BASELINE SOIL ASSESSMENT: NOLANS PROJECT

Arafura Resources Limited

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EXECUTIVE SUMMARY

Arafura Resources Limited (Arafura) required characterisation and mapping of the soils for areas subject to the mining approvals' process as part of the Nolans Project (the Project). The total survey area size is approximately 1,436ha.

A desktop assessment was undertaken prior to commencing field works, to construct a baseline conceptual model of the soil and landscape characteristics of the study area. It identified the preliminary mapping units (PMUs) that would require ground observations (point sampling of soil profiles) during the fieldwork. A total of 24 pit locations were proposed, meeting the requirements of a 1:50,000 scale soil survey for areas likely to be disturbed by the mining activities, and a 1:100,000 scale soil survey for areas outside the main disturbance footprint.

Soils assessed within the three study areas are more similar than they are different. They are all free drained, loamy, non-saline, non-sodic, low fertility, friable earths. The main point of difference that is likely to have management implications is the depth to parent rock, and the associated presence/absence of rock fragments within the soil profile.

The soils from each pit/observation location have been classified into four Soil Profile Classes (SPC), each of which have been extrapolated into polygons termed Soil Mapping Units (SMU), based on having common SPC properties. All SMUs and SPCs exhibit some soil variation. However, they share key morphological and management related characteristics. Map production was based on soil point data, field observations, the preliminary mapping unit process and topographic modelling.

Soil profile classes

Soil Profile Class	Description	Total area covered (Ha)	Land area covered (%)
A	Red earth over rock	841	59%
AS	Red earth over rock, shallow version		
B	Red earth- deep	565	39%
C	Calcareous brown earth	30	2%

With appropriate management, the soils of the study areas present few limitations for plant growth and use in rehabilitation.

1 INTRODUCTION

Arafura Resources Limited (Arafura) required characterisation and mapping of the soils for areas subject to the mining approvals' process as part of the Nolans Project (the Project). This report describes the methodology for the soil survey, and resulting soil pit descriptions and soil profile class (SPC) distribution, and the Soil Management Units (SMUs) identified. The objective of the report is to provide baseline soil capability information.

The area to be investigated is referred to as the 'survey area' and is shown by the red polygons in Figure 1. The total survey area size is approximately 1,436 ha.

2 METHODOLOGY

The methodology adopted for the survey is detailed in this section.

2.1 References and guidelines

The soil survey was developed in reference to the following guidelines:

- Australian Soil and Land Survey: Guidelines for Survey Soil and Land Resources (McKenzie, Grundy, Webster, & Ringrose-Voase, 2008);
- Australian Soil Classification (Isbell, 2002); and
- Australian Soil Survey and Land Survey Field Handbook (National Committee on Soil and Terrain, 2009).

2.2 Desktop assessment

A desktop assessment was undertaken prior to commencing field works, to construct a baseline conceptual model of the soil and landscape characteristics of the study area. It identified the preliminary mapping units (PMUs) that would require ground observations (point sampling of soil profiles) during the fieldwork. The review of existing information identified tracts of land that were expected to share similar features that can be separated from neighbouring tracts of land with a different pattern of attributes. The desktop review included:

- Review of the available topographic, geological and radiometric data, and existing soil and land systems mapping and associated reports for the survey area and surrounding region;
- Review of the aerial imagery of the study area; and
- Identification of PMUs for validation during fieldwork.

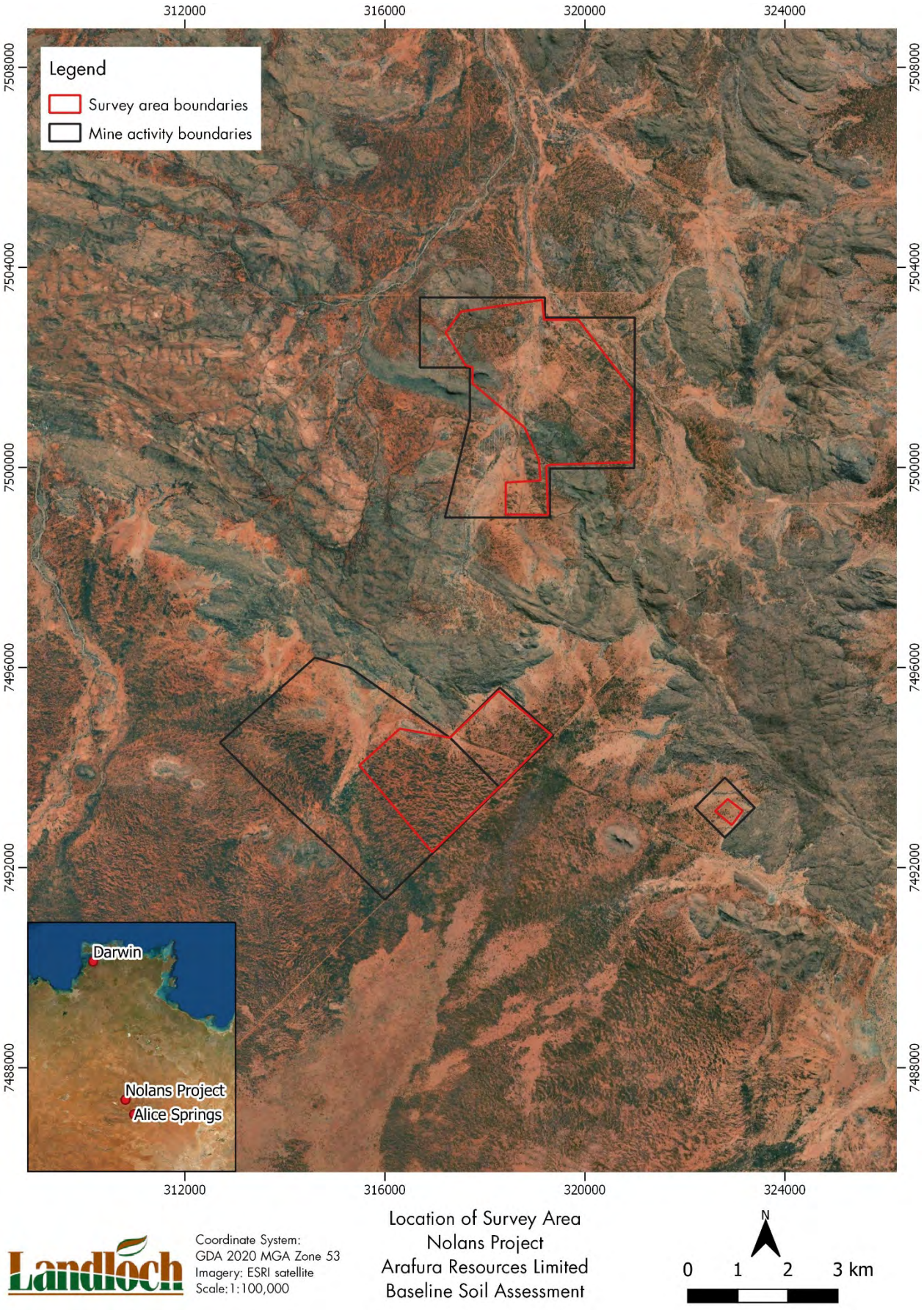


Figure 1: Location of the survey area

Listed below are the information sources referred to in the preliminary desktop component of this study:

- Project boundaries supplied by the client;
- Aerial imagery from Google Earth (2021);
- Digital elevation model (DEM) (Gallant, et al., 2011);
- Previously assessed soil mapping data (CSIRO, 2020);
- Radiometric data from Geoscience Australia (Geoscience Australia, 2015); and
- Climate data downloaded from SILO (Qld Government, 2021)

2.3 Fieldwork

The fieldwork targeted the PMUs identified in the desktop assessment. A total of 24 pit locations were proposed, meeting the requirements of a 1:50,000 scale soil survey for areas likely to be disturbed by the mining activities, and a 1:100,000 scale soil survey for areas outside the main disturbance footprint (McKenzie, Grundy, Webster, & Ringrose-Voase, 2008).

Data were collected from all ground observation sites in accordance with the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009). At all sites, these data included, but were not limited to:

- Geospatial location;
- Land use management;
- Landscape attributes (landform, land use, erosion, micro-relief); and
- Soil surface condition.

Refer to Appendix A for a summary of the surface descriptions collected in the field.

Full morphological descriptions included collecting and recording the following details:

- Horizon depths and designation;
- Horizon boundary distinctness;
- Field texture;
- Colour (Munsell chart) and mottles;
- Pedality and structure;
- Soil consistence and strength;
- Root development;
- Coarse fragments and segregations; and
- Field dispersion on selected samples.

Detailed soil profile descriptions were observed to depths of 1.5 m, or backhoe refusal. Refer to Appendix A for a summary of the soil profile descriptions and results of field tests.

2.4 Laboratory analysis

East West Laboratories (East West) at Tamworth, NSW, undertook laboratory analysis. East West is a National Association of Testing Authorities (NATA) and Australian Soil and Plant Analysis Council (ASPAC) accredited laboratory. The typical analytical suite for the soils includes:

- **Topsoil suite:** pH (1:5 water), electrical conductivity (EC) (1:5 water), Chloride, exchangeable cations, exchangeable sodium percentage (ESP), effective cation exchange capacity (ECEC), organic Carbon, total Nitrogen, Colwell Phosphorus and Potassium, total Phosphorus, available (KCl) Sulphur, and trace elements (B, Cu, Zn, Mn, and Fe);
- **Subsoil suite:** pH, EC, Chloride, exchangeable cations exchangeable sodium percentage (ESP), and effective cation exchange capacity (ECEC).

Appendix B presents the results of the laboratory analyses.

2.5 Soil classification and map production

The soil at each site was classified using the Australian Soil Classification system (Isbell, 2002), to a sub-order level. Soils with comparable profiles determined by similar morphological properties, physicochemical properties, parent material, representative landforms, and geomorphological position in the landscape were grouped into soil profile classes (SPCs) (McKenzie, Grundy, Webster, & Ringrose-Voase, 2008). Map production was based on soil point data, field observations, the preliminary mapping unit process and topographic modelling.

3 DESKTOP DATA REVIEW

3.1 Climate

The site has a hot, arid climate. Temperatures in the summer months range between an average minimum of 21° C and an average maximum of 36° C. In the winter months, temperatures range between an average minimum of 5° C and an average maximum of 24° C. The distribution of rainfall is strongly summer dominant, with an average annual rainfall of approximately 300mm, and a median annual rainfall of approximately 130mm. The difference between the average and the median annual rainfalls reflects a dry climate with the rare occurrence of high rainfall events. Table 1 summarises the 100 year climate data interpolated for the site (Qld Government, 2021).

Table 1: Summary of average monthly rainfall and daily temperature statistics, Aileron.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max. Temp (°C)	36	35	33	29	24	21	21	24	28	32	34	36
Min. Temp (°C)	22	21	19	14	10	6	5	7	11	16	19	21
Rainfall (mm)	53	50	35	14	18	11	10	6	6	18	28	48

3.2 Land systems mapping

Broad scale CSIRO land systems mapping exists across the area to be surveyed. Land systems mapping describes and groups land with a recurring pattern of topography, soil, and vegetation. This produces land systems mapping to a scale of 1:1,000,000 that is useful for regional planning and very extensive (broad scale) land use. There are four land systems that exist within the survey area (Figure 2, Table 2).

Table 2: Summary of land systems within the survey area.

Land System	Land Surface	Estimated Proportion of Survey Area	Description
Napperby	Erosional weathered surface	59%	Granite hills, relief 150m; and gneiss ridges, relief 15m; some shallow soils; sparse grass. Lowlands; red earths and other soils; sparse low trees over short grasses.
Aileron	Erosional weathered surface	16%	Granite hills up to 100m high; some shallow gritty and stony soils; sparse grass. Erosional lowlands and alluvial plains; red earths and red clayey sands; sparse low trees over short grass. Plains of red clayey sand with spinifex.
Harts	Erosional weathered surface	3%	Uplands, steep-sided mountains, and hills relief about 300m; pockets of shallow gritty and stony soils; sparse shrubs and hills.
Bushy Park	Depositional surface	22%	Alluvial plains; red earths; mulga in groves over short grass and woollybutt.

3.3 Gamma radiometrics

Gamma radiometric data sourced from Geoscience Australia can be used to indicate spatial changes in soil properties, and has been related to such features as soil weathering and soil clay content. Figure 3 shows the gamma radiometric data for the survey area. The placement of soil pit locations considered the variability indicated by the gamma radiometric map.

3.4 Available soil mapping

Broadscale soil mapping is available on the Australian Soil Resource Information System (ASRIS), which provides a low precision assessment of the soil orders present across Australia (CSIRO, 2020). Soil mapping of the survey area indicates the presence of Rudosols over the northern portion (67%) and Kandosols over the southern portion (33%) (Figure 4). Rudosols include soils that have negligible pedologic organisation. They are usually young soils in the sense that soil forming factors have had little time to pedologically modify parent rocks or sediments. The component soils can vary widely in terms of texture and depth. Kandosols include soils which lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout.

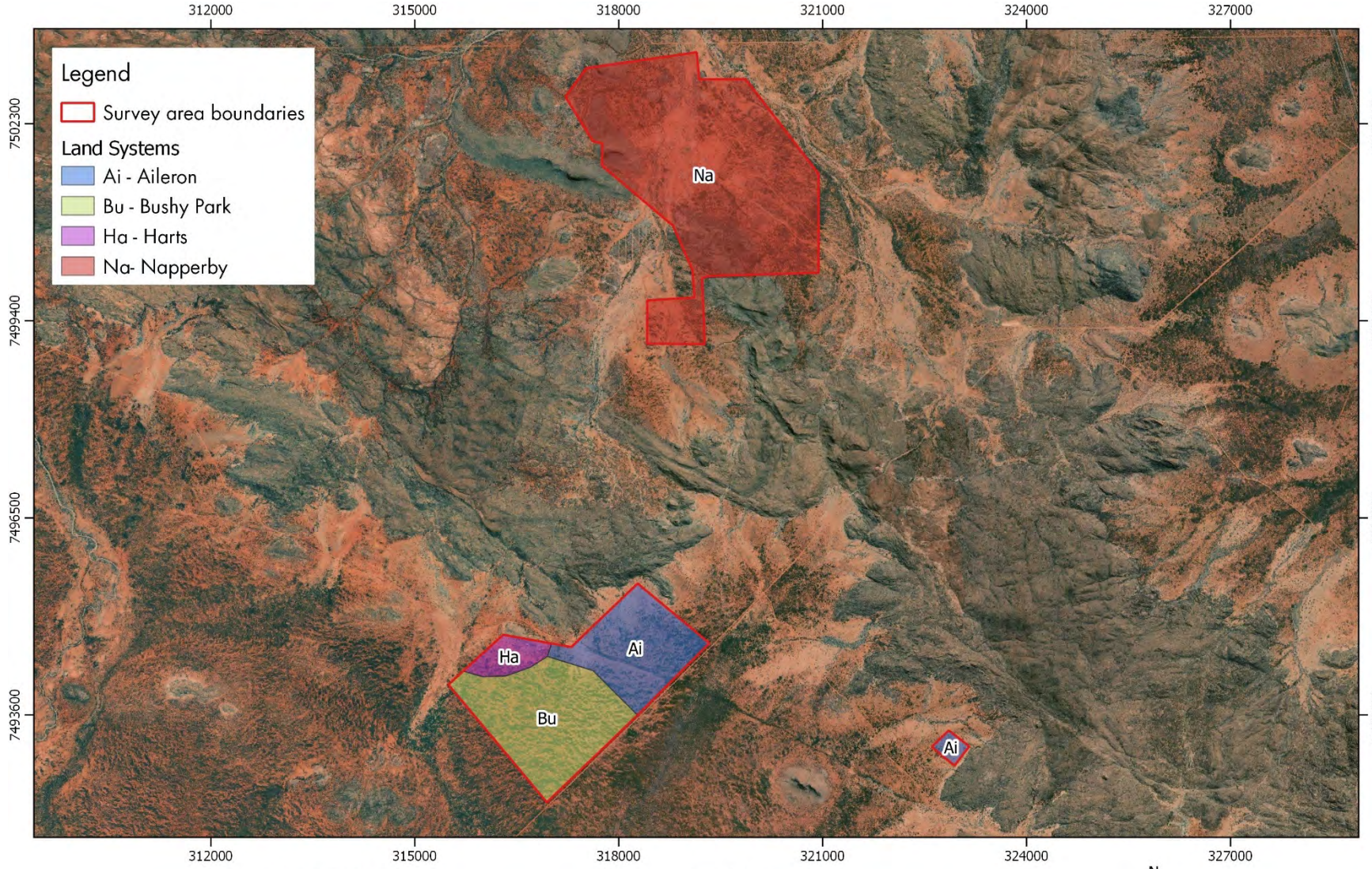


Figure 2: Land systems mapping of survey area

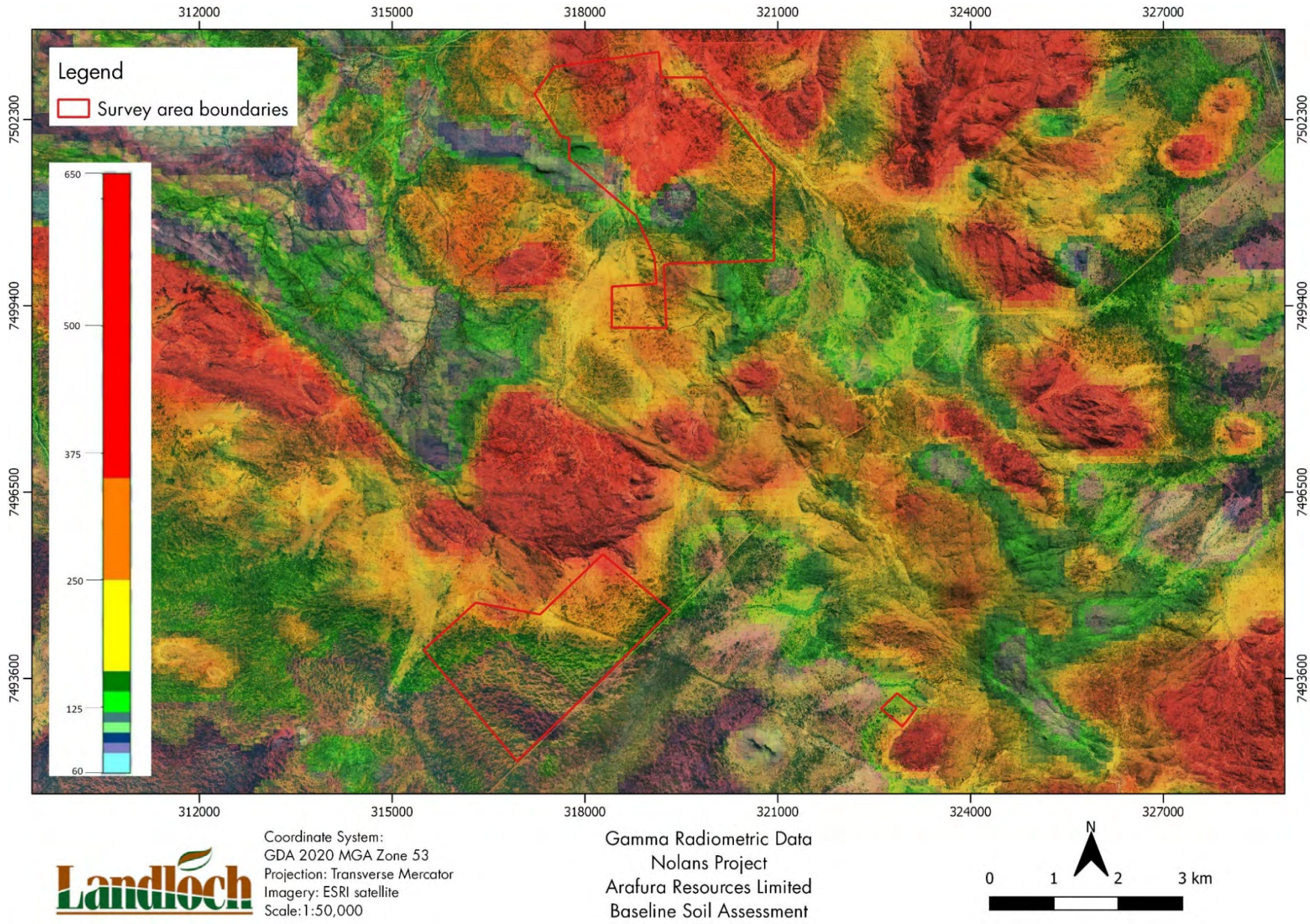


Figure 3: Gamma radiometric data for the survey area

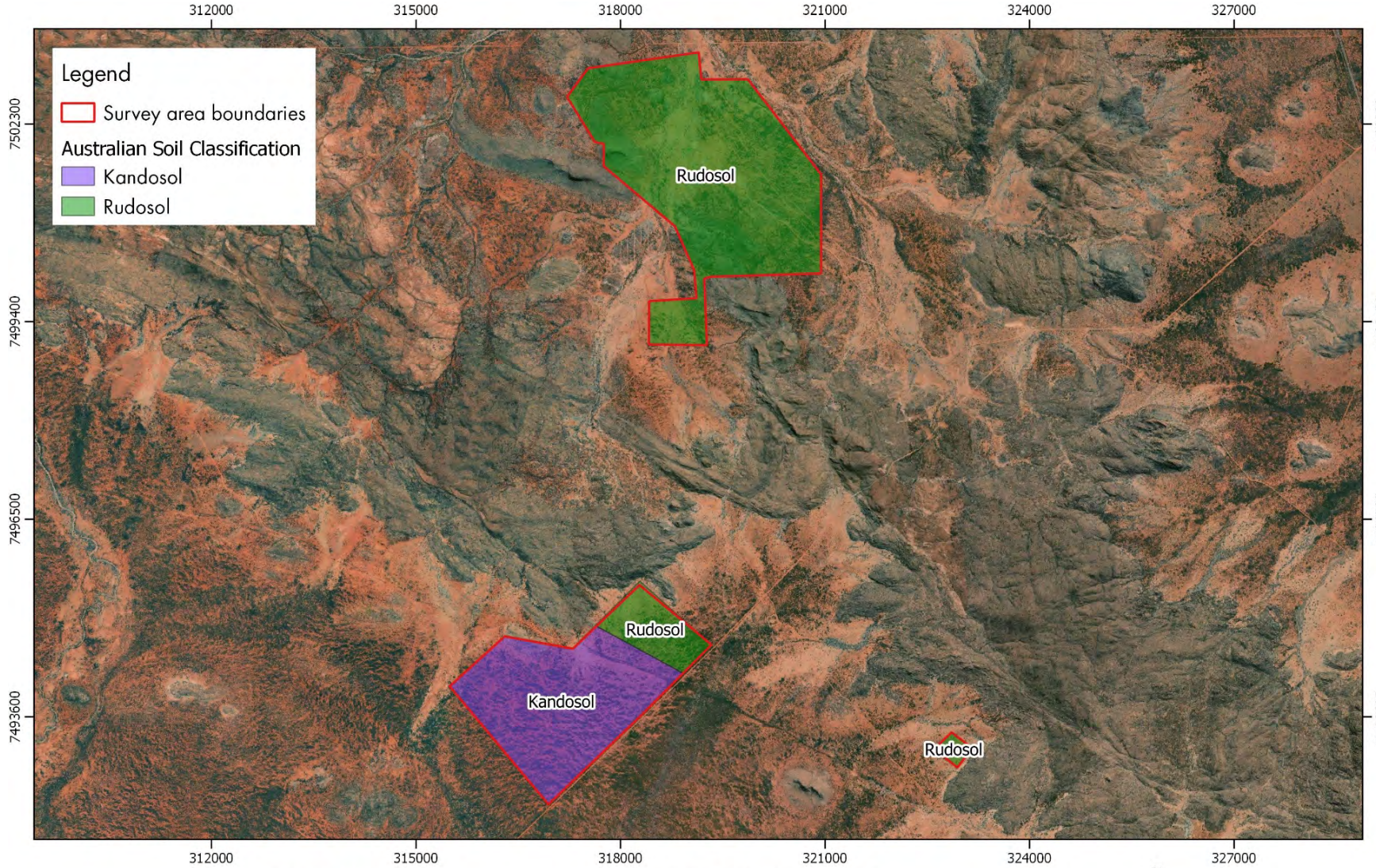


Figure 4: Broadscale ASC mapping

3.5 Sampling locations

Soil pit locations were selected based on the topography, gamma radiometrics, and aerial imagery. The land systems and soil mapping were on too coarse a scale to influence the pit placements. The proposed locations also avoided known exclusion zones. The intent was to capture the major soil types present within the survey area.

4 SOIL PROFILE CLASSES

Soil profiles were described at 24 locations across the survey area, with observation points located based on the broad indicators of landscape variability discussed in Section 3.

Records of field descriptions are provided in Appendix A (Soil Profile Descriptions). Laboratory data are presented in Appendix B. All the soil photos are presented in Appendix C.

Soils from each pit/observation location have been classified into four Soil Profile Classes (SPC), each of which have been extrapolated into polygons termed Soil Mapping Units (SMU), based on having common SPC properties. All SMUs and SPCs exhibit some soil variation. However, they share key morphological and management related characteristics.

All the soils observed within the survey areas shared many common attributes. These included:

- Intermediate textures, mainly loam grading to light clay;
- Non-texture contrast soils;
- Rapidly and uniformly draining;
- Whole coloured and red, apart from SPC C, which was whole coloured and brown;
- Non-saline;
- Non-sodic;
- Free from chemical constraints;
- Weak surface structure; and
- Very low surface organic matter.

The four SPCs are listed in Table 3.

Table 3: Soil profile classes

Soil Profile Class	Description	Total area covered (ha)	Land area covered (%)
A	Red earth over rock	841*	59%
AS	Red earth over rock, shallow version		
B	Red earth- deep	565	39%
C	Calcareous brown earth	30	2%

*Includes SPCs A and AS.

4.1 SPC A and AS: Red earth over rock (+/- shallow version)

The features listed below are characteristic of SPC A and AS:

- Surface runoff likely to occur only after intense rainfall events, with surface infiltration estimated at between 20-60mm/hr.
- Subsoil permeability (below approximately 50cm) is estimated at approximately 10-60mm/hr.
- Uniformly to gradationally textured soil profiles with clay percentages ranging from 20-35% in the surface to 25-35% in the subsoil.
- Soil depth ranging from 40-70cm for SPC AS, and approximately 100-140cm for SPC A. Note that roots generally extended beyond the soil into the fractured weathered parent material below.
- Plant available water capacity (PAWC) of approximately 40-70mm (low) for SPC AS, and approximately 80-140mm (low to moderate) for SPC A.
- Mostly weak soil strength (friable), though sometimes firm to hard if dry.

Figure 1: SPC A and AS

- Mostly weak soil ped structure, combined with an even spread of macropores, indicating even water drainage through the profile. Sometimes a moderately structured, blocky subsoil, but still relatively uniformly draining.
- No physical constraints present, apart from stone comprising fragments of parent material.
- There are no chemical constraints within the soil profile.
- Surface soil fertility rating is *low*;
    - Inherent fertility based on ECEC is low, reflecting the extremely weathered condition of the kaolinitic clay minerals in the soil.
    - Total Nitrogen: 170-390mg/kg - Very low.
    - Available Phosphorus (Colwell): 9-40mg/kg - Low to moderate; Total Phosphorus: 150-830mg/kg.
    - Available Potassium (Colwell): 190-360mg/kg - High.
    - Available (KCl) Sulphur: 8mg/kg - Moderate.
    - Organic Carbon: 0.15-0.28% - Very low.
    - Trace elements (DTPA): Copper: 0.4-0.7mg/kg - Moderate; Zinc: 0.2-0.6mg/kg - Low to moderate; Iron 13-76mg/kg, Manganese 7-42 mg/kg - Moderate to high.
    - Boron: 0.3-0.4 mg/kg - Low.

A summary of the landscape conditions associated with SPC A and AS is provided in Table 4. The surface soils are highly susceptible to compaction if trafficked when wet. They are also prone to becoming loose and dusty if disturbed, prone to erosion by wind and water.

Table 4: The soil landscape conditions SPC A and AS

Brief Description	Gradationally textured earthy loams with bright, even reddish tones throughout. Weathered and fractured parent material in lower profile.		
Landform	Level plain with occasional slight rises		
Geology	Sand plains overlaying granite and gneiss		
ASC	Red Kandosol/Dermosol		
Microrelief	Minor / nil	**Runoff**	Slow.
Permeability	Highly permeable.	**Drainage**	Well drained.
Surface	Firm to hardsetting		
Observations	A- N01, N02, N03, N09, N12, N15 AS- N06, N07, N08, N10, N11, N16		
Laboratory data	A- N01, N09, N12 AS- N06		

Figure 2: Site N12 landscape

Figure 3: Site N12 surface

Table 5 summarises the key chemical parameters that relate to the soil's inherent fertility/clay mineralogy, salinity and pH, and structural stability. The positive attributes are that the soil is non-saline, non-sodic, and friable. The soil was observed to be free draining and porous.

The negative aspects of the soil are low inherent fertility, and mostly weak structure. They are prone to being physically degraded, and may require the addition of fertilisers and/or organic amendments once disturbed (Table 6).

Table 5: Summary of physicochemical parameters of Profile N12.

Typical Depth (cm)	Est. Clay %	pH (water)	$EC_{1:5}$ mS/cm	CEC	ESP %
0 to 20	20	5.8	0.01	9.25	0.47
20 to 50	30	6.9	0.02	6.85	0.63
50 to 80	35	6.8	0.03	-	-
80 to 100	35	6.7	0.03	7.79	0.71
100 to 110	35	7.6	0.07	6.55	0.66

Table 6: Management considerations.

Typical Depth (cm)	Constraints present	Comments
0 to 20	No	Low inherent fertility of surface, coupled with low organic matter content and weak structure, mean that the soil can be powdered up and/or compacted through overworking or trafficking.
20 to 50	No	
50 to 80	No	
80 to 100	No	No chemical constraints throughout.
100 to 110	No	

Table 7 describes the physical attributes of a representative soil profile (Site N12). Site N12 is classified as a Red Kandosol and is a representative profile for SPC A.

Table 7: Representative profile description

A1 0–20 cm	Dark red brown (5YR 3/4) light sandy clay loam. Weak angular blocky structure. Firm resistance to breakage (dry). Roots common. Clear transition to:
B21 20-50 cm	Yellow red (5YR 4/6) clay loam, sandy. Structureless. Weak resistance to breakage. Roots common. Clear transition to:
B22 50-80 cm	Yellow red (5YR 4/6) light clay, sandy. Weak angular blocky structure. Weak resistance to breakage. Many fragments of parent rock present (20 mm). Roots common. Clear transition to:
BC1 80-100 cm	Dark red (2.5YR 3/6) light clay, sandy, with strong brown (7.5YR 4/6) mottles. Moderate angular blocky structure. Weak resistance to breakage. Abundant fragments of parent rock present (30 mm). Roots common. Clear transition to:
BC2 100-110+ cm	Dark red (2.5YR 3/6) light clay, with light olive brown (2.5Y 5/6) mottles. Structureless. Weak resistance to breakage. Abundant fragments of parent rock present (5-200 mm). Roots common.

The lack of a texture contrast between the surface soil and the subsoil, and the presence of visible soil pores throughout, mean that permeability is relatively even throughout the profile. This is also reflected by the even and bright red colouration of the soil. In its current condition, the soil has excellent physical properties for draining water, root growth and air movement.

The intermediate clay content, low fertility, low organic matter content, and weak structure of the soil means that it will be susceptible to compaction and or becoming powdery if over trafficked. The soil has poor capacity to self-repair once it is degraded.

4.2 SPC B: Red earth- deep

The features listed below are characteristic of SPC B:

- Surface runoff likely to occur only after intense rainfall events, with surface infiltration estimated at between 20-60mm/hr.
- Subsoil permeability (below approximately 50cm) is estimated at approximately 10-60mm/hr.
- Uniformly to gradationally textured soil profiles with clay percentages ranging from 15-25% in the surface to 25-35% in the subsoil.
- Soil depth to full depth of pit or greater (150cm).
- Plant available water capacity (PAWC) of approximately 180mm (moderately high).
- Mostly weak soil strength (friable), though sometimes firm to hard if dry.
- Mostly weak soil ped structure, combined with an even spread of macropores, indicating even water drainage through the profile. Sometimes a moderately structured, blocky subsoil, but still relatively uniformly draining.

Figure 4: SPC B

- No physical constraints present.
- There are no chemical constraints within the soil profile.
- Surface soil fertility rating is ***low***;
    - Inherent fertility based on ECEC is very low (<4meq/100g), reflecting the extremely weathered condition of the kaolinitic clay minerals in the soil.
    - Total Nitrogen: 200-340mg/kg - Very low.
    - Available Phosphorus (Colwell): 15-20mg/kg - Low to moderate; Total Phosphorus: 150-180mg/kg.
    - Available Potassium (Colwell): 150-210mg/kg - Moderate to high.
    - Available (KCl) Sulphur: 8mg/kg - Moderate.
    - Organic Carbon: 0.2-0.4% - Very low.
    - Trace elements (DTPA): Copper: 0.4-0.5mg/kg - Moderate; Zinc: 0.2-0.4mg/kg - Low to moderate; Iron 7-16mg/kg, Manganese 7-10mg/kg - Moderate.
    - Boron: 0.3-0.4mg/kg - Low.

A summary of the landscape conditions associated with SPC B is provided in Table 8. The surface soils are highly susceptible to compaction if trafficked when wet. They are also prone to becoming loose and dusty if disturbed, prone to erosion by wind and water.

Table 8: The soil landscape conditions SPC B

Brief Description	Gradationally textured earthy loams with bright, even reddish tones throughout		
Landform	Level plain with occasional slight rises		
Geology	Sand plains overlaying granite and gneiss		
ASC	Red Kandosol/Dermosol		
Microrelief	Minor / nil	**Runoff**	Slow.
Permeability	Highly permeable.	**Drainage**	Well drained.
Surface	Firm to hardsetting		
Observations	N14, N20, N21, N22, N26, N27, N28, N30, N31, N32,		
Laboratory data	N14, N20, N32		

Figure 5: Site N20 landscape

Figure 6: Site N20 surface

Table 9 summarises the key chemical parameters that relate to the soil's inherent fertility/clay mineralogy, salinity and pH, and structural stability. The positive attributes are that the soil is non-saline, non-sodic and friable. The soil was observed to be free draining and porous.

The negative aspects of the soil are low inherent fertility, and mostly weakly structured. They are prone to being physically degraded, and may require the addition of fertilisers and/or organic amendments if disturbed (Table 10).

The low ECEC indicates that the soil is highly weathered. This will mean that the soil's nutrient storage capacity is relatively low for a clayey soil, and fertiliser and amendment additions will need to be managed more precisely and frequently.

Table 11 describes the physical attributes of a representative soil profile (N20). Site N20 is classified as a Red Kandosol. The lack of a texture contrast between the surface soil and the subsoil, and the presence of visible soil pores throughout, mean that permeability is relatively even throughout the profile. This is also reflected by the even and bright red colouration of the soil. In its current condition, the soil has excellent physical properties for draining water, root growth and air movement.

The intermediate clay content, low fertility, low organic matter content, and weak structure of the soil means that it will be susceptible to compaction and or becoming powdery if over trafficked. The soil has poor capacity to self-repair once it is degraded.

Table 9: Summary of physicochemical parameters of Profile N20.

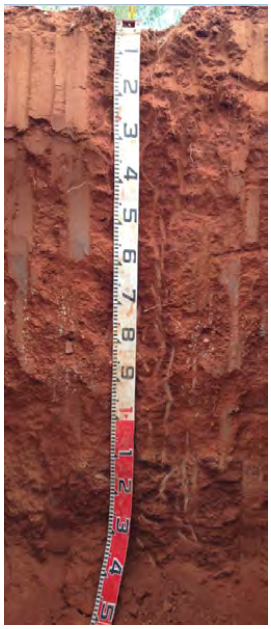
Typical Depth (cm)	Est. Clay %	pH (water)	$EC_{1:5}$ mS/cm	CEC	ESP %
0 to 20	20	6.22	0.01	3.73	1.17
20 to 60	20	6.67	0.01	4.84	0.9
60 to 100	20	6.81	0.02	4.3	1.01
100 to 150	35	7.42	0.02	-	-

Table 10: Management considerations.

Typical Depth (cm)	Constraints present	Comments
0 to 20	No	Low inherent fertility of surface, coupled with low organic matter content and weak structure, mean that the soil can be powdered up and/or compacted through overworking or trafficking.
20 to 60	No	
60 to 100	No	
100 to 150	No	No chemical constraints throughout.

Table 11: Representative profile description

A1 0–20 cm	Dark red brown (2.5YR 2.5/4) light sandy clay loam. Weak sub-angular blocky structure. Weak resistance to breakage. Roots common. Gradual transition to:
A2 20-60 cm	Dark red (2.5YR 3/6) light sandy clay loam. Weak sub-angular blocky structure. Weak resistance to breakage. Roots common. Clear transition to:
B1 60-100 cm	Dark red (2.5YR 3/6) light sandy clay loam. Weak angular blocky structure. Firm resistance to breakage. Roots common. Clear transition to:
B2 100-150 cm	Dark red (2.5YR 3/6) light clay, sandy. Weak angular blocky structure. Hard resistance to breakage. Roots common.



4.3 SPC C: Calcareous brown earth

The features listed below are characteristic of SPC C:

- Surface runoff likely to occur only after intense rainfall events, with surface infiltration estimated at between 20-60mm/hr.
- Subsoil permeability (below approximately 50cm) is estimated at approximately 20-60mm/hr.
- Uniformly textured soil profiles with clay percentages of 20% throughout the profile.
- Soil depth to 90cm, with abundant rock fragments below 30cm.
- Plant available water capacity (PAWC) of approximately 70mm (low).
- Very weak soil strength.
- Structureless, but free and uniformly draining due to field texture and low density.
- No physical constraints present, aside from stone comprising fragments of parent material (calcite and/or quartz crystals).

Figure 7: SPC C

- There are no chemical constraints within the soil profile.
- Surface soil fertility rating is ***moderate to low***;
    - Inherent fertility based on ECEC is moderate to low.
    - Total Nitrogen: 640mg/kg - Low.
    - Available Phosphorus (Colwell): 18mg/kg - Moderate; Total Phosphorus: 561mg/kg.
    - Available Potassium (Colwell): 390mg/kg - High.
    - Available (KCl) Sulphur: 9mg/kg - Moderate.
    - Organic Carbon: 0.7% - Very low.
    - Trace elements (DTPA): Copper: 0.4mg/kg - Moderate; Zinc: 0.5mg/kg - Low to moderate; Iron 24mg/kg, Manganese 14mg/kg - Moderate.
    - Boron: 0.4mg/kg - Low.

A summary of the landscape conditions associated with SPC C is provided in Table 12. The surface soils are highly susceptible to compaction if trafficked when wet.

Table 13 summarises the key chemical parameters that relate to the soil's inherent fertility/clay mineralogy, salinity and pH, and structural stability. The positive attributes are that the soil is non-saline, non-sodic and friable. The soil was observed to be free draining and porous.

The negative aspects of the soil are low inherent fertility, and mostly weakly structured. They are prone to being physically degraded, and may require the addition of fertilisers and/or organic amendments if disturbed (Table 14).

The low CEC indicates that the soil is highly weathered. This will mean that the soil's nutrient storage capacity is relatively low for a clayey soil, and fertiliser and amendment additions will need to be managed more precisely and frequently.

Table 12: The soil landscape conditions SPC C

Brief Description	Uniformly textured earthy loams with bright, even brown tones throughout. Abundant fragments of calcite and/or quartz in mid and lower profile.		
Landform	Level plain		
Geology	Sand plains overlaying granite and gneiss		
ASC	Lithocalcic Calcarosol		
Microrelief	Minor / nil	**Runoff**	Slow.
Permeability	Highly permeable.	**Drainage**	Well drained.
Surface	Firm to hardsetting		
Observations	N04		
Laboratory data	N04		

Figure 8: Site N04 landscape

Figure 9: Site N04 surface

Table 13: Summary of physicochemical parameters of Profile N04

Typical Depth (cm)	Est. Clay %	pH (water)	$EC_{1:5}$ mS/cm	CEC	ESP %
0 to 30	20	8.61	0.1	12.9	0.34
30 to 60	20	8.86	0.09	6.91	0.63
60 to 90	20	8.77	0.11	7.35	0.59
90 to 120	20	8.57	0.15	15.2	0.29

Table 14: Management considerations.

Typical Depth (cm)	Constraints present	Comments
0 to 30	No	Low organic matter content, weak structure, and a loamy texture mean that the soil can be compacted through overworking or trafficking.
30 to 60	Yes	
60 to 90	Yes	No chemical constraints throughout. Abundant stone fragments reduce PAWC.
90 to 120	Yes	

Table 15 describes the physical attributes of a representative soil profile. The lack of a texture contrast between the surface soil and the subsoil, and the presence of visible soil pores throughout, mean that permeability is relatively even throughout the profile. This is also reflected by the even and bright red colouration of the soil. In its current condition, the soil has excellent physical properties for draining water, root growth and air movement.

The intermediate clay content, low fertility, low organic matter content, and weak structure of the soil means that it will be susceptible to compaction and or becoming powdery if over trafficked. The soil has poor capacity to self-repair once it is degraded.

Table 15: Representative profile description

A1 0–30 cm	Dark brown (10YR 3/3) silty loam. Structureless. Very weak resistance to breakage. Rock fragments abundant on the soil surface, with a few fragments present in the sub-surface. Very high HCl fizz of fine earth carbonates. Many roots present. Clear transition to:
B21 30-60 cm	Dark yellow brown (10YR 3/4) silty loam. Structureless. Very weak resistance to breakage. Rock fragments abundant. Very high HCl fizz of fine earth carbonates. Roots common. Gradual transition to:
B22 60-90 cm	Dark yellow brown (10YR 3/6) silty loam. Structureless. Very weak resistance to breakage. Rock fragments abundant. Very high HCl fizz of fine earth carbonates. Roots common. Gradual transition to:
C 90-120 cm	Dark yellow brown (10YR 4/6) silty loam. Structureless. Very weak resistance to breakage. Rock fragments abundant. Very high HCl fizz of fine earth carbonates. Roots common within the narrow fractures in the rock, but otherwise nil.

5 SUMMARY OF KEY CHEMICAL ATTRIBUTES

Of the 24 profiles described at the site, 8 profiles were sampled for laboratory analysis. In addition to the laboratory analysis, a set of field tests were undertaken that were later correlated with the laboratory tests in order to improve the spatial representation of the laboratory data. Laboratory data are provided in Appendix B.

5.1 Surface nutrition fertility

All surface soils had very low to low inherent fertility based on the CEC's measured (Hazelton & Murphy, 2011). For loamy textured soil materials, this indicates the clay minerals in the soil are highly weathered and kaolinitic. The low CEC reflects the soils' poor ability to store and supply plant nutrients (Figure 14). Note that SPCs A, AS and B are all comprised of very similar materials, and for these soils the trends in CEC are similar to those of the estimated clay percentage (Figure 15). From this one can conclude that the soil CEC increases linearly with clay content (or field texture), as described in Appendix A.

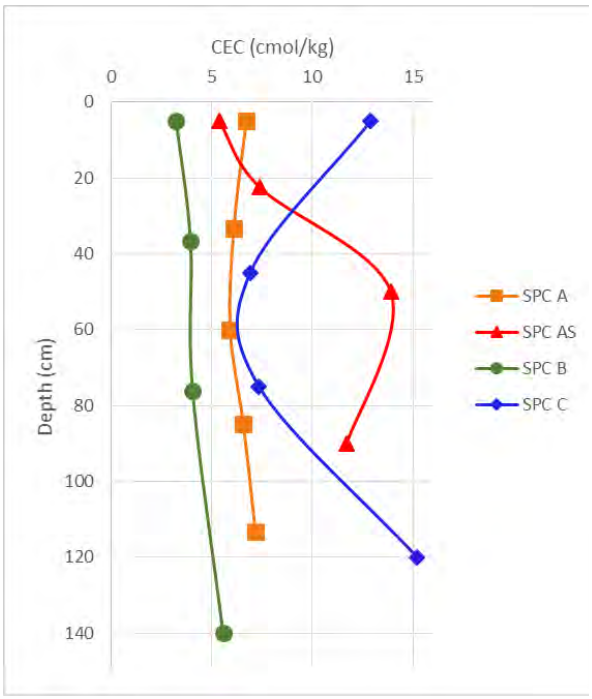


Figure 10: Average CEC of each SPC (meq/100g)

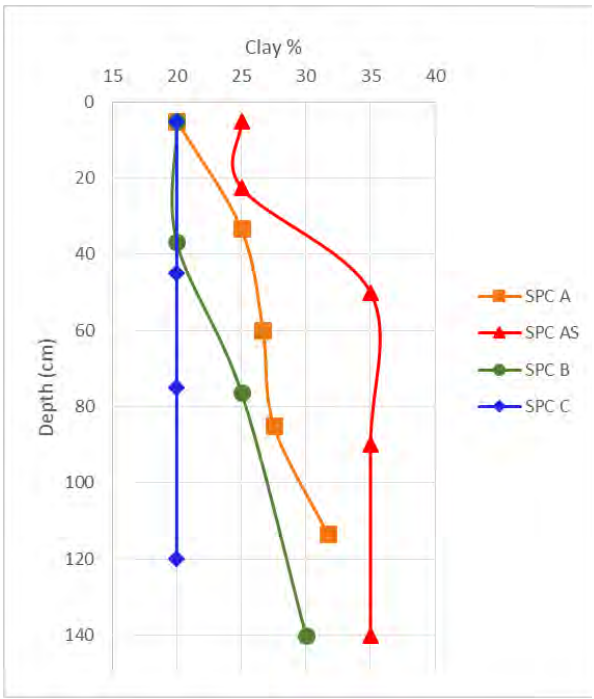


Figure 11: Average estimated clay % of each SPC

Variations in surface measurements were generally similar across SPCs. Table 16 presents the averages and standard deviations of the surface analytes measured.

Table 16: Summary of the surface nutrition analysis of the Nolans soils

Parameter	Total N mg/kg	OC %	Total P mg/kg	Colwell P mg/kg	Colwell K mg/kg	S (KCl) mg/kg
Average	305	0.3	294	20	252	8.5
Standard deviation	154	0.2	258	9	89	0.4
Parameter	**Cu (DTPA) mg/kg**	**Fe (DTPA) mg/kg**	**Mn (DTPA) mg/kg**	**Zn (DTPA) mg/kg**	**B mg/kg**	
Average	0.49	23	14	0.40	0.37	
Standard deviation	0.11	22	11	0.15	0.05	

From these data, the following general statements can be made.

Total Nitrogen and organic Carbon, which are mostly held in the same organic matter pool, are all very low. The low organic Carbon increases the susceptibility of the soil to physical degradation such as hardsetting, compaction, and loss of structure. The correlation between Total Nitrogen and organic Carbon measurements is presented in Figure 16.

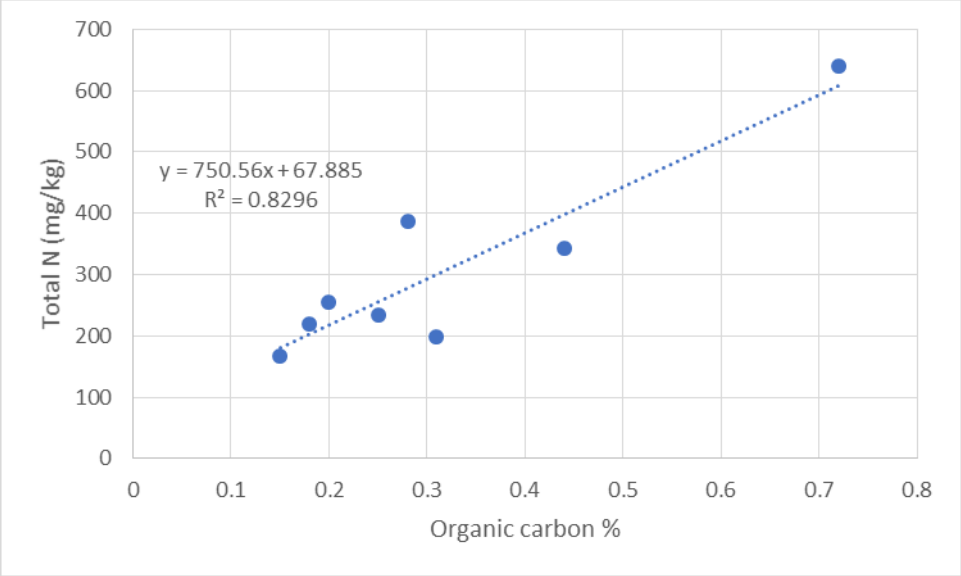


Figure 12: Relationship between organic Carbon (%) and Total N (mg/kg) for Nolans soils

Total Phosphorus and Colwell extractable Phosphorus range from marginal to high (Peverill, Sparrow, & Reuter, 1999). Given the other limitations such as rainfall and Nitrogen, it is unlikely that P will be a limiting factor to plant growth at the site. The correlation between Total P and Colwell P measurements is presented in Figure 17.

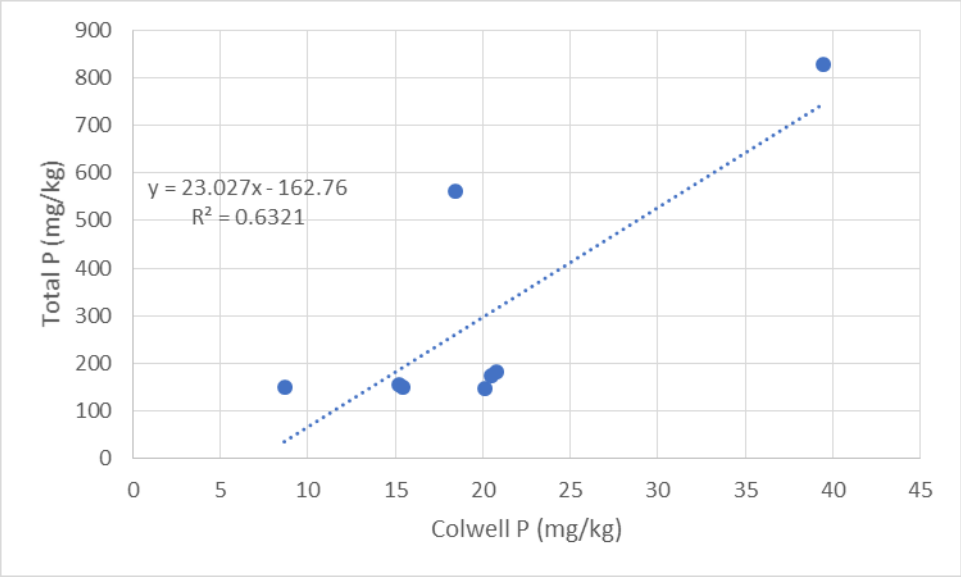


Figure 13: Relationship between Colwell extractable P and Total P for Nolans soils (mg/kg)

Colwell extractable Potassium was generally moderate to high, indicating that the soils are able to supply sufficient K without the addition of fertiliser. Available Sulphur is generally moderate, and is probably adequate for growing pasture grasses in an arid environment. Trace element soil tests are not calibrated to plant requirements, so are difficult to discuss from a sufficiency/deficiency perspective (Peverill, Sparrow, & Reuter, 1999). However, given the amounts measured, trace elements are unlikely to be a limiting factor to plant growth in this environment. Boron levels were low across the site. However, Boron is unlikely to be a limiting factor to the growth of pasture grasses.

5.2 Laboratory and field pH

All of the soil profiles described were assessed for field pH using pH indicator dye. Results are provided in Appendix A.

The average profile pH (laboratory pH from a 1:5 ratio soil:water extract) for each SPC is presented in Figure 18. Generally, pH increased slightly with depth. There were few strongly acidic pH measurements. The pH of SPC C reflects its being a calcareous soil. The high pH of SPC AS was measured from one pit, N06, and they are measurements of substrate material (including parent rock) below the soil profile. The parent rock in this one instance was also strongly sodic.

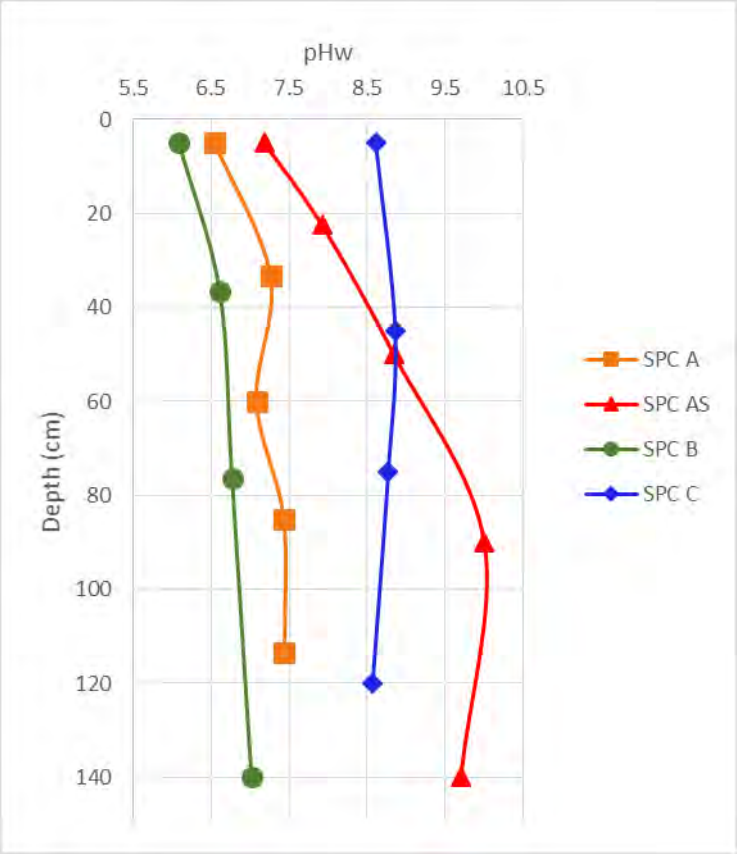


Figure 14: Average laboratory pH for each SPC

Field pH measurements using universal indicator dye were made of most soil materials identified during the survey. Of these, 36 of them were correlated with laboratory pH so as to determine the reliability of the field measurements. Of the 36 correlated field measurements, 67% were within half a unit of the laboratory measurement, and 92% were within one pH unit of the laboratory measurement (Figure 19). This correlation supports the using of the field pH values recorded in Appendix A as accurate, if somewhat imprecise, indicators of a laboratory measured soil pH.

5.3 Sodicity and dispersion

All the soil materials measured were non-sodic. One parent material of weathered granite was assessed from the bottom of pit N06, and was found to be strongly sodic (Figure 20). However, it was not dispersive based on the Emerson dispersion test.

Some "dispersion" was observed for some samples during field tests. However, this could be attributed to the high energy observed during the slaking of the soil. The strong slaking reaction, related to very low organic Carbon levels and weakly coherent materials, resulted in clays being agitated and separated from the soil aggregate, mimicking the cloudiness of a dispersion reaction. Although they are not sodic, the soil materials of SPCs A, AS and B show a tendency to separate into very fine materials when disturbed. In practical terms this means disturbed soils are susceptible to going into fine suspension during high rainfall events.

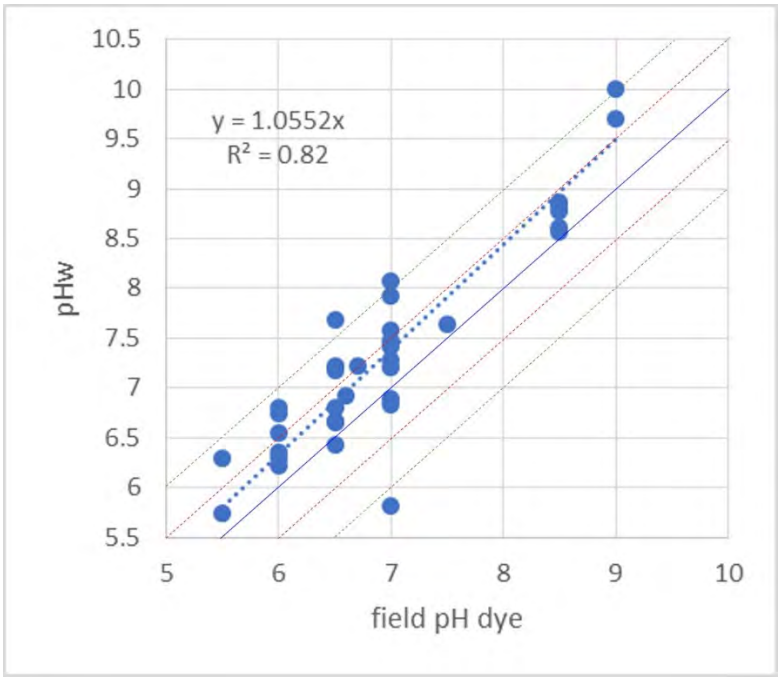


Figure 15: Correlation between field pH and laboratory pH (Blue dotted line: linear regression; Blue solid line: 1:1 correlation; Red dotted line: half unit variance of field pH from lab pH; Green dotted line: one unit variance of field pH from lab pH).

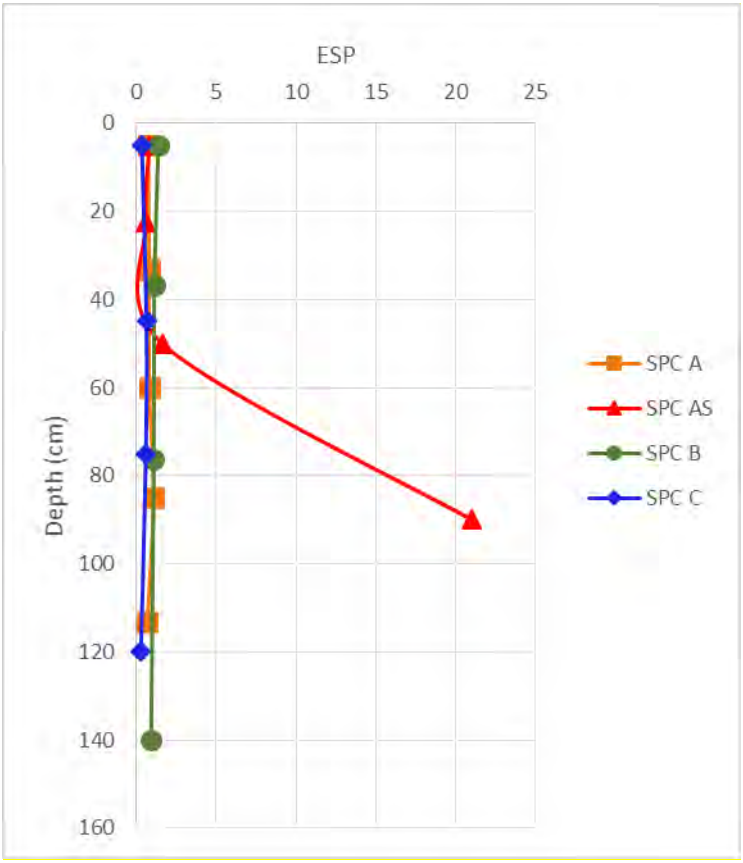


Figure 16: Average ESP for each SPC

5.4 Salinity

All the soil materials can be classed as non-saline (Figure 21). This is as expected, given the free draining nature of the soil materials, and the strongly leached landscape. Salinity will not impact on even salt sensitive plants (Dept of Environment and Resource Management, 2011).

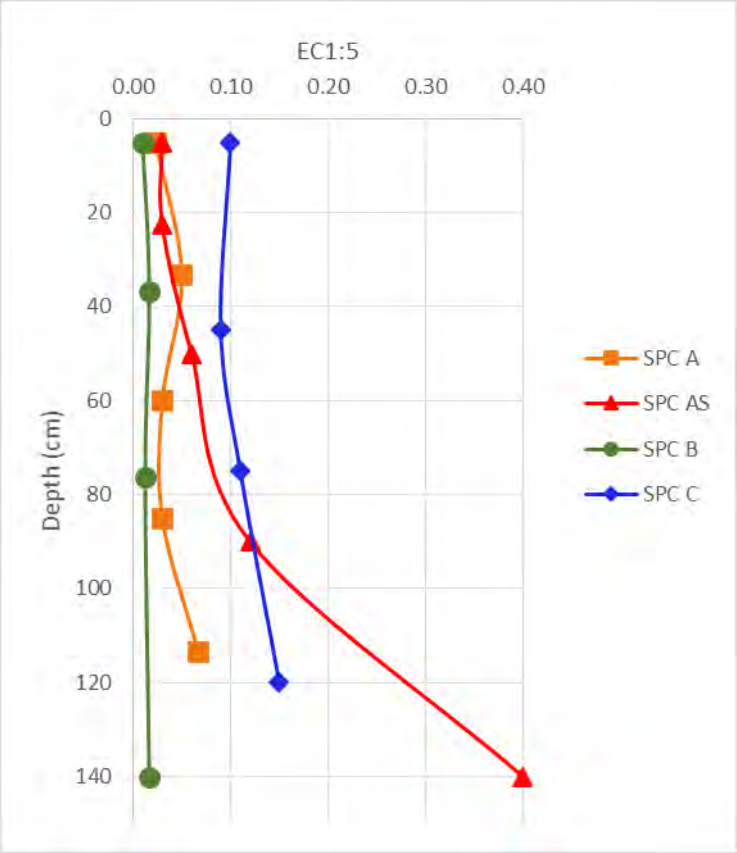


Figure 17: Average salinity for each SPC

6 LAND SUITABILITY ASSESSMENT

The Northern Territory (NT) Land Suitability Guidelines apply internationally recognised land suitability classes to land suitability in the NT (Table 17). The guidelines outline the information required to address the term 'unconstrained land' in Section 11.4 of the NT Planning Scheme (NT Government, 2013). The NT guidelines address the following land suitability categories:

1. Drainage
2. On-site Wastewater Management
3. Erosion Risk
4. Soil Salinity
5. Acid Sulphate Soils
6. Storm Tide Flooding
7. Riverine Flooding

These classes were applied to each of the SPCs/SMUs (Table 18).

Table 17: Land suitability class definitions.

Suitability classes	Description
Class S1 Highly Suitable	Land having no significant limitations to sustained application for a given land use or only minor limitations. Nil to minor negative economic, environmental, health and/or social outcomes.
Class S2 Moderately Suitable	Land having limitations which in aggregate are moderately severe for sustained application of a given land use. Appreciably inferior to S1 land. Potential negative economic, environmental, health and/or social outcomes if not adequately managed.
Class S3 Marginally Suitable	Land having limitations which in aggregate are severe for sustained application of a given use. Moderate to high risk of negative economic, environmental, health and/or social outcomes if not adequately managed.
Class S4 Not Suitable	Land having limitations which may be insurmountable. Limitations are so severe as to preclude successful sustained use of the land. Very high risk of negative economic, environmental and/or social outcomes if not managed.
Class S5 Not Suitable	Land having limitations which appear so severe as to preclude any possibilities of successful sustained use of the land in the given manner. Almost certain risk of significant negative economic, environmental and/or social outcomes.

Table 18: Land suitability classes for each SPC/SMU in the study area.

Suitability categories	Soil profile class/Soil mapping unit			
	A	AS	B	C
Drainage	1	1	1	1
On-site Wastewater Management	1	1	1	1
Erosion Risk	1	1	1	1
Soil Salinity	1	1	1	1
Acid Sulphate Soils	1	1	1	1
Storm Tide Flooding	1	1	1	1
Riverine Flooding	1	1	1	1
Suitability Class	**1**	**1**	**1**	**1**

7 SOIL MAPPING

7.1 Soil mapping units

The following map (Figure 22) illustrates the soil mapping unit (SMU) polygons developed from the soil survey. All SMUs present a level of uncertainty, relating to the degree of uniformity of the landscape, and the scale of the survey.

The SMU labels refer to the following broad SMU descriptions:

- SMU A – Red earth over rock (combining SPC A and AS)
- SMU B – Deep red earth
- SMU C – Calcareous brown earth

The SMUs have the same code and description as the Soil Profile Classes (SPCs) they represent. SPCs A and AS have been combined into one SMU, as it is likely that the depth criteria separating these two SPCs varies over a scale that is much finer than that used for the survey. An attempt to separate the two SPCs into two SMUs is likely to be an artefact of insufficient sampling points, rather than a real delineation of soil property boundaries.

The map shows that the northern parcel where the mine pit is proposed to be located is predominantly SMU A, that is, red earths with varying degrees of shallowness over parent rock. It is likely that the depth to parent rock varies over relatively short distances.

The southern parcel associated with the proposed tailings storage facility and the mine village are dominated by deep red earths, SMU B. These soil profiles are generally deeper than 1.5m above parent rock.

It is difficult to determine the spatial extent of SMU C, given that it was represented by only one soil pit. However, it is likely that it comprises only a small area of the northern mine pit parcel.

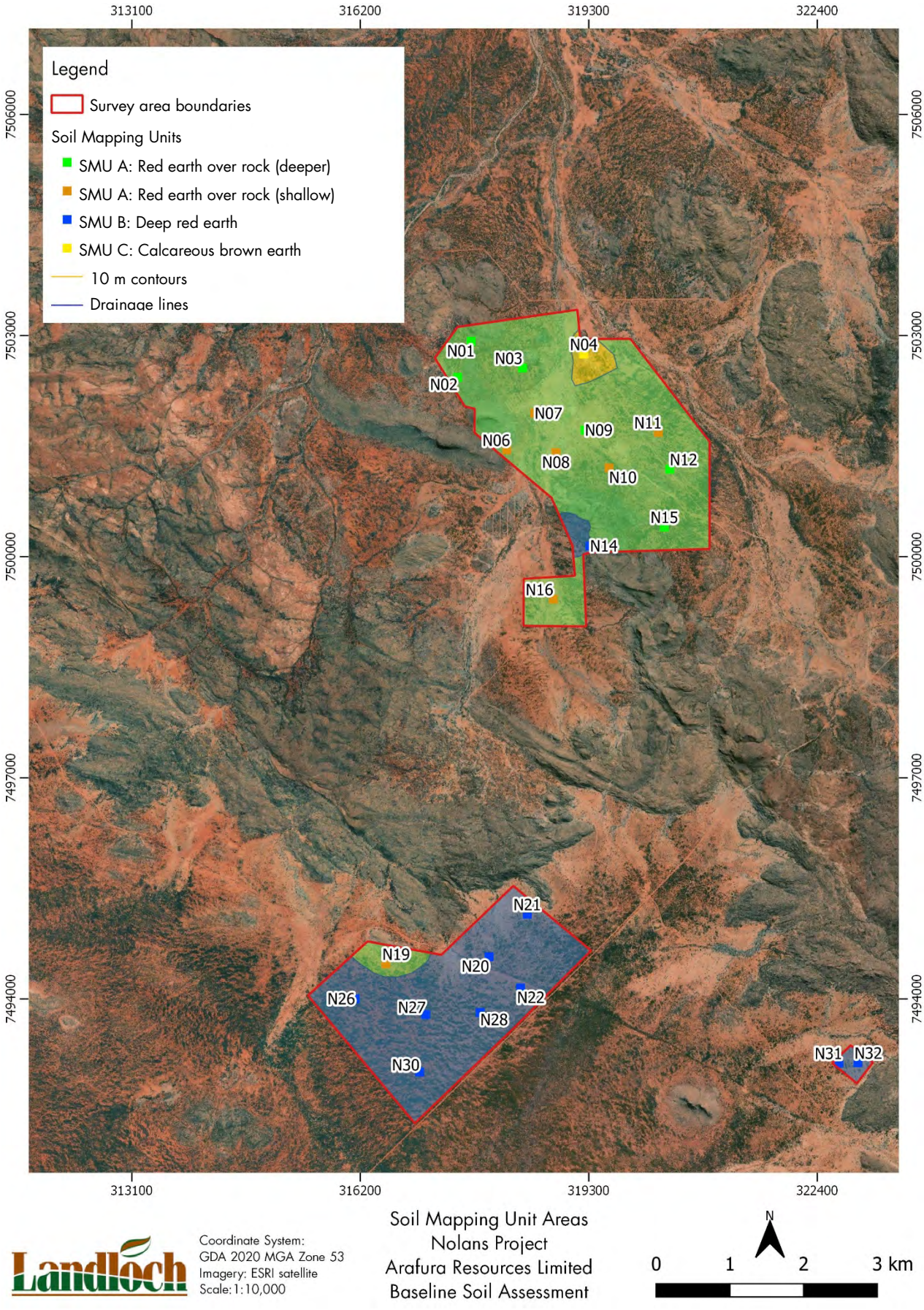


Figure 18: Soil mapping unit areas, with individual observation points identified.

7.2 Topography

Figure 23 illustrates the topography of the study area. The study areas are mainly low plains at the base of low, rocky hills. The non-coloured areas are hills greater than 700m above sea level.

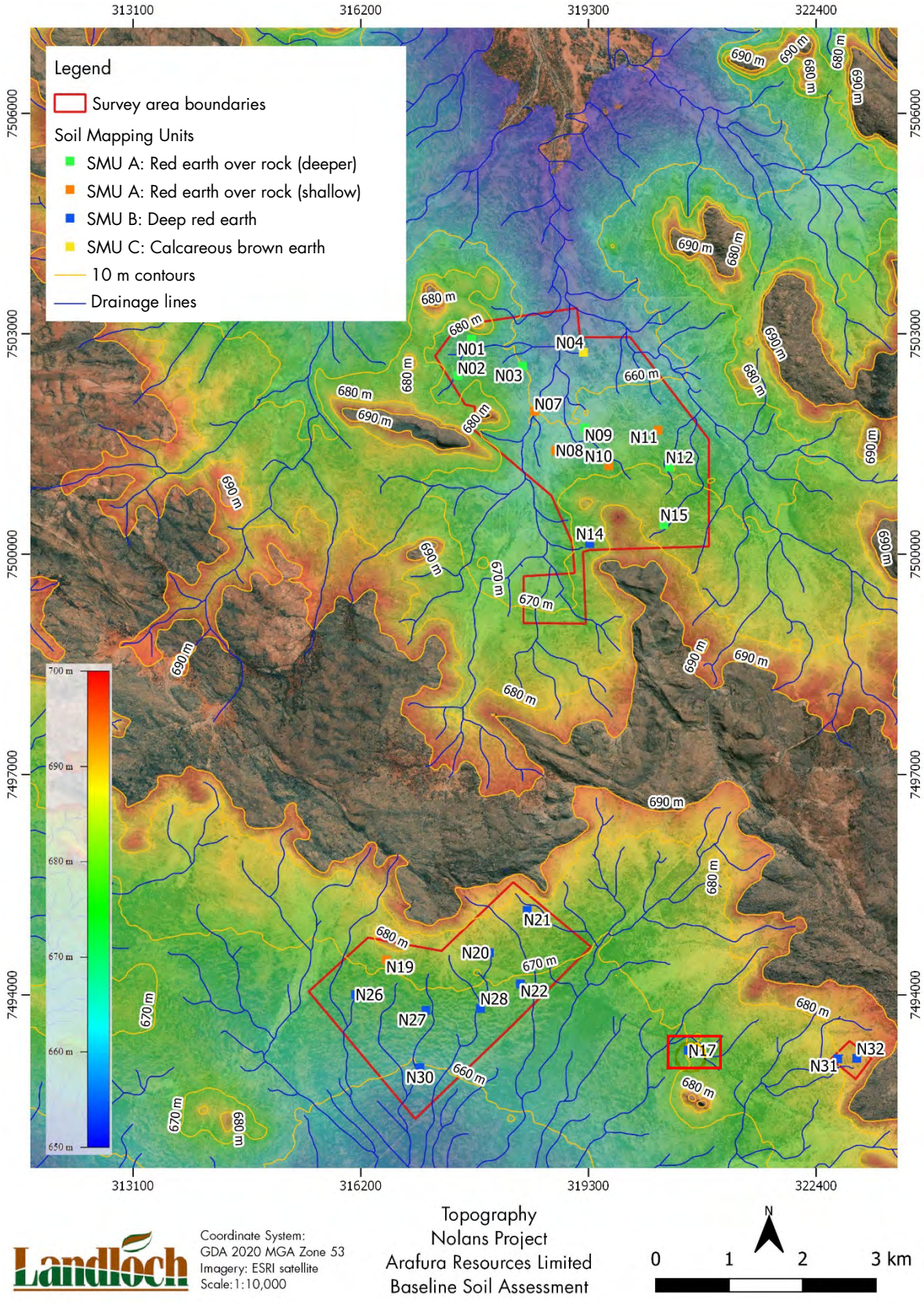


Figure 23: Topography generated from a 1 second digital elevation model

7.3 Slope classes

Figure 24 illustrates the gradients of the study areas grouped into slope classes. The majority of the area has very little relief, mostly being less than 2% slope.

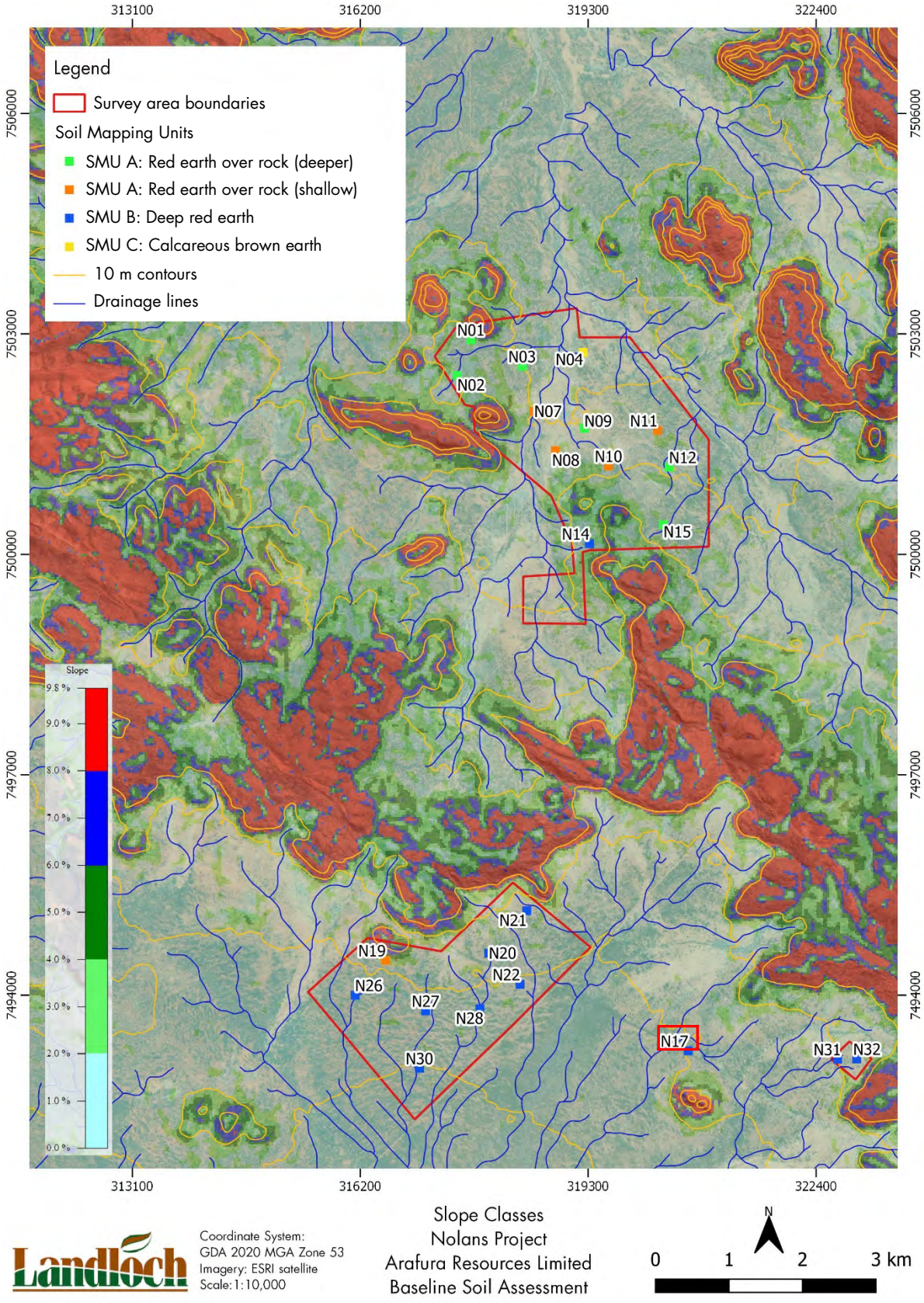


Figure 24: Slope classes generated from a 1 second digital elevation model

8 CONCLUDING REMARKS

The soil survey of the Nolans property has grouped the sites into four soil profile classes (SPC), and delineated these classes into three soil mapping units (SMUs). The boundaries of the SMUs were determined using a range of field observations and GIS data.

All the soils assessed within the three study areas present are more similar than they are different. They are all free drained, loamy, non-saline, non-sodic, low fertility, friable earths. The main difference that is likely to have management implications was the depth to parent rock, and the associated presence/absence of rock fragments within the soil profile. SPC C differed from all the other soils in that it was calcareous throughout. However, the alkalinity of this SPC is within limits suitable for many plants, and is unlikely to be a significant limitation to the land capability.

The soils are relatively stable if undisturbed. However, due to their highly weathered, kaolinitic mineralogy, their weak structure, their loamy texture, and their low organic matter content, they are susceptible to being physically degraded. Over-trafficking when wet are likely to lead to compaction. The soil is also likely to become powdery and loose if over worked.

With appropriate management, the soils of the study areas present few plant growth limitations.

9 LIMITATIONS

This report has been prepared by Landloch. It is in response to, and subject to, the following limitations:

1. The specific instructions received from the client;
2. The specific scope of works set out in correspondence with the client;
3. It may not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Landloch (which consent may or may not be given at the discretion of Landloch);
4. This report comprises the formal report, documentation sections, tables, figures, and appendices as referred to in the index and must not be released to any third party or copied in part without all the material included in this report for any reason;
5. The report relates to the site as at the date of the report. Conditions may change thereafter due to natural processes and/or site activities; and
6. No warranty or guarantee is made in regard to any use other than as specified in the scope of works and only applies to the depth tested and reported in this report and Landloch's Terms and Conditions.

REFERENCES

CSIRO. (2020, January 10). *ASRIS – Australian Soil Resource Information System*. Retrieved from http://www.asris.csiro.au.

Dept of Environment and Resource Management. (2011). *Salinity management handbook-second edition.* Brisbane: Queensland Government.

Gallant, J., Dowling, T., Read, A., Wilson, N., Tickle, P., & Inskeep, C. (2011). *1 second SRTM Derived Digital Elevation Models User Guide.* Canberra, ACT, Australia: Geoscience Australia.

Geoscience Australia. (2015). radmap_v3_2015_unfiltered_terrestrial_dose_rate_grid. Geophysical Archive Data Delivery System. Retrieved March 2020

Hazelton, P., & Murphy, B. (2011). *Interpreting soil test results: what do all the numbers mean?* Collingwood, VIC: CSIRO Publishing.

Isbell, R. (2002). *The Australian Soil Classification. Revised Edition.* Melbourne: CSIRO Publishing.

McKenzie, N. J., Grundy, M. J., Webster, R., & Ringrose-Voase, A. J. (2008). *Guidelines for Surveying Soil and Land Resources (2ed).* Melbourne: CSIRO Publishing.

National Committee on Soil and Terrain. (2009). *Australian Soil and Land Survey Field Handbook. 3rd edition.* Melbourne: CSIRO Publishing.

NT Government. (2013). *Northern Territory Land Suitability Guidelines.* Darwin, Australia: NT Government.

Peverill, K., Sparrow, L., & Reuter, D. (1999). *Soil Analysis: an interpretation manual.* Collingwood, VIC: CSIRO publishing.

Qld Government. (2021, March 21). *SILO- Australian climate data from 1889 to yesterday*. Retrieved March 27, 2020, from Longpaddock: https://www.longpaddock.qld.gov.au/silo/point-data/

APPENDIX A – SOIL PROFILE DESCRIPTIONS

Table A-1: Soil pit coordinates (map datum MGA Zone 53).

Soil Pit ID	Easting (m)	Northing (m)
1	317,727	7,502,922
2	317,528	7,502,445
3	318,406	7,502,567
4	319,241	7,502,728
6	318,186	7,501,440
7	318,565	7,501,953
8	318,844	7,501,399
9	319,258	7,501,759
10	319,573	7,501,206
11	320,253	7,501,674
12	320,407	7,501,169
14	319,324	7,500,149
15	320,326	7,500,401
16	318,818	7,499,427
19	316,545	7,494,475
20	317,945	7,494,583
21	318,471	7,495,143
22	318,373	7,494,152
26	316,138	7,494,008
27	317,088	7,493,795
28	317,830	7,493,830
30	317,008	7,493,012
31	322,686	7,493,132
32	322,957	7,493,136

Profile name	Easting (m) MGA Zone 53	Northing (m) MGA Zone 53	Layer	Depth (cm) - Top	Depth (cm) - Bot.	Horizon	Boundary	Munsell-Colours	Mottles	Texture	Est -clay %	str -Grade	str -Type	str -Size (mm)	Moisture content	Strength	Segregation (mm)	Fragments (mm)	Roots -Rank	HCl - fiz	Dispersion - Spontanuous	Pores	Field pH	field EC1:5	SPC	Comments
N01	317,727	7,502,922	1	0	20	A1	Gradual	5YR3/3	-	Light sandy clay loam	20%	Weak	Subangular blocky	30	Moderately moist	Weak	-	-	Many	-	High*	Few	6	-	A	Red Kandosol, hardsetting to firm surface
N01	317,727	7,502,922	2	20	40	A2	Gradual	5YR3/4	-	Light sandy clay loam	20%	Weak	Subangular blocky	40	Moderately moist	Weak	-	-	Common	-	High*	Few	6.5	-	A	Red Kandosol, hardsetting to firm surface
N01	317,727	7,502,922	3	40	65	B1	Gradual	5YR3/6	-	Sandy clay loam	25%	Weak	Subangular blocky	40	Moderately moist	Weak	-	-	Common	-	Nil	Few	6.5	-	A	Red Kandosol, hardsetting to firm surface
N01	317,727	7,502,922	4	65	100	B3	Gradual	5YR3/6	-	Clay loam, sandy	30%	Weak	Subangular blocky	40	Moist	Weak	-	-	Common	-	Nil	Few	6.5	-	A	Red Kandosol, hardsetting to firm surface
N01	317,727	7,502,922	5	100	150	BC	Gradual	5YR3/4, 60%	10YR4/4, 40%	Clay loam, sandy	30%	Weak	Angular blocky	50	Moderately moist	Weak	-	Many, 10-50mm	Common	-	Nil	Few	7	-	A	Red Kandosol, hardsetting to firm surface
N02	317,528	7,502,445	1	0	20	A1	Clear	5YR3/3	-	Light sandy clay loam	20%	Weak	Platy	40	Dry	Weak	-	-	Common	nil	Nil	Few	6	-	A	Red Kandosol, hardsetting to firm surface
N02	317,528	7,502,445	2	20	40	A2	Clear	5YR3/4	-	Light sandy clay loam	20%	Weak	Angular blocky	50	Moderately moist	Weak	-	-	Common	nil	Nil	Few	6	-	A	Red Kandosol, hardsetting to firm surface
N02	317,528	7,502,445	3	40	70	B2	Clear	5YR3/6	-	Sandy clay loam	25%	Weak	Angular blocky	50	Moderately moist	Weak	-	-	Common	nil	Nil	Few	6	-	A	Red Kandosol, hardsetting to firm surface
N02	317,528	7,502,445	4	70	100	BC	Clear	5YR3/6	-	Sandy clay loam	25%	Massive	Massive	-	Moderately moist	Weak	-	Abundant, 10-100mm	Common	nil	Nil		6	-	A	Red Kandosol, hardsetting to firm surface
N03	318,406	7,502,567	1	0	20	A1	Gradual	2.5YR2.5/4	-	Sandy clay loam	25%	Weak	Angular blocky	40	Dry	Firm	-	-	Common	-	Nil	Few	5.5	5 uS/cm	A	Red Dermosol, hardsetting to firm surface
N03	318,406	7,502,567	2	20	40	A2	Clear	2.5YR3/6	-	Clay loam, sandy	30%	Weak	Angular blocky	40	Dry	Firm	-	-	Common	-	Nil	Few	6	-	A	Red Dermosol, hardsetting to firm surface
N03	318,406	7,502,567	3	40	90	B21	Diffuse	10R3/6	-	Clay loam	30%	Medium	Angular blocky	40	Dry	Very firm	-	Many, 10-20mm	Common	-	Nil	Few	6.5	19 uS/cm	A	Red Dermosol, hardsetting to firm surface
N03	318,406	7,502,567	4	90	130	B22		10R3/6	-	Sandy clay loam	25%	Weak	Angular blocky	50	Dry	Very firm	-	Many, 10-20mm	Common	-	Nil	Few	6.5	-	A	Red Dermosol, hardsetting to firm surface
N04	319,241	7,502,728	1	0	30	A1	Clear	10YR3/3	-	Silty loam	20%	Massive	Massive	-	Moderately moist	Very weak	-	Few, 10mm	Many	very high	Nil	Few	8.5	45 uS/cm	C	Brown Calcarosol, abundant stone at surface (10-50mm)
N04	319,241	7,502,728	2	30	60	B21	Gradual	10YR3/4	-	Silty loam	20%	Massive	Massive	-	Moderately moist	Very weak	Calcite	Abundant, 50%, 10-30mm	Common	very high	Nil	Few	8.5	-	C	Brown Calcarosol, abundant stone at surface (10-50mm)
N04	319,241	7,502,728	3	60	90	B22	Gradual	10YR3/6	-	Silty loam	20%	Massive	Massive	-	Moderately moist	Very weak	Calcite	70%, 10 - 50mm	Common	very high	Nil	Few	8.5	50 uS/cm	C	Brown Calcarosol, abundant stone at surface (10-50mm)
N04	319,241	7,502,728	4	90	120	C		10YR4/6	-	Silty loam	20%	Massive	Massive	-	Moderately moist	Very weak	Calcite	95%, 50-100mm	Common / No roots	very high		Few	8.5	-	C	Brown Calcarosol, abundant stone at surface (10-50mm)
N06	318,186	7,501,440	1	0	15	A1	Clear	5YR2.5/4	-	Sandy clay loam	25%	Weak	Subangular blocky	20	Dry	Firm	-	Many, 10-100mm	Many	nil	Nil	Few	6.5	-	AS	Red Dermosol, hardsetting surface, abundant stone in surface (10-100mm)
N06	318,186	7,501,440	2	15	30	B2	Clear	2.5YR3/4	-	-	-	Weak	Subangular blocky	20	Dry	Firm	-	Abundant, 80%, 10-100mm	Common	nil	Nil	Few	7	-	AS	Red Dermosol, hardsetting surface, abundant stone in surface (10-100mm)
N06	318,186	7,501,440	3	30	70	2B2	Clear	2.5YR3/6	-	Light clay	35%	Medium	Angular blocky	30	Moderately moist	Weak	-	Common, 10mm	Common	mediu m	Nil	Commo n	8.5	90 uS/cm	AS	Red Dermosol, hardsetting surface, abundant stone in surface (10-100mm)
N06	318,186	7,501,440	4	70	110	2BC	Diffuse	2.5YR3/6	White clay, grey granite	Light clay	35%	Strong	Prismatic	100	Moderately moist	Firm	-	Abundant, 60%, 100-200mm	Few	mediu m	Slight	Few	9	280 uS/cm	AS	Red Dermosol, hardsetting surface, abundant stone in surface (10-100mm)
N06	318,186	7,501,440	5	110	150	C		Grey granite	White clay, 2.5YR3/6	Light clay	35%	Strong	Prismatic	100	Moist	Weak	-	80%, 100-200mm	Few	nil	Nil	Few	9	-	AS	Red Dermosol, hardsetting surface, abundant stone in surface (10-100mm)
N07	318,565	7,501,953	1	0	20	A1	Clear	5YR3/3	-	Sandy clay loam	25%	Weak	Subangular blocky	20	-	-	-	-	Common	nil	-	Few	6	-	AS	Red Dermosol, hardsetting to firm surface
N07	318,565	7,501,953	2	20	55	B2	Sharp	5YR3/4	-	Light clay	35%	Medium	Angular blocky	30	-	-	-	-	Common	nil	-	Few	7	-	AS	Red Dermosol, hardsetting to firm surface
N07	318,565	7,501,953	3	55	100	C		-	-	-	-	-	Platy	-	-	-	-	-	Few / No roots	nil	-	-	8	-	AS	Red Dermosol, hardsetting to firm surface
N08	318,844	7,501,399	1	0	20	A1	Gradual	2.5YR3/6	-	Light clay	35%	Weak	Subangular blocky	30	Dry	Very firm	-	Many, 10-30mm	Common	nil	Nil	Few	7	-	AS	Red Dermosol, hardsetting to firm surface, abundant stone in surface (10-50mm)
N08	318,844	7,501,399	2	20	40	B2	Clear	2.5YR3/6	-	Light clay	35%	Medium	Angular blocky	40	Dry	Very firm	-	Many, 10-30mm	Common	nil	Nil	Few	8	-	AS	Red Dermosol, hardsetting to firm surface, abundant stone in surface (10-50mm)
N08	318,844	7,501,399	3	40	70	BC	Clear	2.5YR3/6	-	-	-	Medium	Angular blocky	30	Dry	Very firm to very strong	-	70%	Common	very high	-	-	8.5	-	AS	Red Dermosol, hardsetting to firm surface, abundant stone in surface (10-50mm)
N08	318,844	7,501,399	4	70	100	C			B & W	-	-	Strong	Prismatic	100	Dry	Very firm to very strong	-	99%	Few / No roots	nil	-	-	8.5	-	AS	Red Dermosol, hardsetting to firm surface, abundant stone in surface (10-50mm)
N09	319,258	7,501,759	1	0	20	A1	Clear	5YR3/4	-	Light sandy clay loam	20%	Weak	Platy	50	Dry	Firm / very firm	-	-	Common	-	High*	Few	7	25 uS/cm	A	Red Kandosol, hardsetting surface
N09	319,258	7,501,759	2	20	50	B1	Diffuse	5YR3/4	-	Sandy clay loam	25%	Weak	Subangular blocky	30	Dry	Firm	-	-	Common	-	Nil	Few	7	-	A	Red Kandosol, hardsetting surface
N09	319,258	7,501,759	3	50	75	B21	Diffuse	5YR3/4	-	Sandy clay loam	25%	Weak	Angular blocky	30	Dry	Very firm	-	Common/ many, 5-20mm	Common	-	Nil	Few	7	-	A	Red Kandosol, hardsetting surface
N09	319,258	7,501,759	4	75	100	B22		5YR3/4	-	Sandy clay loam	25%	Weak	Angular blocky	30	Dry	Very firm	-	Many, 5-20mm	Common	-	Nil	Few	7.5	15 uS/cm	A	Red Kandosol, hardsetting surface
N09	319,258	7,501,759	5	100	100	C		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	Red Kandosol, hardsetting surface
N10	319,573	7,501,206	1	0	20	A1	Gradual	5YR3/4	-	Light sandy clay loam	20%	Massive	Massive	-	Moderately moist	Weak	-	Abundant, 20-50mm	Common	-	Nil	Few	-	-	AS	Red Dermosol, hardsetting to firm surface, many stones in surface (2-100mm)
N10	319,573	7,501,206	2	20	50	B2	Gradual	5YR4/6	-	Clay loam, sandy	30%	Medium	Angular blocky / Platy	50	Moderately moist	Firm	-	Abundant, 20-5mm	Common	-	Nil	Few	-	-	AS	Red Dermosol, hardsetting to firm surface, many stones in surface (2-100mm)
N10	319,573	7,501,206	3	50	80	BC		Black & white	-	-	-	Strong	Platy	150	Moderately moist	Firm to very firm	-	Abundant, 150mm	Common / No roots	-				-	AS	Red Dermosol, hardsetting to firm surface, many stones in surface (2-100mm)
N11	320,253	7,501,674	1	0	20	A1	Gradual	5YR3/4	-	Light sandy clay loam	20%	Massive	Massive	-	Moderately moist	Weak	-	-	Common	-	Nil	Few	5.5	-	AS	Red Kandosol, hardsetting to firm surface
N11	320,253	7,501,674	2	20	35	B1	Clear	5YR4/6	-	Sandy clay loam	25%	Massive	Massive	-	Moderately moist	Weak	-	-	Common	-	Nil	Few	6	5 uS/cm	AS	Red Kandosol, hardsetting to firm surface
N11	320,253	7,501,674	3	35	65	B2	Sharp	5YR4/6	-	Clay loam, sandy	30%	Massive	Massive	-	Moist	Weak	-	Many, 5-50mm	Common	-	Nil	Few	6	5 uS/cm	AS	Red Kandosol, hardsetting to firm surface
N11	320,253	7,501,674	4	65	110	C		Black & white chrystaline	-	-	-	Strong	Platy	200	Moist	Very firm to very strong	-	Parent material	Few / No roots	-	Nil		6.5	-	AS	Red Kandosol, hardsetting to firm surface
N12	320,407	7,501,169	1	0	20	A1	Clear	5YR3/4	-	Light sandy clay loam	20%	Weak	Angular blocky	40	Dry	Firm	-	-	Common	-	High*	Few	7	-	A	Red Kandosol, hardsetting to firm surface
N12	320,407	7,501,169	2	20	50	B21	Clear	5YR4/6	-	Clay loam, sandy	30%	Massive	Massive	-	Moist	Weak	-	-	Common	-	Very high*	Few	7	-	A	Red Kandosol, hardsetting to firm surface
N12	320,407	7,501,169	3	50	80	B22	Clear	5YR4/6	-	Light clay, sandy	35%	Weak	Angular blocky	40	Moist	Weak	-	Many, 20mm	Common	-	Nil	Few	7	-	A	Red Kandosol, hardsetting to firm surface
N12	320,407	7,501,169	4	80	100	BC1	Clear	2.5YR3/5, 60%	7.5YR4/6, 40%	Light clay, sandy	35%	Medium	Angular blocky	20	Moist	Weak	-	Abundant, 30mm	Common	-	Nil	Few	6.5	-	A	Red Kandosol, hardsetting to firm surface
N12	320,407	7,501,169	5	100	100+	BC2		2.5YR3/6, 50%	2.5Y5/6, 50%	Light clay	35%	Massive	Massive	-	Moist	Weak	-	Abundant, 50-200mm	Common	-	-	Few	7	-	A	Red Kandosol, hardsetting to firm surface
N14	319,324	7,500,149	1	0	20	A1	Gradual	5YR3/4	-	Light sandy clay loam	20%	Weak	Subangular blocky	20	Dry	Weak	-	-	Common	-	Nil	Few	5.5	-	B	Red Kandosol, firm surface
N14	319,324	7,500,149	2	20	30	A2	Diffuse	2.5YR3/6	-	Sandy loam	15%	Weak	Subangular blocky	30	Dry	Weak	-	-	Common	-	Nil	Few	6	-	B	Red Kandosol, firm surface
N14	319,324	7,500,149	3	30	40	B21	Diffuse	2.5YR3/6	-	Sandy clay loam	25%	Weak	Subangular blocky	30	Moderately moist	Weak	-	-	Common	-	Nil	Few	6	-	B	Red Kandosol, firm surface
N14	319,324	7,500,149	4	40	140	B22	Clear	2.5YR3/6	-	Sandy clay loam	25%	Weak	Subangular blocky	30	Moist	Weak	-	-	Common	-	Nil	Few	6.5	-	B	Red Kandosol, firm surface
N14	319,324	7,500,149	5	140	150	BC		2.5YR3/6	-	?		Weak	Subangular blocky	30	Moist	Weak	-	70% granite	Common	-	-	Few	6		B	Red Kandosol, firm surface

Profile name	Easting (m) MGA Zone 53	Northing (m) MGA Zone 53	Layer	Depth (cm) - Top	Depth (cm) - Bot.	Horizon	Boundary	Munsell-Colours	Mottles	Texture	Est -clay %	str -Grade	str -Type	str -Size (mm)	Moisture content	Strength	Segregation (mm)	Fragments (mm)	Roots -Rank	HCl - fiz	Dispersion - Spontanuous	Pores	Field pH	field EC1:5	SPC	Comments
N15	320,326	7,500,401	1	0	20	A1	Gradual	2.5YR2.5/3	-	Light sandy clay loam	20%	Weak	Angular blocky	30	Dry	Firm	-	-	Common	nil	Moderate*	Few	6	2 uS/cm	A	Red Kandosol, hardsetting to firm surface
N15	320,326	7,500,401	2	20	45	A2	Gradual	2.5YR3/4	-	Light sandy clay loam	20%	Massive	Massive	-	Moderately moist	Weak	-	-	Common	nil	Moderate*	Few	6.5	-	A	Red Kandosol, hardsetting to firm surface
N15	320,326	7,500,401	3	45	85	B21	Gradual	2.5YR3/6	-	Sandy clay loam	25%	Weak	Subangular blocky	30	Moderately moist	Weak	-	-	Common	nil	Moderate*	Few	6.5	-	A	Red Kandosol, hardsetting to firm surface
N15	320,326	7,500,401	4	85	120	B22	Sharp	2.5YR3/6	-	Clay loam, sandy	30%	Weak	Subangular blocky	30	Moderately moist	Weak	-	Many, 30mm	Common	nil	Moderate*	Few	7	10 uS/cm	A	Red Kandosol, hardsetting to firm surface
N15	320,326	7,500,401	5	120	140	C	-	Black & white crystaline	-	-	-	Massive	Massive	-	Moist	Very firm to strong	-	Parent material	-	nil	Nil		8	-	A	Red Kandosol, hardsetting to firm surface
N16	318,818	7,499,427	1	0	10	A1	-	5YR3/3	-	Light sandy clay loam	20%	Massive	Massive	-	Dry	Firm	-	Common, 10-100mm (? Mineral)	Common	nil	Nil	Few	5.5	-	AS	Red Dermosol, hardsetting to firm surface
N16	318,818	7,499,427	2	10	45	B21	-	2.5YR3/6	-	Light clay	35%	Medium	Angular blocky	20	Dry	Firm	-	Few, 10-30mm (? Mineral)	Common	nil	High	Few	7.5	-	AS	Red Dermosol, hardsetting to firm surface
N16	318,818	7,499,427	3	45	85	B22	-	2.5YR3/6	-	Sandy clay loam	25%	Medium	Subangular blocky	30	Dry	Firm	-	Few, 10-50mm (? Mineral)	Common	nil	Nil	Few	8	-	AS	Red Dermosol, hardsetting to firm surface
N16	318,818	7,499,427	4	85	110	BC	-	2.5YR4/6	-	-	-	Massive	Massive	-	Dry	Very firm	-	80% Parent material	Common	nil	Nil	Few	8	-	AS	Red Dermosol, hardsetting to firm surface
N16	318,818	7,499,427	5	110	150	C	-	-	-	-	-	Massive	Massive	-	Dry	Strong	-	100% Parent material		nil	Nil	none	8	-	AS	Red Dermosol, hardsetting to firm surface
N19	316,545	7,494,475	1	0	20	A1	Gradual	5YR3/3	-	Sandy clay loam	25%	Weak	Subangular blocky	20	Dry	Weak	-	Few, 10mm	Many	nil	Nil	Few	6	-	AS	Red Kandosol, hardsetting to firm surface, surface stone common (20mm)
N19	316,545	7,494,475	2	20	45	B2	Gradual	2.5YR4/6	-	Clay loam	30%	Weak	Subangular blocky	30	Moderately moist	Weak	-	Many, 10mm	Common	nil	Nil	Few	6.5	5 uS/cm	AS	Red Kandosol, hardsetting to firm surface, surface stone common (20mm)
N19	316,545	7,494,475	3	45	80	BC	Gradual	2.5YR4/6	-	Clay loam	30%	Strong	Platy	100	Moderately moist	Weak to very firm	-	Abundant, 60%, 100mm	Common	nil	Nil		6.5	-	AS	Red Kandosol, hardsetting to firm surface, surface stone common (20mm)
N19	316,545	7,494,475	4	80	150	C		White	-	-	-	Strong	Platy	200	Moderately moist	Weak to strong	-	95%, 200mm	Few	nil	Nil		6.5	-	AS	Red Kandosol, hardsetting to firm surface, surface stone common (20mm)
N20	317,945	7,494,583	1	0	20	A1	Gradual	2.5YR2.5/4	-	Light sandy clay loam	20%	Weak	Subangular blocky	20	Dry	Weak	-	-	Common	-	Nil	Few	6	-	B	Red Kandosol, hardsetting to firm surface
N20	317,945	7,494,583	2	20	60	A2	Clear	2.5YR3/6	-	Light sandy clay loam	20%	Weak	Subangular blocky	30	Moderately moist	Weak	-	-	Common	-	Medium*	Few	6.5	-	B	Red Kandosol, hardsetting to firm surface
N20	317,945	7,494,583	3	60	100	B1	Clear	2.5YR3/6	-	Light sandy clay loam	20%	Weak	Angular blocky	30	Moderately moist	Firm	-	Many, 5-20mm	Common	-	Nil	Few	6	-	B	Red Kandosol, hardsetting to firm surface
N20	317,945	7,494,583	4	100	150	B2		2.5YR3/6	-	Light clay, sandy	35%	Weak	Angular blocky	40	Moderately moist	Very firm	-	-	Common	-	Nil	Few	7	-	B	Red Kandosol, hardsetting to firm surface
N21	318,471	7,495,143	1	0	20	A1	Gradual	5YR3/4	-	Sandy loam	15%	Massive	Massive	-	Dry	Weak	-	-	Many	-	Nil	Few	6	-	B	Red Kandosol, hardsetting surface
N21	318,471	7,495,143	2	20	50	A2	Gradual	5YR3/4	-	Light sandy clay loam	20%	Massive	Massive	-	Dry	Weak	-	-	Common	-	Nil	Few	6.5	-	B	Red Kandosol, hardsetting surface
N21	318,471	7,495,143	3	50	90	B21	Diffuse	2.5YR3/6	-	Sandy clay loam	25%	Weak	Angular blocky	-	Dry	Firm	-	-	Common	-	Nil	Few	6.5	-	B	Red Kandosol, hardsetting surface
N21	318,471	7,495,143	4	90	150	B22		2.5YR3/6	-	Clay loam, sandy	30%	Weak	Angular blocky	50	Moist	Weak	-	-	Common	-	Nil	Few	6.5	-	B	Red Kandosol, hardsetting surface
N22	318,373	7,494,152	1	0	15	A1	Gradual	2.5YR2.5/4	-	Light sandy clay loam	20%	Weak	Subangular blocky	30	Dry	Weak	-	Common, 5mm	Common	-	-	Few	4.75	-	B	Red Dermosol, hardsetting to firm surface
N22	318,373	7,494,152	2	15	40	A2	Gradual	2.5YR3/6	-	Sandy clay loam	25%	Weak	Subangular blocky	30	Dry	Weak	-	Common, 5mm	Common	-	-	Few	5.5	-	B	Red Dermosol, hardsetting to firm surface
N22	318,373	7,494,152	3	40	90	B1	Gradual	2.5YR3/6	-	Sandy clay loam	25%	Medium	Angular blocky	40	Dry	Weak	-	Common, 5mm	Common	-	-	Few	5.5	-	B	Red Dermosol, hardsetting to firm surface
N22	318,373	7,494,152	4	90	140	B2	Clear	2.5YR3/6	-	Light clay, sandy	35%	Medium	Angular blocky	40	Dry	Firm	-	Many, 5mm	Common	-	-	Few	7	-	B	Red Dermosol, hardsetting to firm surface
N22	318,373	7,494,152	5	140	150	C			-	quartz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	B	Red Dermosol, hardsetting to firm surface
N26	316,138	7,494,008	1	0	20	A1	Gradual	10R3/4	-	Sandy clay loam	25%	Massive	Massive		Dry	Weak	-	-	Common	-	Nil	Few	5	-	B	Red Dermosol, hardsetting to firm surface
N26	316,138	7,494,008	2	20	40	A2	Gradual	10R3/4	-	Light sandy clay loam	20%	Massive	Massive		Moderately moist	Weak	-	-	Common	-	Nil	Few	5.5	-	B	Red Dermosol, hardsetting to firm surface
N26	316,138	7,494,008	3	40	60	B1	Diffuse	10R3/6	-	Light sandy clay loam	20%	Weak	Subangular blocky	30	Moderately moist	Weak	-	Common, 5mm	Common	-	Nil	Few	6	-	B	Red Dermosol, hardsetting to firm surface
N26	316,138	7,494,008	4	60	100	B21	Diffuse	10R3/6	-	Clay loam, sandy	30%	Medium	Angular blocky	40	Moderately moist	Weak	-	Common / Many, 5-10mm	Common	-	Nil	Few	6.5	-	B	Red Dermosol, hardsetting to firm surface
N26	316,138	7,494,008	5	100	150	B22		10R3/4	-	Light clay, sandy	35%	Strong	Angular blocky	40	Moist	Firm	Mn soft?	Common, 5 - 10 mm	Common	-	Nil	Few	6.5	-	B	Red Dermosol, hardsetting to firm surface
N27	317,088	7,493,795	1	0	20	A1	Gradual	2.5YR2.5/3	-	Light sandy clay loam	20%	Massive	Massive	-	Dry	Weak	-	-	Common	-	Nil	Few	5	-	B	Red Dermosol, firm surface
N27	317,088	7,493,795	2	20	60	A2	Gradual	2.5YR3/3	-	Light sandy clay loam	20%	Massive	Massive	-	Moderately moist	Weak	-	Few, 5mm	Common	-	Nil	Few	5	-	B	Red Dermosol, firm surface
N27	317,088	7,493,795	3	60	100	B21	Diffuse	2.5YR3/6	-	Light clay	35%	Weak	Angular blocky	40	Dry	Firm	-	Many, 5-10mm	Common	-	Nil	Few	6	-	B	Red Dermosol, firm surface
N27	317,088	7,493,795	4	100	150	B22		2.5YR3/6	-	Light clay	35%	Medium	Angular blocky	40	Moderately moist	Firm	-	Many, 5-10mm	Common	-	Nil	Few	6.5	-	B	Red Dermosol, firm surface
N28	317,830	7,493,830	1	0	20	A1	Gradual	2.5YR2.5/4	-	Light sandy clay loam	20%	Weak	Subangular blocky	30	Dry	Weak	-	-	Common	-	-	Few	5	-	B	Red Dermosol, hardsetting to firm surface
N28	317,830	7,493,830	2	20	40	A2	Gradual	2.5YR3/4	-	Light sandy clay loam	20%	Weak	Subangular blocky	30	Moderately moist	Weak	-	-	Common	-	-	Few	5.5	-	B	Red Dermosol, hardsetting to firm surface
N28	317,830	7,493,830	3	40	70	B1	Diffuse	2.5YR3/6	-	Sandy clay loam	25%	Weak	Angular blocky	30	Moist	Weak	-	Few, 5 -20mm	Common	-	-	Few	5.5	-	B	Red Dermosol, hardsetting to firm surface
N28	317,830	7,493,830	4	70	100	B21	Clear	2.5YR3/6	-	Light clay	35%	Medium	Angular blocky	30	Moderately moist	Very firm	-	Many 5-40mm	Common	-	-	Few	6.5	-	B	Red Dermosol, hardsetting to firm surface
N28	317,830	7,493,830	5	100	150	B22	-	-	-	Light clay	35%	Medium	Angular blocky	30	Moderately moist	Very firm	-	Abundant, 5-40mm, 50%	Common	-	-	Few	7	-	B	Red Dermosol, hardsetting to firm surface
N30	317,008	7,493,012	1	0	20	A1	Gradual	2.5YR3/4	-	Light sandy clay loam	20%	Massive	Massive	-	Dry	Weak	-	-	Common	-	Nil	Few	4.5	-	B	Red Dermosol, firm surface
N30	317,008	7,493,012	2	20	50	A2	Diffuse	2.5YR3/4	-	Sandy clay loam	25%	Massive	Massive	-	Moderately moist	Weak	-	-	Common	-	Nil	Few	5	-	B	Red Dermosol, firm surface
N30	317,008	7,493,012	3	50	80	B21	Diffuse	2.5YR3/4	-	Clay loam	30%	Weak	Angular blocky	40	Moderately moist	Weak	-	Common, 5 - 10mm	Common	-	Nil	Few	5.5	-	B	Red Dermosol, firm surface
N30	317,008	7,493,012	4	80	110	B22	Diffuse	2.5YR3/4	-	Clay loam	30%	Medium	Angular blocky	50	Moderately moist	Firm	-	Common, 5 - 10mm	Common	-	Nil	Few	5.5	-	B	Red Dermosol, firm surface
N30	317,008	7,493,012	5	110	150	B23		2.5YR3/4	-	Light clay	35%	Medium	Angular blocky	40	Moderately moist	Very firm	-	Common, 5 - 10mm. Quartz	Common	-	Nil	Few	6.5	-	B	Red Dermosol, firm surface
N31	322,686	7,493,132	1	0	20	A1	Diffuse	2.5YR2.5/4	-	Light sandy clay loam	20%	Massive	Massive	-	Moderately moist	Weak	-	-	Common	-	Slight	Few	5.5	-	B	Red Kandosol, hardsetting to firm surface
N31	322,686	7,493,132	2	20	60	A2	Diffuse	2.5YR3/4	-	Light sandy clay loam	20%	Massive	Massive	-	Moderately moist	Weak	-	-	Common	-	Medium	Few	6	-	B	Red Kandosol, hardsetting to firm surface
N31	322,686	7,493,132	3	60	100	B21	Diffuse	2.5YR3/6	-	Sandy clay loam	25%	Weak	Angular blocky	40	Moist	Weak	-	-	Common	-	Nil	Few	6.5	-	B	Red Kandosol, hardsetting to firm surface
N31	322,686	7,493,132	4	100	150	B22		2.5YR3/6	-	Sandy clay loam	25%	Weak	Angular blocky	40	Moist	Weak	-	-	Common	-	Slight	Few	6.5	-	B	Red Kandosol, hardsetting to firm surface
N32	322,957	7,493,136	1	0	20	A1	Gradual	5YR3/3	-	Light sandy clay loam	20%	Massive	Massive	-	Dry	Very firm	-	-	Many	-	Nil	Few	5.5	-	B	Red Kandosol, hardsetting to firm surface
N32	322,957	7,493,136	2	20	50	A2	Gradual	5YR3/4	-	Sandy clay loam	25%	Weak	Subangular blocky	30	Dry	Weak	-	-	Common	-	Nil	Few	6	-	B	Red Kandosol, hardsetting to firm surface
N32	322,957	7,493,136	3	50	75	B1	Diffuse	2.5YR3/4	-	Sandy clay loam	25%	Weak	Subangular blocky	40	Moderately moist	Firm	-	-	Common	-	Nil	Few	6	-	B	Red Kandosol, hardsetting to firm surface
N32	322,957	7,493,136	4	75	110	B21	Diffuse	2.5YR3/4	-	Clay loam, sandy	30%	Weak	Subangular blocky	40	Moderately moist	Firm / very firm	-	Few, 5 - 20mm	Common	-	Nil	Few	6.5	-	B	Red Kandosol, hardsetting to firm surface
N32	322,957	7,493,136	5	110	150	B22		2.5YR3/4	-	Clay loam, sandy	30%	Weak	Angular blocky	40	Moderately moist	Firm	-	-	Common	-	Slight	Few	6.5	-	B	Red Kandosol, hardsetting to firm surface

APPENDIX B – LABORATORY RESULTS

Analysis undertaken on all horizons

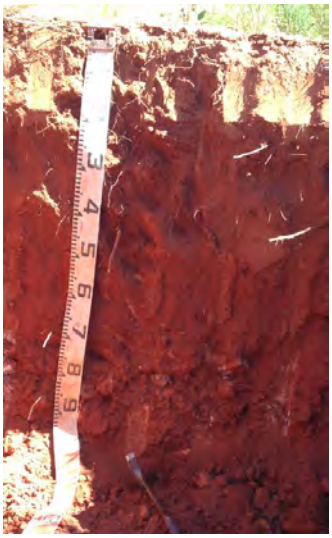
		bottom	Est	pH	pHw	Cl	EC1:5	Exch K	Exch Ca	Exch Mg	Exch Na	Exch Na	ECEC	ESP
Label	SPC	depth	clay %	dye	pH units	mg/kg	dS/m	mg/kg	mg/kg	mg/kg	mg/kg	cmol/kg	cmol/kg	%
N01-1	A	20	20	6	6.55	8.08	0.02	365	449	88.1	9.2	0.04	3.97	1.1
N01-2	A	40	20	6.5	7.68	11.4	0.11	224	857	113	9.2	0.04	3.89	1.12
N01-3	A	65	25	6.6	6.93	5.45	0.02	176	565	110	9.2	0.04	4.25	1.02
N01-4	A	100	30	6.7	7.22	8.35	0.04	268	871	173	16.3	0.07	6.57	1.08
N01-5	A	150	30	7	8.08		0.1							
N04-1	C	30	20	8.5	8.61	11.6	0.1	486	5101	241	9.2	0.04	12.9	0.34
N04-2	C	60	20	8.5	8.86	15.6	0.09	193	4783	190	9.2	0.04	6.91	0.63
N04-3	C	90	20	8.5	8.77	19.3	0.11	857	4898	285	28.7	0.12	7.35	0.59
N04-4	C	120	20	8.5	8.57	35.4	0.15	138	5179	850	58.5	0.25	15.2	0.29
N06-1	AS	15	25	6.5	7.18	13.5	0.03	183	635	199	9.2	0.04	5.36	0.81
N06-2	AS	30	25	7	7.92	13.1	0.03	239	1023	309	13.6	0.06	7.39	0.59
N06-3	AS	70	35	8.5	8.84	7	0.06	494	4454	789	131.0	0.57	13.9	1.61
N06-4	AS	110	35	9	10	24.8	0.12	452	3861	948	1066.0	4.63	11.7	21
N06-5	AS	150	35	9	9.7		0.4							
N09-1	A	20	20	7	7.28	6.85	0.04	278	918	189	9.2	0.04	6.93	0.63
N09-2	A	50	25	7	7.2	5.95	0.02	213	1136	151	11.1	0.05	7.54	0.64
N09-3	A	75	25	7	7.48	6.8	0.04	179	1440	189	10.1	0.04	7.58	0.57
N09-4	A	100	25	7.5	7.64		0.02							
N12-1	A	20	20	7	5.81	17.2	0.01	184	1428	190	9.2	0.04	9.25	0.47
N12-2	A	50	30	7	6.9	6.5	0.02	284	1017	118	9.2	0.04	6.85	0.63
N12-3	A	80	30	7	6.83		0.03							
N12-4	A	100	30	6.5	6.66	9.65	0.03	239	1028	237	12.7	0.06	7.79	0.71
N12-5	A	110	35	7	7.58	12.6	0.07	137	1011	232	19.8	0.09	6.55	0.66
N14-1	B	20	20	5.5	5.74	6.25	0.01	152	333	55.1	9.2	0.04	2.58	1.69
N14-2	B	50	15	6	6.36	4.86	0.01	412	388	47.7	9.2	0.04	3.45	1.26
N14-3	B	90	25	6	6.29	6.7	0.01	216	457	58.2	9.2	0.04	3.38	1.29
N14-4	B	140	25	6.5	6.43	5.7	0.01	138	461	99.8	9.2	0.04	3.55	1.23
N20-1	B	20	20	6	6.22	7.8	0.01	239	514	58.7	9.2	0.04	3.73	1.17
N20-2	B	60	20	6.5	6.67	4.54	0.01	367	609	96	9.2	0.04	4.84	0.9
N20-3	B	100	20	6.5	6.81	7.5	0.02	206	509	141	9.2	0.04	4.3	1.01
N20-4	B	150	35	7	7.42		0.02							
N32-1	B	20	20	5.5	6.3	6.8	0.01	198	435	78.7	9.2	0.04	3.39	1.28
N32-2	B	50	25	6	6.8	12.7	0.03	177	456	88.9	9.2	0.04	3.53	1.23
N32-3	B	75	25	6	6.75	6.4	0.01	181	603	112	9.2	0.04	4.47	0.97
N32-4	B	110	30	6.5	7.22		0.01							
N32-5	B	150	30	6.5	7.2	5.5	0.02	331	950	230	10.8	0.05	7.57	0.62

Nutrition analysis of surface samples

	pHw	EC1:5	Total N	Total P	OC	Colwell P	Colwell K	S	Cu	Zn	Mn	Fe	B
Label	pH units	dS/m	mg/kg	mg/kg	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
N01-1	6.55	0.02	167	148	0.15	20.1	361	8.16	0.45	0.2	7.51	13	0.33
N09-1	7.28	0.04	254	829	0.2	39.5	312	8.59	0.69	0.38	8.84	13.5	0.42
N12-1	5.81	0.01	386	174	0.28	20.5	191	8.77	0.56	0.4	13.6	22	0.34
N06-1	7.18	0.03	219	150	0.18	8.66	215	8.3	0.37	0.65	41.6	75.9	0.43
N14-1	5.74	0.01	199	155	0.31	15.2	156	8.18	0.39	0.2	9.57	16.2	0.36
N20-1	6.22	0.01	343	183	0.44	20.8	214	8.3	0.48	0.42	10.1	9.26	0.39
N32-1	6.3	0.01	234	149	0.25	15.4	176	8.29	0.53	0.39	7.91	7.89	0.29
N04-1	8.61	0.1	640	561	0.72	18.4	388	9.25	0.42	0.52	14.6	24.7	0.4

APPENDIX C – PIT PHOTOS

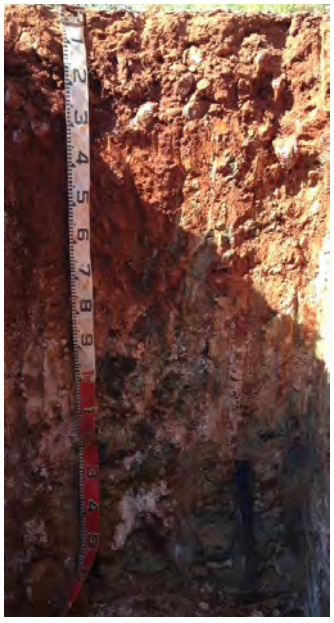
N01



N02

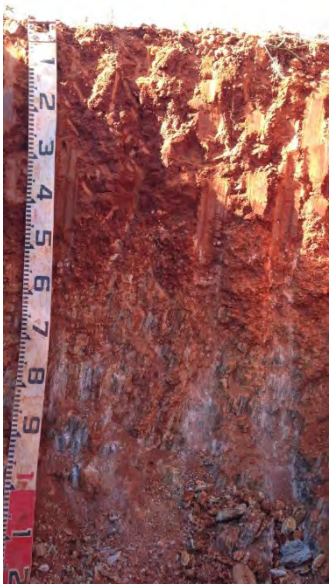
N03

N04

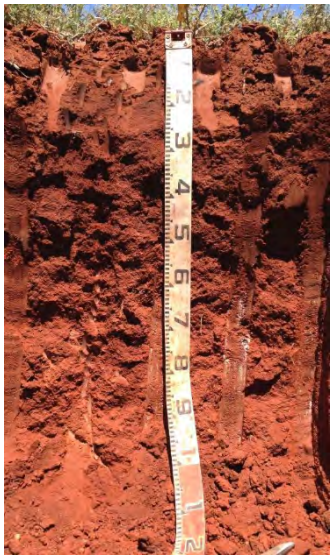


N06

N07



N08

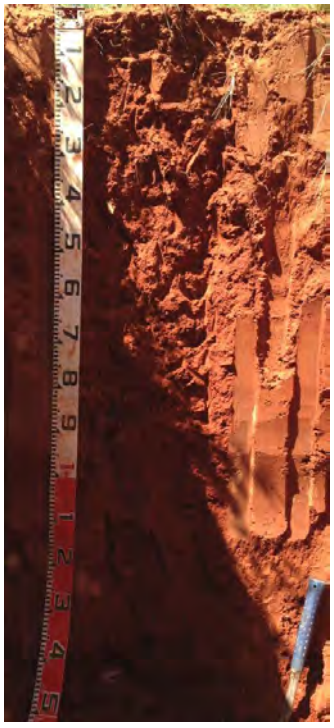


N09

N10

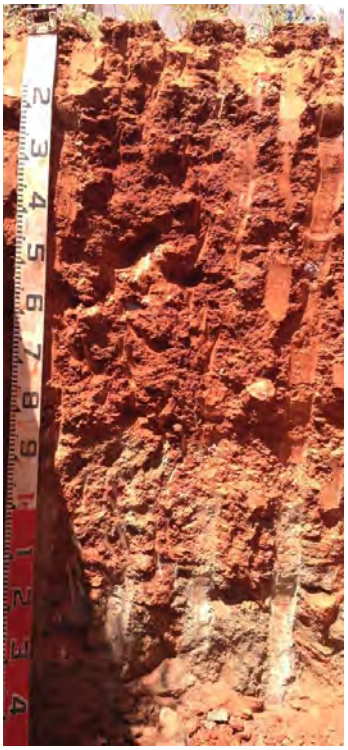
N11

N12



N14

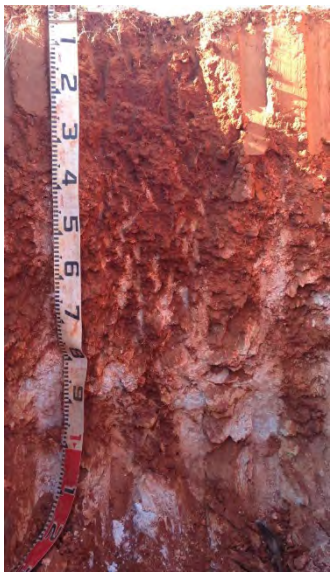
N15



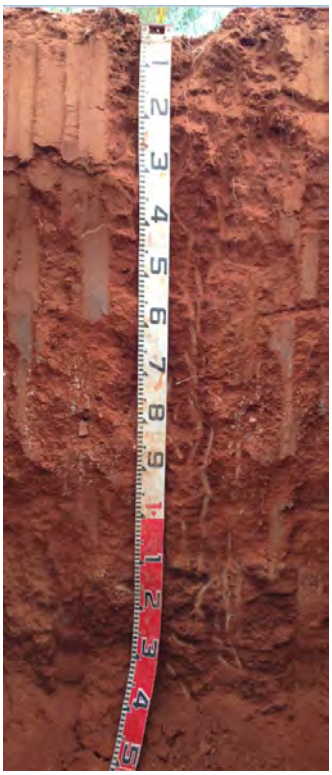
N16

N17

N18



N19

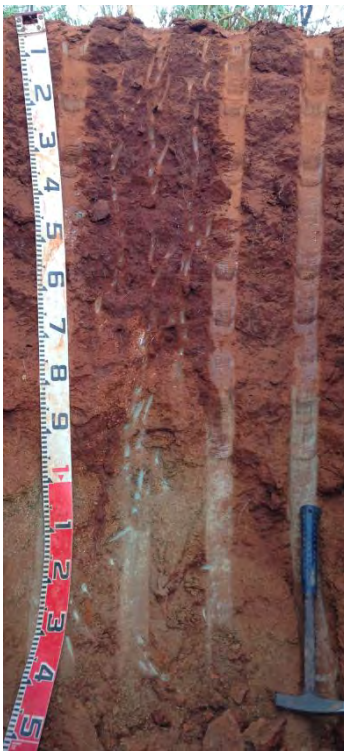


N20

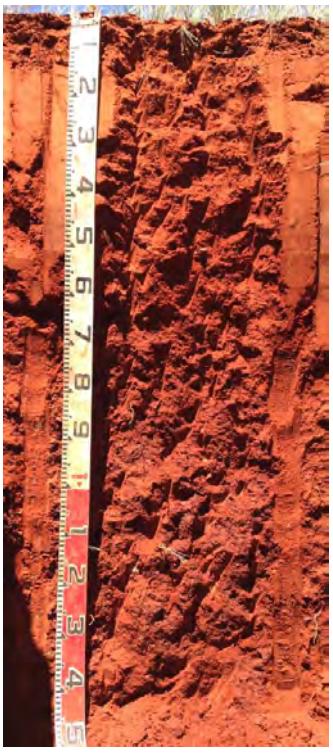
N21

N22

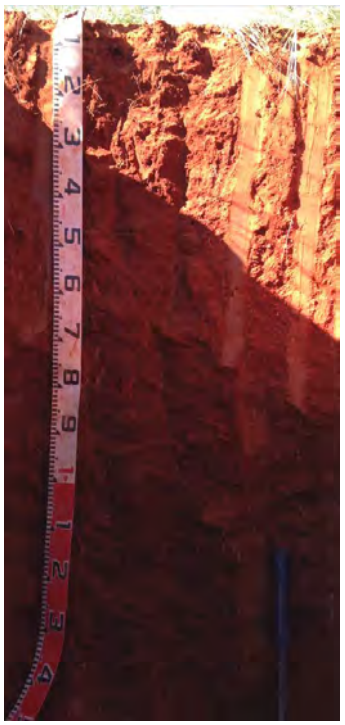
N23



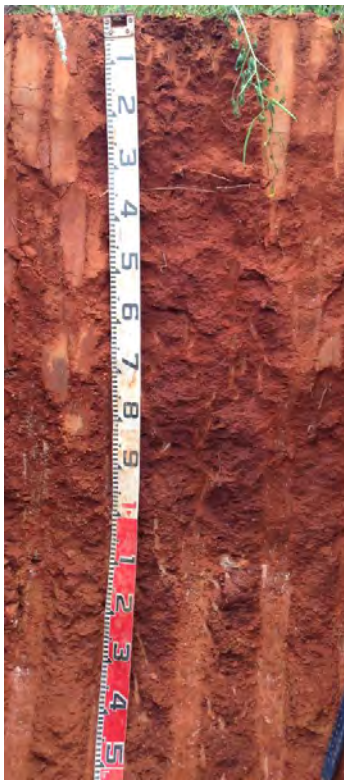
N24



N26



N27



N28	N30	N31	N32