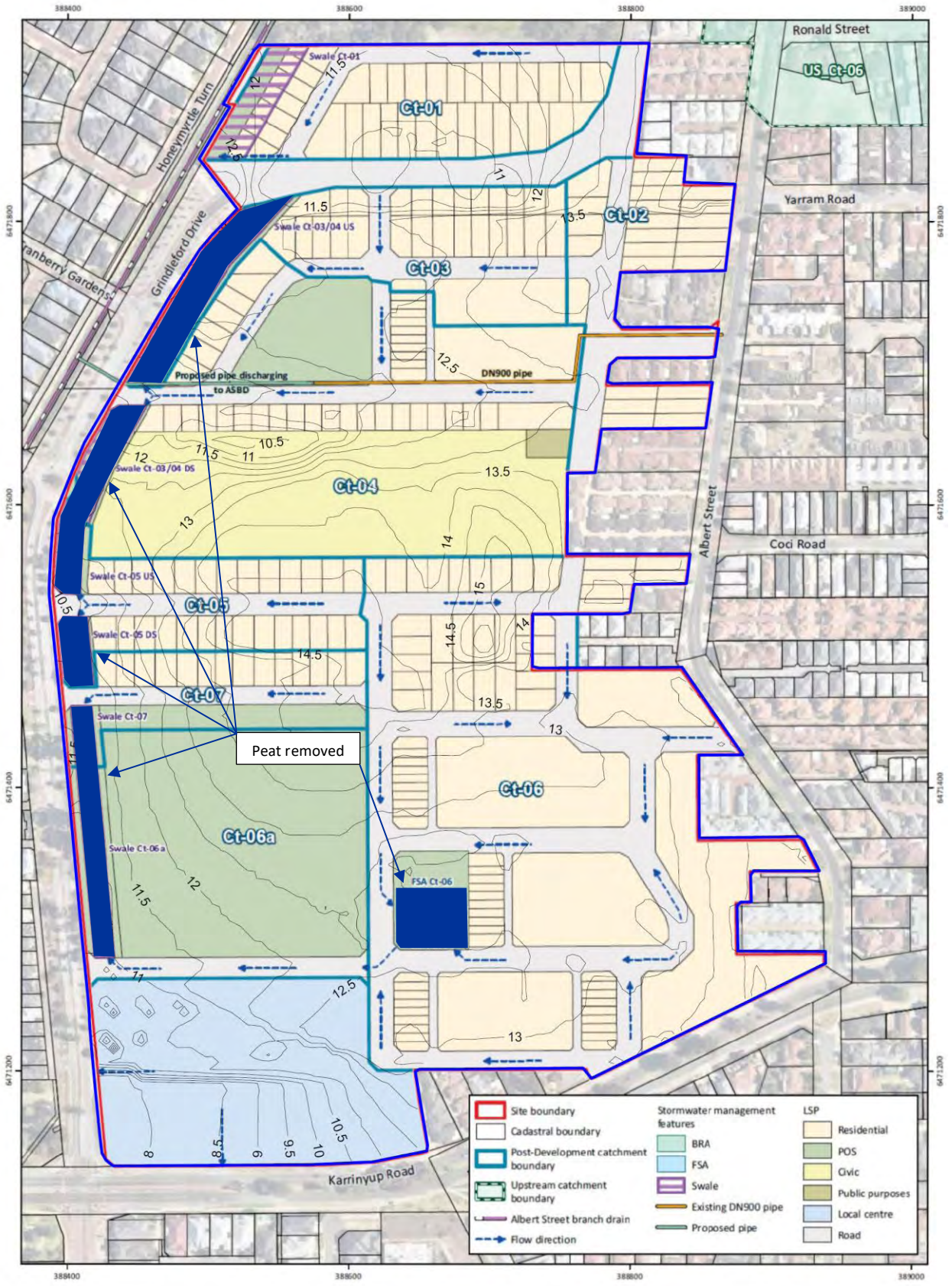


Figure 4-4 Top elevation of peat and limestone raft layer in the model

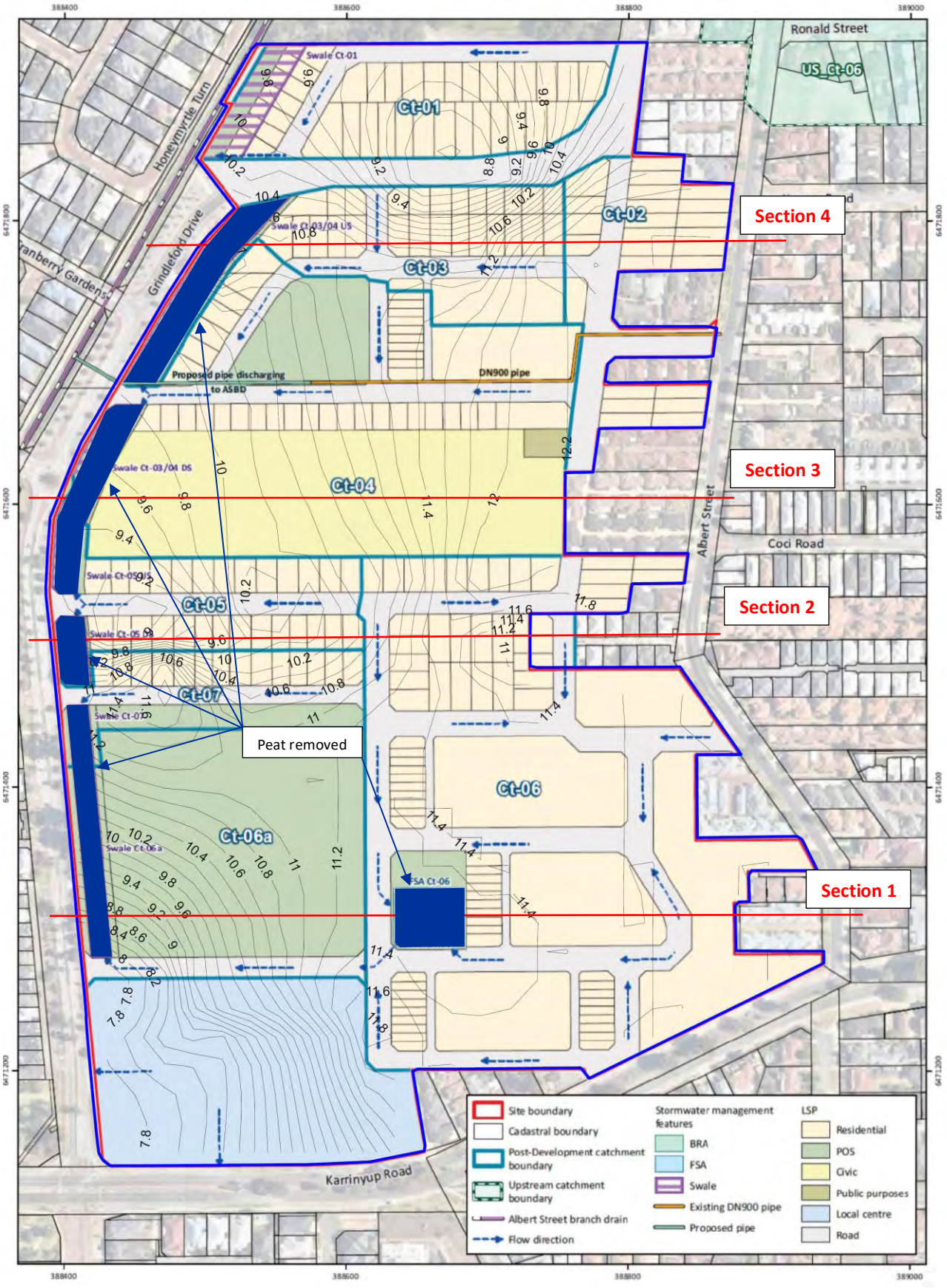


Figure 4-5 Bottom elevation of peat and limestone raft layer in the model

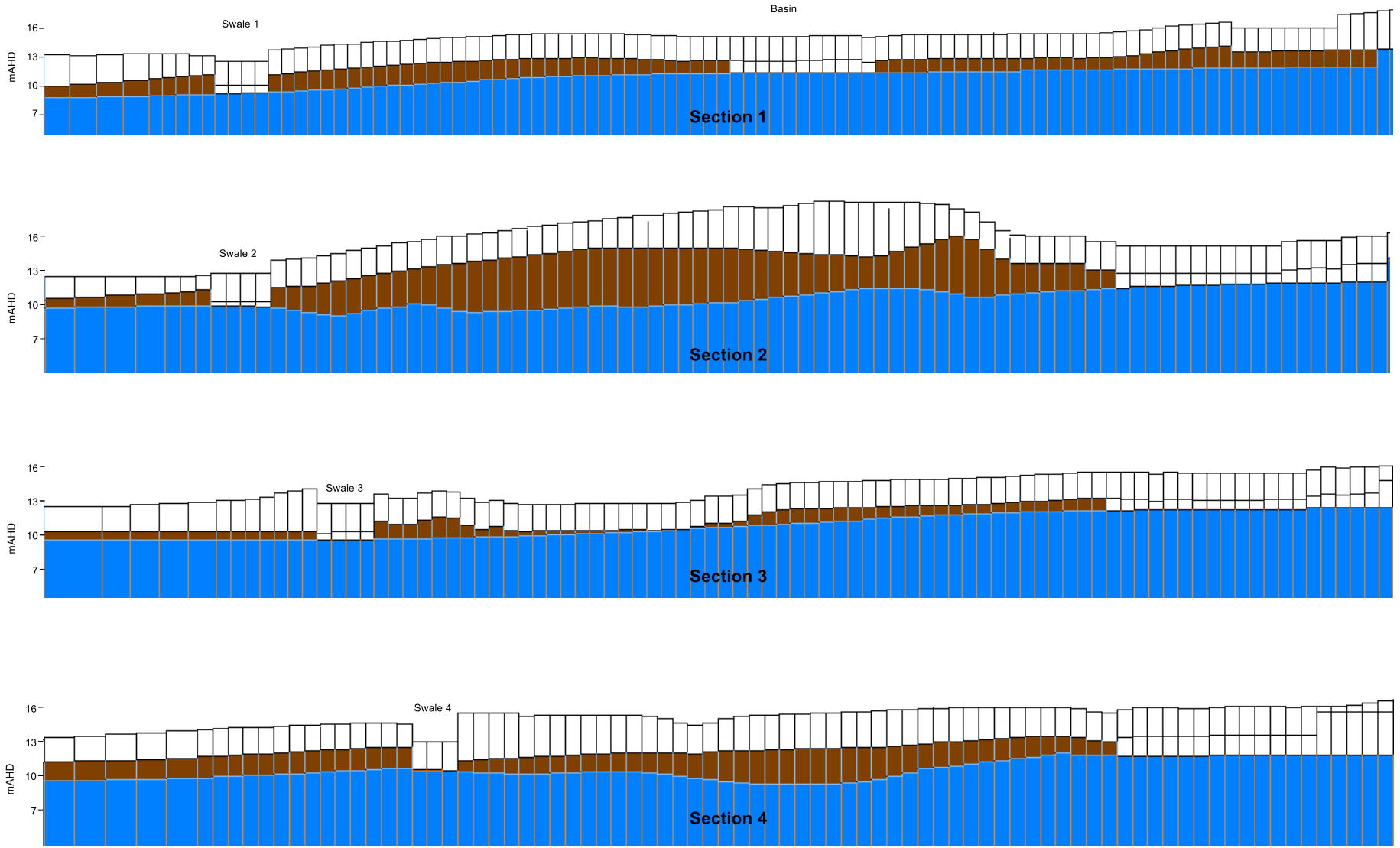


Figure 4-6 Model cross-sections (White = Infill, Brown = Peat/Limestone, Blue = Sand)

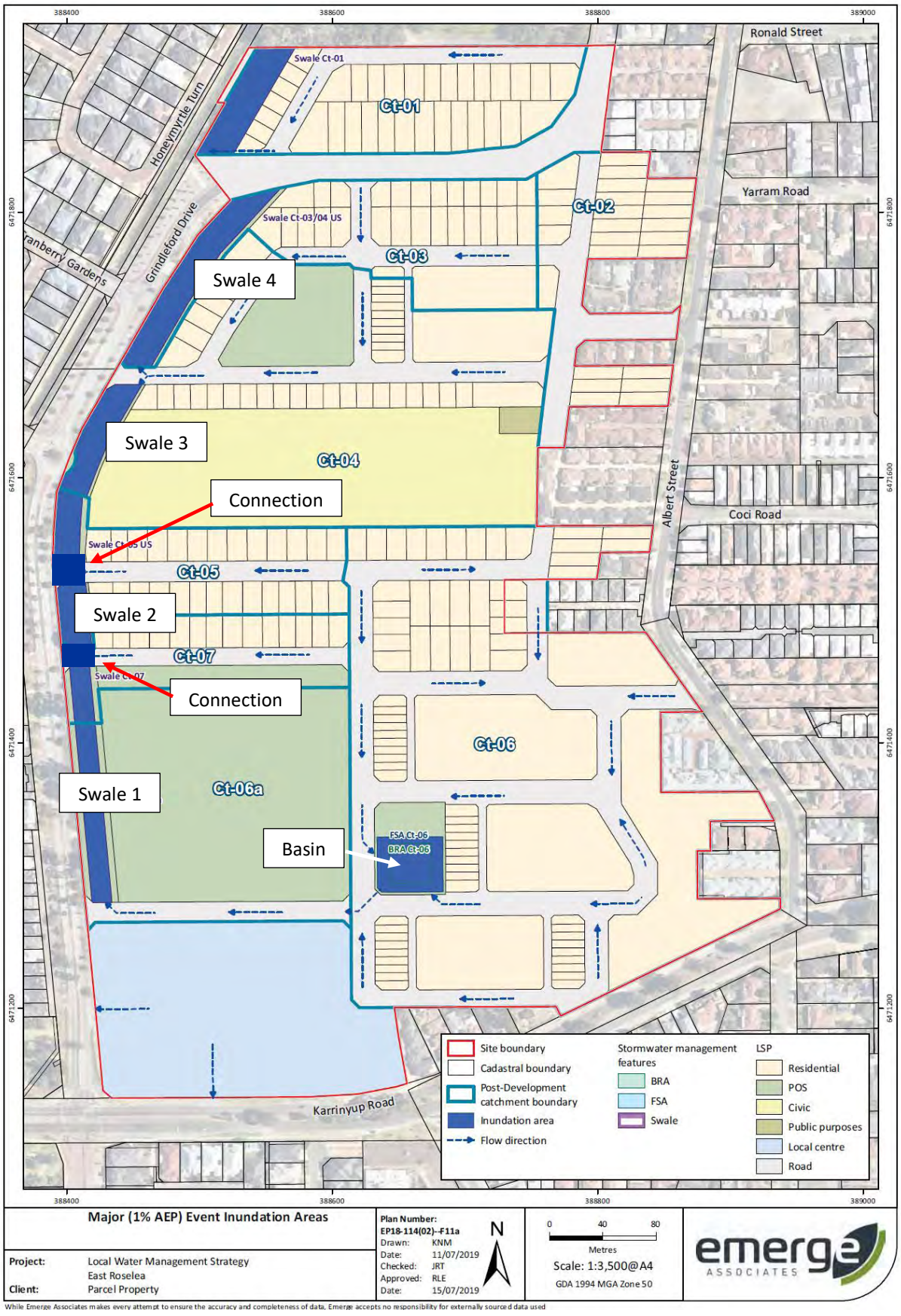


Figure 4-7 Development plan

Rainfall recharge has been applied in the post-development model consistent with the "Selection of future climate projections for Western Australia" report by Department of Water WA (Report no. WST 72, September 2015 'climate report' hereafter).

The Department has developed climate scenarios for five regions of WA, covering the entire state. The climate scenarios are reported using anomalies – the average change in a climatic variable for a future period compared to the baseline period. The period between 1961-1990 was chosen as the baseline period in the climate report.

East Roselea is within the South-West region of WA. The climate report for the South West shows decreases in rainfall and increases in temperature that are consistent with already observed climate trends. The Global Climate Models (GCMs) project decreases in average annual rainfall in the range of 5 to 67%. By identifying the 10th, 50th and 90th percentile scenarios, it is possible to capture a reasonable range of uncertainty without including the most extreme scenarios.

The 10th percentile scenario was used for the Dry scenario. The selected median scenario corresponds to the 50th percentile, as it represents a moderate rainfall reduction, with a moderate temperature rise. For the Wet scenario, an identified 90th percentile GCM was used.

The Dry scenario indicates, for the region as a whole, a 14% decline in rainfall, a 0.7 °C temperature rise and a 3% increase in PET by 2030. The drying trend continues in the latter half of the century, with rainfall projected to be 25% less by 2050, and 47% less by 2100. The Median scenario indicates a less pronounced drying trend, with a 5% reduction in rainfall by 2030 and 17% by 2100. Temperature is projected to rise by 2.4 °C by 2100. The Wet scenario results in only a 7% reduction in rainfall by 2100, and a 2.0 °C temperature rise. The Wet scenario compared to the Median scenario is associated with a larger reduction in relative humidity which results in a slightly larger rise in PET. In the west of the region, drying trends are more pronounced relative to the regional averages.

The gridded change in average annual rainfall have been provided by the Department of Water and Environmental Regulation (DWER) as projected estimates of daily rainfall (in millimetres) for the period 2000 to 2030. Since we are already in September 2020 simulations were run from June 2020 until the end of December 2029. Beyond 2030 the climate for the South-west region is predicted to be drier with even less rainfall and higher temperatures. Based on the rainfall inputs Wet, Median and Dry climate scenarios have been constructed. Consistent with the base case model subsoil drains proposed at East Roselea within the LWMS have not been simulated. The results are presented in Figure 4-8, Figure 4-9, Figure 4-10 and Figure 4-11.

4.2 No Development Scenario

As annually variable recharge has been applied to the development model (i.e. wet, median and dry climate scenarios described in section 4.1) to determine local and regional groundwater levels, the development scenarios must be compared against a model run with no development.

This scenario was run with only seasonal rainfall recharge consistent with the "Selection of future climate projections for Western Australia" report by Department of Water WA – Wet climate scenario. The "No-Development" model is a prediction model assuming "natural" regime without any alterations of the pre-development site conditions apart from rainfall recharge.

The no-development scenario provides conditions over the full prediction period. In general, it is a pre-development model simulating wet climate conditions into the future.

In summary, the following conditions have been applied to the no-development model:

- Rainfall recharge was simulated using "Selection of future climate projections for Western Australia" – Wet climate scenario.
- No development at East Roselea.
- Pre-development site topography.

- Pre-development top, bottom and thickness of the Peat layer.
- Swales and basin not constructed.
- No connections between the Infill (model layer 1) and sand layer (model layer 3) through the Peat layer.

4.3 Development scenario results

The model predicts that, for the wet, median or dry climate scenario groundwater levels would generally stay below the proposed surface elevation at Swale 1 south, Swale 3 north and south, Swale 4, Basin and across the Site.

Only for the wet climate scenario does the model predict short term peaks in projected rainfall would result in groundwater levels being higher (i.e. between 0.1 and 0.2 m) than the bottom of the swale at Swale 1 north and Swale 2 but it is estimated that the swales would not be permanently wet.

Location of the monitoring points presented in Figure 4-8, Figure 4-9 and Figure 4-10 are shown in Figure 4-11. It should be noted that these monitoring points are just control points for the model and not actual monitoring bores.

Figure 4-8 Predicted water levels for Wet, Median and Dry scenarios (Swales 1 and 2)

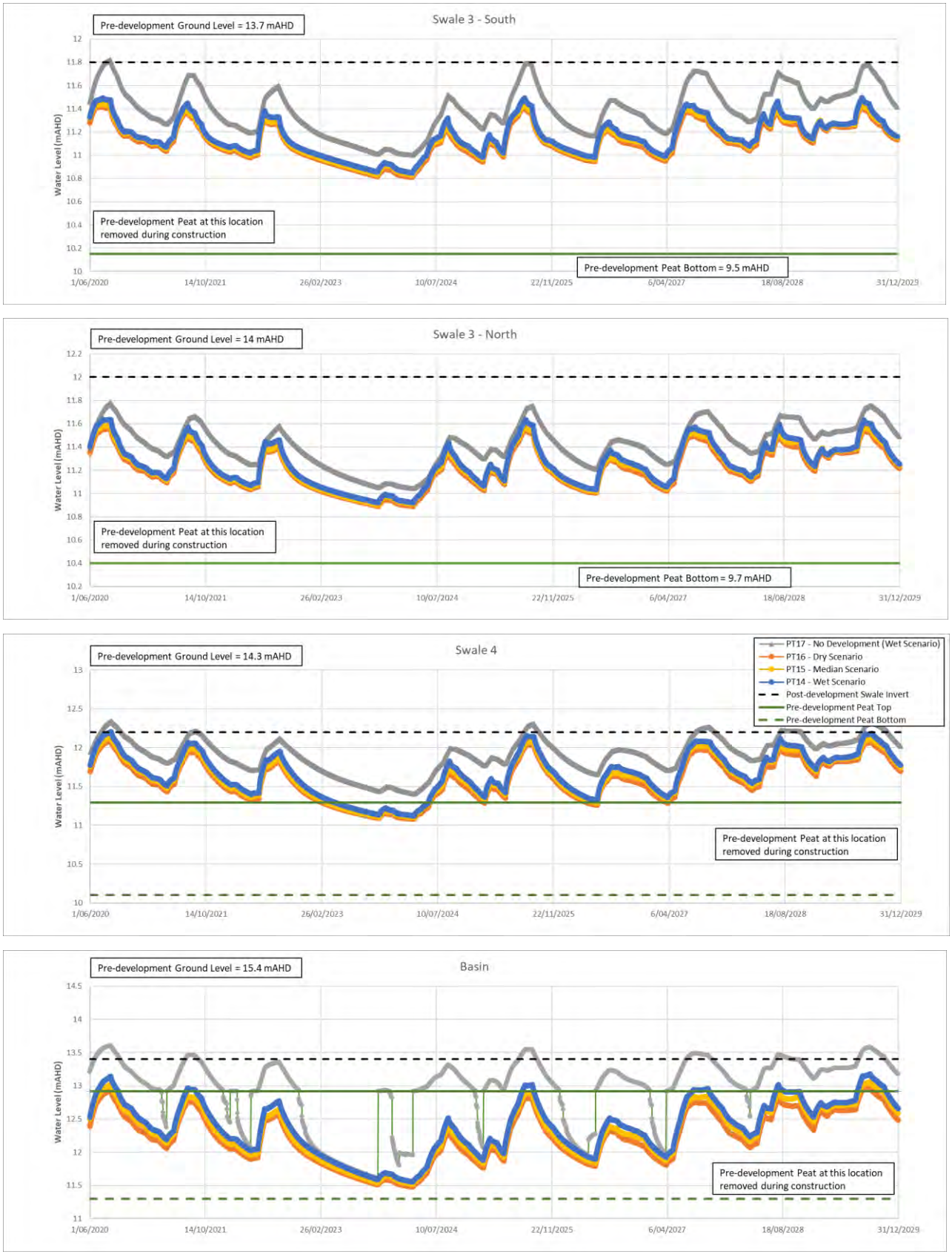


Figure 4-9 Predicted water levels for Wet, Median and Dry scenarios (Swales 3, 4 and Basin)

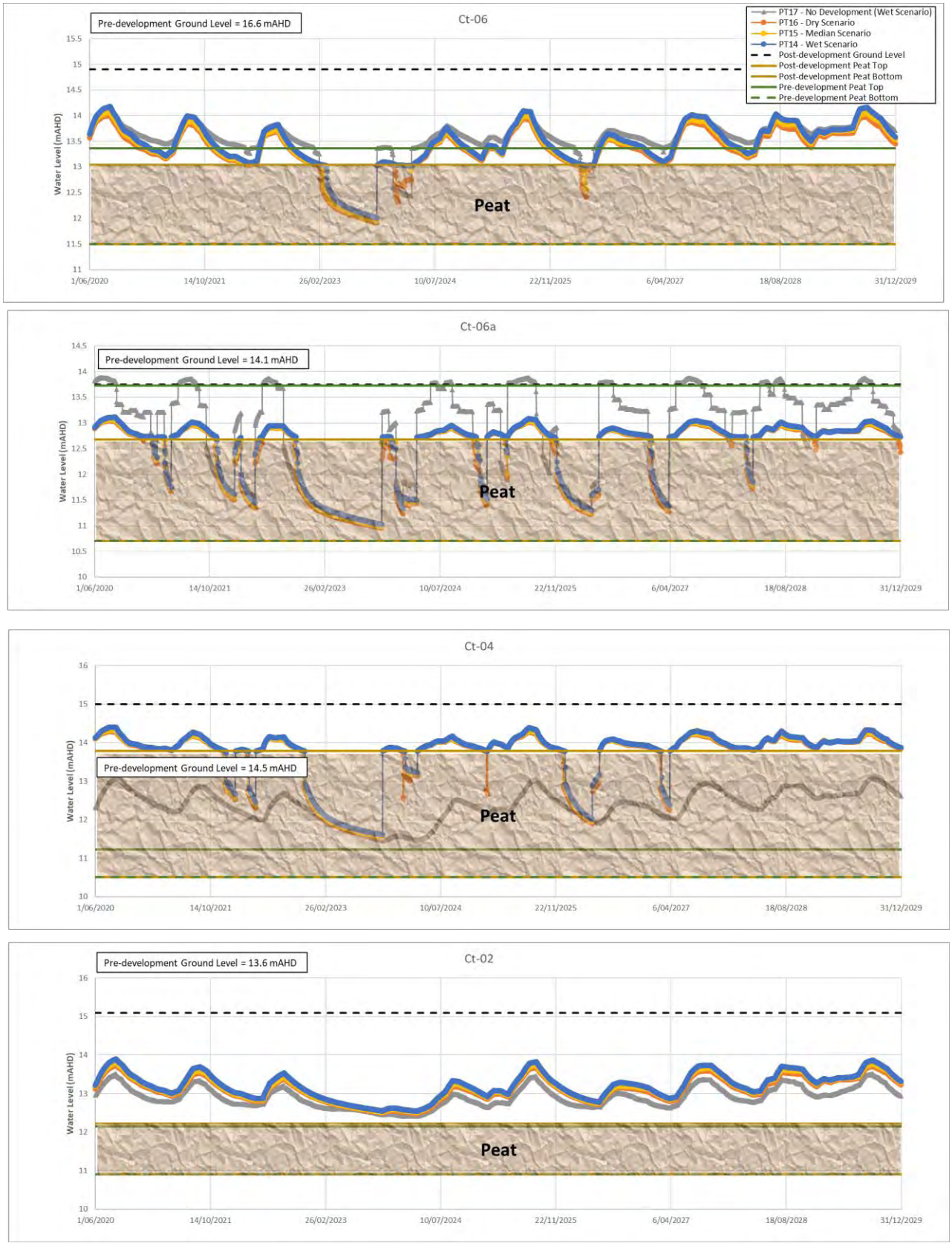


Figure 4-10 Predicted water levels for Wet, Median and Dry scenarios (site locations away from swales and basin)

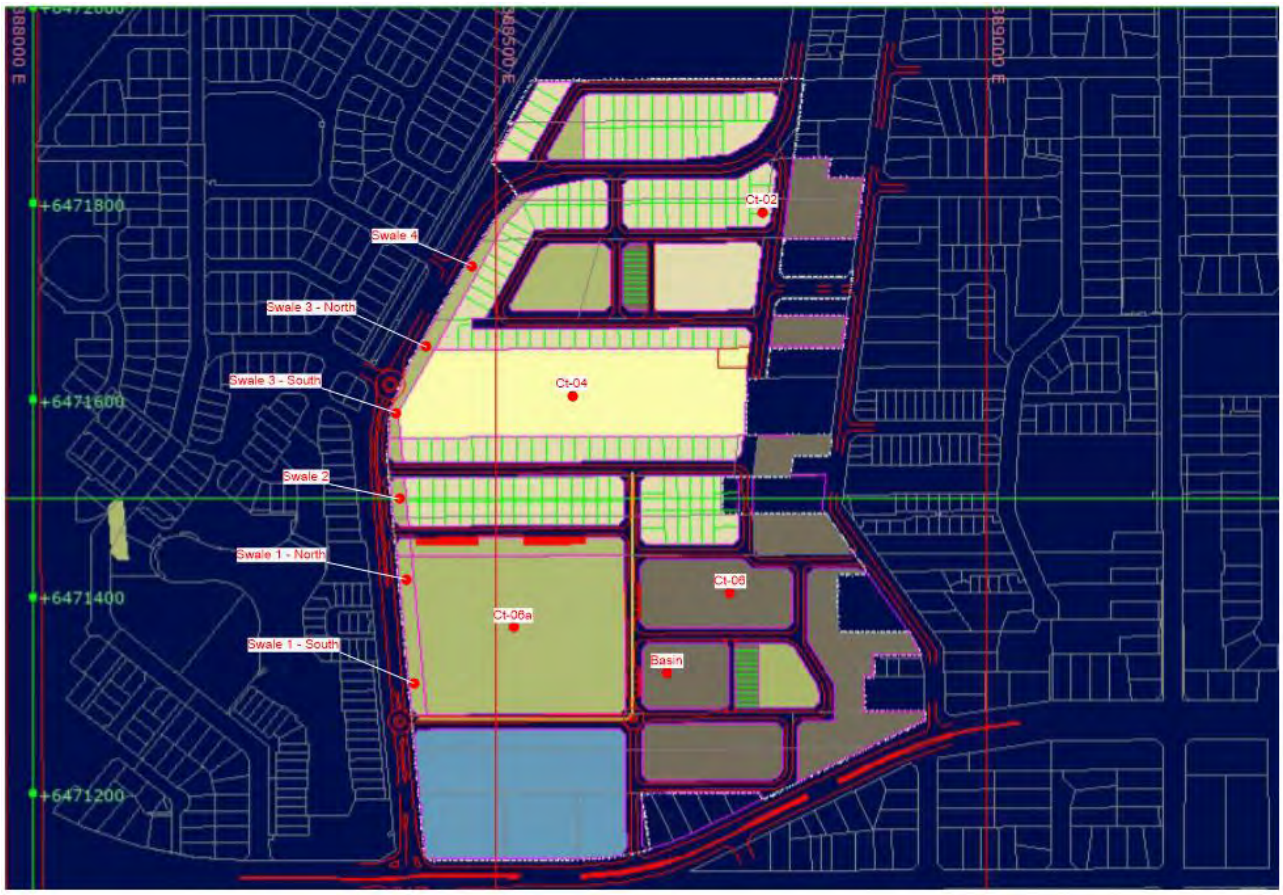


Figure 4-11 Location of the monitoring points

The statistical analysis of the predicted water levels for the wet climate scenario (by Emerge) to determine the 50% AEP indicates that 2021 provides an appropriate approximation of the 50% AEP. The methodology utilised to determine the 50% AEP is summarised in the Emerge technical memo contained in Appendix A. Therefore, predicted groundwater levels presented in Figure 4-12 are representative of 50% AEP and it is a predicted peak in July 2021 (ref Figure 4-8, Figure 4-9 and Figure 4-10).

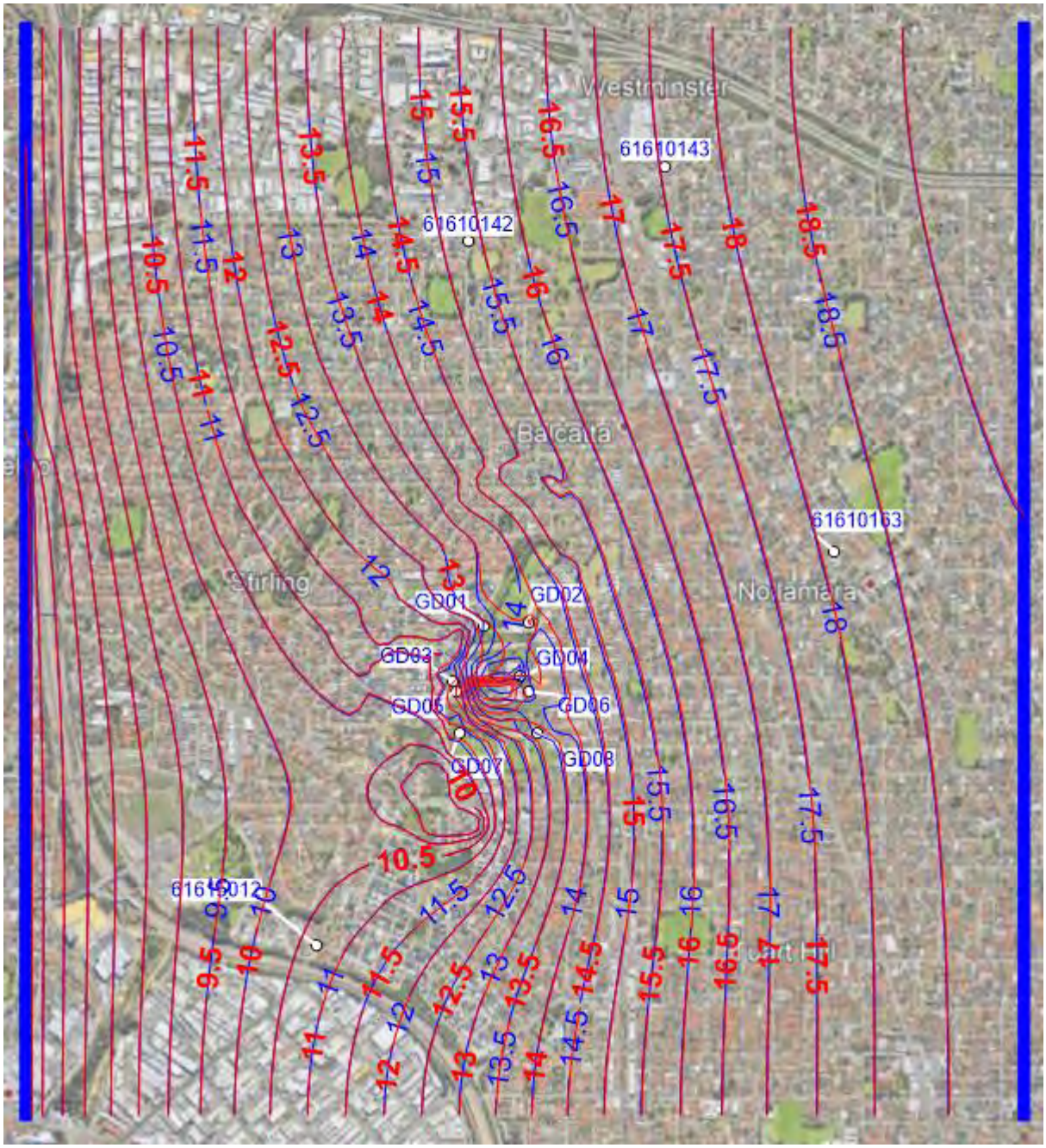


Figure 4-12 Predicted groundwater levels (Blue = Post-development scenario, Red = No development scenario)

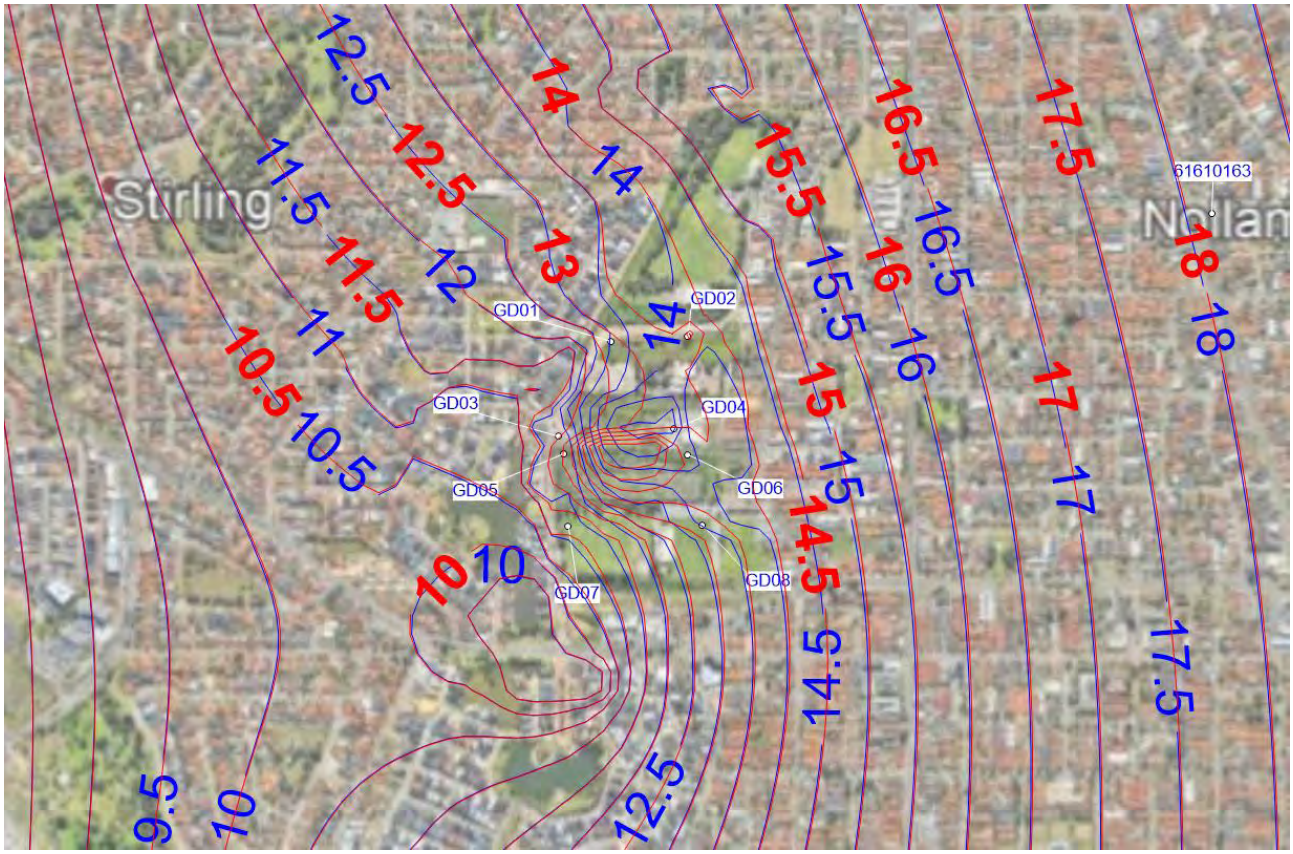


Figure 4-13 Predicted groundwater levels (Blue = Post-development scenario, Red = No development scenario)

Section 5 Sensitivity/Uncertainty Analysis

To assess the potential impact of uncertainties on model predictions, uncertainty analysis have been conducted.

Significant amount of efforts has been invested in developing conceptual hydrological and hydrogeological understanding of East Roselea site, model construction, calibration and predictions. During this process one model feature above all has been identified as a feature that has a major potential to impact on predicted outcomes of the post-development model. That feature is rainfall recharge.

While the groundwater model was calibrated to available data, including rainfall recharge, and modelled development scenarios considered a range of future rainfall events (i.e. wet, median and dry), to assess the uncertainty associated with this parameter measured rainfall and evapotranspiration that were applied to the pre-development (calibrated) model were simulated into the future. The reason for that is that compared to future climate scenarios simulated in the post-development model, pre-development (measured) rainfall is between 40-50% higher over the simulated period of 26 months. This is presented in Figure 5-1.

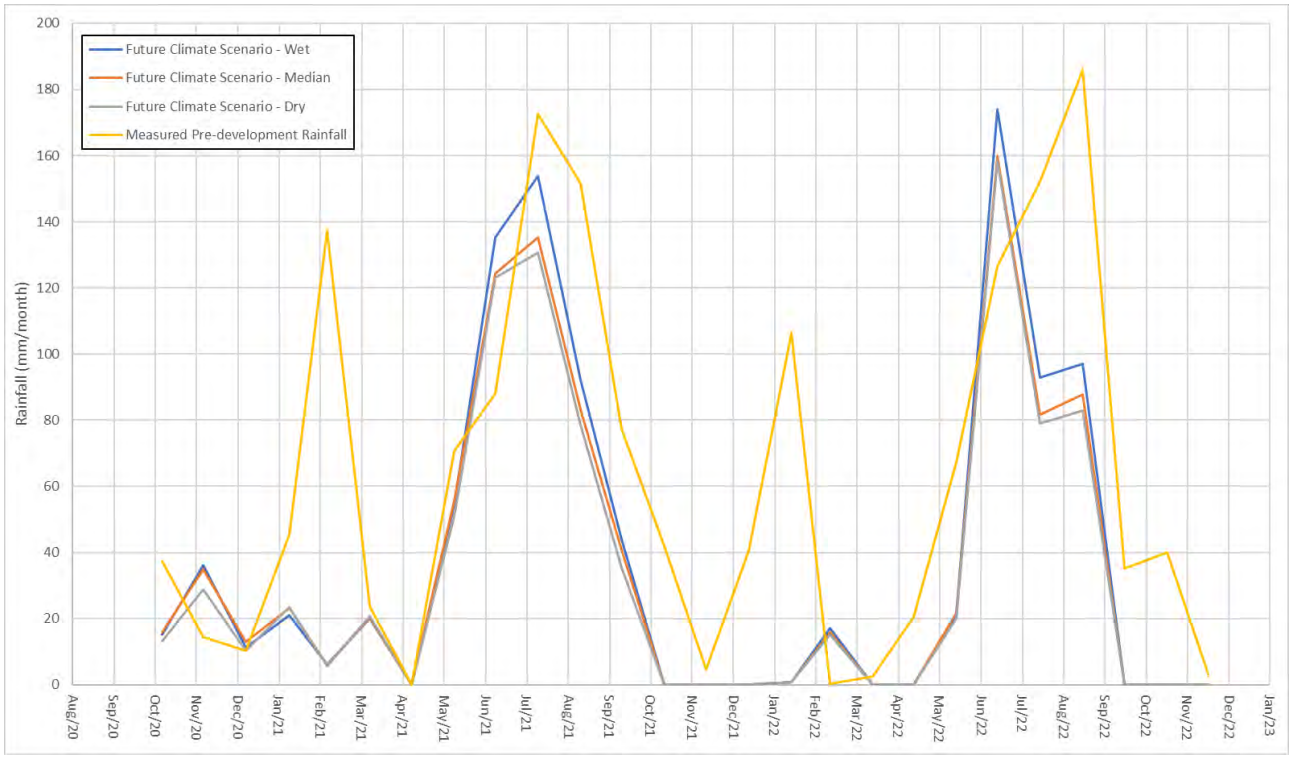


Figure 5-1 Rainfall Comparison Chart

Model setup and assumptions for this uncertainty run are listed below:

- Model simulates 26 monthly stress periods.
- Measured pre-development rainfall and evapotranspiration were applied to the development model.
- Measured pre-development rainfall and evapotranspiration from October 2016 – November 2018 were simulated starting from October 2020 – November 2022.
- Post development site conditions were simulated in this model including post-development site topography, changes to the peat layer, swales, basin and connections between swales and through the peat consistent with the development model described in Section 4.

The results of this model run are presented in Figure 5-2 to Figure 5-6.

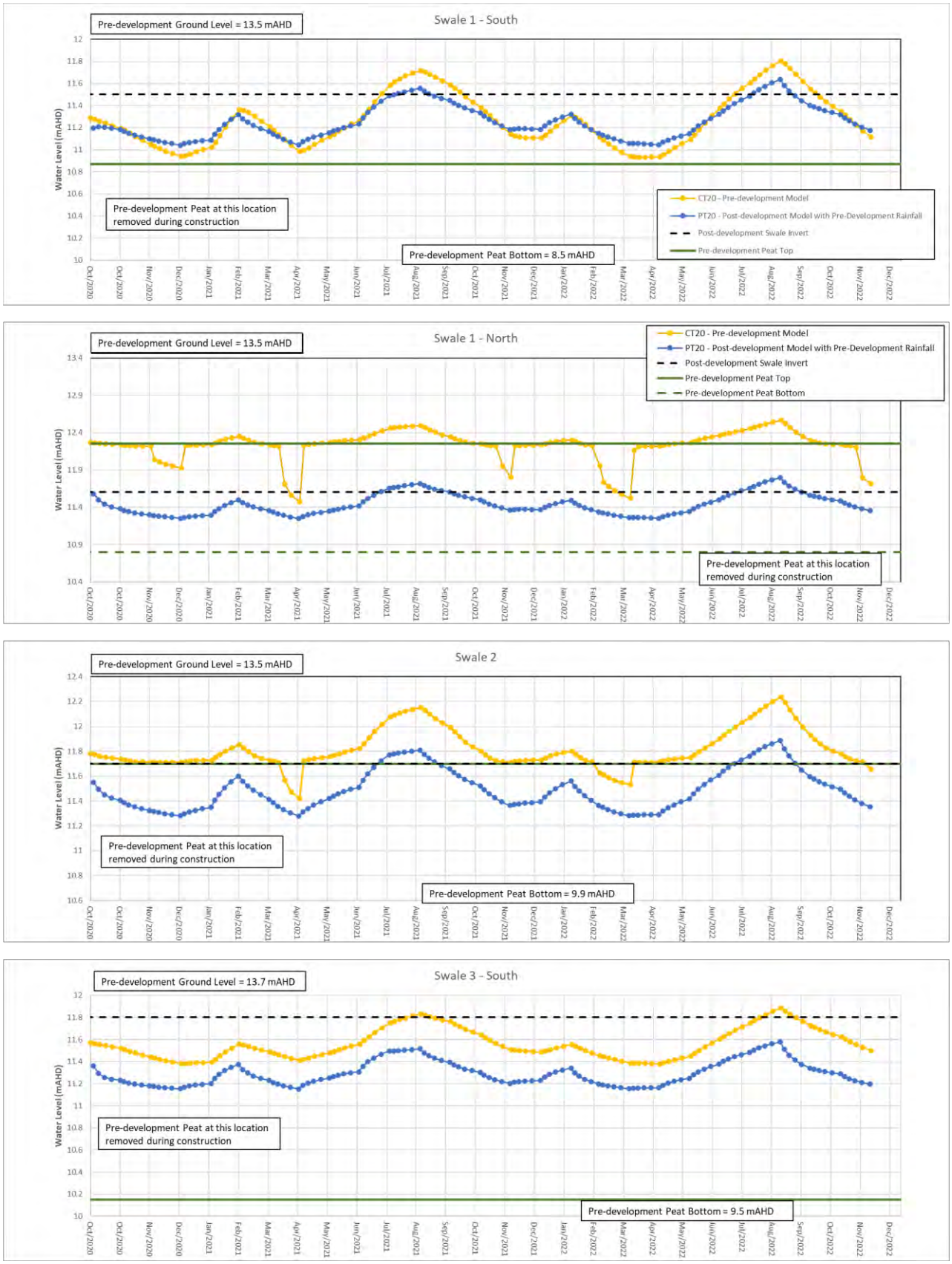


Figure 5-2 Uncertainty results – Predicted water levels at Swales 1-3

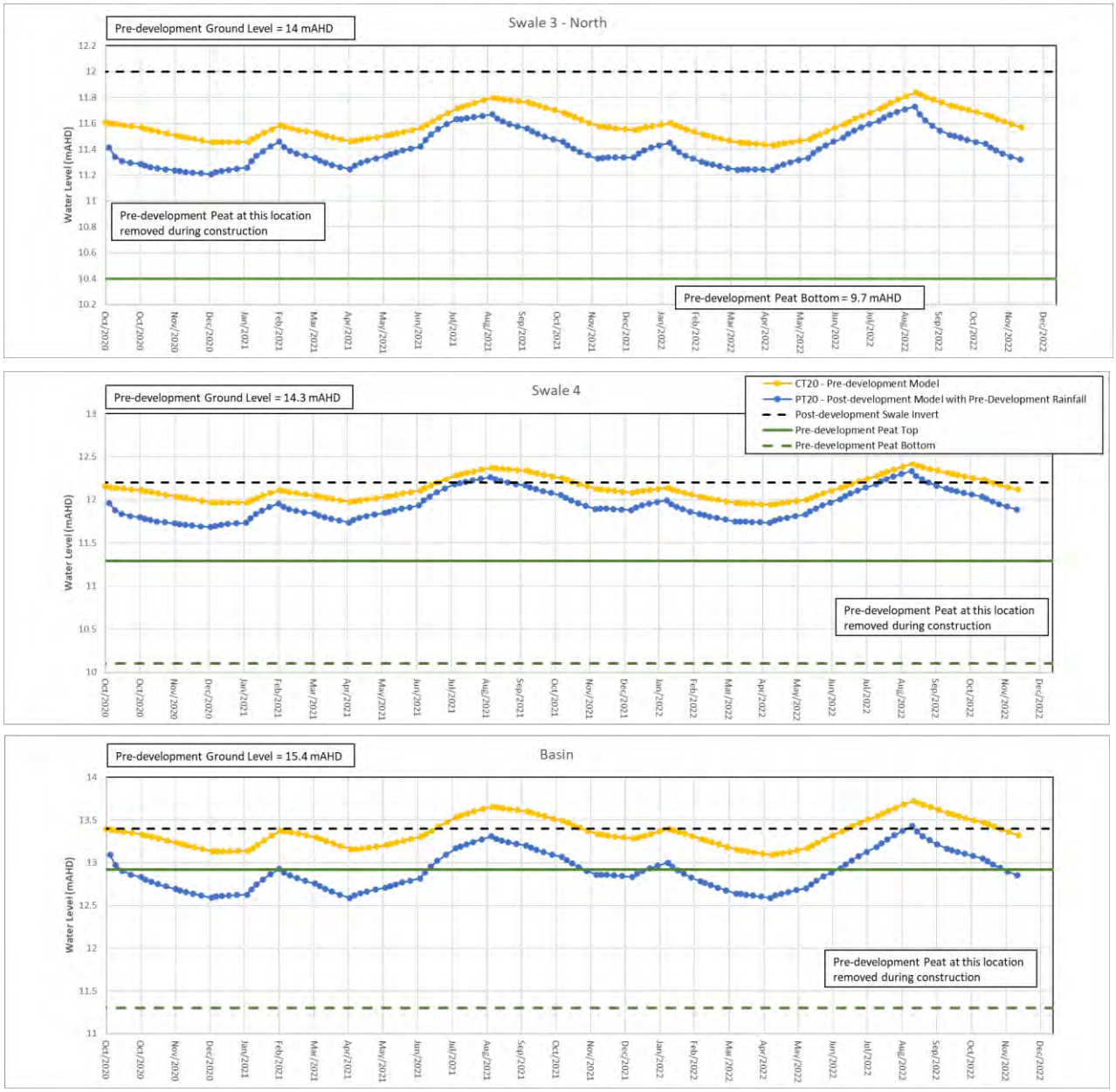


Figure 5-3 Uncertainty results – Predicted water levels at Swale 4 and Basin

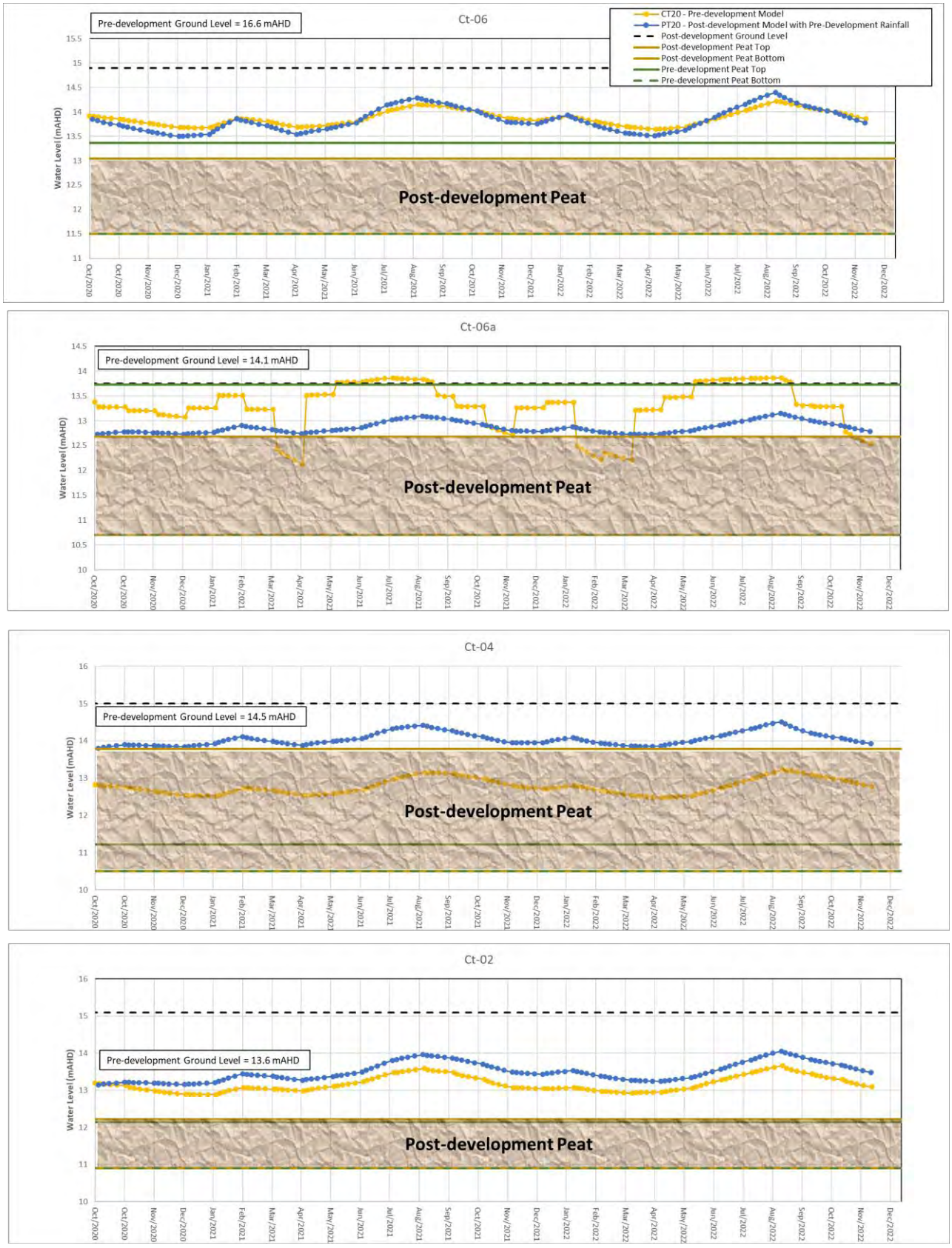


Figure 5-4 Uncertainty results – Predicted water levels at nominal site locations

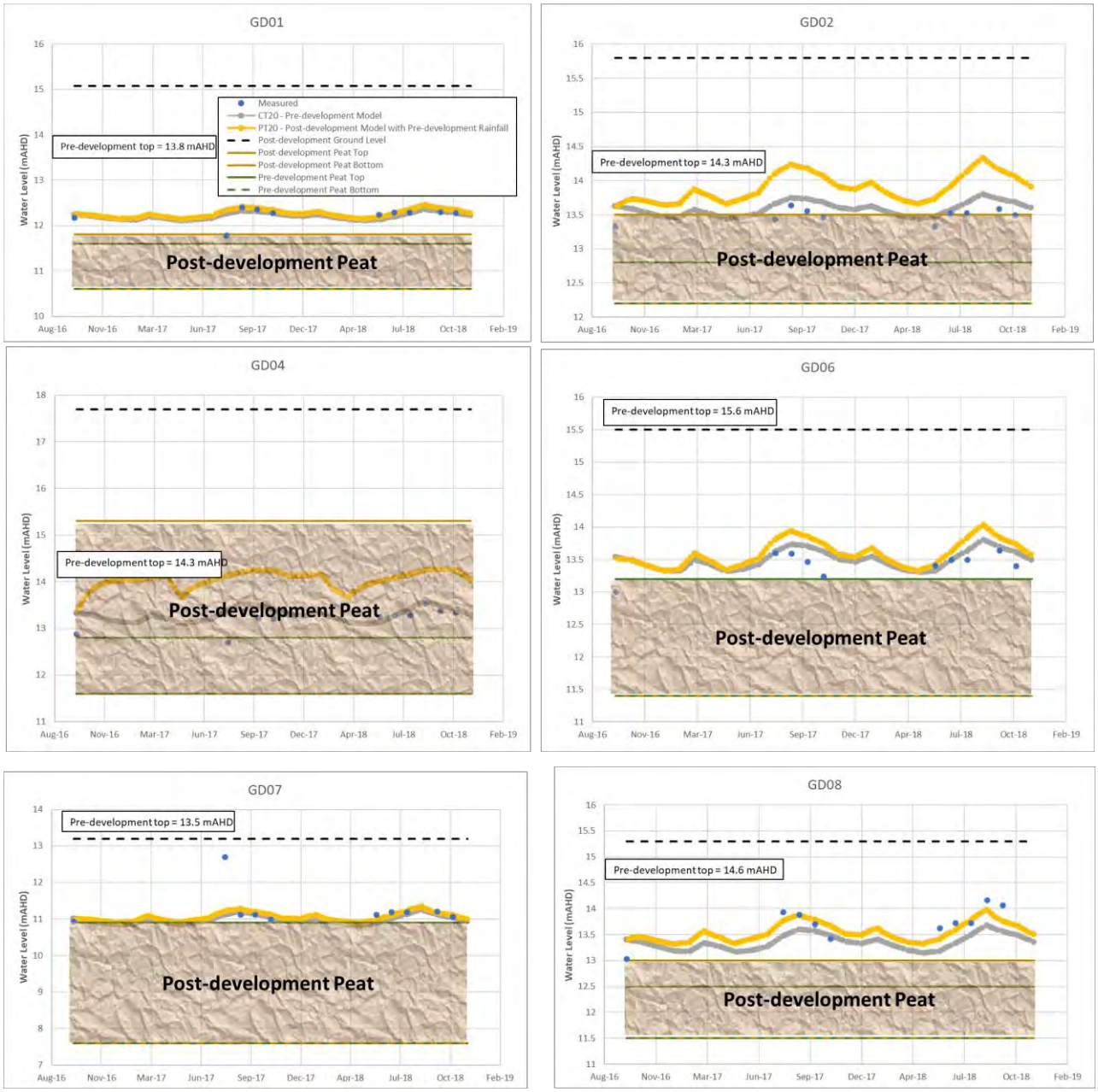


Figure 5-5 Uncertainty results – Predicted water levels at monitoring bores GD01-GD08

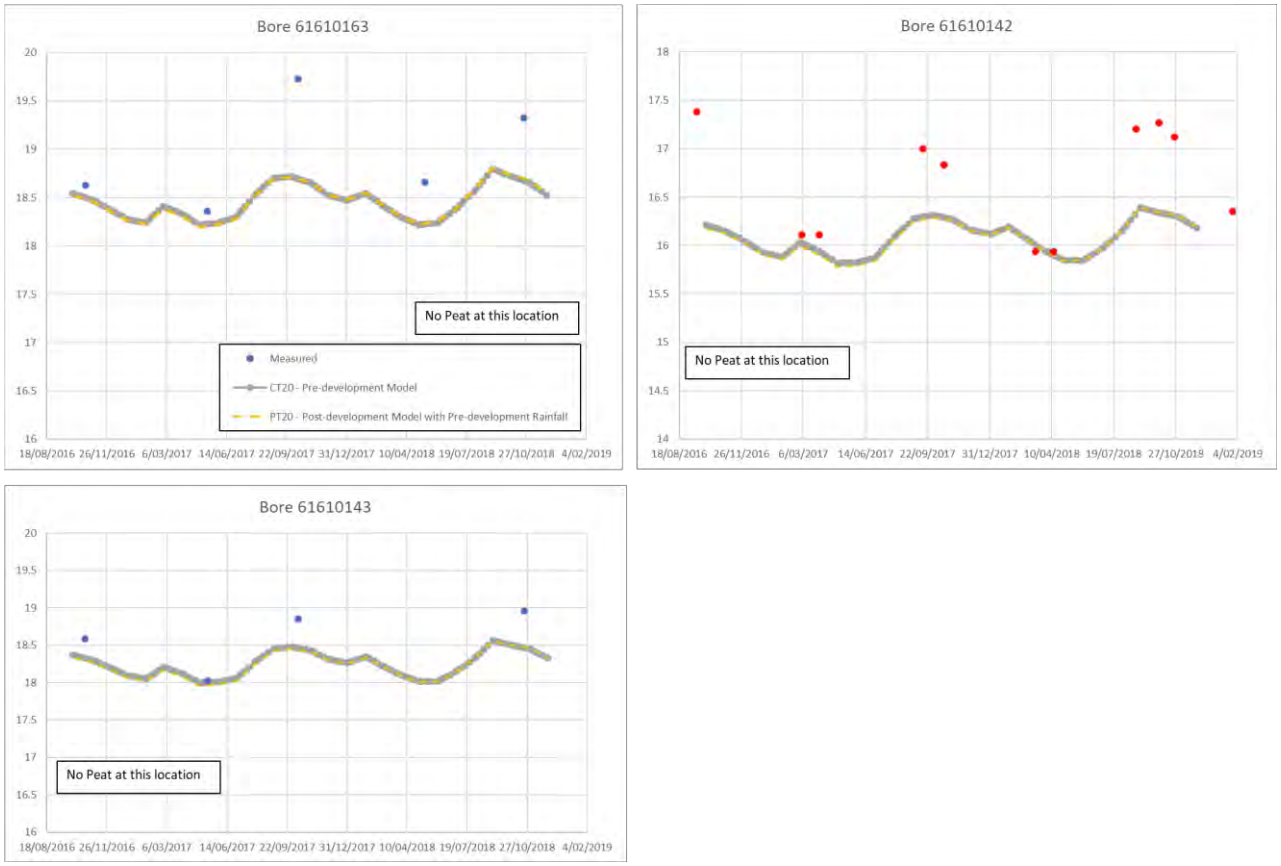


Figure 5-6 Uncertainty results – Predicted water levels at regional monitoring bores

At nominal bore locations presented in Figure 5-2 to Figure 5-4 the model estimates that even with the higher adopted rainfall water levels would stay below the post-development ground levels except at Swale 1, 2 and 4. Short term peaks in simulated rainfall at these three locations result in groundwater levels being marginally (i.e. less than 0.2m) higher than the bottom of the swales in some years. The model also estimates that as soon as the peak rainfall events are over the groundwater level would recede and the swales would not stay permanently wet.

At local and regional monitoring bore locations the model estimates that post development water levels on site would stay below the post-development ground levels. Bores GD03 and GD05 have not been included in Figure 5-5 as they are located inside the swales 2 and 1 respectively and have been included in Figure 5-2. The model estimates that even during the peak rainfall events there would significant clearance between the post-development topo and the estimated groundwater level. At regional bore locations, bore 61610163, 61610142 and 61610143 pre and post development water levels are an absolute match.

Section 6 Conclusions

A numerical groundwater model has been developed in support of the impact assessment for the East Roselea LWMS and Structure Plan. The model development follows the recommendations of the Australian Groundwater Modelling Guidelines (modelling guidelines) (Barnett et al. 2012). The groundwater model is developed using the Modflow-USG operating under the Groundwater Vistas graphical interface. The purpose of the modelling is to simulate impact of the proposed development on groundwater levels and throughflow in and around the site.

This report presents a full record of the model development and predictive simulations conducted using the model, including descriptions of the model construction and calibration, predictive simulations and results, and future climate change analysis.

Model boundary conditions are assigned to represent groundwater throughflow, groundwater recharge, evapotranspiration, and groundwater interactions with surface and sub-surface drainage.

The model is calibrated to available groundwater level records from groundwater monitoring bores in the steady state and transient mode. The period from Oct 2016 to Nov 2018 has been chosen for the transient model calibration based on available monitoring data.

The steady state calibration represents long term average pre-development conditions and provides estimates of the aquifer hydraulic conductivities and the initial condition for the transient calibration. Unconfined storage values have been estimated in the transient calibration run.

Modelling results are presented as maps and charts of estimated pre-development versus post-development water levels. The model predicts that even without the sub-soil drains (proposed in the LWMS) groundwater levels would not rise above the post-development ground levels, except at Swale 1 north and Swale 2 where the model predicts groundwater levels would rise slightly above the bottom of the swale during the peak rainfall events in some years (only for the wet climate scenario), but swales would not become permanently wet.

The model indicates that the proposed development at East Roselea will not adversely impact on groundwater levels outside of the site.

Section 7 References

Emerge Associates, November 2019; "Local Water Management Strategy, East Roselea", Project No: EP18-114(02)

Douglas Partners, 2012; "Geotechnical Logs and Site Plan (DP, 2012), DoW Groundwater Bore Locations EPBC Search Results Dial-Before-You-Dig Search Results"

Galt Geotechnics, February 2015; "Proposed Residential Development – Lots 86, 88 & 129, Grindleford Drive, Balcatta", J1401266 004 R Rev0

Government of Western Australia, Department of Water, September 2015; "Selection of future climate projections for Western Australia", Report no. WST 72

Government of Western Australia, Department of Water, October 2016; "Department of Water supplied future climate data sets"

Bureau of Meteorology, May 2020; Rainfall and Evapotranspiration Data for Perth Metro Weather Station ID: 009225

Water Corporation, May 2020; Drainage assets (Water Corporation data system)

Geoscience Australia, May 2020; Publicly Available Lidar Data

Institute of Public Works Engineering Australia, February 2016; "Specification for separation distances for groundwater-controlled urban development"

Appendix I

Annual Exceedance Probability analysis

Technical Note

Project Name	East Roselea
Project Number	EP18-114
Date	22/09/2020
Purpose	The purpose of this file note is to provide a summary of the groundwater elevation frequency analysis that has been undertaken for annual peak elevations within the East Roselea development

Maximum groundwater elevation frequency analysis

Background

Frequency analysis refers to procedures that use recorded data to identify the frequency and therefore likelihood of an event of a particular magnitude occurring at a particular location. This information can then be used to perform risk-based design and risk assessment.

A maximum groundwater elevation frequency analysis has been performed at ten locations within the East Roselea development based on predicted groundwater levels for 2020-2030 (CDM Smith 2020). The purpose of this assessment is to derive groundwater elevations at each location that represent the 50% annual exceedance probability (AEP) of the predicted elevations. This elevation set will be used to guide development of the site such that compliance with the *Separation distances for groundwater controlled urban development* (IPWEA guidelines) (IPWEA 2016) is achieved.

Frequency analysis

In order to derive the 50% AEP maximum groundwater elevation, a probability distribution was fitted to the predicted elevations of groundwater over the years 2020-2030 as calculated in the GW modelling report (CDMSmith 2020). The probability distribution utilised is the Generalized Extreme Value (GEV), which was fitted to the Annual Maximum Series (AMS) using L-moments. This process is outlined below.

Annual Maximum Series

The *Specification Separation Distances for Groundwater Controlled Urban Development* (IPWEA 2016) state that the 50% AEP phreatic surface is "The phreatic surface that will be exceeded in 50% of years (50% chance each year)". Therefore, the annual maximum groundwater elevation should be considered.

The Annual Maximum Series (AMS) is formed by extracting the maximum elevation in each year. The AEP can be estimated from the AMS by arranging the annual maximum elevation in descending order of magnitudes and assigning the relative rank of these. This form is also convenient for estimation of L-moment parameters and using these to fit a frequency distribution to the AMS.

Frequency distribution

The Generalized Extreme Value (GEV) distribution has been used in this study to represent the probability of the annual maximum elevations. There are several statistical distributions used to model extreme (or annual maximum/minimum) events. The GEV distribution has gained widespread acceptance in these scenarios (typically flow events and rainfall events) {Ball J, 2019 #3915}. The cumulative distribution function F(x) for the GEV is given below.

$$F(x) = exp\,[-\{1 - \{\kappa(x - \xi)/\alpha\}\}^{\frac{1}{\kappa}}]$$

For $\kappa \neq 0$, where ξ, α and κ are known parameters for location, scale and shape, respectively.

L-moments

L-moments are more robust than conventional moments to outliers in the data and enable more secure inferences to be made from small samples about an underlying probability distribution (Hosking 1990). The L-moments can be estimated from linear combinations of probability weighted movements in the from described by Hosking (1985) as show below. Given an ordered sample of size n such that $x_1 \leq x_2 \leq \cdots x_n$ and the moment b_r where r is a real number.

$$b_r = n^{-1} \sum_{j=0}^{n} \frac{(j-1)(j-2)\ldots(j-r)}{(n-1)(n-2)\ldots(n-r)} x_j$$

The linear combinations for the estimation of the first three L-moments from Hosking and Wallis (1997) are as follows:

$$\lambda_1 = b_0$$

$$\lambda_2 = 2b_1 - b_0$$

$$\lambda_3 = 6b_2 - 6b_1 + b_0$$

Generalized extreme value distribution parameter estimation via the L-moments is provided in Table 2 of Hosking (1990). The estimations are as follows.

$$z = {}^{2}/_{(3+\tau_3)} - {}^{\log 2}/_{\log 3}$$

$$\kappa \approx 7.8590z + 2.9554z^2$$

$$\alpha = {}^{\lambda_2\,\kappa}/_{(1-2^{-\kappa})\Gamma(1+\kappa)}$$

$$\xi = \lambda_1 + {}^{\alpha\Gamma\{(1+\kappa)-1\}}/_{\kappa}$$

Where

$$\tau_3 = \lambda_3 {\lambda_2}^{-1}$$

Results

The 50% AEP elevations for each measurement site were derived from the GEV distributions fitted to the AMS at each of these sites. The year where the predicted maximum groundwater levels most closely matched the fitted 50% maximum groundwater level over the 2020-2030 period was 2021. The predicted maximum groundwater elevations for 2021 and the calculated 50% AEP elevations are compared in **Table 1**., and demonstrate that the use of the modelled 2021 groundwater contours provides an appropriate representation of the 50% AEP peak groundwater levels.

Table 1: Calculated 50% AEP values compared to 2021 predicted peak groundwater elevation

Location	50% AEP Groundwater	Predicted maximum GWL 2021	Difference
Swale 1 - South	11.371	11.392	-0.021
Swale 1 - North	11.547	11.571	-0.023
Swale 2	11.703	11.712	-0.009
Swale 3 - South	11.448	11.448	0.000
Swale 3 - North	11.570	11.569	0.001
Swale 4	12.070	12.069	0.001
Basin	12.928	12.967	-0.039
Ct-06a	13.028	13.016	0.012
Ct-06	14.003	13.994	0.009
Ct-04	14.289	14.271	0.017
Ct-02 - West	13.679	13.690	-0.011
Ct-02 - East	14.160	14.212	-0.053

References

Institute of Public Works Engineering Australia (IPWEA) 2016, *Specification: Separation distances for groundwater controlled urban development*, Perth.

Hosking J. 1985, *Estimation of the Generalized Extreme-Value Distribution by the Method of Probability Weighted Moments.*

Hosking J. 1990, L-*Moments: Analysis and Estimation of Distributions Using Linear Combinations of Order Statistics*.

Hosking J, and Wallis J. 1997, *Regional Flood Frequency Analysis. An approach based on L-Moments.*

APPENDIX 10

RETAIL SUSTAINABILITY ASSESSMENT

ROWE GROUP DESIGN

East Roselea Neighbourhood Centre

Retail Sustainability Assessment

August 2018

Dimasi & CO

Dimasi
& CO

Prepared for:

Trendsetter Homes

Prepared by:
Tony Dimasi, Managing Director – Dimasi & Co
dimasi@bigpond.com

Table of contents

Executive summary		1
Introduction		4
Section 1:	Site location and proposed development	6
1.1	Site context and proposed development	6
1.2	Planning background	9
Section 2:	Trade area analysis	12
2.1	Trade area definition	12
2.2	Trade area population	16
2.3	Trade area population profile	18
2.4	Trade area spending	20
Section 3:	Competition	24
3.1	Competition within trade area	24
3.2	Competition beyond trade area	25
3.3	Summary	25
Section 4:	Consideration of economic impacts	26
4.1	Supermarket floorspace analysis	26
4.2	Estimated centre sales potential and market shares	30
4.3	Assessment of likely economic impacts	32
4.4	Trading impacts at 2020/21 and subsequent years	35
4.5	Net community benefit	40
4.6	Compliance with requirements of RSA as per Section 6.5 of SPP 4.2	41

Executive summary

i. The East Roselea Neighbourhood Centre site is located on the north-eastern corner of Karrinyup Road and Grindleford Drive, approximately 10 km north-west of the Perth CBD. The proposed new neighbourhood centre is assumed to be 6,000 sq.m in size, and to open in mid-2020. The centre would add a new service to the existing facilities at the locality, which include various healthcare as well as childcare services .

ii. The subject site is highly visible and easily accessible for the local population, with Karrinyup Road to provide the main vehicular gateway to the proposed centre.

iii. The East Roselea centre will be an easily accessible food and grocery plus convenience shopping destination for surrounding residents. Higher order shopping requirements will continue to be serviced by the much larger facilities at Karrinyup SC and Westfield Innaloo, both located on the western side of the Mitchell Freeway, and to a lesser extent also by Stirling Central and The Square Mirrabooka.

iv. The current population of the main trade area which the new centre will serve is around 25,300, including approx. 16,000 in the key primary sector. This is already a very substantial catchment, but in addition the population will increase significantly as a result of in-fill residential development that is planned to occur on vacant land situated to the immediate north and north-east of the subject site. When developed, that land will accommodate more than 500 new dwellings, expected to house some 1,200 additional residents.

v. The main trade area which the new centre will serve is reflective of an inner to middle suburban residential area, with a mixed profile, housing traditional families in their mid to late life stages as well as younger professionals who are attracted by the proximity of the locality to the CBD.

vi. Total available retail expenditure within the main trade area is forecast to grow in real terms from the current (2018) level of $374 million to a projected total of $470 million at 2026. This level of growth reflects an average annual real growth rate of around 2.6% per annum over the forecast period to 2026.

vii. The analysis of supermarket floorspace indicates that there is a significant undersupply of such floorspace within the defined East Roselea main trade area. There is thus scope, and community need, for the East Roselea Neighbourhood Centre to be developed to help to alleviate the identified floorspace gap.

viii. Sales for the East Roselea Neighbourhood Centre are projected at around $49.3 million (expressed in constant 2017/18 dollars) at Year 1, which is assumed to be FY 2021. On this basis, the centre is expected to achieve a 10.5% share of the total available retail spending in the main trade area, including 13.3% of the available food expenditure. The remaining expenditure of trade area residents (89.5%) would continue to be directed mainly to the surrounding existing facilities, including the facilities within the main trade area as well as the much larger centres outside the trade area, in particular Karrinyup SC and Westfield Innaloo.

ix. A number of economic benefits are expected to flow directly from the development of the East Roselea centre, including:

- A local and modern destination for food and grocery shopping, adding to an existing community facility and focal point;
- A large number of additional local employment opportunities;
- A wider range of shopping choices for local residents; and
- Increased convenience and amenity, together with reduced travel times to access food and grocery shopping, for local residents.

x. Against these benefits, some impacts are projected on centres located both within and beyond the trade area initially. Those impacts would be mainly spread across a number of national brand supermarkets located beyond the trade area, namely Coles at Northlands Plaza SC; Woolworths at Dog Swamp; Coles at Flinders Square; Coles and Woolworths at Westfield Innaloo; and

Woolworths at Karrinyup SC. The much smaller IGA stores which are located within the defined trade area (Osborne Park and Stirling Village) are also estimated to experience some minor to moderate impacts, given their different (limited) roles within their respective localised catchments.

xi. The analysis also shows, however, that these impacts will not threaten the ongoing viability of any existing or planned facilities, which would still have ample capacity to achieve good sales volumes, reflecting the large population base in the trade area. These one-off impacts will be gradually absorbed, with ongoing growth outlooks for each competitive centre thereafter.

xii. The analysis in this report demonstrates that there will be no loss of services to the local community, with all impacted centres well able to continue trading successfully following the development of the East Roselea centre. The new centre would add to the services available to surrounding residents, in the form of a modern facility, which residents would be able to easily access to undertake their weekly food and grocery shopping, convenience shopping and services.

xiii. Having regard to all the above, it can be concluded that a significant net community benefit will result from the development of the East Roselea centre at a total size of 6,000 sq.m. Gross Leasable Area.

Introduction

This report presents a retail sustainability assessment for the proposed development of a new neighbourhood centre, to be anchored by a Woolworths supermarket, on a site fronting Karrinyup Road at East Roselea, within the City of Stirling. The report has been prepared as part of the requirements of *State Planning Policy 4.2 Activity Centres Policy for Perth and Peel* (SPP 4.2), as outlined in Section 6.5 of the Policy, which stipulates the following in regards to Retail Sustainability Assessments:

"*A Retail Sustainability Assessment (RSA) assesses the potential economic and related effects of a significant retail expansion on the network of activity centres in a locality. It addresses such effects from a local community access or benefit perspective, and is limited to considering potential loss of services, and any associated detriment caused by a proposed development. Competition between businesses of itself is not considered a relevant planning consideration.*"

The report therefore considers the potential economic and related impacts of the proposed development of the neighbourhood centre on the surrounding network of centres, addressing the overall costs and benefits of the proposal from a community perspective, and focusing on any potential loss of services and any associated detriment.

The report is presented in four sections as follows:

- **Section 1** examines the location and context of the subject site, and summarises the relevant background with respect to centres planning for the broader region.
- **Section 2** examines the trade area which will be served by the proposed neighbourhood centre, and provides assessments of current and projected population and retail spending levels within the trade area.
- **Section 3** describes the competitive environment within which the proposed centre will operate.

- **Section 4** outlines the estimated sales potential for the proposed centre, and then presents an economic impact assessment for the proposal. The likely trading impacts on other retail facilities throughout the surrounding region are considered, as are the employment and other economic effects of the proposed development. The question of any consequent potential loss of services and any associated detriment, as a result of the proposed development, is also addressed.

Section 1: Site location and proposed development

1.1 Site context and proposed development

The subject site is located on the north-eastern corner of Karrinyup Road and Grindleford Drive (refer Map 1.1), adjacent to an existing medical centre to its immediate east, and a park and sports fields to its north. The site occupies a highly visible location and will be easily accessible for the surrounding local population, with Karrinyup Road providing the main vehicular route to the site.

The plans for the East Roselea Neighbourhood Centre are in the process of being finalised, but Figure 1 shows the indicative layout. The centre is assumed to open around mid-2020, with its first full year of trading therefore being 2020/21.

The centre will be anchored by a Woolworths supermarket, which will occupy 3,600 sq.m., with supporting specialty floorspace and non-retail shopfront uses to occupy the balance of the floorspace. For the purpose of this analysis, the centre size is assumed to be 6,000 sq.m. Supporting this floorspace some 302 at-grade carparking spaces will be provided onsite for centre customers, accessible via both Grindleford Drive and Karrinyup Road.

The proposed centre, as shown on Figure 1.1, would add a new service to the existing facilities on adjacent and nearby sites, including the adjoining Stirling Lakes Medical Centre, which provides doctors, dentist, and physiotherapy services, plus child development services and early learning centre. Waldecks Garden Centre is situated opposite the site, on Karrinyup Road.

The primary supermarket facilities serving surrounding residents currently are located at Primewest Northlands (Coles) to the north-east; Flinders Square (Coles) and Dog Swamp SC (Woolworths) to the south-east; and Karrinyup SC (Woolworths) and Westfield Innaloo (Woolworths and Coles) on the western side of the Mitchell Freeway. Both Karrinyup SC and Westfield Innaloo are major centres, serving both the food and non-food retail needs of residents within the broader City of Stirling region.

Map 1.1: East Roselea Neighbourhood Centre

Site location

Figure 1.1

NLA (m²)	
SUPERMARKET	3,600
BWS	200
SPECIALTIES	2095
	5,895m²

CAR PARKING	
RATIO	5/100m²
PARKING REQ'D	295
PARKING PROVIDED*	302

* including 20 BAYS street parking

SITE AREAS	
RETAIL SITE	17,718m²
MIXED USE	2,539m²

EAST ROSALEA LOCAL CENTRE
INDICATIVE DEVELOPMENT PLAN

Status: PRELIMINARY
Path:

Scale: 1:1000 @ A3
North:

© Hames Sharley

Project Number: 43840
Drawing Number: SK101
Revision: 0
Date: 13/07/2018

Hames Sharley

1.2 Planning background

Activity Centres Policy for Perth and Peel

The *Activity Centres Policy for Perth and Peel* (the Policy) is a state planning policy (SPP 4.2), released in August 2010, for the planning and development of activity centres throughout Perth and Peel.

The purpose of the Policy is to provide broad policy guidance to local governments, state agencies and other stakeholders on matters such as:

- the preferred spatial distribution for retail and commercial use;
- the planning and development of new activity centres;
- the redevelopment and renewal of existing centres in Perth and Peel;
- the urban design considerations for new activity centres, and the associated transport and infrastructure provision.

In order to achieve its objectives, the Policy provides for a hierarchy of activity centres, which differentiates such centres and their planning principles in terms of their roles and functions within the overall network; their indicative retail catchments; and their housing density and mix of land uses. The centres hierarchy is as follows:

- The Perth Capital City is the largest and highest ranking of the activity centres, providing the largest concentration of development in the region, with the greatest range of services and employment facilities.
- Strategic Metropolitan Centres – 10 such centres are designated, at Yanchep, Joondalup, East Roselea, Morley, Midland, Fremantle, Cannington, Armadale, Rockingham and Mandurah. The Strategic Metropolitan Centres are the main regional activity centres, providing a diverse mix of economic and community uses for their extensive catchments. The inner north-western Perth region contains one such centre - the Stirling Strategic Metropolitan Centre (Innaloo).

- Secondary Centres – The Policy identifies 19 Secondary Centres, which are generally evenly distributed across the Perth urban area. Secondary Centres, similar to Strategic Metropolitan Centres, also offer a diverse range of services and facilities, including community and employment opportunities.

- District Centres – A network of District Centres is designated throughout the Perth urban area. These centres are expected to focus on servicing the daily and weekly needs of residents within their local respective catchments. Northlands and Main Street (Osborne Park) are the two closest designated District Centre to the subject site within this region of Perth.

- Neighbourhood Centres – Such centres are expected to provide local community hubs to service the day-to-day needs of the immediately surrounding residents. The Policy does not provide the locations of the neighbourhood centres, but emphasises their important roles, which should be recognised in local planning strategies and structure plans.

City of Stirling Draft Local Planning Strategy – Planning and Sustainability Strategy (the 'Strategy')

The Strategy sets out the long-term planning directions for the City, in particular the planning objectives, policy statements and recommended actions associated with housing, commercial, recreation, transport and environmental and heritage issues over at least the next 10 years and into the future.

The Strategy stresses that: "*People should be **easily** able to meet their education, employment, recreation, service and consumer needs within a reasonable distance of their home.*" (Dimasi & Co emphasis)

In that regard, the development of the East Roselea Neighbourhood Centre will enable the above objective to be met for the surrounding residents, through the provision of a highly convenient local facility to undertake their food and grocery shopping. The potential economic, social and trading implications of this proposal are assessed later in this report.

As noted previously in this report, the proposed neighbourhood centre would add to the various existing facilities at the locality, including medical, child development, early learning, garden centre and park/sports fields, thereby providing a more complete range of facilities, at a convenient location, in line with the above objective.

Section 2: Trade area analysis

This section of the report details the trade area that will be available to be served by the East Roselea Neighbourhood Centre, including the population and spending levels within the trade area and the socio-demographic profile of trade area residents.

2.1 Trade area definition

The extent of a trade area or catchment for any centre is shaped by a number of important factors, which are described as follows:

i. The relative attraction of the centre in question as compared with alternative retail facilities. The factors that determine the strength and attraction of any shopping or activity centre are primarily the scale and composition of the centre, in particular the major trader (or traders) that are included within it; the layout, ambience and presentation of the centre; and carparking, including access and ease of use.

ii. While the strength and appeal of a centre directly impacts on the breadth of customer draw, the proximity and attraction of competitive retail centres impact on a centre's ability to extend its trade area. Thus, the locations, compositions, quality and scale of competitive retail facilities all serve to define the extent of the trade area which the centre in question is effectively able to serve.

iii. The available road network and public transport service and how they operate to effect ease of use and access to the centre in question are also important factors impacting on its relative attractiveness.

iv. Significant physical barriers which are difficult to negotiate or which take considerable time to cross can often act to delineate the boundaries of the trade areas that are able to be served by specific centres.

Taking all of the above into account, the trade area in this instance is influenced in particular by the following:

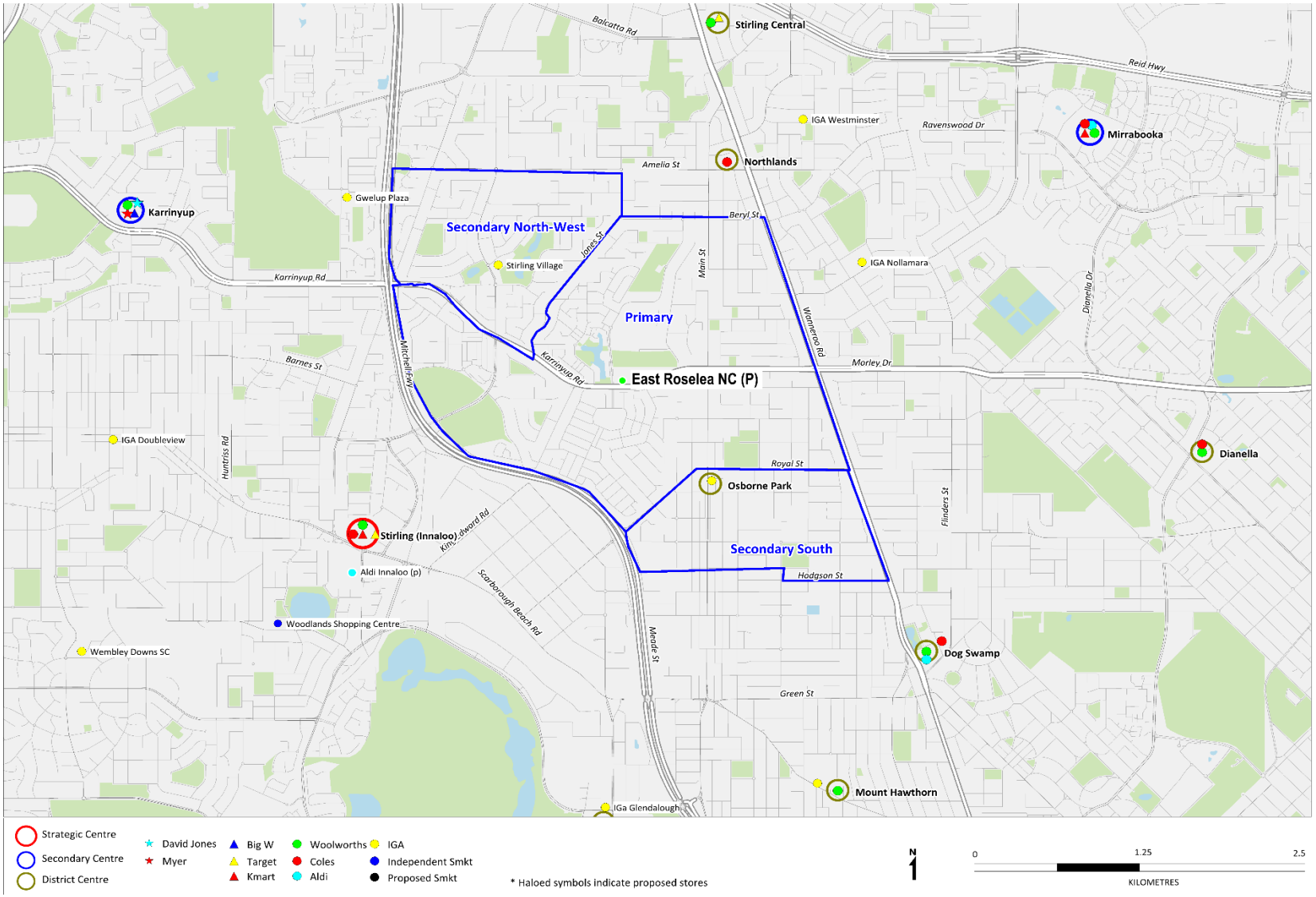
- The ease of access to the site for immediately surrounding residents, reflecting its location on Karrinyup Road, which is a main east-west connector road in the region.
- The convenient food and grocery role that the proposed centre would be able to serve in the region, anchored by a full-line supermarket within a modern and accessible facility.
- The pattern of urban development in the locality and the locations of the Mitchell Freeway and Wanneroo Road to the west and east respectively, which act as 'geographical' barriers that are not straight-forward to cross over.
- The locations of surrounding competitive facilities, including Primewest Northlands (Coles) to the north; Flinders Square (Coles) and Dog Swamp (Woolworths) to the south-east; and to some extent the higher-order centres of Karrinyup SC and Westfield Innaloo on the western side of the Mitchell Freeway.

On this basis, the **main trade area** which will be available to be served by the new neighbourhood centre has been defined to include a primary sector and two secondary sectors, as illustrated on the attached Map 2.1 and described as follows:

- The defined **primary sector** is generally bounded by Karrinyup Road, Jones Street and Beryl Street to the north; Wanneroo Road to the east; and Royal Street, Hutton Street and the Mitchell Freeway to the south and west. There are no supermarket facilities within this substantial primary sector.
- The defined **secondary north-west** sector is bounded by Amelia Street to the north; Jones Street and Karrinyup Road to the south; and the Mitchell Freeway to the west. A small centre, described later in this report, is located within this sector, Stirling Village, which is anchored by an IGA foodstore.
- The **secondary south** sector encompasses a small area generally bounded by Hector Street to the south; the primary sector to the north; and Wanneroo Road to the east. Within this sector there is also a small IGA foodstore, at Osborne Park.

The defined main trade area incorporates most of the suburbs of East Roselea and Tuart Hill, and the southern half of Balcatta. It extends around 1-2 km to the north and south of Karrinyup Road and is sandwiched between the Mitchell Freeway and Wanneroo Road.

The East Roselea Neighbourhood Centre would be ideally located to serve the defined main trade area residents for their food and grocery shopping needs, particularly for primary sector residents, reflecting its convenient accessibility via and visibility from Karrinyup Road. The modern facility to be provided onsite would become a popular, convenient supermarket destination, reducing the travel times required to access food and grocery shopping for these residents.



Map 2.1: East Roselea Neighbourhood Centre

Main trade area and competition

2.2 Trade area population

Table 2.1 details the existing and projected population levels within the defined East Roselea main trade area. The current population is estimated at around 25,300 residents, including around 16,000 in the key primary sector, and is a very substantial catchment.

Table 2.1
East Roselea NC trade area population, 2011-2026*

	Actual/Est. population			Forecast population	
Trade area sector	2011	2016	2018	2021	2026
Primary	14,980	15,628	16,028	16,928	19,428
Secondary sectors					
• Nth-west	4,080	3,993	3,993	4,053	4,153
• South	5,070	5,218	5,318	5,618	6,368
Total secondary	9,150	9,211	9,311	9,671	10,521
Main trade area	**24,130**	**24,839**	**25,339**	**26,599**	**29,949**
	Average annual growth (%)				
Trade area sector	2011-16	2016-18	2018-21	2021-26	
Primary	0.9%	1.3%	1.8%	2.8%	
Secondary sectors					
• Nth-west	-0.4%	0.0%	0.5%	0.5%	
• South	0.6%	1.0%	1.8%	2.5%	
Total secondary	0.1%	0.5%	1.3%	1.7%	
Main trade area	**0.6%**	**1.0%**	**1.6%**	**2.4%**	

**As at June*
Source: ABS Census 2016; WAPC WA Tomorrow 2015; Dimasi & Co

Population growth in the main trade area was very strong between the census years 2006 and 2011, averaging around 3.8% per annum, as the previously unoccupied land surrounding the site was progressively developed for high quality residential use. As a consequence, over the decade 2006-2016, some 5,500 new residents moved into the defined primary sector. The state-wide economic difficulties faced by Western Australia from around 2013 to 2017, following the end of the previously long-running mining boom, saw population stagnation and even slight decline across most parts of Perth, and the Stirling region was no exception.

However, the state economy is already in a phase of slow but steady improvement, and population growth is expected to return to long-term average levels over the next few years. Future population growth within the defined trade area is projected to be steady, facilitated by intensification in the residential density in the surrounding region, as older stocks are replaced in the future, as well as some new residential development to the immediate north of the site.

In particular, there is potential in the future for the stretch of land located immediately north of the subject site (East Roselea precinct) to be developed for medium to high density accommodation, which would significantly add to the immediate population base surrounding the new neighbourhood centre. The recently completed East Roselea Structure Plan (Rowe Group, May 2018) addresses the land generally bound by Grindleford Drive, Karrinyup Road and Albert Street. The Structure Plan has identified capacity for 528 dwellings, on 500 residential lots, accommodating some 1,200 new residents.

Population forecasts for the trade area presented in this report have had regard to the following:

- the results of the 2016 Census of Population and Housing, conducted by the Australian Bureau of Statistics (ABS);
- post-censal population estimates, published by the ABS;
- projections prepared by the Western Australian Planning Commission in 2015; and
- the findings of the East Roselea Structure Plan.

On this basis, the population of the defined main trade area is projected to increase steadily over the period to 2026, particularly within the primary sector. However, it is important to also note that the significant shortfall in neighbourhood retail facilities – which the proposed centre will address – exists now and is a result of the current population level relative to available floorspace, as shown later in this analysis. The future population growth in the area growth will simply increase the extent of the shortfall.

2.3 Trade area population profile

Table 2.2 details the socio-demographic profile of the main trade area population, based on the 2016 Census of Population and Housing, highlighting the following:

- The average age of main trade area residents, at 39.25 years, is older than the metropolitan Perth average of 37.2 years, reflecting an above average proportion of residents aged 65 or older.
- Income levels per capita for the main trade area population are above the respective metropolitan Perth benchmark on a per capita basis, though slightly below average on a per household basis due to smaller average household size.
- Home ownership levels throughout the main trade area are lower than the metropolitan Perth average, with rental accommodation being a popular option in the area.
- Only about half of the trade area residents are Australian born, with a noticeably above average proportion of overseas born residents, from both Europe and Asia.
- There is a higher than average representation of the Gen Y cohort within the area, and also an above average of white collar workers.

In summary, the defined East Roselea main trade area is reflective of an inner to middle suburban residential area, with a mixed profile, housing traditional families in their mid to late life stages as well as younger professionals who are attracted by the relative proximity of the locality to the CBD.

Table 2.2

East Roselea Village MTA socio-demographic profile, 2016

Factor	East Roselea Village Trade Area Sector				Greater Perth	
	Primary	Sec. NW	Sec. South	Total	Metro. Area	Australia
Population						
Estimated Resident population (2016)	15,682	3,993	5,218	24,893	2,022,000	24,210,800
Avge. Annual Growth Rate, 2011-2016	0.87%	-0.43%	0.58%	0.59%	2.05%	1.67%
% of Population aged 0 - 4	6.51%	4.83%	6.43%	6.22%	6.62%	6.37%
% of Population aged 65+	14.78%	23.80%	11.24%	15.53%	13.34%	15.24%
Average age (years)	38.64	43.75	37.53	39.25	37.24	38.44
Households						
No. of Households	6,107	1,410	2,298	9,815	691,175	8,285,829
Average household size	2.30	2.60	1.98	2.27	2.6	2.60
Income						
Average annual income per capita	$47,363	$43,497	$45,895	$46,432	$43,978	$39,620
Average annual income per household	$108,710	$111,488	$91,291	$105,030	$115,141	$103,664
Generational Cohorts (% of Popn.)						
Pre-Boomers	9.77%	15.47%	7.13%	10.16%	8.13%	9.36%
Baby Boomers	18.46%	26.41%	17.25%	19.51%	20.09%	21.70%
Gen X	20.76%	18.18%	19.33%	20.04%	20.69%	20.14%
Gen Y	29.43%	17.29%	38.79%	29.37%	22.99%	21.34%
Gen Z	12.84%	16.61%	9.89%	12.85%	18.88%	18.60%
Gen Alpha	8.74%	6.04%	7.60%	8.06%	9.22%	8.86%
Country of Birth (% of Population)						
Australia	49.88%	58.07%	46.90%	50.57%	57.30%	66.73%
China	2.25%	1.33%	1.38%	1.92%	1.30%	2.15%
India	6.43%	1.17%	6.46%	5.59%	2.37%	1.92%
Asia - balance	7.64%	3.75%	8.54%	7.20%	6.37%	5.33%
Europe	13.27%	22.15%	11.14%	14.25%	11.94%	6.72%
Elsewhere	20.54%	13.53%	25.59%	20.47%	20.73%	17.16%
Housing (% of Households)						
Own/buying home	63.62%	83.66%	54.54%	64.31%	72.07%	67.79%
Renting	35.95%	16.34%	45.19%	35.36%	27.01%	31.42%
Average monthly mortgage payment	$2,332	$2,500	$1,875	$2,244	$2,255	$2,071
Average weekly rental payment	$346	$390	$328	$343	$375	$358
Employment						
% of Workforce White Collar	72.08%	69.22%	71.43%	71.52%	68.36%	70.21%
% of Workforce Blue Collar	27.92%	30.78%	28.57%	28.48%	31.64%	29.79%
Unemployment rate at Census date	7.34%	5.37%	8.74%	7.37%	8.15%	6.86%
Vehicle Ownership						
Average No. of motor vehicles per Household	1.65	2.09	1.44	1.66	1.94	1.80

Sources : Census of Population & Housing, 2016 (ABS); GapMaps

2.4 Trade area spending

Chart 2.1 presents a comparison of retail spending behaviour of the East Roselea main trade area residents with metropolitan Perth averages. All retail spending estimates in this report are expressed in constant 2016/17 dollars (i.e. excluding retail inflation), and including GST.

The estimated retail expenditure capacity of the East Roselea main trade area population is based on information sourced from MDS Market Data Systems, which utilises a detailed micro-simulation model of household expenditure behaviour for all residents of Australia. The model takes into account information from a wide variety of sources, including the regular ABS Household Expenditure Survey, National Accounts Data, Census Data and other information.

The MarketInfo product from MDS starts with the household expenditure survey, a comprehensive exercise conducted by the ABS every five years, where a large sample of households across Australia are asked to provide complete details of their spending over specified periods.

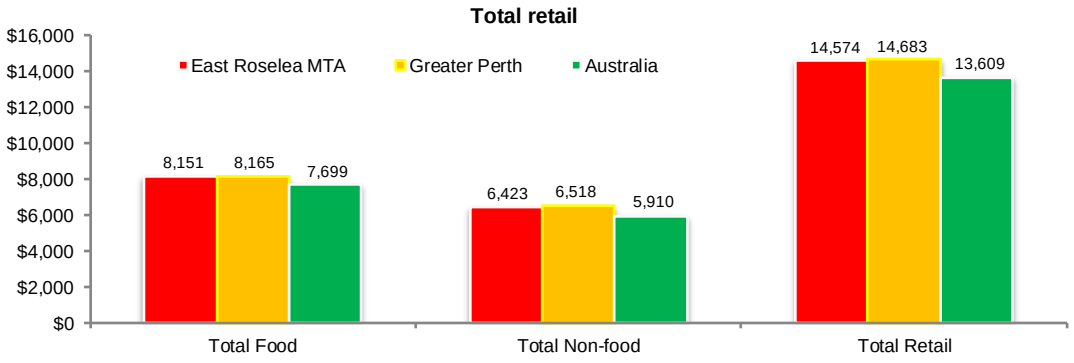
In addition to a thorough interview, each member of the household in question over the age of 15 is required to keep a diary of every expenditure made over a two week period. Complete financial and social information about the entire household is also provided.

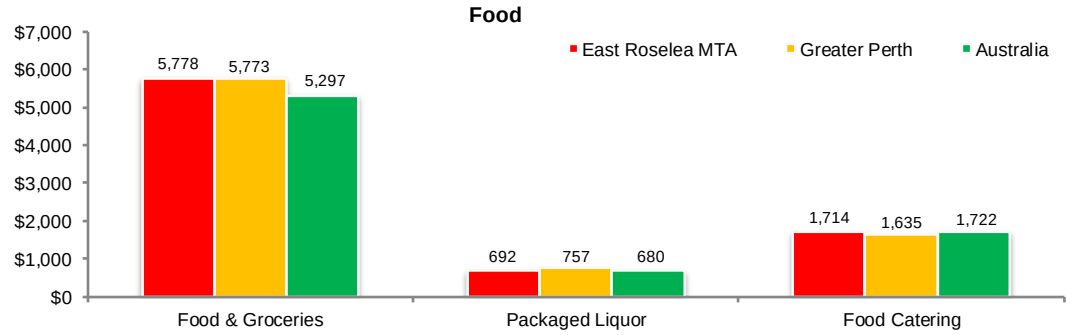
All of these data are then matched with the Census, Centrelink, National Accounts and other data collected by state and national governments to create a model of spending that is at the heart of MarketInfo. Micro-simulation techniques are the method by which these detailed calculations are performed.

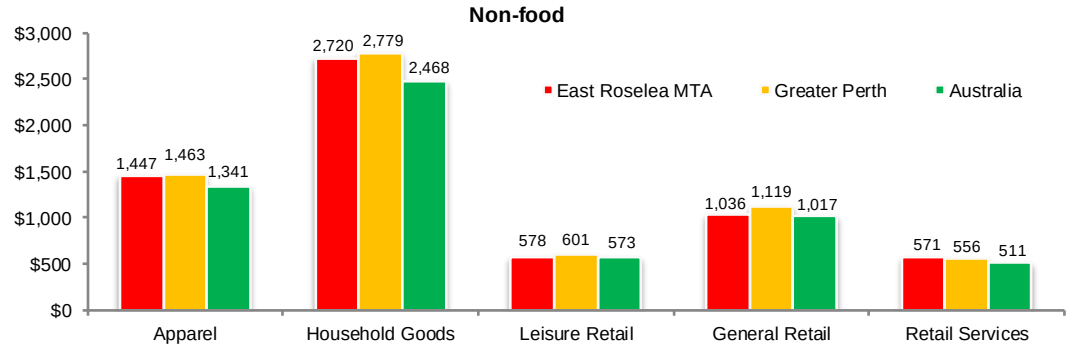
MarketInfo calculates spending levels down to the Statistical Area Level 1 (SA1), the smallest defined area used by the ABS. MarketInfo is able to drill down to this level because it starts with the unit records from the household expenditure survey and then uses the spending and other information from all of the surveyed households as the basis for modelling these actual results to the broader community.

The total level of retail expenditure per person for the East Roselea main trade area population in 2016 is estimated at $14,574, which is marginally lower than the metropolitan Perth average, but well above the national average.

Chart 2.1
East Roselea NC main trade area - retail expenditure per person, 2015/16*







** including GST*
Sources : MarketInfo, Dimasi & Co.

Table 2.3 presents estimates of total retail expenditure generated by the population within the defined main trade area. This table also shows the projected growth in available trade area retail expenditure, taking into account the forecast population levels outlined previously.

Table 2.3
East Roselea NC main trade area - retail expenditure ($M), 2016-2026*

Year ending June	**Primary sector**	**Secondary sectors** Nth-west	South	**Main TA**
2016	229.2	58.1	75.5	362.8
2017	233.6	58.5	76.7	368.8
2018	238.0	58.9	77.9	374.8
2019	241.0	59.6	79.0	379.6
2020	247.7	60.4	81.3	389.5
2021	254.7	61.3	83.6	399.6
2022	263.1	62.2	86.2	411.6
2023	273.1	63.1	89.3	425.5
2024	283.4	64.0	92.4	439.9
2025	294.1	65.0	95.7	454.8
2026	305.3	65.9	99.1	470.3
Average annual growth ($M)				
2016 - 2026	2.9%	1.3%	2.8%	2.6%

** Future year estimates, beyond 2018, presented as constant 2017/18 dollars and including GST*
Sources : MarketInfo, Dimasi & Co.

Total available retail expenditure within the main trade area is forecast to grow in real terms from the current (2018) level of $374.8 million to a projected total of $470.3 million at 2026. This level of growth reflects an average annual real growth rate of 2.6% per annum over the forecast period to 2026. The sources of real spending growth include:

- Main trade area resident population growth, which is projected to average 1.8% over the period to 2026.
- Real growth in retail spending per capita, which is forecast to average around 0.8% annually over the forecast period.

Table 2.4 details the projected retail spending of the main trade area population by retail commodity category. It is estimated that main trade area residents currently (2018) spend $213 million on retail food items and $161.8 million on retail non-food goods and services. Over the forecast period to 2026, retail expenditure on food is expected to increase, in real terms, to $270.3 million, while non-food spending is forecast to increase to $200 million.

Table 2.4
East Roselea NC main trade area - retail expenditure by category ($M), 2016-2026*

Year ending June	FLG	Food catering	**Total Food**	Apparel	H'hold goods	Leisure	General retail	Retail services	**Total non-food**	**Total retail**
2016	161.5	42.8	**204.3**	36.1	67.9	14.4	25.9	14.2	**158.6**	**362.8**
2017	164.7	43.9	**208.6**	36.5	68.6	14.6	26.1	14.4	**160.2**	**368.8**
2018	168.0	45.0	**213.0**	36.9	69.3	14.7	26.4	14.5	**161.8**	**374.8**
2019	170.2	45.8	**216.0**	37.2	70.0	14.9	26.7	14.7	**163.5**	**379.6**
2020	174.7	47.3	**222.0**	38.1	71.7	15.2	27.3	15.1	**167.5**	**389.5**
2021	179.3	48.8	**228.1**	39.1	73.4	15.6	28.0	15.5	**171.5**	**399.6**
2022	184.7	50.5	**235.2**	40.1	75.4	16.0	28.7	16.0	**176.3**	**411.6**
2023	191.0	52.5	**243.5**	41.4	77.8	16.5	29.6	16.5	**182.0**	**425.5**
2024	197.5	54.6	**252.1**	42.7	80.3	17.1	30.6	17.1	**187.8**	**439.9**
2025	204.3	56.7	**261.0**	44.1	82.8	17.6	31.5	17.7	**193.8**	**454.8**
2026	211.3	59.0	**270.3**	45.5	85.5	18.2	32.5	18.3	**200.0**	**470.3**
Average annual growth ($M)										
2016 - 2026	5.0	1.6	**6.6**	0.9	1.8	0.4	0.7	0.4	**4.1**	**10.7**
Average annual growth (%)										
2016 - 2026	2.7%	3.3%	**2.8%**	2.3%	2.3%	2.3%	2.3%	2.5%	**2.3%**	**2.6%**

** Future year estimates, beyond 2018, presented as constant 2017/18 dollars and including GST*
Sources : MarketInfo, Dimasi & Co.

Retail expenditure category definitions:

- FLG: take-home food and groceries, as well as packaged liquor.
- Food catering: expenditure at cafes, take-away food outlets and restaurants.
- Apparel: clothing, footwear, fashion accessories and jewellery.
- Household goods: giftware, electrical, computers, furniture, homewares and hardware goods.
- Leisure: sporting goods, music, DVDs, computer games, books, newspapers & magazines, stationery and photography equipment.
- General retail: pharmaceutical goods, cosmetics, toys, florists, mobile phones and pets.
- Retail services: hair & beauty, optical goods, dry cleaning, key cutting and shoe repairs.

Section 3: Competition

This section of the report considers the competitive environment within which the East Roselea Neighbourhood Centre will operate. Table 3.1 summarises the competitive stores/centres, while the previous Map 2.1 illustrates their locations relative to East Roselea.

Table 3.1
East Roselea NC - schedule of competing retail facilities

Centre	Retail GLA (sq.m)	Major traders	Dist. by road from East Roselea NC (km)
Within trade area			
Osborne Park	2,700	IGA	1.7
Stirling Village	1,400	IGA	2.0
Beyond trade area			
Primewest Northlands	7,000	Coles	2.5
Nollamara	5,200	IGA	2.9
Westfield Innaloo	44,000	Kmart, Target, Woolworths, Coles	3.6
Flinders Square	6,000	Coles	4.6
Dog Swamp SC	7,300	Woolworths	4.6
Karrinyup SC	54,000	Myer, David Jones, Big W, Woolworths	4.7
Mt Hawthorn	10,000	Woolworths	4.9
Stirling Central	25,500	Target, Woolworths	5.0
The Square, Mirrabooka	41,800	Kmart, Big W, Woolworths, Coles	5.5

Sources: Property Council of Australia; Dimasi & Co.

3.1 Competition within the trade area

There are no full-scale supermarkets currently located within the defined trade area and no food and grocery shopping facility at all within the primary sector, with the proposed store therefore to provide a modern supermarket destination for food and grocery shopping for surrounding residents. The subject site is well located on Karrinyup Road, halfway between the Mitchell Freeway and Wannerro Road, and is centrally located and easily accessible to serve the defined main trade area population.

There are two smaller IGA stores, at Stirling Village and Osborne Park to the north-west and south-east respectively. Given the sizes of these stores, each estimated to be between 600 - 750 sq.m in size, they would be predominantly serving the daily convenience and top-up needs of immediately surrounding residents, as compared with the weekly food and grocery offer that will be serviced by the proposed East Roselea Neighbourhood Centre.

3.2 Competition beyond trade area

Beyond the trade area, the major supermarket facilities are provided at Northlands Plaza SC (Coles) to the north-east; and at Flinders Square (Coles) and Dog Swamp (Woolworths) to the south-east.

Also located beyond the trade area, on the western side of the Mitchell Freeway, significant higher-order shopping facilities are provided at Karrinyup SC – the main regional shopping centre serving this inner north-western coastal region of Perth – and at Westfield Innaloo, which is the main retail element of the Stirling Strategic Metropolitan Centre.

Both of the above centres provide an extensive array of food and non-food shopping outlets, as well as other leisure and entertainment faciliites, and would serve an extensive catchment, including from the defined East Roselea trade area, particularly for non-food and discretionary-type shopping. In the future, the two centres are each proposed for their next stages of expansion and redevelopment, which will further improve the shopping range in the region.

3.3 Summary

In summary, the East Roselea Neighbourhood Centre will be an easily accessible and convenient food and grocery shopping destination for surrounding residents; while higher order shopping requirements for trade area residents are served primarily by the existing centres at Karrinyup and Innaloo generally to the west.

Section 4: Consideration of economic impacts

This section of the report considers the sales potential for the East Roselea Neighbourhood Centre, as well as the likely economic impacts that can be anticipated following the development of the store. It also presents a supermarket floorspace analysis for the defined main trade area.

4.1 Supermarket floorspace analysis

In order to assess both the supportability of the East Roselea Neighbourhood Centre, and the likely consequent impacts and implications for the remaining existing and proposed supermarkets of relevance in the region, the first step is to assess the need and demand for supermarket floorspace, since the key addition at East Roselea will be a new Woolworths supermarket. This step is important because the provision of convenient and accessible food and grocery shopping facilities is the most basic and most important need to be met at a neighbourhood level, as is proposed to be provided by the East Roselea centre.

Residents need to be well serviced by an appropriate provision of easily accessible supermarket facilities, as such facilities will create a community focus; provide convenience and amenity for local residents (i.e. residents will not have to travel unnecessarily long distances to access weekly food and grocery shopping); and also create local employment. The provision of convenient, good quality supermarket facilities will service both the existing established population base, and the future residents in the area, and facilitating the social wellbeing of local residents.

At the same time, the purpose of the supermarket floorspace analysis detailed below is also to ensure that there will be sufficient demand for the various other supermarkets (existing and proposed) in the locality, and which will be equally important to the economic wellbeing of the other planned activity centres, and the surrounding catchments which those activity centres currently serve or will serve in due course.

The analysis of supportable floorspace for the proposed East Roselea supermarket presented later in this section is based primarily on an assessment of available Food & Groceries (F&G) expenditure. Per capita expenditure on take-home food and groceries is relatively consistent across most parts of Australia, reflecting the essential nature of take-home food and groceries. Per capita spending in this retail category does not vary to any great extent in response to changes in household income levels, unlike per capita expenditure on the more discretionary retail categories such as apparel, homewares and catered food (i.e. dining out).

In regard to what might be considered to be the 'appropriate' level of supermarket floorspace, the following commentary is of note:

- Firstly, a key objective is to assess the need and demand for supermarket facilities to effectively serve trade area residents, within the context of the supermarket floorspace requirements for all the existing and planned activity centres in the trade area. It is likely, as a matter of course, that some supermarket shopping from trade area residents will also be done at facilities located outside the trade area (i.e. escaping the trade area). However, given that the majority of food and grocery shopping is typically undertaken locally, it is desirable to assess the supermarket floorspace requirements for the trade area as if it were a 'self-sufficient' entity, as some 'captured' expenditure can also be expected, largely offsetting escape expenditure.

- With regard to supermarket facilities located beyond the trade area, the closest such facilities are provided at Primewest Northlands, Flinders Square, Dog Swamp, Karrinyup SC and Westfield Innaloo. However, while some supermarket shopping by trade area residents will inevitably occur at those centres, in association with much more extensive comparison shopping which is directed in particular to Karrinyup SC and Westfield Innaloo, it is entirely reasonable, and highly desirable, that the great majority of the food and grocery shopping by trade area residents should be able to be retained locally, i.e. at the various existing and proposed lower order activity centres within the defined trade area.

Table 4.1 shows the total supply of supermarket floorspace which is considered to be both required and supportable within the defined East Roselea main trade area in order to reasonably meet the requirements of main trade area residents, having regard

to the population projections and expenditure levels detailed in Section 2 of this report. The table also shows the existing and proposed future supply of supermarket floorspace within the trade area, taking into account the network of activity centres servicing the area.

Table 4.1
East Roselea NC trade area - supermarket floorspace analysis, 2018-2026*

Items	2017/18	2020/21	2025/26
Available trade area spend on F&G - $M*	150.1	160.1	188.6
F&G spending to smkts (@ 75%) - $M	112.5	120.1	141.5
Spending retained by TA smkts (@ 50%) - $M	56.3	60.1	70.7
Plus sales from beyond TA (@ 15%) - $M	9.9	10.6	12.5
Total F&G spending to TA smkts - $M	**66.2**	**70.7**	**83.2**
Smkt floorspace demand (sq.m) (assuming average trading level of $10,000 per sq.m)	**6,620**	**7,070**	**8,320**
Total smkt floorspace - existing and proposed			
• Existing facilities**	1,380	1,380	4,980
• Proposed facilities			
- East Roselea Woolworths		3,600	
Total smkt floorspace supply (sq.m)	**1,380**	**4,980**	**4,980**
Under (-)/Over (+) supply (sq.m)	-5,240	-2,090	-3,340

** Constant 2017/18 dollars, and including GST*
***Existing smkt facilities include IGA at Osborne Park and Stirling Village*

The key points to note from Table 4.1 are as follows:

- The available food and grocery (F&G) expenditure generated by trade area residents is approximately $150 million currently, and growing to $160 million at 2020/21, in constant 2017/18 dollar terms.

- The proportion of trade area F&G expenditure which is typically directed to supermarkets (as opposed to fresh food operators and other retailers) is then estimated at 75%, given the mid-suburban nature of the area.

- The proportion of that supermarket expenditure which is likely to be retained within the defined East Roselea main trade area is estimated at 50%. This estimate reflects the discussion outlined previously, whereby a sizeable proportion of the food and groceries shopping by trade area residents should be able to be retained locally, given an appropriate supermarket offer, however there will still be significant escape expenditure directed to the supermarkets at the large nearby centres.

- An allowance for potential expenditure drawn from beyond the trade area (reflecting the exposure of the subject site on Karrinyup Road) is then added, to estimate the total available F&G expenditure for all supermarkets in the defined East Roselea main trade area.

- The total F&G expenditure potentially available to supermarkets within the trade area is therefore estimated at $66.2 million at 2017/18, growing to $70.7 million at 2020/21 and $83.2 million at 2025/26.

- Adopting an average trading level of $10,000 per sq.m for supermarkets, the total supermarket floorspace which is required to reasonably meet the needs of East Roselea main trade area residents is therefore estimated at around 6,670 sq.m at 2018, but will increase to 7,020 sq.m at 2017/18 and further to 8,320 sq.m at 2025/26.

- At present, within the trade area, there are only two small IGA foodstores, estimated to total 1,380 sq.m. between them, or less than half the size of one modern supermarket in total. There is therefore an estimated undersupply of supermarket floorspace within the trade area of around 5,240 sq.m.

- By 2018, allowing for the development of the proposed East Roselea supermarket, the level of supermarket floorspace undersupply would decrease significantly, but there would still be a level of undersupply in the local area.

- With the ongoing steady population growth forecast for the trade area, the level of supermarket floorspace undersupply will then increase further over the subsequent years, reaching in the order of 3,340 sq.m by 2026.

In summary, the analysis shows that there is a clear gap for an additional full-range supermarket within the trade area currently, particularly to serve the needs of the substantial and growing population of the primary sector. There is therefore need and

demand for such a new supermarket to be added within the trade area, as proposed at the subject site.

4.2 Estimated centre sales potential and market shares

Prior to being able to consider the question of potential economic benefits and impacts that will arise from the development of the proposed neighbourhood centre, the necessary first step is to seek to quantify the level of sales that the store can expect to achieve.

The sales performance of any particular retail facility – be it an individual store or a collection of stores provided in a shopping centre – is determined by a combination of the following factors:

- The quality of the facility, with particular regard to the major trader/traders which anchor the centre; the strength of the tenancy mix relative to the needs of the catchment which it seeks to serve; the physical layout and ease of use; the level of accessibility and ease of parking; and the atmosphere/ambience of the centre.
- The size of the available catchment which the centre/store serves determines the upper limit to the likely sales potential achievable by any centre or store.
- The locations and strengths of competitive retail facilities and the degree to which these alternative facilities are able to effectively serve the needs of the population within the relevant trade area.

The likely sales potential for the proposed East Roselea Neighbourhood Centre is now considered, taking all of these factors into account.

It is assumed in these estimates that the new centre will open by around mid 2020, with its first full year of trading being 2020/21. All sales estimates in this report are expressed in constant 2017/18 dollars (i.e. excluding inflation) and including GST.

The East Roselea Neighbourhood Centre is assumed to be 6,000 sq.m in size, and will be anchored by a full-range supermarket. The centre will be easily accessible for surrounding residents, reflecting its location on Karrinyup Road, with trade area

residents expected to associate strongly with the supermarket for their weekly food and convenience shopping needs.

In addition to the supermarket, the neighbourhood centre is expected to contain around 2,400 sq.m. of floorspace for supporting specialty stores and non-retail shop-front uses. The mix of uses cannot be known with certainty in advance, however it is expected to comprise the typical range of uses in similar neighbourhood centres, tailored to the needs of the trade area population. Thus, specialty food uses – both take-home stores and on-premises food and beverage facilities – are expected to occupy much of the floorspace. Other uses likely to be provided include pharmacy (supporting the medical facilities already available), newsagency, and retail services, such as hair and beauty, dry cleaning, and optometry. In addition, some non-retail shopfront uses, such as gym, real estate agency, travel and financial services, are expected to occupy a small proportion of the specialty space.

Table 4.2
East Roselea NC - Centre tenancy mix and sales potential, 2020/21*

Category	East Roselea NC		
	GLA (sq.m)	Est. sales ($'000)	($/sq.m)
Major tenants			
Supermarket	3,600	33,616	9,338
Supermarket	3,600	33,616	9,338
Retail specialties			
Food & liquor	500	5,700	11,400
Food catering	550	3,350	6,091
Apparel	0	0	0
Household	200	900	4,500
Leisure	100	450	4,500
General	300	2,600	8,667
Retail services	350	2,700	7,714
Total retail spec.	2,000	15,700	7,850
Total centre - retail	**5,600**	**49,316**	**8,806**
Non-retail shopfront	**400**	**n.a.**	**n.a.**
Total Centre	**6,000**		

** Constant 2017/18 dollars, and including GST*

Taking the above into account, Table 4.3 presents estimated market shares for the proposed new centre at 2020/21, based on the sales estimates outlined above.

On this basis, the centre is expected to achieve a 10.5% share of the total available retail spending in the main trade area, including 13.3% of the available food expenditure. The remaining expenditure of trade area residents (89.5%) would continue to be directed mainly to the surrounding existing facilities, and to Karrinyup SC, Westfield Innaloo and the Perth CBD, particularly for non-food shopping.

The sales projections for the new neighbourhood centre take into account the trade area analysis and competition detailed in earlier sections of this report; and sales by similar retailers in comparable centres throughout Australia and Western Australia.

Table 4.3
East Roselea NC - Estimated market shares, 2020/21*

	Retail spend ($M)			Centre sales ($M)			Market share		
Trade area	Food	Non-food	Total	Food	Non-food	Total	Food	Non-food	Total
Primary	144.5	110.3	254.7	28.3	5.6	33.9	19.6%	5.1%	13.3%
Secondary sectors									
• Nth-west	35.3	26.0	61.3	3.0	0.6	3.6	8.4%	2.3%	5.8%
• South	48.3	35.3	83.6	3.7	0.7	4.5	7.7%	2.1%	5.4%
Main TA	228.1	171.5	399.6	35.0	6.9	41.9	15.3%	4.0%	10.5%
Sales from beyond TA				6.2	1.2	7.4			
Total centre sales				**41.2**	**8.2**	**49.3**			

** Constant 2017/18 dollars, and including GST*

4.3 Assessment of likely economic impacts

Development of the proposed East Roselea centre is likely to result in a range of impacts. From a trading point of view, some impacts are likely to be experienced by competitive retailers in the surrounding region.

On the other side of the equation, it is clear that the development will also result in a range of important economic benefits. The key positive impacts will include the following:

- The provision of an easily accessible food and grocery shopping facility for the surrounding population. The proposed development will include a full-line supermarket (Woolworths), which will offer the full supermarket range for the daily and weekly shopping needs of the catchment population.

- A conveniently located supermarket at the proposed site will also reduce travel times, while easing traffic conditions at other centres, and decrease the level of escape food and grocery expenditure to facilities located beyond the trade area.

- A wider range of shopping choices for local residents. The East Roselea Neighbourhood Centre will be a full-scale supermarket, which will provide more choice and variety to the surrounding patronage, and therefore increased competition, which might also lead to lower food and grocery prices for consumers.

- Once fully operational, the supermarket would be expected to employ around 144 people, with the specialty uses employing a further 138. Allowing for an estimated 5% of the total increase to be lost as a result of reduced employment at other retail facilities, the net additional number of jobs that will be created at the proposed East Roselea centre is estimated at 274, as summarised in Table 4.3 following. In order to estimate the employment levels generated by the centre, we have relied upon various data sources including data from retailers, the ABS, several state and local government agencies, as well as more than 35 years of experience in preparing assessments of this nature.

Table 4.4
East Roselea NC - estimated centre employment levels

Type of use	Estimated employment per '000 sq.m	East Roselea NC GLA (sq.m)	East Roselea NC Employment (persons)
Supermarket	40	3,600	144
Specialty shops/non-retail	60	2,400	144
Total[1]		**6,000**	**288**
Net increase[2]			**274**

1. Excludes non-retail components
2. Net increase includes an allowance for reduced employment levels at impacted centres, estimated at 5% of the total increase

- The construction of a neighbourhood centre at the East Roselea site will itself also create a substantial number of additional jobs, both for the construction and related industries during the construction phase, and for the economy generally once the centre is completed. The estimated total capital costs for the construction of the centre are $30 million. By utilising the appropriate ABS input/output multipliers, we estimate that the construction period of the proposed development would create some 128 jobs, with a further 205 jobs resulting from supply induced multiplier effects from this period (Table 4.5). Jobs created include both full-time and part-time positions.

  ABS input/output multipliers measure general economic flows between industry sectors. There are several types of input/output multipliers that can be relied upon and we consider for the basis of estimating fairly small scale, and localised impacts, that *employment* multipliers are most suitable for estimating the employment effects of the proposed redevelopment.

- The additional jobs created in the centre, as previously outlined (274), will result in an estimated further 109 jobs in the broader community, based on ABS input/output multipliers.

Table 4.5
East Roselea NC - estimated future additional centre employment levels*

Original stimulus	Direct employment (long-term)	Direct employment (const'n period)	Supplier employment multiplier effects	Total
Store employment impact	274		109	383
Construction impact		128	205	333
Total impact	**274**	**128**	**315**	**716**

** Employment totals include both full-time and part-time work*
1. Indicates the estimated number of net additional ongoing jobs as a result of the proposed development
2. Indicates the estimated number of jobs over the life of the construction project, for the equivalent of one year

Therefore, a number of economic benefits can be expected to flow directly from the development of the East Roselea centre. Against these positive impacts, the question of likely trading impacts on other existing retailers within the broader region needs to be considered. This is analysed in more detail in Section 4.4 following.

4.4 Trading impacts at 2020/21 and subsequent years

A number of factors need to be taken into account in the consideration of the likely broad trading impacts of the proposed development of the East Roselea centre on other retail facilities, both within and beyond the trade area.

Such projections must be considered as indicative only, for the simple reason that it is very difficult to predict with certainty the precise impact on any one retailer or any one centre that will result from a change to the retail structure serving a particular area or region. The impacted centre or retailer has a number of possible actions which it may be able to take for example, which may mitigate the extent of impact, or may eliminate it altogether. Expansions and improvements may be undertaken at other centres and other locations throughout the region, and all of those factors can change the nature of the impact.

It is reasonable for the purposes of impact analysis to therefore consider the likely broad changes in competitive circumstances, and in particular the changes in availability of

retail expenditure for competitive centres that can reasonably be expected to result from the development of the East Roselea centre.

These broad changes effectively set the market conditions within which all competitive centres will operate as a result of the proposed addition of the East Roselea centre, and reasonable conclusions can then be drawn about the possible impacts and subsequent consequences of these broad changes in market conditions.

The projected sales for the East Roselea centre at 2020/21 would result from a redirection of spending to the new centre from a range of other supermarkets and centres located both within and beyond the defined trade area, which are all therefore likely to experience some trading impacts. In order to estimate the likely order of these impacts, we have had particular regard to the location and composition (existing and proposed) of each centre/store relative to the East Roselea site and their respective roles in the region.

The following factors will all be of relevance in terms of how the likely impacts will play out:

- The distance of the (impacted) centre, by road, from the proposed development.
- The size of the centre, in terms of total relevant retail floorspace. More specifically in this instance, the amount of supermarket floorspace available is the most important factor to consider.
- The brand of the anchor tenant(s) with the relevant supermarket anchors again being the key factor.
- The respective role and function of each centre. For example, a centre might be oriented towards convenience retailing, higher order retailing, homewares/bulky goods, or it might primarily service a worker/transit market.
- The relative accessibility and convenience of the impacted centre compared with the proposed retail development.
- The estimated performance of the centre (in current sales) and projected future performance. This accounts for any future developments in the region that might also impact on the future sales of existing centres.

When assessing the dollar (and percentage) impacts that are likely to be absorbed by existing facilities/centres, the following key principles, established as a result of previous experience and numerous observations in many other situations, will normally apply:

- The greatest impacts are typically absorbed by the closest comparable stores/centres. For example, a new Woolworths supermarket is generally likely to impact the closest nearby Woolworths supermarket to the greatest extent, followed by impacts on other comparable supermarkets (e.g. Coles), and at the lower end of the spectrum, by impacts on smaller scale supermarkets/foodstores, which serve much more limited roles.

- Impacts on small scale, local convenience/food stores tend to be relatively smaller in extent, as these stores normally attract a smaller market share of available main trade area expenditure and perform a different role and function in the retail hierarchy. In particular these stores tend to serve the local walkable catchments surrounding them, and/or more specialised/discerning needs (e.g. specialty food stores).

Table 4.6 presents a summary of the projected sales estimates for these stores both with and without the proposed East Roselea development, as well as an assessment of the likely order of impacts. All figures are expressed in constant 2017/18 dollars and include GST, and show the following:

- The first column shows the estimated 2017/18 sales potential for each of the existing centres. These estimates have been derived based on physical inspection of each centre, and also drawing on publicly available information from industry sources.

- The second and third columns show the projected sales potential for each centre at 2020/21, which is assumed to be the first full trading year for the East Roselea Neighbourhood Centre. The sales potential for each centre at 2020/21 is shown under two scenarios – the first assuming no development of the East Roselea centre (i.e. a 'status quo' scenario) and the second assuming that the East Roselea centre is developed.

  The no development scenario allows for the sales potential for each existing centre to increase in line with the underlying growth in retail expenditure capacity of the surrounding area. The estimates of centre sales potential after impact (i.e. assuming

development of the East Roselea centre) are then calculated by allocating the anticipated impacts on each centre from the East Roselea centre, in line with the methodology outlined in greater detail in the remainder of this section.

- The fourth column in Table 4.6 then sets out the estimated sales potential for each centre at 2020/21, again adopting a growth outlook for each centre that reflects the underlying growth in retail expenditure capacity of the surrounding area.

- Columns 5 and 6 show the estimated impacts on each centre at 2020/21, in dollar terms and in percentage terms respectively, resulting from the proposed development of the East Roselea store.

Column 7 then shows the estimated growth in sales potential for each centre between 2018 and 2021, while the last column in the table shows the expected growth position for each centre between 2021 and 2024, highlighting the steady growth in sales potential expected for each centre after the development of the East Roselea centre.

The majority of the projected impacts would occur on supermarket sales at the centres in question; while non-food sales would experience minimal impact, reflecting both the nature and relatively small scale of the proposed East Roselea development, the most important component of which will be a full-scale supermarket.

The estimated levels of impact in Year 1 (2020/21) for the existing supermarket facilities in the trade area (Osborne Park and Stirling Village) would be moderate, reflecting the limited role that each of those centres plays in the locality serving primarily the convenience and top-up needs of immediately surrounding residents. These impacts therefore would not threaten the ongoing viability of these stores which will still have ample capacity to achieve good sales volumes, aided by the substantial existing population base in the trade area which will increase noticeably as the East Roselea Structure Plan area is progressively developed.

The impacts likely to be experienced by each of the other affected centres – all located outside the trade area – will in all cases be minor to moderate, and will be a once-off occurrence. Furthermore, as outlined previously, the impacted centres may take a number of actions which can minimise or eliminate altogether the level of impact from the development of the East Roselea Neighbourhood Centre.

Table 4.6
East Roselea NC - estimated impacts on specific centres ($M)*

Centre	Dist. from site (km)	Est. GLA (sq.m)	Supermarket(s)	Est. sales 2017/18	Proj. 2020/21 sales No dev't	Proj. 2020/21 sales With dev't	Proj. 2023/24 Post-dev't	Impact, 2021 $M	Impact, 2021 %	Growth , with dev't 2018-21	Growth , with dev't 2021-24
Within trade area											
Osborne Park	1.7	2,700	IGA (630)	16.8	18.1	17.1	18.3	-1.0	-5.5%	1.7%	7.1%
Stirling Village	2.0	1,400	IGA (750)	12.3	13.6	12.6	13.4	-1.0	-7.3%	2.7%	6.1%
Total within trade area				**29.1**	**31.7**	**29.7**	**31.7**	**-2.0**	**-6.3%**	**2.2%**	**6.7%**
Beyond trade area											
Primewest Northlands	2.5	7,000	Coles	59.0	63.5	59.0	63.5	-4.5	-7.1%	0.1%	7.7%
Nollamara	2.9	5,200	IGA	30.1	31.9	30.9	32.8	-1.0	-3.1%	2.8%	6.1%
Westfield Innaloo	3.6	44,000	Woolworths, Coles	330.0	355.4	344.4	374.1	-11.0	-3.1%	4.4%	8.6%
Flinders Square	4.6	6,000	Coles	52.5	56.5	53.0	57.6	-3.5	-6.2%	1.0%	8.6%
Dog Swamp	4.6	7,300	Woolworths, Aldi	68.5	73.8	68.8	74.1	-5.0	-6.8%	0.4%	7.7%
Karrinyup SC	4.7	54,000	Woolworths	440.0	473.8	462.8	505.7	-11.0	-2.3%	5.2%	9.3%
All other facilities				n.a	n.a	n.a	n.a	-11.3	n.a	n.a	n.a
Total beyond				**n.a**	**n.a**	**n.a**	**n.a**	**-47.3**	**n.a**	**n.a**	**n.a**
Total								**-49.3**			

4.5 Net community benefit

The analysis in this report has demonstrated that a range of economic and social benefits are likely to arise from the development of the East Roselea neighbourhood centre. These benefits can be summarised as follows:

- A local and modern destination for food and grocery shopping as well as dining, convenience shopping and services, adding to an existing community facility and focal point;
- Substantial ddditional local employment opportunities;
- A wider range of shopping choices for local residents; plus
- Increased convenience and amenity, together with reduced travel times to access food and grocery shopping, for local residents. This outcome will help to meet the objective of the City of Stirling Draft Local Planning Strategy, as outlined previously.

Against these benefits, some impacts are projected on centres located both within and beyond the trade area initially. These impacts will not threaten the ongoing viability of any existing or planned facilities, and will be gradually absorbed, with ongoing growth outlooks for each other centre thereafter. Thus, it can be concluded that a significant net community benefit will result from the development of the East Roselea neighbourhood centre as currently proposed.

4.6 Compliance with requirements of RSA as per Section 6.5 of SPP 4.2

As outlined previously, a Retail Sustainability Assessment should address the potential effects of a significant retail expansion in the network of activity centres, and is "*….limited to considering potential loss of services, and any associated detriment caused by a proposed development.*"

The analysis in this report shows that there is clear need and demand for the development of the East Roselea Neighbourhood Centre. Whilst some trading impacts are expected to be experienced by the surrounding retail facilities following the development of the proposed store, the analysis also demonstrates that there will be no loss of services to the local community. All impacted facilities would still be able to achieve sustainable sales volumes, and to continue to trade, after recovering relatively quickly from their respective impacts.

The development of the East Roselea Neighbourhood Centre would add to the services available to surrounding residents, in the form of a modern facility, which residents would be able to easily access to undertake their weekly food and grocery shopping plus related convenience shopping, dining and retail/non-retail services. The proposed centre therefore would represent a significant economic and social benefit for the local community, and its addition at the subject site would be in accord with a key objective of the Draft Local Planning Strategy of the City of Stirling.

APPENDIX 11

ENGINEERING SERVICES REPORT

ROWE GROUP DESIGN

grindleford drive, balcatta
opportunities and constraints report

Project No. 15-029

pritchard francis
civil and structural engineering consultants

table of contents

1 Introduction 3
2 Site Conditions 4
2.1 Geology 4
2.2 Acid Sulphate Soils 4
2.3 Topography 4
2.4 Groundwater Levels 4
2.5 Earthworks and Retaining 4
2.6 Other Existing Site Constraints 5
3 Infrastructure 6
3.1 Stormwater Drainage 6
3.2 Sewerage Reticulation 7
3.3 Water Reticulation 7
3.4 Local Authority Requirements 7
3.5 Preliminary Road Reserve Sections 7
3.6 Gas Supply 7
3.7 Electrical Supply 7
3.8 Communications 8
4 Conclusion 8

appendix one: structerre geotechnical report

appendix two: proposed preliminary earthworks

appendix three: existing topography

appendix four: water corporation and city of stirling drainage requirements

appendix five: water corporation planning information pack

appendix six: atco gas communication

appendix seven: power servicing information

appendix eight: communications servicing information

appendix nine: preliminary detailed sections

Revision	Description	Author	Date
A	Initial Issue	Denise Tyler-Hare	August 2017
B	Final issue	Denise Tyler-Hare	November 2017
C	Modified Structure Plan incorporated	Clíodhna Doran	February 2018
D	Updated to address council comments	Fabio Otranto	May 2018

1 Introduction

This report has been prepared in support of the Local Structure Plan proposal submitted to the City of Stirling over East Roselea in Balcatta, as depicted in Figure 1 below.

The site is bounded by Karrinyup Road to the south, Grindleford Drive to the west and Albert Street to the east. There are existing residential, commercial and community facilities in the vicinity.

This report covers the existing site geology, topography, groundwater levels and servicing including the proposed stormwater drainage, sewer and water reticulation, gas, power and communications infrastructure and supply. Broader engineering site constraints, providing more details for Lots 30 and 109, 49, 88 and 129, and 86, are considered with general engineering advice provided to enable the existing site ground conditions to be improved to support residential development.

Figure 1: Proposed Structure Plan

2 Site Conditions

The following section outlines the existing site conditions.

2.1 Geology

Numerous geotechnical investigations have been undertaken across various portions of land within the structure plan area to determine the groundwater levels, extent of peat, acid sulphate soils and general ground conditions. These have been reviewed and are listed in Structerre's Review of Remedial Works and Site Classification at Roselea East report included in Appendix One. Indicative cross-sections can be found in Appendix Two for Lots 30 and 109, 49, 88 and 129 and 86, respectively, based on a prior layout plan.

In its current form, the site is not suitable for residential development due to the groundwater level and peat layer being close to existing surface levels, and existence of portions of uncontrolled fill below the surface. To enable development in the area engineered improvements of the site are required to be carried out, with different sections of the area possibly being treated by different engineering improvement options, depending on the volume and depth of peat on site. These options could include removal of the peat, mass stabilisation of the peat, installation of a limestone and geogrid raft or piling of structures.

2.2 Acid Sulphate Soils

The site is identified on the ASS mapping as Class 1 – high to moderate risk of ASS occurring within 3m of the natural surface. Douglas Partners carried out a Preliminary Acid Sulphate Soil and Groundwater Investigation for 309 Albert Street in November 2012 in which they concluded that acid sulphate soils well above the adoption action criterion are present at the site and that any excavations which disturb the natural soils at the site should be undertaken in accordance with an acid sulphate soil management plan (ASSMP).

Galt Geotechnics undertook a geotechnical analysis of the site in February 2015 in which they identified the peat fill on Lots 88 and 129 as an acid sulphate soil and identified the need for further investigation and advice on the management of this environmental issue.

Given the high quantities of peat on site, a management plan will be required for any earthworks and deep services installed on site which encroach into the peat layer, and during dewatering to facilitate deep service installation.

2.3 Topography

The indicative topography can be found in Appendix Three. Feature surveys have been carried out for Lots 30, 88,129, 141 and 86, and in general the area slopes east to west from about RL 15m-16m AHD to RL 12m-14m AHD. Where there are peat and uncontrolled fill stockpiles, the existing levels can be as high as 18m AHD.

2.4 Groundwater Levels

The Perth Groundwater Atlas shows maximum groundwater level to be approximately RL12m AHD to RL13m AHD. The groundwater slopes from east to west, heading toward the Roselea Estate Lake.

Douglas Partners groundwater levels encountered in 2012 have been included in the Lot 30 section in Appendix Two.

2.5 Earthworks and Retaining

Proposed earthworks levels can be found in Appendix Two. Note that this scheme is based on achieving close to existing levels on site, meeting sewer level constraints and allowing drainage across the site as described in Section 3.1 below.

In general, the site supports a fall of approximately 0.6% from east to west across the site, which facilitates drainage and overland flow paths towards the drainage system on Grindleford Drive. There is flexibility in the design to allow for levels to increase or decrease depending on the geotechnical remediation required, and noting the requirement to minimise retaining to adjacent landholders.

A maximum of 4% longitudinal gradient has been assumed in roads to ensure the maximum level difference across lots can be accommodated within 4m front setbacks.

Allowance to retain existing trees can be made in certain areas, as shown in Appendix Nine, which would require the road pavement to be offset slightly within the road reserve to facilitate this during detailed design.

The earthworks methodology is largely guided by the proposed development staging and areas. As such, a detailed earthworks methodology or staging is not able to be advised at structure planning level, rather general guidance only is provided.

Earthworks for this site would be completed in accordance with standards AS3798 – 2007- "Earthworks for Residential and Commercial Developments" and specific Geotechnical Investigations and recommendations provided by Registered Geotechnical Engineers.

Geotechnical Engineers have advised that the site is suitable for residential development provided that any site preparation and earthworks is completed to alleviate any risk posed by natural conditions. The Geotechnical recommendation for remedial earthworks for the site as prepared by Structerre Consulting Engineers – Geotechnical, is provided in Appendix One and describes general earthworks practices that are likely to be employed across the development.

Given the variable nature of the site, with different stockpiles present, it is expected that earthworks will be highly dynamic. For this reason, it would be proposed that any construction works shall be accompanied by thorough and ongoing geotechnical assessment and sign off, where each successive phase of earthworks shall not proceed until preceding works are deemed to be geotechnically compliant. In this manner, development lots are proposed to achieve a classification suitable for residential development, and as verified by the registered Geotechnical Engineer.

Due to existing conditions, it is anticipated there will be certain quantities of uncontrolled fill and peat to be removed from site, the location and magnitude of these quantities is subject to further detailed design and assessment, and confirmation on site during construction. At this stage, the earthworks aim to minimise any disturbance or removal of in-situ underlying peat material by employing a limestone raft and geogrid methodology overlain by considerable free draining sand fill as described further in Structerre's remedial earthworks summary. Indicative finished lot development levels are also provided in Appendix Two, which will guide overall earthworks and fill quantities. Additional surcharge material is expected to be allowed to achieve any consolidation of the peat material under the limestone raft and free draining fill prior to building construction. Settlement monitoring pegs are expected to be implemented to assist with assessing this process and timeframes for removal of any surcharge material. As indicated, these earthworks will be subject to confirmation on site and detailed design, where some areas will not contain underlying peat and therefore will not be subject to the same remedial methodology, and a more traditional approach may be adopted.

Earthworks will also be completed to assist with stormwater management for the site with levels generally grading from east to west. Subsoil drainage would be employed to assist in managing groundwater.

2.6 Other Existing Site Constraints

A search of the Aboriginal Heritage system online indicates there are no specific Aboriginal heritage or any other heritage features within the site, however there are wetlands and waterways downstream on the south side of Karrinyup Road to be aware of.

A search of the bushfire mapping indicates that the site is not within a bushfire prone area.

Any existing structures and associated buried services will need to be demolished prior to any development, and this will need to be undertaken with respect to existing asbestos within the building to avoid contamination of the site. Uncontrolled fill has also been identified within the area which will need to be removed, screened and waste / rubble removed to the appropriate waste facility.

3 Infrastructure

3.1 Stormwater Drainage

There is an existing Water Corporation stormwater drainage system to the west of the proposed structure plan area that encompasses Roselea Estate Lake and a large catchment to the east. As such, any stormwater design completed as part of the Development will need to be in accordance with both the Local Authority and Water Corporation requirements.

A detailed staging plan for drainage infrastructure cannot be reasonably completed at this stage of the structure planning process, as infrastructure construction will be largely guided by proposed development staging and areas, and particularly follow earthworks progress. The proposed drainage strategy would be in accordance with the Local Water Management Strategy (LWMS) as prepared by 360 Environmental and to the requirements of the City of Stirling and The Water Corporation.

The general drainage concept is shown on the typical swale details, which includes a general plan view of swales as included in Appendix Four.

In accordance with the LWMS, it would be proposed to

- Retain the first 15mm of rainfall on site as close to source as practicably possible for all lots.
- Convey the 20% Annual Exceedance Probability (AEP) storm within the piped road network.
- Contain the 1% AEP within the road reserve.
- Ensure properties are 500mm above the 1% AEP flood level within adjacent stormwater detention systems.
- Provide detention of the 20% to 1% AEP events so that the post development peak discharge is comparable to the predevelopment peak discharge.

As shown in the LWMS drainage concept plans and indicative swale details in Appendix Two, the site generally consists of east-west drainage catchments. These are likely to also correlate with the building development areas for the site. From this, it would be assumed that construction staging will likely occur in a similar manner, where east-west cells may occur independently. Should this be the case, it would be expected that associated infrastructure for each stage would be constructed, including road pavements and piped drainage. The road drainage system would be designed to accommodate the 20% AEP short duration storm, and convey this, as shown in concept plans, to vegetate swales to the west of the site along Grindelford Drive, which will aim to detain stormwater to control peak discharge from the site to predevelopment conditions for the 20% to 1% AEP events.

Should greater areas of development occur, then it would be intended to construct more of this system and additional vegetated detention swales to allow for correct detention for the areas being developed to limit discharge to predevelopment conditions.

Preliminary calculations indicate that there is sufficient capacity in the proposed drains to store and infiltrate all road runoff from the development and there will be sufficient depth of free draining fill placed on the lots to accommodate soakwells. This is subject to detailed infiltration testing and hydrogeological modelling of the ground conditions under the proposed swales.

Subsoil drainage will likely also be required, depending on the geotechnical ground improvement solution implemented.

During detailed design both the City of Stirling and Water Corporation will be engaged to discuss the design options and their approval of the final drainage solution sought.

Refer to Appendix Four for correspondence from both authorities regarding the stormwater drainage, along with the preliminary concept for drainage.

3.2 Sewerage Reticulation

There is an existing pump station within 64 Radalj Place that the Water Corporation have confirmed services the catchment within the local structure plan. Refer to Appendix Five for the planning information pack from the Water Corporation.

There are existing 225mm dia. gravity sewers running along, and through, the east of the site which are deep enough to cater for the subject land proposed levels.

In general, it would be proposed to run east-west sewers through roads to the existing deep sewer running north-south. However, it is also proposed to divert the sewer running through Lots 153 and 350 around via the new roads so that it removes one constraint from those lots when they are developed. This may need to be completed in stages, dependent on the land ownership and time of development of each lot.

3.3 Water Reticulation

There are 150mm diameter water reticulation mains along Grindleford Drive which are adequate to service the development as shown on Page 2 of the planning information provided by the Water Corporation in Appendix Five.

3.4 Local Authority Requirements

The development will be designed to connect into existing road levels and will facilitate road widenings and drainage modifications where required, through discussions and coordination with the City. The City of Stirling's requirements for stormwater drainage are included in Appendix Four.

Standard truncations, kerbing and pavement are anticipated to be required, subject to confirmation post geotechnical remediation.

3.5 Preliminary Road Reserve Sections

Indicative cross sections for the various road reserve widths as show on the structure plan layout plan are shown in Appendix Nine. These include standard infrastructure items as per typical liveable neighbourhood and Institute of Public Works Engineering Australasia (IPWEA) requirements, such as roadways, footpaths (which may have potential to be widened to shared paths pending further design), standard public utility service corridors, street trees and lighting. These are noted to be preliminary and typical for the time being, where changes may be necessary as part of subsequent design and planning processes.

The east-west neighbourhood connector "Tree retention option" south of the Public Open Space has been amended to a 12m road reserve as shown on the Structure Plan layout. There may be the opportunity to extend parking outside of the road reserve area into the POS.

3.6 Gas Supply

There are existing gas mains on the western side of Grindleford Drive currently servicing the adjacent subdivision. These mains are 63mm dia. HP and may require upgrading to allow the subject lots to be serviced. ATCO Gas have advised that the MP line has the capacity to supply 700 standard domestic customers at the proposed location through a mains extension of DN150PVC in Karrinyup Road. Refer Appendix Six for information.

3.7 Electrical Supply

The development area is fed by two separate zone substations; Balcatta to the north-west and Yokine to the south-east. Both are approximately 3-4km away from the site. There are existing HV and LV network cables both underground and aerial around the site, from which multiple connection points can be obtained. Both substations have greater than 10MVA of spare capacity, so there should be sufficient capacity for the proposed development.

Based on the existing infrastructure around the site, 3E Consulting Engineers Pty Ltd have advised that there is unlikely to be major network reinforcement works required.

Lots 49, 88 and 129 will require a transformer and switchgear off Grindleford Drive, ideally located on the northern side of POS 141, and Lots 30 and 109 may require a small 315kVA transformer installed on site off an existing switchgear in the development area to the west.

The overall structure plan area could be serviced by about six transformers and four switchgears.

Refer to Appendix Seven for correspondence from 3E Consulting Engineers Pty Ltd regarding the above.

3.8 Communications

The existing developments within the structure plan are currently serviced from the Telstra Tuart Hill Exchange, which is 1.9km from the proposed development. There is an existing P100 conduit from Tuart Hill to the eastern side of the proposed development, which does have spare capacity over some sections. It may be able to support hauling of additional optical cable. Limited copper cable capacity exists to the east and west of the development.

The new development would fall within the NBN Co's fixed line footprint, in which NBN Co deliver FTTP technology. NBN Co expect to convert the Balcatta suburb to broadband progressively from March 2018 and will most likely provide FTTN to existing home owners. Once installed, NBN Co must accept this development if application were made by the Developer for telecommunications infrastructure.

The developer has two obligations in relation to telecommunications; provide fibre ready pit and pipe (Federal Legislation), and to provide telecommunications infrastructure (Federal Ministerial policy).

This development is likely to attract an NBN Co Backhaul charge, which is anticipated to be charged on the basis of connection to the Tuart Hill Exchange, where NBN Co's FAN is located.

4 Conclusion

This report confirms that the site is suitable for development, subject to the geotechnical remediation to a residential and commercial standard. The extent of site remediation and earthworks required is dependent on the ground improvement methodologies implemented and geotechnical monitoring throughout the works. This will feed into detailed design of earthworks, retaining walls, roads and infrastructure. The drainage will also be subject to detailed design and catchment modelling to confirm whether the existing system can support the proposed additional drainage without storage retention within the Local Structure Plan area.

appendices

appendix one:	structerre geotechnical report
appendix two:	proposed preliminary earthworks
appendix three:	existing topography
appendix four:	water corporation and city of stirling drainage requirements
appendix five:	water corporation planning information pack
appendix six:	atco gas communication
appendix seven:	power servicing information
appendix eight:	communications servicing information
appendix nine:	preliminary detailed sections

appendix one: structerre geotechnical report

Doc: GE2.2.001

Project No: D177912

Job No: J188541

18/10/2017

Parcel Property
PO Box 1618
Osborne Park WA 6017

Attention: Jeremy Cordina

REVIEW OF REMEDIAL WORKS AND SITE CLASSIFICATION AT ROSELEA EAST - GRINDLEFORD DR, BALCATTA

1. INTRODUCTION

Parcel Property (The Client) has requested information in regards to the site classification at Roselea East Estate. This report aims to discuss the potential site classifications and proposed remedial works at Lot 30, 49, 88, 86 and 129 Grindleford Drive, Balcatta.

Structerre have been provided with numerous previous investigations in relation to the site, and with the proposed final levels for lots 49, 88 and 129 (Pritchard Francis – 15029-C9-SK-03-A, October 2017).

2. PREVIOUS WORK

Previous investigations have been conducted in and around Roselea East Estate and have been provided to Structerre.

- Geotechnical Review – Subdivision – Lot 350 Grindleford Drive, Stirling, P2963/1-Ac, 25 November 2002, Coffey Geosciences.

  This report conducted by Coffey Geosciences is based on a site south of Lot 86 Grindleford Drive This report states that there is peat present on site and that some remedial work has been conducted, including the stripping of peat and replacement with structural fill. The areas that have been remediated were given a Class M site classification.

- Report on Preliminary Geotechnical Investigation 309 Albert Street Balcatta, WA, Project 76430, October 2012, Douglas Partners

  This report conducted by Douglas Partners is for Lot 30 and the site is classified as Class P. The ground conditions encountered consisted of fill sand, peat (to 3.3m depth) and natural sand. To allow the proposed development (residential subdivision) the site preparation recommendations include removal of existing fill and peat, and replacement with engineered

1 Erindale Road, Balcatta, Western Australia 6021 | PO Box 792, Balcatta, Western Australia 6914
Phone (+618) 9205 4500 | Fax (+618) 9205 4501 | Email wageotecheng@structerre.com.au | Web www.structerre.com.au
ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

fill. Alternatively, the compaction of existing fill and the use of piled foundations is recommended.

- Report on Preliminary Acid Sulphate Soil and Groundwater Investigation and Acid Sulphate Soil And Dewatering Management Plan, Proposed Residential Subdivision 309 Albert Street Balcatta, WA, Project 76430.01, November 2012, Douglas Partners

  This report conducted by Douglas Partners states that the ground conditions comprised of surficial sand fill overlying peat and sand deposits.

- Report on Proposed Residential Development Lots 86, 88 & 129 Grindleford Drive, Balcatta, J1401266 004 R Rev0, 16 February 2015, Galt Geotechnics

  The geotechnical assessment conducted by Galt Geotechnics has identified that peaty soils are present at depth, and that uncontrolled fill is present on site, and as such is classified as Class P. The remedial options presented include stripping of uncontrolled fill and peaty soils, and replacement with approved fill, ground improvement by partial addition/replacement of material, ground improvement by mass stabilisation of the soils using deep soil mixing, or piling of structures.

- Methodology and Cost Assessment 309 Albert St Balcatta, Merit Consulting Group, 3 July 2015

- Report on Geotechnical Desktop Study - East Roselea Structure Plan Area Grindleford Drive, Balcatta, J1702012 001 R Rev1, 10 August 2017, Galt Geotechnics

  The subsurface conditions were reported to consist of fill (sand, building rubble and peaty sand) overlying peat and natural sand. Further assessment was recommended.

A review of these reports show that variable ground conditions were encountered throughout the investigations. Based on the review the underlying ground conditions typically consist of uncontrolled fill (consisting of SAND, peaty SAND building rubble and PEAT), overlying natural PEAT and SAND. This ground profile represents an infilled wetland site. It should be noted that there is a high variance in the level of uncontrolled fill within the ground profile.

3. SITE SUITABILITY FOR DEVELOPMENT

The site is suitable for residential development, however the earthworks and/or the method of construction will be more comprehensive than a typical residential development.

Solutions for the in-situ ground conditions include:

- The use of piled foundations: The site will remain a Class P and will involve minimal earthworks including stripping of topsoil, raking of fill material and compaction. Piled foundations will be taken to the depth of competent natural material which varies across the site, an indicative depth of between 2.0m and 9.0m would be appropriate. This methodology will be suitable for full masonry double brick construction. Through the use of piled foundations, the structure will be adequately supported and will negate the effects of the fill profile upon the structure, however long term settlement will still occur in areas of paving, roads and retaining walls which may not be aesthetically pleasing.

- Remedial earthworks for Class A site: The removal of all uncontrolled fill and peat to competent natural sand. This will involve major earthworks, dewatering and removal of material to a suitable location; environmental constraints will apply. With non-reactive structural fill to natural competent material the site will be upgraded to a Class A and be suitable for full masonry double brick construction.
- Remedial earthworks for Class S to M with the use of limestone and geogrid raft: The methodology for this is outlined below (Section 4). Following the remedial earthworks the site will be upgraded to an equivalent Class S to M and be suitable for full masonry double brick construction.

The table below shows the Site Classification with the appropriate Structerre footing detail.

Potential Site Classification and Structerre Footing Detail

Site Classification	Structerre Footing Detail	Amount of Structural non-reactive fill required	Methodology
Class A	D10 – B1	1.8m minimum	Excavate to natural ground and back fill
Class S – M	C8 – C10	2.2m	As per Section 4

The use of waffle rafts is not recommended at this site due to the significant differential movement during construction which would cause structural issues. Where as a waffle raft does accept larger surface movement, some amount of remediation would still be required.

4. REMEDIAL EARTHWORKS WITH THE USE OF LIMESTONE AND GEOGRID RAFT

All earthworks shall be undertaken in accordance with AS3798-2007 “Earthworks for Residential and Commercial developments”.

Vegetation to be cleared, grubbed and mulched. Loose ground resulting from the removal of vegetation (i.e. trees) should be profiled, compacted and in filled with suitably compacted fill. The topsoil is to be stripped and can be stockpiled for reuse or disposed off site, as required. Re-use of topsoil may require blending for use as fill and it is recommended to blend topsoil with clean sand in ratio to provide an organic content of <2% by mass. Any blended material should not be placed in the upper 1.0m fill profile, however where drainage is a consideration placement should be at depth.

It is considered that the near surface fill materials will require improvement. Therefore, it is proposed to excavate and stockpile the materials for reuse, subject to suitability and blending to provide suitable structural fill. The depth of excavation will be dependent on the proposed final levels and may vary depending on conditions encountered, however it would be considered that a minimum depth of 2.5m below finished pad levels be targeted to provide a suitable base for the proposed ground improvement techniques.

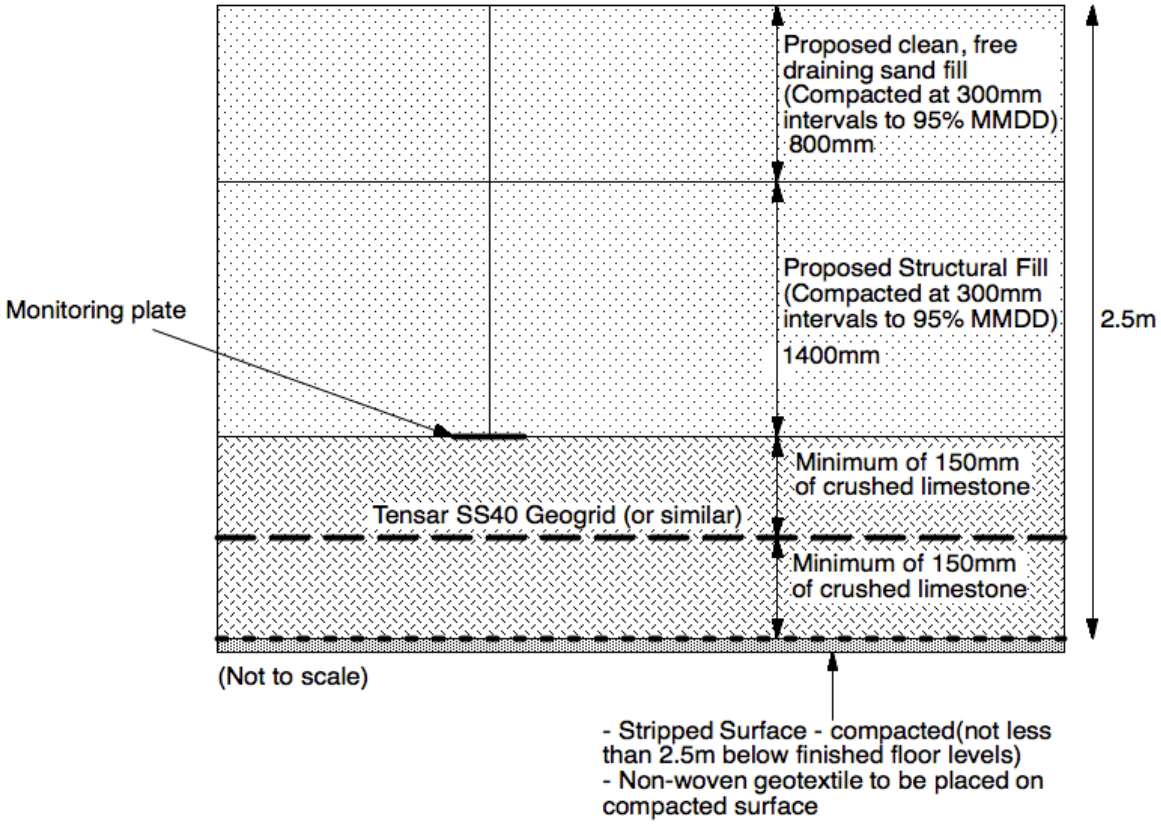
The base of all excavations are to be assessed. At this stage, information can be given on whether additional removal of materials is required, or whether placement of a crushed limestone sub-base is recommended for workability of impact compaction.

The base of the structural areas are to be compacted in situ using an appropriate impact compaction methodology (i.e. HEIDYC or similar), the method of compaction would be determined following the base assessment.

An allowance for the potential use of wick drains should be made, the use of which will be decided during the base assessment.

A stiffened limestone raft is to be constructed on the compacted base (i.e. at approximately 2.5m below finished level), comprising a layer of non-woven geotextile underlying 0.15m compacted limestone layer, a layer of geo-grid and a second 0.15m layer of compacted limestone. Figure 1 below shows the preliminary configuration of the limestone raft.

Figure 1 - Preliminary Configuration of The Limestone Raft



Settlement monitoring plates would be installed on top of the completed stiffened raft.

The area is to be filled in layers (no more than 300mm) and compacted, in accordance with AS3798, to the required finished level with imported non-reactive granular fill or materials cut from site and blended to meet structural requirements. The upper 0.8m should consist of clean (<5% fines content), free draining sand fill.

The area is to be surcharged with approximately 1.8m of compacted sand fill. The settlements generated by the placement of fill should be monitored to enable geotechnical parameters to be back analysed and the surcharging strategy to be amended, if necessary.

Based on experience from previous sites and that the materials are partially saturated the settlement period is considered to be relatively rapid (e.g. <6 months).

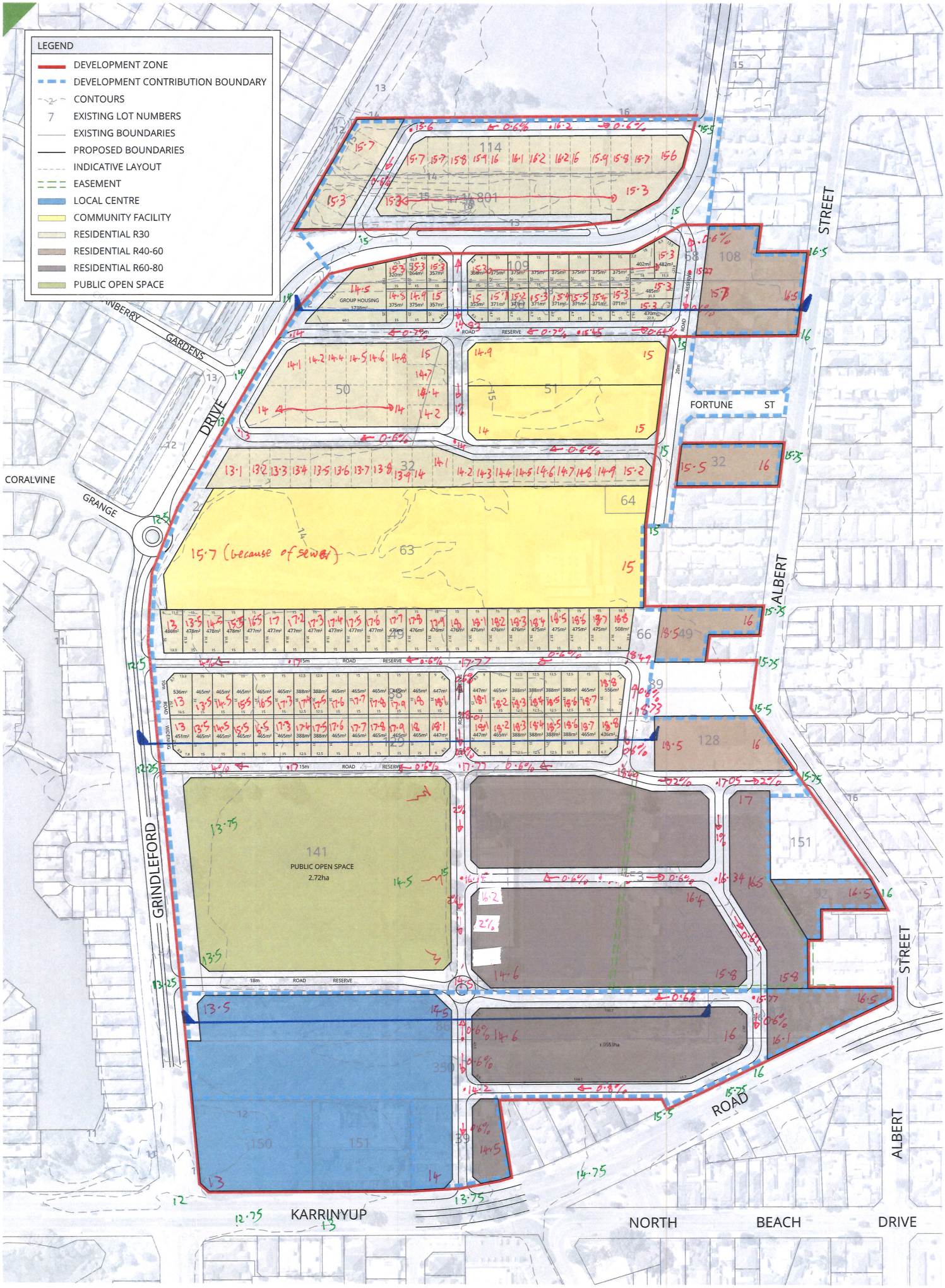
We trust this meets with your requirements. Should you require any additional information, or clarification of the above, please contact the undersigned.

For and behalf of
STRUCTERRE CONSULTING ENGINEERS

Author: Amy Yates
Title: Engineering Geologist
Credentials: BSc (Hons), FGS

Authorised By: Mel Castle
Title: Geotechnical Division Manager

appendix two: proposed preliminary earthworks



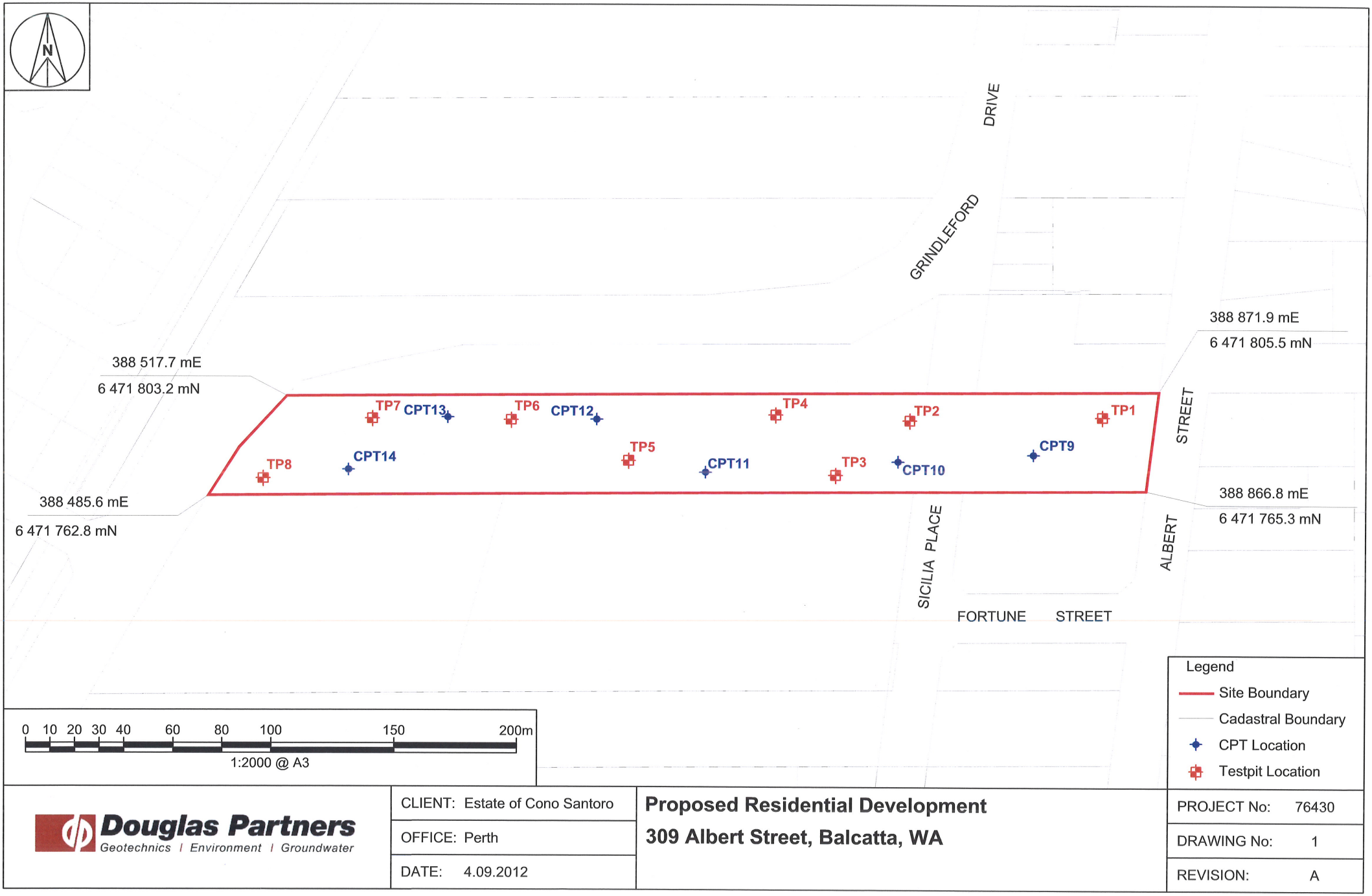
INDICATIVE SUBDIVISION CONCEPT

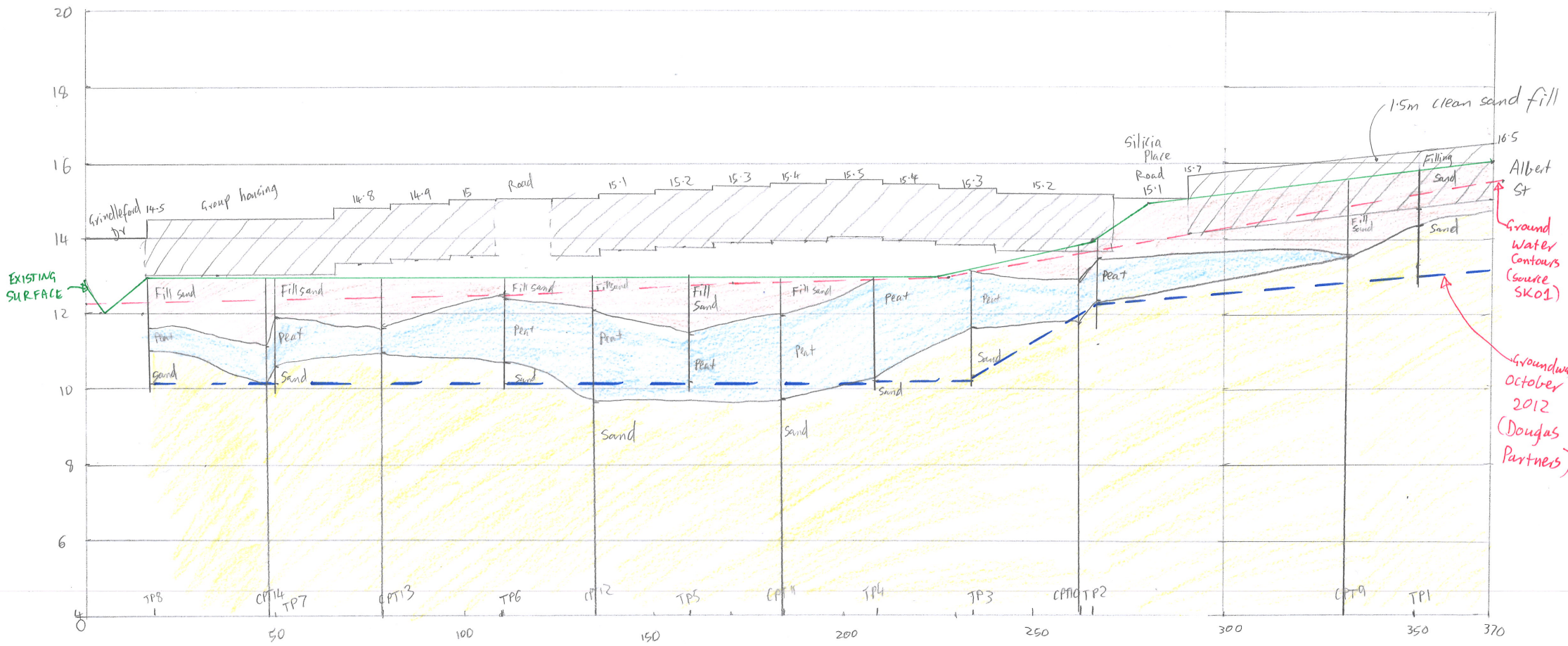
ROSELEA EAST - STRUCTURE PLAN AREA

BALCATTA

ROWEGROUP DESIGN
P: 9221 1991 W: www.rowegroup.com.au E: info@rowegroup.com.au
REF: 8686-CON-02-A DATE: 13.7.2017 DRAWN: WC

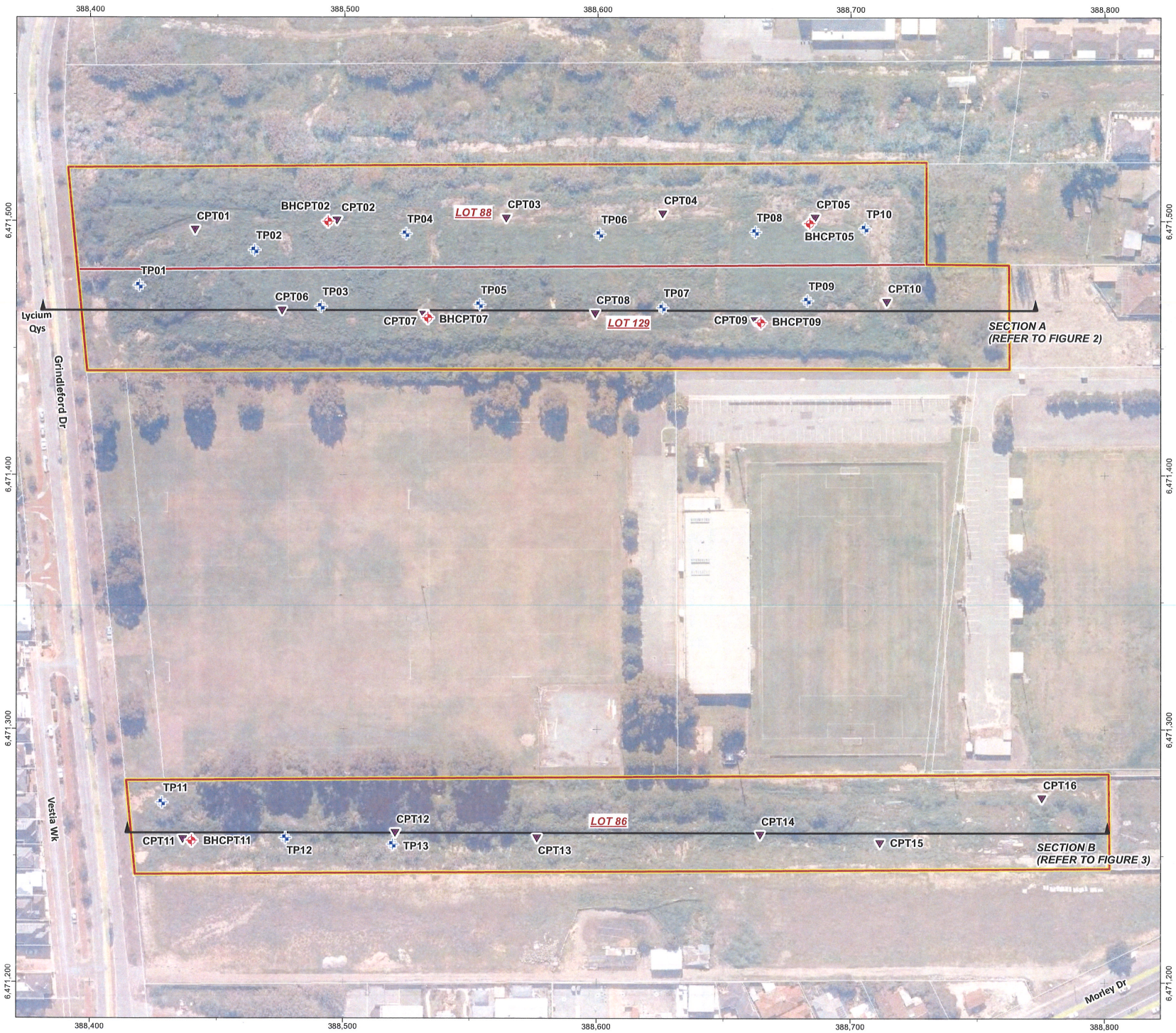
Whilst all care has been taken in the compilation of this document, Rowe Group disclaim any responsibility for any errors or omissions. This document is and remains the property of Rowe Group and may not be reproduced or transmitted, in whole or in part, without the written consent of Rowe Group. All areas and dimensions are subject to survey.


N
DRIVE
GRINDLEFORD
388 871.9 mE
6 471 805.5 mN
388 517.7 mE
6 471 803.2 mN
STREET
TP7
CPT13
TP6
CPT12
TP4
TP2
TP1
TP5
CPT9
TP8
CPT14
CPT11
TP3
CPT10
388 485.6 mE
6 471 762.8 mN
388 866.8 mE
6 471 765.3 mN
SICILIA PLACE
ALBERT
FORTUNE
STREET
Legend
Site Boundary
Cadastral Boundary
CPT Location
Testpit Location
0 10 20 30 40 60 80 100 150 200m
1:2000 @ A3
Douglas Partners
Geotechnics / Environment / Groundwater
CLIENT: Estate of Cono Santoro
OFFICE: Perth
DATE: 4.09.2012
Proposed Residential Development
309 Albert Street, Balcatta, WA
PROJECT No: 76430
DRAWING No: 1
REVISION: A



Douglas Partners 2012 report (assuming ground levels are similar to 2017)

LOT 30
(INDICATIVE FOR LOT 109)



Legend

- Site Boundary
- Lot Boundary

Test Locations

- Borehole
- Cone Penetration Test
- Test Pit
- Geological Section Line

N

0 20 40 60 80 100
Meters

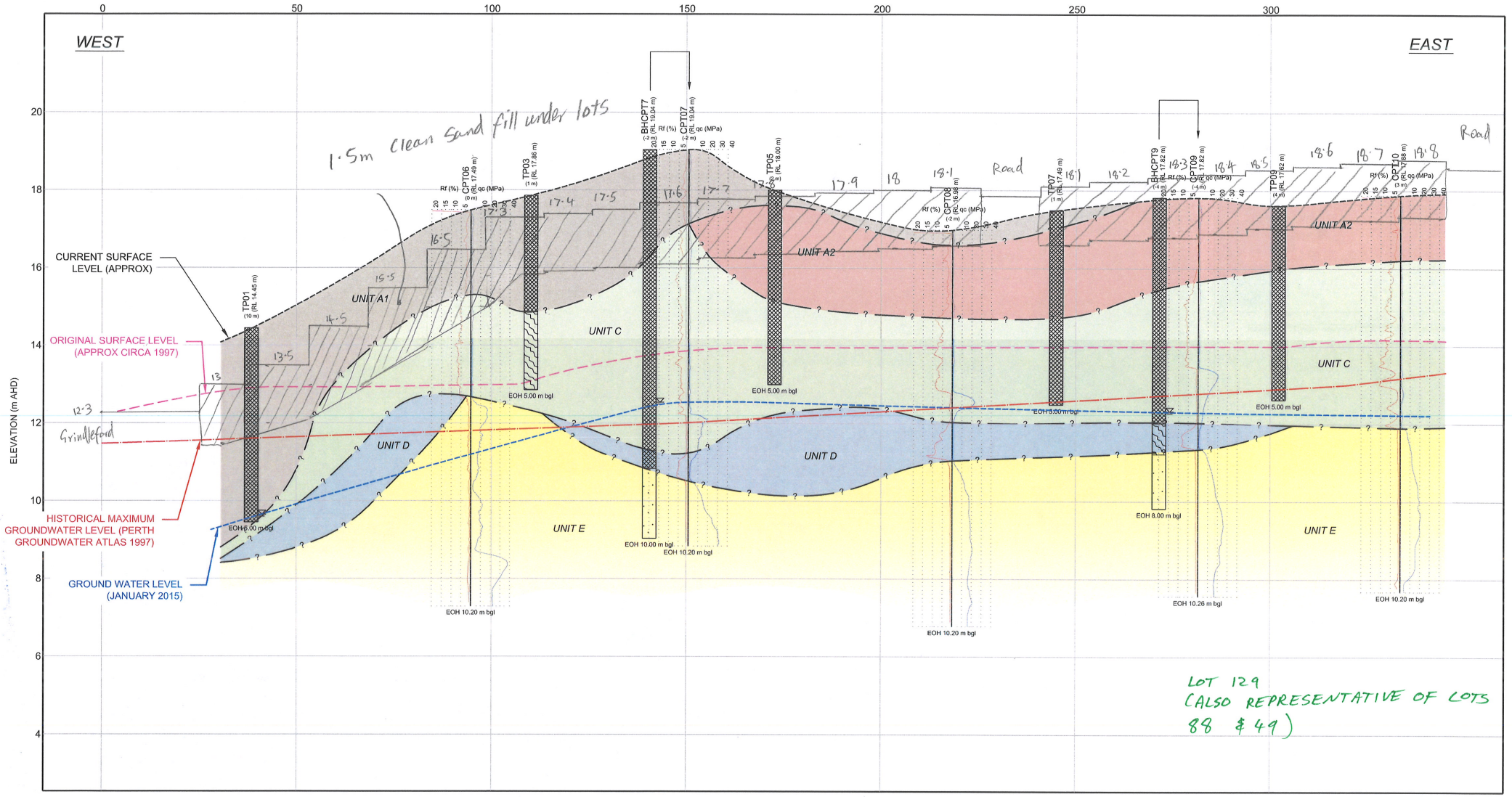
SCALE	1:1,500 (A3)
DRAWN	DAC
DATE DRAWN	16/02/2015
CHECKED	ORW
DATE CHECKED	16/02/2015
PROJECTION	GDA 1994 MGA Zone 50

Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address: U2, 39 Flynn Street, Wembley, WA, 6014

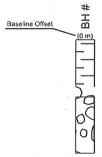
COPYRIGHT © 2015 THIS FIGURE AND ITS CONTENTS REMAINS THE PROPERTY OF GALT GEOTECHNICS PTY LTD AND MAY NOT BE REPRODUCED WITHOUT PRIOR APPROVAL. THIS FIGURE SHOULD BE READ IN CONJUNCTION WITH THE ACCOMPANYING REPORT.

CLIENT	ABN GROUP
PROJECT	PROPOSED RESIDENTIAL DEVELOPMENT
LOCATION	LOTS 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA
TITLE	SITE & LOCATION PLAN
Job No	J1401266
Fig No	FIGURE 1
Rev	A

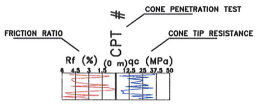
O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\09 GIS\04 MXD\J1401266-001.mxd (damonclark) 16/02/2015 1:48:06 PM



POST LEGEND



CPT DETAILS



MATERIAL GRAPHIC

- FILL
- PEAT
- Poorly-graded SAND
- Organic SAND

SOIL UNIT

A1	FILL: SAND WITH SOME ORGANICS
A2	FILL: PEATY SAND
B	UNCONTROLLED FILL (RUBBLE / RUBBISH / SAND)
C	FILL: PEAT
D	PEAT (NATURAL)
E	SAND, TYPICALLY DENSE

NOTES:

1. Groundwater level data may be inaccurate due to the presence of low permeability fill layers and the nature of the intrusive investigation techniques used. Long-term groundwater monitoring is recommended prior to finalising any earthworks plans
2. Historical maximum groundwater levels taken from the Perth Groundwater Atlas (1997)

H 1:1000
0 10 20 30 40 50m
V 1:100
0 1 2 3 4 5m
Coord.System: MGA94 Zone 50 Height Datum: AHD

REV	DESCRIPTION	DATE	CHK

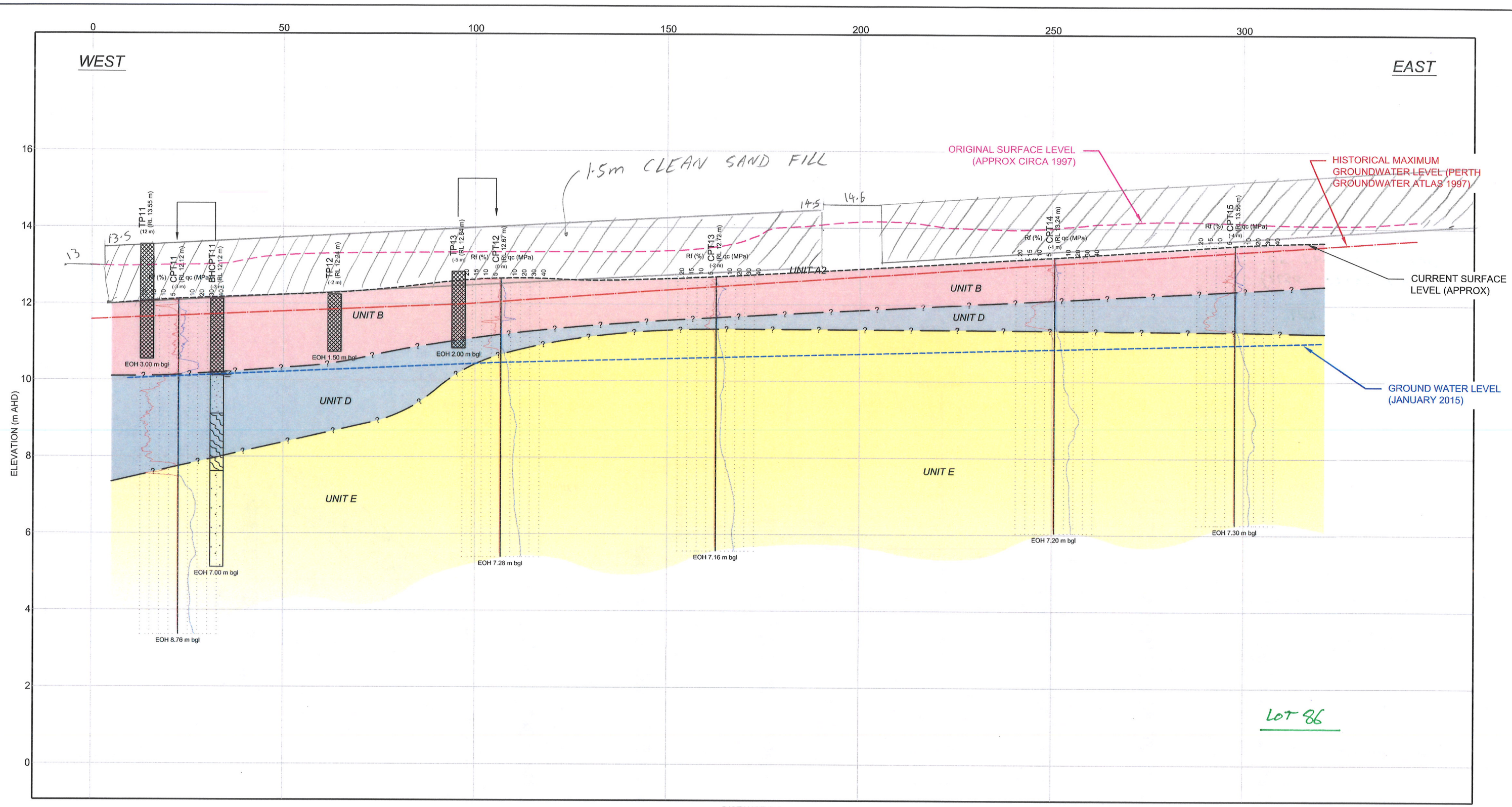
Copyright © 2015 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

SCALE	H 1:1000 V 1:100
DRAWN	DAC
DATE DRAWN	16/02/2015
CHECKED	ORW
DATE CHECKED	16/02/2015

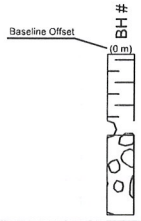
Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address : UNIT 2 39 Flynn Street, Wembley, WA, 6014

CLIENT	ABN GROUP
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	LOT 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA
TITLE	GEOLOGICAL SECTION A
JOB NO	J1401266
FIGURE	FIGURE 2

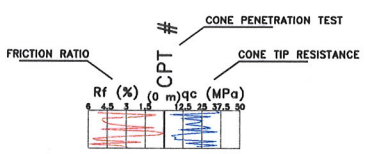
O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\05 CAD\J1401266-SECTIONS.dwg



POST LEGEND



CPT DETAILS



MATERIAL GRAPHIC

- FILL
- PEAT
- Poorly-graded SAND
- Organic SAND

SOIL UNIT

A1	FILL: SAND WITH SOME ORGANICS
A2	FILL: PEATY SAND
B	UNCONTROLLED FILL (RUBBLE / RUBBISH / SAND)
C	FILL: PEAT
D	PEAT (NATURAL)
E	SAND, TYPICALLY DENSE

NOTES:

1. Groundwater level based on one point only (BHCPT11) and may be inaccurate. Long-term groundwater monitoring is recommended prior to finalising any earthworks plans
2. Historical maximum groundwater levels taken from the Perth Groundwater Atlas (1997)

H 1:1000
0 10 20 30 40 50m
V 1:100
0 1 2 3 4 5m
Coord.System: MGA94 Zone 50 Height Datum: AHD

REV	DESCRIPTION	DATE	CHK

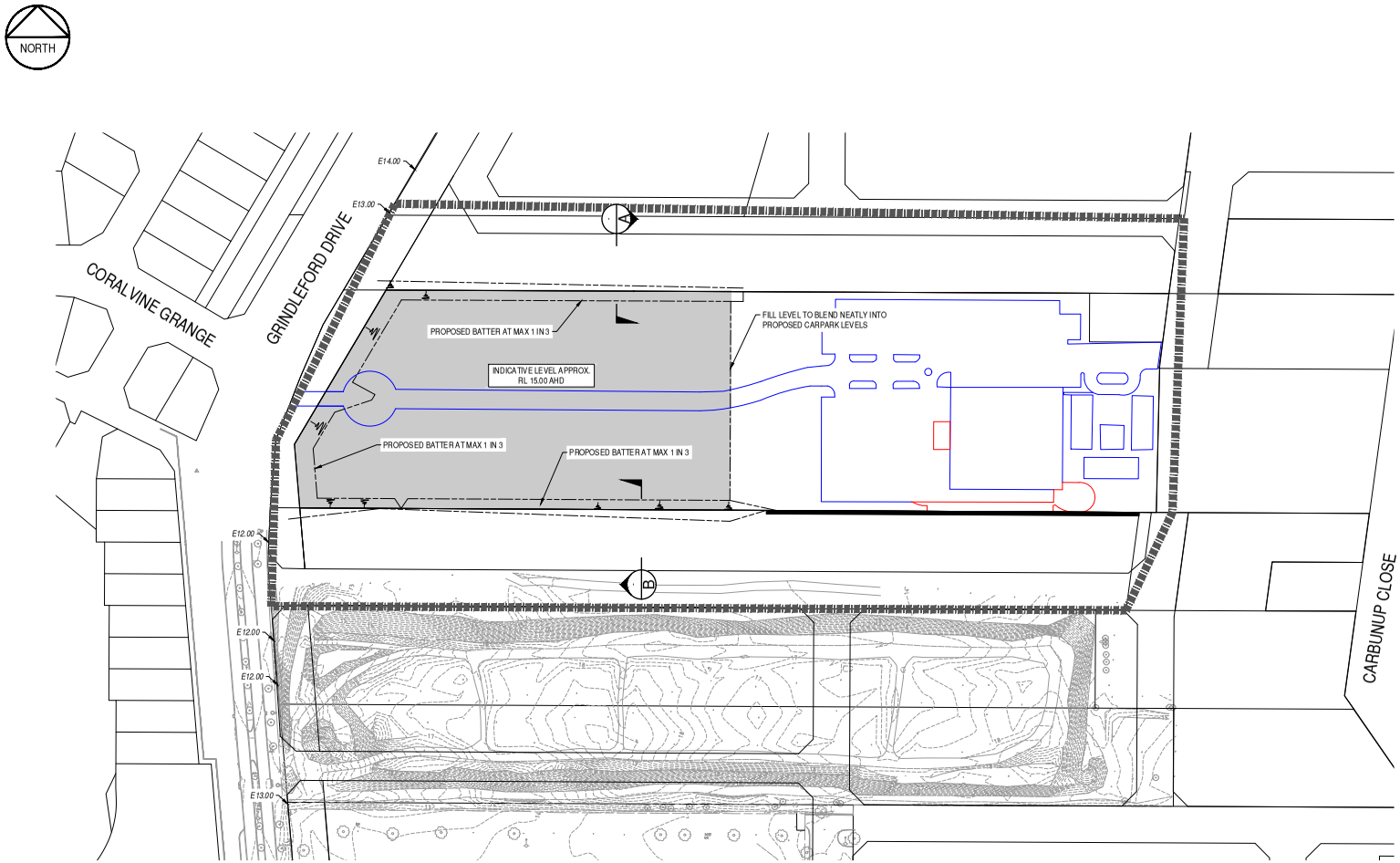
Copyright © 2015 this figure and its contents remains the property of Galt Geotechnics Pty Ltd and may not be reproduced without prior approval. This figure should read in conjunction with the accompanying report.

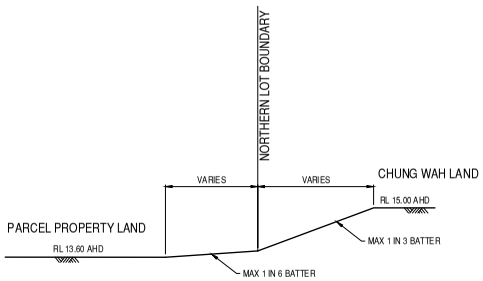
SCALE	H 1:1000 V 1:100
DRAWN	DAC
DATE DRAWN	16/02/2015
CHECKED	ORW
DATE CHECKED	16/02/2015

Galt GEOTECHNICS
Galt Geotechnics Pty Ltd
ACN : 138 490 865
Tel : +61 (0)8 6272-0200
Fax : +61 (0)8 9285 8444
Address : UNIT 2 39 Flynn Street, Wembley, WA, 6014

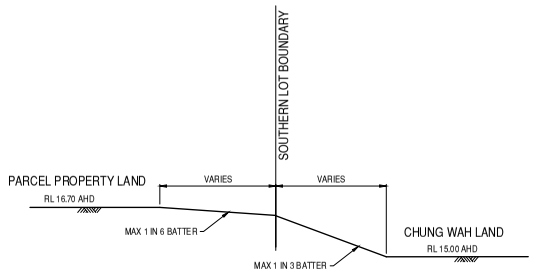
CLIENT	ABN GROUP
PROJECT	PROPOSED RESIDENTIAL SUBDIVISION
LOCATION	LOT 86, 88 & 129 GRINDLEFORD DRIVE BALCATTA
TITLE	GEOLOGICAL SECTION B
JOB NO	J1401266
FIGURE	FIGURE 3

O:\Jobs\2014\J1401266 - ABN Group DD SI Balcatta\05 CAD\J1401266-SECTIONS.dwg





SECTION A
N.T.S.



SECTION B
N.T.S.

SCALE 1:1000 0m 20m 40m

DIAL BEFORE YOU DIG
www.1100.com.au
The Essential First Step.

NOTES

1. ALL DIMENSIONS SHOWN ARE IN METRES U.S.O.
2. ALL CO-ORDINATES AND LEVELS SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS.ANY DISCREPANCIES SHALL BE REPORTED TO THE SUPERINTENDENT WITH IN SEVEN DAYS.
3. SURVEY INFORMATION SUPPLIED BY MNG. SITE CONTROLS TO BE PROVIDED BY MNG.
4. ALL HEIGHTS ARE TO AUSTRALIAN HEIGHT DATUM (AHD) AND ALL LEVELS SHALL BE DERIVED FROM ESTABLISHED BENCHMARKS.
5. ALL BENCHMARKS ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED ON PLANS.
6. FINISHED CONTOURS AND VOLUMES ARE TO ROAD BOXOUT.
7. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE SPECIFICATION AND ALSO THE REQUIREMENTS OF THE CITY OF STIRLING.
8. THE CONTRACTOR SHALL LIAISE WITH ALL RELEVANT AUTHORITIES TO LOCATE ALL EXISTING SERVICES WITHIN THE CONTRACT AREA PRIOR TO THE COMMENCEMENT OF WORK. SERVICES INFORMATION SHOWN ON THE DRAWINGS IS INDICATIVE ONLY AND MAY NOT BE COMPLETE. WHERE EXISTING AND PROPOSED WORKS CONFLICT, LEVELS ARE TO BE TAKEN AND SUPPLIED TO THE SUPERINTENDENT IMMEDIATELY.
9. CONTRACTOR SHALL OBTAIN COUNCIL APPROVAL AND PAY ALL FEES/BONDS PRIOR TO COMMENCEMENT OF WORKS.
10. CONTRACTOR SHALL NOTE THAT NON-TRAFFICABLE SUBTERRANEAN STRUCTURES (SOAKWELLS ETC.) MAY EXIST ON SITE. PRIOR TO EARTHWORKS COMMENCING, CONTRACTOR SHALL LOCATE ANY SOAKWELLS, SEPTIC TANKS, DELETERIOUS MATERIALS AND OTHER SUBTERRANEAN STRUCTURES. THESE MATERIALS AND STRUCTURES ARE TO BE REMOVED AND THE LOCATION BACKFILLED IN ACCORDANCE WITH PROCEDURES SET OUT IN SPECIFICATION (IF APPLICABLE). THE SUPERINTENDENT IS TO BE ADVISED OF ANY UNUSED PIPE WORK ENCOUNTERED.
11. THE CONTRACTOR SHALL PROVIDE TEMPORARY FENCING TO EXISTING LOTS AS REQUIRED.
12. THE CONTRACTOR SHALL PREPARE A DUST MANAGEMENT PLAN IN ACCORDANCE WITH THE DEPARTMENT OF ENVIRONMENT AND CONSERVATION (D.E.C.) GUIDELINES SITE CLASSIFICATION 3 AND OBTAIN APPROVAL FROM THE LOCAL AUTHORITY FOR THE DUST MANAGEMENT PLAN.
    DUST SUPPRESSION METHODS SHALL BE APPLIED BY THE CONTRACTOR DURING EARTHWORKS OPERATIONS IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN.
13. NO CLEARING TO OCCUR UNTIL SUPERINTENDENT HAS IDENTIFIED TREES TO BE RETAINED.
    13a. ALL TREES TO BE RETAINED SHALL BE FENCED OFF FOR THE DURATION OF THE WORKS.
    13b. ALL TREES AND VEGETATION NOT FOR RETENTION SHALL BE MULCHED AND STOCKPILED FOR REUSE OR REMOVAL AS NOTED.
14. THE CONTRACTOR SHALL MAINTAIN PROPER SITE DRAINAGE TO ALL AREAS THROUGHOUT THE CONSTRUCTION PERIOD AND SHALL BE RESPONSIBLE FOR MAINTAINING EXCAVATIONS IN A SAFE AND STABLE CONDITION AT ALL TIMES.
15. TOPSOIL IS TO BE STRIPPED AND MANAGED IN ACCORDANCE WITH THE SPECIFICATION OR AS NOTED ON THE DRAWINGS.
16. ALL ROOTS, BOULDERS AND ANY OTHER DELETERIOUS MATERIAL SHALL BE TOTALLY REMOVED TO A DEPTH OF 600mm BELOW THE LOWER OF THE NATURAL/CUT SURFACE.
17. MINOR AMENDMENTS TO THE EXTENT OF EARTHWORKS MAY OCCUR TO PRESERVE IDENTIFIED TREES.
18. ALL BATTERS TO BE NOMINALLY 1 IN 3, OR FLATTER, UNLESS SHOWN OTHERWISE (U.S.O.).
19. PENETROMETERS USED FOR TESTING MUST BE CALIBRATED FOR SITE AND RECALIBRATED FOR IMPORTED FILL AS REQUIRED.
20. ALL FILL SHALL BE PLACED IN UNIFORM LAYER NOT EXCEEDING 300mm THICKNESS AND COMPACTED TO A DENSITY NOT LESS THAN 95% M.M.D.D. REFER TO SPECIFICATION FOR DETAILED INFORMATION.
21. CONTRACTOR TO COMPLETE ALL BACKFILLING AND EARTHWORKS REQUIRED TO ACHIEVE LEVELS SHOWN.
22. THE SITE IS TO BE LEFT CLEAN AND FREE OF RUBBISH/DEBRIS UPON COMPLETION OF WORKS.
23. TIE INTO ADJACENT BOUNDARIES AND FEATURES TO BE SEAMLESS.
24. 'AS CONSTRUCTED' DRAWINGS ARE TO BE PREPARED IN ACCORDANCE WITH THE SPECIFICATION AND PROVIDED TO THE SUPERINTENDENT PRIOR TO PROCEEDING TO THE NEXT STAGE OF WORKS.

LEGEND

- EARTHWORKS BOUNDARY
- STAGE 1 CHUNG WAH WORKS
- STAGE 2 CHUNG WAH WORKS
- PROPOSED AREA OF FILL
- EDGE OF BATTER
- EXISTING SURFACE CONTOUR
- RETAINING WALL
- 6.80 FINISHED PAD LEVEL
- 6.80 ASSUMED EXISTING PAD LEVEL
- 6.80 FUTURE PAD LEVEL
- E6.80 EXISTING SPOT LEVEL
- PROPOSED BATTER

REV	DATE	DESCRIPTION	BY	CHKR	REV	DATE	DESCRIPTION	BY	CHKR
F	05/12/17	SECTIONS AMENDED	LL	CJ					
E	27/11/17	CLIENT COMMENTS ADDED	LL	DT					
D	31/10/17	NOTES AMENDED	RW	DT					
C	27/10/17	MINOR AMENDMENTS	RW	DT					
B	16/10/17	CLIENT COMMENTS ADDED	LL	DT					
A	10/10/17	FOR INFORMATION ONLY	LL	DT	G	06/02/18	PLANNERS PRECAL AMENDED	JS	CXD

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
OCTOBER 2017	PCG94	AHD

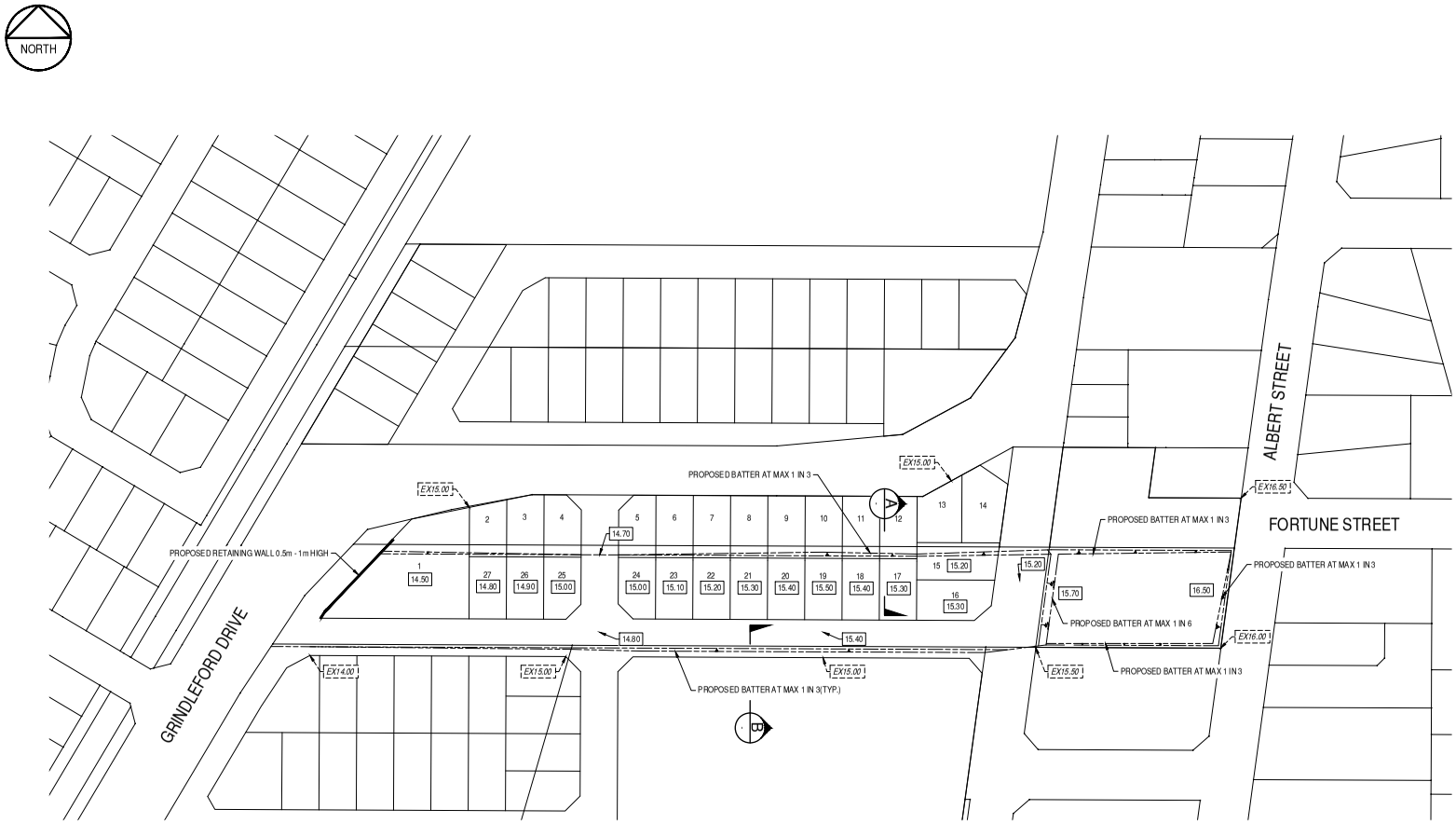
DESIGNED	DRAWN	CHECKED	APPROVED
DT	LL	DT	DT ..... / ..... / .....

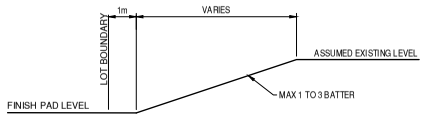
W.A.P.C. N/A | SCALE (U.N.O.) 1:1000 @ | SHEET SIZE A1

CLIENT & JOB: PARCEL PROPERTY GRINDLEFORD DRIVE, BALCATTA

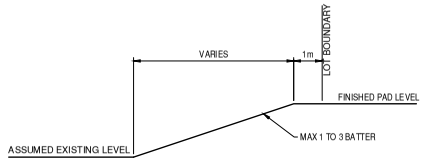
TITLE: PROPOSED RETAINING WALL AND LEVELS - LOT 63

DWG No. 15029-C9-SK-03 | REVISION G





SECTION A
N.T.S.



SECTION B
N.T.S.

NOTES

1. ALL DIMENSIONS SHOWN ARE IN METRES U.S.O.
2. ALL CO-ORDINATES AND LEVELS SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS.ANY DISCREPANCIES SHALL BE REPORTED TO THE SUPERINTENDENT WITH IN SEVEN DAYS.
3. SURVEY INFORMATION SUPPLIED BY MNG. SITE CONTROLS TO BE PROVIDED BY MNG.
4. ALL HEIGHTS ARE TO AUSTRALIAN HEIGHT DATUM (AHD) AND ALL LEVELS SHALL BE DERIVED FROM ESTABLISHED BENCHMARKS.
5. ALL BENCHMARKS ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED ON PLANS.
6. FINISHED CONTOURS AND VOLUMES ARE TO ROAD BOXOUT.
7. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE SPECIFICATION AND ALSO THE REQUIREMENTS OF THE CITY OF STIRLING.
8. THE CONTRACTOR SHALL LIAISE WITH ALL RELEVANT AUTHORITIES TO LOCATE ALL EXISTING SERVICES WITHIN THE CONTRACT AREA PRIOR TO THE COMMENCEMENT OF WORK. SERVICES INFORMATION SHOWN ON THE DRAWINGS IS INDICATIVE ONLY AND MAY NOT BE COMPLETE. WHERE EXISTING AND PROPOSED WORKS CONFLICT, LEVELS ARE TO BE TAKEN AND SUPPLIED TO THE SUPERINTENDENT IMMEDIATELY.
9. CONTRACTOR SHALL OBTAIN COUNCIL APPROVAL AND PAY ALL FEES/BONDS PRIOR TO COMMENCEMENT OF WORKS.
10. CONTRACTOR SHALL NOTE THAT NON-TRAFFICABLE SUBTERRANEAN STRUCTURES (SOAKWELLS ETC.) MAY EXIST ON SITE. PRIOR TO EARTHWORKS COMMENCING, CONTRACTOR SHALL LOCATE ANY SOAKWELLS, SEPTIC TANKS, DELETERIOUS MATERIALS AND OTHER SUBTERRANEAN STRUCTURES. THESE MATERIALS AND STRUCTURES ARE TO BE REMOVED AND THE LOCATION BACKFILLED IN ACCORDANCE WITH PROCEDURES SET OUT IN SPECIFICATION (IF APPLICABLE). THE SUPERINTENDENT IS TO BE ADVISED OF ANY UNUSED PIPE WORK ENCOUNTERED.
11. THE CONTRACTOR SHALL PROVIDE TEMPORARY FENCING TO EXISTING LOTS AS REQUIRED.
12. THE CONTRACTOR SHALL PREPARE A DUST MANAGEMENT PLAN IN ACCORDANCE WITH THE DEPARTMENT OF ENVIRONMENT AND CONSERVATION (D.E.C.) GUIDELINES SITE CLASSIFICATION 3 AND OBTAIN APPROVAL FROM THE LOCAL AUTHORITY FOR THE DUST MANAGEMENT PLAN.
    DUST SUPPRESSION METHODS SHALL BE APPLIED BY THE CONTRACTOR DURING EARTHWORKS OPERATIONS IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN.
13. NO CLEARING TO OCCUR UNTIL SUPERINTENDENT HAS IDENTIFIED TREES TO BE RETAINED.
    13a. ALL TREES TO BE RETAINED SHALL BE FENCED OFF FOR THE DURATION OF THE WORKS.
    13b. ALL TREES AND VEGETATION NOT FOR RETENTION SHALL BE MULCHED AND STOCKPILED FOR REUSE OR REMOVAL AS NOTED.
14. THE CONTRACTOR SHALL MAINTAIN PROPER SITE DRAINAGE TO ALL AREAS THROUGHOUT THE CONSTRUCTION PERIOD AND SHALL BE RESPONSIBLE FOR MAINTAINING EXCAVATIONS IN A SAFE AND STABLE CONDITION AT ALL TIMES.
15. TOPSOIL IS TO BE STRIPPED AND MANAGED IN ACCORDANCE WITH THE SPECIFICATION OR AS NOTED ON THE DRAWINGS.
16. ALL ROOTS, BOULDERS AND ANY OTHER DELETERIOUS MATERIAL SHALL BE TOTALLY REMOVED TO A DEPTH OF 600mm BELOW THE LOWER OF THE NATURAL/CUT SURFACE.
17. MINOR AMENDMENTS TO THE EXTENT OF EARTHWORKS MAY OCCUR TO PRESERVE IDENTIFIED TREES.
18. ALL BATTERS TO BE NOMINALLY 1 IN 3, OR FLATTER, UNLESS SHOWN OTHERWISE (U.S.O.).
19. ALL FILL SHALL BE CLEAN AND BE FREE FROM DELETERIOUS AND/OR ORGANIC MATERIAL.
20. FILL MATERIAL TO BE TESTED BY A REGISTERED MATERIALS TESTING LAB AND RESULTS PROVIDED TO THE SUPERINTENDENT PRIOR TO THE IMPORTATION AND PLACEMENT OF MATERIAL.
21. PENETROMETERS USED FOR TESTING MUST BE CALIBRATED FOR SITE AND RECALIBRATED FOR IMPORTED FILL AS REQUIRED.
22. ALL FILL SHALL BE PLACED IN UNIFORM LAYER NOT EXCEEDING 300mm THICKNESS AND COMPACTED TO A DENSITY NOT LESS THAN 95% M.M.D.D. REFER TO SPECIFICATION FOR DETAILED INFORMATION.
23. CONTRACTOR TO COMPLETE ALL BACKFILLING AND EARTHWORKS REQUIRED TO ACHIEVE LEVELS SHOWN.
24. THE SITE IS TO BE LEFT CLEAN AND FREE OF RUBBISH/DEBRIS UPON COMPLETION OF WORKS.
25. TIE INTO ADJACENT BOUNDARIES AND FEATURES TO BE SEAMLESS.
26. 'AS CONSTRUCTED' DRAWINGS ARE TO BE PREPARED IN ACCORDANCE WITH THE SPECIFICATION AND PROVIDED TO THE SUPERINTENDENT PRIOR TO PROCEEDING TO THE NEXT STAGE OF WORKS.

LEGEND

- EDGE OF BATTER
- RETAINING WALL
- 6.80 FINISHED PAD LEVEL
- 12.10 DESIGN LEVEL
- EX12.10 ASSUMED EXISTING LEVEL
- PROPOSED BATTER

SCALE 1:1000 0m 20m 40m

DIAL BEFORE YOU DIG www.1100.com.au The Essential First Step.

REV	DATE	DESCRIPTION	BY	CHKR
A	27/10/17	FOR INFORMATION ONLY	LL	DT

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
OCTOBER 2017	PCG94	AHD

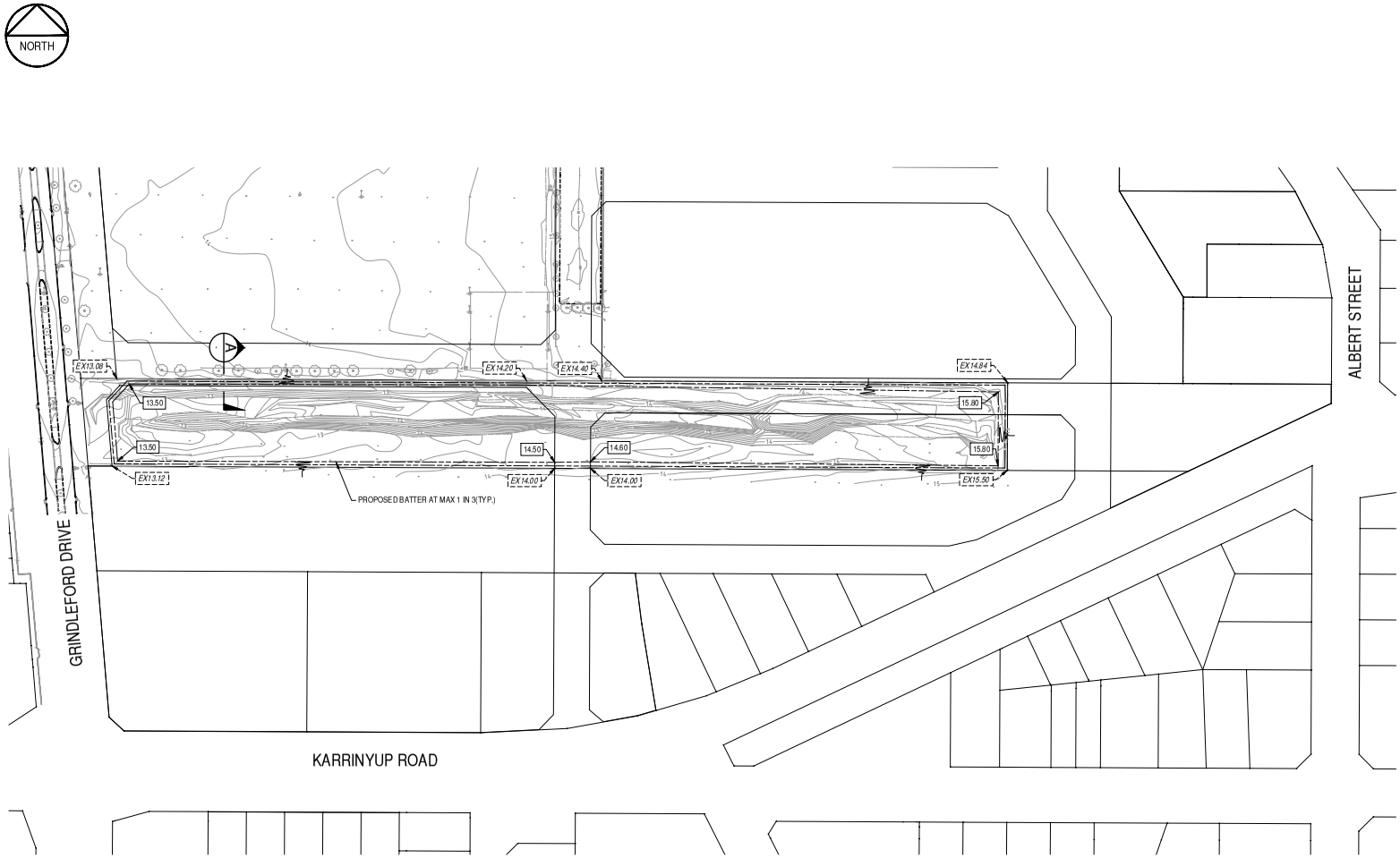
DESIGNED	DRAWN	CHECKED	APPROVED
DT	LL	DT	DT ..... / ...

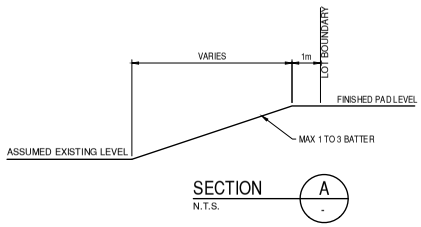
W.A.P.C. N/A | SCALE (at) O. 1:1000 @

CLIENT & JOB: PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

TITLE: PROPOSED RETAINING WALL & LEVELS - LOT 50/51

SHEET SIZE: A1 | DRG No.: 15029-C9-SK-07 | REVISION: A





SECTION A
N.T.S.

SCALE 1:1000 0m 20m 40m

DIAL BEFORE YOU DIG
www.1100.com.au
The Essential First Step.

NOTES

1. ALL DIMENSIONS SHOWN ARE IN METRES U.S.O.
2. ALL CO-ORDINATES AND LEVELS SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS.ANY DISCREPANCIES SHALL BE REPORTED TO THE SUPERINTENDENT WITH IN SEVEN DAYS.
3. SURVEY INFORMATION SUPPLIED BY MNG. SITE CONTROLS TO BE PROVIDED BY MNG.
4. ALL HEIGHTS ARE TO AUSTRALIAN HEIGHT DATUM (AHD) AND ALL LEVELS SHALL BE DERIVED FROM ESTABLISHED BENCHMARKS.
5. ALL BENCHMARKS ARE TO BE PROTECTED AND PRESERVED UNLESS NOTED ON PLANS.
6. FINISHED CONTOURS AND VOLUMES ARE TO ROAD BOXOUT.
7. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE SPECIFICATION AND ALSO THE REQUIREMENTS OF THE CITY OF STIRLING.
8. THE CONTRACTOR SHALL LIAISE WITH ALL RELEVANT AUTHORITIES TO LOCATE ALL EXISTING SERVICES WITHIN THE CONTRACT AREA PRIOR TO THE COMMENCEMENT OF WORK. SERVICES INFORMATION SHOWN ON THE DRAWINGS IS INDICATIVE ONLY AND MAY NOT BE COMPLETE. WHERE EXISTING AND PROPOSED WORKS CONFLICT, LEVELS ARE TO BE TAKEN AND SUPPLIED TO THE SUPERINTENDENT IMMEDIATELY.
9. CONTRACTOR SHALL OBTAIN COUNCIL APPROVAL AND PAY ALL FEES/BONDS PRIOR TO COMMENCEMENT OF WORKS.
10. CONTRACTOR SHALL NOTE THAT NON-TRAFFICABLE SUBTERRANEAN STRUCTURES (SOAKWELLS ETC.) MAY EXIST ON SITE. PRIOR TO EARTHWORKS COMMENCING, CONTRACTOR SHALL LOCATE ANY SOAKWELLS, SEPTIC TANKS, DELETERIOUS MATERIALS AND OTHER SUBTERRANEAN STRUCTURES. THESE MATERIALS AND STRUCTURES ARE TO BE REMOVED AND THE LOCATION BACKFILLED IN ACCORDANCE WITH PROCEDURES SET OUT IN SPECIFICATION (IF APPLICABLE). THE SUPERINTENDENT IS TO BE ADVISED OF ANY UNUSED PIPE WORK ENCOUNTERED.
11. THE CONTRACTOR SHALL PROVIDE TEMPORARY FENCING TO EXISTING LOTS AS REQUIRED.
12. THE CONTRACTOR SHALL PREPARE A DUST MANAGEMENT PLAN IN ACCORDANCE WITH THE DEPARTMENT OF ENVIRONMENT AND CONSERVATION (D.E.C.) GUIDELINES SITE CLASSIFICATION 3 AND OBTAIN APPROVAL FROM THE LOCAL AUTHORITY FOR THE DUST MANAGEMENT PLAN.
    DUST SUPPRESSION METHODS SHALL BE APPLIED BY THE CONTRACTOR DURING EARTHWORKS OPERATIONS IN ACCORDANCE WITH THE APPROVED MANAGEMENT PLAN.
13. NO CLEARING TO OCCUR UNTIL SUPERINTENDENT HAS IDENTIFIED TREES TO BE RETAINED.
    13a. ALL TREES TO BE RETAINED SHALL BE FENCED OFF FOR THE DURATION OF THE WORKS.
    13b. ALL TREES AND VEGETATION NOT FOR RETENTION SHALL BE MULCHED AND STOCKPILED FOR REUSE OR REMOVAL AS NOTED.
14. THE CONTRACTOR SHALL MAINTAIN PROPER SITE DRAINAGE TO ALL AREAS THROUGHOUT THE CONSTRUCTION PERIOD AND SHALL BE RESPONSIBLE FOR MAINTAINING EXCAVATIONS IN A SAFE AND STABLE CONDITION AT ALL TIMES.
15. TOPSOIL IS TO BE STRIPPED AND MANAGED IN ACCORDANCE WITH THE SPECIFICATION OR AS NOTED ON THE DRAWINGS.
16. ALL ROOTS, BOULDERS AND ANY OTHER DELETERIOUS MATERIAL SHALL BE TOTALLY REMOVED TO A DEPTH OF 600mm BELOW THE LOWER OF THE NATURAL/CUT SURFACE.
17. MINOR AMENDMENTS TO THE EXTENT OF EARTHWORKS MAY OCCUR TO PRESERVE IDENTIFIED TREES.
18. ALL BATTERS TO BE NOMINALLY 1 IN 3, OR FLATTER, UNLESS SHOWN OTHERWISE (U.S.O.).
19. ALL FILL SHALL BE CLEAN AND BE FREE FROM DELETERIOUS AND/OR ORGANIC MATERIAL.
20. FILL MATERIAL TO BE TESTED BY A REGISTERED MATERIALS TESTING LAB AND RESULTS PROVIDED TO THE SUPERINTENDENT PRIOR TO THE IMPORTATION AND PLACEMENT OF MATERIAL.
21. PENETROMETERS USED FOR TESTING MUST BE CALIBRATED FOR SITE AND RECALIBRATED FOR IMPORTED FILL AS REQUIRED.
22. ALL FILL SHALL BE PLACED IN UNIFORM LAYER NOT EXCEEDING 300mm THICKNESS AND COMPACTED TO A DENSITY NOT LESS THAN 95% M.M.D.D. REFER TO SPECIFICATION FOR DETAILED INFORMATION.
23. CONTRACTOR TO COMPLETE ALL BACKFILLING AND EARTHWORKS REQUIRED TO ACHIEVE LEVELS SHOWN.
24. THE SITE IS TO BE LEFT CLEAN AND FREE OF RUBBISH/DEBRIS UPON COMPLETION OF WORKS.
25. TIE INTO ADJACENT BOUNDARIES AND FEATURES TO BE SEAMLESS.
26. 'AS CONSTRUCTED' DRAWINGS ARE TO BE PREPARED IN ACCORDANCE WITH THE SPECIFICATION AND PROVIDED TO THE SUPERINTENDENT PRIOR TO PROCEEDING TO THE NEXT STAGE OF WORKS.

LEGEND

- EDGE OF BATTER
- EXISTING SURFACE CONTOUR
- EX12.10 — ASSUMED EXISTING LEVEL
- 12.10 — DESIGN LEVEL
- PROPOSED BATTER

REV	DATE	DESCRIPTION	BY	CHKR
A	27/10/17	FOR INFORMATION ONLY	LL	DT

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
OCTOBER 2017	PCG94	AHD

DESIGNED	DRAWN	CHECKED	APPROVED
DT	LL	DT	DT ..... / ...

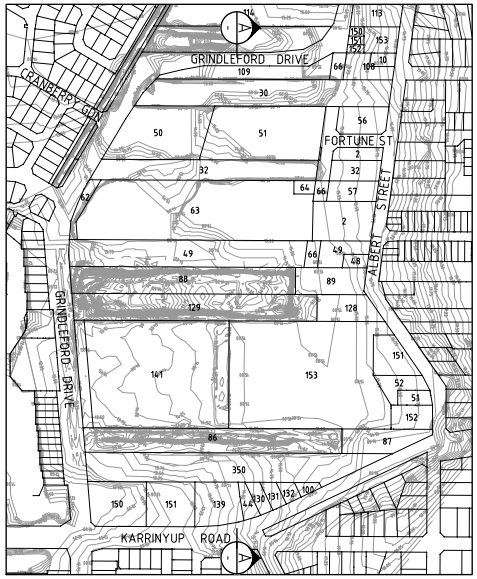
W.A.P.C.: N/A
SCALE (at) O.: 1:1000 @

CLIENT & JOB: PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

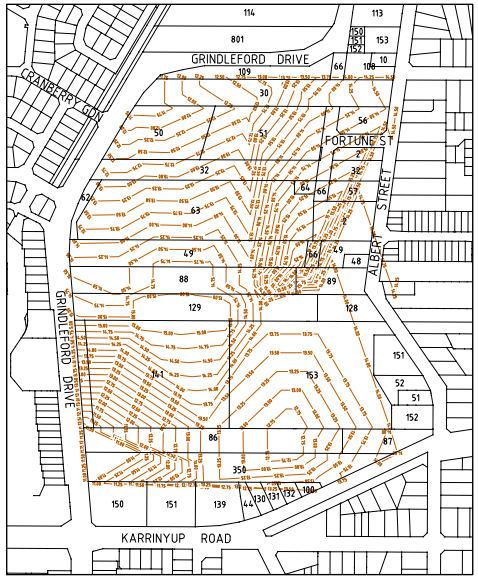
TITLE: PROPOSED RETAINING WALL & LEVELS - LOT 86

SHEET SIZE: A1
DRG No.: 15029-C9-SK-08
REVISION: A

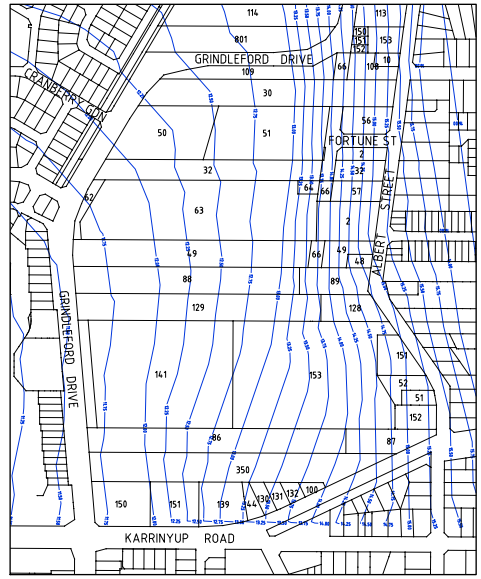
appendix three: existing topography



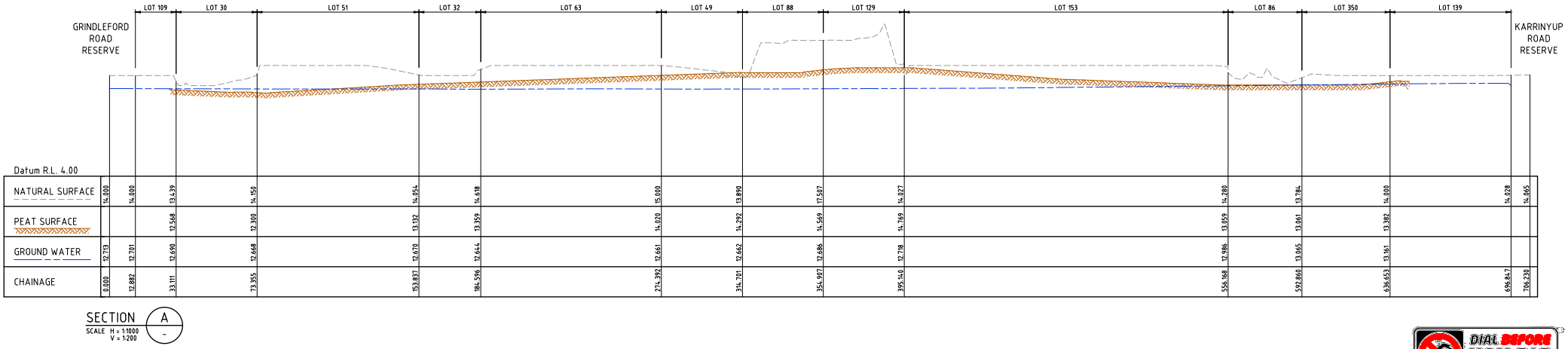
SITE PLAN
NATURAL SURFACE CONTOURS
1:2000



SITE PLAN
PEAT SURFACE CONTOURS
1:2000



SITE PLAN
GROUND WATER CONTOURS
1:2000



SECTION A
SCALE H = 1:1000
V = 1:200

4m 0m 4m 8m
1:200
20m 0m 20m 40m
1:1000
80m 0m 80m 160m
1:4000

REV	BY	CHK	DATE	DESCRIPTION
A	JAS	MRi	21/04/16	ISSUED FOR INFORMATION ONLY

NOT FOR CONSTRUCTION

pritchard francis
Telephone: (08) 9382 5111

SCALE (UNO)	AS SHOWN
DATE	APRIL 2016
DESIGNED	-
DRAWN	JAS
CHECKED	MRi
HORIZONTAL COORDINATE SYSTEM	PCG94
VERTICAL COORDINATE SYSTEM	AHD

CLIENT & JOB: ABN GROUP
LOT 88, 129, 141 AND 86 GRINDLEFORD DRIVE, BALCATTA
TITLE: EXISTING SITE CONTOURING PLAN

SHEET SIZE	DRG No.	REVISION
A1	15029-C9-SK-01	A

appendix four: water corporation and city of stirling drainage requirements

Denise Tyler-Hare

From: Simon Ridgewell <Simon.Ridgewell@watercorporation.com.au>
Sent: Monday, 28 August 2017 10:02 AM
To: Denise Tyler-Hare
Subject: RE: Grindleford Dr Balcatta - Planning Information Pack

Hi Denise,

If you are able to demonstrate the minimal impact, this proposal would need submitted, and would be considered as part of the UWMP.

Best Regards

Simon Ridgewell
Coordinator – Land Servicing
Development Services Branch

E: Simon.Ridgewell@watercorporation.com.au
T: (08) 9420 2775
A: 629 Newcastle Street, Leederville, WA 6007
P: PO Box 100, Leederville, WA 6902

Keep in touch **W:** watercorporation.com.au

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Friday, 25 August 2017 10:30 AM
To: Simon Ridgewell
Cc: Justine Jones (JustineJones@360environmental.com.au)
Subject: RE: Grindleford Dr Balcatta - Planning Information Pack

Hi Simon,

Thanks for the below. Could I ask whether it would be possible to discharge into the lake system, if we can demonstrate a minimal impact on levels?

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Simon Ridgewell [mailto:Simon.Ridgewell@watercorporation.com.au]
Sent: Thursday, 17 August 2017 8:59 AM
To: Denise Tyler-Hare <denise.t@pfeng.com.au>
Subject: RE: Grindleford Dr Balcatta - Planning Information Pack

Good Morning Denise,

We have received advice back from our drainage department with regards to the Drainage associated with the potential development mentioned above.

The development site is located completely within the Albert St Branch Drain which forms part of the Herdsman Main Drain System. All the planning for this potential development area, is based on Rural zoning for the subject area, therefore al the proposed development should limit the post development flows to that of the predevelopment levels. This would require the development to incorporate local drainage strategies including, but not limited to, soak wells, retention/detention tanks, basins prior to discharging stormwater flows into the Water Corporation/Local Authority drains.

The Water Corporation will have to assess the local drainage strategy for its adequacy before approving the development.

Best Regards

Simon Ridgewell
Coordinator – Land Servicing
Development Services Branch

E: Simon.Ridgewell@watercorporation.com.au
T: (08) 9420 2775
A: 629 Newcastle Street, Leederville, WA 6007
P: PO Box 100, Leederville, WA 6902

Keep in touch **W:** watercorporation.com.au

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Thursday, 10 August 2017 2:26 PM
To: Simon Ridgewell
Subject: RE: Grindleford Dr Balcatta - Planning Information Pack

Thanks Simon,

Can you please send through any information (catchments, calculations, regulations) on the drainage in this area?

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Simon Ridgewell [mailto:Simon.Ridgewell@watercorporation.com.au]
Sent: Thursday, 10 August 2017 1:58 PM
To: Denise Tyler-Hare <denise.t@pfeng.com.au>
Subject: Grindleford Dr Balcatta - Planning Information Pack

Good Afternoon Denise,

Please find attached he planning information pack for the abovementioned proposed development.

Should you have any questions about anything, please do not hesitate to contact me.

Best Regards

Simon Ridgewell
Water Supply Reticulation Planner
Development Services Branch

E: Simon.Ridgewell@watercorporation.com.au

T: (08) 9420 2775

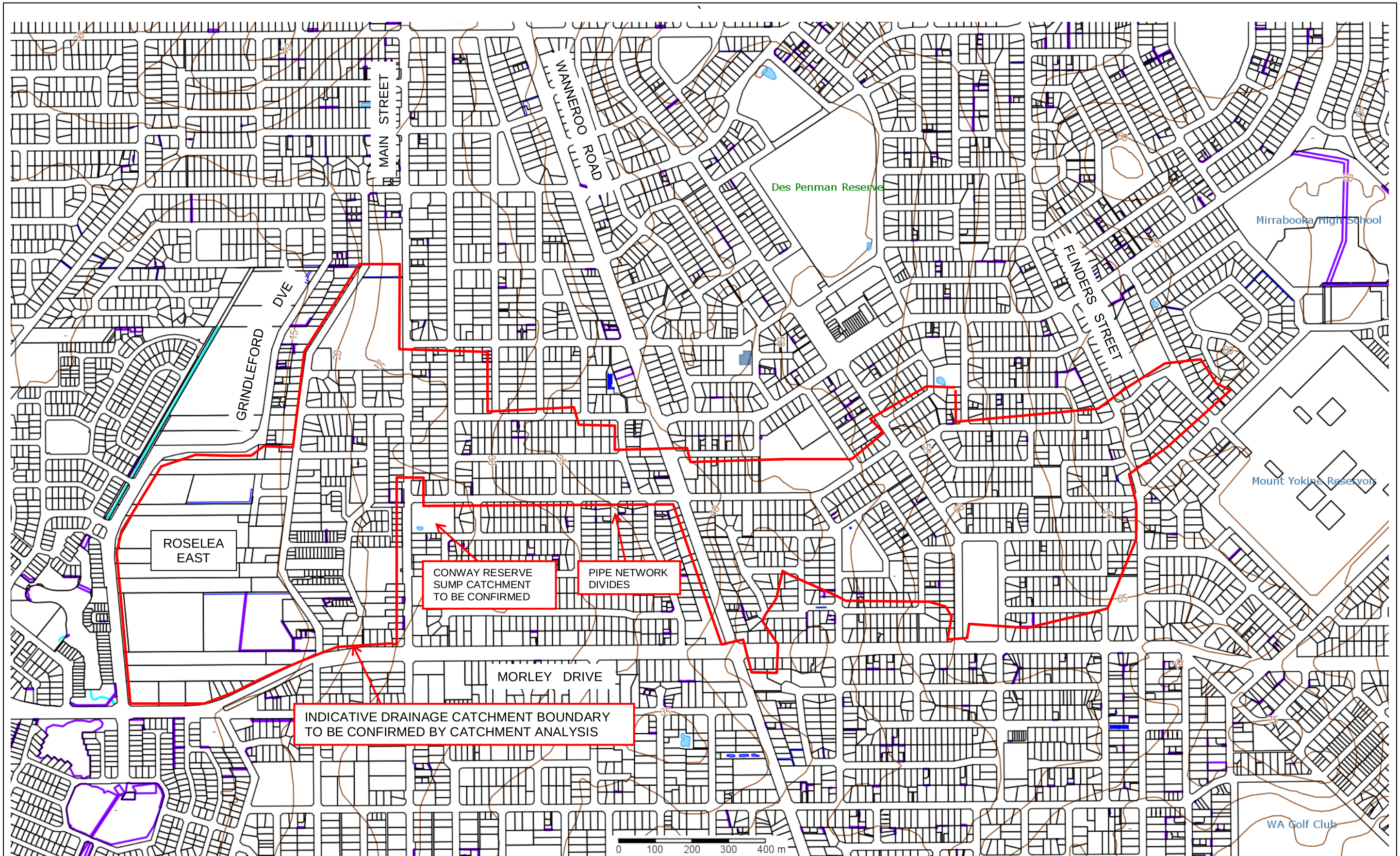
A: 629 Newcastle Street, Leederville, WA 6007

P: PO Box 100, Leederville, WA 6902

Keep in touch **W:** watercorporation.com.au

This Electronic Mail Message and its attachments are confidential. If you are not the intended recipient, you may not disclose or use the information contained in it. If you have received this Electronic Mail Message in error, please advise the sender immediately by replying to this email and delete the message and any associated attachments. While every care is taken, it is recommended that you scan the attachments for viruses. This message has been scanned for malware by Websense. www.websense.com

Water Corporation E-mail - To report spam Click here



City of Stirling
City of Choice

City of Stirling does not warrant the accuracy of this information and any person using, or relying upon, such information does so on the basis that the City shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

Roselea East Structure Plan
Indicative Drainage Catchment Boundary

15/08/2017

1:10000

N

Denise Tyler-Hare

From: Mike Grove <Mike.Grove@stirling.wa.gov.au>
Sent: Wednesday, 16 August 2017 5:57 PM
To: Denise Tyler-Hare
Cc: Rainer Wolker; Daniel Heymans
Subject: RE: Roselea East Structure Plan
Attachments: Roselea East Drainage Catchment.pdf

Dear Ms Tyler-Hare

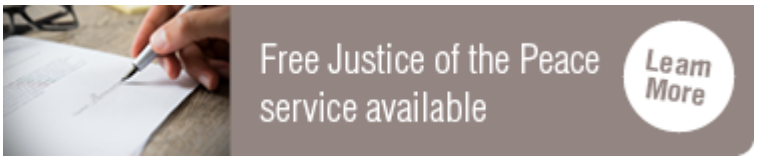
Attached please find the indicative catchment area plan referred to in my earlier email. Apologies for any inconvenience.

Regards

Mike Grove
Design Engineer - Drainage
Engineering Design

City of Stirling
City of Choice

Administration Centre 25 Cedric Street Stirling 6021 WA
Phone (08) 9205 8720 | **Mobile** | **Facsimile** (08) 9205 8822
Email Mike.Grove@stirling.wa.gov.au



From: Mike Grove
Sent: Wednesday, 16 August 2017 5:42 PM
To: Denise Tyler-Hare
Cc: Rainer Wolker; Daniel Heymans
Subject: Roselea East Structure Plan

Dear Ms Tyler-Hare

Thank you for your enquiry requesting information concerning existing drainage catchment data relevant to the proposed Roselea East Structure Plan development.

Further to my interim response of 10 August 2017 I can advise that the City does not have detailed catchment data or calculations for this area.

Attached for your information please find an indicative catchment area plan showing the Roselea East effective drainage catchment. Actual catchment boundaries may at some locations require confirmation by site inspection.

Details of the City's drainage networks for this area are available in MapInfo format if required. Should you require such data please confirm the area of interest and I will arrange for the data to be exported and forwarded to you.

The City's records indicate that the outfall for the attached catchment is via a DN900 pipe network installed in the late 1970's and early 1980's. The outfall discharges to the existing wetland area to the east of Grindleford Drive. At the time of installation this network would have discharged to the general swamp area located between Jones Street and Albert Street with runoff flowing overland to what was then the poorly defined Water Corporation Albert Street Brach Drain that flowed through the central region of the swamp.

The Albert Street Branch Drain has now been formalised in association with the existing Roselea Development. The main water body within the development is actually a Water Corporation stormwater drainage compensating basin. No provision was made as part of the current Roselea Development for future drainage connections. If such a connection is proposed to the Albert Street Branch Drain as part of the Roselea East structure plan, the approval of the Water Corporation will be a prerequisite.

The appropriate Water Management Strategy required by the Department of Water and Environmental Regulation (DWER) Better Urban Water Management will be required to accompany the proposed Roselea East Structure Plan. This Strategy will need to address the drainage issues. Due to the nature of the existing land, extensive post development geotechnical investigation and reporting will also be required. DWER review and endorsement of the Water Management Strategy will also be required.

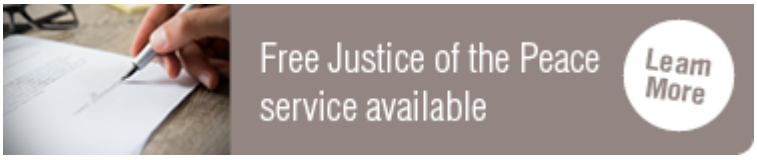
Should you require any additional information or clarification of any issues please do not hesitate to contact me.

Yours sincerely

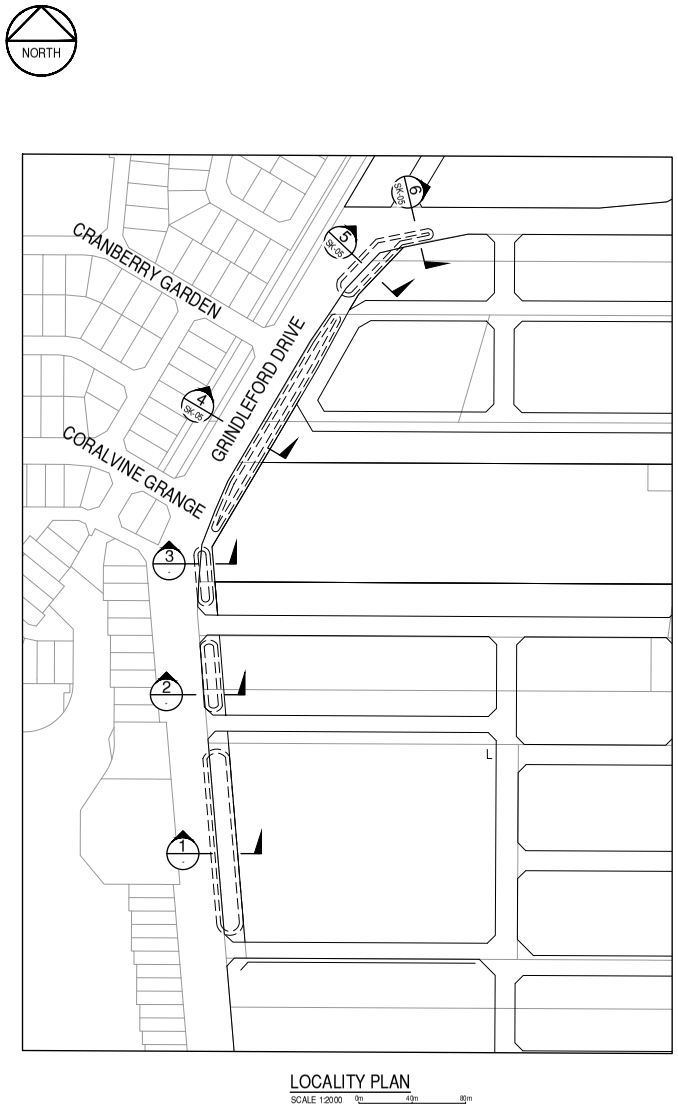
Mike Grove
Design Engineer - Drainage
Engineering Design

City of Stirling
City of Choice

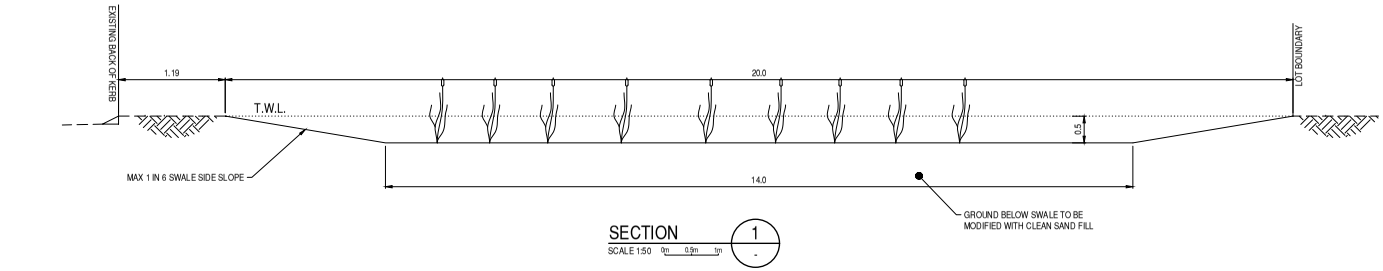
Administration Centre 25 Cedric Street Stirling 6021 WA
Phone (08) 9205 8720 **| Mobile | Facsimile** (08) 9205 8822
Email Mike.Grove@stirling.wa.gov.au



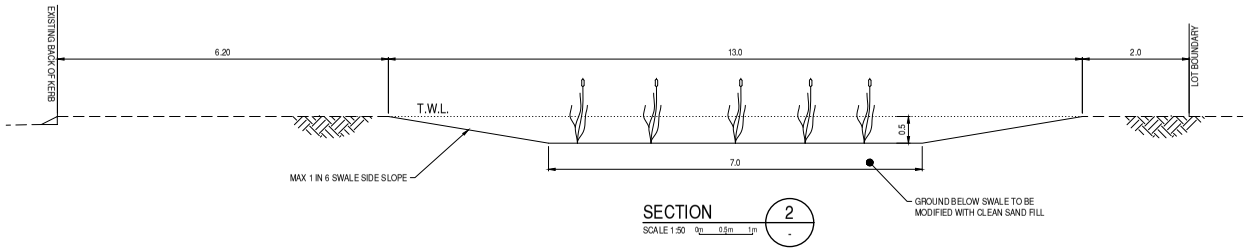
"The information transmitted is intended for the person or entity to which it is addressed and may contain confidential and/or privileged material.
Any review, retransmission, dissemination, copying or other use of, or taking any action in reliance upon, this information by persons or entities other than the intended recipient is prohibited.
If you have received this in error, please contact the sender and delete the material from your system.
The City of Stirling is not responsible for any changes made to the material other than those made by the City of Stirling or for the effect of the changes on the material's meaning."



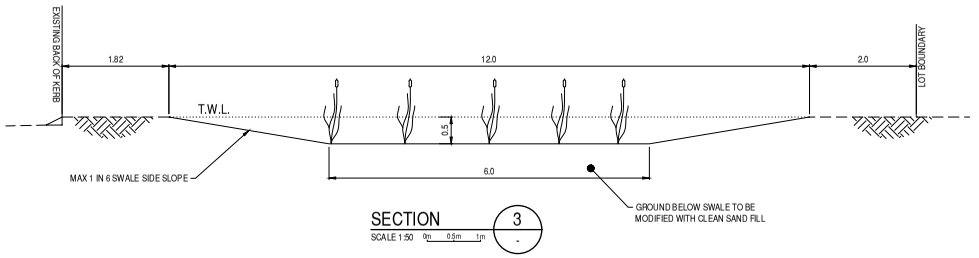
LOCALITY PLAN
SCALE 1:2000 0m 40m 80m



SECTION 1
SCALE 1:50 0m 0.5m 1m



SECTION 2
SCALE 1:50 0m 0.5m 1m



SECTION 3
SCALE 1:50 0m 0.5m 1m

NOTE

ROAD RESERVE BOUNDARY AND EXISTING ROAD TO BE CONFIRMED WITH ADDITIONAL FEATURE SURVEY

DIAL BEFORE YOU DIG
www.1100.com.au
The Essential First Step.

REV	DATE	DESCRIPTION	BY	CHKR
B	06/02/18	SWALES AMENDED TO SUIT PRECAL	JS	CXD
A	16/10/17	FOR INFORMATION ONLY	LL	DT

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION
DATE: OCTOBER 2017
GRID: PCG94
DATUM: AHD
DESIGNED: DT
DRAWN: LL
CHECKED: DT
APPROVED: DT ...../...../.....
W.A.P.C: N/A
SCALE (@ O: AS SHOWN @
SHEET SIZE: A1

CLIENT & JOB: PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

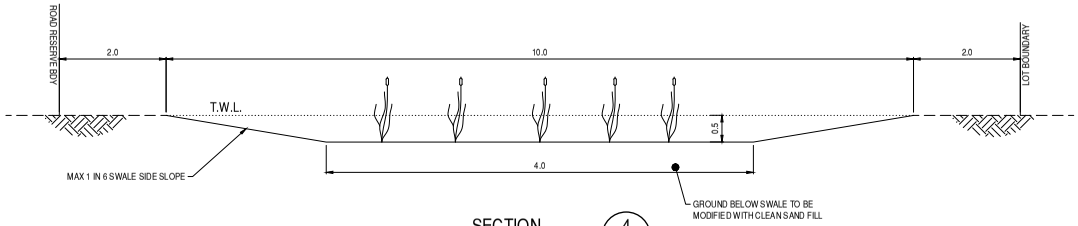
TITLE: PROPOSED SWALE DETAILS
SHEET 1 OF 2

DRG No: 15029-C9-SK-04

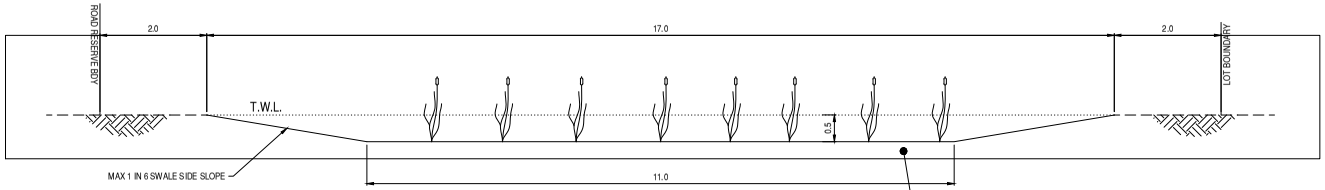
REVISION: B

NOTE

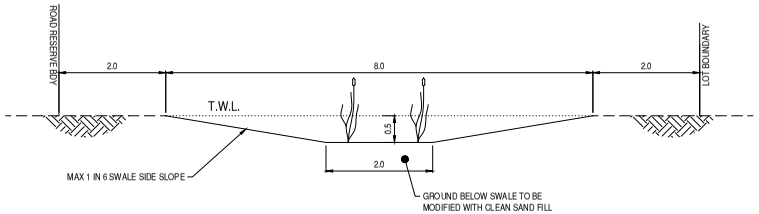
ROAD RESERVE BOUNDARY AND EXISTING ROAD TO BE CONFIRMED WITH ADDITIONAL FEATURE SURVEY



SECTION 4 SK-04
SCALE 1:50 0m 0.9m 1m



SECTION 5 SK-04
SCALE 1:50 0m 0.9m 1m



SECTION 6 SK-04
SCALE 1:50 0m 0.9m 1m

SCALE 1:1000 0m 20m 40m

DIAL BEFORE YOU DIG 1100 www.1100.com.au The Essential First Step.

REV	DATE	DESCRIPTION	BY	CHKR
B	06/02/18	SWALES AMENDED TO SUIT PRECAL	JS	CXD
A	16/10/17	FOR INFORMATION ONLY	LL	DT

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
OCTOBER 2017	PCG94	AHD

DESIGNED	DRAWN	CHECKED	APPROVED
DT	LL	DT	DT ...../...../.....

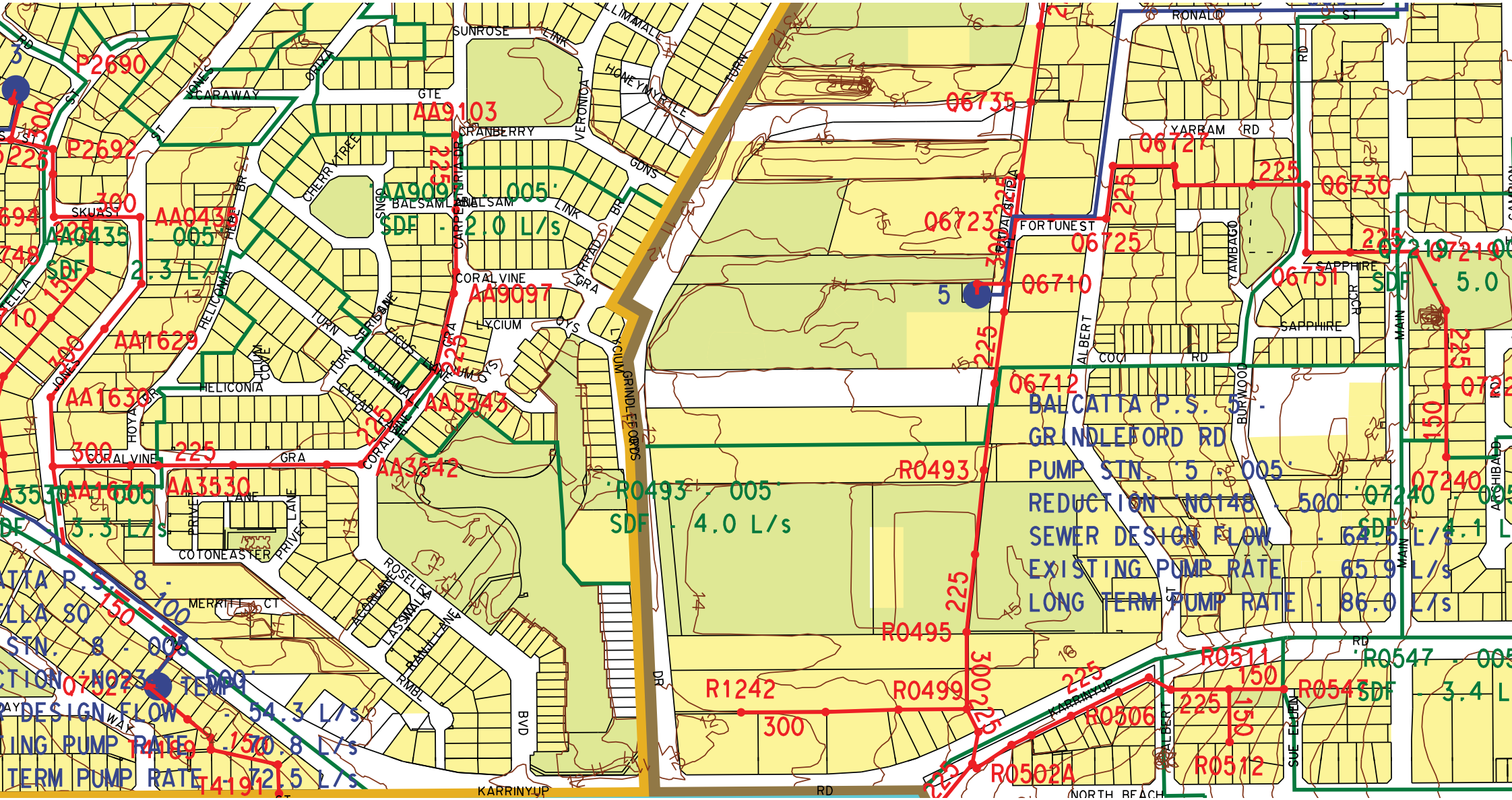
W.A.P.C. N/A | SCALE (UNLESS OTHERWISE STATED) 1:50 @ | SHEET SIZE A1

CLIENT & JOB: PARCEL PROPERTY GRINDLEFORD DRIVE, BALCATTA

TITLE: PROPOSED SWALE DETAILS SHEET 2 OF 2

DRG No. 15029-C9-SK-05 | REVISION B

appendix five: water corporation planning information pack


P2690
P2692
AA0435 - 005
SDF - 2.3 L/s
AA1629
AA1630
AA1631
AA3530
AA3543
AA3542
AA9103
AA9097 - 005
SDF - 2.0 L/s
R0493 - 005
SDF - 4.0 L/s
06735
06727
06730
06723
06725
06710
06731
06712
BALCATTA P.S. 5 -
GRINDLEFORD RD
PUMP STN. - 5 - 005
REDUCTION - N0148 - 500
SEWER DESIGN FLOW - 64.5 L/s
EXISTING PUMP RATE - 65.9 L/s
LONG TERM PUMP RATE - 86.0 L/s
R0493
R0495
R0499
R1242
R0502A
R0506
R0511
R0512
R0547 - 005
SDF - 3.4 L
07240 - 005
SDF - 4.1 L
07219
SDF - 5.0
SUNROSE LINK
CRANBERRY
BALSAM LINK
CORAL VINE
LYCIUM
HELICONIA
FORTUNE ST
SAPPHIRE
YARRAM RD
COCI RD
KARRINYUP RD
GRINDLEFORD
ALBERT
MAIN
ROSELEA
MERRITT CT
COTONEASTER
PRIVET LANE
RMBL
BLVD
NORTH BEACH

Rick Harrison

Digitally signed by Rick Harrison
DN: cn=Rick Harrison, o=Water Corporation, ou=Land Servicing, email=rick.harrison@watercorporation.com.au, c=AU
Date: 2017.08.10 08:46:11 +08'00'

Cranberry Gdns

Coralvine Gr

Grindleford Dr

Albert St

Karrinyup Rd

North Beach Dr

Group Housing

Community Facility

Community Facility

Public Open Space

Local Centre

R40-R60

R40-R60

R40-R60

R40-R60

R60-R80

R60-R80

R60-R80

R60-R80

R60-R80

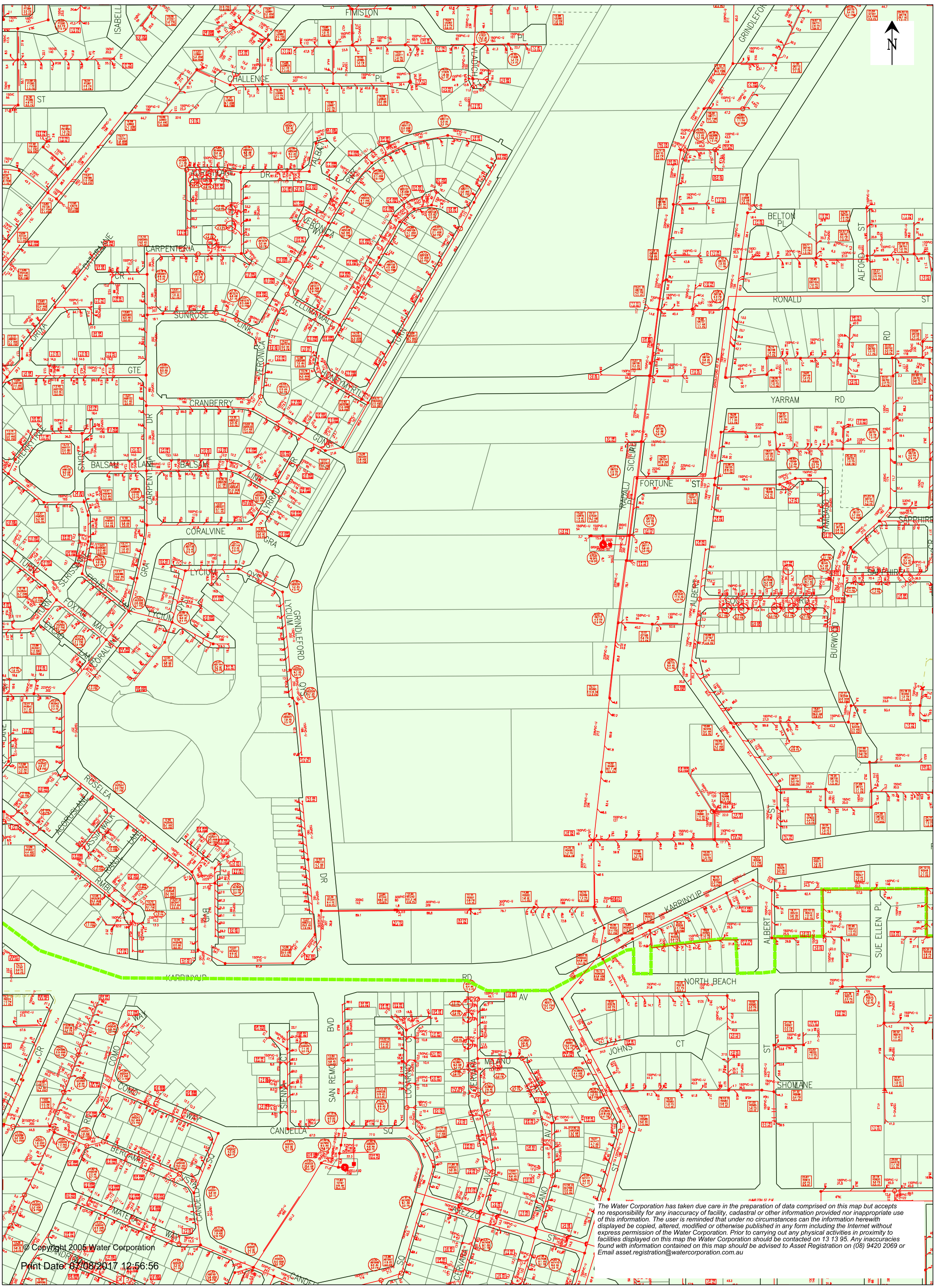
Zone Boundary

Existing/Proposed Distribution

Existing/Proposed DN 200

Existing/Proposed DN 150

Existing/Proposed DN 100 or smaller



© Copyright 2005 Water Corporation

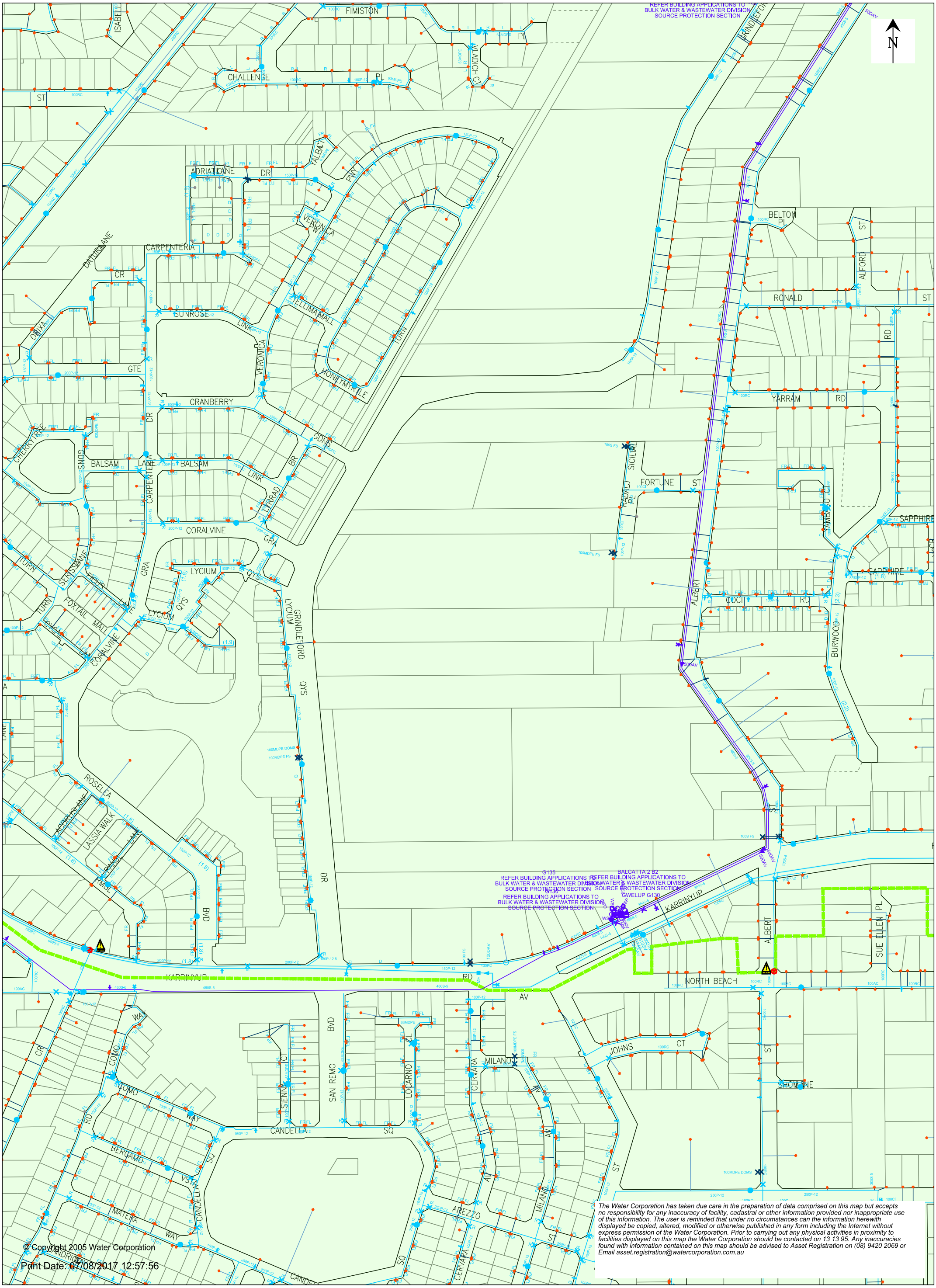
Print Date: 07/08/2017 12:56:56

The Water Corporation has taken due care in the preparation of data comprised on this map but accepts no responsibility for any inaccuracy of facility, cadastral or other information provided nor inappropriate use of this information. The user is reminded that under no circumstances can the information herewith displayed be copied, altered, modified or otherwise published in any form including the Internet without express permission of the Water Corporation. Prior to carrying out any physical activities in proximity to facilities displayed on this map the Water Corporation should be contacted on 13 13 95. Any inaccuracies found with information contained on this map should be advised to Asset Registration on (08) 9420 2069 or Email asset.registration@watercorporation.com.au

Scale 1:4000

0m 40m 80m 120m 160m 200m

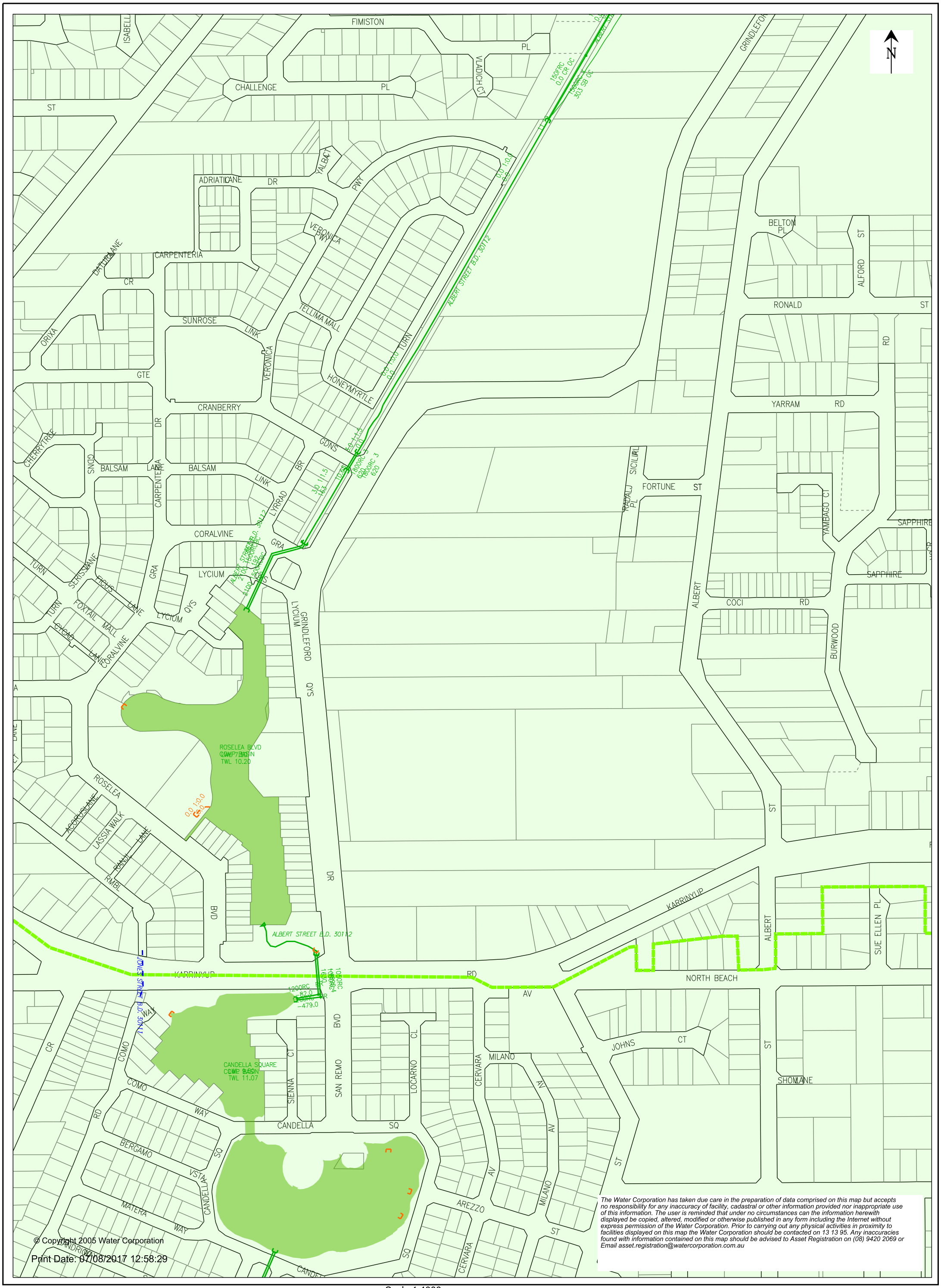
Projection: MGA Zone 50 (m)



Scale 1:4000

0m 40m 80m 120m 160m 200m

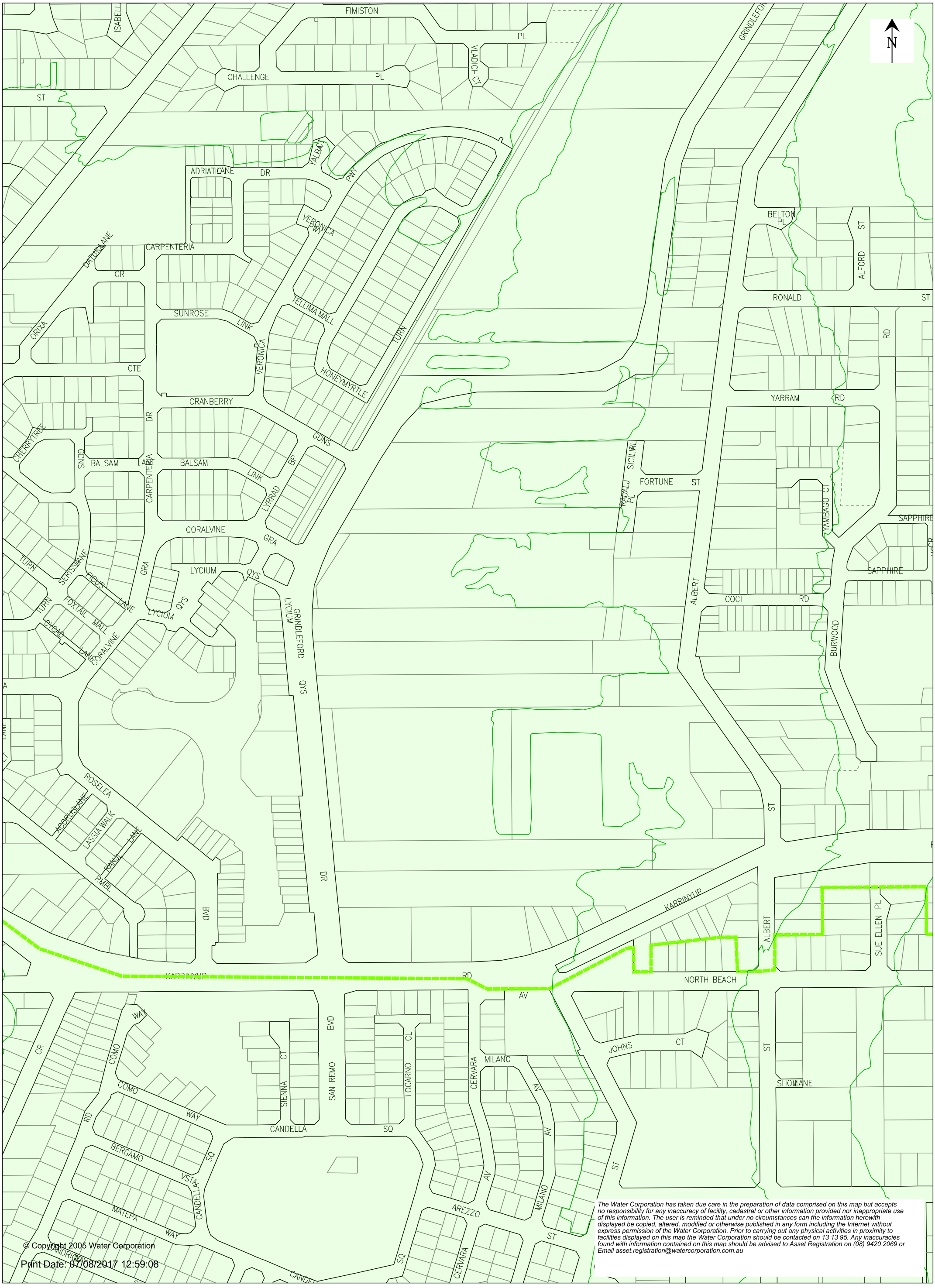
Projection: MGA Zone 50 (m)



Scale 1:4000

0m 40m 80m 120m 160m 200m

Projection: MGA Zone 50 (m)



© Copyright 2005 Water Corporation

Print Date: 07/08/2017 12:59:08

The Water Corporation has taken due care in the preparation of data comprised on this map but accepts no responsibility for any inaccuracy of facility, cadastral or other information provided nor inappropriate use of this information. The user is reminded that under no circumstances can the information herewith displayed be copied, altered, modified or otherwise published in any form including the Internet without express permission of the Water Corporation. Prior to carrying out any physical activities in proximity to facilities displayed on this map the Water Corporation should be contacted on 13 13 95. Any inaccuracies found with information contained on this map should be advised to Asset Registration on (08) 9420 2069 or Email asset.registration@watercorporation.com.au

Scale 1:4000

0m 40m 80m 120m 160m 200m

Projection: MGA Zone 50 (m)

appendix six: atco gas communication

DIAL BEFORE YOU DIG
www.1100.com.au

Main extension for Roselea east

N

25
604 D1
23 PLS
605 D1
21
606 D1
19 - 153 PLS
607 D1
17
608 D1
15 PLS
609 D1
13
610 D1
11 PLS
611 D1
9
612 D1
7 PLS
613 D1
5
615 D1 PLS
3
616 D1
1
804
115 - 157
150
732
151
1 - 7
734
139
736
86
120
350
764
130 D
1 - 4
742
44 D4
740 - 740D
BALCATTA
STIRLING (C)
STIRLING
VESTIA WALK
63 PE 1.5 MP 70kPa
GRINDLEFORD DR
EoM CoD
SV
40PVC
KARRINYUP RD
14633
OLS D1
644 OLS D1
26
645 D1
24
646 D1
22
647 D1
20
648 C1
1338 D1
4
1337 D1
6
1342 D1
7
CERVARA AVE

Operator: WNG\selsheik Printed from GNIS at: Aug 31, 2017 9:59:20 AM
Scale = 1: 955
Map Centre: E: 388,488.002 N: 6,471,195.111 GDA94 MGA Zone 50

WARNING BEWARE
The location of pipes and services are approximate only, and show an indicative position at time of construction.

No guarantee can be given to the accuracy or completeness of information due to the age of some pipes and records.

Refer to "Occupational Safety & Health" and Utility Providers "Code of Practice" for further useful information.

© ATCO Gas Australia Pty Ltd ABN 90 089 531 975

WARNING

HIGH PRESSURE GAS PIPELINE IN THE VICINITY

No excavation permitted without the prior approval of ATCO Gas Australia

PHONE 1300 926 755

© Western Australian Land Information Authority trading as Landgate
Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate

Denise Tyler-Hare

From: Drawing Office <drawing.office@atcogas.com.au>
Sent: Friday, 1 September 2017 10:28 AM
To: Denise Tyler-Hare
Cc: Drawing Office; Elsheikh, Sam; Whiteley, Danielle
Subject: FW: [15-029] Roselea East - local structure plan
Attachments: High Pressure A3 Landscape.pdf

Hi Denise, please find attached comments.

Hope this helps

Regards

Lewis Searle

GNIS Draftsperson
Telephone: (08) 6163 5160

ATCO Gas AUSTRALIA | Connecting WA to natural gas

www.atcogas.com.au

81 Prinsep Road, Jandakot, Western Australia, 6164GNIS Draftsperson
Telephone: (08) 6163 5160

From: Asset Services
Sent: Thursday, 31 August 2017 10:00 AM
To: Searle, Lewis
Cc: Drawing Office; Whiteley, Danielle
Subject: RE: [15-029] Roselea East - local structure plan

Good morning Lewis,

This is in regards supplying Roselea East project with natural gas. By using the following assumptions:

- MP Metro
- Approximately 700 standard domestic customers.
- MLP North Metro

Results:

MP has the capacity to supply 700 standard domestic customers at the proposed location through a main extension of DN150

Please let me know if you require any additional information or have any questions.

Kind regards,
Sam Elsheikh
Hydraulic Modeller

ATCO Gas AUSTRALIA | Connecting WA to natural gas

www.atcogas.com.au

81 Prinsep Road, Jandakot, Western Australia, 6164
Telephone: (08)6163 5109
Mobile: 0449825378

From: Searle, Lewis
Sent: Monday, 28 August 2017 2:49 PM
To: Asset Services; Elsheikh, Sam
Cc: Drawing Office
Subject: FW: [15-029] Roselea East - local structure plan

Hi Asset Services can you please assist client with enquiry, thanks.

Regards

Lewis Searle

GNIS Draftsperson
Telephone: (08) 6163 5160

ATCO Gas AUSTRALIA | Connecting WA to natural gas

www.atcogas.com.au

81 Prinsep Road, Jandakot, Western Australia, 6164GNIS Draftsperson

Telephone: (08) 6163 5160

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Monday, 28 August 2017 2:41 PM
To: Searle, Lewis
Subject: RE: [15-029] Roselea East - local structure plan - more info needed

Hi Lewis,

Sorry I don't have that information at the moment – we are only in the early feasibility stages, so we just need to kn
upgrades or whether the system is likely to have capacity.

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Searle, Lewis [mailto:Lewis.Searle@atcogas.com.au]
Sent: Monday, 28 August 2017 2:38 PM
To: Denise Tyler-Hare <denise.t@pfeng.com.au>
Subject: RE: [15-029] Roselea East - local structure plan - more info needed

Please supply specific information regarding nature of dwellings/facilities, anticipated gas consumption and any other pertine

also please include common trenching water plans and a CAD file in dgn/dwg format so that we might update our GIS with th

Many thanks

Regards

Lewis Searle

GNIS Draftsperson
Telephone: (08) 6163 5160

81 Prinsep Road, Jandakot, Western Australia, 6164GNIS Draftsperson

Telephone: (08) 6163 5160

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Monday, 28 August 2017 2:23 PM
To: Searle, Lewis
Subject: RE: [15-029] Roselea East - local structure plan

Hi Lewis,

Can I please have feedback on the below?

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Denise Tyler-Hare
Sent: Friday, 11 August 2017 8:27 AM

To: 'Searle, Lewis' <Lewis.Searle@atcogas.com.au>
Subject: [15-029] Roselea East - local structure plan

Hi Lewis,

I'm seeking comment on the attached proposed local structure plan with regard to ATCO's capacity to service the p
advise if there is sufficient capacity or whether any upgrades are required?

Denise Tyler-Hare
Project Leader - Civil
BE (Hons) BA MSc MIEAust CPEng NER

pritchard francis
Celebrating 40 years

T (08) 9382 5111 | E denise.t@pfeng.com.au | W www.pfeng.com.au
Level 1, 430 Roberts Road, Subiaco WA 6008 | PO Box 2150 Subiaco WA 6904

All emails sent from ATCO Gas Australia (and any attachments) are intended only for the addressee and may contai
privileged. If you are not the intended addressee, you may not use, disseminate or copy this information. If you have
notify ATCO Gas Australia immediately by return email and delete or destroy the email and attachments.

ATCO Gas Australia may collect personal information from you via email. For more information on how ATCO Ga
discloses your personal information, see our privacy policy at www.atcogas.com.au/privacy.

All emails sent from ATCO Gas Australia (and any attachments) are intended only for the addressee and may contai
privileged. If you are not the intended addressee, you may not use, disseminate or copy this information. If you have
notify ATCO Gas Australia immediately by return email and delete or destroy the email and attachments.

ATCO Gas Australia may collect personal information from you via email. For more information on how ATCO Ga
discloses your personal information, see our privacy policy at www.atcogas.com.au/privacy.

appendix seven: power servicing information

Denise Tyler-Hare

From: Jey Shivakumar <JShivakumar@3ece.com.au>
Sent: Thursday, 24 August 2017 1:44 PM
To: Denise Tyler-Hare; Brian Burton
Subject: RE: [15-029] Roselea East

Hi Denise,

The development area is fed by two separate zone substations. Balcatta to the north-west, and Yokine to the south-east. Approx. 3-4km away from the site. There are existing HV and LV network cables both underground and aerial around the site, from which multiple connection points can be obtained.

Balcatta Zone sub has approx. 20-25MVA of spare capacity, and Yokine has about 10-15MVA of spare capacity. So network capacity for this overall development won't be an issue.

Based on the existing infrastructure around the site, I wouldn't imagine any requirements for major network reinforcement works. At a rough estimate, I would allocate approx. $75k for minor network augmentation to shuffle load to free up some load on the local feeders. Other than that reticulation of power will be as per normal per-lot construction cost.

Initial Stage will be serviced by a transformer and switchgear off Gridleford Drive, ideally located on the northern side of POS 141.

The 2nd phase Lots 30 and 109, we might be able to feed the site off the existing LV network off both sides of the development. But worst case a small 315kVA transformer will need to be installed on site off, and existing switchgear in the development area to the west. Again the cost per lot will be as per normal per-lot construction cost. And for each phase, I would also include about $25k for WP for their quote.

And looking as the area as a whole, based on rough load for the area based on the lot yield provided in the document the whole area could be serviced by about 6 transformers (and 4 switchgears).

Would that be enough info Denise? Brian is preparing his information to send through ASAP.

Regards,

THANANJEYAN (JEY) SHIVAKUMAR
Director
BEng (Electrical & Electronic), MIEAust

3E CONSULTING ENGINEERS PTY LTD
Electrical Engineering Excellence

3E Consulting Engineers Pty Ltd
Phone: 08 **6314 9000** | Fax: 08 9325 3351 | Mob: +61 403 314 136

DISCLAIMER: This email and any attachments transmitted with it are confidential and may contain privileged or copyright information. If you are not the intended recipient you must not disclose or use the information contained in it. If you have received this email in error please notify us immediately by return email and delete the email and any attachments. Any personal views expressed by the sender may not necessarily reflect the views of the company.

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Thursday, 24 August 2017 9:36 AM

To: Jey Shivakumar; Brian Burton
Subject: RE: [15-029] Roselea East

Hi Guys,

Just wondering if you'd had a chance to look at the attached development? I'm trying to put some costings together, so anything you can help with would be great. For your info, the lots in particular Parcel are looking at developing and the order will be:

- Lots 49, 88 & 129 will be developed first as standard residential lots;
- Lots 30 and 109 (109 yet to be purchased) will be developed second as standard residential lots;
- Lot 86 will be divided into two parent titles (future commercial and residential) and sold separately – only earthworks are forecast to take place.

Thanks,

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Denise Tyler-Hare
Sent: Thursday, 10 August 2017 9:34 AM
To: 'JShivakumar@3ece.com.au' <JShivakumar@3ece.com.au>; Brian Burton <bburton@3ece.com.au>
Subject: [15-029] Roselea East

Hi Jey and Brian,

We are looking at the above structure plan for Parcel for an opportunities and constraints report and I was wondering whether you could provide some comment on both the power and comms capacity/servicing requirements/network upgrades/extensions?

Thanks,

Denise Tyler-Hare
Project Leader - Civil
BE (Hons) BA MSc MIEAust CPEng NER

pritchard francis
Celebrating 40 years

T (08) 9382 5111 | E denise.t@pfeng.com.au | W www.pfeng.com.au
Level 1, 430 Roberts Road, Subiaco WA 6008 | PO Box 2150 Subiaco WA 6904

appendix eight: communications servicing information

Denise Tyler-Hare

From: Jey Shivakumar <JShivakumar@3ece.com.au>
Sent: Monday, 28 August 2017 4:45 PM
To: Denise Tyler-Hare; Brian Burton
Cc: Renee Lance
Subject: RE: [15-029] Roselea East

Hi Denise,

Brian was away today, so I have spoken with one of the other Comms guys in the office, and we prepared the following break with the Parcel Property pieces of work.

NBNCo Charges:

	$ (incl GST)			
	Stage 1 (Central)	**Stage 2 (North)**	**Stage 3 (South)**	**Comments**
Option 1 - Total NBN Co Charges for Single Res, Super and Strata lots	60,200	22,000	11,800	Assumes the Developer develops the GH. $20K allowed for Backhaul, applie
Option 2 - Total NBN Co Charges for Single Res and Super lots	60,200	15,600	3,000	Assumes the Developer on-sells Super Backhaul, applies to Stage 1 only

Pit and Pipe Construction:

		Stage 1 (Central)		**Stage 2 (North)**		**Stage 3 (South)**	
	Unit Cost $	**Qty**	**Total (excl GST)**	**Qty**	**Total (excl GST)**	**Qty**	**Total (excl GST)**
Single res - green	800	67	53,600	26	20,800	5	4,000
Strata	600	0	0	16	9,600	22	13,200
Total			**53,600**		**30,400**		**17,200**

Regards,

THANANJEYAN (JEY) SHIVAKUMAR
Director
BEng (Electrical & Electronic), MIEAust

3E CONSULTING ENGINEERS PTY LTD
Electrical Engineering Excellence

3E Consulting Engineers Pty Ltd
Phone: 08 **6314 9000** | Fax: 08 9325 3351 | Mob: +61 403 314 136

DISCLAIMER: This email and any attachments transmitted with it are confidential and may contain privileged or copyright information. If you are not the intended recipient you must
received this email in error please notify us immediately by return email and delete the email and any attachments. Any personal views expressed by the sender may not necessarily re

---

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Monday, 28 August 2017 2:45 PM
To: Brian Burton
Cc: Jey Shivakumar; Renee Lance
Subject: RE: [15-029] Roselea East

Hi Brian,

I'm hoping to send the cost estimate today – any chance of getting the breakdown for this please?

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Denise Tyler-Hare
Sent: Friday, 25 August 2017 9:04 AM
To: Brian Burton <bburton@3ece.com.au>
Cc: Jey Shivakumar <JShivakumar@3ece.com.au>; Renee Lance <RLance@3ece.com.au>
Subject: RE: [15-029] Roselea East

Thanks Brian, would it be possible to get the costs broken down into the 3 stages please?

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Brian Burton [mailto:bburton@3ece.com.au]
Sent: Thursday, 24 August 2017 3:48 PM
To: Denise Tyler-Hare <denise.t@pfeng.com.au>
Cc: Jey Shivakumar <JShivakumar@3ece.com.au>; Renee Lance <RLance@3ece.com.au>
Subject: RE: [15-029] Roselea East

Hi Denise,

The Comms component…

Existing services within the development boundary are currently serviced from the Telstra Tuart Hill Exchange, some 1.9Km r
see DBYD attached. There is existing P100 conduit from Tuart Hill to the eastern side of the proposed development, which do
may be able to support the hauling of additional optical cable. Limited copper cable capacity exists to the east and the west o

The new development would fall within the NBN Co's Fixed Line Footprint, in which NBN Co deliver FTTP technology. NBN Co
broadband over the January to March 2018 timeframe and will most likely provide FTTN to existing home owners. Regardless
development, as Infrastructure Provider of Last Resort (IPOLR). Beyond March 2018, NBN Co must accept the new developme
for telecommunications infrastructure. The Developer has two obligations in relation to telecommunications, for new develo
and pipe, a requirement under Federal legislation. The second, is to provide telecommunications infrastructure, a requiremer
currently do not require the provision of telecommunications, as a condition of subdivision, although that may change in the
development of this size is likely to attract an NBN Co Backhaul Charge, which we expect would be charged on the basis of co
understand NBN Co's FAN is located. In our estimate of the Backhaul Charge we have assumed available conduit capacity for
NBN FAN. The final magnitude of the Backhaul Charge will depend on an assessment by the NBN Co Planners. Retail Service P
Doubleview POI, which then provides access and distribution to its parented FAN's.

If we assume that a mix of green and strata titles are developed, then costs for the overall development would be as follows:

	$ (incl GST)	
Option 1 - Total NBN Co Charges for Single Res, Super and Strata lots	**339,000**	Assumes the Developer d
Option 2 - Total NBN Co Charges for Single Res and Super lots	**206,600**	Assumes the Developer o

	Unit Cost $	Qty	Total (Excl GST)

Pit and Pipe Construction			
Single Res - green	800	311	248,800
Strata	600	331	198,600
Total			**447,400**

Stages 1, 2 and 3 costs would be proportioned in accordance with yield and based on the unit costs above. Please advise if yo
Titled lots were to increase, then the cost would rise accordingly. Please advise if you foresee a lower portion of Strata Titles.
excessive risk, from a communications perspective, in developing this tract of land, if anything, unit costs would be lower tha
Developers in the inner metro area.

Kind Regards,

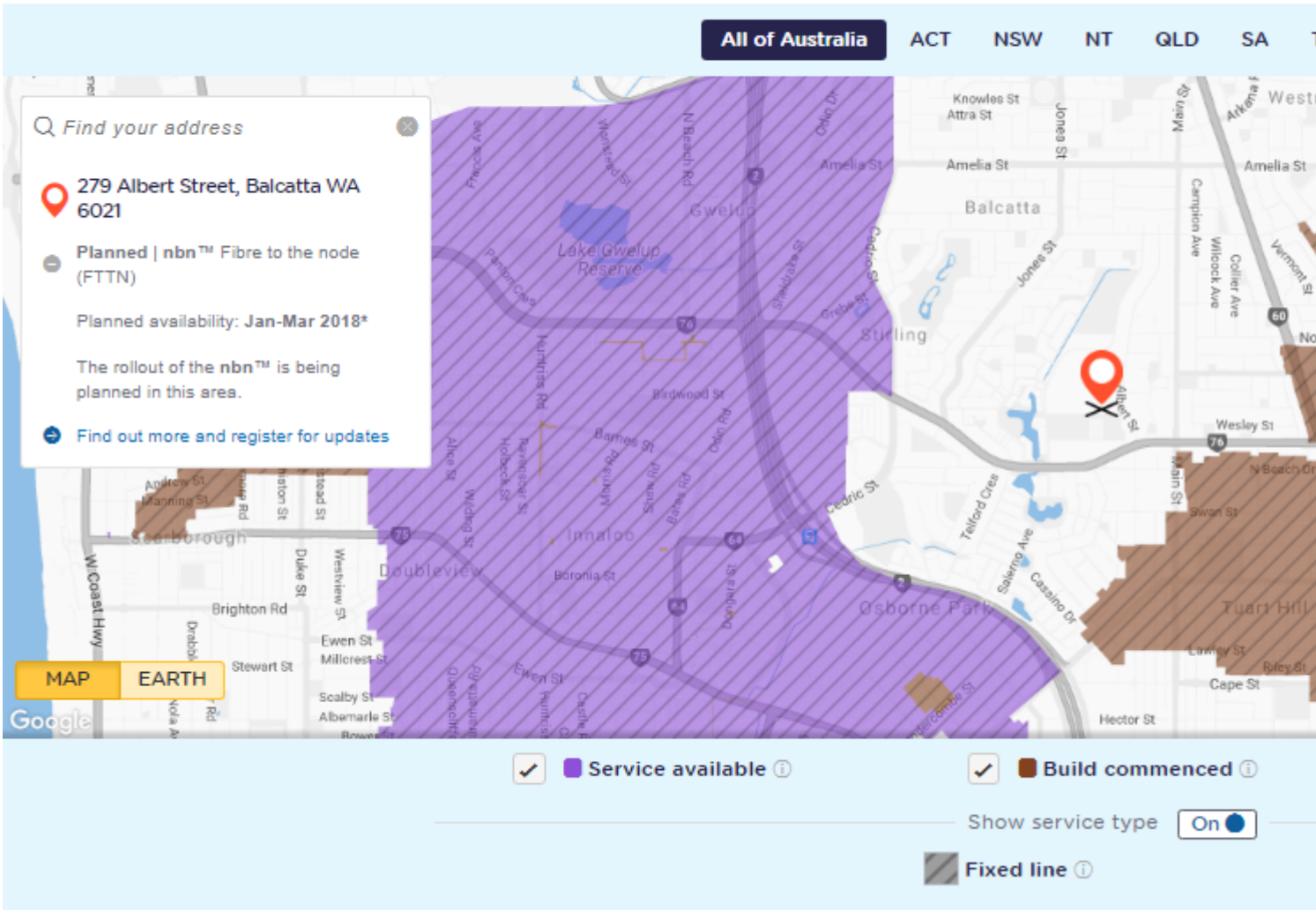
Brian Burton
Senior Communications Engineer
BEng (Electronics)

3E CONSULTING ENGINEERS PTY LTD
Electrical Engineering Excellence

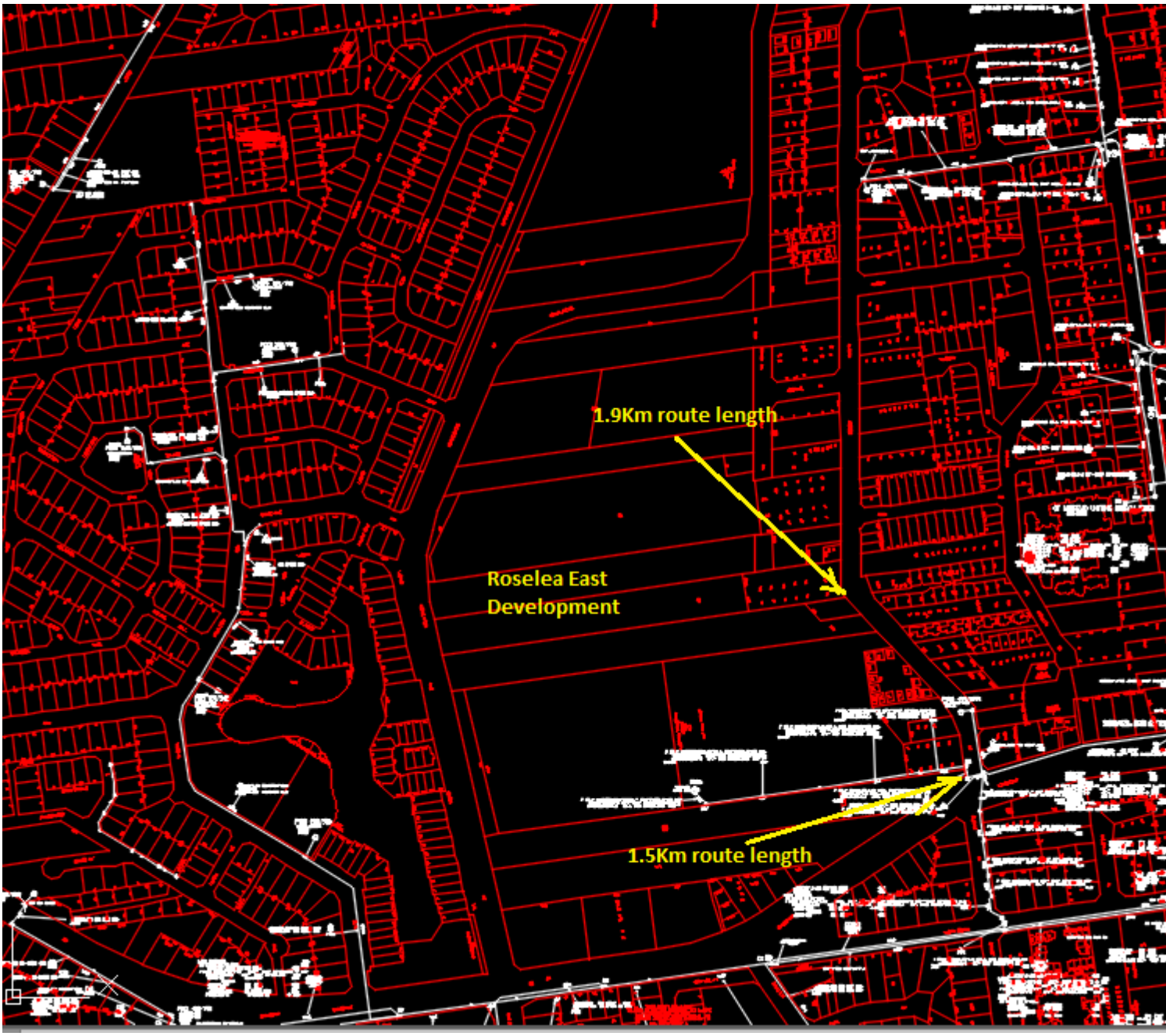
3E Consulting Engineers Pty Ltd
Suite 1, Level 2 Condor Tower, 22 St Georges Tce Perth WA 6000
PO Box 3184 East Perth WA 6892
Phone: 08 **6314 9000** | Fax: 08 9325 3351
Email: bburton@3ece.com.au | Web: www.3ece.com.au

DISCLAIMER: This email and any attachments transmitted with it are confidential and may contain privileged or copyright information. If you are not the intended recip
it. If you have received this email in error please notify us immediately by return email and delete the email and any attachments. Any personal views expressed by the s

NBN Rollout Map



Telstra Main Cable Network to Tuart Hill Exchange



From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]

Sent: Thursday, 24 August 2017 9:46 AM
To: Jey Shivakumar; Brian Burton
Subject: RE: [15-029] Roselea East

Thanks!

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Jey Shivakumar [mailto:JShivakumar@3ece.com.au]
Sent: Thursday, 24 August 2017 9:37 AM
To: Denise Tyler-Hare <denise.t@pfeng.com.au>; Brian Burton <bburton@3ece.com.au>
Subject: RE: [15-029] Roselea East

Heya Denise,
Sorry just been a bit hectic this last couple of weeks.
But will have a look at it today and get you something!!.

Regards,

THANANJEYAN (JEY) SHIVAKUMAR
Director
BEng (Electrical & Electronic), MIEAust

3E CONSULTING ENGINEERS PTY LTD
Electrical Engineering Excellence

3E Consulting Engineers Pty Ltd
Phone: 08 **6314 9000** | Fax: 08 9325 3351 | Mob: +61 403 314 136

DISCLAIMER: This email and any attachments transmitted with it are confidential and may contain privileged or copyright information. If you are not the intended recipient you must
received this email in error please notify us immediately by return email and delete the email and any attachments. Any personal views expressed by the sender may not necessarily re

---

From: Denise Tyler-Hare [mailto:denise.t@pfeng.com.au]
Sent: Thursday, 24 August 2017 9:36 AM

To: Jey Shivakumar; Brian Burton
Subject: RE: [15-029] Roselea East

Hi Guys,

Just wondering if you'd had a chance to look at the attached development? I'm trying to put some costings together great. For your info, the lots in particular Parcel are looking at developing and the order will be:

- Lots 49, 88 & 129 will be developed first as standard residential lots;
- Lots 30 and 109 (109 yet to be purchased) will be developed second as standard residential lots;
- Lot 86 will be divided into two parent titles (future commercial and residential) and sold separately – only earthworks

Thanks,

Denise Tyler-Hare
Project Leader - Civil
Pritchard Francis | T (08) 9382 5111

From: Denise Tyler-Hare
Sent: Thursday, 10 August 2017 9:34 AM
To: 'JShivakumar@3ece.com.au' <JShivakumar@3ece.com.au>; Brian Burton <bburton@3ece.com.au>
Subject: [15-029] Roselea East

Hi Jey and Brian,

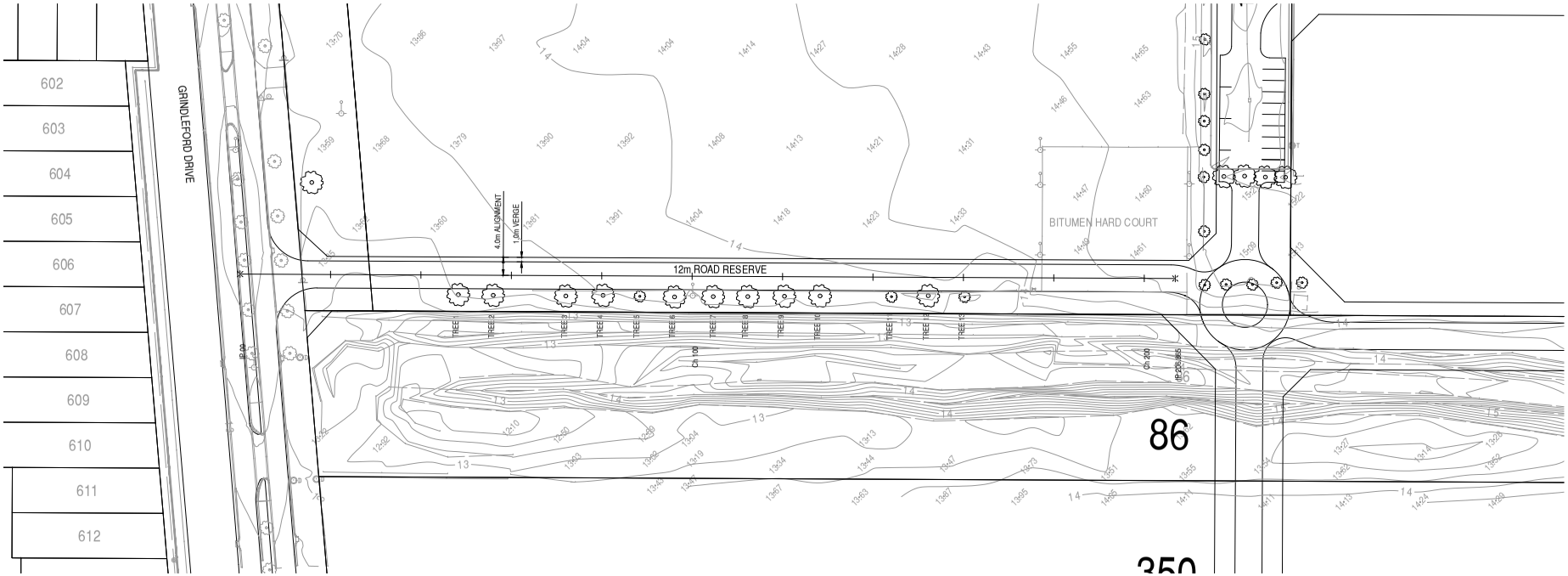
We are looking at the above structure plan for Parcel for an opportunities and constraints report and I was wonderin comment on both the power and comms capacity/servicing requirements/network upgrades/extensions?

Thanks,

Denise Tyler-Hare
Project Leader - Civil
BE (Hons) BA MSc MIEAust CPEng NER

pritchard francis
Celebrating 40 years

appendix nine: preliminary detailed sections



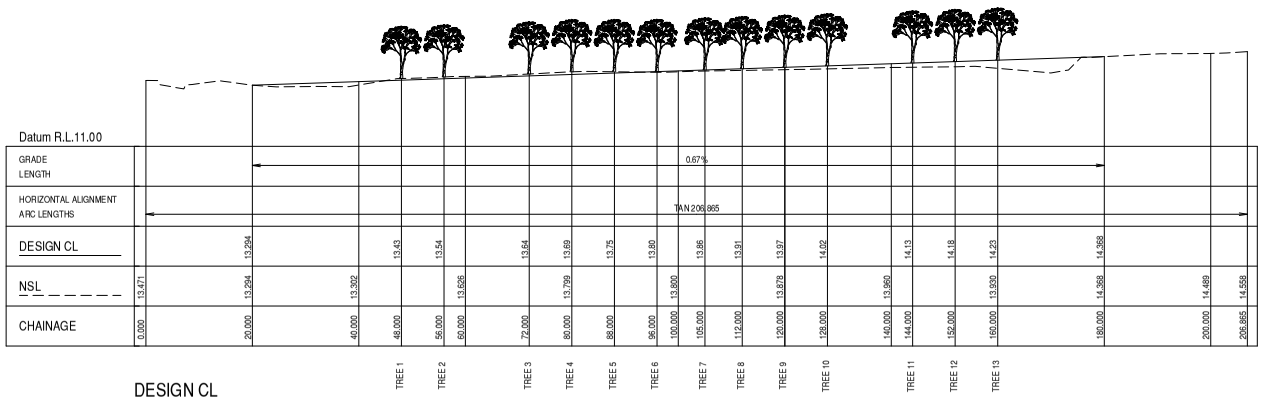
	TREE 1	TREE 2	TREE 3	TREE 4	TREE 5	TREE 6	TREE 7	TREE 8	TREE 9	TREE 10	TREE 11	TREE 12	TREE 13
VERT. CLEAR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HORIZ. CLEAR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
TREE RL (m)	13.52	13.56	13.70	13.75	13.82	13.85	13.89	13.93	13.78	13.92	13.92	14.08	13.43

NOTE:
HORIZONTAL CLEARANCE = 1.0m CLEARANCE FROM FACE OF KERB TO TRUNK CENTRE

VERTICAL CLEARANCE = 0.4m MAX LEVEL DIFFERENCE FROM TRUNK RL TO ROAD CENTERLINE LEVEL

ROAD CENTRELINE IS BASED ON A 7.2m ALIGNMENT FROM NORTHERN PROPERTY BOUNDARY

✓ TREE CAN BE MAINTAINED
✗ TREE CAN TO BE REMOVED



DESIGN CL
SCALE HOR 1:500
VER 1:100

SCALE 1:500 0m 10m 20m
SCALE 1:100 0m 2m 4m

DIAL BEFORE YOU DIG www.1100.com.au The Essential First Step.

REV	DATE	DESCRIPTION	BY	CHKR
B	12/04/18	AMENDED ROAD RESERVE - ISSUED FOR INFORMATION	MFC	CJ
A	19/09/17	ISSUED FOR INFORMATION	JS	CJ

pritchard francis
civil and structural engineering consultants
Level 1, 430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING STATUS: NOT FOR CONSTRUCTION

DATE	GRID	DATUM
SEPT. 2017	PCG94	AHD

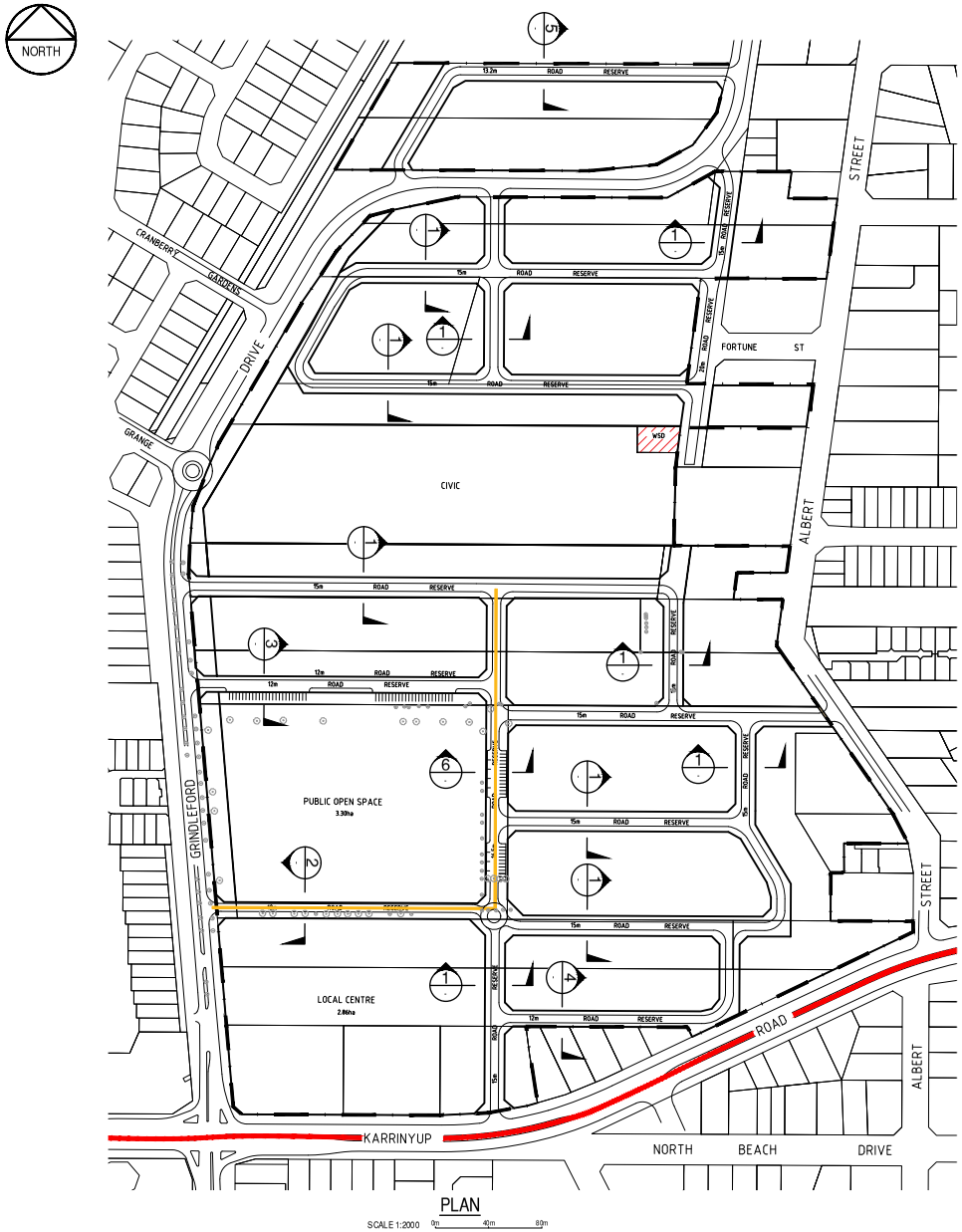
DESIGNED	DRAWN	CHECKED	APPROVED
CJ	JS	CJ	CJ ...../...../.....

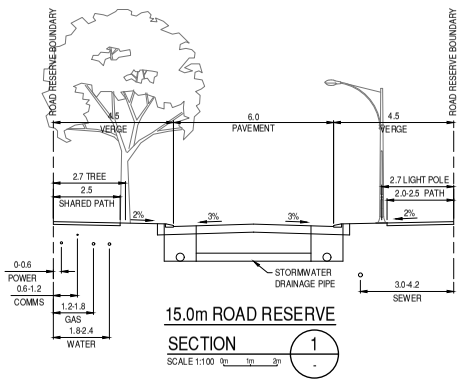
W.A.P.C. -
SCALE U.N.O. AS SHOWN @

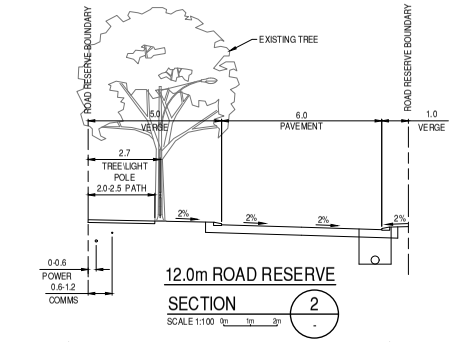
CLIENT & JOB: PARCEL PROPERTY
GRINDLEFORD DRIVE, BALCATTA

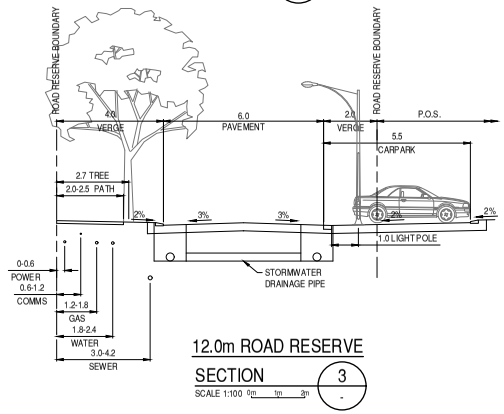
TITLE: TREE RETENTION SKETCH

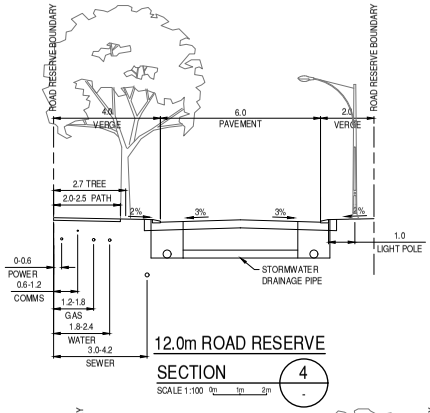
SHEET SIZE: A1
DRG No.: 15029-C9-SK-02
REVISION: B

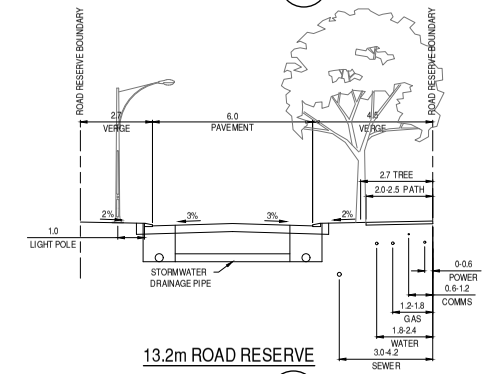


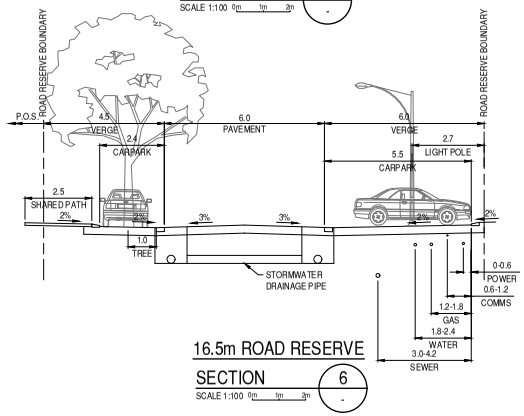












DIAL BEFORE YOU DIG
www.1100.com.au
The Essential First Step.

REV	DATE	DESCRIPTION	BY	CHKR
A	02/05/18	ISSUED FOR INFORMATION	CJD	FO

pritchard francis
civil and structural engineering consultants
430 Roberts Road
Subiaco WA 6008
PO Box 2150
Subiaco WA 6904
Telephone: (08) 9382 5111
admin@pfeng.com.au

DRAWING IS TO BE: NOT FOR CONSTRUCTION

DATE: MAY 2018 | GRID: PCG94 | DATUM: AHD

DESIGNED: FO | DRAWN: CJD | CHECKED: FO | APPROVED: FO ..... / ...

W.A.P.C.: N/A | SCALE U.N.O.: AS SHOWN @ | SHEET SIZE: A1

CLIENT & JOB: PARCEL PROPERTY GRINDLEFORD DRIVE, BALCATTA

TITLE: TYPICAL PRELIMINARY ROAD CROSS SECTIONS

DRG No.: 15029-C9-SK-12

REVISION: A

pritchard francis

430 Roberts Road
SUBIACO WA 6008
PO Box 2150
SUBIACO WA 6904

Tel: (08) 9382 5111
admin@pfeng.com.au

www.pfeng.com.au

Suite 4
2A MacPherson Street
BROOME WA 6725
PO Box 3634
BROOME WA 6725

Tel: (08) 9192 8015
broome@pfeng.com.au

Suite 5
25 Parap Road
PARAP NT 0820
PO Box 104
PARAP NT 0804

Tel: (08) 7999 8811
nt@pfeng.com.au