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20th December 2018

Urbis
Lvl 7/123 Albert Street
BRISBANE QLD 4000

Our Reference **AWT51701**

Your Reference S2711 Curl Curl

Site Address

John Fisher Park

Adams Street

CURL CURL

Commission

Geotechnical Investigation

Resistivity Testing

AS2159 Exposure Rating

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1. Construction Proposal

1.1. The proposed development is the construction of a new telecommunications tower and infrastructure hut.

1.2. At the time of writing we had sighted preliminary plans for the proposed development.

1.3. Onsite testing was conducted by Geosense under the supervision of a representative of this company.

2. Site Description

2.1. The site is located on the southern side of Abbott Road to the south of an existing sports field and to the north of a large river.

2.2. At the time of testing the proposed development site was vacant and vegetation consisted of grasses and numerous mature trees that we believe to be within the zone of influence of the proposed development.

2.3. The site is generally flat.

3. About Your Report

3.1. This geotechnical report is generally in accordance with our interpretation of what is required to build the proposed development and where we consider it appropriate, we have relied upon AS 1726-1993 and AS 2870-2011.

3.2. The statements presented in this report, including attached appendices, are intended to advise you of what should be your realistic expectations of this report and to present you with recommendations as to how to minimise risks associated with ground works for this project.

3.3. These appendices and other cautioning sections are not intended to reduce our level of responsibility but rather to ensure that all parties who may rely on this report are aware of their responsibilities each assumes in so doing.

3.4. As geotechnical consultants on this project, our responsibilities are restricted to determining the parameters of the strata encountered (within the limitations of our commission and budget) so that the design engineer can design suitable footings.

3.5. As an additional service, we have offered advice in this report to the design engineer on the most suitable type of footing for this site, but it is possible that the engineer will have his own method of support for this structure.

4. Testing Programme

4.1. One(1) test site was augered with a 4WD mounted drill rig.

NOTE: This test site was not formally surveyed; therefore its location on the attached site sketch should be treated as approximate.

4.2. Numerous disturbed samples were collected and hand classified.

4.3. The stratum within the active zone was determined to consist primarily of unreactive, non-cohesive sand. Therefore further testing to determine the shrink/swell parameters of the strata was deemed unnecessary.

4.4. Three(3) samples were retrieved and returned to the laboratory to be tested for their salinity and conductivity parameters.

4.5. SPT testing was conducted onsite and the results noted in this report.

5. Findings

5.1. The stratum encountered is recorded on the attached Log Section.

5.2. On the relevant 1:100,000 geological maps, this site plots within the Quaternary-aged Alluvials.

5.3. We encountered water seepage at a depth of 4000mm;

5.3.1. To check whether the above was water seepage or a true water table and its fluctuations, a borehole needs to be fitted out as a monitoring well, then monitored over a series of wet/dry cycles, and clearly on projects like this, there is insufficient time to carry out meaningful monitoring.

5.4. We encountered topsoil/filled material down to a depth of 600mm.

5.5. We encountered loose/very loose sand material at the following depths;

TS No.	Depth
1	0-6000mm

5.6. The results of the laboratory analysis of the sample tested for its pH and Conductivity are as follows;

TS No.	Depth (mm)	pH
1	800-1000mm	8.7
1	4000-4200mm	7.0
1	7500-7950mm	6.3

5.7. The following uncorrected N-values were recorded;

TS No.	500mm	1500mm	3000mm	4500mm	6000mm	7500mm	9000mm	10000mm	11500mm
1	6	4	0	4	17	12	8	19	15

NOTE: Our SPT testing was terminated at a depth of 11500mm due to collapsing material below this depth.

6. Conclusions

6.1. Although this development is not under the scope of AS2870-2011, most consultants find it useful to relate a site to AS2870, and in this case the appropriate AS2870-2011 classification for the site is Class "P", for the following reasons;

Reason 1: We encountered strata with an allowable bearing pressure less than the prescribed minimum as outlined in AS2870-2011.

Reason 2: We encountered filled ground deeper then the deemed to comply limits of AS2870-2011 and as we have not viewed any documentation certifying the fill to an appropriate standard (nor do we believe any exists), we have no option but to classify the fill as "uncontrolled".

6.2. Most consultants also find it useful to know the shrink/swell potential of the strata with changes in soil moisture, and from the strata encountered during our testing, we would expect the ys of the site to be in the 20-40mm (Class M) range according to AS2870-2011.

6.3. Due to the significant depths of soft/loose material on this site, we believe a pad footing to be unsuitable for this development. If a pad footing is envisaged, we should be contacted for further advice.

6.4. Proposed Tower – Monopier

The following parameters are available for a bored monopier, at the following depths.

Depth Based on TS No 1	Ultimate End Bearing	Ø	Modulus of Elasticity	Ka	Kp	C_u	Ultimate Horizontal Bearing	Modulus of Subgrade	Dry Density
0-1000mm	N/A	28°	15MN/m^2	0.36	2.77	-	0kPa	-	21kN/m^3
1000-2000mm	N/A	28°	15MN/m^2	0.36	2.77	-	0kPa	0.015N/mm^3	21kN/m^3
2000-3000mm	150kPa	28°	15MN/m^2	0.36	2.77	-	45kPa	0.015N/mm^3	21kN/m^3
3000-4000mm	150kPa	28°	15MN/m^2	0.36	2.77	-	60kPa	0.015N/mm^3	21kN/m^3
4000-5000mm	150kPa	17°	15MN/m^2	0.55	1.83	20kPa	75kPa	0.015N/mm^3	21kN/m^3
5000-6000mm	150kPa	17°	15MN/m^2	0.55	1.83	20kPa	90kPa	0.015N/mm^3	21kN/m^3
6000-7000mm	450kPa	18°	15MN/m^2	0.53	1.89	85kPa	315kPa	0.015N/mm^3	21kN/m^3
7000-8000mm	450kPa	18°	15MN/m^2	0.53	1.89	60kPa	360kPa	0.015N/mm^3	21kN/m^3
8000-9000mm	450kPa	18°	15MN/m^2	0.53	1.89	60kPa	405kPa	0.015N/mm^3	21kN/m^3
9000-10,000mm	450kPa	18°	15MN/m^2	0.53	1.89	95kPa	450kPa	0.015N/mm^3	21kN/m^3
>10,000mm	450kPa	28°	15MN/m^2	0.36	2.77	-	495kPa	0.015N/mm^3	21kN/m^3

NOTE: Due to the significant depth of water charged sandy strata encountered at this site, we believe excavations will be susceptible to wall collapse/blowout and will need to be fully cased/shored. An adhesion value of zero is applicable for the length of any casing. From our experience, drilling a cased bored pier below the water table will cause sands to flow from the outside of the casing, up and through the end of the casing causing loss of compaction/density to the surrounding strata. On such sites with water charged cohesionless soils, we strongly recommend the use of either screw piers or driven piles if a deep footing is preferred and further testing using a CPT capable drilling rig is recommended.

6.5. Equipment Shelter and outdoor cabinets

6.5.1. The following Ultimate Bearing Capacities are applicable for the equipment shelter and outdoor cabinets;

Bored Piers/Strip footings

100kPa: Founded 100mm below adjacent ground level

6.6. According to AS2870 and AS2159 the samples tested for their Acid Sulphate and Salinity properties results in the following Exposure Classification for piles in regards to Acid Sulfate Soils and soil salinity;

Concrete Piles	Steel Piles
Mild	Non-Aggressive

6.7. In section 9 of this report we have included table 4.3.2(A) of AS2159-2009, with an indication on how it relates to this commission.

6.8. We have calculated an Average Risk Rating (ARR) value of 3.5 for the Geotechnical input. The design engineer must now input his/her values for the structural input and combine them with our input for a final ARR value.

6.9. It should also be noted that the Ultimate Values in this report are un-factored Ultimate Values and the relevant provisions of section 4.4.1 of AS2159-2009 need to be followed in order to determine $R_{d,ug}$.

NOTE 1: For limit state analysis, the design geotechnical strength R^*_g is calculated by multiplying the ultimate geotechnical strength $R_{d,ug}$ by the geotechnical strength reduction factor $Ø_g$.

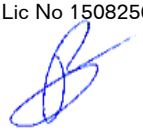
NOTE 2: Based on our experience we recommend adopting a geotechnical strength reduction factor of $Ø_g$ = 0.45-0.50.

NOTE 3: For a working stress analysis, a minimum factor of safety of 3.0 is recommended.

6.10. A full slope stability assessment was not commissioned for this site, however from our onsite testing, we believe this site will be unaffected by slope stability issues. Erosion and fretting from extreme weather events may cause local instability of batters or unretained faces.

NOTE: The above does not ensure that the local authority will not request a slope stability report prior to approval. If requested, we can at such time provide a quotation.

AW Geotechnics Pty Ltd
QBCC Lic No 15082562



Bruce L Hargreaves
Dip.App.Sc (Geology)
QBCC No 616675 (Site Classifier)

7. Report Limitations

7.1. The contents of this report are based on the expertise and experience of the author, representing the company. Our commission didn't extend to assessing instability due to previous existing or proposed sub-surface mining, slope stability or earthquakes, nor did it extend to testing to comply with the relevant Contaminated Land Act.

7.2. The opinions and recommendations made in this report are based on the assumption that the test results are representative of the true site conditions. Even under optimum circumstances, actual conditions may differ from those reported to exist. Economic and time constraints necessarily limit the practical extent of any investigation. We therefore cannot accept responsibility for conditions encountered on this site, outside the areas tested, which are different to those reported. Where the attached soil profiles are similar to each other, then we would expect little variation across the site, so if widely different soils are encountered then a further inspection of the site and/or further testing may be required. If the attached soil profiles are different across the site, then variations will be encountered during footing excavations. In these cases, the design engineer/client must make a decision whether to extend the geotechnical budget to do more testing or to cope with the variations during footing excavations. Regardless of the option chosen the final inspection before placement of concrete is critical and the person certifying this inspection should be competent in identification of strata.

7.3. This report may only be reproduced in full, if any doubt exists to the number of pages in this report we should be contacted. The original copies of this report are signed in blue ink.

8. References

8.1. The following papers, reports or books have been consulted in preparing this report:

- AS 2870-2011 "Residential Slabs & Footings" by Standards Australia
- AS2870-1996 Supplement 1-1996 "Residential Slabs and Footings-Construction-Commentary, (Supplement to AS2870-1996).
- AS 3798-2007 "Guidelines on Earthworks for Commercial and Residential Developments" by Standards Australia.
- Paul Walsh & Don Cameron "The Design of Residential Slabs and Footings" by Standards Australia 1997
- M.F. Atkinson "Structural Foundations Manual for Low-Rise Buildings" 1993
- Monograph 9 "Field Geologists Manual 4th Edition – 2001" compiled by D.A. Berkman for AIMM.
- B.G. Look and S.G. Griffiths "An Engineering Assessment of the Strength and Deformation Properties of Brisbane Rocks". AGS Journal Volume 36, no. 3 September 2001.
- Burt Look "Handbook of Geotechnical Investigation and Design Tables" 2007

We believe these to be the most up to date publications available. Should other publications not listed are brought to our attention, we reserve the right to modify this report if they contain information conflicting with this report.

9. Average Risk Rating (in part)

TABLE 4.3.2(A)

WEIGHTING FACTORS AND INDIVIDUAL RISK RATINGS

FOR RISK FACTORS

Risk Factor	Weighting Factor (w_i)	Typical description of risk circumstances for individual risk rating (IRR)		
		1 (Very low risk)	3 (Moderate)	5 (Very high risk)
Site				
Geological complexity of site	2	Horizontal strata, well-defined soil and rock characteristics	Some variability over site, but without abrupt changes in stratigraphy	Highly variable profile or presence of karstic features or steeply dipping rock levels or faults present on site, or combinations of these
Extent of ground investigation	2	Extensive drilling investigation covering whole site to an adequate depth	Some boreholes extending at least 5 pile diameters below the base of the proposed pile foundation level	Very limited investigation with few shallow boreholes
Amount and quality of geotechnical data	2	Detailed information on strength compressibility of the main strata	CPT probes over full depth of proposed piles or boreholes confirming rock as proposed founding level for piles	Limited amount of simple in-situ testing (e.g. SPT) or index tests only
Method of assessment of geotechnical parameters for design	2	Based on appropriate laboratory or in-situ tests or relevant existing pile load test data	Based on site-specific correlations or on conventional laboratory or in-situ testing	Based on non-site specific correlations with (for example) SPT data

10 Resistivity

Test Method G 57-06

Standard Test method for Field Measurement of Soil Resistivity using the Wenner 4 Electrode Method

10.1. Traverse RD1

Electrode Spacing (m)	Field Reading (ohms (Ω))	Soil Resistivity (ohms-cm or (Ω-cm))
0.5	107	33,615
1	51	32,044
2	19	23,876
4	3	7,540
8	1	5,027
16	N/A	N/A

10.2. Traverse RD2

Electrode Spacing (m)	Field Reading (ohms (Ω))	Soil Resistivity (ohms-cm or (Ω-cm))
0.5	133	41,783
1	68	42,726
2	34	42,726
4	6	15,080
8	1	5,027
16	N/A	N/A

10.3. Traverse RD3

Electrode Spacing (m)	Field Reading (ohms (Ω))	Soil Resistivity (ohms-cm or (Ω-cm))
0.5	145	45,553
1	62	38,956
2	28	35,186
4	5	12,566
8	1	5,027
16	N/A	N/A

(b) *Weathering of rock material*

Table A9 presents a suitable classification system for rock material weathering.

TABLE A9

ROCK MATERIAL WEATHERING CLASSIFICATION

Term	Symbol	Definition
Residual soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported
Extremely weathered rock	XW	Rock is weathered to such an extent that it has 'soil' properties, i.e. it either disintegrates or can be remoulded, in water
Distinctly weathered rock	DW	Rock strength usually changed by weathering. The rock may be highly discoloured, usually be ironstaining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores
Slightly weathered rock	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fresh rock	FR	Rock shows no sign of decomposition or staining

Logs and Site Sketch

GEOSENSE DRILLING & ENGINEERING

BOREHOLE LOG

BH NO. BH1

Project	Proposed Telecommunications Tower	**Sheet**	1 of 2
Location	Abbott Road Fields, Curl Curl NSW	**Date Started**	03/12/2018
Position	Refer to site sketch	**Date Completed**	03/12/2018
Job No.	232	**Logged By** JZ	**Date** 03/12/2018
Client	AW Geotechnics Pty Ltd	**Reviewed By** JZ	**Date** 04/12/2018

Drilling Contactor GeoSense Drilling & Engineering
Drill Rig Hanjin D&B 8D **Inclination** -90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADV	L	▽	0		0.5-0.95m SPT 3,3,3 N=6			SP	Silty SAND; fine to medium grained, dark brown, with low plasticity clay, with fine to medium grained, angular gravel, trace of grass rootlets	D	L	TOPSOIL / FILL
					Acid Sulphate Sample: 0.8-1.0m				0.6m			
			1		1.5-1.95m SPT 1,1,3 N=4			SP	Silty SAND; medium grained, pale-brown	D - M	L	FILL? ALLUVIAL?
					Acid Sulphate Sample: 1.8 - 2.0m				1.75m			
			2					SC	Clayey SAND; fine to medium grained, low plasticity, dark grey, with timber and glass fragments	M - W	VL	
					Acid Sulphate Sample: 2.8-3.0m							
			3		3.0-3.45m SPT 1,0,0 N=0 No sample recovery							
									4.0m			
			4		Acid Sulphate Sample: 4.0 - 4.2m			CL	Sandy CLAY; low plasticity, fine to medium grained, dark grey	>Wp	F	ALLUVIAL
					4.5-4.95m SPT 1,2,2 N=4							
			5		Acid Sulphate Sample: 4.5-4.95m							
			6		6.0-6.45m SPT 7,8,9 N=17						St	
					Acid Sulphate Sample: 6.0-6.45m							
			7		7.5-7.95m SPT 3,7,5 N=12				7.8m			
			8		Acid Sulphate Sample: 7.5-7.95m			CH	Silty CLAY; medium to high plasticity, pale grey, with fine to medium grained sand	>Wp	St	
			9		9.0-9.45m SPT 2,3,5 N=8							
					Acid Sulphate Sample: 9.0-9.45m							
			10									

This borehole log should be read in conjunction with GeoSense's accompanying explanatory notes.

GEOSENSE DRILLING & ENGINEERING

BOREHOLE LOG

BH NO. BH1

Project	Proposed Telecommunications Tower	**Sheet**	2 of 2
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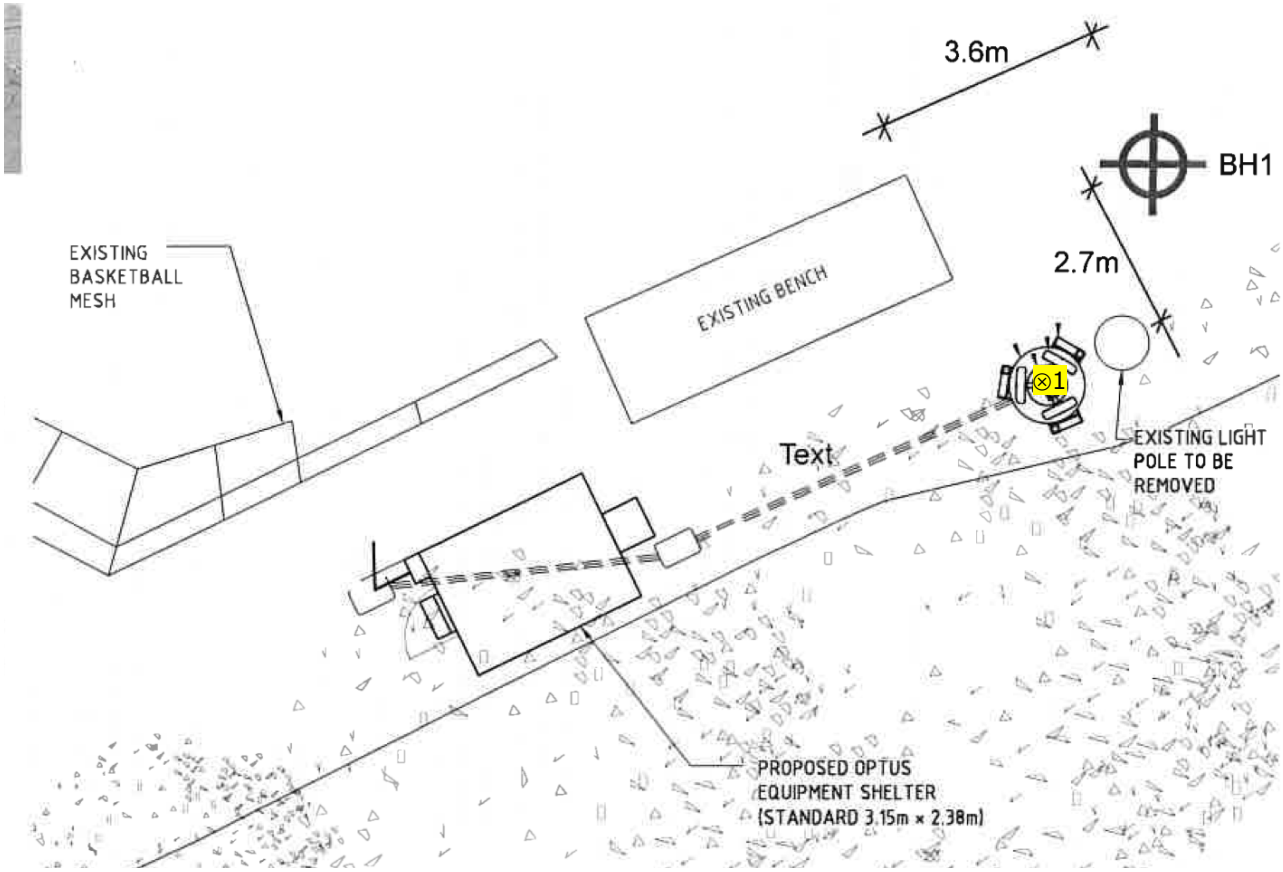
Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	L		10		*10.0-10.45m SPT 5,8,11 N-19* *Acid Sulphate Sample: 10.0-10.45m*			SC	Clayey SAND; fine to medium grained, low plasticity, pale grey	W	MD	ALLUVIAL
			11		*11.5-11.95m SPT 6,7,8 N=15* *Acid Sulphate Sample: 11.5-11.95m*				As above			
			12									
			13		*unable to carry out SPT due to borehole collapse at approx 11.5m*							
			14									
			15									
			16						*End of Borehole at 16.0m*			
			17									
			18									
			19									
			20									

This borehole log should be read in conjunction with GeoSense's accompanying explanatory notes.

Site Sketch (Not to scale)



Lab Results

Concrete piles:

- Samples are considered Soil Condition A
- All have pH > 5.5
- All have Sulfates < 5000ppm
- Exposure Class = **Mild**

TABLE 6.4.2(C)

EXPOSURE CLASSIFICATION FOR CONCRETE PILES—PILES IN SOIL

Exposure conditions				Exposure classification	
Sulfates (expressed as SO_4*)		pH	Chlorides in groundwater	Soil conditions A†	Soil conditions B‡
In soil ppm	In groundwater ppm		ppm		
<5000	<1000	>5.5	<6000	Mild	Non-aggressive
5000–10 000	1000–3000	4.5–5.5	6000–12 000	Moderate	Mild
10 000–20 000	3000–10 000	4–4.5	12 000–30 000	Severe	Moderate
>20 000	>10 000	<4	>30 000	Very severe	Severe

* Approximately 100 ppm SO_4 = 80 ppm SO_3

† Soil conditions A—high permeability soils (e.g., sands and gravels) which are in groundwater

‡ Soil conditions B—low permeability soils (e.g., silts and clays) or all soils above groundwater

Steel piles:

- Samples are considered Soil Condition A
- All have pH > 5.5
- All have chloride < 1000ppm
- All have resistivity >5000 ohm.cm (lab results converted from ohm.m to ohm.cm)
- Exposure Class = **Non-aggressive**

TABLE 6.5.2(C)

EXPOSURE CLASSIFICATION FOR STEEL PILES—PILES IN SOIL

Exposure conditions				Exposure classification	
pH	Chlorides Cl		Resistivity ohm.cm	Soil condition A*	Soil condition B†
	In soil ppm	In groundwater ppm			
>5	<5000	<1 000	>5 000	Non-aggressive	Non-aggressive
4–5	5000–20,000	1 000–10 000	2 000–5 000	Mild	Non-aggressive
3–4	20,000–50,000	10 000–20 000	1 000–2 000	Moderate	Mild
<3	>50,000	>20 000	<1 000	Severe	Moderate

* Soil conditions A—high permeability soils (e.g., sands and gravels) that are in groundwater

† Soil conditions B—low permeability soils (e.g., silts and clays) or all soils above groundwater

SGS

ANALYTICAL RESULTS

SE187511 R0

pH in soil (1:5) [AN101] Tested: 19/12/2018

PARAMETER	UOM	LOR	BH1 0.8-1.0	BH1 4.0-4.2	BH1 7.5-7.95
			SOIL	SOIL	SOIL
			-	-	-
			3/12/2018	3/12/2018	3/12/2018
			SE187511.001	SE187511.002	SE187511.003
pH	pH Units	0.1	8.7	7.0	8.3

19/12/2018

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SGS

ANALYTICAL RESULTS

SE187511 R0

Conductivity and TDS by Calculation - Soil [AN106] Tested: 19/12/2018

PARAMETER	UOM	LOR	BH1 0.8-1.0 SOIL - 3/12/2018 SE187511.001	BH1 4.0-4.2 SOIL - 3/12/2018 SE187511.002	BH1 7.5-7.95 SOIL - 3/12/2018 SE187511.003
Conductivity of Extract (1:5 as received)	µS/cm	1	89	180	34
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	72	250	46
Resistivity of extract (1:5 as received)*	ohm m	0.1	150	56	300

19/12/2018

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SGS

ANALYTICAL RESULTS

SE187511 R0

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 19/12/2018

PARAMETER	UOM	LOR	BH1 0.8-1.0	BH1 4.0-4.2	BH1 7.5-7.95
			SOIL	SOIL	SOIL
			-	-	-
			3/12/2018	3/12/2018	3/12/2018
			SE187511.001	SE187511.002	SE187511.003
Chloride	mg/kg	0.25	2.0	17	16
Sulfate	mg/kg	5	7.8	31	52

19/12/2018

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SGS

ANALYTICAL RESULTS

SE187511 R0

Moisture Content [AN002] Tested: 19/12/2018

PARAMETER	UOM	LOR	BH1 0.8-1.0	BH1 4.0-4.2	BH1 7.5-7.95
			SOIL	SOIL	SOIL
			-	-	-
			3/12/2018	3/12/2018	3/12/2018
			SE187511.001	SE187511.002	SE187511.003
% Moisture	%w/w	0.5	4.3	29	27