Appendix A

Geophysical Investigation

GBGMAPS

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GEOPHYSICAL INVESTIGATION FOR HYDROLOGICAL STUDY, LOTS 209 AND 536, NAMBEELUP, WESTERN AUSTRALIA.

Date: 12 December 2017
Report No.: 70416
Revision: 0
Author: Baqir Al asadi
Review: Andrew Spyrou

Distribution

Bioscience Pty Ltd

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DISTRIBUTION

Revision	Date	Electronic	Paper	Issued to
0	12/12/2017	1	0	Dr Peter Keating, Bioscience

1. INTRODUCTION

At the request of the Bioscience Pty Ltd (Bioscience), GBGMAPS Pty Ltd (GBGMAPS) carried out a geophysical subsurface investigation at Lot 209 and Lot 536 Nambeelup WA within the Peel Harvey Catchment in November 2017.

During the investigation Electrical Resistivity Imaging (ERI) and Ground penetrating Radar (GPR) datasets were acquired, processed and interpreted to generate models of the top 30m of subsurface material in order to assist in a broader scope hydrological study for a proposed irrigation program at the site. In particular the objective of the geophysical testing was to image potential groundwater bearing geological units and confining layers in order to gain an understanding of how groundwater flows through the site.

2. INVESTIGATION SITE

The study area was located within adjacent Lots including Lot 209 (87.403 ha in area) to the east and Lot 536 (51.912 ha in area) to the west. The extents of the study area are shown in Figure 1 below.

The study area was situated within flat open grassed paddocks with occasional trees. The surface soil consisted predominately of sand of the Bassendean System. An aerial image showing the typical landform at the study area is shown in drawing 70416-01 in Appendix B.

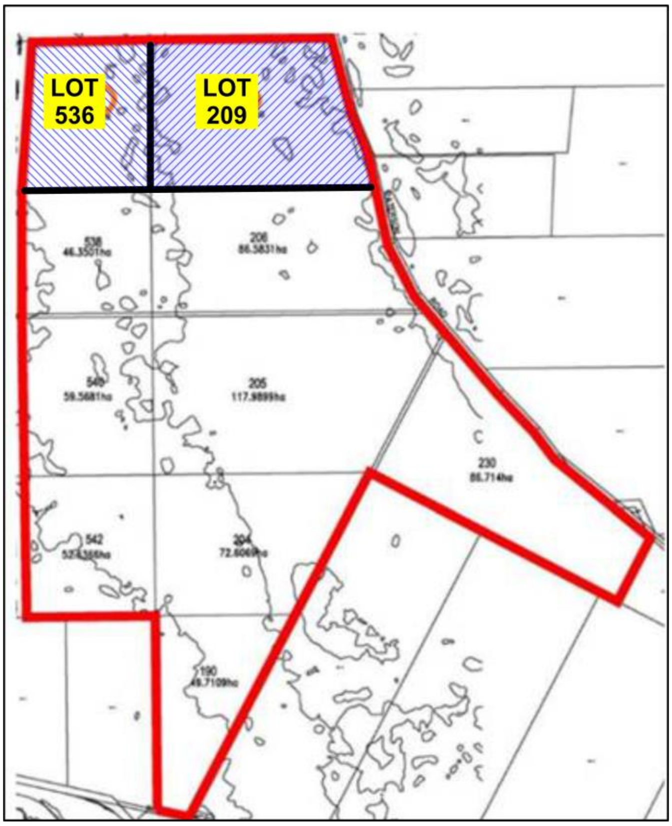

Figure 1: Extent of the geophysical study area including Lots 209 and 536 at Nambeelup WA. Image from Bioscience.

3. SITE GEOLOGY

Review of the existing local and regional geological data indicates some discrepancies between what is believed to be the dominant surface geology in the area but in general the near surface geology is believed to be made up of a sandy layer likely to be the Bassendean Sand. Figure 2 below presents the soil landscape map for the Peel-Harvey Coastal Catchment.

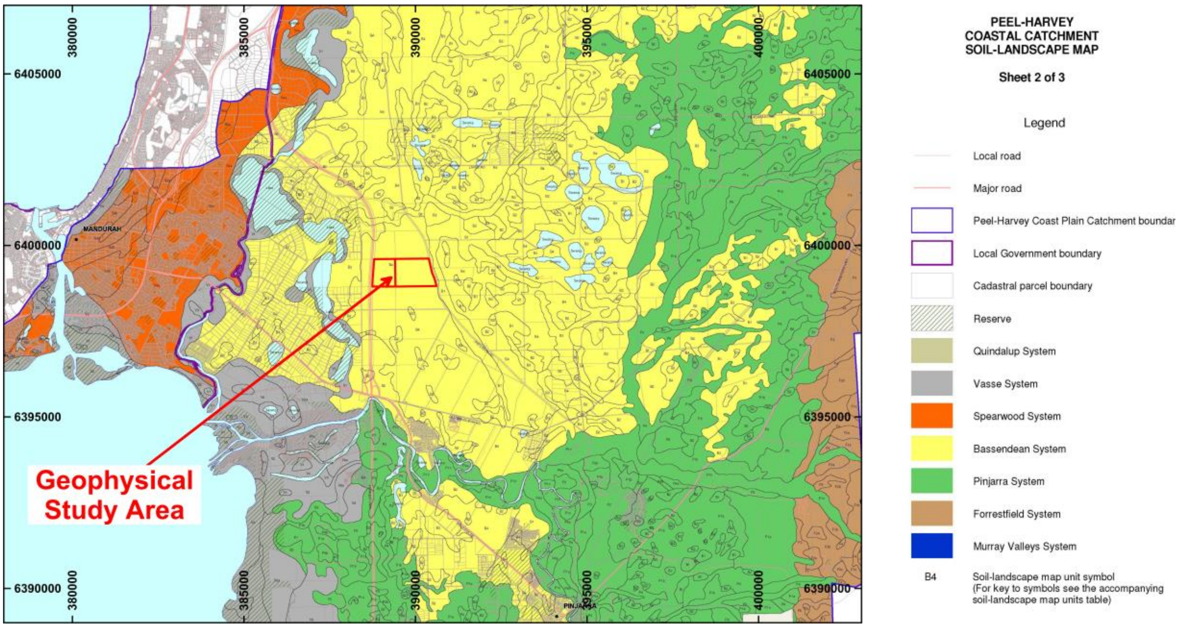

Figure 2: Soil-landscape map showing the dominant surface geology of the Peel-Harvey Coastal Catchment (extract from Peel-Harvey Coastal Soil Landscape Sheet 2, DAFWA soil-landscape mapping database, June 2015).

The Bassendean Sand is unconformably underlain by clay of the Guildford Formation at depths generally greater than 1.5m or less frequently by a strong iron-organic hardpan which is likely impervious to water (Department of Agriculture and Food, 2015). Kelsey et.al (2011) states that occasionally the Guildford Clay unit can be present near the water table as a coffee-brown ferruginised limonitic (iron rich) layer. The strong iron-organic hardpan and the coffee-brown ferruginised limonitc layer are likely to be related. A schematic geological cross-section showing the major stratigraphy from the coast to Darling Scarp is shown in Figure 3 overleaf.

Based on information supplied by the client and from stock watering dams penetrating into the superficial aquifer within the site, it is believed that the local geology within the study area consists of clay, lateritic gravels and ferruginous induration (coffee rock). Also, the superficial aquifer is believed to be very shallow if not at the surface and is believed to continue to a larger depth compared to previously surveyed areas to the east of the site.

With consideration to the known / assumed geology and formation thicknesses the geophysical investigation was designed in order to image the main geological units within the top 30m of subsurface material. The expected electrical geophysical contrast between the units mentioned is believed to be adequate in providing an interpretable subsurface section.

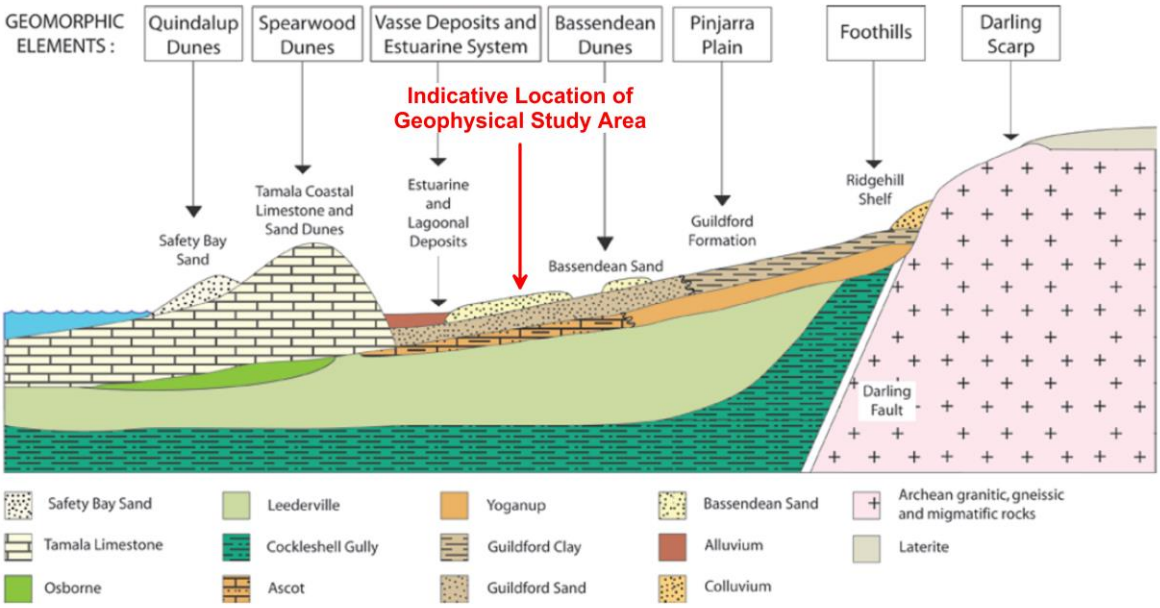

Figure 3: East-west stratigraphic succession around Mandurah/Pinjarra (Figure 2.4, Hydrological and nutrient modelling of the Peel-Harvey Catchment, Government of Western Australia Department of Water).

4. GEOPHYSICAL METHODS

In order to obtain reliable subsurface data the geophysical method/s employed must produce adequate imaging contrasts that reflect the different subsurface lithological units present. Based on the local near surface geology of the site and the required objectives of the investigations the following geophysical methods were used:

- Electrical Resistivity Imaging (ERI) – to obtain electrical resistivity models related to variations subsurface material type and conditions
- Ground Penetrating Radar (GPR) – to obtain subsurface reflection imagery of the near surface related to subsurface material interfaces.

Refer to Appendix A for details on the geophysical methods used during the investigation.

5. DATA COLLECTION METHODOLOGY

The site work for the investigation was carried out by GBGMAPS on the 24th and 27th November 2017. During the investigation 1 geophysical transect was acquired utilising ERI and GPR, 1716m in length and extending west to east over the site. The extent of the geophysical profile is shown in drawing 70416-01 in Appendix B.

5.1 Electrical Resistivity Imaging

ERI data was acquired using a ZZ Resistivity Imaging FlashRES-Universal which utilises a 61 channel, free configuration system allowing for multiple resistance measurements to be made with a single current injection. ERI data was acquired along the transect by planting 64 electrodes at 4m intervals into the ground surface resulting in an single ERI spread of 252m. The electrodes were connected to the ERI acquisition unit via two multicore cables. Readings were then made using a pre-programmed control sequence with 61 resistivity measurements recorded for multiple pairs of current electrodes.

ERI acquisition parameters are provided in Table 1. A photograph of ERI data acquisition is shown in Figure 4.

Table 1: ERI Acquisition Parameters

Electrode spacing	**4m**
Spread length	**252m**
Investigation depth	**30m**
Spread overlap	**1/4**
Injection voltage	**120V**
Maximum current	**2A**
Array type	**Wenner, ZZ custom**

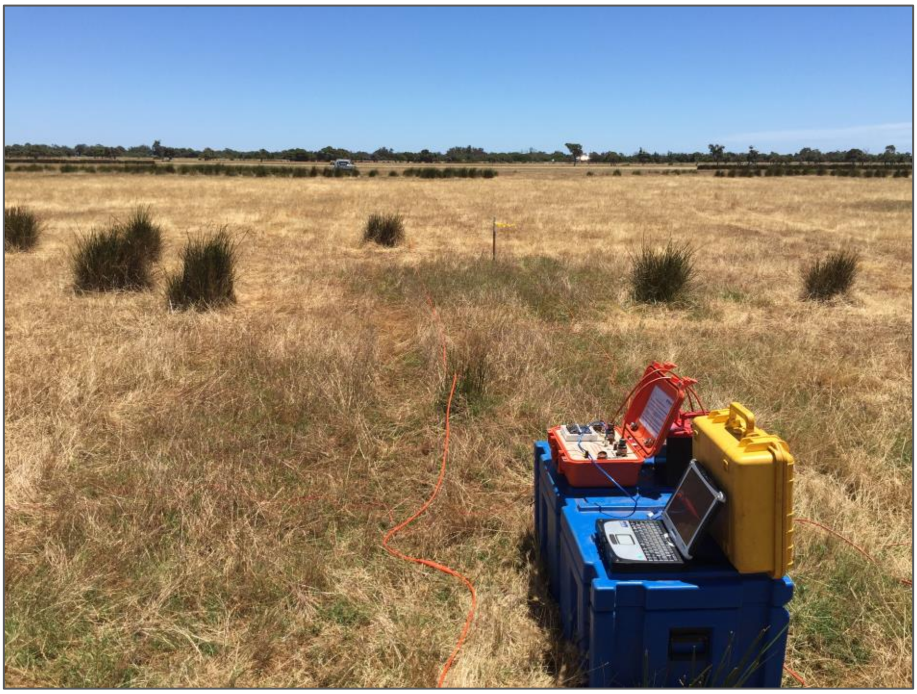

Figure 4: ERI data acquisition.

5.2 Ground Penetrating Radar

GPR data was acquired using a GSSI Sir3000 data collection system utilising a 120MHz centre frequency ground coupled antenna. GPR data was acquired along the required transect by towing the cart based system behind a vehicle. Distance along the transect were logged by a calibrated odometer attached to the system.

GPR acquisition parameters are provided in Table 2. A photograph of GPR data acquisition is shown in Figure 5.

Table 2: GPR Acquisition Parameters

Antenna centre frequency	**120MHz**
Two way travel time	**160ns**
Uncalibrated imaging depth	**10m**
Radar wave velocity	**0.12m/ns**
Scans per metre	**50**
Sample number	**512**
Sample rate	**16 bit**

Figure 5: GPR data acquisition.

6. DATA PROCESSING

6.1 Electrical Resistivity Imaging

The acquired ERI data was processed and inverted using ResINV v4.4 (ZZ Resistivity Imaging, 2017). The electrical resistivity inversion procedure included:

- Checking data quality (Q value) of field data, filtering spurious values where required and exporting to the ZZ inversion file format.
- Viewing resistivity pseudosections of apparent resistivity used as an initial guide for further quantitative interpretation.
- Running the resistivity pseudosections through an inversion algorithm with various parameters such as damping factors and filters being applied. The inversion program was run for up to 20 iterations until an adequate convergence occurred.

The inverted resistivity sections were compiled and gridded in Surfer v13 (Golden Software, 2016) to produce a 2D cross-section show the variation in the modelled electrical resistivity in Ohm metres along the transect and with depth below ground level.

6.2 Ground Penetrating Radar

The acquired GPR data was processed and analysed using ReflexW v7.16 (Sandmeier Software, 2016). Processing steps included gain functions, 1D bandpass filtering, 2D background removal and running average filters, and kirchoff migration.

Analysis of the processed GPR data consisted of viewing the processed radar-grams sequentially with consideration to the target depth using a radar-wave velocity of 0.12m/ns, signal amplitude, continuity and phase. Identified reflection interfaces were digitised and interpreted for subsurface stratigraphic boundaries.

7. RESULTS AND INTERPRETATION

The results of the ERI investigation carried out at Lots 209 and 536 Nambeelup Western Australia are presented in Appendix B of this report as follows:

- **70416-01** – Survey map showing extent of the acquired geophysical profile overlaid onto Landgate aerial imagery.
- **70416-02** – GPR radar-gram, modelled electrical resistivity section and interpretation from chainage 0m to 600m.
- **70416-03** – GPR radar-gram, modelled electrical resistivity section and interpretation from chainage 600m to 1200m.

- **70416-04** – GPR radar-gram, modelled electrical resistivity section and interpretation from chainage 1200m to 1716m.

The geo-electrical section generated from the processed ERI data is presented in the results drawings. These show the variation in the modelled electrical resistivity of the subsurface in Ohm metres (Ωm) as per the colour scale. The modelled resistivity values ranged from 0.001 to 190Ωm. In general this represents a low resistivity range with the overall subsurface geology for the top 30m being electrically conductive, suggesting an overall clayey subsurface material.

The geo-electrical section has been analysed for variations in electrical resistivity with consideration to the expected local geological formations. Note that the classification of the resistivity intensities is relative only and as mentioned previously the resistivity values were found to be generally low for this site. Five classes have been identified representing different subsurface conditions as follows:

Unit 1 – High Electrical Resistivity

Shown in red dot hatch, this unit is typically present from the surface to a depth of less than 3mBGL. The GPR data was used to delineate the lower boundary of this layer with high accuracy as shown in the interpreted GPR section. The unit has been interpreted to be the Bassendean Sand being a highly permeable, dry sand that occurs non-continuously across site.

Unit 2a – High Electrical Conductivity

This unit is shown in blue cross hatched pattern and occupies most of the subsurface extending from the surface in some areas to 30mBGL. Being a very electrically contrasting layer compared to the overlying Bassendean Sand and existing at shallow depths, the top boundary of this unit was imaged using the GPR data across the profile. With reference to a number of geological studies carried out within the area it has been inferred that this unit is likely to be a part of the Guildford Formation. The high conductivity of the layer suggests that it is mainly composed of silty, slightly sandy clay.

Unit 2b – Moderate Electrical Conductivity

This unit is shown in green dot hatch and was found to occur intermediately along the profile at shallow depths. It is interpreted to be a poorly sorted, fine to coarse grained quartz gravelly sand and is believed to be a part of the Guildford Formation.

Unit 2c – Moderate to High Electrical Resistivity

Shown in orange diagonal hatch, this unit occurs as moderate to high resistivity lenses at intermediate depths across the transect. It is inferred to be a hard to moderately hard ferruginised limonitic cemented sand also known as Coffee Rock. This coffee rock is known to exist near the watertable and is also believed to be a part of the Guildford Formation.

Unit 2d – Electrically Moderate to High Resistivity

This unit is shown in magenta diagonal hatch and occurs at depths across the transect. The high resistivity suggests that it is low in water content contrary to the clay occurring above. It has been inferred to be a strong iron-organic hardpan layer that is impermeable to water. This layer is believed to be the major confining layer preventing water flow.

8. CONCLUSIONS

A geophysical subsurface investigation was carried out by GBGMAPS within Lots 209 and 536 Nambeelup within the Peel Harvey Catchment in November 2017. During the investigation an Electrical Resistivity Imaging (ERI) dataset was acquired, processed and interpreted in order to generate subsurface geo-electrical sections. In addition to ERI, a Ground Penetrating Radar (GPR) dataset was acquired to obtain high resolution imagery of the near surface. As anticipated, the GPR signal failed to image layers beyond the clay unit due to the known signal attenuation caused by the high water content in the clay. The findings of the investigation will be used by Bioscience to gain a better understanding on the groundwater flow and confining layers within the site.

Interpretation of the geophysical sections generated from the ERI and GPR data and with reference to known local geology indicates that five geological units representing different materials and material conditions exist at depths of less than 30mBGL within the investigation area. These are interpreted to be the Bassendean Sand and different grades of the Guildford Formation. A deep high resistivity layer has been inferred to be a strong iron-organic hardpan layer that has the potential to be an impermeable confining layer potentially preventing groundwater flow.

The techniques used during the investigation are geophysical, and as such the results are based on indirect measurements and the interpretation of electrical signals. Without physical calibration the exact nature of the anomalies and features identified, interpreted and discussed are not definitely known. The findings in this report represent the best professional opinions of the authors, based on experience gained during previous similar investigations and with correlation to known and assumed subsurface ground conditions at the site.

We trust that this report provides you with the information required. If you require clarification on any points arising from this investigation, please do not hesitate to contact the undersigned or Andrew Spyrou on (08) 6436 1599.

For and on behalf of
GBGMAPS PTY LTD

BAQIR AL-ASADI
Geophysicist

APPENDIX A –GEOPHYSICAL METHODS

ELECTRICAL RESISTIVITY IMAGING

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Advanced Subsurface Investigations

APPLICATIONS

- ✓ Landfill investigations
- ✓ Ground water investigations including depth to water table and aquifers
- ✓ Delineation of freshwater / saltwater interface
- ✓ Mapping and monitoring of soil salinity and inorganic contaminant plumes
- ✓ Location of paleochannels, faults / fractured zones
- ✓ Locating voids and mineshafts / cave systems
- ✓ Stratigraphic mapping including gravel and clay lenses
- ✓ Soil corrosion assessment

METHOD

Electrical Resistivity Tomography (ERT) is sensitive to variations in the electrical resistivity of the subsurface measured in Ohm meters (Ωm). The dominant factors affecting the bulk electric resistivity (and its inverse, conductivity) of soil or rock are:

- Porosity and permeability
- Degree of saturation – the fraction of pore space / fractures filled with fluid
- Fluid type including salt content – the composition of the fluid filling the pore spaces / fractures
- Presence of clays with moderate to high cation exchange capacity (CEC)

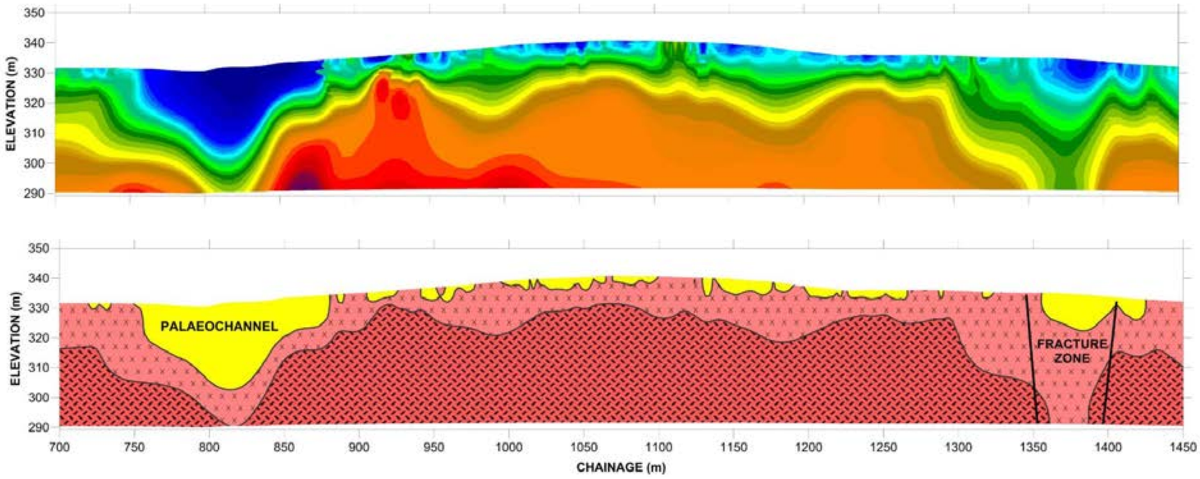
Resistivity measurements are made by inducing an electrical current into the earth through two current electrodes and measuring the resulting voltage difference at two potential electrodes. Knowing the current and voltage values, an apparent resistivity value can be calculated, the investigation depth of which is relative to the spacing between electrodes. Greater depths are achieved by increasing the electrode spacing. A number of different electrode configurations exist, each being suitable under various conditions.

Modern resistivity systems employ multiple electrodes connected to a central control unit via multiple core cables. Once the electrode array is deployed and the sequence program is set in the control unit, readings are automatically taken across a number of electrode positions.

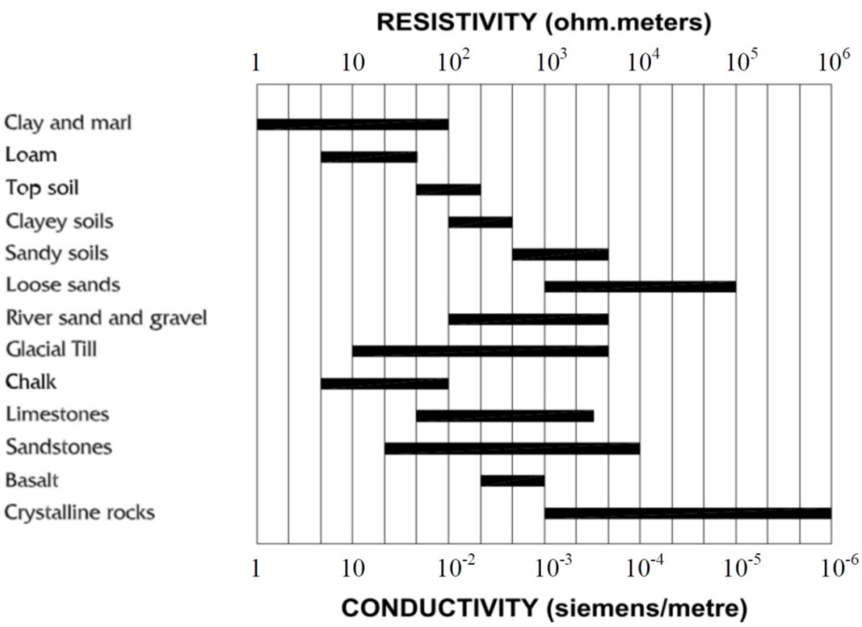
DATA ANALYSIS & PRESENTATION

After collection of a resistivity sequence a pseudo-section is generated showing the apparent resistivity measurements at the various depths along the profile. Quantitative resistivity readings can be calculated by running the pseudo-section through mathematical inversion algorithms resulting in 2D geo-electrical cross-section showing variations in the modelled electrical resistivity of the subsurface. The resistivity section can be interpreted to provide information on subsurface layering, linear and isolated features.

The imaging depth achievable with the ERI method is dependent on the total length of the electrode array, with larger electrode spacings resulting in greater imaging depth. The overall subsurface resistivity also affects the imaging depth with highly resistive ground tending to decrease the depth after inversion.



Electrical Resistivity 2D cross-section (top) with geological interpretation (bottom)



Typical electrical resistivity / conductivity range of common earth materials

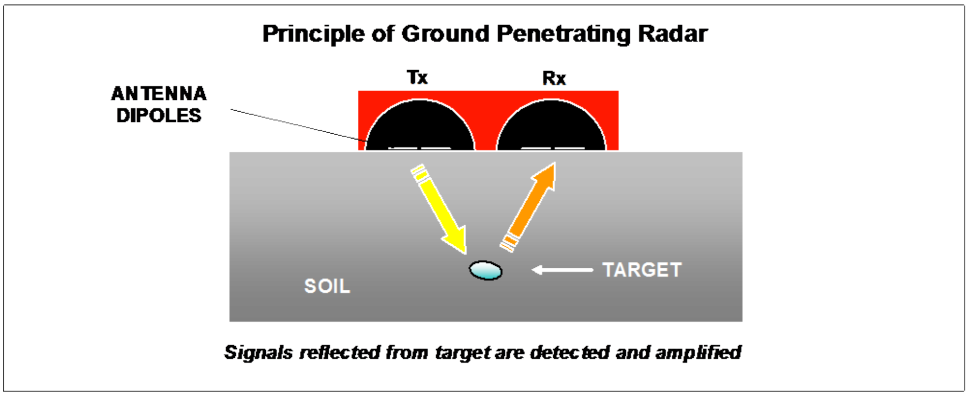
APPLICATIONS

- ✓ Stratigraphic mapping including depth to bedrock
- ✓ Locating karst features, sinkholes, voids or cave systems
- ✓ Depth to water table
- ✓ Archaeology (location of graves and artifacts)
- ✓ Location of underground infrastructure, including UST’s and utilities
- ✓ Assessment of internal condition and defects of engineered structures
- ✓ Assessment of road and rail infrastructure, including asphalt and ballast condition
- ✓ Slab thickness, reinforcement placement and void detection

METHOD

Ground Penetrating Radar (GPR) is a non-destructive and non-invasive geophysical technique for rapidly imaging the shallow subsurface and producing high-resolution colour sections in real time. The method works by transmitting electromagnetic energy into the material being tested (most usual the ground). Typically 100,000 impulses per second are transmitted which are of very short duration and contain a wide spectrum of frequencies.

The transmitted electromagnetic energy propagates through the subsurface as a function of the subsurface material’s electrical properties, which are in turn dependent on its physical and chemical properties. Reflection of radar energy occurs at boundaries between differing stratigraphic layers or inclusions which have contrasting electrical properties. Conversely, no reflections occur from a homogenous material where there are no internal reflectors. The reflections are detected by the receiving antenna placed adjacent to the transmitter. The depth to the target is proportional to the time (in nanoseconds) taken for the signal to travel from the transmitting antenna at the surface to the target and back to the receiver.

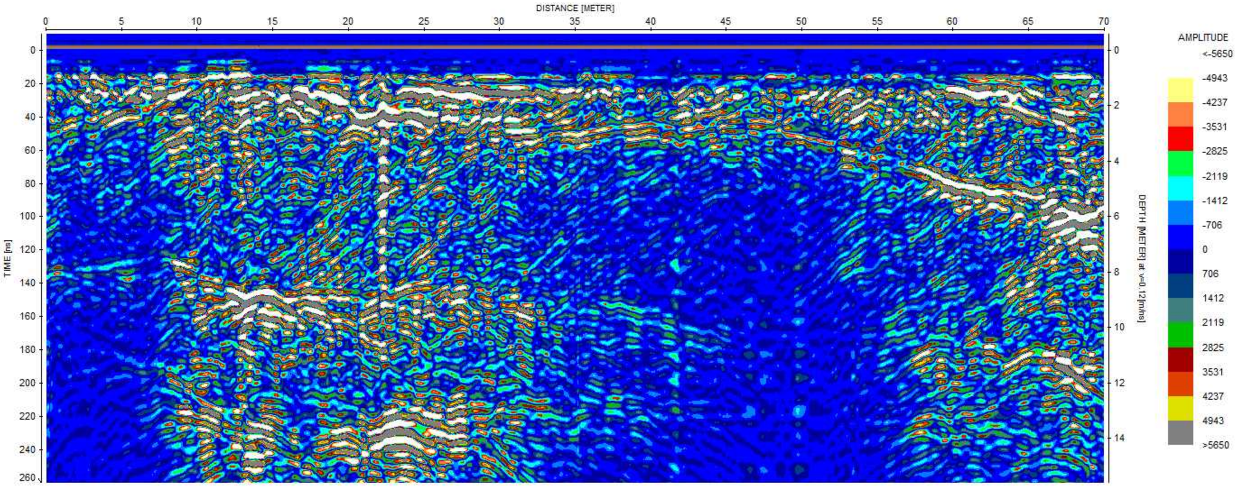


Schematic illustration of the principle behind ground penetrating radar

DATA ANALYSIS & PRESENTATION

A radar-gram profile is built up of continuous scans along a selected line path, see below. These are 2D cross-sections of the subsurface showing variations in reflection amplitude as a colour scale. The recorded reflections can be analysed in terms of shape, phase, travel time and signal amplitude to provide information about a target's size, depth and orientation in relation to the material around it.

The depth of investigation achievable with the GPR method is largely a function of the antenna frequency used. Lower frequencies in the order of 100 MHz are typically used for geological mapping to a maximum depth of approximately 20 m, whilst high frequencies in the order of 1 GHz are used for high resolution investigations of structures including building, bridges and tunnels.



Processed GPR cross-section imaging a karst formation illustrated by the variations in the radar-wave reflection amplitudes. This enables the detailed analysis of voids or caves within limestone bedrock.

APPENDIX B –RESULTS DRAWINGS

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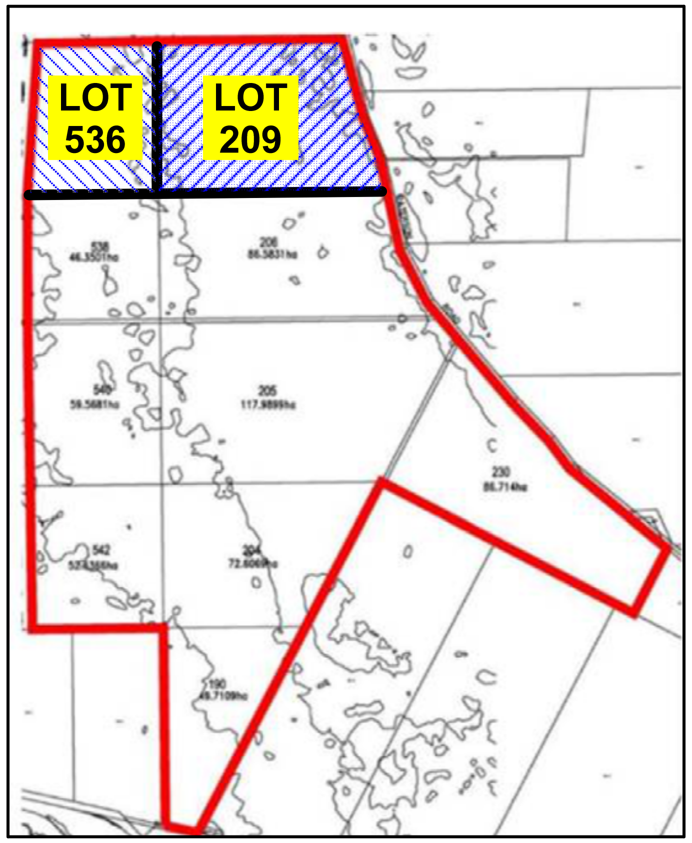
GEOPHYSICAL INVESTIGATION FOR HYDROLOGICAL STUDY - LOTS 536 & 209 NAMBEELUP WESTERN AUSTRALIA

ACQUIRED GEOPHYSICAL TRANSECTS



LEGEND

Acquired Geophysical Transect Electrical Resistivity Imaging and Ground Penetrating Radar (GBGMAPS November 2017)

Lot boundaries

NOTES
Drawing to be used in conjunction with Report 70416.
Map Projection GDA 94, MGA Zone 50
Aerial image from Landgate April 2017.

0 100 200 300 400 500
Metres

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		Drawing	70416-01	Revision	0

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GEOPHYSICAL INVESTIGATION FOR HYDROLOGICAL STUDY - LOTS 536 & 209 NAMBEELUP WESTERN AUSTRALIA

INTERPRETED GEOPHYSICAL SECTIONS 0-600m

Figure 1: Ground Penetrating Radar Interpreted Section

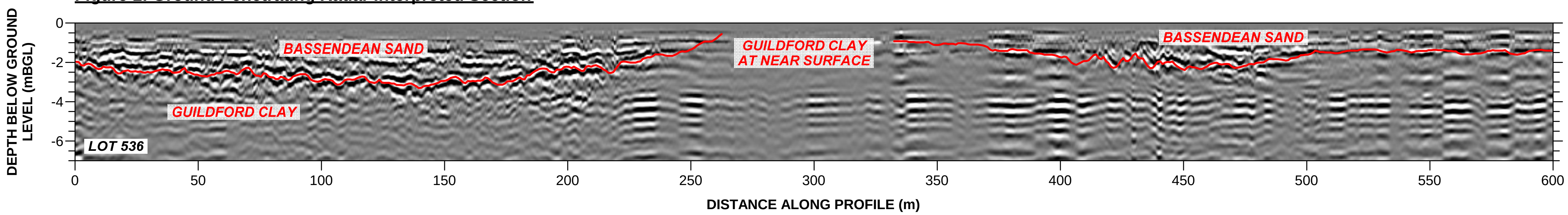


Figure 2: Electrical Resistivity Section

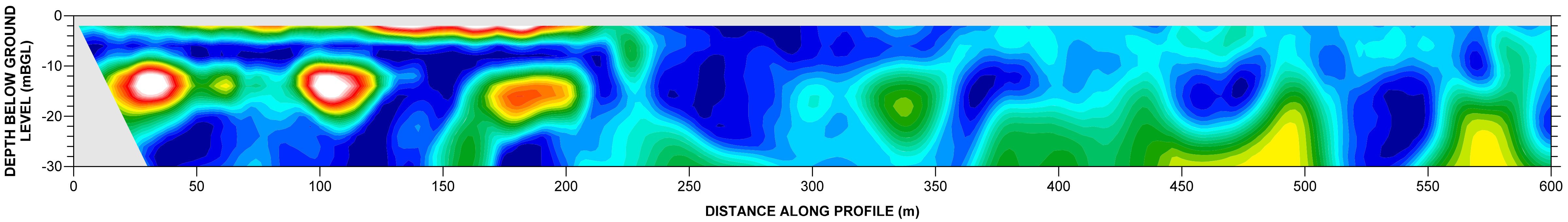
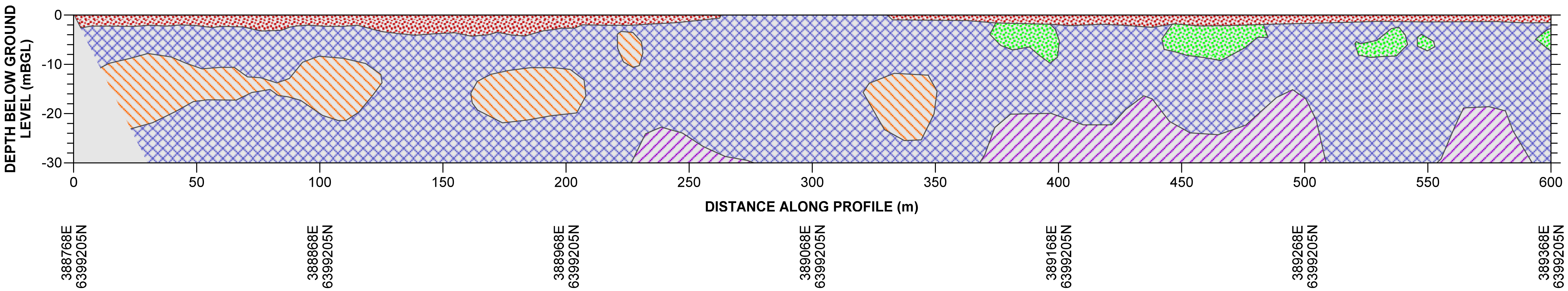


Figure 3: Interpreted Section



Geological Interpretation*

Bassendean Sand →

Unit 1 - Electrically highly resistive: Inferred Bassendean Sand. Highly permeable, dry SAND, near surface (<3mBGL) non-continuous.

Guildford Formation

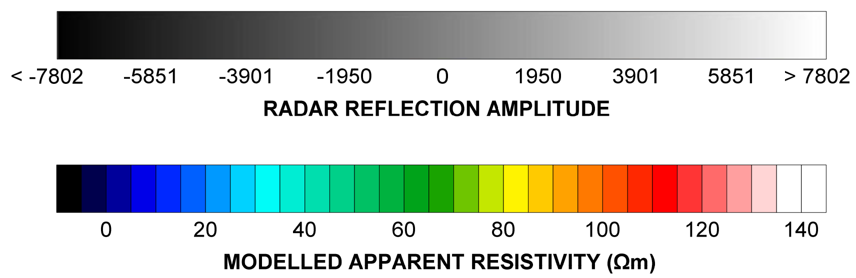
Unit 2a - Electrically very conductive: Inferred Guildford Clay. Silty, slighty sandy CLAY.

Unit 2b - Electrically moderate conductivity: Inferred Gravelly Sand. Poorly sorted, fine to coarse grained quartz gravelly sand

Unit 2c - Electrically moderate to high resistivity: Inferred Coffee Rock. Hard to moderately hard ferruginised limonitic cemented sand occuring as lenses

Unit 2d - Electrically moderately to high resistivity: Inferred iron-organic Hardpan. Strong layer impermeable to water

* refer to report 70416 for details



NOTES
Drawing to be used in conjunction with Report 70416.
Spatial coordinates GDA 94, MGA Zone 50

0 25 50 75 100
All distances are shown in metres
For true to scale reproduction of this drawing, plot to A3 with the Page Scaling set to none.

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		Drawing	70416-02	Revision	0

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GEOPHYSICAL INVESTIGATION FOR HYDROLOGICAL STUDY - LOTS 536 & 209 NAMBEELUP WESTERN AUSTRALIA

INTERPRETED GEOPHYSICAL SECTIONS 600-1200m

Figure 1: Ground Penetrating Radar Interpreted Section

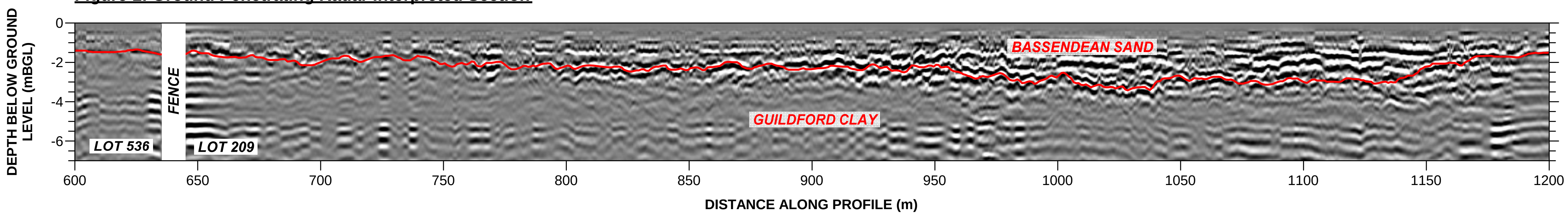


Figure 2: Electrical Resistivity Section

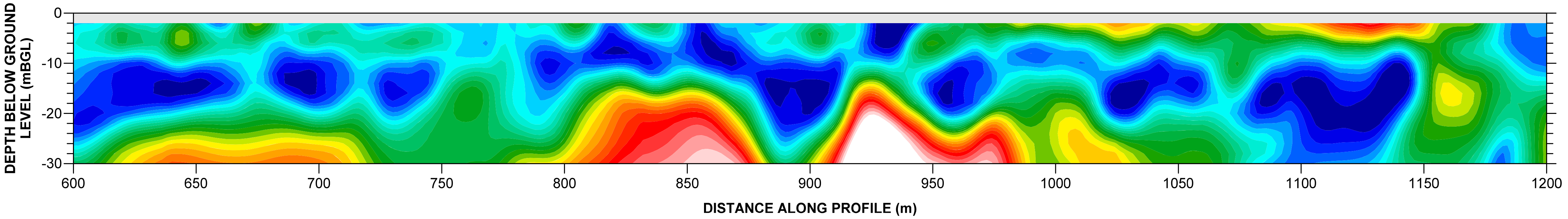
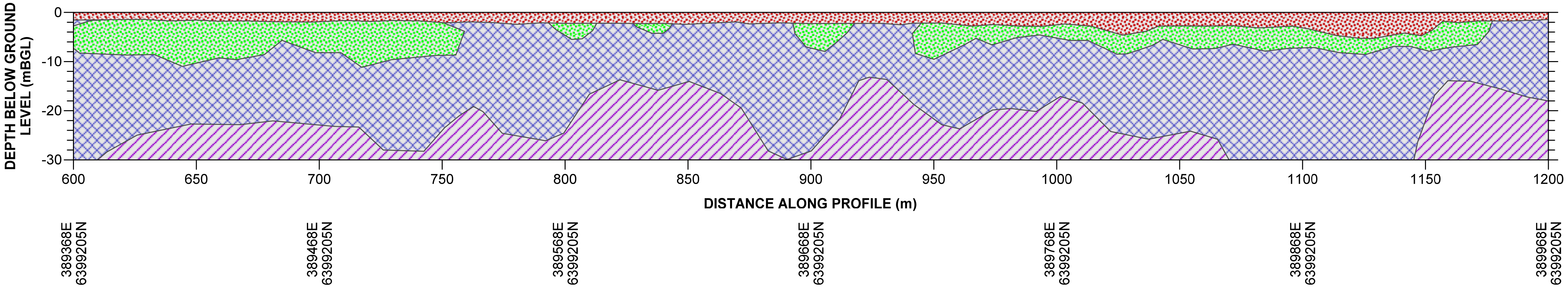


Figure 3: Interpreted Section



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Unit 1 - Electrically highly resistive: Inferred Bassendean Sand.
Highly permeable, dry SAND, near surface (<3mBGL)
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Guildford Formation

Unit 2a - Electrically very conductive: Inferred Guildford Clay.
Silty, slighty sandy CLAY.

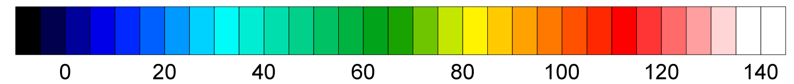
Unit 2b - Electrically moderate conductivity: Inferred Gravelly Sand.
Poorly sorted, fine to coarse grained quartz gravelly sand

Unit 2c - Electrically moderate to high resistivity: Inferred Coffee Rock.
Hard to moderately hard ferruginised limonitic cemented sand occuring as lenses

Unit 2d - Electrically moderately to high resistivity: Inferred iron-organic Hardpan.
Strong layer impermeable to water

* refer to report 70416 for details

RADAR REFLECTION AMPLITUDE



MODELLED APPARENT RESISTIVITY (Ωm)

NOTES
Drawing to be used in conjunction with Report 70416.
Spatial coordinates GDA 94, MGA Zone 50

0 25 50 75 100
All distances are shown in metres
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	Drawing: 70416-03	Revision: 0	

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GEOPHYSICAL INVESTIGATION FOR HYDROLOGICAL STUDY - LOTS 536 & 209 NAMBEELUP WESTERN AUSTRALIA

INTERPRETED GEOPHYSICAL SECTIONS 1200-1716m

Figure 1: Ground Penetrating Radar Interpreted Section

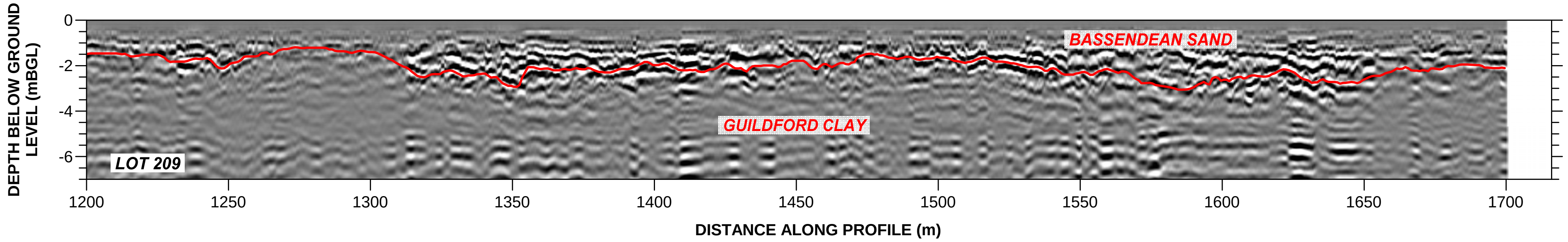


Figure 2: Electrical Resistivity Section

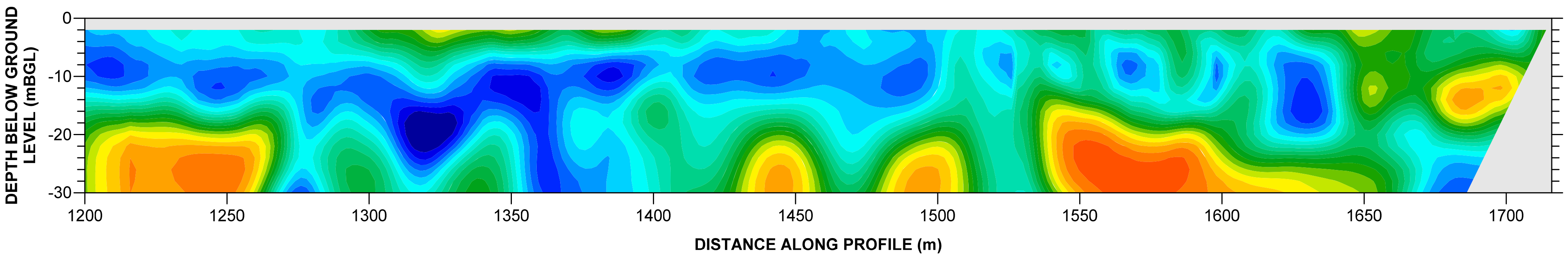
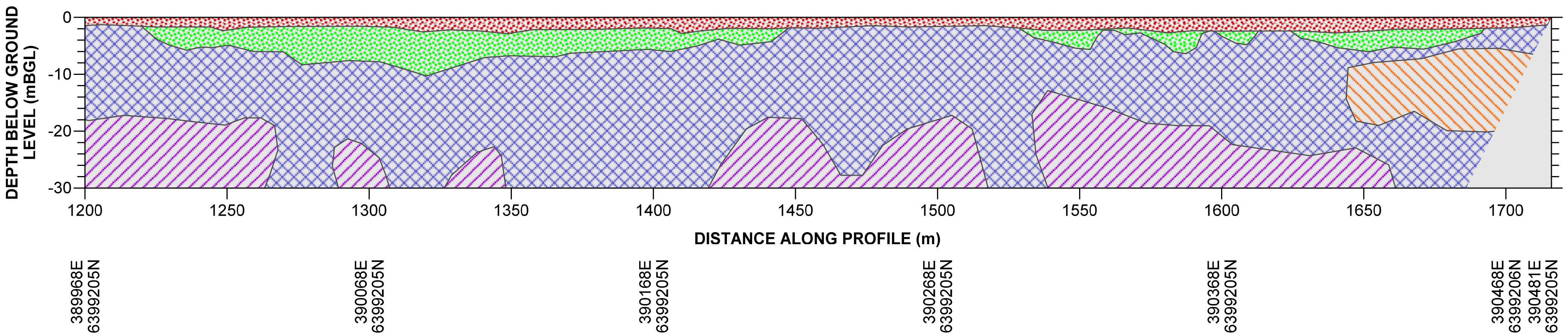


Figure 3: Interpreted Section



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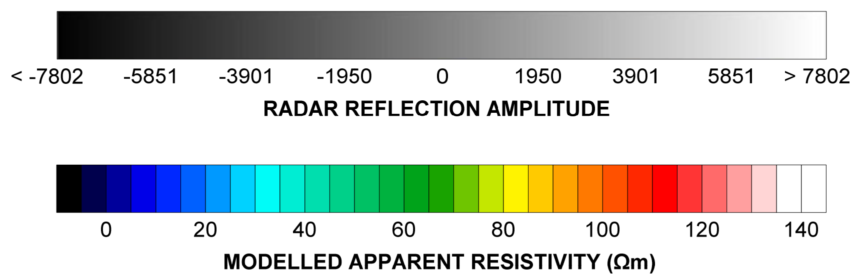
Unit 2b - Electrically moderate conductivity: Inferred Gravelly Sand. Poorly sorted, fine to coarse grained quartz gravelly sand

Unit 2c - Electrically moderate to high resistivity: Inferred Coffee Rock. Hard to moderately hard ferruginised limonitic cemented sand occuring as lenses

Unit 2d - Electrically moderately to high resistivity: Inferred iron-organic Hardpan. Strong layer impermeable to water

* refer to report 70416 for details



NOTES
Drawing to be used in conjunction with Report 70416.
Spatial coordinates GDA 94, MGA Zone 50

0 25 50 75 100
All distances are shown in metres
For true to scale reproduction of this drawing, plot to A3 with the Page Scaling set to none.

CLIENT	BIOSCIENCE Pty Ltd		
Date	5 December 2017	Paper Size	A3
Scale	Horizontal 1:2,000 Vertical as shown	Drawn	AHWS
Drawing	70416-04	Revision	0

GEOPHYSICAL INVESTIGATION FOR HYDROLOGICAL STUDY
LOTS 536 & 209 NAMBEELUP WESTERN AUSTRALIA

GBGMAPS
Advanced Subsurface Investigations
Level 1, 2 Sabre Crescent, Jandakot WA 6164
PO Box 3526, Success WA 6964
Telephone: (08) 6436 1599
Email: info@gbgmaps.com.au

Appendix B

Soil Analysis

BIOSCIENCE PTY LTD ABN: 26 547 517 746
488 NICHOLSON ROAD, FORRESTDALE WA 6112
PO BOX 5466 CANNING VALE SOUTH WA 6155
PHONE (08) 9397 2446, FAX (08) 9397 2447
EMAIL bioscience@biosciencewa.com
WEB www.biosciencewa.com

ANALYTICAL REPORT

CLIENT:	Shane Kelliher	REPORT NO:	8679_2018
TEST REQUEST:	Standard soil fertility plus trace elements x 5	LAB SAMPLE ID:	8679-8683
DATE RECEIVED:	15/01/2018	DATE TESTED:	15/01/2018 - 24/01/2018
SAMPLING LOCATION:	Nambeelup Topsoil	DATE REPORTED:	29/01/2018

SOIL TEST RESULTS

Analyte	8679	8680	8681	8682	8683	Unit	Method / Standard
Electrical Conductivity	0.294	0.082	0.125	0.099	0.197	mS/cm	EC Sensor
pH - $CaCl_2$	4.31	3.94	3.68	3.62	4.79	-	IJ pH Sensor
pH - H_2O	5.39	5.24	4.71	4.84	6.18	-	IJ pH Sensor
Ammonium-N	12.6	8.82	18.8	14.1	10.6	mg/kg	Colorimetric Assay
Nitrate-N	0.90	1.08	14.5	17.5	2.50	mg/kg	Colorimetric Assay
Phosphate-P	10.3	7.35	7.02	6.36	4.06	mg/kg	Colorimetric Assay
Exchangeable Calcium	434	392	734	667	300	mg/kg	NH_4Cl Extraction, Flame AAS
Exchangeable Magnesium	283	149	137	141	118	mg/kg	NH_4Cl Extraction, Flame AAS
Exchangeable Sodium	311	<10	34.6	49.0	121	mg/kg	NH_4Cl Extraction, Flame AAS
Exchangeable Potassium	19.2	29.2	10.6	23.2	14.2	mg/kg	NH_4Cl Extraction, Flame AAS
Extractable Iron	106	47.1	44.9	35.9	58.3	mg/kg	DTPA Extraction, Flame AAS
Extractable Manganese	7.08	7.89	15.6	10.1	3.10	mg/kg	DTPA Extraction, Flame AAS
Extractable Copper	1.12	0.83	0.28	0.03	0.51	mg/kg	DTPA Extraction, Flame AAS
Extractable Zinc	1.59	1.82	2.34	1.30	2.00	mg/kg	DTPA Extraction, Flame AAS
Carbon	3.311	3.735	4.429	3.418	2.023	%	Induction Furnace
Sulphur	0.186	0.172	0.196	0.142	0.101	%	Induction Furnace
PRI	0.28	-0.36	-0.07	-0.07	0.66	ml/g	Colorimetric Assay

Tested by: GM, AS   Date: 25/01/2018

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Appendix C

Water Analysis

Pre and Post Pumping Test

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ANALYTICAL REPORT

CLIENT:	Kelliher Bros	REPORT NO:	1
TEST REQUEST:	H2 Hydrogeological Report	LAB SAMPLE ID:	8742
ADDRESS:	Paterson Road	DATE RECEIVED:	26/01/2018
CLIENT SAMPLE ID:	Kelliher Bros	DATE TESTED:	23/02/2018
SAMPLING LOCATION:	Nambeelup	DATE REPORTED:	26/02/2018

TEST RESULTS

Analytes	Results	Unit	Method / Standard	Potability Standard
Electrical Conductivity (EC)	2.282	mS/cm	EC Sensor	
pH	6.02	-	IJ pH Sensor	6.5 - 8.5 (2a)
Total Dissolved Salts*	1332	mg/L	Calculated	≤500 (2a), ≤1500 (1)
Ammonium-N	0.40	mg/L	Colorimetric Assay	≤0.4 (2a)
Nitrate-N	0.06	mg/L	Colorimetric Assay	≤11 (1,2h)
Phosphate-P	0.049	mg/L	Colorimetric Assay	
Potassium	6.39	mg/L	Flame AAS	
Calcium	10.95	mg/L	Flame AAS	≤200 (1)
Magnesium	36.4	mg/L	Flame AAS	≤150 (1)
Sodium	436	mg/L	Flame AAS	≤180 (2a)
Chloride	538	mg/L	Precipitation	≤250 (2a)
Sulphate	19.8	mg/L	Turbidity Assay	≤250 (2a)
Iron	3.13	mg/L	Flame AAS	≤0.3 (2a)
Manganese	0.10	mg/L	Flame AAS	≤0.1 (2a), ≤0.5 (2h)
Copper	0.01	mg/L	Flame AAS	≤1 (2a), ≤2 (2h)
Zinc	0.14	mg/L	Flame AAS	≤3 (2a)
Total P	0.11	mg/L	Colorimetric Assay	≤0.002 (2h)
Total N	0.46	mg/L	Calculated	

Notes: (1) = World Health Authority; (2) = NHMRC/NRMMC Australian Drinking Water Guidelines 2011, a) aesthetic value, h) health value.
* Estimated from EC
mg/L (milligrams per litre) is equivalent to parts per million (ppm); µg/L (micrograms per litre) is equivalent to parts per billion (ppb).
"<": "less than", "≤": "less than or equal to", AAS: Atomic Absorption Spectrometry

These results reflect our findings of the received sample only.

Tested by:	Genevieve Massam	Date: 23/02/2018
Approved by:	Julia Heide	Date: 26/02/2018

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ANALYTICAL REPORT

CLIENT:	Kelliher Bros	REPORT NO:	2
TEST REQUEST:	H2 Hydrogeological Report	LAB SAMPLE ID:	8750
ADDRESS:	Paterson Road	DATE RECEIVED:	26/01/2018
CLIENT SAMPLE ID:	Kelliher Bros	DATE TESTED:	23/02/2018
SAMPLING LOCATION:	Nambeelup	DATE REPORTED:	26/02/2018

TEST RESULTS

Analytes	Results	Unit	Method / Standard	Potability Standard
Electrical Conductivity (EC)	2.28	mS/cm	EC Sensor	
pH	6.15	-	IJ pH Sensor	6.5 - 8.5 (2a)
Total Dissolved Salts*	1331	mg/L	Calculated	≤500 (2a), ≤1500 (1)
Ammonium-N	0.31	mg/L	Colorimetric Assay	≤0.4 (2a)
Nitrate-N	0.084	mg/L	Colorimetric Assay	≤11 (1,2h)
Phosphate-P	0.061	mg/L	Colorimetric Assay	
Potassium	7.21	mg/L	Flame AAS	
Calcium	11.6	mg/L	Flame AAS	≤200 (1)
Magnesium	35.4	mg/L	Flame AAS	≤150 (1)
Sodium	386	mg/L	Flame AAS	≤180 (2a)
Chloride	525	mg/L	Precipitation	≤250 (2a)
Sulphate	50.8	mg/L	Turbidity Assay	≤250 (2a)
Iron	4.01	mg/L	Flame AAS	≤0.3 (2a)
Manganese	0.10	mg/L	Flame AAS	≤0.1 (2a), ≤0.5 (2h)
Copper	0.01	mg/L	Flame AAS	≤1 (2a), ≤2 (2h)
Zinc	0.08	mg/L	Flame AAS	≤3 (2a)
Total P	0.055	mg/L	Colorimetric Assay	≤0.002 (2h)
Total N	0.39	mg/L	Calculated	

Notes: (1) = World Health Authority; (2) = NHMRC/NRMMC Australian Drinking Water Guidelines 2011, a) aesthetic value, h) health value.
* Estimated from EC
mg/L (milligrams per litre) is equivalent to parts per million (ppm); µg/L (micrograms per litre) is equivalent to parts per billion (ppb).
"<": "less than", "≤": "less than or equal to", AAS: Atomic Absorption Spectrometry

These results reflect our findings of the received sample only.

Tested by:	Genevieve Massam	Date: 23/02/2018
Approved by:	Julia Heide	Date: 26/02/2018