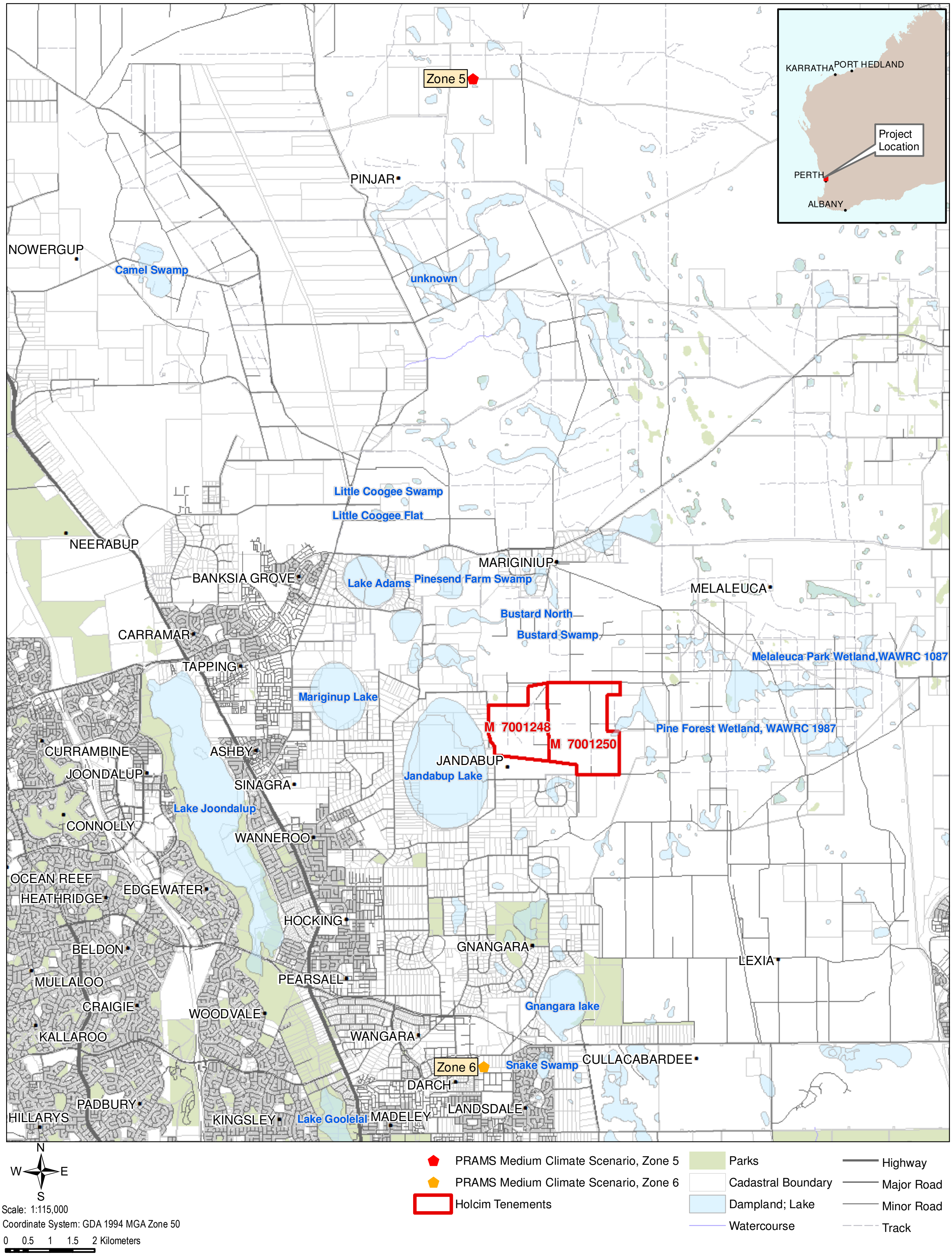
FIGURES



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JANDABUP SAND QUARRY PROJECT
GROUNDWATER IMPACT ASSESSMENT

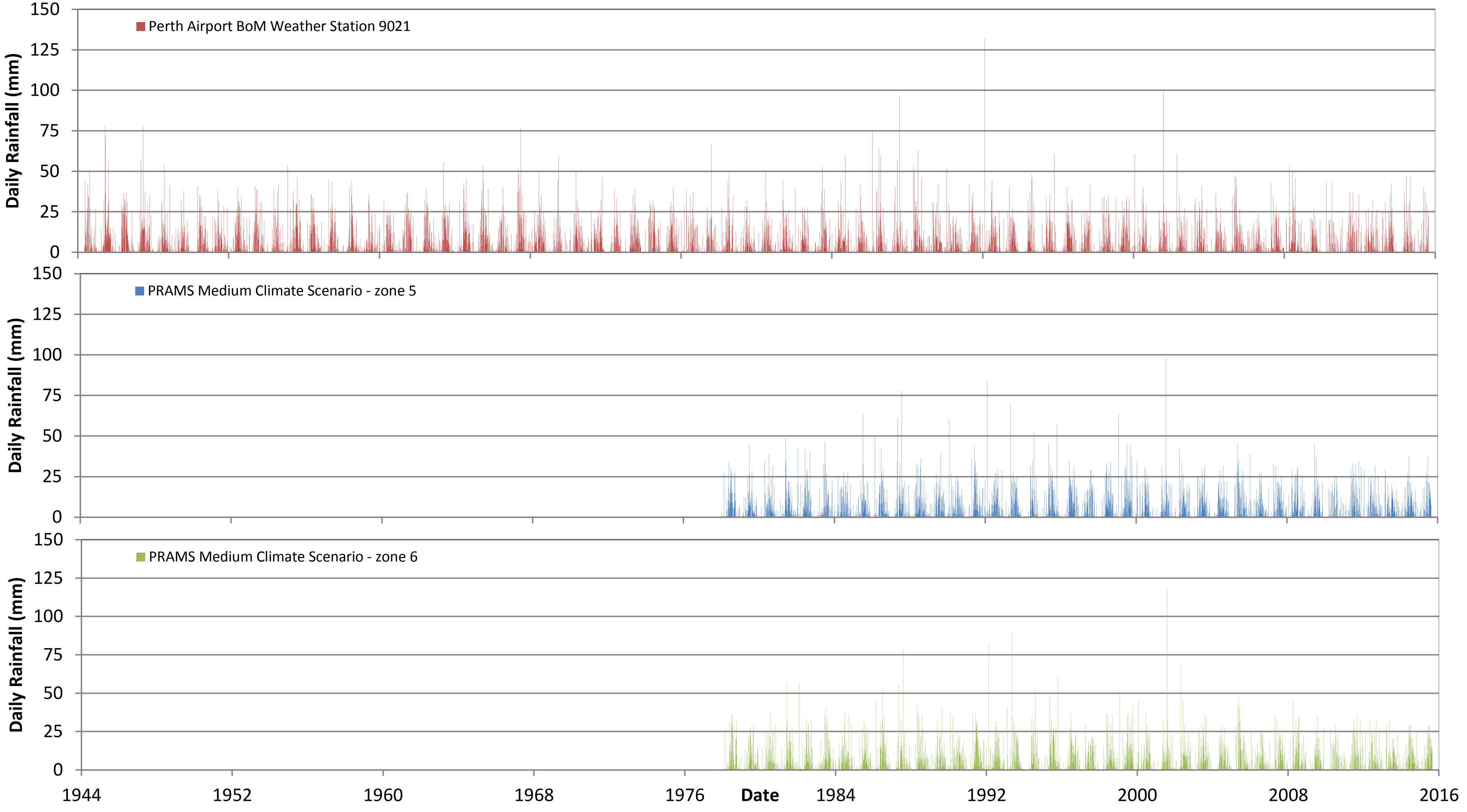
PROJECT LOCATION

URS

INTRODUCTION

Figure: **1-1**

File No: **42908863-001.mxd** Drawn: **RNM** Approved: **RF** Date: **8/09/2015** Rev. **-** A4



Source: BoM 2015

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GROUNDWATER IMPACT ASSESSMENT

HISTORICAL RAINFALL

URS

PHYSICAL ENVIRONMENT

Figure: **2-1**

File No: 42908920-001.xlsx

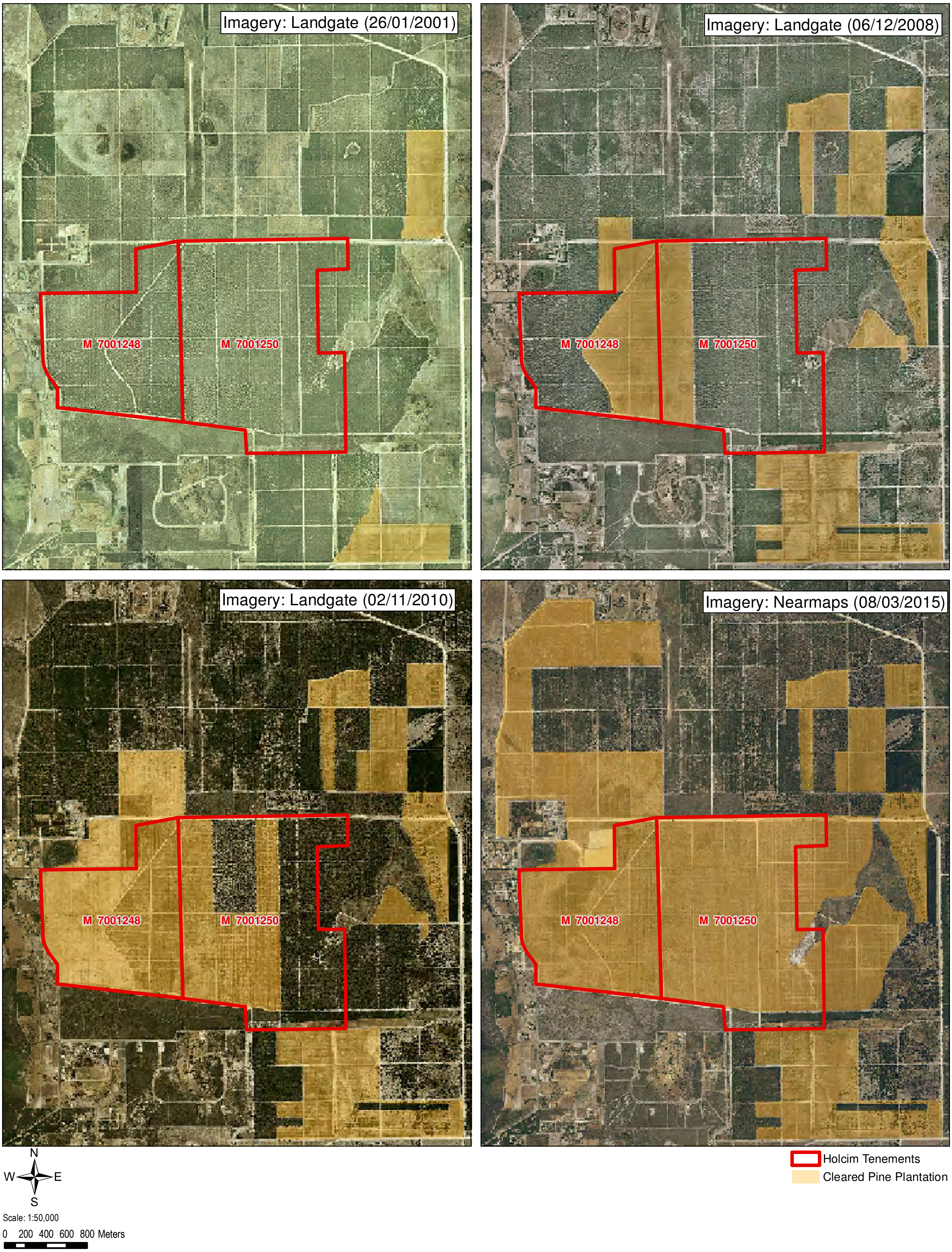
Drawn: RF

Approved: RW

Date: 04/09/2015

Rev: **A**

A4



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GROUNDWATER IMPACT ASSESSMENT

**HISTORICAL LAND-USE
CHANGES 2001 TO 2015**

URS

PHYSICAL ENVIRONMENT

Figure: **2-2**

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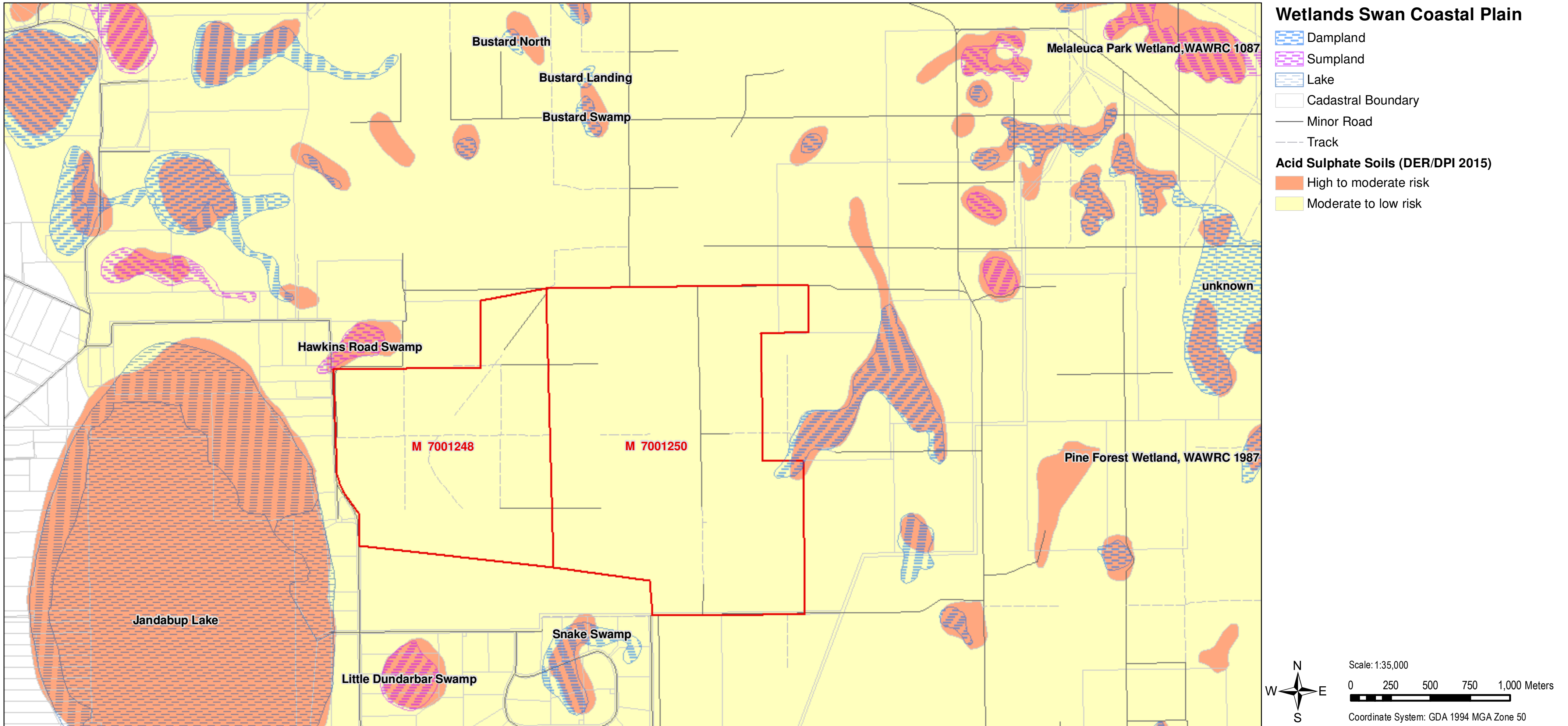

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Bush Forever information from Department of Planning (DOP) via Landgate SLIP Portal

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GROUNDWATER IMPACT ASSESSMENT

**WATER
DEPENDENT
FEATURES**

URS

PHYSICAL ENVIRONMENT

Figure: **2-3**

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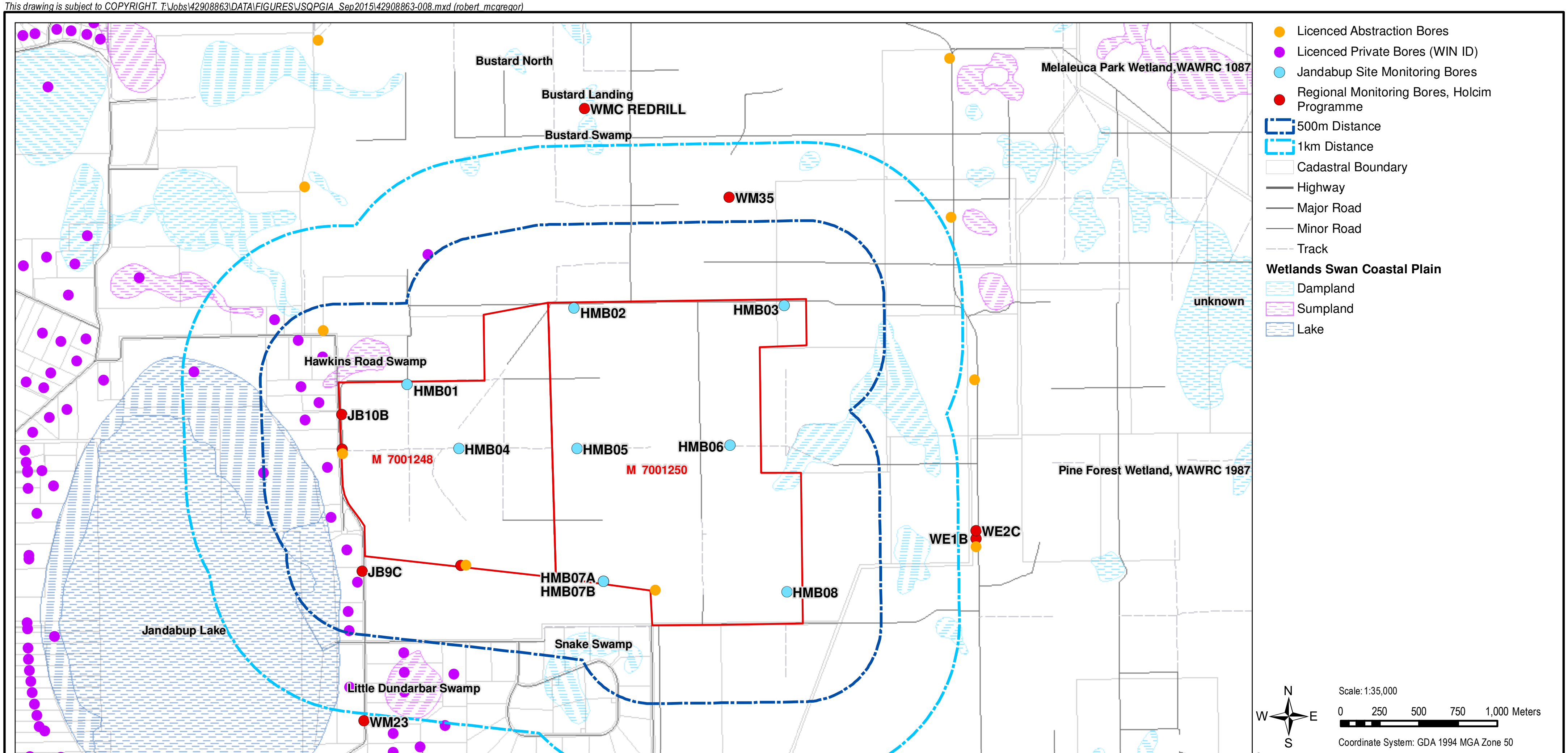

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GROUNDWATER IMPACT ASSESSMENT

EXISTING GROUNDWATER USERS

URS

PHYSICAL ENVIRONMENT

Figure: **2-4**

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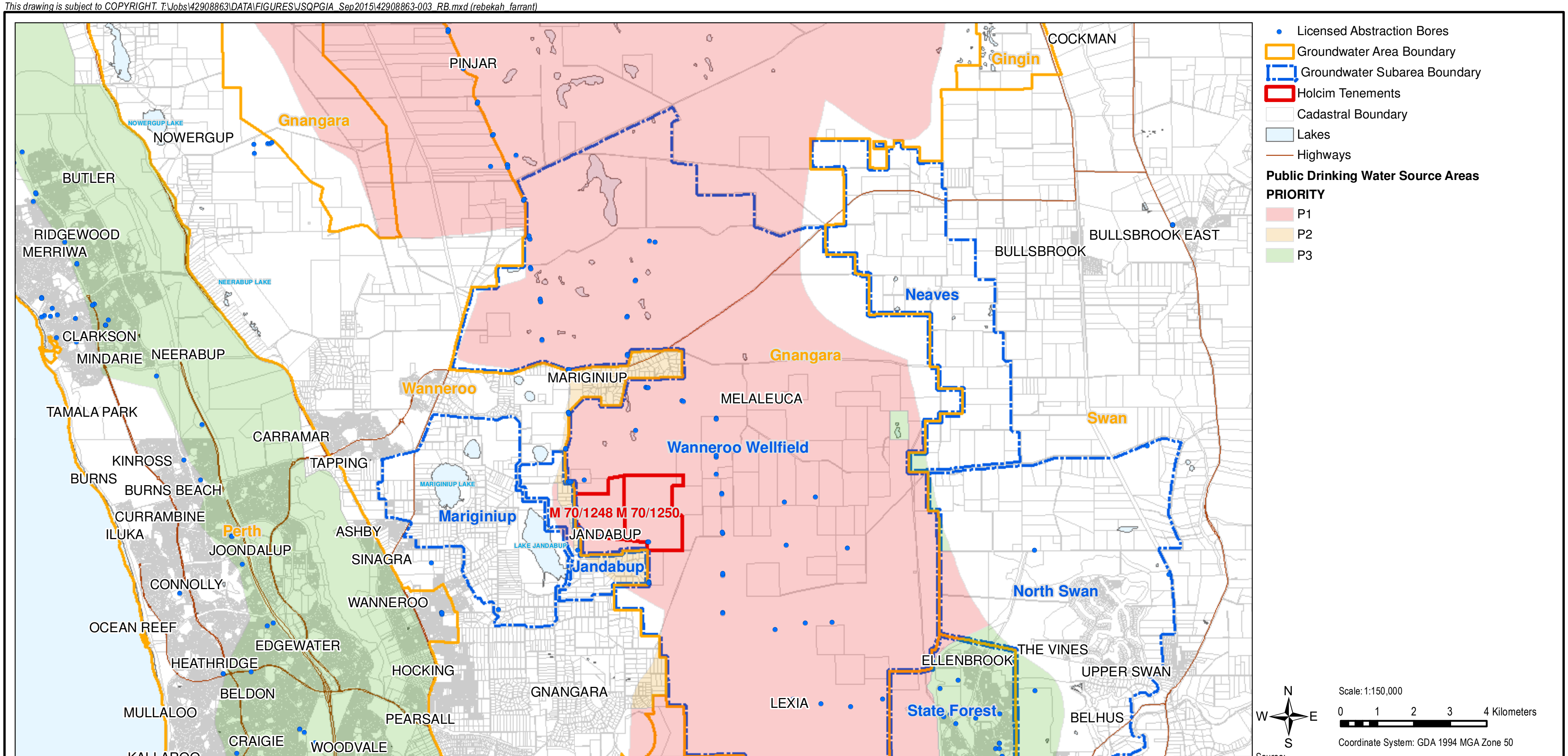

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GROUNDWATER IMPACT ASSESSMENT

REGIONAL WATER MANAGEMENT SCHEMES

URS

GROUNDWATER MANAGEMENT SCHEMES

Figure: **3-1**

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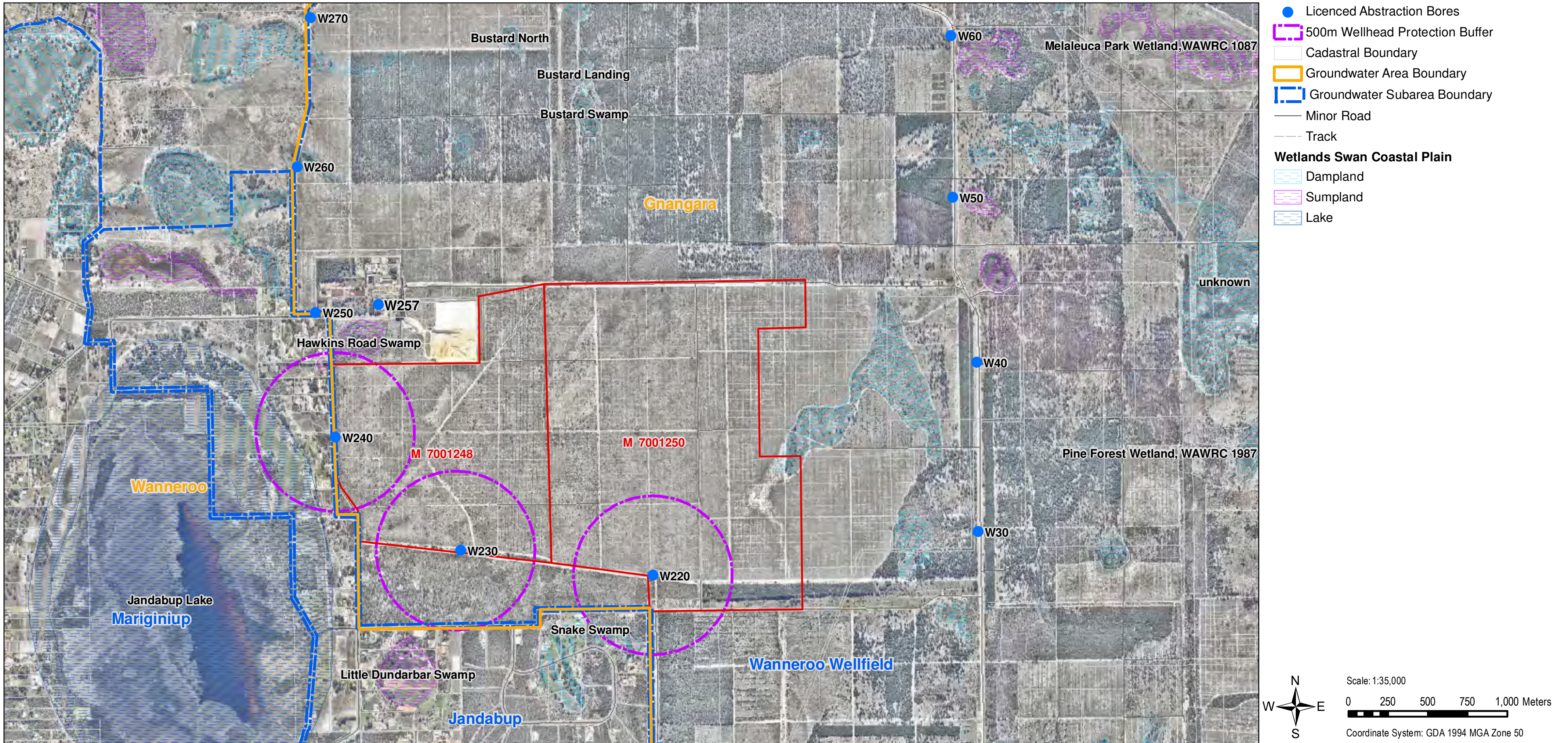

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Nearmap Imagery (27/06/2015)

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GROUNDWATER IMPACT ASSESSMENT

LOCAL WATER MANAGEMENT SCHEMES

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GROUNDWATER MANAGEMENT SCHEMES

Figure: **3-2**

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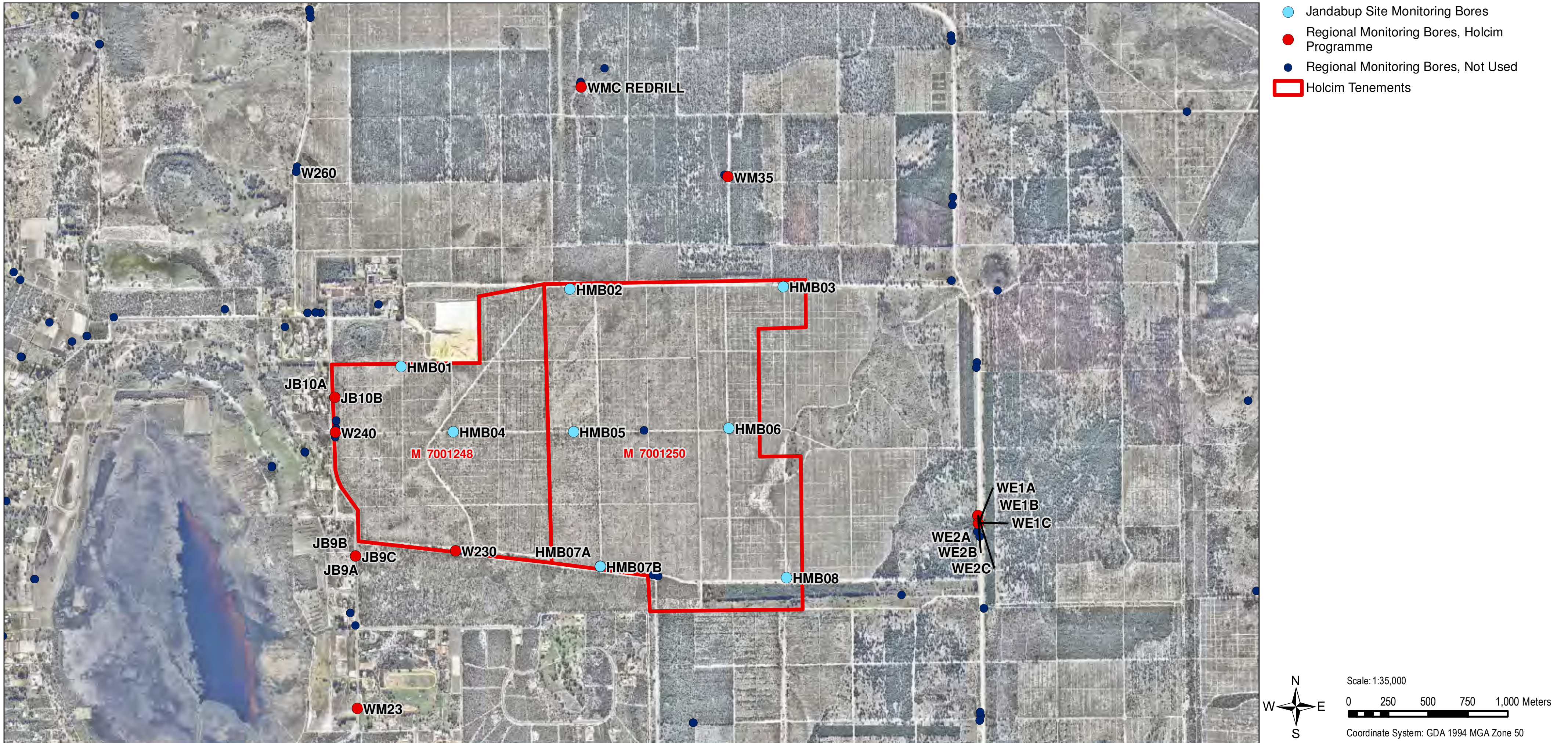

Coordinate System: GDA 1994 MGA Zone 50

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GROUNDWATER IMPACT ASSESSMENT

MONITORING BORE LOCATIONS

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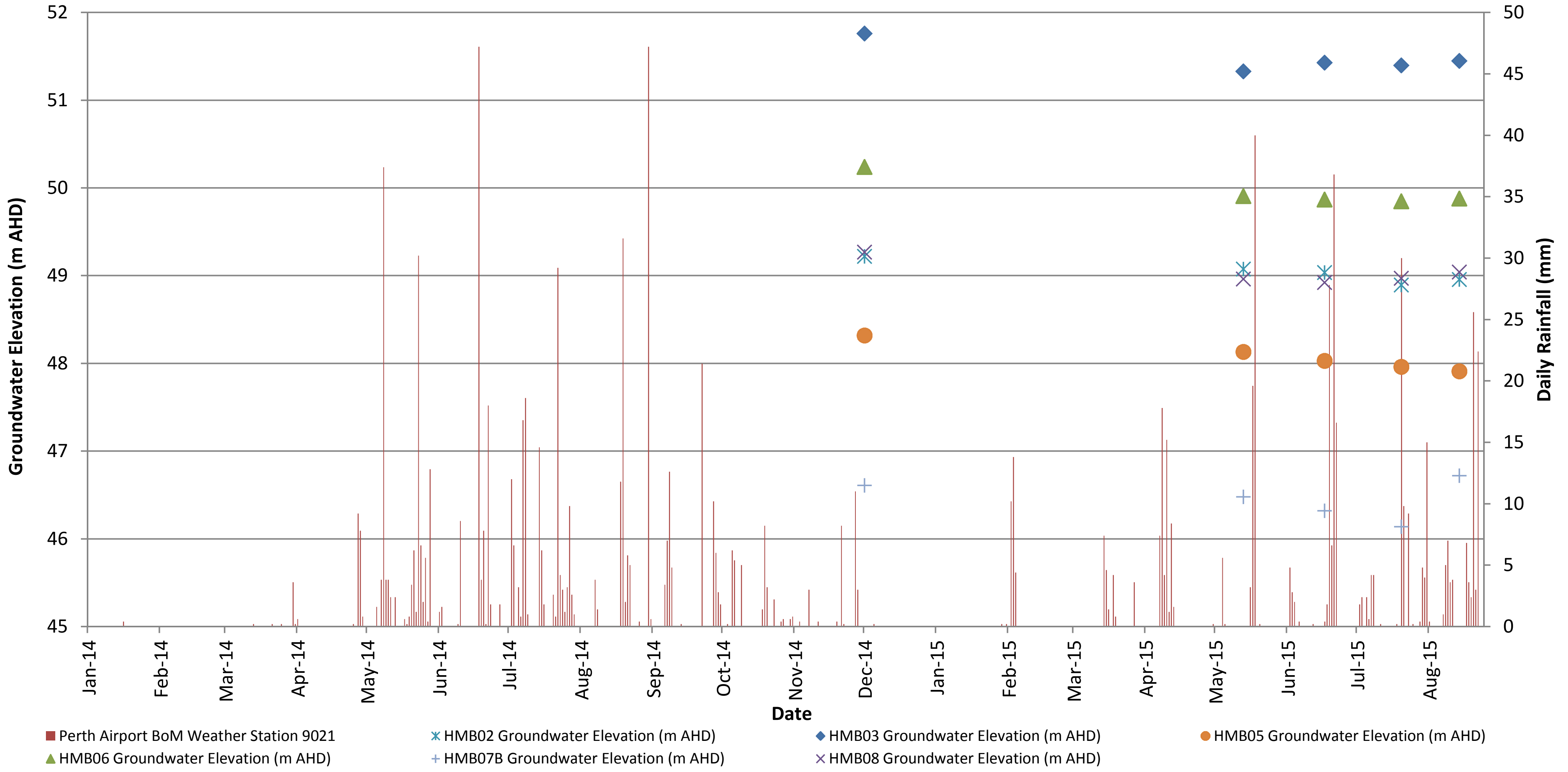
HYDROGEOLOGY

File No: **42908863-005.mxd** Drawn: **RNM** Approved: **RW** Date: **22/09/2015**

Figure: **4-1**

Rev. **A** A4



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GROUNDWATER IMPACT ASSESSMENT

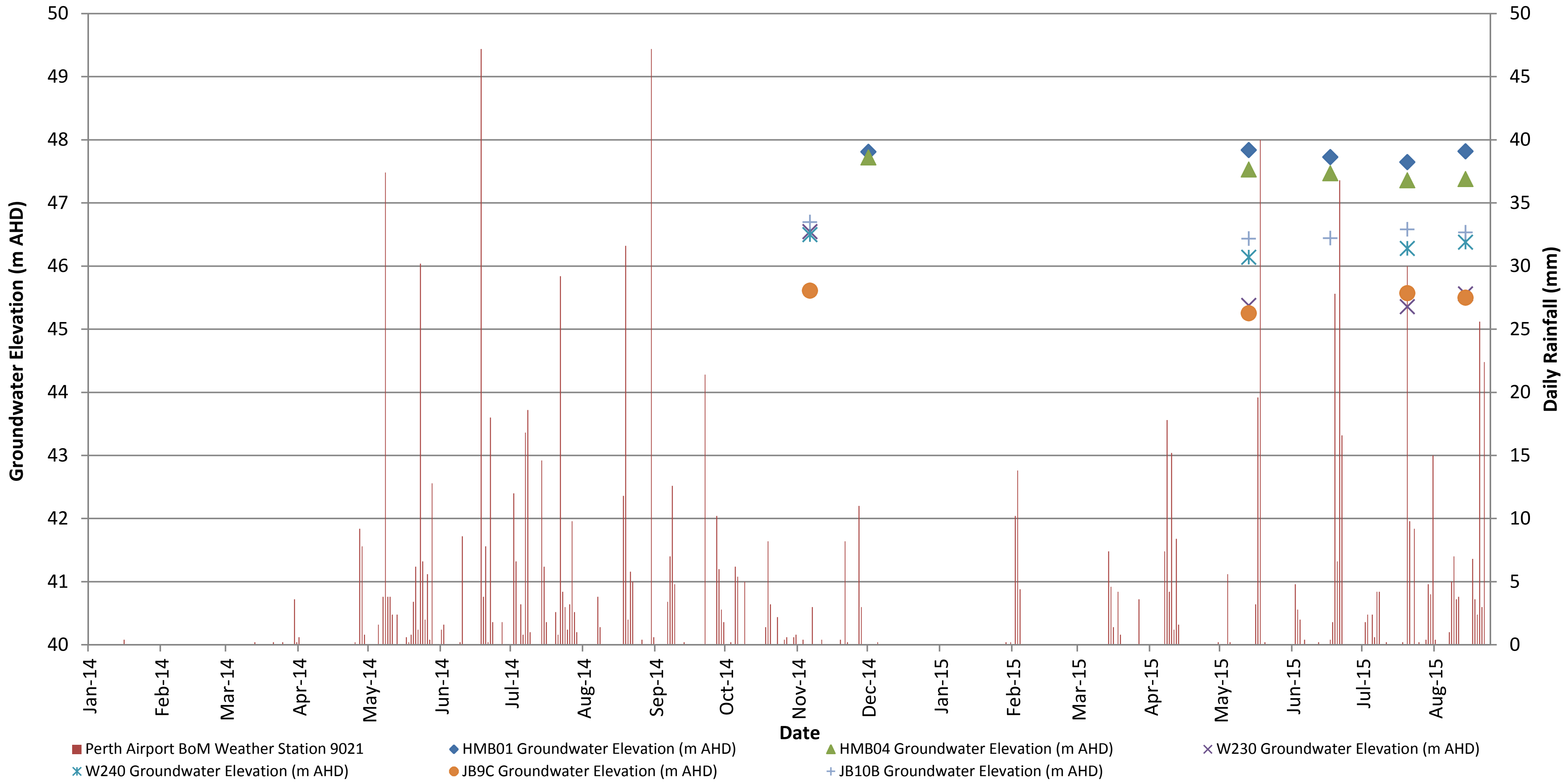
HOLCIM SITE HISTORICAL HYROGRAPHS, EASTERN AREA

URS

HYDROGEOLOGY

Figure: **4-2**

File No: 42908920-002.xlsx
Drawn: RF
Approved: RW
Date: 04/09/2015
Rev: **A**
A4



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GROUNDWATER IMPACT ASSESSMENT

HOLCIM SITE HISTORICAL HYROGRAPHS, WESTERN AREA

URS

HYDROGEOLOGY

Figure: **4-3**

File No: 42908920-003.xlsx
Drawn: RF
Approved: RW
Date: 04/09/2015
Rev: **A**
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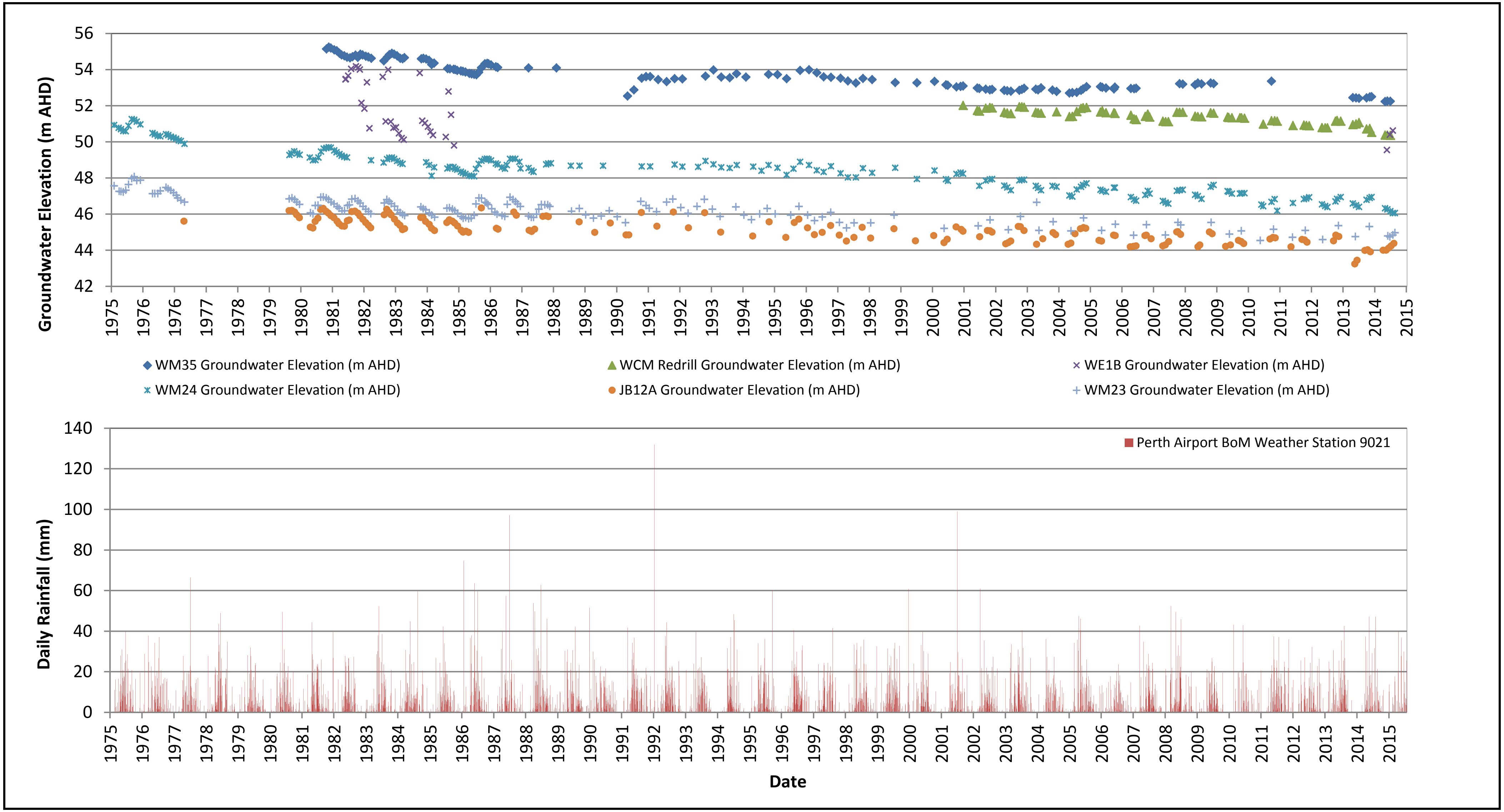

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GROUNDWATER IMPACT ASSESSMENT

**REGIONAL HYDROGRAPHS
(SOUTH, EAST AND NORTH AREAS)**

HYDROGEOLOGY

Figure: **4-4**

File No: 42908920-004.xlsx
Drawn: RF
Approved: RW
Date: 04/09/2015
Rev: **A**
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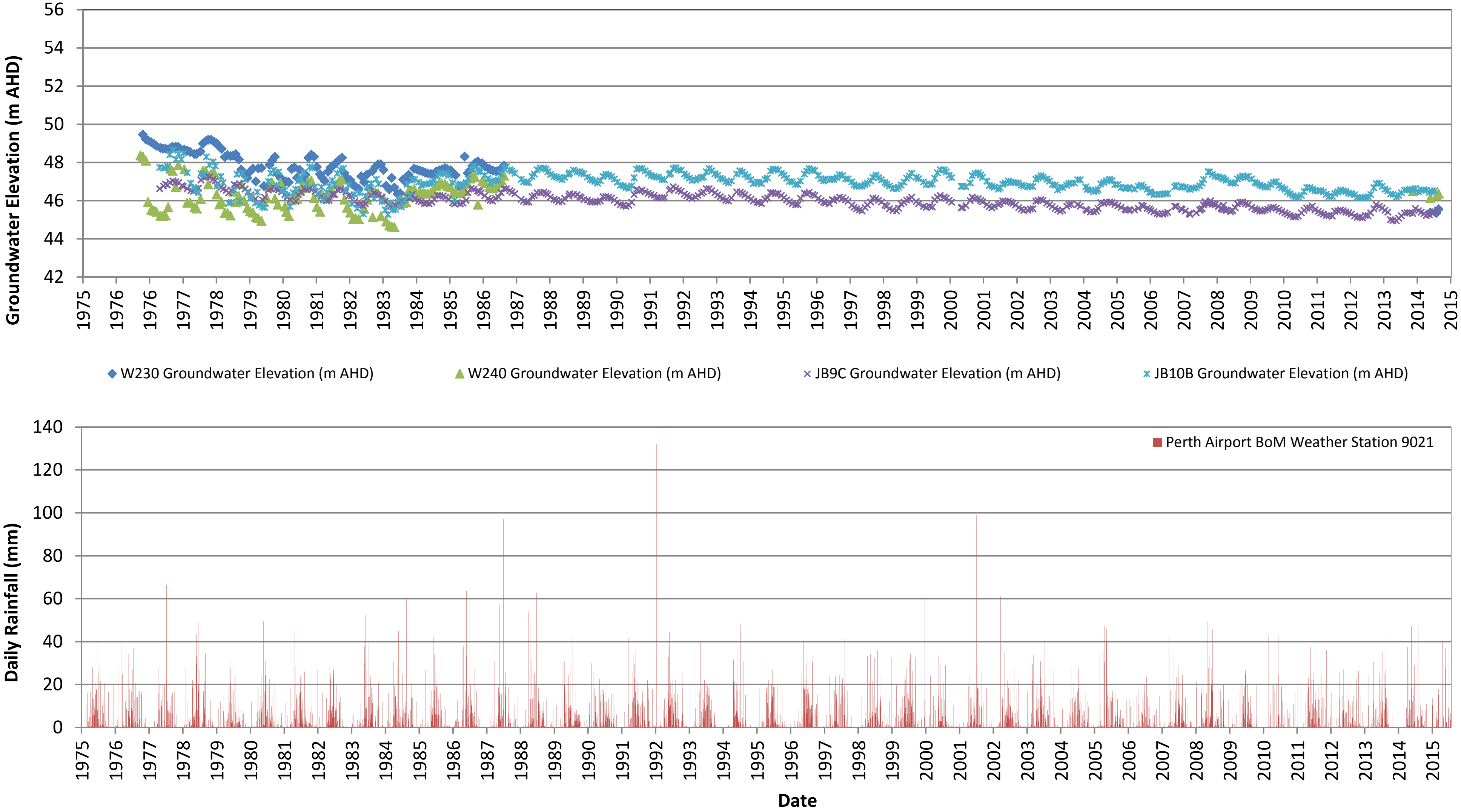

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GROUNDWATER IMPACT ASSESSMENT

REGIONAL HYDROGRAPHS (WESTERN AREAS)

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HYDROGEOLOGY

Figure: **4-5**

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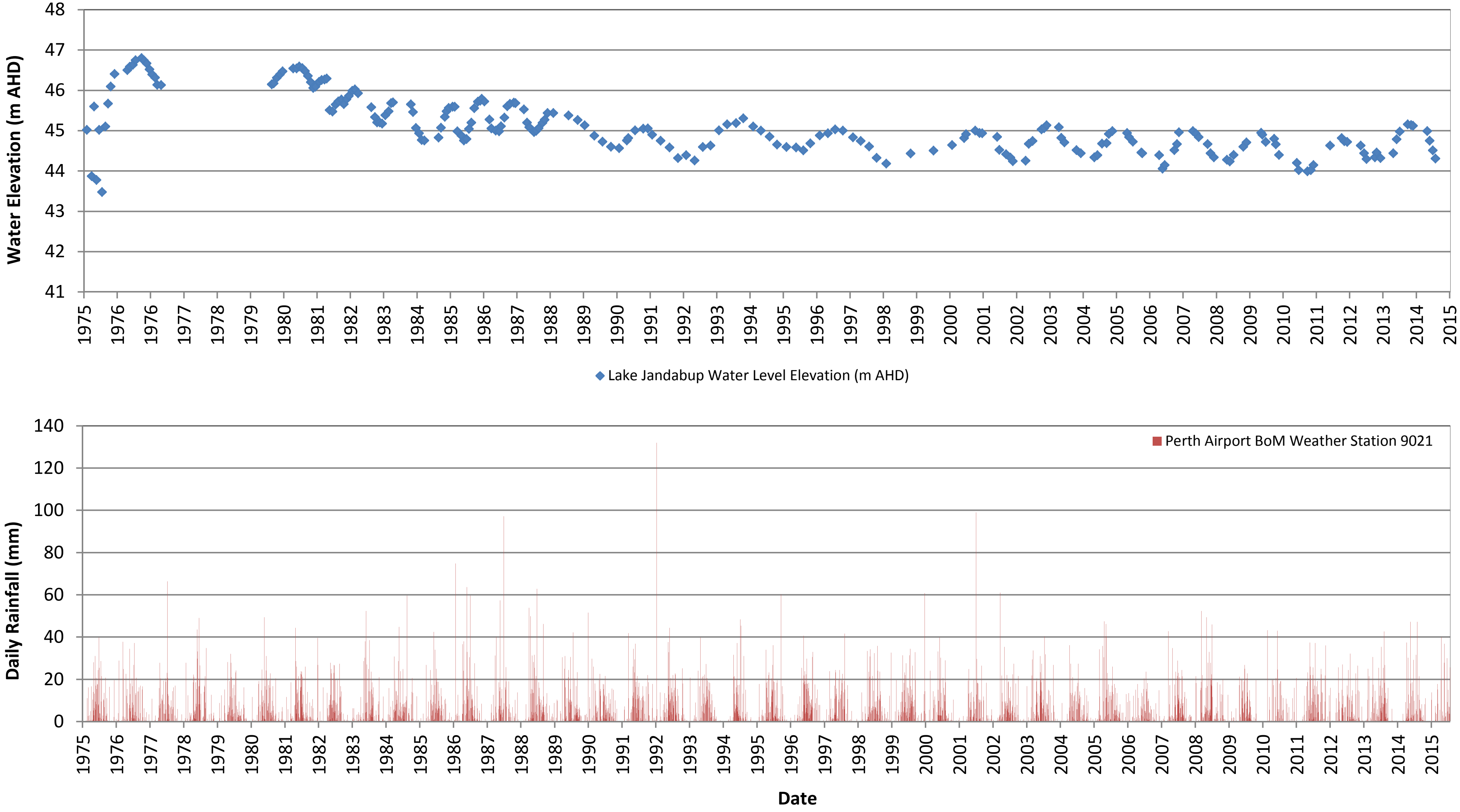

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GROUNDWATER IMPACT ASSESSMENT

HISTORICAL HYDROGRAPH OF LAKE JANDABUP

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HYDROGEOLOGY

Figure: **4-6**

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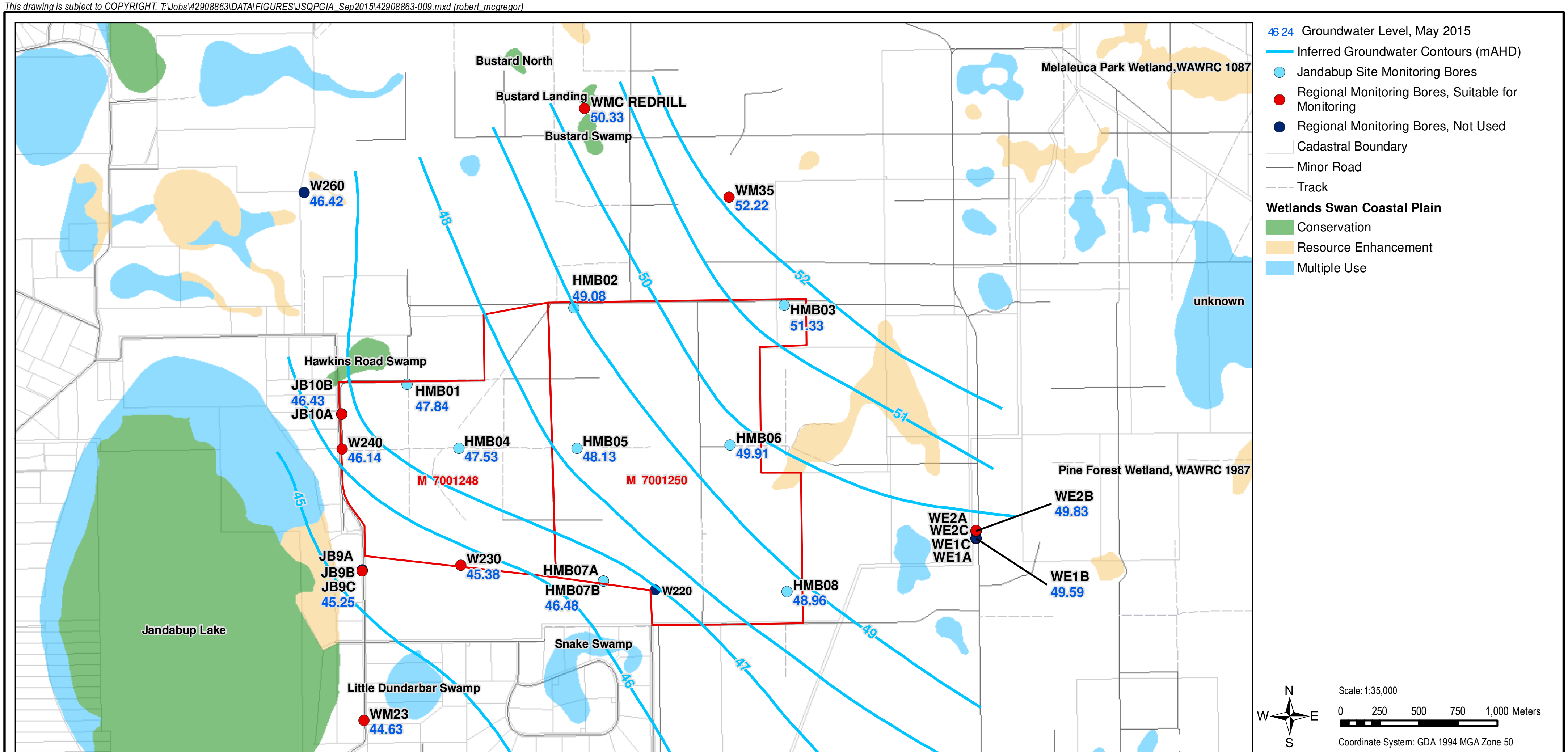

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GROUNDWATER IMPACT ASSESSMENT

CURRENT SUMMER GROUNDWATER LEVEL DISTRIBUTIONS (MAY 2015)

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HYDROGEOLOGY

Figure: **4-7**

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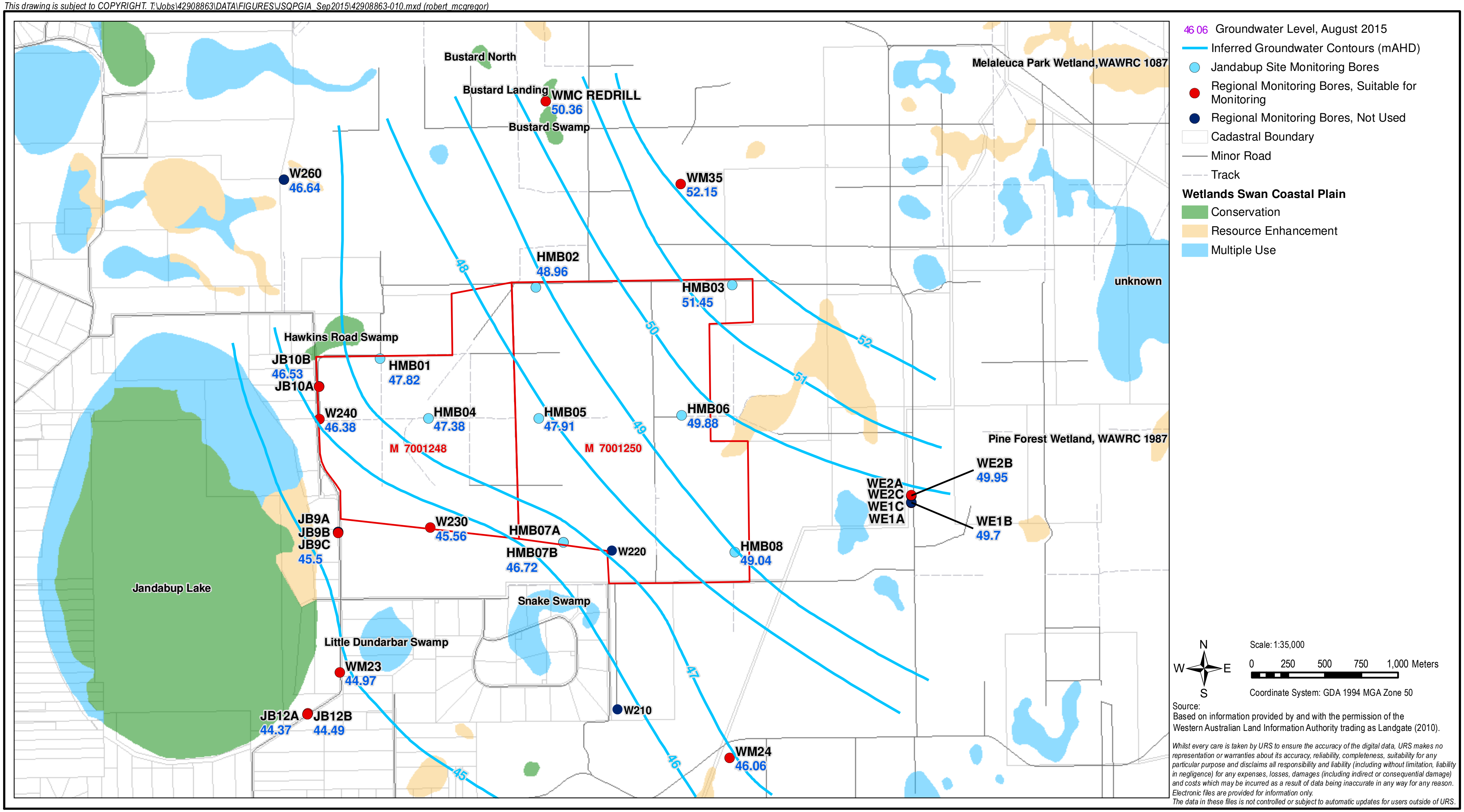

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GROUNDWATER IMPACT ASSESSMENT

CURRENT WINTER GROUNDWATER LEVEL DISTRIBUTIONS (AUGUST 2015)

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HYDROGEOLOGY

Figure: **4-8**

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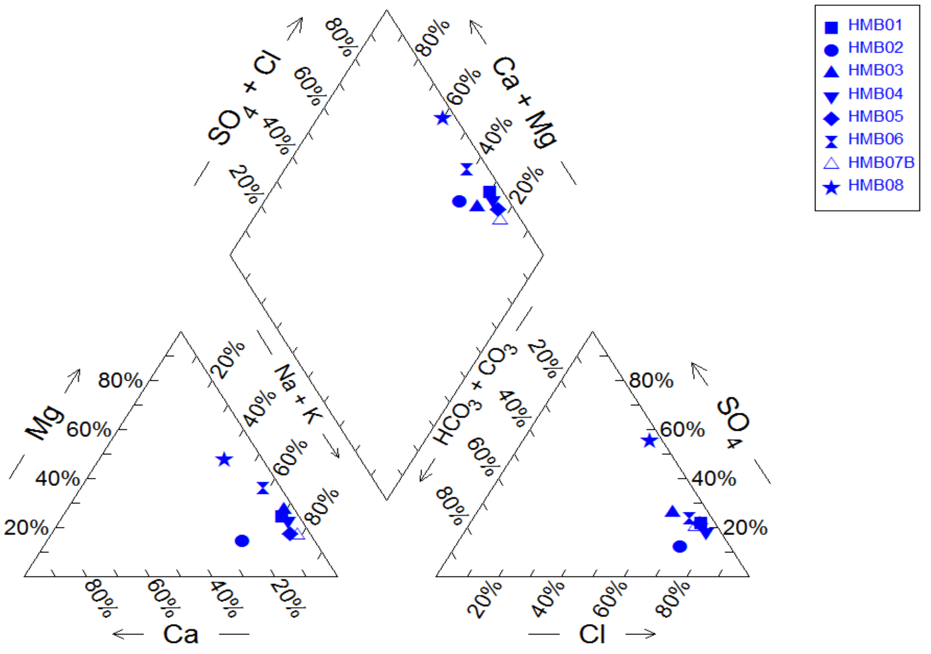
May 2015



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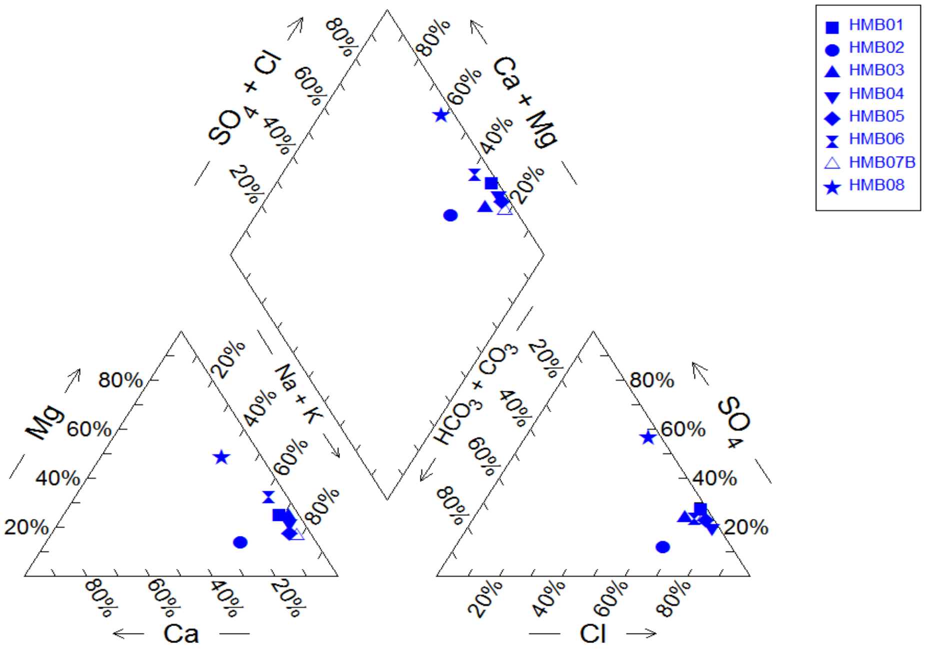

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JANDABUP SAND QUARRY PROJECT
GROUNDWATER IMPACT ASSESSMENT

Piper Diagrams of Local Groundwater

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HYDROGEOLOGY

Figure: **4-9**

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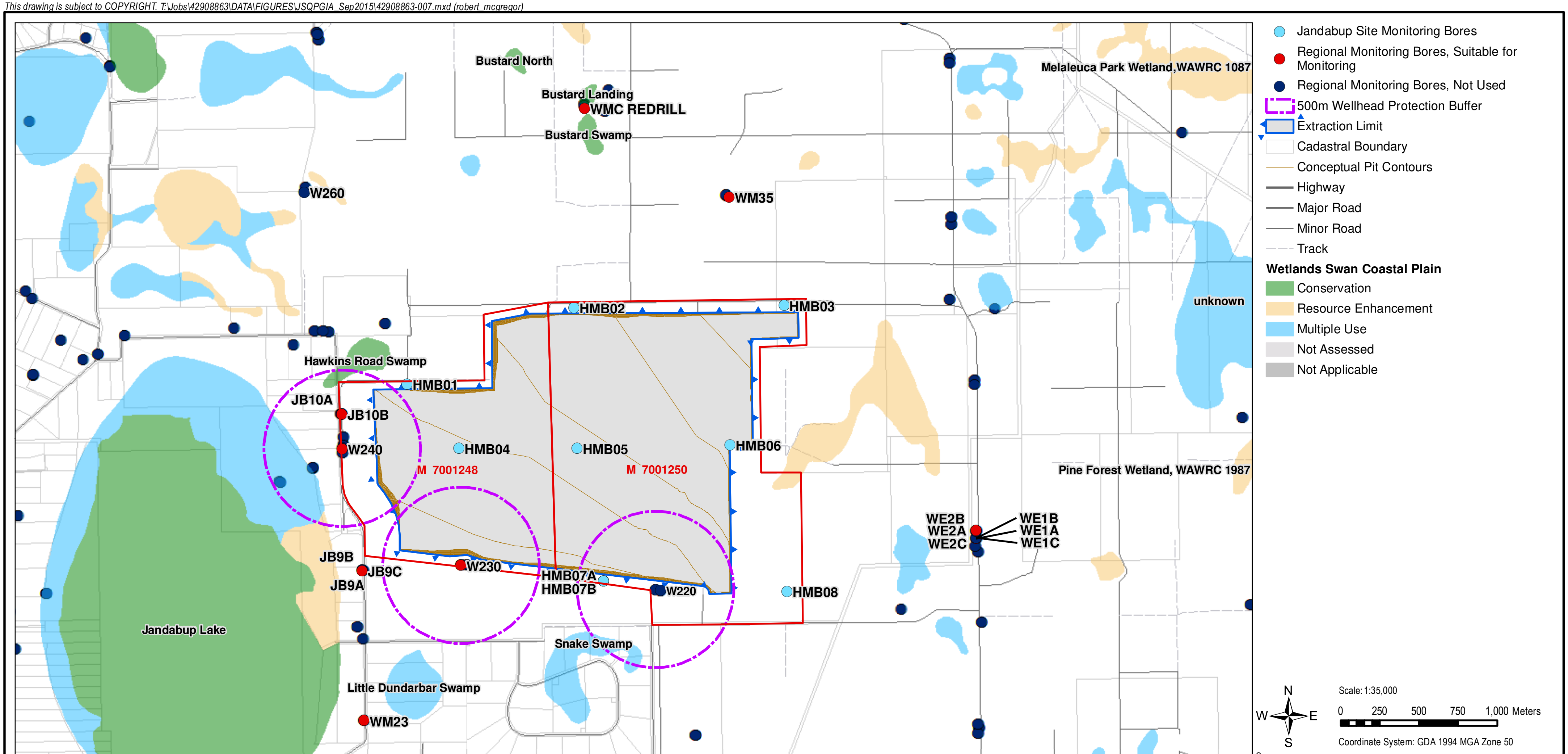

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GROUNDWATER IMPACT ASSESSMENT

HOLCIM MINE PLAN

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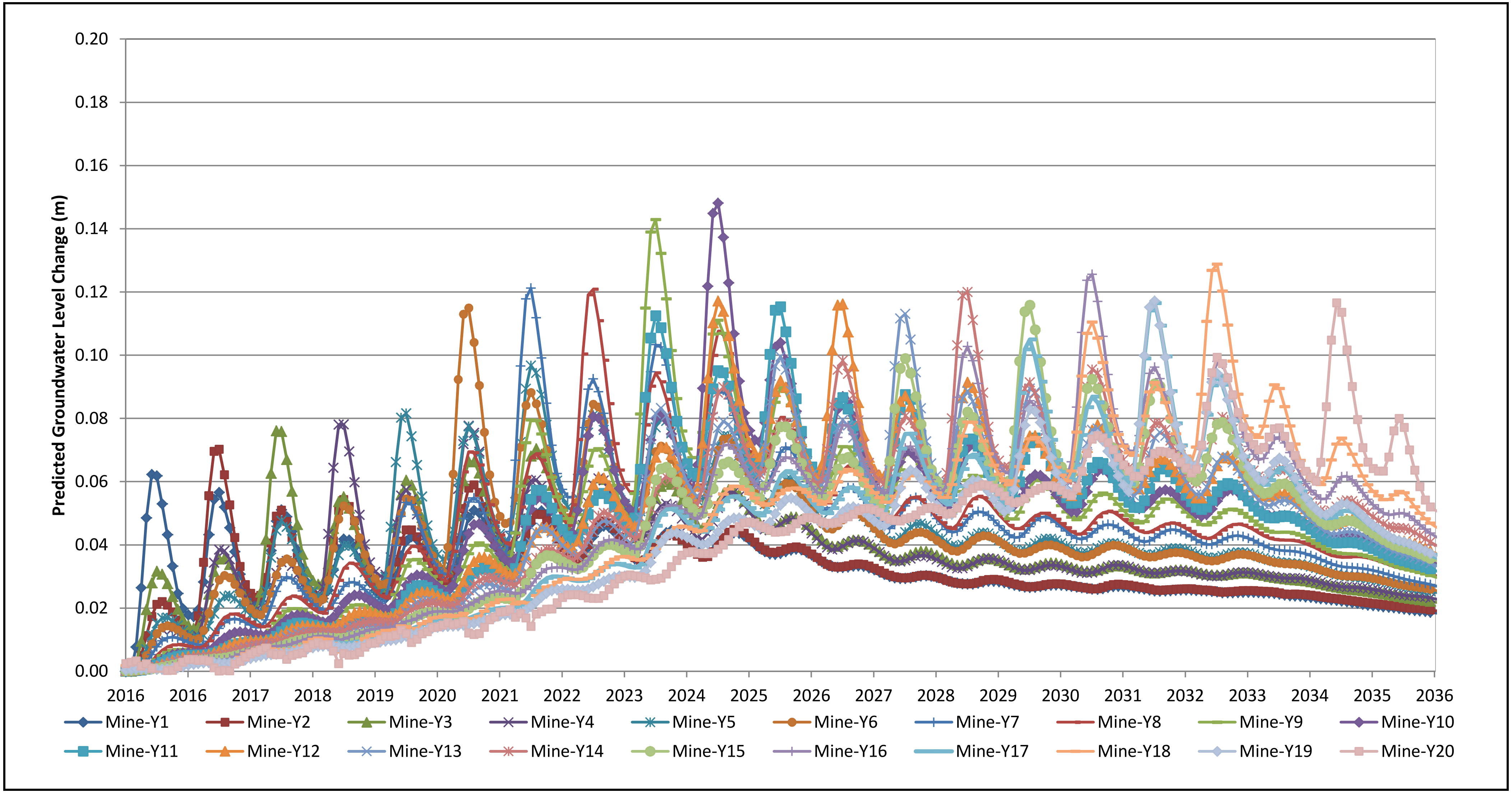
PROJECT DESCRIPTION

Figure: **5-1**

File No: **42908863-007.mxd** Drawn: **RNM** Approved: **RW** Date: **28/10/2015**

Rev. **A** A4



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JANDABUP SAND QUARRY PROJECT
GROUNDWATER IMPACT ASSESSMENT

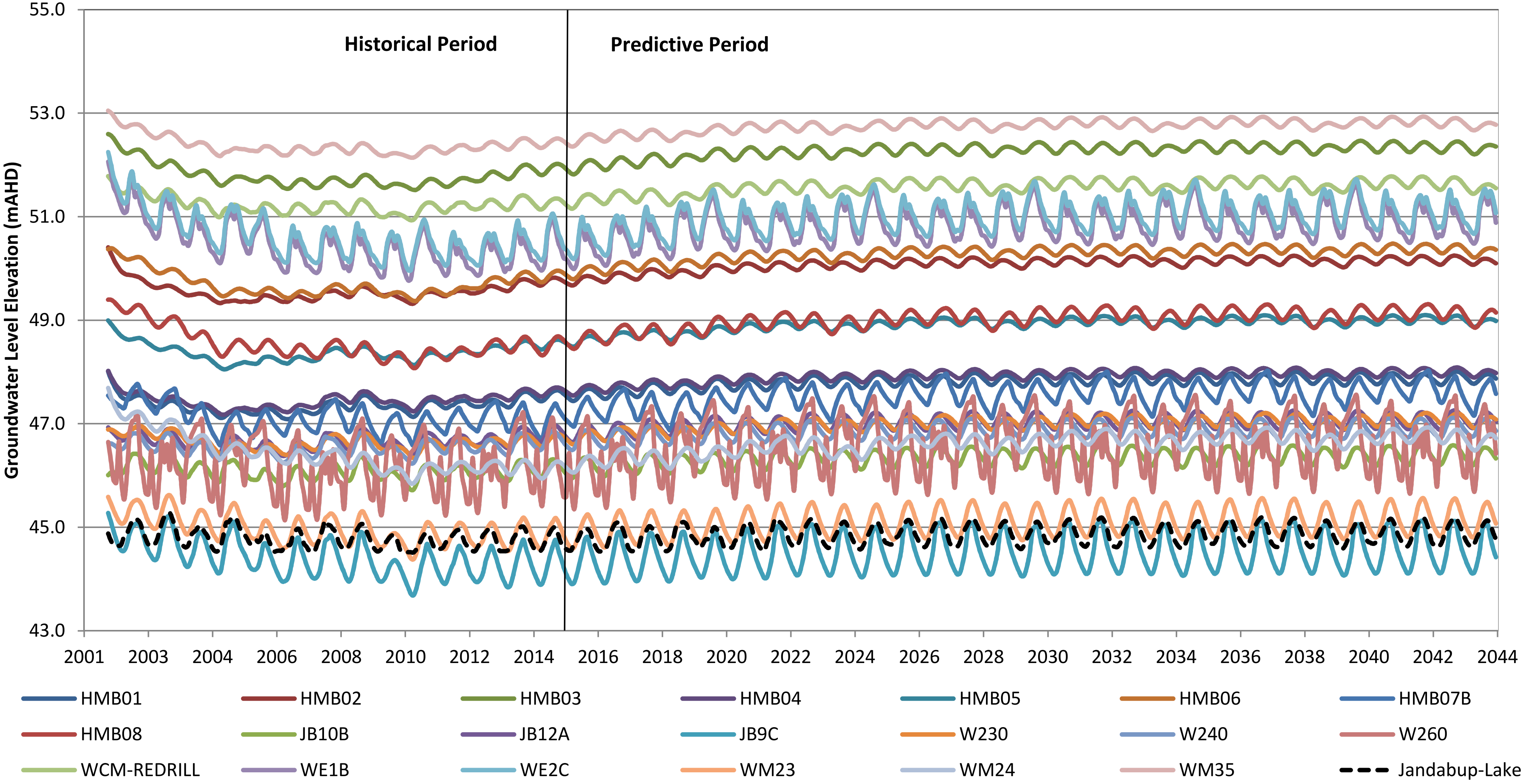
**PREDICTED GROUNDWATER
LEVEL CHANGES DURING MINING**

URS

CHANGE ASSESSMENT

Figure: **6-3**

File No: 42908920-007.xlsx
Drawn: RW
Approved: RW
Date: 04/09/2015
Rev: **A**
A4



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JANDABUP SAND QUARRY PROJECT
GROUNDWATER IMPACT ASSESSMENT

PREDICTED NON-MINING GROUNDWATER LEVELS, 2001 to 2044

URS

CHANGE ASSESSMENT

Figure: **6-4**

File No: 42908920-008.xlsx
Drawn: RW
Approved: RW
Date: 04/09/2015
Rev: **A**
A4

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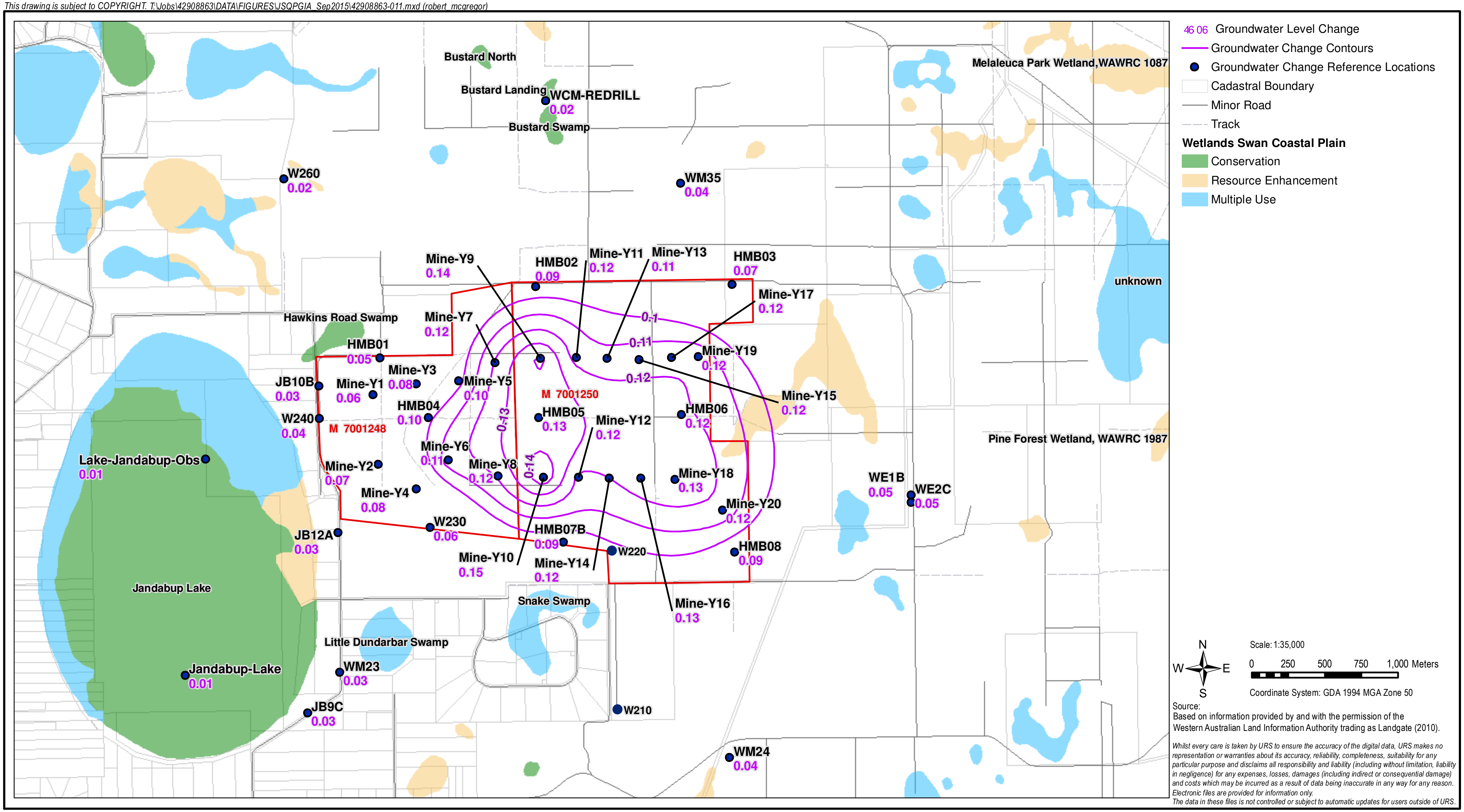

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HOLCIM
(AUSTRALIA)
PTY LTD

JANDABUP SAND QUARRY PROJECT
GROUNDWATER IMPACT ASSESSMENT

PREDICTED EXTENT OF GROUNDWATER CHANGES DUE TO QUARRYING

URS

CHANGE ASSESSMENT

Figure: **6-5**

File No: **42908863-011.mxd** Drawn: **RNM** Approved: **RW** Date: **18/09/2015** Rev. **A** A4

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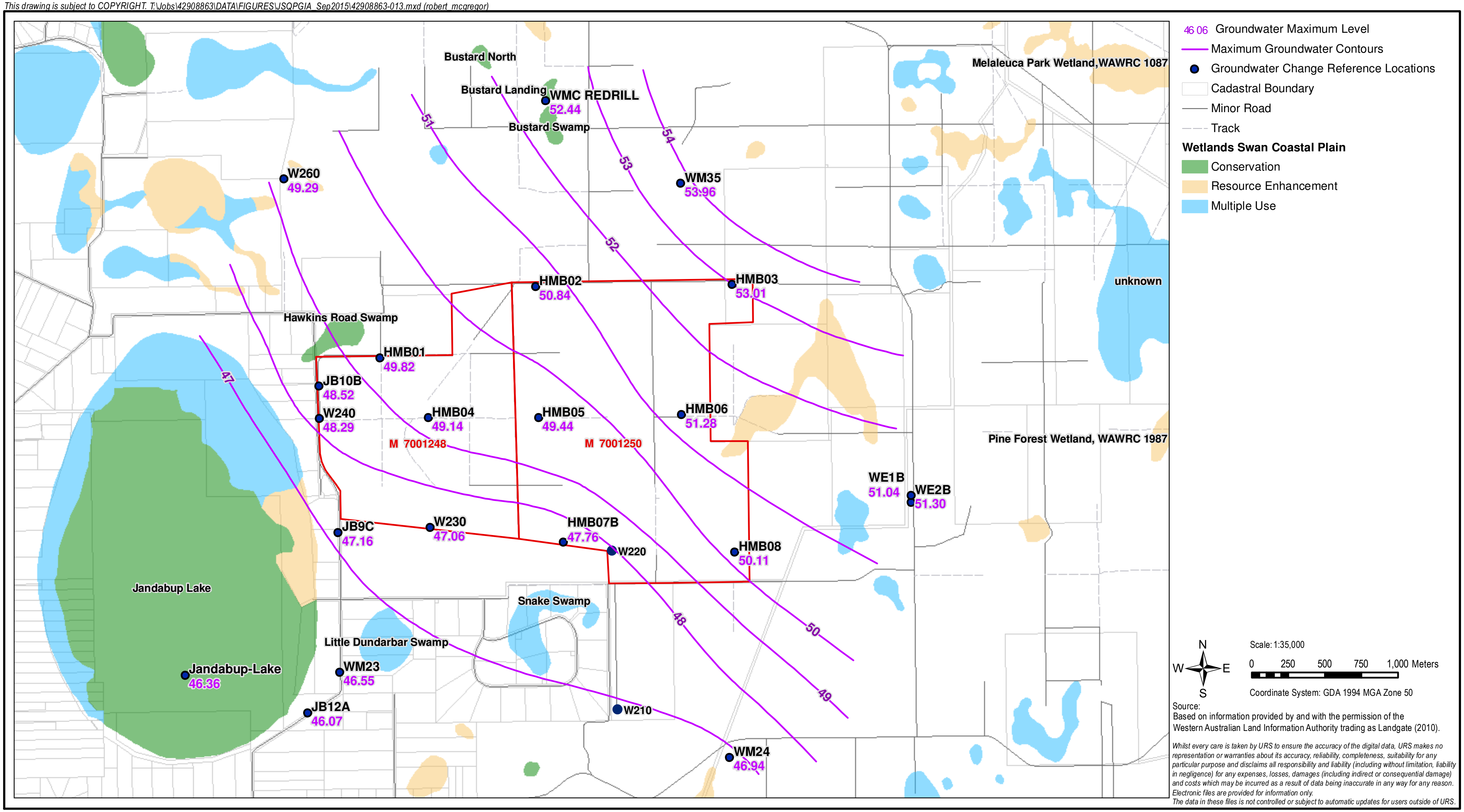

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HOLCIM
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JANDABUP SAND QUARRY PROJECT
GROUNDWATER IMPACT ASSESSMENT

MAXIMUM GROUNDWATER LEVEL

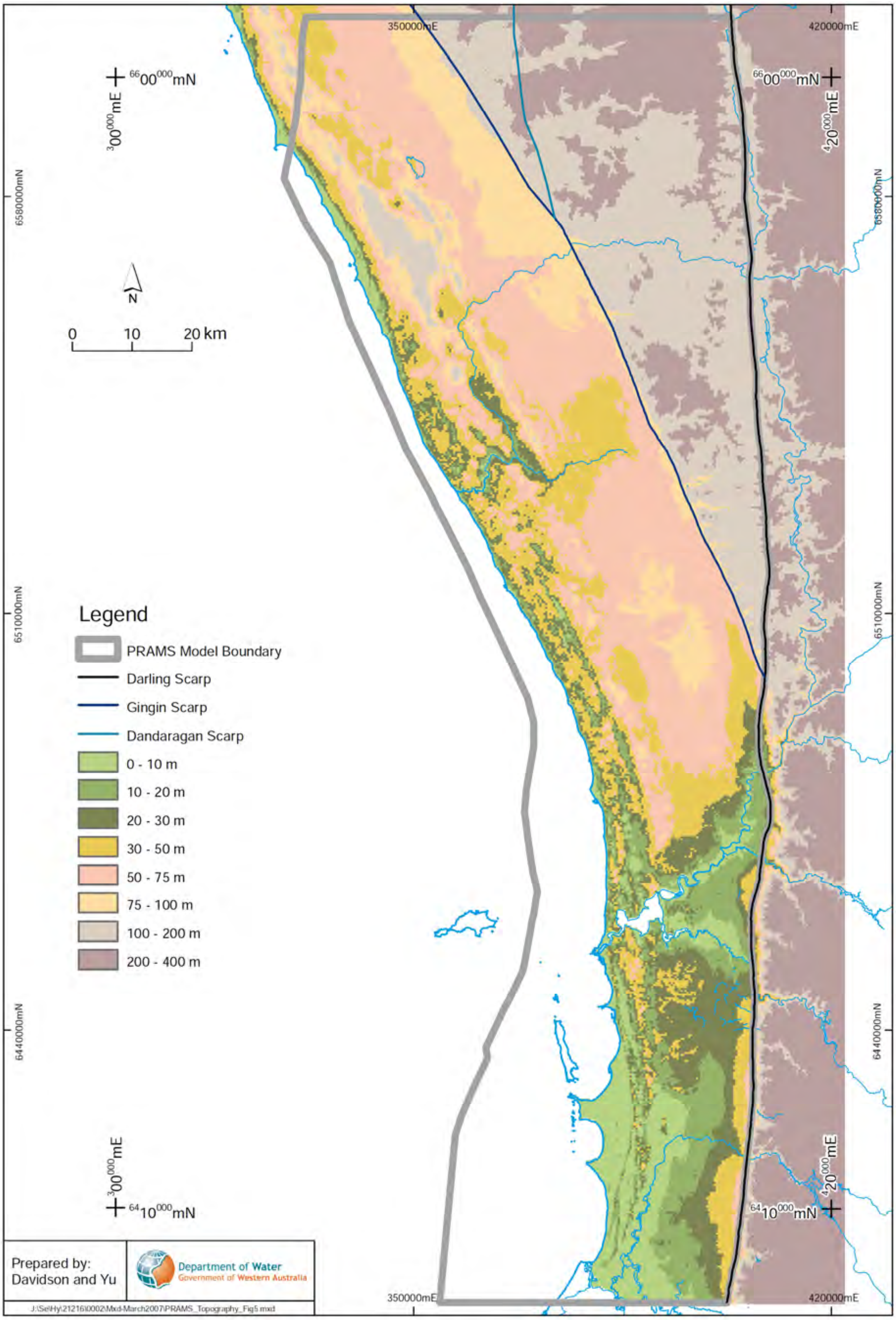
URS

IMPACT ASSESSMENT

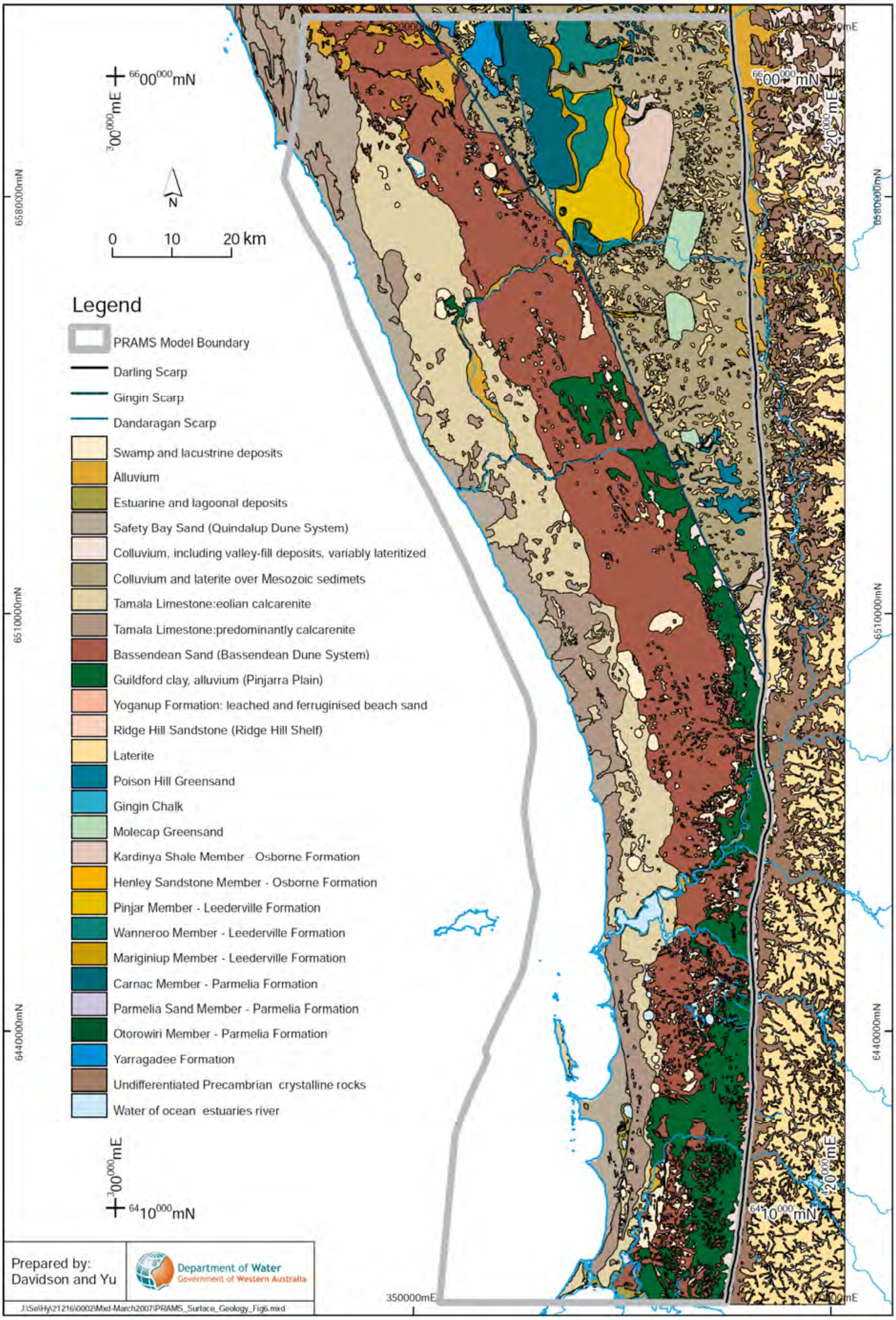
Figure: **7-1**

File No: **42908863-013.mxd** Drawn: **RNM** Approved: **RW** Date: **26/10/2015** Rev. **A** A4

APPENDIX A EXTRACTS FROM DAVIDSON, 1995



Extract 1: Generalised topography (Davidson and Yu 2006)



Extract 2: Surface geology and geomorphology; generalised (Davidson and Yu 2006)

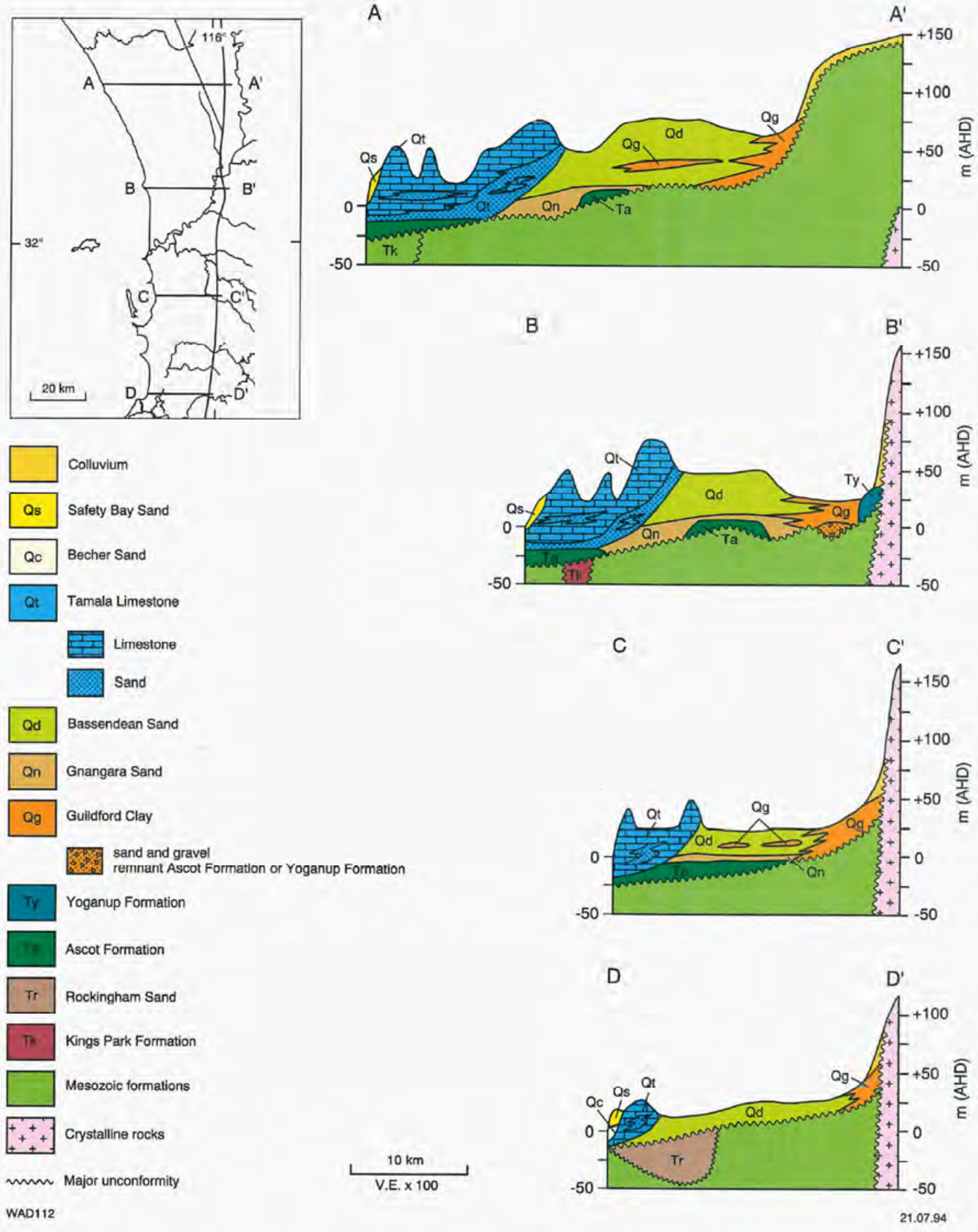


Figure 24. Geological sections showing stratigraphic relationships of superficial formations

Extract 3: Geological sections showing stratigraphic relationships of superficial formations (Davidson and Yu 2006)

Davidson

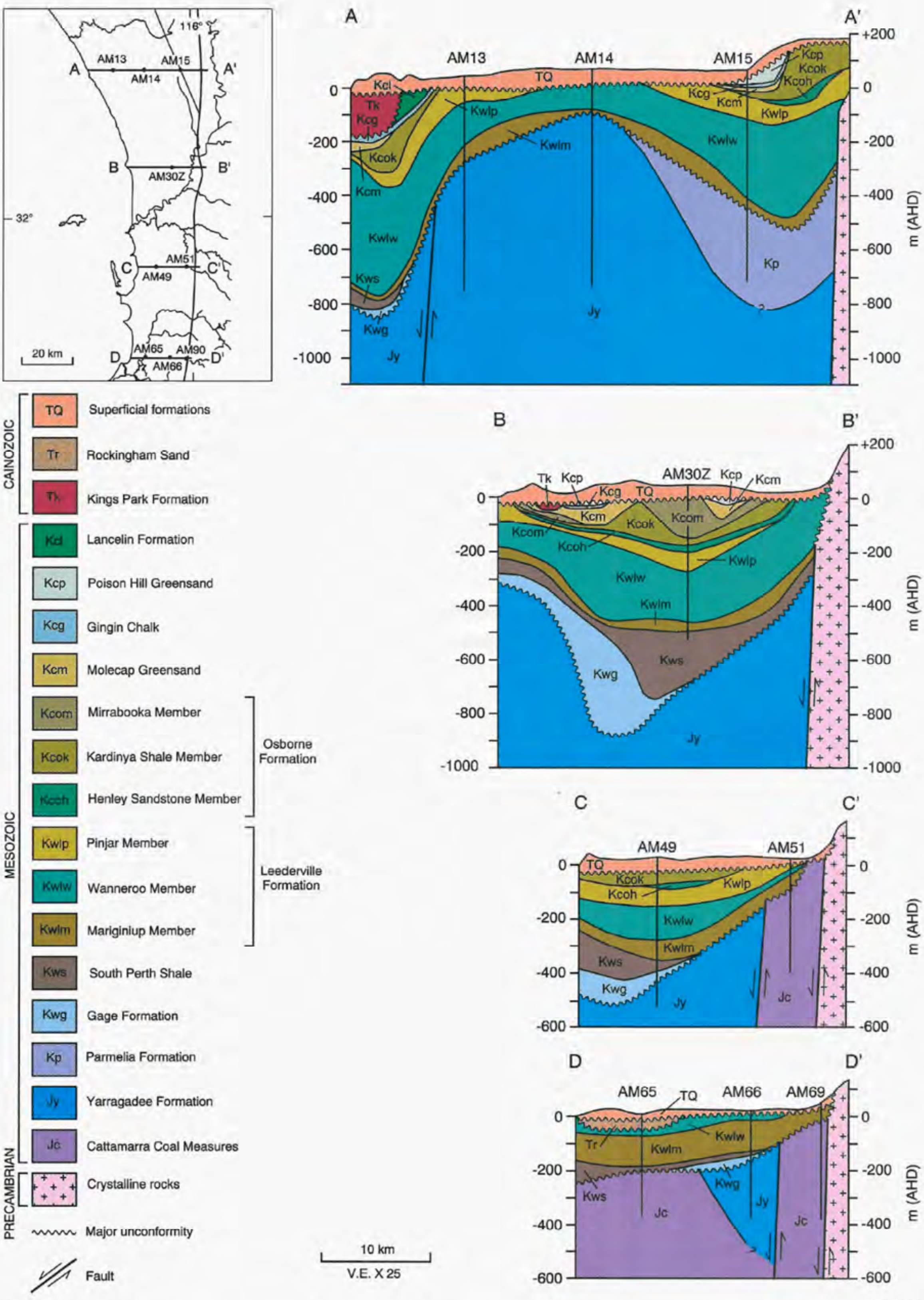


Figure 26. Geological sections showing stratigraphic relationships of Cainozoic and Mesozoic formations

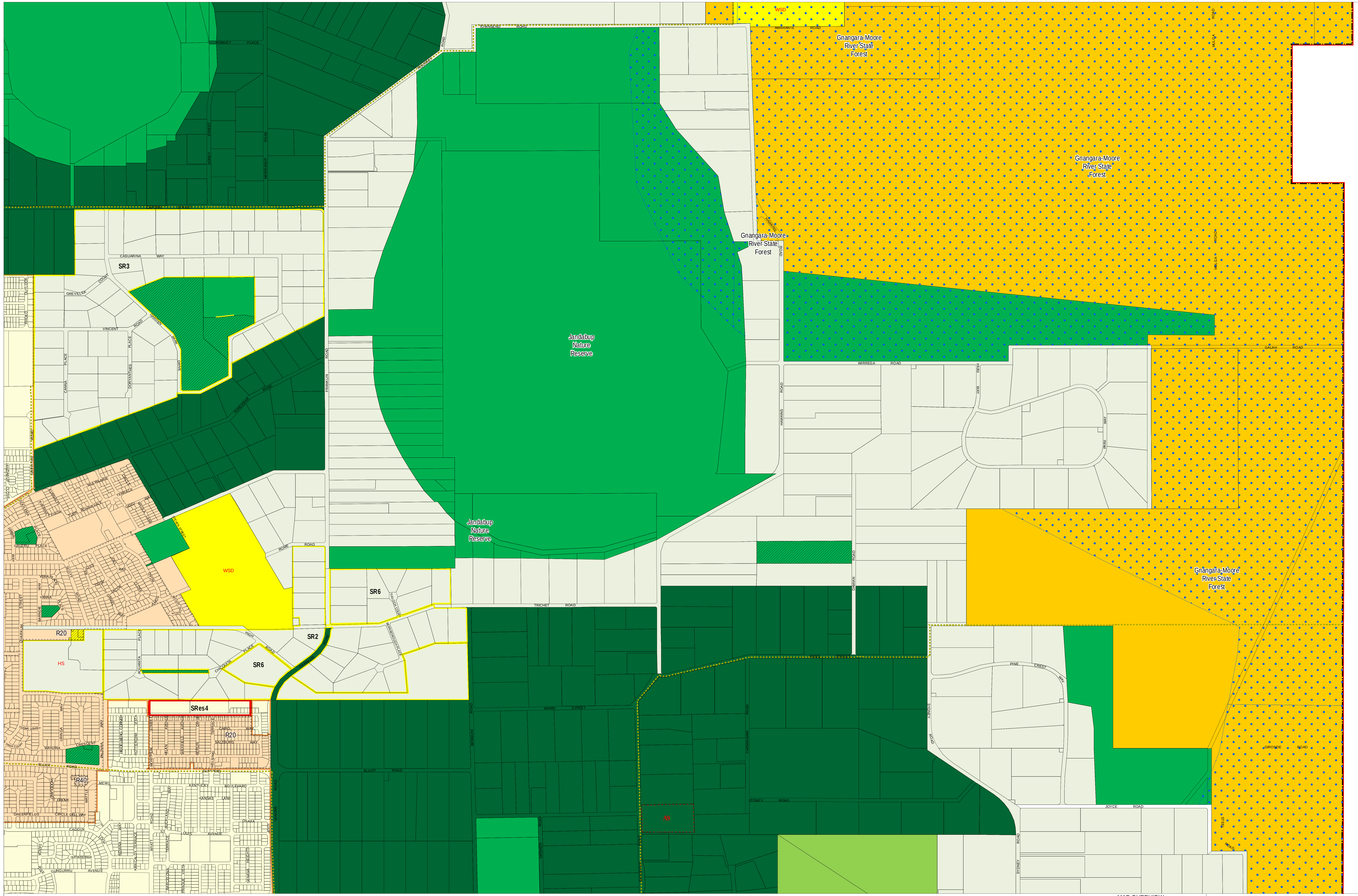
Extract 4: Geological sections showing stratigraphic relationships ofCainozoic and Mesozoic formations (Davidson and Yu 2006)

APPENDIX B DEPARTMENT OF PLANNING MAPS, AUGUST 2015

B.1 Department of Planning, Jandabup Planning Scheme Map

B.2 Department of Planning, Maringiniup Planning Scheme Map

B.3 Department of Planning, Ellenbrook Planning Scheme Map



LEGEND

REGION SCHEME RESERVES (MRS)

🟧 Civic and cultural
🟦 Other regional roads
🟩 Parks and recreation
🟩 R Parks and recreation restricted
▨ Port installations
🟥 Primary regional roads
⬜ Railways
🟨 State forests
⬜ Waterways
⁚ Water catchments

🟨 Public purposes
🟨 CP Public purposes - car park
🟨 CG Public purposes - Commonwealth Government
🟨 HS Public purposes - high school
🟨 H Public purposes - hospital
🟨 P Public purposes - prison
🟨 SU Public purposes - special uses
🟨 SEC Public purposes - State Energy Commission
🟨 TS Public purposes - technical school
🟨 U Public purposes - university
🟨 WSD Public purposes - Water Authority of WA

LOCAL SCHEME RESERVES

(see scheme text for additional information)

▨ Parks and recreation
▨ Public use

▨ HS Public use : High school
▨ PS Public use : Primary school

LOCAL SCHEME ZONES

(see scheme text for additional information)

▥ Business
☐ Centre
▥ Civic and cultural
🟦 Commercial
🟪 General industrial
⬜ General rural
☐ Industrial development
🟦 Marina

🟪 Mixed use
🟩 Private clubs/recreation
🟧 Residential
🟩 Rural resource
🟪 Service industrial
☐ Smart growth community
☐ Special residential
☐ Special rural
☐ Special use
☐ Urban development

OTHER CATEGORIES

(see scheme text for additional information)

☐ Scheme boundary
☐ Local Government boundary
☐ R20 R Codes
☐ A1 Additional uses
☐ R1 Restricted uses
☐ SRes1 Special residential area
☐ SR1 Special rural area
☐ SU1 Special use area
☐ EC1 Environmental condition area
☐ Locality boundary
☐ Rcode subject to agreed structure plan
☐ RC1 Rural community area

☐ No zone
🟦 Waterbodies

VERSION No 1

City of Wanneroo

Town Planning Scheme No. 2

(District Scheme)

Department of Planning

Whilst all care has been taken to accurately portray the current Scheme provisions, no responsibility shall be taken for any omission or errors in this documentation.

Consultation with the respective Local Government should be made to view a legal version of the Scheme. Please advise the Department of Planning of any omissions or errors in the document at Spatialdata@planning.wa.gov.au

Produced by GeoSpatial Planning Support,
Department of Planning.

Base Information Supplied by the Western Australian
Land Information Authority, LI 646-2014-3

City of Wanneroo

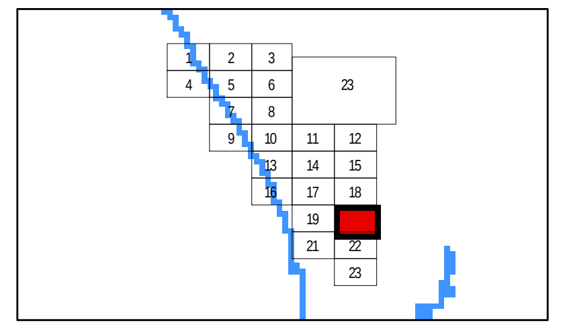
Town Planning Scheme No. 2

(District Scheme)

N

0 250 500 750 1,000
metres

MAP OVERVIEW

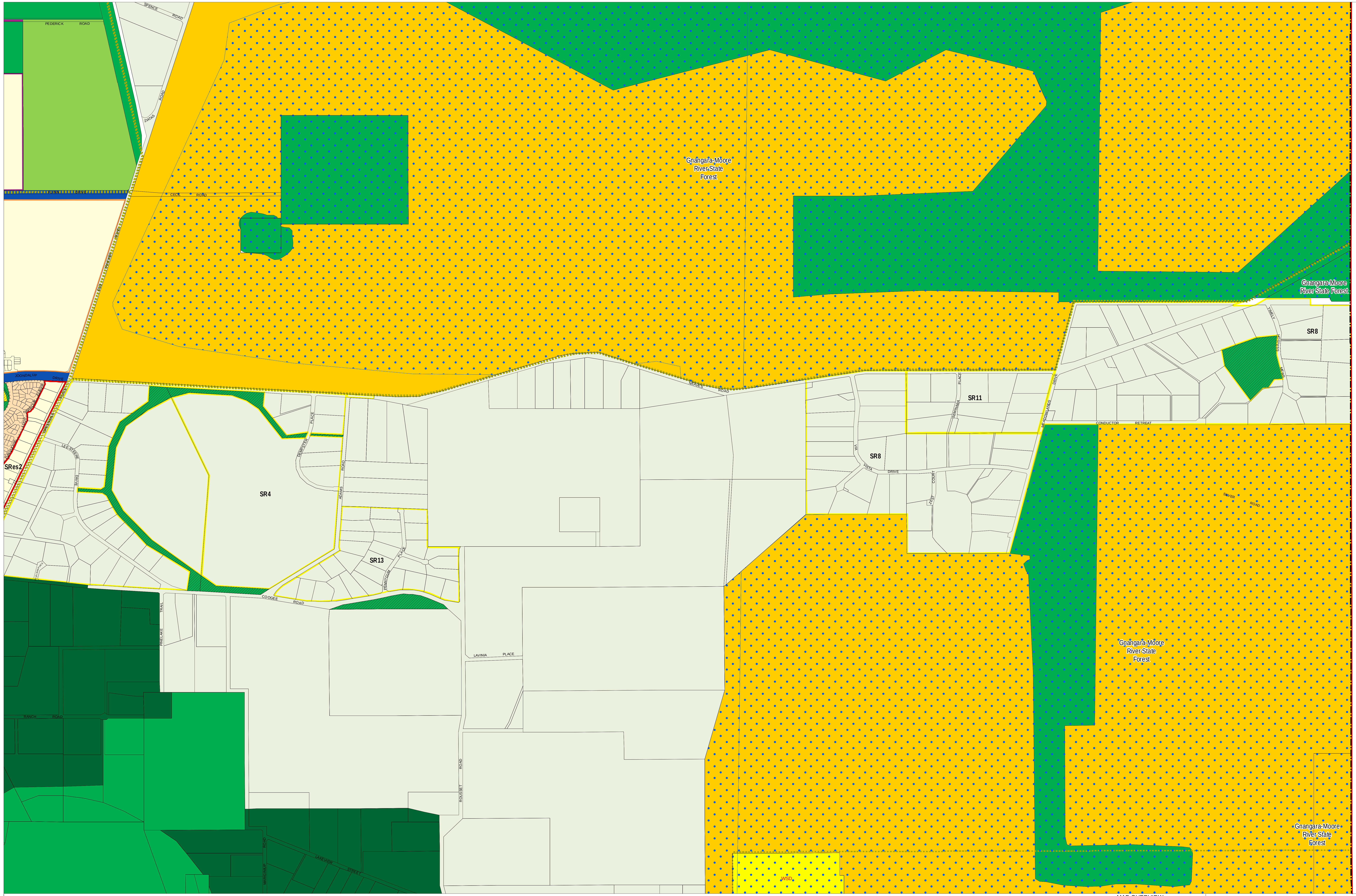


Authorised: T.Servaas

Plot Date: 04 August 2015

G.Gazette: Friday, 6 July 2001

Town Planning Scheme Map No. 20 of 24
MAP: Jandebup Locality



LEGEND

REGION SCHEME RESERVES (MRS)

- 🟧 Civic and cultural
- 🟦 Other regional roads
- 🟩 Parks and recreation
- 🟩 R Parks and recreation restricted
- ▨ Port installations
- 🟥 Primary regional roads
- ⬜ Railways
- 🟨 State forests
- ⬜ Waterways
- ⬚ Water catchments
- 🟨 Public purposes
- 🟨 CP Public purposes - car park
- 🟨 CG Public purposes - Commonwealth Government
- 🟨 HS Public purposes - high school
- 🟨 H Public purposes - hospital
- 🟨 P Public purposes - prison
- 🟨 SU Public purposes - special uses
- 🟨 SEC Public purposes - State Energy Commission
- 🟨 TS Public purposes - technical school
- 🟨 U Public purposes - university
- 🟨 WSD Public purposes - Water Authority of WA

LOCAL SCHEME RESERVES

(see scheme text for additional information)

- ▨ Parks and recreation
- ▨ Public use
- ▨ HS Public use : High school
- ▨ PS Public use : Primary school

LOCAL SCHEME ZONES

(see scheme text for additional information)

- ▨ Business
- ⬜ Centre
- ▨ Civic and cultural
- 🟦 Commercial
- 🟪 General industrial
- ⬜ General rural
- ⬜ Industrial development
- 🟦 Marina
- 🟪 Mixed use
- 🟩 Private clubs/recreation
- 🟧 Residential
- 🟩 Rural resource
- 🟪 Service industrial
- ⬜ Smart growth community
- ⬜ Special residential
- ⬜ Special rural
- ⬜ Special use
- ⬜ Urban development

OTHER CATEGORIES

(see scheme text for additional information)

- ⬚ Scheme boundary
- ⬚ Local Government boundary
- ⬚ R20 R Codes
- ⬚ A1 Additional uses
- ⬚ R1 Restricted uses
- ⬚ SRes1 Special residential area
- ⬚ SR1 Special rural area
- ⬚ SU1 Special use area
- ⬚ EC1 Environmental condition area
- ⬚ Locality boundary
- ⬚ Rcode subject to agreed structure plan
- ⬚ RC1 Rural community area
- ⬜ No zone
- ⬜ Waterbodies

VERSION No 1

City of Wanneroo

Town Planning Scheme No. 2

(District Scheme)

Department of Planning

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Produced by GeoSpatial Planning Support,
Department of Planning.

Base Information Supplied by the Western Australian
Land Information Authority, LI 646-2014-3

City of Wanneroo

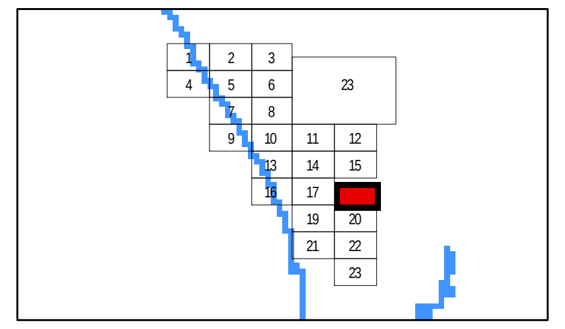
Town Planning Scheme No. 2

(District Scheme)

N

0 250 500 750 1,000
metres

MAP OVERVIEW

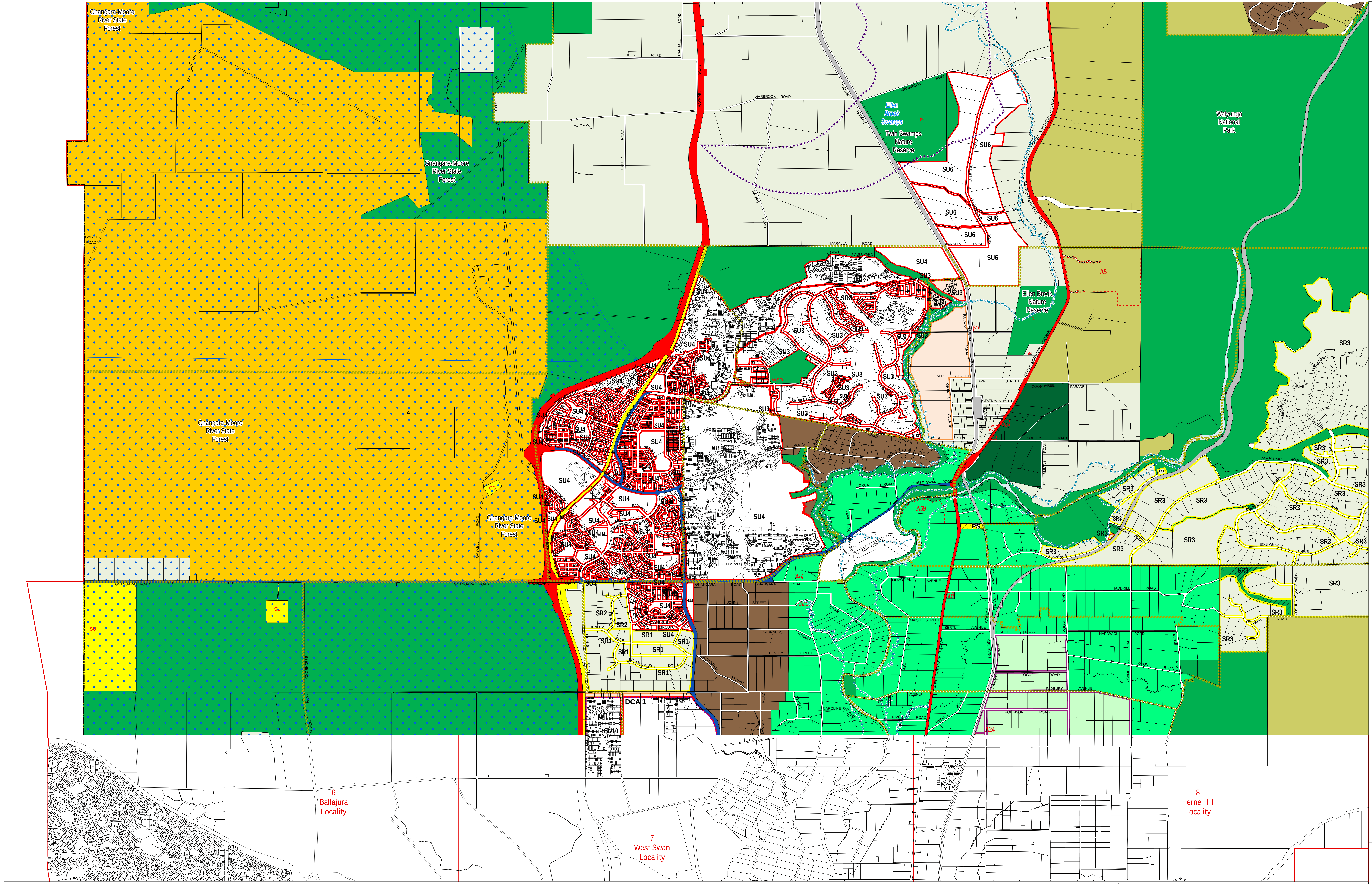


Authorised: T.Servaas

Plot Date: 04 August 2015

G.Gazette: Friday, 6 July 2001

Town Planning Scheme Map No. 18 of 24
MAP: Mariginiup Locality



LEGEND

REGION SCHEME RESERVES (MRS)

🟧		Civic and cultural
🟦		Other regional roads
🟩		Parks and recreation
🟩	R	Parks and recreation restricted
▨		Port installations
🟥		Primary regional roads
⬜		Railways
🟨		State forests
⬜		Waterways
⬜		Water catchments
🟨		Public purposes
🟨	CP	Public purposes - car park
🟨	CG	Public purposes - Commonwealth Government
🟨	HS	Public purposes - high school
🟨	H	Public purposes - hospital
🟨	P	Public purposes - prison
🟨	SU	Public purposes - special uses
🟨	SEC	Public purposes - State Energy Commission
🟨	TS	Public purposes - technical school
🟨	U	Public purposes - university
🟨	WSD	Public purposes - Water Authority of WA

LOCAL SCHEME RESERVES

(see scheme text for additional information)

⬜		Local road
▨		Public purposes
▨	CP	Public purposes : Car park
▨	CB	Public purposes : Cemeteries board
▨	CC	Public purposes : Civic and cultural
▨	FESA	Public purposes : Fire and emergency services
▨	HS	Public purposes : High school
▨	PPS	Public purposes : Pre-primary school
▨	PS	Public purposes : Primary school
▨	P	Public purposes : Prison
▨	TA	Public purposes : Telstra
▨	WC	Public purposes : Water Corporation
▨	WP	Public purposes : Western Power
▨		Recreation

LOCAL SCHEME ZONES

(see scheme text for additional information)

▥	City centre - business
🟦	City centre - commercial deferred
🟦	City centre - mixed use
🟦	City centre - residential
🟦	City centre - shopping
🟦	City centre - showroom
⬜	General commercial
🟪	General industrial
⬜	General rural
⬜	Highway service
⬜	Industrial development
🟨	Landscape
🟪	Light industrial
🟩	Private clubs and institutions
🟧	Residential
⬜	Residential development
⬜	Residential redevelopment
🟩	Resource
⬜	Rural living
🟫	Rural residential
⬜	Special rural
⬜	Special use
🟩	Swan Valley rural

OTHER CATEGORIES

(see scheme text for additional information)

⬚		Scheme boundary
⬜		Local Government boundary
⬜		Midland Redevelopment Area
⬚	R20	R Codes
⬚	A1	Additional uses
⬚	R1	Restricted uses
⬜	SR1	Special rural area
⬜	SU1	Special use area
⬚		Aircraft noise exposure
⬚		Development contribution area boundary
⬚		Flood prone area
⬚		Municipal boundary
⬜		No zone
⬜		Waterbodies

VERSION No 1

City of Swan

Local Planning Scheme No. 17

(District Scheme)

Department of Planning

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Base Information Supplied by the Western Australian Land Information Authority, LI 646-2014-3

City of Swan

Local Planning Scheme No. 17

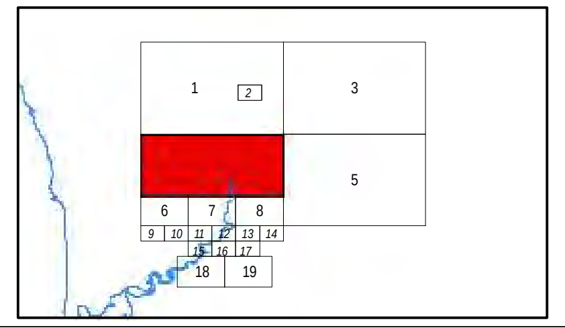
(District Scheme)

N

0 500 1,000 1,500 2,000

metres

MAP OVERVIEW



Authorised: T.Servaas

Plot Date: 17 August 2015

G.Gazette: Monday, 18 February 2008

Local Planning Scheme Map No. 4 of 19
MAP: Ellenbrook Locality

APPENDIX C BASELINE MONITORING PROGRAMME

BASELINE MONITORING PROGRAMME

Frequency	Bore Locations	Parameters	Methodology and QA/QC	Rationale
Monthly	On-site – HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB07B, HMB08	• Groundwater levels • Groundwater quality (EC, pH, temperature, DO)	Groundwater levels to be measured to the nearest cm using a water level meter. Field groundwater quality readings to be taken using a calibrated downhole water quality meter.	Monthly measurements to ensure seasonal variations and short-term trends are captured.
	Off-site – JB10B, JB12A, JB9C, W230, W240, WCM Redrill, WE1B, WE2C, WM24, WM35, WM23.	• Groundwater levels	Collected from the DoW and Water Corporation bores near the project footprint.	To support the on-site monitoring data and to provide a greater spatial representation of groundwater levels in the shallow water table zone.
Biannually	On-site – HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB07B, HMB08	• Groundwater quality (comprehensive DoW suite (DoW 2009b - extract in Appendix D). In addition, the samples will be screened for hydrocarbons, pesticides and herbicides).	Groundwater sampling to be undertaken using low-flow sampling techniques (peristaltic) and where practical dedicated or disposable equipment. *In situ* analysis of groundwater to be conducted using a calibrated water quality meter. QA/QC samples to be taken at the following frequency; • Duplicates and triplicates (1 in 20 primary samples) • Field and rinsate blanks (1 per day of sampling) Samples to be analysed by a NATA accredited laboratory.	To meet the condition outlines in DMP (2006); to provide a certified copy of groundwater analysis from a registered laboratory (salinity, TDS, TSS and pH). To provide background groundwater quality information to support the EIA. To establish antecedent conditions in relation to forestry activities.
	Off-site – JB10B, JB12A, JB9C, W230, W240, WCM Redrill, WE1B, WE2C, WM24, WM35, WM23.	• Groundwater levels • Groundwater quality (EC, pH, temperature, DO)	Collected from nearby private groundwater users (if possible)	To establish baseline conditions in bores of nearby groundwater users.

NB: It is recognised that some of the proposed monitoring bores to be installed within the mine footprint may be destroyed as quarrying operations commence.

Bore WE2B has replaced WE2C in the programme due to a blockage downhole. JB12B has replaced JB12A in the programme due to inconsistencies with data readings.

APPENDIX D RESULTS OF GROUNDWATER LEVEL MONITORING, 2014-2015

Groundwater Levels (2014 - 2015) On Site Monitoring Bores
Jandabup Sand Quarry Project 42908863
Holcim (Australia) Pty Ltd

Appendix D

Bore ID	**HMB01**		**HMB02**		**HMB03**		**HMB04**	
RL collar (m AHD)	**54.647**		**57.496**		**59.498**		**56.937**	
Date	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**
17-Dec-14	6.84	47.81	8.28	49.22	7.74	51.76	9.22	47.72
13-May-15	6.81	47.84	8.42	49.08	8.17	51.33	9.41	47.53
17-Jun-15	6.92	47.73	8.46	49.04	8.07	51.43	9.47	47.47
20-Jul-15	7.00	47.65	8.60	48.90	8.10	51.40	9.58	47.36
14-Aug-15	6.83	47.82	8.54	48.96	8.05	51.45	9.56	47.38
23-Sep-15	6.78	47.87	8.51	48.99	8.97	50.53	9.54	47.40
15-Oct-15	6.82	47.83	8.49	49.01	7.92	51.58	9.34	47.60

Notes

- Not measured or dry

HMB05		**HMB06**		**HMB07B**		**HMB08**	
56.610		**59.078**		**60.560**		**57.052**	
Depth to Water (m btoc)	**Groundwater Elevation (m AHD)**	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**	**Depth to Water (m btoc)**	**Groundwater Elevation (m AHD)**
8.30	48.32	8.84	50.24	13.96	46.61	7.79	49.27
8.48	48.13	9.17	49.91	14.08	46.48	8.09	48.96
8.58	48.03	9.21	49.87	14.24	46.32	8.13	48.92
8.65	47.96	9.23	49.85	14.42	46.14	8.08	48.97
8.7	47.91	9.2	49.88	13.84	46.72	8.01	49.04
8.6	48.01	9.02	50.06	13.7	46.86	7.88	49.17
8.55	48.06	9.02	50.06	13.91	46.65	7.84	49.21

APPENDIX E RESULTS OF FIELD GROUNDWATER QUALITY MONITORING, 2014-2015

		Field Readings						
		pH	Temperature	Electrical conductivity	Total Dissolved Soilds	Dissolved Oxygen	Redox Potential	Comments/Odour Ranking
		pH Units	°C	µS/cm	mg/L	%	mV	
Well	**Date**							
May-15								
HMB01	13-May-15	5.12	20.90	264.40	186.55	6.00	201.50	None
HMB02	13-May-15	5.85	20.20	258.10	184.60	21.70	211.60	Odour Slight organic
HMB03	14-May-15	5.29	22.20	277.20	190.45	9.80	25.00	Odour Strong sulfides
HMB04	13-May-15	5.24	21.70	227.40	157.95	17.40	270.40	Odour Light organic
HMB05	13-May-15	4.27	21.80	251.60	173.55	33.40	316.40	Odour Light organic
HMB06	14-May-15	5.35	21.80	458.30	316.55	10.20	62.80	Odour Light organic
HMB07B	13-May-15	4.48	20.60	173.00	122.85	28.60	285.20	Odour Light organic
HMB08	14-May-15	5.26	23.10	681.00	461.50	12.70	1.20	Odour Sulfides
JB10B	14-May-15	5.54	21.50	730.00	507.00	53.40	220.30	None
JB12B	14-May-15	5.81	21.20	436.50	307.45	18.50	57.80	None
JB9C	14-May-15	5.68	21.00	403.30	284.05	13.40	195.90	None
W230	-	-	-	-	-	-	-	-
W240	-	-	-	-	-	-	-	-
WCM Redrill	14-May-15	4.72	20.00	506.00	364.00	16.80	294.90	Odour Sulfides
WE1B	14-May-15	7.35	20.60	714.00	507.00	70.00	221.00	None
WE2B	14-May-15	7.13	20.80	465.40	328.25	15.80	8.80	Odour Slight organic
WM24	14-May-15	5.17	21.10	260.50	184.60	16.10	123.80	Odour Sulfides
WM35	14-May-15	4.72	19.50	581.00	422.00	21.70	249.20	Odour Sulfides
WM23	14-May-15	6.73	21.40	435.00	303.55	16.00	220.40	None
Jun-15								
HMB01	17-Jun-15	5.04	21.10	232.70	161.20	19.70	222.50	None
HMB02	17-Jun-15	6.24	19.10	317.20	230.75	36.10	200.00	Odour Slight organic
HMB03	17-Jun-15	5.40	20.60	314.30	222.95	15.80	18.70	Odour Slight organic
HMB04	17-Jun-15	5.34	19.50	219.20	159.90	32.10	232.60	None
HMB05	17-Jun-15	4.29	20.20	196.10	140.40	62.70	292.90	None
HMB06	17-Jun-15	5.64	19.60	442.10	319.15	18.40	8.40	Odour Light organic
HMB07B	17-Jun-15	4.56	19.40	168.60	122.85	22.30	262.70	Odour Light organic
HMB08	17-Jun-15	5.44	19.80	682.00	494.00	19.50	16.70	Odour Slight organic
JB10B	18-Jun-15	6.00	20.80	772.00	546.00	45.80	166.60	Odour Slight organic
JB12B	18-Jun-15	5.84	19.90	452.40	325.65	16.00	36.80	Odour Sulfides
JB9C	-	-	-	-	-	-	-	-
W230	-	-	-	-	-	-	-	-
W240	-	-	-	-	-	-	-	-
WCM Redrill	18-Jun-15	4.85	19.90	496.90	356.85	21.30	214.90	Odour Sulfides
WE1B	17-Jun-15	7.49	20.10	754.00	559.00	47.30	66.10	Odour Light organic
WE2B	17-Jun-15	7.29	20.20	469.20	336.05	21.70	-18.70	Odour Slight organic
WM24	18-Jun-15	5.28	20.50	265.00	188.50	22.60	148.40	Odour Sulfides
WM35	18-Jun-15	4.92	19.00	593.00	435.50	33.30	196.90	Odour Sulfides
WM23	18-Jun-15	6.86	20.40	570.00	403.00	47.40	129.30	None

Appendix E - Results of Field Groundwater Quality Monitoring 2014-2015
Jandabup Sand Quarry Project 42908863
Holcim (Australia) Pty Ltd

		Field Readings						
		pH	**Temperature**	**Electrical conductivity**	**Total Dissolved Soilds**	**Dissolved Oxygen**	**Redox Potential**	**Comments/Odour Ranking**
		pH Units	°C	µS/cm	mg/L	%	mV	
Well	**Date**							
Jul-15								
HMB01	20-Jul-15	4.91	20.80	177.50	NT	15.60	151.20	None
HMB02	20-Jul-15	6.30	20.00	222.90	NT	49.80	103.50	Odour Sulfides
HMB03	20-Jul-15	5.34	20.50	248.40	NT	26.10	-56.10	Odour Sulfides
HMB04	20-Jul-15	5.36	19.90	202.30	NT	37.30	122.70	None
HMB05	20-Jul-15	4.37	20.10	195.10	NT	61.70	184.30	None
HMB06	20-Jul-15	5.47	20.10	468.60	NT	18.90	56.30	Odour Sulfides
HMB07B	20-Jul-15	4.92	19.30	189.70	NT	27.10	114.20	None
HMB08	20-Jul-15	5.35	20.50	608.00	NT	20.50	68.90	Odour Sulfides
JB10B	20-Jul-15	6.28	20.40	644.00	NT	60.70	52.40	None
JB12B	20-Jul-15	6.03	19.60	373.90	NT	23.50	-112.50	Odour Sulfides
JB9C	-	-	-	-	-	-	-	-
W230	-	-	-	-	-	-	-	-
W240	-	-	-	-	-	-	-	-
WCM Redrill	20-Jul-15	4.86	19.60	412.10	NT	29.10	172.70	None
WE1B	20-Jul-15	7.40	20.10	665.00	NT	51.80	43.10	None
WE2B	20-Jul-15	7.18	20.30	433.80	NT	24.30	-67.20	None
WM24	20-Jul-15	5.08	20.20	236.10	NT	24.40	56.60	Odour Sulfides
WM35	20-Jul-15	4.94	18.90	524.00	NT	29.30	154.70	None
WM23	20-Jul-15	6.75	20.70	388.00	NT	48.40	6.40	Odour Sulfides
Aug-15								
HMB01	14-Aug-15	4.45	20.00	227.80	162.80	29.60	235.10	None
HMB02	14-Aug-15	5.82	18.10	299.20	218.40	49.40	218.10	None
HMB03	14-Aug-15	4.79	18.80	296.30	296.30	20.10	64.60	Odour Sulfides
HMB04	14-Aug-15	4.72	18.60	243.40	179.40	34.80	207.60	None
HMB05	14-Aug-15	3.69	19.10	250.70	181.70	58.60	228.40	None
HMB06	14-Aug-15	5.17	19.10	544.00	396.50	26.40	77.10	Odour Sulfides
HMB07B	14-Aug-15	3.98	18.60	200.50	147.55	38.20	190.60	None
HMB08	14-Aug-15	5.01	18.80	723.00	533.00	25.80	62.10	None
JB10B	14-Aug-15	5.22	19.00	787.00	578.50	65.70	240.70	None
JB12B	14-Aug-15	5.24	17.30	484.70	367.25	26.00	89.00	None
JB9C	14-Aug-15	5.54	19.00	451.00	330.20	26.10	187.60	None
W230	14-Aug-15	6.44	19.10	291.50	222.10	22.20	16.80	None
W240	14-Aug-15	6.81	19.90	345.00	202.88	44.00	22.01	None
WCM Redrill	14-Aug-15	4.27	19.10	468.90	340.60	31.50	277.80	Odour Sulfides, Rubbish onsite
WE1B	14-Aug-15	7.29	19.30	795.00	578.50	37.40	255.40	None
WE2B	14-Aug-15	7.12	19.20	518.00	377.00	21.20	13.60	Odour Slight organic
WM24	14-Aug-15	4.62	19.80	284.60	205.40	32.70	213.40	Odour Sulfides
WM35	14-Aug-15	4.40	18.50	546.00	481.00	29.40	258.90	None
WM23	14-Aug-15	6.47	19.00	438.00	321.45	51.20	188.80	None
W260	14-Aug-15	5.02	20.40	389.20	266.10	17.80	34.60	None

		Field Readings						
		pH	**Temperature**	**Electrical conductivity**	**Total Dissolved Soilds**	**Dissolved Oxygen**	**Redox Potential**	**Comments/Odour Ranking**
		pH Units	°C	µS/cm	mg/L	%	mV	
Well	**Date**							
Sept-15 (1)								
HMB01	02-Sep-15	5.25	19.70	280.80	172.15	6.90	61.70	None
HMB02	01-Sep-15	5.97	19.70	280.50	171.60	15.70	102.10	Sulfides
HMB03	01-Sep-15	5.34	20.00	298.50	181.50	6.00	-80.40	Sulfides
HMB04	02-Sep-15	5.39	19.20	237.80	147.40	18.20	127.00	None
HMB05	02-Sep-15	4.37	19.40	233.40	144.10	37.40	196.50	None
HMB06	02-Sep-15	5.50	19.90	507.00	308.00	6.20	-72.60	Sulfides strong
HMB07B	02-Sep-15	4.71	18.50	179.50	112.20	22.70	143.50	None
HMB08	02-Sep-15	6.38	19.00	649.00	401.60	7.40	-77.10	Sulfides
JB10B	01-Sep-15	5.69	19.60	769.00	478.50	42.10	109.80	None
JB12B	01-Sep-15	5.72	17.30	436.90	283.90	16.90	-68.20	Sulfides
JB9C	01-Sep-15	5.93	19.20	418.70	260.15	24.00	18.20	Slight sulfides
W230	02-Sep-15	6.19	18.80	316.80	205.15	13.00	-118.70	None
W240	01-Sep-15	6.82	18.80	376.80	239.85	13.30	73.40	Sulfides
WCM Redrill	01-Sep-15	4.88	18.70	440.70	276.10	15.80	120.30	Slight sulfides
WE1B	01-Sep-15	7.56	19.10	786.00	489.50	22.50	26.80	Light organic
WE2B	01-Sep-15	7.21	19.70	508.00	313.50	14.80	116.60	Slight organic
WM24	01-Sep-15	5.34	19.90	295.80	177.65	25.40	89.90	Slight organic
WM35	01-Sep-15	4.84	18.00	616.00	390.50	29.20	195.20	Sulfides
WM23	01-Sep-15	6.65	19.10	363.80	227.70	48.60	32.80	None
W260	01-Sep-15	4.78	19.70	542.00	330.00	13.00	27.90	None
Sept-15 (2)								
HMB01	23-Sep-15	5.06	21.30	205.80	143.65	28.70	193.40	Slight organic
HMB02	23-Sep-15	5.56	20.18	247.30	176.80	49.60	229.60	None
HMB03	23-Sep-15	5.09	20.70	292.50	206.70	18.30	-44.30	Sulfides
HMB04	23-Sep-15	5.28	20.20	193.00	137.15	47.40	183.90	None
HMB05	23-Sep-15	4.14	21.00	193.00	128.70	77.30	283.70	None
HMB06	23-Sep-15	4.81	21.20	548.00	383.50	24.10	170.20	Light organic
HMB07B	23-Sep-15	4.58	20.10	171.40	121.55	27.30	153.90	None
HMB08	23-Sep-15	5.34	20.70	614.00	435.50	21.10	-44.40	Sulfides
JB10B	23-Sep-15	5.82	20.60	744.00	520.00	102.40	174.90	None
JB12B	23-Sep-15	6.58	20.40	444.20	304.20	22.20	-39.50	Sulfides
JB9C	23-Sep-15	5.87	21.30	463.40	327.60	39.80	158.50	None
W230	23-Sep-15	6.00	19.30	292.30	212.55	21.80	-7.90	None
W240	23-Sep-15	6.82	21.20	359.90	250.90	41.30	73.10	None
WCM Redrill	23-Sep-15	4.96	19.80	422.00	282.10	20.60	145.10	Sulfides
WE1B	23-Sep-15	7.28	20.30	705.00	500.60	46.50	153.80	None
WE2B	23-Sep-15	6.48	20.50	480.80	320.45	26.10	139.10	None
WM24	23-Sep-15	5.56	20.00	309.00	174.20	27.30	172.10	None
WM35	23-Sep-15	4.69	19.80	579.00	416.00	29.40	228.80	None
WM23	23-Sep-15	6.28	21.40	287.00	198.90	55.60	133.40	None
W260	23-Sep-15	4.81	20.60	455.40	322.40	29.60	102.30	None

		Field Readings						
		pH	Temperature	Electrical conductivity	Total Dissolved Soilds	Dissolved Oxygen	Redox Potential	Comments/Odour Ranking
		pH Units	°C	µS/cm	mg/L	%	mV	
Well	**Date**							
Oct-15								
HMB01	15-Oct-15	4.96	20.00	181.40	110.00	16.30	69.10	None
HMB02	15-Oct-15	5.73	19.50	186.00	114.40	22.40	57.60	None
HMB03	15-Oct-15	5.16	19.60	259.00	158.95	23.30	-44.00	Strong sulfides
HMB04	15-Oct-15	5.24	20.20	183.60	110.55	33.20	53.40	None
HMB05	15-Oct-15	4.27	19.30	166.80	102.85	65.40	268.30	None
HMB06	15-Oct-15	4.94	20.00	461.40	281.60	22.50	57.60	Light organic
HMB07B	15-Oct-15	4.99	20.10	113.90	68.75	70.20	29.33	None
HMB08	15-Oct-15	5.32	19.60	499.40	306.90	19.30	76.30	Slight Sufides
JB10B	15-Oct-15	5.72	19.70	673.00	412.50	69.20	24.70	None
JB12B	15-Oct-15	6.17	19.40	390.80	239.80	16.30	-120.30	Sulfides
JB9C	15-Oct-15	5.85	20.50	422.70	254.10	32.00	-31.80	None
W230	15-Oct-15	5.98	18.60	262.50	165.00	16.40	-108.20	Slight sulfides
W240	15-Oct-15	6.78	19.80	330.50	200.75	38.30	-47.60	Sulfides
WCM Redrill	15-Oct-15	5.15	20.10	350.50	212.30	17.20	-60.90	Slight sulfides
WE1B	15-Oct-15	7.26	19.80	662.00	401.50	34.00	14.30	None
WE2B	15-Oct-15	7.31	20.30	420.00	249.16	17.40	-31.70	None
WM24	15-Oct-15	5.10	20.30	217.20	132.00	20.60	57.10	Sulfides
WM35	15-Oct-15	5.22	19.40	540.00	330.00	30.00	90.50	Sulfides
WM23	15-Oct-15	6.66	20.60	345.60	206.25	62.30	17.80	Sulfides
W260	15-Oct-15	5.04	20.60	421.10	254.10	15.50	-14.90	None

Legend

- Not measured

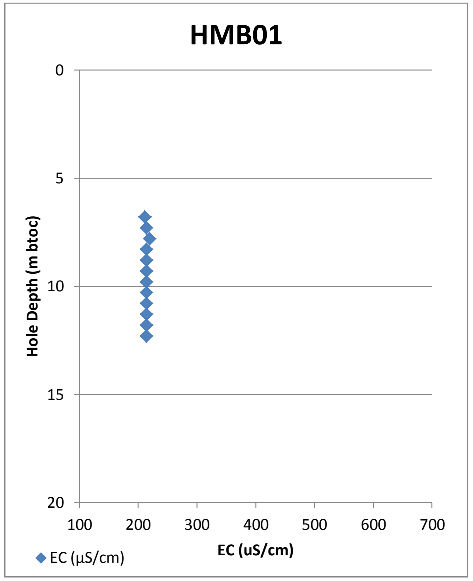
mV = Millivolts

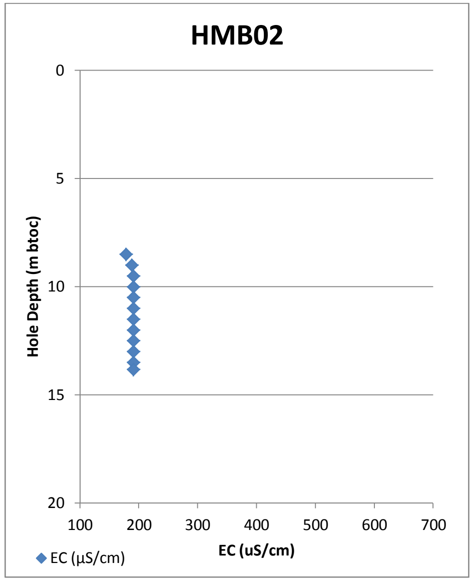
µS/cm = Microsiemens per centimetre

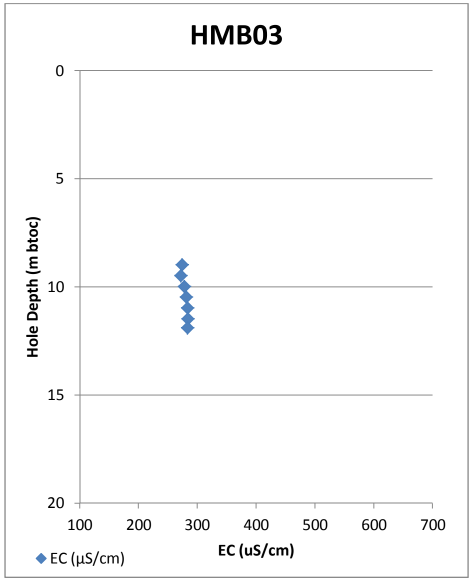
mg/L = Mililgrams per litre

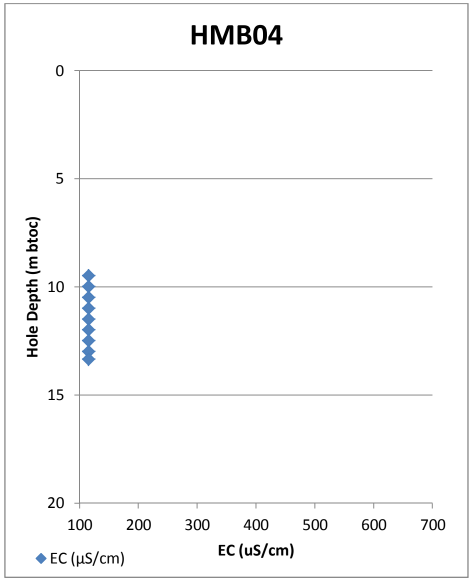
*Bore WE2B has replaced WE2C in the programme due to a blockage downhole. JB12B has replaced JB12A in the programme due to inconsistencies with data readings.

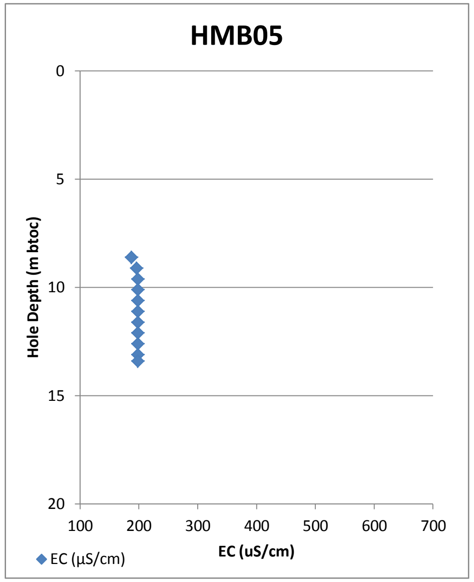
Appendix E
Results of Salinity Profiling
On-site Monitoring Bores
Jandabup Sand Quarry Project 42908863
Holcim (Australia) Pty Ltd

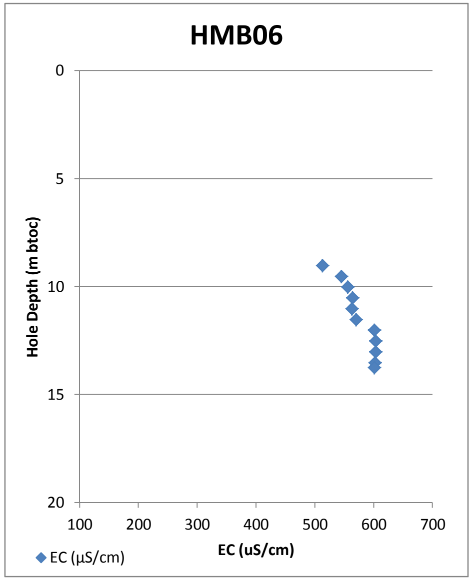


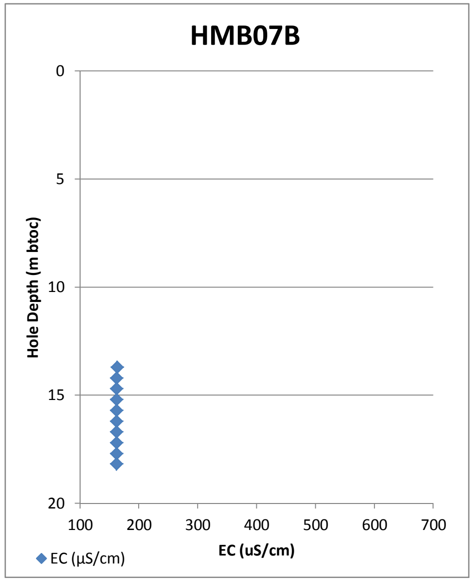


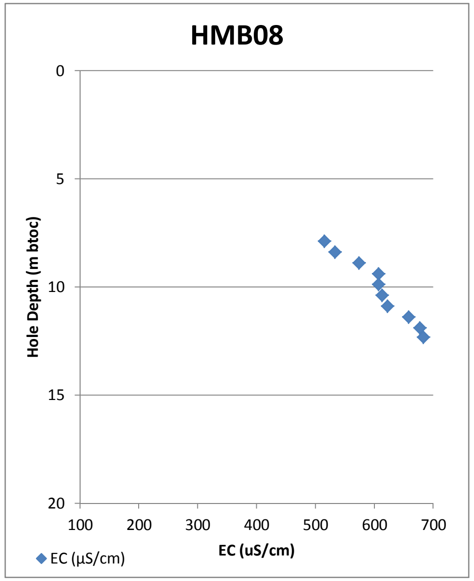












APPENDIX F RESULTS OF LABORATORY ANALYSES OF PROJECT SITE GROUNDWATER

Appendix F
Analytical Groundwater Quality Results - May 2015
Jandabup Water Monitoring
Holcim (Australia) Pty Ltd 42908863

						Location	HMB01	HMB02	HMB03	HMB04	HMB05	HMB06	HMB07B	HMB08
						Sample ID	HMB01	HMB02	HMB03	HMB04	HMB05	HMB06	HMB07	HMB08
						Sample Date	13/05/2015	14/05/2015	14/05/2015	13/05/2015	13/05/2015	14/05/2015	13/05/2015	14/05/2015
						Lab Batch	PE098893-1	PE098893-1	PE098893-1	PE098893-1	PE098893-1	PE098893-1	PE098893-1	PE098893-1
						Sample Type	Primary	Primary	Primary	Primary	Primary	Primary	Primary	Primary
				EPP 1992 Gnangara Mound Environmental Quality Objectives (Groundwater)	**NHMRC 2015 - Australian Drinking Water Health**	**NHMRC 2015 - Australian Drinking Water Aesthetic**								
Chemistry Group	**Analyte**	**Units**	**LOR**											
Total Petroleum Hydrocarbons	C6-C9 fraction	µg/L	40		$15000^{\#}$		<40	<40	<40	<40	<40	<40	<40	<40
	C10-C14 fraction	µg/L	50		$1000^{\#}$		<50	<50	<50	<50	<50	<50	<50	70
	C15-C28 fraction	µg/L	200		$900^{\#}$		<200	<200	<200	<200	<200	<200	<200	380
	C29-C36 fraction	µg/L	200		$900^{\#}$		<200	<200	280	<200	<200	<200	<200	620
	C6-C36 fraction (sum)	µg/L	200	0.5			-	-	280	-	-	-	-	1070
Total Recoverable Hydrocarbons	C6-C10 fraction (minus BTEX)(F1)	µg/L	50				<50	<50	<50	<50	<50	<50	<50	<50
	>C10-C16 fraction	µg/L	60				<60	<60	<60	<60	<60	<60	<60	83
	>C16-C34 fraction	µg/L	500				<500	<500	<500	<500	<500	<500	<500	750
	>C34-C40 fraction	µg/L	500				<500	<500	<500	<500	<500	<500	<500	<500
Benzene	Benzene	µg/L	0.5	0.5	1		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Metals (Dissolved)	Aluminium	mg/L	0.005				0.46	0.036	0.98	0.024	0.64	0.2	0.32	0.64
	Arsenic	mg/L	0.001	0.01	0.01		<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
	Cadmium	mg/L	0.0001		0.002		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001				0.002	0.002	0.005	0.002	0.003	0.004	<0.001	0.003
	Lead	mg/L	0.001	0.01	0.01		<0.001	<0.001	0.003	<0.001	<0.001	0.002	<0.001	0.001
	Manganese	mg/L	0.001	0.02	0.5	0.1	0.01	0.017	0.005	0.002	0.006	0.037	0.01	0.01
	Mercury	mg/L	0.00005	0.0001	0.001		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
	Selenium	mg/L	0.001		0.01		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Zinc	mg/L	0.005	0.02		3	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Physico-Chemical Parameters	Electrical conductivity	µS/cm	2				270	260	270	210	220	430	160	660
	pH	pH Units	0.1	6.5-8.5		6.5-8.5	6.1	6.7	6.1	6.3	5.6	6.3	5.3	6.2
	Redox	mV	-500				372	282	289	467	561	259	604	271
Total Dissolved Solids	Total Dissolved Solids	mg/L	10	100		600	180	180	190	120	120	250	88	420
Alkalinity	Total Alkalinity as CaCO3	mg/L	5				<5	16	13	<5	<5	13	<5	12
	Carbonate as CO3	mg/L	1				<1	<1	<1	<1	<1	<1	<1	<1
	Hardness	mg/L	1				31	38	33	22	17	70	12	170
Nutrients	Nitrate	mg/L	0.2	0.01*	50		2.4	12	<0.2	1.7	10	0.8	6.8	<0.2
	Nitrite	mg/L	0.2		3		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Ammonia	mg/L	0.05	0.01*		0.5	0.1	<0.05	0.61	0.08	<0.05	0.58	<0.05	0.69
	Total Kjeldahl Nitrogen	mg/L	0.05				0.43	0.35	1.2	0.14	0.15	0.82	0.11	1.1
	Reactive Phosphorus (as P)	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Total Phosphorus (as P)	mg/L	0.01	0.02			0.03	0.02	0.01	<0.01	0.03	0.04	<0.01	0.05
Major Ions	Silicon	mg/L	0.02				4.2	2.8	4.9	3.7	3.5	4.8	3.4	6
	Chloride	mg/L	1	20		250	60	53	52	48	43	93	32	87
	Calcium	mg/L	0.2				2.2	9.3	1.5	1.4	1.9	3.9	1	14
	Magnesium	mg/L	0.1				6.1	3.5	7	4.4	3	15	2.3	33
	Potassium	mg/L	0.1				1.4	1.4	1.3	1.3	1	2.9	1.2	3.2
	Silica	mg/L	0.05			80	9	6.1	11	7.8	7.4	10	7.3	13
	Sodium	mg/L	0.5	15		180	32	28	33	26	25	44	20	51
	Sulphate (as SO4-)	mg/L	1	1		250	24	12	29	15	17	43	12	160
Ferrous/Ferric Iron (Dissolved)	Ferrous Iron	mg/L	0.05				<0.05	<0.05	0.24	36	33	0.12	<0.05	0.91
Organochlorine Pesticides (OC)	Aldrin	µg/L	0.1	0.05*			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dieldrin	µg/L	0.1	0.05*			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	a-BHC	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	b-BHC	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	d-BHC	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	g-BHC (Lindane)	µg/L	0.1		10		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	cis-Chlordane	µg/L	0.1	0.3			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	DDD	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	DDE	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	DDT	µg/L	0.1	0.15	9		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endosulfan 1	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endosulfan 2	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endosulfan sulfate	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endrin	µg/L	0.1	0.05*			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endrin ketone	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Heptachlor	µg/L	0.1	0.15	0.3		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Heptachlor epoxide	µg/L	0.1	0.15			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Hexachlorobenzene (HCB)	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Methoxychlor	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	gamma-Chlordane	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Isodrin	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Mirex	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Organophosphorus Pesticides (OP)	Azinphos Methyl	µg/L	0.2	0.5	30		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Bromophos-ethyl	µg/L	0.2		10		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Chlorpyrifos	µg/L	0.2		10		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Diazinon	µg/L	0.5		4		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dichlorvos	µg/L	1		5		<1	<1	<1	<1	<1	<1	<1	<1
	Dimethoate	µg/L	1		7		<1	<1	<1	<1	<1	<1	<1	<1
	Ethion	µg/L	0.2		4		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Fenitrothion	µg/L	0.2		7		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Malathion	µg/L	0.2		70		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Methidathion	µg/L	1		6		<1	<1	<1	<1	<1	<1	<1	<1
	Parathion	µg/L	1	1.5	20		<1	<1	<1	<1	<1	<1	<1	<1

Legend

Exceeds NHMRC/NRMMC, 2011 - Australian Drinking Water Aesthetic Guidelines (Updated March 2015)
Exceeds NHMRC/NRMMC, 2011 - Australian Drinking Water Health Guidelines (Updated March 2015)
Exceeds EPP 1992 Gnangara Mound Environmental Quality Objectives (Groundwater)
 - Not Analysed
µg/L = micrograms per litre
mg/L = milligrams per litre
µS/cm = Microsiemens per centimetre
LOR = Limit of Reporting
* LOR exceeds the guideline value
# Sourced from WHO 2008 - Drinking-water Quality (x10):World Health Organization, 2008. Guidelines for Drinking-water Quality

Appendix F
Analytical Groundwater Quality Results - September 2015
Jandabup Water Monitoring
Holcim (Australia) Pty Ltd 42908863

						Location	HMB01	HMB02	HMB03	HMB04	HMB05	HMB06	HMB06	HMB07B	HMB07B	HMB08
						Sample ID	HMB0902-06	HMB0901-01	HMB0901-02	HMB0902-05	HMB0902-04	HMB0902-03	HMB0902-103	HMB0902-01	HMB0902-101	HMB0902-02
						Sample Date	2/09/2015	1/09/2015	1/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015
						Lab Batch	PE101592	PE101592	PE101592 PE101592A	PE101592	PE101592	PE101592 PE101592A	PE101592	PE101592	PE101592	PE101592 PE101592A
						Sample Type	Primary	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary	Duplicate	Primary
				EPP 1992 Gnangara Mound Environmental Quality Objectives (Groundwater)	**NHMRC 2015 - Australian Drinking Water Health**	**NHMRC 2015 - Australian Drinking Water Aesthetic**										
Chemistry Group	**Analyte**	**Units**	**LOR**													
Total Petroleum Hydrocarbons	C6-C9 fraction	µg/L	40		15000$^{\#}$		<40	<40	<40	<40	<40	<40	<40	<40	<40	<40
	C10-C14 fraction	µg/L	50		1000$^{\#}$		<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	C15-C28 fraction	µg/L	200		900$^{\#}$		<200	<200	<200	<200	<200	210	<200	<200	<200	310
	C29-C36 fraction	µg/L	200		900#		<200	<200	480	<200	<200	390	<200	<200	<200	590
	C6-C36 fraction (sum)	µg/L	200	0.5			-	-	480	-	-	600	-	-	-	900
Total Petroleum Hydrocarbons - Silica Gel	C10-C14 fraction (Silica Gel)	µg/L	50		1000$^{\#}$		-	-	<50	-	-	<50	-	-	-	<50
	C15-C28 fraction (Silica Gel)	µg/L	200		900$^{\#}$		-	-	<200	-	-	<200	-	-	-	<200
	C29-C36 fraction (Silica Gel)	µg/L	200		900$^{\#}$		-	-	450	-	-	330	-	-	-	560
	C10-C36 fraction (Silica Gel) (Sum)	µg/L	200	0.5			-	-	450	-	-	330	-	-	-	560
Total Recoverable Hydrocarbons	C6-C10 fraction (minus BTEX)(F1)	µg/L	50				<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	>C10-C16 fraction	µg/L	60				<60	<60	<60	<60	<60	<60	<60	<60	<60	<60
	>C16-C34 fraction	µg/L	500				<500	<500	<500	<500	<500	<500	<500	<500	<500	630
	>C34-C40 fraction	µg/L	500				<500	<500	<500	<500	<500	<500	<500	<500	<500	640
BTEXN	Benzene	µg/L	0.5	0.5	1		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Toluene	µg/L	0.5		800	25	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Ethylbenzene	µg/L	0.5		300	3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	m&p-Xylene	µg/L	1				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	o-Xylene	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Naphthalene	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Phenolic Compounds	2,4,6-Trichlorophenol	µg/L	0.5		20	2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dinoseb	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Metals (Dissolved)	Aluminium	mg/L	0.02				0.48	0.04	0.95	0.03	0.79	0.3	0.28	0.32	0.34	0.73
	Arsenic	mg/L	0.02	0.01	0.01		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Cadmium	mg/L	0.001		0.002		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Chromium	mg/L	0.005				<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Lead	mg/L	0.02	0.01	0.01		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Manganese	mg/L	0.005	0.02	0.5	0.1	0.013	0.012	0.007	<0.005	0.008	0.035	0.036	0.016	0.014	0.04
	Mercury	mg/L	0.00005	0.0001	0.001		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
	Nickel	mg/L	0.005		0.02		<0.005	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	0.007
	Selenium	mg/L	0.05		0.01		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	Zinc	mg/L	0.01	0.02		3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Physico-Chemical Parameters	Electrical conductivity	µS/cm	2000				<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000	<2000
	pH	pH Units	0.1	6.5-8.5		6.5-8.5	5.7	6.8	6.1	5.9	4.4	6.2	6.2	4.9	4.7	6.1
Total Dissolved Solids	Total Dissolved Solids	mg/L	2	100		600	150	150	160	130	130	280	280	97	97	360
Alkalinity	Total Alkalinity as CaCO3	mg/L	5				<5	23	10	<5	<5	11	9	<5	<5	12
	Carbonate as CO3	mg/L	5				<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Hardness	mg/L	1				34	43	32	24	19	72	72	13	13	180
Nutrients	Nitrate	mg/L	0.2	0.01*	50		2.5	10	<0.2	1.7	11	1.5	1.7	4.2	4.1	<0.2
	Nitrite	mg/L	0.2		3		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Ammonia	mg/L	0.05	0.01*		0.5	0.06	<0.05	0.51	<0.05	<0.05	0.48	0.47	<0.05	<0.05	0.67
	Total Kjeldahl Nitrogen	mg/L	0.05				0.39	0.34	1.1	0.18	0.17	0.73	0.77	0.09	0.1	1.3
	Reactive Phosphorus (as P)	mg/L	0.01				<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Total Phosphorus (as P)	mg/L	0.01	0.02			0.01	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Major Ions	Chloride	mg/L	1	20		250	52	50	53	51	44	100	100	33	33	77
	Bromide	mg/L	0.05				0.17	0.18	0.24	0.12	0.09	0.24	0.24	0.1	0.44	0.33
	Calcium	mg/L	0.2				2.8	11	1.6	1.7	2.1	4.6	4.6	1.2	1.2	15
	Magnesium	mg/L	0.1				6.5	3.7	6.7	4.8	3.2	15	15	2.4	2.3	34
	Potassium	mg/L	0.1				1.7	2	1.6	1.8	1.4	3.7	3.7	1.6	1.5	3.4
	Silica	mg/L	0.05			80	9.6	6.2	10	8.4	8	11	11	7.7	7.9	14
	Sodium	mg/L	0.5	15		180	33	31	36	30	26	52	51	21	21	50
	Sulphate (as SO4-)	mg/L	1	1		250	27	12	25	17	18	45	46	14	14	150
Ferrous/Ferric Iron (Dissolved)	Ferrous Iron	mg/L	0.05				0.29	0.12	0.85	0.11	<0.05	1.3	1.2	0.3	0.3	1.5
Organochlorine Pesticides (OC)	Aldrin	µg/L	0.1	0.05*			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Dieldrin	µg/L	0.1	0.05*			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	a-BHC	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	b-BHC	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	d-BHC	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	g-BHC (Lindane)	µg/L	0.1		10		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	cis-Chlordane	µg/L	0.1	0.3			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	DDD	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	DDE	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	DDT	µg/L	0.1	0.15	9		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endosulfan 1	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endosulfan 2	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endosulfan sulfate	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endrin	µg/L	0.1	0.05*			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Endrin ketone	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Heptachlor	µg/L	0.1	0.15	0.3		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Heptachlor epoxide	µg/L	0.1	0.15			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Hexachlorobenzene (HCB)	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Methoxychlor	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	gamma-Chlordane	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Isodrin	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Mirex	µg/L	0.1				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Appendix F
Analytical Groundwater Quality Results - September 2015
Jandabup Water Monitoring
Holcim (Australia) Pty Ltd 42908863

						Location	HMB01	HMB02	HMB03	HMB04	HMB05	HMB06	HMB06	HMB07B	HMB07B	HMB08
						Sample ID	HMB0902-06	HMB0901-01	HMB0901-02	HMB0902-05	HMB0902-04	HMB0902-03	HMB0902-103	HMB0902-01	HMB0902-101	HMB0902-02
						Sample Date	2/09/2015	1/09/2015	1/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015	2/09/2015
						Lab Batch	PE101592	PE101592	PE101592 PE101592A	PE101592	PE101592	PE101592 PE101592A	PE101592	PE101592	PE101592	PE101592 PE101592A
						Sample Type	Primary	Primary	Primary	Primary	Primary	Primary	Duplicate	Primary	Duplicate	Primary
				EPP 1992 Gnangara Mound Environmental Quality Objectives (Groundwater)	**NHMRC 2015 - Australian Drinking Water Health**	**NHMRC 2015 - Australian Drinking Water Aesthetic**										
Chemistry Group	**Analyte**	**Units**	**LOR**													
Organophosphorus Pesticides (OP)	Azinphos Methyl	µg/L	0.2	0.5	30		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Bromophos-ethyl	µg/L	0.2		10		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Chlorpyrifos	µg/L	0.2		10		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Diazinon	µg/L	0.5		4		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dichlorvos	µg/L	0.5		5		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dimethoate	µg/L	0.5		7		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Ethion	µg/L	0.2		4		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Fenitrothion	µg/L	0.2		7		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Malathion	µg/L	0.2		70		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	Methidathion	µg/L	0.5		6		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Parathion	µg/L	0.2	1.5	20		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Phenoxyacetic Acid Herbicides	2,4,5-TP (Silvex)	µg/L	0.5		10		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2,6-D	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Chlorophenoxy acetic acid	µg/L	1				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Clopyralid	µg/L	0.5		2000		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dicamba	µg/L	0.5		100		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Fluroxypyr	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Mecoprop	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Picloram	µg/L	1		300		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Triclopyr	µg/L	0.5		20		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Herbicides	2,4,5-Trichlorophenoxy acetic acid	µg/L	0.5		100		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2,4-Dichlorophenoxy butanoic acid	µg/L	0.5				<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2,4-Dichlorprop	µg/L	0.5		100		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2,4-Dichlorophenoxy acetic acid	µg/L	0.5	5	30		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Bromoxynil	µg/L	0.5		10		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Methyl-4-chlorophenoxyacetic acid	µg/L	0.5		40		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Methyl-4-Chlorophenoxy Butanoic Acid	µg/L	1				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Other	Actril	µg/L	1				<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Legend
Exceeds NHMRC/NRMMC, 2011 - Australian Drinking Water Aesthetic Guidelines (Updated March 2015)
Exceeds NHMRC/NRMMC, 2011 - Australian Drinking Water Health Guidelines (Updated March 2015)
Exceeds EPP 1992 Gnangara Mound Environmental Quality Objectives (Groundwater)
- Not Analysed
µg/L = micrograms per litre
mg/L = milligrams per litre
µS/cm = Microsiemens per centimetre
* LOR exceeds the guideline value * LOR exceeds the guideline value * LOR ex* LOR ex* LOR exceeds the guideline * LOR exceeds the guideline * LOR exceeds the guide * LOR exceed * LOR exceed * LOR exceed * LOR exceed * LOR exceed * LOR exceed * LOR exceeds * LOR exceed * LOR exceeds * LOR exceed
LOR = Limit of Reporting
# Sourced from WHO 2008 - Drinking-water Quality (x10):World Health Organization, 2008. Guidelines for Drinking-water Quality

SAMPLE RECEIPT ADVICE

PE098893

CLIENT DETAILS

Contact	Conor O'Neill
Client	HOLCIM
Address	PO BOX 138 GOSNELLS WA 6990
Telephone	9391 6461
Facsimile	(Not specified)
Email	conor.oneill@holcim.com
Project	**JAN-HOL-0515**
Order Number	**4599009040**
Samples	8

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
Samples Received	Fri 15/5/2015
Report Due	Tue 26/5/2015
SGS Reference	**PE098893**

SUBMISSION DETAILS

This is to confirm that 8 samples were received on Friday 15/5/2015. Results are expected to be ready by Tuesday 26/5/2015. Please quote SGS reference PE098893 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	8 waters	Type of documentation received	COC
Date documentation received	15/5/2015	Samples received in good order	No - refer to comments
Samples received without headspace	Yes	Sample temperature upon receipt	20.4°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	No - refer to comments	Sufficient sample for analysis	Yes
Sample cooling method	Ice Bricks	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	2

Samples will be held for one month for water samples and two months for soil samples from date of report, unless otherwise instructed.

COMMENTS

Did not receive 'HMB07' but received sample 'HMB07B'. Registered 'HMB07B' as' HMB07B' as 'HMB07' as per NH.
No plastics preserved with HCl provided for ferrous iron analysis - subsampled from 1 L plastic and preserved on receipt.

To the extent not inconsistent with the other provisions of this document and unless specifically agreed otherwise in writing by SGS , all SGS services are rendered in accordance with the applicable SGS General Conditions of Service accessible at http://www.sgs.com/en/Terms-and-Conditions/General-Conditions-of-Services-English.aspx as at the date of this document.
Attention is drawn to the limitations of liability and to the clauses of indemnification.

SAMPLE RECEIPT ADVICE

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0515

SUMMARY OF ANALYSIS

No.	Sample ID	Alkalinity	Chloride by Discrete Analyser in Water	Conductivity and TDS by Calculation - Water	Dissolved Oxygen by Membrane Electrode	pH in water	Redox Potential (Eh) in water	Sulphate in water	Total Dissolved Solids (TDS) in water
001	HMB05	3	1	1	1	1	2	1	1
002	HMB04	3	1	1	1	1	2	1	1
003	HMB01	3	1	1	1	1	2	1	1
004	HMB02	3	1	1	1	1	2	1	1
005	HMB03	3	1	1	1	1	2	1	1
006	HMB06	3	1	1	1	1	2	1	1
007	HMB08	3	1	1	1	1	2	1	1
008	HMB07	3	1	1	1	1	2	1	1

CONTINUED OVERLEAF

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SAMPLE RECEIPT ADVICE

PE098893

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0515

SUMMARY OF ANALYSIS

No.	Sample ID	Ammonia Nitrogen by FIA	Ferrous Iron in water	Filterable Reactive Phosphorus (FRP)	Mercury (dissolved) in Water	Metals in Water (Dissolved) by ICPOES	Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA	TKN Kjeldahl Digestion by Discrete Analyser	Total Phosphorus by Kjeldahl Digestion DA in	Trace Metals (Dissolved) in Water by ICPMS in	Volatile Petroleum Hydrocarbons in Water
001	HMB05	1	1	1	1	7	2	1	1	8	7
002	HMB04	1	1	1	1	7	2	1	1	8	7
003	HMB01	1	1	1	1	7	2	1	1	8	7
004	HMB02	1	1	1	1	7	2	1	1	8	7
005	HMB03	1	1	1	1	7	2	1	1	8	7
006	HMB06	1	1	1	1	7	2	1	1	8	7
007	HMB08	1	1	1	1	7	2	1	1	8	7
008	HMB07	1	1	1	1	7	2	1	1	8	7

CONTINUED OVERLEAF

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SAMPLE RECEIPT ADVICE

PE098893

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0515

SUMMARY OF ANALYSIS

No.	Sample ID	SVOC in Water	TRH (Total Recoverable Hydrocarbons) in Water	VOCs in Water
001	HMB05	38	6	4
002	HMB04	38	6	4
003	HMB01	38	6	4
004	HMB02	38	6	4
005	HMB03	38	6	4
006	HMB06	38	6	4
007	HMB08	38	6	4
008	HMB07	38	6	4

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SGS

SGS Environmental Services
28 Reid Road,
Perth Airport
WA 6105
Tel: 08 9373 3500 Fax: 08 9373 3668

ATTN: Sample Receipt
Email: AU.SampleReceipt.Perth@sgs.com

CHAIN OF CUSTODY & ANALYSIS REQUEST

Lab ID Number: PE098893 *(please quote on all correspondence)*

Page ____ of ____

Please remember to fill in your company details below or attach business card.

Company Name:	HOLCIM Australia	Project Name/No:	JAN-HOL-0515
Address:	18 Brodie Hall Drive Bentley WA 6102	Purchase Order No:	4599009040
		Results Required Date:	may 2015
Contact Name:	Conor O'Neill	Telephone:	92122025
		Fax:	
SGS Client Contact:	Natalie	Email Results to:	conor.oneill@holcim.com ______@______ ______@______
Laboratory Quotation No:			

SGS ID	Client Sample ID	Sampling Date/Time (field record sheet number)	Solid Sample	Liquid Sample	Gas/Air Sample	PRESERVATIVE	NO. OF ITEMS	As per attachment	OC ✓	OP ✓	Herbicides	TRH C6-C40								Notes/Guidelines/LOR/ Special instructions
1	HMB05	13/05/15 @ 1:22		✓																
2	HMB04	13/05/15 @ 2:38		✓																
3	HMB01	13/05/15 @ 4:14		✓																
4	HMB02	13/05/15 @ 9:02		✓																
5	HMB03	14/05/15 @ 10:24		✓																
6	HMB06	14/05/15 @ 11:39		✓																
~~7~~	~~HMB06~~	~~14/05/15 @ 11.~~		~~✓~~																
7	HMB08.	14/05/15. @ 12:53		✓																
8	HMB07	13/05/15 @ 12:01.		✓																

ANALYSIS REQUESTED. SPECIFY & TICK AS APPROPRIATE

Relinquished By:	Date/Time:	Received By: C. Tadena	Date/Time: 15/5/15 @ 12.10 pm
Relinquished By:	Date/Time:	Received By:	Date/Time:
Samples Intact: *Yes / No*	Temperature: *Ambient / Chilled / NA*	Sample Security Sealed: *Yes / No*	
Sampling by SGS: *Yes / No*	Sampler ID:		

Comments / Subcontracting details:
i.e. samples subcontracted to SGS Sydney due to TAT requested

Quarantine: *Yes / No*

Hazards: *e.g. may contain Asbestos*

SGS

AUSTRALIA-ENVIRONMENTAL-PERTH AIRPORT- PROFORMA -QU101

REGISTRATION DETAILS

APPROVED BY: R. MA

Bottle Map	1L	500mL	250mL	500mL	250mL	125mL	1L	500mL	100mL	40mL	40mL	500mL	250mL	125mL	250mL	125mL	1L	Other	Ziplock Bag/ Other
	Plastic	Plastic	Plastic	Amber	Plastic	Plastic	Amber	Amber	Amber	Glass Vial	Glass Vial	Plastic	Plastic	Plastic	Glass Jar	Glass Jar	Plastic	Lab	
Sample Numbers:	Green	Green	Purple	Green	Green	Red	Green	Orange	Green	White	HAA	Blue	Orange	Brown			Yellow		
1-7	1					1			1	2				1(sub)					
8	1					1			1	2				1(sub)					

Job Number: PE098893

# of Eskies: 2

Esky Numbers:

[✓ IB] / ICE / None

Temp: 20.4 °C

Tray Numbers:
W-239, 240
M-19
V-43

Registration comments:

I.D. 8. HMB07 been mislabelled as HMB07B waiting for confirmation
No HCl preserved bottles provided for Fe^{2+}

Action Taken:

was told to go with CoC labelling

→ Subsampled.

Registered By:

CF 20/5/15

①

Appendix C4 Comprehensive analysis

A comprehensive analysis most commonly applies to activities with the potential to contaminate the groundwater, such as horticulture, industry and, in some cases, mining. In these cases additional analytes to those specified in the major component analyses may need to be measured (e.g. nitrate; total phosphorus, indicating possible groundwater pollution by fertilisers).

1 *Field analysis*

- Temperature (°C)
- pH
- Eh
- Conductivity (compensated to 25°C, or if uncompensated – report the value measured and the temperature; report complete units (e.g. mS/cm, not mS)
- Dissolved oxygen
- Bicarbonate (HCO_3)

2 *Laboratory analysis*

<u>Physico-chemical</u>

- pH
- Conductivity (preferably compensated to 25°C; report value measured; compensation factor and complete units (e.g. mS/cm, not mS)
- Total dissolved solids (calculated @ 180°C)
- Total hardness (as $CaCO_3$)
- Total alkalinity (as $CaCO_3$)

<u>Ions (mg/L)</u>

Calcium	Ca
Magnesium	Mg
Sodium	Na
Potassium	K
Ammonia	NH_3
Phosphate	PO_4
Carbonate	CO_3
Bicarbonate	HCO_3
Chloride	Cl
Sulphate	SO_4
Nitrate	NO_3

2

Nitrite	NO_2 ✓
Silica	SiO_2 ✓

Metals (mg/L)

Filter and acidify samples in field

Aluminium	Al ✓
Arsenic	As ✓
Cadmium	Cd ✓
Chromium	Cr ✓
Iron	Fe^{2+} ✓
Lead	Pb ✓
Manganese	Mn ✓
Mercury	Hg ✓
Selenium	Se ✓
Zinc	Zn ✓

Nutrients

Total Kjeldahl nitrogen	TKN ✓
Total phosphorus	TP ✓

Other analytes where appropriate

(e.g. bromide; nickel; organics)

ANALYTICAL REPORT

CLIENT DETAILS

Contact	Conor O'Neill
Client	HOLCIM
Address	PO BOX 138 GOSNELLS WA 6990
Telephone	9391 6461
Facsimile	(Not specified)
Email	conor.oneill@holcim.com
Project	**JAN-HOL-0515**
Order Number	**4599009040**
Samples	8
Date Started	20 May 2015

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE098893 R0**
Report Number	0000108383
Date Reported	02 Jun 2015
Date Received	15 May 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

Metals: The over range results on ICPMS Method AN318 were reported using ICPOES method AN320.

Metals subcontracted to SGS Cairns, 2/58 Comport St, Portsmith QLD 4870, NATA Accreditation Number: 2562, Site Number: 3146,CE115344

SIGNATORIES

Gary Walton
Organics Supervisor

Hue Thanh Ly
Metals Team Leader

Mary Ann Ola-A
Inorganics Team Leader

Michael McKay
Inorganics and ARD Supervisor

Ohmar David
Metals Chemist

		Sample Number	PE098893.001	PE098893.002	PE098893.003	PE098893.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	13 May 2015	13 May 2015	13 May 2015	14 May 2015
		Sample Name	HMB05	HMB04	HMB01	HMB02
Parameter	**Units**	**LOR**				
pH in water Method: AN101 Tested: 15/5/2015						
pH**	pH Units	0.1	5.6	6.3	6.1	6.7
Conductivity and TDS by Calculation - Water Method: AN106 Tested: 15/5/2015						
Conductivity @ 25 C	µS/cm	2	220	210	270	260
Alkalinity Method: ME-AU-ENVAN135 Tested: 15/5/2015						
Bicarbonate Alkalinity as HCO3	mg/L	5	<5	<5	6	20
Carbonate Alkalinity as CO3	mg/L	1	<1	<1	<1	<1
Total Alkalinity as CaCO3	mg/L	5	<5	<5	<5	16
Dissolved Oxygen by Membrane Electrode Method: AN176 Tested: 22/5/2015						
Dissolved Oxygen**	mg/L	1	9.1	9.2	9.2	9.1
Redox Potential (Eh) in water Method: AN240 Tested: 20/5/2015						
Eh of Sample Relative to Standard H^+ Electrode***	mV	-500	561	467	372	282
Temperature of Sample*	°C	0.1	21.7	21.6	22.8	23.9
Chloride by Discrete Analyser in Water Method: AN274 Tested: 20/5/2015						
Chloride, Cl	mg/L	1	43	48	60	53
Sulphate in water Method: AN275 Tested: 20/5/2015						
Sulphate, SO4	mg/L	1	17	15	24	12
Total Dissolved Solids (TDS) in water Method: AN113 Tested: 21/5/2015						
Total Dissolved Solids Dried at 175-185°C	mg/L	10	120	120	180	180

		Sample Number Sample Matrix Sample Date Sample Name	PE098893.001 Water 13 May 2015 HMB05	PE098893.002 Water 13 May 2015 HMB04	PE098893.003 Water 13 May 2015 HMB01	PE098893.004 Water 14 May 2015 HMB02
Parameter	Units	LOR				

Ferrous Iron in water Method: AN271 Tested: 20/5/2015

Ferrous Iron, Fe2+	mg/L	0.05	**33**	**36**	<0.05	<0.05

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 20/5/2015

Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	**10**	**1.7**	**2.4**	**12**

Ammonia Nitrogen by FIA Method: AN261 Tested: 20/5/2015

Ammonia, NH_3	mg/L	0.05	<0.05	**0.08**	**0.10**	<0.05

TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 22/5/2015

Total Kjeldahl Nitrogen	mg/L	0.05	**0.15**	**0.14**	**0.43**	**0.35**

Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 21/5/2015

Filterable Reactive Phosphorus as PO4	mg/L	0.01	<0.01	<0.01	<0.01	<0.01

Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293 Tested: 22/5/2015

Total Phosphorus (Kjeldahl Digestion)	mg/L	0.01	**0.03**	<0.01	**0.03**	**0.02**

Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 25/5/2015

Calcium, Ca	mg/L	0.2	**1.9**	**1.4**	**2.2**	**9.3**
Magnesium, Mg	mg/L	0.1	**3.0**	**4.4**	**6.1**	**3.5**
Potassium, K	mg/L	0.1	**1.0**	**1.3**	**1.4**	**1.4**
Silica, Soluble	mg/L	0.05	**7.4**	**7.8**	**9.0**	**6.1**
Silicon, Si	mg/L	0.02	**3.5**	**3.7**	**4.2**	**2.8**
Sodium, Na	mg/L	0.5	**25**	**26**	**32**	**28**
Total Hardness by Calculation	mg CaCO3/L	1	**17**	**22**	**31**	**38**

		Sample Number	PE098893.001	PE098893.002	PE098893.003	PE098893.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	13 May 2015	13 May 2015	13 May 2015	14 May 2015
		Sample Name	HMB05	HMB04	HMB01	HMB02
Parameter	Units	LOR				

Trace Metals (Dissolved) in Water by ICPMS in mg/L Method: AN318 Tested: 25/5/2015

Aluminium, Al	mg/L	0.005	**0.64**	**0.024**	**0.46**	**0.036**
Arsenic, As	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium, Cr	mg/L	0.001	**0.003**	**0.002**	**0.002**	**0.002**
Lead, Pb	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Manganese, Mn	mg/L	0.001	**0.006**	**0.002**	**0.010**	**0.017**
Selenium, Se	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Zinc, Zn	mg/L	0.005	<0.005	<0.005	<0.005	<0.005

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 25/5/2015

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 20/5/2015

TRH C6-C9	µg/L	40	<40	<40	<40	<40

Surrogates

Dibromofluoromethane (Surrogate)	%	-	**101**	**95**	**100**	**95**
d4-1,2-dichloroethane (Surrogate)	%	-	**99**	**94**	**101**	**100**
d8-toluene (Surrogate)	%	-	**97**	**91**	**94**	**95**
Bromofluorobenzene (Surrogate)	%	-	**93**	**90**	**92**	**92**

VPH F Bands

Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 20/5/2015

TRH C10-C14	µg/L	50	<50	<50	<50	<50
TRH C15-C28	µg/L	200	<200	<200	<200	<200
TRH C29-C36	µg/L	200	<200	<200	<200	<200

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE098893.001 Water 13 May 2015 HMB05	PE098893.002 Water 13 May 2015 HMB04	PE098893.003 Water 13 May 2015 HMB01	PE098893.004 Water 14 May 2015 HMB02

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 20/5/2015 (continued)

TRH F Bands

Parameter	Units	LOR	PE098893.001	PE098893.002	PE098893.003	PE098893.004
TRH >C10-C16 (F2)	µg/L	60	<60	<60	<60	<60
TRH >C16-C34 (F3)	µg/L	500	<500	<500	<500	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500	<500	<500

VOCs in Water Method: AN433/AN434 Tested: 20/5/2015

Surrogates

Parameter	Units	LOR	PE098893.001	PE098893.002	PE098893.003	PE098893.004
Dibromofluoromethane (Surrogate)	%	-	101	95	100	95
d4-1,2-dichloroethane (Surrogate)	%	-	99	94	101	100
d8-toluene (Surrogate)	%	-	97	91	94	95
Bromofluorobenzene (Surrogate)	%	-	93	90	92	92

SVOC in Water Method: AN420 Tested: 20/5/2015

OCs

Parameter	Units	LOR	PE098893.001	PE098893.002	PE098893.003	PE098893.004
Alpha-BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene (HCB)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta-BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Gamma-BHC (Lindane)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Delta-BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Gamma-chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha-chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha-endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p-DDE	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta-endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p-DDD	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p-DDT	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin ketone	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Mirex	µg/L	0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Units	LOR	PE098893.001 Water 13 May 2015 HMB05	PE098893.002 Water 13 May 2015 HMB04	PE098893.003 Water 13 May 2015 HMB01	PE098893.004 Water 14 May 2015 HMB02

Sample Number / Sample Matrix / Sample Date / Sample Name

SVOC in Water Method: AN420 Tested: 20/5/2015 (continued)

OPs

Parameter	Units	LOR	PE098893.001	PE098893.002	PE098893.003	PE098893.004
Dichlorvos	µg/L	1	<1	<1	<1	<1
Dimethoate	µg/L	1	<1	<1	<1	<1
Diazinon (Dimpylate)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Fenitrothion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Malathion (Maldison)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos (Chlorpyrifos Ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Parathion ethyl (Parathion)	µg/L	1	<1.0	<1.0	<1.0	<1.0
Bromophos ethyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Methidathion	µg/L	1	<1	<1	<1	<1
Ethion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Azinphos-methyl (Guthion)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2

Surrogates

Parameter	Units	LOR	PE098893.001	PE098893.002	PE098893.003	PE098893.004
2-fluorobiphenyl (Surrogate)	%	-	52	52	54	48
d5-phenol (Surrogate)	%	-	61	53	57	58
2,4,6-tribromophenol (Surrogate)	%	-	44	46	43	48
d14-p-terphenyl (Surrogate)	%	-	52	58	54	56
d5-nitrobenzene (Surrogate)	%	-	50	54	54	48

		Sample Number	PE098893.005	PE098893.006	PE098893.007	PE098893.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	14 May 2015	14 May 2015	14 May 2015	13 May 2015
		Sample Name	HMB03	HMB06	HMB08	HMB07
Parameter	Units	LOR				

pH in water Method: AN101 Tested: 15/5/2015

pH**	pH Units	0.1	6.1	6.3	6.2	5.3

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 15/5/2015

Conductivity @ 25 C	µS/cm	2	270	430	660	160

Alkalinity Method: ME-AU-ENVAN135 Tested: 15/5/2015

Bicarbonate Alkalinity as HCO3	mg/L	5	16	16	15	<5
Carbonate Alkalinity as CO3	mg/L	1	<1	<1	<1	<1
Total Alkalinity as CaCO3	mg/L	5	13	13	12	<5

Dissolved Oxygen by Membrane Electrode Method: AN176 Tested: 22/5/2015

Dissolved Oxygen**	mg/L	1	8.5	8.4	8.1	8.9

Redox Potential (Eh) in water Method: AN240 Tested: 20/5/2015

Eh of Sample Relative to Standard H^+ Electrode***	mV	-500	289	259	271	604
Temperature of Sample*	°C	0.1	23.9	23.7	24.2	22.3

Chloride by Discrete Analyser in Water Method: AN274 Tested: 20/5/2015

Chloride, Cl	mg/L	1	52	93	87	32

Sulphate in water Method: AN275 Tested: 20/5/2015

Sulphate, SO4	mg/L	1	29	43	160	12

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 21/5/2015

Total Dissolved Solids Dried at 175-185°C	mg/L	10	190	250	420	88

		Sample Number	PE098893.005	PE098893.006	PE098893.007	PE098893.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	14 May 2015	14 May 2015	14 May 2015	13 May 2015
		Sample Name	HMB03	HMB06	HMB08	HMB07
Parameter	**Units**	**LOR**				
Ferrous Iron in water Method: AN271 Tested: 20/5/2015						
Ferrous Iron, Fe2+	mg/L	0.05	0.24	0.12	0.91	<0.05
Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 20/5/2015						
Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	<0.2	0.8	<0.2	6.8
Ammonia Nitrogen by FIA Method: AN261 Tested: 20/5/2015						
Ammonia, NH_3	mg/L	0.05	0.61	0.58	0.69	<0.05
TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 22/5/2015						
Total Kjeldahl Nitrogen	mg/L	0.05	1.2	0.82	1.1	0.11
Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 21/5/2015						
Filterable Reactive Phosphorus as PO4	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293 Tested: 22/5/2015						
Total Phosphorus (Kjeldahl Digestion)	mg/L	0.01	0.01	0.04	0.05	<0.01
Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 25/5/2015						
Calcium, Ca	mg/L	0.2	1.5	3.9	14	1.0
Magnesium, Mg	mg/L	0.1	7.0	15	33	2.3
Potassium, K	mg/L	0.1	1.3	2.9	3.2	1.2
Silica, Soluble	mg/L	0.05	11	10	13	7.3
Silicon, Si	mg/L	0.02	4.9	4.8	6.0	3.4
Sodium, Na	mg/L	0.5	33	44	51	20
Total Hardness by Calculation	mg CaCO3/L	1	33	70	170	12

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE098893.005 Water 14 May 2015 HMB03	PE098893.006 Water 14 May 2015 HMB06	PE098893.007 Water 14 May 2015 HMB08	PE098893.008 Water 13 May 2015 HMB07

Trace Metals (Dissolved) in Water by ICPMS in mg/L Method: AN318 Tested: 25/5/2015

Parameter	Units	LOR	PE098893.005	PE098893.006	PE098893.007	PE098893.008
Aluminium, Al	mg/L	0.005	**0.98**	**0.20**	**0.64**	**0.32**
Arsenic, As	mg/L	0.001	**0.002**	<0.001	<0.001	<0.001
Cadmium, Cd	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium, Cr	mg/L	0.001	**0.005**	**0.004**	**0.003**	<0.001
Lead, Pb	mg/L	0.001	**0.003**	**0.002**	**0.001**	<0.001
Manganese, Mn	mg/L	0.001	**0.005**	**0.037**	**0.010**	**0.010**
Selenium, Se	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Zinc, Zn	mg/L	0.005	<0.005	<0.005	<0.005	<0.005

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 25/5/2015

Parameter	Units	LOR	PE098893.005	PE098893.006	PE098893.007	PE098893.008
Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 20/5/2015

Parameter	Units	LOR	PE098893.005	PE098893.006	PE098893.007	PE098893.008
TRH C6-C9	µg/L	40	<40	<40	<40	<40

Surrogates

Parameter	Units	LOR	PE098893.005	PE098893.006	PE098893.007	PE098893.008
Dibromofluoromethane (Surrogate)	%	-	**104**	**92**	**94**	**94**
d4-1,2-dichloroethane (Surrogate)	%	-	**104**	**103**	**97**	**103**
d8-toluene (Surrogate)	%	-	**99**	**95**	**89**	**93**
Bromofluorobenzene (Surrogate)	%	-	**92**	**91**	**86**	**93**

VPH F Bands

Parameter	Units	LOR	PE098893.005	PE098893.006	PE098893.007	PE098893.008
Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 20/5/2015

Parameter	Units	LOR	PE098893.005	PE098893.006	PE098893.007	PE098893.008
TRH C10-C14	µg/L	50	<50	<50	**70**	<50
TRH C15-C28	µg/L	200	<200	<200	**380**	<200
TRH C29-C36	µg/L	200	**280**	<200	**620**	<200

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name: PE098893.005 Water 14 May 2015 HMB03	PE098893.006 Water 14 May 2015 HMB06	PE098893.007 Water 14 May 2015 HMB08	PE098893.008 Water 13 May 2015 HMB07

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 20/5/2015 (continued)

TRH F Bands

TRH >C10-C16 (F2)	µg/L	60	<60	<60	**83**	<60
TRH >C16-C34 (F3)	µg/L	500	<500	<500	**750**	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500	<500	<500

VOCs in Water Method: AN433/AN434 Tested: 20/5/2015

Surrogates

Dibromofluoromethane (Surrogate)	%	-	**104**	**92**	**94**	**94**
d4-1,2-dichloroethane (Surrogate)	%	-	**104**	**103**	**97**	**103**
d8-toluene (Surrogate)	%	-	**99**	**95**	**89**	**93**
Bromofluorobenzene (Surrogate)	%	-	**92**	**91**	**86**	**93**

SVOC in Water Method: AN420 Tested: 20/5/2015

OCs

Alpha-BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene (HCB)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta-BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Gamma-BHC (Lindane)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Delta-BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Gamma-chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha-chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha-endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p-DDE	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta-endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p-DDD	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p-DDT	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin ketone	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Mirex	µg/L	0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE098893.005 Water 14 May 2015 HMB03	PE098893.006 Water 14 May 2015 HMB06	PE098893.007 Water 14 May 2015 HMB08	PE098893.008 Water 13 May 2015 HMB07

SVOC in Water Method: AN420 Tested: 20/5/2015 (continued)

OPs

Dichlorvos	µg/L	1	<1	<1	<1	<1
Dimethoate	µg/L	1	<1	<1	<1	<1
Diazinon (Dimpylate)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Fenitrothion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Malathion (Maldison)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos (Chlorpyrifos Ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Parathion ethyl (Parathion)	µg/L	1	<1.0	<1.0	<1.0	<1.0
Bromophos ethyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Methidathion	µg/L	1	<1	<1	<1	<1
Ethion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Azinphos-methyl (Guthion)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2

Surrogates

2-fluorobiphenyl (Surrogate)	%	-	60	54	66	50
d5-phenol (Surrogate)	%	-	59	63	68	61
2,4,6-tribromophenol (Surrogate)	%	-	49	53	57	56
d14-p-terphenyl (Surrogate)	%	-	62	62	66	62
d5-nitrobenzene (Surrogate)	%	-	58	56	64	60

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Alkalinity Method: ME-AU-ENVAN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Bicarbonate Alkalinity as HCO3	LB102964	mg/L	5	<5		
Carbonate Alkalinity as CO3	LB102964	mg/L	1	<1		
Total Alkalinity as CaCO3	LB102964	mg/L	5	<5	0 - 10%	102%

Ammonia Nitrogen by FIA Method: ME-(AU)-[ENV]AN261

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Ammonia, NH_3	LB102949	mg/L	0.05	<0.05	1 - 31%	98 - 101%

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Chloride, Cl	LB102946	mg/L	1	<1	0 - 1%	104%	92 - 96%

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity @ 25 C	LB102962	µS/cm	2	<2	0%	99%

Dissolved Oxygen by Membrane Electrode Method: ME-(AU)-[ENV]AN176

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Dissolved Oxygen**	LB102999	mg/L	1	<1.0	1%	105%

Ferrous Iron in water Method: ME-(AU)-[ENV]AN271

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Ferrous Iron, Fe2+	LB102943	mg/L	0.05	<0.05	0%	111%

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Filterable Reactive Phosphorus (FRP) Method: ME-(AU)-[ENV]AN278

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Filterable Reactive Phosphorus as PO4	LB102982	mg/L	0.01	<0.01	0%	NA	NA

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB103122	mg/L	0.00005	<0.00005	0%	98%	91%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320/AN321

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Calcium, Ca	LB103176	mg/L	0.2	<0.2	0%	91%	90%
Magnesium, Mg	LB103176	mg/L	0.1	<0.1	1%	95%	94%
Potassium, K	LB103176	mg/L	0.1	<0.1	1%	105%	104%
Silica, Soluble	LB103176	mg/L	0.05	<0.05			
Silicon, Si	LB103176	mg/L	0.02	<0.02	1%	103%	104%
Sodium, Na	LB103176	mg/L	0.5	<0.5	1%	92%	90%
Total Hardness by Calculation	LB103176	mg CaCO3/L	1	<1			

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB102962	pH Units	0.1	5.9	0 - 2%	100%

Redox Potential (Eh) in water Method: ME-(AU)-[ENV]AN240

Parameter	QC Reference	Units	LOR	DUP %RPD	LCS %Recovery
Eh of Sample Relative to Standard H^+ Electrode***	LB102971	mV	-500	0%	103%

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Sulphate in water Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulphate, SO4	LB102946	mg/L	1	<1	0 - 2%	106%	91 - 97%

SVOC in Water Method: ME-(AU)-[ENV]AN420

OCs

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Alpha-BHC	LB102905	µg/L	0.1	<0.1	
Hexachlorobenzene (HCB)	LB102905	µg/L	0.1	<0.1	57%
Beta-BHC	LB102905	µg/L	0.1	<0.1	
Gamma-BHC (Lindane)	LB102905	µg/L	0.1	<0.1	59%
Delta-BHC	LB102905	µg/L	0.1	<0.1	
Heptachlor	LB102905	µg/L	0.1	<0.1	55%
Aldrin	LB102905	µg/L	0.1	<0.1	53%
Heptachlor epoxide	LB102905	µg/L	0.1	<0.1	
Isodrin	LB102905	µg/L	0.1	<0.1	58%
Gamma-chlordane	LB102905	µg/L	0.1	<0.1	54%
Alpha-chlordane	LB102905	µg/L	0.1	<0.1	
Alpha-endosulfan	LB102905	µg/L	0.1	<0.1	
p,p-DDE	LB102905	µg/L	0.1	<0.1	56%
Dieldrin	LB102905	µg/L	0.1	<0.1	56%
Endrin	LB102905	µg/L	0.1	<0.1	67%
Beta-endosulfan	LB102905	µg/L	0.1	<0.1	
p,p-DDD	LB102905	µg/L	0.1	<0.1	
Endosulfan sulphate	LB102905	µg/L	0.1	<0.1	
p,p-DDT	LB102905	µg/L	0.1	<0.1	
Endrin ketone	LB102905	µg/L	0.1	<0.1	
Methoxychlor	LB102905	µg/L	0.1	<0.1	
Mirex	LB102905	µg/L	0.1	<0.1	57%

OPs

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Dichlorvos	LB102905	µg/L	1	<1	
Dimethoate	LB102905	µg/L	1	<1	
Diazinon (Dimpylate)	LB102905	µg/L	0.5	<0.5	59%
Fenitrothion	LB102905	µg/L	0.2	<0.2	
Malathion (Maldison)	LB102905	µg/L	0.2	<0.2	
Chlorpyrifos (Chlorpyrifos Ethyl)	LB102905	µg/L	0.2	<0.2	62%
Parathion ethyl (Parathion)	LB102905	µg/L	1	<1.0	91%
Bromophos ethyl	LB102905	µg/L	0.2	<0.2	
Methidathion	LB102905	µg/L	1	<1	53%
Ethion	LB102905	µg/L	0.2	<0.2	
Azinphos-methyl (Guthion)	LB102905	µg/L	0.2	<0.2	

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
2-fluorobiphenyl (Surrogate)	LB102905	%	-	44%	40%
d5-phenol (Surrogate)	LB102905	%	-	43%	61%
2,4,6-tribromophenol (Surrogate)	LB102905	%	-	41%	47%
d14-p-terphenyl (Surrogate)	LB102905	%	-	56%	56%
d5-nitrobenzene (Surrogate)	LB102905	%	-	50%	54%

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

TKN Kjeldahl Digestion by Discrete Analyser Method: ME-(AU)-[ENV]AN281

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Kjeldahl Nitrogen	LB103050	mg/L	0.05	<0.05	2 - 16%	98%

Total Dissolved Solids (TDS) in water Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB102975	mg/L	10	<10	1 - 2%	97%	97%	0%

Total Phosphorus by Kjeldahl Digestion DA in Water Method: ME-(AU)-[ENV]AN279/AN293

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Phosphorus (Kjeldahl Digestion)	LB103050	mg/L	0.01	<0.01	0 - 20%	109%

Trace Metals (Dissolved) in Water by ICPMS in mg/L Method: ME-(AU)-[ENV]AN318

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium, Al	LB103175	mg/L	0.005	<0.005		111%	
Arsenic, As	LB103175	mg/L	0.001	0.000	27%	110%	106%
Cadmium, Cd	LB103175	mg/L	0.0001	<0.0001	0%	105%	107%
Chromium, Cr	LB103175	mg/L	0.001	0.000	5%	110%	103%
Lead, Pb	LB103175	mg/L	0.001	0.000	7%	106%	103%
Manganese, Mn	LB103175	mg/L	0.001	0.000	2%	111%	102%
Selenium, Se	LB103175	mg/L	0.001	<0.001	0%	102%	110%
Zinc, Zn	LB103175	mg/L	0.005	0.000	5%	118%	111%

TRH (Total Recoverable Hydrocarbons) in Water Method: ME-(AU)-[ENV]AN403

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH C10-C14	LB102905	µg/L	50	<50	68%
TRH C15-C28	LB102905	µg/L	200	<200	70%
TRH C29-C36	LB102905	µg/L	200	<200	70%

TRH F Bands

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH >C10-C16 (F2)	LB102905	µg/L	60	<60	68%
TRH >C16-C34 (F3)	LB102905	µg/L	500	<500	70%
TRH >C34-C40 (F4)	LB102905	µg/L	500	<500	70%

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

VOCs in Water **Method: ME-(AU)-[ENV]AN433/AN434**

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Dibromofluoromethane (Surrogate)	LB102919	%	-	95%	103%
d4-1,2-dichloroethane (Surrogate)	LB102919	%	-	100%	106%
d8-toluene (Surrogate)	LB102919	%	-	96%	98%
Bromofluorobenzene (Surrogate)	LB102919	%	-	95%	94%

Volatile Petroleum Hydrocarbons in Water **Method: ME-(AU)-[ENV]AN433/AN434/AN410**

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH C6-C9	LB102919	µg/L	40	<40	99%

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Dibromofluoromethane (Surrogate)	LB102919	%	-	95%	103%
d4-1,2-dichloroethane (Surrogate)	LB102919	%	-	100%	106%
d8-toluene (Surrogate)	LB102919	%	-	96%	98%
Bromofluorobenzene (Surrogate)	LB102919	%	-	95%	94%

VPH F Bands

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Benzene (F0)	LB102919	µg/L	0.5	<0.5	86%
TRH C6-C10 minus BTEX (F1)	LB102919	µg/L	50	<50	

METHOD	METHODOLOGY SUMMARY
	Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F.
AN083	Separatory funnels are used for aqueous samples and extracted by transferring an appropriate volume (mass) of liquid into a separatory funnel and adding 3 serial aliquots of dichloromethane. Samples receive a single extraction at pH 7 to recover base / neutral analytes and two extractions at pH < 2 to recover acidic analytes. QC samples are prepared by spiking organic free water with target analytes and extracting as per samples.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2520 B.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135
AN135	Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.
AN176	Dissolved Oxygen: Dissolved oxygen is measured directly using an oxygen permeable membrane electrode and meter. Under steady state conditions the current is directly proportional to the DO concentration. Samples with no headspace are required for this analysis and if headspace is observed this will be recorded on the report. Internal Reference is AN176 based on APHA 4500-O, C and G.
AN240	Oxidation-Reduction Potential (Eh): Electrometric measurements are made by potentiometric determination of electron activity (or intensity) with an inert indicator electrode and a suitable reference electrode. At redox equilibrium, the potential difference between the two electrodes equals the redox potential of the system . This measurement is then corrected for the difference between the potential of the reference electrode and that of the standard hydrogen electrode.
AN261	Ammonia by Continuous Flow Analyser: Ammonium in a basic medium forms ammonia gas, which is separated from the sample matrix by diffusion through a polypropylene membrane. The ammonia is reacted with phenol and hypochlorite to form indophenol blue at an intensity proportional to the ammonia concentration. The blue colour is intensified with sodium nitroprusside and the absorbance measured at 630 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-NH3 H.
AN271	Ferrous Iron by Aquakem DA: Iron in the ferrous state is treated with 1,10-phenathroline at pH 3.2. The intensity of the resultant orange/red coloured solution is proportional to the amount of ferrous iron present. Reference APHA 3500-Fe D.
AN274	Chloride by Aquakem DA: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-

METHOD	METHODOLOGY SUMMARY
AN275	Sulphate by Aquakem DA: Sulphate is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulphate concentration in the sample. Reference APHA 4500-SO42-. Internal reference AN275.
AN278	Reactive Phosphorus by DA: Orthophosphate reacts with ammonium molybdate (Mo VI) and potassium antimonyl tartrate (Sb III) in acid medium to form an antimony-phosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue colour and the absorbance is read at 880 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-P F
AN279/AN293	The sample is digested with Sulphuric acid, K2SO4 and CuSO4. All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.
AN281	An unfiltered water or soil sample is first digested in a block digestor with sulphuric acid, K2SO4 and CuSO4. The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.
AN311/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN318	Determination of elements at trace level in waters by ICP-MS technique, in accordance with USEPA 6020A.
AN320/AN321	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components .
AN320/AN321	Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the Draft NEPM 2011, >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is not corrected for Naphthalene.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents .
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependant on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN433/AN434	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.
AN433/AN434/AN410	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	This analysis is not covered by the scope of accreditation.	QFH	QC result is above the upper tolerance
**	Indicative data, theoretical holding time exceeded.	QFL	QC result is below the lower tolerance
^	Performed by outside laboratory.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here:
http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions/General-Conditions-of-Services-English.aspx. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

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SAMPLE RECEIPT ADVICE

PE101592

CLIENT DETAILS

Contact	Conor O'Neill
Client	HOLCIM
Address	PO BOX 138 GOSNELLS WA 6990
Telephone	9391 6461
Facsimile	(Not specified)
Email	conor.oneill@holcim.com
Project	**JAN-HOL-0915**
Order Number	**4599009040**
Samples	10

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
Samples Received	Thu 3/9/2015
Report Due	Thu 10/9/2015
SGS Reference	**PE101592**

SUBMISSION DETAILS

This is to confirm that 10 samples were received on Thursday 3/9/2015. Results are expected to be ready by Thursday 10/9/2015. Please quote SGS reference PE101592 when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	10 Water	Type of documentation received	COC
Date documentation received	3/9/2015	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	14°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	No-refer to comments	Sufficient sample for analysis	Yes
Sample cooling method	Ice Bricks	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	1

Samples will be held for one month for water samples and two months for soil samples from date of report, unless otherwise instructed.

COMMENTS

Subsampled for Ferrous Iron as no appropriate container was received.

To the extent not inconsistent with the other provisions of this document and unless specifically agreed otherwise in writing by SGS , all SGS services are rendered in accordance with the applicable SGS General Conditions of Service accessible at http://www.sgs.com/en/Terms-and-Conditions/General-Conditions-of-Services-English.aspx as at the date of this document.
Attention is drawn to the limitations of liability and to the clauses of indemnification.

SAMPLE RECEIPT ADVICE

PE101592

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0915

SUMMARY OF ANALYSIS

No.	Sample ID	Alkalinity	Ammonia Nitrogen by FIA	Chloride by Discrete Analyser in Water	Conductivity and TDS by Calculation - Water	Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA	pH in water	Sulphate in water	TKN Kjeldahl Digestion by Discrete Analyser
001	HMB0901-01	3	1	1	2	2	1	1	1
002	HMB0901-02	3	1	1	2	2	1	1	1
003	HMB0902-01	3	1	1	2	2	1	1	1
004	HMB0902-101	3	1	1	2	2	1	1	1
005	HMB0902-02	3	1	1	2	2	1	1	1
006	HMB0902-03	3	1	1	2	2	1	1	1
007	HMB0902-103	3	1	1	2	2	1	1	1
008	HMB0902-04	3	1	1	2	2	1	1	1
009	HMB0902-05	3	1	1	2	2	1	1	1
010	HMB0902-06	3	1	1	2	2	1	1	1

CONTINUED OVERLEAF

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SAMPLE RECEIPT ADVICE

PE101592

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0915

SUMMARY OF ANALYSIS

No.	Sample ID	Anions by Ion Chromatography in Water	Ferrous Iron in water	Filterable Reactive Phosphorus (FRP)	Mercury (dissolved) in Water	Metals in Water (Dissolved) by ICPOES	Total Phosphorus by Kjeldahl Digestion DA in	TRH (Total Recoverable Hydrocarbons) in Water	VOCs in Water	Volatile Petroleum Hydrocarbons in Water
001	HMB0901-01	1	1	1	1	15	1	6	10	7
002	HMB0901-02	1	1	1	1	15	1	6	10	7
003	HMB0902-01	1	1	1	1	15	1	6	10	7
004	HMB0902-101	1	1	1	1	15	1	6	10	7
005	HMB0902-02	1	1	1	1	15	1	6	10	7
006	HMB0902-03	1	1	1	1	15	1	6	10	7
007	HMB0902-103	1	1	1	1	15	1	6	10	7
008	HMB0902-04	1	1	1	1	15	1	6	10	7
009	HMB0902-05	1	1	1	1	15	1	6	10	7
010	HMB0902-06	1	1	1	1	15	1	6	10	7

CONTINUED OVERLEAF

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SAMPLE RECEIPT ADVICE

PE101592

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0915

SUMMARY OF ANALYSIS

No.	Sample ID	Acid Herbicides in Water	OC Pesticides in Water	OP Pesticides in Water
001	HMB0901-01	20	24	12
002	HMB0901-02	20	24	12
003	HMB0902-01	20	24	12
004	HMB0902-101	20	24	12
005	HMB0902-02	20	24	12
006	HMB0902-03	20	24	12
007	HMB0902-103	20	24	12
008	HMB0902-04	20	24	12
009	HMB0902-05	20	24	12
010	HMB0902-06	20	24	12

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

SGS

SGS Environmental Services
28 Reid Road,
Perth Airport
WA 6105
Tel: 08 9373 3500 Fax: 08 9373 3668

ATTN: Sample Receipt
Email: AU.SampleReceipt.Perth@sgs.com

CHAIN OF CUSTODY & ANALYSIS REQUEST

Lab ID Number: PE101592 (please quote on all correspondence)

Page ___ of ___

Please remember to fill in your company details below or attach business card.

Company Name: HOLCIM Australia
Address: 18 Brodie Hall Drive
Bentley WA 6102
Contact Name: Conor O'Neill
SGS Client Contact: Natalie Hill
Laboratory Quotation No:
Project Name/No: JAN-HOL-0915
Purchase Order No: PO 4599009040
Results Required Date: Sep 2015
Telephone: 9212 2025
Fax:
Email Results to: conor.oneill@holcim.com
@

SGS ID	Client Sample ID	Sampling Date/Time *(field record sheet number)*	Solid Sample	Liquid Sample	Gas/Air Sample	PRESERVATIVE	NO. OF ITEMS	As per attachment ✓	OC ✓	OP ✓	Herbicides ✓	TRH C6-C40 ✓								Notes/Guidelines/LOR/ Special instructions
1	HMB0901-01	01/09/15 pm		✓																
2	HMB0901-02	01/09/15 pm		✓																
3	HMB0902-01	02/09/15 am		✓																
4	HMB0902-101	02/09/15 am		✓																
5	HMB0902-02	02/09/15 am		✓																
6	HMB0902-03	02/09/15 AM		✓																
7	HMB0902-103	02/09/15 am		✓																
8	HMB0902-04	02/09/15 pm		✓																
9	HMB0902-05	02/09/15 pm		✓																
10	HMB0902-06	02/09/15 pm		✓																

Relinquished By: Date/Time: Received By: Date/Time:

Relinquished By: Conor O'Neill Date/Time: 03/09/15 13.10. Received By: Simone Date/Time: 3/9/15 @ 1:10pm

Samples Intact: *Yes / No*
Temperature: *Ambient / [✓ Chilled] / NA*
Sample Security Sealed: *Yes / [✓ No]*

Sampling by SGS: *Yes / No*
Sampler ID:

Comments / Subcontracting details:
i.e. samples subcontracted to SGS Sydney due to TAT requested

Quarantine: *Yes / No*
Hazards: *e.g. may contain Asbestos*

Appendix C4 Comprehensive analysis

A comprehensive analysis most commonly applies to activities with the potential to contaminate the groundwater, such as horticulture, industry and, in some cases, mining. In these cases additional analytes to those specified in the major component analyses may need to be measured (e.g. nitrate; total phosphorus, indicating possible groundwater pollution by fertilisers).

1 *Field analysis*

- Temperature (°C)
- pH
- Eh
- Conductivity (compensated to 25°C, or if uncompensated – report the value measured and the temperature; report complete units (e.g. mS/cm, not mS)
- Dissolved oxygen
- Bicarbonate (HCO_3)

2 *Laboratory analysis*

Physico-chemical

- pH
- Conductivity (preferably compensated to 25°C; report value measured; compensation factor and complete units (e.g. mS/cm, not mS)
- Total dissolved solids (calculated @ 180°C)
- Total hardness (as $CaCO_3$)
- Total alkalinity (as $CaCO_3$)

Ions (mg/L)

- Calcium Ca
- Magnesium Mg
- Sodium Na
- Potassium K
- Ammonia NH_3
- Phosphate PO_4
- Carbonate CO_3
- Bicarbonate HCO_3
- Chloride Cl
- Sulphate SO_4
- Nitrate NO_3

SGS

AUSTRALIA-ENVIRONMENTAL-PERTH AIRPORT- PROFORMA -QU101

REGISTRATION DETAILS

APPROVED BY: R. MA

Bottle Map **Sample Numbers:**	1L Plastic Green	500mL Plastic Green	500mL Plastic Purple	500mL Amber Green	250mL Plastic Green	125mL Plastic Red	1L Amber Green	500mL Amber Orange	100mL Amber Green	40mL Glass Vial White	40mL Glass Vial HAA	500mL Plastic Blue	250mL Plastic Orange	125mL Plastic Brown	250mL Glass Jar	125mL Glass Jar	1L Plastic Yellow	Other Lab	Ziplock Bag/ Other
1-10	1				1	1			1	2				1(subs)					

Job Number: PE01592

# of Eskies: 1

Esky Numbers:

[✓ IB] / ICE / None

Temp: 14 °C

Tray Numbers:
W560-561
V-37
M21

Registration comments:

Action Taken:

Registered By: FG 4/9/15

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Conor O'Neill
Client	HOLCIM
Address	PO BOX 138 GOSNELLS WA 6990
Telephone	9391 6461
Facsimile	(Not specified)
Email	conor.oneill@holcim.com
Project	**JAN-HOL-0915**
Order Number	**4599009040**
Samples	10

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE101592 R0**
Date Received	03 Sep 2015
Date Reported	11 Sep 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

SVOC: Surrogate recovery "2,4-DCPA" for MB was below acceptance criteria. Recoveries for all other surrogates are within range. Samples are below LOR for all analytes, result reported.

SIGNATORIES

Gary Walton
Organics Supervisor

Hue Thanh Ly
Metals Team Leader

Mary Ann Ola-A
Inorganics Team Leader

Michael McKay
Inorganics and ARD Supervisor

Ohmar David
Metals Chemist

		Sample Number	PE101592.001	PE101592.002	PE101592.003	PE101592.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	01 Sep 2015	01 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0901-01	HMB0901-02	HMB0902-01	HMB0902-101
Parameter	Units	LOR				

pH in water Method: AN101 Tested: 3/9/2015

pH**	pH Units	0.1	**6.8**	**6.1**	**4.9**	**4.7**

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 3/9/2015

Conductivity @ 25 C	mS/cm	2	<2	<2	<2	<2
Total Dissolved Solids (by calculation)	mg/L	2	**150**	**160**	**97**	**97**

Alkalinity Method: ME-AU-ENVAN135 Tested: 3/9/2015

Bicarbonate Alkalinity as HCO3	mg/L	5	**28**	**12**	<5	<5
Carbonate Alkalinity as CO3	mg/L	5	<5	<5	<5	<5
Total Alkalinity as CaCO3	mg/L	5	**23**	**10**	<5	<5

Sulphate in water Method: AN275 Tested: 8/9/2015

Sulphate, SO4	mg/L	1	**12**	**25**	**14**	**14**

Chloride by Discrete Analyser in Water Method: AN274 Tested: 8/9/2015

Chloride, Cl	mg/L	1	**50**	**53**	**33**	**33**

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 9/9/2015

Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	**10**	<0.2	**4.2**	**4.1**

Ammonia Nitrogen by FIA Method: AN261 Tested: 9/9/2015

Ammonia, NH_3	mg/L	0.05	<0.05	**0.51**	<0.05	<0.05

		Sample Number	PE101592.001	PE101592.002	PE101592.003	PE101592.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	01 Sep 2015	01 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0901-01	HMB0901-02	HMB0902-01	HMB0902-101
Parameter	Units	LOR				

TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 7/9/2015

Total Kjeldahl Nitrogen	mg/L	0.05	**0.34**	**1.1**	**0.09**	**0.10**

Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293 Tested: 7/9/2015

Total Phosphorus (Kjeldahl Digestion)	mg/L	0.01	**0.01**	<0.01	<0.01	<0.01

Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 8/9/2015

Filterable Reactive Phosphorus as PO4	mg/L	0.01	<0.01	<0.01	<0.01	<0.01

Anions by Ion Chromatography in Water Method: ME-AU-ENVAN245 Tested: 8/9/2015

Bromide	mg/L	0.05	**0.18**	**0.24**	**0.10**	**0.44**

Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 7/9/2015

Aluminium, Al	mg/L	0.02	**0.04**	**0.95**	**0.32**	**0.34**
Arsenic, As	mg/L	0.02	<0.020	<0.020	<0.020	<0.020
Cadmium, Cd	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Calcium, Ca	mg/L	0.2	**11**	**1.6**	**1.2**	**1.2**
Chromium, Cr	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Lead, Pb	mg/L	0.02	<0.020	<0.020	<0.020	<0.020
Magnesium, Mg	mg/L	0.1	**3.7**	**6.7**	**2.4**	**2.3**
Manganese, Mn	mg/L	0.005	**0.012**	**0.007**	**0.016**	**0.014**
Nickel, Ni	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Potassium, K	mg/L	0.1	**2.0**	**1.6**	**1.6**	**1.5**
Selenium, Se	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Silica, Soluble	mg/L	0.05	**6.2**	**10**	**7.7**	**7.9**
Sodium, Na	mg/L	0.5	**31**	**36**	**21**	**21**
Zinc, Zn	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Total Hardness by Calculation	mg CaCO3/L	1	**43**	**32**	**13**	**13**

		Sample Number	PE101592.001	PE101592.002	PE101592.003	PE101592.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	01 Sep 2015	01 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0901-01	HMB0901-02	HMB0902-01	HMB0902-101
Parameter	Units	LOR				

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 9/9/2015

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

Ferrous Iron in water Method: AN271 Tested: 4/9/2015

Ferrous Iron, Fe2+	mg/L	0.05	**0.12**	**0.85**	**0.30**	**0.30**

VOCs in Water Method: AN433/AN434 Tested: 8/9/2015

Monocyclic Aromatic Hydrocarbons

Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
o-xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
m/p-xylene	µg/L	1	<1	<1	<1	<1

Polycyclic VOCs

Naphthalene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5

Surrogates

Dibromofluoromethane (Surrogate)	%	-	**112**	**118**	**112**	**115**
d4-1,2-dichloroethane (Surrogate)	%	-	**107**	**110**	**108**	**111**
d8-toluene (Surrogate)	%	-	**94**	**91**	**96**	**91**
Bromofluorobenzene (Surrogate)	%	-	**79**	**78**	**79**	**76**

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 8/9/2015

TRH C6-C9	µg/L	40	<40	<40	<40	<40

Surrogates

Dibromofluoromethane (Surrogate)	%	-	**112**	**118**	**112**	**115**
d4-1,2-dichloroethane (Surrogate)	%	-	**107**	**110**	**108**	**111**
d8-toluene (Surrogate)	%	-	**94**	**91**	**96**	**91**
Bromofluorobenzene (Surrogate)	%	-	**79**	**78**	**79**	**76**

		Sample Number	PE101592.001	PE101592.002	PE101592.003	PE101592.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	01 Sep 2015	01 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0901-01	HMB0901-02	HMB0902-01	HMB0902-101
Parameter	Units	LOR				

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 8/9/2015 (continued)

VPH F Bands

Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 5/9/2015

TRH C10-C14	µg/L	50	<50	<50	<50	<50
TRH C15-C28	µg/L	200	<200	<200	<200	<200
TRH C29-C36	µg/L	200	<200	**480**	<200	<200

TRH F Bands

TRH >C10-C16 (F2)	µg/L	60	<60	<60	<60	<60
TRH >C16-C34 (F3)	µg/L	500	<500	<500	<500	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500	<500	<500

OC Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015

Alpha BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene (HCB)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Lindane (gamma BHC)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Gamma Chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDD	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin ketone	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Mirex	µg/L	0.1	<0.1	<0.1	<0.1	<0.1

		Sample Number	PE101592.001	PE101592.002	PE101592.003	PE101592.004
		Sample Matrix	Water	Water	Water	Water
		Sample Date	01 Sep 2015	01 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0901-01	HMB0901-02	HMB0902-01	HMB0902-101
Parameter	**Units**	**LOR**				

OC Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015 (continued)

Surrogates

d14-p-terphenyl (Surrogate)	%	-	79	81	86	82

OP Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015

Dichlorvos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dimethoate	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Diazinon (Dimpylate)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Fenitrothion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Malathion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos (Chlorpyrifos Ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Parathion-ethyl (Parathion)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Bromophos Ethyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Methidathion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ethion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Azinphos-methyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2

Surrogates

d14-p-terphenyl (Surrogate)	%	-	79	81	86	82

Acid Herbicides in Water Method: AN420 Tested: 5/9/2015

Clopyralid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
4-chlorophenoxy acetic acid (4-CPA)	µg/L	1	<1	<1	<1	<1
Dicamba	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPP (Mecoprop)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPA	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,6-D	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dichlorprop (2,4-DP)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4-D*	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Bromoxynil	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Triclopyr*	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-trichlorophenoxyacetic acid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-TP (Silvex, Fenopop)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-T	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPB	µg/L	1	<1	<1	<1	<1
Dinoseb (Dinitrobutylphenol)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Fluroxypyr	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4-DB	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ioxynil	µg/L	1	<1	<1	<1	<1
Picloram	µg/L	1	<1	<1	<1	<1

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE101592.001 Water 01 Sep 2015 HMB0901-01	PE101592.002 Water 01 Sep 2015 HMB0901-02	PE101592.003 Water 02 Sep 2015 HMB0902-01	PE101592.004 Water 02 Sep 2015 HMB0902-101
Acid Herbicides in Water Method: AN420 Tested: 5/9/2015 (continued)							
Surrogates							
2,4-DCPAA (Surrogate)	%	-		64	67	55	56

		Sample Number	PE101592.005	PE101592.006	PE101592.007	PE101592.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-02	HMB0902-03	HMB0902-103	HMB0902-04
Parameter	Units	LOR				

pH in water Method: AN101 Tested: 3/9/2015

pH**	pH Units	0.1	6.1	6.2	6.2	4.4

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 3/9/2015

Conductivity @ 25 C	mS/cm	2	<2	<2	<2	<2
Total Dissolved Solids (by calculation)	mg/L	2	360	280	280	130

Alkalinity Method: ME-AU-ENVAN135 Tested: 3/9/2015

Bicarbonate Alkalinity as HCO3	mg/L	5	14	14	11	<5
Carbonate Alkalinity as CO3	mg/L	5	<5	<5	<5	<5
Total Alkalinity as CaCO3	mg/L	5	12	11	9	<5

Sulphate in water Method: AN275 Tested: 8/9/2015

Sulphate, SO4	mg/L	1	150	45	46	18

Chloride by Discrete Analyser in Water Method: AN274 Tested: 8/9/2015

Chloride, Cl	mg/L	1	77	100	100	44

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 9/9/2015

Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2	<0.2	<0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	<0.2	1.5	1.7	11

Ammonia Nitrogen by FIA Method: AN261 Tested: 9/9/2015

Ammonia, NH_3	mg/L	0.05	0.67	0.48	0.47	<0.05

		Sample Number	PE101592.005	PE101592.006	PE101592.007	PE101592.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-02	HMB0902-03	HMB0902-103	HMB0902-04
Parameter	Units	LOR				
TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 7/9/2015						
Total Kjeldahl Nitrogen	mg/L	0.05	**1.3**	**0.73**	**0.77**	**0.17**
Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293 Tested: 7/9/2015						
Total Phosphorus (Kjeldahl Digestion)	mg/L	0.01	<0.01	**0.01**	<0.01	**0.01**
Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 8/9/2015						
Filterable Reactive Phosphorus as PO4	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Anions by Ion Chromatography in Water Method: ME-AU-ENVAN245 Tested: 8/9/2015						
Bromide	mg/L	0.05	**0.33**	**0.24**	**0.24**	**0.09**
Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 7/9/2015						
Aluminium, Al	mg/L	0.02	**0.73**	**0.30**	**0.28**	**0.79**
Arsenic, As	mg/L	0.02	<0.020	<0.020	<0.020	<0.020
Cadmium, Cd	mg/L	0.001	<0.001	<0.001	<0.001	<0.001
Calcium, Ca	mg/L	0.2	**15**	**4.6**	**4.6**	**2.1**
Chromium, Cr	mg/L	0.005	<0.005	<0.005	<0.005	<0.005
Lead, Pb	mg/L	0.02	<0.020	<0.020	<0.020	<0.020
Magnesium, Mg	mg/L	0.1	**34**	**15**	**15**	**3.2**
Manganese, Mn	mg/L	0.005	**0.040**	**0.035**	**0.036**	**0.008**
Nickel, Ni	mg/L	0.005	**0.007**	<0.005	<0.005	**0.005**
Potassium, K	mg/L	0.1	**3.4**	**3.7**	**3.7**	**1.4**
Selenium, Se	mg/L	0.05	<0.05	<0.05	<0.05	<0.05
Silica, Soluble	mg/L	0.05	**14**	**11**	**11**	**8.0**
Sodium, Na	mg/L	0.5	**50**	**52**	**51**	**26**
Zinc, Zn	mg/L	0.01	<0.01	<0.01	<0.01	<0.01
Total Hardness by Calculation	mg CaCO3/L	1	**180**	**72**	**72**	**19**

Parameter	Units	LOR				
		Sample Number	PE101592.005	PE101592.006	PE101592.007	PE101592.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-02	HMB0902-03	HMB0902-103	HMB0902-04

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 9/9/2015

Mercury	mg/L	0.00005	<0.00005	<0.00005	<0.00005	<0.00005

Ferrous Iron in water Method: AN271 Tested: 4/9/2015

Ferrous Iron, Fe2+	mg/L	0.05	**1.5**	**1.3**	**1.2**	<0.05

VOCs in Water Method: AN433/AN434 Tested: 8/9/2015

Monocyclic Aromatic Hydrocarbons

Benzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Toluene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ethylbenzene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
o-xylene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
m/p-xylene	µg/L	1	<1	<1	<1	<1

Polycyclic VOCs

Naphthalene	µg/L	0.5	<0.5	<0.5	<0.5	<0.5

Surrogates

Dibromofluoromethane (Surrogate)	%	-	**113**	**120**	**115**	**113**
d4-1,2-dichloroethane (Surrogate)	%	-	**109**	**112**	**108**	**104**
d8-toluene (Surrogate)	%	-	**96**	**93**	**92**	**96**
Bromofluorobenzene (Surrogate)	%	-	**79**	**78**	**77**	**79**

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 8/9/2015

TRH C6-C9	µg/L	40	<40	<40	<40	<40

Surrogates

Dibromofluoromethane (Surrogate)	%	-	**113**	**120**	**115**	**113**
d4-1,2-dichloroethane (Surrogate)	%	-	**109**	**112**	**108**	**104**
d8-toluene (Surrogate)	%	-	**96**	**93**	**92**	**96**
Bromofluorobenzene (Surrogate)	%	-	**79**	**78**	**77**	**79**

		Sample Number	PE101592.005	PE101592.006	PE101592.007	PE101592.008
		Sample Matrix	Water	Water	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-02	HMB0902-03	HMB0902-103	HMB0902-04
Parameter	Units	LOR				

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 8/9/2015 (continued)

VPH F Bands

Parameter	Units	LOR	PE101592.005	PE101592.006	PE101592.007	PE101592.008
Benzene (F0)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 5/9/2015

Parameter	Units	LOR	PE101592.005	PE101592.006	PE101592.007	PE101592.008
TRH C10-C14	µg/L	50	<50	<50	<50	<50
TRH C15-C28	µg/L	200	**310**	**210**	<200	<200
TRH C29-C36	µg/L	200	**590**	**390**	<200	<200

TRH F Bands

Parameter	Units	LOR	PE101592.005	PE101592.006	PE101592.007	PE101592.008
TRH >C10-C16 (F2)	µg/L	60	<60	<60	<60	<60
TRH >C16-C34 (F3)	µg/L	500	**630**	<500	<500	<500
TRH >C34-C40 (F4)	µg/L	500	**640**	<500	<500	<500

OC Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015

Parameter	Units	LOR	PE101592.005	PE101592.006	PE101592.007	PE101592.008
Alpha BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Hexachlorobenzene (HCB)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Lindane (gamma BHC)	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Gamma Chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDD	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Endrin ketone	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Mirex	µg/L	0.1	<0.1	<0.1	<0.1	<0.1

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE101592.005 Water 02 Sep 2015 HMB0902-02	PE101592.006 Water 02 Sep 2015 HMB0902-03	PE101592.007 Water 02 Sep 2015 HMB0902-103	PE101592.008 Water 02 Sep 2015 HMB0902-04

OC Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015 (continued)

Surrogates

d14-p-terphenyl (Surrogate)	%	-	85	88	88	86

OP Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015

Dichlorvos	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dimethoate	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Diazinon (Dimpylate)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Fenitrothion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Malathion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chlorpyrifos (Chlorpyrifos Ethyl)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Parathion-ethyl (Parathion)	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Bromophos Ethyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Methidathion	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ethion	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Azinphos-methyl	µg/L	0.2	<0.2	<0.2	<0.2	<0.2

Surrogates

d14-p-terphenyl (Surrogate)	%	-	85	88	88	86

Acid Herbicides in Water Method: AN420 Tested: 5/9/2015

Clopyralid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
4-chlorophenoxy acetic acid (4-CPA)	µg/L	1	<1	<1	<1	<1
Dicamba	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPP (Mecoprop)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPA	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,6-D	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Dichlorprop (2,4-DP)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4-D*	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Bromoxynil	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Triclopyr*	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,6-trichlorophenoxyacetic acid	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-TP (Silvex, Fenopop)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4,5-T	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
MCPB	µg/L	1	<1	<1	<1	<1
Dinoseb (Dinitrobutylphenol)	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Fluroxypyr	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
2,4-DB	µg/L	0.5	<0.5	<0.5	<0.5	<0.5
Ioxynil	µg/L	1	<1	<1	<1	<1
Picloram	µg/L	1	<1	<1	<1	<1

Parameter	Units	LOR	PE101592.005 Water 02 Sep 2015 HMB0902-02	PE101592.006 Water 02 Sep 2015 HMB0902-03	PE101592.007 Water 02 Sep 2015 HMB0902-103	PE101592.008 Water 02 Sep 2015 HMB0902-04
Acid Herbicides in Water Method: AN420 Tested: 5/9/2015 (continued)						
Surrogates						
2,4-DCPAA (Surrogate)	%	-	74	74	72	63

		Sample Number	PE101592.009	PE101592.010
		Sample Matrix	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-05	HMB0902-06
Parameter	Units	LOR		

pH in water Method: AN101 Tested: 3/9/2015

pH**	pH Units	0.1	**5.9**	**5.7**

Conductivity and TDS by Calculation - Water Method: AN106 Tested: 3/9/2015

Conductivity @ 25 C	mS/cm	2	<2	<2
Total Dissolved Solids (by calculation)	mg/L	2	**130**	**150**

Alkalinity Method: ME-AU-ENVAN135 Tested: 3/9/2015

Bicarbonate Alkalinity as HCO3	mg/L	5	<5	<5
Carbonate Alkalinity as CO3	mg/L	5	<5	<5
Total Alkalinity as CaCO3	mg/L	5	<5	<5

Sulphate in water Method: AN275 Tested: 8/9/2015

Sulphate, SO4	mg/L	1	**17**	**27**

Chloride by Discrete Analyser in Water Method: AN274 Tested: 8/9/2015

Chloride, Cl	mg/L	1	**51**	**52**

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 9/9/2015

Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	**1.7**	**2.5**

Ammonia Nitrogen by FIA Method: AN261 Tested: 9/9/2015

Ammonia, NH_3	mg/L	0.05	<0.05	**0.06**

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name: PE101592.009 Water 02 Sep 2015 HMB0902-05	PE101592.010 Water 02 Sep 2015 HMB0902-06

TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 7/9/2015

Total Kjeldahl Nitrogen	mg/L	0.05	**0.18**	**0.39**

Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293 Tested: 7/9/2015

Total Phosphorus (Kjeldahl Digestion)	mg/L	0.01	**0.01**	**0.01**

Filterable Reactive Phosphorus (FRP) Method: AN278 Tested: 8/9/2015

Filterable Reactive Phosphorus as PO4	mg/L	0.01	<0.01	<0.01

Anions by Ion Chromatography in Water Method: ME-AU-ENVAN245 Tested: 8/9/2015

Bromide	mg/L	0.05	**0.12**	**0.17**

Metals in Water (Dissolved) by ICPOES Method: AN320/AN321 Tested: 7/9/2015

Aluminium, Al	mg/L	0.02	**0.03**	**0.48**
Arsenic, As	mg/L	0.02	<0.020	<0.020
Cadmium, Cd	mg/L	0.001	<0.001	<0.001
Calcium, Ca	mg/L	0.2	**1.7**	**2.8**
Chromium, Cr	mg/L	0.005	<0.005	<0.005
Lead, Pb	mg/L	0.02	<0.020	<0.020
Magnesium, Mg	mg/L	0.1	**4.8**	**6.5**
Manganese, Mn	mg/L	0.005	<0.005	**0.013**
Nickel, Ni	mg/L	0.005	<0.005	<0.005
Potassium, K	mg/L	0.1	**1.8**	**1.7**
Selenium, Se	mg/L	0.05	<0.05	<0.05
Silica, Soluble	mg/L	0.05	**8.4**	**9.6**
Sodium, Na	mg/L	0.5	**30**	**33**
Zinc, Zn	mg/L	0.01	<0.01	<0.01
Total Hardness by Calculation	mg CaCO3/L	1	**24**	**34**

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE101592.009 Water 02 Sep 2015 HMB0902-05	PE101592.010 Water 02 Sep 2015 HMB0902-06

Mercury (dissolved) in Water Method: AN311/AN312 Tested: 9/9/2015

Parameter	Units	LOR	PE101592.009	PE101592.010
Mercury	mg/L	0.00005	<0.00005	<0.00005

Ferrous Iron in water Method: AN271 Tested: 4/9/2015

Parameter	Units	LOR	PE101592.009	PE101592.010
Ferrous Iron, Fe2+	mg/L	0.05	**0.11**	**0.29**

VOCs in Water Method: AN433/AN434 Tested: 8/9/2015

Monocyclic Aromatic Hydrocarbons

Parameter	Units	LOR	PE101592.009	PE101592.010
Benzene	µg/L	0.5	<0.5	<0.5
Toluene	µg/L	0.5	<0.5	<0.5
Ethylbenzene	µg/L	0.5	<0.5	<0.5
o-xylene	µg/L	0.5	<0.5	<0.5
m/p-xylene	µg/L	1	<1	<1

Polycyclic VOCs

Parameter	Units	LOR	PE101592.009	PE101592.010
Naphthalene	µg/L	0.5	<0.5	<0.5

Surrogates

Parameter	Units	LOR	PE101592.009	PE101592.010
Dibromofluoromethane (Surrogate)	%	-	**113**	**111**
d4-1,2-dichloroethane (Surrogate)	%	-	**104**	**105**
d8-toluene (Surrogate)	%	-	**94**	**89**
Bromofluorobenzene (Surrogate)	%	-	**77**	**74**

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 8/9/2015

Parameter	Units	LOR	PE101592.009	PE101592.010
TRH C6-C9	µg/L	40	<40	<40

Surrogates

Parameter	Units	LOR	PE101592.009	PE101592.010
Dibromofluoromethane (Surrogate)	%	-	**113**	**111**
d4-1,2-dichloroethane (Surrogate)	%	-	**104**	**105**
d8-toluene (Surrogate)	%	-	**94**	**89**
Bromofluorobenzene (Surrogate)	%	-	**77**	**74**

		Sample Number	PE101592.009	PE101592.010
		Sample Matrix	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-05	HMB0902-06
Parameter	Units	LOR		

Volatile Petroleum Hydrocarbons in Water Method: AN433/AN434/AN410 Tested: 8/9/2015 (continued)

VPH F Bands

Benzene (F0)	µg/L	0.5	<0.5	<0.5
TRH C6-C10 minus BTEX (F1)	µg/L	50	<50	<50

TRH (Total Recoverable Hydrocarbons) in Water Method: AN403 Tested: 5/9/2015

TRH C10-C14	µg/L	50	<50	<50
TRH C15-C28	µg/L	200	<200	<200
TRH C29-C36	µg/L	200	<200	<200

TRH F Bands

TRH >C10-C16 (F2)	µg/L	60	<60	<60
TRH >C16-C34 (F3)	µg/L	500	<500	<500
TRH >C34-C40 (F4)	µg/L	500	<500	<500

OC Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015

Alpha BHC	µg/L	0.1	<0.1	<0.1
Hexachlorobenzene (HCB)	µg/L	0.1	<0.1	<0.1
Beta BHC	µg/L	0.1	<0.1	<0.1
Lindane (gamma BHC)	µg/L	0.1	<0.1	<0.1
Delta BHC	µg/L	0.1	<0.1	<0.1
Heptachlor	µg/L	0.1	<0.1	<0.1
Aldrin	µg/L	0.1	<0.1	<0.1
Isodrin	µg/L	0.1	<0.1	<0.1
Heptachlor epoxide	µg/L	0.1	<0.1	<0.1
Gamma Chlordane	µg/L	0.1	<0.1	<0.1
Alpha Chlordane	µg/L	0.1	<0.1	<0.1
Alpha Endosulfan	µg/L	0.1	<0.1	<0.1
p,p'-DDE	µg/L	0.1	<0.1	<0.1
Dieldrin	µg/L	0.1	<0.1	<0.1
Endrin	µg/L	0.1	<0.1	<0.1
Beta Endosulfan	µg/L	0.1	<0.1	<0.1
p,p'-DDD	µg/L	0.1	<0.1	<0.1
Endosulfan sulphate	µg/L	0.1	<0.1	<0.1
p,p'-DDT	µg/L	0.1	<0.1	<0.1
Endrin ketone	µg/L	0.1	<0.1	<0.1
Methoxychlor	µg/L	0.1	<0.1	<0.1
Mirex	µg/L	0.1	<0.1	<0.1

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE101592.009 Water 02 Sep 2015 HMB0902-05	PE101592.010 Water 02 Sep 2015 HMB0902-06

OC Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015 (continued)

Surrogates

d14-p-terphenyl (Surrogate)	%	-	59	69

OP Pesticides in Water Method: AN400/AN420 Tested: 5/9/2015

Dichlorvos	µg/L	0.5	<0.5	<0.5
Dimethoate	µg/L	0.5	<0.5	<0.5
Diazinon (Dimpylate)	µg/L	0.5	<0.5	<0.5
Fenitrothion	µg/L	0.2	<0.2	<0.2
Malathion	µg/L	0.2	<0.2	<0.2
Chlorpyrifos (Chlorpyrifos Ethyl)	µg/L	0.2	<0.2	<0.2
Parathion-ethyl (Parathion)	µg/L	0.2	<0.2	<0.2
Bromophos Ethyl	µg/L	0.2	<0.2	<0.2
Methidathion	µg/L	0.5	<0.5	<0.5
Ethion	µg/L	0.2	<0.2	<0.2
Azinphos-methyl	µg/L	0.2	<0.2	<0.2

Surrogates

d14-p-terphenyl (Surrogate)	%	-	59	69

Acid Herbicides in Water Method: AN420 Tested: 5/9/2015

Clopyralid	µg/L	0.5	<0.5	<0.5
4-chlorophenoxy acetic acid (4-CPA)	µg/L	1	<1	<1
Dicamba	µg/L	0.5	<0.5	<0.5
MCPP (Mecoprop)	µg/L	0.5	<0.5	<0.5
MCPA	µg/L	0.5	<0.5	<0.5
2,6-D	µg/L	0.5	<0.5	<0.5
Dichlorprop (2,4-DP)	µg/L	0.5	<0.5	<0.5
2,4-D*	µg/L	0.5	<0.5	<0.5
Bromoxynil	µg/L	0.5	<0.5	<0.5
Triclopyr*	µg/L	0.5	<0.5	<0.5
2,4,6-trichlorophenoxyacetic acid	µg/L	0.5	<0.5	<0.5
2,4,5-TP (Silvex, Fenopop)	µg/L	0.5	<0.5	<0.5
2,4,5-T	µg/L	0.5	<0.5	<0.5
MCPB	µg/L	1	<1	<1
Dinoseb (Dinitrobutylphenol)	µg/L	0.5	<0.5	<0.5
Fluroxypyr	µg/L	0.5	<0.5	<0.5
2,4-DB	µg/L	0.5	<0.5	<0.5
Ioxynil	µg/L	1	<1	<1
Picloram	µg/L	1	<1	<1

Parameter	Units	LOR	Sample Number Sample Matrix Sample Date Sample Name	PE101592.009 Water 02 Sep 2015 HMB0902-05	PE101592.010 Water 02 Sep 2015 HMB0902-06
Acid Herbicides in Water Method: AN420 Tested: 5/9/2015 (continued)					
Surrogates					
2,4-DCPAA (Surrogate)	%	-		42	51

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Acid Herbicides in Water Method: ME-(AU)-[ENV]AN420

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Clopyralid	LB107716	µg/L	0.5	<0.5	
4-chlorophenoxy acetic acid (4-CPA)	LB107716	µg/L	1	<1	
Dicamba	LB107716	µg/L	0.5	<0.5	
MCPP (Mecoprop)	LB107716	µg/L	0.5	<0.5	61%
MCPA	LB107716	µg/L	0.5	<0.5	53%
2,6-D	LB107716	µg/L	0.5	<0.5	
Dichlorprop (2,4-DP)	LB107716	µg/L	0.5	<0.5	
2,4-D*	LB107716	µg/L	0.5	<0.5	52%
Bromoxynil	LB107716	µg/L	0.5	<0.5	
Triclopyr*	LB107716	µg/L	0.5	<0.5	
2,4,6-trichlorophenoxyacetic acid	LB107716	µg/L	0.5	<0.5	
2,4,5-TP (Silvex, Fenopop)	LB107716	µg/L	0.5	<0.5	64%
2,4,5-T	LB107716	µg/L	0.5	<0.5	50%
MCPB	LB107716	µg/L	1	<1	
Dinoseb (Dinitrobutylphenol)	LB107716	µg/L	0.5	<0.5	
Fluroxypyr	LB107716	µg/L	0.5	<0.5	
2,4-DB	LB107716	µg/L	0.5	<0.5	
Ioxynil	LB107716	µg/L	1	<1	
Picloram	LB107716	µg/L	1	<1	

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
2,4-DCPAA (Surrogate)	LB107716	%	-	42%	64%

Alkalinity Method: ME-AU-ENVAN135

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Bicarbonate Alkalinity as HCO3	LB107702	mg/L	5	<5		
Carbonate Alkalinity as CO3	LB107702	mg/L	5	<5		
Total Alkalinity as CaCO3	LB107702	mg/L	5	<5	0 - 14%	103%

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Ammonia Nitrogen by FIA Method: ME-(AU)-[ENV]AN261

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Ammonia, NH_3	LB107856	mg/L	0.05	<0.05	2%	NA

Anions by Ion Chromatography in Water Method: ME-AU-ENVAN245

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Bromide	LB107807	mg/L	0.05	<0.05	1 - 6%	90 - 91%

Chloride by Discrete Analyser in Water Method: ME-(AU)-[ENV]AN274

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Chloride, Cl	LB107809	mg/L	1	<1	0%	105%	76 - 92%

Conductivity and TDS by Calculation - Water Method: ME-(AU)-[ENV]AN106

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Conductivity @ 25 C	LB107707	mS/cm	2	<2	0 - 1%	99 - 100%
Total Dissolved Solids (by calculation)	LB107707	mg/L	2	<2	1%	NA

Ferrous Iron in water Method: ME-(AU)-[ENV]AN271

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Ferrous Iron, Fe2+	LB107736	mg/L	0.05	<0.05	2%	109%

Filterable Reactive Phosphorus (FRP) Method: ME-(AU)-[ENV]AN278

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Filterable Reactive Phosphorus as PO4	LB107808	mg/L	0.01	<0.01	0%	NA	NA

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Mercury (dissolved) in Water Method: ME-(AU)-[ENV]AN311/AN312

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Mercury	LB107841	mg/L	0.00005	<0.00005	0%	101%	100%

Metals in Water (Dissolved) by ICPOES Method: ME-(AU)-[ENV]AN320/AN321

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Aluminium, Al	LB107737	mg/L	0.02	<0.02	1%	109%	104%
Arsenic, As	LB107737	mg/L	0.02	<0.020	0%	112%	117%
Cadmium, Cd	LB107737	mg/L	0.001	<0.001	0%	112%	110%
Calcium, Ca	LB107737	mg/L	0.2	<0.2	2%	104%	101%
Chromium, Cr	LB107737	mg/L	0.005	<0.005	0%	105%	104%
Lead, Pb	LB107737	mg/L	0.02	<0.020	0%	112%	109%
Magnesium, Mg	LB107737	mg/L	0.1	<0.1	2%	97%	94%
Manganese, Mn	LB107737	mg/L	0.005	<0.005	2%	106%	105%
Nickel, Ni	LB107737	mg/L	0.005	<0.005	0%	109%	108%
Potassium, K	LB107737	mg/L	0.1	<0.1	1 - 3%	104%	101%
Selenium, Se	LB107737	mg/L	0.05	<0.05	0%	112%	109%
Silica, Soluble	LB107737	mg/L	0.05	<0.05			
Sodium, Na	LB107737	mg/L	0.5	<0.5	2%	103%	97%
Zinc, Zn	LB107737	mg/L	0.01	<0.01	0%	109%	108%
Total Hardness by Calculation	LB107737	mg CaCO3/L	1	<1			

OC Pesticides in Water Method: ME-(AU)-[ENV]AN400/AN420

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Alpha BHC	LB107716	µg/L	0.1	<0.1	
Hexachlorobenzene (HCB)	LB107716	µg/L	0.1	<0.1	61%
Beta BHC	LB107716	µg/L	0.1	<0.1	
Lindane (gamma BHC)	LB107716	µg/L	0.1	<0.1	55%
Delta BHC	LB107716	µg/L	0.1	<0.1	
Heptachlor	LB107716	µg/L	0.1	<0.1	71%
Aldrin	LB107716	µg/L	0.1	<0.1	58%
Isodrin	LB107716	µg/L	0.1	<0.1	64%
Heptachlor epoxide	LB107716	µg/L	0.1	<0.1	
Gamma Chlordane	LB107716	µg/L	0.1	<0.1	75%
Alpha Chlordane	LB107716	µg/L	0.1	<0.1	
Alpha Endosulfan	LB107716	µg/L	0.1	<0.1	
p,p'-DDE	LB107716	µg/L	0.1	<0.1	73%
Dieldrin	LB107716	µg/L	0.1	<0.1	69%
Endrin	LB107716	µg/L	0.1	<0.1	68%
Beta Endosulfan	LB107716	µg/L	0.1	<0.1	
p,p'-DDD	LB107716	µg/L	0.1	<0.1	
Endosulfan sulphate	LB107716	µg/L	0.1	<0.1	
p,p'-DDT	LB107716	µg/L	0.1	<0.1	
Endrin ketone	LB107716	µg/L	0.1	<0.1	
Methoxychlor	LB107716	µg/L	0.1	<0.1	
Mirex	LB107716	µg/L	0.1	<0.1	67%

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
d14-p-terphenyl (Surrogate)	LB107716	%	-	76%	83%

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

OP Pesticides in Water Method: ME-(AU)-[ENV]AN400/AN420

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Dichlorvos	LB107716	µg/L	0.5	<0.5	
Dimethoate	LB107716	µg/L	0.5	<0.5	
Diazinon (Dimpylate)	LB107716	µg/L	0.5	<0.5	64%
Fenitrothion	LB107716	µg/L	0.2	<0.2	
Malathion	LB107716	µg/L	0.2	<0.2	
Chlorpyrifos (Chlorpyrifos Ethyl)	LB107716	µg/L	0.2	<0.2	68%
Parathion-ethyl (Parathion)	LB107716	µg/L	0.2	<0.2	69%
Bromophos Ethyl	LB107716	µg/L	0.2	<0.2	
Methidathion	LB107716	µg/L	0.5	<0.5	75%
Ethion	LB107716	µg/L	0.2	<0.2	
Azinphos-methyl	LB107716	µg/L	0.2	<0.2	

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
d14-p-terphenyl (Surrogate)	LB107716	%	-	76%	83%

pH in water Method: ME-(AU)-[ENV]AN101

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
pH**	LB107707	pH Units	0.1	5.6 - 6.1	0 - 1%	100%

Sulphate in water Method: ME-(AU)-[ENV]AN275

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery
Sulphate, SO4	LB107809	mg/L	1	<1	0 - 2%	104 - 105%	86 - 90%

TKN Kjeldahl Digestion by Discrete Analyser Method: ME-(AU)-[ENV]AN281

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Kjeldahl Nitrogen	LB107767	mg/L	0.05	<0.05	0 - 4%	100%

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Total Phosphorus by Kjeldahl Digestion DA in Water Method: ME-(AU)-[ENV]AN279/AN293

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Phosphorus (Kjeldahl Digestion)	LB107767	mg/L	0.01	<0.01	0 - 7%	106%

TRH (Total Recoverable Hydrocarbons) in Water Method: ME-(AU)-[ENV]AN403

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH C10-C14	LB107716	µg/L	50	<50	80%
TRH C15-C28	LB107716	µg/L	200	<200	70%
TRH C29-C36	LB107716	µg/L	200	<200	67%

TRH F Bands

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH >C10-C16 (F2)	LB107716	µg/L	60	<60	80%
TRH >C16-C34 (F3)	LB107716	µg/L	500	<500	70%
TRH >C34-C40 (F4)	LB107716	µg/L	500	<500	67%

VOCs in Water Method: ME-(AU)-[ENV]AN433/AN434

Monocyclic Aromatic Hydrocarbons

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Benzene	LB107801	µg/L	0.5	<0.5	95%
Toluene	LB107801	µg/L	0.5	<0.5	102%
Ethylbenzene	LB107801	µg/L	0.5	<0.5	100%
o-xylene	LB107801	µg/L	0.5	<0.5	
m/p-xylene	LB107801	µg/L	1	<1	

Polycyclic VOCs

Parameter	QC Reference	Units	LOR	MB
Naphthalene	LB107801	µg/L	0.5	<0.5

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Dibromofluoromethane (Surrogate)	LB107801	%	-	107%	97%
d4-1,2-dichloroethane (Surrogate)	LB107801	%	-	105%	110%
d8-toluene (Surrogate)	LB107801	%	-	96%	90%
Bromofluorobenzene (Surrogate)	LB107801	%	-	83%	99%

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Volatile Petroleum Hydrocarbons in Water **Method: ME-(AU)-[ENV]AN433/AN434/AN410**

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH C6-C9	LB107801	µg/L	40	<40	85%

Surrogates

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Dibromofluoromethane (Surrogate)	LB107801	%	-	107%	97%
d4-1,2-dichloroethane (Surrogate)	LB107801	%	-	105%	110%
d8-toluene (Surrogate)	LB107801	%	-	96%	90%
Bromofluorobenzene (Surrogate)	LB107801	%	-	83%	99%

VPH F Bands

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
Benzene (F0)	LB107801	µg/L	0.5	<0.5	95%
TRH C6-C10 minus BTEX (F1)	LB107801	µg/L	50	<50	

METHOD	METHODOLOGY SUMMARY
	Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F.
AN083	Separatory funnels are used for aqueous samples and extracted by transferring an appropriate volume (mass) of liquid into a separatory funnel and adding 3 serial aliquots of dichloromethane. Samples receive a single extraction at pH 7 to recover base / neutral analytes and two extractions at pH < 2 to recover acidic analytes. QC samples are prepared by spiking organic free water with target analytes and extracting as per samples.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN135	Alkalinity (and forms of) by Titration: The sample is titrated with standard acid to pH 8.3 (P titre) and pH 4.5 (T titre) and permanent and/or total alkalinity calculated. The results are expressed as equivalents of calcium carbonate or recalculated as bicarbonate, carbonate and hydroxide. Reference APHA 2320. Internal Reference AN135 Free and Total Carbon Dioxide may be calculated using alkalinity forms only when the samples TDS is <500mg/L. If TDS is >500mg/L free or total carbon dioxide cannot be reported. APHA4500CO2 D.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN261	Ammonia by Continuous Flow Analyser: Ammonium in a basic medium forms ammonia gas, which is separated from the sample matrix by diffusion through a polypropylene membrane. The ammonia is reacted with phenol and hypochlorite to form indophenol blue at an intensity proportional to the ammonia concentration. The blue colour is intensified with sodium nitroprusside and the absorbance measured at 630 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-NH3 H.
AN271	Ferrous Iron by Aquakem DA: Iron in the ferrous state is treated with 1,10-phenathroline at pH 3.2. The intensity of the resultant orange/red coloured solution is proportional to the amount of ferrous iron present. Reference APHA 3500-Fe D.
AN274	Chloride by Aquakem DA: Chloride reacts with mercuric thiocyanate forming a mercuric chloride complex. In the presence of ferric iron, highly coloured ferric thiocyanate is formed which is proportional to the chloride concentration. Reference APHA 4500Cl-
AN275	sulfate by Aquakem DA: sulfate is precipitated in an acidic medium with barium chloride. The resulting turbidity is measured photometrically at 405nm and compared with standard calibration solutions to determine the sulfate concentration in the sample. Reference APHA 4500-SO42-. Internal reference AN275.
AN278	Reactive Phosphorus by DA: Orthophosphate reacts with ammonium molybdate (Mo VI) and potassium antimonyl tartrate (Sb III) in acid medium to form an antimony-phosphomolybdate complex. This complex is subsequently reduced with ascorbic acid to form a blue colour and the absorbance is read at 880 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-P F

METHOD	METHODOLOGY SUMMARY
AN279/AN293	The sample is digested with Sulphuric acid, K2SO4 and CuSO4. All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.
AN281	An unfiltered water or soil sample is first digested in a block digestor with sulfuric acid, K2SO4 and CuSO4. The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.
AN311/AN312	Mercury by Cold Vapour AAS in Waters: Mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500.
AN320/AN321	Metals by ICP-OES: Samples are preserved with 10% nitric acid for a wide range of metals and some non-metals. This solution is measured by Inductively Coupled Plasma. Solutions are aspirated into an argon plasma at 8000-10000K and emit characteristic energy or light as a result of electron transitions through unique energy levels. The emitted light is focused onto a diffraction grating where it is separated into components . Photomultipliers or CCDs are used to measure the light intensity at specific wavelengths. This intensity is directly proportional to concentration. Corrections are required to compensate for spectral overlap between elements. Reference APHA 3120 B.
AN400	OC and OP Pesticides by GC-ECD: The determination of organochlorine (OC) and organophosphorus (OP) pesticides and polychlorinated biphenyls (PCBs) in soils, sludges and groundwater. (Based on USEPA methods 3510, 3550, 8140 and 8080.)
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is not corrected for Naphthalene. Additionally, the volatile C6-C9/C6-C10 fractions may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents . The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D). SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN433/AN434	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN433/AN434/AN410	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
^	Performed by outside laboratory.	NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here:
http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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SAMPLE RECEIPT ADVICE

PE101592A

CLIENT DETAILS

Contact	Conor O'Neill
Client	HOLCIM
Address	PO BOX 138 GOSNELLS WA 6990
Telephone	9391 6461
Facsimile	(Not specified)
Email	conor.oneill@holcim.com
Project	**JAN-HOL-0915**
Order Number	**4599009040**
Samples	3

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
Samples Received	Fri 11/9/2015
Report Due	Fri 18/9/2015
SGS Reference	**PE101592A**

SUBMISSION DETAILS

This is to confirm that 3 samples were received on Friday 11/9/2015. Results are expected to be ready by Friday 18/9/2015. Please quote SGS reference PE101592A when making enquiries. Refer below for details relating to sample integrity upon receipt.

Sample counts by matrix	3 Water	Type of documentation received	Email
Date documentation received	11/9/2015	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	14°C
Sample container provider	SGS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	Ice Bricks	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	1

Samples will be held for one month for water samples and two months for soil samples from date of report, unless otherwise instructed.

COMMENTS

To the extent not inconsistent with the other provisions of this document and unless specifically agreed otherwise in writing by SGS , all SGS services are rendered in accordance with the applicable SGS General Conditions of Service accessible at http://www.sgs.com/en/Terms-and-Conditions/General-Conditions-of-Services-English.aspx as at the date of this document.
Attention is drawn to the limitations of liability and to the clauses of indemnification.

SAMPLE RECEIPT ADVICE

CLIENT DETAILS

Client HOLCIM

Project JAN-HOL-0915

SUMMARY OF ANALYSIS

No.	Sample ID	TRH Silica Gel (Total Recoverable
002	HMB0901-02	3
005	HMB0902-02	3
006	HMB0902-03	3

The above table represents SGS Environmental Services' interpretation of the client-supplied Chain Of Custody document.
The numbers shown in the table indicate the number of results requested in each package.
Please indicate as soon as possible should your request differ from these details .
Testing as per this table shall commence immediately unless the client intervenes with a correction .

Foo, Charlene (Perth) PE101592A

From: Hill, Natalie (Perth)
Sent: Friday, 11 September 2015 12:24 PM
To: Foo, Charlene (Perth); McLennan. Olivia (Perth); Go, Flor (Perth)
Subject: FW: Quote

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Please make an A job for Silica gel

Kind Regards,

Natalie Hill
Environmental Services
Key Account Manager
Phone: +61 8 93733527

From: Walton, Gary (Perth)
Sent: Friday, 11 September 2015 12:19 PM
To: Hill, Natalie (Perth)
Subject: RE: Quote

Hi Nat,

Please have an A job created for PE101592 samples #2, 5, & 6.

Cheers,

Gary Walton
Environmental Services
Organics Team Leader

Phone: +61 (0)8 9373 3652
Fax: +61 (0)8 9373 3668

CF 11/9/15

From: Hill, Natalie (Perth)
Sent: Friday, 11 September 2015 12:07 PM
To: Walton, Gary (Perth)
Subject: FW: Quote

TRH Silica for the latest.
If you can let me know samples I will get SR to add.

Kind Regards,

Natalie Hill
Environmental Services
Key Account Manager
Phone: +61 8 93733527

From: O'Neill, Conor [mailto:conor.oneill@lafargeholcim.com]
Sent: Friday, 11 September 2015 11:48 AM
To: Hill, Natalie (Perth)
Subject: Re: Quote

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Conor O'Neill
Client	HOLCIM
Address	PO BOX 138 GOSNELLS WA 6990
Telephone	9391 6461
Facsimile	(Not specified)
Email	conor.oneill@holcim.com
Project	**JAN-HOL-0915**
Order Number	**4599009040**
Samples	3

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE101592A R0**
Date Received	11 Sep 2015
Date Reported	17 Sep 2015

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

SIGNATORIES

Gary Walton
Organics Supervisor

		Sample Number	PE101592A.002
		Sample Matrix	Water
		Sample Date	01 Sep 2015
		Sample Name	HMB0901-02
Parameter	Units	LOR	

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water Method: AN403 Tested: 5/9/2015

TRH C10-C14-Silica	μg/L	50	<50
TRH C15-C28-Silica	μg/L	200	<200
TRH C29-C36-Silica	μg/L	200	**450**

		Sample Number	PE101592A.005	PE101592A.006
		Sample Matrix	Water	Water
		Sample Date	02 Sep 2015	02 Sep 2015
		Sample Name	HMB0902-02	HMB0902-03
Parameter	Units	LOR		
TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water Method: AN403 Tested: 5/9/2015				
TRH C10-C14-Silica	µg/L	50	<50	<50
TRH C15-C28-Silica	µg/L	200	<200	<200
TRH C29-C36-Silica	µg/L	200	**560**	**330**

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

TRH Silica Gel (Total Recoverable Hydrocarbons - Silica Gel) in Water   Method: ME-(AU)-[ENV]AN403

Parameter	QC Reference	Units	LOR	MB	LCS %Recovery
TRH C10-C14-Silica	LB107999	µg/L	50	<50	94%
TRH C15-C28-Silica	LB107999	µg/L	200	<200	89%
TRH C29-C36-Silica	LB107999	µg/L	200	<200	95%

METHOD SUMMARY

METHOD	METHODOLOGY SUMMARY
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents .
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
^	Performed by outside laboratory.	NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions/General-Conditions-of-Services-English.aspx. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

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Appendix F

September 2015 Bore ID vs Lab ID

42908363

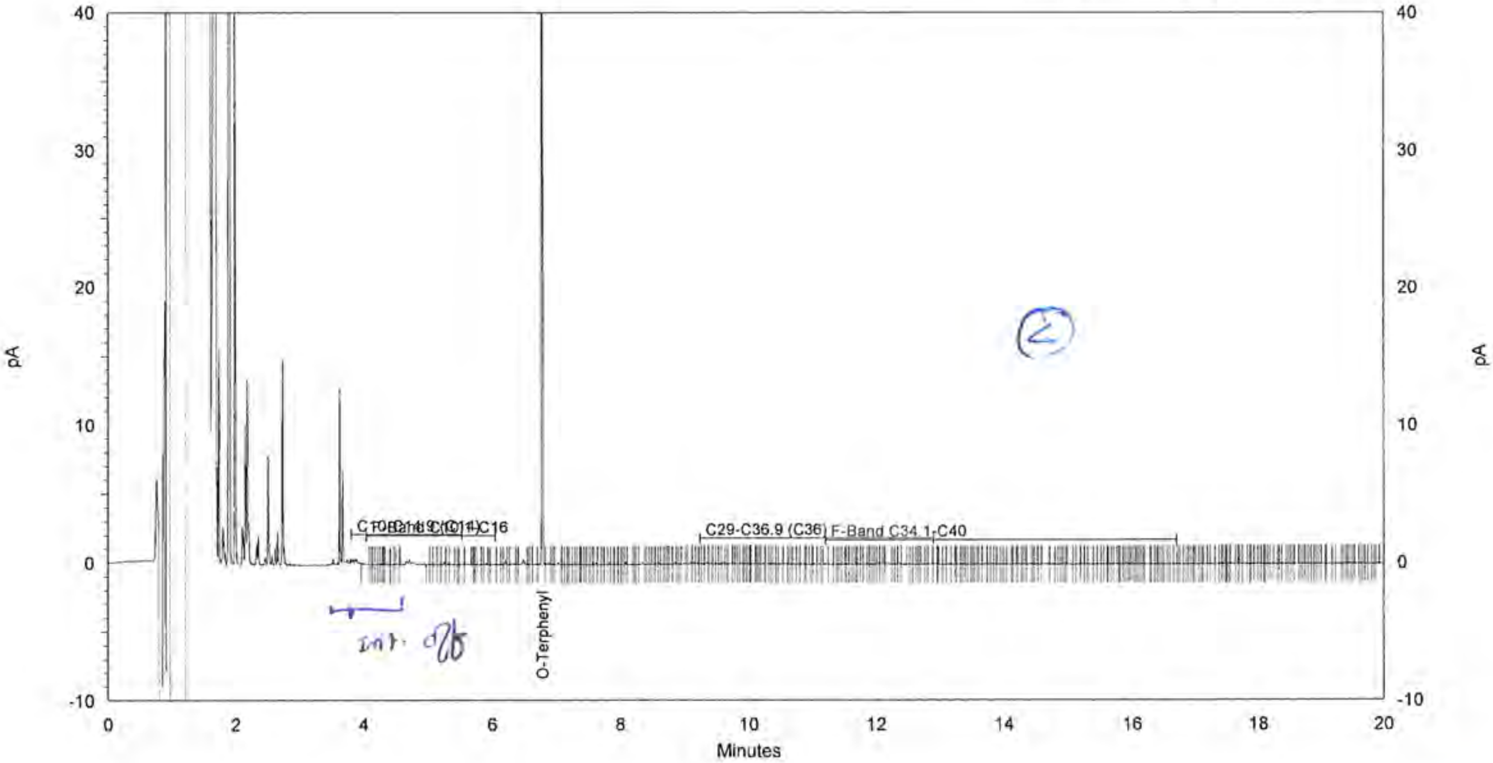
ID	FEILD ID	BORE ID
1	HMB0901-01	HMB02
2	HMB0901-02	HMB03
3	HMB0902-01	HMB07B
4	HMB0902-101	HMB07B DUPLICATE
5	HMB0902-02	HMB08
6	HMB0902-03	HMB06
7	HMB0902-103	HMB06 DUPLICATE
8	HMB0902-04	HMB05
9	HMB0902-05	HMB04
10	HMB0902-06	HMB01

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: BLK LB107999 TPH C2X
Vial: 7
Seq./Rslt Set: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\150916003.rst
Datafile: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\F-150916007.dat
Method: C:\Enterprise\Projects\Method\Quant method\Front Column\2015\08.AUG 15\FRONT_150807_M_CALI_A019.met
Run Time: 16/09/2015 8:15:45 PM (GMT +08:00)
Quant Time: 17/09/2015 11:34:55 AM (GMT +08:00)
Analyst: RT

Multiplier 1: 62.5 Multiplier 2: 1
Total factor: 62.5 ✓

integration off G5REP-5



68% ✓

Front Signal Results

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.783	1072376	855	ug/L
C10-C14.9 (C14)		12341	9	ppm
C15-C28.9 (C24)		61502	61	ppm
C29-C36.9 (C36)		83354	94	ppm
F-Band C10.1-C16		16589	12	ppm
F-Band C16.1-C34		116477	117	ppm
F-Band C34.1-C40		69797	99	ppm ✓

Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: 101592-2 TPH C2X
Vial: 12
Seq./Rslt Set: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\150916003.rst
Datafile: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\F-150916012.dat
Method: C:\Enterprise\Projects\Method\Quant method\Front Column\2015\08.AUG 15\FRONT_150807_M_CALI_A019.met
Run Time: 16/09/2015 10:48:55 PM (GMT +08:00)
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Analyst: RT

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Total factor: 63.06

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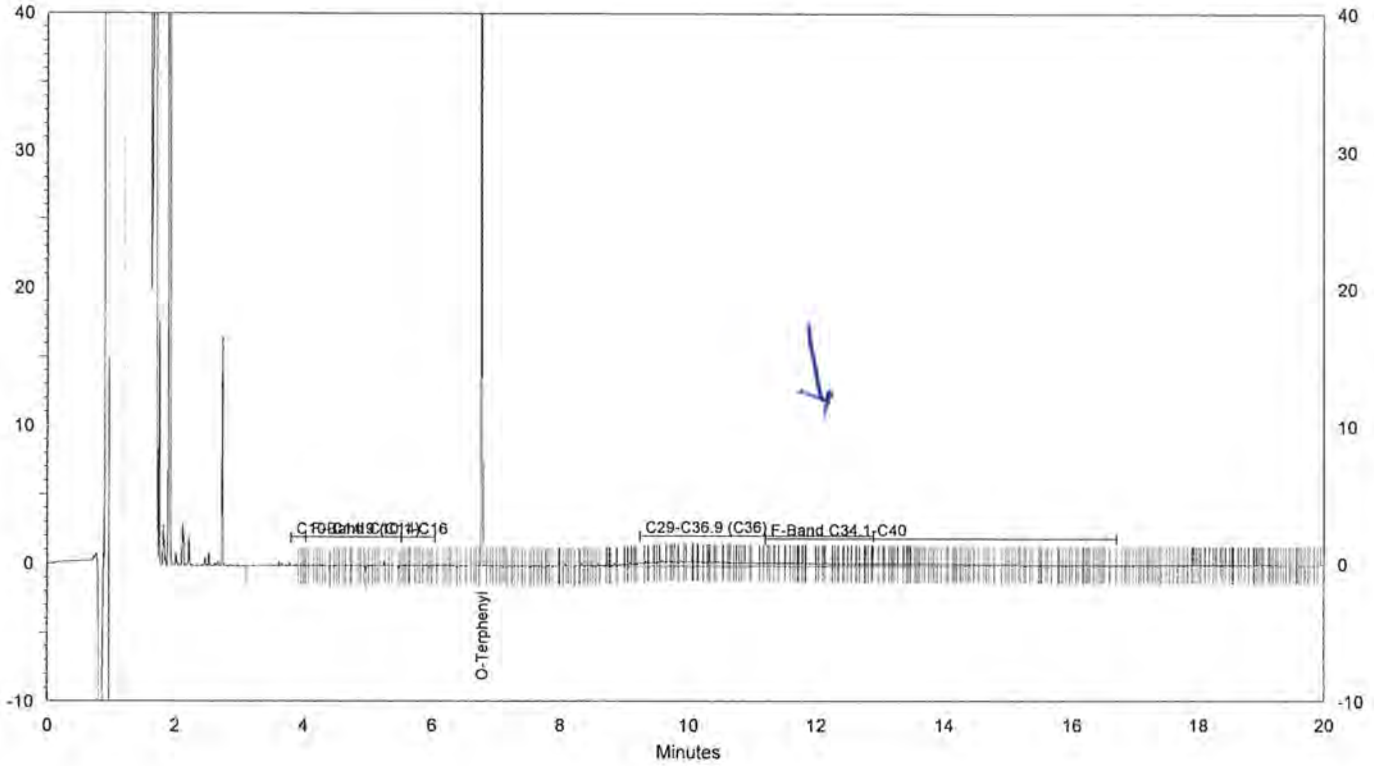

Front Signal Results

55.16

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.780	863279	694	ug/L
C10-C14.9 (C14)		26034	20	ppm
C15-C28.9 (C24)		46645	46	ppm
C29-C36.9 (C36)		387784	451 ✓	ppm
F-Band C10.1-C16		18899	14	ppm
F-Band C16.1-C34		290525	295	ppm
F-Band C34.1-C40		291083	416	ppm

Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: 101592-5 TPH C2X
Vial: 14
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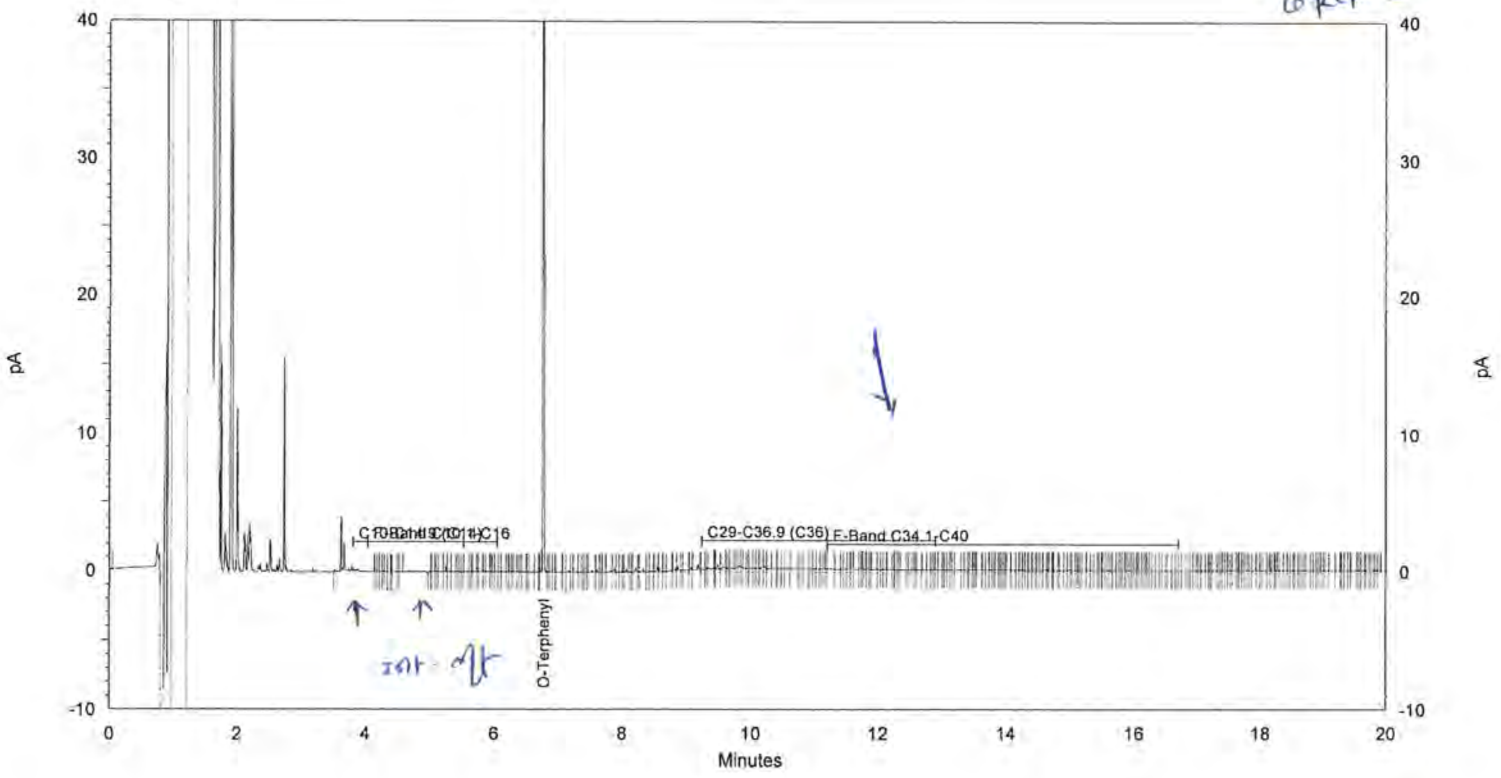
Total factor: 66.45

6 Rep-5



Front Signal Results

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.773	1826808	1548	ug/L
C10-C14.9 (C14)		60066	48	ppm
C15-C28.9 (C24)		86362	91	ppm
C29-C36.9 (C36)		453160	562	ppm
F-Band C10.1-C16		64065	51	ppm
F-Band C16.1-C34		359401	384	ppm
F-Band C34.1-C40		500539	755	ppm

116%

Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: 101592-6 TPH C2X
Vial: 11
Seq./Rslt Set: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\150916003.rst
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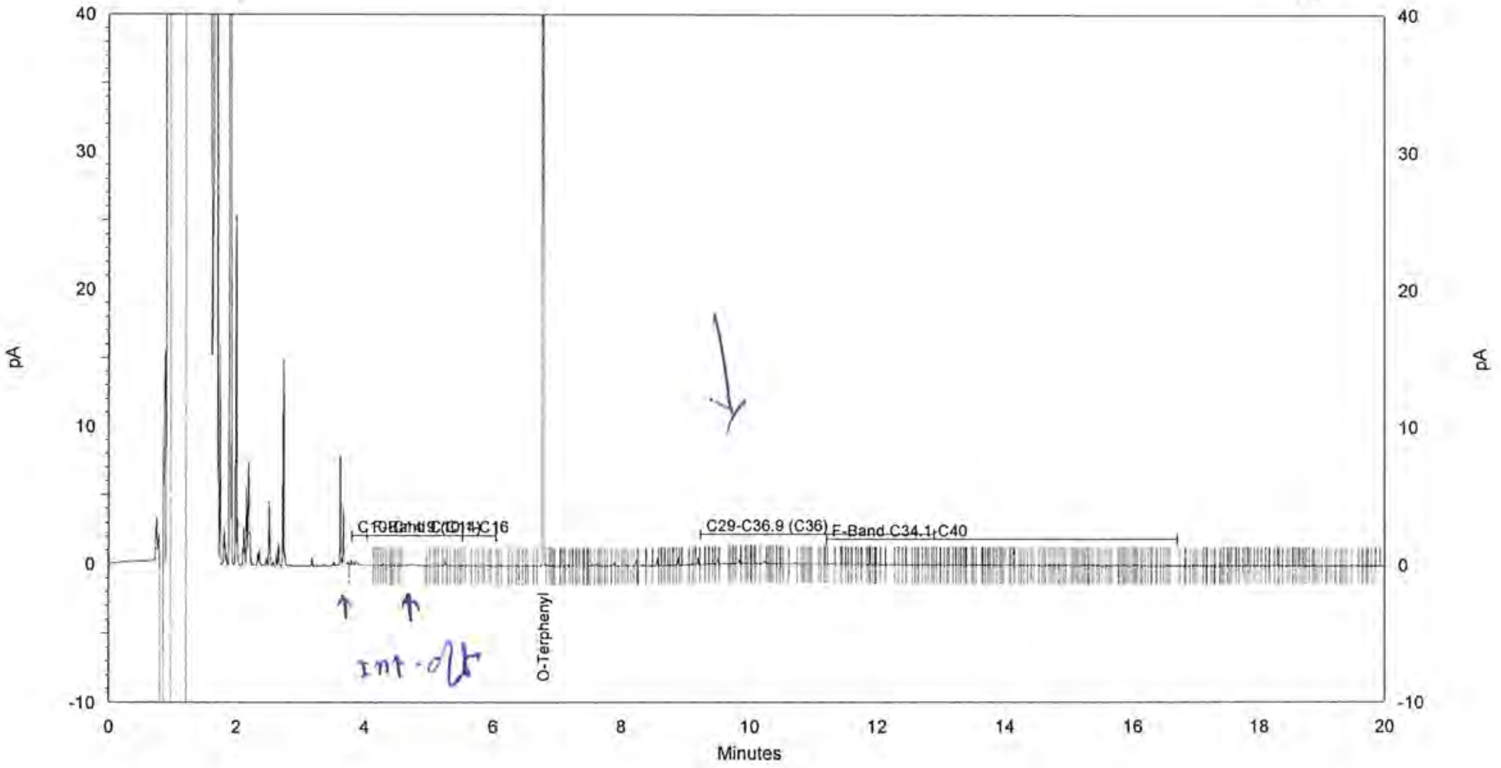
Analyst: RT

Multiplier 1: 63.45 Multiplier 2: 1
Total factor: 63.45

6 Rep - 5



Int - 025

129 %

Front Signal Results

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.783	2038094	1649	ug/L
C10-C14.9 (C14)		22970	18	ppm
C15-C28.9 (C24)		66239	66	ppm
C29-C36.9 (C36)		280769	329	ppm
F-Band C10.1-C16		27608	21	ppm
F-Band C16.1-C34		241982	247	ppm
F-Band C34.1-C40		256826	370	ppm

Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: BLK LB107999 TPH C2X
Vial: 7
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Analyst: RT

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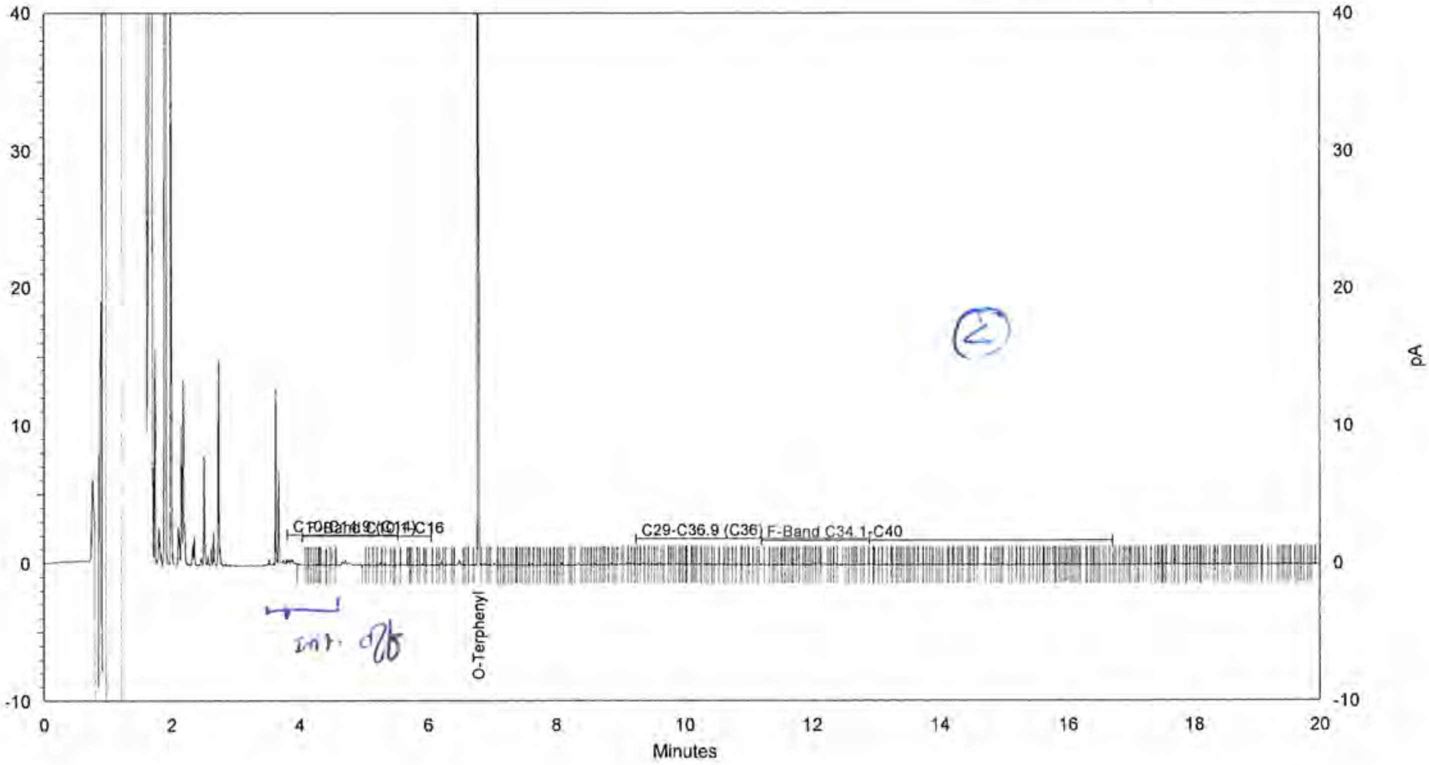
Integration off G15PER-5



②

Int. off

68%

Front Signal Results

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.783	1072376	855	ug/L
C10-C14.9 (C14)		12341	9	ppm
C15-C28.9 (C24)		61502	61	ppm
C29-C36.9 (C36)		83354	94	ppm
F-Band C10.1-C16		16589	12	ppm
F-Band C16.1-C34		116477	117	ppm
F-Band C34.1-C40		69797	99	ppm

✓

Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID:	101592-2 TPH C2X
Vial:	12
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Analyst:	RT

Multiplier 1: 63.06 Multiplier 2: 1
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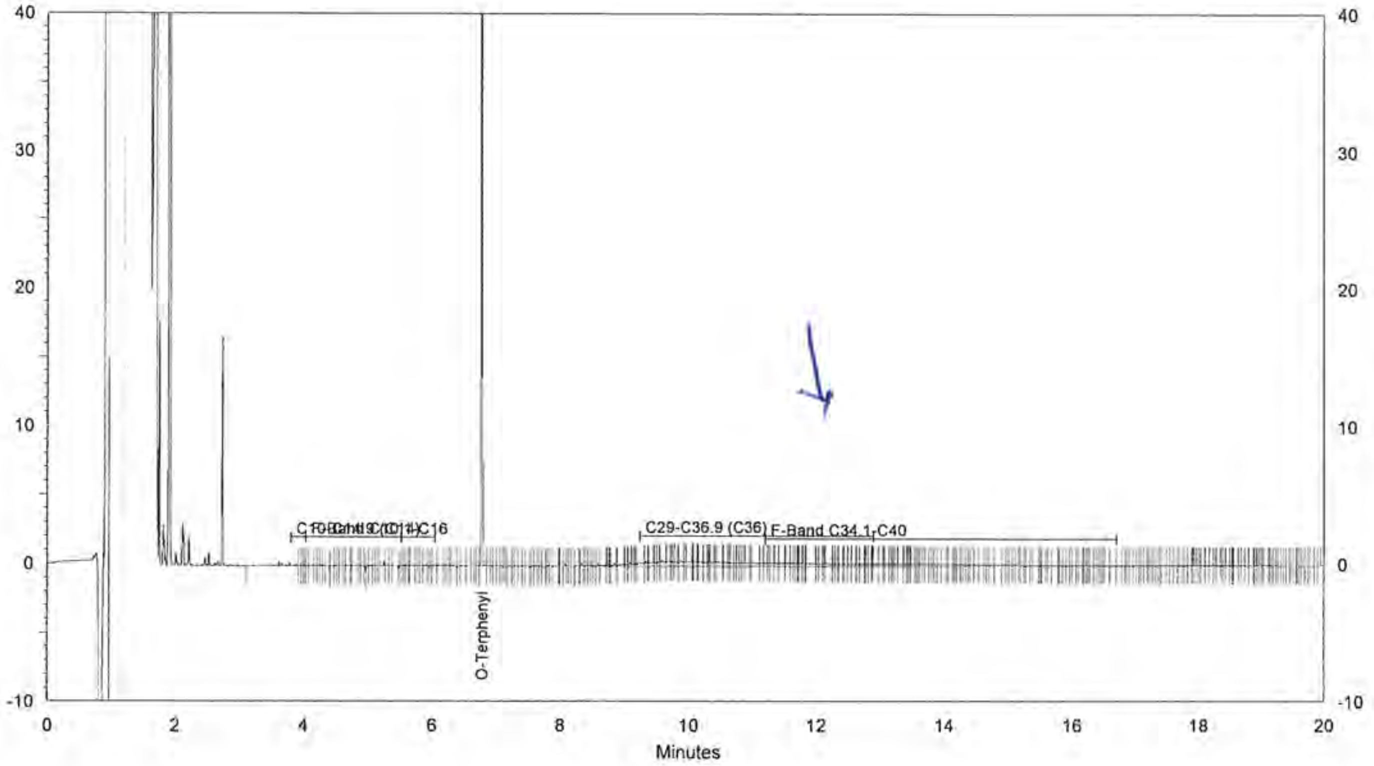

Front Signal Results

55.16

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.780	863279	694	ug/L
C10-C14.9 (C14)		26034	20	ppm
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C29-C36.9 (C36)		387784	451 ✓	ppm
F-Band C10.1-C16		18899	14	ppm
F-Band C16.1-C34		290525	295	ppm
F-Band C34.1-C40		291083	416	ppm

Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: 101592-5 TPH C2X
Vial: 14
Seq./Rslt Set: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\150916003.rst
Datafile: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\F-150916014.dat
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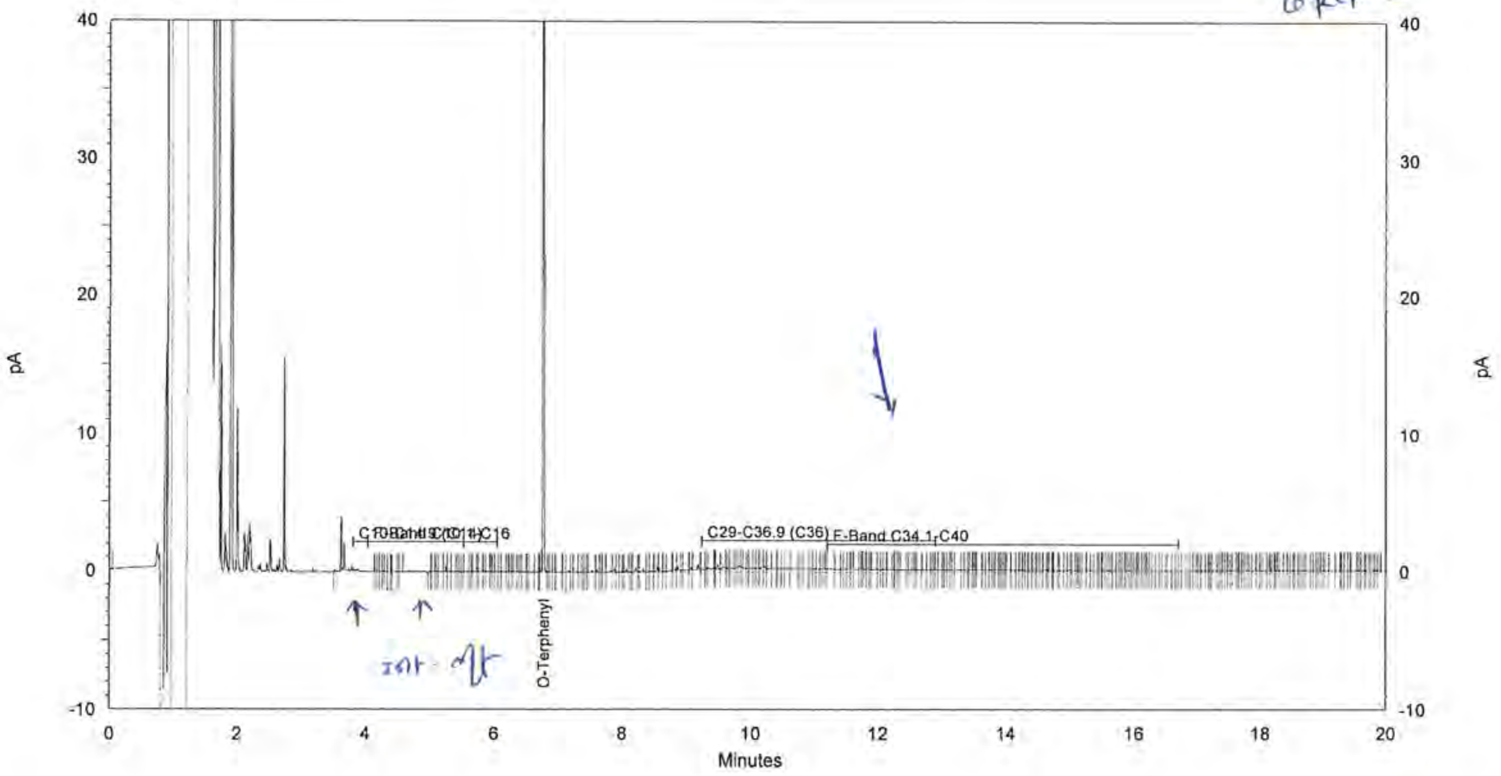
Run Time: 17/09/2015 12:04:18 AM (GMT +08:00)
Quant Time: 17/09/2015 11:38:40 AM (GMT +08:00)
Analyst: RT

Multiplier 1: 66.45 Multiplier 2: 1
Total factor: 66.45

6 Rep-5



Front Signal Results

116%

Name	Ret. Time	Area	Concentration	Units
O-Terphenyl	6.773	1826808	1548	ug/L
C10-C14.9 (C14)		60066	48	ppm
C15-C28.9 (C24)		86362	91	ppm
C29-C36.9 (C36)		453160	562	ppm
F-Band C10.1-C16		64065	51	ppm
F-Band C16.1-C34		359401	384	ppm
F-Band C34.1-C40		500539	755	ppm

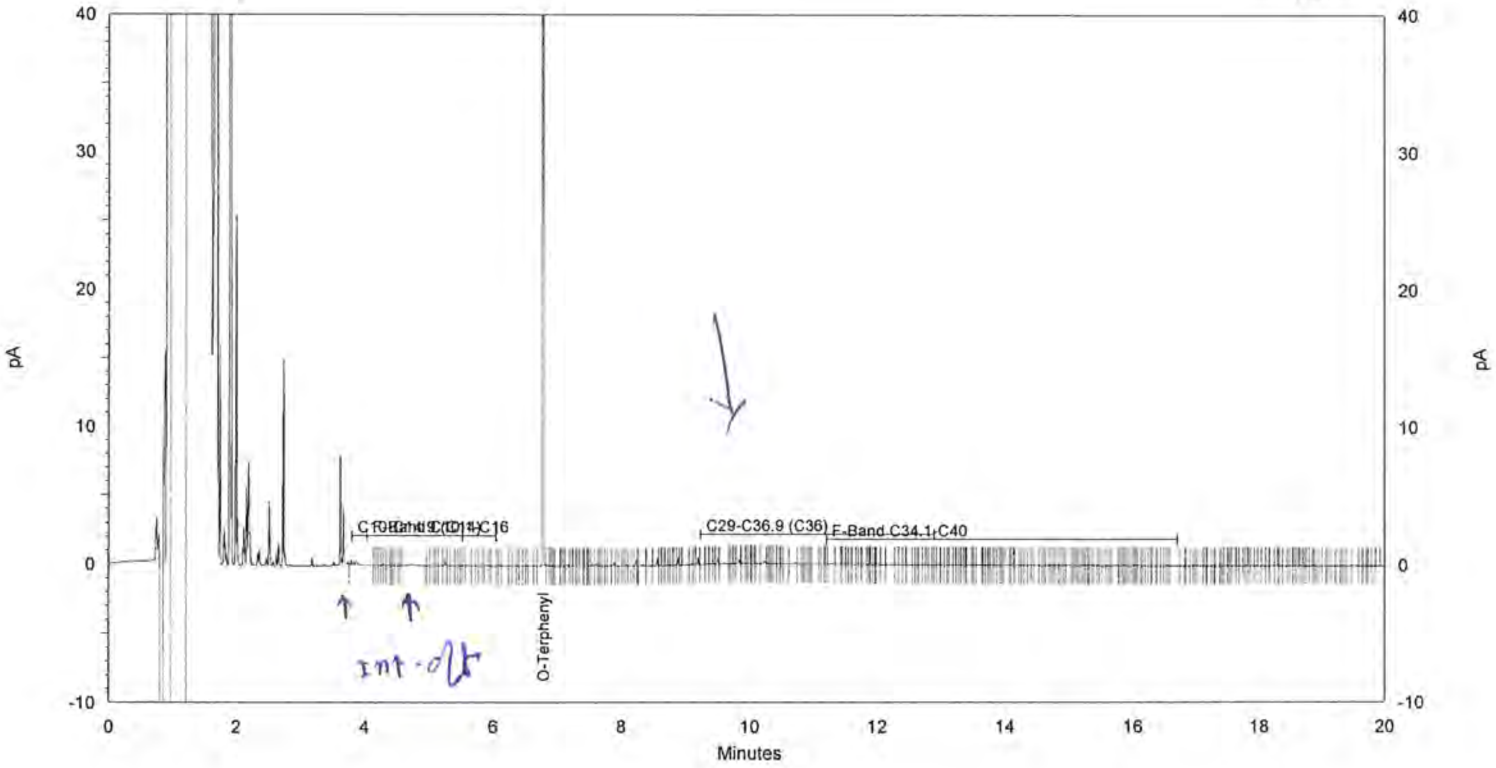
Front Column

TRH B - Total Recoverable Hydrocarbons by GC-FID

Sample ID: 101592-6 TPH C2X
Vial: 11
Seq./Rslt Set: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\150916003.rst
Datafile: C:\Enterprise\Projects\Result\2015\09.SEPT\150916\F-150916011.dat
Method: C:\Enterprise\Projects\Method\Quant method\Front Column\2015\08.AUG 15\FRONT_150807_M_CALI_A019.met
Run Time: 16/09/2015 10:23:37 PM (GMT +08:00)
Quant Time: 17/09/2015 11:35:38 AM (GMT +08:00)
Analyst: RT

Multiplier 1: 63.45 Multiplier 2: 1
Total factor: 63.45

6 Rep - 5



129 %

Front Signal Results

Name	**Ret. Time**	**Area**	**Concentration**	**Units**
O-Terphenyl	6.783	2038094	1649	ug/L
C10-C14.9 (C14)		22970	18	ppm
C15-C28.9 (C24)		66239	66	ppm
C29-C36.9 (C36)		280769	329	ppm
F-Band C10.1-C16		27608	21	ppm
F-Band C16.1-C34		241982	247	ppm
F-Band C34.1-C40		256826	370	ppm

APPENDIX G GROUNDWATER MODELLING DETAILS

G.1 Approach and Methodology

G.2 Validation of the Model’s Functionality

G.3 Model Re-configuration

G.4 Sensitivity Analysis

G.5 Assumptions

G.1 Approach and Methodology

The groundwater model used for this assessment was adopted from an existing model published by the DoW (DoW, 2009a) covering the project area and surrounding area. Key features of the model include:

- an arcuate-shaped domain extending from Pinjar in the north, Gnangara in the south, Melaleuca in the east and Wanneroo in the west
- northern and southern no-flow boundaries that represent regional flow lines from the Gnangara Mound in the northeast to the Lake Joondalup lakes in the west and southwest.
- seven layers representing the Superficial aquifer (Bassendean Sand and other units) with the base representing the top of the Mirrabooka Aquifer
- lakes Jandabup and Maringiniup within the domain represented as through-flow groundwater expressions
- specified groundwater levels at the boundaries of 60m in the east (up-gradient) and 36m in the west (down-gradient)

The model does not include any vertical flow between the Superficial aquifer and the Mirrabooka, or Leederville aquifers. It was determined at that time that the vertical flow components were unlikely to affect the water balance of the model.

The model was originally run using MODFLOW 2000 runtime engine with GMS (version 6.5) as the pre-processor. The finite difference grid ranges from 50m cell sizes in the Maringiniup and Jandabup lakes area ranging up to 250m near the model boundaries. Lakes Jandabup and Maringiniup were represented using the MODFLOW Lakes Package, which defines the hydrology of the lake.

Upon receipt of the model files, they were each unpackaged to verify which scenarios were represented. The 2009 base case model was identified and adopted as the starting point for this assessment. The model functionality was checked using GMS Version 7.1 software. The approach, described below, involved:

- Model validation
- Re-configuration
- Predictive simulations
- Sensitivity analyses

The modelling programme comprised a setup model (2001 to 2015), a predictive model (2016 to 2037), and a closure model (2038 to 2068), all based on the same base-case model, barring changes to recharge domains and rates as described in Section H.3.

G.2 Validation of the Model's Functionality

The model's functionality was validated by re-running the original model using MODFLOW 2000 and compared to the supplied output files from the original runs performed in 2009. A comparison was made to determine that the current predictions were based on the same values. The outputs from the 2009 and 2015 model runs are compared for selected bores in Figure G-1.

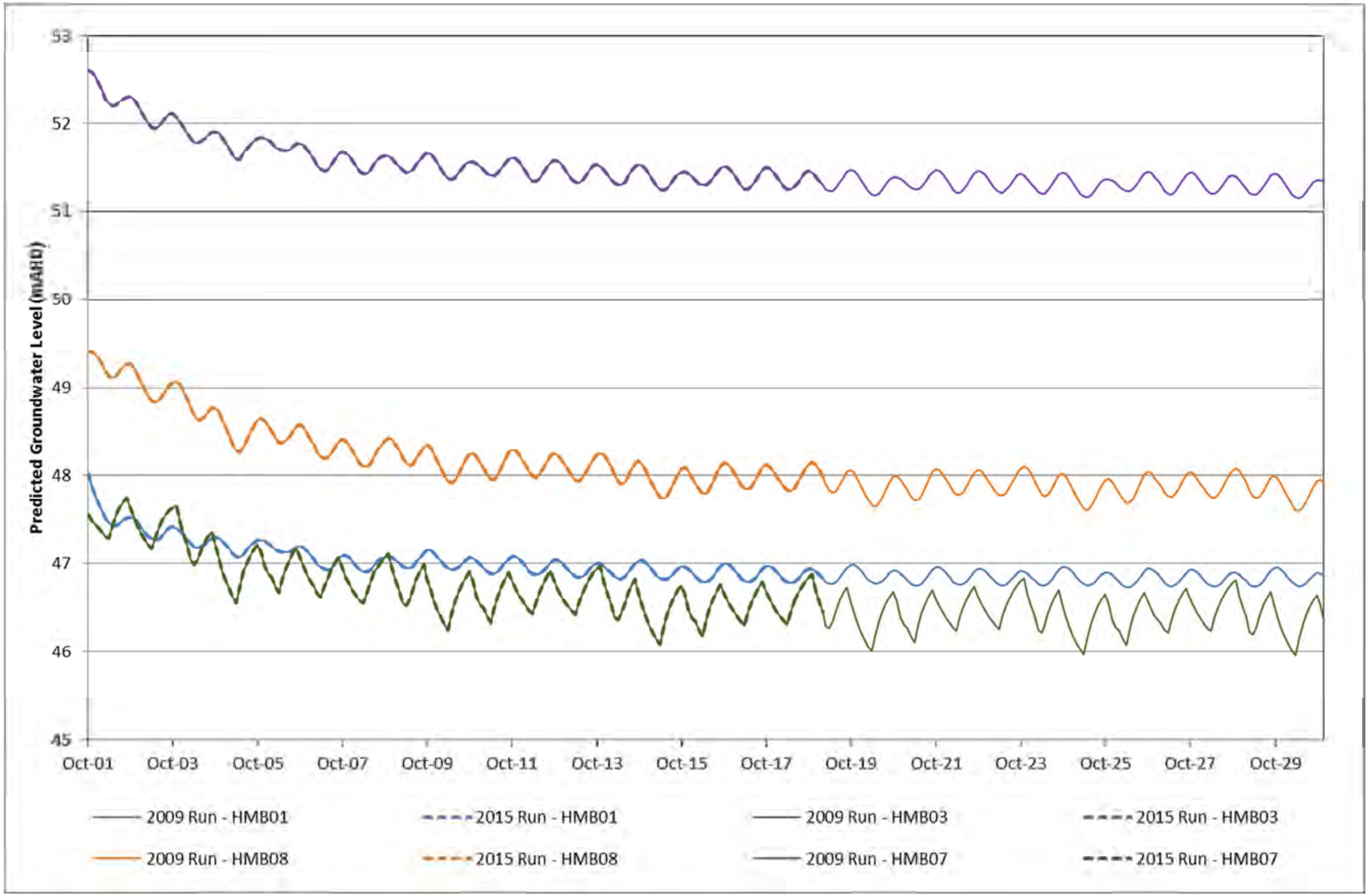


Figure G-1 Example Hydrographs to Show the Repeatability of the Model Outputs

The 2009 model was not re-calibrated. However, differences between predicted and observed groundwater levels were reviewed for all on-site monitoring bores. A comparison of these data for four monitoring events between December 2014 and June 2015 is depicted in Figure G-2. This comparison indicates there is a good alignment between the two datasets. A further comparison of the prediction residuals against the observed groundwater levels is provided in Figure G-3. This presentation indicates the observed levels are higher than the predicted levels by an average of 0.5m.

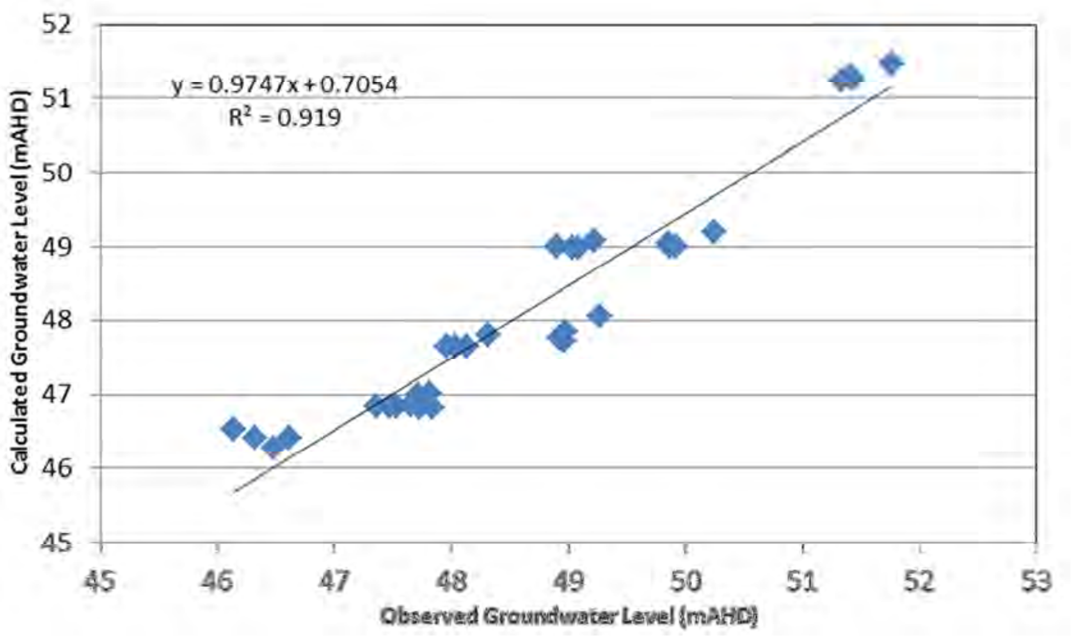


Figure G-2 Observed vs. Predicted Groundwater Levels (HMB01-HMB08) 2014 to 2015

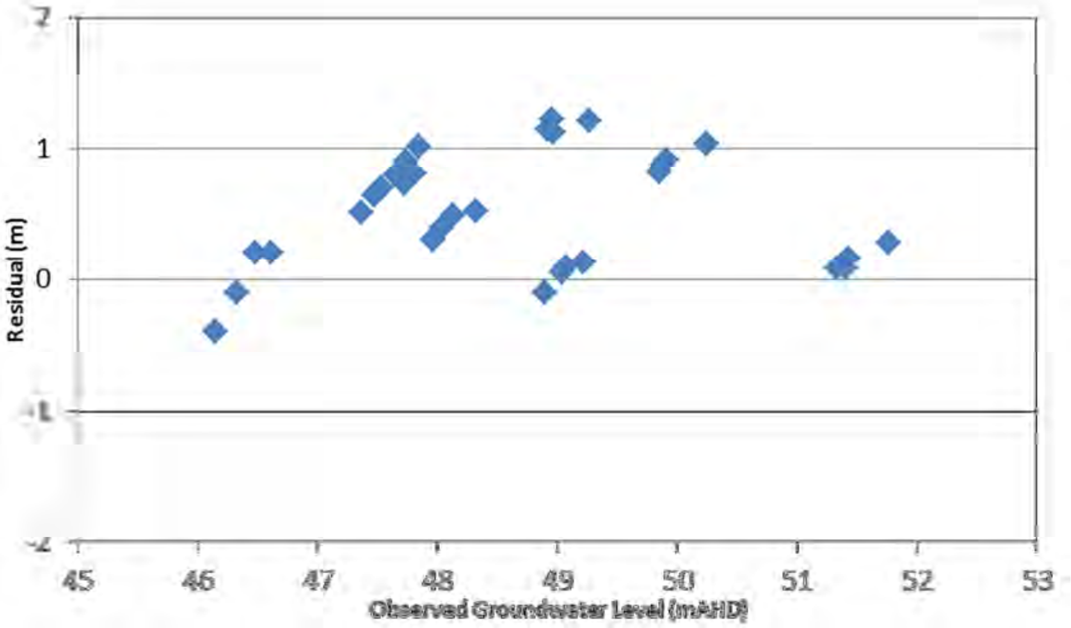


Figure G-3 Prediction Residuals vs. Observed Groundwater

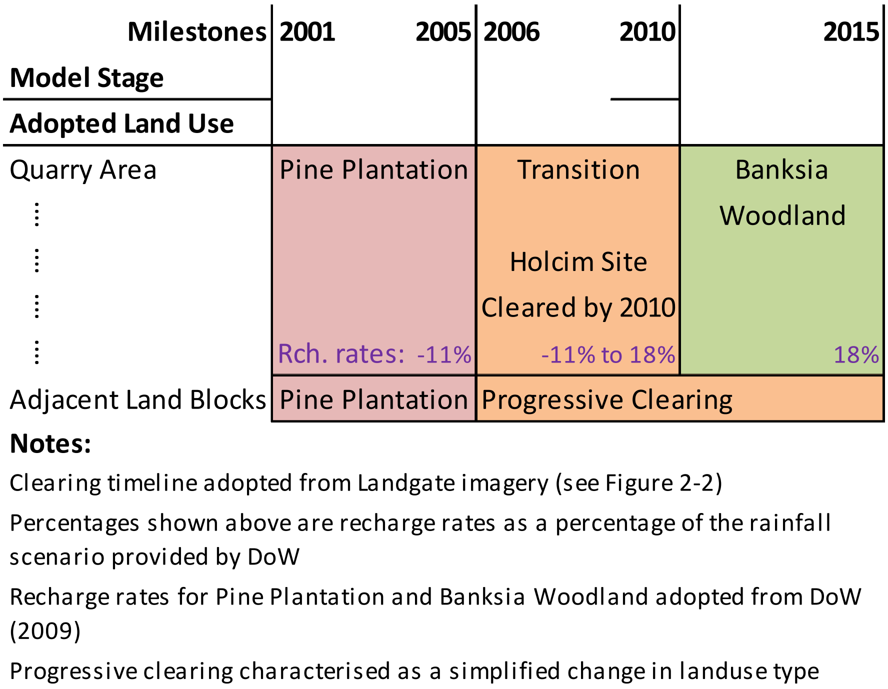
G.3 Model Re-configuration

To support the questions that need to be answered by this assessment, several aspects of the model set-up were re-configured. The key outcome of this assessment is to characterise the future Maximum Groundwater Level (MGL) across the Holcim Project site. Given the calibration residuals (predicted minus observed levels) are significant in terms of determining the MGL directly with the model, the model was re-purposed to calculate the groundwater level changes as a result of historical and future changes to land-uses and rainfall. These variables were altered as follows.

G.3.1 Base-case setup model land-use changes

The 2009 base-case model was calibrated to an array of land-uses across the domain including bushland, pine plantation, industrial, lakes, horticulture/pastoral, and urban. Each land-use type was characterised by adjusting the rate that rainfall would recharge the water table. The calibration period was October 2001 to October 2006. The recharge rates ranged from -11% of the monthly rainfall (pine plantations) to 45% for urban and industrial land-uses.

It was recognised, however, that since October 2006 (the end of the calibration period), that land-uses across the Project site and adjacent areas has changed significantly. To account for these changes, the polygons defining the above land-uses in the base-case setup model were refined to reflect three periods as depicted in Figure G-4.



Milestones	2001 2005	2006 2010	2015
Model Stage			
Adopted Land Use			
Quarry Area	Pine Plantation Rch. rates: -11%	Transition Holcim Site Cleared by 2010 -11% to 18%	Banksia Woodland 18%
Adjacent Land Blocks	Pine Plantation	Progressive Clearing	

Notes:

Clearing timeline adopted from Landgate imagery (see Figure 2-2)

Percentages shown above are recharge rates as a percentage of the rainfall scenario provided by DoW

Recharge rates for Pine Plantation and Banksia Woodland adopted from DoW (2009)

Progressive clearing characterised as a simplified change in landuse type

Figure G-4 Base-case setup Model Recharge Configuration

In effect, the removal if the pine plantations were characterised by a staged increase in the adopted recharge rate between 2006 and 2010 when the Project site was fully cleared. Adjacent areas continue to be cleared. No other parameters in the DoW were altered during any of these simulations.

G.3.2 *Base-case predictive model changes due to quarrying*

To account for future changes due to quarrying, the model was re-configured to account for clearing of the existing bush regrowth in nominal annual quarry blocks. The nominal blocks capture land-use changes on a simplified, annual basis as depicted in Figure G-5. The time-sequencing of the quarry blocks and applied recharge rates is depicted in Figure G-6.

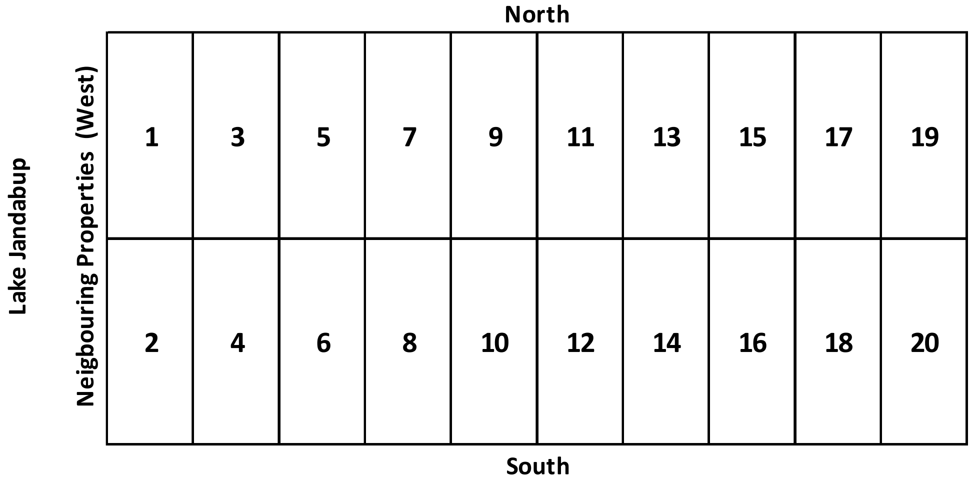
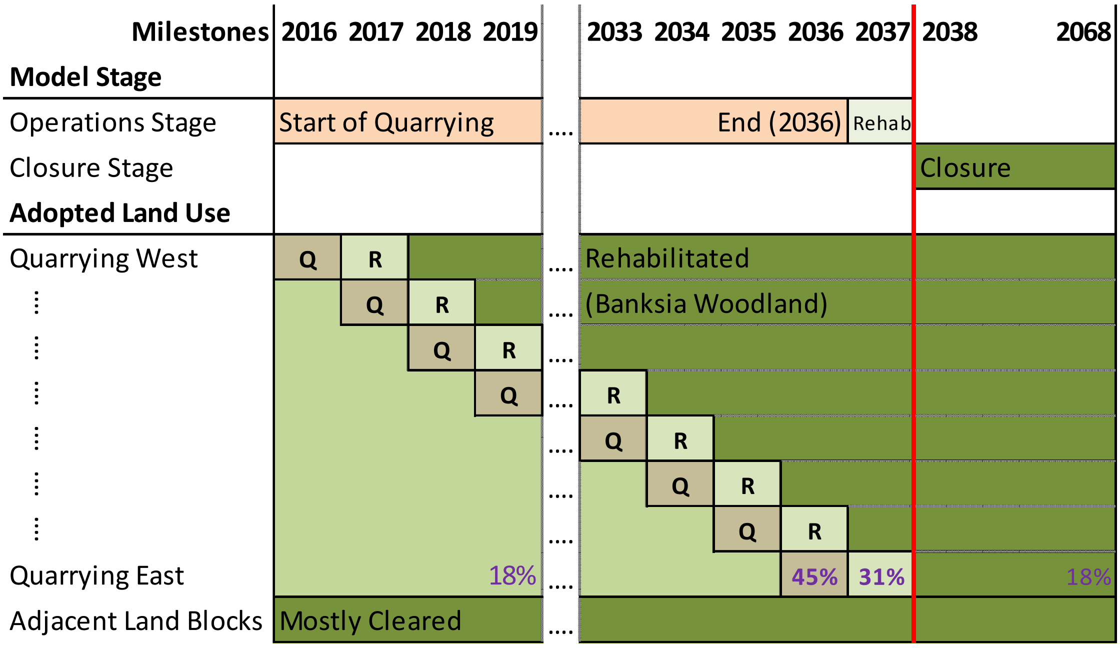


Figure G-5 Nominal Quarry Block Sequence



Notes:

Percentages shown above are recharge rates as a percentage of the rainfall scenario provided by DoW

Recharge rates for Banksia Woodland adopted from DoW (2009)

Recharge rate for quarrying land use type (**Q above**) assumed to be 45% based on the highest rate in DoW (2009)

Rehabilitation recharge (**R above**) assumed to be 31% based on half the difference between Quarrying and Banksia Woodland types

Figure G-6 Predictive Model Recharge Configuration

After closure, all quarry blocks and cleared pine plantation areas were reconfigured to represent "banksia woodland" recharge rates.

G.3.3 Changes to rainfall

Long term reductions to winter rainfall across the southwest of Australia of about 17% have been recorded since 1970 (BoM and CSIRO, 2015). This decrease is directly linked to changes in the rate of recharge applicable to the Project site, particularly since the bulk of the recharge occurs during and shortly after the winter months. The model is setup to define the rate of recharge as a percentage of these monthly rainfall totals. A reduction in the rainfall totals translates to a decrease in the recharge rate.

The 2009 setup model was further reconfigured to account for recorded rainfall between 2001 and 2015. These data were derived from the DoW, (pers. comm. Yesertener, Cahit, 28 August 2015) adopting an average of SILO data interpolated for Zone 5 and Zone 6 in PRAMS as the Jandabup site is located mid-way between the two SILO sites. These SILO data are an interpolation of all available Bureau of Meteorology (BoM) sites nearby such as Wanneroo and Perth Airport.

The predictive model adopted a synthetic rainfall dataset at the request of the DoW (pers. comm. Mackintosh, James, 28 August 2015) also from PRAMS for 2016 onwards. These data are a repeated sequence of monthly rainfall totals that have been used in PRAMS to characterise the “medium” future rainfall scenario.

G.4 Sensitivity Analysis

After the base-case and predictive models were completed, additional scenarios were run to test the sensitivity of the models outputs to uncertainty as follows:

1. Higher rates of recharge in disturbed areas during quarrying
2. An increase in the rainfall (+10%).
3. A decrease in rainfall (-10%).
4. Impact of urbanisation and complete pine plantation removal on the Project site MGL.

The rationale and setup details for these scenarios are as follows:

Higher rates of recharge in disturbed areas during quarrying

Disturbed areas that have no vegetation have been characterised by adopting a high rate of recharge, based on the established urban and industrial land-use in the DoW model. To test the sensitivity of the predicted changes, the DoW model was reconfigured to increase the “disturbed area” recharge from 45% to 50%. The outputs were not intended to define precisely the expected change, but provide a sense of how significant the assumed rate is in defining the MGL.

To achieve this, the assigned rainfall rates to the recharge domain representing quarry areas were increased by a nominal 10%. No other changes to the setup were made to this predictive model.

Increase / decrease in rainfall

The intent of these scenarios is not to specifically predict potential alternative MGLs, but rather identify a range of MGLs that the predictive model may fall within should the climate continue to dry (-10% case) or become wetter (+10%) case. Based on the recent State of the Climate 2014 report (BoM and CSIRO, 2015), it is expected that rainfall will continue to decrease in the foreseeable future. It is likely then, that, Scenario 2, the -10% rainfall case, will be more relevant to defining the likely MGL range.

To simulate these alternative outcomes, the rainfall rates used to calculate the recharge rates were all increased and reduced by 10%. No other changes were made to the model setup. The changes to the rainfall / recharge rates were assumed to have occurred at the start of the simulation in order to allow the groundwater levels to stabilise within 30-year simulation period. The MGL for each on-site and off-site monitoring bore was extracted to calculate the net change compared to the predicted base-case MGL.

Impact of urbanisation and complete pine plantation removal

Based on recent discussions, it is apparent that the DoW are planning for a future scenario involving more extensive urbanisation, and full removal of all pine trees in favour of a future pasture land-use. The intent of this scenario is to characterise the magnitude of the change that might be expected if no further land-use changes occurred. This sensitivity was tested by estimating water table rises using the local-scaled model that was configured to account for observed land-uses up to and including 2015. The local-scaled model did not include more extensive urbanisation adopted in the PRAMS simulation, or the regional impacts associated with pine plantation removal. It also assumed that the post-pine plantation land-use will be Banksia Woodland, based on recent discussions with DPaW.

To compare the results with the supplied PRAMS results, the local-scaled model was run for a 30-year simulation period. The predicted groundwater levels were first adjusted for minor calibration residuals by comparing observed and simulated levels from August 2015. The highest predicted groundwater level was then extracted and compared to levels measured in August 2015. Differences between the PRAMS-derived changes, and local model-derived changes, were generated for each of the Holcim monitoring bores to allow the sensitivity of the DoWs assumptions in the adopted MGLs to be understood.

G.5 Assumptions

The following assumptions were made during the modelling simulations for this assessment:

- The assumptions published with the model in 2009 (DoW, 2009a) are mostly still valid. The assumption relating to the up-gradient (eastern) fixed head boundary elevation was tested during the sensitivity analyses. Outputs in the DoW report indicate that the previously adopted boundary condition was producing an up-gradient mounding-type artefact (Figure 27; DoW, 2009a).
- The 2009 model calibration is adequate to characterise changes to groundwater levels due to changing recharge rates from prevailing land-use and rainfall conditions. This assumption was checked by comparing predicted and observed data from 2014 and 2015 (Section H.2).
- The boundary conditions included in the 2009 model were retained as-is. The eastern model boundary groundwater elevation (60m AHD) was adopted by the DoW based on regional groundwater level mapping by the DoW in 2008 (Figure 5; DoW, 2009a). In reality, the up-gradient fixed head elevation may be different depending on future groundwater levels in response to pine plantation removal and climate change. Comparison between the PRAMS and local-scaled models, however, indicate the net effect of pine removal is small.

- The extent and rates of groundwater abstraction included in the 2009 DoW model are adequate to characterise the MGL across the Project site for the sensitivity analysis. A significant increase in abstraction is unlikely because the Jandabup Sub-area is already fully allocated. A significant decrease (leading to a higher future MGL) is unlikely given that the local Water Corporation bores have not been used since the mid-1980s.
- The adopted “medium” case rainfall data set was adopted to negate differences between the PRAMS and local-scaled models. This dataset assumes that rainfall will cycle seasonally and neither increase nor decrease with time. This assumption is considered conservative because available analyses indicate the rainfall is likely to continue to decrease.
- All rainfall, no matter how small results in a corresponding increase in the recharge rate. This assumption is considered conservative in that smaller rainfall events are unlikely to result in recharge due to soil moisture retention and evapotranspiration losses from local vegetation.

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PO Box 6004, East Perth,
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F: 61 8 9326 0296

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APPENDIX B. FLORA AND FAUNA HABITAT REPORT (ENVIROWORKS CONSULTING, 2015A)

Flora Survey and Fauna Habitat Assessment, Proposed Sand Quarry, Jandabup

Holcim (Australia) Pty Ltd

H04 – J06

5 October 2015

www.enviroworks.com.au

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REPORT DETAILS

Project Number: H04 – J06	
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EXECUTIVE SUMMARY

Holcim (Australia) Pty Ltd (Holcim) proposes to establish a sand quarry on tenements M70/1248 and M70/1250, located in Jandabup north of Perth, approximately 8 km north east of Wanneroo, Western Australia. The vegetation within this area includes Banksia – Melaleuca Woodlands, *Pinus pinaster* plantation and areas of regrowth previously covered by pine plantation which has been cleared. As part of the approvals process a flora and fauna habitat study, involving database searches, a desktop review and on-site floristic surveys, was undertaken in Autumn and Spring 2015 (field visits occurred 13th May, 7th, 8th and 10th September) in accordance with Environmental Protection Authority (EPA) Guidance Statement Number 51 (2004) *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*.

The surveys involved traversal of the study area during which plant specimens were collected for later identification. Field studies focused on determining the type of plant communities present, compilation of comprehensive plant species lists, assessment for threatened and priority flora and description of fauna habitat. Mapping of native vegetation was based on aerial photograph interpretation with the field studies providing details of community floristics and structure. Fauna habitat assessment involved determination of the range of habitats present and assessment of potential nesting and shelter locations (e.g. nests, hollows, burrows, fallen tree limbs, etc.) and food resources.

The study area is located within the banksia woodland belt of the Swan Coastal Plain (SCP). Areas of native vegetation were cleared approximately 85 years ago to establish the Gnangara Pine Plantation. Most of the area making up the tenement was harvested recently, as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Environment and Conservation and Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009).

Two native vegetation community types were identified locally:

- The first community (a low woodland of *Banksia attenuata – Banksia menziesii* in degraded to very good ecological condition) occurs in small uncleared southern sections of the tenement outside the proposed clearing footprint. The community occupies 24.8 ha and is most similar floristically to SCP23a Central *Banksia attenuata-Banksia menziesii* Woodlands.
- The second community (open woodland of *Eucalyptus rudis* over a low woodland of *Melaleuca preissiana* over wetlands in degraded to good ecological condition) is found as a small area (20 ha) of wetland vegetation on seasonally wet sands near the eastern edge of the tenement, outside the proposed clearing footprint. It is most similar floristically to SCP4 *Melaleuca preissiana* Woodlands.

It is understood that the proposed exploration and future quarry will not result in any clearing of the above two native vegetation communities. Much of the survey area consists of cleared pine plantation (424 ha). One small area of Pine plantation remains (11 ha). It is understood that the proposed quarry activities will be limited to occurring within the cleared pine plantation areas. The native plant communities present within the study area range from degraded to very good in condition while within the pine and cleared areas ecological condition was assessed as completely degraded to degraded.

No Threatened or Priority Ecological Communities (TEC's/PEC's) were identified within the study area via the Department of Parks and Wildlife (DPaW) database search or through field visits – this is to be expected given the study area is predominantly cleared pine plantation. The native plant communities present (SCP4 and SCP23a) are not considered to be at risk and are well conserved.

155 native plant species representing 110 genera and 39 families were recorded within the study area. The most common plant families included Proteaceae, Myrtaceae and Fabaceae. Species of *Eucalyptus, Banksia, Melaleuca* and *Nuytsia floribunda* dominate the tree and taller shrub flora while Myrtaceae and Fabaceae species are most common within the lower shrubs. *Macrozamia fraseri* and *Xanthorrhoea preissii*

occur occasionally. The ground flora is species rich with Cyperaceae, Haemodoraceae and Asteraceae being the most common. Weeds were extensive in the Pine Plantation and cleared areas with 61 species being recorded.

No conservation significant plant taxa were recorded within the study areas. The DPaW significant flora record within the project area is a recorded location of *Pimelea calcicola* from Hepburn Heights and has been incorrectly placed within the Jandabup search area likely due to DPaW database data entry or recording errors.

No threatened or priority fauna were observed. Fauna habitat within the proposed project area is limited due to the sparse nature of the understorey and small stature of the re-growth/rehabilitated vegetation.

Given the proposed exploration and future quarry disturbance is limited to pine plantation areas, no native vegetation clearing will occur. Provided appropriate environmental management controls are put in place, the proposed quarry is unlikely to have a significant impact on flora, vegetation and fauna habitat values in the area. Proposed clearing is unlikely to be at variance with the 10 Clearing Principles, as listed under Schedule 5 of the *Environment Protection Act (1986)* (EP Act).

1 INTRODUCTION

Holcim (Australia) Pty Ltd (Holcim) proposes to establish a sand quarry on tenements M70/1248 and M70/1250, located in Jandabup north of Perth, approximately 8 km north east of Wanneroo, Western Australia (Figures 1 and 2). Initial exploratory drilling is proposed to be conducted as shown in Figures 3 and 4.

As part of the approvals process for initial exploratory drilling and the future quarry, a flora study is required to determine the nature of the vegetation present and the presence of threatened species / communities and significant fauna habitat.

The objectives of the survey were to:

- Develop an inventory of the flora occurring within the survey area and to determine the presence of any flora of conservation significance.

- Undertake an assessment of vegetation communities and fauna habitat present, their condition and potential conservation significance.

- Provide an assessment of the potential impacts of activity to flora and vegetation in the areas surveyed.

- Provide a statement against the 10 Clearing Principles, as listed under Schedule 5 of the EP Act.

2 METHODS

The potentially significant species and associations of flora expected to occur within the vicinity of the project area were identified and compiled by searching Department of Parks and Wildlife (DPaW) databases using a 10 x 10 km (x,y) search buffer for flora and fauna species around the clearing footprint. Databases searched included the following:

- The Threatened Flora Database.
- The Threatened Fauna Database.
- The WA Herbarium.
- The Declared Rare Flora and Priority Flora List.
- The Threatened and Priority Ecological Community Database.

The on-site floristic survey was undertaken in Autumn and Spring (visits occurred 13th May, 7th, 8th and 10th September) in accordance with Environmental Protection Authority (EPA) Guidance Statement Number 51 (2004) *Guidance for the Assessment of Environmental Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*.

The surveys involved traversal of the study area during which plant specimens were collected for later identification. During traversal, particular attention was paid to determining the extent of Rare and Priority species and, if found, the status of any populations of these species. Plant specimens were identified and verified using the resources of the State Herbarium and on-line State Herbarium database 'Florabase'.

Floristic community types are assemblages as defined by Gibson *et al.* (1994). The presence or absence of individual taxa in standard areas (quadrats) is used to define floristic groupings (or community types) based on shared species. A total of eight 100 m^2 floristic quadrats were established within the native vegetation and cleared portions of the study area. Within each quadrat all plant species were identified and their cover determined. Mapping of plant communities was based on aerial photograph interpretation with the field studies providing details of community floristics and structure. Ecological condition was assessed according to Keighery (1994). The vegetation condition rating scale used is included as Appendix A. Plant structural formation definitions follow Muir (1977) as outlined in Appendix B.

Vegetation was mapped at the community level and is based on floristics and land systems as per EPA Guidance Statement No. 51 (EPA 2004). The 8 study quadrats were compared statistically against the 1098 quadrats of the Swan floristic database available from Naturemap. This database combines the results of a number of floristic studies conducted on plant communities of the IBRA Swan Coastal Plain Bioregion south of the Moore River (Keighery *et al.* 2012). It incorporates the studies by Gibson *et al.* (1994) and various quadrats established by Perth Biodiversity Project and others. Quadrats were classified by creating a dendrogram based on Sorensen's index of similarity (equivalent to Bray-Curtis index, with species presence-absence data only). The dendrogram was created using the Group Average Method ('UPGMA'), implemented in Primer v6 (Clarke and Gorley 2006, Legendre & Legendre 2012). It should be noted that the comparative Swan dataset does not include cover information. Hence only binary (species presence/absence) comparison is possible.

Fauna habitat assessment involved determination of the extent, type and quality of the vegetation present, including the presence and extent of plants known to be used by black cockatoos. The habitat assessment included searching for signs of use by black cockatoos. Signs of use include suitable nest hollows, feeding signs or feeding debris, and sighting records. The presence of cockatoo droppings and feathers, or 'chewed' banksia or pine cones or marri nuts, can indicate feeding by black cockatoos (including, if possible, the identification of bite patterns to indicate which black cockatoo species fed there).

All maps and data are in GDA94 Zone 50 coordinates.

3 ASSESSMENT OF CONSERVATION SIGNIFICANCE

The conservation status of both flora and fauna species is assessed under Commonwealth and State legislation such as the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) *1999* and the *WA Wildlife Conservation Act 1950* (WC Act). The significance levels for species used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources. The WC Act uses a set of Schedules but also classifies species using IUCN categories.

In Western Australia, the Department of Environment and Regulation (DER) has also produced a supplementary list of Priority Flora and Fauna, being species that are not considered threatened under the WC Act but for which there is cause for concern. Some priority species however are also assigned an IUCN Conservation category. The following levels of conservation significance are recognised in this report.

WA Wildlife Conservation Act (1950) Classification

Under the WC Act, specially protected species are listed under one of four schedules:

- Schedule 1 – Species that are rare or likely to become extinct. Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection Species listed under Schedule 1 are also referred to as Threatened Species for fauna or Declared Rare Flora (DRF) for flora.
- Schedule 2 – Species that are presumed to be extinct. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.
- Schedule 3 – Birds protected under an international agreement.
- Schedule 4 – Other specially protected fauna.

ICUN Classifications

The DPaW in WA also classifies species into one of five IUCN categories:

- Extinct (EX) - also listed on Schedule 2 above.
- Extinct in the wild (EW) - also listed on Schedule 1 above.
- Critically endangered (CR) - also listed on Schedule 1 above.
- Endangered (EN) - also listed on Schedule 1 above.
- Vulnerable (VU) - also listed on Schedule 1 above.

These categories are determined by the total distribution of the species, and not just their distribution within WA.

Priority Species

If a species does not meet the criteria for listing as Threatened Fauna or DRF (e.g. due to lack of information) and is poorly known and/or conservation dependent, it may then be classified as Priority species. Priority species are placed into one of five categories of priority and are managed by DPaW accordingly.

- Priority One: Taxa with few, poorly known populations (generally <5) on threatened lands.
- Priority Two: Taxa with few, poorly known populations (generally <5) on conservation lands (at least some of which are not believed to be under immediate threat).
- Priority Three: Taxa with several, poorly known populations, some on conservation lands (at least some of which are not believed to be under immediate threat).
- Priority Four: Taxa in need of monitoring. Taxa which are considered to have been adequately

surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

- Priority Five: Taxa that are conservation dependent (i.e. their conservation status is dependent on ongoing active management).

In summary the following categories (Table 1) and criteria are used to define the status of species at international, national and state levels and where relevant have been used within this report.

Table 1: Categories Used to Define the Conservation Status of Species.

Level	Governing Body, Legislation (if relevant)	Conservation Categories
International	International Union for Conservation of Nature and natural resources (IUCN)	Extinct (EX) Extinct in the Wild (EW) Critically Endangered (CR) Endangered (EN) Vulnerable (VU) Near Threatened (NT) Least Concern (LC) Data Deficient (DD) Not Evaluated (NE)
National	Commonwealth Department of Environment (DoE), EPBC Act	Extinct Extinct in the Wild Critically Endangered Endangered Vulnerable Conservation Dependent
State of WA	DPaW, WC Act	Threatened Fauna/DRF (Schedule 1) Extinct in the Wild Critically Endangered Endangered Vulnerable Extinct (Schedule 2) Schedule 3 (Fauna) Birds protected under an international agreement Schedule 4 (Fauna)
State of WA	DPaW supplementary priority list (not listed under legislation)	Priority species: Priority One Priority Two Priority Three Priority Four Priority Five

4 RESULTS

The study area is located within the banksia woodland belt of the Swan Coastal Plain (SCP). Areas of the tenement were cleared approximately 85 years ago to establish the Gnangara Pine Plantation. Some sections of the plantation have been harvested recently as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Environment and Conservation and Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009).

4.1 PRE-EUROPEAN VEGETATION

The study area is found over three pre-european vegetation complexes as mapped by Heddle *et al.* (1980), see Table 2 and Figure 1. These complexes are broadly circumscribed and include a range of vegetation communities.

Table 2: Circa 1997 Aerial Extent of the Associated Vegetation Complex in the Swan Coastal Plain (Heddle *et al.* 1980, BushForever 2000, del Marco *et al.* 2004))

Name	Description	Original Extent (ha)	Extent (1997) (ha)
Bassendean Complex–North	Low open forest and low woodland of *Banksia* spp.-*Eucalyptus todtiana* to a low woodland of *Melaleuca* spp. and sedgelands in moister areas.	74,147	53,384 (72%)
Bassendean Complex–North Transition	Low open forest and low woodland of *Banksia* spp.-*Eucalyptus todtiana* differing from Bassendean Complex-North in understorey floristics	17,675	16,308 (92%)
Pinjar	Woodland of *Banksia* spp. – *Eucalyptus marginata* on dune slopes to a woodland of *E. rudis – Melaleuca preissiana* and sedgelands in depressions.	4,893	1,294 (26%)

The composition of the native species flora within the study area is consistent with Bassendean Complex–North and Bassendean Complex–North Transition descriptions. Plant communities mapped across the study area are shown in Figure 3 and described below.

4.2 WETLANDS

Categorisation of wetlands has been undertaken by Hill *et al.* (1996) for the SCP into a series of “Geomorphic Wetlands” as follows:

- “Conservation Category Wetlands” are those which support high levels of ecological attributes and hydrologic functions.
- “Resource Enhancement Wetlands” are those that have been partly modified but still support substantial functions and attributes.
- “Multiple Use Wetlands” are classified as those wetlands with few ecological attributes but which still provide important hydrologic functions.

A wetland may be classed as Conservation category if it:

- Is a representative wetland type (i.e., representative of its consanguineous suite).
- Exhibits representative wetland processes (i.e., representative of its consanguineous suite and geomorphic setting).
- Is an important breeding, feeding or watering site for migratory populations (local and international).
- Exhibits unaltered wetland vegetation and fauna.

Jandabup Lake is located approximately 500 m to the west of the proposed quarry (Figure 1). Water levels in this lake have been artificially maintained in summer since 1999 with water from the Leederville confined aquifer in order to prevent recurring acidification events (Sommer, 2007). In fact all of the monitored Bassendean wetlands on the Gnangara mound are now acidic (Clark, J; Horwitz, P, 2005), apart from Lake Jandabup. The reason for the acidification of the Bassendean wetlands is likely to be the steadily dropping groundwater table, combined with the low buffering capacity of the leached sandy sediments. Lake Jandabup has been impacted by drought and acidification. Monitoring detected serious impacts on aquatic macroinvertebrate community structure (including local extinctions) at Lake Jandabup following the prolonged summer drought of 1997/1998 (Sommer & Horwitz, 2001). The Lake and the surrounding area is a Nature Reserve and listed on the Register of the National Estate (RNE), being an important drought refuge for diverse populations of water birds (Department of the Environment, Water, Heritage and the Arts, 2012).

Hawkins Road Swamp is located immediately north of Tenement M70/1248 and will not be directly disturbed. It is in degraded ecological condition, and is used as a horse exercise area by neighbours, which is supported by the numerous tracks circling the swamp visible on aerial photography.

Both Jandabup Lake and Hawkins Road Swamp described above are classed as Conservation Category under the Geomorphic Wetlands Classification system.

An un-named Resource Enhancement wetland occurs in part on Tenement M70/1250 (Figure 1).

It is understood that the proposed quarry will maintain a buffer distance of 100 m from all naturally vegetated geomorphic wetlands.

4.3 DRAINAGE

Local topography slopes towards the wetlands.

There are no significant surface drainage lines or creeks within 5 km of the proposed quarry. Therefore all runoff is assumed to be via shallow dispersed flow.

The shallow geology of the project area consists predominantly of Bassendean sands. High infiltration is therefore expected. The lack of visible surface channelisation suggests that percolation of rainfall to groundwater is more significant than surface runoff.

4.4 CONSERVATION AREAS

A number of Bush Forever sites occur locally (Figure 1). Bush Forever Sites 141, 146 and 399 occur entirely or partly within the study area as shown in Figure 1. Summary descriptions of these Bush Forever Sites are detailed below (Government of Western Australia, 2000). It is understood that the proposed quarry will maintain a buffer distance of 50 m from all Bush Forever Sites.

BushForever Site 141 146: NUMBAT ROAD BUSHLAND, MARIGINIUP

Sites 141 and 146 are part of proposed Gnangara Park, State Forest 65. Floristic Community Types have not been assessed. Structural Units present include uplands of: *Banksia attenuata, B. ilicifolia, B. menziesii* Low Woodland; *Banksia menziesii, B. attenuata* Low Open Woodland. Wetlands include *Melaleuca preissiana* Low Open Forest over *Astartea* aff. *fascicularis* Open Shrubland; *Melaleuca preissiana* Low Open Woodland. Vegetation Condition is >40% Excellent, >40% Very Good, <15% Good, with areas of severe localised disturbance. There is no adjacent native vegetation.

BushForever Site 324: JANDABUP LAKE AND ADJACENT BUSHLANDS, JANDABUP/MARIGINIUP

Part of proposed Gnangara Park. Floristic Community Types have not been assessed. Structural Units present include uplands of *Eucalyptus marginata* Closed Forest; *Banksia attenuata* and *B. menziesii* Low Open Forest*; Banksia attenuata, B. menziesii* and *Allocasuarina fraseriana* Low Open Forest; *Acacia saligna* Tall Open Scrub.. Wetlands include *Eucalyptus rudis* Woodland to Open Forest; *Melaleuca rhaphiophylla* Low Woodland to Low Open Forest; *Viminaria juncea* Tall Open Scrub; *Astartea aff. fascicularis* and *Regelia ciliata* Open Heath with emergent scattered *Melaleuca preissiana; Villarsia sp.* Herbland; Closed Sedgeland to Sedgeland dominated by *Baumea articulata, B. preissii, B. juncea, Lepyrodia muirii* and *Meeboldinia scariosa.* Vegetation Condition is <70-80% Excellent - Very Good, 20-30% Good to Degraded, with areas of severe localised disturbance. Part of a regionally significant contiguous and fragmented bushland/wetland linkage. A number of conservation significant flora and fauna have been recorded for the site.

BushForever Site 326: HAWKINS RD BUSHLANDS, JANDABUP/GNANGARA

Part of proposed Gnangara Park. Floristic Community Types have been assessed in part - SCP23a (Central *Banksia attenuata — B. menziesii* woodlands) being recorded. Structural Units present include uplands of *Banksia attenuata, B. menziesii*, *Eucalyptus todtiana* and *Allocasuarina fraseriana* Low Woodland/ Low Open Forest; *Banksia attenuata* and *B. ilicifolia* Low Woodland; *Adenanthos cygnorum* Tall Open Shrubland; Low Shrublands to Open Heaths dominated by *Stirlingia latifolia, Leucopogon conostephioides, Acacia pulchella, Conospermum stoechadis*, *Hibbertia hypericoides, Calytrix fraseri* and *Xanthorrhoea preissii* and combinations of these Wetlands include *Eucalyptus rudis Woodland; Melaleuca preissiana* and *Banksia ilicifolia* Low Woodland to Open Forest; Mixed Tall Shrubland; *Astartea aff. fascicularis* Open Heath to Closed Tall Scrub; *Pultenaea reticulata* Open Scrub*, Pericalymma ellipticum* Shrubland; *Hypocalymma angustifolium* Low Open Heath*; Cyathochaeta avenacea* Sedgeland. Vegetation Condition is >30% Excellent to Pristine, <40% Very Good to Good and <30% Degraded, with areas of severe localised disturbance. Part of a regionally significant contiguous and fragmented bushland/wetland linkage. It is part of the catchment for local mound springs. Brown *et al.* (2009) note the bushland as being part of a regional ecological linkage within the Gnangara Groundwater System.

4.5 LOCAL NATIVE VEGETATION PLANT COMMUNITIES

Figures 2, 3 and 4 show the history of the plantation and its removal, the ecological condition and vegetation communities present within the survey area.

Two native vegetation community types were identified locally which are broadly consistent with the corresponding vegetation units mapped by Heddle et al. (1980), see Table 2:

- The first community (low woodland of *Banksia attenuata – Banksia menziesii*) occurs in localised uncleared southern sections of the tenement (Figure 3).
- The second community (low woodland of *Melaleuca preissiana* over wetlands) occurs as a small eastern intrusion of wetland vegetation on seasonally wet sands (Figure 3)

Each of these communities is described below.

4.5.1 COMMUNITY 1: LOW WOODLAND OF BANKSIA ATTENUATA – BANKSIA MENZIESII

Area: 24.8 ha
Landscape: slopes and crests, flat areas
Substrate: grey, white sands
Species richness (100m^2): 56
Plant Cover: 40%
Weed Frequency: 2
Vegetation Condition: very good 5.5ha, degraded-good 19.3ha
Structure: Open Scrub over very/open herbland
Structural units:
- Low woodland
- Scrub, open scrub
- Heath, low heath
- Herbs, open herbs

Floristic Communities: SCP23a
Illustration: Plates 1 and 2

Description: *Banksia attenuata, B. menziesii, Allocasuarina fraseriana* Woodland to 7m in height. The understorey consists of shrubs (*Jacksonia furcellata, Xanthorrhoea preissii, Scholtzia involucrata, Hibbertia hypericoides)* over a species rich ground layer of low shrubs, herbs, lilies and sedge-like species *(e.g. Anarthria prolifera, Calytrix fraseri, Conostylis aculeata, Dasypogon bromellifolius, Hibbertia subvaginata, Patersonia occidentalis, Pithocarpa pulchella*). Exotic species (e.g. Capeweed, Galdiolus, Veldt Grass) are confined to the edges and disturbed areas. The community is mostly in very good ecological condition within Bushforever Site 326 and is in degraded/good condition below power lines elsewhere. Figure 2 shows this degraded area as “Banksia Woodland – Modified”. Weed invasion and physical damage are the main disturbances

Plate 1: Low *Banksia attenuata – B. menziesii* Woodland

Plate 2: *Adenanthos cygnorum shrubland below power lines*

4.5.2 COMMUNITY 2: LOW WOODLAND OF *MELALEUCA PREISSIANA* OVER WETLANDS.

Area: 20 ha
Landscape: slopes and flat areas
Substrate: grey, white sands
Species richness (100m^2): 23
Plant Cover: 30%
Weed Frequency: 3
Vegetation Condition: degraded-good 20ha
Structure: Open Scrub over very open /herbland
Structural units:
  Woodland, low woodland
  Scrub, open scrub
  Heath, low heath
  Herbs, open herbs
Floristic Communities: elements of SCP4, SCP22, SCP23a, SCP23b
Illustration: Plate 3

Description: Open Low woodland (to 10m) of *Eucalyptus rudis* over *Melaleuca preissiana* (to 5m) over low shrubs (*Hypocalymma angustifolium, Pultenaea reticulata, Hakea varia, Xanthorrhoea preissii*), over a groundlayer of *Anigozanthos humilis, Lyginia barbata, Dasypogon bromelifolius* and exotic grasses and herbs. Native spring ephemerals were absent at the time of the field visit. This community occurs in a small area on poorly drained areas of grey sand (Figure 2). The community is in degraded ecological condition and was originally cleared for plantation. Weeds are common

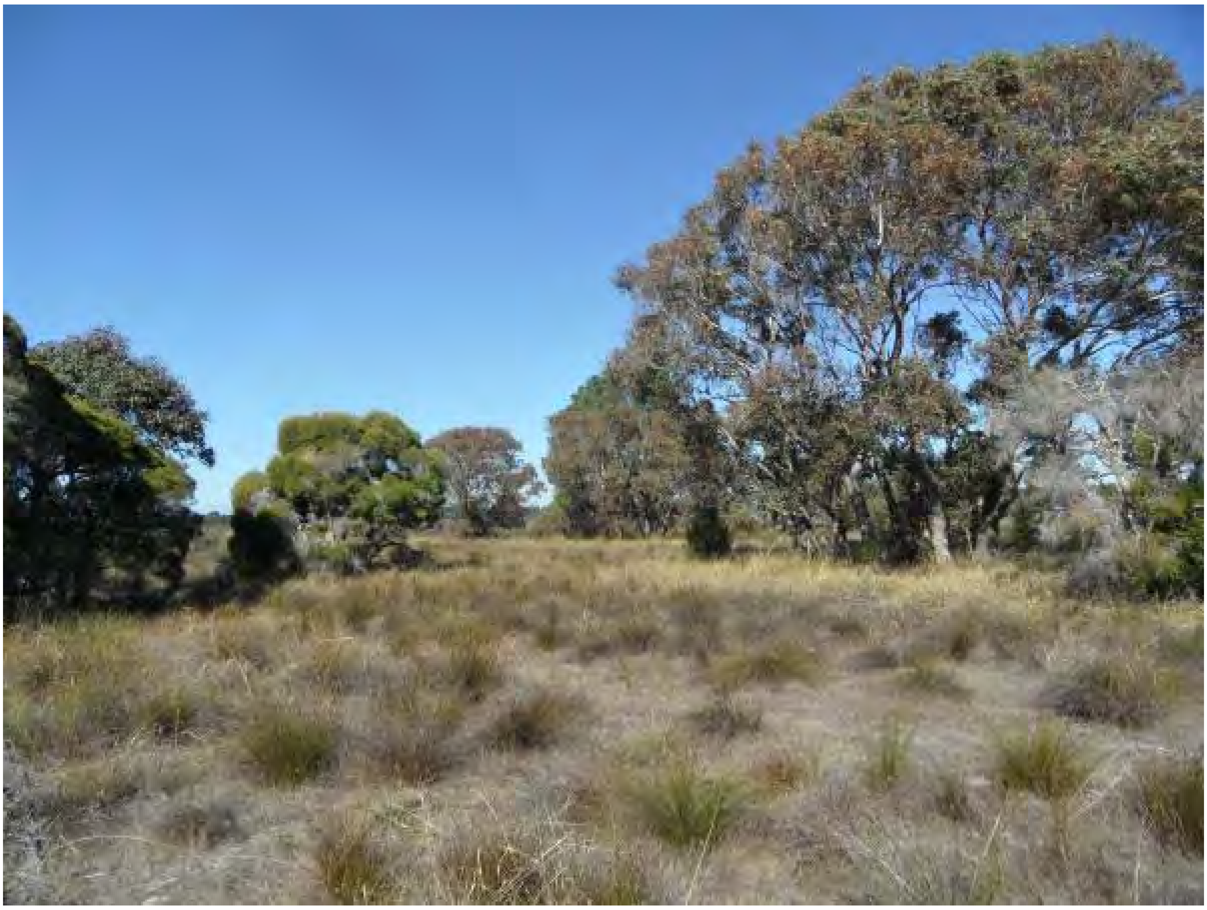


Plate 3: *Melaleuca preissiana* Open Woodland

4.6 PINE PLANTATION

Much of the native vegetation in the study area was cleared approximately 85 years ago to establish the Gnangara Pine Plantation. Parts of the plantation within the tenement were harvested recently, as part of the Gnangara Sustainability Strategy (GSS), which is a joint project between the Department of Water, Department of Agriculture and Food WA, Department of Environment and Conservation and Department for Planning and Infrastructure, Forest Products Commission, Water Corporation and CSIRO (Department of Water, 2009). Harvest times were determined by review of historical aerial photographs.

4.6.1 PINE PLANTATION

Existing pine plantation occupies 11 hectares (Figure 3, Plate 6). Native plant species occur sporadically within the plantations with obvious recolonisation occurring within harvested and thinned plantation areas. The vegetation consists of self-sown scattered individual plants of *Nuytsia floribunda, Xanthorrhoea preissii*, *Jacksonia* spp. and low woody shrubs such as *Hypocalymma robustum* and *Acacia pulchella*. Weeds (especially grasses) are common. The vegetation condition within these areas is degraded.

Plate 4: Thinned plantation with a sparse native understorey.

4.6.2 CLEARED PINE PLANTATION

Sections of the pine plantation have been harvested within the last 20 years (Figure 3, Plates 5 - 7). These areas occupy 424 ha within the tenements. Small areas were rehabilitated via direct seeding and planting. Native vegetation present consists of scattered individual plants of *Nuytsia floribunda, Xanthorrhoea preissii*, *Jacksonia* spp. and low woody shrubs (e.g. *Acacia puchella, Daviesia divaricata, D. physodes, Hibbertia subvaginata, Hypocalymma robustum*). The ground layer typically consists of annual herbs (e.g. *Podotheca* sps.) and geophytes (e.g. species of Cyperaceae, Restionaceae). Annual weeds are very common.

Clearing of the plantation may involve complete removal of the pine tree (Plate 5) or gradual thinning (Plate 4). Native species richness increases and vegetation structure becomes more similar to remnant native vegetation over time. Ecological condition varies from being completely degraded in recently cleared areas to degraded in older regrowth.

Plate 5: Plantation Cleared 2013.

Plate 6: Native regrowth (cleared 2006)

Plate 7: Rehabilitation planting

4.7 FLORISTIC ANALYSIS

Dendrogram 1 shows the final results of the classification of the 1098 quadrats in the Swan floristic dataset and the 8 quadrats established in this study. The highlighted divisions indicate the positions of the floristic quadrats. Division A identifies the 6 quadrats established within the cleared pine plantation (Quadrats 1, 4, 5, 6, 7 and 8). Division B identifies the *Banksia* woodland quadrat (#2) while Division C indicates the *Eucalyptus rudis-Melaleuca preissii* quadrat (#3)

The results of the Similarity Comparisons are shown below in Table 3. Each of the 8 floristic quadrats established within the study area was compared with the 1098 Floristic quadrats of the Swan dataset. For each quadrat a list of the 10 most similar floristic quadrats is displayed. These quadrats are listed in order of decreasing similarity; i.e. the most similar site is the first in each list.

One Sandplain community (Community type SCP23a – Central *Banksia attenuata-Banksia menziesii* woodlands) dominates the list for the undisturbed Banksia woodland quadrat (#2). SCP23a extends from the southern parts of the Shire of Chittering to the Shire of Serpentine-Jarrahdale. The average species richness of Sandplain Community type 23a is 62.8 per 100m^2 respectively (Gibson *et al.* 1994). Fifty six species were recorded in Quadrat 2. Though less, this number is considered to be normal for good/very good condition remnant vegetation.

Floristic Community 23a is not considered to be threatened - the community is not currently listed as a TEC or PEC. Gibson *et al.* (1994) determined that SCP23a is well reserved and at low conservation risk. Locally SCP23a is recorded from Bushforever Site 326 (Hawkins Rd Bushland). The community type is not associated closely with wetlands.

One Sandplain community (Community type SCP4) dominates the list for the *E.rudis-M.preissiana* open woodland quadrat (#3). SCP4 extends from the southern parts of the Shire of Gingin to the Shire of Busselton.

The average species richness of Sandplain Community type 4 is 36.9 per 100m^2 respectively (Gibson *et al.* 1994). Twenty Three species were recorded in Quadrat 3. This number is considered to be indicative of disturbed remnant vegetation.

Floristic Community 4 is not considered to be threatened - the community is not currently listed as a TEC or PEC. Gibson *et al.* (1994) determined that SCP4 is well reserved and at low conservation risk. Locally SCP4 is recorded from Bushforever Site 399 (Melaleuca Park). The community type is associated closely with wetlands.

Comparison of the Floristic quadrats established within the cleared plantations areas (quadrats 1, 4 to 8) reveal no clear patterns of similarities. They indicate a general resemblance to Banksia woodland communities (types 21a, 21b, 21c, 23a, 24 and 28). This is due to the presence of species common to Banksia woodlands and found across all floristic community types. Native species richness within these Quadrats (mean 21 species) is low compared with the Gibson *et al.* sites and reflects the fact that these areas are regenerating and are in completely degraded-degraded ecological condition.

Table 3: Similarity Comparisons of floristics Quadrats.

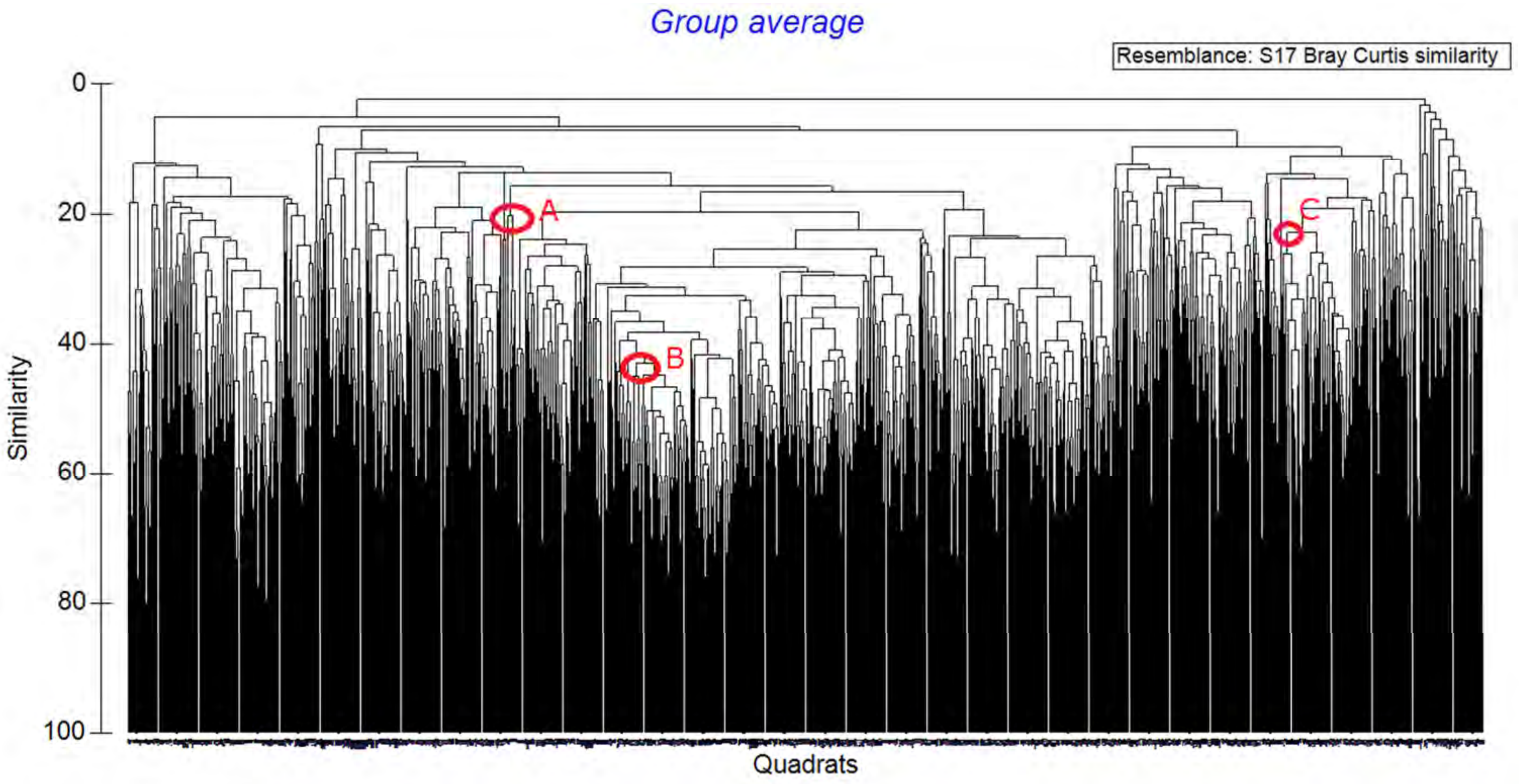
Quadrat 1 – cleared Pine			**Quadrat 2 – Banksia woodland**		
Floristic Quadrat	Community Type	Similarity	Floristic Quadrat	Community Type	Similarity
jand02	23a	43	WIRR-2	23a	57
FL-6	21c	40	WIRR-1	23a	56
THOM-2	24	39	WHITE-1	23a	54
bibra01	23a	38	ELE03	23b	54
WIRR-2	23a	38	ELE16	23b	52

Quadrat 1 – cleared Pine			**Quadrat 2 – Banksia woodland**		
Cavs11	21a	37	WARB-3	23a	52
FL-5	21c	37	ELE08	23b	51
TRIG-3	28	36	ELE02	21c	51
perth08	23a	35	perth08	23a	50
cas03	23a	35	WARB-1	23a	50

Quadrat 3 – *E.rudis – M.preissiana* woodland			**Quadrat 4 – cleared Pine**		
Floristic Quadrat	**Community Type**	**Similarity**	**Floristic Quadrat**	**Community Type**	**Similarity**
ELE32	4	37	FL-5	21c	29
MODO-6	4	36	jand02	23a	28
MUK02	4	35	gnan03	23a	28
cas04	4	34	Tele01	23a	28
ELE07	4	34	bibra01	23a	28
WHITE-2	4	34	Cavs10	21a	27
KOOLJ-1	4	33	THOM-2	24	27
MODO-1	4	32	Light01	23a	26
perth10	4	31	C71-3	21a	26
C58-1	4	31	DEJONG02	21c	26

Quadrat 5 – cleared Pine			**Quadrat 6 – cleared Pine**		
Floristic Quadrat	Community Type	Similarity	Floristic Quadrat	Community Type	Similarity
wire02	28	30	THOM-2	24	39
SHENT-1	28	29	jand02	23a	36
WN100WNR	23b	26	Cavs11	21a	33
5A01	23b	25	bibra01	23a	33
FL-5	21c	25	hurst04	23a	32
raven05	22	24	ELE24	23b	31
sand01	28	24	ELE03	23b	30
NEER-3	28	23	WN086CHE	23b	30
Light01	23a	23	WIRR-2	23a	30
bibra01	23a	23	WHITE-1	23a	30

Quadrat 7– cleared Pine			**Quadrat 8– cleared Pine**		
Floristic Quadrat	**Community Type**	**Similarity**	**Floristic Quadrat**	**Community Type**	**Similarity**
ELE22	21c	37	KING-2	28	28
Cavs11	21a	35	TRIG-6	24	28
ELE21	S09	33	sand01	28	28
ELE03	23b	32	THOM-2	24	27
ELE11	21a	32	FL-6	21c	27
ELE29	21c	31	TRIG-2	29a	27
ELE28	23b	31	ELE11	21a	27
perth10	4	31	jand05	21c	27
ELE02	21c	30	wire02	28	26
wire02	28	30	Cavs02	21a	26



Dendrogram 1: Floristic Analysis of 1102 Floristic Quadrats

4.8 CONSERVATION SIGNIFICANT NATIVE VEGETATION COMMUNITIES

A Threatened or Priority Ecological Community (TEC or PEC) is one that has been endorsed by WA's Environment Minister as being subject to processes that threaten to destroy or significantly modify it across much of its range. A search of the DPaW TEC/PEC database indicated 17 TECs / PECs occur within the search area which included a 10 km buffer around the study area (Table 4), however none of these TEC / PEC records occur within the proposed project area (Figure 1).

Analysis of the floristic quadrats indicated that the quadrat within the *Banksia* woodland area was most similar to SCP23a while the quadrat within the *Melaleuca* woodland area was most similar to SCP4. It is concluded that the native bushlands within the tenement (predominantly coinciding with Bush Forever Sites) include areas of extensive common floristic communities which are not at risk (e.g. SCP23a, SCP4)

The areas of cleared pine plantation are similar to completely degraded-degraded *Banksia* woodland community types.

Table 4: DPaW TEC / PEC Records within 10 km Buffer of Study Area

Name	ID	Conservation Status
Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain	CAVES SCP01	Critically Endangered
Banksia attenuata woodland over species rich dense shrublands	SCP20a	Endangered
Banksia ilicifolia woodlands	SCP22	Priority 3
Coastal shrublands on shallow sands	SCP29a	Priority 3
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	Mound Springs SCP	Critically Endangered
Eucalyptus calophylla - Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain	SCP3c	Critically Endangered
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	SCP15	Vulnerable
Herb rich saline shrublands in clay pans	SCP07	Vulnerable
Herb rich shrublands in clay pans	SCP08	Vulnerable
Low lying Banksia attenuata woodlands or shrublands	SCP21c	Priority 3
Melaleuca huegelii - Melaleuca acerosa (currently M. systena) shrublands on limestone ridges (Gibson et al. 1994 type 26a)	Limestone ridges (SCP 26a)	Endangered
Northern Spearwood shrublands and woodlands	SCP24	Priority 3
Shrublands and woodlands on Muchea Limestone	Muchea Limestone	Endangered
Shrublands on calcareous silts of the Swan Coastal Plain	SCP18	Vulnerable
Shrublands on dry clay flats	SCP10a	Endangered
Southern Eucalyptus gomphocephala-Agonis flexuosa woodlands	SCP25	Priority 3
Swan Coastal Plain Banksia attenuata - Banksia menziesii woodlands	SCP23b	Priority 3

4.9 ECOLOGICAL CONDITION

The native plant communities present within the study area range from degraded to very good in condition while within the pine and cleared areas ecological condition was assessed as completely degraded to degraded, according to the rating scale outlined in Keighery (1994) – see Figure 4, Table 5. Much of the area has had a long history as a *Pinus pinaster* plantation. Parts of the plantation have been removed within the last 20 years and the native vegetation which is present is re-growth and young rehabilitation. Uncleared native vegetation is generally in good to very good ecological condition apart from localised disturbances and weed invasion associated with tracks and human activities.

Table 5: Ecological Condition

Ecological Condition	Area (ha)
Very Good	5.5
Degraded - Good	36.6
Completely degraded/degraded	221.1
Completely degraded	206.7
Plantation	11.0
road	25.1
TOTAL	506.1

4.10 NATIVE FLORA

155 native plant species representing 110 genera and 39 families were recorded within the study area (Table 6). The most common native plant families included Proteaceae, Myrtaceae and Fabaceae. Species of *Eucalyptus, Banksia, Melaleuca* and *Nuytsia floribunda* dominate the tree and taller shrub flora while Myrtaceae, Ericaceae and Fabaceae species are most common within the lower shrubs. *Macrozamia fraseri* and *Xanthorrhoea preissii* plants are common. The native ground flora is species rich with Cyperaceae, Restionaceae, Haemodoraceae and Asteraceae being the most common families.

Table 6: Native Plant Species

Species	Author	Family
Acacia hueglii	Benth.	Fabaceae
Acacia pulchella	R.Br.	Fabaceae
Acacia saligna	(Labill.) Wendl.	Fabaceae
Acacia sessilis	Benth.	Fabaceae
Adenanthos cygnorum var cygnorum	Diels	Proteaceae
Adenanthos obovatus	Labill.	Proteaceae
Alexgeorgea nitens	(Nees) L.A.S.Johnson & B.G.Briggs	Restionaceae
Allocasuarina fraseriana	(Miq.) LAS .Johnson	Casuarinaceae
Allocasuarina humilis	(Otto & Dietr.) LAS.Johnson	Casuarinaceae
Anarthria prolifera	R.Br.	Anarthriaceae
Anigozanthos humilis	Lindl.	Haemodoraceae
Anigozanthos manglesii	D.Don	Haemodoraceae
Aotus gracillima	Meisn.	Fabaceae
Astartea fascicularis	(Labill.)DC	Myrtaceae
Astroloma macrocalyx	Sond.	Ericaceae

Species	Author	Family
Astroloma xerophyllum	(DC) Sonder	Ericaceae
Austrostipa compressa	(R.Br.) S.W.L.Jacobs & J.Everett	Poaceae
Banksia attenuata	R.Br.	Proteaceae
Banksia grandis	Willd.	Proteaceae
Banksia ilicifolia	R.Br.	Proteaceae
Banksia menziesii	R.Br.	Proteaceae
Bossiaea eriocarpa	Benth.	Fabaceae
Burchardia congesta	(Turner) J.Agardh	Colchicaceae
Caesia micrantha	Lindl.	Hemerocallidaceae
Caladenia flava	R.Br.	Orchidaceae
Caladenia sps. (indet.)		Orchidaceae
Calandrinia linifolia	Fenzl.	Portulacaceae
Calectasia narragara	R.L.Barret & K.L.Dixon	Dasypogonaceae
Calothamnus sanguineus	Labill.	Myrtaceae
Calytrix angulata	Lindl.	Myrtaceae
Calytrix fraseri	Cunn.	Myrtaceae
Cartonema philydroides	F.Muell.	Commelinaceae
Cassytha glabella	R.Br.	Lauraceae
Caustis dioica	R.Br.	Cyperaceae
Chamelaucium uncinatum	Schauer	Myrtaceae
Comesperma calymega	Labill.	Polygalaceae
Conospermum incurvum	Lind.	Proteaceae
Conospermum triplinervum	R.Br.	Proteaceae
Conostephium pendulum	Benth.	Ericaceae
Conostylis aculeata	R.Br.	Haemodoraceae
Conostylis juncea	Endl.	Haemodoraceae
Corynotheca micrantha	(Lindley) J.F. Macbride	Hemerocallidaceae
Crassula colorata	(Nees.)Ostenf.	Crassulaceae
Dampiera lavandulacea	Lindl.	Goodeniaceae
Dampiera linearis	de Vriese	Goodeniaceae
Dasypogon bromelifolius	R.Br.	Dasypogonaceae
Daucus glochidiatus	(Labill.)Fisch,Mey,Ave-Lall	Apiaceae
Daviesia divaricata	Benth.	Fabaceae
Daviesia physodes	Cunn ex. Don	Fabaceae
Daviesia triflora	M.D. Crisp	Fabaceae
Desmocladus flexuosa	(R.Br.)B.G.Briggs & L.A.A.Johnson	Restionaceae
Dianella divaricata	R.Br.	Hemerocallidaceae
Dielsia stenostachya	(W.Fitzg.) B.G.Briggs & L.A.S.Johnson	Restionaceae
Diuris sp (indet.)		Orchidaceae
Drosera erythrorhiza	Lindl.	Droseraceae
Drosera menziesii subsp. menziesii	R. Br. ex DC	Droseraceae
Drosera sps (indet.)		Droseraceae
Eremaea pauciflora	(Endl.) Druce	Myrtaceae
Eriochilus dilatatus	Lindl.	Orchidaceae
Eucalyptus erythrocorys	F.Muell.	Myrtaceae

Species	Author	Family
Eucalyptus marginata	Donn ex Smith	Myrtaceae
Eucalyptus rudis	Endl.	Myrtaceae
Eucalyptus todtiana	F.Muell.	Myrtaceae
Euchilopsis linearis	(Benth.) F. Muell.	Fabaceae
Gastrolobium capitatum	(Benth.) G.Chandler & Crisp	Fabaceae
Gompholobium tomentosum	Labill.	Fabaceae
Haemodorum spicatum	R.Br.	Haemodoraceae
Hakea prostrata	R.Br.	Proteaceae
Hakea varia	R.Br.	Proteaceae
Hardenbergia comptoniana	(Andrews) Benth.	Fabaceae
Hemiandra pungens	R.Br.	Lamiaceae
Hibbertia hueglii	(Endl.) F. Muell.	Dilleniaceae
Hibbertia hypericoides	(DC)Benth.	Dilleniaceae
Hibbertia subvaginata	(Steudel) F. Muell.	Dilleniaceae
Hibbertia vaginata	(Benth.)F.Muell.	Dilleniaceae
Hovea pungens	Benth.	Fabaceae
Hyalosperma cotula	(Benth.)P.G.Wilson	Asteraceae
Hybanthus calycinus	(DC ex Ging.) F. Muell.	Violaceae
Hypocalymma angustifolium	(Endl.)Schauer	Myrtaceae
Hypocalymma robustum	(Endl.)Lindl.	Myrtaceae
Hypocalymma xanthopetalum	F.Muell.	Myrtaceae
Hypolaena exsulca	R.Br.	Restionaceae
Jacksonia floribunda	Endl.	Fabaceae
Jacksonia furcellata	(Bonpl.)DC	Fabaceae
Jacksonia sternbergiana	Huegel	Fabaceae
Kunzea glabrescens	Tolken	Myrtaceae
Lagenophora hueglii	Benth.	Asteraceae
Laxmannia ramosa	Lindl.	Asparagaceae
Laxmannia squarrosa	Lindl.	Asparagaceae
Lechenaultia biloba	Lindl.	Goodeniaceae
Lechenaultia floribunda	Benth.	Goodeniaceae
Lepidosperma longitudinale	Labill.	Cyperaceae
Lepidosperma squamatum	Labill.	Cyperaceae
Leucopogon australis	R.Br.	Ericaceae
Leucopogon conostephioides	DC	Ericaceae
Leucopogon polymorphus	Sonder	Ericaceae
Leucopogon squarrosus	Benth.	Ericaceae
Levenhookia stipitata	(Sonder)F.Muell.	Stylidiaceae
Lobelia tenuior	R.Br.	Campanulaceae
Lomandra hermaphrodita	(Andrews)Gardner	Asparagaceae
Loxocarya cinerea	R.Br.	Restionaceae
Lyginia barbata	R.Br.	Restionaceae
Macarthuria australis	Huegel ex Endl.	Molluginaceae
Macrozamia fraseri	Miq.	Zamiaceae
Meeboldina coangustata	(Nees.)Briggs&Johnson	Restionaceae

Species	Author	Family
Melaleuca preissiana	Schauer	Myrtaceae
Melaleuca seriata	Lindl.	Myrtaceae
Mesomelaena pseudostygia	(Kurek.)K.L.Wilson	Cyperaceae
Microtis media	R.Br.	Orchidaceae
Millotia myosotidifolia	(Benth.)Steetz	Asteraceae
Neurachne alopecuroides	R.Br.	Poaceae
Nuytsia floribunda	(Labill.) R.Br. ex Fenzl	Loranthaceae
Patersonia juncea	Lindl.	Iridaceae
Patersonia occidentalis	R.Br.	Iridaceae
Pericalymma eliptica	(Endl.) Schauer	Myrtaceae
Persoonia saccata	R.Br.	Proteaceae
Petrophile linearis	R.Br.	Proteaceae
Philotheca spicatus	(A Rich)P.Wilson	Rutaceae
Phlebocarya ciliata	R.Br.	Haemodoraceae
Phyllanthus calycinus	Labill.	Phyllanthaceae
Pimelea imbricata var piligera	(Benth.) Diels	Thymeleaceae
Pithocarpa pulchella	Lindl.	Asteraceae
Podotheca chrysantha	(Steetz)Benth.	Asteraceae
Podotheca gnaphalioides	R.A.Graham	Asteraceae
Poranthera microphylla	Brongn	Phyllanthaceae
Pultenaea reticulata	Smith(Benth.)	Fabaceae
Pyrorchis sp (indet.)		Orchidaceae
Quinetia urvillei	Cass.	Asteraceae
Regelia ciliata	Schauer	Myrtaceae
Rytidosperma occidentale	(Vickery) Connor & Edgar	Poaceae
Scaevola canescens	Benth.	Goodeniaceae
Scaevola repens var angustifolia	de Vriese	Goodeniaceae
Schoenus curvifolius	(R.Br.)Roem&Schult	Cyperaceae
Scholtzia involucrata	(Endl.)Druce	Myrtaceae
Siloxeros humifusus	Labill.	Asteraceae
Sowerbaea laxiflora	Lindl.	Asparagaceae
Stirlingia latifolia	(R.Br.) Steudel	Proteaceae
Stylidium brunonianum	Benth.	Stylidiaceae
Stylidium calcaratum	R.Br.	Stylidiaceae
Stylidium repens	R.Br.	Stylidiaceae
Stylidium schoenoides	DC	Stylidiaceae
Taxandria linearifolia	(DC) Schauer	Myrtaceae
Thysanotus manglesianus	Kunth	Asparagaceae
Trachymene pilosa	Smith	Araliaceae
Tribonanthes australis	Endl.	Haemodoraceae
Tribonanthes longipetala	Lindl.	Haemodoraceae
Tricoryne elatior	R.Br.	Hemerocallidaceae
Tripterococcus brunonis	Endl.	Celastraceae
Verticordia densiflora var. densiflora	Lindl.	Myrtaceae
Verticordia nitens	(Lindley)Endlicher	Myrtaceae

Species	Author	Family
Wahlenbergia preissii	de Vriese	Campanulaceae
Waitzia suaveolens	(Benth.) Druce	Asteraceae
Xanthorrhoea preissii	Endl.	Xanthorrhoeaceae
Xanthosia hueglii	(Benth.)Steudl.	Apiaceae

4.11 CONSERVATION SIGNIFICANT FLORA

A significant flora search requested from DPaW for a 10 km buffer of the study area found 37 species of conservation significance. None of these DPaW records occur within the proposed project area. The recorded location of *Pimelea calcicola* is from Hepburn Heights and has been incorrectly placed within the study area likely due to data entry or recording errors. All significant flora species from the DPaW search are listed in Table 7, along with their conservation significance and an assessment of the likely presence within the tenements.

No conservation significant flora species were located during field studies. It is unlikely that conservation significant flora species occur within the pine plantation areas, however they could be present within the Bush Forever Sites. Field studies were considered to be optimal in timing for the detection of conservation significant flora.

Table 7: DPaW Significant Flora Records within 10 km Buffer of Study Area

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
Acacia anomala	Threatened	August to September	Slender, rush-like shrub, 0.2-0.5 m high, yellow flowers	Lateritic soils. Slopes.	Not recorded from the City of Wanneroo. A species occurring on laterite which is not present in the tenements
Acacia benthamii	Priority 2	August to September	shrub growing to 1m, producing yellow flowers	Brown/grey sand on limestone breakaways	A conspicuous coastal species. Unlikely to be present. Field studies corresponded to flowering times
Anigozanthos humilis subsp. chrysanthus	Priority 4	July to October	Rhizomatous, perennial, herb, 0.2-0.4(-0.8) m high. Fl. yellow	Grey or yellow sand.	Not recorded from the City of Wanneroo. A conspicuous species. Field studies corresponded to flowering times. Unlikely to be present.
Baeckea sp. Limestone (N. Gibson & M.N. Lyons 1425)	Priority 1	November	A woody shrub	grey sand on limestone breakaways	Baeckea sps are generally conspicuous – this species is unlikely to be present
Caladenia huegelii	Threatened	September to October	Tuberous, perennial, herb, 0.25-0.6 m high. Fl. green & cream & red	Grey or brown sand, clay loam	Possibly present in the undisturbed banksia woodland, unlikely to be present in plantation or regrowth areas. Field studies corresponded to flowering time
Calectasia sp. Pinjar (C. Tauss 557)	Priority 1	September to November	Perennial, herb, to 0.4 m high, with multiple stems and roots.	Deep grey quartz soils. Gentle slopes, above damplands.	A conspicuous species. Damplands are limited within the tenements. Unlikely to be present.
Chamaescilla gibsonii	Priority 3	Spring ephemeral	Small lily, Blue flowers	Damp sandy clays.	Not recorded from the City of Wanneroo. . Damplands are limited within the tenements. Unlikely to be present.
Conostylis bracteata	Priority 3	August to September	perennial, rhizomatous, tufted or shortly proliferous grass like herb, yellow flowers	Sand over limestone on coastal dunes	A conspicuous coastal species. Unlikely to be present. Field studies corresponded to flowering times.
Cyathochaeta teretifolia	Priority 3	September	Clumped tuberous, herb. Fl. blue	Clay to sandy clay. Winter-wet flats, shallow water-filled claypans.	A conspicuous species. Damplands are limited within the tenements. Field studies corresponded to flowering times. Unlikely to be present.
Dampiera triloba	Priority 3	August to December	Erect perennial, herb or shrub, to 0.5 m high, Flowers blue	Loamy poorly drained sand.	Unlikely to be present. Field studies corresponded to flowering times.
Darwinia foetida	Threatened	October to November	Shrub to 1m, flowers red-green	grey-black sandy rises in winter-damp to wet clay flats	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present.
Dasymalla axillaris	Threatened	Spring	Grey shrub to 80cm. Flowers pink/red	Grey sands, damplands	A conspicuous species unlikely to be present. Field studies corresponded to flowering times.

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
Drosera occidentalis subsp. occidentalis	Priority 4	November to December	Fibrous-rooted, rosetted perennial, herb, to 0.01 m high. Fl. pink/white,	Sandy & clayey soils. Swamps & wet depressions.	Damplands are limited within the tenements. Unlikely to be present.
Drosera x sidjamesii	Priority 1	November to March	Fibrous-rooted perennial, herb, to 0.06 m high. Fl. green-pink	Peaty sand. Along lake margins, close to winter high-water line	Damplands are limited within the tenements. Unlikely to be present.
Eleocharis keigheryi	Threatened	August to November	Rhizomatous, clumped perennial, grass-like or herb (sedge), to 0.4 m high. Fl. green	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Not recorded from the City of Wanneroo. No standing water is present within the tenements.
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	Priority 3	Spring	Spring ephemeral	damplands	Not recorded from the City of Wanneroo. A distinctive species unlikely to be present. Field studies corresponded to flowering times.
Grevillea curviloba subsp. curviloba	Threatened	October	Prostrate to erect shrub, 0.1-2.5 m high. Fl. white-cream	Grey sand. Winter-wet heath	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times
Grevillea curviloba subsp. incurva	Threatened	August to September	Prostrate to erect shrub, 0.1-2.5 m high. Fl. white-cream	Sand, sandy loam. Winter-wet heath.	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times
Guichenotia tuberculata	Priority 3	August to October	Erect, open shrub, (0.25-)0.6-0.9 m high. Fl. purple-pink	Sand clay over laterite, sand.	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times
Hibbertia helianthemoides	Priority 4	July to October	spreading to erect, low or prostrate shrub growing to 0.3 m high. It produces yellow flowers	Clayey sand over sandstone or loam over quartzite on hills and scree slopes	Unlikely to be present. Field studies corresponded to flowering times. Unlikely to be present.
Hydrocotyle lemnoides	Priority 4	August to October	Aquatic, floating annual, herb	Swamps	Not recorded from the City of Wanneroo. No standing water is present within the tenements. Unlikely to be present.
Hypolaena robusta	Priority 4	September to October	Dioecious rhizomatous, perennial, herb, ca 0.5 m high	White sand. Sandplains	Not recorded from the City of Wanneroo. Field studies corresponded to flowering times. Unlikely to be present.
Jacksonia sericea	Priority 4	December to February	Low spreading shrub, to 0.6 m high. Fl. orange	Calcareous & sandy soils	A conspicuous species unlikely to be present
Phlebocarya pilosissima subsp. pilosissima	Priority 3	August to December	Shortly rhizomatous, compactly tufted perennial, grass-like or herb, 0.15-0.4 m high. Fl. cream-white	White or grey sand, lateritic gravel	Not recorded from the City of Wanneroo. Field studies corresponded to flowering times. Unlikely to be present.

Species	Conservation Status	Flowering Time	Habit	Habitat Notes	Presence in Tenements
Pimelea calcicola	Priority 3	September to November	erect to spreading shrub growing to 1m high, producing pink flowers	Sand over limestone in coastal areas	A conspicuous coastal species. Unlikely to be present. Field studies corresponded to flowering times
Pithocarpa corymbulosa	Priority 3	January to April.	erect to scrambling perennial herb growing to 1 m high, producing white flowers	Gravelly or sandy loam amongst granite outcrops near the coast	A coastal species unlikely to be present
Platysace ramosissima	Priority 3	October to November	Perennial, herb, to 0.3 m high. Fl. white-cream	Sandy soils	Not recorded from the City of Wanneroo. Unlikely to be present
Poranthera moorokatta	Priority 2	September to November	annual herb to 5cm, flowers pink/white	Damplands, sandy soils	Not recorded from the City of Wanneroo. Damplands are limited within the tenements. Unlikely to be present
Schoenus griffinianus	Priority 3	September to October	Small, tufted perennial, grass-like or herb (sedge), to 0.1 m high.	White sand	Not recorded from the City of Wanneroo. Unlikely to be present
Stenanthemum sublineare	Priority 2	October to December	Erect shrub, to 0.1 m high. Fl. green	Littered white sand. Coastal plain	A coastal species unlikely to be present
Stylidium longitubum	Priority 3	October to December	Erect annual (ephemeral), herb, 0.05-0.12 m high. Fl. pink	Sandy clay, clay. Seasonal wetlands	Damplands are limited within the tenements. Unlikely to be present
Stylidium trudgenii	Priority 3	October	Caespitose perennial, herb, 0.05-0.5 m high	Grey sand, dark grey to black sandy peat. Margins of winter-wet swamps, depressions	Not recorded from the City of Wanneroo. Damplands are limited within the tenements. Unlikely to be present
Tetraria sp. Chandala (G.J. Keighery 17055)	Priority 2	November to December	A sedge	Grey sand, Margins of winter-wet swamps, depressions	Damplands are limited within the tenements. Unlikely to be present
Thelymitra variegata	Priority 3	June to September	Tuberous, perennial, herb, 0.1-0.35 m high. Fl. orange & red & purple & pink	Sandy clay, sand, laterite.	Possibly present in the undisturbed banksia woodland, unlikely to be present in plantation or regrowth areas. Field studies corresponded to flowering time
Trichocline sp. Treeton (B.J. Keighery & N. Gibson 564)	Priority 2	November to December	Tuberous, perennial, herb, to 1.6 m high.	Sand over limestone, sandy clay over ironstone. Seasonally wet flats.	Not recorded from the City of Wanneroo. Unlikely to be present.
Tripterococcus paniculatus	Priority 4	October to November	Spring ephemeral, flowers green-yellow	Seasonal Wetland, flat ground, black fine peaty clay loam sand, poor drainage, wet during winter/spring	Damplands are limited within the tenements. Unlikely to be present
Verticordia serrata var. linearis	Priority 3	September to October	Shrub, to 1 m high, yellow flowers	White sand, gravel. Open woodland	Not recorded from the City of Wanneroo. A conspicuous species unlikely to be present. Field studies corresponded to flowering times.

4.12 WEEDS

During the field survey 61 weed species were recorded as outlined below in Table 8. All species are common weeds associated with disturbance and agriculture. One species *Emex australis* (Doublegee) is a Priority 1 Declared Plant within some W.A. local government areas under the *Agriculture and Related Resources Act 1976.* Weeds were most common within the plantation areas and along tracks. The majority of species are not considered to be serious environmental problems – DPaW Swan Region - Environmental Weed List - (DPaW, 2013).

Table 8: Weed Species Recorded in Field Survey

Species	Author	Family
Acacia iteaphylla	Benth.	Fabaceae
Acacia longifolia var sophorae	(Labill.)Court	Fabaceae
Agave americana	L.	Asparagaceae
Aira caryophylloides	L.	Poaceae
Arctotheca calendula	(L.) Levyns	Asteraceae
Asphodelus fistulosus	L.	Asphodelaceae
Brassica tournefortii	Gouan	Brassicaceae
Briza maxima	L.	Poaceae
Carpobrotus edulis	(L.)N.E.Br.	Aizoaceae
Centaurea melitensis	L.	Asteraceae
Coronopus didymus	(L.)Smith	Brassicaceae
Crassula glomerata	P.J.Bergius	Crassulaceae
Dimorphotheca ecklonius	DC	Asteraceae
Diplotaxis muralis	(L.) DC.	Brassicaceae
Dittrichia viscosa	(L.) Greuter	Asteraceae
Ehrharta calycina	Smith	Poaceae
Emex australis	Steinh.	Polygonaceae
Eragrostis curvula	(Schrad.) Nees	Poaceae
Erodium botrys	(Cav.)Bertol.	Geraniaceae
Erodium moschatum	(L.) L'Her.	Geraniaceae
Eucalyptus saligna	Sm.	Myrtaceae
Eucalyptus sp (indet.)		Myrtaceae
Euphorbia australis	Boiss.	Euphorbiaceae
Euphorbia terracina	L.	Euphorbiaceae
Foeniculum vulgare	Mill.	Apiaceae
Freesia sp.	N.A.	Iridaceae
Gazania linearis	(Thunb.) Druce	Asteraceae
Gladiolus caryophyllaceus	(N.L. Burman) Poiret	Iridaceae
Hypochaeris glabra	L.	Asteraceae
Ipomoea cairica	(L.) Sweet	Convolvulaceae
Lagurus ovatus	L.	Poaceae
Leptospermum laevigatum	(Gaertn.)F.Muell.	Myrtaceae
Lotus angustissimus	L.	Fabaceae
Lupinus consentinii	Guss.	Fabaceae

Species	Author	Family
Lysimachia minima	(L.) U.Manns & Anderb	Primulaceae
Melilotus indicus	(L.)All.	Fabaceae
Oenothera drummondii	Hook.	Onagraceae
Ornithopus compressus	L.	Fabaceae
Orobanche minor	Smith	Orobanchaceae
Oxalis pes-caprae	L.	Oxalidaceae
Pelargonium capitatum	(L.) L.'Her.	Geraniaceae
Petrorhagia velutina	(Guss.)Bail.&Heywood	Caryophyllaceae
Phytolacca octandra	L.	Phytolaccaceae
Pinus pinaster	Aiton	Pinaceae
Plantago lanceolata	L.	Plantaginaceae
Polycarpon tetraphyllum	(L.)L.	Caryophyllaceae
Raphanus raphinistrum	L.	Brassicaceae
Ricinis communis	L.	Euphorbiaceae
Romulea rosea	(L.) Ecklon	Iridaceae
Solanum nigrum	L.	Solanaceae
Sonchus asper	Hill	Asteraceae
Sonchus oleraceus	L.	Asteraceae
Spergularia diandra	(Guss.) Heldr.	Caryophyllaceae
Tolpis barbata	(L.)Gaertn.	Asteraceae
Trachyandra divaricata	(Jacq.)Kunth	Asphodelaceae
Trifolium hirtum	All.	Fabaceae
Ursinia anthemoides	(L.) Poiret	Asteraceae
Verbascum virgatum	Stokes	Scrophulariaceae
Verbesina encelioides	(Cav.) A.Gray	Asteraceae
Wahlenbergia capensis	(L.)A.D.C.	Campanulaceae
Yucca aliofolia	L.	Agavaceae

4.13 CONSERVATION SIGNIFICANT FAUNA AND HABITAT

A significant fauna search requested from DPaW for a 10 km buffer around the study area, showed 28 species of conservation significance recorded previously within the search area as listed in Table 9 below. However none of these DPaW records occur within the proposed project area.

No threatened fauna were observed during field studies. There was little evidence of fauna presence apart from kangaroos and birds.

The pine plantation vegetation and regrowth areas provide limited shelter,nesting locations and food resources (flowers, fruit, leaves) for terrestrial, arboreal and aerial species. The lack of large trees means the area does not contain habitat for large arboreal or aerial species. There are no trees present which may provide suitable breeding hollows for black cockatoo. The low species richness of the native flora and the sparseness of this vegetation limits the habitat values of these areas.

The area of native wetland vegetation are likely to provide fauna habitat including some seasonal aquatic habitat. The Banksia woodland community and existing Pine Plantation may provide foraging resources for Carnaby's Cockatoo (Valentine, and Stock 2008).

Table 9: DPaW Significant Fauna Records within 10 km Buffer of Study Area

Species Name	Common Name	Status
Botaurus poiciloptilus	Australasian Bittern	Threatened
Calidris ferruginea	Curlew Sandpiper	Threatened
Calyptorhynchus baudinii	Baudin's Cockatoo (long-billed black-cockatoo), Baudin's Cockatoo	Threatened
Calyptorhynchus latirostris	Carnaby's Cockatoo (short-billed black-cockatoo), Carnaby's Cockatoo	Threatened
Dasyurus geoffroii	Chuditch, Western Quoll	Threatened
Falco peregrinus	Peregrine Falcon	Schedule Priority 4 (Specially Protected)
Falco peregrinus subsp. macropus	Australian Peregrine Falcon	Schedule Priority 4 (Specially Protected)
Actitis hypoleucos	Common Sandpiper	International Agreement (Migratory)
Ardea modesta	Eastern Great Egret	International Agreement (Migratory)
Calidris ruficollis	Red-necked Stint	International Agreement (Migratory)
Glareola maldivarum	Oriental Pratincole	International Agreement (Migratory)
Haliaeetus leucogaster	White-bellied Sea-Eagle	International Agreement (Migratory)
Limosa lapponica	Bar-tailed Godwit	International Agreement (Migratory)
Merops ornatus	Rainbow Bee-eater	International Agreement (Migratory)
Plegadis falcinellus	Glossy Ibis	International Agreement (Migratory)
Pluvialis squatarola	Grey Plover	International Agreement (Migratory)
Tringa glareola	Wood Sandpiper	International Agreement (Migratory)
Tringa nebularia	Common Greenshank	International Agreement (Migratory)
Tringa stagnatilis	Marsh Sandpiper	International Agreement (Migratory)
Xenus cinereus	Terek Sandpiper	International Agreement (Migratory)
Hylaeus globuliferus	Native Bee	Priority 3
Leioproctus contrarius	Native Bee	Priority 3
Neelaps calonotos	Black-striped Snake	Priority 3
Tyto novaehollandiae subsp. novaehollandiae	Masked Owl (southern subsp)	Priority 3
Ardeotis australis	Australian Bustard	Priority 4
Ixobrychus minutus	Little Bittern	Priority 4
Macropus irma	Western Brush Wallaby	Priority 4
Isoodon obesulus subsp. fusciventer	Quenda, Southern Brown Bandicoot	Priority 5

5 ASSESSMENT AGAINST TEN CLEARING PRINCIPLES

Table 10 summarises the ecological attributes of the vegetation in the study area against the 10 Clearing Principles as listed under Schedule 5 of the EP Act.

Table 10: Assessment of Proposed Quarry Against Ten Clearing Principles

Clearing Principle Native Vegetation should not be cleared if….	Site Assessment: Proposed Sand Quarry, Holcim (Australia)
1) It comprises a high level of biological diversity.	Much of the area to be cleared, is already cleared pine plantation, containing self-sown or trial seeded small plants. Uncleared native vegetation is in good to very good ecological condition. 155 native species were recorded and this is considered to be a normal complement for the vegetation communities present. Given the proposed quarry will only occur in cleared pine plantation, it will not affect vegetation of high biological diversity.
2) It comprises the whole or part of, or is necessary for the maintenance of a significant habitat for fauna indigenous to WA.	No significant fauna or fauna habitats were observed within the regrowth areas or the plantation. Seasonal wetlands occur which may provide fauna habitat values. The Banksia woodland may provide foraging resources for Carnaby's Cockatoo. Given the proposed quarry will only occur in cleared pine plantation, it will not affect significant fauna habitat.
3) It includes, or it is necessary for the continued existence of rare flora.	No conservation significant flora species were located in the study area. The timing of the survey is considered to be optimal for detection of conservation priority species. It is unlikely they would occur within pine plantation, but could be present within the Bush Forever Sites. Given the proposed quarry will only occur in cleared pine plantation, it is unlikely to affect significant flora.
4) It comprises the whole or a part of, or is necessary for the maintenance of a TEC.	No TEC's were identified Two native bushlands within the tenement were identified as being most similar to SCP4 and SCP23a which are not risk. Given the proposed quarry will only occur in cleared pine plantation, it is unlikely to affect any TEC or PEC.
5) It is significant as a remnant of native vegetation in an area that has been extensively cleared.	Cleared pine plantation areas which are to be disturbed are not considered native remnant vegetation.
6) It is growing in, or in association with, an environment associated with a watercourse or wetland.	Appropriate quarry management measures should avoid impacts (such as runoff, erosion and weed transport) to wetlands. A 100 m buffer will be maintained from all naturally vegetated geomorphic wetlands, therefore the project is unlikely to affect wetland vegetation.
7) The clearing of the vegetation is likely to cause appreciable land degradation.	Quarry management measures methods should ensure that runoff and erosion are contained.

Clearing Principle Native Vegetation should not be cleared if….	Site Assessment: Proposed Sand Quarry, Holcim (Australia)
8) The clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Quarry environmental management measures should ensure that indirect impacts (such as runoff, erosion and weed transport) to local conservation areas (such as conservation category wetlands and Bushforever Sites) are avoided.
9) The clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	It is unlikely that there will be a significant impact on ground or surface water quality. Quarry management methods should ensure that runoff, spills and erosion are contained. Mining is unlikely to extend below the groundwater table.
10) The clearing of the vegetation is likely to cause or exacerbate the incidence or intensity of flooding.	Quarry management measures should address impacts of surface runoff and minimise the risk of flooding.

6 LIMITATIONS

There are a number of limitations that may arise during flora and vegetation surveying. These survey limitations are addressed in Table 11 below.

Table 11: Consideration of Study Limitations

Limitation	Comment
Survey Intensity (In retrospect, was the intensity adequate?)	Survey intensity (desktop research followed by site visits in Autumn and Spring) follows EPA (2004) recommendations.
Competency/experience of the consultant(s) carrying out the survey.	The author has had significant experience in flora and vegetation surveys including desktop reviews, site inspections and report writing.
Scope. (life forms sampled etc).	All flora species observed during the site visits were identified, with a focus on searching for any significant species or TEC/PEC's during the survey.
Proportion of flora collected and identified (based on sampling, timing and intensity).	Only species which were not identifiable in the field were collected for further identification. This was deemed suitable for the type of survey undertaken.
Timing/weather/season/cycle.	Survey intensity (desktop research followed by a site visit in Autumn and Spring) follows EPA (2004) recommendations.
Disturbances (e.g. fire, flood, accidental human intervention etc.) which affected results of survey.	No disturbances affected the survey.
Completeness (e.g. was relevant area fully surveyed) and further work which might be needed.	Desktop study covered proposed clearing area. Site inspection covered all areas of proposed disturbance. No further work is currently deemed necessary.
Resources (e.g. degree of expertise available in flora identification to taxon level).	Appropriate resources were used. Most specimens identified to species level.
Mapping reliability.	All mapping completed is deemed reliable. Hand held GPS used to record coordinates and mapping done using professional GIS system.
Access problems.	No access problems encountered.
Sources of information and availability of contextual information (i.e. pre- existing background versus new material).	Extensive regional and local information was available and was consulted. DPaW Threatened Flora, Fauna and TEC Databases were searched and the author had conducted several previous studies in the region.

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8 GIS DATASET CITATIONS

Table 12: GIS Dataset Citations.

Reference No.	Dataset (short name)	Citation
4A	Australia TOPO250K Layers	GEODATA TOPO 250K Series 3 Topographic Data, Geoscience Australia. Publication date June 2006.
10A	(ESA) Environmentally Sensitive Areas	Clearing Regulations – Environmentally Sensitive Areas (ESA), Department of Environment and Conservation Western Australia. Publication date 12/05/2011.
10F	DPaW Managed Lands	DPaW Managed Lands and Waters, Department of Environment and Conservation Western Australia. Publication date 05/10/2013.
17C	Roads (LGATE-012)	WA Road Network, Geographic Services, Landgate. Access date 25/07/2013.
21AF	DoW Linear Hydrography	DoW Linear Hydrography, Department of Water, WA. Download date 04/10/2013.

Notes: Citations are sourced from the metadata that accompanies the dataset. If no metadata is available, the citation appears in grey text.

9 FIGURES

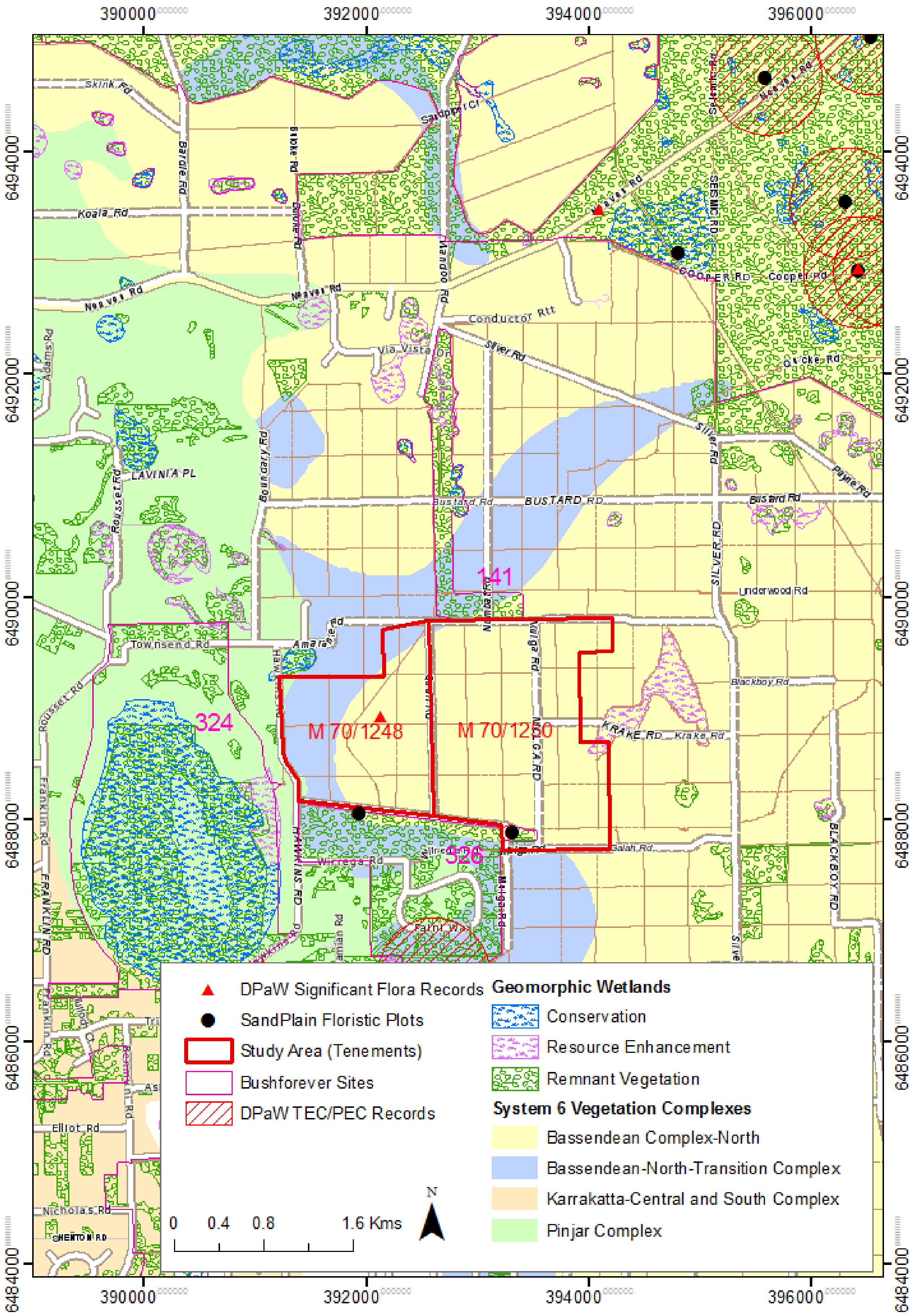

Figure 1: Location of Tenements and Ecological Context.

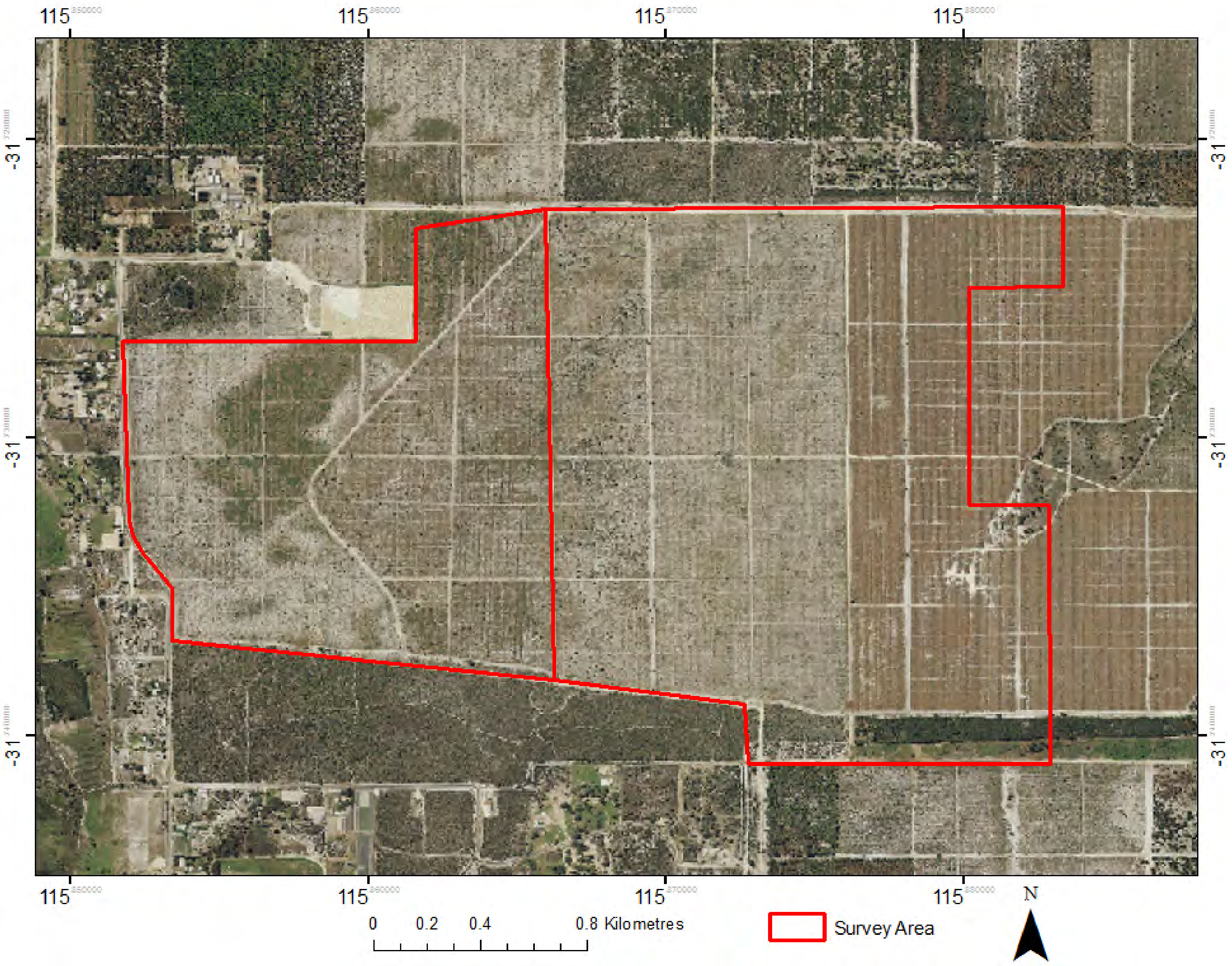

Figure 2: Regional Aerial Photography, September 2013.

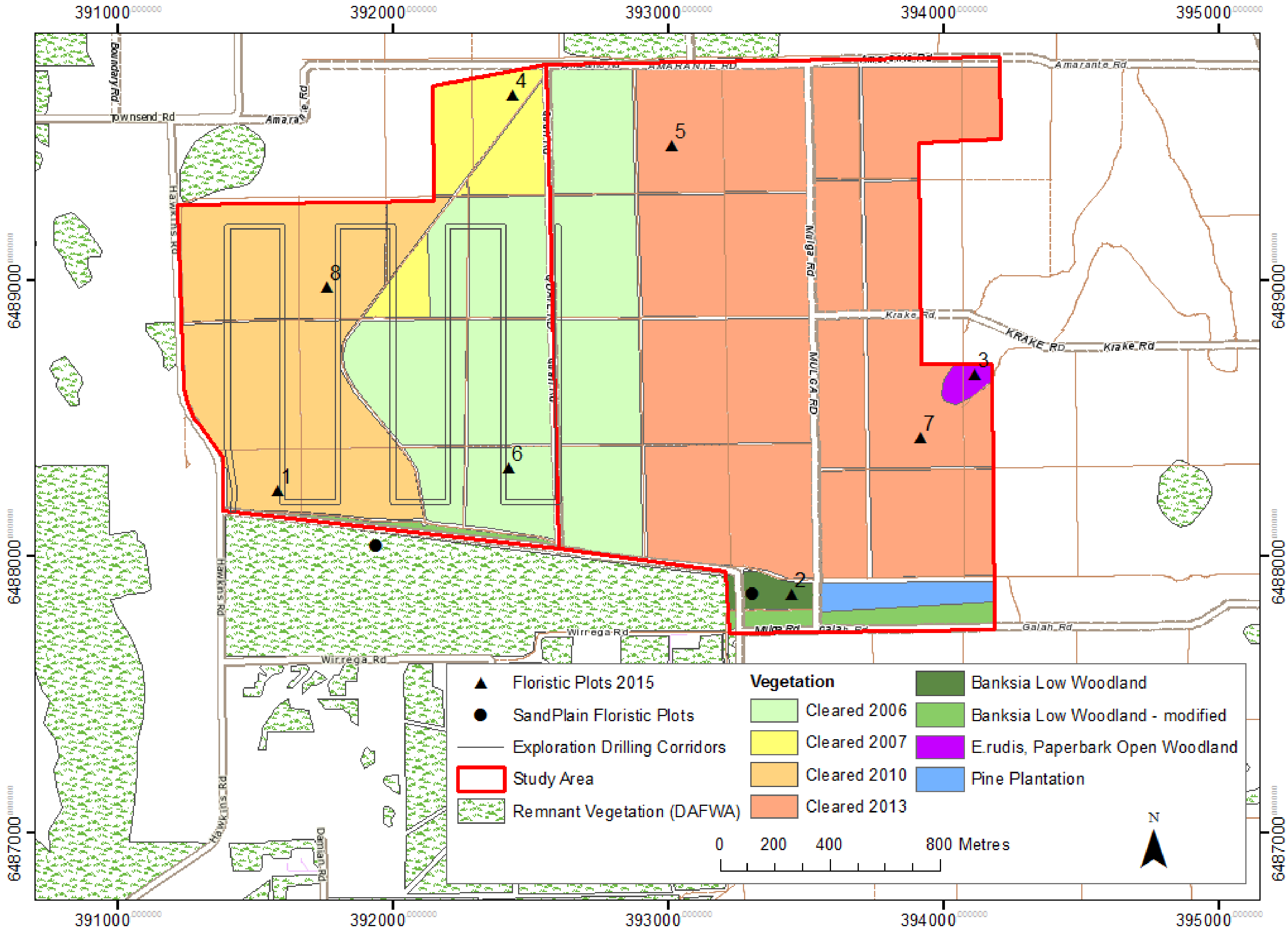

Figure 3: Plant Community Mapping.

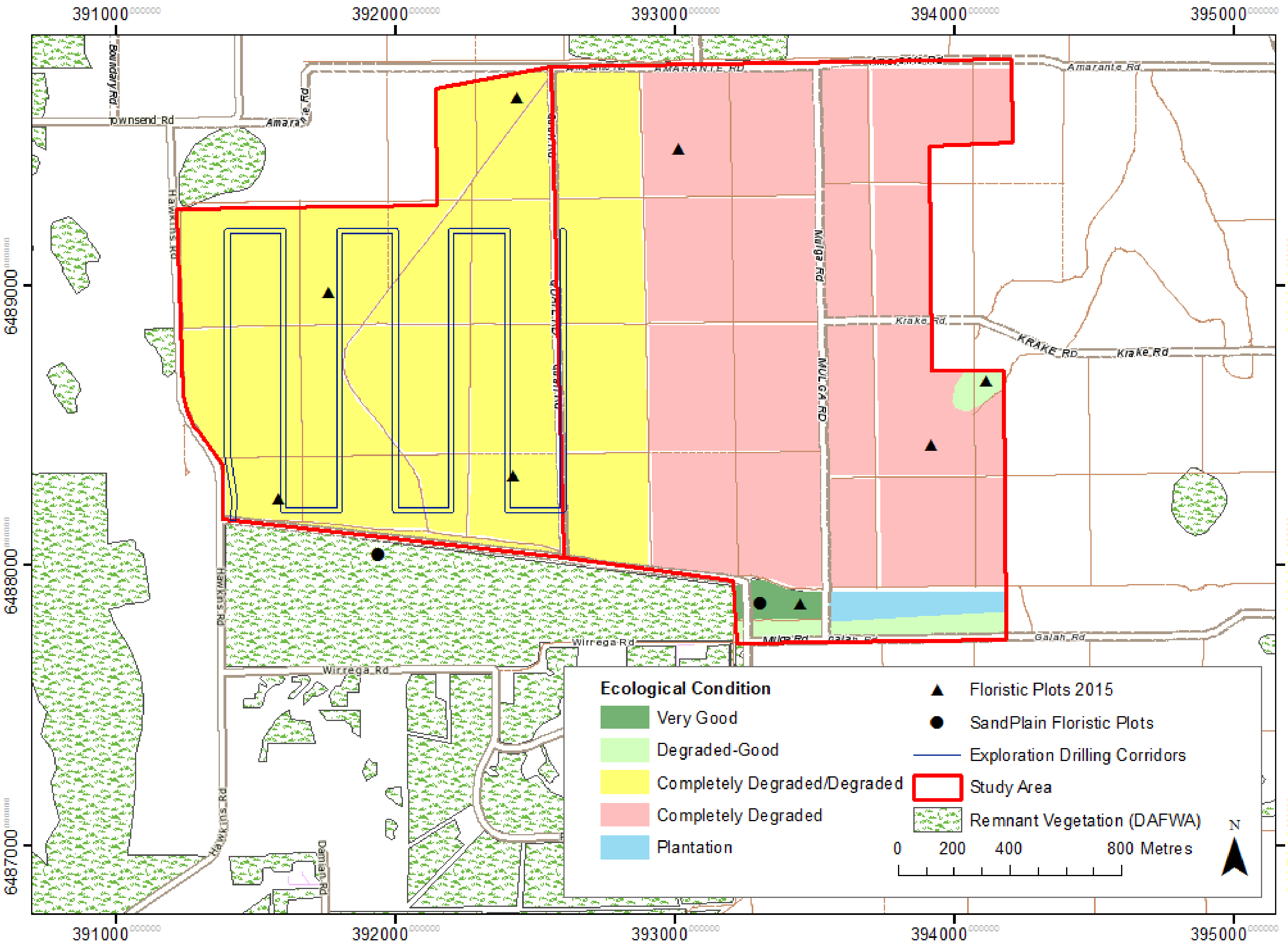

Figure 4: Ecological Condition.

APPENDIX A. CRITERIA USED FOR THE ASSESSMENT OF REMNANT VEGETATION CONDITION (KEIGHERY, 1994)

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

APPENDIX B. PLANT COMMUNITY STRUCTURAL FORMATION AND HEIGHT CLASSES (MUIR, 1977)

LIFE FORM/ HEIGHT CLASS	CANOPY COVER			
	Dense 70% - 100%	Mid-Dense 30% - 70%	Sparse 10% - 30%	Very Sparse 2% - 10%
Trees > 30 m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15 – 30 m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5 – 15 m	Dense Low Forest A	Low Forest A	Low woodland A	Open Low Woodland A
Trees < 5 m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee Tree Form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee Shrub Form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs > 2 m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5 – 2 m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1 – 1.5 m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5 – 1 m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs 0 – 0.5 m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat Plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock Grass	Dense Hummock Grass	Mid-dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch grass >0.5 m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch grass < .5 m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges > 0.5 m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges < 0.5 m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, liverworts	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

APPENDIX C. QUADRAT LOCATIONS

Quadrat	Easting	Northing
1	391586	6488241
2	393453	6487863
3	394118	6488663
4	392439	6489673
5	393016	6489491
6	392425	6488321
7	393918	6488431
8	391762	6488978

APPENDIX D. SPECIES LIST

Family	Species	1	2	3	4	5	6	7	8
Agavaceae	*Yucca aliofolia								
Aizoaceae	*Carpobrotus edulis	1	1				1		
Anarthriaceae	Anarthria prolifera		1						
Apiaceae	Daucus glochidiatus								1
	*Foeniculum vulgare								
	Xanthosia hueglii	1	1	1					
Araliaceae	Trachymene pilosa	1	1	1			1	1	
Asparagaceae	*Agave americana								
	Laxmannia ramosa								
	Laxmannia squarrosa		1		1				
	Lomandra hermaphrodita	1	1						
	Sowerbaea laxiflora		1		1			1	
	Thysanotus manglesianus								
Asphodelaceae	*Asphodelus fistulosus								
	*Trachyandra divaricata								
Asteraceae	*Arctotheca calendula	1				1	1	1	
	*Centaurea melitensis								
	*Dimorphotheca ecklonius								
	*Dittrichia viscosa								
	*Gazania linearis								
	Hyalosperma cotula		1				1		
	*Hypochaeris glabra								
	Lagenophora hueglii		1				1		
	Millotia myosotidifolia								
	Pithocarpa pulchella		1						
	Podotheca chrysantha								1

Family	Species	1	2	3	4	5	6	7	8
	Podotheca gnaphalioides		1		1		1		1
	Quinetia urvillei	1	1						
	Siloxeros humifusus								
	*Sonchus asper								
	*Sonchus oleraceus						1	1	1
	*Tolpis barbata								
	*Ursinia anthemoides	1			1		1	1	1
	*Verbesina encelioides								
	Waitzia suaveolens								
Brassicaceae	*Brassica tournefortii								
	*Coronopus didymus					1	1	1	
	*Diplotaxis muralis								
	*Raphanus raphinistrum				1	1		1	
Campanulaceae	Lobelia tenuior					1		1	
	*Wahlenbergia capensis				1	1			
	Wahlenbergia preissii								
Caryophyllaceae	*Petrorhagia velutina								
	*Polycarpon tetraphyllum								
	*Spergularia diandra								
Casuarinaceae	Allocasuarina fraseriana								
	Allocasuarina humilis				1		1		
Celastraceae	Tripterococcus brunonis								
Colchicaceae	Burchardia congesta		1						
Commelinaceae	Cartonema philydroides								
Convolvulaceae	*Ipomoea cairica								
Crassulaceae	Crassula colorata				1		1	1	
	*Crassula glomerata	1			1	1	1		1
Cyperaceae	Caustis dioica								
	Lepidosperma longitudinale			1					
	Lepidosperma squamatum	1	1						
	Mesomelaena pseudostygia	1		1		1			

Family	Species	1	2	3	4	5	6	7	8
	Schoenus curvifolius		1					1	
Dasypogonaceae	Calectasia narragara								
	Dasypogon bromelifolius			1	1		1		1
Dilleniaceae	Hibbertia hueglii								
	Hibbertia hypericoides		1	1			1	1	1
	Hibbertia subvaginata			1					
	Hibbertia vaginata		1						
Droseraceae	Drosera erythrorhiza			1					
	Drosera menziesii subsp. menziesii				1				
	Drosera sps (indet.)								
Ericaceae	Astroloma macrocalyx								
	Astroloma xerophyllum			1					
	Conostephium pendulum			1					
	Leucopogon australis								
	Leucopogon conostephioides			1					
	Leucopogon polymorphus								
	Leucopogon squarrosus								
	Styphelia tenuiflora			1					
Euphorbiaceae	*Euphorbia australis								
	*Euphorbia terracina		1					1	
	*Ricinis communis								
Fabaceae	Acacia hueglii		1						
	*Acacia iteaphylla								
	*Acacia longifolia var sophorae								
	Acacia pulchella		1	1			1		
	Acacia saligna		1			1		1	
	Acacia sessilis								
	Aotus gracillima								
	Bossiaea eriocarpa			1		1		1	1
	Daviesia divaricata					1	1	1	
	Daviesia physodes		1						1

Family	Species	1	2	3	4	5	6	7	8
Fabaceae	Daviesia triflora		1						
	Euchilopsis linearis								
	Gastrolobium capitatum		1			1			1
	Gompholobium tomentosum	1	1		1				
	Hardenbergia comptoniana	1			1		1		1
	Hovea pungens		1						
	Jacksonia floribunda		1		1	1	1		
	Jacksonia furcellata	1					1		
	Jacksonia sternbergiana	1							1
	*Lotus angustissimus								
	*Lupinus consentinii	1			1				1
	*Melilotus indicus								
	*Ornithopus compressus								
	Pultenaea reticulata								
	*Trifolium hirtum								
Geraniaceae	*Erodium botrys	1				1			
	*Erodium moschatum								
	*Pelargonium capitatum	1					1	1	1
Goodeniaceae	Dampiera lavandulacea								
	Dampiera linearis	1	1				1		
	Lechenaultia biloba								1
	Lechenaultia floribunda								
	Scaevola canescens								
	Scaevola repens var angustifolia		1						
Haemodoraceae	Anigozanthos humilis								1
	Anigozanthos manglesii		1		1				
	Conostylis aculeata	1	1			1	1		
	Conostylis juncea								
	Haemodorum spicatum	1	1				1	1	
	Phlebocarya ciliata			1			1		1
	Tribonanthes australis				1				

Family	Species	1	2	3	4	5	6	7	8
	Tribonanthes longipetala			1					
Hemerocallidaceae	Caesia micrantha								
	Corynotheca micrantha				1				1
	Dianella divaricata						1		1
	Tricoryne elatior		1						
Iridaceae	*Freesia sp.								
	*Gladiolus caryophyllaceus	1	1	1			1	1	
	Patersonia juncea								
	Patersonia occidentalis	1	1		1		1		1
	*Romulea rosea								
Lamiaceae	Hemiandra pungens								
Lauraceae	Cassytha glabella								
Loranthaceae	Nuytsia floribunda	1	1		1		1		
Molluginaceae	Macarthuria australis					1	1		1
	Astartea fascicularis								
	Calothamnus sanguineus								
	Calytrix angulata		1						
	Calytrix fraseri	1	1						
	Chamelaucium uncinatum								
	Eremaea pauciflora		1						
	Eucalyptus erythrocorys								
	Eucalyptus marginata								
	Eucalyptus rudis			1					
	*Eucalyptus saligna								
	*Eucalyptus sp (indet.)								
	Eucalyptus todtiana		1				1	1	
	Hypocalymma angustifolium			1				1	
	Hypocalymma robustum		1		1		1		1
	Hypocalymma xanthopetalum								
	Kunzea glabrescens			1				1	
	*Leptospermum laevigatum								

Family	Species	1	2	3	4	5	6	7	8
Myrtaceae	Melaleuca preissiana			1					
	Melaleuca seriata						1		
	Pericalymma eliptica			1					
	Regelia ciliata								
	Scholtzia involucrata		1						
	Taxandria linearifolia								
	Verticordia densiflora var. densiflora								
	Verticordia nitens								
Onagraceae	*Oenothera drummondii								
Orchidaceae	Caladenia flava								
	Caladenia sps. (indet.)								
	Diuris sp (indet.)								
	Eriochilus dilatatus			1					
	Microtis media								
	Pyrorchis sp (indet.)								
Orobanchaceae	*Orobanche minor						1		
Oxalidaceae	*Oxalis pes-caprae					1			
Phyllanthaceae	Phyllanthus calycinus								
	Poranthera microphylla								
Phytolaccaceae	*Phytolacca octandra						1		
Pinaceae	*Pinus pinaster	1		1	1				
Plantaginaceae	*Plantago lanceolata								
Poaceae	*Aira caryophylloides								
	Austrostipa compressa								
	*Briza maxima	1		1	1	1		1	1
	*Ehrharta calycina	1			1		1		1
	*Eragrostis curvula								
	*Lagurus ovatus								
	Neurachne alopecuroides					1			1
	Rytidosperma occidentale	1							
Polygalaceae	Comesperma calymega								

Family	Species	1	2	3	4	5	6	7	8
Polygonaceae	*Emex australis								
Portulacaceae	Calandrinia linifolia								
Primulaceae	*Lysimachia minima								
Proteaceae	Adenanthos cygnorum var cygnorum	1	1			1		1	1
	Adenanthos obovatus								
	Banksia attenuata		1			1			1
	Banksia grandis								
	Banksia ilicifolia								
	Banksia menziesii		1					1	
	Conospermum incurvum								
	Conospermum triplinervum								
	Hakea prostrata								
	Hakea varia			1					
	Persoonia saccata								
	Petrophile linearis		1			1			
	Stirlingia latifolia		1		1		1		1
Restionaceae	Alexgeorgea nitens		1						
	Desmocladus flexuosa		1						
	Dielsia stenostachya			1					
	Hypolaena exsulca								
	Loxocarya cinerea			1					
	Lyginia barbata	1	1	1					
	Meeboldina coangustata								
Rutaceae	Philotheca spicatus				1			1	
Scrophulariaceae	*Verbascum virgatum								
Solanaceae	*Solanum nigrum	1				1	1		1
Stylidiaceae	Levenhookia stipitata		1						
	Stylidium brunonianum		1						
	Stylidium calcaratum								
	Stylidium repens			1					
	Stylidium schoenoides		1						

Family	Species	1	2	3	4	5	6	7	8
Thymeleaceae	Pimelea imbricata var piligera								
Violaceae	Hybanthus calycinus								
Xanthorrhoeaceae	Xanthorrhoea preissii	1	1	1	1	1	1	1	1
Zamiaceae	Macrozamia fraseri	1					1		

APPENDIX C. NOISE REPORT (HERRING STORER ACCOUSTICS, 2015)

Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
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HOLCIM

SAND EXTRACTION OPERATIONS

360 HAWKINS ROAD, JANDABUP

ACOUSTIC ASSESSMENT

SEPTEMBER 2015

OUR REFERENCE: 19686-4-15226

DOCUMENT CONTROL PAGE

ACOUSTIC ASSESSMENT
JANDABUP

Job No: 15226

Document Reference: 19686-4-15226

FOR

HOLCIM

DOCUMENT INFORMATION			
Author:	Paul Daly	**Checked By:**	Tim Reynolds
Date of Issue :	29 September 2015		

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1	Client Comments	30/09/15	PLD	
2	Holcim Pit Review	27/10/2015	PLD	
3	Pit Boundary for Figures	28/10/2015	PLD	

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1	4	Enviroworks Consulting – Laura Todd		✓

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7. CONCLUSION 7

APPENDICIES

A Figure A1 – Site Layout

B Noise Contours

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Enviroworks Consulting, on behalf of Holcim to undertake an acoustic assessment of noise emissions from a proposed sand extraction operation site located at 360 Hawkins Road, Jandabup.

The sand extraction component of the operation entails the usage of a front end loaders, and a screen. The sand is to be removed from site in a 19 stage approach.

This assessment takes into account the noise levels of both the sand extraction and processing at the commencement of operations, i.e. stage 1 and 2. It should be noted modelling was only conducted for Stage 1 and 2. For other stages, the noise sources would be located at greater distances from the receivers, hence noise levels would be less than those reported. The transport of sand off site via semi-trailer has also been assessed with truck noise sources placed at the most critical locations along the access road off Hawkins Road. The assessment is provided to support the regulatory approvals processes.

Additionally, as there are two neighbouring sand extraction operations (not yet fully operational), the cumulative noise levels of all three operations have been accounted for in this assessment to provide the cumulative noise. Figure 1 details the Holcim sand extraction area, as well as the potential adjoining quarries.

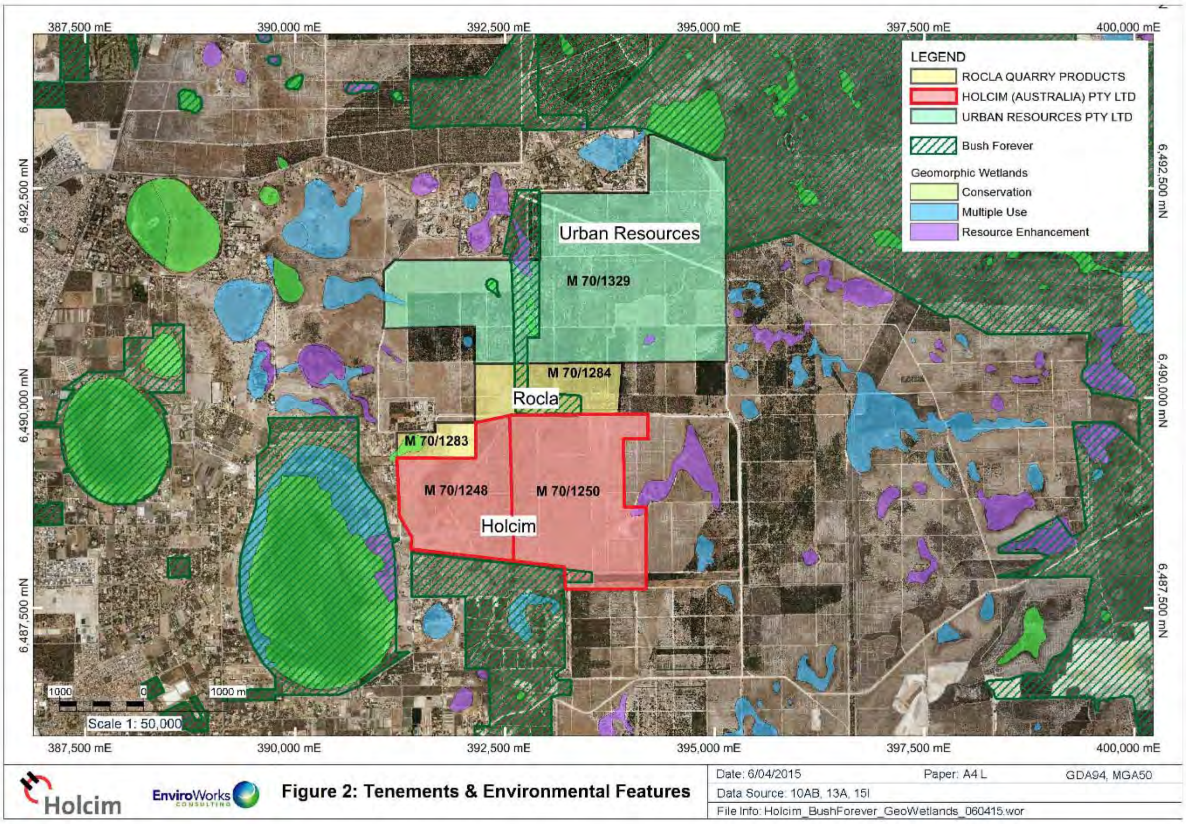


FIGURE 1 – PROPOSED SAND EXTRACTION INDUSTRIES

Operational hours for the site are proposed to be Monday to Saturday 07:00 to 17:00 hours (excluding Public Holidays).

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

- Identification of individual operations and the associated noise levels, including extraction at commencement of operations.
- Assess the predicted noise levels at the nearest surrounding noise sensitive premises for compliance with the appropriate criteria.
- If exceedances are predicted, comment on possible noise amelioration options for compliance with the appropriate criteria.

For information, a locality plan is shown in Appendix A.

2. SUMMARY

An acoustic assessment has been conducted on the proposed sand extraction operation at 360 Hawkins Road, Jandabup.

The applicable criterion for this assessment is 49 dB(A) for the nearest residential locations.

Noise received at the residential premises has been determined, to be 49 dB(A) for the sand extraction operations, for the most critical stage (natural ground level).

The above noise levels have been considered to contain tonal characteristics, therefore contain a +5 dB(A) penalty.

Given these operating parameters, noise levels received at the nearest premises has been calculated to comply with the *Environmental Protection (Noise) Regulations 1997* for the operating times as outlined in this assessment.

3. CRITERIA

The allowable noise level at the surrounding locales is prescribed by the *Environmental Protection (Noise) Regulations 1997*. Regulations 7 & 8 stipulate maximum allowable external noise levels determined by the calculation of an influencing factor, which is then added to the base levels shown below. The influencing factor is calculated for the usage of land within two circles, having radii of 100m and 450m from the premises of concern.

TABLE 1 - BASELINE ASSIGNED OUTDOOR NOISE LEVEL

Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
Noise sensitive premises	0700 - 1900 hours Monday to Saturday (Day)	45 + IF	55 + IF	65 + IF
	0900 - 1900 hours Sunday and Public Holidays (Sunday / Public Holiday Day Period)	40 + IF	50 + IF	65 + IF
	1900 - 2200 hours all days (Evening)	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays (Night)	35 + IF	45 + IF	55 + IF
Industrial and Utility Premises	All Hours	65	80	90

Note: L_{A10} is the noise level exceeded for 10% of the time.
L_{A1} is the noise level exceeded for 1% of the time.
L_{Amax} is the maximum noise level.
IF is the influencing factor.

It is a requirement that received noise be free of annoying characteristics (tonality, modulation and impulsiveness), defined below as per Regulation 9.

"impulsiveness" means a variation in the emission of a noise where the difference between L_{Apeak} and $L_{Amax\ Slow}$ is more than 15 dB when determined for a single representative event;

"modulation" means a variation in the emission of noise that –

(a) is more than 3dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;
(b) is present for more at least 10% of the representative assessment period; and
(c) is regular, cyclic and audible;

"tonality" means the presence in the noise emission of tonal characteristics where the difference between –

(a) the A-weighted sound pressure level in any one-third octave band; and
(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

Where the noise emission is not music, if the above characteristics exist and cannot be practicably removed, then any measured level is adjusted according to Table 2 below.

TABLE 2 - ADJUSTMENTS TO MEASURED LEVELS

Where **tonality** is present	Where **modulation** is present	Where **impulsiveness** is present
+5 dB(A)	+5 dB(A)	+10 dB(A)

Note: These adjustments are cumulative to a maximum of 15 dB.

The nearest potential noise sensitive premises to the proposed development have been identified using the area map in Figure 1. Due to location of the premises and the proposed development, the influencing factor has been assessed as 4 dB(A) for the nearest residence.

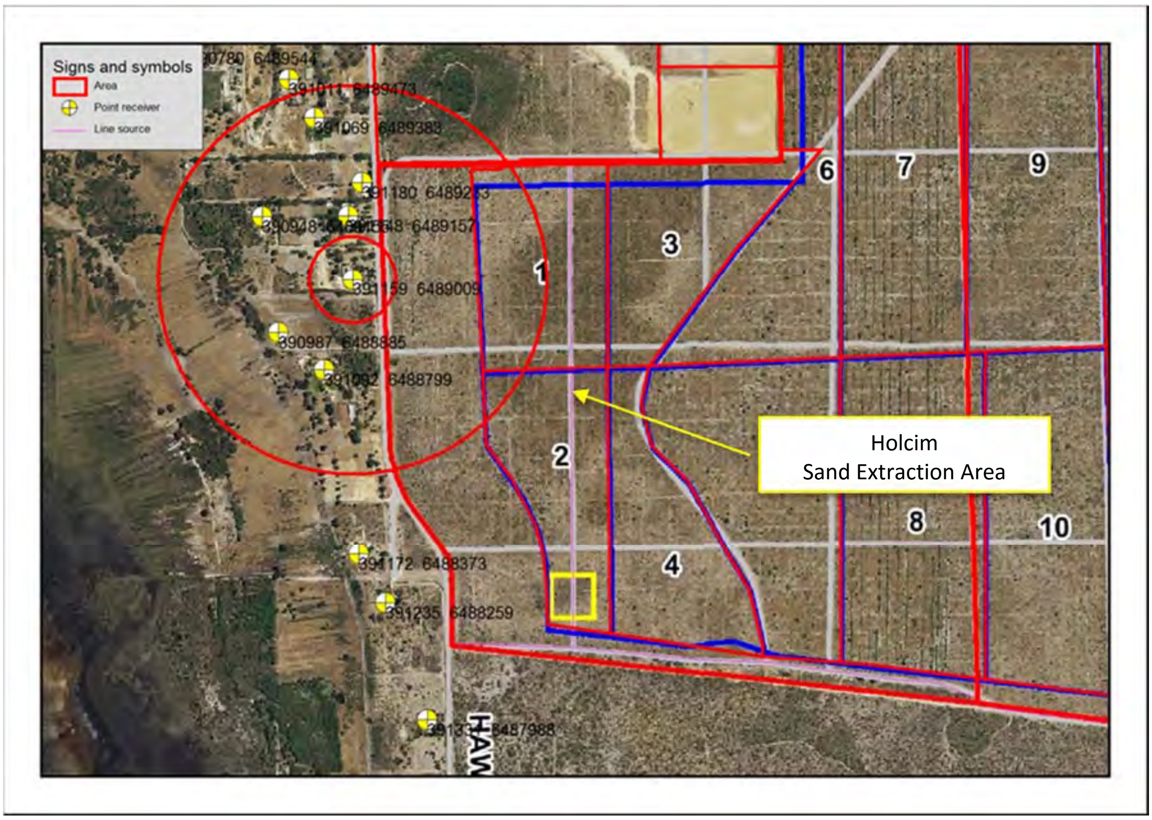


FIGURE 2 – RECEIVER LOCATION

Therefore, the assigned noise level is as noted in Table 3.

TABLE 3 – ASSIGNED NOISE LEVELS

Premises Receiving Noise	IF dB	Time of Day	Assigned Level (dB)		
			$L_{A\ 10}$	$L_{A\ 1}$	$L_{A\ max}$
Receiver A to F	4	0700 - 1900 hours Monday to Saturday (Day)	49	59	69

4. CALCULATED NOISE LEVELS

Noise imissions[1] at the nearest neighbouring residential premises, due to noise associated with the proposed sand extraction operations, were modelled with the computer programme SoundPlan. Sound power levels used for the calculations are based on measured sound pressure levels of similar equipment proposed for use on site.

The modelling of noise levels has been based on noise sources and sound power levels shown in Table 4.

TABLE 4 – SOUND POWER LEVEL - NOISE SOURCES dB(A)

Element Name	Frequency Hz										dB(A)
	31.5	63	125	250	500	1k	2k	4k	8k	16k	Sum
Komatsu FEL	50	76	77	84	90	97	94	91	86	73	105
	52	64	74	85	93	97	95	90	82	67	
	62	72	80	89	95	95	93	92	77	58	
Screen	-	69	79	86	92	95	96	96	94	-	102
Large Semi Tipper	35	54	66	82	84	90	86	77	68	10	98
	40	53	70	79	88	88	85	74	66		
	53	61	75	83	92	87	81	71	63		

---

1 Immissions – noise received at a source
2 Emissions – noise emanating from a source and / or location

Based on noise emissions[2] from the above equipment, three operating scenarios have been developed. These scenarios represent periods of worst case noise emissions for the entire operations. These scenarios are as listed as follows:

- **Scenario 1** – Operations at the commencement of operations consisting all equipment operating in Stage 1.
- **Scenario 2** – Operations at the commencement of operations consisting all equipment operating in Stage 2.
- **Scenario 3** – As per the above with the inclusion of the two neighbouring quarry operations.

To allow for the worst case "locational" noise levels, noise modelling was undertaken using single point noise sources for the extraction equipment such as the screen and loaders, and a continuous line source for the truck movements. The addition of the highest noise level (maximum) for the truck source was combined with the noise level from the extraction plant. This was used due to the large area the trucks traverse and the greater distance for each of the stages. The results of this calculation provide the highest noise level for each of the operating scenarios.

For the neighbouring quarry operations noise sources included a screen, 2 x front end loaders and a truck. The noise sources were positioned in the "worst case" location, closest to the Holcim operations and to the nearest noise sensitive premises.

It is noted that only modelling was conducted for Stage 1 and 2. For other stages, the noise sources would be located at greater distances from the receivers, hence noise levels would be less than those reported.

The design layout and site configuration, including source location is shown in Appendix A, Figure 2.

This is understood to be representative of the maximum noise levels associated with the proposed sand extraction site.

The following input data was used in the calculations:

a) Provided backgrounds.
b) Sound Power Levels listed in Table 4.
c) Ground contours and receiver point provided by client.

Weather conditions for modelling were as stipulated in the Environmental Protection Authority's "*Draft Guidance for Assessment of Environmental Factors No. 8 - Environmental Noise"* and for the day period are as listed in Table 5.

TABLE 5 – WEATHER CONDITIONS

Condition	Day
Temperature	20°C
Relative humidity	50%
Pasquill Stability Class	E
Wind speed	4 m/s*

* From sources, towards receivers.

---

5. RESULTS

Calculated noise levels associated with the noise emissions from the proposed sand extraction for the assumed scenarios, are summarised below in Table 6. Appendix B contains noise contour plots for each of the scenarios.

TABLE 6 – CALCULATED NOISE LEVEL – NO NOISE CONTROL

Receiver	Sand Extraction Stage 1		Sand Extraction Stage 2	
	Scenario 1 (Holcim Operations)	Scenario 3 (Cumulative Operations)	Scenario 2 (Holcim Operations)	Scenario 3 (Cumulative Operations)
A	43	44	37	40
B	35	35	35	36
C	44	45	39	41
D	42	42	40	41
E	40	40	39	40
F	42	42	44	45

6. ASSESSMENT

Based on calculated noise levels at the nearest premises, noise levels could be considered as being tonal in characteristics. Therefore, a +5 dB(A) penalty has been included to allow for a tonal component.

It is noted that under a cumulative assessment, noise received at the neighbouring residence would not be considered tonal and no penalty would be applied.

Hence, Table 7 summarises the applicable Assigned Noise Levels, and assessable noise level emissions, for the scenarios considered.

TABLE 7 – ASSESSMENT OF NOISE LEVELS

Receiver	Scenario 1	Scenario 2	Scenario 3
	Stage 1	Stage 2	Stage 3
A	48	42	44
B	40	40	36
C	49	44	45
D	47	45	42
E	45	44	40
F	47	49	45

Based on the assessable noise levels above, comparison against the relevant assigned noise level is contained in Table 8

TABLE 8 – ASSESSMENT OF NOISE LEVELS STAGE 1

Premises Receiving Noise	Assessable Noise Level dB(A)			Time of Day	Assigned Level (dB)	Compliance
	Stage 1	Stage 2	Stage 3			
A	48	42	44	0700 - 1900 hours Monday to Saturday (Day)	49	Complies
B	40	40	36			Complies
C	49	44	45			Complies
D	47	45	42			Complies
E	45	44	40			Complies
F	47	49	45			Complies

7. CONCLUSION

Assessment has been conducted on the proposed sand extraction operation at 360 Hawkins Road, Jandabup.

The applicable criterion for this assessment is 49 dB(A) for the nearest residential locations.

Noise received at the residential premises has been determined, to be 49 dB(A) for the sand extraction operations, for the most critical stage (natural ground level).

The above noise levels have been considered to contain tonal characteristics, therefore contain a +5 dB(A) penalty.

Given these operating parameters, noise levels received at the nearest premises has been calculated to comply with the *Environmental Protection (Noise) Regulations 1997* for the operating times as outlined in this assessment.

APPENDIX A

FIGURE A1 – LOCATION MAP
FIGURE A2 – RECEIVER LOCATION

FIGURE A1 – SITE LAYOUT

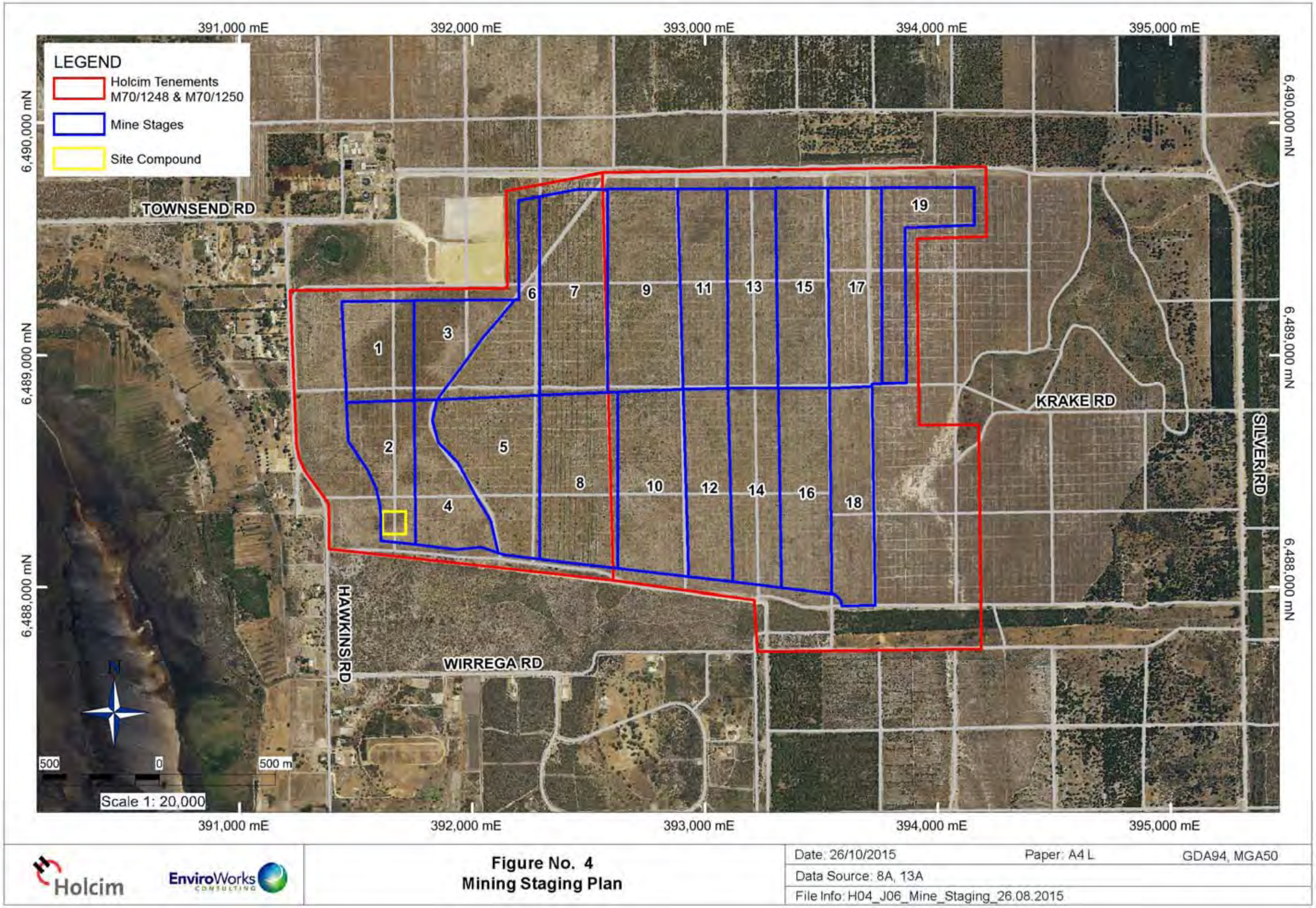
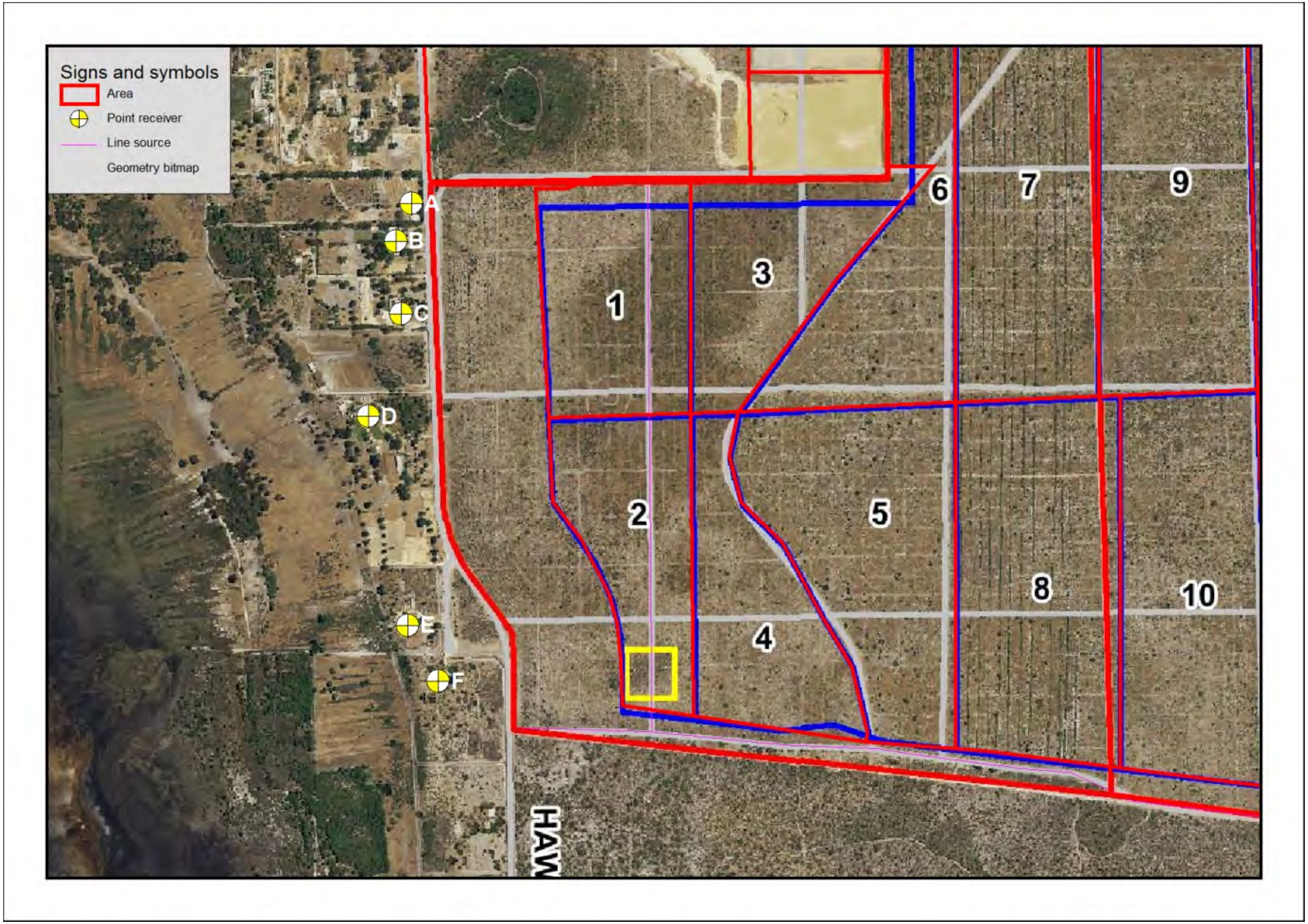
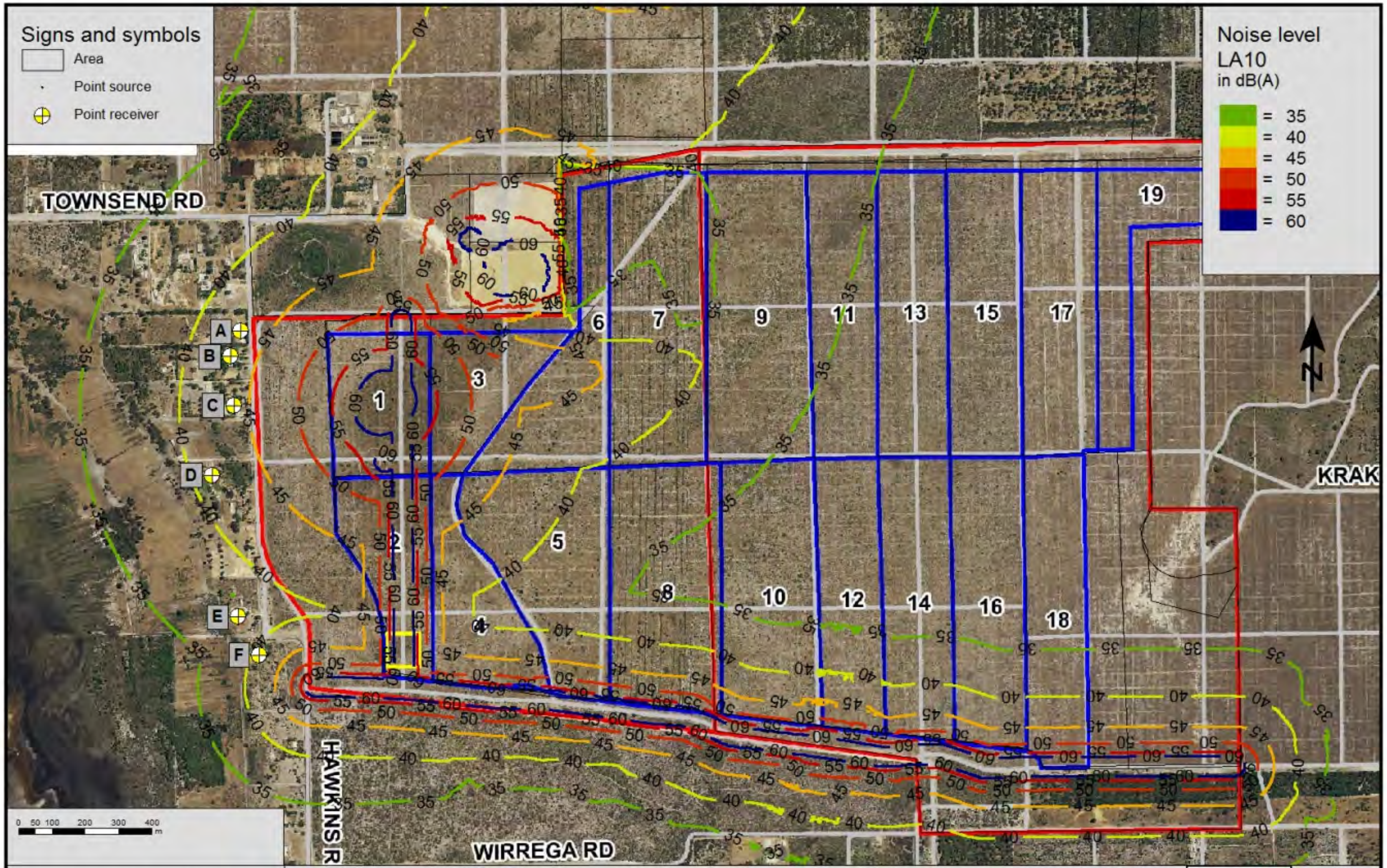


FIGURE A2 – RECEIVER LOCATION



APPENDIX B

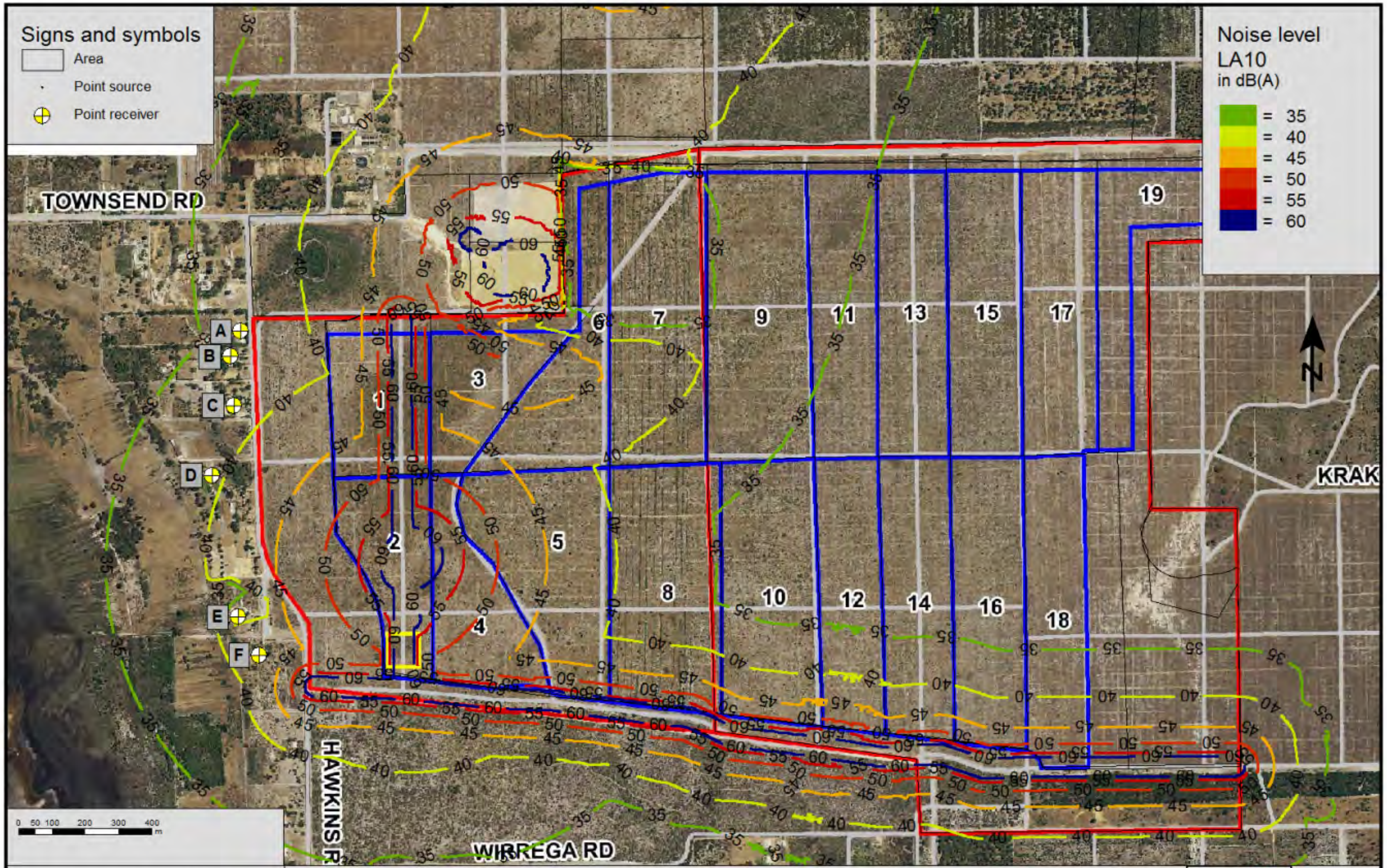
Noise Contours



HERRING STORER ACOUSTICS
JOB No 15226

HOLCIM SAND EXTRACTION PROPOSAL
DAY OPERATION - STAGE 1
ALL NOISE SOURCES

FIGURE 1



HERRING STORER ACOUSTICS
JOB No 15226

HOLCIM SAND EXTRACTION PROPOSAL
DAY OPERATION - STAGE 2
ALL NOISE SOURCES

FIGURE 2

APPENDIX D. HERITAGE LETTER REPORT (AUSTRALIAN HERITAGE MANAGEMENT SOLUTIONS, 2015)

AHMS ARCHAEOLOGICAL & HERITAGE MANAGEMENT SOLUTIONS

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Perth WA 6000
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30th September 2015

South West Aboriginal Land & Sea Council (SWALSC)
1490 Albany Highway,
Cannington
WA 6107

Our Ref: *PER15037*

Attention: Justin McAllister

Re: Holcim Australia Pty Ltd Heritage Survey - Jandabup Sand Quarry Preliminary Results & Recommendations

Dear Justin,

Holcim Australia Pty Ltd (Holcim) requested we provide SWALSC with a letter summarising the preliminary results of archaeological and ethnographic survey work at the Jandabup Sand Quarry, a final report will be issued to Holcim the next few weeks.

Background

Archaeological & Heritage Management Solutions Pty Ltd (AHMS) were engaged to undertake an Aboriginal heritage assessment of the proposed Jandabup quarry site.

Heritage survey took place over two days. The first heritage survey was conducted ahead of a proposed programme of exploratory drilling within tenement M70/1248. The fieldwork was undertaken on the 10th September 2015. The initial phase of fieldwork was followed by a second survey within the adjacent tenement M70/1250 undertaken on the 29 September 2015. The purpose of the heritage surveys was to identify whether or not any Aboriginal sites may be disturbed by Holcim's proposed future drilling, quarrying and associated operations within the subject tenements.

The extent of the two tenement areas and the drill holes proposed as part of the Jandabup Sand Quarry Project are shown on Figure 1. The drilling project consists of 42 proposed drill holes and associated tracks though no blade to ground track is intended for the program. Future sand quarrying is also proposed across both subject tenements. The drilling for M70/1248 is expected to commence in October but full mine expansion into M70/1250 is not expected to commence for another 10-15 years.

Holcim contacted SWALSC in July 2015 to inform them of the proposed works and to seek advice regarding the engagement of survey participants for the Jandabup location. SWLASC provided a contact list prior to the survey taking place. Eight Aboriginal Consultants were nominated to participate in the combined surveys and all reasonable attempts were made to contact the individuals nominated. SWALSC was informed where contact was not possible. Alternate contact details were requested, however these generally were not available.

An archaeological and ethnographic field survey was completed on 10 and 29 September 2015. The survey teams are described below in Table 1.

Table 1 - Survey Team

Date	Aboriginal Consultants (Survey Team)	AHMS Consultants	Holcim Representatives
10 Sept 2015	Ron Gidjup Snr, William Warrell, Sheldon Warrell Muriel Bowie	Emma Beckett - Archaeologist Pip Hudson - Archaeologist, Ari Schipf - Anthropologist	Conor O'Neill - Senior Planning and Environment Coordinator, Ian Dieroff – Operations Support Manager
29 Sept 2015	Muriel Bowie, Tristan Narrier, Joe Narrier Bella Bropho	Emma Beckett - Archaeologist Pip Hudson - Archaeologist, Ari Schipf - Anthropologist	Jo Russell - Planning & Environment Manager Josh Marks - Tenement & Licensing Coordinator Neil Dieroff – Quarry Manager

The following summary of results and recommendations are preliminary. A full description of the results of survey will be included in the final report, which will be provided to Holcim and SWALSC for their reference when completed.

Jandabup Sand Quarry Preliminary Archaeological Results

The survey areas were inspected by archaeologists and Aboriginal Consultants by pedestrian transect. During the survey all drill hole locations were inspected and consultation regarding the purpose of the drilling program and the extent of the disturbance was discussed. As the proposed drill holes are evenly distributed across the tenement areas, the survey also provided balanced survey coverage of the entire study area and provided an opportunity to examine the extent of prior ground disturbance, soil conditions and other factors that have an influence on the archaeological potential of the subject land.

Our assessment found that the potential for sub-surface Aboriginal archaeological sites is very low. The entire survey area comprises sandy loam soils which have been significantly disturbed by previous pine plantations, establishment of tracks and soil dumping.

No evidence or indications of historical archaeological sites or features were identified during the survey.

There is however always some potential for the discovery of previously unrecorded Aboriginal or historical archaeological sites during development works. Therefore, the following recommendations are made in the event that unexpected Aboriginal or historical archaeological material is found during works.

1. There are currently no known Aboriginal sites or historical heritage places identified within the Jandabup development area. Therefore there are currently no approvals required from state or federal heritage consent authorities prior to commencement of development.
2. Our assessment found that the potential for sub-surface Aboriginal or historical archaeological sites is generally low. However, there is always potential for the discovery of previously unrecorded Aboriginal or historical archaeological sites during development works. Therefore, the following recommendations are made in the event that unexpected Aboriginal or historical archaeological material is found during works:
    a. If any suspected Aboriginal or historical archaeological objects or sites are found during development works or at any other time, works in that area must cease immediately and a suitably qualified archaeologist should be engaged to inspect the discovery and provide advice regarding any further management or approvals that may be required under the *Aboriginal Heritage Act 1972* and the *Heritage of Western Australia Act 1990*, including any

consultation required with the Dept of Aboriginal Affairs and/or the State Heritage Office WA. Any required approvals must be obtained before work can re-commence in that area; and

b. If any suspected human skeletal remains are identified during development works or at any other time, works must stop in the vicinity of the find and the Western Australian Police, in the first instance, should be contacted to assess the remains and provide advice regarding any relevant legislative requirements and protocols to appropriately manage the remains.

Jandabup Sand Quarry Preliminary Ethnographic Preliminary Results

On the 10 September 2015 the Whadjuk Aboriginal Consultants inspected tenement M70/1248 by vehicle, that being the boundary of the tenement area which contains the proposed drilling program and inspected some drill hole locations (refer to Figure 1). The anthropologist and the survey team discussed the proposed program and determined that there were no known ethnographic sites within the tenement area. One ethnographic site, Marrynginup (Site Id 22160) is located in the vicinity of the tenement area. As this is located outside the tenement area, it was confirmed that Holcim's proposed drilling program and future quarrying would not impact this site. The Aboriginal Consultants stated that vegetation clearing should be minimised during the initial clearing and that Holcim's water monitoring program should continue to ensure the aquifers are not impacted.

On the 29 September 2015 the Whadjuk Aboriginal Consultants inspected tenement M70/1250 by vehicle, that being the boundary of the tenement area proposed for future development of a sand quarry (refer to Figure 1). Holcim representatives confirmed that this tenement area would not be developed for another 10-15 years and that the quarry plan was not finalised. The Aboriginal Consultants asked that Holcim keep them informed of the final design plan and requested monitors be engaged during the initial ground disturbance clearance for the sand quarry. Holcim also confirmed that the drilling program for both areas would not clear tracks or pads and therefore the survey team were satisfied that monitors would not be required for the drilling project as initially recommended on the 10 September survey.

The anthropologist and the survey team discussed the proposed program and determined that there were no known ethnographic sites within the tenement area. In addition, those who were not in attendance for the 10 September survey were informed of the results and recommendations put forward for the adjacent area. The survey team were satisfied that both areas did not impact on any ethnographic sites.

On completion of the field work for both tenement areas conducted separately (10th and 29th September), at both debriefings with Holcim representatives the Aboriginal consultants requested monitors be engaged for the initial ground disturbance works associated with the construction phase of the sand quarry as part of ongoing heritage management strategy to reduce the potential of impacting any unidentified heritage places.

The Whadjuk Aboriginal Consultant survey team agreed with the following outcomes:

1. The Whadjuk Aboriginal Consultants, on behalf of the Whadjuk People, have completed an ethnographic Work Area Clearance of Holcim's proposed drilling program and proposed mine quarry for the adjacent tenement in order to assist Holcim to meet its obligations in respect of the Aboriginal Heritage Act 1972 and the Aboriginal and Torres Strait Islander Heritage Protection Act 1984.

2. No ethnographic issues or concerns were raised in relation to the proposed drilling program and proposed quarry, both areas are ethnographically cleared for the development of the drilling program to proceed and for the proposed futurequarry operations.

3. It was requested that Holcim engage up to two Aboriginal Consultants as monitors during the initial ground disturbance and clearance ahead of the quarry developnent as part of ongoing heritage management strategy.

4. Holcim should consult with the Whadjuk representatives regarding any further heritage matters that may arise in relation to these work areas, including any further proposed work areas or programs or.

5. Holcim employees and contractors undertaking the proposed work programs should be informed of the contents of the final report.

6. It is recommended Holcim develop a Cultural Heritage Management Plan with the Whadjuk representatives to ensure they are informed and involved in Holcim's future developments and to ensure any potential heritage places are managed appropriately, including during development of rehabilitation and decommissioning plans.

Conclusion

The archaeological and anthropological fieldwork undertaken on 10 and 29 September has provided sufficient information regarding the heritage of this area. Recommendations provided here in association with the final report will allow Holcim to commence the proposed works

Please don't hesitate to contact me if you wish to discuss our assessment further.

Yours sincerely,

Beckett

Emma Beckett
Heritage Advisor

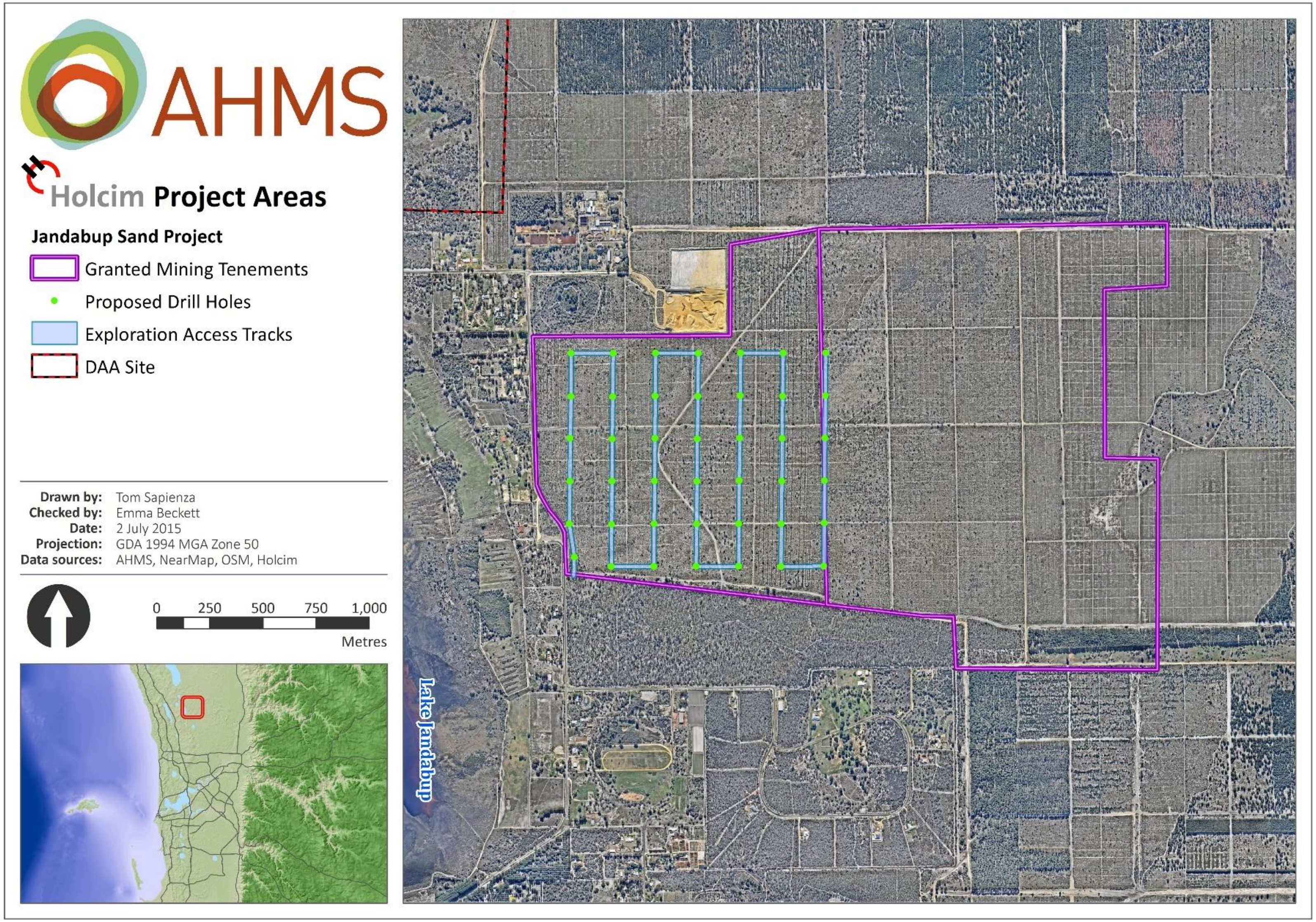

Figure 1 Jandabup Survey Area

APPENDIX E. ENVIRONMENTAL MANAGEMENT PLAN (ENVIROWORKS CONSULTING, 2015B)

Environmental Management Plan Holcim Sand Quarry Jandabup – Tenements M70/1248 and M70/1250

Holcim (Australia) Pty Ltd

H04 – J06

30 October 2015

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Report Name: Environmental Management Plan Holcim Sand Quarry Jandabup – Tenements M70/1248 and M70/1250

AUTHORISATION FOR ISSUE

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Please Note: This document is considered uncontrolled once printed.

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EXECUTIVE SUMMARY

Holcim (Australia) Pty Ltd (Holcim) proposes to develop a Sand Quarry on tenements M70/1248 and M70/1250, located in Jandabup north of Perth, approximately 8 km north east of Wanneroo and within the Local Government Area of Wanneroo. The site falls within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time.

The project site is on the Gnangara Mound and is within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA) and an Underground Water Pollution Control Area (UWPCA). Both are managed by the Department of Water (DoW). Water Corporation operates a public drinking water supply scheme that spans the Gnangara Mound. The site is at the south-western edge of this scheme.

As per the Statement of Planning Policy 2.2 *Gnangara Groundwater Protection* (Western Australian Planning Commission, 2005), sand extraction activities above the Gnangara groundwater mounds are permitted, but subject to environmental management detailed in the State-wide Policy No. 1 *Policy and Guidelines for Construction and Silica Sand Mining in Public Drinking Water Source Areas* (Waters and Rivers Commission, 2004). On that basis, Holcim has pro-actively initiated the consultation with the appropriate Governmental Agencies to discuss the key environmental management aspects to take into consideration.

Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually. The sand will be screened onsite and then trucked offsite Holcim concrete plants and/or customer locations.

Holcim proposes to undertake the following environmental commitments during the project to minimise potential impacts to the environment (Table E1).

Table E1: Summary of Commitments

Environmental Impact/Issue	Management Commitment
Access	• Holcim commit to reaching agreement with DPaW on roading access routes on an ongoing basis throughout the project. The process will be primarily managed through formal annual reviews with DPaW.
Visual Amenity	• Rehabilitate all disturbed and excavated areas, when work is completed. • Ensure barriers, fences and gates are compatible with the semi-rural style of the area or of a similar colour and texture to the natural landscape. • Locate the screening plant so the quarry pit walls screen it as far as possible. • Locate buildings in areas of low visual impact, and maintain appropriate size. • Operations will be undertaken from 0700–1700 Monday - Saturday (excluding public holidays) only. • A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation. • Locate product stockpiles to create screening as far as practicable. • Adopt good house-keeping practises, such as orderly storage and removal of disused equipment or waste.
Surface Water	• Tree stumps will be retained as long as possible to assist soil stabilization. • A buffer zone of 100 m will be maintained between operations and naturally vegetated geomorphic wetlands. • Stockpiles of erodible material will be located away from roads and pavements to minimise sediment transport in runoff. • Each stage will be progressively rehabilitated at completion. • Vegetative cover will be established to minimise erosion. • Holcim will provide spill response equipment at the site.

Environmental Impact/Issue	Management Commitment
	• Bunds will be established along the access road to contain stormwater runoff and settle out sediment. • Hydrocarbon and chemical management measures will ensure surface water contamination does not occur.
Groundwater	• Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a). • Contamination and spills management will be implemented as described below. • Surface water management as described above will ensure that all potentially contaminated surface water runoff will be detained and/or treated before discharge to the environment, minimising the risk of contamination to groundwater via infiltration. • Waste management will ensure that all wastes are disposed of appropriately minimising the risk of groundwater contamination.
Hydrocarbon, Dangerous Goods and Hazardous Substance Management	• The storage, handling and disposal of hazardous materials will be undertaken in a manner that complies with all relevant legal requirements. • Storage of minor quantities of hazardous substances and dangerous goods will only occur in designated areas, which are appropriately signed, bunded or contained. These areas are to be maintained in a clean and tidy state to minimise potential for spills or littering. • All hydrocarbons (grease, fuel, oils and lubricants) will be contained within bunds according to the requirements of Australian Standard 1940. • Hydrocarbons and other hazardous materials shall not be delivered to on site storage areas without appropriate bunding/containment. • Controlled wastes (including waste oil) will be collected and disposed of in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004* which requires*:* o A licensed contractor to remove, transport and dispose of controlled wastes o Sufficient information be provided to enable categorisation of the waste and selection of an appropriate disposal site o Waste types and packaging to be suitable for transportation prior to collection. • Soil contaminated by hydrocarbons will be segregated into designated sites for storage, then removed from site. • Hydrocarbons and oily wastes (e.g. fuels, greases, de-greaser, emulsified oils and oily waste water) are to be managed using the following practices: o Minimal generation of waste and associated contaminants o Appropriate storage and handling procedures o Segregation of hydrocarbon waste from stormwater and other water o Clean-up procedures for spills. • Regular housekeeping and inspections of dangerous goods and hazardous substances will occur to ensure that storage and handling is appropriate. • Material Safety Data Sheets (MSDS) will maintained and easily accessible/located on-site for all hazardous substances and dangerous goods stored on site. • The workforce will be trained on handling dangerous goods and hazardous substances in line with associated MSDS. • A Spill Response Procedure will be implemented by Holcim. • Hydrocarbon/hazardous material spills will be reported in accordance with Holcim Incident Management Procedures. • Appropriate emergency equipment (including spill kits) will be made available on-site and replenished when required. • All spills will be immediately contained and cleaned up. All wastes from clean-up will be appropriately stored and disposed. • All site personnel will receive training on the Spill Response Procedure. • Copies of the Spill Response Procedure will be available with spill kits and in designated storage areas. • The Site Supervisor shall: o Provide advice in a timely nature as required by personnel regarding the management of hydrocarbons. o Ensure changes to management requirements are communicated to the workforce. o Ensure inspections are done on hydrocarbon storage areas.

Environmental Impact/Issue	Management Commitment
	o Ensure training on Hydrocarbon Management is made available for operational personnel.
Flora and Clearing	• Clearing will only occur in previously cleared pine plantation. • 50 m buffers will be maintained to Bush Forever Sites • 100 m buffers will be maintained to naturally vegetated geomorphic wetlands. • 200m vegetation buffer will be maintained on the west boundary to screen the operation. • Vehicles will be restricted to designated access roads and excavation areas. • Areas will be cleared of tree stumps in stages, as they help stabilise the soil.
Dieback	• All vehicles and equipment will be free of soil and plant material before entering the property. • Training programs and inductions will be conducted for site personnel. • All surface water will be contained onsite. Runoff from the quarry pit, stockpiles, cleaning down and haul roads will be contained, and not released into areas of native vegetation. • Light vehicles and machinery will be restricted to access roads, tracks and the excavation area.
Weeds	• All machinery and equipment brought onto site will be clean and free of soil and vegetative material. • Site personnel will be educated on weed risk measures and identification of problem species.
Fauna	• All disturbance will occur in previously cleared pine plantation. • 50 m buffers will be maintained to the remnant vegetation in Bush Forever Sites • 100 m buffers will be maintained to naturally vegetated geomorphic wetlands. • Vehicles will be restricted to designated access roads and the excavation area.
Topsoil /Acid Sulphate Soils (ASS)	• Holcim will avoid disturbance of high ASS risk areas. Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not). • If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval. • Overburden will be stockpiled and used for rehabilitation. • Excavation will not intersect the water table. Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a). • Based on precedents set by other sand mining operations in the pine plantation (including Rocla's adjacent Hawkins Rd Quarry), the topsoil will not be stripped separately, as the native seed bank will be negligible after growing pines since the 1960's. • Overburden and oversize material stockpiles will be used to recontour and rehabilitate the landscape at quarry closure and are thus temporary.
Waste	• Hydrocarbons and chemical containers, such as lubricants will be regularly removed from site for disposal at a licensed landfill facility or recycling centre. • Sewage waste will be transported off-site for treatment and disposal by a licensed contractor. No effluent will be released onsite. • Instruction will be provided to site personnel on waste management.
Noise	• The quarry pit face will be used as far as practicable to provide noise suppression between the nearest dwellings. • Operations will occur between 0700 – 1700 Monday – Saturday (excluding public holidays) to minimise the likelihood of noise nuisance. • All mobile equipment will be maintained, with efficient mufflers and noise shielding. • Any complaints received regarding noise disturbance will be recorded and investigated immediately.
Dust	• Dust suppression measures, such as water sprays/carts, will be implemented as necessary, in the event that high levels of dust are observed. • Dust will be visually monitored daily during operations and construction to ensure control measures are effective. • Cleared areas will be limited (as many tree stumps will be retained as possible, for as long as possible).

Environmental Impact/Issue	Management Commitment
	• Access roads will be constructed of crushed limestone or other suitable road making material. • Activities with high dust-causing potential, such as stripping, will not be carried out in sensitive areas during adverse wind conditions. • Material drop heights between loaders and trucks and trucks to stockpiles will kept to the minimum practical height. • Any complaints will be investigated immediately.
Heritage	• Holcim has already undertaken an Aboriginal Heritage survey. • Any identified heritage material will be protected and reported in accordance with relevant legislation. • Should any evidence of early aboriginal occupation be uncovered during works, all activities will be stopped, pending an assessment by a recognised consultant. • All heritage management measures will be incorporated into the Environmental Management Plan.
Monitoring	• Incorporate the following re-vegetation monitoring: o Short-term monitoring (eg 2nd Spring – 15 months) will focus on establishment success and the need for any short term remedial action including weed control. o Long-term vegetation observations will provide data regarding plant mortality, health, and reproduction to enable analysis of system function, dynamics and resilience. o Monitoring management measure will be incorporated into the Water, Rehabilitation and Environmental Management Plans as relevant. • The operational groundwater monitoring programme will commence following the onset of quarrying operations. The programme focuses on the key risks to the groundwater resource identified in the Water Management Plan (URS, 2015b). The comprehensive suite of analytes will be requested biannually.

1 BACKGROUND INFORMATION

Holcim (Australia) Pty Ltd (Holcim) proposes to develop a Sand Quarry on tenements M70/1248 and M70/1250, located in Jandabup north of Perth, approximately 8 km north east of Wanneroo and within the Local Government Area of Wanneroo. The site falls within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time.

1.1 PROJECT OBJECTIVES

The objective of this project is to extract sand to supply to customers predominantly in the construction industry.

Up to 1,200,000 tonnes is proposed to be extracted annually. It is estimated approximately 30,000,000 tonnes will be extracted over the 25 year quarry life. Up to 1,000,000 tonnes is proposed to be screened annually. The sand will be screened onsite and then trucked offsite Holcim concrete plants and/or customer locations.

1.2 LOCATION

The proposed quarry is located within Gnangara-Moore River State Forest in the City of Wanneroo. Tenements M70/1248 and M70/1250 fall within the Gnangara Pine Plantation, which has been progressively harvested since 2003 until the current time. The proposed project is located north of Perth, approximately 8 km north east of Wanneroo, within the Local Government Area of the City of Wanneroo.

The project site is on the Gnangara Mound and is within a Priority 1 Drinking Water Source Protection Area (P1 DWSPA) and an Underground Water Pollution Control Area (UWPCA). Both are managed by the Department of Water (DoW). Water Corporation operates a public drinking water supply scheme that spans the Gnangara Mound. The site is at the south-western edge of this scheme.

2 ENVIRONMENTAL MANAGEMENT

Environmental management measures for this project are described in the sub-sections below.

2.1 VISUAL AMENITY

Visual impact can occur when the operation is visible from neighbouring properties or roads, caused by being too high in the landscape, too close to neighbours, or having insufficient visual screening.

There is a significant buffer of at least 300 m between the proposed quarry site and all residents, this includes a 200m strip of vegetation to screen the operation. This complies with the recommended buffer for sand mining within EPA Guidance Statement Number 3 *Separation Distances between Industrial and Sensitive Land Uses* (Environmental Protection Authority, 2005).

The Water Corporation Groundwater Treatment Plant (GWTP) is approximately 500 m to the north of the proposed sand quarry.

Based on the buffer distance of 300 m from residential areas, it is unlikely visual amenity will be a problem.

2.1.1 MANAGEMENT STRATEGIES:

Visual amenity management measures include:

- Rehabilitate all disturbed and excavated areas, when work is completed.
- Ensure barriers, fences and gates are compatible with the semi-rural style of the area or of a similar colour and texture to the natural landscape.
- Locate the screening plant so the quarry pit walls screen it as far as possible.
- Locate buildings in areas of low visual impact, and maintain appropriate size.
- Operations will be undertaken from 0700–1700 Monday - Saturday only (excluding public holidays).
- Locate product stockpiles to create screening as far as practicable.
- A 300 m buffer will be maintained between the proposed quarry and all residents, this includes a 200m strip of vegetation to screen the operation.
- Adopt good house-keeping practises, such as orderly storage and removal of disused equipment or waste.

2.2 SURFACE WATER MANAGEMENT

Flooding is not considered an issue in the areas that operations will be occurring. The Bassendean Sands in the area have a high hydraulic conductivity and rainfall infiltrates rapidly.

Considering the high infiltration rate, potential impacts to nearby surface water bodies such as Hawkins Road Swamp are considered low.

2.2.1 MANAGEMENT STRATEGIES

The project site will be designed, constructed and operated to avoid disruption of surface water flows and ensure that potential contaminants are not released into Wetlands or Bush Forever Sites. Operational areas will be located 100 m and 50 m from naturally vegetated geomorphic wetlands and Bush Forever Sites respectively.

To manage the potential effects on water quality from the discharge of storm water with elevated sediment levels or any other contaminants, the following practices will be employed:

- Tree stumps will be retained as long as possible to assist soil stabilization.
- A buffer zone of 100 m will be maintained between operations and naturally vegetated geomorphic wetlands.
- Stockpiles of erodible material will be located away from roads and pavements to minimise sediment transport in runoff.
- Each stage will be progressively rehabilitated at completion.
- Vegetative cover will be established to minimise erosion.
- Holcim will provide spill response equipment at the site.
- Bunds will be established along the access road to contain stormwater runoff and settle out sediment.
- Hydrocarbon and chemical management measures will ensure surface water contamination does not occur.
- Annual surface water monitoring will be undertaken when surface water is present.

2.3 GROUNDWATER MANAGEMENT

Given that neither pit dewatering or groundwater abstraction for water supply are proposed as part of this project, impact to groundwater is unlikely.

The only potential source of impact to groundwater is contamination via hydrocarbons and sewerage. There are minimal hydrocarbons and chemicals to be stored on site, reducing the likelihood of any major groundwater contamination.

A Groundwater Assessment has been prepared for this project – Appendix A (URS, 2015a). To manage the risk of groundwater contamination, it is proposed to limit excavation depth to 3 m above the MGL determined by URS (2015a) as well as implement contamination prevention measures as described subsequent sections.

The Wanneroo Water treatment plant is located at the top northeast corner of the proposed site. The treatment plant is fed via a network of production bores and pipelines. The Water Corporation infrastructure mainly consists of bore headworks and collector mains. Major collector mains of DN600 AC, DN900 and DN1200 steel mains are located along Amaranted Rd. Bore 240 head works and bore compound as well as a 450/375 AC collector main is located along Hawking Rd. Bore 230 and bore 220 together with associated compounds and collector mains (DN375/DN300 AC) are located north of Wirrega Rd. No recorded water assets are located in close proximity to the western boundary of proposed site. A formal risk assessment determined that a 50m excavation buffer distance is considered to be adequate for the proposed excavation site expansion.

2.3.1 MANAGEMENT STRATEGIES

Management practices to minimise the potential for impact to groundwater quality and quantity include:

- Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).
- Contamination and spills management will be implemented as described below.
- Surface water management as described above will ensure that all potentially contaminated surface water runoff will be detained and/or treated before discharge to the environment, minimising the risk of contamination to groundwater via infiltration.
- Waste management will ensure that all wastes are disposed of appropriately minimising the risk of groundwater contamination.

2.4 HYDROCARBON, DANGEROUS GOODS AND HAZARDOUS SUBSTANCE MANAGEMENT

The types of hydrocarbons, dangerous good and hazardous materials proposed to be stored and used at the quarry, with the potential to cause contamination include:

- Hydrocarbons (oils, greases, fuels and degreasers)
- Solvents
- Detergents
- Glues
- Paints
- Hazardous wastes (such as sewage, used hydrocarbons and chemicals etc).

Hazardous materials, such as fuels, lubricants, solvents, detergents and paints have the potential to cause atmospheric, soil or water contamination and human health issues if incorrectly stored, used or disposed of. Appropriate management of these substances is required to prevent such impacts.

2.4.1 MANAGEMENT STRATEGIES

Holcim will transport, store and use dangerous goods and hazardous materials in accordance with the following legislation and standards:

- *Dangerous Goods Safety Act, 2004*
- *Dangerous Goods (Explosives) Regulations, 2007*
- *Dangerous Goods (General) Regulations, 2007*
- *Dangerous Goods (Road and Rail Transport of Non-explosives) Regulations, 2007*
- *Dangerous Goods (Storage and Handling of Non-explosives) Regulations, 2007*
- *Australian Code for the Transport of Dangerous Goods by Road and Rail, (7th Ed.)*
- *Road Traffic Act, 1974*
- *Australian Standard AS 1940-2004: The storage and handling of flammable and combustible liquids*
- *Quarry Safety and Inspections Act, 1994.*

The following management measures will be used to effectively manage dangerous goods and hazardous materials:

- The storage, handling and disposal of hazardous materials will be undertaken in a manner that complies with all relevant legal requirements.
- Storage of minor quantities of hazardous substances and dangerous goods will only occur in designated areas, which are appropriately signed, bunded or contained. These areas are to be maintained in a clean and tidy state to minimise potential for spills or littering.
- All hydrocarbons (grease, fuel, oils and lubricants) will be contained within bunds according to the requirements of Australian Standard 1940.
- Hydrocarbons and other hazardous materials shall not be delivered to on site storage areas without appropriate bunding/containment.
- Controlled wastes (including waste oil) will be collected and disposed of in accordance with the *Environmental Protection (Controlled Waste) Regulations 2004* which requires*:*
  - A licensed contractor to remove, transport and dispose of controlled wastes
  - Sufficient information be provided to enable categorisation of the waste and selection of an appropriate disposal site
  - Waste types and packaging to be suitable for transportation prior to collection.
- Soil contaminated by hydrocarbons will be segregated into designated sites for storage, then removed from site.

- Hydrocarbons and oily wastes (e.g. fuels, greases, de-greaser, emulsified oils and oily waste water) are to be managed using the following practices:
  - Minimal generation of waste and associated contaminants
  - Appropriate storage and handling procedures
  - Segregation of hydrocarbon waste from stormwater and other water
  - Clean-up procedures for spills.
- Regular housekeeping and inspections of dangerous goods and hazardous substances will occur to ensure that storage and handling is appropriate.
- Material Safety Data Sheets (MSDS) will maintained and easily accessible/located on-site for all hazardous substances and dangerous goods stored on site.
- The workforce will be trained on handling dangerous goods and hazardous substances in line with associated MSDS.
- A Spill Response Procedure will be implemented by Holcim.
- Hydrocarbon/hazardous material spills will be reported in accordance with Holcim Incident Management Procedures.
- Appropriate emergency equipment (including spill kits) will be made available on-site and replenished when required.
- All spills will be immediately contained and cleaned up. All wastes from clean-up will be appropriately stored and disposed.
- All site personnel will receive training on the Spill Response Procedure.
- Copies of the Spill Response Procedure will be available with spill kits and in designated storage areas.
- The Site Supervisor shall:
  - Provide advice in a timely nature as required by personnel regarding the management of hydrocarbons.
  - Ensure changes to management requirements are communicated to the workforce.
  - Ensure inspections are done on hydrocarbon storage areas.
  - Ensure training on Hydrocarbon Management is made available for operational personnel.

2.5 FLORA AND CLEARING

The proposed quarry footprint is located exclusively on harvested pine plantation. Therefore there will be no clearing of remnant native vegetation or flora. However, the area has been identified to be within a non-permitted area (defined under Schedule 1, Section 4 of *the Environmental Protection (Clearing of Native Vegetation) Regulations 2004*). The clearing required to support this program has been approved by Native Vegetation Clearing Permit 6617/1 – granted on 6 August 2015.

2.5.1 MANAGEMENT STRATEGIES

Flora and clearing management strategies include:

- Clearing will only occur in previously cleared pine plantation.
- 50 m buffers will be maintained to Bush Forever Sites
- 100 m buffers will be maintained to naturally vegetated geomorphic wetlands.
- Vehicles will be restricted to designated access roads and excavation areas.
- Areas will be cleared of tree stumps in stages, as they help stabilise the soil.

2.6 DIEBACK MANAGEMENT

Due to the removal of native vegetation in the 1960's to establish the pine plantation, the absence of indicator species mean the site is considered Un-interpretable. Therefore the site will be managed using the precautionary principle, and as such hygiene guidelines will be implemented in accordance with the Dieback Management Protocol, The aim of dieback management during excavation is to minimise the risk of entry of dieback to the site. This is achieved by preventing the import of any soil or plant material on mobile equipment and vehicles. As vehicles will be travelling on sealed surfaces prior to entering the quarry site, the risk is low. Holcim will ensure that all plant and equipment is clean prior to entering the site.

As the proposed quarry footprint is within cleared land, the second objective is to prevent the spread of dieback from this disturbed area into neighbouring areas of native vegetation; in particular, Wetlands and the Bush Forever site.

2.6.1 MANAGEMENT STRATEGIES

In many ways, the management strategies for dieback control are very similar to that of weed control, and the two management practices should be considered together. Many of the below strategies are recommended for Un-interpretable sites in the Management of *Phytophthora* Dieback in Extractive Industries document (Dieback Working Group, 2005).

Broadly the following principles of dieback management will be applied to this project:

- All vehicles and equipment will be free of soil and plant material before entering the property.
- Training programs and inductions will be conducted for site personnel.
- All surface water will be contained onsite. Runoff from the quarry pit, stockpiles, cleaning down and haul roads will be contained, and not released into areas of native vegetation.
- Light vehicles and machinery will be restricted to access roads, tracks and the excavation area.

2.7 WEED MANAGEMENT

Earthworks, topsoil and overburden transportation, vehicle movement and other factors have the potential to introduce additional weeds to the area and to spread existing populations of introduced flora within the proposed quarry site. A weed is a plant that is non-native to an area or region and is considered to be a nuisance due to excessive growth and/or disturbance to the local eco-system. The principles of weed management are similar to that of plant diseases. Generally if the actions taken to prevent Dieback spread are applied, weeds will also be controlled.

During the field survey 61 weed species were recorded. All species are common weeds associated with disturbance and agriculture. One species *Emex australis* (Doublegee) is a Priority 1 Declared Plant within some W.A. local government areas under the Agriculture and Related Resources Act 1976. Weeds were most common within the plantation areas and along tracks. The majority of species are not considered to be serious environmental problems (EnviroWorks Consulting, 2015a).

2.7.1 MANAGEMENT STRATEGIES

Holcim Weed Management approach includes:

- Identification of type of weeds being targeted.
- Appropriate timing of spraying / other management measures.
- Appropriate type of spray and/or weed control measures being used.
- Planning for ongoing management of weeds.

Broadly the following principles of weed management will be applied to this project:

- All machinery and equipment brought onto site will be clean and free of soil and vegetative material.
- Site personnel will be educated on weed risk measures and identification of problem species.

Weed management will need to take into account the status of the P1 PDWSA as only certain chemcials can be used in these areas. Any weed sprays will need to be approved by DoW.

2.8 FAUNA

The proposed site layout has been planned to eliminate any clearing of native vegetation. As the quarry footprint is cleared pine plantation, it is unlikely significant fauna species of habitat will be directly disturbed by the project. There will likely be some localised loss of individual fauna due to direct mortality arising from the additional traffic between the proposed quarry and customer locations. It is unlikely, however, that the loss of individuals associated with these events would be significant enough to affect the conservation status of any of the species recorded from the region.

The proposed quarry may have the following potential impacts on native fauna:

- Loss of fauna habitat through vegetation clearing (unlikely to be significant);
- Ecological impacts such as changes to fire frequency and feral species numbers;
- Fauna deaths through clearing and road kill from traffic and
- Loss of fauna by contamination of water source or direct contact with hazardous substances.

It should be noted that pine wildings, do represent potential foraging habitat for Carnaby's cockatoo which will feed on pine cones. However, the impact on Carnaby's feeding resources due to pine removal in the area is not likely considered to be an issue as pine removal more broadly is being addressed through the Strategic Assessment of the Perth and Peel Regions (Department of Premier and Cabinet, Under Development)

2.8.1 MANAGEMENT STRATEGIES

Holcim will employ management precautions with regard to fauna. These will include:

- All disturbance will occur in previously cleared pine plantation;
- 50 m buffers will be maintained to the remnant vegetation in Bush Forever Sites;
- 100 m buffers will be maintained to naturally vegetated geomorphic wetlands;
- Vehicles will be restricted to designated access roads and the excavation area; and

2.9 TOPSOIL AND ACID SULPHATE SOIL

There is no native topsoil available for rehabilitation at the site. *Pinus pinaster* plantation has been in place since the 1960's, and the native seed bank would be negligible. Depending on topsoil viability, the site will be single stripped as overburden, which will be stockpiled for use in future rehabilitation activities.

Overburden will be stripped from the clearing footprint, and will be stockpiled on the edge of the run of quarry pad in appropriate windrows. Stripping of overburden will occur in calm wind conditions. The overburden stockpiles will be located along the western edge of the run of quarry pad to provide maximum screening from neighbours.

As the proposed activities will not disturb the ground below the water table or any areas of high probability of ASS occurrence, it is unlikely that any ASS will be exposed or disturbed.

DMP has advised that '*according to the DEC guideline 'Identification and investigation of acid sulphate soils and acidic landscapes', sites should be investigated for ASS if extractive industry works are proposed in any of the areas listed in Table 1, which includes wetlands as found in the proposed tenement*.' Accordingly, Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not). If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval. The large sand resource in this tenement provides sufficient flexibility for forward planning and investigations to occur in a timely manner

2.9.1 MANAGEMENT STRATEGIES

Holcim plan to manage ASS and overburden/topsoil in the following manner:

- Holcim will avoid disturbance of high ASS risk areas. Holcim commits to the exclusion of mining from a 100 metre buffer around mapped high to moderate risk ASS soils (including 100 metres around all wetlands whether mapped as high to moderate risk or not).
- If mining is proposed within the 100 metre buffer, Holcim commits to the provision of a management plan which will include the results of ASS investigations and will incorporate the results into management strategies to be presented with a new mining proposal to be submitted for approval.
- Overburden will be stockpiled and used for rehabilitation.
- Excavation will not intersect the water table. Excavation depth is limited to 3m above maximum groundwater level determined by URS (2015a).
- Based on precedents set by other sand mining operations in the pine plantation (including Rocla's adjacent Hawkins Rd Quarry), the topsoil will not be stripped separately, as the native seed bank will be negligible after growing pines since the 1960's.
- Overburden and oversize material stockpiles will be used to recontour the landscape and rehabilitate the excavation at quarry closure and are thus temporary.
- All topsoil / ASS management measures will be incorporated into the Environmental and Water Management Plan.

2.10 WASTE MANAGEMENT

Wastes must be managed in order to prevent visual impacts, contamination of groundwater, soil and surface water, and human health issues. Holcim apply the waste management principles of reduce, re-use and recycle. The following wastes may potentially be produced by the proposed project:

- Hydrocarbon and chemical contaminated wastes (such as used oil, empty drums and containers, spill absorbent materials etc).
- General waste (such as kitchen waste, paper, cardboard etc).
- Sewage and domestic wastewater.

2.10.1 MANAGEMENT STRATEGIES

Holcim plan to manage wastes in the following manner:

- Hydrocarbons and chemical containers, such as lubricants will be regularly removed from site for disposal at a licensed landfill facility or recycling facility.
- Sewage waste will be transported off-site for treatment and disposal by a licensed contractor. No effluent will be released onsite.
- Instruction will be provided to site personnel on waste management.

2.11 NOISE

Noise generated by the proposed quarry is expected to be localised and due to:

- Operation of earthmoving equipment throughout the construction and operational phases.
- Traffic along the transport routes.
- Noise generated by the screening machinery.

Occupational noise associated with mining falls under the *Mines Safety and Inspection Act 1994* and *Regulations 1995*. It is usually managed by providing all necessary hearing protection, and conducting inductions and educational programs for all staff.

Research into the impact of noise on fauna is relatively scarce however it is known that a large number of animals are quick to adapt to man-made noises if other threats are absent. The expected operational and transport noise generated by this quarry is unlikely to have an adverse effect on local wildlife.

A noise assessment was completed for this project by Herring Storer Acoustics (2015) – refer to Appendix C. The Herring Storer study predicted that noise levels received at the nearest premises will comply with the Environmental Protection (Noise) Regulations 1997 for the operating times proposed - 0700 – 1700 Monday – Saturday (excluding public holidays).

2.11.1 MANAGEMENT STRATEGIES

Sound travels mostly by line-of-sight, so many noise management strategies involve locating equipment and processing plant in a depression, on the pit floor or behind stockpiles or bunds, to reflect the noise. Holcim will implement the following management strategies to minimise off site noise:

- The quarry pit face will be used as far as practicable to provide noise suppression between the nearest dwellings.
- Operations will occur between 0700 – 1700 Monday – Saturday (excluding public holidays) to minimise the likelihood of noise nuisance.
- All mobile equipment will be maintained, with efficient mufflers and noise shielding.
- Any complaints received regarding noise disturbance will be recorded and investigated immediately.

2.12 DUST

Excessive dust can have adverse impacts on both workers and health of surrounding vegetation. Dust generated from the proposed quarries is expected to be minor and localised. Dust may be generated by:

- Earthworks during the construction and operational phase
- Clearing and stripping
- Excavation
- Screening
- Loading and transport
- Movement of vehicles
- Wind erosion of exposed surfaces.

A dust management for the proposed operation, based on the DER publication "*A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities*" (Department of Environment and Conservation, 2011). All dust management measures have been incorporated into the Environmental Management Plan (Appendix E).

2.12.1 MANAGEMENT STRATEGIES

Holcim have made allowance for water cart operation, and ensuring the disturbed area exposed is kept to a minimum at all times. To satisfy the requirements of the *Mines Safety and Inspection Act 1994 and Regulations 1995* in regard to occupational health risks from dust, Holcim will ensure that all personnel will have access to efficient dust masks and that a water cart is available during mining operations.

Access roads and internal road will be constructed of compacted crushed limestone (they will not be sealed). Dust will be managed via the use of water carts where necessary to prevent dust generation.

Standard dust suppression measures will be implemented during construction and operation to minimise impacts on surrounding vegetation. Management strategies to be undertaken are as follows:

- Dust suppression measures, such as water sprays/carts, will be implemented as necessary, in the event that high levels of dust are observed.
- Dust will be visually monitored daily during operations and construction to ensure control measures are effective.
- Cleared areas will be limited (as many tree stumps will be retained as possible, for as long as possible).
- Access roads will be constructed of crushed limestone or other suitable road making material.
- Activities with high dust-causing potential, such as stripping, will not be carried out in sensitive areas during adverse wind conditions.
- Material drop heights between loaders and trucks and trucks to stockpiles will kept to the minimum practical height.
- Any complaints will be investigated immediately.

2.13 HERITAGE

There are several recorded Aboriginal Heritage sites nearby, with the closest mapped site (ID 22160) located approximately 500 m to the north west.

Land clearing (including soil disturbance) for pine establishment commenced in the 1960's. It is highly likely that any heritage sites if present, would have been destroyed during this initial land clearing and pine forest establishment process. Therefore it is considered highly unlikely that any aboriginal heritage sites would remain within the pine plantation due to historical disturbance. In addition recent clearing of pines by the Forest Products Commission has resulted in significant additional disturbance.

Holcim commissioned Australian Heritage Management Solutions to undertake a heritage study over the project area. No heritage sites were identified during this survey (Australian Heritage Management Solutions, 2015).

The potential for risk of disturbance to aboriginal heritage sites is therefore considered low.

There are no known European heritage sites within the tenement boundaries – the closest is Delamare House approximately 700 m to the North West of the tenement.

Mineral extraction and associated works have the potential to disturb Aboriginal artefacts if they are likely to exist in the proposed disturbance footprint.

2.13.1 MANAGEMENT STRATEGIES

Heritage management measures include:

- Holcim has already undertaken an Aboriginal Heritage survey (refer to Appendix C).
- Any identified heritage material will be protected and reported in accordance with relevant legislation.
- Should any evidence of early aboriginal occupation be uncovered during works, all activities will be stopped, pending an assessment by a recognised consultant.
- All heritage management measures will be incorporated into the Environmental Management Plan.
- Holcim commit to develop a Cultural Heritage Management Plan with the Whadjuk representatives to ensure they are informed and involved in Holcim's future developments and to ensure any potential heritage places are managed appropriately, including during development of rehabilitation and decommissioning plans.

2.14 WORKFORCE INDUCTION AND TRAINING

Holcim will develop an environmental induction that all personnel must complete prior to work commencing onsite. It will summarise the potential issues and environmental management strategies detailed this document. Personnel will complete refresher training annually.

3 MONITORING AND REPORTING

Quarry activities and potential environmental impacts require ongoing monitoring to ensure legislation, policies, standards and guidelines are being met.

3.1 ENVIRONMENTAL MONITORING PROGRAMME

3.1.1 REVEGETATION MONITORING

The rehabilitation monitoring program will be largely driven by the requirements of the related research trials. Subject to the design and requirements of research trials the monitoring program should constitute the following elements:

- Short-term monitoring (eg 2nd Spring – 15 months) will focus on establishment success and the need for any short term remedial action including weed control.
- Long-term vegetation observations will provide data regarding plant mortality, health, and reproduction to enable analysis of system function, dynamics and resilience. Long-term observations will include:
    - Native seedling recruitment (derived from the topsoil, from seed broadcasting, and tubestock) following each Spring for years 3 & 5, following rehabilitation operations;
    - Plant reproductive and regenerative capability over time;
    - Recruitment and persistence of weeds with subsequent management, which may include spraying for removal if necessary; and
    - The need for supplementary planting of tubestock.

3.1.2 GROUNDWATER MONITORING

The operational groundwater monitoring programme (Table 1) will commence following the onset of quarrying operations, currently scheduled for early 2016. The operational programme focuses on the key risks to the groundwater resource identified in the Water Management Plan (URS, 2015b). The comprehensive suite of analytes will be requested biannually and comprises:

***General water suite** (chloride, sulphate, alkalinity, acidity, pH, electrical conductivity, total dissolved solids, calcium, magnesium, sodium, potassium, iron, manganese and aluminium, carbonate, bicarbonate, total hardness), **Nutrients** (TKN, Total P, ammonia, NO_3), **Organic suite** (TPH/TRH(C6-C36 or 40)/BTEX).*

Table 1: Operational Groundwater Monitoring Programme

Frequency	Bore Locations	Parameters	Methodology and QA/QC	Rationale
Monthly	WHPZ bores: HMB07B, W230, JB10B, W240	Groundwater levels	Groundwater levels to be measured to the nearest cm using a water level meter.	Monthly measurements to ensure seasonal variations and short-term trends are captured. These levels will be assessed against assigned trigger values. Monthly data will improve the understanding of the effects climate change and land use are having on the local water table, and will identify any project attributable impacts to the water table.
Quarterly	JB12B, JB9C, WCM Redrill, WE1B, WE2B, WM24, WM35, WM23. HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB08	Groundwater levels	Groundwater levels to be measured to the nearest cm using a water level meter.	Quarterly measurements to capture seasonal trends. These levels will be assessed against assigned trigger values. This data will support the on-site monitoring data and to provide a greater spatial representation of groundwater levels in the shallow water table zone.
	WHPZ bores: HMB07B, W230, JB10B, W240	Groundwater quality (EC, pH, temperature)	Field groundwater quality readings to be taken using a calibrated water quality meter.	There is a minor risk to local groundwater resources from the application of water containing low concentrations of salt, which may accumulate at the water table.
Annually	WHPZ bores: HMB07B, W230, JB10B, W240 On-site bores: HMB01, HMB02, HMB03, HMB04, HMB05, HMB06, HMB08	Groundwater quality (comprehensive suite)	Groundwater sampling to be undertaken using low-flow sampling (peristaltic). *In situ* analysis of groundwater to be conducted using a calibrated water quality meter. QA/QC samples to be taken at the following frequency; • Duplicates and triplicates (1 in 20 primary samples) • Field and rinsate blanks (1 per day of sampling) Samples to be analysed by a NATA accredited laboratory.	Potential identified risk for the contamination of groundwater at the water table if there is a significant unplanned leak or unmanaged spill. Hydrocarbons and nutrients were detected above assessment levels (NH&MRC, 2015) in samples taken during the pre-quarrying programme detected. Potential unplanned release of these substances includes on-site hydrocarbons and ablution facilities. The laboratory results will be assessed against appropriate assessment levels.
	Off-site bores: JB12B, JB9C, WCM Redrill, WE1B, WE2B, WM24, WM35, WM23.	Groundwater levels Groundwater quality (EC, pH, temperature)	Groundwater levels to be measured to the nearest cm using a water level meter. Field groundwater quality readings to be taken using a calibrated water quality meter.	There is a potential for water table mounding beneath cleared quarry areas. The monitoring will aim to identify any changes in water levels before r nearby water-sensitive features. There is a minor risk to local groundwater resources from the application of water containing low concentrations of salt, which may accumulate at the water table.
It is recognised that some of the proposed monitoring bores to be installed within the mine footprint may be destroyed as quarrying operations commence.				

3.2 INSPECTIONS AND AUDITS

Monthly Environmental, Health and Safety (EHS) inspections will be undertaken by the Site Supervisor, using a checklist. All corrective actions will be logged and must be completed.

3.3 ANNUAL REPORTING

Under the *Mining Act 1978*, mining lease holders are required to submit an Annual Environmental Report (AER) to the DMP each year. An AER will also be submitted to the DER as required by the Environmental Licence. The AER will include the following:

- Progress of excavation, including the volume/tonnage removed
- Volume screened
- Contingency actions and outcomes
- Environmental incidents
- Community complaints and responses.

3.4 INCIDENTS AND COMPLAINTS

Holcim commit to reporting all environmental incidents which may occur onsite. An environmental incident is any event that could or does result in environmental impact, including the following:

- Contamination of water
- Contamination of soil
- Incorrect waste disposal
- Illegal clearing of native vegetation
- Death of wildlife
- Spills by hazardous materials, chemicals, or hydrocarbons
- Unauthorised land disturbance, including clearing or disturbance of heritage sites
- Fumes or spills from waste
- Waste that is available to native fauna or will attract feral wildlife
- Community complaints
- Other environmental harm.

Holcim will systematically investigate incidents, identify root causes and implement preventative measures.

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5 GLOSSARY

5.1 UNITS, SYMBOLS AND PREFIXES

5.1.1 UNITS

g	Gram; a unit used to express weight
L	Litre; a unit used to express volume
m	Metre; a unit used to express length
bcm	Bank cubic meters; a unit used to describe the volume of in-situ rock
dB	Decibel; unit used to express sound intensity
h	Hour; a unit used to express time
ha	Hectare; a unit used to express area
m2	Square metre; a unit used to express area
m3	Cubic metre; unit used to express volume.
V	Volt; a unit used to express the potential difference across a conductor
VA	Volt-amp; a unit used to express apparent power; is equal to voltage applied multiplied by current drawn
VPD	Vehicles per day
yr	Year
s	Second; a unit used to express time
ppm	Parts per million; a unit used to express concentration
ppt	Parts per thousand; a unit used to express concentration
T	Tonne

5.1.2 SYMBOLS

%	percentage (proportion out of one hundred)
/	Per
p	per
$	Australian dollars
a	annum; year
°C	degree Celsius

5.1.3 PREFIXES

G	10^9
M	10^6
k	10^3
d	10^{-1}
c	10^{-2}
m	10^{-3}.
µ	10^{-6}
N	10^{-9}

5.2 WORDS AND ABBREVIATIONS

Term	Definition/Expansion
acid	Substance with a pH less than 7.0; the lower the pH the higher the corrosive ability of the substance.

Term	Definition/Expansion
acidic	Having a pH less than 7.0.
AHD	Australian Height Datum
ALARP	As low as reasonably practicable.
amenity	The desirability of an area.
amphibians	Animals (such as frogs) adapted to live both on land and in water.
ARI	Average recurrence interval; a measure of the rarity of a rainfall event.
artefact	Anything made by human workmanship, particularly by previous cultures (such as chipped and modified stones used as tools).
background	The conditions (e.g., noise levels, bird populations) already present in an area before the commencement of a specific activity (e.g., a mining operation).
best practice	A best practice is a process, technique, or use of technology, equipment or resource that has a proven record of success.
bioregion	A complex land area composed of a cluster of interacting ecosystems that are repeated in similar form. It describes the dominant landscape scale attributes of climate, lithology, geology, landforms and vegetation. It is based on the Interim Biogeographic Regionalisation for Australia (see IBRA).
biodiversity	The diversity of different species of plants, animals and microorganisms, including the genes they contain, in the ecosystem of which they are part.
bore	A well, usually of less than 20 cm diameter, sunk into the ground and from which water is pumped.
bund	An earth, rock, or concrete embankment constructed to prevent the inflow or outflow of liquids or the transmission of noise.
catchment	The entire land area from which water (e.g., rainfall) drains to a specific water course or waterbody.
clay	A discrete mineral species, belonging to the layered silicate group of less than 2 microns in diameter.
compaction	The process of close packing of individual grains in a soil or sediment as a response to pressure.
concentration	The amount of a substance per unit of mass or volume of the medium in which it occurs.
conservative	A prediction, assumption, or measurement that errs on the side of safety.
contractor	Specialist brought in to perform a specific task, such as the construction of quarry infrastructure or the excavation (mining) of the open pit.
DER	Department of Environment and Regulation (WA)
DoE	Department of Environment (Federal)
DPaW	Department of Parks and Wildlife (WA)
density	The mass of a substance divided by its volume.
DIA	Department of Indigenous Affairs (WA)
DoCEP	Department of Consumer and Employment Protection (WA)
DoW	Department of Water (WA)
DRF	Declared Rare Flora.
DSP	District Structure Plan
ecosystem	An interacting system of animals, plants, other organisms and non-living parts of the environment.
emission	A discharge of a substance (e.g., dust) into the environment.
endemic	Native to, or restricted to, a certain country or area.
environment	A general term for all the conditions (physical, chemical, biological and social) in which an organism or group of organisms (including human beings) exists.
EPA	Environmental Protection Authority.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

Term	Definition/Expansion
erosion	The wearing away of the land surface (whether natural or artificial) by the action of water, wind and ice.
fauna	A general term for animals (birds, reptiles, marsupials, fish etc.), particularly in a defined area or over a defined time period.
feed	Material being fed into a process.
flora	A general term for plants, particularly those found in a defined area or characteristic of a defined time period.
foraging	Searching for food over a wide area.
grade	The concentration of metal, e.g., iron either in an individual rock sample or averaged over a specified volume of rock.
gradient	Rate of change of a given variable (such as temperature or elevation) with distance.
greenhouse gases	Carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulfur hexafluoride.
ground vibration	Vibration transmitted through the ground following blasting.
groundwater	All waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.
habitat	The particular local environment occupied by an organism.
hydrology	The study of water, particularly its movement in streams, rivers, or underground.
infrastructure	The supporting installations and services that supply the needs of a project.
introduced	Introduced to a particular environment; exotic.
invertebrates	Commonly, animals without a backbone (jellyfish, worms, molluscs, etc.).
irrigation	The artificial flooding of agricultural land to promote cultivation.
landform	A specific feature of a landscape (such as a hill) or the general shape of the land.
load	The amount of a substance discharged into a body of water (e.g., salt or sediment); usually expressed as mass over a specified time (e.g., tonnes per year).
MBGL	Meters Below Ground Level
model	A mathematical simulation of a natural system (such as the variation of particulate levels within a lake) used to predict how the system will change with time, particularly where external changes have been imposed upon it (such as from mining operations).
monitoring	Systematic sampling and, if appropriate, sample analysis to record changes over time caused by impacts such as mining.
native	Belonging to, or found naturally, in a particular environment.
natural	Existing in, or formed by, nature (generally excludes anything obviously modified by human beings).
neutral	Neither acidic nor basic (e.g., a pH equal to 7.0).
nutrients	Generally refers to nitrogen and phosphorus, which are essential for biological growth.
operations	Mining and ore processing activities.
ORV	Off Road Vehicles.
passive	Performing a function without electrical or mechanical action or movement.
PER	Public environmental review.
pH	Percentage hydrogen; a measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral and 14 is most basic (alkaline).
Prescribed Premise	A premise that falls into the categories prescribed in Schedule 1 of the Environmental Protection Regulations 1987.
project area	the total area covered by the project, including pit, processing plant, stockpiles, haul road, rail siding, port facilities etc.

Term	Definition/Expansion
quadrat	A square measuring area used in ecological studies such as the distribution of plants or animals in an area. Quadrats can vary in size depending largely on the focus of the study.
receptor	A designated place at which an impact may occur (e.g., a dwelling).
recharge	The addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.
rehabilitation	The restoration of a landscape and especially the vegetation following its disturbance.
reptiles	Cold-blooded vertebrates, including lizards, snakes, turtles, and crocodiles.
reserve	The calculated tonnage and grade of ore which can be extracted profitably from a mineral deposit; classified according to the level of confidence that can be placed in the data.
residual impacts	Impacts from an activity (e.g., mining) that remain after mitigation measures.
resource	The calculated amount of material in a mineral deposit, based on exploration drilling information.
richness (of fauna or flora)	A measure of the number of species in a given area or assemblage.
runoff	That portion of precipitation (rain, hail and snow) that flows from a specific area as water.
ore	Siliceous group of particles within the size range 63 microns to 2 millimetres.
silt	Sediment with particles finer than ore and coarser than clay, i.e., 2 to 63 microns.
species	A taxonomic grouping of organisms that is able to interbreed with each other but not with members of other species.
stockpile	A pile used to store material (such as low-grade ore) for future use.
stockpiled	Stored in a stockpile.
stripping	Removal of vegetation and topsoil.
surface water	Water flowing over, or contained on, a landscape (e.g., runoff, streams, lakes, etc.).
taxa	Plural of taxon.
taxon	A group or category, at any level, in a system for classifying plants or animals. Animal or plant group having natural relations.
TEC	Threatened Ecological Community.
topography	Physical relief and contour of a region.
topsoil	Upper layer of soil, usually containing more organic material and nutrients than the subsoil beneath it.
TPS	Town Planning Scheme
variable	Not constant, subject to change.
vibration	Oscillating movement.
WAPC	Western Australian Planning Commission
WAWC Act	WA Wildlife Conservation Act, 1950
water balance	The sum of the inputs and outputs and changes in storage levels of water in a given locality.
water quality	Degree of the lack of contamination of water.
watertable	The surface of the groundwater, below which soil and rock are saturated.
watercourse	Stream or river, running water.
weed	Any plant (in particular an herbaceous one) that survives in an area where it is harmful or troublesome to the desired land use.
wetland	A low-lying area regularly inundated or permanently covered by shallow water.