BASELINE SOIL ASSESSMENT – EARL GREY LITHIUM PROJECT

Covalent Lithium

September 2023

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TOOWOOMBA
PO Box 57
HARLAXTON QLD 4350
Phone (07) 4613 1825

PERTH
PO Box 5175
SOUTH LAKE WA 6164
Phone (08) 9494 2835

NEWCASTLE
PO Box 7017
REDHEAD NSW 2290
Phone (02) 4965 7717

Landloch Pty Ltd
A.C.N. 011 032 803
A.B.N. 29011032803

Web site: www.landloch.com.au
Email: admin@landloch.com.au

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1 INTRODUCTION

Covalent Lithium (Covalent) are preparing to expand the Earl Grey Lithium Project (the Project) north of the existing infrastructure and mining operations. As part of this expansion, a baseline soil characterisation survey is required to inform management of soil resources and to provide support in approvals documentation.

Landloch Pty Ltd (Landloch) were engaged to complete a baseline soil assessment for the footprint of the Project. The Project area includes the planned disturbance footprint of the future expansion and the land surrounding this footprint. This report presents the results of the baseline soil characterisation survey, and includes:

- The background information of the Project;
- The regulatory requirements that guided the soil survey;
- Methodology for field-based survey;
- Classification and mapping of the soils in line the relevant standards;
- Grouping of soils into soil mapping units and a summary of their soil and landform characteristics;
- Discussions outlining soil constraints and opportunities; and associated soil amelioration recommendations (where appropriate);
- Estimations of soil stripping depths and useable soil volumes; and
- Soil handling recommendations.

1.1 Background

The Early Grey Lithium Project is located approximately 105 km south-south-east of Southern Cross, in the Goldfields-Esperance region of Western Australia. Landloch was initially engaged in 2021 to undertake a baseline soil characterisation of the, at the time, proposed disturbance areas associated with future infrastructure. The Project area assessed within this report is located directly to the north-north-west of the initial area surveyed in 2021.

The total size of the survey area is 1,643 ha and is comprised of two parts: the overall project area and the planned disturbance footprint. The planned disturbance footprint is associated with the future expansion of the Project and is 942 ha in size. The remaining area of land that surrounds the disturbance area and is 701 ha in size.

The location of the Project area, disturbance footprint and the area surveyed in 2022 are presented in Figure 1.

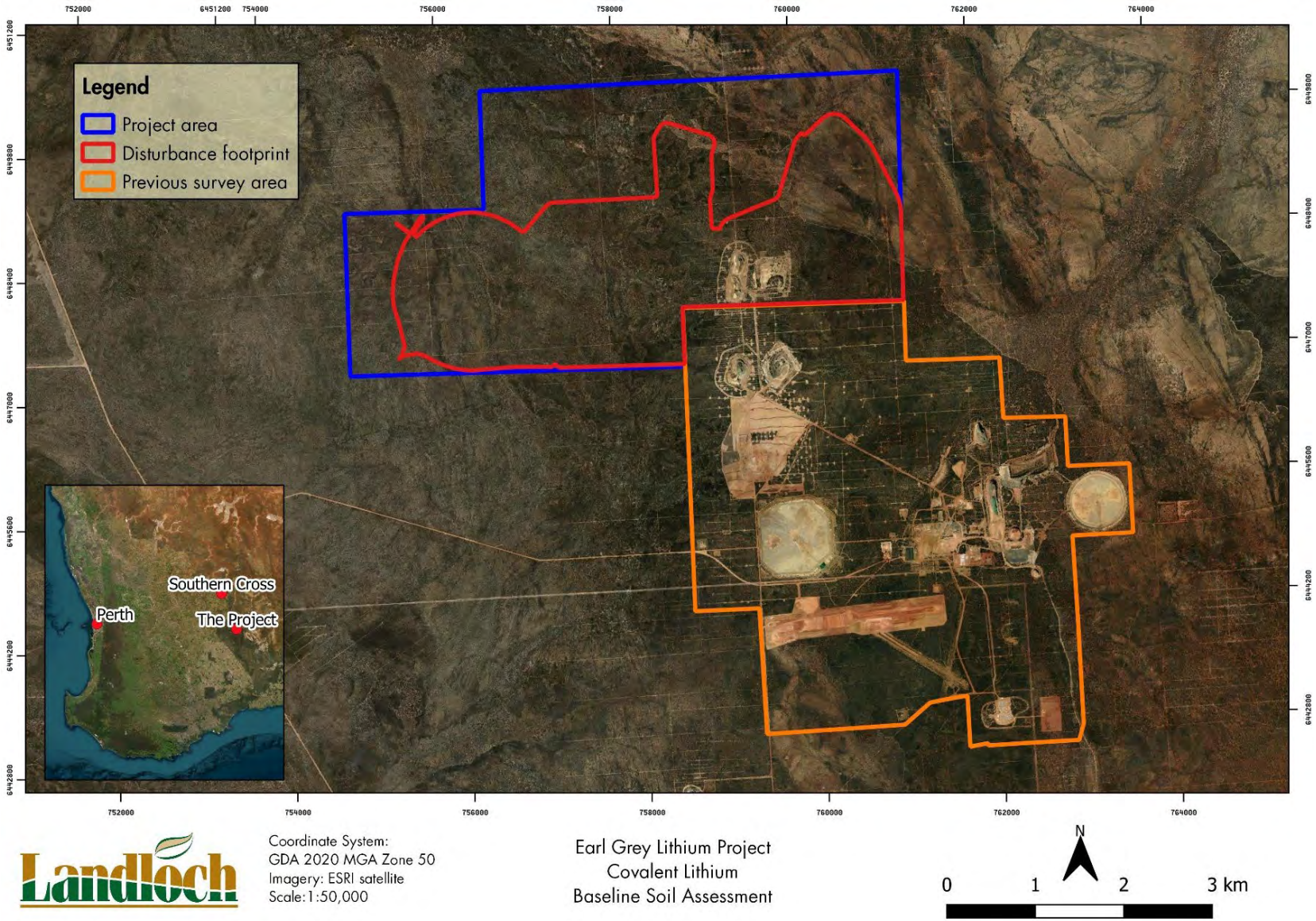

Figure 1: Location of the Project, disturbance footprint and previous survey area.

1.2 Regulatory requirements

This baseline soil survey was undertaken in line with the following regulatory guidelines:

- *Statutory Guidelines for Mining Proposals* (DMIRS 2020a);
- *Mining Proposal Guidance* (DMIRS 2020b);
- *Statutory Guidelines for Mine Closure Plans* (DMIRS 2020d); and
- *Draft Guidance Material Characterisation Baseline Data Requirements for Mining Proposals* (DMP 2016).

A summary of the regulatory requirements relating to soils, and how the methodology adopted for this soil survey addresses these requirements is summarised in Appendix A.

2 OUTLINE OF APPROACH

Broadly, the approach taken to complete the survey included:

- A desktop review and development of a Sampling and Analysis Plan;
- Field survey to ground-truth and sample the soils;
- Classification of soils into soil types and mapping of their extents;
- Grouping of soil types based on similarities in characteristics; and
- Determination of potential topsoil and subsoil stripping depths and volumes.

2.1 Desktop review

A desktop review of existing soil, landscape, and vegetation data was undertaken to gain an understanding of the type and variability of the soils and landscapes within the survey area. Soil inspection sites were selected to ground-truth the pre-existing soil and landscape data. A summary of the desktop review is provided in this section, with additional information found within the Sampling and Analysis Plan (Landloch 2023).

2.1.1 2022 Soil Characterisation

Landloch previously undertook a baseline soil characterisation for the 1,862 ha area to the south of the Project area. It can be expected, but not guaranteed, that many of the soil types encountered in the 2022 assessment will be present in the Project area. The soils encountered in the previous assessment were classified using both the ASC and Soil Groups of Western Australia (SGWA). The soils were also grouped into Soil Mapping Units (SMU) based on their management requirements, morphological properties, particle size and coarse fragment percentages.

The soil classes and SMU identified in the 2022 soil assessment are presented in Tables 1 to 3. Maps showing the distribution of the soil classes can be found in Appendix B.

Table 1: Australian Soil Classification of the soils within the 2022 survey (Landloch 2022).

ASC	Description	Percentage of area (%)
Kandosols	Soils that lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout the profile.	69
Vertosols	Clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides and/or lenticular structural aggregates.	17
Dermosols	Soils with structured B2 horizons and lacking a strong texture contrast between the A and B horizons. Although there is some diversity within the order, it brings together a range of soils with some important properties in common.	14

Table 2: Soil Groups of WA classification for soils within the 2022 survey (Landloch 2022).

Soil Group of WA	Description	Percentage of area (%)
Loamy Gravel	Soils that have an ironstone gravel layer or ferricrete within the top 0.15 m, with no texture or permeability contrast layer within the top 0.3 m.	32
Hard Cracking Clay	Soils that have a clay surface at least 0.3 m thick and crack strongly when dry. Massive, crusting or coarsely pedal surface.	18
Red/brown non-cracking Clay	Soils that have a clay surface at least 0.3 m thick and do not crack strongly when dry and are red or brown within the top 0.3 m.	18
Yellow Sandy Earth	Soils with a sandy surface and grading to loam by 0.8 m. May be clayey at depth. Yellow within top 0.3 m.	13
Ironstone Gravelly Soils	Soils that have an ironstone gravel layer or ferricrete within the top 0.15 m.	10
Brown sandy Earth	Soils that have an ironstone gravel layer or ferricrete within the top 0.15 m. Gravels with predominately sandy matrix to greater than 0.8 m.	5
Deep Sandy Gravel	Sand greater that 0.8 m, with an abundance of gravel.	2
Brown Deep Sand	Sand greater than 0.8 m, brown within 30cm.	1

Table 3: Soil Mapping Units identified within the 2022 survey (Landloch 2022).

Soil Mapping Unit	Description	Percentage of area (%)
Structured Deep Clays	Structured soils with high clay content. Topsoils and subsoils are typically clay dominated but can be loamy. Highly sodic at depth and are prone to structural instability.	48
Gravelly Soils	Soils dominated by gravel throughout the profile. Typically weakly to massive structured subsoils. Textures vary from sands to loam. These soils tend to be located in the upper slopes and mid-slopes of the landscape.	41
Acidic Soils	Sandy and loamy soils with a high abundance of gravel that are characterised by high acidity (pH <5.5). Both the topsoils and subsoils are generally acidic.	11

2.1.2 Land systems mapping

Broadscale land systems mapping is available for the Project area (Northcote 1967). Land systems mapping describes and groups land with a recurring pattern of topography, soil, and vegetation. This mapping is useful for regional and very extensive (broad scale) land use planning. It also provides an indication of potential variability in soil type for the Project area.

One land system is present over the Project area, which includes the Ya28 and AC1 sub-systems. A brief description of each sub-system is provided in Table 4.

The dominant sub-system present over the Project area is Ya28, described as sandy plains with some clay pans, salt lakes and dunes occurring. The second sub-system, AC1, only occurs in the western portion of the Project area and is comprised of gently undulating plateaus atop granites with long gentle slopes.

Soil profiles are expected to vary within each system, with Ya28 comprised of depositional soils (sandy alkaline soils and calcareous earths), and AC1 comprised of erosional soils (sandy soils and ironstone gravels).

Table 4: Summary of land systems within the project area.

Land System Code	Land System	Soils (Major/ Minor)	Description	% of Survey Area
261o5	Ya28 Atlas system	Sandy alkaline soils and calcareous earths.	Sandy plains with some clay pans, salt lakes and dunes.	86
261d3	AC1 Atlas system	Yellow sandy soils atop depositional ironstone gravels.	Gently sloping to gently undulating plateau areas on granites with long gentle slopes and occasional erosional scarps.	14

2.1.3 Landscape gradient and relief

Differences in landscape gradient and relief (land elevation relative to the minimum elevation in the area) play an important role in soil formation and provide an indication of variability in soil types across a landscape. Contour data provided by Covalent was converted into a digital elevation model (DEM) to assess changes in gradient and relief. The DEM is presented in Figure 2.

The elevation ranges from 426 m above sea level in the south-eastern corner of the Project area to 478 m at the highest point of the ridge that runs along the centre of the area. The Project area has a maximum relief of 52 m.

2.1.4 Vegetation mapping

Vegetation mapping was provided by Covalent for the Survey Area. Vegetation surveys were undertaken in the years 2016, 2021, 2022 and 2023, with the results being presented in Figure 3. There are 16 vegetation units present within the Survey Area, these can broadly be grouped into two types of vegetation units:

- Vegetation units dominated by Allocasuarina species; and
- Vegetation units dominated by Eucalyptus species.

A table summarising the vegetation units is provided in Appendix C.

2.1.5 Australian Soil Characterisation

The Australian Soil Resource Information System (ASRIS) contains broadscale interpolated soils data across Australia. This includes classification of soils in line with the Australia Soil Classification (ASC). There are two soil orders present within the Project area, Sodosols and Tenosols. Sodosols are soils that do have a clear texture contrast within their soil profiles, and which are sodic throughout the majority of the profile. Tenosols include soils with generally only weak pedologic organisation apart from the presence on an A horizon.

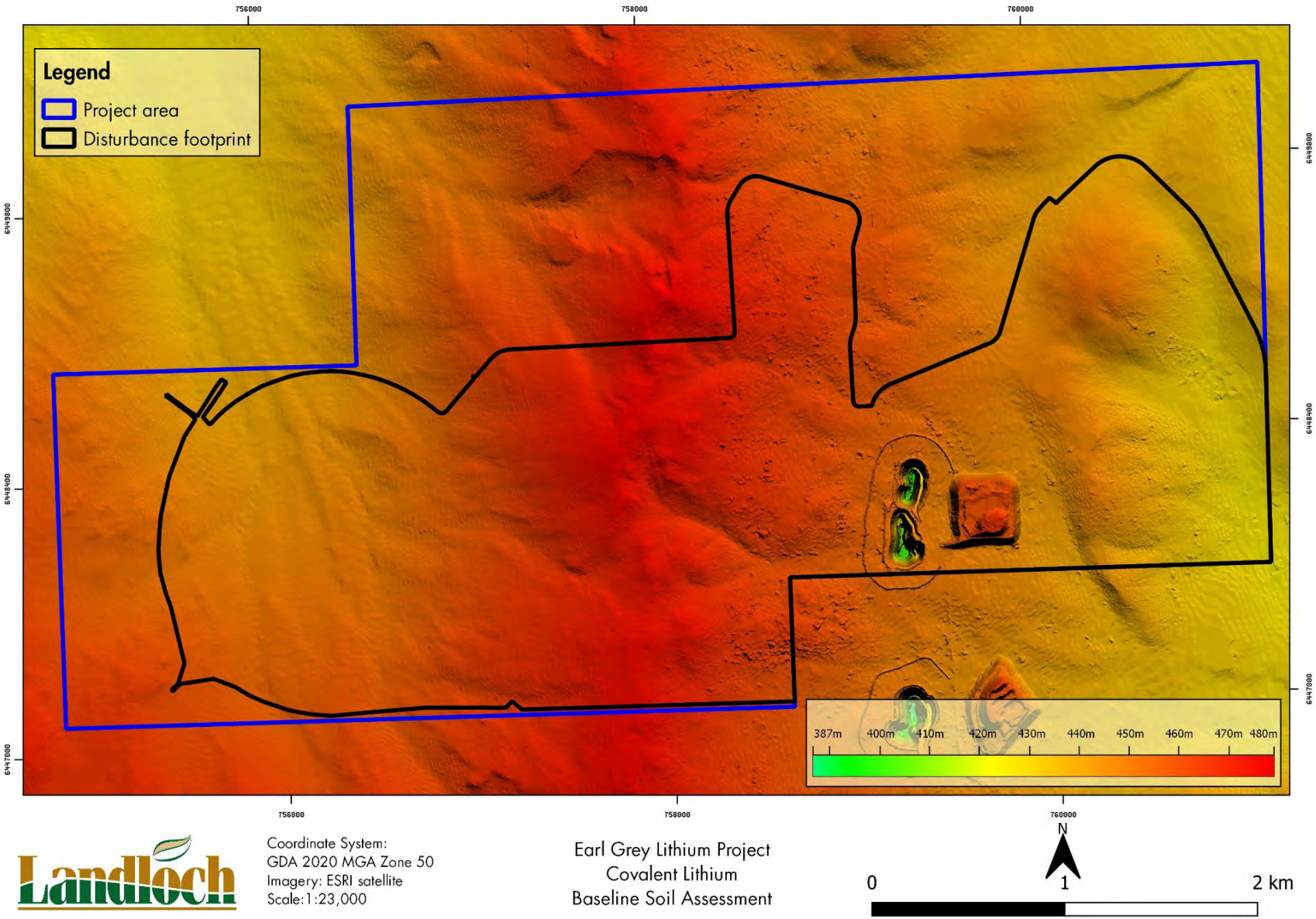

Figure 2: DEM of the Project area.

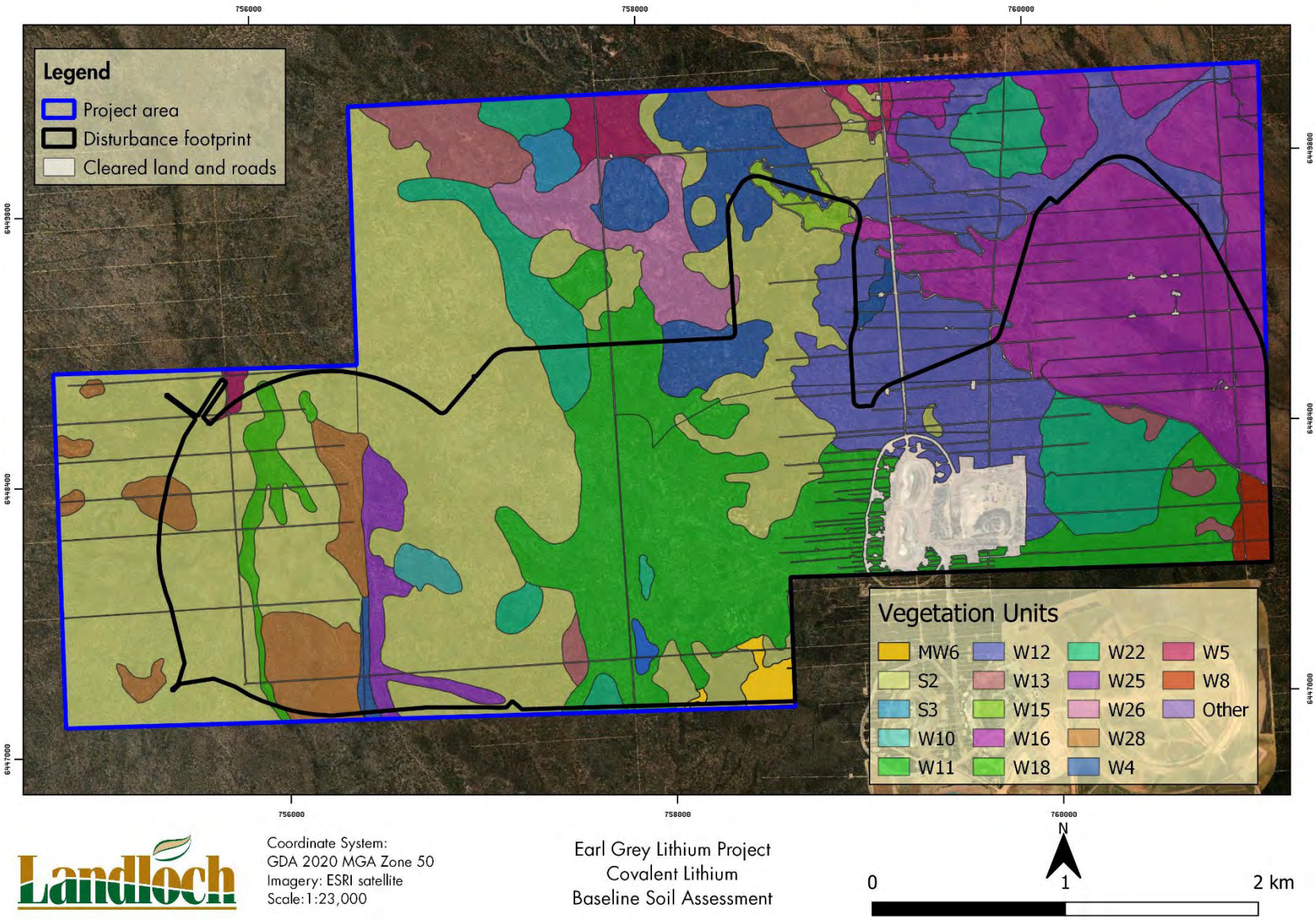

Figure 3: Vegetation mapping of the Project area.

2.2 Field-based survey

2.2.1 Mapping scale and sampling density

Separate sampling scales and densities were applied for the disturbance area and the wider project area. The required soil inspection density for a range of assessment types is provided in *Guidelines for Surveying Soil and Land Resources* (Mckenzie *et al.* 2008), part of the Australian soil and land survey handbook series. The Project area is ~1,643ha in size (which includes the disturbance area), and the disturbance area is ~942ha.

2.2.1.1 Disturbance area

The required scale of soil mapping and the size of the survey area dictates the number of soil inspection sites required. For the objective of assessing moderately intense land uses at the semi-detailed project planning level (1:50,000 scale), and inspection site is required every 20 – 100ha. This scale of mapping delineates areas approximately 10ha in size, and details groups of soils with similar properties. This was considered an appropriate scale for the areas within the disturbance area footprint.

For the disturbance area (942ha), a total of 23 inspection sites were selected, equivalent to an inspection density of 1 site per ~41ha.

During the field survey 7 of the 23 inspection sites within the disturbance area were inaccessible due to dense vegetation along the access tracks. Ultimately 16 of the 23 sites were successfully investigated. This changed the equivalent inspection density to 1 site per ~58ha.

2.2.1.2 General project area

For assessing the general project area outside of the disturbance area (701ha), a 'low (semi-detailed)' level of assessment was adopted. This level of assessment is suitable for extensive land use, project feasibility, regional land inventory and district level planning. And inspection site is required every 100 – 400ha, to produce a scale of 1:100,000. This will delineate areas of ~40ha and will allow for the definition of soil units rather than individual soil types. Based on this, 7 sites outside of the disturbance footprint (but within the project area) were selected to be investigated, equating to 1 site per ~100ha.

Due to accessibility issues during the field investigation, 2 of the 7 sites outside the disturbance footprint were not investigated. This equates to 1 site per ~140ha.

2.2.2 Selection of inspection sites

The locations of the soil inspection sites were determined prior to mobilisation into the field. Locations were selected based on the outcomes of the desktop data review, with consideration of the following:

- Existing soils and landform data;

- Land systems mapping;
- Broadscale ASC mapping;
- Aerial imagery;
- Land gradient and relief; and
- Accessibility (existing track locations).

The field survey was conducted in June 2023. Each soil inspection site was located in-field using hand-held GPS. The locations were adjusted where necessary to allow for a suitable inspection site to be constructed safely.

Due to dense vegetation along some of the access tracks, several inspection sites were inaccessible at the time of the field survey. For this reason, only 21 of the proposed 30 inspection sites were inspected during the field survey. Coordinates for each soil inspection site are provided in Table 5 (with sites not investigated struck-through and highlighted grey), and their locations are shown in Figure 4.

Table 5: Soil inspection site coordinates, sites not investigated are highlighted in grey (GDA2020, Zone 50).

Site ID	Easting (m)	Northing (m)
S01	760,501	6,447,982
S02	760,996	6,448,508
S03	760,995	6,448,873
S04	760,556	6,449,167
S05	760,299	6,449,167
S06	759,933	6,448,737
S07	759,617	6,448,662
~~S08~~	~~759,712~~	~~6,448,327~~
S09	759,444	6,448,873
S10	758,851	6,449,265
~~S11~~	~~758,858~~	~~6,449,650~~
S12	759,522	6,449,874
S13	758,912	6,450,053
~~S14~~	~~758,715~~	~~6,448,316~~
S15	757,790	6,447,598
S16	757,780	6,448,728
S17	757,799	6,448,493
S18	757,778	6,448,962
S19	757,787	6,449,628
S20	757,766	6,450,093
~~S21~~	~~757,043~~	~~6,447,355~~
S22	756,341	6,447,344
S23	755,991	6,447,337
S24	755,786	6,447,767
~~S25~~	~~755,125~~	~~6,447,717~~
S26	756,117	6,448,125
~~S27~~	~~756,375~~	~~6,448,344~~
~~S28~~	~~756,134~~	~~6,448,543~~
~~S29~~	~~755,779~~	~~6,448,655~~
~~S30~~	~~755,060~~	~~6,448,510~~

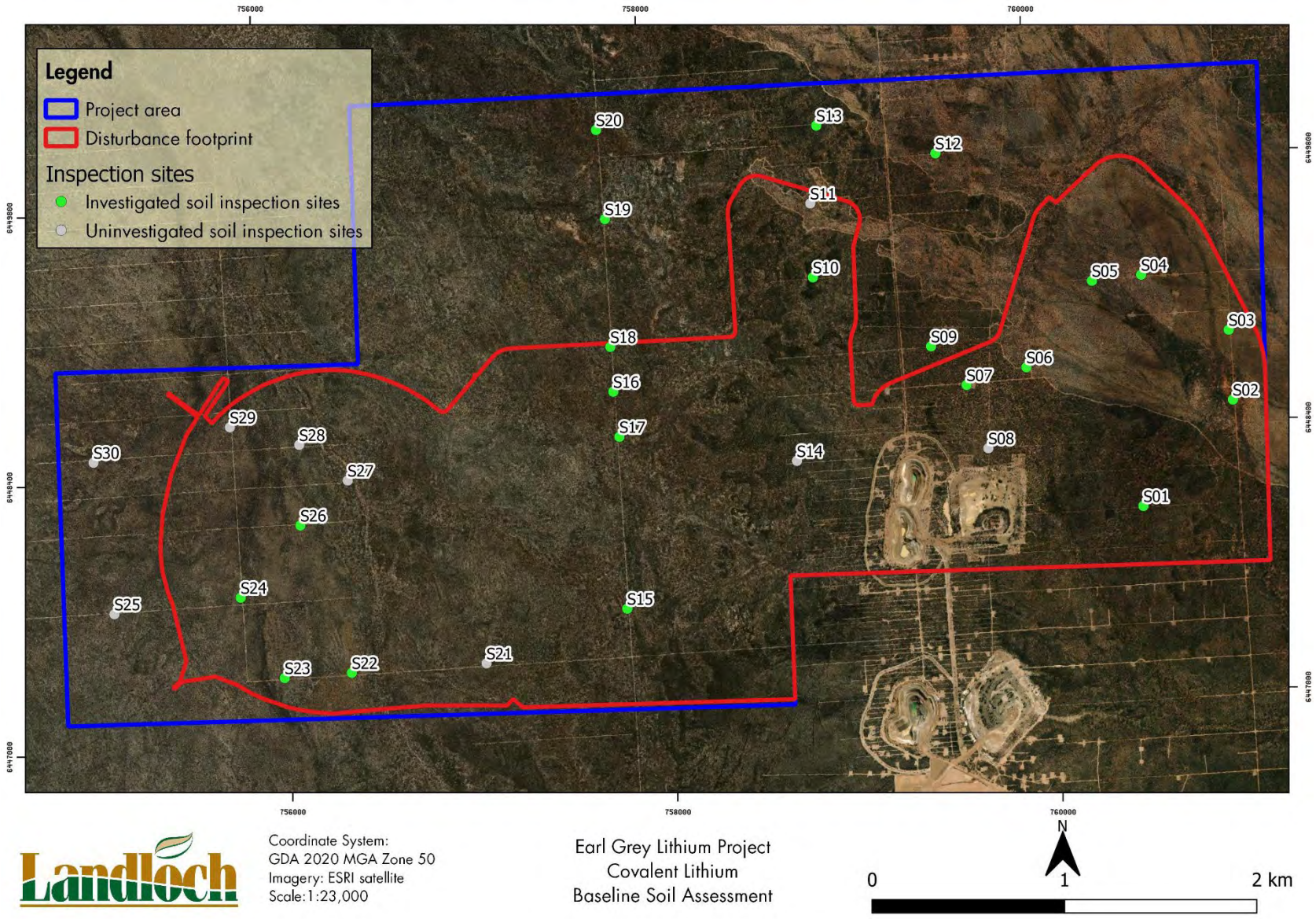

Figure 4: Location of soil inspection sites within the Project area.

2.2.3 Soil inspection site descriptions

Site information, soil profile descriptions, and baseline soils data were recorded at each of the soil inspection sites in line with the Australian Soil and Landscape Survey Field Handbook (NCST 2009). At each location, a soil pit was dug using an excavator to a depth of 1.5m or machinery refusal. Images of the landscape, vegetation, soil surface and soil profile were taken. Observations of the location, landform type, vegetation, land surface, and soil profile were recorded at each site.

Location, landform, vegetation, and land surface observations included:

- Assessment date;
- GPS coordinates;
- Current land use;
- Dominant vegetation forms;
- Vegetation cover percentage;
- Land surface aspect and microrelief;
- Surface coarse fragments (abundance and size);
- Rock outcrop abundance; and
- Erosion state, type and extent.

The following information was recorded for each soil horizon observed within an assessed soil profile:

- Horizons (including depth and boundary type);
- Field texture;
- Colour (Munsell);
- Coarse fragment abundance and size;
- Soil structure type and grade;
- Soil consistency;
- Root abundance and size; and
- Presence of mottling and segregations.

The information recorded for each soil inspection site is provided in the soil log data sheets (Appendix D).

2.2.4 Soil sampling

Soil samples from a range of depths were collected from all soil inspection sites. The number of samples taken at each site varied based on the depth of the soil pit and/or the homogeneity of the soils within the soil profile. Generally, one sample was taken from the topsoil (A) horizon, and 1 – 4 samples from the diagnostic (B) horizons. A total of 83 soil samples were collected from the 21 soil inspections sites.

2.3 Soil characterisation

2.3.1 Soil testing

All soil samples collected were transported to Landloch's facility in Perth and assessed for the following parameters:

- pH_w (1:5 solids: deionised water solution);
- Salinity, $EC_{1:5}$ (1:5 solids: deionised water solution),
- Emerson dispersion test;
- Coarse fraction percentage (>2mm diameter);
- Coarse/fine fraction percentage; and
- Water repellence.

In addition to this, 48 samples from 12 sites were submitted for more detailed laboratory analysis (Table 6). The laboratory analyses were split into a topsoil and subsoil characterisation suite in line with DMP (2016). Of the 48 samples, 12 were topsoils and 36 were subsoils.

Table 6: Soil laboratory analysis performed on a subset of samples.

Test suite	Target samples	Analysis
Topsoil	Topsoil (A) horizon, generally the surface 100-200 mm. Analyses include chemical and physical properties of the soil, and soil fertility. This is the soil depth that contains the majority of fertility and is supporting existing vegetation.	• pH_w • Salinity, $EC_{1:5}$ • Soluble Cl • Exchangeable cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Al^{3+}) • Effective cation exchange capacity (ECEC) • Exchangeable sodium percentage (ESP) • Particle size distribution of the fine fraction (<2mm) • Organic C • Total N and Total P • Available P and K (Colwell) • Available S (KCl) • Trace Cu, Zn, Mn, Fe (DTPA)
Subsoil	Subsoil (B) and substrate (C) horizons, below the topsoil. Analyses include chemical and physical properties of the soil, excluding fertility.	• pH_w • Salinity, $EC_{1:5}$ • Soluble Cl • Exchangeable cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Al^{3+}) • Effective cation exchange capacity (ECEC) • Exchangeable sodium percentage (ESP) • Particle size distribution of the fine fraction (<2mm)

2.3.2 Data interpretation scheme

A scheme was developed to assist with interpretation of soils data as part of the 2022 baseline soils assessment (Landloch 2022), which was used to define growth media suitability and structural stability of the soils. For this report, the results of the initial soils assessment were used to further refine the scheme. The scheme establishes a baseline of the existing properties of soils depending on whether they support vegetation (to varying degrees). Parameters considered include pH_w, $EC_{1:5}$, fertility, structural

stability, coarse fraction percentage. The defined values are relevant to the Project area. This interpretation scheme can continue to be validated and further refined by future growth median/vegetation trials, particularly if waste materials sourced from depth are used as alternative growth media as part of rehabilitation.

2.3.2.1 Soil pH_w

A general classification of soil pH_w values is given in Table 7 (Hazelton and Murphy 2016). This classification allows for pH values to be expressed in qualitative terms but does not provide guidance on the suitability of a given pH value for vegetation establishment. A reasonable approach for assessing the suitability of soil pH is to consider the pH levels of the topsoils that currently support vegetation. This approach acknowledges vegetation presence but does not identify potential differences in vegetation type that may establish at varying pH values.

The range of pH_w values of the topsoils from inspection sites supporting mid – dense foliar cover levels (30 – 90%) and common to many roots (10 to >200) ranged from 5.5 to 9.5. This is a range from strongly acid to strongly alkaline pH_w (Table 7). For the 2022 assessment, the range of pH values of the topsoils from inspection sites that support mid – dense foliar cover levels and common to many roots was 4.3 – 9.4 (strongly acid to strongly alkaline). A pH_w range of 5.0 – 9.5 (strongly acid to strongly alkaline) was used in this report to define pH values that will not adversely affect vegetation growth or establishment. Soils with pH_w values greater than 9.5 or less that 5.0 will be defined as soils that may not be suited to establishment and growth of the more prevalent species of vegetation, and may require an alternative approach if used in rehabilitation (i.e. adoption of alternative vegetation species that are suited to the pH conditions).

Table 7: General soil pH_w classification.

pH_w (pH units)	Classification
<4.0	Very strongly acid
4.0–5.5	Strongly acid
5.5–6.0	Moderately acid
6.0–7.0	Slightly acid
7.0–8.0	Slightly alkaline
8.0–9.0	Moderately alkaline
9.0–10.0	Strongly alkaline
>10.0	Very strongly alkaline

2.3.2.2 Soil salinity ($EC_{1:5}$)

Salinity is often measured using the electrical conductivity (EC) of a solution containing 1 part solids to 5 parts deionised water ($EC_{1:5}$). Most published salinity suitability ranking systems assume agricultural vegetation, and application of these ranking systems have little relevance for plant species used in rangeland rehabilitation. The Western Australian Department of Agriculture and Food provide a summary of published salinity tolerance values for a range of common species used in revegetation

of disturbed rangelands in Western Australia (Department of Agriculture and Food 2004). Slightly to moderately salt tolerant species (e.g. many *Eucalyptus* and *Acacia* species) have salt tolerance values of 0.2 – 0.8dS/m. Salt tolerant species (e.g. *Atriplex*, *Tecticornia* species) are likely to exhibit some adverse impacts on vegetation growth at $EC_{1:5}$ values greater than ~2dS/m. Plants are particularly sensitive to salt during germination and establishment. Many *Eucalyptus* species have salt tolerance values ($EC_{1:5}$) for germination ranging from 0.5 – 2.0dS/m. Salinity trials performed near Kalgoorlie indicated that soil salinity ($EC_{1:5}$) in excess of 4dS/m is likely to cause significant adverse impacts on germination and establishment of salt tolerant species (Jenning *et al.* 1993).

Therefore, salinity values >1 dS/m were used to indicate materials that may adversely impact sensitive to moderately sensitive species. Values >2 dS/m may adversely impact salt tolerant species. All vegetation with the exception of the most salt tolerant species are likely to be greatly negatively impacted by salinity values >4 dS/m.

Table 8: Soil salinity classes for the Southern Cross region.

Classification	Soil salinity (dS/m)
Low (non-saline)	0.01 – 0.5
Moderate (saline)	0.5 – 2.0
High (highly saline)	>2.0

2.3.2.3 Fertility

Similar to the pH values, the determination of generalised guidelines for suitable fertility values for a wide range of soils and sites is very difficult, and a reasonable approach for defining suitable soil fertility is to consider the fertility values of the topsoils that had mid to dense foliar cover levels (30 – 90%) and common to many roots (10 – >200 roots present). This data also incorporates results from the 2022 soil assessment. The resulting fertility parameter values are summarised in Table 9 and represent values that are not expected to limit vegetation growth or establishment. Total phosphorus is low across all sites and appears to not be a limiting factor for vegetation growth in the area, for this reason it is not considered in the fertility parameter values.

Table 9: Suitable nutrient values based on measured values from the topsoils.

Nutrient	Unit	Value
Total Nitrogen	mg/kg	>280
Available Phosphorus (Colwell)	mg/kg	>30
Available Potassium (Colwell)	mg/kg	>50

2.3.2.4 Structural stability

Structure is the arrangement of primary particles into secondary units or peds. The secondary units are characterised on the basis of size, shape, and grade. A structurally unstable soil is one that tends to have minor or reduced particle arrangement.

It is important to note that structural stability as used in this report is different to geotechnical stability.

Structurally unstable soils may be prone to:

- Tunnel erosion;
- Increased bulk density and hardsetting surfaces;
- Increased runoff and erosion potential;
- Reduced water holding capacity and infiltration capacity; and
- Reduced root penetrability.

A soil's potential to have an unstable structure is dependent on both its chemical and physical characteristics. These are considered in a number of ways.

The proportion of exchangeable Na held on the soil's exchange complex in relation to other exchangeable cations is important. This is referred to as the Exchangeable Sodium Percentage (ESP). McKenzie *et al.* (2004) considers the measurement of ESP as suitable for assessing the potential for clay dispersion when a soil's Effective Cation Exchange Capacity (ECEC) is >3meq/100g and exchangeable Na is >0.3 meq/100g. Further, clay dispersion risk is greatest in soils with loam or clay textures (clay fraction >10%). Sand dominated soils are not prone to structural instability even if they have high ESP.

Clay dispersion potential for a soil is also influenced by interactions between clay content, ESP, and $EC_{1:5}$. The Electrochemical Stability Index (ESI) is a way of considering the relationship between ESP and $EC_{1:5}$ for loam and clay textured soils (clay fraction >10%). A tentative critical ESI value is 0.05 (McKenzie *et al.* 2004), with ESI <0.05 and clay content >10% indicating a soil that is prone to structural instability due to clay dispersion.

Magnesic soils can also be prone to clay dispersion. This is assessed using a combination of the Exchangeable Magnesium Percentage (EMP), exchangeable Ca:Mg ratio, ESP, and clay content. Clay dispersion may occur if the following conditions are met:

- EMP >30%, Ca:Mg ration <1 and ESP >4%. Clay dispersion has been recorded when (ESP + EMP/10) is >6%, assuming the soil also has >10% clay (Fenton and Conyers 2002).

Soils with a high combined proportion of fine sand, silt, and clay (particles ≤0.2mm) are prone to structural instability, even if their clay fractions are not chemically dispersive. This is because these smaller particles can mobilise within the coarse sand matrix. For this reason, soils with a combined fine sand, silt, and clay fraction >70% are considered to be at increased risk of structural instability (Vacher *et al.* 2004).

It is noted that a soil can have a fine fraction that is prone to structural instability, but if the proportion of unstable fines is small, the soil as a whole may be structurally stable. Typically, a binary mixture with >30 – 40% fine and <60 – 70% coarse fraction could be considered a fines-dominated material with some coarse fraction; a binary mixture with <30 – 40% fines and >60 – 70% coarse fraction could be considered a coarse-dominated materials with some fines. Based on this, a fines fraction cut-off of >40% seems reasonable, with soils that contain >40% fines being at risk of structural instability if the fine fraction meets one or more of the other criteria outlined above. A soil with <40% fines is classified as not being prone to instability, even if the fine fraction is prone to instability.

To capture interactions between physical and chemical properties and their effect on structural stability, the samples were assessed against these four criteria. If any of these criteria are met, that soil was classified as being prone to structural instability. The criteria are detailed in Table 10.

Table 10: Structural stability criteria.

ESP criteria	EMP criteria
• Clay content >10% of fines, and • Fines >40%, and • ECEC >3meq/100g, and • Ex. Na >0.3meq/100g, and • ESP >6%.	• Clay content >10% of fines, and • Fines >40%, and • ECEC >3meq/100g, and • EMP >30%, Ca:Mg <1, & ESP >4%, or • EMP >30%, Ca:Mg <1, & (ESP + (EMP/10) >6%
ESI criteria	**PSD criteria**
• Clay content >10% of fines, and • Fines >40%, and • ESI <0.05.	• Fines >40%, and • Fine sand + silt + clay >70% of fine fraction.

2.3.2.5 Coarse fraction

In addition to its influence on structural stability, the abundance and size of coarse the coarse fraction also has a significant bearing on a soil's erosion potential. In semi-arid environments where vegetation does not effectively control surface erosion rates, the condition of the surface (in particular the rockiness) is a key determinant of erosion potential (along with surface treatments such as tree debris and landform shape). Surfaces with more abundant durable coarse fragments are more likely to be erosion resistant than surfaces with a lower abundance of durable coarse fragments.

For the purpose of this report, soils with a coarse fragment abundance >50% and coarse fragment sizes >20mm will be considered to have a high resistance to erosion.

2.4 Soil classification schemes

The soils of the survey area were classified using the following soil classification systems:

- Australian Soil Classification; and

- Soil Groups of Western Australia.

Details on these systems are provided below.

2.4.1 Australian Soil Classification (ASC)

The Australian Soil Classification (ASC) (Isbell and NCST 2021) is the national system for soil classification. The scheme defines soil classes on real soil bodies using a key. The ASC uses a set of defined attributes, horizons, and materials to assign a soil profile to a class. Collectively, these concepts are called diagnostic features. Classes are allocated based on a vertical soil profile as seen in an exposed soil pit, and account for geographic attributes of the landform.

2.4.2 Soil Groups of Western Australia (SGWA)

The SGWA (Schoknecht and Pathan 2013) is a standardised scheme that provides common names for the main soil types specific to Western Australia. SGWA classes are allocated based on soil texture and depth and is used to assist with communicating information collected from land and rangeland mapping programs. The soils are named and described at two levels:

1. Soil supergroups, using three criteria:
    a. Texture or permeability profile;
    b. Coarse fragments (presence and nature); and
    c. Water regime
2. Soil groups, using one or more of the following:
    a. Calcareous layer (presence of carbonates);
    b. Colour;
    c. Depth of horizons/profile;
    d. pH (acidity/alkalinity); and
    e. Structures.

Similar to the ASC, the main method for classification is through soil description of an exposed soil profile. This provides the majority of the primary and secondary criteria required to classify the soils into a soil supergroup, and then the soil group.

2.5 Soil mapping units

In addition to the ASC and SGWA, the soils of the Project area were grouped into Soil Mapping Units (SMUs). SMUs are the basic geographic component of a soils map and can be associated with a single or multiple soil types with definable characteristics. SMUs are developed based on recurring landscape and soil attributes, with minor variations in soil properties allowable within each SMU. The purpose of SMUs is to group soils by their management requirements, such as depth, salinity, sodicity, and coarse fragments. For the purpose of this project, SMUs were used as the basis for defining the viability and volume of the potential topsoil and subsoils resource.

3 SOIL CLASSIFICATION

3.1 Australian Soil Classification

The ASC uses a set of defined attributes, horizons, and materials to assign a soil profile to a class. Collectively, these concepts are called diagnostic features. These features are ranked based on their likely importance to use of the soil, however this ranking is subjective and arbitrary to a varying extent. In this way, the ASC provides an indication of a soil's potential for use, generally from an agricultural perspective. Classification of soils to the ASC relies on observations made of the soil profile, and interpretation of physical and chemical soils data.

Within the survey area, soil inspections sites were classified to the ASC, with four classes identified:

- Dermosols;
- Tenosols;
- Kandosols; and
- Sodosols.

A summary of each ASC Order and associated soil inspection sites is provided in Table 11. A spatial representation of each ASC Order is illustrated in Figure 5.

The most common soil order found in the survey area are Dermosols (11 sites). Both Sodosols and Kandosols were associated with a reduced number of inspection sites (4 sites) with Tenosols only being associated with two inspection sites.

Dermosols are soils with structured B2 horizons that lack a strong texture contrast between the A and B horizons. A key feature of these soils is the development of coherent soil structure. The Dermosols of the survey area are associated with almost all landform types, including ridges, upper and lower slopes, and the plains (i.e. both erosional and depositional zones). The Dermosols encountered typically have a low to moderate abundance of coarse fragments (>2 mm in size) and pH range from acidic to moderately alkaline.

Sodosols are associated with four inspection sites across the survey area. Sodosols are classified as soils with a clear and abrupt textural contrast between the A and B horizons, where the majority of the B horizon is sodic (ESP >6 %). As such a key defining characteristic of Sodosols is their susceptible to structural instability due to their sodic properties. The Sodosols encountered have medium to heavy clay subsoils with sandy to loamy topsoils. Typically, both the topsoils and subsoils contained a low to moderate abundance of coarse fragments (>2 mm in size). These soils are typically associated with mid-slopes and foot-slopes throughout the landscape (i.e. depositional zones).

Kandosols are associated with four inspections sties. Similar to Dermosols, Kandosols lack a texture contrast between the A and B horizons, yet unlike Dermosols the B horizon is poorly structured. The Kandosols of the survey area are associated with ridges and upper slopes of the landscape (i.e. erosional zones).

Tenosols comprise only a minor proportion of the soils present across the survey area. Tenosols are typically weakly structured soils with minimal pedological development

apart from the presence of an A horizon. Tenosols are associated with shallow profiles over a hard-pan or concreted lateritic layer. The Tenosols of the survey area are associated with the upper slopes of the landscape.

Table 11: Australian Soil Classification of the soils within the survey area.

ASC	Description	Sites
Dermosol	Soils with structured B2 horizons and lacking a strong texture contrast between the A and B horizons. Although there is some diversity within the order, it brings together a range of soils with some important properties in common.	S01, S02, S07, S15, S16, S17, S18, S22, S23 S19, S26
Sodosol	Soils that have a clear and abrupt texture contrast between the A and B horizons. The majority of the soil profile is sodic.	S04, S06, S09, S12
Kandosol	Soils that lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout the profile.	S10, S13, S20, S24
Tenosol	Soils with weak pedological organisation apart from the presence of an A horizon.	S03, S05

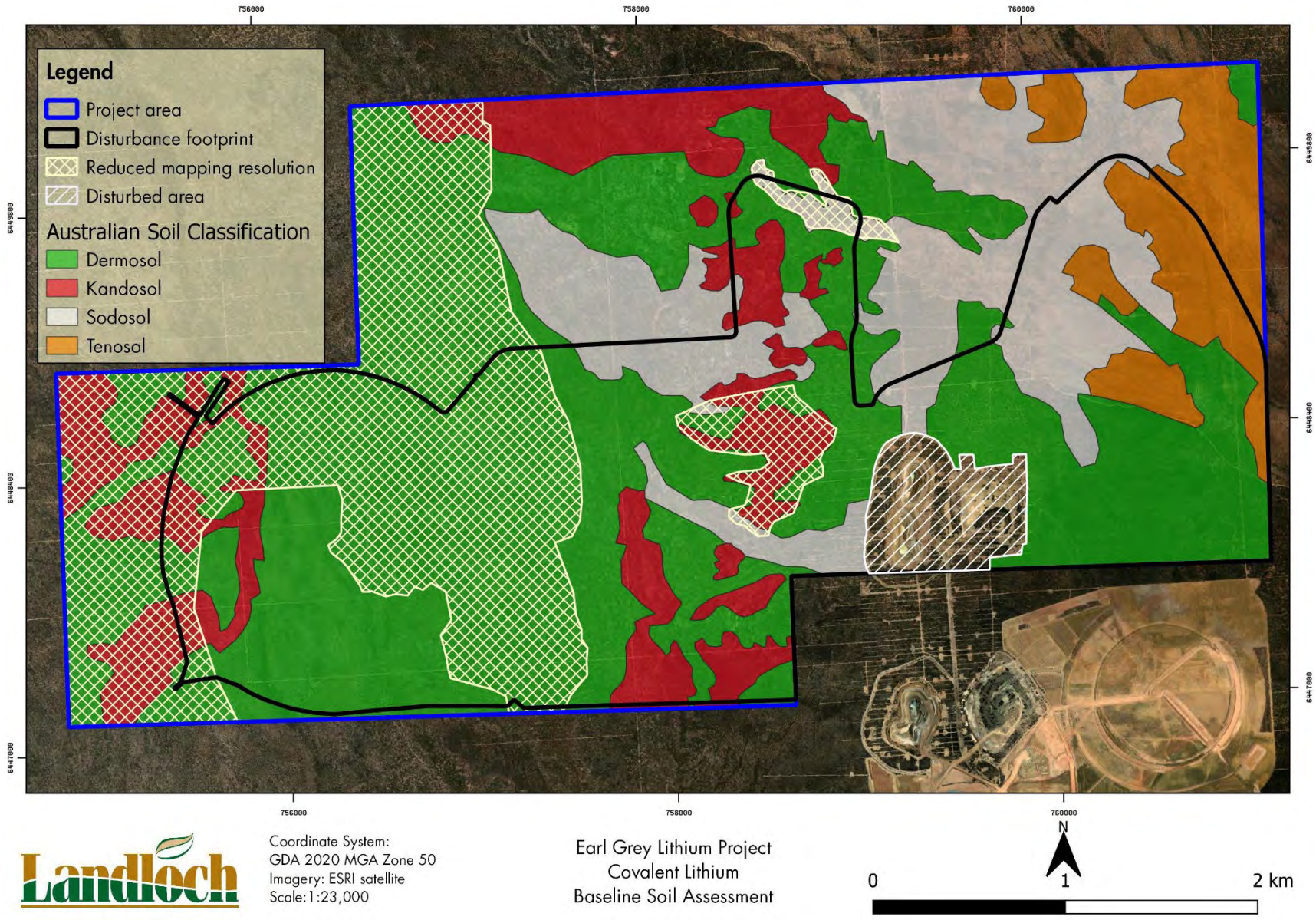

Figure 5: Australian Soil Classification Order distribution within the survey area.

3.2 Soil Groups of Western Australia

The SGWA classification system was developed to assist with communication of information collected in land resource and rangeland mapping programs, especially in areas where detailed soil information is limited or incomplete. It was designed to provide a standard way of giving common names to the main soils of the state, to provide a simple method for identification, and to assist with the communication of the soils information at a general level.

Similar to the ASC, the main method for classification is through soil description of an exposed soil profile. This provides the majority of the primary and secondary criteria required to classify the soils into a soil supergroup, and then the soil group. Using the soil profile descriptions collected at each soil inspection site, all sites were classified to the SGWA, with resulting classifications outlined in Table 12 and mapping illustrated in Figure 6.

Table 12: Soil Groups of WA classification of the soils within the project area.

Soil Group of WA	Description	Sites
Friable Red/brown Loamy Earth	Friable soils with a red or brown loamy surface that are either loamy throughout or grade to clay by depths of 0.8 m.	S01, S02, S07, S16, S20
Alkaline Grey/brown Shallow Loamy Duplex	Soils with a loamy surface and a texture contrast to clay at depths 0.03 to <0.3 m, over alkaline subsoils.	S06, S09, S12
Yellow/brown Shallow Sand	Sands less than 0.8 m in depth, over laying rock, hardpan or a cemented layer.	S03, S05
Yellow/brown Shallow Sandy Duplex	Soils with a sandy surface and a texture or permeability contrast at depths of 0.03 to <0.3 m.	S17, S26
Alkaline Grey Deep Sandy Duplex	Soils with a sandy surface and a texture or permeability contrast at 0.03 to 0.8 m with alkaline subsoils.	S04
Brown Loamy Earth	Brown or grey surface soils with a loamy texture that stay loamy throughout or grade to clay by 0.8 m.	S10
Acid Yellow Sandy Earth	Soils with a sandy surface and grading to loam by 0.8m, strongly acid within the top 0.3 m.	S13
Red/brown Hardpan Shallow Lamy	Shallow loam overlying a hardpan encountered by 0.5 m.	S15
Yellow/brown Shallow Sandy Duplex	Yellow or brown sandy surface with a texture or permeability contrast at depths of 0.03 to <0.3 m.	S18
Pale Sandy Earth	White or grey sandy surface grading to loam by a depth of 0.8 m.	S19
Alkaline Red Shallow Loamy Duplex	Red loamy surface soils with a texture contrast by 0.03 to <0.3 m, alkaline subsoil.	S22
Yellow/brown Deep Sandy Duplex	Yellow or brown sandy surface with a texture contrast at depths of 0.3 to 0.8 m.	S23
Yellow Loamy Earth	Soils with a yellow loamy surface and either loamy throughout or grading to clay by 0.8 m.	S24

The most common SGWA class is the Friable Red/brown Loamy Earths, making up approximately 24% of all the surveyed inspection sites. These are well structured loamy soils that do not have a texture contrast. In the project area they typically have loamy topsoils that grade to clay with depth. Coarse fragment abundance is typically low.

Alkaline Grey/brown Shallow Loamy Duplexes are the second most abundant class, identified at approximately 14% of the inspection sites. These are soils with a loamy surface and a clear texture contrast at 0.03 to 0.3 m, and alkaline subsoils. These soils are associated with the flats and low slopes of the north-western portion of the survey area.

The remaining soil classes are typically associated with only one or two inspections sites and contain Loamy or Sandy Earths and Deep Sandy or Loamy Duplexes of varying colour and pH. Associations between landscape position and soil class are not apparent due to the abundance of different SGWA classes present in the survey area.

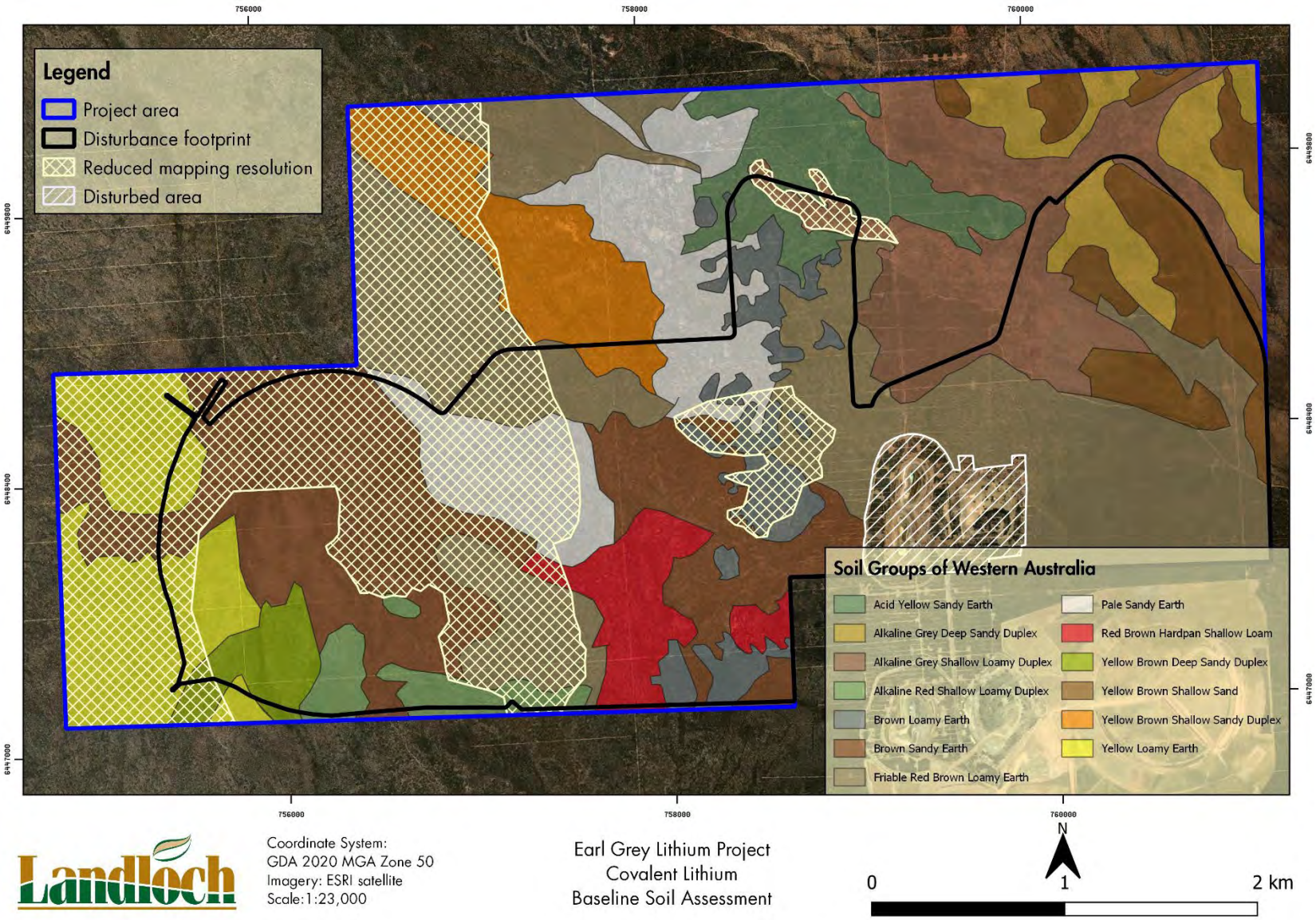

Figure 6: SGWA distribution within the survey area.

3.3 Soil Mapping Units

Both the ASC and SGWA classification systems provide a high-level understanding of the soils for a given area. However, these classification systems were developed to understand the *in situ* soils. These classification schemes do not consider land uses that actively strip, invert, and/or stockpile soils (i.e., mining). Development of SMUs allows for consideration of the soil-disturbing actions in light of the end use of the soils, that is rehabilitation of the land disturbed by mining. As such, this report focuses on the development and mapping of SMUs for the determination of stripping depths, potential for re-use during rehabilitation, and management of the soil resources during the life of the mine.

Using both the ASC and SGWA classifications, the soils inspections sites were grouped into SMUs based on their management requirements, particularly their morphological properties, chemical data, particle size distributions, and coarse fragment abundance. Three SMUs were defined:

- Structured Deep Clays: Gradational soils characterised by their well-structured and highly sodic subsoils. Topsoils are typically dominated by loams but can be sandy. Clay content typically increases significantly with depth, with some loamy subsoils. The subsoils are highly sodic and are prone to structural instability. The Structured Deep Clays are located in various landscape positions, from ridges and upper slopes to the low flats of the survey area. They are likely to have formed from a combination of pedogenic and depositional processes.
- Gravelly Soils: Soils in which the majority of the soil profile is contains a significant abundance of gravelly material (subsoil coarse fragment abundance >50%). Soil texture ranges from sands to clays but are typically sand or loam dominated in both the topsoils and subsoils. The Gravelly Soils are located in the upper and lower slopes of the landscape and are likely formed through both pedogenic and depositional processes.
- Acidic Soils: Sandy and loamy soils that are defined by their high acidity (pH <5.5). Both the topsoils and subsoils are highly acidic and non-saline. The Acidic soils are found on the mid-lower slopes and flatter areas of the landscape.

A summary of the SMUs and the soil inspection sites associated with each is provided in Table 13.

Table 13: Soil Mapping Units within the survey area.

Soil Mapping Unit	Description	Sites
Structured Deep Clays	Deep soil profiles that trend from loam topsoils to clay subsoils. Highly sodic and saline subsoils. Prone to structural instability.	S01, S02, S06, S07, S09, S12, S17, S18, S19, S22, S23
Gravelly Soils	Sandy or Loamy soils containing a greater abundance of coarse fragments.	S04, S05, S15, S16, S20, S24

Soil Mapping Unit	Description	Sites
Acidic Soils	Soils with both highly acidic topsoils and subsoils (pH <5.5).	S03, S10, S13, S26

An overview of the key soil attributes that are common across the three SMUs, and those which differentiate the SMUs are given below.

3.3.1 Common attributes of the SMUs

Attributes of the soils that are consistent across the survey area and as such, are not a differentiating factor for the development of SMUs are outlined as follows:

- Mid-dense (30-70%) to dense (>70%) woody foliar cover.
- Common to many root abundance in the topsoils, with common grading to no roots in the subsoils.
- Typically deep soil profiles with a depth >1000 m. A cemented lateritic hardpan layer was encountered at depths <600 mm at three sites (S03, S05 and S15).
- Of the samples sent for laboratory analysis, 75% have fine fractions that are prone to structural instability based on ESI, 65% based on exchangeable magnesium percentage and 63% based on ESP. The failure of any one of these criteria would indicate soils that are susceptible to structural instability.
- Gravel size throughout the SMUs is typically 2-6 mm or 6-20 mm in diameter. Individual soil horizons across all SMUs contain gravel sizes >20 mm in abundances >50%, although this is not consistent throughout the soil profiles. As such the gravel content is unlikely to be sufficient to mitigate structural instability.

3.3.2 Differentiation soil attributes of the SMUs

The key differentiating attributes of the three SMUs are:

- Subsoil salinity ($EC_{1:5}$);
- Soil pH;
- Coarse fragment abundance; and
- Soil texture

3.3.2.1 Subsoil salinity

The topsoils of all soils within the survey area are non-saline (median $EC_{1:5}$ <0.04 dS/m). The subsoils of both the Gravelly Soils and Acidic soils increase with depth to varying degrees but remain non-saline (median $EC_{1:5}$ 0.30 dS/m and 0.05 dS/m, respectively). The subsoils of the Structured Deep Clays are moderately saline (median $EC_{1:5}$ 1.60 dS/m). The increased salinity of the Structured Deep Clay subsoils may inhibit vegetation establishment if used as a growth medium.

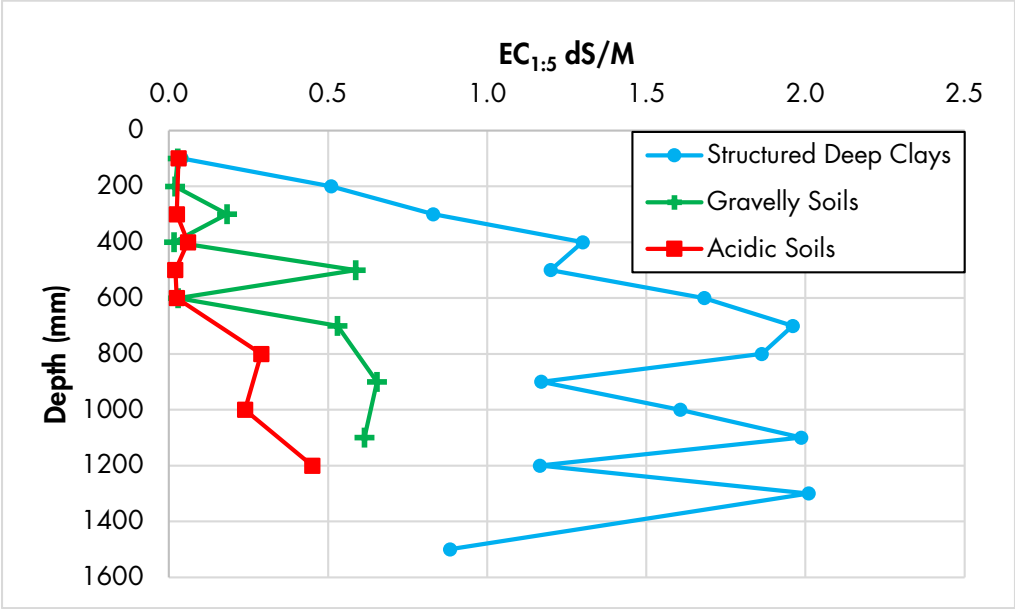

Figure 7: Median $EC_{1:5}$ values throughout the observed soil profile for the SMUs.

3.3.2.2 Soil pH

Soil pH varies across all SMUs. The Structured Deep Clays typically have neutral pH in their topsoils and alkaline pH in the subsoils (median pH values 6.9 and 8.9 respectively). The topsoils and subsoils of the Gravelly Soils are both circum-neutral (median pH 6.5 and 7.1 respectively). One of the defining properties of the Acidic Soils is that both the topsoils and subsoils are strongly acidic (median pH values 5.5 and 4.8 respectively). While soil pH is variable across the three SMUs, vegetation is consistently mid-dense to dense. The native vegetation present within the survey area is suited to the varied pH levels and such it is unlikely that vegetation establishment would be negatively impacted by the topsoil pH of any SMU. While the vegetation cover is consistent, vegetation mapping (Figure 3) shows that the different vegetation communities appear to vary based on soil pH.

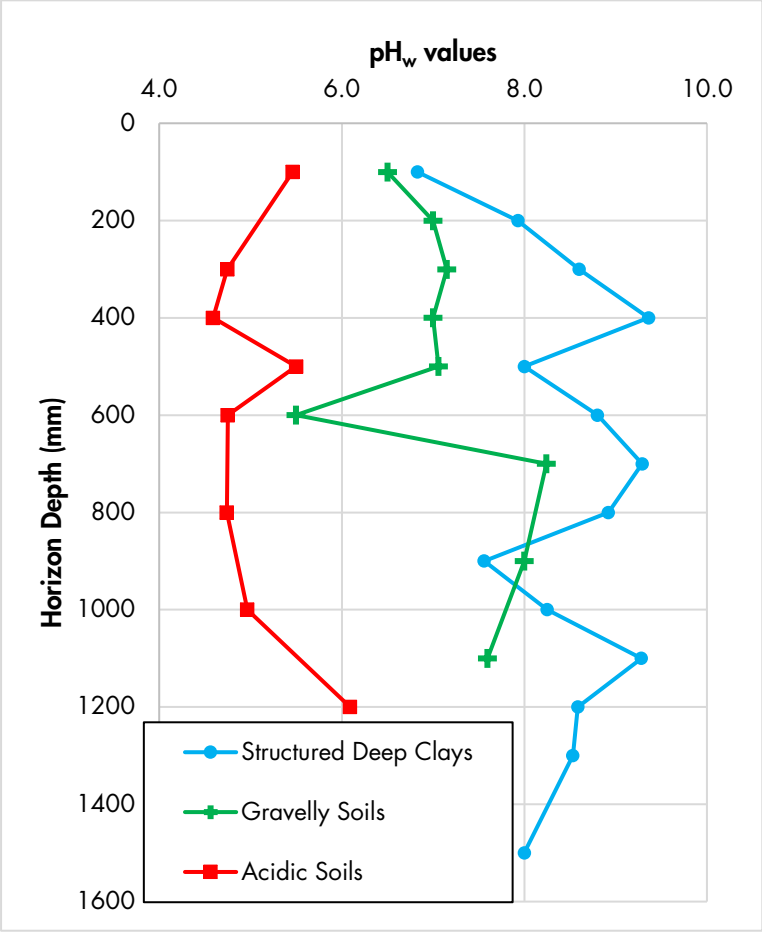

Figure 8: Median pH values throughout the observed soil profile for the SMUs.

3.3.2.3 Coarse fragment abundance

The median coarse fragment abundance is higher in both the topsoils and subsoils of the Gravelly Soils (23% and 61% respectively) than both the Structured Deep Clays and Gravelly Soils. The Structured Deep Clays have the lowest abundance of coarse fragments (topsoils 12% and subsoils 22%) while the Acidic Soils have a moderate abundance of coarse fragments in their subsoils (45%). Coarse fragment abundance can impact the potential use of a soil resource through influencing various soil properties, i.e., water holding capacity and resistance to erosion.

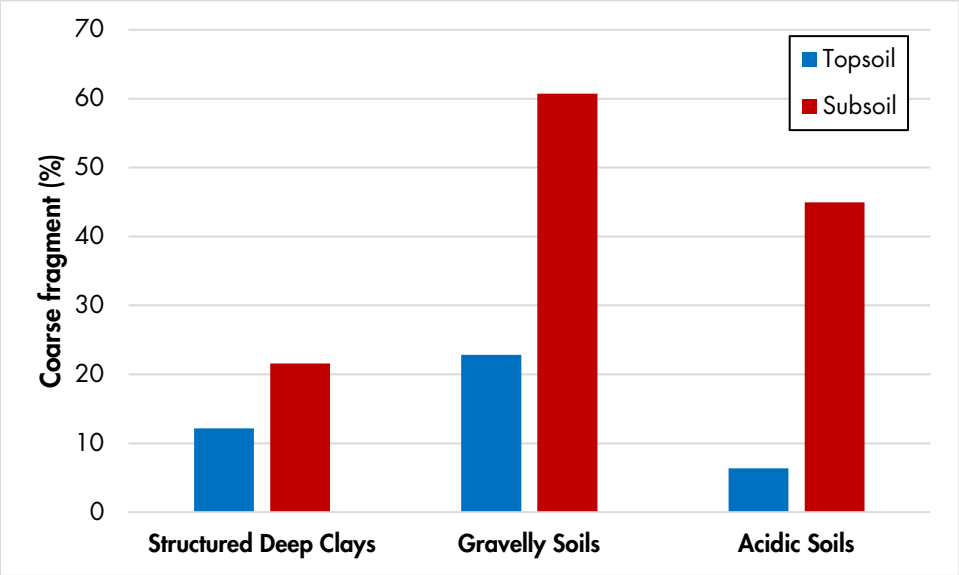

Figure 9: Abundance of coarse fragments of observed soil horizons.

3.3.2.4 Soil texture

The soil textures of the Structured Deep Clays vary from sandy and loamy topsoils to heavier clays in the subsoil, typically having the higher clay content than the Gravelly Soils and Acidic Soils. The Gravelly Soils have sandy or loamy topsoils that grade to clay loam or clay at depth. The Acidic Soils have a uniform soil texture, ranging from loamy sand to sandy loam.

Figure 10 shows the soil texture of the fine fraction (particles <2mm) of the samples sent for laboratory analysis.

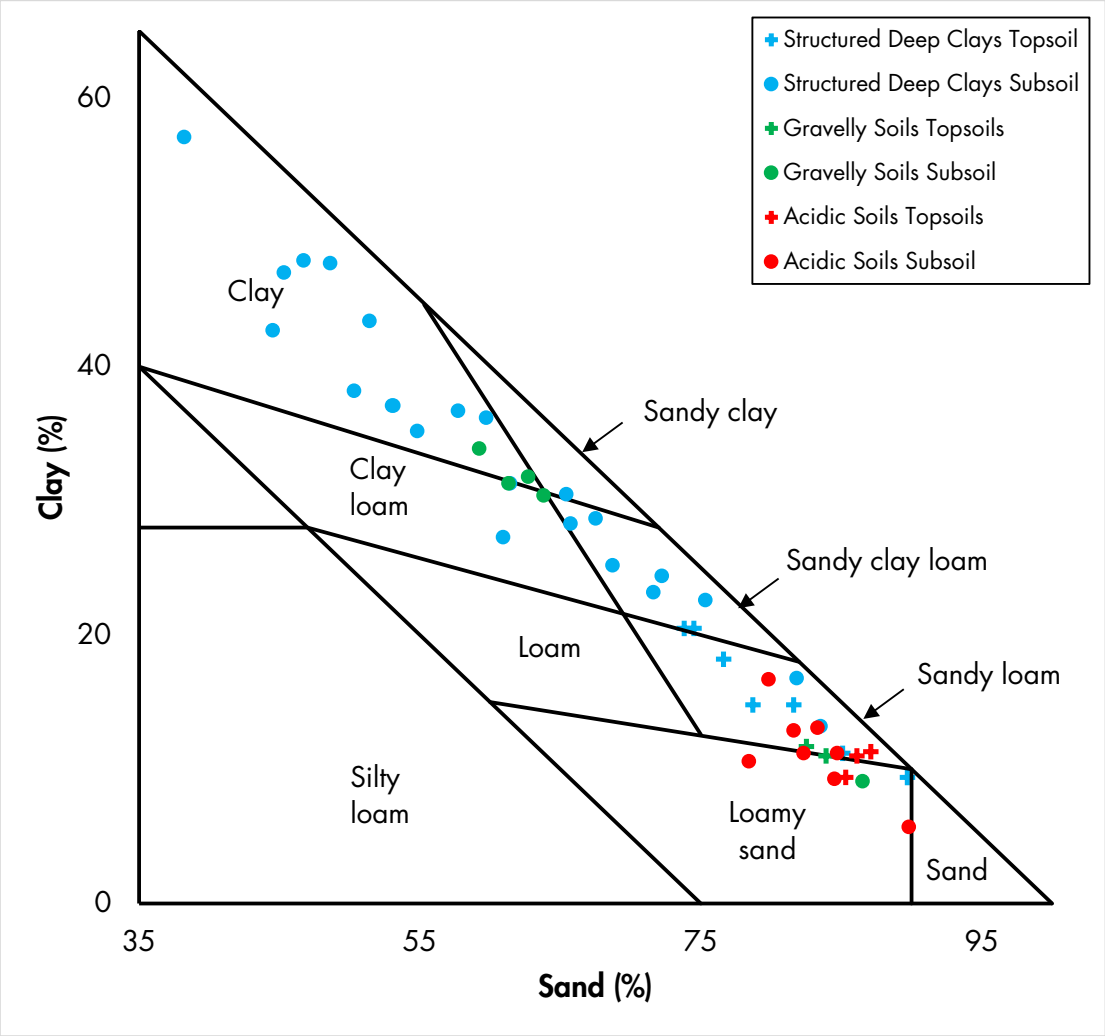

Figure 10: Soil textures of the samples that underwent detailed laboratory analysis for each SMU. Texture triangle has been altered to show sand content range 35 – 100% and clay content 0 – 70%.

3.3.3 Soil distribution

A correlation between the soil and landscape position (i.e. upper slopes – lower slopes – ridges) was observed. In general, the Structured Deep Clays were found on the upper and lower slopes, simple slopes and flat areas. The Gravelly Soils were associated with the ridges, upper slopes and lower slopes of the landscape. The Acidic Soils were found on the low-lying areas of the landscape, typically lower slopes and flats. This relationship between soil type and landscape position aided in the mapping of the SMUs.

Covalent provided up to date vegetation mapping for the survey area (Section 2.1.3), with the most recent mapping years ranging from 2016 – 2023. A correlation between the soil and different vegetations units was observed. The Structured Deep Clays are associated with various vegetation units dominated by eucalypt species. The Gravelly Soils are associated with both *Eucalyptus* and *Allocasuarina* dominated vegetation units. The Acidic Soils were found in areas associated with the *Allocasuarina* dominated vegetation units. This relationship between the soil types and

vegetation units, in addition to the above-mentioned landscape position, aided in the mapping of the SMUs.

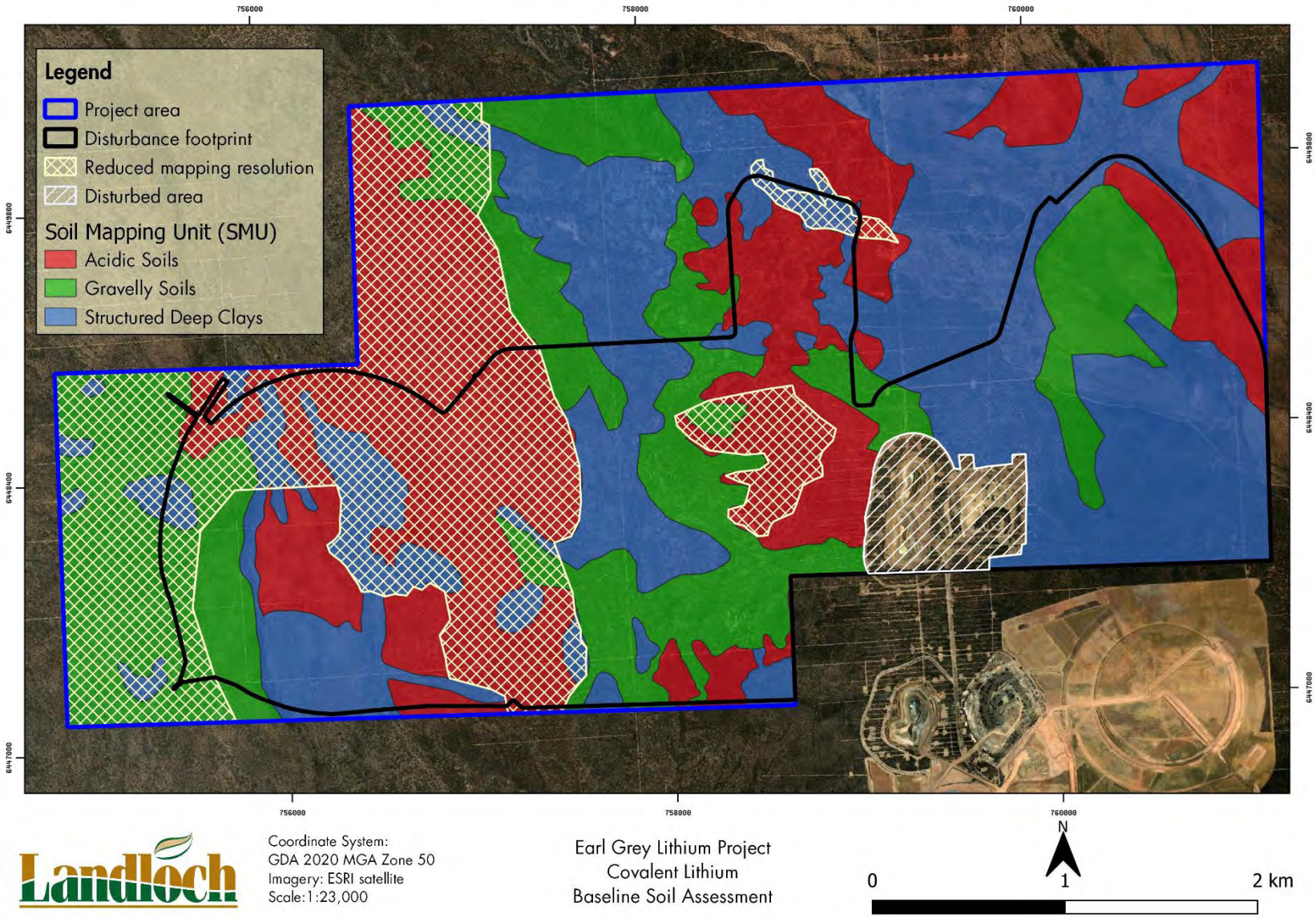

Figure 11: SMU distribution within the survey area.

3.3.4 Structured Deep Clays

The Structured Deep Clays are typically associated with various landscape positions, from ridges and upper slopes to the low flats of the survey area. The soils associated with this SMU are expected to have been formed from pedogenic processes. The Structured Deep Clays typically consist of a deep soil profile (>1000 mm) with sandy or loamy topsoils atop clay subsoils. The Structured Deep Clay have moderate to strong pedological structure and a low abundance of coarse fragments.

The Structured Deep Clays associated with the western region of the Survey Area (S18, S22 and S23) have reduced clay content in comparison to the other sites associated with this SMU. These three sites typically have light clay and clay loam subsoils, in comparison to the light medium and medium clays of the eastern region. With the data available, the western Structured Deep Clays are not considered a separate SMU.

The soils of this SMU are highly sodic and are considered to be prone to structural instability. Twenty-seven Structured Deep Clay samples were sent for laboratory analysis, 93% of the samples are prone to structural instability due to meeting the ESP, EMP and ESI based criteria, 26% of the samples meet all four criteria.

Table 14 summarises the typical characterisation of the Structured Deep Clays with median values shown in brackets. Table 15 summarises the median properties of the Structured Deep Clays against the threshold values. Material characterisation data of the samples sent for more detailed laboratory analysis is given in Table 16. The physical and morphological attributes of the soil horizons of a representative soil profile for the Structured Deep Clays is given in Table 17.

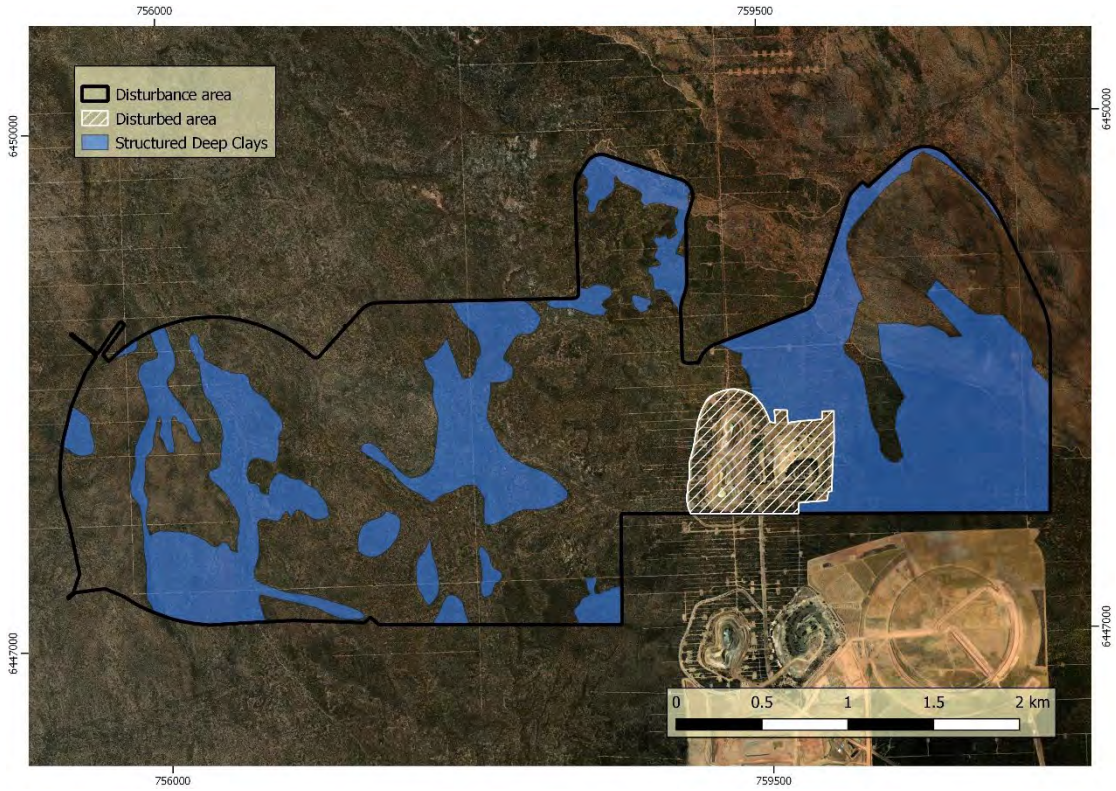

Figure 12: Distribution of the Structured Deep Clays in the disturbance area.

Table 14: Typical material characteristics of the Structured Deep Clays.

Characteristics	Topsoil	Subsoil	Subsoil
Horizon	A	B	B
Depth (mm)	0-100	100-1000	>1000
Texture (class)	Clayey sand – clay loam	Clay loam – medium heavy clay	Medium clay – heavy clay
Structure (grade)	Weak/moderate	Moderate	Moderate/strong
Consistency	Weak/firm	Firm	Firm/strong
Coarse fragments	12% 2 - 6mm^	21% 2 - 20mm^	30% 2 - 20mm^
pH	6.0 – 8.0 (6.8)	5.9 – 9.5 (8.9)	8.0 – 9.5 (8.8)
Salinity (dS/m)	0.02 – 0.35 (0.04)	0.02 – 2.30 (1.47)	0.72 – 2.36 (1.71)
Sodicity, ESP (%)	5 – 24 (12)	29 – 55 (45)	48 – 62 (54)
ESI	0.002 – 0.007 (0.005)	0.010 – 0.070 (0.030)	0.010 – 0.050 (0.040)
Ca:Mg	0.20 – 0.90 (0.05)	0.03 – 0.40 (0.13)	0.03 – 0.22 (0.07)
Emerson Class	2 – 4 (3)*	2 – 6 (2)*	1 – 5 (2)*
Fertility Class	High	Moderate – high	-

*Signifies the mode value rather than the median value. ^Values estimated from visual observations.

Table 15: Summary of Structured Deep Clay properties (median values) against data interpretation scheme.

Parameter	Unit	Threshold	Topsoil	Subsoil
Soil chemical properties				
Soil pH	-	5.0 – 9.5	6.9	8.9
Soil salinity	dS/m	>2.0	0.04	1.60
Soil fertility				
Total nitrogen	mg/kg	>280	320	300
Avail. phosphorus	mg/kg	>30	35	32
Avail. potassium	mg/kg	>50	115	219
Structural stability				
Structural stability	-	ESI/EMP ESP/PSD	ESP, EMP, ESI	ESP, EMP, ESI, PSD
Soil physical properties				
Coarse fraction	%	50% >20mm	12% 2 – 6mm	22% 2 – 20mm

Table 16: Material characterisation data of the Structured Deep Clays samples sent for more detailed laboratory analysis.

Analyses		Unit	S01					S06
Depth		mm	0-50	100-150	250-350	500-600	800-900	0-100
pH (water)		pH units	6.8	7.9	9.4	9.2	6.4	7.3
Electrical Conductivity, $EC_{1:5}$		dS/m	0.03	0.51	1.30	1.93	1.71	0.04
Chloride		mg/kg	41	476	1,170	1,850	1,780	29
Total Nitrogen		mg/kg	803	491	-	-	-	323
Total Phosphorus		mg/kg	70	<40	-	-	-	<40
Organic Carbon		%	1.2	1.0	-	-	-	0.6
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	37.1	32.2	-	-	-	32.2
	Potassium - Colwell	mg/kg	217	174	-	-	-	146
	Sulphur - KCl	mg/kg	5.3	36.9	-	-	-	4.9
	Copper – DTPA	mg/kg	1.10	2.20	-	-	-	0.76
	Iron – DTPA	mg/kg	8.66	5.04	-	-	-	7.72
	Manganese – DTPA	mg/kg	9.01	5.19	-	-	-	4.77
	Zinc – DTPA	mg/kg	0.50	0.24	-	-	-	0.22
Exchangeable Cations	Calcium	meq/100g	2.93	2.47	2.45	1.82	1.15	1.26
	Magnesium	meq/100g	3.38	5.72	7.79	8.16	5.33	2.41
	Potassium	meq/100g	0.30	0.23	0.30	0.54	0.24	0.24
	Sodium	meq/100g	0.32	3.74	6.87	7.91	3.63	0.54
	Aluminium	meq/100g	0.02	0.02	0.02	0.02	0.02	0.02
Effective Cation Exchange Capacity		meq/100g	6.9	12.2	17.4	18.5	10.4	4.5
Exchangeable Sodium Percentage		%	4.6	30.7	39.4	42.9	35.0	12.2
Electrochemical Stability Index		-	0.007	0.017	0.033	0.045	0.049	0.003
Calcium : Magnesium Ratio		-	0.9	0.4	0.3	0.2	0.2	0.5
Coarse Fragments > 2.0mm		%	17	13	11	54	18	14
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	36.9	31.5	25.8	27.5	37.4	45.5
	Fine Sand 0.02-0.2mm	%	39.7	33.9	27.2	22.8	22.3	36.1
	Silt 0.002-0.02mm	%	2.9	3.0	8.9	6.7	3.0	2.9
	Clay <0.002mm	%	18.2	30.5	37.1	38.2	36.2	14.8
Emerson class		Class	3	2	2	4	6	2
Water repellence		Class	No	No	No	No	No	No
Carbonates Fizz Test		Class	No Fizz	No Fizz	Fizz	Fizz	No Fizz	No Fizz

Analyses		Unit	S06			S07		
Depth		mm	250-350	500-600	1000-1100	0-100	150-250	700-800
pH (water)		pH units	9.2	9.1	8.8	7.1	9.0	8.9
Electrical Conductivity, $EC_{1:5}$		dS/m	1.27	2.06	2.36	0.04	0.82	2.30
Chloride		mg/kg	1,160	2,050	2,430	42	754	2,360
Total Nitrogen		mg/kg	303	-	-	465	307	-
Total Phosphorus		mg/kg	<40	-	-	<40	<40	-
Organic Carbon		%	0.5	-	-	0.6	0.6	-
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	32.2	-	-	38.9	32.2	-
	Potassium - Colwell	mg/kg	257	-	-	115	219	-
	Sulphur - KCl	mg/kg	115	-	-	4.1	79.7	-
	Copper – DTPA	mg/kg	2.14	-	-	0.96	1.72	-
	Iron – DTPA	mg/kg	5.44	-	-	7.04	3.46	-
	Manganese – DTPA	mg/kg	3.97	-	-	11.3	6.79	-
	Zinc – DTPA	mg/kg	<0.20	-	-	0.22	0.20	-
Exchangeable Cations	Calcium	meq/100g	2.04	0.72	0.30	1.89	1.99	0.95
	Magnesium	meq/100g	8.28	7.32	6.04	3.95	6.91	7.42
	Potassium	meq/100g	0.61	0.84	0.82	0.28	0.39	0.96
	Sodium	meq/100g	6.35	7.72	6.68	2.05	6.21	7.98
	Aluminium	meq/100g	0.02	0.02	0.02	0.02	0.02	0.02
Effective Cation Exchange Capacity		meq/100g	17.3	16.6	13.9	8.2	15.5	17.3
Exchangeable Sodium Percentage		%	36.7	46.4	48.2	25.1	40.0	46.0
Electrochemical Stability Index		-	0.035	0.044	0.049	0.002	0.020	0.050
Calcium : Magnesium Ratio		-	0.2	0.1	0.1	0.5	0.3	0.1
Coarse Fragments > 2.0mm		%	17	29	46	12	21	41
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	30.5	29.0	25.1	34.2	31.8	28.0
	Fine Sand 0.02-0.2mm	%	20.9	17.7	13.1	39.6	25.9	17.3
	Silt 0.002-0.02mm	%	5.1	5.2	3.2	4.8	5.0	7.0
	Clay <0.002mm	%	43.4	47.9	57.1	20.5	36.7	47.0
Emerson class		Class	2	2	2	2	2	2
Water repellence		Class	No	No	No	No	No	No
Carbonates Fizz Test		Class	Fizz	No Fizz	No Fizz	No Fizz	No Fizz	No Fizz

Analyses		Unit	S07	S09	S12			
Depth		mm	1200-1300	600-700	0-100	200-300	600-700	1000-1100
pH (water)		pH units	8.5	9.0	7.8	9.5	9.3	9.3
Electrical Conductivity, $EC_{1:5}$		dS/m	2.0	2.0	0.2	2.1	2.1	2.2
Chloride		mg/kg	2,050	1,790	112	1,860	1,870	1,960
Total Nitrogen		mg/kg	-	-	513	249	-	-
Total Phosphorus		mg/kg	-	-	69	<40	-	-
Organic Carbon		%	-	-	1.1	0.5	-	-
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	-	-	33.1	31.3	-	-
	Potassium - Colwell	mg/kg	-	-	193	392	-	-
	Sulphur - KCl	mg/kg	-	-	8.1	378	-	-
	Copper – DTPA	mg/kg	-	-	0.72	0.88	-	-
	Iron – DTPA	mg/kg	-	-	7.96	5.06	-	-
	Manganese – DTPA	mg/kg	-	-	17.8	2.47	-	-
	Zinc – DTPA	mg/kg	-	-	0.26	0.22	-	-
Exchangeable Cations	Calcium	meq/100g	0.41	0.56	1.58	1.43	0.62	0.45
	Magnesium	meq/100g	4.17	7.98	3.37	7.49	5.56	6.42
	Potassium	meq/100g	0.51	0.83	0.30	0.90	0.79	0.87
	Sodium	meq/100g	4.93	7.37	1.64	9.83	8.46	9.26
	Aluminium	meq/100g	0.02	0.02	0.02	0.02	0.02	0.02
Effective Cation Exchange Capacity		meq/100g	10.0	16.8	6.9	19.7	15.4	17.0
Exchangeable Sodium Percentage		%	49.2	44.0	23.8	50.0	54.8	54.4
Electrochemical Stability Index		-	0.041	0.045	0.006	0.043	0.039	0.040
Calcium : Magnesium Ratio		-	0.1	0.1	0.5	0.2	0.1	0.1
Coarse Fragments > 2.0mm		%	14	56	23	25	49	70
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	42.4	28.3	41.8	27.2	27.3	34.6
	Fine Sand 0.02-0.2mm	%	25.1	20.3	36.9	27.6	17.2	18.5
	Silt 0.002-0.02mm	%	3.0	3.2	4.7	8.9	10.8	8.9
	Clay <0.002mm	%	28.7	47.7	14.8	35.2	42.7	37.1
Emerson class		Class	5	2	2	2	2	2
Water repellence		Class	No	No	No	No	No	No
Carbonates Fizz Test		Class	No Fizz	No Fizz	No Fizz	Fizz	No Fizz	No Fizz

Analyses		Unit	S17				S18	
Depth		mm	0-100	200-300	600-700	1000-1100	0-100	200-300
pH (water)		pH units	6.4	8.7	9.3	9.3	6.4	5.9
Electrical Conductivity, $EC_{1:5}$		dS/m	0.04	0.84	1.52	1.59	0.02	0.45
Chloride		mg/kg	41	1,005	1,615	1,575	22	420
Total Nitrogen		mg/kg	275	375	-	-	289	280
Total Phosphorus		mg/kg	<40	<40	-	-	62	<40
Organic Carbon		%	0.8	0.7	-	-	0.7	0.6
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	34.9	39.8	-	-	32.6	31.7
	Potassium - Colwell	mg/kg	75.6	220	-	-	54.2	136
	Sulphur - KCl	mg/kg	5.7	71.6	-	-	5.0	50.9
	Copper – DTPA	mg/kg	<0.20	0.60	-	-	<0.20	0.44
	Iron – DTPA	mg/kg	27.5	14.5	-	-	21.5	54.0
	Manganese – DTPA	mg/kg	2.77	2.53	-	-	2.85	1.15
	Zinc – DTPA	mg/kg	<0.20	<0.20	-	-	<0.20	<0.20
Exchangeable Cations	Calcium	meq/100g	1.51	0.79	0.38	0.18	0.96	0.44
	Magnesium	meq/100g	1.73	4.87	5.96	6.03	0.89	3.54
	Potassium	meq/100g	0.18	0.38	0.77	0.87	0.12	0.26
	Sodium	meq/100g	0.32	4.77	8.20	8.74	0.14	1.73
	Aluminium	meq/100g	0.02	0.02	0.02	0.02	0.02	0.06
Effective Cation Exchange Capacity		meq/100g	3.8	10.8	15.3	15.8	2.1	6.0
Exchangeable Sodium Percentage		%	8.4	44.1	53.5	55.2	6.5	28.7
Electrochemical Stability Index		-	0.005	0.019	0.028	0.029	0.003	0.016
Calcium : Magnesium Ratio		-	0.9	0.2	0.1	0.0	1.1	0.1
Coarse Fragments > 2.0mm		%	15	61	54	55	2	9
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	35.8	30.2	31.5	42.6	55.0	44.4
	Fine Sand 0.02-0.2mm	%	49.3	35.5	29.4	26.1	34.7	30.9
	Silt 0.002-0.02mm	%	2.9	4.9	10.8	5.0	0.7	1.1
	Clay <0.002mm	%	11.2	28.3	27.3	25.2	9.4	22.6
Emerson class		Class	3	2	2	2	3	2
Water repellence		Class	Repellent	Repellent	Repellent	No	No	No
Carbonates Fizz Test		Class	Fizz	No Fizz	No Fizz	No Fizz	No Fizz	No Fizz

Analyses		Unit	S18		S22			
Depth		mm	500-600	800-900	0-100	300-400	650-750	1100-1200
pH (water)		pH units	8.5	8.7	6.8	9.4	8.9	8.7
Electrical Conductivity, $EC_{1:5}$		dS/m	0.37	0.63	0.17	1.68	1.47	0.72
Chloride		mg/kg	395	677	197	1,745	1,720	822
Total Nitrogen		mg/kg	-	-	298	134	-	-
Total Phosphorus		mg/kg	-	-	<40	<40	-	-
Organic Carbon		%	-	-	0.7	<0.2	-	-
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	-	-	63.2	92.5	-	-
	Potassium - Colwell	mg/kg	-	-	11.3	97.5	-	-
	Sulphur - KCl	mg/kg	-	-	0.70	0.2	-	-
	Copper – DTPA	mg/kg	-	-	0.40	0.92	-	-
	Iron – DTPA	mg/kg	-	-	5.58	5.32	-	-
	Manganese – DTPA	mg/kg	-	-	1.99	1.09	-	-
	Zinc – DTPA	mg/kg	-	-	<0.20	<0.20	-	-
Exchangeable Cations	Calcium	meq/100g	0.13	0.19	1.27	1.29	0.50	0.20
	Magnesium	meq/100g	2.78	2.50	5.48	7.58	5.93	3.30
	Potassium	meq/100g	0.29	0.29	0.15	0.20	0.22	0.18
	Sodium	meq/100g	2.70	2.45	2.05	7.74	6.46	5.97
	Aluminium	meq/100g	0.02	0.02	0.02	0.02	0.02	0.02
Effective Cation Exchange Capacity		meq/100g	5.9	5.4	9.0	16.8	13.1	9.7
Exchangeable Sodium Percentage		%	45.5	45.0	22.9	46.0	49.2	61.8
Electrochemical Stability Index		-	0.008	0.014	0.007	0.037	0.030	0.012
Calcium : Magnesium Ratio		-	0.05	0.1	0.2	0.2	0.1	0.1
Coarse Fragments > 2.0mm		%	39	0	2	53	30	4
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	50.1	55.7	46.7	38.4	46.8	43.3
	Fine Sand 0.02-0.2mm	%	31.7	27.8	27.8	23	24.8	28.9
	Silt 0.002-0.02mm	%	1.1	3.0	4.8	7.0	6.0	3.0
	Clay <0.002mm	%	16.8	13.2	20.5	31.3	23.2	24.4
Emerson class		Class	2	2	2	2	2	2
Water repellence		Class	No	No	No	No	No	No
Carbonates Fizz Test		Class	No Fizz	No Fizz	Fizz	No Fizz	No Fizz	No Fizz

Table 17: Representative inspection site of the Structured Deep Clays.

Representative Site No: S02 **Landform:** Open depression **Micro-relief:** N/A **Surface condition:** Soft	**Dominant Vegetation**: Woody **Surface cover:** Mid-dense (30-70%) **Site Drainage:** Moderately well-drained	**Soil Group of Western Australia:** Friable red/brown loamy earth **Australian Soil Classification:** Dermosol	**General comments:** Site beside a disturbed drill pad, <5% surface rock cover. Clay increases with depth.

Landscape Photos	Profile Photo	Horizon (mm)	Moist Colour	Texture	Structure	Consistence	Roots	pH_w & $EC_{1:5}$
		A1 (0 – 100)	2.5YR 2.5/3 Reddish Brown	Clay Loam	Prismatic	Weak (dry)	Common (10 – 25) Very fine (<1mm)	pH: 8.0 EC: 0.11 dS/m
		B1 (100 – 300)	2.5YR 4/6 Red	Light Medium Clay	Subangular Blocky	Firm (dry)	Common (10 – 25) Fine (1 – 2mm)	pH: 9.5 EC: 1.69 dS/m
		B21 (300 – 550)	2.5YR 5/6 Red	Medium Clay	Subangular Blocky	Firm (dry)	Common (10 – 25) Very fine (<1mm)	pH: 9.5 EC: 2.04 dS/m
		B22 (550 – 950)	2.5YR 7/6 Light red	Medium Clay	Subangular blocky	Firm (dry)	Few (1 – 10) Very Fine (<1mm)	pH: 9.5 EC: 1.86 dS/m
		B23 (950 – 1300)	2.5YR 7/4 Light reddish brown	Medium Heavy Clay	Prismatic	Strong (dry)	No roots	pH: 9.5 EC: 1.80 dS/m

3.3.5 Gravelly Soils

The Gravelly Soils are typically found along the ridges and upper and lower slopes of the landscape. They are associated with both Eucalyptus and Allocasuarina dominated vegetation units. This SMU is characterised by a higher abundance of coarse material in the subsoils, and reduced abundance of clay.

This Gravelly Soils SMU consists of generally deep (~>900mm) sandy, loamy and clayey soils with higher abundance of coarse fragments in comparison to the other SMUs of the Survey Area. On occasion the Gravelly Soils lay atop a shallow lateritic hardpan at depths as shallow as 400mm. The Gravelly Soils are prone to structural instability due to the topsoils and subsoils meeting the ESP, EMP and ESI based criteria. The abundance and size of the coarse material is insufficient to any considerable protection to erosion.

Table 18 summarises the typical characteristics of the Gravelly Soils with median values shown in brackets. Table 19 summarises the median properties of the Gravelly Soils against the threshold values. Material characterisation data from the samples of the Gravelly Soils sent for more laboratory analysis are given in Table 20. Table 21 presents the physical and morphological attributes of the soil horizons of representative soil profiles for the Gravelly Soils.

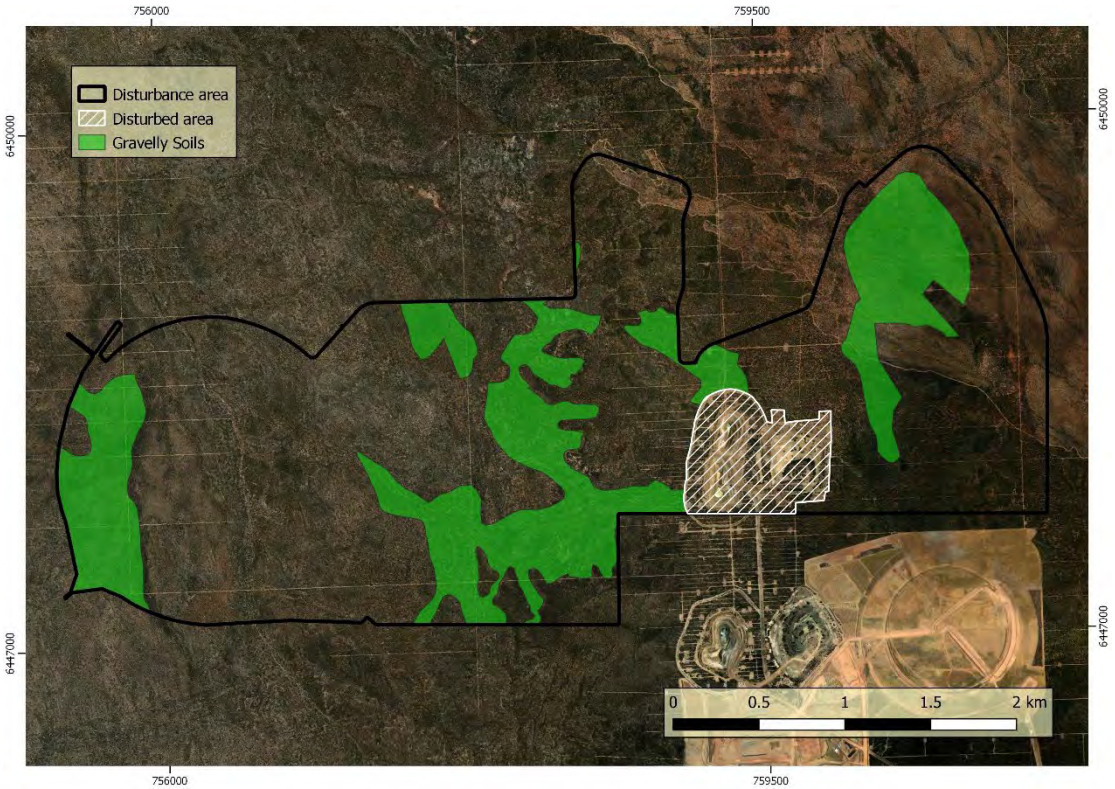

Figure 13: Distribution of the Gravelly Soils within the Disturbance Area.

Table 18: Typical material characteristics of the Gravelly Soils.

Characteristics	Topsoil	Subsoil	Subsoil
Horizon	A	B	B
Depth (mm)	0-150	150-600	>600
Texture (class)	Sand – clay loam	Clay loam – medium clay	Clay loam – medium clay
Structure (grade)	Weak/moderate	Single grain/moderate	Weak/moderate
Consistency	Weak (dry)	Weak/firm	Very firm/strong
Coarse fragments	15-25% 6-20mm^	30-70% 20-60mm^	25-55% 6-20mm^
pH	6.0 – 7.0 (7.0)	5.5 – 8.5 (7.0)	6.0 – 9.2 (8.0)
Salinity (dS/m)	0.02 – 0.07 (0.03)	0.02 – 1.02 (0.07)	0.03 – 1.20 (0.65)
Sodicity, ESP (%)	6 – 9 (8)	6 – 46 (36)	42
ESI	0.003 – 0.008 (0.006)	0.005 – 0.022 (0.016)	0.028
Ca:Mg	0.5 – 4.9 (2.7)	0.1 – 2.0 (0.2)	0.1
Emerson Class	3 – 6 (3)*	2 – 6 (2)*	2 – 6 (2)*
Fertility Class	High	Moderate	-

*Signifies the mode value rather than the median value. ^Values estimated from visual observations.

Table 19: Summary of Gravelly Soils properties (median values) against data interpretation scheme.

Parameter	Unit	Threshold	Topsoil	Subsoil
Soil chemical properties				
Soil pH	-	5.0 – 9.5	6.5	7.1
Soil salinity	dS/m	>2.0	0.02	0.30
Soil fertility				
Total nitrogen	mg/kg	>280	468	312
Avail. phosphorus	mg/kg	>30	36	34
Avail. potassium	mg/kg	>50	99	69
Structural stability				
Structural stability	-	ESI/EMP ESP/PSD	ESP, EMP, ESI	ESP, EMP, ESI
Soil physical properties				
Coarse fraction	%	50% >20 mm	23% 6-20 mm	61% 2-20 mm

Table 20: Material characterisation data of the Gravelly Soils samples sent for more detailed laboratory analysis.

Analyses		Unit	S04				S15		
Depth		mm	0-100	200-300	550-650	950-1050	0-100	200-300	400-500
pH (water)		pH units	6.6	7.2	8.2	9.2	6.3	6.9	7.1
Electrical Conductivity, $EC_{1:5}$		dS/m	0.02	0.03	0.53	1.20	0.07	0.61	1.02
Chloride		mg/kg	8	14	581	1,220	64	780	1,140
Total Nitrogen		mg/kg	611	152	-	-	324	471	-
Total Phosphorus		mg/kg	53	<40	-	-	<40	<40	-
Organic Carbon		%	1.7	0.2	-	-	0.8	1.3	-
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	38.0	34.0	-	-	35.3	33.5	-
	Potassium - Colwell	mg/kg	88.2	87.6	-	-	110	50.8	-
	Sulphur - KCl	mg/kg	4.1	6.6	-	-	8.3	45.3	-
	Copper – DTPA	mg/kg	<0.20	<0.20	-	-	<0.20	0.23	-
	Iron – DTPA	mg/kg	13.7	15.8	-	-	11.3	69.3	-
	Manganese – DTPA	mg/kg	5.31	2.85	-	-	1.93	1.18	-
	Zinc – DTPA	mg/kg	0.24	<0.20	-	-	<0.20	0.21	-
Exchangeable Cations	Calcium	meq/100g	3.77	1.47	1.07	0.91	1.31	0.75	0.52
	Magnesium	meq/100g	0.78	0.72	4.56	6.23	2.41	4.45	7.13
	Potassium	meq/100g	0.19	0.17	0.42	0.73	0.19	0.10	0.12
	Sodium	meq/100g	0.30	0.14	3.62	5.82	0.39	2.75	6.70
	Aluminium	meq/100g	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Effective Cation Exchange Capacity		meq/100g	5.1	2.5	9.7	13.7	4.3	8.1	14.5
Exchangeable Sodium Percentage		%	6.0	5.6	37.4	42.5	8.9	34.0	46.2
Electrochemical Stability Index		-	0.003	0.005	0.014	0.028	0.008	0.018	0.022
Calcium : Magnesium Ratio		-	4.9	2.0	0.2	0.1	0.5	0.2	0.1
Coarse Fragments > 2.0mm		%	25	70	61	53	14	61	51
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	46.8	37.7	32.6	33.6	42.9	33.8	38.5
	Fine Sand 0.02-0.2mm	%	37.1	48.8	30.1	25.6	39.6	30	22.8
	Silt 0.002-0.02mm	%	2.9	1.1	3.0	3.0	5.0	4.9	7.0
	Clay <0.002mm	%	11.0	9.1	31.8	33.9	11.7	30.4	31.3
Emerson class		Class	3	3	2	2	4	2	2
Water repellence		Class	No	No	No	No	No	No	No
Carbonates Fizz Test		Class	No Fizz	No Fizz	No Fizz	No Fizz	Fizz	Fizz	No Fizz

Table 21: Representative inspection site of the Gravelly Soils.

Representative Site No: S04 **Landform:** Mid-slope **Micro-relief:** N/A **Surface condition:** Soft	**Dominant Vegetation**: Woody **Surface cover:** Mid-dense (30-70%) **Site Drainage:** Imperfectly drained	**Soil Group of Western Australia:** Alkaline grey deep sandy duplex **Australian Soil Classification:** Sodosol	**General comments:** 40% surface rock cover. Coarse fragment abundance is variable in the profile.

Landscape Photos	Profile Photo	Horizon (mm)	Moist Colour	Texture	Structure	Consistence	Roots	pH_w & $EC_{1:5}$
		A (0-150)	7.5 YR 4/3 Brown	Loam	Polyhedral	Weak (dry)	Many (25-200) Fine (1-2 mm)	pH: 6.6 EC: 0.02 dS/m
		A2 (150-450)	7.5 YR 7/2 Pinkish grey	Sand	Apedal	Weak (dry)	Common (10-25) Very fine (<1mm)	pH: 7.2 EC: 0.03 dS/m
		B21 (450-750)	7.5 YR 7/1 Light grey	Med. Clay	Subangular blocky	Firm (dry)	Few (1-10) Very fine (<1 mm)	pH: 8.2 EC: 0.53 dS/m
		B22 (750-1300)	7.5 YR 6/3 Light brown	Med. Clay	Subangular blocky	Strong (dry)	No roots	pH 9.2 EC: 1.20 dS/m

3.3.6 Acidic Soils

The Acidic Soils are typically located in the low-lying areas of the landscape, the lower slopes, and flats. The soils of this SMU are associated with the *Allocasuarina* dominated vegetation communities. The Acidic Soils are defined by their highly acidic topsoils and subsoils.

The Acidic Soils typically consist of non-sodic deep soil profiles (>800mm) sands or loams. One site associated with the Acidic Soils (S03) lay atop a cemented lateritic horizon at a depth of 800mm. Both the topsoils and subsoils are strongly acidic (pH <5.5), the topsoils generally have the lowest abundance of coarse materials of all SMU (6%) while the subsoils have a moderate abundance (45%).

Table 22 summarises the typical characteristics of the Acidic Soils with median values shown in brackets. Table 23 summarises the median properties of the Acidic Soils against the threshold values. Material characteristic data from the samples of the Acidic Soils sent for more laboratory analysis are given in Table 24. Table 25 presents the physical and morphological attributes of the soil horizons of representative soil profiles for the Acidic Soils.

The Acidic Soils are prone to structural instability as they meet the ESI based criteria.

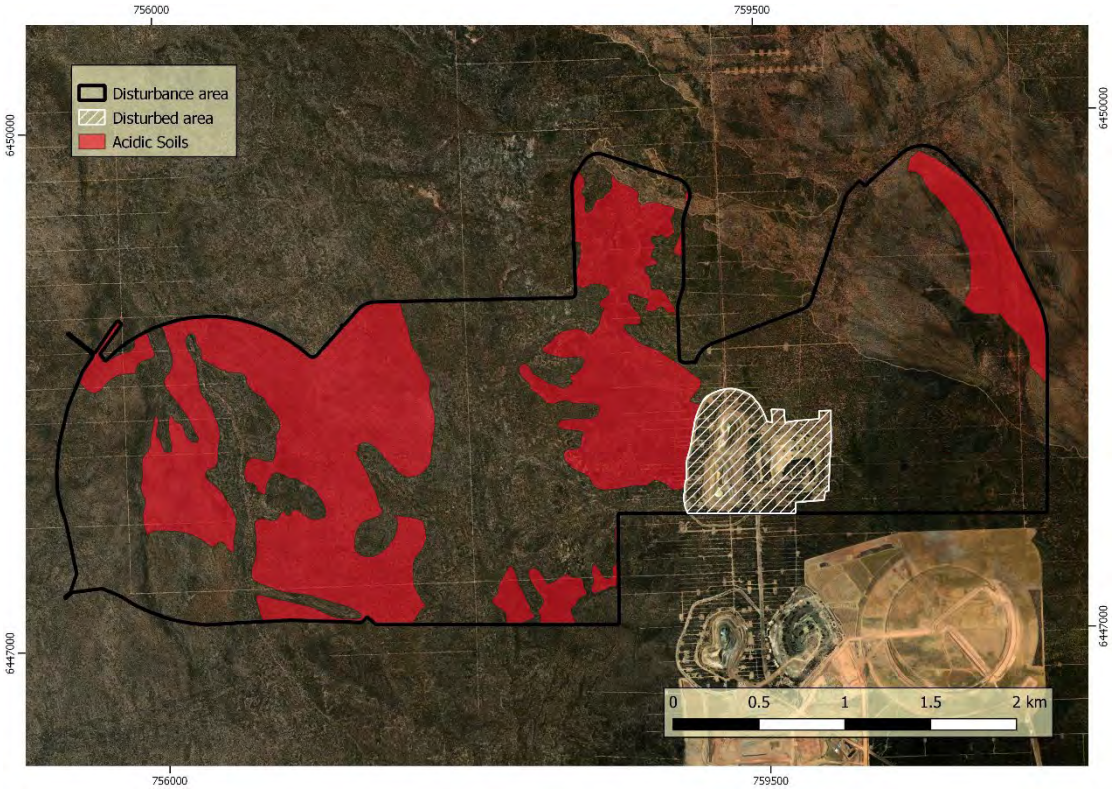

Figure 14: Distribution of the Acidic Soils SMU within the Disturbance Area.

Table 22: Typical material characteristics of the Acidic Soils.

Characteristics	Topsoil	Subsoil	Subsoil
Horizon	A	B	B
Depth (mm)	0-100	100-800	>800
Texture (class)	Loamy sand – sandy loam	Sand – sandy clay loam	Sandy clay loam
Structure (grade)	Weak	Single grain/moderate	Weak/massive
Consistency	Weak/firm (dry)	Weak/firm	Firm/strong
Coarse fragments	2-10% 2-20mm^	10-90% 6-60mm^	2-90% 2-20mm^
pH	5.1 – 5.7 (5.5)	4.6 – 5.5 (4.7)	4.4 – 6.1 (5.5)
Salinity (dS/m)	0.01 – 0.04 (0.03)	0.02 – 0.29 (0.03)	0.04 – 0.45 (0.44)
Sodicity, ESP (%)	4 – 14 (5)	3 – 16 (8)	12 – 35 (24)
ESI	0.003 – 0.004 (0.003)	0.003 – 0.019 (0.005)	0.003 – 0.013 (0.008)
Ca:Mg	1.3 – 2.4 (2.0)	0.1 – 5.6 (1.1)	0.1 – 0.7 (0.4)
Emerson Class	4 – 6 (6)*	6	2 – 6 (6)*
Fertility Class	High	Moderate – high	-

*Signifies the mode value rather than the median value. ^Values estimated from visual observations.

Table 23: Summary of Acidic Soils properties (median values) against data interpretation scheme.

Parameter	Unit	Threshold	Topsoil	Subsoil
Soil chemical properties				
Soil pH	-	5.0 – 9.5	5.5	4.8
Soil salinity	dS/m	>2.0	0.03	0.05
Soil fertility				
Total nitrogen	mg/kg	>280	356	399
Avail. phosphorus	mg/kg	>30	36	36
Avail. potassium	mg/kg	>50	87	54
Structural stability				
Structural stability	-	ESI/EMP ESP/PSD	ESI	ESI
Soil physical properties				
Coarse fraction	%	50% >20mm	6% 2-20mm	45% 2-60mm

Table 24: Material characterisation data of the Acidic Soils samples sent for more detailed laboratory analysis.

Analyses		Unit	S03			S10			
Depth		mm	0-100	200-300	500-600	0-100	300-400	700-800	1100-1200
pH (water)		pH units	5.4	4.9	4.8	5.0	4.6	4.7	6.1
Electrical Conductivity, $EC_{1:5}$		dS/m	0.02	0.03	0.03	0.04	0.06	0.29	0.45
Chloride		mg/kg	21	26	15	25	45	395	500
Total Nitrogen		mg/kg	326	399	-	844	570	-	-
Total Phosphorus		mg/kg	<40	<40	-	<40	<40	-	-
Organic Carbon		%	0.5	0.4	-	1.5	0.5	-	-
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	35.0	35.8	-	36.2	32.2	-	-
	Potassium - Colwell	mg/kg	86.5	87.8	-	170	54.3	-	-
	Sulphur - KCl	mg/kg	14.4	21.2	-	13.0	21.6	-	-
	Copper – DTPA	mg/kg	<0.20	<0.20	-	<0.20	<0.20	-	-
	Iron – DTPA	mg/kg	11.4	15.1	-	116	59.7	-	-
	Manganese – DTPA	mg/kg	1.89	1.01	-	1.63	1.01	-	-
	Zinc – DTPA	mg/kg	<0.20	<0.20	-	0.20	<0.20	-	-
Exchangeable Cations	Calcium	meq/100g	0.46	0.17	0.33	0.61	0.21	0.18	0.19
	Magnesium	meq/100g	0.23	0.03	0.32	0.47	0.20	1.47	3.62
	Potassium	meq/100g	0.13	0.06	0.08	0.36	0.13	0.10	0.18
	Sodium	meq/100g	0.05	0.09	0.04	0.35	0.23	0.50	2.16
	Aluminium	meq/100g	0.19	0.53	0.67	0.74	1.56	1.00	0.02
Effective Cation Exchange Capacity		meq/100g	1.1	0.9	1.4	2.5	2.3	3.2	6.2
Exchangeable Sodium Percentage		%	4.9	10.6	3.0	13.8	9.9	15.5	35.0
Electrochemical Stability Index		-	0.004	0.003	0.010	0.003	0.006	0.019	0.013
Calcium : Magnesium Ratio		-	2.0	5.6	1.1	1.3	1.1	0.1	0.1
Coarse Fragments > 2.0mm		%	19	62	83	5	28	69	56
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	50.7	46.6	39.7	48.3	39.7	46.9	48.5
	Fine Sand 0.02-0.2mm	%	35.4	35.0	38.7	38.8	40.1	36.4	33.8
	Silt 0.002-0.02mm	%	1.1	2.9	4.5	1.1	2.9	2.9	4.8
	Clay <0.002mm	%	11.0	12.9	10.6	11.3	16.7	13.1	11.2
Emerson class		Class	6	6	6	5	6	6	2
Water repellence		Class	No	No	No	No	No	No	No
Carbonates Fizz Test		Class	No Fizz	No Fizz	No Fizz	No Fizz	No Fizz	No Fizz	No Fizz

Analyses		Unit	S26			
Depth		mm	0-100	200-300	500-600	900-1000
pH (water)		pH units	5.8	4.6	4.7	4.4
Electrical Conductivity, $EC_{1:5}$		dS/m	0.01	0.02	0.02	0.04
Chloride		mg/kg	15.7	19.0	17.9	33.8
Total Nitrogen		mg/kg	356	152	-	-
Total Phosphorus		mg/kg	<40	<40	-	-
Organic Carbon		%	0.6	<0.2	-	-
Plant Available Nutrients	Phosphorus - Colwell	mg/kg	62.9	40.2	-	-
	Potassium - Colwell	mg/kg	4.81	3.0	-	-
	Sulphur - KCl	mg/kg	0.61	0.2	-	-
	Copper – DTPA	mg/kg	<0.20	<0.20	-	-
	Iron – DTPA	mg/kg	13.50	4.66	-	-
	Manganese – DTPA	mg/kg	1.73	<1.00	-	-
	Zinc – DTPA	mg/kg	<0.20	<0.20	-	-
Exchangeable Cations	Calcium	meq/100g	0.87	0.25	0.16	0.29
	Magnesium	meq/100g	0.36	0.21	0.27	0.43
	Potassium	meq/100g	0.15	0.08	0.08	0.10
	Sodium	meq/100g	0.06	0.08	0.10	0.24
	Aluminium	meq/100g	0.10	1.06	1.04	0.98
Effective Cation Exchange Capacity		meq/100g	1.5	1.7	1.6	2.0
Exchangeable Sodium Percentage		%	3.7	4.5	6.0	12.0
Electrochemical Stability Index		-	0.003	0.004	0.003	0.003
Calcium : Magnesium Ratio		-	2.4	1.2	0.6	0.7
Coarse Fragments > 2.0mm		%	7	32	15	7
Particle Size Distribution of Fine Fraction	Coarse Sand 0.2-2.0mm	%	51.4	63.7	61.8	58.5
	Fine Sand 0.02-0.2mm	%	33.9	26.1	22.7	26.2
	Silt 0.002-0.02mm	%	4.8	2.9	4.7	2.9
	Clay <0.002mm	%	9.4	5.7	9.3	11.2
Emerson class		Class	4	6	6	6
Water repellence		Class	No	No	No	No
Carbonates Fizz Test		Class	Fizz	No Fizz	No Fizz	No Fizz

Table 25: Representative inspection site of the Acidic Soils.

Representative Site No: S10 **Landform:** Mid-slope **Micro-relief:** N/A **Surface condition:** Open depression	**Dominant Vegetation**: Woody **Surface cover:** Dense (>70%) **Site Drainage:** Moderately well-drained	**Soil Group of Western Australia:** Brown Loamy Earth **Australian Soil Classification:** Kandosol	**General comments:** 60% surface rock cover. Coarse fragment abundance increases with depth.

Landscape Photos	Profile Photo	Horizon (mm)	Moist Colour	Texture	Structure	Consistence	Roots	pH_w & $EC_{1:5}$
		A (0-100)	7.5 YR 4/2 Brown	Sandy Loam	Polyhedral	Firm (moderately moist)	Many (25-200) Fine (1-2 mm)	pH: 5.1 EC: 0.04dS/m
		B21 (100-400)	7.5 YR 6/4 Light brown	Sandy Loam	Polyhedral	Weak (moderately moist)	Common (10-25) Medium (2-5 mm)	pH: 4.6 EC: 0.06dS/m
		B22 (400-800)	7.5 YR 6/3 Light brown	Sandy Loam	Subangular blocky	Firm (dry)	Common (10-25) Fine (1-2 mm)	pH: 4.7 EC: 0.29dS/m
		BC (800-1300)	7.5 YR 7/2 Pinkish grey	Sandy Clay Loam	Subangular blocky	Strong (dry)	No roots	pH 6.1 EC: 0.45dS/m

4 SOIL MANAGEMENT

4.1 Soil suitability

The majority of the subsoils for all three SMU are associated with an increased risk of structural instability. The characteristics of the *in situ* subsoils typically do not impede root penetration, as roots are present within the subsoil. The risks associated with structural instability are likely to be heightened through disturbance of these subsoils via stripping, stockpiling and respreading. This may result in potential hardsetting or compaction which may impact their use for rehabilitation.

The topsoils and subsoils of the Structured Deep Clays are prone to structural instability due to their ESP, EMP, ESI and at times PSD. Subsoils become highly sodic at depths >0.3 m increasing their potential to be hardsetting, resulting in low permeability and high bulk density. Both the topsoils and subsoils have moderate to high fertility values indicating that they are a good potential growth medium. Placement of these soils on steeper gradient slopes such as batters should be avoided. These soils could be placed on very gentle slopes or flat surfaces. Use of subsoils on flat surfaces may have risks associated with them, therefore it would be beneficial to reconstitute the soil profile, i.e., topsoil placement on top of subsoil.

The topsoils and subsoils of the Gravelly Soils are prone to structural instability due to their ESP, EMP and ESI. Both the topsoils and subsoils have moderate to high fertility values indicating that they are a good potential growth medium. The increased abundance of coarse material in the subsoils is not expected to be sufficient to provide erosion resistance when placed on a sloped surface. It is recommended that their erosion potential be assessed if placement on steep batters is to be considered. Their usefulness on low to steeper gradient surfaces may be affected due to their increased potential to hardsetting, resulting in low permeability and high bulk density. The soils of this SMU could be placed on very gentle slopes or flat surfaces. Use of the subsoils on flat surfaces may have risks associated with them, therefore it would be beneficial to reconstitute the soil profile, i.e., spreading topsoil on top of the subsoil.

The topsoils and subsoils of the Acidic Soils are prone to structural instability due to their ESI. This may limit their usefulness on steeper gradient slopes, however the coarse fragment content of this material may offset some of these effects. Both the topsoils and subsoils have moderate to high fertility values, however they are significantly more acidic than the other soils of the Survey Area. If the Acidic Soils are to be used as a growth medium, targeting vegetation species that are adapted to low pH soils will be key to successful rehabilitation. Notably, the Acidic Soils were mapped to areas associated with the vegetation units S2 and W5 which are both dominated by *Allocasuarina acutivalvis* and *Eucalyptus burracoppinensis*.

4.2 Soil stripping

The purpose of determining suitable soil stripping depths is to provide an estimate of the maximum soils volumes that are potentially available for rehabilitation. To determine the maximum available soil volumes, both the suitable stripping depth and the area to be stripped must be known.

Suitable stripping depths are based on the attributes of the soils and are determined separately for each SMU. The key attribute determining the suitable stripping depth is soil depth.

The area that is likely to be stripped (within the Survey Area) is limited to the disturbance area outlined in Section 1 (excluding ~50ha of pre-disturbed land) which is approximately 932 ha in size.

Topsoils should be stripped and stockpiled separately from subsoils if stockpiled as they contain higher levels of organic matter, soil biology, and seed. Any vegetation debris should also be retained as it will likely be useful in maintaining the nutrient store, and if sufficiently large in size (i.e., branches, trucks), may provide additional erosion resistance.

4.2.1 Structured Deep Clays

Topsoils and subsoils of the Structured Deep Clays can be stripped for use as a rehabilitation resource.

The Structured Deep Clays are a potential rehabilitation resource for use on low gradient surfaces due to their high fertility values. There are no limitations to the stripping depth of the Structured Deep Clays based on the properties of the soils down to 0.3 m. The subsoils become highly sodic and saline at depths beyond 0.3 m, increasing the potential for hardsetting and further risks of structural instability, and may inhibit vegetation establishment. From a practicality purpose, the Structured Deep Clays could be stripped to a total depth of 0.3 m, provided that they are managed appropriately when stockpiled and when used for rehabilitation.

For the purpose of stripping the maximum volume of soil, it is assumed that the topsoils of the Structured Deep Clays will be stripped to 0.1 m and stockpiled separately from the subsoils, and subsoils stripped from 0.1 – 0.3 m (depth of 0.2 m).

Covalent plans to maintain consistent stripping practices within the Project, in practice the topsoils of the Structured Deep Clays will be stripped to 0.15 m and stockpiled separately from the subsoils, and subsoils stripped from 0.15 – 0.3 m (depth of 0.15 m).

4.2.2 Gravelly Soils

Topsoils and subsoils of the Gravelly Soils can be stripped for use as a rehabilitation resource.

The Gravelly Soils are a potential rehabilitation resource for use on low gradient surfaces due to their high fertility values. There are no limitations to the stripping depth of the Gravelly Soils on the properties of the soils down to 0.4 m. The subsoils increase in sodicity at depths greater than 0.4 m, increasing the potential for hardsetting and further risks of structural instability. From a practicality purpose, the Gravelly Soils could be stripped to a depth of 0.4 m, provided that they are managed appropriately when stockpiled and when used for rehabilitation.

It is noted that the Gravelly Soils from the current Earl Grey Project have been stripped to a depth of 0.3m, with topsoil stripped from 0 – 0.15m, and subsoils from 0.15 –

0.3m. To maintain a consistency soil management strategy, it is recommended that the stripping depth and management strategy remain the same. For the purpose of this report, it is noted that the subsoils encountered within this survey could be stripped from 0.15 – 0.4m if additional rehabilitation resources are required.

4.2.3 Acidic Soils

Topsoils and subsoils of the Acidic Soils can be stripped for use as a rehabilitation resource. The low pH of the topsoils may not hinder vegetation establishment if native species that are adapted to acidic soil are used in rehabilitation. The subsoils typically have lower pH than the topsoils (median pH <5.0), which may hinder vegetation establishment.

The Acidic Soils are a potential rehabilitation resource for use on low gradient surfaces due to their high fertility values. There are no limitations to the stripping depth of the Acidic Soils on the properties of the soils down to 0.6 m. The subsoils increase in both sodicity and salinity at depths greater than 0.6 m, increasing the potential for hardsetting, further risks of structural instability, and salinity levels that may hinder vegetation establishment. From a practicality purpose, the Acidic Soils could be stripped to a depth of 0.6 m, provided that they are managed appropriately when stockpiled and when used for rehabilitation.

It is noted that the Acidic Soils from the current Earl Grey Project have been stripped to a depth of 0.3m, with topsoil stripped from 0 – 0.15m, and subsoils from 0.15 – 0.3m. To maintain a consistency soil management strategy, it is recommended that the stripping depth and management strategy remain the same. For the purpose of this report, it is noted that the subsoils encountered within this survey could be stripped from 0.15 – 0.6m if additional rehabilitation resources are required.

4.3 Soil volumes

Estimated total volumes of soils for the Structured Deep Clays, Gravelly Soils and Acidic Soils are provided in Table 26. If soils are stripped to their maximum depth, the total amount of available soil resource is outline in Table 27.

Table 26: Volumes of topsoil and subsoil to be recovered by SMU from the disturbance area.

SMU	Soil Volume (m^3)		
	Topsoil	Subsoil	Total volume (m^3)
Structured Deep Clays	533,985	533,985	**1,067,970**
Gravelly Soils	363,345	363,345	**726,690**
Acidic Soils	500,865	500,865	**1,001,730**
Total	**1,398,195**	**1,398,195**	**2,796,390**

Table 27: Maximum recoverable volume of topsoil and subsoil by SMU from the disturbance area.

SMU	Maximum Recoverable Volume (m^3)		
	Topsoil	Subsoil	Total volume (m^3)
Structured Deep Clays	355,990	711,980	**1,067,970**
Gravelly Soils	363,345	605,575	**968,920**
Acidic Soils	333,910	1,669,550	**2,003,460**
Total	**1,053,245**	**2,987,105**	**4,040,350**

4.4 Soil stockpiling

The materials from the three SMUs have different physical and chemical properties. Importantly, the differences in sodicity, pH, coarse fragment abundance and risk of structural instability results in different recommendations for each SMU. If stripped, each SMU should be stockpiled separately to facilitate the optimum use of the materials for rehabilitation and closure based on their inherent properties.

Further, topsoils generally have a higher store of vegetative debris, organic matter, soil biology, and seed than subsoils. Any topsoils that are stripped should be stockpiled separately from any other sub-surface soils.

As all soils associated with the Disturbance Area are considered to be prone to structural instability, when stockpiling these soils, no stockpile should be greater than 2m in height.

4.5 Wind erosion

The susceptibility of a material to wind erosion is related to the material's aggregated PSD. Other factors such as coarse fraction abundance and size and soil moisture also strongly influence wind erosion potential (Hazelton and Murphy 2016). Sandy soils (>90% sand by weight), particularly those containing fine sand, tend to have high wind erosion potential while sandy loams to clay loams have moderate wind erosion potential, and clays have low wind erosion potential. Rocky or gravelly soils also have low wind erosion potential.

The Structured Deep Clays and Gravelly Soils typically have loamy or clay textures with clay contents ranging from 15 – 55% and 10 – 30%, respectively. Additionally, the Gravelly Soils have an elevated coarse fragment abundance, meaning that these two SMUs have a low susceptibility to wind erosion.

The Acidic Soils have a reduced clay content of 5 – 15% in addition to a coarse fragment abundance that does not offer resistance to wind erosion (<50%). The Acidic Soils are susceptible to wind erosion. To mitigate this risk, when stockpiling and respreading the Acidic Soils, the addition of large vegetation debris (i.e., trunks, branches) can offer protection to wind erosion.

4.6 Water erosion

The soils within the disturbance area that are prone to low permeability, structural instability or soil detachment or a combination of these factors, most notably the Structured Deep Clays and Gravelly Soils, have an increased risk of water erosion. The coarse fraction present within the material will act to reduce this erosion, though the degree of reduction is unknown.

When respreading these soils as part of rehabilitation works, risks associated with water erosion must be considered. Placement of these materials on steep batter slopes could result in significant gullies and erosion when the slop geometries adopted (length, gradient, profile shape) produce erosion potentials that are unacceptably high. Use of these soils on outer batters is currently not recommended, if it is to be considered for achieving acceptable long-term erosion rates validation through further erodibility testing and erosion modelling must be undertaken. It will be critical to confirm their limitations in terms of acceptable slope lengths, gradients, and batter profile shapes. This testing could also consider the impacts of the addition of tree debris or waste rock (if available) as an armouring element and the risks posed by berms and other engineered flow control structures (sizing of these structures such that the risk of dispersion is reduced would form part of this testing and assessment).

4.7 Soil amendments

Total N and P, and available P and K values for topsoils are variable across the survey area but are considered to be sufficient for vegetation growth. The subsoils of all SMUs typically have comparable fertility values when compared to the topsoils, but do not have the benefit of standing biomass.

It is noted that removal of a significant proportion of the standing biomass as part of stripping will result in a loss of organic carbon and nitrogen from the topsoil. For rehabilitation, it is recommended to replace or supplement nutrients lost through disturbance to encourage rapid establishment of vegetation. Application of fertiliser to the topsoil and subsoil is recommended based on the loss of nutrients caused by the removal of vegetation (mostly topsoil), disturbance of the soil, and the likely respreading of topsoil in a thin layer over less fertile subsoil.

The degree to which low fertility impacts plant growth could be considered as part of greenhouse or field trials conducted once the soils are disturbed. Such trials would be beneficial in defining the required types of fertilisers and their mode of application, and in optimising the rates and timing of application.

Rates of fertilisation should be assessed once the soils are stripped and stockpiled. Once collected, data for these disturbed soils could be useful compared against the fertility values found in this report.

If the Structured Deep Clays are to be stripped and stockpiled, amelioration of the subsoil's high sodicity may be considered. Management of sodic soils typically involves tilling the top 30cm of the soil, following respreading, in conjunction with the addition of calcium via the application of gypsum. Rates of gypsum application should be assessed once the soils are stripped and stockpile.

The addition of lime to any stripped subsoils of the Acidic Soils can be considered if the stockpiled subsoils are deemed too acidic for vegetation establishment. Rates of lime application should be assessed once the soils are stripped and stockpiled. Once collected, pH data for these Acidic Soils could be useful compared against the pH tolerance of vegetation species used in rehabilitation.

4.8 Mapping resolution

Due to nine inspection sites being inaccessible during the field investigation, the inspection detail for the disturbance and general project area were reduced to 1 site per 58 ha and 1 site per 140 ha, respectively. The mapping scale for the survey area has not been impacted by this reduction (1:50,000 scale for the disturbance area and 1:100,000 scale for the general project area).

The areas where more extrapolation of soils data to undertaking mapping was required have been highlighted in the three soils maps (Figures 5, 6 and 11). This is most evident in the western and north-western portions of the survey area. Inspection and sampling of the 9 sites that were originally inaccessible, when accessibility becomes available, will provide more accuracy in the soils mapping.

As mentioned in Section 3.3.4, the Structured Deep Clays associated with the western portion of the Survey Area have reduced clay content. Due to the number of inaccessible inspection sites in this area (six of the nine inaccessible sites are in the western area) insufficient data is available for separating these soils into their own SMU. If these sites are investigated in the future, there is potential that the deep structured soils may be classed under a separate and unique SMU.

4.9 Summary

The limitations, opportunities, growth media potential, erosion potential, and recommendations for use as rehabilitation materials for the soils found within each SMU are summarised in Table 28.

Table 28: Summary of the key limitations, opportunities, and suitability for rehabilitation of the soils within each SMU.

Material	Material	Limitation	Opportunities	Suitability for Rehabilitation
Structured Deep Clays	Topsoil and subsoil	• High risk of structural instability due to ESP, EMP and ESI. • May be prone to erosion if placed on sloping surfaces (e.g. batter slopes). • Highly sodic, prone to hardsetting. • Saline subsoils.	• Non-saline. • pH values that support vegetation. • Moderate capacity to hold water and nutrients due to their elevated clay content. • Moderate to high topsoil and subsoil fertility that typically supports vegetation. • Not likely to be susceptible to wind erosion. • Potentially well suited to placement on flat surfaces as a growth medium.	• Stripping of the topsoils is recommended to a depth of 0.1m. • Stripping of the subsoils is recommended to a depth of 0.3m. • The topsoils and subsoils of the Structured Deep Clays are considered a good potential growth medium for the survey area. An erodibility assessment is recommended to assess the soil's erosion potential and/or to assess its potential to reduce other materials erosion potential.
Gravelly Soils	Topsoil and subsoil	• High risk of structural instability due to ESP, EMP and ESI. • Coarse fragment abundance is unlikely to be sufficient to offer resistance to erosion. • May be prone to erosion if placed on sloping surfaces (e.g. batter slopes).	• Non-saline. • pH values that support vegetation. • Moderate to high topsoil and subsoil fertility that typically supports vegetation. • Not likely to be susceptible to wind erosion. • Potentially well suited to placement on flat surfaces as a growth medium.	• Stripping of the topsoils is recommended to a depth of 0.15m. • Stripping of the subsoils is recommended to a depth of 0.4m. • The topsoils and subsoils of the Gravelly Soils have some potential for use as a growth media if placed on flat surfaces. The erodibility characteristics of this material should be tested if intended for use on batter slopes.

Material	Material	Limitation	Opportunities	Suitability for Rehabilitation
Acidic Soils	Topsoil and subsoil	• Potentially at risk of structural instability due to ESI. • Low pH values. • Potentially susceptible to wind erosion.	• Non-saline. • Top soil pH values that support vegetation. • Moderate to high topsoil and subsoil fertility that typically supports vegetation. • Potentially well suited for placement on low gradient areas as a growth medium.	• Stripping of the topsoils is recommended to a depth of 0.1m. • Stripping of the subsoils is recommended to a depth of 0.6m. • If the Acidic Soils are used as a growth medium, targeting low pH tolerant vegetation species will aid in rehabilitation. • Subsoils may require the application of lime to raise the pH to levels suitable for vegetation establishment. pH characteristics of stockpiled subsoils should be tested prior to use as a growth medium. • The erodibility characteristics of this material should be tested if intended for use on batter slopes.

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APPENDIX A: SUMMARY OF REGULATORY REQUIREMENTS

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Regulatory document	Requirement/Recommendation	Landloch's strategy
Statutory Guidelines for Mining Proposals	Baseline Environmental data: • Material characterisation including soils.	Completion of a soil survey that includes sampling of key soil types, laboratory analysis, and interpretation.
Mining Proposal Guidance	Regarding soils, it is recommended that the mining proposal addresses the following aspects: • A description of the major soils occurring in the project area including the indicative volume and characterisation of topsoil and subsoil available for rehabilitation. • Where there are multiple soil types identified, a map showing the spatial extent of each identified soil type in the project area shall be provided. The map should include a scale bar, latitude and longitude coordinates, date of field survey, and regional map location. Soils may be classified according to the WA Soil groups outlined in Schoknecht and Pathan (2013). • Adequate characterisation of the soils to ensure that the risk posed by adverse components can be determined. • Reference to the characterisation methodologies used. • Interpretation of baseline data & broad implications for risk assessment and treatments. • Relevant technical reports attached as appendices.	Revision of all existing soils data including land systems mapping, existing soil assessments, elevation data (slope and relief), vegetation mapping. These data guided selection of sampling locations to target variability in soil type across the project area. Site information and soil morphology were recorded at each site according to the Australian Soil and Landscape Survey Field Handbook. Soils were classified to the Australian Soil Classification (ASC) and Soil Groups of WA (SGWA) and split into Soil Mapping Units (SMUs). Soil maps have been provided that illustrate the extent of the soil types as per these classifications. Soil samples were analysed to determine key risks and limitations, and management strategies and potential amelioration options have been provided.
Statutory Guidelines for Mine Closure Plans	Baseline and Closure Data and Analysis The mine closure plan must include baseline data that: • Informs successful rehabilitation and closure • Establishes baseline conditions for closure monitoring programs The mine closure plan must include: • Details of the methodology of analysing the baseline data.	Baseline soils and landform data were collected as part of the soil investigation. Interpretation of these data have provided baseline conditions prior to the commencement of mining. Data have been analysed based on available suitable classification schemes, including Landloch's experience with soils in the area.
Mine Closure Plan Guidance	Baseline and Closure Data and Analysis • Soil and waste materials characterisation – soil structure and stability (e.g. erodibility), growth media type. Other closure related data: • Availability and volumes of key materials required for rehabilitation such as competent waste rock, subsoil, topsoil and low-permeability clays (i.e. encapsulation material).	Soil structure was assessed in the field as part of soil morphology. The susceptibility of the soils to erode were assessed based on soil texture, particle size distribution, salinity, sodicity, ESI and the Ca:Mg ratio. Results outlined the materials susceptibility to structural decline but did not define erosion rates. More detailed erodibility test work (e.g., simulated rainfall and overland flows capable of determining erosion rates) has not been conducted or

Regulatory document	Requirement/Recommendation	Landloch's strategy
	Closure Implementation: • Availability and management of closure material sources – including topsoil, competent waste rock and subsoil. Progressive rehabilitation: • Landform surface treatments (ripping, selective application of topsoil, placement of materials).	reported as they are typically completed within landform design studies, once the soil and waste materials to be used within rehabilitation have been identified. The availability and volumes of topsoil and subsoil have been based on the disturbance footprint and the abundance of each soil type within that footprint. Stripping depths have been determined based on key characteristics of the topsoil and subsoil of each soil type within the disturbance footprint. Management strategies (e.g. strategic/preferential soil placement based on risk) have been discussed from a structural stability, erodibility, and growth media perspective.
Draft Guidance Material Characterisation Baseline Data Requirements for Mining Proposals	Soil characterisation should be undertaken for the purposes of: • Estimating the quantity and quality of the soil resources (topsoil and subsoil) including each major soil type. • Characterising the baseline growth medium attributes of each major soil type including water holding capacity and nutrients status. • Evaluating potential risk associated with salinity, wind erosion and water erosion. A comprehensive sampling program must consider the following: • The climate of the project area • Optimal timing of sampling • Soil landscape mapping completed by the Department of Agriculture and Food (DAFWA). This delineates broad scale landscape patterns, landform and associated major soil groups and vegetation types. • Adequate spatial coverage and replication to identify and characterise major soil types. Soils can be classified in accordance with Soil Groups of Western Australia Resource Management Technical Report 380 Fourth Edition Schoknecht and Pathan (2013). Sampling should include surface and subsoil layers. Physical soil measurements will have long-term value if they have an associated site and profile description that conforms to standards defined in the Australian Soil and Land Survey Field Handbook (NCST, 2009). Collation and interpretation of soil analysis results should include:	Soil landscape mapping were reviewed as part of the desktop review, and informed sampling locations. The number of sampling locations was based on Guidelines for Survey Soil and Land Resources (McKenzie et al. 2008) as outlined in Section 2.3. Soils have been classified to the SGWA and ASC standards. Soil maps are provided that illustrate the extent of the soil types as per these standards. Soil profiles have been described as per the Australian Soil and Land Survey Field Handbook (NCST, 2009). Nutrient status has been captured as part of the proposed laboratory suite. Water holding capacity was estimated based on surrogate measures of soil texture and particle size. The laboratory analysis has been conducted in line with the recommended analysis within this guidance document. Soil characterisation included estimations of quantity and quality of the soil resource for each major soil type as identified by Soil Mapping Units (SMUs). The report included sections on soil limitations, soil handling and soil volumes. Included was an assessment of salinity and water

Regulatory document	Requirement/Recommendation	Landloch's strategy
	• WA Soil groups • Water holding capacity • Nutrient status • Salinity • Sodicity • Dispersion risk • Erodibility	and wind erosion.

APPENDIX B: SOILS MAPPING FOR MT HOLLAND 2022

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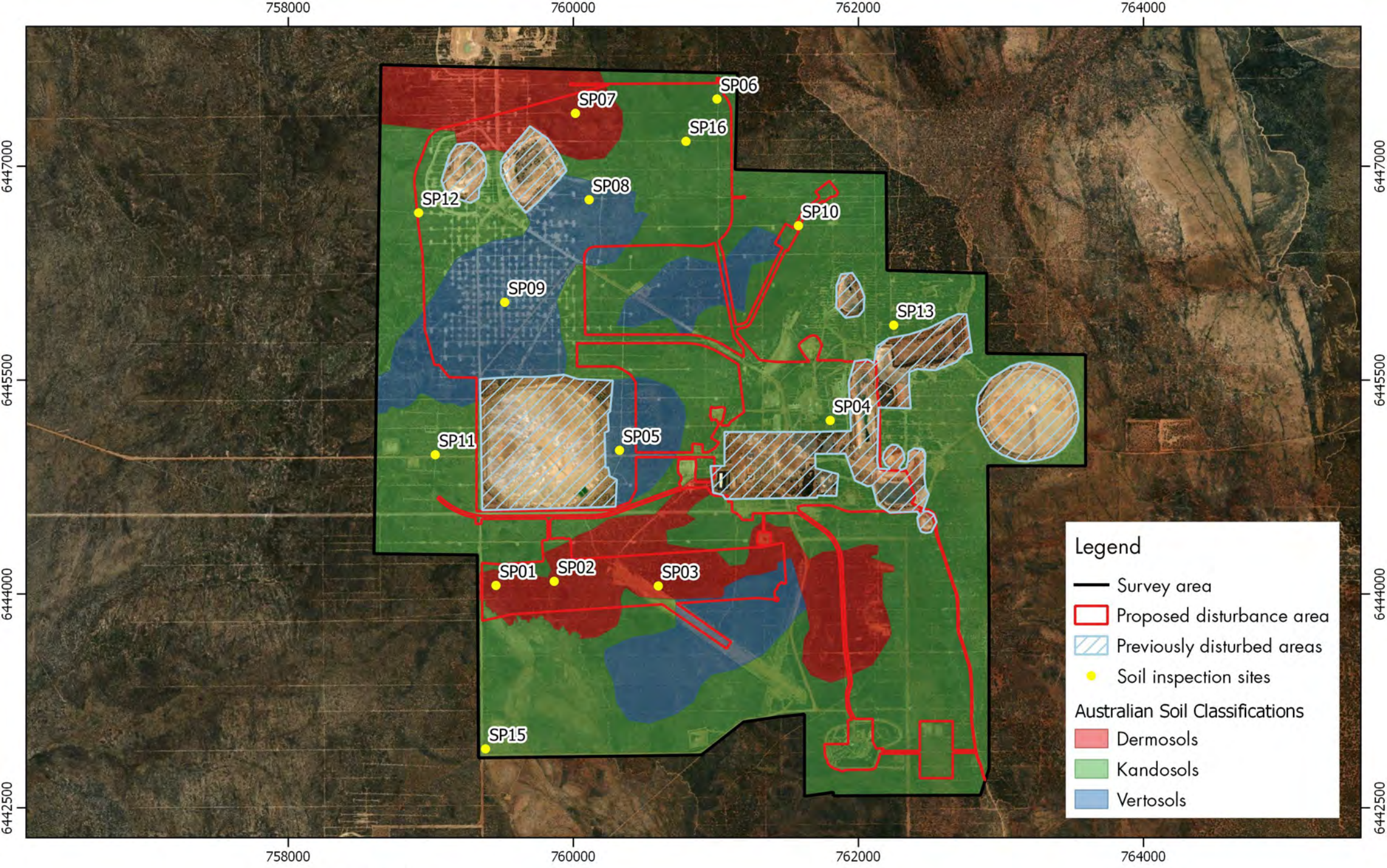


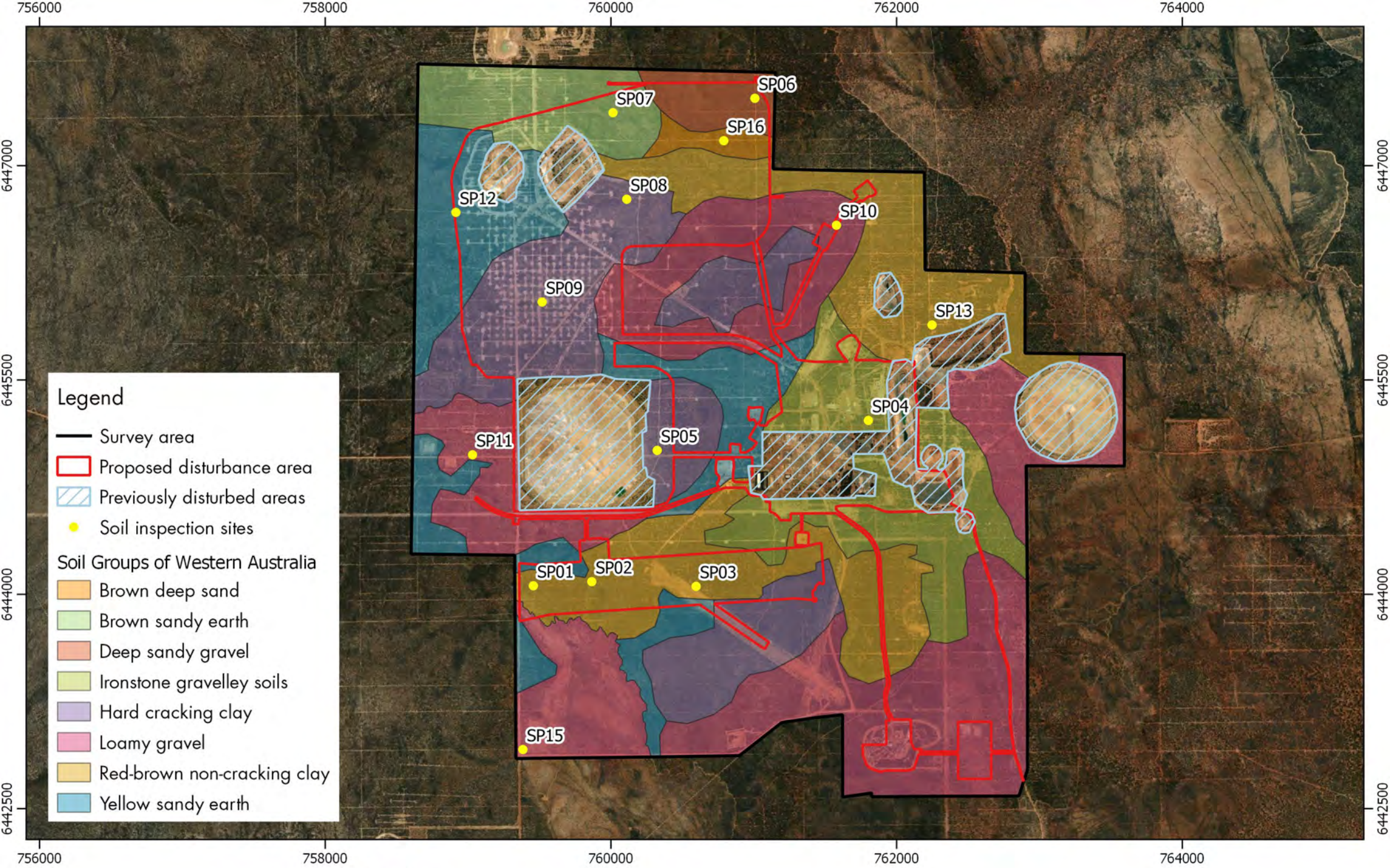
Landloch

Coordinate System:
GDA 2020 MGA Zone 50
Projection: Transverse Mercator
Imagery: ESRI satellite
Scale:1:33,000

Mount Holland Project
Covalent Lithium
Soil Assessment

0 1 2 km

N



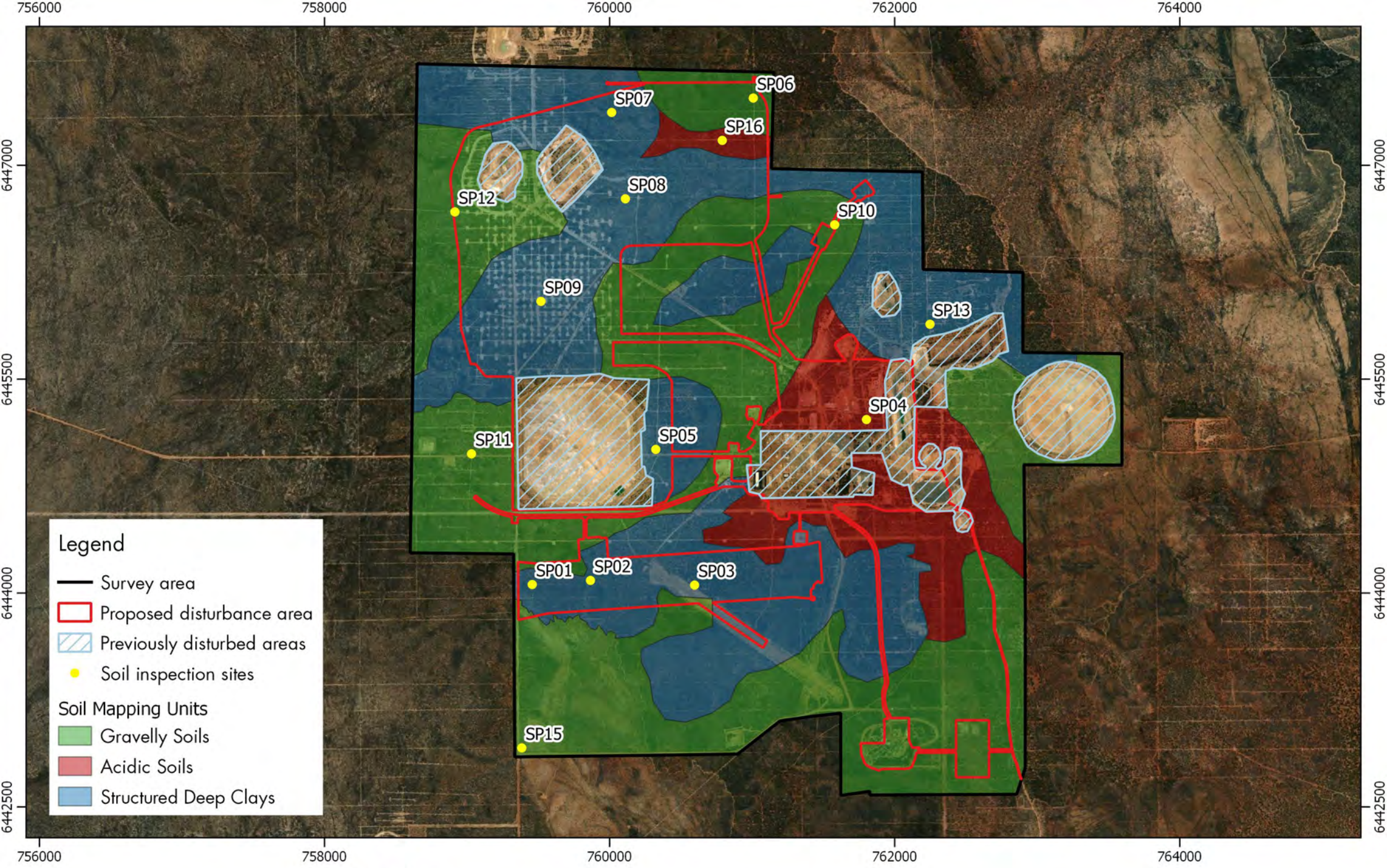
Landloch

Coordinate System:
GDA 2020 MGA Zone 50
Projection: Transverse Mercator
Imagery: ESRI satellite
Scale:1:33,000

Mount Holland Project
Covalent Lithium
Soil Assessment

0 1 2 km

N



Landloch

Coordinate System:
GDA 2020 MGA Zone 50
Projection: Transverse Mercator
Imagery: ESRI satellite
Scale:1:33,000

Mount Holland Project
Covalent Lithium
Soil Assessment

0 1 2 km

N

APPENDIX C: VEGETATION UNITS AND DESCRIPTIONS

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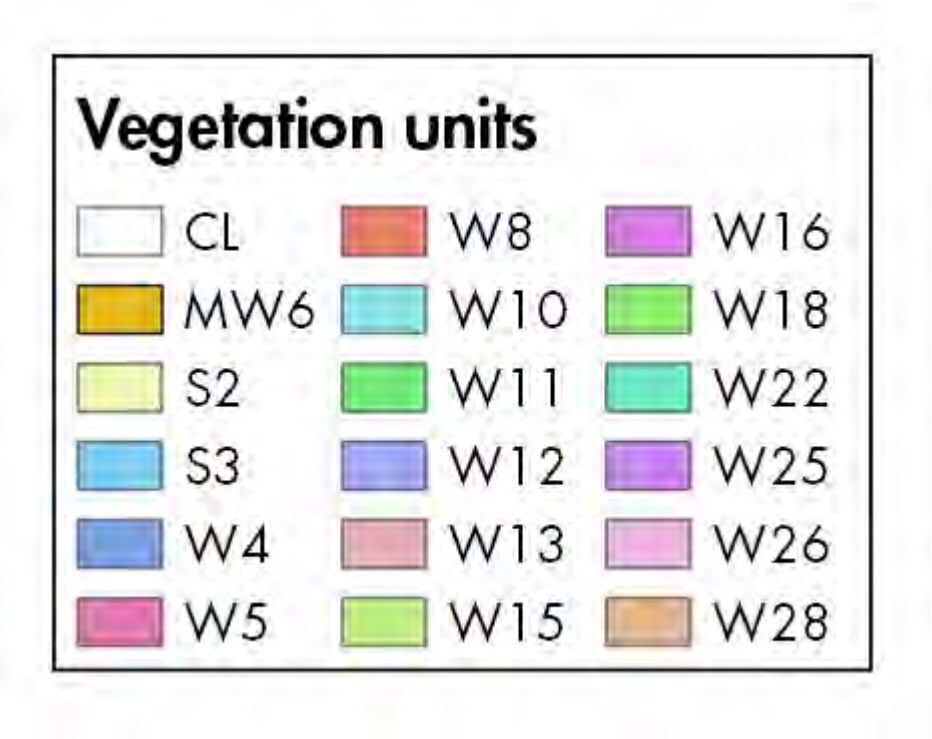
Vegetation Unit	Description	Percentage of survey area (%)
CL	Cleared land	3.9
MW6	*Allocasuarina acutivalvis*, *Eucalyptus burracoppinensis*, *Allocasuarina spinosissima* tall open shrubland over *Thryptomene kochii*, *Micromyrtus erichsenii*, *Hakea erectra* mid sparse heathland.	0.4
S2	*Allocasuarina acutivalvis*, *Eucalyptus burracoppinensis*, *Allocasuarina spinosissima* tall open shrubland over *Thryptomene kochii*, *Micromyrtus erichsenii*, *Hakea erecta* mid sparse heathland.	34.4
S3	*Allocasuarina acutivalvis*, *Eucalyptus burracoppinensis* tall sparse shrubland over *Banksia purdieana*, *Banksia sphaerocarpa* var. *dolichostyla* (T), *Hakea subsulcata* mid sparse shrubland.	0.4
W4	*Eucalyptus eremophila*, *Eucalyptus salubris* low mallee woodland over *Exocarpos aphyllus*, *Melaleuca eleuterostachya*, *Melaleuca sparsiflora* mid sparse shrubland over *Acacia tetraptera*, *Acacia hystrix* subsp. *hystrix* low sparse shrubland.	4.6
W5	*Eucalyptus burracoppinensis*, *Allocasuarina acutivalvis* low open mallee woodland over *Melaleuca cordata*, *Hakea erecta*, *Thryptomene kochii* mid sparse shrubland over *Drummondita hassellii*, *Hibbertia stowardii*, *Euryomyrtus maidenii* low sparse shrubland.	1.2
W8	*Eucalyptus salmonophloia*, *Eucalyptus prolixa*, *Eucalyptus urna* mid mallee woodland over *Santalum acuminatum*, *Melaleuca eleuterostachya* mid sparse shrubland over *Daviesia argillacea*, *Acacia hemiteles*, *Acacia merrallii* low sparse shrubland.	0.5
W10	*Eucalyptus* sp. (E. *flocktoniae* subsp. *flocktoniae*, E. *urna*, E. *cylindriflora*, E, *rigidula*) low open woodland over *Melaleuca pauperiflora* subsp. *pauperiflora* mid open shrubland.	0.4
W11	*Eucalyptus flocktoniae* subsp. *flocktoniae*, *Eucalyptus eremophila*, *Eucalyptus rigidula* low mallee woodland over *Melaleuca lateriflora*, *Melaleuca depauperata*, *Exocarpos aphyllus* mid sparse shrubland.	13.7
W12	*Eucalyptus eremophila*, *Eucalyptus cylindriflora* low open mallee woodland over *Melaleuca lateriflora*, *Melaleuca eleuterostachya*, *Melaleuca acuminata* mid sparse shrubland.	9.7
W13	*Eucalyptus rigidula* low open mallee woodland over *Allocasuarina spinosissima*, *Santalum acuminatum*, *Hakea erecta* mid sparse shrubland.	2.7
W15	Burnt *Allocasuarina acutivalvis*, *Eucalyptus* sp. (E. *cylindriflora*, E. *eremophila*, E, *gracilis*, E. *rigidula*, E. *burracoppinensis*) low open mallee woodland over *Santalum acuminatum* mid sparse shrubland.	0.4
W16	Burnt *Eucalyptus* sp. (E. *burracoppinensis*, E. *eremophila*, E. sp.) low open mallee woodland over *Melaleuca eleuterostachya*, *Santalum acuminatum*, *Acacia assimilis* mid sparse shrubland.	13.6
W18	*Eucalyptus rigidula* low open mallee woodland over *Melaleuca* sp. *Broombrush* complex, *Hakea erecta*, *Allocasuarina spinosissima* mid sparse shrubland.	1.1
W22	*Eucalyptus eremophila* low open mallee woodland over *Melaleuca sp. Broombrush* complex, *Grevillea oncogyne*, *Melaleuca eleuterostachya* mid sparse shrubland.	6.2
W25	*Eucalyptus eremophila* mid mallee woodland over *Melaleuca* sp. *Broombush* complex, Melaleuca eleuterostachya, *Melaleuca lateriflora* mid open shrubland.	1.2

Vegetation Unit	Description	Percentage of survey area (%)
W26	*Eucalyptus capillosa, Callitris columellaris* low open woodland over *Melaleuca condylosa, Melaleuca sparsiflora* low open shrubland.	2.4
W28	*Eucalyptus capillosa, Callitris columellaris* low open woodland over *Melaleuca condylosa, Melaleuca sparsiflora* low open shrubland.	3.2



APPENDIX D: SOIL LOG DATA SHEETS

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Site Information

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	24/5/23	M.White	S01	Soil pit	760,501		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,447,982		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
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Firm	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Surface cover rocks 10% 2-10mm. 60% leaf cover.

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	0-50		Clear	Loam	5yr 3/2 Dark reddish brown	No mottles	<2 % Carbonates	<2 % 2-6 mm	Angular blocky	Weak	Firm (dry)	Many (25-200) Very fine (<1 mm)	6.8	0.03	0-50
B1	50-150		Clear	Light Clay	5yr 4/3 Reddish brown	No mottles	<2 % Carbonates	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	Common (10-25) Medium (2-5 mm)	7.9	0.51	100-150
B	150-350		Gradual	Light Clay	5yr 5/6 Yellowish red	No mottles	<2 % Carbonates	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	Common (10-25) Fine (1-2 mm)	9.4	1.30	250-350
B21	350-700		Clear	Medium Clay	5yrv6/6 Reddish yellow	White 30-40%	2-10 % Other	50-90 % 6-20 mm	Angular blocky	Weak	Firm (dry)	Few (1-10) Very fine (<1 mm)	9.2	1.93	500-600
B22	700-1100			Medium Clay	5yr 6/6 Reddish yellow	Grey 5-10%	Not recorded	2-10 % 2-6 mm	Subangular blocky	Strong	Strong (dry)	No roots (0)	6.4	1.71	800-900

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	24/5/23	M.White	S02	Soil pit	760,996		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,448,508		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Sparse (10-30%)	1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Open depression	Soft		

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Signs of mild disturbance. Next to drill pad. cracking presnt in areas. <5% rock cover 2mm.

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Soil Profile Description

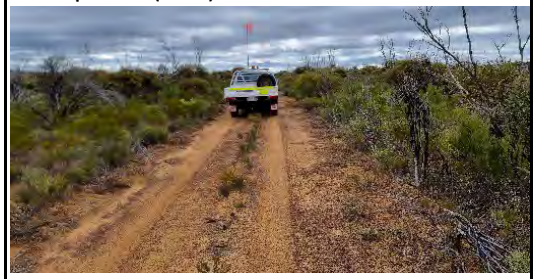
Horizon	Depth (mm)	Profile Photo	Boundary	Texture	Moist Colour	Mottle (colour, abundance)	Segregations (abundance, nature)	Coarse fragments (abundance, size)	Structure (type)	Structure (grade)	Consistence (soil water status)	Roots (abundance, size)	pH	EC (dS/m)	Depth of Sample for Lab (mm)
A1	0-100		Clear	Clay Loam	2.5yr 2.5/3 Reddish brown	No mottles	<2 % Carbonates	2-10 % 2-6 mm	Prismatic	Weak	Weak (dry)	Common (10-25) Very fine (<1 mm)	8.0	0.11	0-100
B1	100-300		Clear	Light Medium Clay	2.5yr 4/6 Red	No mottles	<2 % Carbonates	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	Common (10-25) Fine (1-2 mm)	9.5	1.69	200-300
B21	300-550		Clear	Medium Clay	2.5yr 5/6 Red	No mottles	Not recorded	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	Common (10-25) Very fine (<1 mm)	9.5	2.04	400-500
B22	550-950		Abrupt	Medium Clay	2.5yr 7/6 Light red	White 30%	Not recorded	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	Few (1-10) Very fine (<1 mm)	9.5	1.86	650-750
B23	950-1300			Medium Heavy Clay	2.5yr 7/4 Light reddish brown	No mottles	2-10% Organic	<2 % 2-6 mm	Prismatic	Moderate	Strong (dry)	No roots (0)	9.5	1.80	1000-1100

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	24/5/23	M.White	S03	Soil pit	760,995		Sodosol
Dominant Vegetation Form	Woody	**Ground Cover %**	Dense (>70%)	**Aspect**	**Northing/ Longitude** 6,448,873	**Scale**	**ASC Ground Truth** Tenosol
Secondary Vegetation Form	Non-woody	**Ground Cover %**	Sparse (10-30%)	**Slope %** 3	**Rock Outcrop** No rock outcrop	**Erosion Type**	None evident
Vegetation (species)					**Drainage (site)** Moderately well-drained	**Erosion Extent**	
Landform	Mid-slope	**Soil Surface Condition (dry)**	Firm		**Land Use** Mining	**Erosion State**	

Landscape Photo (North)



Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Other Information: Undulating area. surface 40% rock cover 10-20mm

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	0-100		Clear	Loamy Sand	5yr 4/6 Yellowish red	No mottles	Not recorded	2-10 % 6-20 mm	Polyhedral	Weak	Firm (dry)	Common (10-25) Fine (1-2 mm)	5.4	0.02	0-100
B1	100-300		Gradual	Sandy Loam	7.5yr 646 Reddish yellow	No mottles	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Weak (dry)	Common (10-25) Fine (1-2 mm)	4.9	0.03	200-300
B2	300-800		Abrupt	Sand	7.5yr 6/8 Reddish yelow	No mottles	Not recorded	50-90 % 20-60 mm	Apedal	Single grain	Weak (dry)	Few (1-10) Very fine (<1 mm)	4.8	0.03	500-600
C	800+		Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not sampled

Other information: Rocky subsoils atop laterite at 800mm. Lateritic C horizon not sampled.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	24/5/23	M.White	S04	Soil pit	760,556		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,449,184		Sodosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Sparse (10-30%)	5	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Soft	Mining	

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

Type

Vertical (m)

Horizontal (m)

Sampled

Other Information: Surface rock cover of 40%, 10mm.

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	0-150		Clear	Loam	7.5yr 4/3 Brown	No mottles	Not recorded	2-10 % 6-20 mm	Polyhedral	Weak	Weak (dry)	Many (25-200) Fine (1-2 mm)	6.6	0.02	0-100
A2	150-450		Abrupt	Sand	7.5yr 7/2 Pinkish gray	No mottles	Not recorded	50-90 % 20-60 mm	Apedal	Single grain	Weak (dry)	Common (10-25) Very fine (<1 mm)	7.2	0.03	200-300
B21	450-750		Gradual	Medium Clay	7.5yr 7/1 Light gray	No mottles	Not recorded	2-10 % 6-20 mm	Subangular blocky	Weak	Firm (dry)	Few (1-10) Very fine (<1 mm)	8.2	0.53	550-650
B22	750-1300			Medium Clay	7.5yr 6/3 Light brown	No mottles	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Strong (dry)	No roots (0)	9.2	1.20	950-1050

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	24/5/23	M.White	S05	Soil pit	760,299		Sodosol
Dominant Vegetation Form	Woody	**Ground Cover %**	Dense (>70%)	**Aspect**	**Northing/ Longitude** 6,449,167	**Scale**	**ASC Ground Truth** Tenosol
Secondary Vegetation Form	Non-woody	**Ground Cover %**	Sparse (10-30%)	**Slope %** 2	**Rock Outcrop** No rock outcrop	**Erosion Type**	None evident
Vegetation (species)					**Drainage (site)** Moderately well-drained	**Erosion Extent**	
Landform	Upper slope	**Soil Surface Condition (dry)**	Firm		**Land Use** Mining	**Erosion State**	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Surface cover rocks 50-70% size 10-20mm.

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	0-100		Clear	Sand	7.5 3⁴2 Dark brown	No mottles	Not recorded	2-10 % 2-6 mm	Angular blocky	Weak	Weak (dry)	Common (10-25) Fine (1-2 mm)	7.0	0.038	0-100
B1	100-200		Clear	Loamy Sand	7.5 6/3 Light brown	No mottles	Not recorded	20-50 % 6-20 mm	Polyhedral	Weak	Weak (dry)	Common (10-25) Fine (1-2 mm)	7.0	0.019	150-200
B2	200-400		Abrupt	Sand	7.5yr 7/2 Pinkish gray	No mottles	2-10 % Unidentified	50-90 % 20-60 mm	Apedal	Single grain	Weak (dry)	Few (1-10) Fine (1-2 mm)	7.0	0.016	300-400
C	400+		Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not sampled

Other information: Hydrophobic subsoils. Sandy soils above concreted lateritic layer at 400mm. C horizon not sampled.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S06	Soil pit	759,933		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,448,737		Sodosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Sparse (10-30%)	1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Other Information: Pit dug after rain. Surface cover 10% rocks 10mm.

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	0-150		Clear	Sandy Loam	7.5yr 4/4 Brown	No mottles	<2 % Carbonates	2-10 % 2-6 mm	Polyhedral	Weak	Weak (dry)	Common (10-25) Fine (1-2 mm)	7.3	0.04	0-100
B21	150-400		Clear	Light Medium Clay	7.5yr 7/4 Pink	No mottles	Not recorded	2-10 % 2-6 mm	Subangular blocky	Strong	Weak (dry)	Common (10-25) Medium (2-5 mm)	9.3	1.27	250-350
B22	400-800		Gradual	Medium Clay	7.5yr 5/4 Brown	White 20-30%	Not recorded	10-20 % 6-20 mm	Subangular blocky	Weak	Firm (dry)	Few (1-10) Very fine (<1 mm)	9.1	2.06	500-600
B23	800-1300		Clear	Medium Heavy Clay	7.5yr 5/4 Brown	No mottles	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Firm (dry)	No roots (0)	8.9	2.36	1000-1100
B2c	1300-1600			Light Medium Clay	7.5yr 5/2 Brown	No mottles	Not recorded	>90 % 20-60 mm	Apedal	Massive	Strong (dry)	No roots (0)	Not sampled	Not sampled	Not sampled

Other information: Bc or B2c contains large amounts of hard cemented areas with soil within. Could not ben sampled.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S07	Soil pit	759,617		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,448,662		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Sparse (10-30%)	2	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Lower slope	Firm	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Site of recent rain. Surcace rock cover 10% 10mm.

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	0-100		Clear	Clay Loam	7.5yr 5/6 Strong brown	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Moderate	Firm (moderately moist)	Common (10-25) Medium (2-5 mm)	7.2	0.04	0-100
B21	100-300		Gradual	Light Clay	7.5yr 6/3 Light brown	No mottles	Not recorded	20-50 % 6-20 mm	Subangular blocky	Strong	Weak (dry)	Common (10-25) Fine (1-2 mm)	9.0	0.82	150-250
B22	300-1000		Clear	Medium Clay	7.5yr 6/4 Light brown	White 15%	10-20 % Gypsum	20-50 % 6-20 mm	Subangular blocky	Moderate	Firm (dry)	Few (1-10) Fine (1-2 mm)	8.9	2.30	700-800
B3	1000-1500			Medium Clay	7.5yr 6/6 Reddish yellow	Red 40%	Not recorded	2-10 % 6-20 mm	Subangular blocky	Moderate	Very firm (dry)	No roots (0)	8.5	2.01	1200-1300

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S09	Soil pit	759,444		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,448,873		Sodosol

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
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Mid-slope	Firm	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Dominant Vegetation Photo 1

Dominant Vegetation Photo 2

Other Vegetation Photo

Other Information: Recently rained. Surface cover rocks 10% size 10mm.

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	0-100		Clear	Clay Loam, Sandy	7.5yr 4/6 Strong brown	No mottles	Not recorded	2-10 % 6-20 mm	Polyhedral	Weak	Firm (moderately moist)	Common (10-25) Medium (2-5 mm)	6.5	0.03	0-100
B	100-400		Clear	Medium Clay	7.5yr 4/3 Brown	No mottles	10-20 % Carbonates	20-50 % 20-60 mm	Subangular blocky	Strong	Firm (dry)	Common (10-25) Medium (2-5 mm)	8.5	1.20	200-300
B21	400-800		Clear	Medium Heavy Clay	7.5yr 5/4 Brown	White and grey 20%	Not recorded	20-50 % 20-60 mm	Subangular blocky	Weak	Firm (dry)	Common (10-25) Fine (1-2 mm)	9.0	1.96	600-700
B22	800-1000		Clear	Medium Clay	7.5yr 6/3 Light brown	Yellow 30%	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Firm (dry)	Few (1-10) Fine (1-2 mm)	8.5	1.92	850-950
B23	1000-1400			Medium Clay	7.5yr 7/3 Pink	Grey 30%	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Strong (dry)	No roots (0)	8.5	1.61	1100-1200

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S10	Soil pit	758,851		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Dense (>70%)		6,449,265		Kandosol

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
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Open depression	Firm	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Inspected during light rain. Surface rock cover 30% 20mm, vegetation debris cover 60%.

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	0-100		Clear	Sandy Loam	7.5yr 4/2 Brown	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Weak	Firm (moderately moist)	Many (25-200) Fine (1-2 mm)	5.1	0.04	0-100
B21	100-400		Gradual	Sandy Loam	7.5yr 6/4 Light brown	No mottles	Not recorded	10-20 % 6-20 mm	Polyhedral	Weak	Weak (moderately moist)	Common (10-25) Medium (2-5 mm)	4.6	0.06	300-400
B22	400-800		Gradual	Sandy Loam	7.5yr 6/3 Light brown	No mottles	Not recorded	50-90 % 20-60 mm	Subangular blocky	Weak	Firm (dry)	Common (10-25) Fine (1-2 mm)	4.7	0.29	700-800
B2c	800-1300		Clear	Sandy Clay Loam	7.5yr 7/2 Pinkish gray	Red 20%	Not recorded	50-90 % 6-20 mm	Subangular blocky	Weak	Strong (dry)	No roots (0)	6.1	0.45	1100-1200

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S12	Soil pit	759,522		Sodosol
Dominant Vegetation Form	Woody	**Ground Cover %**	Dense (>70%)	**Aspect**	**Northing/ Longitude** 6,449,874	**Scale**	**ASC Ground Truth** Sodosol
Secondary Vegetation Form	Non-woody	**Ground Cover %**	Sparse (10-30%)	**Slope %** 2	**Rock Outcrop** No rock outcrop	**Erosion Type**	None evident
Vegetation (species)					**Drainage (site)** Moderately well-drained	**Erosion Extent**	
Landform	Simple slope	**Soil Surface Condition (dry)**	Firm		**Land Use** Mining	**Erosion State**	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Inspected in wet conditions. Surface rock cover 20% 20mm.

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	0-100		Clear	Loam	7.5 4/3 Brown	No mottles	Not recorded	2-10 % 6-20 mm	Polyhedral	Moderate	Firm (moderately moist)	Many (25-200) Medium (2-5 mm)	7.8	0.15	0-100
B1	100-300		Clear	Light Medium Clay	7.5yr 4/4 Brown	No mottles	Not recorded	10-20 % 6-20 mm	Subangular blocky	Strong	Firm (moderately moist)	Common (10-25) Medium (2-5 mm)	9.5	2.14	200-300
B21	300-800		Gradual	Medium Clay	7.5yr 5/4 Brown	White 30%	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Firm (dry)	Few (1-10) Fine (1-2 mm)	9.3	2.12	600-700
B22	800-1300			Medium Clay	7.5yr 5/4 Brown	No mottles	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Strong (dry)	No roots (0)	9.3	2.17	1000-1100

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S13	Soil pit	758,912		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Dense (>70%)		6,450,053		Kandosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Sparse (10-30%)	2	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Simple slope	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Inspected in wet conditions. one side of the pit is in an old soil mound, minimal surface rock cover.

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	0-200		Clear	Clayey Sand	7.5yr 7/4 Pink	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Weak	Weak (dry)	Not recorded	5.5	0.04	0-100
B21	200-700		Gradual	Sandy Clay Loam	7.5 YR 7/6 Reddish yellow	No mottles	Not recorded	20-50 % 6-20 mm	Subangular blocky	Weak	Weak (dry)	Not recorded	5.5	0.08	400-500
B22	700-1200			Sandy Clay Loam	7.5YR 7/4 Pink	No mottles	Not recorded	10-20 % 6-20 mm	Subangular blocky	Weak	Firm (dry)	Not recorded	5.5	0.44	900-1000

Other information: Inspection interrupted by rain. Observations may be lacking. One profile contained an old soil mound (anthroposol layer) this profile was not inspected. The profile on the opposite side of the soil pit appeared to not contain any previously piled soils.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S15	Soil pit	757,790		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,447,598		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Very sparse (0.2-10%)	2	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Simple slope	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Inspected in wet conditions, rock surface cover 20% 20-40mm

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	0-100		Clear	Sandy Loam	7.5 7/4 Pink	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Moderate	Weak (dry)	Common (10-25) Medium (2-5 mm)	6.3	0.07	0-100
B21	100-350		Clear	Sandy Clay Loam	7.5 6/3 Light brown	No mottles	Not recorded	50-90 % 6-20 mm	Polyhedral	Moderate	Weak (dry)	Common (10-25) Medium (2-5 mm)	6.9	0.61	200-300
B2c	350-500		Clear	Sandy Clay Loam	7.5yr 7/4 Pink	No mottles	Not recorded	20-50 % 20-60 mm	Polyhedral	Weak	Weak (dry)	No roots (0)	7.1	1.02	400-500
C	500+		Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Not sampled

Other information: Hard lateritic layer encountered at 500mm.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S16	Soil pit	757,780		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Dense (>70%)		6,448,728		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Very sparse (0.2-10%)	2	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Open depression	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

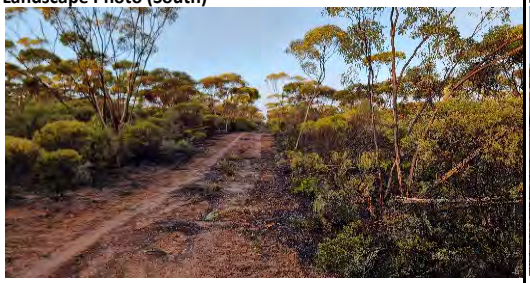
Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)



Landscape Photo (West)

Other Photo

Other20mm.formation: Site was dug the day before and it rained over night. Rock surface cover 10% 20mm

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	0-150		Gradual	Clay Loam	7.5yr 5/4 Brown	No mottles	Not recorded	2-10 % 6-20 mm	Polyhedral	Weak	Weak (dry)	Many (25-200) Medium (2-5 mm)	6.0	0.03	0-100
B1	150-350		Clear	Light Clay	7.5yr 7/6 Reddish yello	Red 5%	2-10 % Organic	10-20 % 20-60 mm	Subangular blocky	Moderate	Weak (dry)	Common (10-25) Medium (2-5 mm)	5.5	0.07	200-300
B21	350-550		Gradual	Light Clay	7.5yr 6/4 Light brown	No mottles	Not recorded	50-90 % 20-60 mm	Subangular blocky	Moderate	Weak (dry)	Few (1-10) Fine (1-2 mm)	6.0	0.07	400-500
B22	550-1100			Light Clay	2.5yr 5/6 Red	White and grey 20%	Not recorded	<2 % 6-20 mm	Subangular blocky	Moderate	Strong (dry)	No roots (0)	7.5	0.74	800-900

Other information: Structure hard to identify in wet conditions.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S17	Soil pit	757,799		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,448,493		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Very sparse (0.2-10%)	1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Simple slope	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Inspected in wet conditions. Surface rock cover 10-20% 50mm

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	0-150		Clear	Clayey Sand	5/4 yr Brown	No mottles	Not recorded		Angular blocky	Moderate	Firm (moderately moist)	Common (10-25) Medium (2-5 mm)	6.4	0.04	0-100
B1	150-400		Clear	Clayey Sand	7.5yr 7/2 Pinkish gray	No mottles	Not recorded	10-20 % 6-20 mm	Angular blocky	Moderate	Weak (moderately moist)	Common (10-25) Medium (2-5 mm)	8.7	0.84	200-300
B21	400-800		Gradual	Light Clay	7.5yr 7/2 Pinkish gray	No mottles	Not recorded	20-50 % 20-60 mm	Subangular blocky	Moderate	Firm (dry)	Few (1-10) Fine (1-2 mm)	9.3	1.52	600-700
B22	800-1200			Light Clay (sandy)	7.5yr 6/3 Light brown	Red 10%	Not recorded	20-50 % 20-60 mm	Subangular blocky	Moderate	Firm (dry)	No roots (0)	9.3	1.59	1000-1100

Other information: Inspected in poor rainy conditions. structure for the two clays is not certain but likely.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S18	Soil pit	757,778		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Dense (>70%)		6,448,962		Sodosol

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

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Simple slope	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Wet conditions, rained the night before. Surface rock cover 5% 2mm. Veg debris cover 40%

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	0-100		Clear	Clayey Sand	7.5yr 6/3 Light brown	No mottles	<2 % Carbonates	2-10 % 6-20 mm	Polyhedral	Weak	Weak (dry)	Common (10-25) Medium (2-5 mm)	6.4	0.02	0-100
B	100-350		Clear	Light Medium Clay (sandy)	7.5yr 6/2 Pinkish gray	No mottles	Not recorded	2-10 % 6-20 mm	Angular blocky	Moderate	Firm (moderately moist)	Common (10-25) Medium (2-5 mm)	5.9	0.45	200-300
B21	350-700		Gradual	Sandy Clay Loam	7.5yr 8/2 Pinkish white	No mottles	Not recorded	10-20 % 6-20 mm	Polyhedral	Weak	Firm (dry)	Few (1-10) Medium (2-5 mm)	8.5	0.37	500-600
B22	700-1050			Sandy Clay Loam	7.5yr 7/6 Reddish yellow	Red and grey 10%	Not recorded	20-50 % 6-20 mm	Angular blocky	Weak	Very firm (dry)	No roots (0)	8.7	0.63	800-900

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S19	Soil pit	757,787		Sodosol

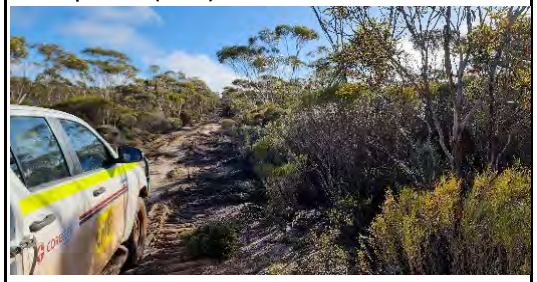
Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,449,628		Dermosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Very sparse (0.2-10%)	4	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Firm	Mining	

Landscape Photo (North)



Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Wet conditions. Surface rock cover 10^5 20-30mm.

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	0-100		Clear	Clayey Sand	7.5yr 6/2 Pinkish gray	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Moderate	Weak (moderately moist)	Many (25-200) Fine (1-2 mm)	6.0	0.04	0-50
B1	100-250		Clear	Clayey Sand	7.5yr 7/2 Pinkish gray	No mottles	Not recorded	2-10 % 2-6 mm	Subangular blocky	Weak	Firm (moderately moist)	Many (25-200) Medium (2-5 mm)	6.5	0.23	150-250
B21	250-600		Clear	Sandy Clay Loam	7.5yr 8/3 Pink	No mottles	Not recorded	10-20 % 6-20 mm	Subangular blocky	Moderate	Firm (moderately moist)	Common (10-25) Medium (2-5 mm)	6.5	0.36	400-500
B22	600-1200		Gradual	Light Clay (sandy)	7.5yr 6/6 Reddish yellow	Red 10%	Not recorded	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	Few (1-10) Medium (2-5 mm)	8.0	0.92	900-1000
B23	1200-1400			Light Clay	7.5yr 646 Reddish yellow	Red 10%	Not recorded	2-10 % 2-6 mm	Subangular blocky	Moderate	Firm (dry)	No roots (0)	Not sampled	Not sampled	Not sampled

Other information: Rain impacted and poor quality profile. B23 not sampled.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	26/6/23	M.White	S20	Soil pit	757,766		Sodosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Mid-dense (30-70%)		6,450,093		Kandosol

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

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Crest	Firm	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

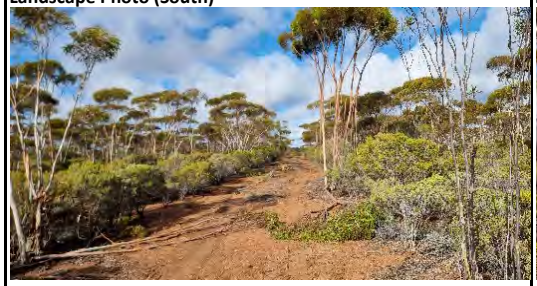
Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)



Landscape Photo (West)

Other Photo

Other Information: Inspected in post rain conditions. Surface rock cover 40-50% 10-30mm.

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	0-100		Clear	Sandy Clay Loam	5yr 4/4 Reddish brown	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Moderate	Weak (dry)	Common (10-25) Fine (1-2 mm)	6.5	0.02	0-50
B21	100-250		Clear	Light Medium Clay	5yr 4/4 Reddish brown	No mottles	2-10 % Organic	10-20 % 6-20 mm	Subangular blocky	Strong	Firm (dry)	Common (10-25) Medium (2-5 mm)	8.5	0.30	150-250
B22	250-600		Clear	Medium Clay	7.5yr 7/6 Reddish yellow	No mottles	2-10 % Organic	20-50 % 20-60 mm	Angular blocky	Moderate	Weak (dry)	Few (1-10) Fine (1-2 mm)	8.5	0.59	400-500
B23	600-1200			Clay Loam, Sandy	7.5yr 7/6 Reddish yellow	Red 30%	Not recorded	2-10 % 6-20 mm	Subangular blocky	Weak	Strong (dry)	No roots (0)	8.5	0.57	800-900

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	27/6/23	M.White	S22	Soil pit	756,341		Rudosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Dense (>70%)		6,447,344		Sodosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Very sparse (0.2-10%)	1	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Flat	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Surface rock cover 5% 10mm.

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	0-150		Clear	Clay Loam, Sandy	5yr 5/6 Yellowish red	No mottles	Not recorded	<2 % 6-20 mm	Subangular blocky	Moderate	Weak (dry)	Common (10-25) Medium (2-5 mm)	6.8	0.17	0-100
B21	150-500		Gradual	Medium Heavy Clay	7.5yr 6/3 Light brown	No mottles	2-10 % Gypsum	20-50 % 200-600 mm	Subangular blocky	Strong	Weak (dry)	Common (10-25) Medium (2-5 mm)	9.4	1.68	300-400
B22	500-900		Clear	Medium Clay (sandy)	7.5yr 6/6 Reddish yellow	No mottles	Not recorded	20-50 % 20-60 mm	Subangular blocky	Weak	Firm (dry)	No roots (0)	8.9	1.47	650-750
B23	900-1400			Medium Clay	7.5yr 7/3 Pink	Red 10%	Not recorded	<2 % 2-6 mm	Angular blocky	Strong	Strong (dry)	No roots (0)	8.7	0.72	1100-1200

Other information: Coarse fragments in B21 range from 20-400 mm in diameter.

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	27/6/23	M.White	S23	Soil pit	755,991		Rudosol

Dominant Vegetation Form	Ground Cover %	Aspect	Northing/ Longitude	Scale	ASC Ground Truth
Woody	Dense (>70%)		6,447,337		Sodosol

Secondary Vegetation Form	Ground Cover %	Slope %	Rock Outcrop	Erosion Type
Non-woody	Very sparse (0.2-10%)	2	No rock outcrop	None evident

Vegetation (species)	Drainage (site)	Erosion Extent
	Moderately well-drained	

Landform	Soil Surface Condition (dry)	Land Use	Erosion State
Open depression	Soft	Mining	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Surface rock cover 5% 2mm.

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	0-100		Clear	Clayey Sand	7.5yr 5⁴3 Brown	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Weak	Weak (dry)	Common (10-25) Medium (2-5 mm)	7.0	0.35	0-50
B1	100-350		Clear	Clayey Sand	7.5yr 7/3 Pink	No mottles	Not recorded	2-10 % 2-6 mm	Angular blocky	Weak	Weak (dry)	Common (10-25) Medium (2-5 mm)	7.0	0.12	200-300
B21	350-700		Clear	Medium Clay	5y 7⁴2 Pinkish gray	No mottles	Not recorded	2-10 % 6-20 mm	Subangular blocky	Moderate	Firm (dry)	Few (1-10) Fine (1-2 mm)	8.5	1.43	500-600
B22	700-1350		Clear	Medium Clay	10yr 8/3 Very pale brown	Pinkish grey 20%	Not recorded	2-10 % 6-20 mm	Angular blocky	Moderate	Firm (dry)	No roots (0)	8.5	1.61	900-1000
B23	1350-1500			Heavy Clay	10yr 7/3 Very pale brown	No mottles	Not recorded	<2 % 6-20 mm	Apedal	Massive	Strong (dry)	No roots (0)	8.0	0.88	1400-1500

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	27/6/23	M.White	S24	Soil pit	755,786		Rudosol
Dominant Vegetation Form	Woody	**Ground Cover %**	Dense (>70%)	**Aspect**	**Northing/ Longitude** 6,447,767	**Scale**	**ASC Ground Truth** Kandosol
Secondary Vegetation Form	Non-woody	**Ground Cover %**	Very sparse (0.2-10%)	**Slope %** 1	**Rock Outcrop** No rock outcrop	**Erosion Type**	None evident
Vegetation (species)					**Drainage (site)** Moderately well-drained	**Erosion Extent**	
Landform	Simple slope	**Soil Surface Condition (dry)**	Soft		**Land Use** Mining	**Erosion State**	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Landscape Photo (South)

Landscape Photo (West)

Other Photo

Other Information: Surface rock cover 10-20% 20mm.

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	0-150		Clear	Sandy Clay Loam	7.5yr 7/3 Pink	No mottles	Not recorded	2-10 % 6-20 mm	Polyhedral	Weak	Weak (dry)	Common (10-25) Medium (2-5 mm)	6.5	0.02	0-100
B21	150-900		Gradual	Sandy Clay Loam	7.5yr 7/4 Pink	No mottles	Not recorded	50-90 % 20-60 mm	Apedal	Single grain	Weak (dry)	Common (10-25) Fine (1-2 mm)	5.5	0.03	500-600
B2c	900-1250			Sandy Clay Loam	7.5yr 7/6 Reddish yellow	Red 20%	Not recorded	20-50 % 6-20 mm	Angular blocky	Moderate	Very firm (dry)	No roots (0)	6.0	0.03	1000-1100

Other information:

Soil Profile Description

Project	Date	Scribe	Location	Observation	Easting/ Latitude	Zone	ASC Mapped
	27/6/23	M.White	S26	Soil pit	756,117		Rudosol
Dominant Vegetation Form	Woody	**Ground Cover %**	Dense (>70%)	**Aspect**	**Northing/ Longitude** 6,448,125	**Scale**	**ASC Ground Truth** Dermosol
Secondary Vegetation Form	Non-woody	**Ground Cover %**	Very sparse (0.2-10%)	**Slope %** 1	**Rock Outcrop** No rock outcrop	**Erosion Type**	None evident
Vegetation (species)					**Drainage (site)** Moderately well-drained	**Erosion Extent**	
Landform	Flat	**Soil Surface Condition (dry)**	Soft		**Land Use** Mining	**Erosion State**	

Landscape Photo (North)

Landscape Photo (East)

Soil Surface Condition Photo

Site Type

Detailed + Sampled for Lab

Microrelief

Type

Vertical (m)

Horizontal (m)

Sampled

Other Information: Surface rock cover 60% 10-20mm.

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	0-150		Clear	Clayey Sand	7.5yr 5/4 Brown	No mottles	Not recorded	2-10 % 2-6 mm	Polyhedral	Weak	Weak (dry)	Common (10-25) Medium (2-5 mm)	5.8	0.01	0-100
B1	150-400		Clear	Clayey Sand	7.5yr 7/8 Reddish yellow	No mottles	Not recorded	50-90 % 20-60 mm	Angular blocky	Moderate	Firm (dry)	Common (10-25) Medium (2-5 mm)	4.6	0.02	200-300
B21	400-750		Clear	Sandy Clay Loam	7.5yr 7/6 Reddish yellow	No mottles	Not recorded	20-50 % 6-20 mm	Angular blocky	Moderate	Firm (dry)	Few (1-10) Fine (1-2 mm)	4.7	0.02	500-600
B22	750-1000			Sandy Clay Loam	7.5yr 8/4 Pink	Red 10%	Not recorded	<2 %	Apedal	Massive	Strong (dry)	No roots (0)	4.4	0.04	900-1000

Other information: