Soil Mapping Unit: Acidic Texture-contrast Soils

Representative Site No: 5

Landform: Upper Slope

Micro-relief: None evident

Slope: 3% - South aspect

Dominant Vegetation: Grasses (30 - 70%), Woody (30 –70%)

Surface cover: 80%

Site Drainage: Moderately well drained

Surface condition: Poached (dry)

Australian Soil Classification: Kurosol

General comments on the soils of this mapping unit: Acidic soils with primary and secondary structure and displaying hardsetting characteristics. Smooth-faced peds are evidence of clay translocation down the profile resulting in clay coatings on peds. Many old roots and root channels in-filled with soil from above horizons.

Landscape Photos	Profile Photo	Horizon	Moist Colour	Texture	Structure	Consistence	Rooting depth	pH & EC
  		A 0 – 0.1 m	10YR 3/3 Dark brown	Silty Clay Loam	Polyhedral Moderate structure	Firm (dry)	Many (25-200) Coarse – Very fine	N/A
		B21 0.1 – 0.35 m	10YR 4/2 Dark greyish brown (Yellowish brown mottling)	Medium Heavy Clay	Subangular blocky parting to platy Moderate structure	Very strong (moderately moist)	Many (25-200) Medium – Very fine	pH: 5.9 EC: 0.044 dS/m
		B22 0.35 – 1.2 m	10YR 4/2 Dark greyish brown (Yellowish brown mottling)	Heavy Clay	Subangular blocky parting to platy Moderate structure	Strong (moist)	Common (10-25) Medium – Very fine	pH: 5.3 EC: 0.190 dS/m
		B23 1.2+ m	10YR 4/1 Dark grey (Olive brown mottling)	Medium Clay	Subangular blocky parting to platy Moderate structure	Firm (moist)	Few (1-20) Medium – Very fine	N/A

Soil Mapping Unit: Uniform and Gradational Soils

Representative Site No: 4

Landform: Upper Slope

Micro-relief: Hummocky or normal Gilgai

Slope: 3% - North aspect

Dominant Vegetation: Grasses (>70%),

Surface cover: 100% grass cover

Site Drainage: Moderately well drained

Surface condition: Firm (dry)

Australian Soil Classification: Vertosol/Deromosol

General comments on the soils of this mapping unit: Landscape varies between hummocky and flat. Gently undulating topography. Moderately well drained profiles. Lighter clays present. Evidence of yellow/grey mottling down the profile.

Landscape Photos	Profile Photo	Horizon	Moist Colour	Texture	Structure	Consistence	Rooting depth	pH & EC
  		A11 0 -0.1 m	10YR 3/3 Dark brown	Light Clay	Polyhedral Weak to moderate structure	Strong (dry)	Many (25-200) Coarse – Very fine	N/A
		A12 0.1 – 0.35 m	10YR 4/2 Dark greyish brown	Light Medium Clay	Angular blocky Moderate structure	Firm (moist)	Many (25-200) Medium – Very fine	pH: 5.7 EC: 0.085 dS/m
		B21 0.35 – 0.9 m	2.5Y 5/6 Light olive brown (yellow mottling)	Heavy Clay	Subangular blocky parting to platy Moderate structure	Firm (moist)	Common (10-25) Medium – Very fine	pH: 5.6 EC: 0.330 dS/m
		B22 0.9 – 1.2+ m Refusal at 1.8 m	2.5Y 5/1 Grey (Yellow/grey mottling)	Heavy Clay	Subangular blocky parting to platy Moderate structure	Firm (moist)	Few (1-20) Medium – Very fine	N/A

Soil Mapping Unit: Sodic Texture-contrast Soils

Representative Site No: 10

Landform: Lower slope

Micro relief: None evident

Slope: 2% - East aspect

Dominant Vegetation: Grasses (>70%),

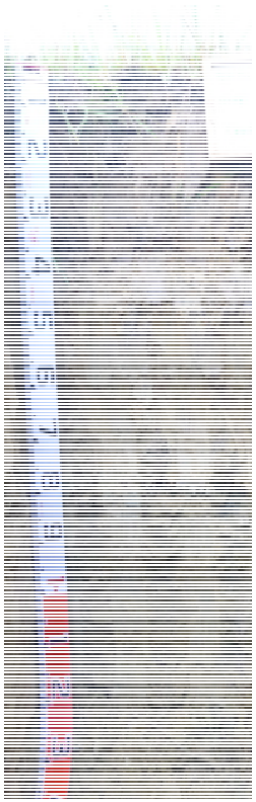
Surface cover: 80% grass cover

Site Drainage: Moderate well-drained

Surface condition: Firm (dry)

Australian Soil Classification: Sodosol

General comments on the soils of this mapping unit: Good structured soil with sodic properties. Weathered parent material at base of profile.

Landscape Photos	Profile Photo	Horizon	Moist Colour	Texture	Structure	Consistence	Rooting depth	pH & EC
  		A1 0.0 – 0.2 m	7.5 YR 3/2 Dark Brown	Silty Clay Loam	Subangular blocky Moderate structure	Very strong (dry)	Many (25-200) Coarse – Very fine	pH: 5.6 EC: 0.13 dS/m
		B 0.2 – 0.8 m	10 YR 5/2 Grayish brown	Heavy Clay	Angular blocky parting to platy Moderate structure	Strong (moist)	Common (10-25) Medium – Very fine	pH: 5.8 EC: 0.07 dS/m
		BC 0.8 – 1.2 +	2.5 Y 5/4 Light olive brown	Loam	Apedal No structure	Not applicable	Few (1-20) Medium – Very fine	N/A

2.3 Land capability assessment

The assessment of land capability to support urban development for the Project is based on the *Soil and land constraint assessment for urban and regional planning* (DECCW 2010). The soil and land constraint assessment scheme builds on the existing capability systems applied in NSW, and provides an indication of the potential of land to sustainably support a specific land use. In addition, the system accounts for the cost of ameliorating site constraints and the remnant risks.

2.3.1 Land constraint criteria

The land constraint system provides semi-quantitative outputs from the combined effects of all constraints, and determines an overall ranking that accounts for any mitigation measures that are applied to overcome constraints. This differs from standard capability systems that only consider the most limiting constraint. An overall constraint class is applied by evaluating the combined effects of a number of key soils and landscape attributes. Each of the five constraint classes is assigned a number of constraint points representing the degree of associated financial, environmental and social costs. Five classes of constraint, ranging from 1 to 5, are applied to individual attributes as defined below in **Table 2-5.**

Table 2-5 : Constraint classes of individual attributes

Constraint Class	Description	Constraint points
1 – Very low	Very low constraint; low treatment costs; straightforward or no maintenance; associated with negligible financial, environmental or social site costs; very low residual risk.	0
2 – Low	Low constraint; associated with minor financial, environmental or social site costs; straightforward or low maintenance; low residual risk.	0
3 – Moderate	Moderate constraint; moderate financial, environmental or social costs beyond the standard; frequent maintenance required; moderate residual risk; marginally acceptable to society – other factors may intervene.	1
4 – High	High constraint; high financial, environmental or social costs beyond the standard; special mitigation measures are required; regular specialist maintenance; moderate to high residual risks and costs.	3
5 – Very high	Very high constraint; risks very difficult to control even with site-specific investigation and design; very high financial, environmental or social costs beyond the standard; regular specialist maintenance may be mandatory; high residual risk; generally, not acceptable to society.	6

The constraint points are then applied to the individual attributes and added together to give a total score for a particular site. The higher the total score, the more costly and inappropriate the proposed land-use change. Results are then presented on a scale of 0 – 12 constraint points, which can be grouped into three broad classes:

- **0 – 3**: low constraint, high capability.
- **4 – 7**: moderate constraint, moderate capability.
- **8 – 12**: high constraint, low capability.

A high score does not directly indicate areas to be excluded from particular land uses, but rather it indicates the large amount of resources that would have to be expended in order to make the land use viable. In practice, scores higher than 8 would generally exclude a land use from further consideration. In some cases, however, it will be deemed desirable to allocate the necessary resources.

2.3.2 Land constraint assessment

To represent the proposed future land use, two constraint assessment tables as identified in DECCW (2010) were used for this assessment and include criteria for a standard residential development and a medium density residential development; refer to **Table 2-6**. It is noted that while the land use in the assessment tables refer to residential development, this land use is in line with expected disturbance and development of the Project.

Table 2-6 : Land use key constraints

Land use	Context	Key constraints
Standard Development	This use refers to standard suburban residential developments as might be established on new residential estates. Such residential areas would include: • Standard housing up to two storeys with either pier or concrete slab foundations and generally no basement. • Sealed roads with kerb and gutters. • Underground infrastructure including plumbing, storm water, power and telecommunication services.	• Slope (%). • Erosion hazard. • Wave erosion hazard. • Flood hazard. • Mass movement hazard. • Acid sulphate soil. • Shrink-swell potential. • Soil strength. • Salinity. • Waterlogging. • Foundation hazard • Rock outcrop.
Medium density development	This use refers to medium density residential as might be established as part of expanding metropolitan areas, including: • Buildings such as villa complexes and small sized residential apartment blocks. These are assumed to be 1-3 storeys with all types of foundations, involving excavations to several meters' depth, typically into solid bedrock. • Sealed roads with kerbs and gutters, sealed parking areas and paved footpaths. • Extensive above and below ground infrastructure including plumbing, storm water, power and telecommunication services.	• Slope (%). • Erosion hazard. • Wave erosion hazard. • Flood hazard. • Mass movement hazard. • Acid sulphate soil. • Shrink-swell potential. • Salinity. • Waterlogging. • Foundation hazard.

The associated constraint assessment tables can be found in *Soil and land constraint assessment for urban and regional planning* (DECCW 2010).

Results from the soil survey outlined in **Section 2.2** provide the major source of data for the assessment process. Additional data was drawn from the Geotechnical Report.

The land use constraints are assessed against the properties each SMU, with results presented in **Table 2-8** and **Table 2-9.** The outcomes of the assessment are illustrated in **Figure 2-4.**

Table 2-7 : Constraint key

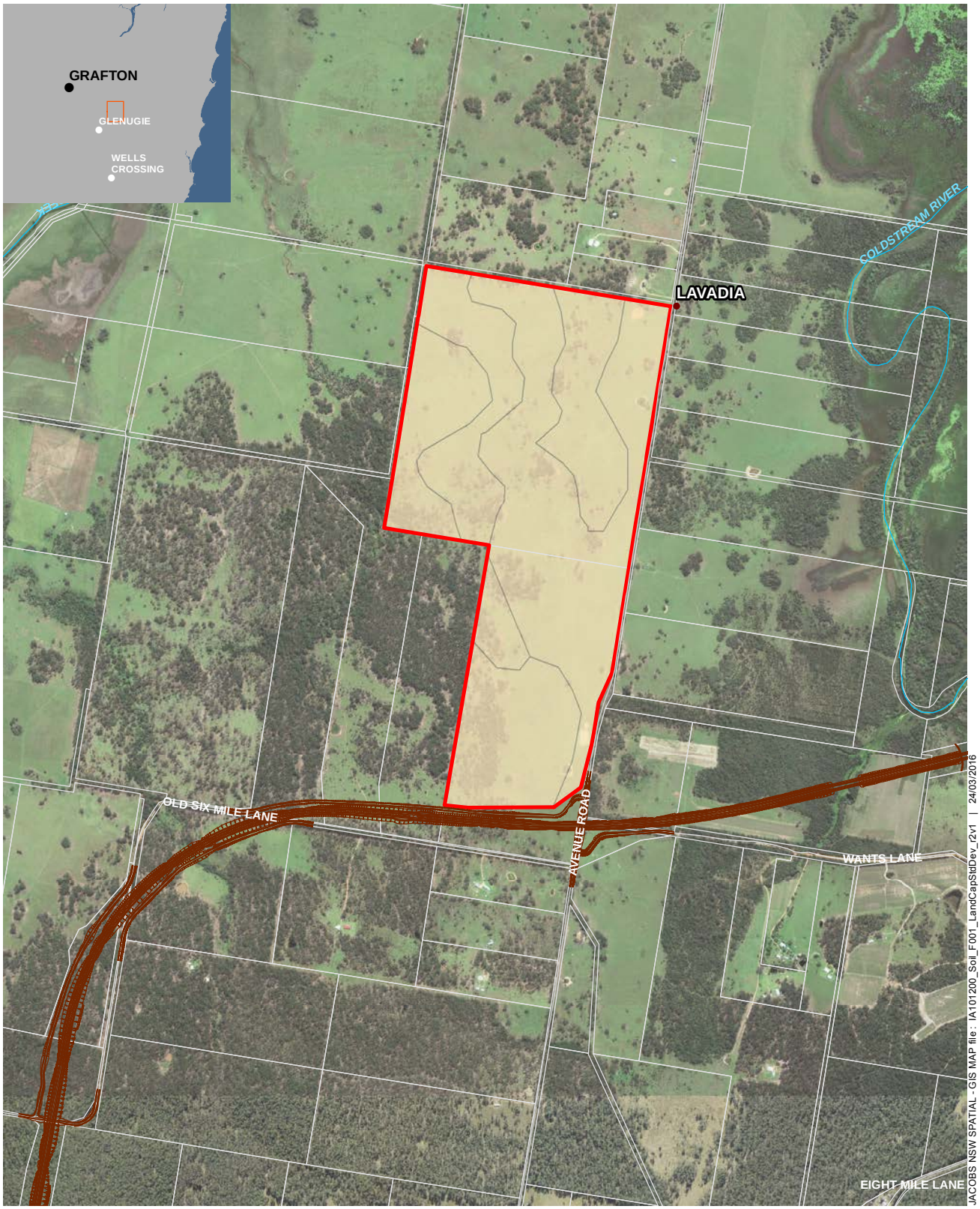
Constraint	Score	Code
1 – Very low constraint	0	
2 – Low constraint	0	
3 – Moderate constraint	1	
4 – High constraint	2	
5 – Very high constraint	3	

Table 2-8 : Standard Development constraint table

Attribute	Acidic Texture-contrast Soils	Uniform and Gradational Soils	Sodic Texture-contrast Soils
Slope % (average)	4 – 8%	4 – 8%	4 – 8%
Erosion hazard (t/ha/y)	3 – 8	3 – 8	3 – 8
Wave erosion hazard	Not applicable	Not applicable	Not applicable
Flood probability	Low	Low	Low
General occurrence	Not applicable	Not applicable	Not applicable
Terrain unit	Hillslopes units (excluding foot slopes)	Low foot slopes, plains (excluding floodplains)	Hillslopes units (excluding foot slopes)
Mass movement hazard	None present	None present	None present
Acid sulfate soil risk	Low	Low	Low
Shrink-swell limitation	None present	None present	None present
Volume expansion %	5 – 15%	5 – 15%	5 – 15%
Low wet bearing strength	High, moderate	High, moderate	High, moderate
Organic soils	None present	None present	None present
Saline soil materials	None present	None present	None present
Saline landscapes	None present	None present	None present
ECe (dS/m)	>2.0	0.1 – 2.0	>2.0
Seasonal waterlogging	Widespread	Widespread	Widespread
Permanently high water table	No	No	No
Rock outcrop	None present	None present	None present
General foundation hazard	Localised	Localised	Localised

Table 2-9 : Medium Density Development constraint table

Attribute	Acidic Texture-contrast Soils	Uniform and Gradational Soils	Sodic Texture-contrast Soils
Slope %	4 – 8%	4 – 8%	4 – 8%
Erosion hazard (t/ha/y)	<5	<5	<5
Wave erosion hazard	Not applicable	Not applicable	Not applicable
Flood probability	Low	Low	Low
General occurrence	Not applicable	Not applicable	Not applicable
Terrain unit	Hillslopes units (excluding foot slopes)	Low foot slopes, plains (excluding floodplains)	Hillslopes units (excluding foot slopes)
Mass movement hazard	None present	None present	None present
Acid sulfate soil risk	Low	Low	Low
Shrink-swell limitation	None present	None present	None present
Volume expansion %	<10	<10	<10
Saline soil materials	None present	None present	None present
Saline landscapes	None present	None present	None present
ECe (dS/m)	>2.0	<2.0	>2.0
Seasonal waterlogging	Widespread	Widespread	Widespread
Permanently high water table	No	No	No
General foundation hazard	Localised	Localised	Localised



Legend

The Project

Grafton Bypass (proposed)

Land Capability - Standard Development

5

0 500 1000 Metres

1:25,000 @ A4

N

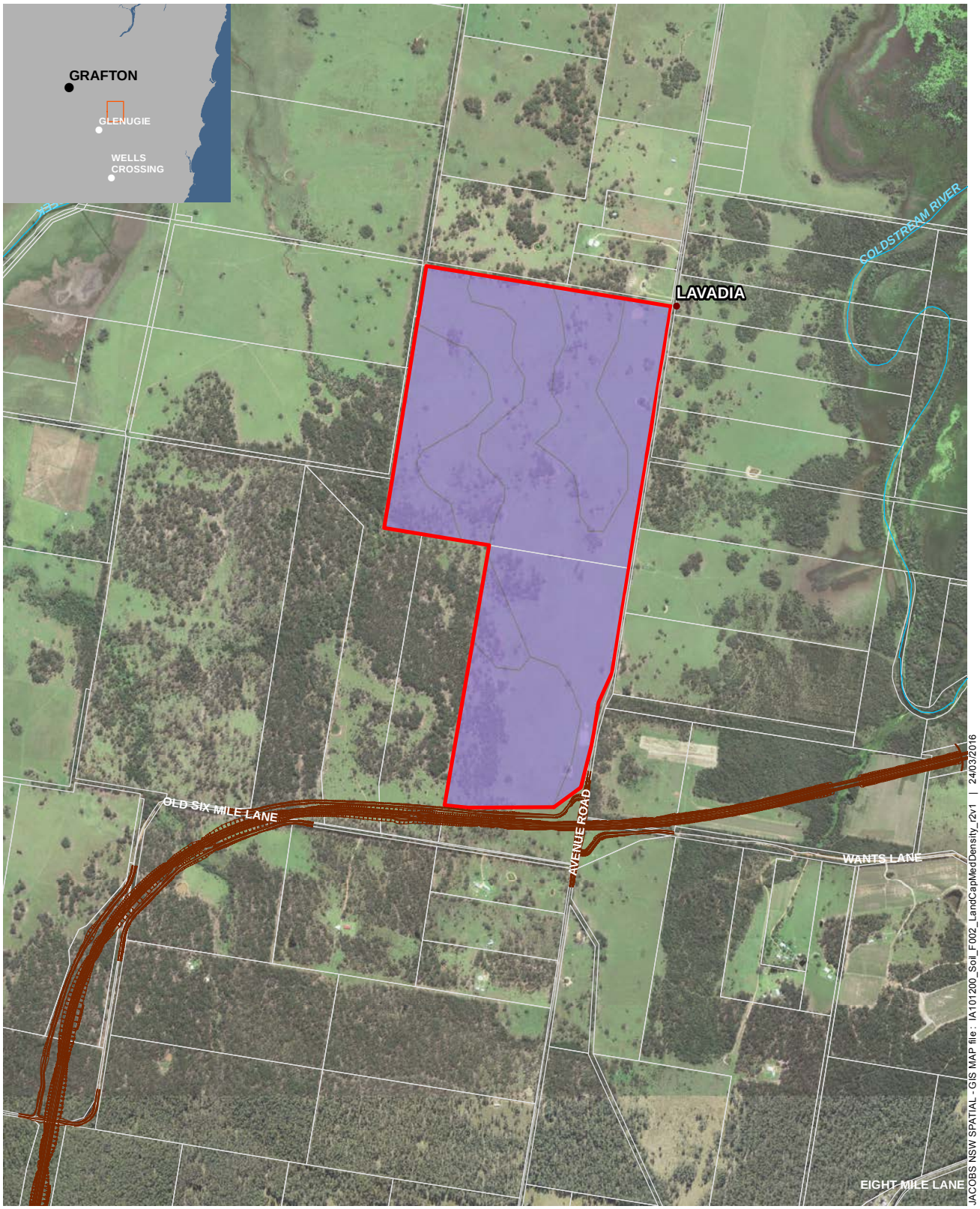
Data sources

Jacobs 2015

LPI 2015

RMS 2013 (W2B Alliance)

Figure 2-4 | Land capability - Standard development



Data sources
Jacobs 2015
LPI 2015
RMS 2013 (W2B Alliance)

Figure 2-5 | Land capability - Medium Density

2.3.3 Land constraint score

A summary of the land constraint scores are provided in **Table 2-10.**

Table 2-10 : Summary of land constraint assessment

Constraints	Acidic Texture-contrast Soils	Uniform and Gradational Soils	Sodic Texture-contrast Soils
Standard Development			
Constraint Score	5	5	5
Confidence Rating	Confident	Confident	Confident
Medium Density Development			
Constraint Score	3	3	3
Confidence Rating	Confident	Confident	Confident

Based on the outcomes of the assessment, the main constraints to the proposed land use are seasonal waterlogging of the soils and a general foundation hazard due to the dispersive nature of the clay subsoils.

Using the standard development capability, all SMU's of the Project Site have a moderate constraint and moderate capability for the proposed land use. Under the medium density development scenario, all three soil mapping units have a low constraint and high capability.

Note that while the scores seem to indicate that the landscape is less suited to standard development; the two scenarios reflect different scales of expenditure. This is largely because constraint scores depend on the relative budget and economics of the land use, with the cost of overcoming constraints being based on a percentage of the initial development costs. For example, the costs of overcoming constraints such as erosion hazard are proportionally smaller for medium density development than for standard development.

Both development scenarios have similar scores indicating that the land is potentially suitable for both levels of disturbance. These scores are reflected across the SMU's, reflecting similarities in soil and landscape constraints across the units.

Overall, the Project Site can be considered as suitable for the proposed land use, if the key soil constraints (seasonal waterlogging and dispersive subsoils) are mitigated. Strategies and mitigation measures to manage/ameliorate these constraints are presented in **Section 3** and **Section 4**

3. Soil salinity

3.1 Soil salinity assessment

Soil salinity is a characteristic of soil relating to its content of water soluble salts. Saline soils contain high concentrations of soluble salts, although the term does not differentiate between the type and proportion of ions present in soil solution. Salinity impacts include damage to buildings or roads, vegetation dieback, soil erosion and waterlogging. These impacts can be exacerbated by development or changes in surface, drainage and vegetation conditions.

The requirements for soil salinity assessment are outlined in the *Site Investigations for Urban Salinity* (DLWC 2002) booklet. A four phased assessment is recommended:

1) Desktop review and initial site investigation.
2) Detailed site investigation.
3) Laboratory analysis of selected soil samples.
4) Selection of appropriate management and evaluation techniques.

Rather than conduct two separate field investigations, Phase 1 and Phase 2 were addressed as part of the soil survey and land capability assessment.

3.1.1 Phase 1 – Desktop review and initial site investigation

As part of the soil survey for land capability, the climate, geology, geomorphology and soils data were reviewed for the Project Site (refer to **Section 2.2**). The results of the desktop review found there were insufficient data to make an informed decision on the salinity risk for the Project Site.

An initial site investigation involves observing and recording data relating to visual environmental indicators of salinity, including bare soil patches, salt crystals in the soil, dieback of trees, etc. As these observations align with the methods of the soil survey, the initial and detailed salinity investigations were run in parallel with the soil survey and land capability assessment.

3.1.2 Phase 2 – Detailed site investigation

For detailed site investigations, the number of samples should enable identification of the soils and landscapes that have different salinity hazards and require different management options. The scale of investigations is dependent on the variation in soil and landscape characteristics across the site.

A total of 15 locations were investigated across the Project Site. This number of locations falls between a 1:10,000 and 1: 25,000 scale of investigation and is considered sufficient for the proposed land use (DLWC 2002). Detail on the soil profile and landscape descriptions can be found in **Section 4.1**.

Land use across the Project Site is predominantly cattle grazing of pastures, and it is likely the land was cleared of trees for this purpose. This removal of trees can result in an increased salinity risk as the water table and associated salts rise. However, no evidence of increased salinity was observed during the soil survey and land capability assessment conducted between the 8th and 11th February 2016.

3.1.3 Phase 3 – Laboratory analysis

All 34 samples collected from the 15 locations investigated as part of the soil survey and land capability assessment were analysed for salinity. The analyses are categorised into two suites:

- The **water movement suite**: tests that provide information on water movement through the soil and possible impediments to drainage.

- The **corrosivity suite**: tests that determine how corrosive the soil will be to building materials and infrastructure.

Detailed site and soil profile descriptions are provided in **Appendix A**. The reference risk rating key for the results of the laboratory analyses are provided in **Table 3-1** with the results summarised in Table 3-2. The full laboratory reports are available in **Appendix B**.

Table 3-1 : Reference key

Risk rating	Code
Low risk	
Moderate risk	
High risk	
Severe risk	

Table 3-2 : Laboratory results – salinity

	Water Movement Suite								Corrosivity Suite					Overall Risk rating
Sample No.	Cation Exchange Capacity (meq/100g)					ESP	Permeability[1]	Emerson's	Chloride	Sulfate	pH	Resistivity	ECe	
	Ca	K	Mg	Na	CEC	%	mm/h	Class	mg/kg	mg/kg	pH unit	Ohm/cm	dS/m	
Site 1 A	3.7	0.7 6.4		0.37	11	3	15	8	27	20	5.9	12000	0.74	Low
Site 1 B	0.8	<0.1	5	1.1	7	16	5	1	170	93	5.4	4700	1.68	Low
Site 2 A	3.6	0.2 4.2		0.49	8.6	6	15	8	20	<10	5.8	20000	0.49	Low
Site 2 B	0.2	<0.1 1.8		0.73	2.8	26	5	1	280	110	5.2	3700	2.16	Low
Site 3 A	0.4	0.2 7.7 2.3			11	22	2.5	3b	230	34	5.1	4800	1.26	Low
Site 3 B	<0.1	<0.1	2.7	1.3	4.1	32	5	3b	470	160	4.9	2000	3.92	Moderate
Site 4 A	3.5	0.2 8.7		0.85	13	6	5	3b	49	<10	5.7	12000	0.68	Low
Site 4 B	0.6	0.1 6.9 1.8			9.3	19	2.5	2	320	93	5.6	3000	1.98	Low
Site 5 A	0.7	<0.1 6.5		1.2	8.5	14	2.5	3a	20	<10	5.9	23000	0.31	Low
Site 5 B	0.2	0.1 7.7		2	10	20	2.5	3a	140	69	5.3	5400	1.14	Low
Site 6 A	3.9	0.3 8.7 1.3			14	9	15	3a	23	10	5.4	16000	0.62	Low
Site 6 B	<0.1	<0.1	2.2	1.5	3.7	39	2.5	3b	430	130	4.8	2100	3.36	Moderate
Site 7 A	0.1	0.1 5.9 1.9			8.1	24	2.5	3a	110	32	5.4	7500	0.78	Low
Site 7 B	<0.1	<0.1	3	1.5	4.6	33	2.5	6	580	85	4.8	2100	2.94	Moderate
Site 8 A	1.8	0.2 9.8 1.4			13	11	2.5	3b	68	29	5.3	9600	0.60	Low
Site 8 B	0.6	0.1	12	3.9	16	24	2.5	6	680	99	4.8	1800	4.48	Moderate
Site 9 A	6	0.2	2.2 0.2		8.6	2	15	5	74	10	5.6	9700	1.00	Low

[1] Permeability is determined from in-field interpretations of soil texture

Sample No.	Water Movement Suite								Corrosivity Suite					Overall Risk rating
	Cation Exchange Capacity (meq/100g)					ESP	Permeability[1]	Emerson's	Chloride	Sulfate	pH	Resistivity	ECe	
	Ca	K	Mg	Na	CEC	%	mm/h	Class	mg/kg	mg/kg	pH unit	Ohm/cm	dS/m	
Site 9 B	1.4	<0.1 5.6		1.5	8.6	17	2.5	6	380	24	4.9	3400	1.74	Low
Site 9 C	1.2	<0.1 7.8		3.3	12	27	2.5	6	710	130	4.7	3500	3.84	Moderate
Site 10 A	12	0.4	5.2	0.45	18	3	15	5	10	<10	5.6	1600	1.30	Low
Site 10 B	5.5	0.2 9.7 1.5			17	9	2.5	3b	45	<10	5.8	11000	0.44	Low
Site 11 A	5.1	0.1 4.7		0.78	11	7	5	8	59	10	5.7	9300	1.02	Low
Site 11 B	0.2	<0.1 1.4		0.69	2.3	29	2.5	1	130	52	5.3	3800	1.80	Low
Site 12 A	3.7	0.1 2.5		0.25	6.5	4	15	8	20	<10	5.9	31000	0.35	Low
Site 12 B	0.1	<0.1 1.6		0.96	2.7	35	2.5	2	600	110	4.9	19000	3.30	Moderate
Site 13 A	8.7	0.3 4.5		0.31	14	2	15	8	20	<10	6.1	12000	1.10	Low
Site 13 B	1.5	<0.1	11	3.3	16	21	2.5	3b	390	190	5.2	2400	2.58	Moderate
Site 14 A	0.7	<0.1 3.5		1.1	5.3	20	2.5	6	550	260	5.1	1700	3.60	Moderate
Site 14 B	2.7	0.1	11	2.5	17	15	2.5	6	380	210	5.1	2400	2.58	Moderate
Site 15 A	11	0.2	7.1	0.45	19	2	5	8	<10	<10	5.7	17000	0.63	Low
Site 15 B	12	0.2	8.7 0.7		22	3	2.5	8	10	<10	5.8	18000	0.34	Low
Site 15 C	9.4	<0.1	16	5.5	31	18	2.5	5	500	59	6.9	2100	2.82	Moderate

Water movement suite

Results from the water movement analyses indicate that the majority of samples are sodic, with an exchangeable sodium percentage (ESP) >5. Almost all subsoils are highly sodic, with an ESP >15. Emerson results indicate a range of stability classes across the samples, from very high dispersivity to complete stability. Topsoil samples were generally stable to slightly dispersive. Subsoil samples varied from very highly dispersive to slightly dispersive.

Corrosivity suite

Chloride and sulphate levels were low across all samples, representing no risk to the proposed land use. In addition, resistivity was generally high, indicating a low risk for steel corrosion. The samples were generally acidic, representing a low to moderate risk to corrode concrete structures. Salinity levels (ECe) indicate the soils are either non-saline or slightly saline.

Further detail on the corrosivity potential of the soils can be found in the geotechnical investigation working paper.

3.1.4 Phase 4 – Management and evaluation

The Project Site is characterised by a gentle sloping landform, with no evidence of salt scalding or salt accumulation in the landscape. The soils comprise of a silty clay topsoil overlying medium to heavy clay subsoils, with low permeability and evidence of seasonal waterlogging. These clay soils are generally sodic and acidic and susceptible to dispersion, further reducing permeability and soil structure.

The land capability assessment indicates that the soils are not saline and are unlikely to be corrosive to concrete or steel infrastructure. Changes to the site hydrology (e.g. removal of vegetation) may result in the capillary rise of salts from the clay subsoils; however, it is unlikely that salt levels will rise to the level required to cause damage to infrastructure.

It is anticipated that the entire site will be cleared prior to construction. Removal of deep-rooted vegetation (tree species) from catchment recharge areas will cause groundwater levels to rise. Groundwater levels were recorded in March 2015 as part of the geotechnical investigations, refer further to the Geotechnical Working Paper, with no water encountered at full depth (15 m) in the northern part of the site, indicating a deep groundwater table. However, in the southern part of the site, groundwater was encountered 5.5 m below the existing surface, indicating a relatively shallow groundwater table. Groundwater testing suggests that the water is saline (EC of 16 dS/m); as a result, a significant rise in groundwater will increase salinity in the soil profile.

The soils on the southern section of the site are dominated by texture contrast loams over clay. As such, water will infiltrate slowly through the medium and heavy clay soils. During precipitation events of sufficient magnitude, soil saturation will be reached rapidly in the top of the profile. Water will preferentially runoff both the surface and clay sub-surface to discharge points down the catchment. Additionally, the position of the facility in the landscape will effectively remove the recharge point at the top of the catchment, further reducing the capability of the system to increase groundwater supply. Overall, while groundwater levels are expected to increase, the inherent properties of the soil and construction of the facility is expected to prevent a significant rise. This assumes that the gentle slopes will remain, preventing the ponding of water and allowing water to move down the catchment.

A key risk to the Project is the presence of sodic (dispersive) and shrink-swell clays. These clays are typically unstable when disturbed resulting in disaggregation and structural collapse. Once these clays disperse, the redistribution of the silt and clay-sized particles restricts water movement through the soil resulting in poor drainage and water logging.

The following strategies could be implemented to reduce the risk associated with sodic subsoils:

- Avoid or minimise cut and fill of soils identified as sodic to reduce exposure of sodic subsoils.
- If disturbance is unavoidable, sodic soils should be excavated and stockpiled separately to avoid mixing with non-sodic soils, and soil ameliorants (e.g. gypsum) should be incorporated as required.
- Avoid or minimise the re-use of sodic clays unless specific investigations relating to their use for earthworks are conducted.
- Return of disturbed soils in order of excavation (subsoils first).
- Prevent pooling of water and increased recharge of groundwater

Overall, the Project presents a low salinity risk and the soils should be suitable for construction if the dispersive subsoils are appropriately managed. Mitigation strategies are outlined in **Section 4**.

4. Assessment and management of construction and operation impacts

4.1 Potential construction impacts

Construction would have the following potential impacts on soils:

- **Soil erosion and loss of topsoil:** This could result from the removal of vegetation (clearing and grubbing) and disturbance of the ground surface during site preparation, earthworks, excavation and other construction activities. Earth-moving activities could also expose loose soils and mobilise these materials.
- **Exposure of sodic subsoils:** The excavation of sodic soils during construction activities will disturb the existing soil structure and, if exposed to water, these soils are likely to disperse. This results in soil loss due to erosion. Construction activities may also affect the undisturbed sodic soils of the site if adequate soil erosion and sediment control measures are not in place. For example, the undisturbed sodic subsoils may be susceptible to tunnel erosion if the movement of water across the site is not managed appropriately.

4.2 Potential operation impacts

Once the Project is operational, there would be potential for indirect impacts on soils as a result of run-off and drainage over exposed soils with sodic subsoils, and tunnel erosion of undisturbed sodic soils.

4.2.1 Safeguards and management measures

Safeguards and mitigation measures to manage potential impacts on soils and on water quality as a result of erosion and sediment distribution and to reduce the extent of exposed soils are presented in **Table 4-1.**

Table 4-1 : Summary of potential impact and mitigation strategies

ID	Impact	Environmental safeguards	Responsibility	Timing
SQ-1	Tunnel erosion of subsoil as a result of exposure during construction	Excavation of subsoil materials should be minimised where possible. During excavation, sodic subsoils must be excavated and stockpiled separately to avoid mixing with competent materials. • Topsoil thickness determined prior to excavation • Topsoil will not be mixed with subsoil • Topsoil to be reinstated within the minimum time practicable • Sodic subsoil thickness determined before stripping and minimal exposure of sodic soils. • Sodic subsoils to be treated with a soil conditioner to improve soil stability and structure • Sodic soil materials should be buried at depth and beneath a layer of competent and stable non-sodic soil materials. • Erosion measures are in place in accordance with the Erosion and Sediment Control Plan • Periodic inspections of stockpiles after rain events to assess stability of sodic	Construction contractor	Construction

ID	Impact	Environmental safeguards	Responsibility	Timing
		materials • Replace soils in their original order if excavations are undertaken, to ensure that sodic materials are buried. • Re-direct water away from areas where sodic subsoils have been exposed.		
SQ-2	Waterlogging of soils as a result of changes to drainage during construction	Drainage pathways should direct water away from exposed soils to prevent pooling of water on the soil surface. Management methods include: • Early installation of physical controls to convey water around the site. • Retaining natural catchment slopes to route water to the discharge zone • Reduce exposure of sodic subsoils to allow drainage of water through the soil profile (see excavation management above). • Establishment and maintenance of vegetation where soil is exposed.	Construction contractor	Pre-construction, Construction, Operation
SQ-3	Site management erosion controls	Construction activities will be sequenced and managed to minimise potential water quality degradation due to erosion. Management methods will include: • Early installation of physical controls, including cross drainage to convey clean water around or through the site and the construction of sedimentation controls • Minimising the duration of exposed topsoil by retaining topsoil cover, grassed drainage lines and shrub cover on the soil surface for as long as possible • Minimising the extent of disturbed areas • Minimising stockpiling areas • Minimising the lengths of slopes through limiting the extent of excavations and the use of diversion drains to reduce water velocity over disturbed areas • Where possible, constructing working platforms from rock fill so that bare earth is not exposed • Progressive rehabilitation or sealing of work areas.	Construction contractor	Pre-construction, Construction, Operation

5. Conclusions

5.1 Land capability assessment

Based on the outcomes of the land capability assessment, the main constraints to the proposed land use are seasonal waterlogging of the soils, and a general foundation hazard due to the dispersive nature of the clay subsoils.

Using the standard development capability, all SMU's of the Project Site have a moderate constraint and moderate capability for the proposed land use. Under the medium density development scenario, all three soil mapping units have a low constraint and high capability.

Both development scenarios have similar scores indicating that the land is potentially suitable for both levels of disturbance. These scores are reflected across the SMU's, demonstrating that the soil and landscape properties are generally similar across soil units.

5.2 Project Site salinity assessment

The land capability assessment indicates that the soils are not saline and are unlikely to be corrosive to concrete or steel infrastructure. Changes to the site hydrology (e.g. removal of vegetation) may result in the capillary rise of salts from the clay subsoils; however, it is unlikely that salt levels will rise to the level required to cause damage to infrastructure.

The soils on the southern section of the site are dominated by texture contrast loams over clay. As such, water will infiltrate slowly through the medium and heavy clay soils. During precipitation events of sufficient magnitude, soil saturation will be reached rapidly in the top of the profile. Water will preferentially runoff both the surface and clay sub-surface to discharge points down the catchment. Additionally, the position of the facility in the landscape will effectively remove the recharge point at the top of the catchment, further reducing the capability of the system to increase groundwater supply. Overall, while groundwater levels are expected to increase, the inherent properties of the soil and construction of the facility is expected to prevent a significant rise. This assumes that the gentle slopes will remain, preventing the ponding of water and allowing water to move down the catchment.

A key risk to the Project is the presence of sodic (dispersive) and shrink-swell clays. These clays are typically unstable when disturbed resulting in disaggregation and structural collapse. Once these clays disperse, the redistribution of the silt and clay-sized particles restricts water movement through the soil resulting in poor drainage and water logging.

Overall, the Project presents a low salinity risk. The soils are suitable for construction if the sodic subsoils are appropriately managed.

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Appendix A. Soil log sheets

Site Information

Project IA101200	**Date** 8/02/2016	**Scribe** K. Brown	**Location** Site 1	**Observation** Soil pit	**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody		**Ground Cover %** Dense (>70%)	**Aspect** South		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Kurosol
Secondary Vegetation Form Non-woody		**Ground Cover %** Sparse (10-30%)	**Slope %** 5		**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species) Themeda australis, Paspalum dilatatum					**Drainage (soil and site)** Imperfectly drained	**Erosion Extent** None evident	
Landform Element Lower slope			**Soil Surface Condition (dry)** Firm		**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Microrelief Yes

Type Hummocky or normal gilgai

Vertical (m) ~ 0.3 m

Horizontal (m) 1-3 m

Described/ sampled Mound

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Other Information:

Site located in drainage line which runs alongside a hill identified as having cultural heritage significance. Microrelief (most likely to be normal gilgai) is evident. Imperfectly drained due to weak structure and heavy clay texture.

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A1	0 - 0.05		Abrupt	Silty Clay Loam	Dark brown (7.5 YR 3/3)	Nil	Nil	0-2% 2-6 mm	Polyhedral	Moderate	Weak (dry)	Many (25-200) coarse, fine, very fine	Lab	Lab	0-0.05
B1	0.05-0.25		Abrupt	Medium Heavy Clay	Dark greyish brown (10YR 4/2)	10-20% distinct yellowish brown (10YR 5/6)	<2% fine, white, soft, unidentified	Nil	Subangular blocky	Moderate	Firm (moderately moist)	Few (10-25) coarse, many (25-200) fine and very fine	–	–	–
B21	0.25-0.90		Clear	Medium Heavy Clay	Brown (10YR 5/3)	20-50% prominent yellowish brown (10YR 5/8)		Nil	Subangular blocky parting to platy	Moderate	Firm (moist)		Lab	Lab	0.60-0.70
B22	0.90-1.2+			Medium Clay	Dark greyish brown (10YR 4/2)			Nil		Moderate	Firm (moderately moist)	Few (1-10) fine	–	–	–

Other information:

From 0.90-1.2 m material is more "friable", partially weathered, finer structure, siltstone fragments at 1.0 m. Siltstone present at 1.5 m.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	8/02/2016	K. Brown	Site 2	Soil pit			Dermosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	North			Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Sparse (10-30%)	3	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Imperfectly drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Firm	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Microrelief	Yes
Type	Hummocky or normal gilgai
Vertical (m)	~ 0-0.3 m
Horizontal (m)	1-3 m
Described/ sampled	Mound

Other Information:
Microrelief likely to be gilgai. More difficult to interpret due to dense vegetation cover. Imperfectly drained due to weak structure and heavy clay texture.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A1	0-0.08		Abrupt	Silty Clay Loam	Very dark greyish brown (10 YR 3/2)	Nil	Nil	Nil	Polyhedral	Moderate	Firm (dry)	Many (25-200) coarse, fine, very fine	Lab	Lab	0.08
B21	0.08-0.35		Gradual	Light Clay	10 YR 3/2	Nil	Nil	Nil	Subangular blocky	Moderate	Strong (moderately moist)	Few (10-25) coarse, many (25-200) fine and very fine	–	–	–
B22	0.35-0.60		Abrupt	Light Clay	10 YR 4/2	7.5 YR 5/8	Nil	Nil	Subangular blocky parting to platy	Moderate	Weak (moist)		Lab	Lab	0.6
B23	0.60-1.10+			Light Clay	7.5 YR 6/1	7.5 YR 5/8 and 10 R 4/4	2-10%, medium, charcoal	Nil	Subangular blocky parting to platy	Moderate	Firm (moderately moist)	Few (1-10) fine	–	–	–

Other information:

From 0.60- 1.6 m secondary platy structure. From 1.6-2.4 m, weak blocky structure parting to secondary platy structure with grey and red mottling. 1-2 mm charcoal segregations throughout mottled zones from 0.60 m onwards. Mottles increasing with depth.

Soil Profile Description

Project IA101200	**Date** 9/02/2016	**Scribe** K. Brown	**Location** Site 3	**Observation** Soil pit		**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody			**Ground Cover %** Dense (>70%)	**Aspect** North		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Kurosol
Secondary Vegetation Form Non-woody			**Ground Cover %** Sparse (10-30%)	**Slope %** 3		**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species) Themeda australis, Paspalum dilatatum						**Drainage (site)** Imperfectly drained	**Erosion Extent** None evident	
Landform Mid-slope			**Soil Surface Condition (dry)** Firm			**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Microrelief	Yes
Type	Hummocky or normal gilgai
Vertical (m)	Not recorded
Horizontal (m)	Not recorded
Described/ sampled	

Other Information:
Imperfectly drained due to weak structure and heavy clay texture.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A	0 - 0.15		Abrupt	Silty Clay Loam	7.5 YR 3/1	Nil	Nil	0 - 2%	Polyhedral	Moderate	Firm (moderately moist)	Many coarse, medium, fine, very fine	–	–	–
B1	0.15 - 0.35		Clear	Medium Heavy Clay	7.5 YR 4/1	5 YR 5/8	Nil	2 - 10%	Subangular blocky	Moderate	Firm (moist)	Many medium, fine, very fine	–	–	–
B2	0.35 - 0.7		Clear	Heavy Clay	7.5 YR 4/1	5 YR 5/8	Charcoal 2-10 % (2-5 mm)	2 - 10%	Subangular blocky parting to platy		Firm (moist)	Common medium, fine, very fine	Lab	Lab	350 - 700
B3	0.7 - 1.2		Gradual	Light Medium Clay	7.5 YR 5/2	10 YR 6/8	Nil	2 - 10%	Subangular blocky parting to platy		Weak (moist)	Common medium, fine, very fine	Lab	Lab	900 - 1000
BC	1.2-1.9+			Clay	Not recorded	White + orange mottling	Nil	Orange gravel	Not recorded	Not recorded	Not recorded	Few fine, very fine	–	–	–

Other information:

Clear boundary due to roots going from v.many (all sizes) to many/few and change in texture. Substructure (lenticular) but looks massive due to shearing. Old roots and root channels.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	9/02/2016	K. Brown	Site 4	Soil pit			Dermosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	North			Vertosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Mid-dense (30-70%)	3	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Upper slope	Firm	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief Yes, but not as abundant

Type Hummocky or normal gilgai

Vertical (m)

Horizontal (m)

Described/ sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information:
Less hummocky than previous sites.
Topography is gently undulating.
Drainage differs from previous sites.
As per previous sites, vegetation cover is 100%.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A11	0 -0.1		Clear	Light Clay	10 YR 3/3	Nil	0 - 2% Unidentified	0 - 2% Sub-angular (2-4 mm)	Polyhedral	Weak to moderate	Strong (dry)	-	–	–	–
A12	0.1 - 0.35		Gradual	Light Medium Clay	10 YR 4/2	Nil	Nil	0 - 2% Sub-angular (2-4 mm)	Angular blocky	Moderate	Firm (moist)	Many medium, fine, very fine	Lab	Lab	150 - 250
B21	0.35 - 0.9		Gradual	Heavy Clay	2.5 Y 5/1	Light olive brown (2.5 Y 5/6)	Nil	0 - 2% Sub-angular (2-4 mm)	Subangular blocky parting to platy	Moderate	Firm (moist)	Common medium, fine, very fine	Lab	Lab	500 - 600
B22	0.9 - 1.2+		Gradual	Heavy Clay	2.5 Y 5/1	Light olive brown 2.5 Y 5/4	Nil	0 - 2% Sub-angular (2-4 mm)	Subangular blocky parting to platy	Moderate	Firm (moist)	Few medium, fine, very fine	–	–	–
BC	Refusal at 1.8 m														

Other information: Yellow mottle increasing with grey mottle coming through further down the profile.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	9/02/2016	K. Brown	Site 5	Soil pit			Kurosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	South			Kurosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Mid-dense (30-70%)	3	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Upper slope	Poached	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief No

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information:
Soil surface condition is soft to firm, can be indented with thumb. Ground cover is ~80%.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A	0 - 0.1		Abrupt	Silty Clay Loam	10 YR 5/2 10 YR 3/3	Nil	0 - 2% Unidentified	0 - 2%	Polyhedral	Moderate	Firm (dry)	Many coarse, medium, fine, very fine	–	–	–
B1	0.1 - 0.35		Clear	Medium Heavy Clay	10 YR 4/2	10 YR 5/8 many, fine	Nil	Red sandstone (10-20 mm)	Subangular blocky parting to platy	Moderate	Very strong (moderately moist)	Many medium, fine, very fine	Lab	Lab	150 - 250
B21	0.35 - 1.2		Clear	Heavy Clay	10 YR 4/2	10 YR 5/8 many, fine	Nil	0 - 2 %	Subangular blocky parting to platy	Moderate	Strong (moist)	Common medium, fine, very fine	Lab	Lab	700 - 800
B22	1.2+			Medium Clay	Dark grey clay	2.5 YR 4/8 fine	Nil	Nil	Subangular blocky parting to platy	Moderate	Firm (moist)	Few medium, fine, very fine	–	–	–

Other information:

Hardsetting (very weak to massive) B1 horizon. With increase in moisture content, structure increases to subangular blocky peds that part to secondary platy structure. Smooth-faced ped surfaces indicating clay transloaction and coatings. Many old roots and old root channels infilled with soil from above horizons.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	9/02/2016	K. Brown	Site 6	Soil pit			Kurosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	South			Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Mid-dense (30-70%)	3	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Upper slope	Soft	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief Yes

Type Hummocky or normal gilgai

Vertical (m)

Horizontal (m)

Described/ sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information:
Ground cover ~90%.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0 - 0.3		Clear	Silty Clay Loam	7.5 YR 3/2	Nil	Nil	10-20% siltstone	Subangular blocky	Moderate	Firm (dry)	Many coarse, medium, fine, very fine	Lab	Lab	200 - 300
B1	0.3 -0.6		Gradual	Light Clay	7.5 YR 3/2	Mottling present	Nil	2-10% siltstone and 2% red, unidentified (coarser-grained than siltstone)	Subangular blocky parting to platy	Moderate	Very strong (moderately moist)	Many medium, fine, very fine	–	–	–
B21	0.6 - 1.2		Gradual	Light Medium Clay	7.5 YR 5/2	10YR 5/8	Nil		Subangular blocky parting to platy	Moderate	Firm (moist)	Common medium, fine, very fine	Lab	Lab	700 - 800
B22	1.2 - 1.9		Gradual	Light Medium Clay	10 YR 5/2	10YR 5/8	Nil		Subangular blocky parting to platy	Moderate	Firm (moist)	Few medium, fine, very fine	–	–	–
B23	1.9 - 2.5			Light Medium Clay	10 YR 5/2	10YR 5/8	Nil	Not recorded	Not recorded	Not recorded	Not recorded	Very few	–	–	–

Other information:

0-0.05 m many roots make for a more friable topsoil. Brown sandy clay loam transitioning into a grey/brown clay, with a gradual transition to grey clay with yellow mottling. Further gradual change to dark brown grey clay, with plastic properties present, moving to red siltstone laminae at 1900 mm. Smooth faced peds and slickensides present within the B horizon.

Soil Profile Description

Project IA101200	**Date** 9/02/2016	**Scribe** K. Brown	**Location** Site 7	**Observation** Soil pit		**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Aspect** West		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Kurosol
Secondary Vegetation Form Woody			**Ground Cover %** Sparse (10-30%)	**Slope %** 2		**Rock Outcrop** No rock outcrop	**Erosion Type** Water (sheet)	
Vegetation (species) Themeda australis, Paspalum dilatatum						**Drainage (site)** Moderately well-drained	**Erosion Extent** Minor or present	
Landform Mid-slope			**Soil Surface Condition (dry)** Trampled and cryptogram			**Land Use** Grazing	**Erosion State** Stabilised	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief None

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Other Information:
Trampled. Cryptogram (moss/ lichens)

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0 - 0.1		Abrupt	Silty Clay Loam	10 YR 3/2	Nil	Charcoal (5 - 10%)	2 - 10%	Subangular blocky	Weak	Firm (dry)	Many coarse, medium, fine, very fine	–	–	–
B1	0.1 - 0.3		Clear	Medium Heavy Clay	10 YR 3/2	10 YR 7/6 faint, fine	Charcoal (5 - 10%)	2 - 10%	Subangular blocky parting to platy	Moderate	Very strong (moderately moist)	Common medium, fine, very fine	Lab	Lab	100 - 200
B2	0.3 - 1.1		Clear	Heavy Clay	7.5 YR 3/2	10 YR 6/6 distinct, fine	Charcoal (5 - 10%)	2 - 10%	Subangular blocky parting to platy	Moderate	Strong (moist)	Few medium, fine, very fine	Lab	Lab	500 - 600
B3	1.1 - 1.8		Clear	Light Medium Clay	10 YR 5/2	10 YR 6/6 many, distinct, fine	Charcoal (5 - 10%)	20 - 30%	Subangular blocky parting to platy	Moderate	Firm (moist)	Very few	–	–	–
BC	1.8 +			Light Medium Clay	10 YR 5/2	10 YR 6/6 many, distinct, fine	Nil	Not recorded	Not recorded	Moderate	Not recorded	Not recorded	–	–	–

Other information:

Suspect structure of heavy clays changes with moisture status. At time of survey clays were moist and sheared when excavated. Clods did not break when dropped from height so difficult to confirm primary structure.

Soil Profile Description

Project IA101200	**Date** 9/02/2016	**Scribe** K. Brown	**Location** Site 8	**Observation** Soil pit	**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody		**Ground Cover %** Mid-dense (30-70%)	**Aspect** South		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Dermosol
Secondary Vegetation Form Non-woody		**Ground Cover %** Sparse (10-30%)	**Slope %** 4		**Rock Outcrop** No rock outcrop	**Erosion Type** Water (sheet)	
Vegetation (species) Themeda australis, Paspalum dilatatum					**Drainage (site)** Moderately well-drained	**Erosion Extent** Minor or present	
Landform Upper slope		**Soil Surface Condition (dry)** Firm			**Land Use** Grazing	**Erosion State** Stabilised	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief N/A

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Other Information:
Ground cover ~80%

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A	0 - 0.05		Clear	Silty Clay Loam	7.5 YR 3/3	Nil	Nil	2 - 10%	Subangular blocky	Weak to moderate	Firm (dry)	Many coarse, medium, fine, very fine	–	–	–
B21	0.05 - 0.3		Abrupt	Light Medium Clay	7.5 YR 4/2 10 YR 4/3	Many, medium (7.5 YR 6/1) and (2.5 YR 4/6)	Nil	10%	Subangular blocky parting to platy	Moderate	Very strong (moderately moist)	Common medium, fine, very fine	–	–	–
B22	0.3 - 0.8		Clear	Light Medium Clay	10 YR 5/6 10 YR 5/2	Distinct grey (7.5 YR 6/1) and red (2.5 YR 4/6)	Nil	0 - 2%	Subangular blocky parting to platy	Moderate	Firm (moist)	Few medium, fine, very fine	Lab	Lab	500 - 600
B23	0.8 - 1.4+			Light Medium Clay	7.5 YR 6/1	Many coarse, distinct yellowish red (5 YR 5/8) and white (7.5YR 9.5/1)	Nil	Nil	Subangular blocky parting to platy	Moderate	Firm (moist)	Very few	Lab	Lab	1000 - 1100

Other information: Clay within B horizon is angular, rounded and smooth.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	9/02/2016	K. Brown	Site 9	Soil pit			Kurosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	North			Kurosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Woody	Very sparse (0.2-10%)	3	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Lower slope	Trampled	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Microrelief	Yes
Type	Hummocky or normal gilgai
Vertical (m)	~ 0-0.3 m
Horizontal (m)	3-10 m
Described/ sampled	Mound

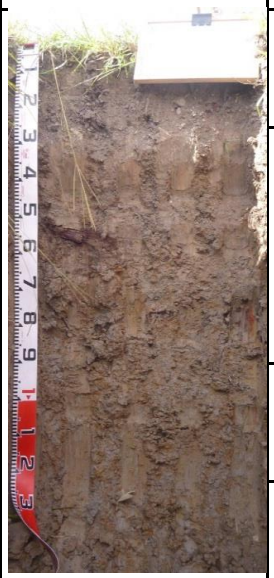
Other Information:
Mounds and depressions are evident

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A1	0 - 0.2		Abrupt	Silty Clay Loam	7.5 YR 3/3	Nil	Nil	2 - 10%	Polyhedral	Weak	Firm (dry)	Many coarse, medium, fine, very fine	Lab	Lab	100 - 100
B22	0.2-0.6		Gradual	Medium Heavy Clay	10 YR 4/3	Many coarse grey (7.5 YR 6/1) and red (2.5 YR 4/6)	Nil	2-10%	Subangular blocky parting to platy	Moderate	Very strong (moderately moist)	Many to common medium, fine, very fine	–	–	–
									Subangular blocky parting to platy	Moderate	Firm (moist)		Lab	Lab	500 - 600
B23	0.6- 1.3+		N/A	Heavy Clay	7.5 YR 6/1	Many coarse yellowish red (5 YR 5/8)	Nil	Nil	Subangular blocky parting to platy	Moderate	Firm (moist)	Few medium, fine, very fine	Lab	Lab	1000 - 1100

Other information: Pale gravel comp over red bnrown clay, over yellow brown clay.

Soil Profile Description

Project IA101200	**Date** 10/02/2016	**Scribe** K. Brown	**Location** Site 10	**Observation** Soil pit		**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Aspect** North		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Sodosol
Secondary Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Slope %** 11		**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species) Themeda australis, Paspalum dilatatum						**Drainage (site)** Moderately well-drained	**Erosion Extent** None evident	
Landform Mid-slope			**Soil Surface Condition (dry)** Firm			**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief No

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Other Information:

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0 - 0.2		Abrupt	Silty Clay Loam	7.5 YR 3/2	Nil	Nil	2 - 10%	Subangular blocky	Moderate	Very strong (dry)	Many coarse, medium, fine, very fine	Lab	Lab	0 - 200
B	0.2 - 0.8		Abrupt	Heavy Clay	10 YR 5/2	Many to common, coarse, yellowish brown (10 YR 5/8)	Many soft fragments of charcoal	2 - 10%	Angular blocky parting to platy	Moderate	Strong (moist)	Common medium, fine, very fine	Lab	Lab	500 - 600
BC	0.8 - 1.2+		N/A	Loam	2.5 Y 5/4		Nil	Clay and weathered siltstone	Apedal	Massive	Not recorded	Few medium, fine, very fine	–	–	–

Other information:

This profile has more developed structure, smooth-faced peds, evidence of clay coatings (unidentified). Weathered parent material at base of pit thought to be weathered siltstone and contributed to "loam" texture.

Soil Profile Description

Project IA101200	**Date** 10/02/2016	**Scribe** K. Brown	**Location** Site 11	**Observation** Soil pit	**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody		**Ground Cover %** Mid-dense (30-70%)	**Aspect** East		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Dermosol
Secondary Vegetation Form Non-woody		**Ground Cover %** Sparse (10-30%)	**Slope %** 2		**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species) Themeda australis, Paspalum dilatatum					**Drainage (site)** Moderately well-drained	**Erosion Extent** None evident	
Landform Lower slope		**Soil Surface Condition (dry)** Firm			**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief No

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Other Information:

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0 - 0.05		Abrupt	Clay Loam	7.5 YR 3/2	7.5 YR 5/8	Nil	2 - 10%, unidentified	Subangular blocky	Weak	Very strong (dry)	Many coarse, medium, fine, very fine	–	–	–
B1	0.05 - 0.2		Clear	Light Clay	7.5 YR 4/2	Common, faint, strong brown (7.5 YR 5/8)	Nil	2 - 10%, unidentified	Angular blocky parting to platy	Moderate	Very strong (moderately moist)	Common medium, fine, very fine	Lab	Lab	100 - 200
B2	0.2 - 0.8		Clear	Light Medium Clay	7.5 YR 4/1		Many soft fragments of charcoal	2 - 10%, unidentified	Angular blocky parting to platy	Moderate	Strong (moderately moist)	Few medium, fine, very fine	Lab	Lab	500 - 600
B3	0.8 - 1.6+			Light Medium Clay	7.5 YR 5/2		Many soft fragments of charcoal	2 - 10%, unidentified	Apedal	Massive	Weak (moderately moist)	Few fine, very fine	–	–	–

Other information:

B horizon is a dense heavy clay.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	10/02/2016	K. Brown	Site 12	Soil pit			Kurosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	South			Kurosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Mid-dense (30-70%)	4	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Lower slope	Firm	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief Yes

Type Hummocky or normal gilgai

Vertical (m) 0-0.2 m

Horizontal (m) 1-2 m

Described/ sampled Mound

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information:

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0 - 0.15		Abrupt	Silty Clay Loam	7.5 YR 3/2	Nil	Nil	Unidentified and varied lithologies, smooth and rounded as well as angular	Subangular blocky	Weak to moderate	Very strong (dry)	Many coarse, medium, fine, very fine	Lab	Lab	0 - 150
B2	0.15 - 1.2		Gradual	Medium Heavy Clay	7.5 YR 5/1	Fine, many, faint yellowish red (5 YR 5/6) and red (2.5YR 4/6, 10R 4/6)	Nil		Subangular blocky parting to platy	Moderate	Firm (moist)	Common medium, fine, very fine	Lab	Lab	600 - 700
B3	1.2 - 2.1+			Medium Heavy Clay	7.5 YR 5/2		Nil			Moderate	Firm (moist)	Very few fine, very fine	–	–	–

Other information:

Abundant coarse fragments from 0.1-0.15 m (above the B horizon). Yellow grey/brown mottled clay to grey/red mottled clay with signs of weathering at depth.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
IA101200	10/02/2016	K. Brown	Site 13	Soil pit			Kurosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Non-woody	Mid-dense (30-70%)	South-east			Kurosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Mid-dense (30-70%)	3	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
Themeda australis, Paspalum dilatatum	Moderately well-drained	None evident

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Upper slope	Firm	Grazing	None evident

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief N/A

Type

Vertical (m)

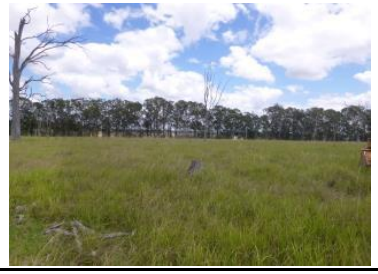
Horizontal (m)

Described/ sampled

Other Information:

Landscape Photo (South)

Landscape Photo (West)



Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0 - 0.2		Sharp	Silty Clay Loam	7.5 YR 4/2	Nil	Nil	Unidentified and varied lithologies, smooth and rounded as well as angular	Subangular blocky	Moderate	Very strong (dry)	Many coarse, medium, fine, very fine	Lab	Lab	100 - 200
B21	0.2 - 0.8		Gradual	Medium Heavy Clay	7.5 YR 4/1	Many, coarse (10 YR 5/6)and common medium (2.5 YR 4/6)	Nil		`	Moderate	Firm (moist)	Few medium, fine, very fine	Lab	Lab	600 - 700
B22	0.8 - 1.2		Clear	Medium Heavy Clay	7.5 YR 5/2		Nil				Firm (moist)	Very few fine, very fine	–	–	–
B23	1.2-2.1			Medium Heavy Clay	7.5 YR 5/2		Nil				Firm (moist)	Not recorded	–	–	–
End of Pit	2.1			Parent material thought to be siltstone											

Other information:

Abundant coarse fragments from 0.1-0.2 m (above the B horizon). Coarse fragments rounded and smooth, with angular rock fragments (potentially siltstone) present.

Soil Profile Description

Project IA101200	**Date** 10/02/2016	**Scribe** K. Brown	**Location** Site 14	**Observation** Soil pit		**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Aspect** South		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Kurosol
Secondary Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Slope %** 3		**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species) Themeda australis, Paspalum dilatatum						**Drainage (site)** Moderately well-drained	**Erosion Extent** None evident	
Landform Lower slope			**Soil Surface Condition (dry)** Firm			**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief No

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Other Information:

Landscape Photo (South)

Landscape Photo (West)

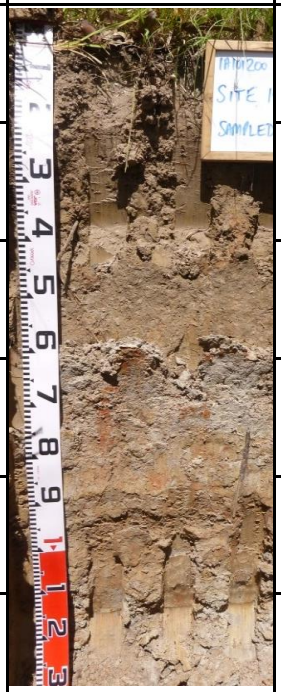
Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A	0-0.1		Abrupt	Silty Clay Loam	7.5 YR 3/2	Nil	Nil	Nil	Subangular blocky	Moderate	Very strong (dry)	Many coarse, medium, fine, very fine	–	–	–
B1	0.1-0.4		Clear	Medium Heavy Clay	Grey (7.5 YR 5/1)	Many, medium to coarse distinct yellowish red (5 YR 5/6) and red (2.5YR 4/6, 10R 4/6)	Nil	Unidentified and varied lithologies, smooth and rounded as well as angular	Subangular blocky parting to platy	Moderate	Firm (moist)	Common medium, fine, very fine	Lab	Lab	0.5-0.6 (QC1)
B2	0.4-0.6		Clear	Medium Heavy Clay	7.5 YR 5/2		Nil				Firm (moist)	Very few fine, very fine	Lab	Lab	1200
B3	0.6-1.2+			Medium Clay	7.5 YR 5/2						Firm (moist)	Very few fine, very fine			

Other information:
Appears similar to Site 12.

Soil Profile Description

Project IA101200	**Date** 10/02/2016	**Scribe** K. Brown	**Location** Site 15	**Observation** Soil pit		**Easting/ Latitude**	**Zone**	**ASC Mapped** Kurosol
Dominant Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Aspect** East		**Northing/ Longitude**	**Scale**	**ASC Ground Truth** Dermosol
Secondary Vegetation Form Non-woody			**Ground Cover %** Mid-dense (30-70%)	**Slope %** 9		**Rock Outcrop** No rock outcrop	**Erosion Type** None evident	
Vegetation (species) Themeda australis, Paspalum dilatatum						**Drainage (site)** Moderately well-drained	**Erosion Extent** None evident	
Landform Mid-slope			**Soil Surface Condition (dry)** Firm			**Land Use** Grazing	**Erosion State** None evident	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief None

Type

Vertical (m)

Horizontal (m)

Described/ sampled

Other Information:

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

Horizon	Depth (m)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (m)
A	0-0.1		Abrupt	Light Medium Clay	Dark brown (7.5YR 3/3)	Nil	Nil	2-5% (2-5 mm) unidentified subangular	Subangular blocky	Moderate	Very strong (dry)	Many coarse, medium, fine, very fine	Lab	Lab	0.01-0.02 (QC2)
B21	0.1-0.35		Clear	Medium Heavy Clay	Brown (7.5YR 4/3)	Few, medium red (2.5YR 5/6)	Nil	5-10% (5-10 mm) unidentified subangular	Subangular blocky parting to platy	Moderate	Very strong (moderately moist)	Common medium, fine, very fine	_	_	0.2-0.3
B22	0.35-1.2+		Gradual	Medium Heavy Clay	Yellowish brown (10YR 5/6)	Few, medium red (2.5YR 5/6)	Nil	2-10% (5-10 mm) unidentified subangular		Moderate	Very strong (moist)	Few fine, very fine	Lab	Lab	0.6-0.7

Other information: Brown clay from 0 - 100 mm, transiting to mottled brown/red/yellow zone. Shifts to yellow clay past 400 mm.

Appendix B. Laboratory results

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email: sydney@envirolab.com.au
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Envirolab Services Pty Ltd - Sydney | ABN 37 112 535 645

CERTIFICATE OF ANALYSIS 141708

Client:

Jacobs Group (Australia) Pty Ltd (Newcastle)
710 Hunter St
Newcastle West
NSW 2302

Attention: Isaac Kelder

Sample log in details:

Your Reference:	**IA101200 - Land Capability & Salinity**
No. of samples:	34 Soils
Date samples received / completed instructions received	12/02/16 / 12/02/16

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by: / Issue Date:	2/03/16 / 2/03/16
Date of Preliminary Report:	None Issued

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

Misc Inorg - Soil						
Our Reference:	UNITS	141708-1	141708-2	141708-3	141708-4	141708-5
Your Reference	---------- -	Site 1 A	Site 1 B	Site 2 A	Site 2 B	Site 3 A
Depth	----------	0.00-0.05	0.06-0.07	0.00-0.08	0.50-0.60	0.35-0.70
Date Sampled		8/02/2016	8/02/2016	8/02/2016	8/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	27	170	20	280	230
Sulphate, SO4 1:5 soil:water	mg/kg	20	93	<10	110	34
pH 1:5 soil:water	pH Units	5.9	5.4	5.8	5.2	5.1
Electrical Conductivity 1:5 soil:water	µS/cm	74	210	49	270	210
Resistivity in soil*	ohm m	130	47	200	37	48
Emerson Class No.	-	8	1	8	1	3b

Misc Inorg - Soil						
Our Reference:	UNITS	141708-6	141708-7	141708-8	141708-9	141708-10
Your Reference	---------- -	Site 3 B	Site 4 A	Site 4 B	Site 5 A	Site 5 B
Depth	----------	0.90-1.00	0.15-0.25	0.50-0.60	0.15-0.25	0.70-0.80
Date Sampled		9/02/2016	9/02/2016	9/02/2016	9/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	470	49	320	20	140
Sulphate, SO4 1:5 soil:water	mg/kg	160	<10	93	<10	69
pH 1:5 soil:water	pH Units	4.9	5.7	5.6	5.9	5.3
Electrical Conductivity 1:5 soil:water	µS/cm	490	85	330	44	190
Resistivity in soil*	ohm m	20	120	30	230	54
Emerson Class No.	-	3b	3b	2	3a	3a

Misc Inorg - Soil						
Our Reference:	UNITS	141708-11	141708-12	141708-13	141708-14	141708-15
Your Reference	---------- -	Site 6 A	Site 6 B	Site 7 A	Site 7 B	Site 8 A
Depth	----------	0.20-0.30	0.70-0.80	0.10-0.20	-	0.50-0.60
Date Sampled		9/02/2016	9/02/2016	9/02/2016	9/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	23	430	110	580	68
Sulphate, SO4 1:5 soil:water	mg/kg	10	130	32	85	29
pH 1:5 soil:water	pH Units	5.4	4.8	5.4	4.8	5.3
Electrical Conductivity 1:5 soil:water	µS/cm	62	480	130	490	100
Resistivity in soil*	ohm m	160	21	75	21	96
Emerson Class No.	-	3a	3b	3a	6	3b

Misc Inorg - Soil						
Our Reference:	UNITS	141708-16	141708-17	141708-18	141708-19	141708-20
Your Reference	---------- -	Site 8 B	Site 9 A	Site 9 B	Site 9 C	Site 10 A
Depth	----------	1.00-1.10	0.10-0.20	0.50-0.60	1.00-1.10	0.00-0.20
Date Sampled		9/02/2016	10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	680	74	380	860	10
Sulphate, SO4 1:5 soil:water	mg/kg	110	10	24	150	<10
pH 1:5 soil:water	pH Units	4.8	5.6	4.9	4.7	5.6
Electrical Conductivity 1:5 soil:water	µS/cm	560	100	290	640	130
Resistivity in soil*	ohmm	18	97	34	35	16
Emerson Class No.	-	6	5	6	6	5

Misc Inorg - Soil						
Our Reference:	UNITS	141708-21	141708-22	141708-23	141708-24	141708-25
Your Reference	---------- -	Site 10 B	Site 11 A	Site 11 B	Site 12 A	Site 12 B
Depth	----------	0.50-0.60	0.10-0.20	0.50-0.60	0.00-0.15	0.60-0.70
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	45	59	130	20	600
Sulphate, SO4 1:5 soil:water	mg/kg	<10	10	52	<10	110
pH 1:5 soil:water	pH Units	5.8	5.7	5.3	5.9	4.9
Electrical Conductivity 1:5 soil:water	µS/cm	73	120	300	35	550
Resistivity in soil*	ohmm	110	93	38	310	19
Emerson Class No.	-	3b	8	1	8	2

Misc Inorg - Soil						
Our Reference:	UNITS	141708-26	141708-27	141708-28	141708-29	141708-30
Your Reference	---------- -	Site 13 A	Site 13 B	Site 14 A	Site 14 B	Site 15 A
Depth	----------	0.10-0.20	0.60-0.70	0.50-0.60	1.2	0.10-0.20
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	20	390	550	380	<10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	190	260	210	<10
pH 1:5 soil:water	pH Units	6.1	5.2	5.1	5.1	5.7
Electrical Conductivity 1:5 soil:water	µS/cm	110	430	600	430	79
Resistivity in soil*	ohmm	120	24	17	24	170
Emerson Class No.	-	8	3b	6	6	8

Misc Inorg - Soil					
Our Reference:	UNITS	141708-31	141708-32	141708-33	141708-34
Your Reference	---------- -	Site 15 B	Site 15 C	QC1	QC2
Depth	----------	0.3	0.60-0.70	-	-
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	17/02/2016	17/02/2016	17/02/2016	17/02/2016
Date analysed	-	18/02/2016	18/02/2016	18/02/2016	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	10	500	590	10
Sulphate, SO4 1:5 soil:water	mg/kg	<10	59	320	<10
pH 1:5 soil:water	pH Units	5.8	6.9	5.0	5.8
Electrical Conductivity 1:5 soil:water	µS/cm	57	470	620	61
Resistivity in soil*	ohm m	180	21	16	160
Emerson Class No.	-	8	5	6	8

ESP/CEC Our Reference: Your Reference	UNITS ----------	141708-1 Site 1 A	141708-2 Site 1 B	141708-3 Site 2 A	141708-4 Site 2 B	141708-5 Site 3 A
	-					
Depth	----------	0.00-0.05	0.06-0.07	0.00-0.08	0.50-0.60	0.35-0.70
Date Sampled		8/02/2016	8/02/2016	8/02/2016	8/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	3.7	0.8	3.6	0.2	0.4
Exchangeable K	meq/100g	0.7	<0.1	0.2	<0.1	0.2
Exchangeable Mg	meq/100g	6.4	5.0	4.2	1.8	7.7
Exchangeable Na	meq/100g	0.37	1.1	0.49	0.73	2.3
Cation Exchange Capacity	meq/100g	11	7.0	8.6	2.8	11
ESP	%	3	16	6	26	22

ESP/CEC Our Reference: Your Reference	UNITS ----------	141708-6 Site 3 B	141708-7 Site 4 A	141708-8 Site 4 B	141708-9 Site 5 A	141708-10 Site 5 B
	-					
Depth	----------	0.90-1.00	0.15-0.25	0.50-0.60	0.15-0.25	0.70-0.80
Date Sampled		9/02/2016	9/02/2016	9/02/2016	9/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	<0.1	3.5	0.6	0.7	0.2
Exchangeable K	meq/100g	<0.1	0.2	0.1	<0.1	0.1
Exchangeable Mg	meq/100g	2.7	8.7	6.9	6.5	7.7
Exchangeable Na	meq/100g	1.3	0.85	1.8	1.2	2.0
Cation Exchange Capacity	meq/100g	4.1	13	9.3	8.5	10
ESP	%	32	6	19	14	20

ESP/CEC Our Reference: Your Reference	UNITS ----------	141708-11 Site 6 A	141708-12 Site 6 B	141708-13 Site 7 A	141708-14 Site 7 B	141708-15 Site 8 A
	-					
Depth	----------	0.20-0.30	0.70-0.80	0.10-0.20	-	0.50-0.60
Date Sampled		9/02/2016	9/02/2016	9/02/2016	9/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	3.9	<0.1	0.1	<0.1	1.8
Exchangeable K	meq/100g	0.3	<0.1	0.1	<0.1	0.2
Exchangeable Mg	meq/100g	8.7	2.2	5.9	3.0	9.8
Exchangeable Na	meq/100g	1.3	1.5	1.9	1.5	1.4
Cation Exchange Capacity	meq/100g	14	3.7	8.1	4.6	13
ESP	%	9	39	24	33	11

ESP/CEC						
Our Reference:	UNITS	141708-16	141708-17	141708-18	141708-19	141708-20
Your Reference	---------- -	Site 8 B	Site 9 A	Site 9 B	Site 9 C	Site 10 A
Depth	----------	1.00-1.10	0.10-0.20	0.50-0.60	1.00-1.10	0.00-0.20
Date Sampled		9/02/2016	10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	0.6	6.0	1.4	1.2	12
Exchangeable K	meq/100g	0.1	0.2	<0.1	<0.1	0.4
Exchangeable Mg	meq/100g	12	2.2	5.6	7.8	5.2
Exchangeable Na	meq/100g	3.9	0.20	1.5	3.3	0.45
Cation Exchange Capacity	meq/100g	16	8.6	8.6	12	18
ESP	%	24	2	17	27	3

ESP/CEC						
Our Reference:	UNITS	141708-21	141708-22	141708-23	141708-24	141708-25
Your Reference	---------- -	Site 10 B	Site 11 A	Site 11 B	Site 12 A	Site 12 B
Depth	----------	0.50-0.60	0.10-0.20	0.50-0.60	0.00-0.15	0.60-0.70
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	5.5	5.1	0.2	3.7	0.1
Exchangeable K	meq/100g	0.2	0.1	<0.1	0.1	<0.1
Exchangeable Mg	meq/100g	9.7	4.7	1.4	2.5	1.6
Exchangeable Na	meq/100g	1.5	0.78	0.69	0.25	0.96
Cation Exchange Capacity	meq/100g	17	11	2.3	6.5	2.7
ESP	%	9	7	29	4	35

ESP/CEC						
Our Reference:	UNITS	141708-26	141708-27	141708-28	141708-29	141708-30
Your Reference	---------- -	Site 13 A	Site 13 B	Site 14 A	Site 14 B	Site 15 A
Depth	----------	0.10-0.20	0.60-0.70	0.50-0.60	1.2	0.10-0.20
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	8.7	1.5	0.7	2.7	11
Exchangeable K	meq/100g	0.3	<0.1	<0.1	0.1	0.2
Exchangeable Mg	meq/100g	4.5	11	3.5	11	7.1
Exchangeable Na	meq/100g	0.31	3.3	1.1	2.5	0.45
Cation Exchange Capacity	meq/100g	14	16	5.3	17	19
ESP	%	2	21	20	15	2

ESP/CEC Our Reference: Your Reference	UNITS ----------	141708-31 Site 15 B	141708-32 Site 15 C	141708-33 QC1	141708-34 QC2
	-				
Depth	----------	0.3	0.60-0.70	-	-
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Date analysed	-	19/02/2016	19/02/2016	19/02/2016	19/02/2016
Exchangeable Ca	meq/100g	12	9.4	2.2	12
Exchangeable K	meq/100g	0.2	<0.1	<0.1	0.2
Exchangeable Mg	meq/100g	8.7	16	11	9.9
Exchangeable Na	meq/100g	0.70	5.5	2.9	0.96
Cation Exchange Capacity	meq/100g	22	31	16	23
ESP	%	3	18	18	4

Particle Size Distribution in Soils						
Our Reference:	UNITS	141708-3	141708-4	141708-7	141708-8	141708-11
Your Reference	---------- -	Site 2 A	Site 2 B	Site 4 A	Site 4 B	Site 6 A
Depth	----------	0.00-0.08	0.50-0.60	0.15-0.25	0.50-0.60	0.20-0.30
Date Sampled		8/02/2016	8/02/2016	9/02/2016	9/02/2016	9/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	24/02/2016	24/02/2016	24/02/2016	24/02/2016	24/02/2016
Date analysed	-	24/02/2016	24/02/2016	24/02/2016	24/02/2016	24/02/2016
Cobbles >75mm	%	<1	<1	<1	<1	<1
Cobbles/Coarse Gravel 63-75mm	%	<1	<1	<1	<1	<1
Coarse Gravel 37.5-63mm	%	<1	<1	<1	<1	<1
Coarse Gravel 26.5-37.5mm	%	<1	<1	<1	<1	<1
Coarse Gravel 19-26.5mm	%	<1	<1	<1	<1	<1
Medium Gravel 13.2-19mm	%	<1	<1	<1	<1	<1
Medium Gravel 9.5-13.2mm	%	<1	<1	<1	<1	<1
Medium Gravel 6.7-9.5mm	%	<1	<1	<1	<1	<1
Medium Gravel 4.75-6.7mm	%	1	<1	<1	<1	<1
Fine Gravel 2.36-4.75mm	%	4	<1	2	1	3
Very Coarse Sand 1.18-2.36mm	%	<1	2	2	<1	1
Coarse Sand 0.6-1.18mm	%	<1	3	2	<1	2
Medium Sand 0.425-0.6mm	%	2	1	<1	<1	<1
Medium Sand 0.3-0.425mm	%	<1	1	<1	<1	1
Fine Sand 0.15-0.3mm	%	16	11	6	<1	35
Very Fine Sand 0.075-0.15mm	%	14	20	18	14	20
Coarse Silt 0.020-0.075mm	%	16	15	27	16	8
Fine Silt 0.002-0.020mm	%	24	24	10	19	7
Clay <0.002mm	%	21	21	32	47	22

Particle Size Distribution in Soils						
Our Reference:	UNITS	141708-12	141708-15	141708-16	141708-20	141708-21
Your Reference	---------- -	Site 6 B	Site 8 A	Site 8 B	Site 10 A	Site 10 B
Depth	----------	0.70-0.80	0.50-0.60	1.00-1.10	0.00-0.20	0.50-0.60
Date Sampled		9/02/2016	9/02/2016	9/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	24/02/2016	24/02/2016	24/02/2016	24/02/2016	24/02/2016
Date analysed	-	24/02/2016	24/02/2016	24/02/2016	24/02/2016	24/02/2016
Cobbles >75mm	%	<1	<1	<1	<1	<1
Cobbles/Coarse Gravel 63-75mm	%	<1	<1	<1	<1	<1
Coarse Gravel 37.5-63mm	%	<1	<1	<1	<1	<1
Coarse Gravel 26.5-37.5mm	%	<1	<1	<1	<1	<1
Coarse Gravel 19-26.5mm	%	<1	<1	<1	<1	<1
Medium Gravel 13.2-19mm	%	<1	<1	<1	<1	<1
Medium Gravel 9.5-13.2mm	%	<1	<1	<1	<1	<1
Medium Gravel 6.7-9.5mm	%	<1	<1	<1	<1	2
Medium Gravel 4.75-6.7mm	%	<1	<1	<1	1	<1
Fine Gravel 2.36-4.75mm	%	<1	<1	<1	<1	2
Very Coarse Sand 1.18-2.36mm	%	<1	<1	<1	<1	<1
Coarse Sand 0.6-1.18mm	%	<1	<1	<1	<1	<1
Medium Sand 0.425-0.6mm	%	<1	<1	<1	<1	<1
Medium Sand 0.3-0.425mm	%	<1	<1	<1	<1	<1
Fine Sand 0.15-0.3mm	%	34	28	25	27	23
Very Fine Sand 0.075-0.15mm	%	13	26	28	15	25
Coarse Silt 0.020-0.075mm	%	9	13	15	29	12
Fine Silt 0.002-0.020mm	%	5	7	5	11	6
Clay <0.002mm	%	37	24	26	15	29

Particle Size Distribution in Soils					
Our Reference:	UNITS	141708-24	141708-25	141708-28	141708-29
Your Reference	----------	Site 12 A	Site 12 B	Site 14 A	Site 14 B
	-				
Depth	----------	0.00-0.15	0.60-0.70	0.50-0.60	1.2
Date Sampled		10/02/2016	10/02/2016	10/02/2016	10/02/2016
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	24/02/2016	24/02/2016	24/02/2016	24/02/2016
Date analysed	-	24/02/2016	24/02/2016	24/02/2016	24/02/2016
Cobbles >75mm	%	<1	<1	<1	<1
Cobbles/Coarse Gravel 63-75mm	%	<1	<1	<1	<1
Coarse Gravel 37.5-63mm	%	<1	<1	<1	<1
Coarse Gravel 26.5-37.5mm	%	<1	<1	<1	<1
Coarse Gravel 19-26.5mm	%	<1	<1	<1	<1
Medium Gravel 13.2-19mm	%	<1	<1	<1	<1
Medium Gravel 9.5-13.2mm	%	<1	<1	<1	<1
Medium Gravel 6.7-9.5mm	%	3	<1	<1	<1
Medium Gravel 4.75-6.7mm	%	<1	1	<1	<1
Fine Gravel 2.36-4.75mm	%	4	2	<1	<1
Very Coarse Sand 1.18-2.36mm	%	9	1	<1	<1
Coarse Sand 0.6-1.18mm	%	3	<1	2	<1
Medium Sand 0.425-0.6mm	%	2	<1	1	<1
Medium Sand 0.3-0.425mm	%	4	<1	<1	1
Fine Sand 0.15-0.3mm	%	12	28	13	22
Very Fine Sand 0.075-0.15mm	%	13	15	21	23
Coarse Silt 0.020-0.075mm	%	23	12	19	11
Fine Silt 0.002-0.020mm	%	15	7	16	10
Clay <0.002mm	%	13	31	27	32

Method ID	Methodology Summary
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Alternatively determined by colourimetry/turbidity using Discrete Analyer.
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity.
Ext-037	Analysed by Sydney Environmental & Soil Laboratory
Metals-009	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.
Inorg-107	Particle Size Distribution using AS1269.3.6.3 and AS1269.3.6.1 and in house INORG-107.

QUALITY CONTROL Misc Inorg - Soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			17/02/2016	141708-1	17/02/2016 || 17/02/2016	LCS-1	17/02/2016
Date analysed	-			18/02/2016	141708-1	18/02/2016 || 18/02/2016	LCS-1	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	141708-1	27 || 33 || RPD: 20	LCS-1	97%
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	141708-1	20 || 20 || RPD: 0	LCS-1	107%
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	141708-1	5.9 || 5.8 || RPD: 2	LCS-1	100%
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	141708-1	74 || 82 || RPD: 10	LCS-1	104%
Resistivity in soil*	ohm m	1	Inorg-002	<1.0	141708-1	130 || 120 || RPD: 8	[NR]	[NR]
Emerson Class No.	-	0	Ext-037	0	141708-1	8 || [N/T]	[NR]	[NR]

QUALITY CONTROL ESP/CEC	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			19/02/2016	141708-6	19/02/2016 || 19/02/2016	LCS-1	19/02/2016
Date analysed	-			19/02/2016	141708-6	19/02/2016 || 19/02/2016	LCS-1	19/02/2016
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	141708-6	<0.1 || <0.1	LCS-1	105%
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	141708-6	<0.1 || <0.1	LCS-1	101%
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	141708-6	2.7 || 2.3 || RPD: 16	LCS-1	102%
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	141708-6	1.3 || 1.2 || RPD: 8	LCS-1	96%
ESP	%	1	Metals-009	<1	141708-6	32 || 33 || RPD: 3	[NR]	[NR]

QUALITY CONTROL Particle Size Distribution in Soils	UNITS	PQL	METHOD	Blank
Date prepared	-			24/02/2016
Date analysed	-			24/02/2016

QUALITY CONTROL Misc Inorg - Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	141708-11	17/02/2016 || 17/02/2016	LCS-2	17/02/2016
Date analysed	-	141708-11	18/02/2016 || 18/02/2016	LCS-2	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	141708-11	23 || 25 || RPD: 8	LCS-2	97%
Sulphate, SO4 1:5 soil:water	mg/kg	141708-11	10 || <10	LCS-2	113%
pH 1:5 soil:water	pH Units	141708-11	5.4 || 5.4 || RPD: 0	LCS-2	100%
Electrical Conductivity 1:5 soil:water	µS/cm	141708-11	62 || 63 || RPD: 2	LCS-2	103%
Resistivity in soil*	ohm m	141708-11	160 || 160 || RPD: 0	[NR]	[NR]

QUALITY CONTROL ESP/CEC	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	141708-18	19/02/2016 || 19/02/2016	LCS-2	19/02/2016
Date analysed	-	141708-18	19/02/2016 || 19/02/2016	LCS-2	19/02/2016
Exchangeable Ca	meq/100 g	141708-18	1.4 || 1.6 || RPD: 13	LCS-2	105%
Exchangeable K	meq/100 g	141708-18	<0.1 || 0.1	LCS-2	97%
Exchangeable Mg	meq/100 g	141708-18	5.6 || 6.1 || RPD: 9	LCS-2	102%
Exchangeable Na	meq/100 g	141708-18	1.5 || 1.6 || RPD: 6	LCS-2	90%
ESP	%	141708-18	17 || 17 || RPD: 0	[NR]	[NR]
QUALITY CONTROL Misc Inorg - Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	141708-21	17/02/2016 || 17/02/2016	141708-3	17/02/2016
Date analysed	-	141708-21	18/02/2016 || 18/02/2016	141708-3	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	141708-21	45 || 42 || RPD: 7	141708-3	79%
Sulphate, SO4 1:5 soil:water	mg/kg	141708-21	<10 || <10	141708-3	82%
pH 1:5 soil:water	pH Units	141708-21	5.8 || 5.9 || RPD: 2	[NR]	[NR]
Electrical Conductivity 1:5 soil:water	µS/cm	141708-21	73 || 68 || RPD: 7	[NR]	[NR]
Resistivity in soil*	ohm m	141708-21	110 || 150 || RPD: 31	[NR]	[NR]

QUALITY CONTROL ESP/CEC	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	141708-27	19/02/2016 || 19/02/2016
Date analysed	-	141708-27	19/02/2016 || 19/02/2016
Exchangeable Ca	meq/100 g	141708-27	1.5 || 1.4 || RPD: 7
Exchangeable K	meq/100 g	141708-27	<0.1 || <0.1
Exchangeable Mg	meq/100 g	141708-27	11 || 11 || RPD: 0
Exchangeable Na	meq/100 g	141708-27	3.3 || 3.2 || RPD: 3
ESP	%	141708-27	21 || 21 || RPD: 0

QUALITY CONTROL Misc Inorg - Soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	141708-31	17/02/2016 || 17/02/2016	141708-22	17/02/2016
Date analysed	-	141708-31	18/02/2016 || 18/02/2016	141708-22	18/02/2016
Chloride, Cl 1:5 soil:water	mg/kg	141708-31	10 || 10 || RPD: 0	141708-22	89%
Sulphate, SO4 1:5 soil:water	mg/kg	141708-31	<10 || <10	141708-22	80%
pH 1:5 soil:water	pH Units	141708-31	5.8 || 5.8 || RPD: 0	[NR]	[NR]
Electrical Conductivity 1:5 soil:water	µS/cm	141708-31	57 || 52 || RPD: 9	[NR]	[NR]
Resistivity in soil*	ohm m	141708-31	180 || 190 || RPD: 5	[NR]	[NR]

QUALITY CONTROL ESP/CEC	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD
Date prepared	-	141708-33	19/02/2016 || 19/02/2016
Date analysed	-	141708-33	19/02/2016 || 19/02/2016
Exchangeable Ca	meq/100 g	141708-33	2.2 || 2.1 || RPD: 5
Exchangeable K	meq/100 g	141708-33	<0.1 || <0.1
Exchangeable Mg	meq/100 g	141708-33	11 || 10 || RPD: 10
Exchangeable Na	meq/100 g	141708-33	2.9 || 2.7 || RPD: 7
ESP	%	141708-33	18 || 18 || RPD: 0

Report Comments:

Emerson Class analysed by East West. Report No.EW160333.
3b=Moderate to slight dispersion of the remould. 3a=Severe dispersion of the remould.
Please note: sample 22 showed moderate dispersion even though the ped did not slake.

PSD fractions may not add to exactly 100% due to rounding effect.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NR: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.