Appendix 7

Land and Soil Capability Assessment

prepared by

Sustainable Soils Management Pty Ltd

(Total No. of pages including blank pages = 285)

RZ RESOURCES

Copi Mineral Sands Project

Land and Soil Capability Assessment

Prepared by
SUSTAINABLE SOILS MANAGEMENT PTY LTD

January, 2024

Mineral Sands Project

Land and Soil Capability Assessment

Prepared for:		
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Document Control Statement

Version	Description
1.0	P Hulme, June, 2022. Footprint 14,180 ha. Sections 1 to 8 and 11
1.1	P Hulme, December, 2022. Sections 9 and 10 after received updated mine layout
1.2	P Hulme, January, 2023. Incorporate RW Corkery comments
1.3	P Hulme, March, 2023. Incorporate modified mine layout and extended Mine Site boundary
2.0	P Hulme, December, 2023. Footprint 16,197 ha.
2.1	P Hulme, January, 2024. Incorporate RW Corkery and RZ Resources comments
2.2	P Hulme, March, 2024. Update project description, disturbance footprint, figures supplied by RW Corkery

SUMMARY

Soil properties were assessed over a Soil Study Area covering 16,197 ha of Copi Mineral Sands Soil Study Area. The two major landforms in the Soil Study Area are elevated Dunefields and Sand Plains, and 2 relict lakes with a mixture of soil types.

The soil is sandy throughout, with large variation in the subsoil concentration of anions of carbonate, sulphate and chloride. The dominant anion varies with landform. Carbonate dominates anions in the dunefields and sand plains, chloride and sulphate are common the relict lake floors, and carbonate and sulphate are common in lunettes around the relict lakes. Salinity generally increases with depth from low concentration in the surface 20 to 30 cm with the exception of the Lake Floor East Association, which is saline from the surface.

The Soil Study Area was divided into 6 Soil Associations. The Dunefields and Sand Plains Association, covering 41% of the Soil Study Area are typical of surrounding land, and was rich in carbonate, alkaline and had low salinity (Table S1). The Dunefields and Sand Plains Association was divided into a dunes phase with slightly deeper and sandier topsoil and lower salinity that the swales phase. The remaining 5 Soil Associations were in or near the relict lakes and had a range of soil properties that varied with position in the landscape and depth to groundwater.

Table S1. Summary of soil properties in Soil Study Area

Association	Area (ha)	pH_{H2O} trend	Carbonate trend	Sulphate trend	Salinity trend
Dunefields and Sand Plains-Swales	5,322	Above 8	Increase from 4% to 18%	Very Low	Low
Dunefields and Sand Plains-Dunes	1,266	Above 8	Increase from 4% to 19%	Very Low	Low
Blanchetown	1,570	Around 9	Average around 9%, but variable	Low to 30 cm, then high	Low to 60 cm, then limiting
Lunettes	2,195	Increase from 8.7 to 9.3	Increase from 4% to 10%	Moderate, increase with depth	Low
Lunettes with Copi	2,415	Around 8.5	Increase from 4% to 98%	Moderate to high	Low to 30 cm, then high
Lake Floor East	1,921	Around 8.3	Low throughout	High throughout	Toxic to most plants
Lake Floor West	1,507	Increase from 7.7 to 8.3	Low throughout	Low to 60 cm, then moderate	Low to 30 cm, then limiting

The land was rated as having high limitations for high impact uses. 79% of the Soil Study Area was rated as Land and Soil Capability (LSC) class 6, with the

remainder split evenly between LSC classes 7 and 8. Susceptibility of the sandy topsoil to wind erosion was the dominant factor limiting Land and Soil capability of LSC class 6 land while salinity limited the capability of LSC class 7 and 8 land. This LSC rating means that the current landuse of grazing of native grasses and shrubs is consistent with the capacity of the soil to withstand disturbance.

A desktop assessment and field testing of soil from 7 sites in and around the relict lakes did not detect Acid Sulphate or Potential Acid Sulphate Soil. The area with potential to contain acid sulphate soil was very strongly saline, and salinity was judged to be a greater hazard at this site than acid sulphate soil.

The Project plans to extract and process ore using dredges and a floating concentration plant from a 3,009 ha area using a continuous mining process. An Off Path Storage Facility, Water Storage Dam and Soil Borrow Area would cover 644 ha, soil stockpile area would cover 215 ha, infrastructure of concentration plant, office, workshop, camps, and power generation would cover 96 ha. Permission is sought to disturb an additional 1,664 ha to give a total Disturbance Area of 5,628 ha.

The major impacts of the Project on soil resources will be clearing of land for roads and infrastructure and excavation of the mine. Land cleared for internal roads and infrastructure will have soil profiles rebuilt, then vegetation re-established at mine closure. Rehabilitation of the mine pit will occur during the mine life as the mine pit progresses through the Mine Disturbance Area.

There is potential to rehabilitate the vast majority of the Mine Disturbance Area to the existing Land and Soil Capability or higher, with a planned increase in the area of LSC class 6 land of 413 ha and reduction of 455 of the area of LSC class 8. Although an overall soil balance indicates that there is adequate soil for this rehabilitation, the large scale and plan to progressively rehabilitate the mine footprint over the 20 year life of the mine means that this soil may not be available when or where it is required. Consequently, an annual soil balance should be developed before the start of mining and updated during the mine's life.

The impact of the Project on agricultural production was estimated as potential gross margin from the 3,788 ha of LSC class 6 land to be disturbed. This would be 3,788 ha * 0.31 DSE/ha * $43/DSE or approximately $50,494/year in the disturbance area. It is planned to rehabilitate disturbed land to return productive potential to be close to the pre-mining potential, but it is planned to use the land for grazing by native animals.

Note that LSC classes 7 and 8 land was regarded as yielding minimal forage for grazing, so was excluded from the estimate of agricultural production.

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1. INTRODUCTION

1.1. OVERVIEW

RZ Resources Ltd ("the Applicant"), is seeking State Significant Development Consent for the Copi Mineral Sands Project ("the Project"). The Project would comprise a dredging operation, mineral concentration plant, Mine Camp, Site Access Road and associated infrastructure. The Project Site is located approximately 75 km northwest of Wentworth in the Far West Region of NSW within the Wentworth Local Government Area (LGA) (Figure 1.1).

Each year, the Project would extract up to approximately 76 million tonnes (Mt) of overburden and interburden and 227.7 Mt of ore to produce up to 500,000 tonnes/year of heavy mineral concentrate containing Rutile, Zircon, Leucoxene, Ilmenite, Monazite and Xenotime from a mineral resource of approximately 2,540 Mt of heavy mineral sand (Table 1.1). The heavy mineral sand will be mined by dredges floating on a dredge pond that would move progressively along the mine path. Land would be progressively stripped of soil, mined, back filled and shaped and soil spread and rehabilitated throughout the life of the Mine. The heavy mineral concentrate will be separated from the heavy mineral sands by a floating concentration plant and trucked to Broken Hill to be loaded on rail carriages or transported by road. The Project will have a workforce of up to approximately 480 persons during construction and 240 during operations and would operate for a period of 26 years, comprising approximately 2 years construction, 17 years mining. This would be followed by approximately 7 years rehabilitation. The Extraction Area would cover an area of approximately 2,431 ha within a total disturbance footprint of 5,622 ha.

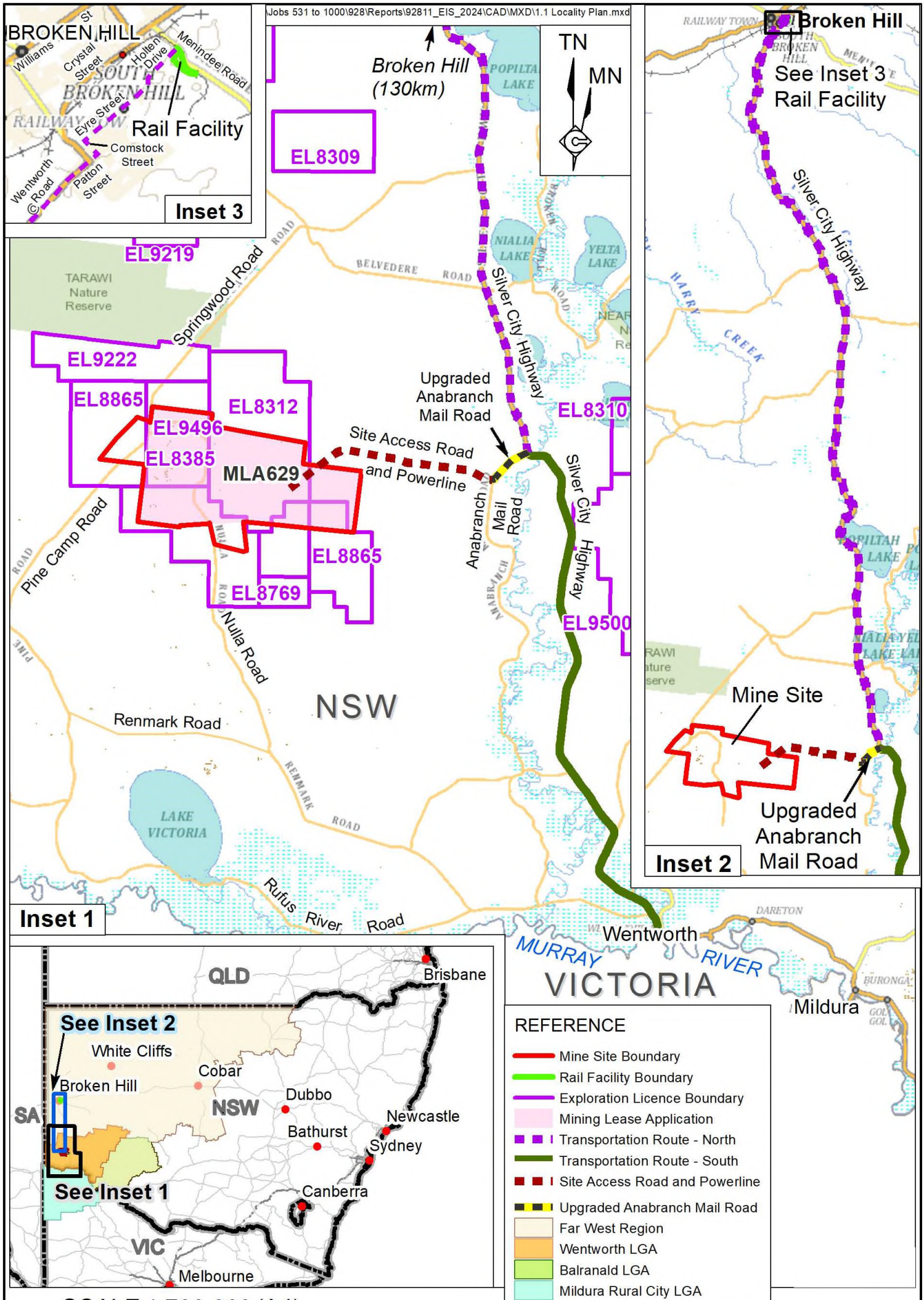

Figure 1.1. Locality Plan

Table 1.1. Project Overview

Project Element	Summary of the Project
Mining Method	• Dredge mining from an Extraction Area approximately 17km long and up to approximately 3.3km wide. • Mining would commence with a starter pond at the at the southwestern extent of the deposit. The starter pond would be extracted using conventional free dig, load and haul mining techniques. Extracted overburden, namely material located above the water table with no heavy mineral, would be used to construct infrastructure within the Mine Site or stockpiled for later use during rehabilitation operations. • Following establishment of the starter pond, the dredges would be installed, followed by the floating Wet Concentration Plant. • Interburden, namely material located below the water table with uneconomic heavy mineral, would be extracted using floating dredges. Interburden would initially be transferred to the Off Path Storage Facility. Once the dredge pond has achieved its full operational size, extracted interburden would be used to backfill completed sections of the Extraction Area. • Ore, namely material with sufficient heavy mineral to justify processing, would be extracted using a floating dredge. The ore would be transferred to the floating Wet Concentration Plant for processing. • Reject from the Wet Concentration Plant would initially be transferred to the Off Path Storage Facility. Once the dredge pond has achieved its full operational size, reject would be combined with the extracted interburden to backfill completed sections of the Extraction Area. • The placed reject and interburden would be covered by overburden and soil before being rehabilitated.
Mineral Resource	• Heavy mineral sand deposit approximately 23km long and up to 5km wide. • Indicated and Inferred JORC-compliant resource (September 2023) – 2.54Mt at 1.2% heavy mineral comprising ilmenite, leucoxene, rutile, zircon, monazite and xenotime.
Annual Production	• Ore ..... up to approximately 27.7Mtpa • Interburden..... up to approximately 48.0Mtpa • Overburden ..... up to approximately 28.2Mtpa
Mine Life	• Project life ..... approximately 26 years, comprising – Construction ..... approximately 2 years – Mining ..... approximately 17 years – Post-mining Rehabilitation..... approximately 7 years post mining Note: Construction and mining operations would be partially undertaken concurrently
Total Resource Recovered	• Ore mined ..... up to 406.4Mt
Disturbance Area	• Mine Site ..... approximately 5,622ha • Rail Facility..... approximately 3.0ha (all existing disturbance, nil additional)

Table 3.1.1 (Cont'd)
Project Overview

Project Element	Summary of the Project
Processing	• Processing operations would involve the following. – Wet screening and gravity separation of up to approximately 27.7Mtpa of ore within the Wet Concentration Plant. – Dewatering and transfer of the Heavy Mineral Concentrate to the Rare Earth Concentrate Plant. – Washing, drying and separation within the Rare Earth Concentrate Plant to produce up to 511,000tpa of the following. o A primary and secondary ilmenite product. o A monazite product. o A non-magnetic concentrate.
Management of Mining Waste	• Overburden – Extracted using dry mining techniques. – Initially used to construct infrastructure within the Mine Site or stockpiled for later use, after which it would be transferred directly to completed sections of the Extraction Area to reestablish the final landform. • Oversize – Screened and transferred directly to completed sections of the Extraction Area. • Interburden and Wet Concentration Plant reject and slimes – Initially transferred to the Off Path Storage Facility. Once the dredge pond has achieved its full operational size, reject would be combined with the extracted interburden to backfill completed sections of the Extraction Area. • Rare Earth Concentrate Plant reject. – Placed within completed sections of the Extraction Area. • General wastes and recyclables – Collected from site and transferred to a licenced waste management facility.
Transportation Operations	• Internal transportation – Mine Site Access Road (approximately 27km) – would be constructed from the realigned Anabranch Mail Road to the Infrastructure Area. – Other light and heavy vehicle internal roads would be constructed within the proposed area of disturbance and would be relocated as required. • Transportation routes. – Realigned Anabranch Mail Road (approximately 6.1km) – from the Site Access Road to the Silver City Highway – Transportation Route - North (to Broken Hill) – Silver City Highway, Patton, Comstock and Eyre Streets and Holton Drive. – Transportation Route - South (to Wentworth) – Silver City Highway. – Other routes – use of other routes would be prohibited for Applicant-controlled vehicles and discouraged for all other vehicles. • Public road upgrades to accommodate Project generated traffic. – Realigned and upgraded section of Anabranch Mail Road from the intersection with the Mine Site Access Road to the Silver City Highway (approximately 6.1km). – Upgraded intersection of Anabranch Mail Road and the Silver City Highway. – Upgraded intersection of Patton and Comstock Streets. – Upgraded intersection of Comstock and Eyre Streets. – Upgraded intersection of Holten Drive and the Rail Facility Access Road.

Table 3.1.1 (Cont'd)
Project Overview

Project Element	Summary of the Project
Transportation Operations (Cont'd)	• Public road closure and realignment – Nulla Road between the "Huntingfield" homestead and the "Wenba" Station access road would be closed indicatively during Years 11, 12 and 13 when the Project would mine through the road. – The road would be reinstated in a realigned location as soon as practicable once mining has progressed through that section of the road. • Product/concentrate transportation – Route ..... via Transport Route North to the Rail Facility – Vehicle type..... AB-triple (Type 1) or AB-quad (Type 2) road trains – Material classification (under Australian Code for the Transport of Dangerous Goods by Road & Rail) o Ilmenite products and non-magnetic concentrate ..... Not classified o Monazite product .....Class 7 (Radioactive Material) – Traffic level o AB-triple (Type 1) road trains ..... up to 16 laden movements per day o AB-quad (Type 2) road trains..... up to 12 laden movements per day – Onward transportation from Broken Hill (under separate approval) o Ilmenite product and non-magnetic concentrate.....by rail o Monazite product ..... by road or rail Note: AB-quad road trains would be used only once the required road permits have been obtained • All other deliveries/consumables – Route o Transport Route South ..... approximately 90% of movements o Transportation Route North ..... approximately 10% of movements – Vehicle type.....up to B-double – Traffic level.....up to 11 laden movements per day
General Infrastructure	On-site infrastructure not addressed above would include the following. • Mine Camp associated infrastructure for up to 220 personnel. • A 66kV transmission line from the 220kV Buronga to Broken Hill transmission line. The transmission line would be located adjacent to the Mine Site Access Road. • Solar Farm and associated infrastructure. • A power station comprising modular, silenced, diesel generators and associated infrastructure for use during construction and for emergency power requirement during operations. • Offices and Administration Area. • Workshops, Stores and Laydown Areas.
Power	• Power for the Project would be provided by a combination of: – diesel generated power during construction operations; – solar power from an approximately 35MW solar farm (if required); and – mains power sourced via the above 66kV powerline. • Power distribution infrastructure, including substations and overhead, buried and floating transmissions lines. • A minimum 30% of the Project's power would be sourced from renewable sources, including the onsite solar farm and/or externally contracted and certified renewable sources.
Water Management	• Groundwater within the target Loxton Parilla Sands is highly saline, with limited to no beneficial use..

Table 3.1.1 (Cont'd)
Project Overview

Project Element	**Summary of the Project**		
Water Management (Cont'd)	• Dredging operations would be reliant on groundwater inflows to the Extraction Area to form the pond upon which the dredges and Wet Concentration Plant would be floated • Production bores would be installed within the Loxton-Parilla Sands to provide water for initial construction operations and feed for one or more reverse osmosis plants. – Treated water would be used for camp amenities, concentrate washing, dust suppression (in conjunction with polymer-based dust suppressants) and other purposes as required. – Brine from the reverse osmosis plant would initially be placed within a pond within the Extraction Area footprint, after which it would be transferred to the dredge pond. • Production bores and the Water Storage Dam would be used to manage the water level within the Starter Pond to allow construction and floating of the dredges and Wet Concentration Plant. • Sediment laden (dirty) water would be retained on site and used for mining-related purposes. • Water from undisturbed sections of the Mine Site (clean water) would be prevented from entering disturbed sections of the Mine Site. Where clean water accumulates adjacent to the clean water exclusion bunds, that water would be used for mining-related purposes.		
Workforce	• Construction..... up to approximately 480 persons • Operations..... up to approximately 240 persons • Rehabilitation..... up to approximately 40 persons Note: Work and fatigue management rosters would result in not all personnel being on site at the same time		
Hours of Operation	**Activity**	**Proposed Days of Operation**	**Proposed Hours of Operation**
	Land preparation	7 days per week	7:00am to 6:00pm
	Construction operations • Road construction within Broken Hill LGA • All other construction	 7 days per week 7 days per week	 7:00am to 10:00pm 24 hours per day
	Mining operations	7 days per week	24 hours per day
	Processing operations	7 days per week	24 hours per day
	Transportation operations • Mine product transportation within Broken Hill LGA • All other transportation	 7 days per week 7 days per week	 7:00am to 10:00pm 24 hours per day
	Maintenance operations	7 days per week	24 hours per day
	Rehabilitation operations	7 days per week	7:00am to 10:00pm
Capital Investment Value	A$638.9 million		
Final Landform	• All infrastructure not required for the final land use removed or reduced in size. • A backfilled, shaped and revegetated Extraction Area with no final void. • Realigned Nulla Road. • Upgraded public infrastructure retained for public use.		
Final Land Use	• Native ecosystem, with active investigation of alternative post-mining land uses, including renewable energy generation.		
Rehabilitation	• Rehabilitation would occur progressively throughout the life of the Project, with the Extraction Area progressively backfilled, shaped and rehabilitated.		

1.2. PURPOSE OF THIS REPORT

This report has been prepared to address government agency assessment requirements relating to soil and land resources for the Soil Study Area and so provides the following information:

- A description and map of soil associations (Section 6).
- Determine whether Acid Sulphate Soil is present within the surface metre (Section 7).
- An assessment and map of land and soil capability classes (Section 8).
- A summary of the areas of soil that will be disturbed by the Project and the proposed soil and land capability during the life of the Project and after soil rehabilitation (Section 9).
- A summary of the soil management practises to rehabilitate the soil to the proposed land and soil capability (Section 10).
- An assessment of the potential agricultural impact of the Project (Section 11).

1.3. ASSESSMENT GUIDELINES AND CRITERIA

1.3.1. Secretary's Environmental Assessment Requirements

Environmental Assessment Requirements (EARs) for the Project were issued by the Department of Planning and Environment (DPE) on 20 May 2022 and were reissued on 18 December 2022 with no changes to the Land and Soil requirements. The EARs identify matters which must be addressed in the EIS and essentially form its terms of reference. Table 1.2 lists individual EARs relevant to this report and where they are addressed in this report.

Table 1.2. Soil and land related EARs addressed in this report (Paraphrased and forwarded to SSM on 20/12/2023).

Relevant Requirement		Relevant Section(s)
Secretary's Environmental Assessment Requirements		
Land and Soil		
• an assessment of the likely impacts of the development on the soils and land capability of the site and surrounds, and a description of the mitigation and management measures to prevent, control or minimise impacts of the development and to inform progressive rehabilitation;		9
• an assessment of the likely impacts of the development on agriculture, including measures to manage biosecurity matters including spread of weeds;		10
• the likely impact of the development on landforms (topography), including the long-term geotechnical stability of any new landforms on site; and		RZ
• the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements of Part 2.3 of *State Environmental Planning (Resources and Energy) 2021*, paying particular attention to the agricultural land use in the region;		11
• consideration of potential land contamination consistent with the requirements of Chapter 4 Remediation of Land of the *State Environment Planning Policy (Resilience and Hazards) 2021*;		RZ
Other Government Agencies		
Land Resources		
Department of Primary Industries – Agriculture 02/05/2022	Land and soil assessment to inform the progressive rehabilitation of the project area.	2 to 8, 10
	Assessment of agricultural impacts from the development on current and future agriculture.	11
	Identification and management of biosecurity matters, e.g. measures to prevent the introduction and spread of weeds that could impact on grazing systems during construction, operation and rehabilitation.	10
NSW Environment Protection Authority 04/05/2022	The following potential environmental impacts of the Project need to be assessed, quantified and reported on. (d) Land; The Environmental Assessment (EA) should address how the required environmental goals outlined below will be met for each potential impact. The EA should describe mitigation and management options that will be used to prevent, control, abate or mitigate identified potential environmental impacts associated with the Project and to reduce risks to human health and prevent the degradation of the environment.	
	Potential impacts on land The goals of the Project should include the following. • No pollution of land, except to the extent authorised by the EPA (i.e. in accordance with an Environment Protection Licence);	RZ
	• The potential impact of land erosion from the development is mitigated;	10

Relevant Requirement		Relevant Section(s)
	• That landscapes impacted by mining activities and vehicle movements are appropriately monitored and managed in accordance with relevant EPA guidelines.	RZ
	The EA should document the measures that will achieve the above goals and should include the proposed rehabilitation measures that will be implemented to restore the mining pathway.	10

1.3.2. Guidelines

The assessment was conducted following guidelines in:

- Australian Soil and Land Survey Handbook (NCST, 2009)
- Guidelines for Surveying Soil and Land Resources (McKenzie *et al.*, 2008)
- The land and soil capability assessment scheme: second approximation (OEH, 2012)
- Primefact 1063: Infrastructure proposals on rural land (Kovac and Briggs, 2013)

1.4. TERMINOLOGY

The following terminology is used in this assessment.

- **Applicant** - RZ Resources Ltd.
- **Mine Site** – A 32,840 ha area as shown in Figure 1.2.
- **The Project** incorporates all activities undertaken on the Mine Site.
- **Limit of Disturbance** – A 5,622 ha area that represents the maximum area within the Mine Site that is planned to be disturbed by the Extraction Area and associated infrastructure, including: the Extraction Area, Mine Office and Workshop, Mine Camp, Power Station, Solar Farm, and stockpiles for soil and reject.
- **Soil Study Area** – a 16,197 ha area that is largely, but not completely within the Mine Site and includes the whole of the Limit of Disturbance (Figure 1.1).
- **Relict Lake** – a lake that represents a remnant resulting from a partial extinction of the original body of water.
- **Overburden** - material from above the existing water table with insufficient heavy mineral to justifying processing.
- **Interburden** - material from below the existing water table with insufficient heavy mineral to justifying processing.
- **Reject** - material from which heavy mineral has been removed.
- **Starter Pond** – Initial mining void constructed to float dredges that would be subsequently used for continuous mining.
- **Off Path Storage Facility** – Emplacement to store interburden, overburden and reject from the starter pond.

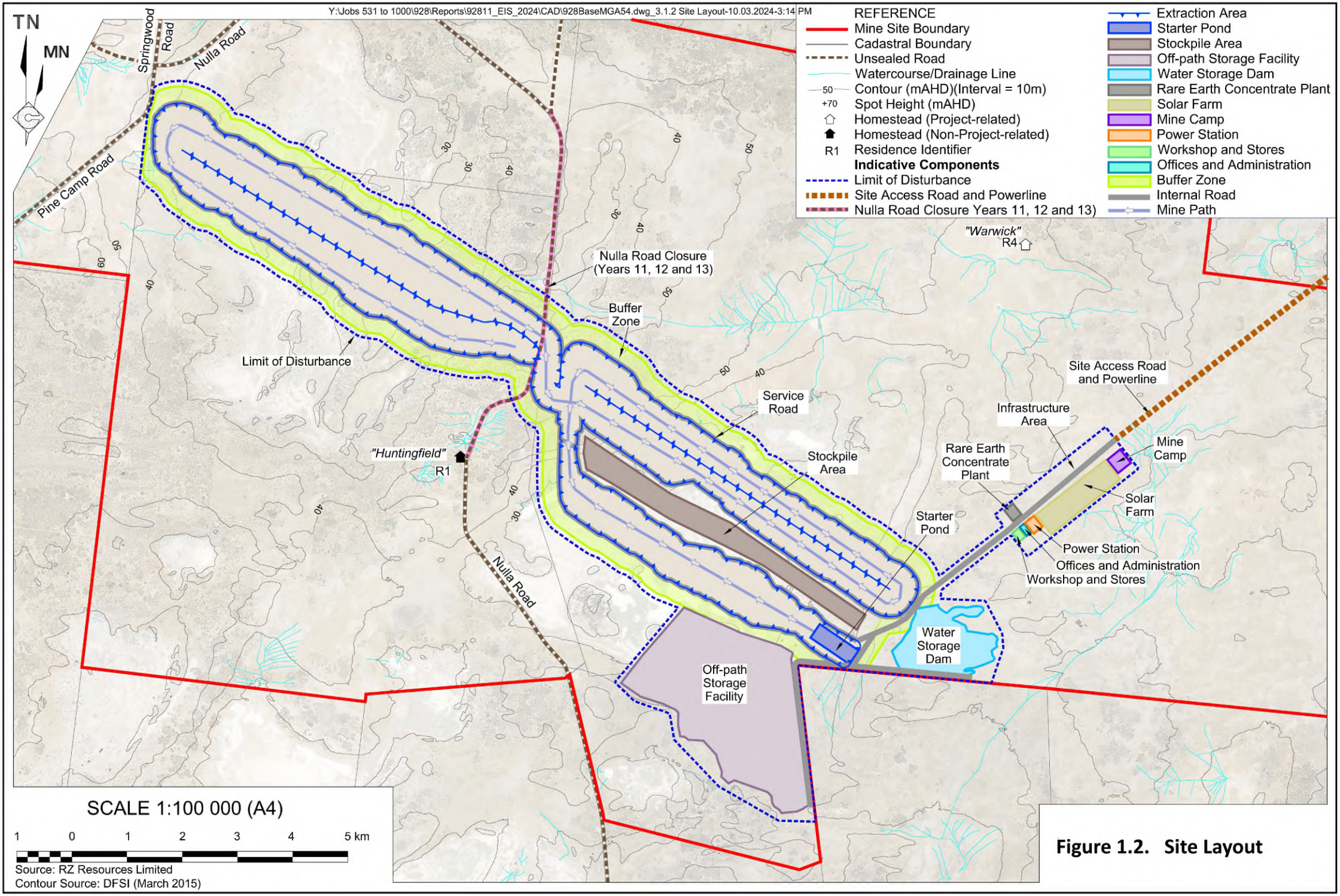

Figure 1.2. Site Layout

2. LAND AND SOIL CAPABILITY ASSESSMENT METHODS

2.1. LOCATION OF SOIL STUDY AREA

The Soil Study Area covers 16,197 ha (Figure 2.1) and consists of a 14,180 ha 2021 Soil Study Area and a 2,017 ha 2023 extension. The 2021 Soil Study Area boundary was supplied to Sustainable Soil Management by R.W. Corkery & Co Pty Limited (RWC) in October, 2021. The 2023 extension was generated by Sustainable Soil Management from a Disturbance Boundary supplied by RWC in November, 2023, and approved by the Applicant on 6/11/2023. The 2023 extension included the Infrastructure Area in Figure 1.2, and the whole of the Mine Site in the southern zone containing the Off Path Storage Facility. The Site Access Road and powerline were not included in the Soil Study Area. The soil assessment described in this report is based on this boundary and an electromagnetic (EM) and gamma survey conducted from January to April, 2022, and in December, 2023, and soil sampling conducted in April and May, 2022, and November, 2023.

2.2. OVERVIEW OF ASSESSMENT PROCESS

The soil and landscape assessment was undertaken as a stratigraphic survey (Hewitt *et al.*, 2008) in 2 stages. A stratigraphic soil survey is one in which properties at each location are assumed to be correlated to some extent with the position in the landscape and broad scale variables such as geology and slope. Soil properties between each site observed are then expected to vary with covariates such as slope, soil colour or geology, and these covariates are then used to map soil type boundaries.

The following steps were undertaken to complete the land capability and soil assessment for this report:

- A desktop review and assessment of existing information relating to soils and landforms in the Soil Study Area (Section 3).
- A proximal survey of electromagnetic induction (EM) and gamma radiometrics at 50 m to 200 m transect spacings, supplemented by additional transects parallel to and either side of significant landform features (Section 4).
- Digital soil maps of depth to critical carbonate, chloride, sulphate and texture values (Section 5).
- A soil survey that consisted of field description of soil properties and laboratory analysis to assess the range and distribution of soil properties across the Soil Study Area as Soil Associations (Section 6).
- A preliminary assessment of the extent of Acid Sulphate Soil was conducted in and around the relict lakes (Section 7).
- Use of a subset of results from the soil survey to assess Land and Soil Capability across the Soil Study Area (Section 8).
- Combine mapped soil properties with disturbance footprint and description of disturbance provided by the Applicant to estimate impact of the Project on Land Soil Capability within the Disturbance Area (Section 9).

- Use of a subset of results from the soil survey to provide soil management and mitigation measures (Section 10).
- Use of soil type distribution and land and soil capability and assess the impact of the Project on agricultural soil resources (Section 11).

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SUNSHINE
BELMORE
NULLA ROAD
WARWICK
HUNTINGFIELD
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W
E
S

Copi Mineral Sands Project

W e n t w o r t h

Aerial Image and Hillshade

Mine Site Boundary
Homestead
Road
2023 Soil Study Area
2021 Soil Study Area
2020 Soil Study Area

Property
Belmore
Huntingfield
Nulla
Warwick
Road Reserve

0 1 2 3 4
kilometres
1 cm = 0.7 km on A3

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr497
Map Printed: 2023
Contact: Sustainable Soils Mar
Phone : (02) 68 473367
Barest Earth Aerial Image: GeoscienceAustralia
Hillshade: From NSW Spatial Services DEM

Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 2.1

2.3. DESKTOP ASSESSMENT

The desktop assessment reviewed a range of soil and landscape information across the Soil Study Area. Layers included: barest earth aerial image, published soil landscapes and their properties, historic land use, geology, regolith, and the shape of the land surface as indicated by selected indices.

The desktop assessment procedure was:

- Overlay the Soil Study Area boundary on regional (1:250,000 scale) soil and landscape properties.
- Map remote sensed data of barest earth satellite image, and land shape calculated from a 5 m resolution digital elevation model generated from photogrammetric data by NSW Spatial Services.

2.4. PROXIMAL SURVEY METHODS

Proximal soil sensors measure variation in soil properties without disturbing the soil and from a distance of the order of 1 m. The 2 techniques used in this soil assessment measured soil conductivity using electromagnetic induction (EM techniques), which in turn is affected primarily by soil salinity and water content, and gamma radiometrics, which is influenced by minerals in the surface 30 cm to 40 cm.

The EM and gamma radiometrics survey was conducted by Terrabyte Services using a DualEM21HS and a portable radiometer from 11/1/2022 to 2/4/2022 and 2/12/2023 to 3/12/2023. An EM survey of the 2020 Soil Study Area (SSM, 2020) was conducted from 16/1/2020 to 19/1/2020.

A description of how the EM operates is included as Appendix I. The DualEM21HS has dual-geometry receivers at separations of 2, 1 and ½ m from the transmitter, which provide simultaneous conductivity measurements at depths of 0.3, 0.5, 0.8, 1, 1.6 and 3.2 m. Readings were taken at approximately 5 m spacings along 50 m transects within the 2020 Soil Study Area giving approximately 40 readings/ha. The transect spacing of 50 m was spread to 200 m for the 2022 survey. These were supplemented by cross transects that were aligned with boundaries in land shape and also at 200 m spacings. The transect spacing in 2023 was reduced to 100 m.

Gamma radiation was measured with a radiometer, which was mounted on the utility vehicle that was pulling the EM sensor. The radiometer measures total count and radiation emitted by potassium, thorium and uranium that naturally occur in the soil.

Sampling locations were recorded using a Trimble TMX2050 Global Positioning System (GPS) receiver. The position was differentially corrected to give a position accuracy of less than 10 cm.

A gridded surface was fitted to the readings of apparent electrical conductivity using a kriging algorithm in Surfer®. The surfaces were presented with each 10 mS/m interval allocated a different colour. To help identify the range of soil classes present in the study area, the apparent electrical conductivity (ECa) values were plotted onto frequency histogram charts that are presented with the EM surfaces.

The accuracy of the predicted ECa and gamma values was assessed by mapping the prediction error calculated using the variogram package in R.

2.5. FIELD SURVEY

2.5.1. Sample Site Selection

Twenty five sample sites (test pits) were selected for the 2020 survey using the conditioned Latin Hypercube (Minasny and McBratney, 2006) method. The Latin Hypercube aims to simultaneously sample the range of a number of variables. Variables used to select the 25 sample sites in the 2020 Soil Study Area were: Easting, the 0.8 and 3.2 m layers of the EM survey, red band of the red/green/blue (RGB) barest earth satellite image, elevation and derived values of slope, slope position, depth below the rim of closed depression and Multi-Resolution Valley Bottom Flatness (MrVBF).

Eighty five sample sites (soil cores) for the 2022 survey and 16 sample sites for the 2023 survey were selected using a conditioned Latin Hypercube (Minasny and McBratney, 2006) method. Covariates used to select sample sites in the Soil Study Area were: 6 layers of the EM survey, total radiation and potassium percentage from the proximal gamma survey, red band of the red/green/blue (RGB) barest earth satellite image, elevation and derived values of slope, slope position, depth below the rim of closed depression, LS (slope length) factor and Multi-Resolution Valley Bottom Flatness (MrVBF). The location of the 25 sites sampled by SSM (2020) was taken into account by the conditioned Latin Hypercube algorithm using the logic of Malone *et al.* (2019).

The planned 2022 soil sample site distribution was adjusted when permission to access to Huntingfield (Figure 2.1) was withdrawn from 13 April, 2022 (P. Smith, RZ Resources, pers comm.). This resulted in additional soil sample sites on Belmore and Warwick (Figure 2.1) and greater reliance on Digital Soil Mapping to locate Soil Association boundaries within Huntingfield than was initially planned. Permission to access Huntingfield was not available in 2022 or 2023.

The resulting sample density of 101 soil cores and 25 soil pits (Figure 2.2) across the 16,197 ha Soil Study Area is an average of 129 ha per sample site. This sample density is appropriate for a 1:100,000 scale map (Schoknecht *et al.*, 2008), which is appropriate for strategic planning for intensive landuse. These 126 sample sites were found to be sufficient samples to describe 95% of variation in the selected covariates (Figure 2.3).

520000 525000 530000 535000 540000

6285000 6280000 6275000

SUNSHINE
BELMORE
NULLA ROAD
HUNTINGFIELD
WARWICK

N W E S

Copi Mineral Sands Project

Wentworth

Sample Sites

Mine Site Boundary
2023 Soil Study Area
2021 Soil Study Area
2020 Soil Study Area

Site_Type
2020 Pit
2020 AcidSulphate Pit
2020 Observation
2022 and 2023 Core

Property
Belmore
Huntingfield
Nulla
Warwick
Road Reserve

Homestead
Road

0 1 2 3 4
kilometres
1 cm = 0.7 km on A3

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

SSM Sustainable Soil Management

Job Code: Cr497
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367

Datum: WGS 84
Projection: UTM

Figure 2.2

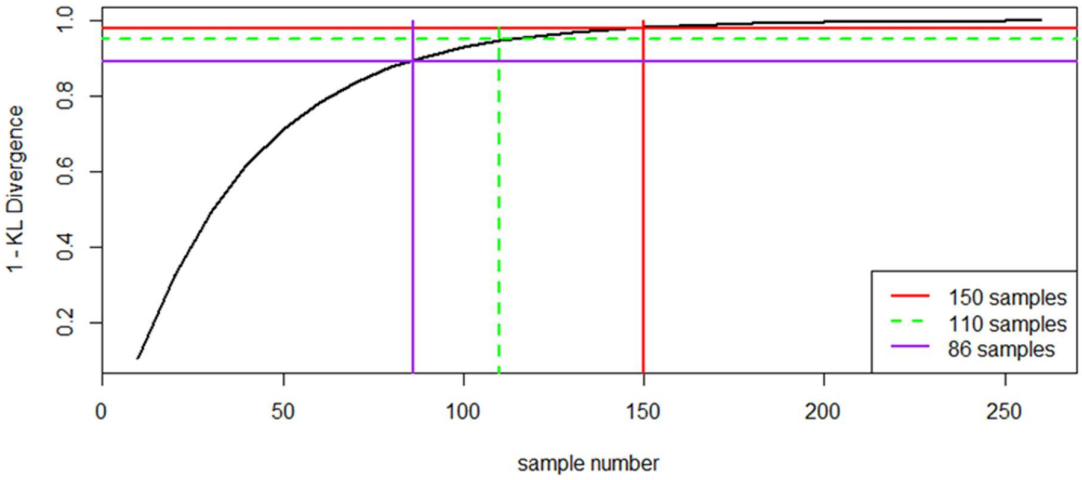


Figure 2.3. Proportion of covariate variation as measured by Kullbak-Liebler divergence for 150 samples (98%), and 86 samples (89%) for Soil Study Area. 110 samples accounts for 95% of variation as recommended by Malone *et al.* (2019).

In 2020, properties of an additional 16 sites were described in less detail, and used as observation sites to check the accuracy of mapping. Seven sites were sampled as part of the potential Acid Sulphate Soil Assessment (Section 7) and nine sites were sampled for geotechnical testing.

2.5.2. Survey Observations and Methods

Soil testing and description methods were consistent between the 2020, 2022 and 2023 campaigns. However, the sampling method changed from soil pits dug at least 1.4 m deep in 2020 to composite samples from 3 by 1.4 m deep cores per site in 2022 and 2023. Locations of the sample sites were recorded using a handheld Garmin GPS, giving position accuracy of 5 m radius.

Selected soil properties in each site were described according to the 'Australian Soil and Land Field Survey Handbook' (NCST, 2009). The soil properties described were:

- Depth of each horizon.
- Texture.
- Field pH using a kit based on the specifications of Raupach and Tucker.
- Dispersion.
- Root density.
- Proportion of soil occupied by gravel.
- Main colour and degree of mottling.
- Grade and type of structure. In addition, ped size was estimated in the pits in 2020

- Size and type of concretions.
- Effervescence as an indication of the proportion of soft carbonates.
- Permeability and drainage were assessed for the profile as a whole.
- Nature of surface 2 cm of soil, i.e., whether or not soil was hard setting.

Additional measurements taken were:

- Potential rooting depth for annual field crops was estimated from structure, texture, and pH.
- Volume of Readily Available Water (RAW) was calculated from rooting depth and standard estimates of available water for each texture class.
- Salinity was estimated by measuring the electrical conductivity of a suspension of 1 volume of soil in 5 volumes of water.
- SOILpak score according to McKenzie (1998).

Each profile was classified to Suborder level of the Australian Soil Classification of Isbell and NCST (2021).

These properties were recorded on field sheets and entered into a custom soil database. Data were extracted from this database to estimate LSC class and used to construct logs of profile properties.

2.6. LABORATORY TESTING

Laboratory testing was undertaken to assist in the classification of soil types and the determination of land and soil capability classes.

Soil samples were collected from standard depths of 0 to 15 cm, 15 to 30 cm, 30 to 60 cm and 60 to 100 cm for all sites unless the depth range covered the boundary between the A and B horizons of duplex profiles. In duplex soil where a sample range covered the A to B horizon boundary, the depth range was shortened and only one horizon was sampled.

Samples were tested by Incitec Pivot Laboratories which has NATA accreditation in accordance with ISO/IEC 17025, and ASPAC accreditation using the methods of Rayment and Lyons (2010).

The laboratory analyses were selected to differentiate the range of texture across the Soil Study Area and the salts present. The analytes tested were:

- Anions of chloride, sulphate (KCl), and carbonate (%$CaCO_3$ equivalent).
- pH (1:5 water), pH (1:5 $CaCl_2$), electrical conductivity (1:5 water).
- Particle size distribution was measured using the hydrometer method for all samples. The proportion of clay, silt, fine sand and coarse sand was reported for these samples.
- Nitrate nitrogen and ammonium nitrogen.
- Ratios calculated from the measured properties were: ECe (electrical conductivity of saturated extract). This was corrected for sulphate according to Shaw (1999).

Additional testing was conducted for sites that covered the range of soil types across the Soil Study Area. Cations of calcium, magnesium, sodium, potassium and aluminium were measured for the standard depths of 0 to 15 cm, 15 to 30 cm, 30 to 60 cm and 60 to 100 cm in 18 sites. In addition, organic carbon, available phosphorus, and available micronutrients of zinc, copper, iron and manganese were tested in the 0 to 15 cm and 15 to 30 cm layer of 8 core sites.

2.7. ACID SULPHATE SOIL ASSESSMENT

SSM (2020) undertook measurements and observations in soil pits to determine whether the Soil Study Area contains Potential Acid Sulphate Soil. Potential Acid Sulphate Soil (PASS) is not acidic, but is soil that is waterlogged in its undisturbed state and has the potential to become acidic when oxidised (Ahern *et al.,* 1998).

Assessment of the presence and extent of Potential Acid Sulphate Soil in the Soil Study Area was undertaken following the guidelines of Ahern *et al.,* (1998) as far as practicable. These guidelines are written as a series of sequential steps in which a site is classified as not having a risk of acid sulphate once it fails to satisfy any criterion.

2.8. DIGITAL SOIL MAPPING OF SOIL CHEMICAL PROPERTIES AND PARTICLE SIZE DISTRIBUTION

The land and soil capability assessment of SSM (2020) found variation in soil chemical properties of soil salinity, sulphate-sulphur, carbonate, and percentage clay that was large enough to guide the mapping of Soil Associations. These properties are amenable to Digital Soil Mapping and the process was applied using environmental correlations as described by Minasny *et al.* (2008). The environmental correlations refer to correlations between soil properties measured at the sample sites and the environmental properties such as land shape, soil conductivity and gamma radiometrics that were used in the sample site selection process described in Section 2.5.1.

The relationship between environmental factors and soil properties was estimated using the Random Forest (Breimen, 2001) machine learning method. The precision of predicted values was estimated using the Quantile Regression Forests method of Meinshausen (2006) using an R script that was modified from the 2021 International Soil Reference and Information Centre (ISRIC) Spring School script prepared by Dr B. Kempen and Dr L. Poggio.

2.9. SOIL STRIPPING AND RESTORATION OF LAND CAPABILITY

Suitability of soil for use in rehabilitation was assumed to be controlled by soil chemical properties of salinity measured as chloride concentration, gypsum or copi measured as sulphate-sulphur concentration, carbonate concentration and clay content to a lesser extent. This strategy was used as the topsoil sampled in the Soil Study Area was sandy, and had too little coherence for it to be classified as suitable for topdressing according to the commonly used criteria of Elliott and Veness (1981).

The depth to critical values of soil properties from digital soil maps was calculated to the nearest centimetre. The critical values were selected based on likely suitability of soil for rehabilitation (Table 2.1).

Table 2.1. Critical values of soil properties for use in rehabilitation.

Property	Critical value	Reason
Chloride	1,000 mg/kg	Reduce growth of most plants
Sulphate-sulphur	1,000 mg/kg	Gypsum observed in soil
Carbonate	2%	pH_{H2O} greater than 8
Clay	30%	Clay loam texture, soil likely to be coherent

Management strategies to overcome the unstable surface structure are to protect the surface from wind and establish vegetation as quickly as possible. These are outlined in Section 10.

2.10. SOIL MAPPING UNIT BOUNDARIES

Soil in the Soil Study Area was divided into 6 Soil Associations based on topsoil texture and the type and concentration of salts in the subsoil.

Soil Association boundaries were determined using an iterative process based on inputs of: soil profile properties, soil chemistry, ECa from the EM survey, soil surface colour and land shape. Essentially, Soil Association boundaries were drawn, chemistry of the resulting groups of profiles was compared, outliers were moved to another Soil Association, boundaries were redrawn, and the process repeated.

2.11. LAND CAPABILITY ASSESSMENT

The land and soil capability was determined according to criteria in *Land and Soil Capability Assessment Scheme: second approximation* (OEH, 2012). Capability assessment is based on slope, wind hazard, soil pH, surface structural stability, salinity, rock outcrop, waterlogging potential, and existing erosion (OEH, 2012). The LSC class was determined for each Land Type from the average of the calculated value for each profile description within the Land Type. This process is described in more detail in Section 8.

3. REGIONAL SETTING

3.1. INTRODUCTION

Dominant land types in the Soil Study Area are undulating sand plains with linear sand dunes and large closed depressions. The large closed depressions have soil that is much saltier than the surrounding sand plains. There are gypsum rich lunettes to the east of the closed depressions.

Although there are essentially no continuous drainage lines across the site there is a trend that dune soil is sandier than in neighbouring swales (linear depressions).

3.2. CLIMATE

The Soil Study Area is located approximately 75 km northwest of Wentworth in southwestern NSW and with a Grassland climate with a persistently dry rainfall pattern, and is on the boundary between warm and hot temperature classes (BOM, 2005). The average rainfall is 235 mm (Queensland Government, 2020) and is distributed relatively evenly throughout the year.

Average monthly rainfall ranges from 14 mm in March to 24 mm in October and is much less than average potential plant water use for all months (Figure 3.1). Evaporative demand is much more consistent than rainfall and total annual reference evapotranspiration averages 1,472 mm. There are sporadic months when rainfall is greater than potential evapotranspiration, resulting in opportunities for plant emergence that occur mainly from May to July.

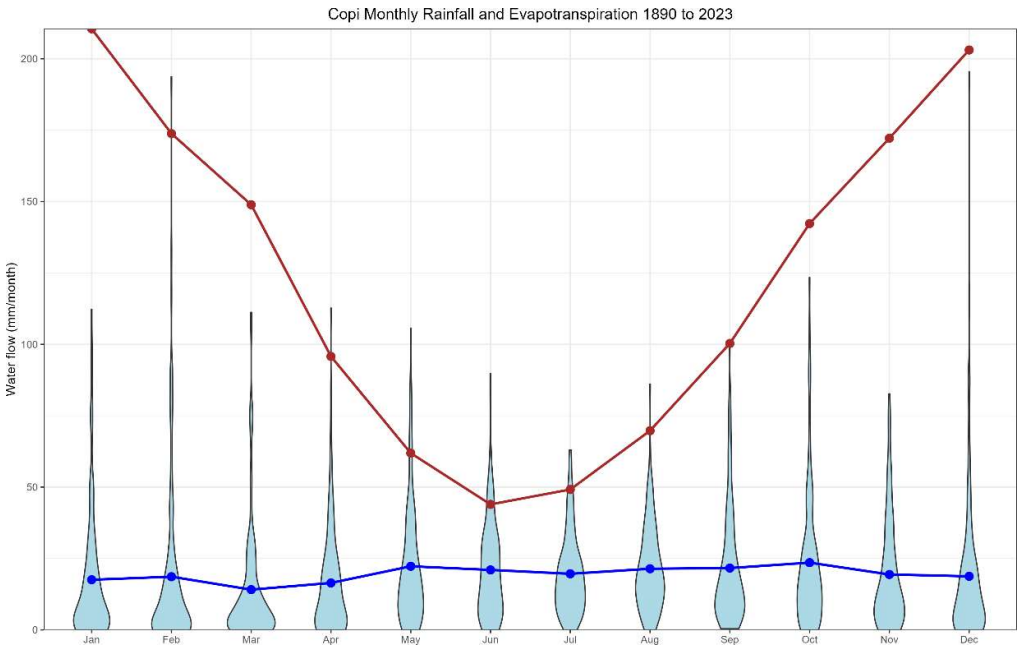


Figure 3.1. Monthly rainfall violin (frequency density) plots and average monthly rainfall and potential evapotranspiration for the Soil Study Area (33°39' S, 141°21' E) from 1889 to 2023 (Queensland Government, 2023).

The annual average monthly maximum temperatures for the Soil Study Area range from 33°C in January and February to 16°C in July and minimum temperatures range from 5°C in July to 17°C in January and February (Figure 3.2).

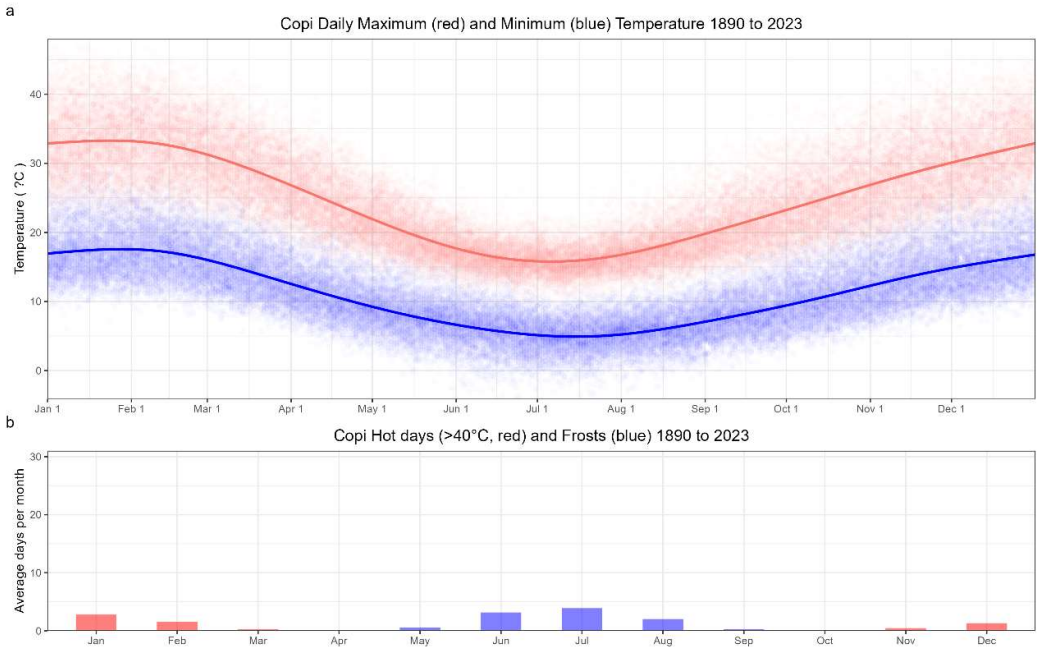


Figure 3.2. a) Average monthly maximum and minimum temperatures and b) average hot and frost days per month for the Soil Study Area (33°39' S, 141°21' E) from 1889 to 2023 (Queensland Government, 2023).

January is the hottest month, with an average 2.9 days when maximum temperature exceeded 40°C (Figure 3.2b), while February and December have 2.0 and 1.6 similarly hot days.

The frequency of frosts was calculated as the number of days when the minimum temperature was estimated to be less than 2.2°C at screen level (1.2 m above ground, BOM, 2014). Frosts are relatively common in winter months (Figure 3.2b), but moderate temperatures mean that the frosts are likely to affect only frost sensitive plants.

3.3. REGIONAL SOIL AND LAND DESCRIPTION

Soil properties and vegetation across the Soil Study Area are inter-related, and vary in a pattern that is controlled by geomorphology (Figure 3.3). The key landforms are relict lake-beds with lunettes on the down-wind side, relatively level sand plains, and a complex landscape of dunes and swales.

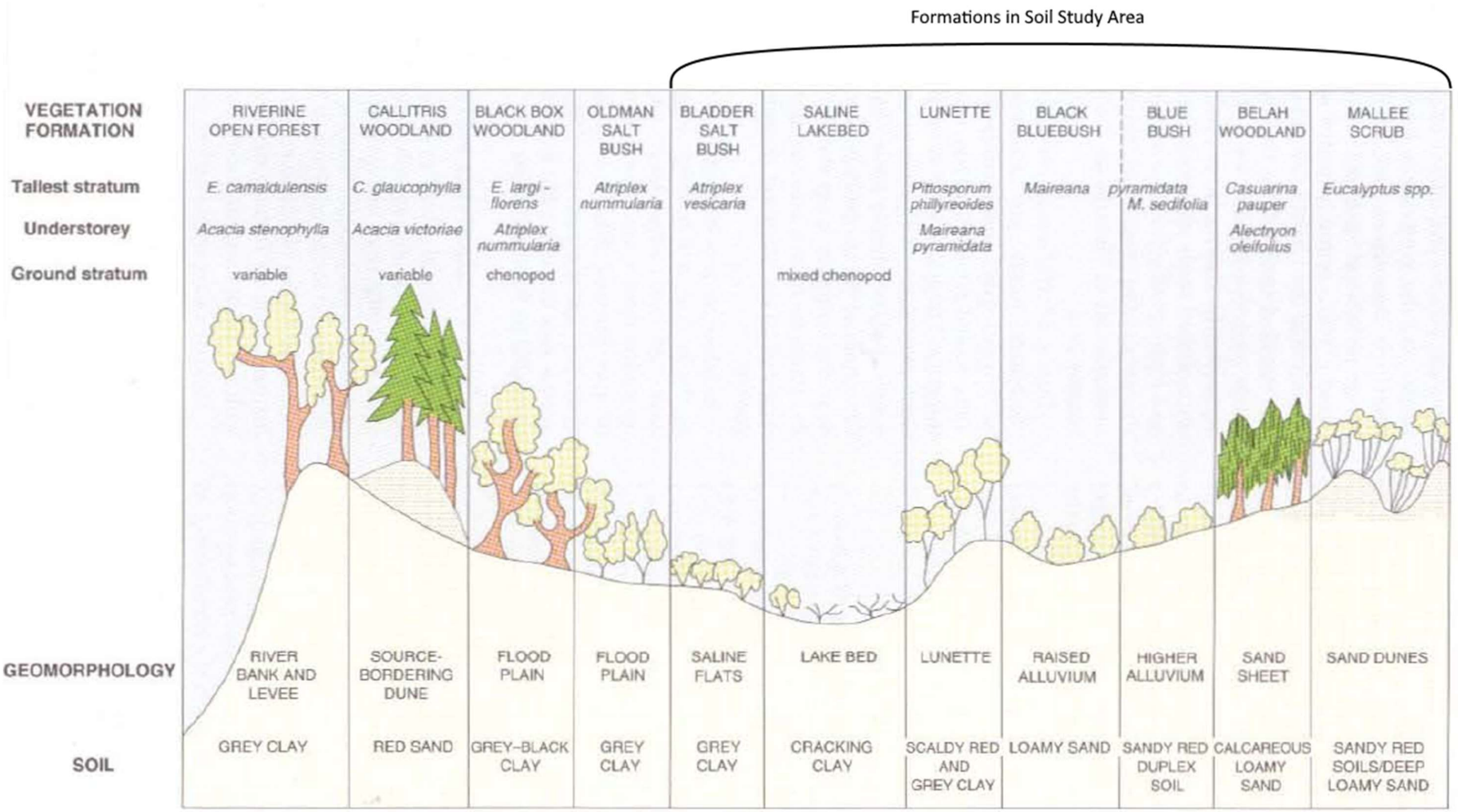


Figure 3.3. Idealised continuum of soil types, geomorphology and vegetation communities in Ana Branch 1:250,000 Map Sheet (Ray, 1996).

3.3.1. Land Systems

Rangelands of western New South Wales that include the Soil Study Area were mapped by Walker (1991) using a hierarchical system in which rangeland types, based on landform and vegetation, were subdivided into Land Systems. Land Systems are areas or groups of areas throughout which there is a recurring pattern of topography, soil and vegetation.

The Soil Study Area is in a landscape dominated by sand-plains and dune fields. However, the 48% of the Soil Study Area occupied by the large, closed depressions was mapped by Walker (1991) as groundwater discharge basins occupied by the Huntingfield Land System (Table 3.1, Figure 3.4a). Walker (1991) described the Huntingfield Land System as basin floors with a mosaic of gypseous or saline clays, islands of brownish soil underlain by powdery gypsum (copi); sandplains and lunettes of siliceous sand and deep earthy sand underlain by gypsum.

The remaining 52% of the Soil Study Area was mapped by Walker (1991) as sandplains with a varying proportion of dunes (Table 3.1, Figure 3.4a). The soil types in these Land Systems are predominantly Calcarosols and Chromosols in swales, and sandy Arenosols in dunes.

Table 3.1. Summary of Walker (1991) Land Systems in Copi Mineral Sands Project Soil Study Area.

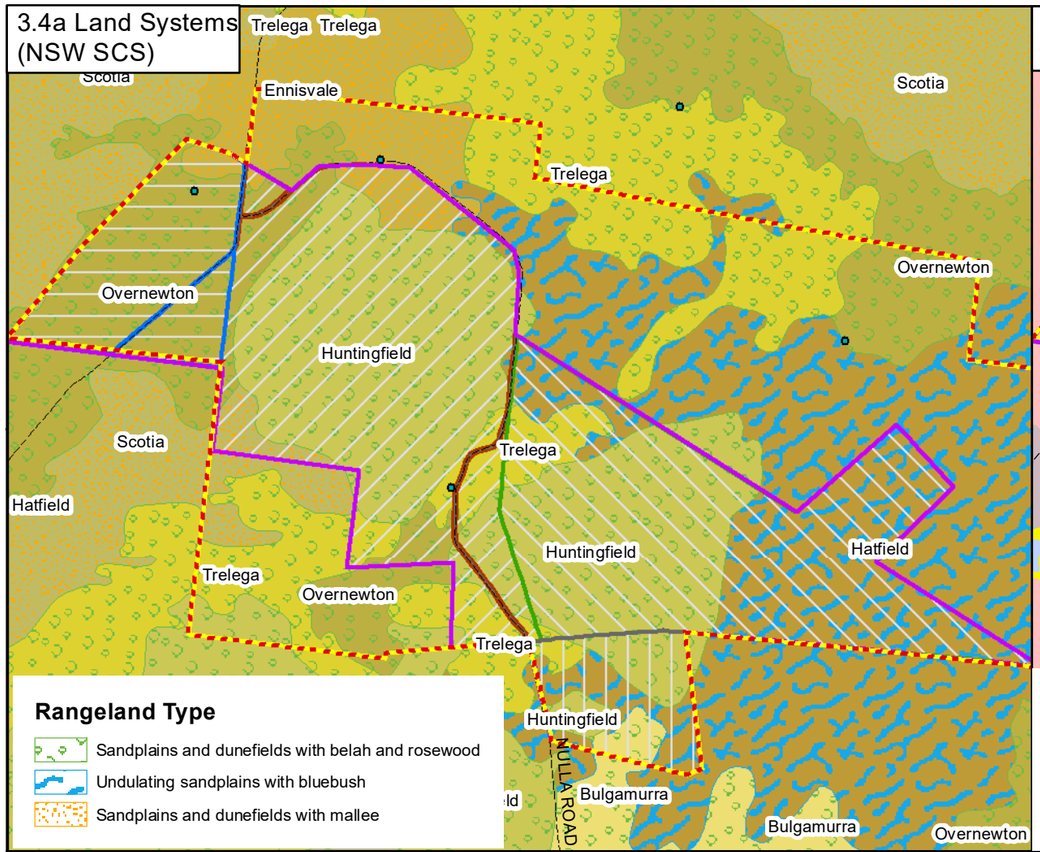
Land System	Area (ha)	Rangeland Type	Physiography	Dominant Soil	LSC Class
Huntingfield	7836	Sandplains and dunefields with belah and rosewood	Playas and Basins	Hydrosols, Kandosols and Arenosols	8
Bulgamurra	172	Sandplains and dunefields with belah and rosewood	Sandplain	Calcarosols, and Arenosols	5
Hatfield	3514	Undulating sandplains with bluebush	Sandplain	Calcarosols, Kandosols and Arenosols	5
Overnewton	2775	Sandplains and dunefields with belah and rosewood	Sandplain	Calcarosols	5
Trelega	1160	Sandplains and dunefields with belah and rosewood	Sandplain	Calcarosols	4
Ennisvale	488	Sandplains and dunefields with mallee	Dunefields	Calcarosols and Chromosols	5
Scotia	253	Sandplains and dunefields with mallee	Dunefields	Calcarosols and Arenosols	5

The statewide Land and Soil Capability mapping rated the Huntingfield Land System as LSC class 8, which is extremely low capability land (Figure 3.4d). The Trelega Land System (7% of the Soil Study Area) was rated as LSC class 4, which is moderately capable land. (Figure 3.4d). The remaining 5 land systems which cover 44% of the Soil Study Area were rated as LSC class 5 or moderately low capability land.

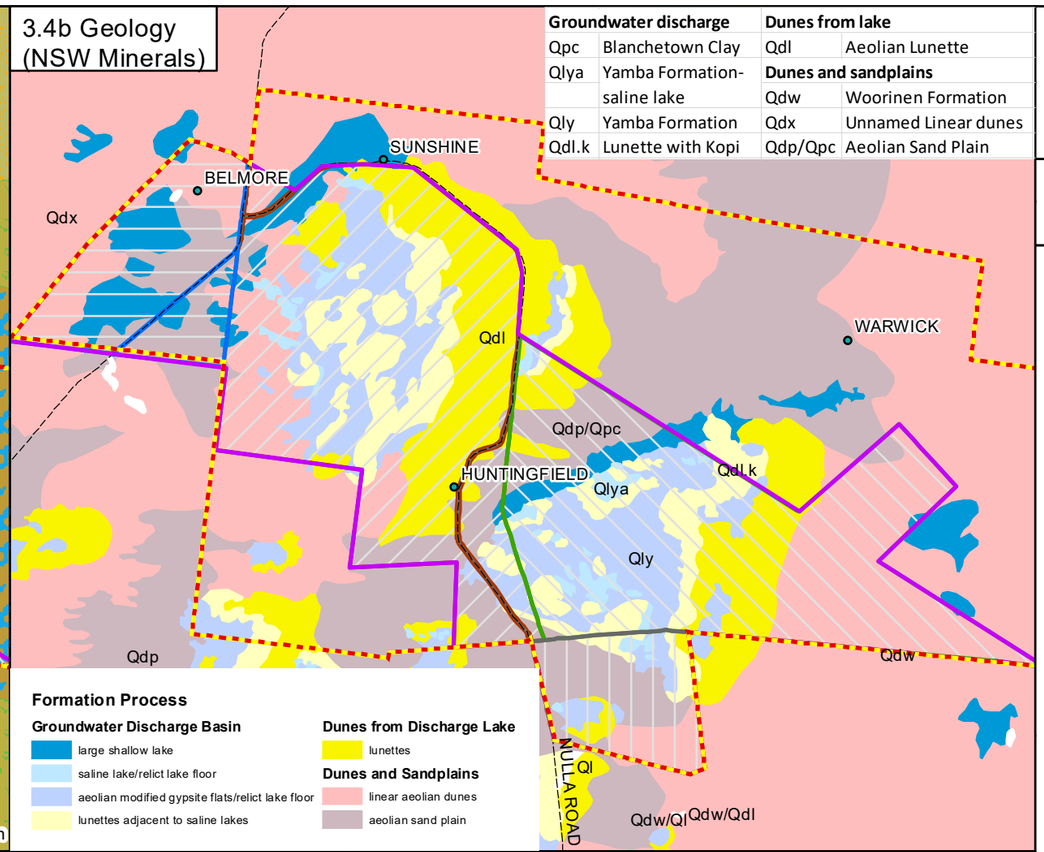
Copi Mineral Sands Project

Wentworth

3.4a Land Systems (NSW SCS)

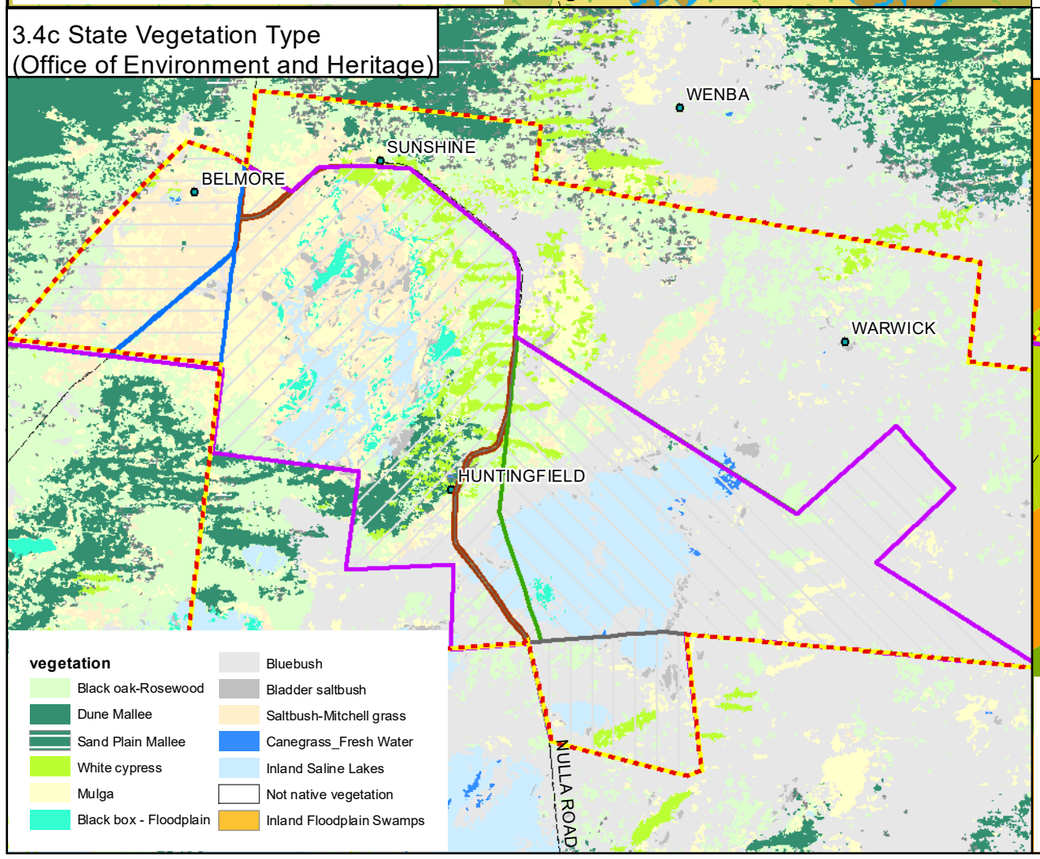


3.4b Geology (NSW Minerals)

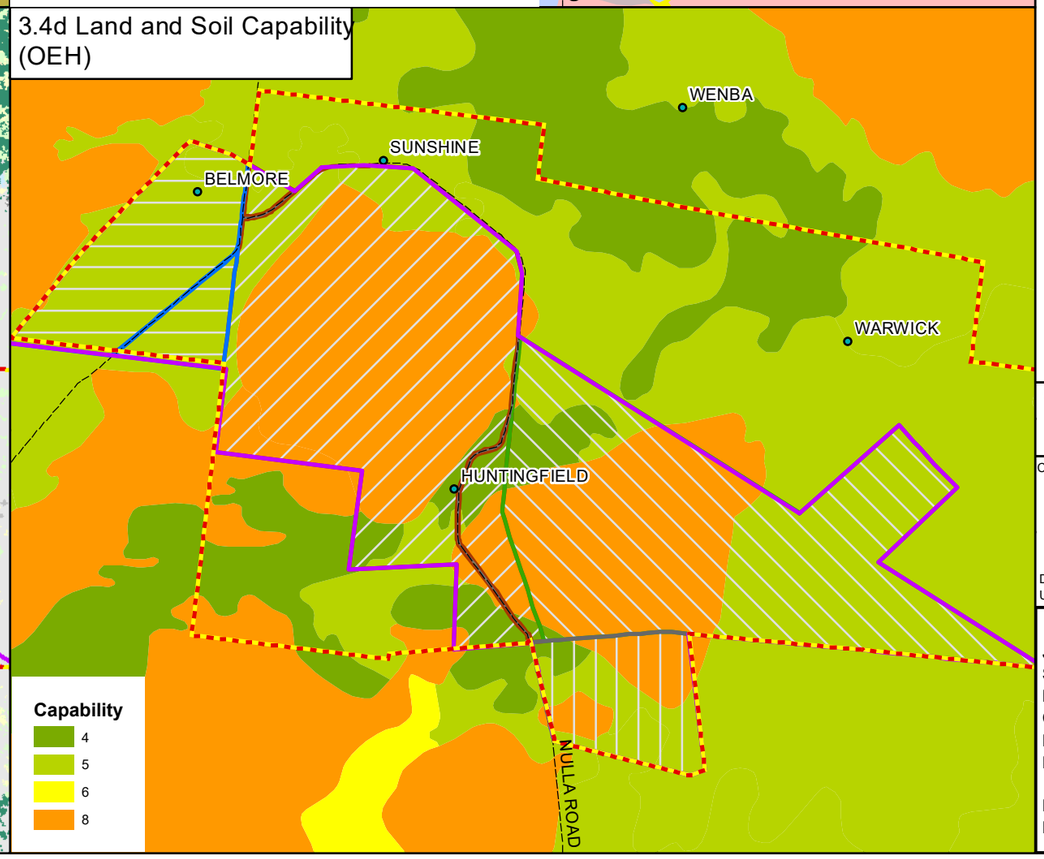


Groundwater discharge		Dunes from lake	
Qpc	Blanchetown Clay	Qdl	Aeolian Lunette
Qlya	Yamba Formation- saline lake	**Dunes and sandplains**	
		Qdw	Woorinen Formation
Qly	Yamba Formation	Qdx	Unnamed Linear dunes
Qdl.k	Lunette with Kopi	Qdp/Qpc	Aeolian Sand Plain

3.4c State Vegetation Type (Office of Environment and Heritage)



3.4d Land and Soil Capability (OEH)



Landscape Properties

- Mine Site Boundary
- Soil Study Area
- Homestead
- Road

Property

- Belmore
- Huntingfield
- Nulla
- Warwick
- Road Reserve

N
W E
S

0 2,000 4,000 6,000 8,000

Metres

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr497
Surveyed:
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367
Roads: NSW Minerals

Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 3.4

3.3.2. Geology

The geology map (Figure 3.4b) depicts the variation in soil properties in more detail than the Land Systems map. The geology map divides the Huntingfield Land System into material deposited in:

- Saline lake (relict lake floor) – Yamba Formation (Qly), which consists of gypsiferous clay, gypsite and other salt deposits, and overlies the Blanchetown clay (Ray, 1996).
- Aeolian modified gypsite flats/relict lake floor (Qlya) – sandy material of the Yamba Formation that has been moved by wind from lower parts of the lake floor.
- Lunettes adjacent to saline lakes (Qdl.k) – predominantly pale to cream gypsite (Copi). The Lunettes were formed between 700,000 and 400,000 years ago (Ray, 1996).
- Lunettes (Qdl) – generally crescent shaped dunes east of and adjacent to the saline lakes and contain sediment dominated by sand and clay with some gypsite.

The western slope of the eastern lake and some low-lying areas in the northwest of Huntingfield and Belmore were mapped as:

- Large shallow lakes – This is Blanchetown Clay (Qpc), which consists of laminated greenish grey and red brown clay. Ray (1996) reported that the Blanchetown clay was deposited in the floor of the relict freshwater Lake Bungunnia, which drained 700,000 years ago. The Blanchetown clay is not uniformly present, and overlies the Loxton-Parilla Sands Formation, the host of the mineral sands deposits (Ray, 1996).

The remaining 4 Land Systems were mapped as:

- Linear Aeolian dunes – Woorinen Formation (Qdw) in the east and consists predominantly of a mixture of clayey siliceous sand, calcareous silty clay and sandy clay and is generally less than 15 m thick. Woorinen Formation is thought to have been deposited within the past 400,000 or 500,000 years (Ray, 1996). However, the most recent dune building phase was between 25,000 and 13,000 years ago.
  Unnamed linear dunes (Qdx) with silty quartz sand were mapped on Belmore. These dunes are younger than the Woorinen Formation. Both dune formations overly Blanchetown Clay where it is present.
- Aeolian sand plain (Qdp/Qpc) – This consists of sandy and loamy soil that forms a thin veneer (few metres thick) over Blanchetown clay and has flat to hummocky surface profile (Ray, 1996).

3.3.3. Vegetation Type

The State Vegetation Type indicates that in Warwick, the eastern half of the Soil Study Area is dominated by Bluebush (Figure 3.4c). The majority of the Huntingfield Land System in Warwick is mapped as Inland Saline Lake vegetation.

The zone between the patches of Huntingfield land system contains White Cypress and Mallee vegetation on dunes, and Black Oak (Belah) in swales.

Vegetation in the Huntingfield Land System on Huntingfield is mapped as a mixture of Inland Saline Lake, Mulga, Black Box - floodplain and Saltbush-Mitchell grass vegetation with small patches of Bladder saltbush.

This mixture of vegetation types continues through more elevated land on Belmore, with much of the western edge of the Soil Study Area mapped as Black Oak (Belah)-Rosewood vegetation.

3.4. LAND SHAPE PROPERTIES

3.4.1. Elevation

There is more than 35 m of relief across the Soil Study Area, from elevation less than 26 m in the floor of the both large relict lakes and the smaller lake near the southwestern extremity of the Soil Study Area to higher than 62 m on dunes near both the eastern and western ends of the Soil Study Area (Figure 3.5 a). The floor of the relict lakes is 30 m lower than surrounding sand plains (upwind) and lunettes (downwind). The linear dunes consist of 3 to 5 m high dunes aligned east-west and 250 to 350 m apart that are on low hills.

3.4.2. Slope

The average slope across the Soil Study Area is 2%. Figure 3.5c shows 3 slope patterns. The easternmost relict lake floor is roughly triangular and bordered to the east, south and west by 500 to 700 m long slopes with a fall generally between 2.5 and 5%. There is a similar shape to the east of the westernmost relict lake floor. Within the relict lake floor there are thin strips with slope steeper than 5%. These predominantly border lunettes adjacent to the saline lakes and the aeolian modified gypsite flats (Figure 3.4b).

The changes in land shape around the eastern relict lake are sharper than those around the western relict lake.

The linear dunes have east-west orientation and are bordered to the north and south by land with a slope of 2.5% for a distance of less than 100 m (Figure 3.5a).

The average slope on the western side of the eastern relict lake was measured as 4% (1 in 25, Figure 3.6). Field observations such as the photograph in Figure 3.6 indicate that land surface with this slope is susceptible to form gullies if water flow is concentrated by structures such as tracks. Development of erosion gullies can be minimised by spreading water flow rather than allowing it to concentrate. Practises to achieve this are well known and widely practised in land management systems that are more intensive than rangeland grazing.

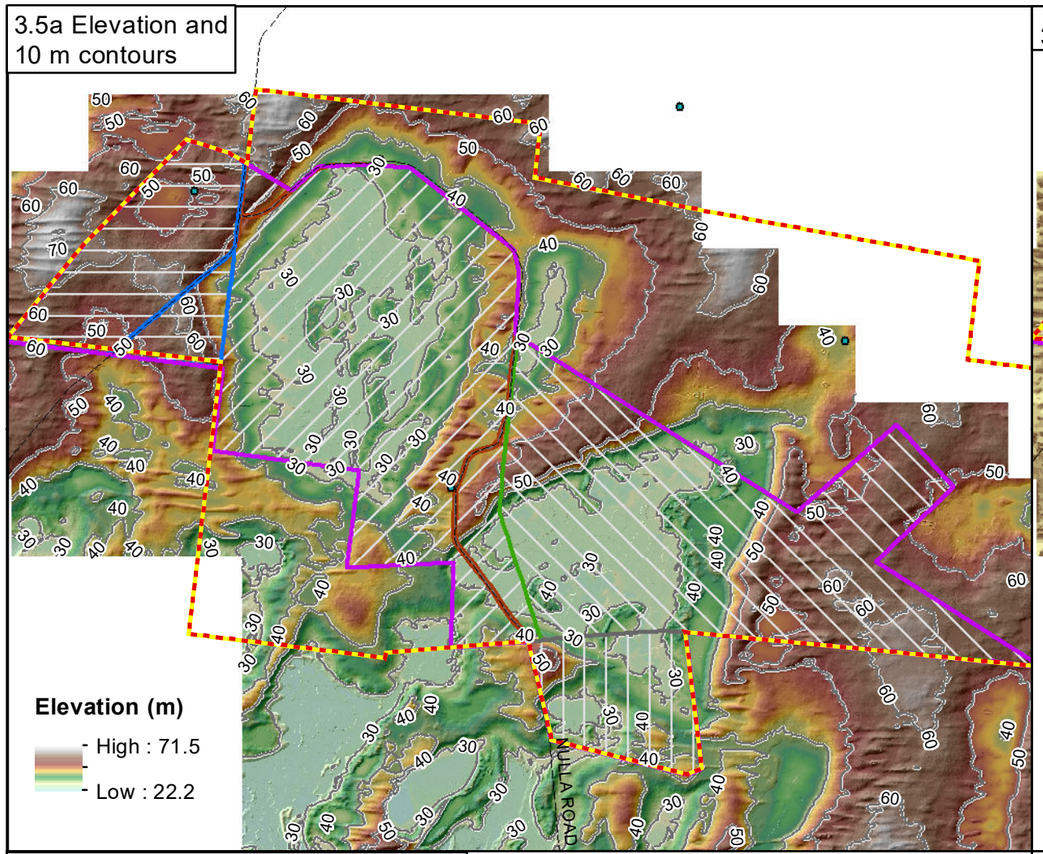
3.4.3. Multi-resolution Valley Bottom Flatness Index

Within the Soil Study Area, the Multi-resolution Valley Bottom Flatness index (MrVBF) shows a clear difference in land shape between the flat areas of relict lakes, continuous fall beside the relict lakes, and the undulating topography in the dunes and sand plains (Figure 3.5b). Both the areas mapped as dunes and those mapped as sand plains contain areas of moderate valley floor. These are swales or small valleys between the dunes.

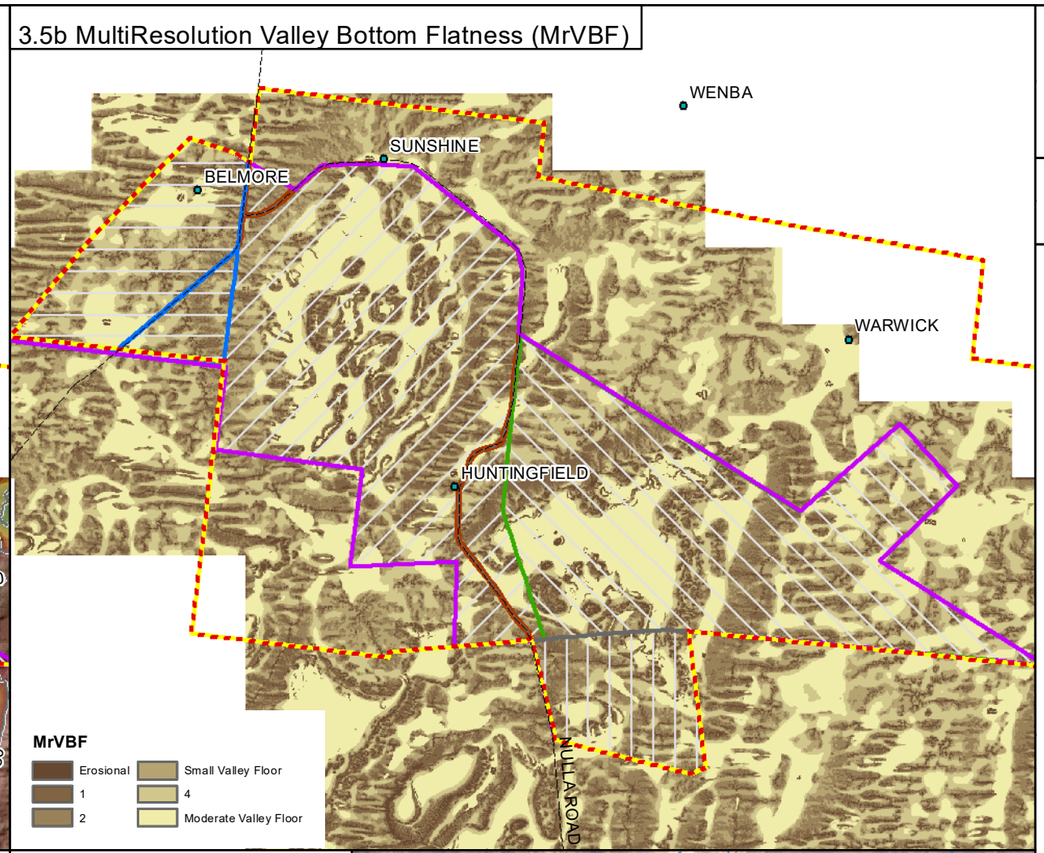
Copi Mineral Sands Project

Wentworth

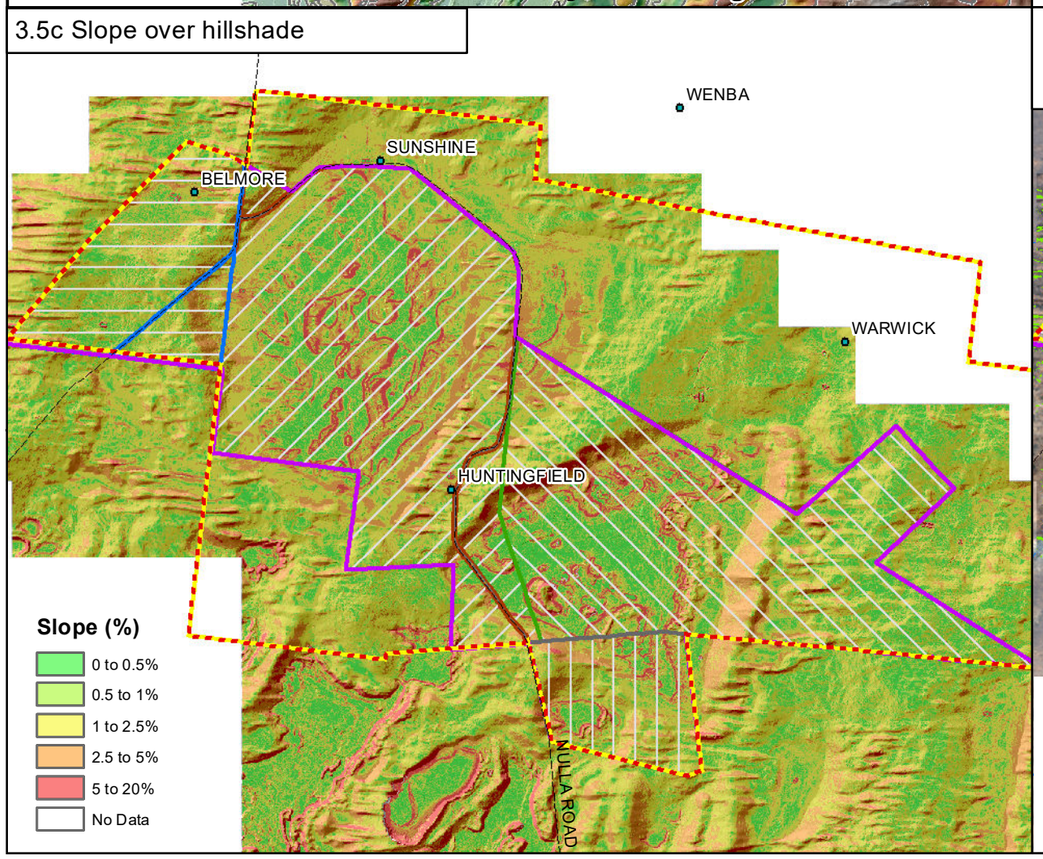
3.5a Elevation and 10 m contours



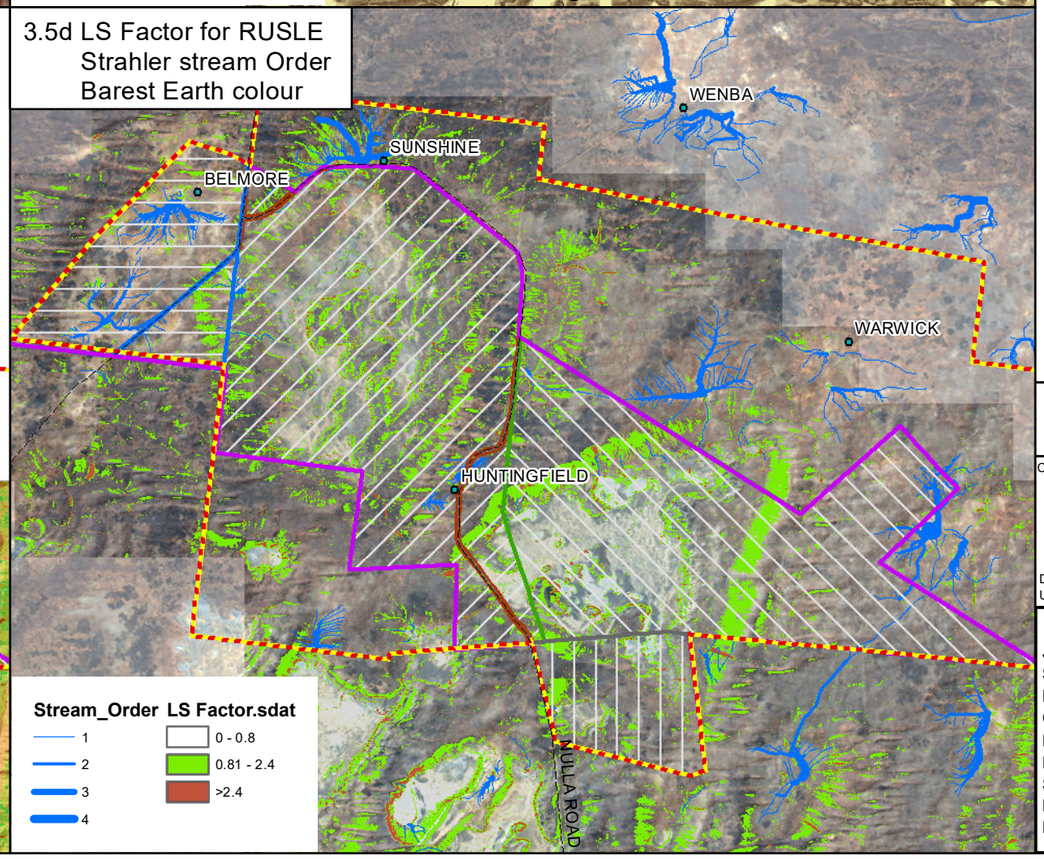
3.5b MultiResolution Valley Bottom Flatness (MrVBF)



3.5c Slope over hillshade



3.5d LS Factor for RUSLE
Strahler stream Order
Barest Earth colour



Selected
Land Shape Properties

Mine Site Boundary
Homestead
Road
Soil Study Area

Property

Belmore
Huntingfield
Nulla
Warwick
Road Reserve

N
W E
S

0 2,000 4,000 6,000 8,000
Metres

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr497
Surveyed:
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367
Roads: NSW Minerals
Stream Order: NSW Hydrography
Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 3.5

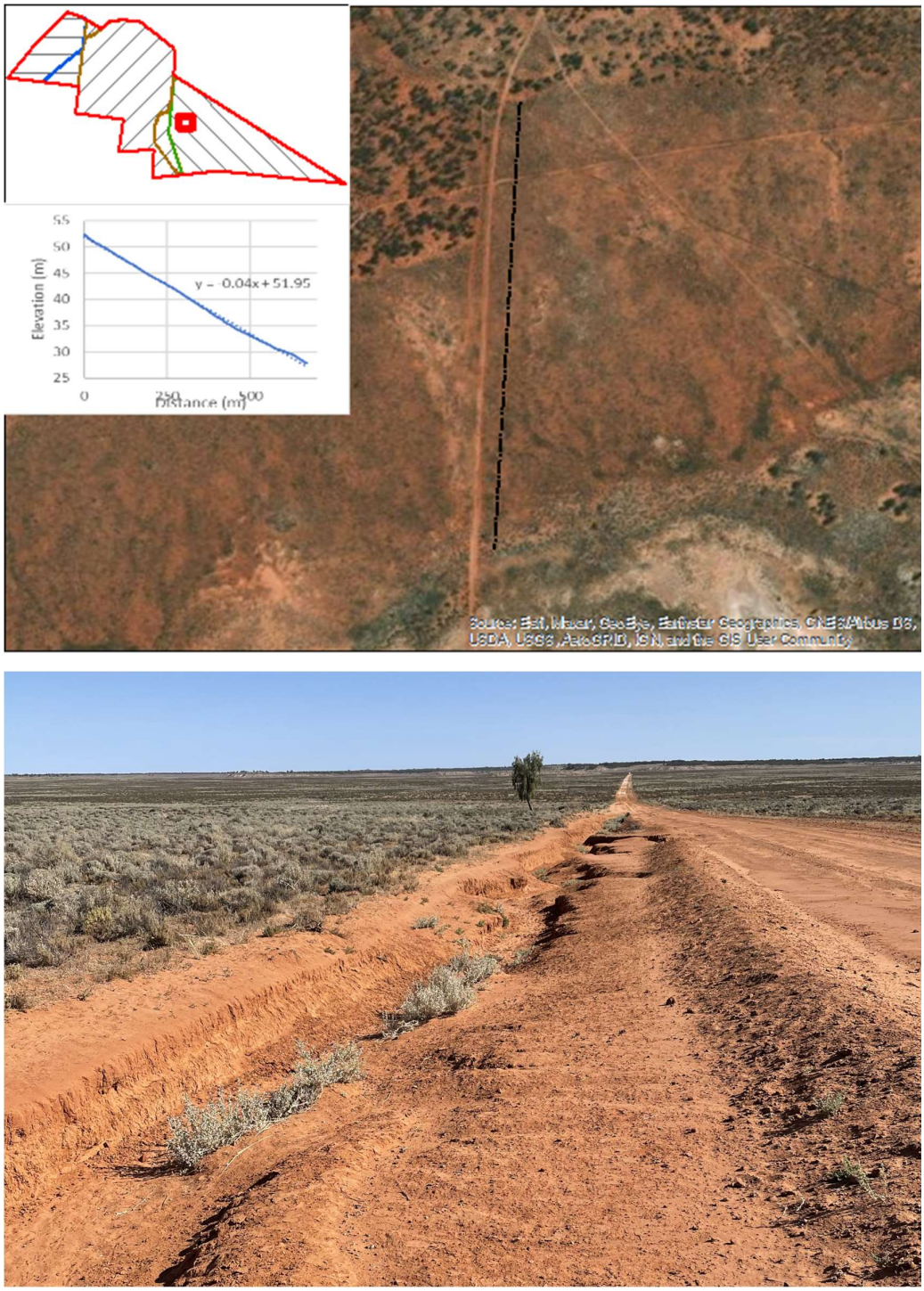


Figure 3.6. Calculated slope (graph), location on aerial image and within Soil Study Area and photograph of small erosion gully on western slope of eastern relict lake in November, 2023.

3.4.4. LS Factor for RUSLE and Stream Order

The Revised Universal Soil Loss Equation (RUSLE) is used in agriculture and in the NSW guidelines for managing runoff from construction sites (Landcom, 2004) to estimate potential soil loss from water erosion. RUSLE estimates annual soil loss as the product of rainfall erosivity, soil erodibility, slope length (LS) factor, crop management and cropping system. The LS factor uses inputs of slope length and steepness to estimate the contribution of land shape to erosion potential. LS values range from 0.04 to more than 50 (Landcom, 2004). LS values across the Soil Study Area were generally less than 0.5, an indication that land shape would not contribute greatly to water erosion.

The Strahler stream order lines were obtained from NSW hydroline data. The data shows that the watersheds within the Soil Study area that have a dendritic (shaped like tree branches) drainage pattern that drain to the location of dams on the grazing properties. The hydroline data does not show runoff into the either of the relict lakes. This is consistent with the lakes being formed by sand removal by wind rather than water erosion.

3.4.5. Catchment Scale Land Use

The NSW Office of Environment and Heritage eSpade 2.0 website (eSPADE v2.2 (nsw.gov.au)) indicated on December 6, 2023 that landuse of the Soil Study Area and surrounding land is grazing of native vegetation. Some parts of the floor of the relict lakes were mapped as water.

3.4.6. Potential Acid Sulphate Soil

The NSW government Acid Sulphate Soil risk mapping on Naylor et. (1998 and Figure 3.7) indicates that acid sulphate soil in NSW is not a concern within 800 km of the Soil Study Area. In contrast, Tulau and Morand (2013) found sulfidic soil in all sampled layers in 15 of 60 sites sampled in the Edward Wakool channel system and 200 km east of the Soil Study Area (Figure 3.7)

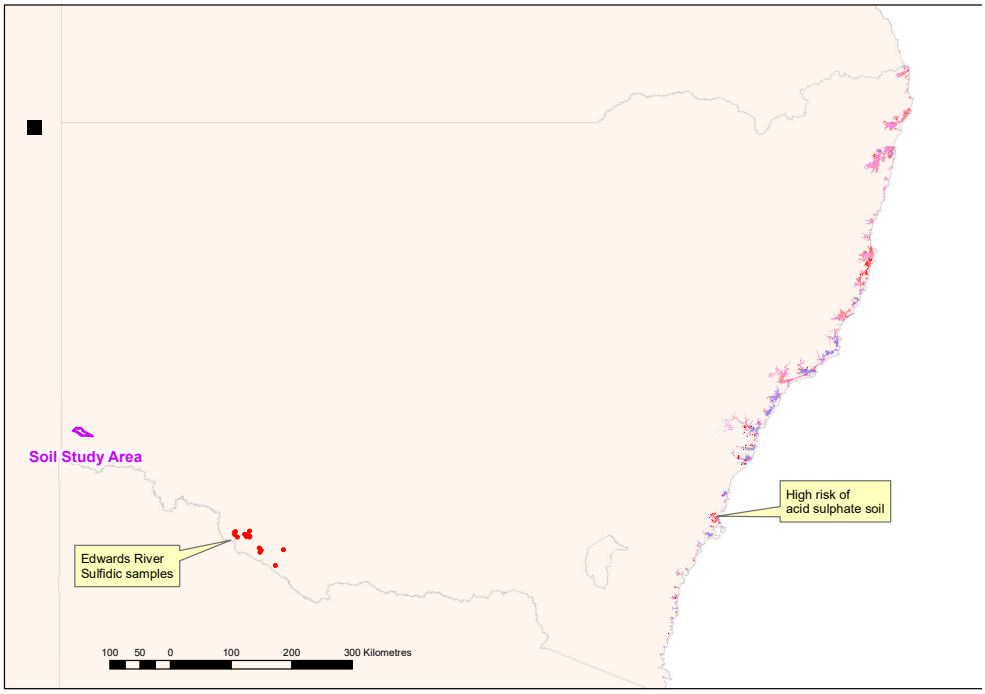


Figure 3.7. Mapped extent of high risk of Acid Sulphate Soil in NSW (Naylor et al., 1998) and sulfidic sites in Edward Wakool River (Tulau and Morand, 2013).

However, the Atlas of Australian Acid Sulphate Soils (https://www.asris.csiro.au/themes/AcidSulfateSoils.html) mapped the eastern relict lake in the Soil Study Area as land having a high probability of containing acid sulphate soil, but very low confidence on the basis that the site has not been sampled (Figure 3.8). The low confidence can be addressed with soil testing.

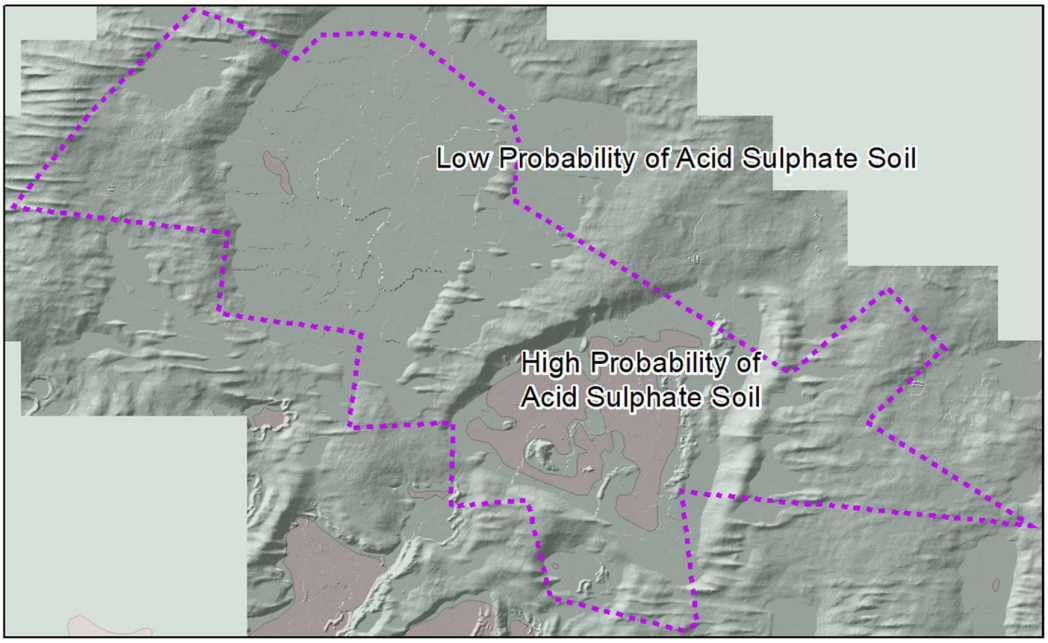


Figure 3.8. Acid Sulphate Soil hazard of Soil Study Area (from CSIRO Atlas of Australian Acid Sulphate Soils).

3.5. REGIONAL SETTING SUMMARY

The Soil Study Area is persistently dry, with average annual rainfall of 230 mm, and potential evapotranspiration of 1,472 mm. Average maximum temperature ranges from 16°C in June and July to 33°C in January and February. Frosts occur on an average 3.5 days in each winter month and occasionally in Autumn and Spring (Figure 3.2).

The geology map in Figure 3.4b and geomorphology cross section in Figure 3.3 explain soil patterns in the Soil Study Area was formed from sediment that was moved by water and wind and has been deposited in the past 2 million years. The oldest soil layer is Blanchetown Clay, which was deposited in the floor of a large freshwater lake 500 to 700,000 years ago and is exposed at an elevation of 30 to 50 m in low-lying areas of Belmore, in the northwestern corner of Huntingfield and to the west of the eastern relict lake.

The dominant surface features in the Soil Study Area are 2 relict lakes. These lakes have associated features of small and large lunettes with copi or flour gypsum (Ca_2SO_4). The lake floors contain some elevated terraces with less saline soil and crystalline gypsum or gypsite deposits.

Land away from the lakes and associated lunettes is covered by sand plains and aeolian dunes. The sand plains were formed in areas where there was insufficient sand over the underlying Blanchetown Clay to form dunes. Soil properties in the dunefields would be expected to vary from deep sandy soil in dunes to poorer drained clayey soil in swales.

The soil forming processes have resulted in a complex surface with more than 35 m relief that is dominated by 2 closed depressions formed by the relict lakes (Figure 3.5). Each relict lake is bordered on the east by a series of lunettes and has a relatively even and steep slope to the west. The dunefields are characterized by east-west oriented linear dunes.

4. PROXIMAL SURVEY

4.1. SITE CONDITIONS

Apparent electrical conductivity (ECa) which is measured during the EM survey is influenced primarily by soil salinity and soil moisture profile (Rhoades *et al.*, 1999). Consequently, soil moisture profile must be similar in order to compare results from EM surveys at different times.

Approximately 170 mm rain was recorded in the 12 months before the proximal survey at Nulla, 20 km south of the Soil Study Area (downloaded from Climate Data Online - Map search (bom.gov.au) on 31/5/22). Similarly, approximately 190 mm was estimated by Queensland Government (2023) in the 12 months before the 2023 proximal survey. (There were inadequate 2023 rainfall records within 60 km of the Soil Study Area when the report was written.) Conditions were a little drier for the 2020 EM survey, with a total of approximately 20 mm rainfall in the 6 months before the survey was conducted (Queensland Government, 2023). However, potential evapotranspiration in 1 month before the EM survey would be expected to exceed rainfall in the months before the EM survey (Figure 3.1) This indicates that the soil profile would be expected to have been dry at the time of both proximal surveys. As a result, the 2020, 2022 and 2023 proximal survey results were undertaken under comparable soil moisture conditions and are therefore able to be combined and analysis as a single dataset.

Moist soil in the floor of relict lakes would be expected to raise the ECa by 10 to 20 mS/m, which is small compared to the influence of salinity on ECa.

4.2. EM SURVEY RESULTS

ECa values were strongly skewed, with the majority of ECa readings being low to moderately low that increased rapidly with depth, and a small tail of high values (Figure 4.1, 4.2). Such skewed distributions are common in landscapes where the majority of soil is non saline, and small areas are saline.

ECa values in the 0 to 30 cm layer were very low. These increased tenfold to the 0 to 50 cm layer, increased by 30% to the 0 to 80 cm layer, then a further 60% to the 0 to 100 cm layer, and 20% to the 0 to 160 cm layer, then doubled to the 0 to 330 cm layer (Figure 4.2). This pattern is consistent with very dry surface soil, and increasing soil moisture and salinity with depth.

Even though there were large differences between the absolute ECa value of sensor pairs, there was a very high correlation between the relative ECa for all depths. In other words, ECa at one depth can be predicted from knowledge of ECa at another depth and the relationship between them as shown in Figure 4.1. Consequently, spatial patterns will be described for the layer with the least skewed distribution, which was the 0 to 330 cm layer.

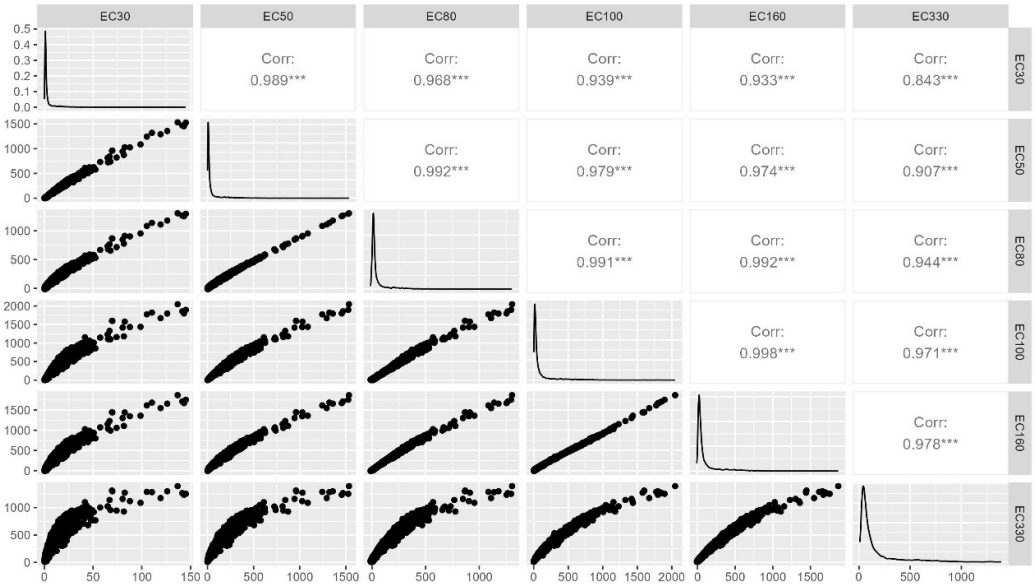


Figure 4.1. Multivariate scatterplot for 6 sensor pairs of the DualEM21HS in Soil Study Site.

In general, ECa values in the Soil Study Area were highest in areas where elevation was lower than 30 m (Figure 4.2e). These are also mapped as groundwater discharge basins in Map Figure 3.4b, and the consistent elevation of the relict lake floors is consistent with a perched water table near this elevation. The patches of elevated ECa in the relict lakes floors was aligned closely with the areas mapped as Moderate Valley Floor or MrVBF class 5 in Figure 3.5b. Lunettes within the relict lakes often had ECa less than 50 mS/m.

There were 3 patches of moderately high ECa along the northern boundary of the Soil Study Area in Warwick that were in small depressions. Elevated ECa of the eastern relict lake extended southward from Warwick into Nulla, and there was a small relict lake (Figure 3.5) with elevated ECa (Figure 4.2) in Nulla near the southwestern corner of the Soil Study Area.

There was a general trend that ECa in the dunes and sand plains was lowest near the eastern margin of dunes and lakes, and increased with distance eastward from the lakes. ECa in the 0 to 330 cm layer was less than 50 mS/m the area east of the relict lakes in Warwick, Huntingfield and Nulla. This was predominantly in areas mapped as lunettes geology (Figure 3.4b). There was also a zone of ECa less than 50 mS/m south of the eastern relict lake in Warwick that extended into Nulla and to the east of the small relict lake in the southwest of the Nulla Soil Study Area.

ECa in the 0 to 330 cm layer in Warwick east and northeast, and between dunes and relict lakes in Nulla was generally between 50 and 100 mS/m.

Between the eastern and western relict lakes, there was a pattern of ECa less than 50 mS/m in the lunettes, then a broad depression with ECa between 100 and 200 mS/m. A sand plain with ECa between the depression and the eastern relict lake had ECa 50 and 100 mS/m. While the fall from the sandplain to the relict lake had ECa between 100 and 200 mS/m.

ECa in the 0 to 330 cm layer in Belmore was predominantly between 100 and 200 mS/m.

Copi Mineral Sands Project

Wentworth

a) 0 to 30 cm

b) 0 to 50 cm

c) 0 to 80 cm

d) 0 to 100 cm

e) 0 to 160 cm
30 m elevation

f) 0 to 330 cm
50 and 200 mS/m contours

BELMORE
SUNSHINE
WARWICK
HUNTINGFIELD
NULLA ROAD

DualEM21HS
Conductivity (mS/m)

- Homestead
- Road
- Soil Study Area
- Mine Site Boundary

Property

- Belmore
- Huntingfield
- Nulla
- Warwick
- Road Reserve

ECa (mS/m)

- 3 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 80
- 81 - 100
- 101 - 120
- 121 - 140
- 141 - 150
- 151 - 160
- 161 - 180
- 181 - 200
- 201 - 225
- 226 - 250
- 251 - 300
- 301 - 500
- 501 - 750
- 751 - 1,000

Sensor pair	25th centile	Median	75th centile
EC30	1	1	3
EC50	8	14	31
EC80	10	18	41
EC100	16	30	74
EC160	19	36	83
EC330	43	72	148

0 2,300 4,600 6,900 9,200
Metres

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr397
Surveyed: 2020 to 2023
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367

SSM Sustainable Soil Management
Terrabyte services

Datum: WGS 84
Projection: UTM

Figure 4.2

4.2.1. Conductivity Patterns Around Relict Lakes

The areas of elevated ECa (>200 mS/m) were predominantly in the floors of the 2 relict lakes (Figure 4.3). Given that these relict lake floors have the highest potential in the Soil Study Area to be Potential Acid Sulphate Soil (Figure 3.6), ECa patterns were examined in more detail in the areas of high ECa than in the remainder of the Soil Study Area.

This examination showed that the highest ECa occurred in the floor of the eastern relict lake (Figure 4.3a). The eastern zone of elevated ECa covers around 1,800 ha, while the smaller relict lake near the southwestern corner of the Soil Study Area within Nulla covers 80 ha.

In the western relict lake, the zone of elevated ECa covers approximately 1,500 ha (Figure 4.3b), but ECa was generally lower than in the eastern relict lake (Figure 4.3a).

These zones of elevated ECa were sampled with the aim of assessing the extent of Potential Acid Sulphate Soil (Section 7).

4.3. RADIOMETRICS SURVEY RESULTS

The radiometrics survey showed **Total Count** was highest in Belmore, the eastern relict lake and elevated terrace between the 2 lines of lunettes east of the eastern relict lake than in other parts of the Soil Study Area (Figure 4.4b). Total count was lowest in lunettes and elevated mounds in both relict lakes, the eastern face of lunettes east of the eastern relict lake and on linear dunes in Warwick and Nulla.

Counts of the individual elements of **potassium**, **thorium** and **uranium** were highest in the southern half of Belmore, the eastern relict lake and terrace to the east of this lake. The high count form each of these elements resulted in a whitish colour of the Ternary Radiometrics (Figure 4.4a.). There was a trend of lower uranium in dunes and sand plain in the north of Huntingfield, the northwestern corner and eastern quarter of Warwick and the southern half of Nulla, resulting in a yellowish hue in the Ternary radiometrics. In Nulla, there was a pale line along the southern edge of the eastern relict lake.

Data from each of the 3 subsets of the radiometrics data was normally distributed. This is shown by each of the histograms in Figure 4.4 where the frequency is highest in the centre and has tails of lower frequency that are close to symmetric. Spatial patterns differed between the EM and radiometrics surfaces.

The radiometrics surfaces, together with the EM and elevation surfaces were used to map the distribution of soil properties in Section 5.

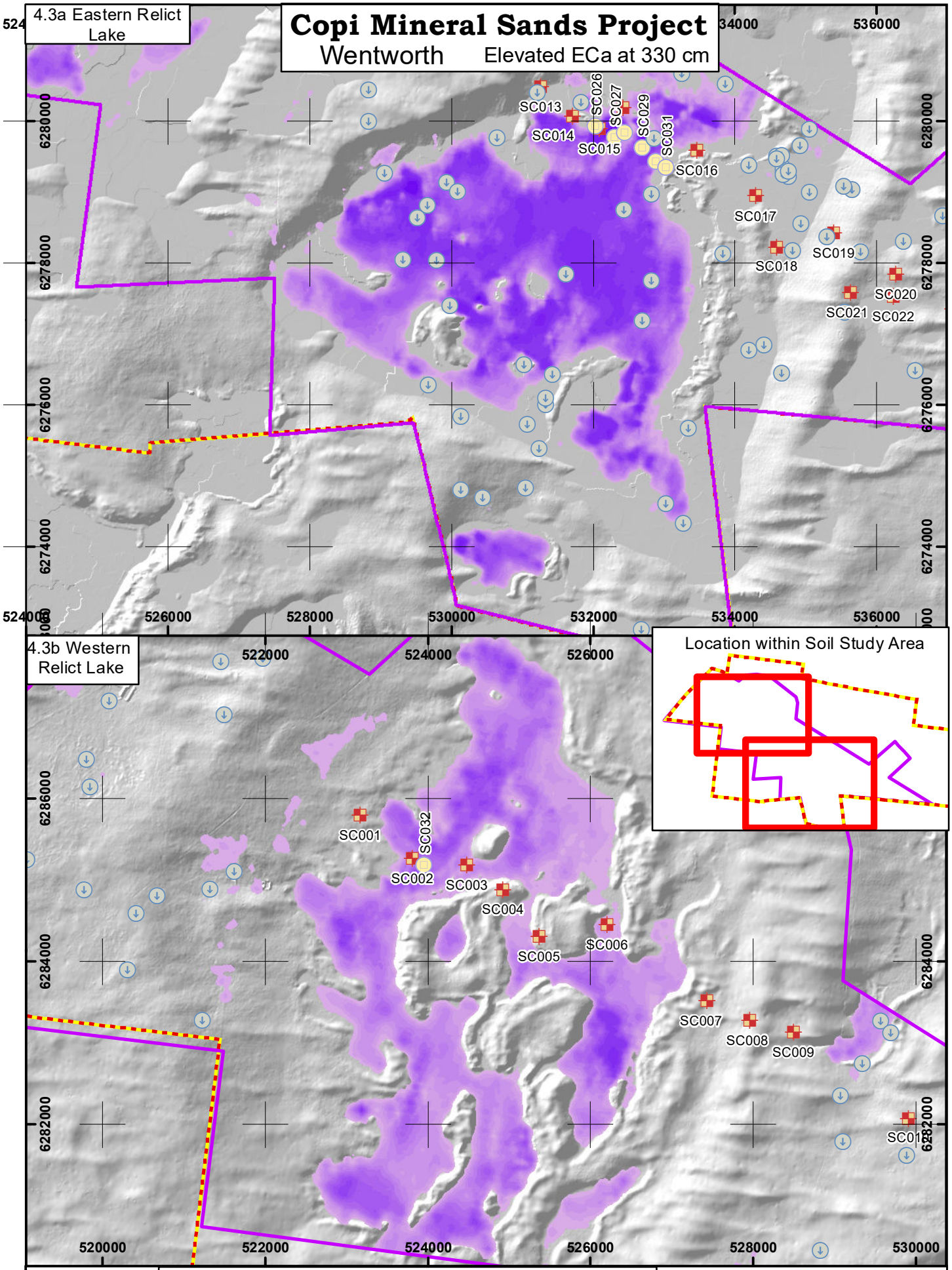
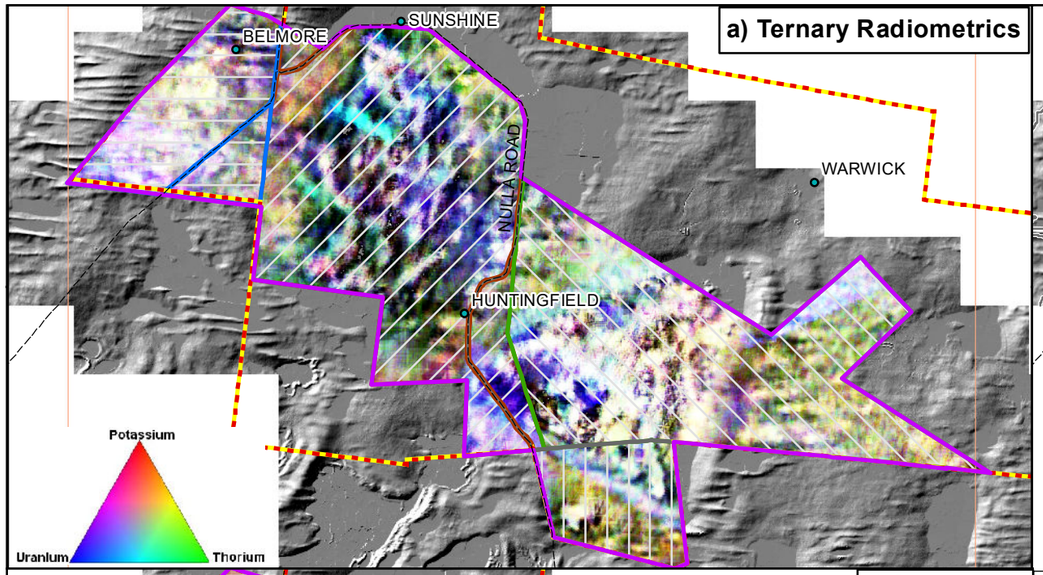

4.3a Eastern Relict Lake
Copi Mineral Sands Project
Wentworth
Elevated ECa at 330 cm
SC013
SC014
SC015
SC026
SC027
SC029
SC031
SC016
SC017
SC018
SC019
SC020
SC021
SC022
4.3b Western Relict Lake
Location within Soil Study Area
SC001
SC032
SC002
SC003
SC004
SC005
SC006
SC007
SC008
SC009
524000
526000
528000
530000
532000
534000
536000
520000
522000
6280000
6278000
6276000
6274000
6286000
6284000
6282000
Certification
Site_Type
Detailed Pit
Acid Sulphate Site
Core
Soil Study Area
Mine Site Boundary
ECa (mS/m)
<200 mS/cm
201 - 250
251 - 300
301 - 350
351 - 400
401 - 450
451 - 500
501 - 550
551 - 600
601 - 650
651 - 700
701 - 800
801 - 1,000
1,001 - 1,200
1,201 - 1,400
0 0.25 0.5 1 1.5 2
Kilometres
Draft/Uncontrolled Document Unless Signed & Dated
Job Code:CR497
Surveyed: 2020 to 2023
Map Printed:2023
EM Survey: Terrabyte Srevices
Contact: Sustainable Soils Management
Phone : (02) 68 473367
Datum: WGS 84
Projection: UTM
Terrabyte services
SSM
Sustainable Soil Management

Figure 4.3

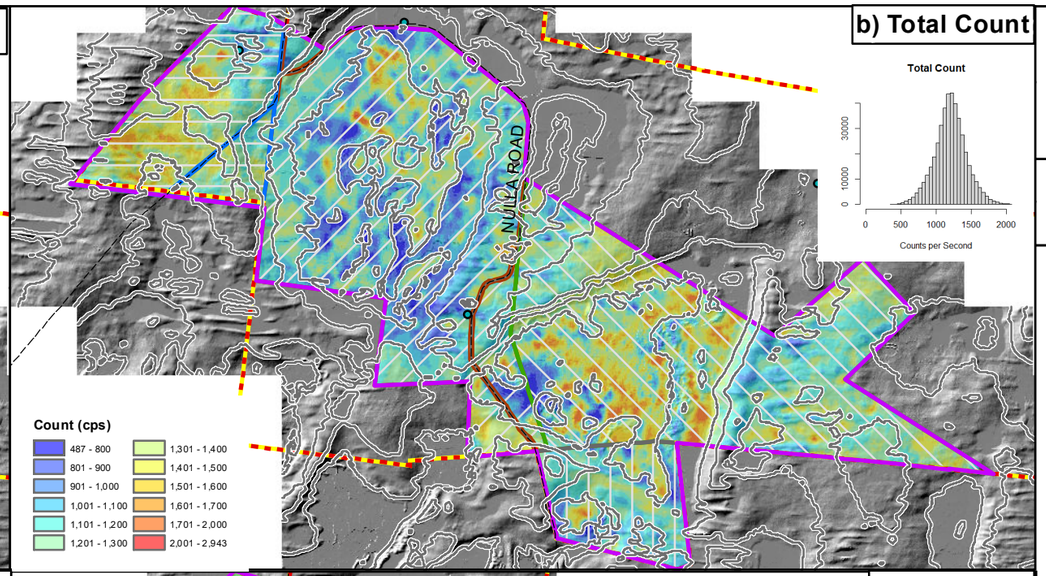
Copi Mineral Sands Project

Wentworth

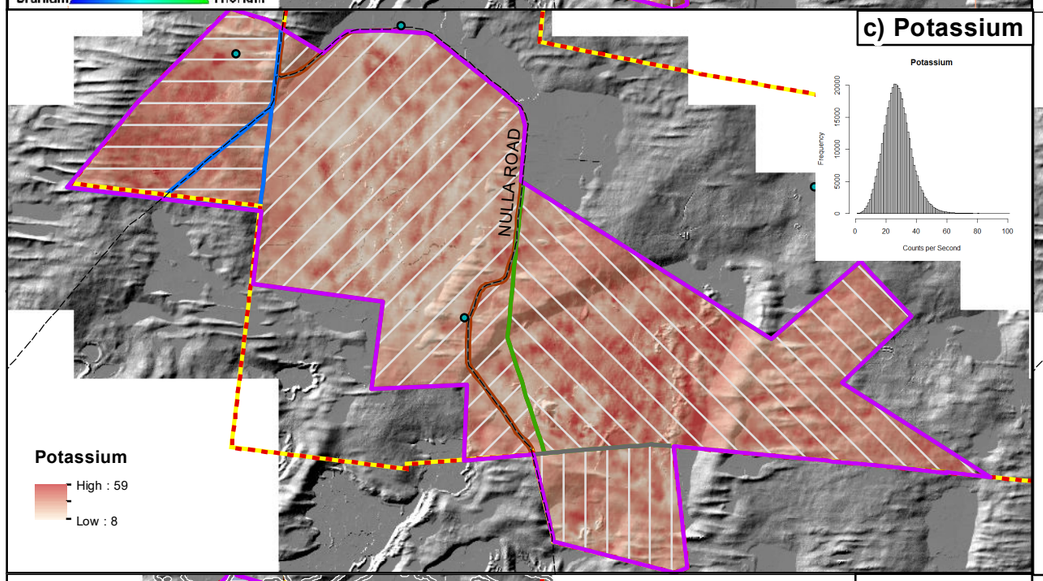
a) Ternary Radiometrics



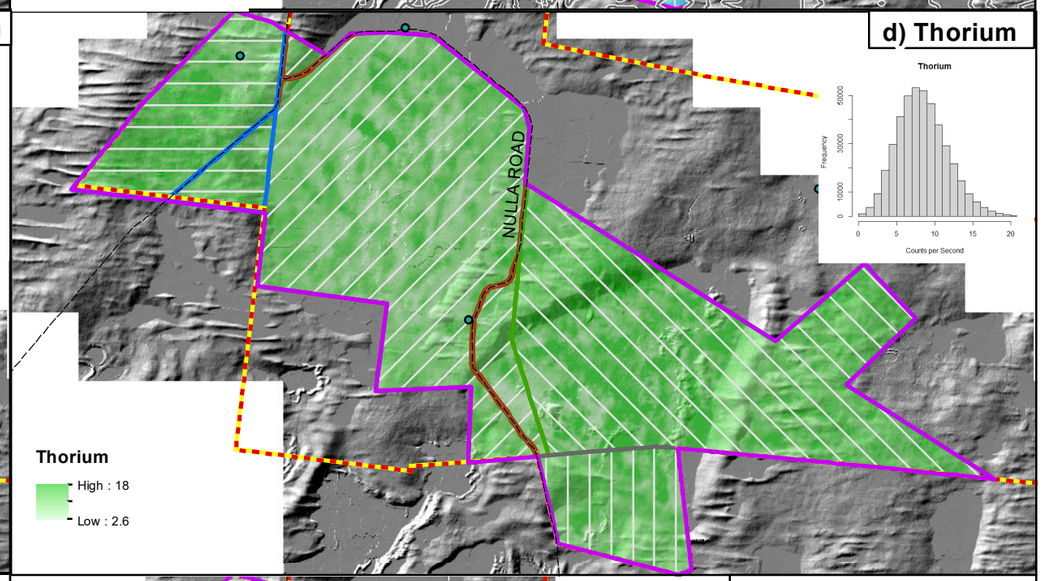
b) Total Count



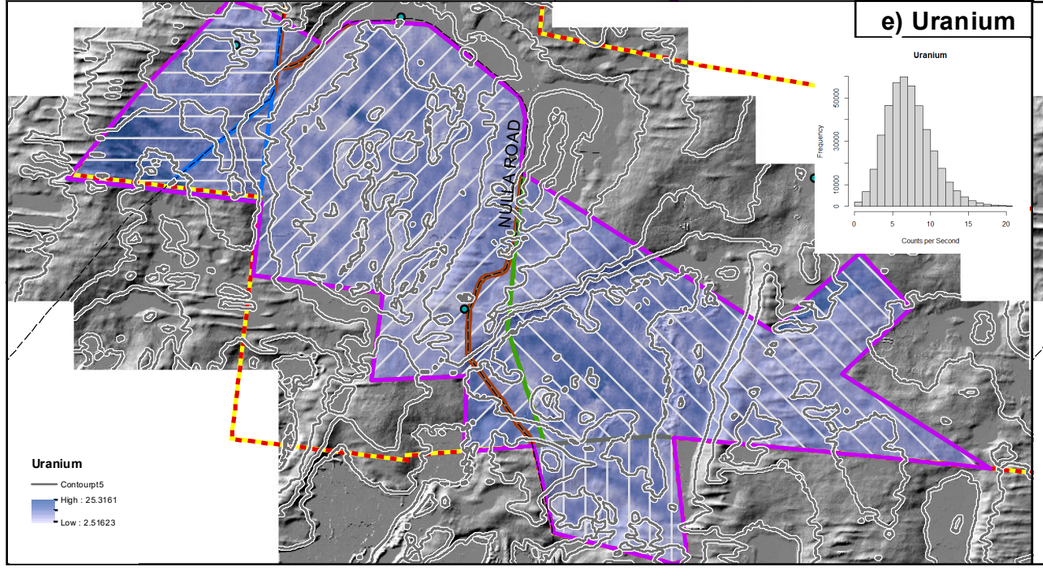
c) Potassium



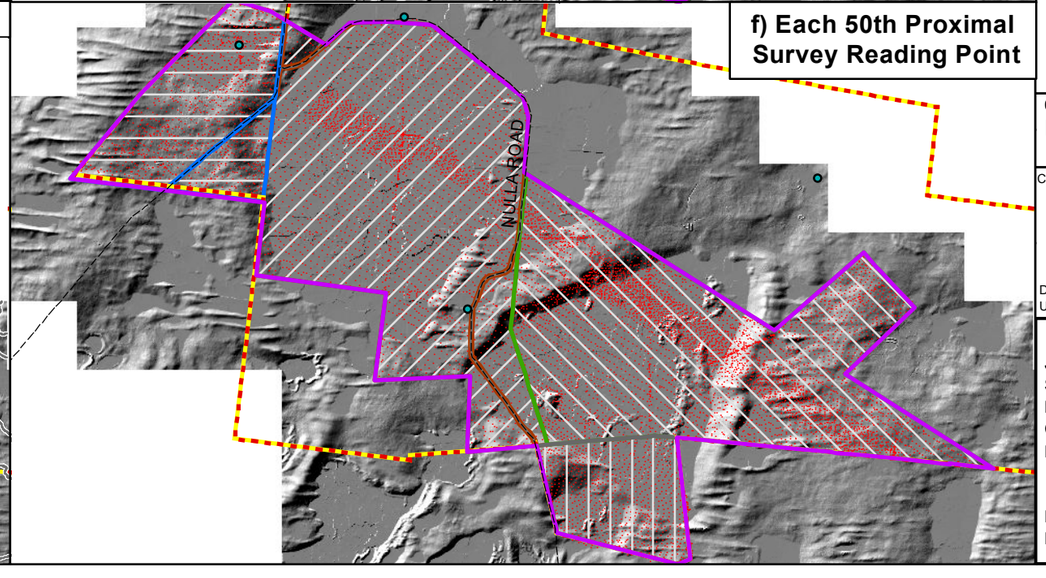
d) Thorium



e) Uranium



f) Each 50th Proximal Survey Reading Point



Gamma Radiometrics

- Homestead
- Road
- Soil Study Area
- Mine Site Boundary

Property

- Belmore
- Huntingfield
- Nulla
- Warwick
- Road Reserve

0 2,300 4,600 6,900 9,200

Metres

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr397
Surveyed: 2022 and 2023
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367

SSM Sustainable Soil Management

Terrabyte services

Datum: WGS 84
Projection: UTM

Figure 4.4

4.4. COMPARISON OF EM AND RADIOMETRICS VALUES

There is a much weaker correlation between values from the EM and gamma radiometrics surveys than between the measurements within either of these surveys. This is illustrated by high correlation coefficient of 0.98 between EM readings for the 0 to 100 and 0 to 330 cm depths and 0.78 between the Total Count and Thorium counts, but 0.33 or lower for comparisons between EM and gamma radiometrics values (Figure 4.5). This difference means that the gamma radiometrics survey collected additional data about soil variation to that collected by the EM survey alone.

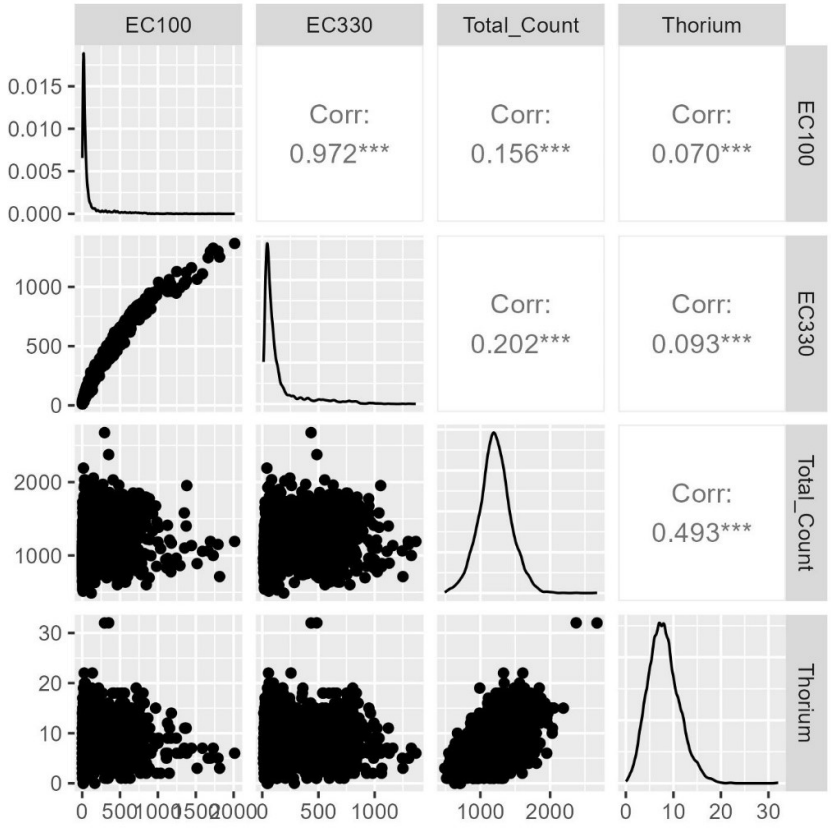


Figure 4.5. Multivariate comparison of EM and gamma radiometrics data collected at Copi Mineral sands Project.

5. OVERVIEW OF SOIL PROPERTIES

This section describes the general theme of soil properties across the Soil Study Area, while Section 6 describes how properties of the mapped Soil Associations vary from this theme. This section first outlines variation in particle size and salt with depth, then the spatial pattern in the depth to critical values of carbonate, sulphate, chloride and clay predicted using Digital Soil Mapping techniques outlined in Section 2.8. Digital Soil Mapping was important in this assessment because permission was given to access Huntingfield for the Proximal Survey (Section 4) and 2020 sampling (Figure 2.2), but not 2022 or 2023 sampling. The section concludes with a table of properties used to differentiate 6 Soil Associations across the Soil Study Area.

The Soil Study Area is in a region characterised by sandy textured, alkaline soil types containing a large proportion of carbonate and are classified as Calcarosols (McKenzie *et al.*, 2004). Calcarosols are common in southwestern NSW in areas with average annual rainfall between 200 and 350 mm. Wetter climate leaches the calcium salts from the profile.

The particle size distributions in Figure 5.1 indicated that the most common texture in the 0 to 15 cm layer was Loamy Sand. The clay content then increased with depth. The most common clay content in the 60 to 100 cm layer would result in sandy clay loam texture, but there is much wider spread in typical clay content in the 60 to 100 cm than shallower layers. The trend in coarse sand with depth is more consistent than clay content, and decreases with depth (Figure 5.1b) as the clay content increases.

a b

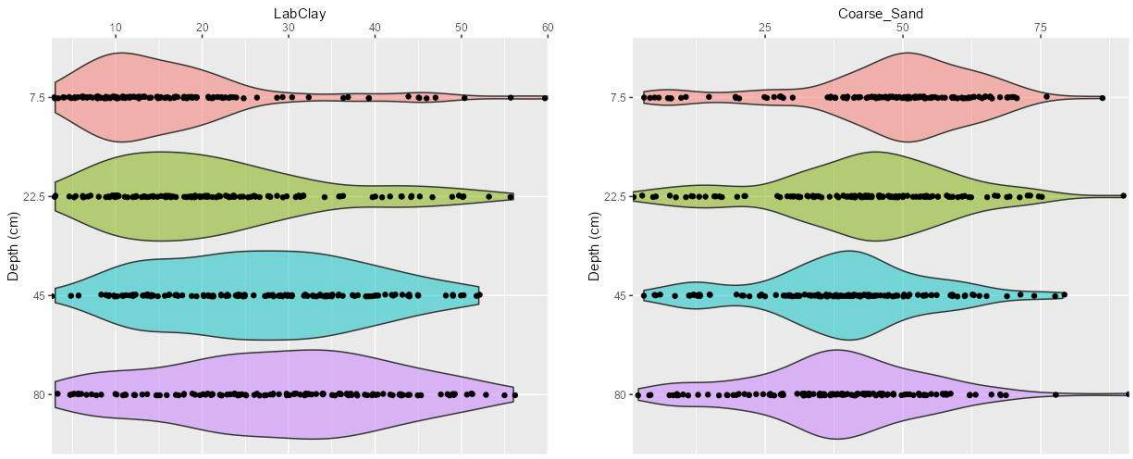


Figure 5.1. Violin plots of percentage clay and coarse sand measured at 4 depths in 126 sites across the Soil Study Area.

The sandy soil in the Soil Study Area has characteristics that are consistent with a landscape in which sand drifts slowly enough that there are substantial and consistent changes in soil properties with depth. Unstable landscapes such as moving sand dunes would have soil with uniform properties through the profile.

As a result, the consistently alkaline pH in Figure 5.2a is typical of soil in the region, as is the presence of calcium carbonate throughout the profile in Figure 5.2b. The presence of Sulphate Sulphur in the samples centred on 45 and 80 cm is common. However, Sulphate frequency of more than 25% of samples with more than 1,000 mg Sulphate Sulphur (Figure 5.2d) is uncommon. Similarly, the trend of chloride concentration increasing with depth is common, but the presence of chloride concentration greater than 1,000 mg/kg in more than 30% of samples in Figure 5.2c is uncommon. The elevated Sulphate Sulphur and chloride concentrations reflect the salts associated with the relict lakes in the Soil Study Area.

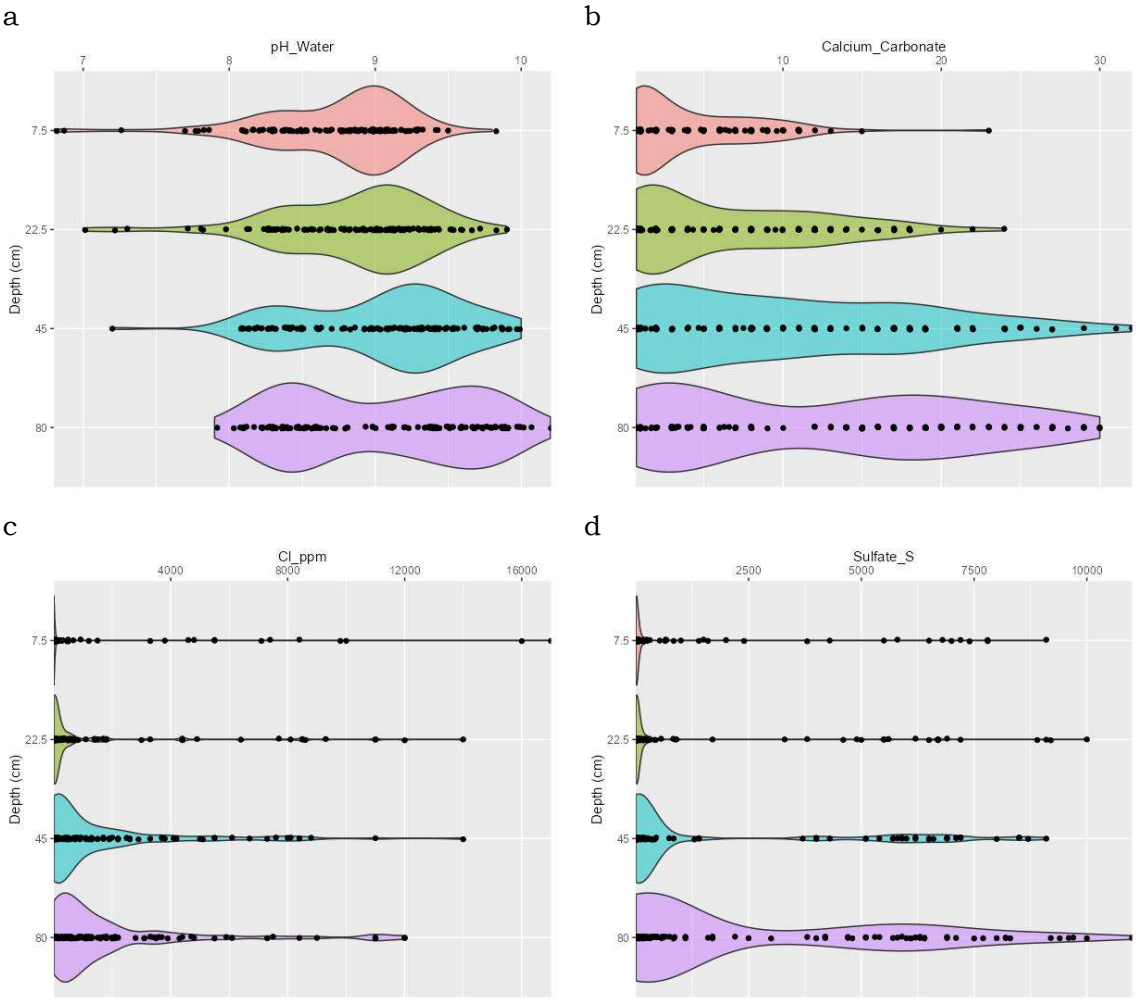


Figure 5.2. Violin plots of soil chemical properties measured at 4 depths in 126 sites across the Soil Study Area.

The spatial patterns of the soil properties were strongly influenced by the relict lakes. Soil pH_{H2O} was generally higher than 8 in all of the Soil Study Area except from some areas in the floor of the relict lakes. An area of 250 ha where pH in the surface layer was less than 8 was estimated using Digital Soil Mapping. The maps in Figure 5.3 show:

- Calcium carbonate concentration was lower than 10% to 100 cm in the majority of the floor of the relict lakes (Figure 5.3a). In contrast, carbonate greater than 10% was encountered between 25 and 50 cm across most of the upland areas, with the exception of low-lying land or swales on Belmore and Warwick, and small areas in Huntingfield and Nulla. These patches coincide with areas with ECa 330 cm between 150 and 200 mS/m (Figure 4.2).
- Soil chloride greater than 1,000 mg/kg in the surface 100 cm is predicted to occur in the floor of the relict lakes as well as low-lying patches in Belmore, and other patches with elevated ECa (Figure 5.3b).
- Soil clay was lower in the sites sampled in Huntingfield than either Belmore or Warwick shown by the small bar charts in Figure 5.3c). As a result, the digital soil mapping predicted a large depth to 30% clay in the western relict lake on Huntingfield than in the eastern relict lake on Warwick. It is possible that the lower clay content coincides with an area where the Blanchetown Clay Formation is missing. Elevated clay content was sampled in the low-lying areas on Warwick and Nulla and east of the eastern relict lake.
- The predicted depth to 500 mg/kg of sulphate sulphur followed a similar pattern to that for chloride (Figure 5.3). However, there were some patches of shallow elevated sulphate sulphur to the west of both relict lakes where chloride concentration was less than 1,000 mg/kg.

a) Calcium Carbonate 10%

b) Chloride 1,000 mg/kg

c) Clay 30% (Clay Loam or heavier)

d) Sulphate 500 mg/kg

BELMORE
SUNSHINE
HUNTINGFIELD
520000
530000
540000
6280000

Carbonate
15
cm7_5
cm22_5
cm45
cm80

Calcium_Carbonate
10 20 30

Chloride
8,500
cm7_5
cm22_5
cm45
cm80

Cl_ppm
4000 8000 12000 16000

% Clay
30
cm7_5
cm22_5
cm45
cm80

LabClay
10 20 30 40 50 60

Sulphate Sulphur
5,500
cm7_5
cm22_5
cm45
cm80

Sulfate_S
2500 5000 7500 10000

7.5
22.5
45
80

Copi Mineral Sands Project

Wentworth

Depth to Critical Soil Properties

Depth (cm)

- 8 - 10
- 11 - 25
- 26 - 50
- 51 - 75
- 76 - 101

Soil Associations
Soil Study Area
Mine Site Boundary

Property

- Belmore
- Huntingfield
- Nulla
- Warwick
- Road Reserve

Homestead

0 1 2 3 4
km
1 cm = 1.4 km on A3

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr498

Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367

Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 5.3

The cumulative distribution function in Figure 5.4 indicates more than half the pixels in the maps in Figure 5.3 had carbonate 10% deeper than 100 cm, a similar proportion had sulphate sulphur of 500 mg/kg deeper than 100 cm, more than 60% of sites had chloride concentration less than 1,000 mg/kg and 70% of sites had clay content less than 30% to 100 cm.

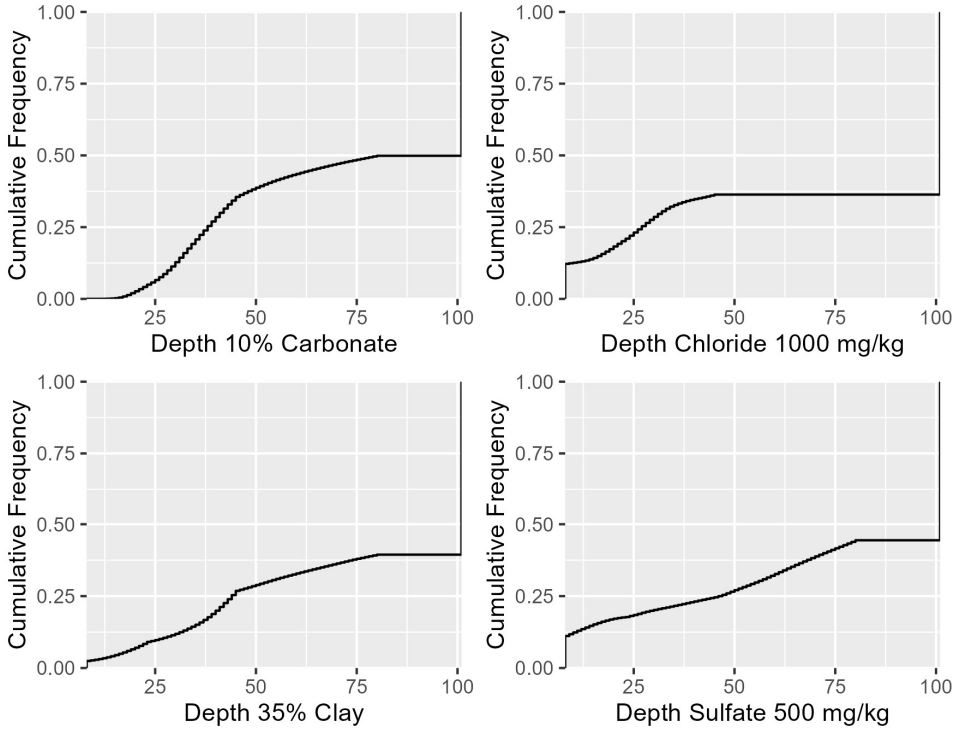


Figure 5.4. Copi Mineral Sands Project cumulative frequency distribution of depths to critical soil properties.

Six Soil Associations were mapped across the Soil Study Area based on a range of measurements as shown in Table 5.1. Location of Association boundaries was aided by a map of soil clusters that were generated from depth weighted average soil chloride, clay content, and pH. Profile average was used rather than the critical depths in Figures 5.3 and 5.4 because there were too many 0s and 100s for the process to work effectively These associations are described in more detail in Section 6.

Table 5.1. Criteria used to map Soil Associations

Soil Association	EM330 Zone	Land shape	Geological Unit	Radiometrics	Checks from Digital Soil Mapping
Dunefield and Sand Plains	Very low on dunes. Higher in swales	Areas of level plains and areas with dunes and swales.	Aeolian Sandplain and Woorinen formation	Higher total count in dunes than swales	Carbonate present across area, elevated chloride not detected, elevated sulphate rare, less clay in dunes than swales
Blanche-town Clay	Moderate (125 – 200)	Level, broad depression	Blanchetown	Total count moderate to high	Large depth to carbonate, moderate depth to chloride, sulphate and clay 35%.
Lunettes	Low to moderate	Large north-south dunes to east of lakes.	Lunettes	Moderately low	About half area had carbonate 10% shallower than 1 m.
Lunettes with Copi	Moderately low (25 to 125)	Mostly east of a relict lake.	Lunettes with Kopi	Low	LS factor > 0.8 in tall lunette east of eastern relict lake
Lake Floor East and Lake Floor West	Very high (>200)	Base of closed depression	Yamba		Elevated chloride and sulphate, eastern lake more clayey than western lake.

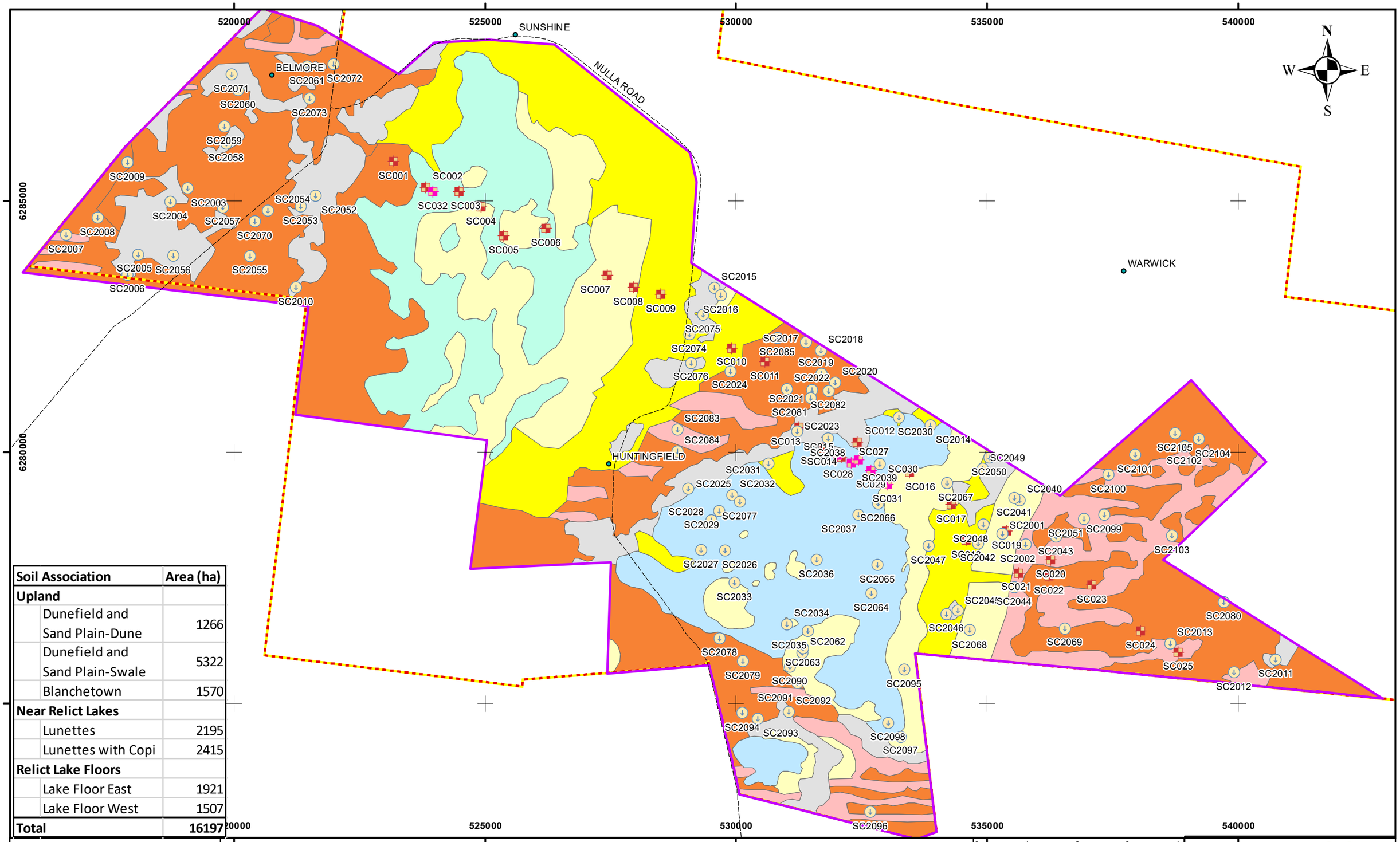
6. SOIL ASSSOCIATIONS

6.1. DESCRIPTION OF SOIL ASSOCIATIONS

Six Soil Associations, which are groups of soil with similar properties in similar landforms were mapped across the Soil Study Area (Figure 6.1). General properties are:

- **Dunefield and Sand Plains** which had profiles of red sandy topsoil over sand to sandy clay loam subsoil. The landform ranged from undulating plains to dunes and swales. Profiles had low salinity, but carbonate was common. This Association was subdivided into the **dunes phase** with less clay, salt, and sulphate than the **swales phase**.
- **Blanchetown Clay** occupied low lying areas in Belmore, the western slope of the eastern relict lake, and several depressions in Warwick. The texture profile was sandy surface soil over moist, plastic clayey subsoil, which was associated with moderate salinity.
- **Lunettes** on the eastern side of the relict lakes. It appears that these lunettes contain a large proportion of material that has been blown out of the relict lakes.
- **Lunettes with Copi** was either near or downwind of the relict lakes, which are their likely source of the copi or flour gypsum. Profiles contained a mixture of salts of carbonate, sulphate and chloride.
- **Lake Floor East** is the floor of the eastern relict lake. Soil salt chemistry appears to be dominated by chloride and sulphate. Soil was clayey.
- **Lake Floor West** is the floor of the western relict lake. Soil salt chemistry appears to be dominated by sulphate. Sampled soil was sandy.

Soil properties of these Associations are described below.



Soil Association	Area (ha)
Upland	
Dunefield and Sand Plain-Dune	1266
Dunefield and Sand Plain-Swale	5322
Blanchetown	1570
Near Relict Lakes	
Lunettes	2195
Lunettes with Copi	2415
Relict Lake Floors	
Lake Floor East	1921
Lake Floor West	1507
Total	**16197**

Copi Mineral Sands Project

Wentworth

Soil Associations

Soil Study Area
Mine Site Boundary
Homestead
Road

Site_Type
Core
Pit
AcidSS Pit

Associations
Upland
Dunes and Sandplains-Dunes
Dunes and Sandplains-Swale
Blanchetown

Near Lake
Lunettes
Lunettes with Copi

Relict Lake Floor
Lake Floor East
Lake Floor West

0 1 2 3 4
kilometres
1 cm = 0.7 km on A3

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr498
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367

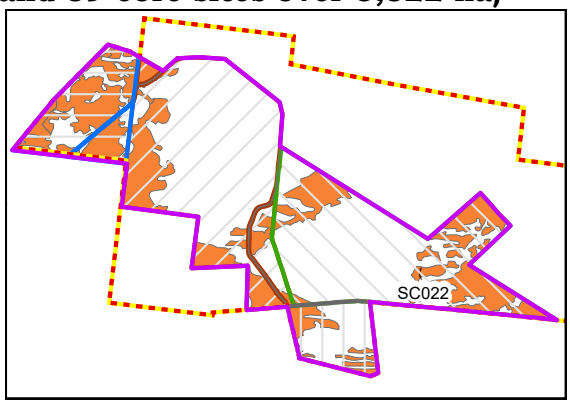
Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 6.1

6.1.1. Swales Phase of Dunefield and Sand Plains Soil Association (5 pits and 39 core sites over 5,322 ha)

Profiles in the Dunefield and Sand Plains Soil Association had the potential to be well drained. Despite this, they had an accumulation of carbonate in the soil. This accumulation is consistent with the large excess of potential evapotranspiration over rainfall as shown in Figure 3.1 and is shown by the classification of the soil as Calcarosols.



Representative Soil Test Pit Profile Description: Dunefield and Sand Plains: Swales

Soil Test Pit: SC022	
	
Soil Test Pit SC022	**Landscape view, soil test pit SC022**
Australian Soil Classification Order	Calcarosol (34), Chromosol (8), Kandosol (1), Rudosol (1)
Australian Soil Classification Sub-order	Supracalcic (8), Lithocalcic (2), Hypercalcic (10), Calcic (11), Hypocalcic (3), Red (9), Stratic (1)
Representative Soil Test Pits	SC001, SC011, SC022, SC023, SC024, SC2003, SC2008, SC2009, SC2012, SC2013, SC2017, SC2018, SC2019, SC2020, SC2021, SC2022, SC2024, SC2043, SC2053, SC2054, SC2055, SC2057, SC2059, SC2060, SC2061, SC2070, SC2072, SC2073, SC2078, SC2079, SC2080, SC2081, SC2082, SC2084, SC2085, SC2091, SC2093, SC2094, SC2096, SC2099, SC2101, SC2103, SC2104, SC2105
Drainage	Poorly (7%), Imperfectly (11%), Moderately well (36%), Well (43%), Rapidly (2%)
Average ECa for Surface to 3.3 m	79 mS/m (standard deviation 32 mS/m)

6.1.1.1. Swales Phase of Dunefield and Sand Plains Soil Association Chemistry

The pH of the pits sampled in the Swales Phase of Dunefield and Sand Plains was alkaline (Figure 6.2). This was consistent between pits and between depths within pits.

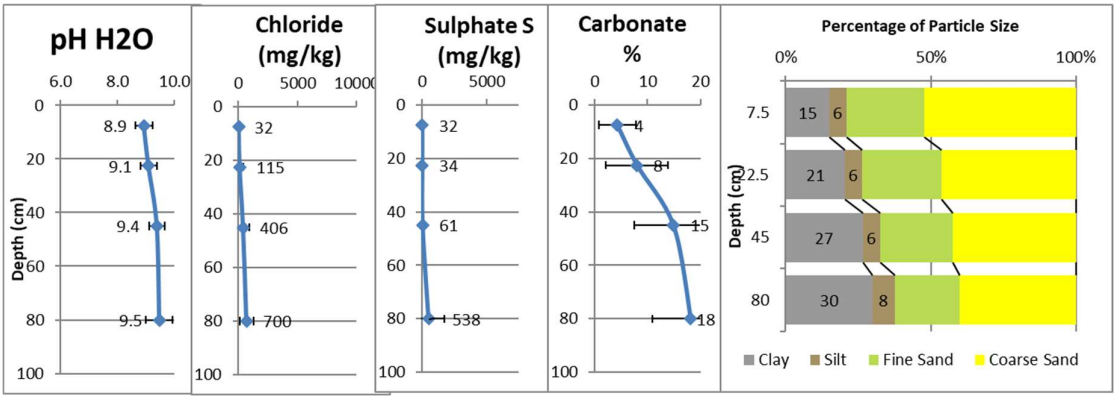


Figure 6.2. Chemistry Summary for Swales Phase of Dunefield and Sand Plains Association in the Soil Study Area.

Concentrations of chloride, an indicator of salinity, were desirably low for all depths except the 60 to 90 cm layer where values were marginally high.

Sulphate concentration was low to moderate in the top 3 layers, and higher than 250 mg/kg in the 60 to 100 cm layer in 15 of 44 sites. This is consistent with field observations of gypsum in pits.

Carbonate concentration was high throughout the profile that the average soil was classified as calcic, and increased with depth.

Average clay content increased from 15% in the 0 to 15 cm layer to around 30% in deeper layers. Coarse sand accounted for the majority of the remainder of the soil particles.

Cation ratios were dominated by calcium (Figure 6.3). Exchangeable Sodium Percentage (ESP) increased from desirably low 2.6% in the 0 to 15 cm layer to 17% in the 60 to 100 cm layer. This trend will be important for rehabilitation. Cation exchange capacity was about double the expected value for the soil clay content and increased with depth from 25 to 35 meq/100g, which is in the desirable range.

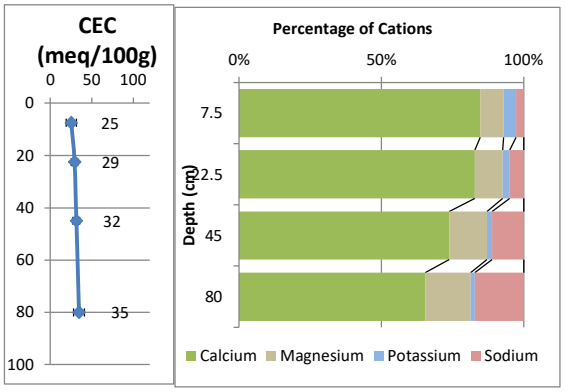
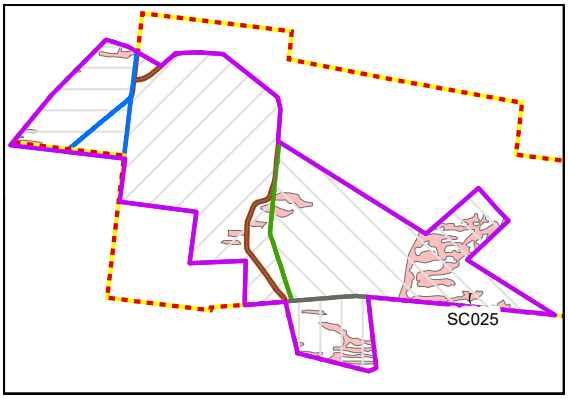


Figure 6.3. Cation Ratios in Swales Phase of Dunefield and Sand Plains Association in the Soil Study Area (average of 15 sites).

Soil nutrition was measured at 15 sites. Topsoil organic carbon was 0.4%, (s.d. 0.1%), nitrate N was 6.1 mg/kg, (s.d. 6.2) and available P was 10 mg/kg (s.d. 3.3). Micronutrient levels were: Zinc 0.2 mg/kg, (s.d. 0.2), Copper 0.8 mg/kg, (s.d. 0.2), Manganese 3.5 mg/kg (s.d. 0.9), and Iron 3.4 mg/kg (s.d. 0.7). These values indicates that nutrients except sulphur and copper were at relatively low levels. This is appropriate for species that are adapted to this nutrition regime.

Soil in the sampled layers of the Swales Phase of the Dunefield and Sand Plain Association did not contain plant limiting concentrations of anions, making it a suitable medium for plants that can tolerate high pH, low water availability and relatively low nutrient concentrations. Nutrient levels were generally adequate. However, it has the ubiquitous limitation for rehabilitation of being susceptible to wind erosion because it is very sandy and has very low organic carbon.

6.1.2. Dunes Phase of Dunefield and Sand Plains Soil Association: (3 pits and 8 core sites over 1,266 ha)



Profiles in the Dunes Phase of Dunefield and Sand Plains Soil Association were higher in the landscape and had sandier surface soil than the Swales Phase. Despite being well drained, they had an accumulation of carbonate in the soil. This accumulation is consistent with the large excess of potential evapotranspiration over rainfall as shown in Figure 3.1 and is shown by the classification of the soil as Calcarosols.

Representative Soil Test Pit Profile Description: Dunefield and Sand Plains: Dunes

Soil Test Pit: SC022	
	
Soil Test Pit SC025	**Landscape view, soil test pit SC025**
Australian Soil Classification Order	Calcarosol (9), Chromosol (2)
Australian Soil Classification Sub-order	Supracalcic (2), Lithocalcic (1), Hypercalcic (3), Calcic (1), Hypocalcic (2), Red (1), Brown (1)
Representative Soil Test Pits	SC020, SC021, SC025, SC2002, SC2007, SC2044, SC2051, SC2069, SC2083, SC2100, SC2102
Drainage	Moderately well (55%), Well (36%), Rapidly (9%)
Average ECa for Surface to 3 m	46 mS/m (standard deviation 17 mS/m)

6.1.2.1. Dunes Phase of Dunefield and Sand Plains Soil Association Chemistry

The pH of the pits sampled in the Dunes Phase of Dunefield and Sand Plains was alkaline (Figure 6.3). This was consistent between pits and between depths within pits.

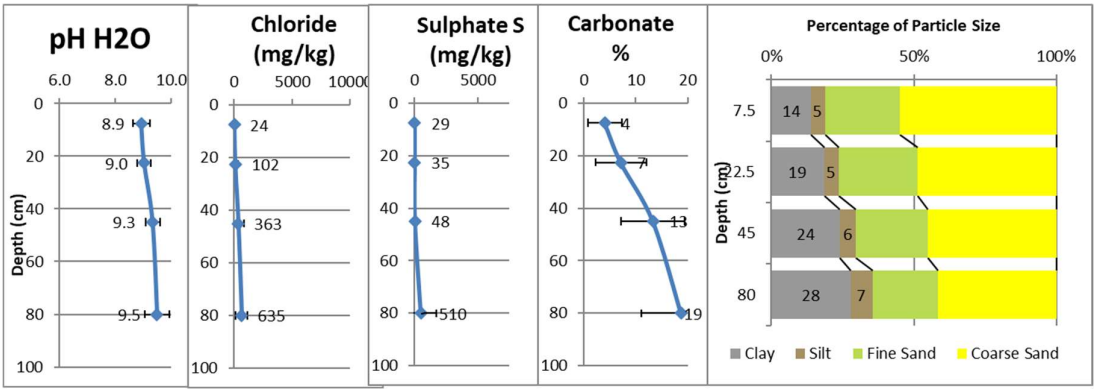


Figure 6.4. Chemistry Summary for Dunes Phase of Dunefield and Sand Plains Association in the Soil Study Area.

Concentrations of chloride, an indicator of salinity, were desirably low for all depths except the 60 to 90 cm layer where values were marginally high.

Sulphate concentration was low to moderate in the top 3 layers, and higher than 250 mg/kg in the 60 to 100 cm layer in 2 of 11 sites. This is consistent with field observations of gypsum in pits.

Carbonate concentration was high throughout the profile that the average soil was classified as calcic, and increased with depth.

Average clay content increased from 14% in the 0 to 15 cm layer to around 28% in deeper layers. Coarse sand accounted for the majority of the remainder of the soil particles.

Cation ratios were dominated by calcium (Figure 6.5). Exchangeable Sodium Percentage (ESP) increased from desirably low 1.6% in the 0 to 15 cm layer to 16% in the 60 to 100 cm layer. This trend will be important for rehabilitation. Cation exchange capacity increased with depth from 20 to 33 meq/100g, which is in the desirable range.

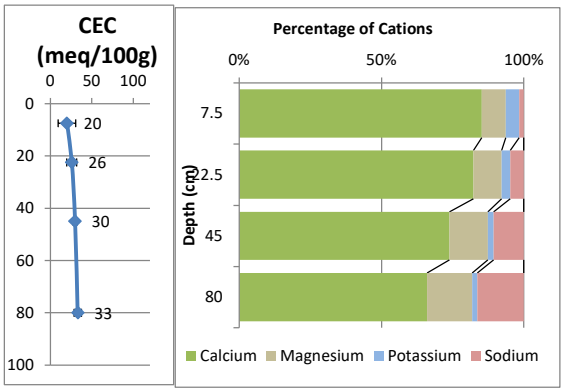


Figure 6.5. Cation Ratios in Dunes Phase of Dunefield and Sand Plains Association in the Soil Study Area (average of 3 sites).

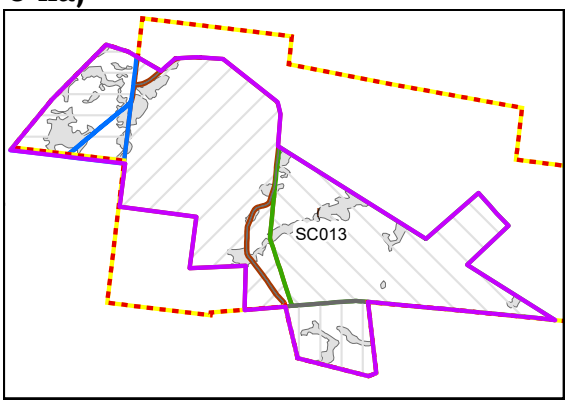
Soil nutrition was measure at 3 sites. Topsoil organic carbon was 0.3%, (s.d. 0.1%), nitrate N was 6.5 mg/kg, (s.d. 6.1) and available P was 11 mg/kg (s.d. 5.6). Micronutrient levels were: Zinc 0.3 mg/kg, (s.d. 0.1), Copper 0.5 mg/kg, (s.d. 0.2), Manganese 2.8 mg/kg (s.d. 0.2), and Iron 2.1 mg/kg (s.d. 0.4).

Soil in the sampled layers of the Dunes Phase of the Dunefield and Sand Plain Association did not contain plant limiting concentrations of anions making it a suitable medium for plants that can tolerate high pH, relatively low nutrient concentrations and low water availability. Nutrient levels were generally adequate. However, it has the ubiquitous limitation for rehabilitation of being susceptible to wind erosion because it is very sandy and has very low organic carbon.

The Dunes Phase of the Dunefield and Sand Plain Association, had slightly more coarse sand, was slightly less salty and had slightly less sulphate than the Swales Phase of the Dunefield and Sand Plain Association. The small difference in soil properties between dunes and swales is most likely associated with slow movement of the dunes as the soil surface is stabilised by the vegetation. As such, soil from the 2 phases can be managed together during rehabilitation, with some accounting for differences in topsoil thickness.

6.1.3. Blanchetown Clay Soil Association (3 pits and 16 core sites over 1,570 ha)

Profiles in the Blanchetown Clay Soil Association commonly had a pattern of sandy or loamy topsoil over clayey subsoil as depicted below. The clayey subsoil appears to have restricted drainage to the extent that salts have built up in the profiles sampled.



Representative Soil Test Pit Profile Description: Blanchetown Clay

Soil Test Pit: SC013	
	
Soil Test Pit SC013	**Landscape view, soil test pit SC013**
Australian Soil Classification Order	Calcarosol (10), Chromosol (7), Kandosol (2)
Australian Soil Classification Sub-order	Hypercalcic (4), Supracalcic (2), Calcic (2), Hypocalcic (1), Hypergypsic (2), Red (6), Brown (2)
Representative Soil Test Pits	SC012, SC013, SC014, SC2004, SC2005, SC2006, SC2010, SC2011, SC2015, SC2023, SC2025, SC2045, SC2050, SC2052, SC2056, SC2058, SC2071, SC2076, SC2092
Drainage	Imperfectly (32%), Moderately well (53%), Well (16%)
Average ECa for Surface to 3.3 m	155 mS/m (standard deviation 49 mS/m)

6.1.3.1. Blanchetown Clay Soil Association Chemistry

Soil in the Blanchetown Clay Association was consistently alkaline and changed little through the profile (Figure 6.6).

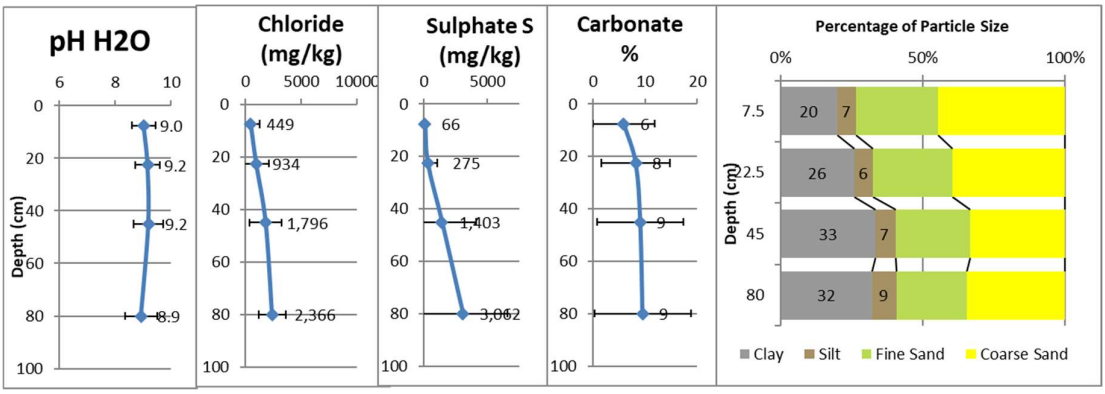


Figure 6.6. Chemistry Summary for Blanchetown Association in the Soil Study Area.

Chloride concentration increased from desirably low in the 0 to 15 cm layer to a plant limiting concentration of 2,400 mg/kg for 60 to 100 cm.

Sulphate sulphur was also low in the surface, and increased to 3,000 mg/kg in the 60 to 100 cm layer.

Average carbonate concentration was around 10% through the profile.

Average clay content increased from 20% in the 0 to 15 cm layer to 32% in the 60 to 100 cm layer. The coarser soil particles had a wide range of grain sizes.

Cation ratios followed a pattern of adequate calcium, moderate magnesium and potassium, and higher ESP than optimum (Figure 6.7). Each of the 4 sites tested had higher ESP than optimum in at least 2 of the 4 layers tested. CEC appears to have been artificially inflated by gypsum in the soil.

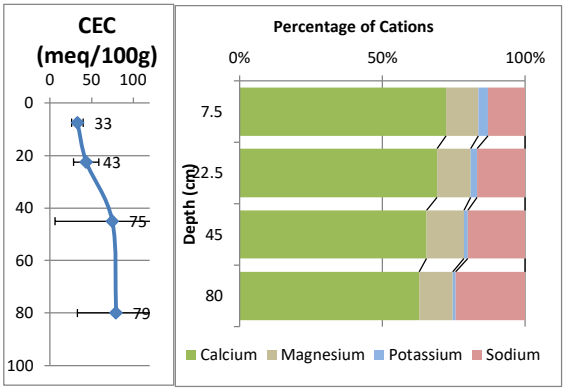


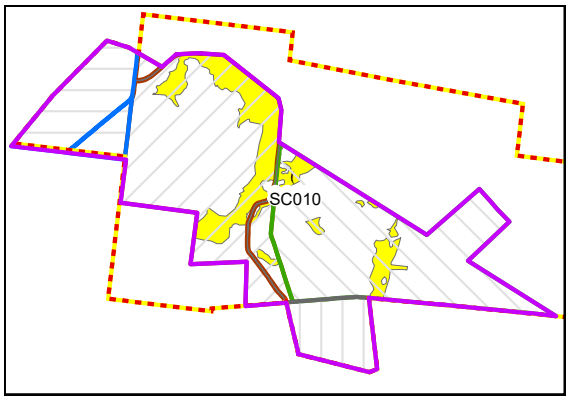
Figure 6.7. Cation Ratios in Blanchetown Clay Association in the Soil Study Area (Average of 4 sites).

Soil nutrition was measured at 2 sites. Topsoil organic carbon was 0.4%, nitrate N was 11 mg/kg, (s.d. 17) and available P was 6.5 mg/kg. Micronutrient levels were: Zinc 0.2 mg/kg, (s.d. 0), Copper 1.1 mg/kg, (s.d. 0.3), Manganese 4.3 mg/kg (s.d. 1.5), and Iron 1.8 mg/kg (s.d. 1.8).

Soil in the Blanchetown Clay Association had topsoil that is a reasonable medium for plant growth over hostile subsoil. This soil would not be expected to be productive in its natural state and will require care to be used successfully for rehabilitation.

6.1.4. Lunettes Soil Association (3 pits and 6 core sites over 2,195 ha)

Soil in the Lunettes Soil Association appeared to contain sediment that had been moved by wind from relict lakes to the west. This was evident in the pale soil colour, which appears to be influenced by particles of gypsite and other salts that have blown out of the relict lakes.



Representative Soil Test Pit Profile Description: Lunettes

Soil Test Pit: SC010	
	
Soil Test Pit SC010	**Landscape view, soil test pit SC010**
Australian Soil Classification Order	Arenosol (2), Calcarosol (7)
Australian Soil Classification Sub-order	Red (2), Lithocalcic (1), Hypercalcic (2), Supracalcic (3), Calcic (1)
Representative Soil Test Pits	SC009, SC010, SC018, SC2042, SC2046, SC2048, SC2049, SC2074, SC2075
Drainage	Moderately well (44%), Well (33%), Rapidly (22%)
Average ECa for Surface to 3.3 m	65 mS/m (standard deviation 39 mS/m)

6.1.4.1. Lunettes Soil Association Chemistry

Average soil pH in the Lunettes Association increased from 7.9 to 8.4 with depth (Figure 6.8).

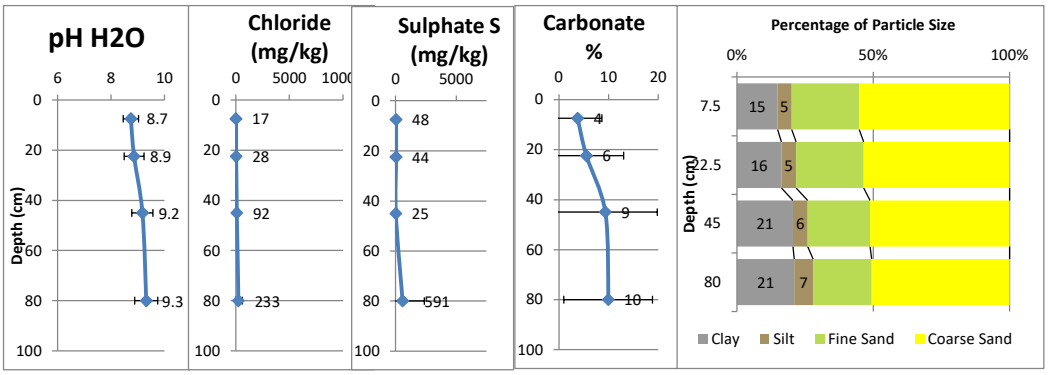


Figure 6.8. Chemistry Summary for Lunettes Association in the Soil Study Area.

The 3 anions of chloride, sulphate and carbonate followed different patterns with depth in the profile. Carbonate concentration increased from the 0 to 15 to the 30 to 60 cm layer, then remained constant to the 60 to 100 cm layer. Sulphate increased throughout the 4 layers tested. Average soil chloride increased with depth, but was desirably low for all layers tested.

Clay content increased from around 15% in the 0 to 15 cm layer to around 21% in the 60 to 100 cm layer. The majority of the remainder of soil particles were coarse sand.

Cation ratios were dominated by calcium (Figure 6.9). ESP was desirably low through the profile. Cation Exchange was relatively low through the profile with a maximum of 9 meq/100g in the 60 to 100 cm layer.

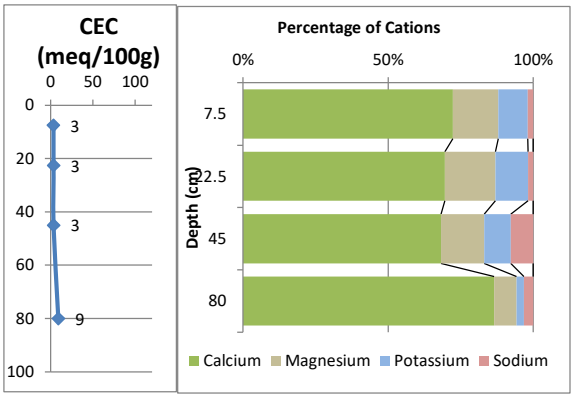


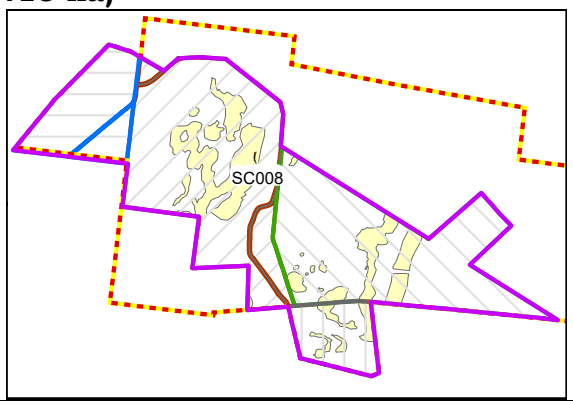
Figure 6.9. Cation Ratios in Lunettes Association in the Soil Study Area (from 1 site).

Soil chemistry was measured at one site. Topsoil organic carbon was 0.2%, nitrate N was 5.8 mg/kg, (s.d. 3.5) and available P was 6 mg/kg. Micronutrient levels were: Zinc 0.2 mg/kg, Copper 0.2 mg/kg, Manganese 3.1 mg/kg, and Iron 1.6 mg/kg.

Soil in the Lunettes Association did not contain concentrations of salts that would limit plant growth. Nutrient levels were moderately low. This indicates that soil in the Lunettes Association could be used as topsoil during rehabilitation. It is likely that gypsite or copi occur in the Lunettes Association below the depths sampled.

6.1.5. Lunettes with Copi Soil Association (7 pits and 15 core sites over 2,415 ha)

Soil in the Lunettes with Copi Soil Association was strongly influenced by material moved by wind from relict lakes to the west. This was evident in the common observation of layers of gypsum or copi in the sites examined.



Representative Soil Test Pit Profile Description: Lunettes

Soil Test Pit: SC008	
	
Soil Test Pit SC008	**Landscape view, soil test pit SC008**
Australian Soil Classification Order	Calcarosol (18), Chromosol (3), Kandosol (1)
Australian Soil Classification Sub-order	Supracalcic (3), Hypercalcic (3), Calcic (2), Hypergypsic (8), Red (3), Brown (1)
Representative Soil Test Pits	SC004, SC005, SC007, SC008, SC016, SC017, SC019, SC2001, SC2016, SC2033, SC2034, SC2035, SC2040, SC2041, SC2047, SC2062, SC2063, SC2067, SC2068, SC2090, SC2095, SC2097
Drainage	Imperfectly (5%), Moderately well (32%), Well (64%)
Average ECa for Surface to 3 m	60 mS/m (standard deviation 50 mS/m)

6.1.5.1. Lunettes with Copi Soil Association Chemistry

Soil pH in the Lunettes with Copi Association was around 8.5 throughout the profile (Figure 6.10) which is intermediate in the Soil Study Area.

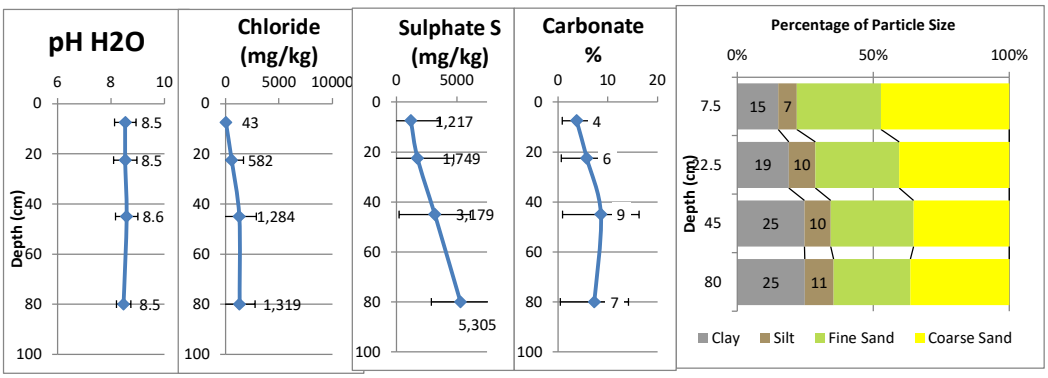


Figure 6.10. Chemistry Summary for Lunettes with Copi Association in the Soil Study Area.

The 3 anions of chloride, sulphate and carbonate were all present at concentrations high enough to indicate that wind-blown sediment from relict lakes had added these salts to the profile. Chloride levels were desirably low in the 0 to 15 cm layer and increased to levels that would limit plant growth in the 30 to 100 cm layer. There was large variation in Sulphate Sulphur, but average concentrations from 1.2 to 5.3 g/kg where carbonate levels were also moderately high.

Clay content increased from around 15% in the 0 to 15 cm layer to around 25% in the 60 to 100 cm layer. The remainder of soil particles were a mixture of sand sizes.

Cation ratios in the Lunettes with Copi Association were dominated by calcium (Figure 6.11). However, the very high average CEC of 50 to 130 meq/100g indicates that the measurements are affected by salts, so the results are unreliable.

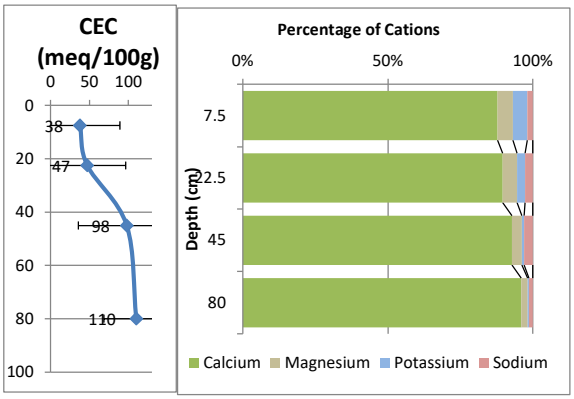


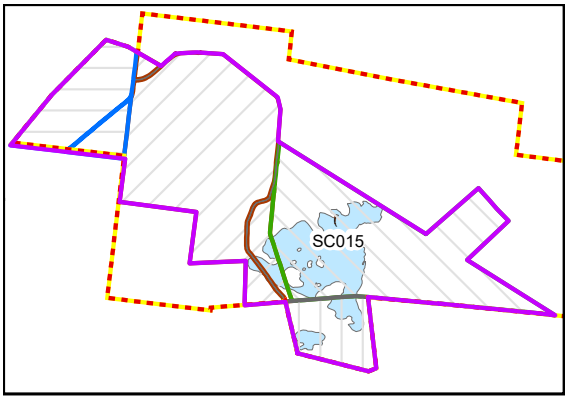
Figure 6.11. Cation Ratios in Lunettes with Copi Association in the Soil Study Area (8 sites).

Soil nutrition was measured at 5 sites. Topsoil organic carbon was 0.4%, (s.d. 0.2%), nitrate N was 6.3 mg/kg, (s.d. 4.8) and available P was 11.2 mg/kg (s.d. 4.5). Micronutrient levels were: Zinc 0.2 mg/kg, (s.d. 0.2), Copper 0.5 mg/kg (s.d. 0.1), Manganese 2.9 mg/kg (s.d. 1), and Iron 2.9 mg/kg (s.d. 1).

Soil in the Lunettes with Copi Association was variable, caused by differences in the proportion of the soil made up by salts moved by wind from nearby relict lakes. In some places there is a surface layer of soil that supports current vegetation, and could be used for rehabilitation. In other areas there is very little soil that can support plant growth.

6.1.6. Lake Floor East Soil Association (1 pit and 14 core sites over 1,921 ha)

Soil in the Lake Floor East Association was saline enough to be toxic to plants. The soil in the bed of the lake consists of relatively thin layers with a large range of properties.



The existing vegetation varies with soil thickness which is influenced by micro topography in that slightly elevated areas have less saline soil than surrounding areas that are as little as 1 m lower.

Representative Soil Test Pit Profile Description: Lake Floor East

Soil Test Pit: SC015	
	
Soil Test Pit SC015	**Landscape view, soil test pit SC015**
Australian Soil Classification Order	Hydrosol (11), Calcarosol (3), Rudosol (1)
Australian Soil Classification Sub-order	Hyposalic (12), Hypergypsic (3)
Representative Soil Test Pits	SC015, SC2026, SC2027, SC2028, SC2029, SC2032, SC2036, SC2037, SC2038, SC2039, SC2064, SC2065, SC2066, SC2077, SC2098,
Drainage	Very Poor (27%), Poor (53%), Imperfect (13%), Moderately well (7%)
Average ECa for Surface to 3.3 m	549 mS/m (standard deviation 216 mS/m)

6.1.6.1. Lake Floor East Soil Association Chemistry

Average soil chloride concentration in the Lake Floor East Association is high enough that it is toxic to plants (Figure 6.12). The soil was also alkaline had elevated sulphate sulphur and low carbonate concentration.

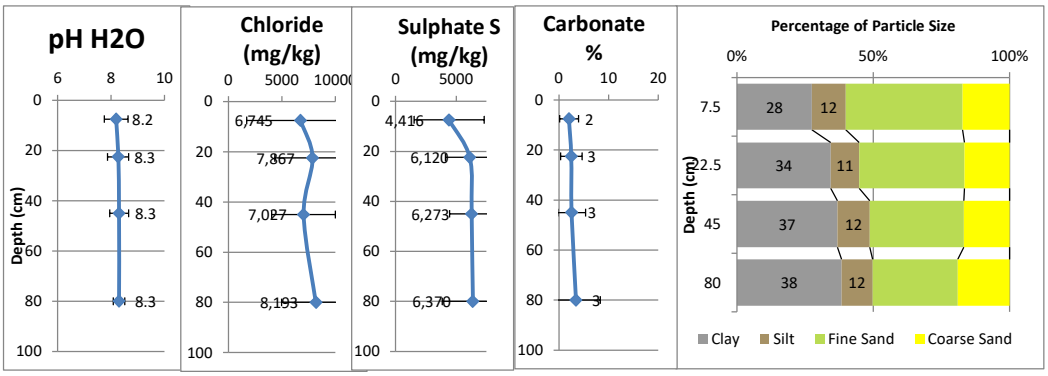


Figure 6.12. Chemistry Summary for Lake Floor East Association in the Soil Study Area.

Soil clay content increased from 28% in the 0 to 15 cm layer to 38% in the 60 to 100 cm layer. The remainder of particle size distribution was dominated by fine sand (Figure 6.12).

The cation ratios had undesirably high ESP, although the high CEC of 95 to 170 meq/100g indicates that measurements were contaminated by soluble salts (Figure 6.13).

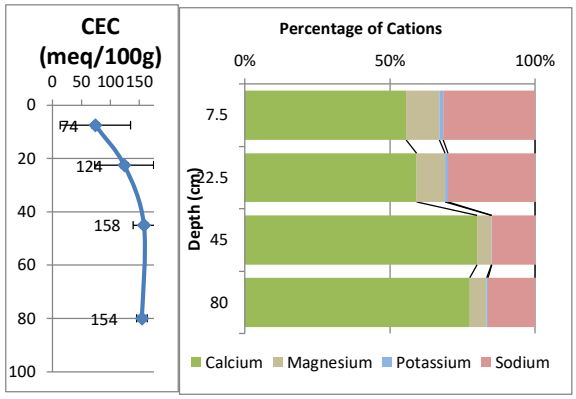


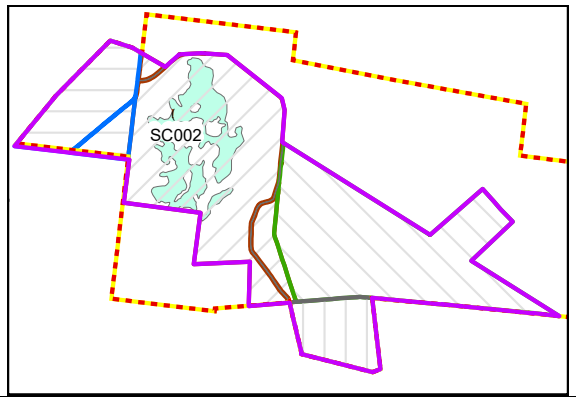
Figure 6.13. Cation Ratios in Lake Floor East Association in the Soil Study Area (average of 3 sites).

Soil nutrition was measured at 2 sites. Topsoil organic carbon was 0.4%, nitrate N was 8.2 mg/kg, (s.d. 6) and available P was 44 mg/kg. Micronutrient levels were: Zinc 0.1 mg/kg, (s.d. 0.1), Copper 0.3 mg/kg, (s.d. 0.1), Manganese 2.4 mg/kg (s.d. 0.1), and Iron 1.6 mg/kg (s.d. 0.5).

This material is so salty that it has no agricultural value and is only suitable to be returned to the same position in the landscape in the expectation that only salt tolerant plants will grow on it.

6.1.7. Lake Floor West Soil Association (3 pits over 1,507 ha)

Soil examined in the Lake Floor West Association consisted of a 30 cm layer of sand over more clayey material (see photo below). The soil supported scattered vegetation, but there was water with EC over 100 dS/m at 1 m depth.



Representative Soil Test Pit Profile Description: Lake Floor West

Soil Test Pit: SC002	
	
Soil Test Pit SC002	**Landscape view, soil test pit SC002**
Australian Soil Classification Order	Arenosol (1), Rudosol (1), Calcarosol (1)
Australian Soil Classification Sub-order	Brown (1), Hypersalic (1), Hypocalcic (1)
Representative Soil Test Pits	SC002, SC003, SC006
Drainage	Poor (67%), Imperfect (33%)
Average ECa for Surface to 3 m	367 mS/m (standard deviation 125 mS/m)

6.1.7.1. Lake Floor West Soil Association Chemistry

Average soil pH_{H2O} increased from 7.7 in the 0 to 15 cm layer to more than 8.3 in the 30 to 60 and 60 to 100 cm layers (Figure 6.14).

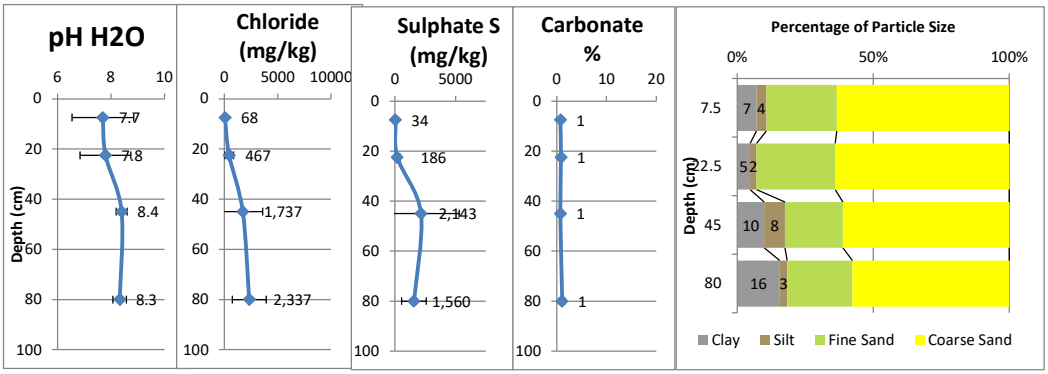


Figure 6.14. Chemistry Summary for Lake Floor West Association in the Soil Study Area.

Soil chloride was desirably low in the 0 to 15 and 15 to 30 cm layers, but increased to levels that would restrict the growth of most plants in the 30 to 60 and 60 to 100 cm layers.

Sulphate and carbonate concentration was generally low for most samples tested in the Lake Floor West Association.

Clay content increased from 5% in the 0 to 15 and 15 to 30 cm layers to around 10% in deeper layers. Coarse sand accounted for more than 60% of soil particles. This is higher than all other Associations.

Profile properties indicate that it may be possible to use as much as 30 cm of soil from the Lake Floor West Association as topsoil during rehabilitation. However, care will be required to avoid deeper, saline soil.

6.2. SUMMARY OF SOIL PROPERTIES ACROSS SOIL STUDY AREA

6.2.1. Soil Chemistry Trends by Soil Association

The aim of mapping soil properties is to group sites with similar properties. This is shown in the graphs in Figure 6.15 and 6.16 which show the following patterns:

- Average **pH_{H2O}** was lower in Lake Floor West than the remaining 6 Soil Associations. pH_{H2O} increased with depth in both phases of the Dunes and Sandplains Association, and in the Lunettes Association. There was little pH_{H2O} depth trend in the remaining soil associations
- Average **carbonate** was 1 to 2% for all depths in both Lake Floor Associations. In the remaining Associations, carbonate was around 5% in the 0 to 15 cm depth. Carbonate increased 4-fold between the 0 to 15 and 60 to 100 cm layers in the Dunefield and Plains Associations, and increased by a smaller amount in the remaining 3 Associations.
- Average **chloride** was very low but increased with depth in both phases of the Dunefield and Sand Plain Association. Chloride content was desirably low in the Lunettes Association. Chloride was consistently higher than 4,000 mg/kg in Lake Floor East Association and more than 1,000 mg/kg in the remaining 3 Associations, which is likely to restrict plant growth.
- Average **sulphate** was relatively low in both phases of the Dunes and Sandplains Association and the Lunettes Association. Average sulphate sulphur concentration was moderate in surface layers and increased rapidly with depth in the Blanchetown, Lunettes with Copi and Lake Floor West Associations was greater than 1000 mg/kg for all sites sampled in the Lunettes with Copi Association Average sulphate sulphur concentration was greater than 4 g/kg for all layers in the Lake Floor East Association.

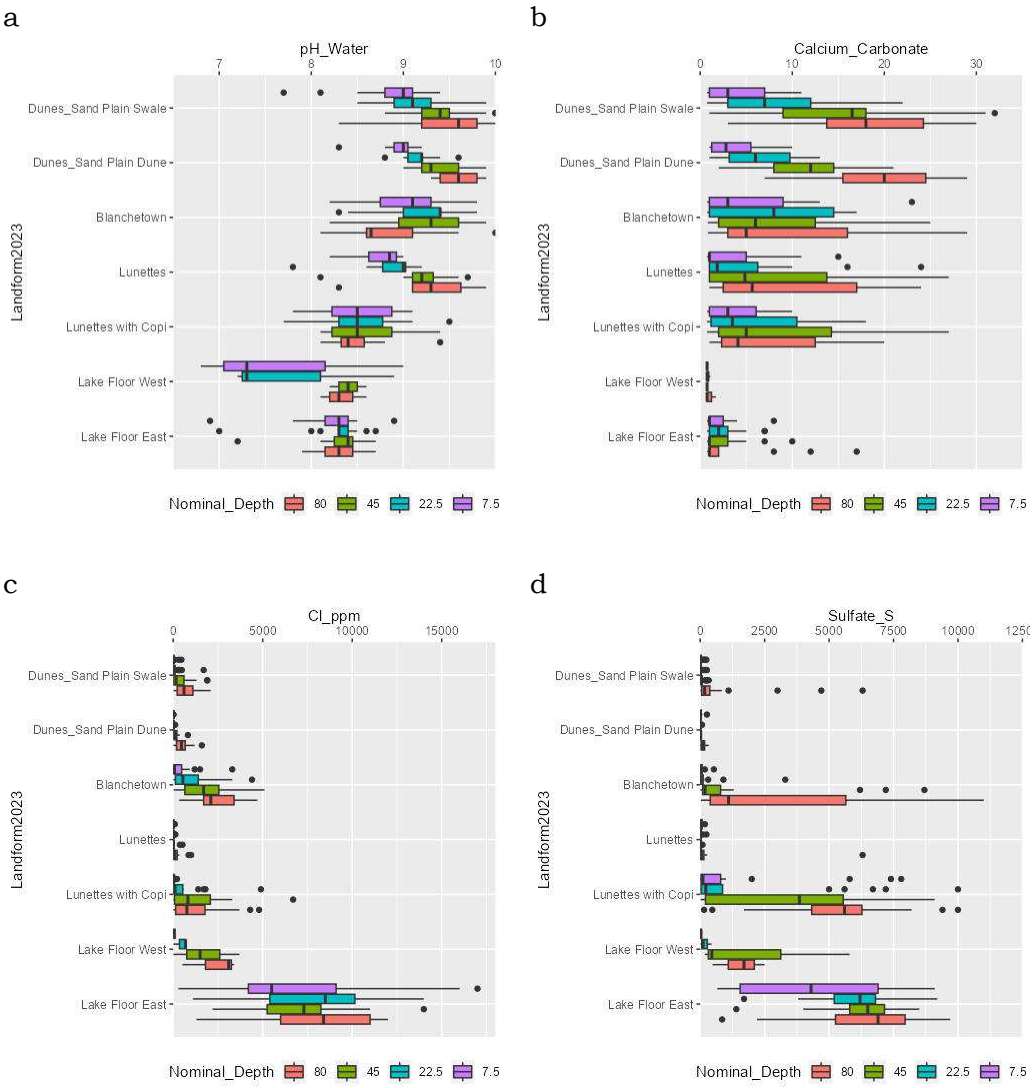


Figure 6.15. Boxplots of soil chemical properties measured in 6 Soil Associations across the Soil Study Area.

Average particle size distribution also differed between the Soil Associations. Clay content was lowest in the Lake Floor West (Figure 6.16a). Average clay content of the Lake Floor East and Blanchetown Clay Associations was more than 3 times that of the Lake Floor West Associations. Clay content was similar for the Dunefield and Sand Plain and both Lunette Associations.

The coarse sand fraction had the opposite trends to the clay fraction except the Blanchetown Clay Association had much more coarse sand than the Lake Floor West Association. The Lunettes with Copi Association had substantially lower coarse sand content than the Lunettes Association, which was similar to the Dunefield and Sand Plains Association.

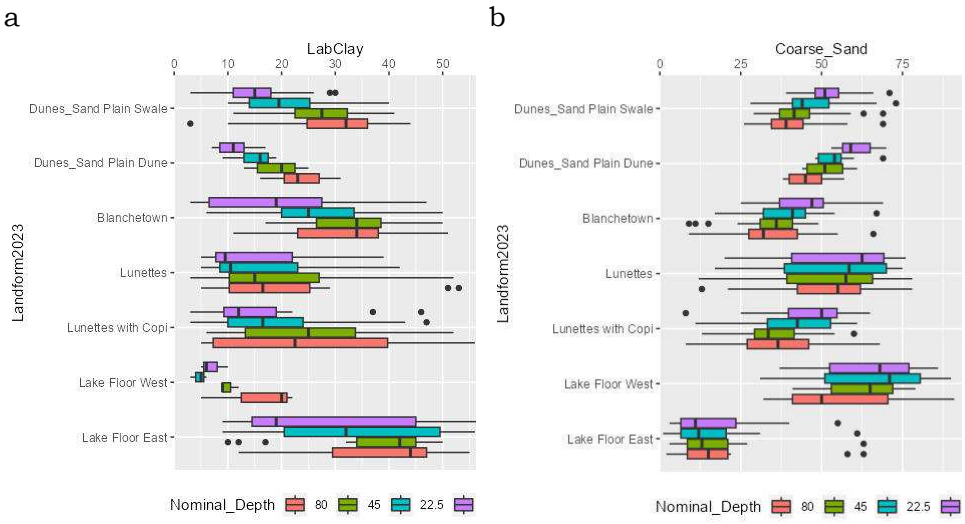


Figure 6.16. Boxplots of percentage clay and coarse sand measured at 4 depths in 6 Soil Associations across the Soil Study Area.

6.2.2. Soil Associations

The soil mapping strategy adopted in the Soil Study Area was to separate zones with differences in suitability of the soil for use as topsoil when rehabilitating land within the Limit of Disturbance . In doing this, the important properties were considered to be the depth to chemical properties that limit plant growth, and a degree of limitation from these hostile soil properties.

The Soil Study Area was divided into 3 landform groups;

- dunefields, sandplains and small depressions
- relict lakes, and
- lunettes formed from windblown sediment that came from the lakes.

Each landform group was divided into 2 Soil Associations, which are:

Dunefield and Sand Plains, in which the dominant profile form was sandy topsoil with low salt concentrations over sandy clay loam to clay loam subsoil that had low salinity, but is rich in carbonates (Table 6.1). This Association had an undulating surface with occasional linear dunes. The depth to carbonate was shallower in swales between dunes than on the dunes. While subsoil of the Dunefield and Sand Plains Association had physical properties that make it challenging to build stable topsoil during rehabilitation, it was not toxic to plants.

Blanchetown Clay occupied closed depressions within the Dunefields and Sand Plains landform. This association was also mapped on the western slope of the eastern relict lake. The soil profile had sandy topsoil over sandy clay loam to clay subsoil. The soil had moderate carbonate concentration throughout, but chloride and sulphate concentrations were elevated in the subsoil (Table 6.1). The Blanchetown Clay subsoil also had elevated sodium concentrations. These chemical properties are so far from ideal that the Blanchetown Clay will require substantial amendment if it is to be used during rehabilitation (Section 9).

Lunettes, occupied dunes to the east of both relict lakes in the Soil Study Area. The soil profile also had loamy sand topsoil over sandy clay loam subsoil. The soil profile was rich in carbonates but had desirably low salinity as measured by chloride concentration, and elevated subsoil sulphate sulphur (Table 6.1). Subsoil of the Lunettes Association also had properties that make it poorly suited as topsoil during rehabilitation, but not toxic to plants.

Lunettes with Copi occupied dunes to the east of the relict lakes as well as hillocks within the relict lakes. The soil was characterised by elevated sulphur, with indicates the presence of gypsum or copi (Table 6.1). Topsoil in most of the Lunettes with Copi Association is suitable for rehabilitation, although there are significant areas with minimal topsoil over copi.

Lake Floor East occupied the floor of the eastern relict lake and margins to the east. Soil in the lake floor was strongly saline (Table 6.1) and suitable only for placement as deep subsoil or as soil in the rebuilt lake floor. There were also slightly elevated patches with a thin (10 to 20 cm) layer of less saline soil.

Lake Floor West had a layer of wind-blown sand over saline subsoil. The 3 sites examined had 30 cm of moderately low salinity sandy soil over saline subsoil (Table 6.1). Care will be needed to avoid mixing the saline subsoil with less saline topsoil during the rehabilitation process.

Table 6.1. Summary of average soil chemical properties of 6 Soil Associations in the Soil Study Area.

Association	ASC Order	pH_{H2O}	Chloride	Carbonate	Sulphate	Cations
Dunefield and Sand Plains-Swales (33% of Soil Study Area)	Calcarosol (79%)	Increased from 8.9 to 9.5 with depth	Desirably low to 30 cm in 42 of 43 sites, to 60 cm in 37 of 43 sites, and 100 cm in 32 of 43 sites	Increased from 4% to 18% with depth	Low except 550 mg/kg in 60 to 100 cm layer	Dominated by calcium except that 30 to 100 cm layer sodic
Dunefield and Sand Plains-Dunes (8% of Soil Study Area)	Calcarosol (82%)	Increased from 8.9 to 9.5 with depth	Desirably low to 60 cm in all sites, and to 100 cm in 9 of 11 sites	Increased from 4% to 19% with depth	Low except 500 mg/kg in 60 to 100 cm layer	Dominated by calcium except that 30 to 100 cm layer slightly sodic
Blanchetown (10% of Soil Study Area)	Calcarosol (53%) Chromosol (37%)	Around 9 through profile	Desirably low to 15 cm in 18 of 19 sites and to 100 cm in 1 of 19 sites	Increased from 6 to 9% through profile, but variable	Low in 0 to 30 cm layer. Increased to much greater concentration by 60 to 100 cm	Dominated by sodium
Lunettes (14% of Soil Study Area)	Calcarosol (77%), Arenosol (33%)	Increased from 8.7 to 9.3 with depth	Desirably low for all samples	Increased from 4% to 10% with depth	Low except 800 mg/kg in 60 to 100 cm layer	Dominated by calcium
Lunette with Copi (15% of Soil Study Area)	Calcarosol (82%)	Around 8.5 through profile	Desirably low to 15 cm in all sites, to 30 cm in 19 of 22 sites, and to 100 cm in 9 sites	Increased from 4% in 0 to 15 cm to 9% in 30 to 60 cm layer, but variable	Increased from 1,200 to 5,300 mg/kg with depth	Dominated by calcium, but results contaminated by soluble salts
Lake Floor East (12% of Soil Study Area)	Hydrosol (73%)	Around 8.3 through profile	Toxic to most plants. Thin topsoil of less saline soil in elevated patches, sampled in 3 of 15 sites	Averaged 2 to 3%	Greater than 4,000 mg/kg for all layers tested	Dominated by sodium in soluble salts
Lake Floor West (9% of Soil Study Area)	Arenosol, Calcarosol	Increased from 7.7 in 0 to 15 cm to 8.3 in 30 to 100 cm	Desirably low in 0 to 30 cm layer. High enough to restrict plant growth in 30 to 100 cm layers	1% throughout depths tested	Low to 30 cm, then increased with depth to 1 m	Not measured

7. ACID SULPHATE SOIL ASSESSMENT

7.1. INTRODUCTION

The Acid Sulphate Soil Assessment steps of Ahern *et al.*, (1998) are summarized below. They are written in a way that a more detailed investigation is required for each step. In most situations, a finding for one step that the site does not contain Acid Sulphate Soil means that the assessment needs proceed no further. The steps are:

- **Step 1** - Check whether site is an area mapped by NSW government as having a risk of containing Acid Sulphate Soil.
- **Step 2** - Check whether Project Area meets geomorphic or site criteria.
- **Step 3** - Analyse soil and water indicators.
- **Step 4** - Chemical analysis to confirm Acid Sulphate Soil and action levels.

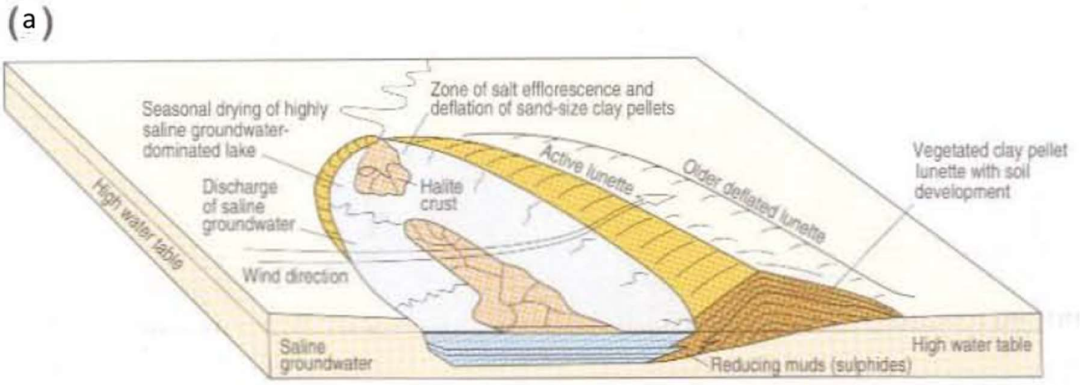
7.2. STEP 1. DETERMINE WHETHER SITE IS MAPPED AS ACID SULPHATE SOIL

The desktop Acid Sulphate Soil assessment indicted that there is a possibility of encountering acid sulphate soil in the Eastern relict lake.

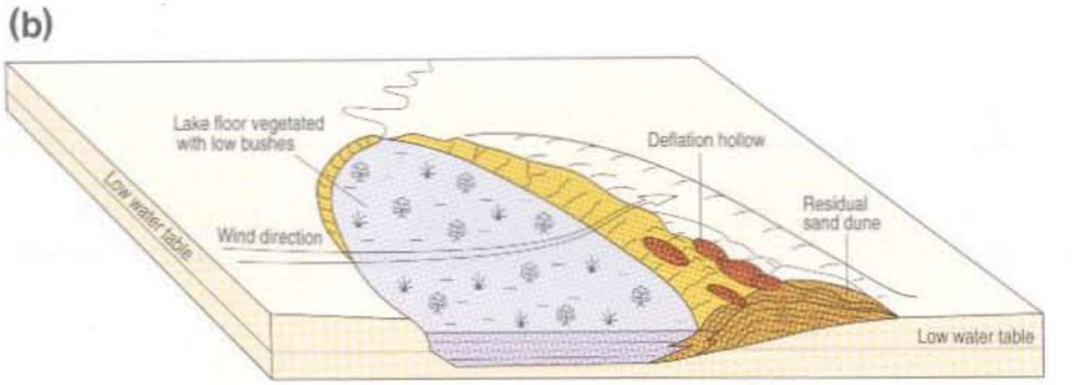
This indicates that Acid Sulphate Soil Assessment for the Soil Study Area should proceed to Step 2.

7.3. STEP 2. DETERMINE WHETHER PROJECT AREA MEETS GEOMORPHIC OR SITE CRITERIA

The Soil Study Area satisfies one of the geomorphic indicators in that Ray (1996) describes the Yamba Formation lake floor sediment as an "*upper layer of black sulphide-rich mud"* with an ephemeral salt crust. The diagram below shows reducing muds (sulphides) near the base of the lunette (Figure 7.1a). This diagram illustrates the process of forming relict saline lakes and associated lunettes in the Ana Branch 1:250,000 Map Sheet that appears similar to the eastern relict lake (Figure 7.1). As a result, Acid Sulphate Soil Assessment for the Soil Study Area should progress to Step 3.



(a) Formation of clay pellet-dominated lunette by saltation of sand-size clay pellets from deflated lake floor, during periods of seasonal aridity and drying of groundwater-dominated saline lake, resulting from discharge of highly saline groundwater from high water tables.
Suitable conditions are thought to have prevailed during transitional periods when climatic conditions were increasingly hot and arid but when high groundwater tables were inherited from a preceding less-arid climatic phase.



(b) Formation of residual sand dune deposits over eroded and deflated lunette.
Deflated clay and salt components of lunette were reworked and deposited down-wind, while residual sand was deposited as dunefields of clean white sand over crestal and eastern slopes of the lunette, as well as adjacent to deflation hollows on western slopes. The lunette was subject to wind erosion to form extensive deflated amphitheatre-like hollows devoid of vegetation and containing remnant pinnacles of the vegetated lunette material. The lunettes were also eroded by heavy rains from infrequent thunderstorms to form deep vertical rills and gullies. Groundwater tables were too low to allow discharge of saline waters, and lake floor sediments have been partly vegetated.

Figure 7.1. Steps in formation of lake/lunette complex (from Ray, 1996). Site observations indicate that the eastern relict lake is similar to a) whereas the western relict lake is similar to b).

7.4. STEP 3. ANALYSE SOIL AND WATER INDICATORS.

This step was undertaken using data collected for general groundwater investigation and soil samples from soil assessment and stored for quality control.

The water chemistry available found that the average chloride concentration was 32,500 mg/L (Table 7.1) which is 67% higher than the average seawater concentration of 19,400 (Ahern *et al.,* 1998). The average sulphate concentration of 10,241 mg/L was 280% higher than the average seawater concentration of 2,700 mg/L. The resulting Chloride to Sulphate ratio of 3.2:1 (Table 7.1) is not a definitive indicator of the presence or absence of sulphides (Ahern *et al.,* 1998).

Table 7.1. Selected values from groundwater analysis in Project Area (AGE, 2020).

Sample ID	pH*	Sulphate (mg/L)	Chloride (mg/L)	Ratio Cl^- /SO_4^{2-}	Total Dissolved Solids (mg/L)
MB08s	n.d.	8,580	31,600	3.7	68,331
MB11	n.d.	8,820	30,700	3.5	62,577
PB02	n.d.	8,660	33,000	3.8	67,713
MB06	n.d.	8,500	30,400	3.6	60,619
MB14	n.d.	9,910	24,900	2.5	52,911
MB17	n.d.	11,600	35,000	3.0	71,681
MB15	n.d.	10,800	33,700	3.1	69,473
MB26D	n.d.	15,300	40,800	2.7	87,010
MB26S	n.d.	10,000	32,900	3.3	67,394
Average		*10,241*	*32,556*	*3.2*	*67,523*

*n.d. indicates no data

The field peroxide soil test was conducted on stored samples from SC002 and SC015 following the procedure Ahern *et al.,* (1998) except that the samples had been stored at room temperature for 2 months following sample collection.

Figure 7.2. Pit SC015 showing green-grey mud at 120 cm.

Samples from these sites were selected because they were collected from waterlogged areas of the western and eastern relict lake floors respectively.

Soil in the profile of SC015 contained layers of soft, buttery green-grey mud (Figure 7.2). Soil pH of this layer was 1.4 after mixing with 30% peroxide. This result is indicative rather than reliable because of the delay between sampling and testing.

The low pH after mixing with 30% peroxide and the green-grey clay depicted in Figure 7.2 means that it is possible that Potential Acid Sulphate Soil is present in some parts of the Soil Study Area. On this basis, Acid Sulphate Soil Assessment for the Soil Study Area should proceed to Step 4.

7.5. STEP 4. CHEMICAL ANALYSIS TO CONFIRM ACID SULPHATE SOILS AND "ACTION LEVELS".

Step 4 involves collection and testing of soil samples to improve the understanding of the extent of the Potential Acid Sulphate Soil in the Soil Study Area.

The sample programme in the Soil Study Area consisted of 7 sample sites. Six sites (SC026 to SC031) were in a transect across the Lake Floor East Association. The aim of these sites was to sample a range of landscape positions and apparent electrical conductivity (ECa) from the surface to 330 cm layer of the DualEM21HS survey (Figure 4.3). Site SC032 was in an area of the Lake Floor West Association with very high DualEM21H ECa.

Samples were collected from 0 to 25, 25 to 50, 50 to 75, 75 to 100 and 100 to 125 cm layers in all pits, cooled, then frozen and consigned to Envirolab in Sydney for Acid Sulphate specific testing. This consisted of the field peroxide test and laboratory chemical analysis if was judged to be required.

Selected field properties of texture, colour, electrical conductivity, effervescence to 1 Molar hydrochloric acid and moisture of disturbed samples were described by SSM. These descriptions were used as observation sites in Section 6.

7.5.1. Results and Interpretation of Testing to Confirm Presence of Acid Sulphate Soil

7.5.1.1. Interpretation Description

Interpretation consisted of tabulating results of all sites for the individual tests, then applying the following rules (Ahern et al., 1999).

1. Samples with field pH (pH_F) greater than 4 are not Acid Sulphate Soil. No analysis of likelihood of Potential Acid Sulphate Soil is conducted.
2. Samples with pH after oxidation (pH_{FOX}) more than 1 unit less than pH_F may indicate Potential Acid Sulphate Soil. The strength of the indication increases as pH_{FOX} declines from 7 (not Potential Acid Sulphate Soil) to 2.5 (very likely).
3. Samples with pH_{FOX}:
   - Less than 3 combined with a strong reaction to peroxide are very likely to be Potential Acid Sulphate Soil.
   - Between 3 and 4 with low, medium or strong reaction with peroxide, indicates that the sample may be Potential Acid Sulphate Soil.
   - Between 4 and 5 provide an inclusive assessment.
   - Greater than 5 with small or no fall in pH but low, medium or strong reaction with peroxide provide an inconclusive assessment.
4. Soil that was aerated when sampled was unlikely to be Potential Acid Sulphate Soil as such soil is acidified when it is aerated.
5. Presence of carbonate in sample neutralises acid created by oxidation of Potential Acid Sulphate Soil.

7.5.1.2. Results

Results from the 35 field peroxide tests are presented in Appendix III. All 35 samples had pH_F greater than 4 (Table 7.2). This indicates that the samples are not Acid Sulphate Soil.

Table 7.2. Field pH (pH_F) during field peroxide test (green shading indicates that soil was not Acid Sulphate Soil).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	7.7	8.2	7.7	7.7	7.8	8.8	7.6
25	50	8.4	7.8	7.7	8.1	7.4	8.6	7.1
50	75	8.3	7.8	8.1	8.2	7.6	8.3	5.4
75	100	8.2	7.9	7.9	7.9	8	8.4	5.3
100	125	8.7	8.1	8	8	8.1	8.3	5.1

All 35 samples had pH_{FOX} greater than 5 (Table 7.3). This indicates that a small amount to no sulphides were oxidised by the peroxide, the strongest indication from this testing regime will be inconclusive.

Table 7.3. Field peroxide pH (pH_{FOX}) during field peroxide test (green shading indicates that Potential Acid Sulphate Soil was not detected by this test).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	7.6	6.2	6.4	7.5	7	8.4	6.5
25	50	8.5	5.9	5.9	8	6.5	8.2	7.7
50	75	8.7	6	6.2	8.5	6	8.4	5.6
75	100	8.3	8	7.7	8.2	8.3	8.6	5.7
100	125	6.8	7.6	7.2	8.2	8	8.5	5.5

The pH change from adding 30% hydrogen peroxide ranged from a fall of 2 pH units to an increase of 0.6 units (Table 7.4). Nine of the 35 samples had pH fall of greater than 1 unit, which is the critical value indicating a likelihood of Potential Acid Sulphate Soil.

Table 7.4. Decrease in pH (pH_F-pH_{FOX}) during field peroxide test (green shading indicates that Potential Acid Sulphate Soil was not detected by this test, orange shading indicates inconclusive result).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	0.1	2	1.3	0.2	0.8	0.4	1.1
25	50	-0.1	1.9	1.8	0.1	0.9	0.4	-0.6
50	75	-0.4	1.8	1.9	-0.3	1.6	-0.1	-0.2
75	100	-0.1	-0.1	0.2	-0.3	-0.3	-0.2	-0.4
100	125	1.9	0.5	0.8	-0.2	0.1	-0.2	-0.4

Extreme or volcanic reaction to mixing the soil with 30% hydrogen peroxide occurred in 17 of 35 samples (Table 7.5). These extreme or volcanic reactions can also be caused by even minor amounts of sulphate (oxidised sulphur) in the soil sample (Sullivan *et al.,* 1999).

Table 7.5. Soil reaction to 30% hydrogen peroxide during field peroxide test (green shading indicates this test did not detect Potential Acid Sulphate Soil; orange shading indicates that sample may contain Potential Acid Sulphate Soil).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	Extreme	Low	Medium	Extreme	Medium	Volcanic	Extreme
25	50	Volcanic	Medium	Low	Volcanic	Medium	Extreme	Volcanic
50	75	High	Low	Low	Extreme	Medium	Extreme	Low
75	100	High	Extreme	Medium	Extreme	Extreme	Extreme	Low
100	125	Medium	Low	Medium	Volcanic	Extreme	Extreme	Low

Potential Acid Sulphate Soil is converted to Acid Sulphate Soil when the soil is aerated. Six of the thirty five samples were rated as wet and potentially waterlogged (Figure 7.6). The remainder could contain Acid Sulphate Soil if the pH_F was less than 4, but are unlikely to be Potentially Acid Sulphate Soil.

Table 7.6. Soil moisture rating according to NSCT (2009) (green shading indicates soil is likely to be aerated, orange shading indicates that soil is likely to be waterlogged and could contain Potential Acid Sulphate Soil).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	Moist	Moist	Moist	Moist	Moist	Dry	Moist
25	50	Moist	Moist	Moist	Moist	Moist	Dry	Moist
50	75	Moist	Moist	Moist	Moist	Moist	Trace of Moisture	Moist
75	100	Moist	Wet	Moist	Wet	Moist	Trace of Moisture	Moist
100	125	Moist	Wet	Wet	Wet	Moist	Trace of Moisture	Wet

Five of the thirty five samples contained carbonate as indicated by their reaction to 1 Molar hydrochloric acid (Table 7.7).

Table 7.7. Field carbonate test conducted by SSM (green shading indicates that there is sufficient carbonate in soil to neutralise acid produced by oxidation of Potential Acid Sulphate Soil, orange shading indicates that carbonate not detected).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	None	None	None	None	None	None	None
25	50	Moderately	None	None	Slightly	None	None	None
50	75	Moderately	None	None	None	None	Very Highly	None
75	100	None	None	None	None	None	Very Highly	None
100	125	None	None	None	None	None	Very Highly	None

The combination of results from the field peroxide field moisture and field carbonate tests did not detect Acid Sulphate Soil or Potential Acid Sulphate Soil (Table 7.8).

Table 7.8. Likelihood that sample is Potential Acid Sulphate Soil based on the criteria of Ahern et al., 1999).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
25	50	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
50	75	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
75	100	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
100	125	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low

Soil salinity was measured in conjunction with the acid sulphate testing. These measurements indicated that salinity in 27 of 29 samples was either toxic to most plants, or very close to it (Table 7.9, Appendix IV).

Table 7.9. Electrical conductivity of saturated extract of samples subjected to field peroxide test (green shading indicates low salinity and red shading indicates high salinity, DWLBC, 2002).

Upper Depth (cm)	Lower Depth (cm)	SC026	SC027	SC028	SC029	SC030	SC031	SC032
0	25	33	170	68	79	36	6	121
25	50	45	66	61	39	81	6	74
50	75	40	66	50	46	43	45	29
75	100	33	109	71	102	44	42	46
100	125	n.d.	n.d.	n.d.	n.d.	n.d.	33	n.d.

The field peroxide tests produced conflicting results in that the reaction to 30% hydrogen peroxide (Table 7.5) was generally much greater than would be expected for the relatively high pH_{FOX} (Table 7.3). Samples with extreme and volcanic reaction had pH_{FOX} of 6.5 to 8.6. Gypsum or carbonate concretions were observed in 7 of the 16 samples with extreme and volcanic reaction to 30% hydrogen peroxide. The presence of gypsum in the landscape and soil samples indicate that it is likely that the reaction in the field peroxide test indicated the presence of oxidised sulphur rather than reduced sulphur as observed by Sullivan *et al.,* (1999).

In this case, the pH_{FOX} of 5.5 to 8.7 was interpreted as indicating that the samples were not Potential Acid Sulphate Soil. Similarly, pH_F of 5.1 to 8.7 is interpreted as indicating that no Acid Sulphate Soil was sampled.

7.6. Acid Sulphate Soil Risk Assessment

The analysis above indicates that it is very unlikely that there is Potential Acid Sulphate Soil in the areas sampled. This interpretation is based on the relatively high pH_F and pH_{FOX} and indicates that there is a low risk of Acid Sulphate Soil degrading soil in the Soil Study Area. This is despite the High rating for several factors if Acid Sulphate Soil is present (Table 7.10).

Table 7.10. Acid Sulphate Soil Risk Assessment based on Table 3.1 of Ahern *et al.,* 1998.

Factor in deciding level of risk	Project description	Project Risk Ranking
Volume of material to be disturbed	1.2 billion tonnes ore + similar amount of overburden (Table 1.1)	High
Distance between Acid Sulphate Soils and depth of disturbance	0 m	High
Change of surface drainage	Surface drains will not capture potentially acidic groundwater	Low
Duration of disturbance		
Case 1: Routine Mining	Overburden removed from advancing face and placed in retreating face	Low
Case 2: Off Path Storage Facility	Overburden, Interburden and reject from starter pond stored permanently	High
Level of certainty with mitigation strategy	High certainty that burying potentially acid sulphate soil will prevent movement of leachate from this material reaching the surface	Low
Likely severity of Acid Sulphate Soils based on peroxide reaction	Extreme to Volcanic	High
Likely severity of Acid Sulphate Soils based on peroxide final pH	Minimum pH 5.5	Nil
Connection to natural waterbodies or wetlands	Accepts local runoff, with limited connection to surface drainage network (Figure 3.5d)	Low

Soil with potential to contain Acid Sulphate Soil appears to be contained within soil that has salt concentration that is toxic to most plants (Table 7.9). It is likely that practices that minimise impacts of this saline soil will also minimise impacts of any Potential Acid Sulphate Soil that may be contained within the saline soil.

7.7. PRELIMINARY ACID SULPHATE SOIL MANAGEMENT PLAN.

It is proposed that a separate Acid Sulphate Soil Management Plan is unnecessary because the potentially small volume of Acid Sulphate Soil occurs within a much larger volume of highly saline soil. As such, Acid Sulphate Soil Management should be incorporated into the general soil management plan in which:

- Soil from the Lake Floor East and Lake Floor West Associations is stripped, stockpiled and replaced separately to soil from the remaining associations.

8. LAND AND SOIL CAPABILITY ASSESSMENT

8.1. LAND AND SOIL CAPABILITY ASSESMENT PROCESS

The Land and Soil Capability (LSC) assessment classifies land into one of eight land and soil capability classes. These classes give an indication of the intensity of use the land can withstand without suffering land and soil degradation (Table 8.1).

Table 8.1. Land and Soil Capability Classes – general definitions (OEH, 2012).

LSC class	Description
Land capable of wide variety of uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	Extremely high capability land: Land has no limitations. No special land management practices required. Land capable of all rural uses and land management practices.
2	Very high capability land: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	High capability land. Land: Has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental limitations.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	Moderate land capability land: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	Moderate-low capability land: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations will need to be carefully managed to prevent long-term degradation.
Land capable of a limited set of land uses (grazing, forestry, nature conservation and some horticulture)	
6	Low capability land: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agriculture land use (selective forestry, nature conservation)	
7	Very low capability land: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	Extremely low capability: Limitations are so severe that land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

The Land and Soil Capability (LSC) classes of the Soil Study Area were assessed in accordance with the land and soil capability assessment scheme – second approximation (OEH 2012).

The LSC assessment scheme is a 2 step process. The first step is to assess the LSC based on each of 8 individual hazards (water erosion, wind erosion, soil structure decline, soil acidification, salinity, waterlogging, shallow soils and mass movement) at each of the 25 sites assessed. For each of these hazards, the area around each site was assigned an LSC class from 1 (least hazard) to 8 (greatest). The final LSC for each site was determined by the highest class assigned to any hazard for that site (Figure 8.1).

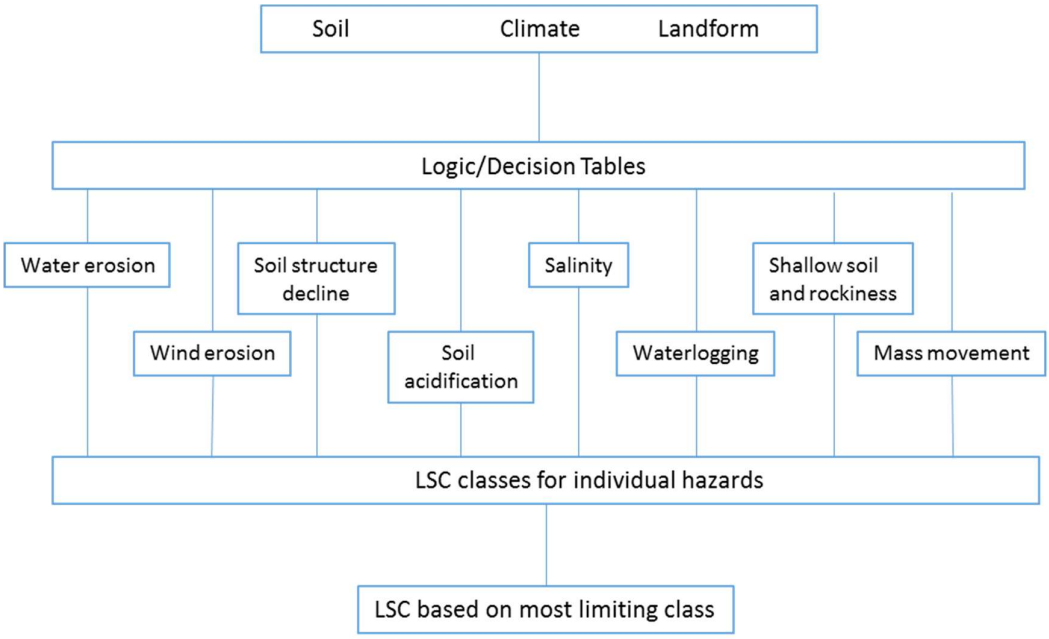


Figure 8.1. Biophysical information used to determine LSC class (from OEH, 2012).

The assessment of LSC classes for the Soil Study Area was based on data collected during the field survey, laboratory analysis of soil samples and is supplemented with information collected during the desktop assessment.

8.1.1. ASSESSMENT OF INDIVIDUAL HAZARDS

Methods used to assess each of the hazards are summarized below.

8.1.1.1. Water erosion hazard

Assessment of water erosion hazard is based on slope and a lookup table in OEH (2012). This was applied on 2 scales. The slope was measured in the field for each site, and the value input to Table 4 of OEH (2012) to give LSC class of the site described.

A slope assessment for the entire Soil Study Area was conducted using a 5 m photogrammetric digital elevation model (DEM) from NSW Spatial Services (Map 3a). This was combined with the slope classes in Table 4 of OEH (2012) to give LSC class over the whole Soil Study Area. The slope surface covers the whole of the Soil Study Area, allowing the accurate delineation of areas where water erosion is the most limiting hazard.

8.1.1.2. Wind erosion hazard

Calculation of wind erosion hazard considers average rainfall, wind erosivity, site exposure to prevailing wind and soil erodibility to wind. These factors were

combined to determine the wind erosion hazard following Tables 5 and 6 in OEH (2012):

- Soil was divided into 3 erodibility classes based on surface soil texture in the pits described, ranging from low for loam to clay texture to high for loamy sand.
- Wind erosive power at this locality is moderate.
- Site morphology was divided into 3 site exposure classes, ranging from low for sheltered locations to high for hilltops, cols or saddles.
- The average rainfall of 230 mm is associated with less groundcover than expected for higher rainfall, consequently a higher wind erosion hazard.

8.1.1.3. Soil structure decline

The soil structural decline hazard is determined by properties of the surface soil. The assessment considers surface soil texture, degree of hardsetting and presence of organic matter (Table 7, OEH, 2012).

Soil texture and relevant soil structure observations were determined at each site.

8.1.1.4. Soil acidification hazard

Acidification hazard is based on a combination of buffering capacity of the soil (surface soil texture), rainfall and pH of the surface soil. Assessment of the acidification hazard is a 3 step process:

- Soil buffering capacity was estimated from field assessed topsoil texture (Table 10, OEH, 2012).
- Surface soil pH_{CaCl2} was taken from 0 to 15 cm samples analysed in a laboratory.
- Average annual rainfall of 230 mm (Queensland Government, 2023) is in the lowest rainfall class used.

These parameters were input to Table 12 (OEH, 2012) to give soil acidification hazard class.

8.1.1.5. Salinity hazard

There are 3 factors in estimating salinity hazard. They are: recharge potential, which is minimal in the low rainfall in the Soil Study Area; discharge potential which was assessed from observed vegetation and groundwater levels; and salt store, which was estimated from the subsoil salinity. These factors were input to Table 13 in OEH (2012).

8.1.1.6. Waterlogging hazard

Waterlogging hazard is based on the NCST (2009) drainage classes observed during the field survey. The waterlogging hazard class was based on Table 14 in OEH (2012) with one modification. The modification was that poorly drained sites could be either LSC Class 5 if the site was judged to be not waterlogged most years or LSC Class 6 if it appeared that the site was waterlogged in most years.

8.1.1.7. Shallow soils and rockiness hazard

Shallow soils and rockiness hazard was based on field observations of soil depth and observed rock outcrop. The hazard was determined from Table 15 in OEH (2012).

8.1.1.8. Mass movement hazard

Mass movement hazard was based on existing observed mass movement, slope class and rainfall. The hazard was determined from Table 16 in OEH (2012).

8.1.2. DETERMINE LAND AND SOIL CAPABILITY CLASS

The LSC class was determined by allocating an LSC class to each Soil Association in Figure 6.1. This was based on the LSC class of each of the 126 sites assessed in the Soil Study Area. The LSC class of each of these sites was calculated for each site as the maximum LSC class of each of the 8 hazards described above. The Soil Association LSC class was calculated from the average LSC class of the sites.

8.2. LSC ASSESSMENT RESULTS

8.2.1. Summary of Individual Hazards

The methodology followed in this assessment resulted in 17% of sites being allocated to LSC 4, 16% to LSC 5, 34% to LSC 6, 8% to LSC7 and 25% to LSC 8. The LSC 4 sites were all in the elevated Dunes and Sand Plains and Lunettes Soil Associations (Figure 8.3).

The most limiting hazard that determined the LSC class was susceptibility to wind erosion (Figure 8.2), followed by salinity and susceptibility to hardsetting from breakdown of soil structure.

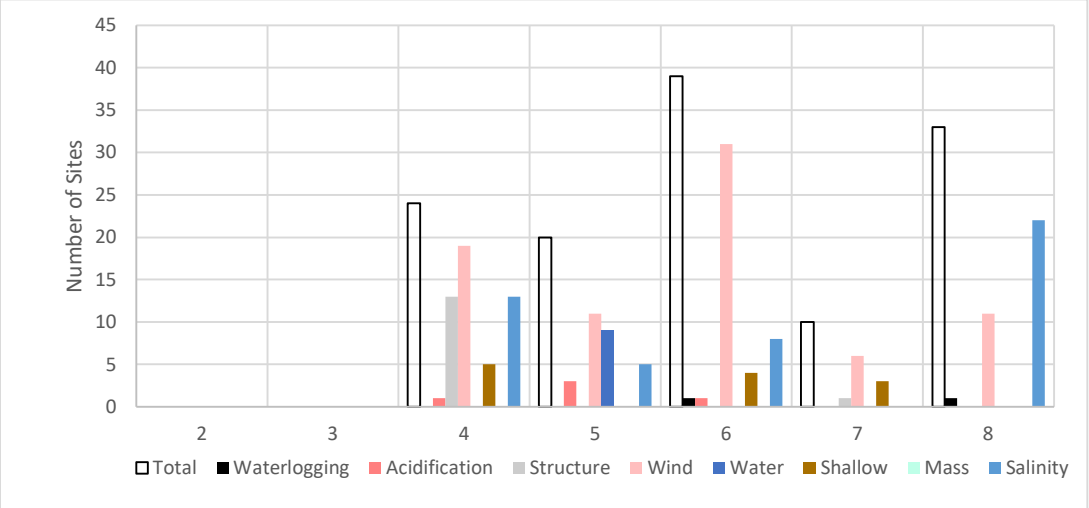


Figure 8.2. Hazard that limits Land and Soil Capability in each LSC class.

8.2.2. Limiting Hazard within Associations

Susceptibility to wind erosion was the most limiting hazard in 4 of the 6 Associations (Table 8.2). Salinity was the most limiting hazard in the Blanchetown Clay and Lake Floor East Association, while 3 hazards constrained land and soil capability in the Lake Floor West Association.

Table 8.2. Average LSC class for each of the 8 hazards assessed for each Soil Association in the Soil Study Area. (Grey shading indicates the most limiting hazard.)

Association	Water logging	Acidification	Structure	Wind	Water	Shallow	Mass	Salinity	*Mean LSC**
Dunes_Sand Plain Swale	1.6	2.0	2.5	5.4	2.2	3.1	1.0	3.4	**6**
Dunes_Sand Plain Dune	1.6	1.6	2.7	6.0	2.2	2.8	1.0	3.0	**6**
Blanchetown	2.3	1.4	2.8	4.8	1.9	4.1	1.0	5.6	**6**
Lunettes	1.8	1.9	2.1	5.5	2.3	1.9	1.0	2.9	**6**
Lunettes with Copi	1.5	1.9	3.5	4.6	2.4	2.5	1.0	4.0	**6**
Lake Floor East	2.6	2.2	2.6	4.2	2.0	5.9	1.0	8.0	**8**
Lake Floor West	5.3	2.3	3.0	5.3	1.3	2.0	1.0	5.3	**7**
Site Average	2.4	1.9	2.8	5.1	2.1	3.2	1.0	4.6	

** Note that LSC is the largest hazard for each site rather than the largest average in this table.*

8.2.3. Pattern of LSC across Soil Study Area

Approximately 79% of the Soil Study Area was allocated to LSC 6 or land that has very high limitations for high-impact land uses. The remaining 21% was allocated to LSC 7 and 8 which can tolerate very limited disturbance.

Mapping the majority of the Soil Study Area as LSC 6 appears to be consistent with the intent of the LSC methodology given the similarity between many of the soil assessment site photos (Appendix II) and the photo in Figure 8.3, given as a typical of LSC by OEH (2012).

Figure 8.3. Example LSC 6 from OEH, 2012.

520000 525000 530000 535000 540000

6285000 6280000 6275000

SUNSHINE
BELMORE
NULLA ROAD
WARWICK
HUNTINGFIELD

N W E S

LSC	Area (ha)
6	12769
7	1507
8	1921
Total	16197

LSC: 6, 7, 8
Site LSC: 4, 5, 6, 7, 8
Homestead
Road
Soil Study Area
Mine Site Boundary
FootprintRd: Belmore, Huntingfield, Nulla, Warwick, Road Reserve

0 1 2 3 4 kilometres
1 cm = 0.7 km on A3

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Wentworth

Land and Soil Capability

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

SSM Sustainable Soil Management

Job Code: Cr498
Map Printed: 2023
Contact: Sustainable Soils Management
Phone : (02) 68 473367

Datum: WGS 84
Projection: UTM

Figure 8.4

8.3. IMPLICATIONS OF LSC RATING

Allocating the Soil Study Area to LSC classes 6, 7 and 8 is consistent with use of the land for rangeland grazing. It is also consistent with occurrence of erosion under this low impact management.

The majority of the Soil Study Area had sandy surface soil that is prone to wind erosion unless it is protected by vegetation. This vegetation slows wind near the soil surface, thus reducing the potential for wind erosion. The soil surface is further protected from erosion by a biological cryptogram crust that can take decades to re-establish after disturbance (Eldridge, 1998). As a result, the widely practised landuse of grazing of naturalised vegetation appears to be the most intensive landuse that the soil can withstand.

Low capability of the Lake Floor Associations indicated by LSC 7 and 8 indicates that the current landuse of grazing at low stocking rates is an appropriate landuse provided total grazing pressure is managed to limit overgrazing.

8.4. LSC ASSESSMENT CONCLUSIONS

- LSC class predicted using the OEH (2012) assessment scheme reflects the limited capacity of the land to withstand disturbance.
- Approximately three quarters of the Soil Study Area was LSC class 6, and one quarter of the area was LSC class 7 and 8. Specifically:
    - 12,769 ha of LSC Class 6;
    - 1,507 ha of LSC Class 7;
    - 1,921 ha of LSC Class 8.
- Susceptibility to wind erosion is the dominant hazard across the Soil Study Area. This can be managed by maintaining surface roughness. Since the soil is sandy, the most robust way to do this is to maintain surface vegetative cover.
- Areas in the relict lakes are susceptible to waterlogging and salinization. This would mean that disturbance for agriculture is risky, and that care will be needed to account for this during disturbance for mining.

9. POTENTIAL IMPACT OF PROJECT ON SOIL RESOURCES

9.1. OVERVIEW OF IMPACTS ON SOIL

The major soil disturbance of the Project would be progressive excavation, movement and replacement of overburden and soil (Section 10). Although this extent of soil disturbance has the potential to render the soil unproductive, the aim of soil management during the Project is to minimise this soil degradation by forming a soil profile, then establishing vegetation on it.

The soil assessment described in Section 6 indicates that soil in the Soil Study Area apart from Lake Floor East consists of a 10 to 30 cm sandy topsoil over subsoil with a range of concentration of a number of salts. The aim when forming soil profiles would be to replace subsoil in the Soil Association from which it was stripped.

Additional potential impacts from the Project on the soil in the Soil Study Area include:

- **Soil compaction** from wheeling by heavy vehicles and machinery during the soil stripping, stockpiling and respreading.
- **Loss of soil resource** when areas of soil are removed by construction of the pit, buried under stockpiles, or moved to level the land surface before construction of roads and other infrastructure.
- **Soil erosion** when soil is left bare and vulnerable to wind erosion.
- **Soil contamination** from hydrocarbon spills.
- **Soil salinisation** from use of saline water on roads for dust suppression.

This section would focus on loss of the soil resource as the major likely impact of the Project on soil in the Soil Study Area. It is assumed that the threats from soil compaction and erosion would be managed by practices to minimise the loss of soil resource. It is also assumed that soil contamination from hydrocarbon spills would be minimized by work practices at the mine.

The remaining issues, which are discussed below are the extent and principles for management of disturbed soil.

9.1.1. PLANNING TO MINIMISE LOSS OF SOIL RESOURCE

The project's potential impacts on soil resources in the Soil Study Area are associated with temporary loss of land during construction and operation of mine infrastructure and with potential permanent reduction in productive potential of disturbed land. This assessment is limited to the disturbance footprint within the Soil Study Area.

The Applicant plans that rehabilitated land would be grazed by native animals rather than cloven hoofed sheep and goats that grazed the land pre Project. Access of sheep and goats to rehabilitated land can be managed by location of water sources as surveys have shown that goats rarely graze further than 4 km from fresh water (Russell *et al.*, 2010). This implies that removing artificial watering points within 4 km of rehabilitated land could effectively manage grazing of rehabilitated land during dry periods.

Topsoil would be stripped from selected areas that are to be disturbed. All disturbed land, with the exception of land within the eastern relict lake would be rehabilitated with stockpiled soil to return the land to a stable state.

Restoration of land would require the formation of a functional soil profile with a landform consistent with the surrounding landscape. The soil profile should supply water, nutrients, aeration and anchorage for plants, as well as allowing through drainage of water.

9.1.2. Disturbance Footprint

It is planned to disturb up to 5,622 ha during the Project (Figure 9.1). The areas and timing of disturbance are summarized in Table 9.1. Soil would be disturbed across the Soil Study Area for the purposes of:

- mining within the Extraction Area;
- construction of internal service roads;
- construction of a soil stockpile area;
- construction of an Off Path storage facility;
- construction of a water storage dam
- construction of level pads for a concentrate upgrade plant, mine offices, workshops, storage sheds, and a power station and
- construction of solar farm

The infrastructure complex is planned for a broad ridge to the northeast of the Extraction Area.

In addition to the above, a range of additional activities would disturb land within the Soil Study Area. As a result, the Applicant has identified a Limit of Disturbance that defines the maximum extent of Project-related disturbance. This is divided into 2 zones: a 300 m wide Buffer Zone around the Extraction Area shown in Figure 9.1, and a further 100 m wide zone where no disturbance is specified. For the purposes of this assessment, it has been assumed that the full area of the Limit of Disturbance would be disturbed by the Project. In reality, it is likely that sections of the identified Limit of Disturbance would not be disturbed.

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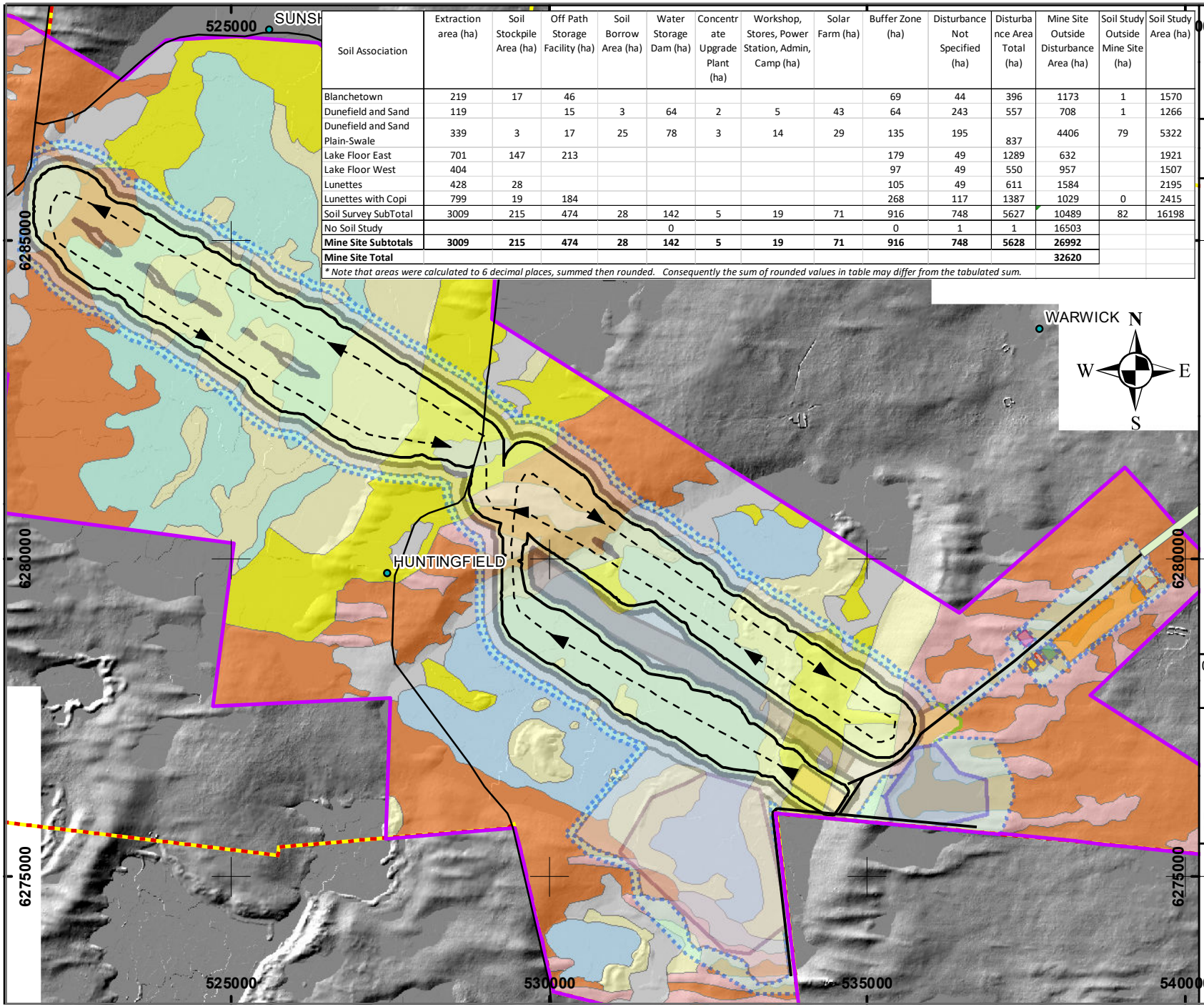
Disturbance at 15/3/24 and Soil Associations

Soil Association	Extraction area (ha)	Soil Stockpile Area (ha)	Off Path Storage Facility (ha)	Soil Borrow Area (ha)	Water Storage Dam (ha)	Concentrate Upgrade Plant (ha)	Workshop, Stores, Power Station, Admin, Camp (ha)	Solar Farm (ha)	Buffer Zone (ha)	Disturbance Not Specified (ha)	Disturbance Area Total (ha)	Mine Site Outside Disturbance Area (ha)	Soil Study Outside Mine Site (ha)	Soil Study Area (ha)
Blanchetown	219	17	46						69	44	396	1173	1	1570
Dunefield and Sand	119		15	3	64	2	5	43	64	243	557	708	1	1266
Dunefield and Sand Plain-Swale	339	3	17	25	78	3	14	29	135	195	837	4406	79	5322
Lake Floor East	701	147	213						179	49	1289	632		1921
Lake Floor West	404								97	49	550	957		1507
Lunettes	428	28							105	49	611	1584		2195
Lunettes with Copi	799	19	184						268	117	1387	1029	0	2415
Soil Survey SubTotal	3009	215	474	28	142	5	19	71	916	748	5627	10489	82	16198
No Soil Study					0				0	1	1	16503		
Mine Site Subtotals	**3009**	**215**	**474**	**28**	**142**	**5**	**19**	**71**	**916**	**748**	**5628**	**26992**		
Mine Site Total												**32620**		

** Note that areas were calculated to 6 decimal places, summed then rounded. Consequently the sum of rounded values in table may differ from the tabulated sum.*



- Homestead
- Road
- Soil Study Area
- Mine Site Boundary

Associations

Upland
- Dunes
- Swale
- Blanchetown

Near Lake
- Lunettes
- Lunettes with Copi

Relict Lake Floor
- Lake Floor East
- Lake Floor West

- Access Road Corridor
- Mining path
- Service Road

MiningDisturba...
- Extraction Area
- Starter Pond
- Stockpile Area
- Off Path Storage Facility
- Water Storage Dam
- Soil Borrow Area

Infrastructure
- Concentrate Upgrade Plant
- Power Station
- Office_Admin
- Workshop_Stores
- Mine Camp
- Solar Farm

Buffers
- Disturbance not specified
- Buffer Zone

0 500 1,000
Metres

1 cm = 0.85 km

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr498
Map Printed: 2024
Disturbance Boundaries: RZ
Roads, Homesteads: Geoscience Australia
Contact: Sustainable Soils Management
Phone : (02) 68 473367

Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 9.1

Table 9.1. Areas disturbed by components of the Project.

Infrastructure	Area (ha)	Timing
Extraction Area	3,009	Throughout Project life
Soil Stockpile Area	215	Project establishment
Off Path Storage Facility	474	Project establishment and following 18 months
Soil Borrow Area	28	Project establishment
Water Storage Dam	165	Project establishment
Concentrate Upgrade Plant	5	Project establishment and following 2 years
Workshop, store	3	Project establishment
Solar Farm and power station	76	Project establishment
Offices, administration, camp	11	Project establishment
Buffer Zone	Up to 916	Throughout Project life
Balance of Mine Disturbance Area	Up to 748	Throughout Project life
Total	**5,628***	

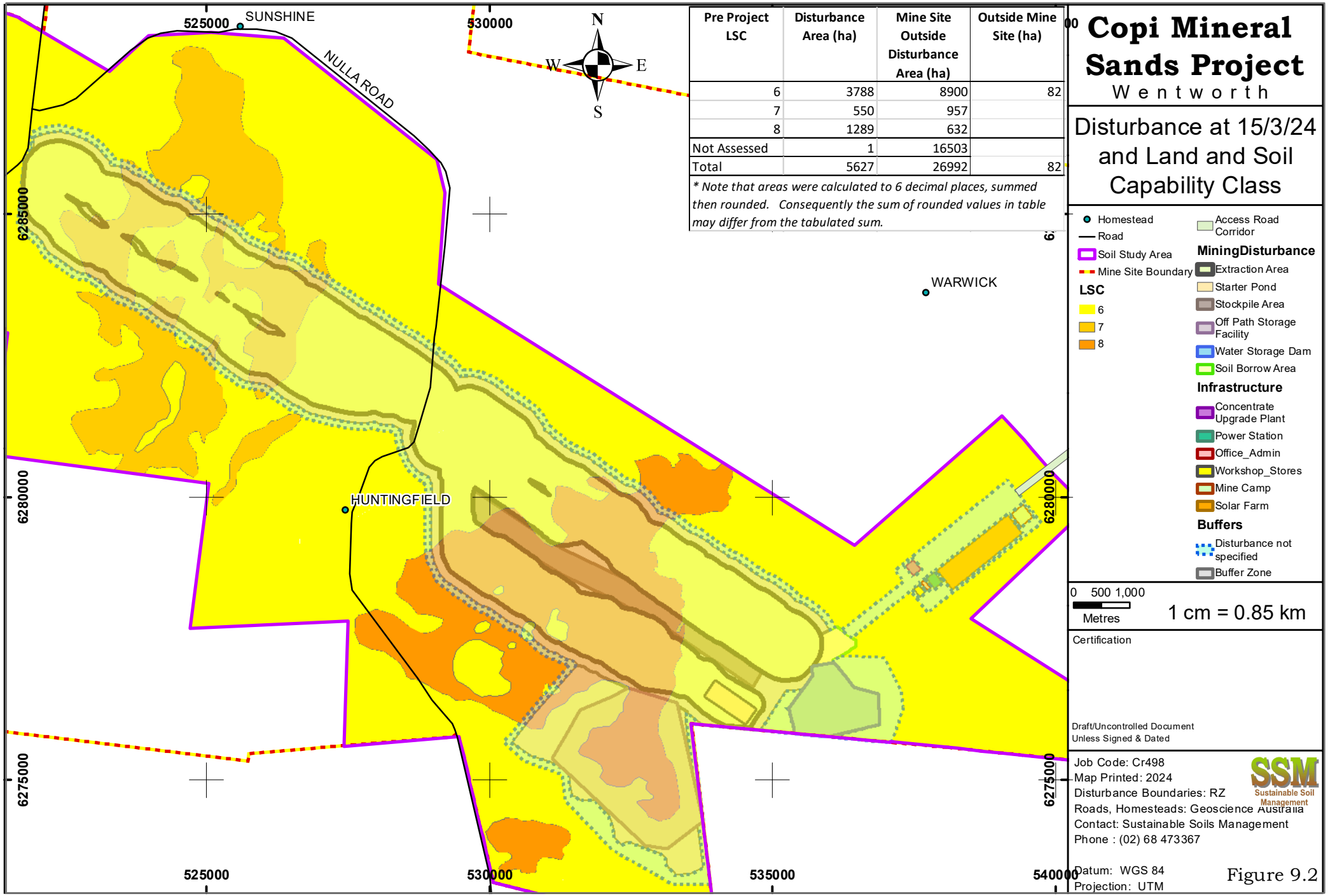
* *Note that areas were calculated to 6 decimal places, summed then rounded. Consequently, the sum of rounded values in table may differ from the tabulated sum.*

9.1.3. Soil Associations and LSC of Disturbed Areas

The Project would disturb 5,628 ha or 35% of the 16,197 ha Soil Study Area. Soil disturbance would occur on all Soil Associations mapped over the Soil Study Area (Figure 9.1). The Swales Phase of Dunefield and Sand Plain Soil Association would have the smallest proportion disturbed at 16%. Two thirds of the Lake Floor East Association and 57% of the Lunettes with Copi would be disturbed, and between 25 and 44% of the remaining 4 Soil Associations would be disturbed.

The disturbance footprint also covers all 3 LSC classes, with 73% of the Disturbance Area rated as LSC class 6, 20% being rated as LSC class 7, and 8% being rated as LSC class 8 (Figure 9.2).

The whole of the limit of disturbance would be alienated from agriculture at times during the Project. As a result, the whole of the limit of disturbance would be classified as LSC 8 during the Project.



Pre Project LSC	Disturbance Area (ha)	Mine Site Outside Disturbance Area (ha)	Outside Mine Site (ha)
6	3788	8900	82
7	550	957	
8	1289	632	
Not Assessed	1	16503	
Total	5627	26992	82

** Note that areas were calculated to 6 decimal places, summed then rounded. Consequently the sum of rounded values in table may differ from the tabulated sum.*

Copi Mineral Sands Project

Wentworth

Disturbance at 15/3/24 and Land and Soil Capability Class

- Homestead
- Road
- Soil Study Area
- Mine Site Boundary

LSC

- 6
- 7
- 8

- Access Road Corridor

MiningDisturbance

- Extraction Area
- Starter Pond
- Stockpile Area
- Off Path Storage Facility
- Water Storage Dam
- Soil Borrow Area

Infrastructure

- Concentrate Upgrade Plant
- Power Station
- Office_Admin
- Workshop_Stores
- Mine Camp
- Solar Farm

Buffers

- Disturbance not specified
- Buffer Zone

0 500 1,000
Metres

1 cm = 0.85 km

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SSM Sustainable Soil Management

Figure 9.2

9.1.4. Soil Stripping Depth

Soil would be stripped from all areas of disturbance, with the exception of areas within the Lake Floor East Soil Association. Stripped soil material would be used to construct a new soil profile on top of a reshaped surface during rehabilitation operations. The constructed soil would be required to perform similar functions to the existing soil in order for the rehabilitation to be successful.

The standard method to assess suitability of soil for rehabilitation of Elliot and Veness (1981) selects soil with strong coherence. This soil retains structure when it is disturbed by earthmoving machinery. The sandy soil in the Soil Study Area has almost no coherence, but it does support the existing vegetation and it is the only material available for rehabilitation, so it would be used.

The second critical characteristic of soil in the Soil Study Area is that the concentration of salts in layers deeper than 20 cm in the Blanchetown Clay (Figure 6.6), Lunettes with Copi (Figure 6.10), and Lake Floor West (Figure 6.14) Associations is much greater than the concentration in the surface to 20 cm layer Despite the high subsoil salt concentration there were roots observed to 1 m in all but the most saline profiles (Appendix II). These saline profiles were most common in the Lake Floor East Association.

The third critical property is exchangeable sodium percentage (ESP), which can be associated with tunnelling on the crest of constructed landforms, and rilling on long slopes (Squires *et al.*, 2012).

This pattern indicates that acceptable quality of rehabilitation is more likely if the surface topsoil is stripped and stockpiled separately to the underlying subsoil. Experience in the mineral sands mining industry in the Murray Basin is that machinery used to level irrigated fields (laser buckets) would be more appropriate for stripping topsoil in this landscape than mining machinery such as elevating scrapers.

Suitability of soil in the Soil Study Area was assessed using the following criteria:

- Thickness of A horizon as the B and deeper horizons were dispersive in many pits (Appendix II);
- Soil pH_{CaCl2} of less than 8.5 (Elliot and Veness, 1981);
- $EC_{1:5}$ less than 1.5 dS/m (Elliot and Veness, 1981);
- ESP less than 6% (Squires *et al.*, 2012).

The measured values of topsoil depth were skewed (Figure 9.3), so the mean value was considered an inaccurate value to represent the Association. The selected topsoil depth (Table 9.2) was the lowest of the modal (most common) and median (middle value) depth. This approach was chosen because of the desire to have a desirably low proportion of subsoil in the stripped topsoil generated using simple, robust soil stripping guidelines.

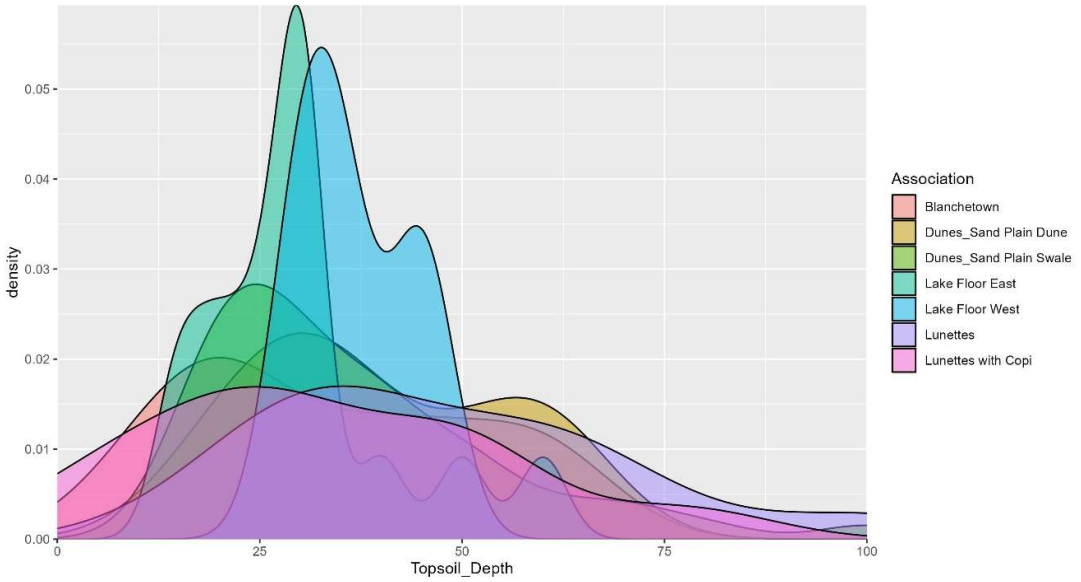

Figure 9.3. Smoothed histograms (density plots) of Topsoil Depth (cm) at soil sample sites grouped by Association.

Table 9.2. Selected depth of soil that may be suitable for stripping, storage and use as Topsoil in the Soil Study Area. Selected value is shaded.

Soil Association	Measure of Central Tendency of Topsoil Depth		
	Mean	Median	Mode
Dunes and Sand Plains – Swales Phase	37	30	20
Dunes and Sand Plains – Dunes Phase	40	35	30 to 60
Blanchetown Clay	34	30	20
Lunettes	48	43	30 to 60
Lunettes with Copi	33	30	50
Lake Floor East	30	30	30
Lake Floor West	37	35	35

The depth of soil available for use as topsoil varied from 20 cm in the Blanchetown Clay and Dunes and Sand Plain- Swale phase, through 30 cm in the Lunettes with Copi Association to 35 cm in the Dunes and Sand Plain-Dunes phase and Lake Floor West Associations and 43 cm in the Lunettes Associations (Table 9.3). All soil in the Lake Floor East Association was too saline to be used as topsoil. Blanchetown Clay topsoil can be used as topsoil with the addition of 0.5% by weight of gypsum to lower ESP to 5%.

Table 9.3. Estimated depth of soil suitable for stripping, storage and use as Topsoil in the Soil Study Area. Most limiting factor is shaded.

Soil Association	Selected Topsoil Depth (cm)**	Average $EC_{1:5}$ (dS/m)			ESP 0 to 30 cm	pH_{CaCl2}	Recommended Stripping Depth for Topsoil (cm)
		0 to 15 cm	15 to 30 cm	30 to 60 cm			
Dunes and Sand Plains- Swales phase	20	0.2	0.2	0.5	4%	8.3	20
Dunes and Sand Plains- Dunes phase	35	0.2	0.1	0.3	4%	8.3	35
Blanchetown Clay	20	0.5	1.0	2.0	15%	8.4	20*
Lunettes	40	0.1	0.2	0.2	2%	8.1	40
Lunettes with Copi	30	0.6	1.0	2.3	2%	8.1	30
Lake Floor East	30	4.4	8.4	7.3	35%	8.2	0
Lake Floor West	35	0.1	0.6	2.0	n.d.	7.8	30

*Blanchetown clay requires addition of gypsum at 0.5% by weight to be used as topsoil
n.d. – no data due to restricted access.
** Table 9.2 values rounded down to the nearest 5 cm.

Subsoil properties can be further from ideal than the topsoil because they do not affect the critical germination phase of plants, and is protected by the topsoil above from wind and water erosion. In semi-arid climates, the subsoil is often more saline and has higher ESP than topsoil. In this case, the critical salinity was doubled to an $EC_{1:5}$ less than 3 dS/m and ESP increased to less than 14% that defines strongly sodic soil (Hazelton and Murphy, 2011). This material should be stockpiled separately from the topsoil as it can trigger erosion and tunnelling when used as topsoil (Squires *et al.*, 2012).

Applying these rules resulted in an additional 60 to 70 cm material available for use in building soil profiles from Lunettes, Lunettes with Copi, Lake Floor West and both Swales and Dunes phases of Dunes and Sand Plains Associations, (Table 9.4).

Table 9.4. Soil properties for 30 to 100 cm zone in the Soil Study Area and suitability for stripping, storage and use as Subsoil. Most limiting factor is shaded.

Soil Association	Average $EC_{1:5}$ (dS/m)		30 to 100 cm ESP	30 to 100 cm pH_{CaCl2}	Recommended Stripping Depth for Subsoil (cm)
	30 to 60 cm	60 to 100 cm			
Dunes and Sand Plains- Swales phase	0.5	1.1	14%	8.5	20 to 100+
Dunes and Sand Plains- Dunes phase	0.3	0.6	12%	8.4	20 to 100+
Blanchetown Clay	2.0	3.2	22%	8.5	None
Lunettes	0.2	0.6	5%	8.3	40 to 100+
Lunettes with Copi	2.3	3.0	1%	8.2	30 to 100
Lake Floor East	7.3	7.0	20%	8.2	None
Lake Floor West	2.0	2.9	n.d.	8.1	35 to 60*

**Lake Floor West subsoil was not sampled extensively and may contain saline patches. Management alternatives are to either strip only 25 cm from this area or sample to verify subsoil salinity.*

9.1.5. Post Mine Soil Profiles

Soil profiles would be built in the Extraction Area, the Off Path Storage Facility, in which the elevation of the soil surface would be changes and the Water Storage Dam, which would be used to temporarily store saline water. The rarity of rainfall exceeding potential evapotranspiration in Figure 3.1 indicates that salts added to subsoil beneath the water storage dam would leach very slowly.

The following rules, based contours from a final surface supplied by RZ Resources on 21/12/2023 were used to map Soil Associations of the built soil profiles:

- In the eastern relict lake, areas with surface elevation lower than the 28.6 m contour were mapped as Hydrosols or wet soil.
- In the western relict lake, areas with surface elevation between the 24.6 and 28.6 m contours were mapped as Rudosols or young soil;
- In the western relict lake, areas with elevation between the -14.6 and 24.6 m contours were mapped as Lake;
- The remaining areas would have a loamy topsoil and more clayey subsoil with calcium in the form of either carbonate or gypsum, so were mapped as Calcarosols, or soil containing calcium salts.

9.1.6. Post Mine Land and Soil Capability

9.1.6.1. Profile Properties

The goal in the Project's rehabilitation plan is to return disturbed land to a condition that is stable, non-polluting, and supports the proposed post mining landuse, which is naturalised vegetation grazed by native animals (Section 9.1.1).

The predicted LSC class was based on tables in the Land and Soil Capability Assessment guidelines (OEH, 2012). Table 15 of OEH (2012) indicates that in areas with <30% rock outcrop, shallow soil with less than 25 cm soil over weathered rock is LSC class 7, while a profile with 25 to 50 cm of soil is rated as LSC 6. This implies that the constructed profile would need to be a minimum 25 cm thick. It is suggested that a profile thickness of 40 cm be adopted to allow for imperfections in the constructed surface, settlement and some soil movement (erosion).

The constructed profile of 20 cm topsoil and 20 cm subsoil can have the properties of a shallow Chromosol or Calcarosol, depending on the subsoil chemistry. This profile would have an LSC class of 6, due to the constraints of shallow soil depth and susceptibility of the sandy topsoil to wind erosion.

Properties of topsoil stripped from the Dunes and Sand Plains, and Lunettes are similar (Tables 9.3 and 9.4), and soil borrowed from these landscapes could be used widely for rehabilitation across the Disturbance Area. Elevated salinity in the Lunettes with Copi Association is likely to limit the range of plants that can grow well in this soil. Profiles constructed from the Blanchetown clay are likely to have a tendency to be poorly drained, so this soil should not be used on emplacement batters.

Soil sampled in Lake Floor West was sandy and had low salinity. The high coarse sand and low clay content make this soil susceptible to erosion. Soil from the Lake Floor East is toxically saline.

Table 9.5. LSC class changes during the Project

Disturbance Type	Disturbance and Rehabilitation Activities	Predicted Post-Mining LSC
Extraction Area	**Starter Pond:** Vegetation, topsoil and subsoil selectively removed. Stockpiled separately. Overburden removed and stored in the Off Path Storage Facility **Continuous Mining:** Vegetation, topsoil subsoil and overburden removed from advancing face and placed in retreating face to build desired landform. **Progressive revegetation** during the Project.	LSC would be determined by land shape and height above groundwater. Constructed emplacements should have LSC 6, the same as existing landforms. Modified Lake Floor West with low salinity, but waterlogging can be LSC 7, and saline Lake Floor East LSC 8. Large depressions will also be LSC 8.
Off Path Storage Facility	Vegetation, topsoil and subsoil removed. Off Path Storage Facility to receive overburden, interburden and reject until the starter pond is complete. Topsoil and subsoil placed and site revegetated	Would be a constructed emplacement, so should be LSC 6
Water Storage Dam	Vegetation, topsoil and subsoil removed. Water table lowered to 2 m below surface. Topsoil and subsoil replaced and area revegetated. Subsoil required here as site does not receive enough rain to flush subsoil.	LSC the same as it was before disturbance after vegetation to protect from wind erosion is established.
Soil Stockpile Area	Vegetation, topsoil and subsoil removed. Stockpile separately. Soil placed during initial mining operations until progressive rehabilitation can commence. Stockpiled soil removed during years14 to 16 when mining occurring within the Lake Floor East Soil Association. Substrate loosened. Subsoil and topsoil replaced. Revegetated.	LSC the same as it was before disturbance after vegetation to protect from wind erosion is established.
Heavy Mineral Concentrate Plant Power Station Workshop/Stores Mine Office/Admin Mine Camp	Vegetation, topsoil removed and stockpiled separately. Site levelled. Infrastructure built, operated then removed. Landform rebuilt, substrate loosened, subsoil and topsoil replaced. Revegetated.	LSC the same as it was before disturbance after vegetation to protect from wind erosion is established.
Access Road within Limit of Disturbance, Haul Roads, Service Corridor, Buffer Zones and Disturbance not Specified	Vegetation removed from road and table drains and topsoil graded into windrows beside the road. Road covered with sheet of imported road-base. Dust suppression using binding agents or non-saline water. Road sheet removed, subsoil loosened, land-shape reformed and topsoil replaced. Revegetated.	LSC the same as it was before disturbance after vegetation to protect from wind erosion is established.
Solar Farm areas	Larger vegetation removed, but understorey of grass and herbs retained. Install solar panels and cabling. Encourage forbs and grasses during operational life. Remove panels and posts, allow regeneration of shrubs and trees.	LSC the same as it was before disturbance.

9.1.6.2. Land Shape Properties

The post-mining land shape over the Project would only change in the Extraction Area (Figure 9.4) where the natural landform would be replaced by a series of flat-topped emplacements that are separated by flat floors in the Lake Floor East and Lake Floor West Associations. Mining would be completed in the eastern end of Lake Floor East and the final void would be filled by material stored in the Off Path Storage Facility for the duration of mining.

The simplified post-mining land shape shown in Figure 9.4 would result in a 550 ha reduction in the combined area of Lake Floor East and the built replacement of Hydrosol. This is due to construction of an east-west ridge through the centre of the Lake Floor East Association. In contrast, there would be a 270 ha increase in the area of Lake Floor West Association and its built replacement the Rudosol Association.

The shape of constructed landform can have a large effect on the stability of the constructed landscape. The main threats are rilling and tunnel erosion from runoff during infrequent rainfall events. This is demonstrated in the Soil Study Area where gully erosion was observed in an area with slope the 4% (1 in 25) as shown in Figure 3.6.

Squires *et al.* (2012) concluded that the following measures were required to ensure that emplacements are stable:

- Batter slope of 1:7 or flatter
- Tree debris spread on batter surfaces to slow surface flow
- Use only topsoil with ESP less than 5%
- Construct bund walls approximately 1 m around the edge of emplacements and drain water away from the edge of the emplacement
- Divide the top of emplacements into level cells that are also bordered by 1 m high embankments.

520000 525000 530000 535000 540000

6285000

6280000

SUNSHINE

BELMORE

NULLA ROAD

WARWICK

HUNTINGFIELD

N

W E

S

Soil Association		Area (ha)
Upland		
	Dunefield and Sand Plain-Dune	1066
	Dunefield and Sand Plain-Swale	4864
	Blanchetown	1305
Near Relict Lakes		
	Lunettes	1767
	Lunettes with Copi	1432
Relict Lake Floor		
	Lake Floor East	1007
	Lake Floor West	1103
Built Soil		
	Calcarosol	2615
	Rudosol	680
	Hydrosol	358
Total		**16197**

525000 530000 535000 540000

Copi Mineral Sands Project

Wentworth

Post Project
Soil Associations

BuiltSoil
- Calcarosol
- Rudosol
- Hydrosol

Upland
- Dunes
- Swale
- Blanchetown

Near Lake
- Lunettes
- Lunettes with Copi

Relict Lake Floor
- Lake Floor East
- Lake Floor West

- Mine Site Boundary
- Soil Study Area
- Access Road Corridor
- Homestead
- Road

0 1 2 3 4
kilometres
1 cm = 0.7 km on A3

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr498
Map Printed: 2024
Built Landform: RZ Resources
Contact: Sustainable Soils Management
Phone : (02) 68 473367

SSM Sustainable Soil Management

Datum: WGS 84
Projection: UTM

Figure 9.4

9.1.6.3. LSC Class

The Project is predicted to be associated with a nett increase of 280 ha of soil in LSC class 6 and 276 ha in the area of LSC class 7 and a 556 ha reduction in the area of LSC class 8 (Figure 9.5 and Table 9.6). The increased area of LSC class 6 is primarily associated with raising the surface elevation of the rehabilitated Off Path Storage Facility, and the southernmost part of the extraction area in the eastern relict lake (Figure 9.5).

Table 9.6. Change in areas of each Land and Soil Capability class within the Disturbance Area over the life of the Project.

LSC Class	Capability	Pre-mining area (ha)	Post-mining area (ha)	Change (ha)
Land with a wide range of uses (cropping, grazing, horticulture, nature conservation)				
1	Extremely high	0	0	0
2	Very high	0	0	0
3	High	0	0	0
Land with a variety of uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)				
4	Moderate			
5	Moderate-low			
Land with a limited range of uses (grazing, forestry and nature conservation				
6	Low	3788	4068	+280
Land generally unable to support agriculture (selective forestry and nature conservation)				
7	Very low	550	826	+276
8	Extremely low	1289	733	-556

Values tabulated above have been calculated with a precision of 0.0000001ha, then rounded to the nearest hectare. As a result, the total values may be different to the sum of the rounded values

520000 525000 530000 535000 540000

6285000

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SUNSHINE

BELMORE

NULLA ROAD

WARWICK

HUNTINGFIELD

N

W E

S

Post Project LSC	Disturbance Area (ha)	Mine Site Outside Disturbance Area (ha)	Outside Mine Site (ha)
6	4068	8900	82
7	826	957	
8	733	632	
Not assessed	1	16503	
Total	**5627**	**26992**	**82**

525000 530000 535000 540000

Copi Mineral Sands Project

Wentworth

Post Project
Land and Soil Capability

LSC
- 6
- 7
- 8

MiningDisturbance
- Extraction Area
- Starter Pond
- Stockpile Area
- Off Path Storage Facility
- Water Storage Dam
- Soil Borrow Area

Infrastructure
- Concentrate Upgrade Plant
- Power Station
- Office_Admin
- Workshop_Stores
- Mine Camp
- Solar Farm

Buffers
- Disturbance not specified
- Buffer Zone

- Mine Site Boundary
- Soil Study Area
- Access Road Corridor
- Homestead
- Road

0 1 2 3 4
kilometres
1 cm = 0.7 km on A3

Certification

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SSM Sustainable Soil Management

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Figure 9.5

10. MANAGEMENT OF DISTURBED SOIL

10.1. INTRODUCTION

The challenge for creating a stable landform after soil disturbance is that the sandy textured soil that is ubiquitous across the Soil Study Area requires cover to protect it from erosion. The cheapest and most sustainable type of cover is vegetation. However, the dry climate is not conductive to growth of vegetation, and the erratic nature of rainfall means:

- Rehabilitated surface may be bare for an extended period in the absence of sufficient rain to germinate seed. So, the soil surface would require protection from erosion.
- There is a conundrum in that sowing seed into moist soil gives the best chance of reliable establishment, but in this climate, sowing seed into dry soil is likely to result in vegetation establishment sooner. This occurs because disturbing the soil to plant seed exposes soil to evaporation, and can result in loss of all moisture from small rainfall.
- In this marginal climate, plant establishment is more reliable if the seedling has some physical protection from wind and the sun, provided the protection does not compete for moisture.

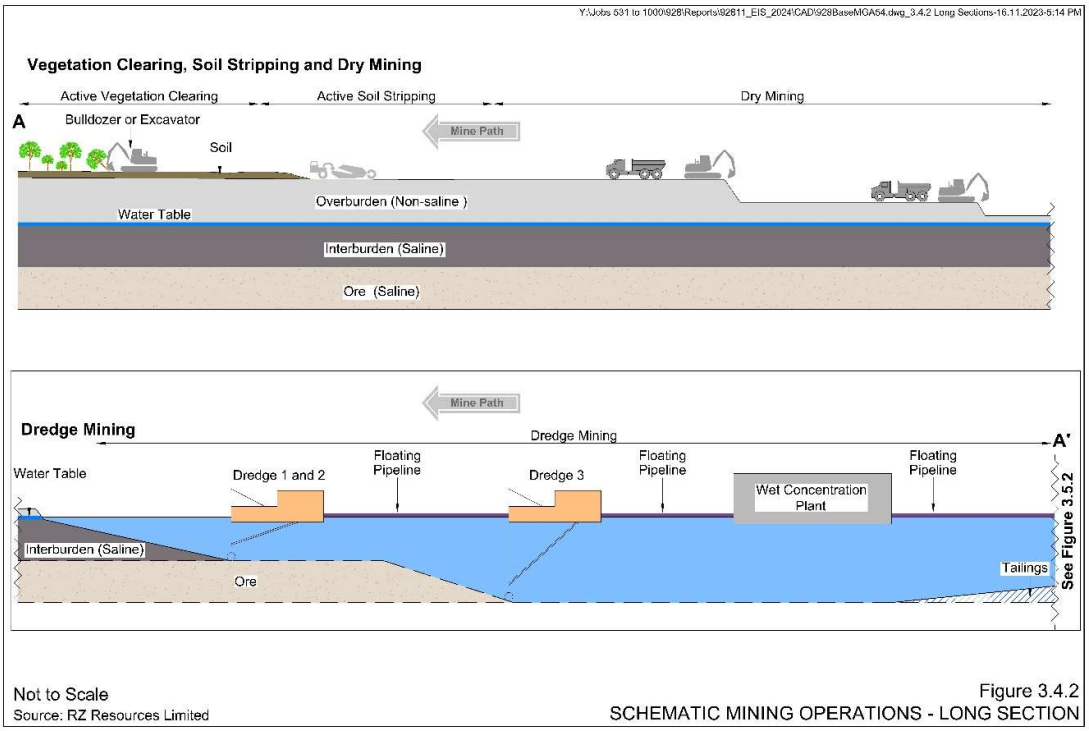
Conversely, the coarse soil texture means that much of the moisture from small rainfall events is available to plants. This means that plant establishment is more reliable and growth is greater than is the case for finer textured soil in the climate in the Soil Study Area. So, the challenge for rehabilitation in this site is to create a soil surface that is resistant to wind erosion, allows rapid water infiltration, and protects seedlings from sand blast. Seeds of preferred species should then be sown at a time of year and moisture regime that gives an acceptable chance of successful establishment. Plants that emerged should then be protected until enough of them reach a growth stage where their remains can protect the soil even if the plants die.

All these processes are more likely to succeed if the soil created to support these plants has physical and chemical properties that facilitate plant growth. Most of Section 10 describes practices that can enable creation of these soil properties.

10.2. OVERVIEW OF MINING AND REHABILITATION PROCESSES

Soil handling processes would follow 2 general patterns. Land which supports the infrastructure of Mine Camp, Office and Workshop and access roads would have soil stripped at the start of the Project, and stockpiled for the duration of the Project and replaced at the completion of the Project.

The progressive mining would begin with starter near the southeastern corner of the Extraction Area Figure 9.1. Overburden (Figure 10.1) would be used to construct the Off Path Storage Facility and interburden and reject would be placed into the Facility. Following this initial phase, soil, overburden, interburden and reject would be extracted from the advance face of the Extraction Area and placed in the retreating face (Figure 10.1). Soil movement would be parallel to the direction of mining advance during this process.



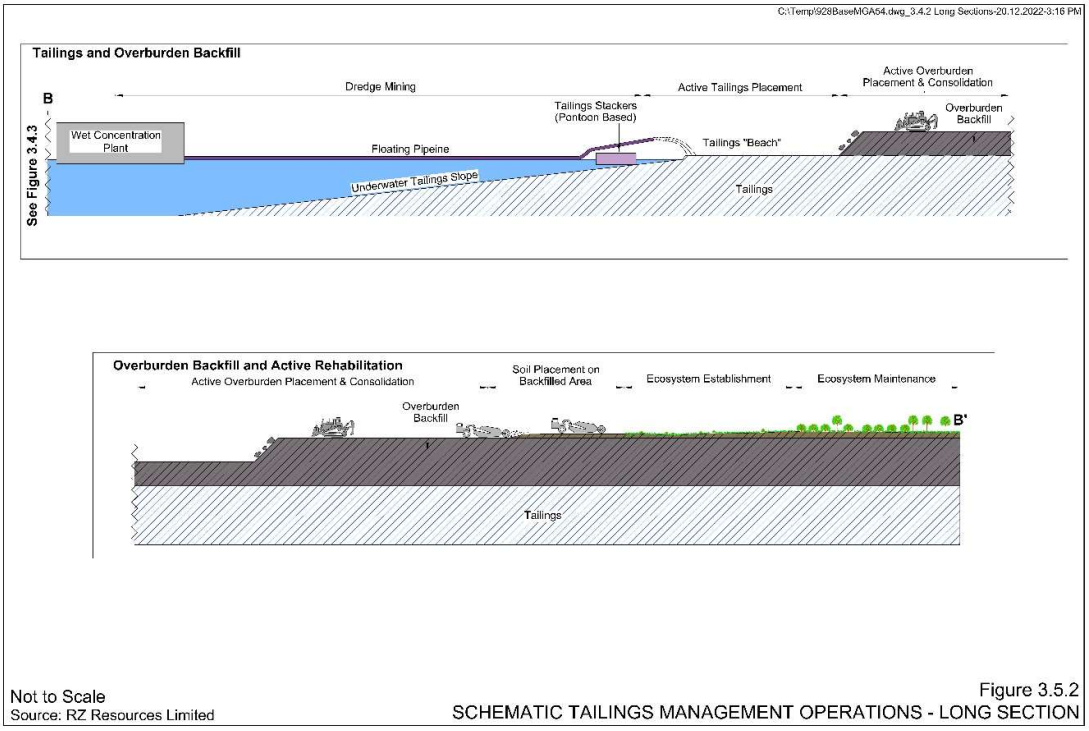


Figure 10.1. Conceptual cross section of continuous mining in the Project. (Not to scale.)

10.3. SOIL PREPARATION FOR REHABILITATION

10.3.1. Estimate Whether Adequate Soil is Available

The gross soil balance in Table 10.1 estimates that there is a total 8,200,000 m^3 topsoil and 15,600,000 m^3 subsoil available to supply the 7,800,000 m^3 topsoil and 9,000,000 m^3 subsoil required to build the profile of 23 cm topsoil and 20 cm of subsoil that would result in soil with the desired LSC class 6 (Section 9.1.5.1).

These volumes indicate that there is a small estimated topsoil surplus and abundant subsoil for the planned rehabilitation. However, the spread out nature of the Limit of Disturbance and progressive mining practice means that careful planning of soil handling would be requires to ensure that adequate soil would be available for rehabilitation of all disturbed areas.

The first step in calculating a more detailed balance is to limit the estimate of volume of soil available to the planned footprint of the planned structure rather than the whole of the domain. This has been done for the Off Path Storage Facility in Table 10.2, which indicates that there would be a 360,000 m^3 topsoil shortfall for the planned rehabilitation. This occurs because 210 ha of the 470 ha footprint is mapped as Lake Floor East, from which topsoil is unsuitable for use in rehabilitation, but topsoil is required for rehabilitation.

The soil balance in the Extraction Area indicates that there is an overall 750,000 m^3 excess of topsoil. However, there will be relatively little topsoil available during mining to the east of Nulla Road because of high salinity in the lake Floor East topsoil.

The discussion above shows the potential for imbalances between the soil required for the planned rehabilitation and soil available in the leg from the starter pond to the northwest in Figure 9.1. This shortfall is likely because the planned post-mining soil association in this leg is Chromosol (Figure 9.4), requiring 23 cm of topsoil and 20 cm of subsoil (Section 9.1.6.1), but the pre-Project Soil Association is predominantly Lake Floor East Association (Figure 9.1), which is predicted to yield no soil that is suitable for rehabilitation (Tables 9.3 and 9.4). As a result, it is recommended that RZ Resources prepare a year by year soil inventory before the Project commences, and that this inventory be updated annually. An initial annual soil balance is presented in Section 10.4.

Table 10 indicates that there would be adequate soil available to reconstruct soil profiles beneath the Water Storage Dam and land supporting Project buildings and similar infrastructure.

Table 10.1. Soil volumes available to be stripped grouped by Infrastructure Type and Soil Association.

Infrastructure	Association	Area	Topsoil available			
			Depth (cm)	Volume (m3)	Depth (cm)	Volume (m3)
Starter Pond						
	Lunettes	18	40	70,546	60	105,818
	Lunettes with Copi	8	30	23,591	70	55,045
Extraction Area						
	Blanchetown	219	20	437,512	0	-
	Dunefield and Sand Plain-Dune	119	35	415,962	65	772,501
	Dunefield and Sand Plain-Swale	339	20	677,039	80	2,708,156
	Lake Floor East	701	0	-	0	-
	Lake Floor West	404	30	1,211,953	70	1,211,953
	Lunettes	411	40	1,642,849	60	2,464,273
	Lunettes with Copi	791	30	2,374,160	70	5,539,707
Subtotal		3009		6,853,611		12,857,452
Off Path Storage Facility						
	Blanchetown	46	20	91,626	0	-
	Dunefield and Sand Plain-Dune	15	35	53,471	65	99,303
	Dunefield and Sand Plain-Swale	17	20	33,092	80	132,370
	Lake Floor East	213	0	-	0	-
	Lunettes with Copi	184	30	551,232	70	1,286,207
Subtotal		474		729,421		1,517,881
Water Storage Dam and Soil Borrow Area						
	Dunefield and Sand Plain-Dune	66	35	232,739	65	432,230
	Dunefield and Sand Plain-Swale	103	20	206,220	80	824,881
Subtotal		170		438,959		1,257,111
Concentrate Upgrade Plant, Mine Camp, Office_ Admin, Power Station, Stockpile Area and Workshop_Stores						
	Blanchetown	17	20	34,700		-
	Dunefield and Sand Plain-Dune	7	35	25,005		-
	Dunefield and Sand Plain-Swale	20	20	39,713		-
	Lake Floor East	147	0	-		-
	Lunettes	28	40	113,469		-
	Lunettes with Copi	19	30	58,316		-
Subtotal		240		271,204		-
Buffer Zone, Disturbance not specified and Solar Farm		1,735				
Disturbance Area Total		5,627		8,293,195		15,632,444

Values tabulated above have been calculated with a precision of 0.0000001%, then rounded to the nearest hectare or cubic metre or percentage point. As a result, the total values may be different to the sum (or product) of the rounded values.

Table 10.2. Soil volumes required for rehabilitation by Infrastructure Type and Soil Association.

Infrastructure Type	Soil Available (m^3) Topsoil	Subsoil	Association	Soil Required Area (ha)	Topsoil (m^3)	Subsoil (m^3)	Soil Balance (m^3) Topsoil	Subsoil
Extraction Area								
	6,853,611	12,857,452	Calcarosol	1,971	4,533,226	3,496,060		
			Rudosol	680	1,563,206	-		
			Hydrosol	358	-	-		
Subtotal				3,009	6,096,432	3,496,060		
Balance							757,179	7,566,207
Off Path								
	1,524,009	2,684,321	Calcarosol	474	1,090,268	699,354		
Balance							-360,847	569,821
Water Storage Dam and Soil Borrow Area								
	438,959	1,257,111	Calcarosol	170	390,115	329,861		
Balance							48,844	917,880
Stockpile Area								
	214,208		Lake Floor East	147	-			
	-	-	Other Associations	68	156,071			
Subtotal					156,071			
Balance							55,816	
Concentrate Upgrade Plant, Mine Camp, Office_Admin, Power Station and Workshop_Stores								
	59,317		All Associations	24	48,600	-		
Balance							10,717	
Overall Balance	9,087,783	16,798,884			7,781,487	6,588,535	511,708	9,043.909

Values tabulated above have been calculated with a precision of 0.0000001%, then rounded to the nearest hectare or cubic metre or percentage point. As a result, the total values may be different to the sum (or product) of the rounded values.

10.3.2. Minimise Soil Loss from Stockpiles

Sandy topsoil would be vulnerable to wind movement unless it is protected. Susceptibility to wind erosion is greater in exposed locations such as elevated stockpiles. Vegetation can protect the surface from wind. Vegetation should be established on Long Term Soil Stockpiles that are expected to be in place for more than 3 months. An alternative would be to create a crust with an applied soil stabilizer or soil binder.

Soil in this dry environment is susceptible to water erosion if runoff is concentrated. For this reason, bunds should be constructed around the edge of large, flat-topped stockpiles. The top of these stockpiles should be shaped to direct excess water away from the edge of the bunded area. Squires *et al*. (2012) recommended a 1:7 (V:H) maximum gradient for stockpile batters in similar soil and climate to the Project.

10.3.3. Minimise Soil Degradation in Stockpiles

Compaction of soil during stripping and stockpiling can be minimised by using appropriate machinery and soil movement practices. For example, it would be preferable to strip and move soil that is moist rather than being wet or dry. When constructing stockpiles, traffic on stockpiled soil should be minimised.

Degradation of topsoil in the stockpiles is inevitable because deeper layers of the stockpile would have much smaller oxygen supply than is available near the soil surface. Some biological activity in this soil can be maintained by limiting the height of topsoil stockpiles to 2 m and by growing vegetation on these stockpiles. Growing vegetation on stockpiles would maintain some biological activity in the soil.

10.3.4. Prevent Soil Contamination

Hydrocarbon management practises would be implemented to prevent hydrocarbon spills throughout the life of the Project, and spill containment materials would be available to clean up spills if they occur.

Saline subsoil is a threat to the capacity to form topsoil that would facilitate plant emergence. Care is required to minimise the amount of subsoil in topsoil stockpiles.

Saline water management practises would be implemented to prevent contamination of both existing topsoil and constructed profiles with saline water

Construction material brought on to the site would need to be clean and contaminant and weed free.

10.3.5. Vegetation Clearing

Larger native vegetation (trees) should be cleared 12 months in advance of topsoil stripping if feasible (Squires *et al.,* 2012). This allows soil to consolidate and encourages seed set of annual plants. The timber should be stockpiled for use to protect soil surface and create habitat.

The low shrubs that dominate much of the Soil Study Area and currently protect the surface should be preserved. It is uncertain whether the most effective method is to mulch the shrubs and incorporate them into the topsoil or stockpile the shrubs separately. Techniques should be trialled during mine operation.

10.3.6. Obtain Seed for Revegetation

Since the aim is to restore the land to close to its existing state, then the most appropriate seed source is within the Soil Study Area. An alternative would be seed collected from nearby areas with similar vegetation communities.

Seed collection should focus on desirable species with adequate seedling vigour. Seed should be collected from species with a range of germination moisture requirements (Duncan *et al.,* 2019) to improve the likelihood of successful vegetation establishment.

Even the most hostile soil supports some vegetation which is highly salt tolerant (Figure 10.2, bottom left). It is likely that the surface 5 to 10 cm from even these areas contains viable seed. This means that one approach to obtaining seed for rehabilitating the Lake Floor East Association would be to strip the surface 5 cm of soil (or even thinner) from land of the same elevation (30 m) and spread this soil over areas to be rehabilitated.

10.3.7. Principles to Achieve Successful Rehabilitation

The detail of how successful rehabilitation is achieved would vary with the soil and landscape properties and management preferences. However, the detail of what should be achieved varies little. The principles are:

- Minimise weed growth before stripping, during stockpiling and after spreading of soil by using appropriate agronomic management practices such as competition from desired species, tillage, mulch and herbicides.
- Minimise compaction in stockpiles.
- Establish vegetation on Long Term Soil Stockpiles to maintain some biological activity in them. In the short term, apply soil stabiliser to minimise wind erosion on stockpiles.
- Shape the subgrade layer to manage runoff. Direct water away from the edges of flat topped stockpiles.
- Loosen the subgrade to facilitate drainage past the rootzone and root growth into this layer.
- Test the stockpiled soil and apply amendments as needed during respreading.
- Add nutrients appropriate to the desired plant species and level of productivity.
- Inoculate the surface soil with microorganisms as well as seeding appropriate grasses, forbs, shrubs and trees.
- During seeding process, conduct soil surface preparation to improve moisture retention and if required apply stabilisers and / or mulch to reduce wind and water erosion
- Post establishment, conduct maintenance activities such as supplementary planting , fertilising or minor repairs
- Carefully manage **total** grazing pressure (includes domesticated livestock, native and feral animals) particularly during the establishment phase.

10.3.8. Contingency Measures

Although the soil balance in Table 10.1 indicates that there is adequate soil for the planned rehabilitation, shortfalls can still occur. If there is insufficient volume of soil available at the time of rehabilitation, or if the soil has degraded to a greater extent than expected, then implement the following contingency measures:

- Stockpile additional soil resources for use in the event that subsequent soil shortfalls occur or remediation is required.
- Spread topsoil at a shallower thickness, or only spread on selected parts of the disturbed area.
- Use subsoil that has been tested and found to have salt levels that do not suppress plant growth can be used as a topsoil substitute.

Although implementation of these contingency measures would enable satisfactory rehabilitation, it is likely that it would take longer for productivity to reach the target levels. It should be noted that achieving the LSC class in Section 9.1.5.1. is constrained by having at least 40 cm of soil apart from Lake Floor East.

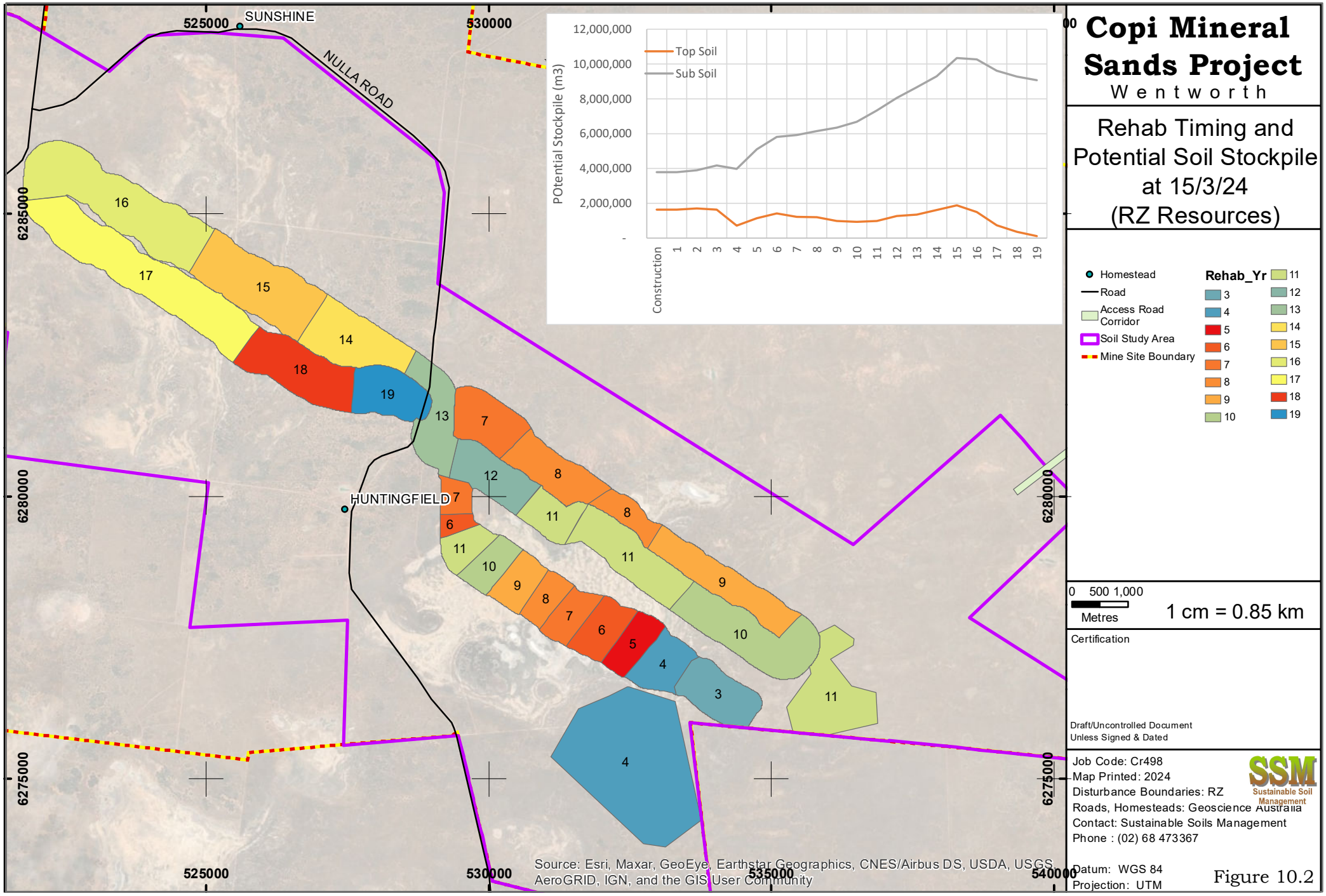
10.4. SOIL MANAGEMENT DURING STRIPPING, STOCKPILING AND REHABILITATION

10.4.1. Check that there is Adequate Soil Available

The continuous movement of soil, overburden, interburden and ore/reject during operation of the Project would require continuous planning and monitoring to ensure that demand for soil is matched by the availability. This soil can come from either freshly stripped or from stockpiled soil.

To minimize the risk of soil shortfalls, it is recommended that an annual soil balance for each year of the mine's life be prepared in the planning phase (Section 10.3.1), and that this balance be recalculated for each of the next 5 years every 12 months.

RZ Resources have prepared a projected annual soil balanced based on the stripping and soil placement recommendations in Section 9, Soil Association boundaries Figure 6.1, and the Project's construction and mining schedule. The soil balance accounts for the area of each Soil Association to be stripped each year as well as differences between the soil required to construct each of the 3 built Soil Associations of Calcarosol, Rudosol, and Hydrosol. It is presented in detail in Table 10.1, and rehabilitation and potential soil stockpiles are summarised in Figure 10.2



Copi Mineral Sands Project

Wentworth

Rehab Timing and Potential Soil Stockpile at 15/3/24 (RZ Resources)

Certification

Draft/Uncontrolled Document
Unless Signed & Dated

Job Code: Cr498
Map Printed: 2024
Disturbance Boundaries: RZ
Roads, Homesteads: Geoscience Australia
Contact: Sustainable Soils Management
Phone : (02) 68 473367

Datum: WGS 84
Projection: UTM

SSM Sustainable Soil Management

Figure 10.2

Table 10.2. Planned annual soil balance prepared by RZ Resources.

Year	Soil Stripping			Cumulative Soil Stockpiles		Soil Spreading		
	Pre mining Soil Association	Available Soil Volume (m^3)		Stockpile Volume (m^3)		Post Mining Soil Association	Required Soil Volume (m^3)	
		Top Soil	Sub Soil	Top Soil	Sub Soil		Top Soil	Sub Soil
Construction	Blanchetown	95,204	-	1,634,862	3,790,881	Calcarosol	-	-
	Dunefield and Sand Plain-Dune	297,988	681,115			Rudosol	-	-
	Dunefield and Sand Plain-Swale	251,166	1,004,664			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	247,291	370,936					
	Lunettes with Copi	743,214	1,734,165					
1	Blanchetown	-	-	1,634,862	3,790,881	Calcarosol	-	-
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	-	-					
	Lunettes with Copi	-	-					
2	Blanchetown	24,554	-	1,706,796	3,901,432	Calcarosol	-	-
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	-	-					
	Lunettes with Copi	47,379	110,552					
3	Blanchetown	28,725	-	1,637,773	4,169,933	Calcarosol	254,908	221,659
	Dunefield and Sand Plain-Dune	80,782	184,644			Rudosol	-	-
	Dunefield and Sand Plain-Swale	76,379	305,516			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	-	-					
	Lunettes with Copi	-	-					
4	Blanchetown	3,239	-	717,706	3,972,505	Calcarosol	1,273,972	1,107,802
	Dunefield and Sand Plain-Dune	127,028	290,350			Rudosol	-	-
	Dunefield and Sand Plain-Swale	113,827	455,308			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	109,811	164,716					
	Lunettes with Copi	-	-					
5	Blanchetown	88,012	-	1,142,902	5,100,739	Calcarosol	142,576	123,979
	Dunefield and Sand Plain-Dune	67,705	154,753			Rudosol	-	-
	Dunefield and Sand Plain-Swale	107,656	430,623			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	52,115	78,173					
	Lunettes with Copi	252,284	588,663					
6	Blanchetown	-	-	1,420,885	5,812,721	Calcarosol	215,919	187,756
	Dunefield and Sand Plain-Dune	41,615	95,119			Rudosol	-	-
	Dunefield and Sand Plain-Swale	719	2,877			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	302,300	453,450					
	Lunettes with Copi	149,268	348,292					

Table 10.4.9 (Cont'd)
Annual Soil Balance

Year	Soil Stripping			Cumulative Soil Stockpiles		Soil Spreading		
	Pre mining Soil Association	Available Soil Volume (m^3)		Stockpile Volume (m^3)		Post Mining Soil Association	Required Soil Volume (m^3)	
		Top Soil	Sub Soil	Top Soil	Sub Soil		Top Soil	Sub Soil
7	Blanchetown	-	-	1,225,963	5,921,835	Calcarosol	443,857	385,963
	Dunefield and Sand Plain-Dune	37,897	86,622			Rudosol	-	-
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	100,761	151,142					
	Lunettes with Copi	110,277	257,314					
8	Blanchetown	11,676	-	1,203,074	6,146,663	Calcarosol	350,961	305,183
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	390	1,558			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	250,675	376,012					
	Lunettes with Copi	65,332	152,440					
9	Blanchetown	34,206	-	985,052	6,349,961	Calcarosol	484,334	421,160
	Dunefield and Sand Plain-Dune	49,634	113,449			Rudosol	-	-
	Dunefield and Sand Plain-Swale	94,921	379,684			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	87,550	131,325					
	Lunettes with Copi	-	-					
10	Blanchetown	40,443	-	932,343	6,678,302	Calcarosol	601,179	522,764
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	401,151	601,726					
	Lunettes with Copi	106,877	249,379					
11	Blanchetown	-	-	984,245	7,331,269	Calcarosol	661,569	575,277
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	327,391	327,391					
	Lunettes	-	-					
	Lunettes with Copi	386,080	900,853					
12	Blanchetown	-	-	1,272,431	8,052,728	Calcarosol	247,204	214,960
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	234,618	234,618					
	Lunettes	-	-					
	Lunettes with Copi	300,772	701,802					
13	Blanchetown	40,692	-	1,348,194	8,662,787	Calcarosol	272,017	236,537
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	179,836	719,343			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	127,252	127,252					
	Lunettes	-	-					
	Lunettes with Copi	-	-					

Table 10.4.9 (Cont'd)
Annual Soil Balance

Year	Soil Stripping			Cumulative Soil Stockpiles		Soil Spreading		
	Pre mining Soil Association	Available Soil Volume (m^3)		Stockpile Volume (m^3)		Post Mining Soil Association	Required Soil Volume (m^3)	
		Top Soil	Sub Soil	Top Soil	Sub Soil		Top Soil	Sub Soil
14	Blanchetown	119,979	-	1,613,688	9,302,723	Calcarosol	349,504	303,917
	Dunefield and Sand Plain-Dune	-	-			Rudosol	-	-
	Dunefield and Sand Plain-Swale	92,023	368,092			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	273,423	273,423					
	Lunettes	-	-					
	Lunettes with Copi	129,574	302,339					
15	Blanchetown	-	-	1,886,837	10,347,677	Calcarosol	367,722	319,758
	Dunefield and Sand Plain-Dune	-	-			Rudosol	138,705	120,613
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	250,265	250,265					
	Lunettes	-	-					
	Lunettes with Copi	529,312	1,235,061					
16	Blanchetown	42,739	-	1,501,713	10,269,714	Calcarosol	549,659	477,964
	Dunefield and Sand Plain-Dune	-	-			Rudosol	171,903	149,481
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	162,978	244,467					
	Lunettes with Copi	130,721	305,015					
17	Blanchetown	-	-	743,844	9,610,698	Calcarosol	176,305	153,309
	Dunefield and Sand Plain-Dune	-	-			Rudosol	581,564	505,708
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	-	-					
	Lunettes with Copi	-	-					
18	Blanchetown	-	-	363,514	9,279,975	Calcarosol	81,113	70,533
	Dunefield and Sand Plain-Dune	-	-			Rudosol	299,217	260,189
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	-	-					
	Lunettes with Copi	-	-					
19	Blanchetown	-	-	120,726	9,068,856	Calcarosol	66,116	57,493
	Dunefield and Sand Plain-Dune	-	-			Rudosol	176,671	153,627
	Dunefield and Sand Plain-Swale	-	-			Hydrosol	-	-
	Lake Floor East	-	-					
	Lake Floor West	-	-					
	Lunettes	-	-					
	Lunettes with Copi	-	-					

Source: RZ Resources Limited

10.4.2. Soil Stripping

Topsoil should be stripped and stockpiled separately to the underlying subsoil. This is because of the increase in clay content, carbonate percentage, sodicity and exchangeable sodium percentage between the topsoil and subsoil underlying soil in some Soil Associations (Section 6). This would result in stockpiles being constructed by soil depth (topsoil, and subsoil).

The following topsoil stripping and handling techniques should be implemented where practicable to minimise soil deterioration:

- The area to be stripped would be clearly defined on the ground. The target depths of topsoil and subsoil to be stripped at each location would be clearly communicated to machinery operators and supervisors.
- A combination of suitable equipment would be used for stripping and placing soil in stockpiles. Machinery circuits would be located to minimise compaction of both undisturbed and stockpiled soil.
- Ideally, the soil material should be maintained in a slightly moist condition during stripping. Material should not be stripped in either an excessively dry or wet condition.
- All machinery brought onto the site for soil stripping must comply with weed management and biosecurity protocols established for the site.
- Trees present should be cleared and grubbed 12 months prior to soil stripping and stockpiling.
- Topsoil and subsoil would be stockpiled separately.
- Handling and rehandling topsoil would be minimised as far as possible.

10.4.3. Soil Stockpiling

The topsoil should be stored in a way that minimises compaction of the whole stockpile, and maximises biological activity. The following techniques should be implemented where practicable to achieve these goals:

- Topsoil and subsoil should be stockpiled separately. Where this is not possible, combined topsoil and subsoil stockpiles would be built to the specifications of topsoil stockpiles.
- All soil stockpiles would have batter slope of 14% (1V:7H, Squires *et al.,* 2012) or flatter to limit erosion potential.
- Topsoil stockpiles would be designed and constructed to a depth not greater than 2 m in order to minimise the development of anaerobic conditions and to minimise the deterioration of biota and seed banks.
- Subsoil stockpiles can be 4 m high.
- The surface of short term soil stockpiles would be left in a rough condition to promote water infiltration rather than runoff and to slow wind. Wind erosion can level this surface so surface roughness should be monitored. If required, sediment controls would be implemented downslope of stockpiles to capture eroded sediment.

- Long term stockpiles would be managed to stabilise the surface, limit dust generation and minimise erosion. These would require a bunded crown in which runoff is directed away from the edge. Ideally a surface crust should be formed and vegetation should be established to competition for weeds.
- Batters of long term stockpiles would require erosion protection in the form of tree debris or similar.
- After the stockpiles are established, machinery and vehicles would be excluded from general access. Stockpile location would be marked on site maps to identify them so that they are protected from disturbance.
- Stockpiles would be surveyed and data recorded about the volumes and soil types present.
- Stockpiles would be monitored for the establishment of weeds and control programmes implemented as required.
- Soil transported by dump trucks may be placed directly into storage. Soil transported by bottom dumping scrapers is best pushed to form stockpiles by other equipment (e.g., bulldozer or excavator) to avoid tracking over previously laid soil by the scraper.
- Overland flow onto and across stockpile sites would be kept to a practical minimum.

10.4.4. Soil Respreading

The aim of respreading is to construct a layered material with properties that can perform similar functions to the undisturbed soil. Topsoil provides a path for entry of water and air, storage of nutrients and water, and plant support. Subsoil should have continuous pores to allow entry of water and air as well as root growth. Subsoil has a larger role in storage of water than nutrients, and is important in supporting plants. The soil should not have sharp differences between the properties of layers as the discontinuities at these boundaries can slow water movement. The spreading of topsoil and subsoil should be carried out to achieve these aims. The recommended process for spreading of topsoil and subsoil is as follows:

- A soil balance plan showing the depths and volumes of soil to be spread would be prepared before the soil is spread. The plan would take account of the erodibility of the stockpiled soil, with more erodible soil being placed on flatter areas to minimise the potential for erosion.
- Stockpiled topsoil and subsoil would be tested to determine the required ameliorants.
- After decommissioning, infrastructure areas and roads to be decommissioned would be ripped.
- The subgrade surface would be reshaped to appropriate landforms, ensuring that water cannot run off flat tops of reshaped land.
- A second ripping may be required after the surface is reshaped.
- Ameliorants would be mixed with the soil as it is being spread if required.

- Spread subsoil in even layers at thickness appropriate for the desired land capability, then spread topsoil.
- Soil should be moist to just moist rather than wet or dry when being respread.
- Traffic patterns would be managed to minimise compaction of topsoiled areas. Soil can be ripped, imprinted or scarified after seeding to remove wheel ruts and compaction.
- Timber that was stockpiled during clearing should be placed on exposed areas such as batters of overburden stockpiles or upper slopes of dunes. This timber can be transported in dump trucks and spread with dozers fitted with stick rakes.
- Erosion and sediment controls would be implemented where necessary prior to vegetation establishment.

10.4.5. Seeding

Examination of the pattern of rainfall and evapotranspiration in Figure 3.1 indicates that the rainfall deficit is smallest in May, June and July. This indicates that this would be the period when moisture conditions are most likely to favour germination and establishment. This is also the coolest time of year, so summer-growing species may not germinate until summer rainfall provides sufficient moisture. Recommended practices are:

- Plan to seed for a short period in early winter (Squires *et al.,* 2012) each year.
- Seeding will occur with a one-pass machine that applies seeds and ameliorants, scarifies or imprints the surface with a roller and applies a surface stabilising mixture.

10.4.6. Post Seeding

The key issue post seeding is to reduce total grazing pressure to the extent that enough seedlings survive to protect the surface soil. Total grazing pressure includes grazing by domestic animals (e.g., sheep, cattle and goats), feral animals (e.g., goats) and native animals (e.g., kangaroos). The greatest detrimental grazing is likely to occur during periods of lower than average rainfall.

10.4.7. Surface Soil Stability

Wind erosion is the dominant hazard in the Soil Study Area (Table 8.2). Criteria that determine Wind Erosion Hazard are soil erodibility, wind erosive power and exposure to wind (Table 6 of OEH, 2012).

Soil erodibility can be lowered by forming a surface crust. A range of mechanisms that stabilise the soil were recorded during the soil assessment. These include hardsetting of soil, and surface protection from plants and plant litter (Figure 10.3). Cryptogram crusts (thin crusts of mosses, lichens, algae and bacteria) were also recorded.

Figure 10.3. Natural surface erosion protection recorded during soil assessment. Top left: Hardset silty surface soil. Top right: sand built up around bases of blue bush shrubs with litter from annual medics and grasses. Bottom left: Pigface, samphire and poppy saltbush in extremely saline soil. Bottom right: cryptogram crust after rain.

A surface crust can be created in the short term by applying a chemical soil stabilizer or a mulch of tree debris or cereal straw. Growing plants and stubble offer a longer term solution. This surface protection of rehabilitated land would increase as shrubs and trees become established.

Biological cryptogram crusts have been shown to reduce wind erosion by as much as 90% (Eldridge and Greene, 1994). These crusts take many years to establish on disturbed sites. Eldridge (1998) at a site in South Australia receiving average 200 mm rain/year observed that complete recovery of organisms in cryptogram crusts took 30 to 40 years. However, Bowker (2007) described the barriers to successful establishment of the biological cryptogram crusts and methods to overcome these limitations.

10.5. MONITORING AND REPORTING

The successful rehabilitation of soil in the Limit of Disturbance would depend on the following key steps:

1. Stripping and stockpiling sufficient soil to provide topsoil and subsoil for the area to be rehabilitated.
2. Maintaining biological activity and adequate aeration in the stockpiled soil.
3. Preparation of the subgrade and construction of the rehabilitated soil.
4. Establishment of desired plants on the rehabilitated soil.

All these steps would require some degree of monitoring. It is likely that steps 1 and 3 would require the most intensive monitoring, and annual monitoring of vegetation health, groundcover percentage, weed presence and wind erosion, is recommended.

A detailed rehabilitation management plan should be developed and approved prior to the commencement of the Project, and include the following items:

- Monitoring of stripping and stockpiling should ensure that the design depth of topsoil is stripped and that the subsoil salinity is not excessive. The volumes of topsoil and subsoil should be checked to ensure that there is sufficient soil to enable the planned rehabilitation.
- Maintenance of biological activity would require plants to be grown. The species and vigour of plants growing on the stockpiles should be monitored.
- The soil stockpiles should be tested before the soil is spread to determine the ameliorants required to construct a fertile soil profile. It is likely that nutrients would be required in the topsoil. Some gypsum may also be required.

Achieving the planned LSC class depends on accurate placement of the subsoil and topsoil. Achieving the desired soil thickness would in turn depend on accurate preparation of the subgrade. As such, an accurate survey of the thickness of the soil layer should be conducted.

The success of rehabilitation would be determined by the plant growth in the rehabilitated landscape. This should be monitored.

10.6. REVEGETATION ISSUES REQUIRING FURTHER INVESTIGATION

Recommendations on soil management and revegetation practices outlined above were based on the assumptions that the key limitations to successful rehabilitation are stabilising surface soil until vegetation is established, then establishing vegetation. The aim is to rely on natural rainfall and use the resources of timber and seed that can be harvested from the Soil Study Area. These recommendations concerning managing a rebuilt landscape are made about a locality where agricultural operations are basically rangeland grazing with almost zero tillage. Existing land disturbance is restricted to clearing vegetation and levelling a 5 to 10 m wide strip for fencelines and farm tracks, and constructing dams or ground tanks and diversion drains to help fill them.

As a result, it is likely that the revegetated land would be more susceptible to wind erosion until either there is sufficient vegetation or a biological cryptogram crust has reformed to protect the surface soil from wind erosion during inevitable droughts, so it could be beneficial to investigate 3 topics:

1. Methods to improve the quality of the biological cryptogram crust in rehabilitated areas.

2. The rehabilitated landform would be most vulnerable to erosion in the time between placement of the topsoil and establishment of the vegetative cover. So, a key issue is management of topsoil in the time between placing topsoil and planting seed. Questions include:
   - How rough should the surface be?
   - Should surface be consolidated or loose?
   - Can the biomass from shrubs protect the surface during this period?

3. The aim is to use local seed to re-establish vegetation. The success of the revegetation would depend on the quality of the seed used. This refers to both the health of the seed and the species chosen. An important decision is selection of species for revegetation.

   This could build on the work of Duncan *et al.,* (2012) and should involve small scale field trials of a number of common species. This can also guide selection of the optimum planting date. The trials would also guide whether there is a benefit in controlling growth in annual species where perennials such as Pearl bluebush (*Maireana sedifolia*) are planted.

   Also, the range of vegetation communities across the Soil Study Area indicates that these communities grow best in different soil types. The generic Chromosol is likely to be better suited to shrubs than trees, but this should be investigated.

11. POTENTIAL IMPACT OF PROJECT ON AGRICULTURAL PRODUCTIVITY

The main potential impact of the Project on agricultural productivity will be to remove an area from agricultural landuse for the duration of mining plus the time taken for the land to return to its current level of production. This was estimated based on the following assumptions:

- The whole of the footprint of the Limit of Disturbance (5,622 ha) will be removed from agricultural production.
- Productivity of the land removed from agriculture will be equivalent to the average for rangeland grazing in the Wentworth-Balranald, Australian Statistical Geography Standard (ASGS) area.
- Land will return to its current level of agricultural productivity after the site is rehabilitated however grazing exclusion and native ecosystem restoration is the expected end use for the disturbed landscape and potentially the entire project site.

This section presents a summary of agricultural productivity in the Wentworth Shire to support assumptions about potential agricultural productivity on the Soil Study Area. This level of productivity is combined with gross margins from NSW DPI to estimate the value of production that is foregone when the land is used for a mine rather than for grazing.

11.1. AGRICULTURAL PRODUCTION IN WENTWORTH SHIRE

11.1.1. Overview

The Wentworth Shire covers approximately 2,600,000 ha (26,000 km^2), in the southwestern corner of New South Wales. It is bordered to the south by the Murray River and west by the South Australian border. The Darling River runs from north to south through the eastern half of the shire.

A little over 7,000 people live in the Wentworth Shire (Table 11.1). Approximately two thirds of these live in the towns of Wentworth, Gol Gol, Buronga, Dareton and Pooncarie which are beside the Murray and Darling Rivers. Agriculture is the dominant employer in the Shire, directly employing approximately 25% of the Shire's labour force.

Table 11.1. Employment in Wentworth Shire (ABS, 2021 and ABS, 2019).

Population Category	Number
Total persons	7,453
Total labour force	3,317
Total employed in agriculture*	1,050 (25%)*

**Number employed in agriculture from ABS (2019) as this data was not provided by ABS (2021).*

11.1.2. Agriculture in the Wentworth Shire

The area of each landuse type was calculated in ArcGIS by intersecting the boundary of the Wentworth Shire with a shapefile downloaded from ABARES

(2022). This data is a product of the Australian Collaborative Land Use and Management Program (ACLUMP).

Approximately 82% of the area of the Wentworth Shire is used for rangeland grazing, and 1% is used for grazing of improved pasture (Table 11.2). A much smaller 4% is used for cropping, 1.5% and 0.55% of the shire area is irrigated. A further 12% of the shire area is used for nature conservation, forestry, infrastructure or intensive industry. The remaining 4% of the shire area is mapped as water features of rivers and lakes.

Table 11.2. Landuse in Wentworth Shire.

Landuse	Area (ha)	Proportion
Rangeland Grazing	2,156,604	82%
Improved Pasture	31,475	1%
Rainfed cropping	108,732	4%
Broadacre irrigation	2,056	0.1%
Irrigated Horticulture	12,282	0.5%
Intensive industry	153	0.0%
Mining	2,762	0.1%
Infrastructure	5,996	0.2%
Nature Conservation and forests	187,605	7%
Rivers, lakes and wetlands	114,695	4%
Total	**2,622,360**	

The gross value of livestock production in 2020-21 of $41 million (Table 11.3) is equivalent to around $19/ha. Grain growing in the same year returned an average gross of $257/per ha (of land classified as cropping land rather than area cropped).

Table 11.3. Annual value of Agricultural production in Wentworth Shire (Australian Agricultural Census 2020–21 visualisations – LGA - DAFF (agriculture.gov.au)).

Product Type	Value ($ million)
Sheep and Lambs	34
Meat cattle	9
Grain and hay	28
Tree crops	202
Vegetables	20
Nurseries and Turf	7
Total	**300**

Carrying capacity is a key driver of the expected returns from grazing enterprises. One method of comparing different animal enterprises is to use a standard animal. In New South Wales it is common to use Dry Sheep Equivalent, which is the feed consumed by a 50 kg wether.

Stocking rates in 2020/21 from ABS were combined with standard conversion rates from Millear *et al,* (2003) to estimate that the 2,188,079 ha of grazing land in Wentworth Shire carried 686,698 DSEs (Table 11.4). This is equivalent to 0.31 DSE/grazed ha.

Table 11.4. Stocking rate of Wentworth Shire in 2020/21 (Australian Agricultural Census 2020–21 visualisations – LGA - DAFF (agriculture.gov.au)).

Stock Class	Total number	Estimated Dry Sheep Equivalent*
Sheep	377,121	490,257
Meat Cattle	14,326	186,238
Other Livestock (Goats assumed)	10,203	10,203
Total		686,698

*Dry Sheep Equivalents estimated using ratios of 1.3 for ewes and lambs, 13 for breeding cattle and 1 for goats.

11.1.3. Estimate of Potential Agricultural Production in the Soil Study Area

A common sheep enterprise around the Soil Study Area is to run a self-replacing flock of Dorper breed of sheep. Self-replacing means that ewes are bred on-farm, rams are purchased from studs and lambs and ewes older than breeding age are sold. DPI (2022) estimates a gross margin of $118.49/ewe, and a DSE rating of 2.8 DSE/ewe to give a gross margin of $43/DSE.

The selected gross margin of $43/DSE combined with the average stocking rate of 0.31 DSE/ha in Section 11.1.2 gives an average annual Gross Margin of approximately $13/ha. This gross margin will be applied to land with LSC class 6. However, land with LSC 7 will be allocated zero stocking rate and gross margin.

11.2. PRE-MINING POTENTIAL AGRICULTURAL PRODUCTIVITY

The current carrying capacity of the 3,788 ha of LSC class 6 land within the 5,628 ha in the Disturbance Footprint is estimated to be 440 Dorper ewes. This is equivalent to 1220 DSE, which would be expected to return an annual gross margin of approximately $50,494 (calculated as 3,788 ha * 0.31 DSE/ha * $43/DSE).

The 1,839 ha of LSC classes 7 and 8 was rated as having no agricultural productivity

11.3. POTENTIAL AGRICULTURAL PRODUCTIVITY DURING MINING

The planned mine life of 25 years (Section 1.1) means that it is prudent to assume that the whole of the Limit of Disturbance footprint will be inaccessible to grazing livestock for the life of the mine. As such, it is assumed that the Limit of Disturbance footprint will carry 0 head for the life of the mine.

11.4. POTENTIAL AGRICULTURAL PRODUCTIVITY POST REHABILITATION

The primary aim of rehabilitation is to create a stable, non-polluting landscape. An adjunct to this aim will be that the rehabilitated land should be able to support the existing stocking rate. This is because a relatively small mass of vegetation is harvested by grazing livestock.

The vegetation harvested by 0.31 DSE/ha of livestock is equivalent to around 120 kg/ha/year of dry matter. This dry matter was calculated on the assumption that 1 DSE is equivalent to approximately 1 kg dry matter per day. As such, the vegetation established during rehabilitation should be able to supply the feed required by grazing animals if it is dense enough to provide the function of protecting the soil surface from wind erosion.

As such, it is estimated that the carrying capacity of rehabilitated land will be 0.31 DSE/ha. This is aided by the planned 280 ha increase in the area of LSC class 6 land balanced by a planned 280 ha reduction in the area of LSC classes 7 and 8 land (Table 9.6).

11.5. POTENTIAL IMPACT ON WATER RESOURCES

There is potential for the Project to reduce the volume of water available to neighbouring landholders. This could happen if disturbance created by the Project intercepted surface water, extracted surface water that could be used by other water users, or lowers groundwater levels around the Project. The Project is unlikely to intercept **surface water** as there is minimal surface water flow because of the low rainfall and leaky surface soil.

The Project will not extract surface water, so it will not reduce surface water available to other users.

The Project plans to float dredges and the wet concentration plant in water that discharges from a saline water table into the mine sump. Some water will be extracted from the sump and pass through a reverse osmosis desalination plant before being used for camp amenities, maintenance, concentrate washing and dewatering and dust control where required. This is expected to have minimal impact on surrounding **groundwater** because of the small volume being used and shallow depth that water will flow from groundwater.

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13. LIMITATIONS

The investigations described in this report identified actual conditions only at those locations where sampling occurred. This data has been interpreted and an opinion given regarding the overall physical and chemical conditions at the site.

Although the information in this report has been used to interpret conditions at the site, actual conditions may vary from those inferred, especially between sampling locations. Consequently, this report should be read with the understanding that it is a professional interpretation of conditions at the site based on a set of data. Although the data were considered representative of the site they cannot fully define the conditions across the site.

APPENDIX I:

Logs of Soil Description.

Copi Mineral Sands Copi Mineral Sands
Cr456

TEST HOLE SC001

Date Excavated: 21/1/20
Logged by: PJH Datum: WGS84
Easting: 523172 Northing: 6285797
Surface Elevation(m): 29.2
Equipment: Backhoe

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 115
Drainage: Well drained
Estimated Permeability: > 500 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Turpentine

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has an average number of roots present.	5.5		Nil			
	A12		Red sandy loam with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has an average number of roots present.	8		Nil		0.7	
50	B2k		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Slight	20% Carb		
100	C		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5			2% Carb	1.1	
150			COMMENTS: Well drained carbonate ridge Bottom of hole at 140						

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Copi Mineral Sands Copi Mineral Sands
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TEST HOLE SC002

Date Excavated: 21/1/20
Logged by: PJH Datum: WGS84
Easting: 523814 Northing: 6285271
Surface Elevation(m): 25.2
Equipment: Backhoe

Australian Soil Class: Hypersalic Rudosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 59
Drainage: Poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Open depression
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: ND

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown light clay with weak grade of structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	6.5		Nil			
50	B		Brown sandy clay loam with weak grade of structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	7		Nil		28.5	
	C1		Brown sand with single grained grade of structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	7.5		Nil		44.4	
100	C2		Grey sand with single grained grade of structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	5		Nil		103.2	
150			COMMENTS: C1 looks like river sand, medium, rounded., C2 looks like beach sand., Water EC 115 dS/m, Iron? In 3rd layer						

Bottom of hole at 150

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TEST HOLE SC003

Date Excavated: 21/1/20
Logged by: PJH Datum: WGS84
Easting: 524483 Northing: 6285188
Surface Elevation(m): 26.5
Equipment: Backhoe

Australian Soil Class: Brown Arenosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 52
Drainage: Imperfectly drained
Estimated Permeability: 50 to 500 mm/day

Geology: Yamba Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown loamy sand with weak grade of subangular blocky structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8		Nil			
50	B		Brown loamy sand with weak grade of subangular blocky structure and ped size of 3 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	6.5		Nil		15	
	C		Brown loamy sand with weak grade of subangular blocky structure and ped size of 2 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5		Slight	2% Gyp		
100	2B		Brown sandy clay loam with weak grade of subangular blocky structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has no roots present.	6		Nil	50% Gyp	27.5	
150			COMMENTS: High ECa due to gypsum at depth Bottom of hole at 120						

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Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bull Mallee

Copi Mineral Sands Copi Mineral Sands
Cr456

TEST HOLE SC004

Date Excavated: 21/1/20
Logged by: PJH Datum: WGS84
Easting: 524923 Northing: 6284883
Surface Elevation(m): 34.5
Equipment: Backhoe

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 86
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: 10% Carbonate upslope

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown sandy loam. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has abundant roots present.	9		High			
	B11		Grey light clay with weak grade of subangular blocky structure and ped size of 10 cm breaking to 2 cm. Soil is not dispersive, doesn't slake, has a moderate SOILpak score and has few roots present.	9		Slight		14.7	
50									
	B12		Grey light clay with weak grade of subangular blocky structure and ped size of 15 cm breaking to 3 cm. Soil is not dispersive, doesn't slake, has a moderate SOILpak score and has few roots present.	9		Slight			
100									
	B2		Red light clay with weak grade of subangular blocky structure and ped size of 15 cm breaking to 3 cm. Soil is not dispersive, doesn't slake, has a poor to moderate SOILpak score and has no roots present.	9		Slight		20	
150									
			COMMENTS: A little soil over gypsite Bottom of hole at 150						

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: ND

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TEST HOLE SC005

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 525369 Northing: 6284308
Surface Elevation(m): 32.0
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 125
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: Carbonate 30 m west

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with strong grade of subangular blocky structure and ped size of 2 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	7.5		Nil			
50	B1		Red sandy clay loam with strong grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8		Moderate		1.4	
	B2k		Red sandy clay loam with strong grade of polyhedral structure and ped size of 10 cm breaking to 2 cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		High	20% Carb		
100	Ck		Red sandy clay loam with strong grade of polyhedral structure and ped size of 0.5. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	7.5		High	50% Carb	19	
			COMMENTS: Refusal at 130 cm in calcrete Bottom of hole at 130						
150									

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: ND

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TEST HOLE SC006

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 526208 Northing: 6284453
Surface Elevation(m): 26.6
Equipment: Backhoe

Australian Soil Class: Hypocalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 56
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with moderate grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has abundant roots present.	8		Slight			
50	B21		Brown sandy clay loam with weak grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Nil	20% Gyp	8.2	
	B22		Brown sandy clay loam with weak grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has few roots present.	8		Nil	10% Gyp		
100	2A		Red sandy clay with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has few roots present.	7.5		Nil			
	3A		Brown sand with massive grade of structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	7.5		Nil		11.4	
150			COMMENTS: Roots in B, 2A mostly in vertical , macropores infilled with red sand Bottom of hole at 150						

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Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Bush?

Copi Mineral Sands Copi Mineral Sands
Cr456

TEST HOLE SC007

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 527433 Northing: 6283516
Surface Elevation(m): 31.3
Equipment: Backhoe

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 35
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with moderate grade of subangular blocky structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8		Very high			
	A12		Red sandy loam with strong grade of subangular blocky structure and ped size of 1 cm breaking to 0.5 cm. Soil is not dispersive, partially slakes, has a good SOILpak score and has abundant roots present.	8		Very high		3.3	
50	B21k		Red sandy clay with moderate grade of subangular blocky structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8		Very high	20% Carb		
100	B22k		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 20 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8		Very high	30% Carb	19.5	
150			COMMENTS: Very high effervescence throughout., Soil bare apart from mallee Bottom of hole at 150						

Landscape Properties

Landscape position: Open depression
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bull Mallee

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TEST HOLE SC008

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 527953 Northing: 6283281
Surface Elevation(m): 40.9
Equipment: Backhoe

Australian Soil Class: Lithocalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 50
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure and ped size of 10 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	9		Very high			
	Bk		Brown loamy sand with weak grade of subangular blocky structure and ped size of 0.5. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	80% Carb	15	
50	C1		Brown loamy sand with weak grade of subangular blocky structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has no roots present.	7		Very high	2% Carb		
100	C2		Brown loamy sand with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	7.5		High		16.8	
150			COMMENTS: Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Mallee/shrub

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TEST HOLE SC009

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 528497 Northing: 6283133
Surface Elevation(m): 39.6
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 69
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	1A		Red loamy sand with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has abundant roots present.	7		Nil			
50	2A		Red loamy sand with weak grade of subangular blocky structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has abundant roots present.	8.5		Very high		6.7	
100	2Bk		Red sandy clay loam. Soil is not dispersive, completely slakes	8.5		Very high	50% Carb	12.5	
150			COMMENTS: Looks like surface 35 cm blew in, on top of existing profile Bottom of hole at 150						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Mallee/shrub

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TEST HOLE SC010

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 529908 Northing: 6282076
Surface Elevation(m): 43.5
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 65
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	7.5		Nil			
	A12		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	7.5		Very high		1	
	B1k		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 2 cm breaking to 0.5 cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	50% Carb		
50									
	B2k		Red sandy clay loam with weak grade of prismatic structure and ped size of 10 cm breaking to 2 cm. Soil has a poor to moderate SOILpak score and has few roots present.	8.5		Very high	20% Carb	5.4	
100									
150			COMMENTS: Similar to SC009 Bottom of hole at 150						

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush

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TEST HOLE SC011

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 530575 Northing: 6281800
Surface Elevation(m): 51.0
Equipment: Backhoe

Australian Soil Class: Lithocalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 78
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has abundant roots present.	8.5		Very high			
	A12		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8.5		Very high		2.1	
50	B22k		Red light clay with weak grade of subangular blocky structure and ped size of 2 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	60% Carb		
	B23K		Red sandy clay loam with weak grade of polyhedral structure and ped size of 20 cm breaking to 1 cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	8.5		Very high	30% Carb	19	
100			COMMENTS: Refusal at 120 cm Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush

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TEST HOLE SC012

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 532415 Northing: 6280204
Surface Elevation(m): 27.9
Equipment: Backhoe

Australian Soil Class: Brown Kandosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 60
Drainage: Imperfectly drained
Estimated Permeability: 50 to 500 mm/day

Geology: Yamba Formation
Landuse: Naturalised pasture
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red loamy sand with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, doesn't slake, has a moderate to good SOILpak score and has abundant roots present.	8		Nil			
	A3		Red sandy clay loam with weak grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8		Nil		20	
50	B		Brown sandy clay loam with weak grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	8.5		Slight	30% Gyp		
	2C		Brown loamy sand with weak grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, doesn't slake, has a moderate SOILpak score and has no roots present.	8.5		Nil		22.2	
100									
150			COMMENTS: Ironstone at 80 to 105 cm Bottom of hole at 150						

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush

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TEST HOLE SC013

Date Excavated: 22/1/20
Logged by: PJH Datum: WGS84
Easting: 531247 Northing: 6280507
Surface Elevation(m): 35.6
Equipment: Backhoe

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 96
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown Clay
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with moderate grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	6.5		Slight			
	B1		Red sandy clay loam with moderate grade of columnar structure and ped size of 20 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	6.5		Slight		15	
50	B2		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8		Slight	5% Carb		
100	C		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8		Slight	5% Carb	28.5	
150			COMMENTS: Ironstone at 80 to 105 cm Bottom of hole at 110						

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Saltbush

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TEST HOLE SC014

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 531708 Northing: 6280085
Surface Elevation(m): 30.3
Equipment: Backhoe

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 86
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Saltbush

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure and ped size of 20 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	6.5		Nil			
	B2		Red light clay with moderate grade of polyhedral structure and ped size of 20 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		Nil		28	
50	B3		Brown sandy clay loam with weak grade of polyhedral structure and ped size of 5 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Slight	10% Carb		
100	C		Brown sandy loam with weak grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has no roots present.	8.5		Slight		39.5	
150			COMMENTS: Weak A2 50-60 cm Bottom of hole at 150						

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TEST HOLE SC015

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 532090 Northing: 6279906
Surface Elevation(m): 25.0
Equipment: Backhoe

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 0
Plant Available Water (mm): 0
Drainage: Very poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation - saline lakes
Landuse: Naturalised pasture
Surface condition: Firm
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
			Brown loamy sand with weak grade of subangular blocky structure and ped size of 1 cm breaking to 0.5 cm. With 10% R mottle. Soil is not dispersive, completely slakes, has a poor SOILpak score and has no roots present.	6					
			Brown loamy sand with weak grade of polyhedral structure and ped size of 1 cm breaking to 0.5 cm. Soil is not dispersive, partially slakes, has a poor SOILpak score and has no roots present.	7.5				98.4	
50			Red light clay with weak grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a poor SOILpak score and has no roots present.	7.5					
100			Brown sand. Soil is not dispersive, completely slakes, has a poor SOILpak score and has no roots present.	7.5				168	
150			Yellow light medium clay with massive grade of structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a terrible SOILpak score and has no roots present.	7.5					
			COMMENTS: Edge of salty lake Bottom of hole at 150						

Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: ND

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TEST HOLE SC016

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 533456 Northing: 6279593
Surface Elevation(m): 36.5
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 49
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown sandy loam with moderate grade of subangular blocky structure and ped size of 15 cm breaking to 5 cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	8		Slight			
	B2k		Brown sandy clay loam with moderate grade of subangular blocky structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8		High	50% Carb	32.5	
50	2A		Brown sandy loam with moderate grade of polyhedral structure and ped size of 3 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		High	5% Carb		
100	B3		Brown sandy loam with weak grade of platy structure and ped size of 2 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5		High	10% Carb	12.5	
150			COMMENTS: A2 - 10YR 7/3 dry Bottom of hole at 150						

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bluebush

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TEST HOLE SC017

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 534290 Northing: 6278951
Surface Elevation(m): 34.2
Equipment: Backhoe

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 70
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Lower slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bluebush

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red silty clay loam with moderate grade of subangular blocky structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	6		Slight			
	B1		Red light clay with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		High	2% Carb	6.5	
50	B2k		Red light clay with moderate grade of polyhedral structure and ped size of 20 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has few roots present.	8.5		High	20% Carb		
100	2A		Yellow sand. Soil is slightly dispersive, partially slakes, has a poor to moderate SOILpak score and has no roots present.	7.5		High	10% Carb	13.3	
150			COMMENTS: Looks like reasonable soil Bottom of hole at 150						

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TEST HOLE SC018

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 534585 Northing: 6278237
Surface Elevation(m): 35.3
Equipment: Backhoe

Australian Soil Class: Lithocalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 69
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown silty clay loam with moderate grade of subangular blocky structure and ped size of 3 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	7.5		Very high			
	B2k		Yellow silty clay loam with moderate grade of subangular blocky structure and ped size of 3 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	9		Very high	30% Carb	8.9	
50	B31k		Brown clay loam with weak grade of polyhedral structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5		High	60% Carb		
100	B32		Brown sandy clay loam with massive grade of polyhedral structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a poor SOILpak score and has no roots present.	7.5		Moderate	60% Gyp	34	
150			COMMENTS: Gypsum very common. Looks like, "runoff" country Bottom of hole at 150						

Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Partly stabilised Scald
Vegetation: ND

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TEST HOLE SC019

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 535385 Northing: 6278434
Surface Elevation(m): 45.5
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 64
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red silty clay with moderate grade of subangular blocky structure and ped size of 5 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8.5		Very high			
	B1k		Red silty clay loam with moderate grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		Very high	20% Carb	2.3	
50	B2k		Red silty clay with moderate grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	50% Carb		
	2B		Brown silty clay loam with moderate grade of polyhedral structure and ped size of 2 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	8		Slight	90% Gyp	21.5	
100									
150			COMMENTS: Gypsic C - again Bottom of hole at 150						

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush

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TEST HOLE SC020

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 536267 Northing: 6277854
Surface Elevation(m): 57.4
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 89
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown sandy clay loam with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		High			
50	B1k		Red sandy loam with moderate grade of polyhedral structure and ped size of 5 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8		Very high	20% Carb	2.6	
100	B22k		Brown sandy loam with moderate grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has few roots present.	8		Very high	50% Carb		
	B23k		Red sandy clay loam with weak grade of polyhedral structure and ped size of 10 cm breaking to 2 cm. Soil is slightly dispersive, completely slakes, has a poor SOILpak score and has few roots present.	8		Very high	50% Carb	14.5	
150			COMMENTS: Sandier than last few pits Bottom of hole at 150						

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Belah/Pearl bluebush

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TEST HOLE SC021

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 535629 Northing: 6277596
Surface Elevation(m): 54.5
Equipment: Backhoe

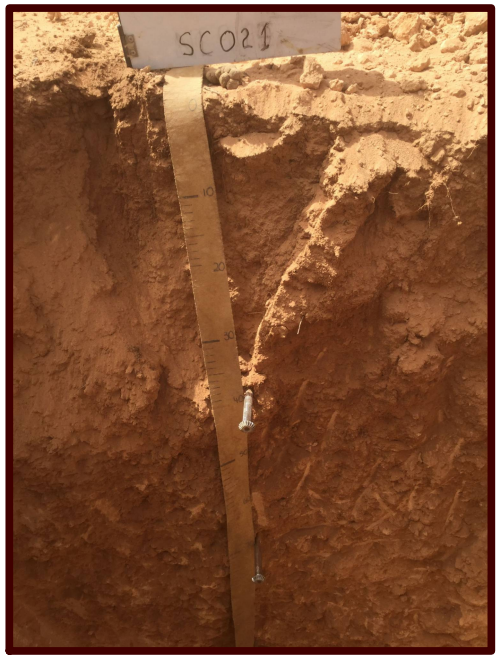
Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 107
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has many roots present.	8.5		Very high			
50	B1		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		Very high	10% Carb	2.6	
100	B22k		Red sandy clay with weak grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	20% Carb		
	B23k		Red sandy clay loam with weak grade of platy structure and ped size of 20 cm breaking to 1 cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	8.5		Very high	50% Carb	13.5	
150			COMMENTS: Sandy top, clayey bottom Bottom of hole at 150						

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bluebush



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TEST HOLE SC022

Date Excavated: 23/1/20
Logged by: PJH Datum: WGS84
Easting: 536232 Northing: 6277527
Surface Elevation(m): 51.4
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 63
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Hard-setting
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy clay loam with moderate grade of subangular blocky structure and ped size of 5 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8.5		Very high			
	B1k		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8.5		Very high	10% Carb	2.3	
50	B2k		Red sandy clay with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	40% Carb		
100	B3		Red sandy clay with moderate grade of platy structure and ped size of 20 cm breaking to 2 cm. Soil is not dispersive, partially slakes, has a poor to moderate SOILpak score and has no roots present.	8.5		Very high	10% Gyp	19.6	
150			COMMENTS: Carbonate hard digging Bottom of hole at 150						

Landscape Properties

Landscape position: Lower slope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Pearl bluebush

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TEST HOLE SC023

Date Excavated: 24/1/20
Logged by: PJH Datum: WGS84
Easting: 537078 Northing: 6277355
Surface Elevation(m): 58.3
Equipment: Backhoe

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 55
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bluebush

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 3 cm breaking to 0.5 cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has many roots present.	8		Very high			
	B1		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5		Very high	10% Carb	1.2	
	B2k		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 2 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	50% Carb		
50									
	B3k		Red sandy loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5		Very high	30% Gyp	27	
100									
150			COMMENTS: A second layer of gypsum starts at 130 cm, Also some carbonate in B3 Bottom of hole at 150						

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TEST HOLE SC024

Date Excavated: 24/1/20
Logged by: PJH Datum: WGS84
Easting: 538054 Northing: 6276447
Surface Elevation(m): 59.9
Equipment: Backhoe

Australian Soil Class: Lithocalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 54
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy clay loam with weak grade of subangular blocky structure and ped size of 3 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8		Very high			
50	B21k		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 4 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	50% Carb	1.2	
	B22k		Red sandy clay loam with strong grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has few roots present.	8.5		Very high	70% Carb		
100	B3k		Red light clay with strong grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a poor SOILpak score and has few roots present.	8.5		High	20% Gyp	18.9	
150			COMMENTS: Some gypsum 60 to 90, Roots in B22 and B3 growing through macropores, Looks like older soil than western half						

Bottom of hole at 150

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Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearlbush/ medic

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TEST HOLE SC025

Date Excavated: 24/1/20
Logged by: PJH Datum: WGS84
Easting: 538796 Northing: 6276019
Surface Elevation(m): 62.3
Equipment: Backhoe

Australian Soil Class: Lithocalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 59
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with moderate grade of subangular blocky structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8.5		Very high			
	A12		Red sandy loam with moderate grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	8.5		Very high		1	
50	B21k		Red sandy clay loam with moderate grade of polyhedral structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5		Very high	70% Carb		
100	B22k		Red sandy clay loam with strong grade of polyhedral structure and ped size of 20 cm breaking to 2 cm. Soil is moderately dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5		Very high	70% Carb	5.2	
150			COMMENTS: Reasonable soil Bottom of hole at 150						

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Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Bluebush/ medic

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TEST HOLE SC2001

Date Excavated: 31/3/22
Logged by: PJH Datum: WGS 84
Easting: 535298 Northing: 6278373
Surface Elevation(m): 43.6
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 107
Drainage: Moderately well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy clay loam. Soil is not dispersive, completely slakes	9	Dry	Very high			
50	A2k		Red sandy clay loam. Soil is not dispersive, completely slakes	9	Dry	Very high	10% Carb	0.6	
100	Bk		Red sandy clay. Soil is slightly dispersive, completely slakes	9	Dry	Very high	20% Carb	1.6	
150			COMMENTS: A2 5YR 7/4 dry. No concretion to 30, increasing carbonates to 110. Bottom of hole at 110						

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, medic, corkscrew grass.

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TEST HOLE SC2002

Date Excavated: 31/3/22
Logged by: PJH Datum: WGS 84
Easting: 535769 Northing: 6278156
Surface Elevation(m): 55.4
Equipment: Christie

Australian Soil Class: Hypocalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 75
Drainage: Moderately well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam. Soil is not dispersive, completely slakes	8.5	Dry	Very high	Error 2015		
50	A12		Red silty clay loam. Soil is slightly dispersive, completely slakes	9	Dry	Very high	5% Carb	9.2	
100	Bk		Red sandy clay loam. Soil is moderately dispersive, completely slakes	9	Dry	Very high	20% Carb	12	
150			COMMENTS: Topsoil deeper than 1 m, less clay at bottom. B appears to be more carbonate and less clay than 1. No concretions to 30, little carbonate to 60, common to 110. Bottom of hole at 110						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Sheet

Vegetation: Poor pearl bluebush, medic, corkscrew grass. Belah nearby

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Cr 481

TEST HOLE SC2003

Date Excavated: 1/4/22
Logged by: PJH Datum: WGS 84
Easting: 519077 Northing: 6285247
Surface Elevation(m): 59.6
Equipment: Christie

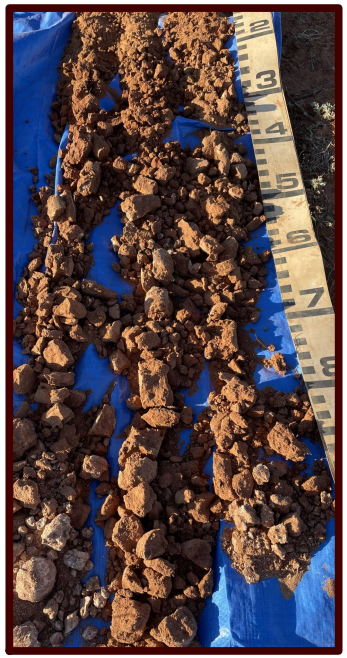
Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 108
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of structure. Soil is slightly dispersive, completely slakes	9	Dry	Moderate			
	B1		Red silty clay loam with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	Moderate		1.8	
50	B22t		Red sandy clay with moderate grade of structure. Soil is not dispersive, completely slakes	8.5	Dry	High	5% Carb		
	B23y		Red silty clay loam with moderate grade of structure. Soil is not dispersive, completely slakes	8.5	Dry	Slight	20% Gyp	31.5	
100			COMMENTS: Few mangans in B22. No concretion to 30, carbonates to 90, gypsums to 110. Bottom of hole at 110						
150									

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Active Sheet
Vegetation: Copperburr, medic



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TEST HOLE SC2004

Date Excavated: 1/4/22
Logged by: PJH Datum: WGS 84
Easting: 518734 Northing: 6284988
Surface Elevation(m): 55.4
Equipment: Christie

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 87
Drainage: Well drained
Estimated Permeability: < 5 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of structure. Soil is not dispersive, completely slakes	9	Dry	Slight			
	B22k		Red silty clay loam with moderate grade of structure. Soil is not dispersive, completely slakes	8.5	Dry	High	20% Carb	8.1	
50	B23t		Brown sandy clay with moderate grade of structure. Soil is not dispersive, partially slakes	8.5	Dry	Moderate	5% Carb		
	B3y		Brown light medium clay with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	Nil	50% Gyp	25.2	
100			COMMENTS: Severe water erosion around site. No concretion to 15, carbonates to 90, gypsum to 110. Bottom of hole at 110						
150									

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Active Sheet
Vegetation: Medic, scattered pearl bluebush

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TEST HOLE SC2005

Date Excavated: 1/4/22
Logged by: PJH Datum: WGS 84
Easting: 518095 Northing: 6283938
Surface Elevation(m): 49.4
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 97
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: 5% Carbonate
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red silty clay loam with weak grade of structure. Soil is not dispersive, completely slakes	9	Dry	Very high			
	B21		Red silty clay loam with weak grade of structure. Soil is not dispersive, completely slakes	9	Dry	Very high	5% Carb	3.3	
50	B22		Red silt loam with weak grade of structure. Soil is moderately dispersive, completely slakes	9	Dry	Very high	5% Carb		
	2A		Red sandy loam with weak grade of structure. Soil is moderately dispersive, completely slakes	9	Dry	Very high	5% Carb	5.4	
100			COMMENTS: Sand coarse in 2A. Is this a moving dune? Carb throughout. Bottom of hole at 110						
150									

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Active Wind
Vegetation: Medic

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TEST HOLE SC2006

Date Excavated: 1/4/22
Logged by: PJH Datum: WGS 84
Easting: 517872 Northing: 6283534
Surface Elevation(m): 49.8
Equipment: Christie

Australian Soil Class: Hypocalcic Kandosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 79
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation - dunefield
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with moderate grade of structure. Soil is not dispersive, partially slakes	9	Dry	Very high	2% Carb		
	A3		Red sandy clay loam with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	Moderate	2% Carb	19.5	
50	B2t		Red light clay with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	Slight	2% Gyp		
	B3y		Red light clay with strong grade of structure. Soil is not dispersive, completely slakes	8	Dry	Moderate	20% Gyp	33.3	
100			COMMENTS: Sand to 20, little carbonate to 45, common gypsum to 110. Bottom of hole at 110						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Active Wind
Vegetation: Medic

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TEST HOLE SC2007

Date Excavated: 2/4/22
Logged by: PJH Datum: WGS 84
Easting: 516652 Northing: 6284324
Surface Elevation(m): 59.6
Equipment: Christie

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 79
Drainage: Rapidly drained
Estimated Permeability: 50 to 500 mm/day

Geology: Woorinen Formation - dunefield
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with single grained grade of structure. Soil is not dispersive, completely slakes.	8.5	Dry	High	1% Carb		
	A3		Red loamy sand with weak grade of structure. Soil is not dispersive, completely slakes	9	Dry	Very high	5% Carb	1.6	
50	B22k		Brown sandy clay loam with weak grade of structure. Soil is not dispersive, partially slakes	9	Dry	Very high	50% Carb		
100	B23k		Red sandy loam with weak grade of structure. Soil is not dispersive, partially slakes	9	Dry	Very high	20% Carb	0.2	
			COMMENTS: Rabbit warrens common in this dune (been ripped). No concretion to 30, hard carbonate to 100, soft carbonate to 110. Bottom of hole at 110						
150									

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Active Sheet
Vegetation: Belah, copperburr

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TEST HOLE SC2008

Date Excavated: 2/4/22
Logged by: PJH Datum: WGS 84
Easting: 517281 Northing: 6284666
Surface Elevation(m): 56.7
Equipment: Christie

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 41
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation - dunefield
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high			
	B1k		Red loam, fine sandy with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	Very high	10% Carb	1.1	
50	B2k		Red fine sandy clay loam with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	Very high	60% Carb	1.4	
100			COMMENTS: No carbonate to 30, 10% carbonate to 50, 80% carbonate to 110. Bottom of hole at 110						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Sheet
Vegetation: Medic, copperburr, few belah nearby

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Cr 481

TEST HOLE SC2009

Date Excavated: 2/4/22
Logged by: PJH Datum: WGS 84
Easting: 517875 Northing: 6285767
Surface Elevation(m): 61.9
Equipment: Christie

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 37
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation - dunefield
Landuse: Rangeland Grazing
Surface condition: Firm
Surface gravel: 1% rounded carbonate medium gravel
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of structure. Soil is slightly dispersive, completely slakes	8.5	Dry	Slight			
	B1		Red loam, fine sandy with weak grade of structure. Soil is not dispersive, partially slakes	9	Dry	Moderate	5% Carb	8.5	
50	B2k		Red clay loam with weak grade of structure. Soil is not dispersive, completely slakes	9	Dry	Very high	80% Carb	9.2	
100			COMMENTS: Similar to SC2008. Appears to be layer rounded carbonate nodules 45 to 60. No carbonate to 25, 5% carbonate to 40, 80% carbonate to 110. Bottom of hole at 110						
150									

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Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Semi Active Sheet
Vegetation: Edge belah, copperburr, medic

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Cr 481

TEST HOLE SC2010

Date Excavated: 2/4/22
Logged by: PJH Datum: WGS 84
Easting: 521229 Northing: 6283280
Surface Elevation(m): 52.6
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 33
Drainage: Moderately well drained
Estimated Permeability: < 5 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: 5% carbonate fine gravel
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1k		Red clay loam with moderate grade of structure. Soil is not dispersive, completely slakes	9	Dry	High	20% Carb		
	A3y		Red sandy clay with strong grade of structure. Soil is not dispersive, partially slakes	9	Dry	Moderate	50% Gyp	30.1	
50	B2t		Brown light medium clay with strong grade of structure. With 5%R mottle. Soil is not dispersive, partially slakes	8	Trace	Very high	10% Gyp	32.9	
100			COMMENTS: Humps of soil around plants. Surface soil appears to be subsoil exposed by sheet erosion of sandy topsoil. Bottom of hole at 110						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Active Sheet
Vegetation: Medic, copperburr, few black bluebush

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TEST HOLE SC2011

Date Excavated: 8/4/22
Logged by: PJH Datum: WGS 84
Easting: 540742 Northing: 6275866
Surface Elevation(m): 57.0
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 97
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes, has a good SOILpak score and has many roots present.	8	Dry	Very high			
50	B1k		Red sandy clay with strong grade of angular blocky structure. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8.5	Dry	High	20% Carb	1.2	
	B22t		Red light medium clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has few roots present.	8.5	Dry	Moderate	10% Carb		
100	B23y		Red light medium clay with strong grade of polyhedral structure. With 10%Gr mottle. Soil is not dispersive, partially slakes, has a poor to moderate SOILpak score and has no roots present.	8.5	Trace	Slight	20% Gyp	17.9	
150			COMMENTS: Little mounds of soil around base of bluebush. Soil here OK. (Low radiometrics). Landform element - Rise, surface condition - weak crust.						

Bottom of hole at 140

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Landscape Properties

Landscape position: Hillock
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush, cannonball, medic, corkscrew grass.

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TEST HOLE SC2012

Date Excavated: 8/4/22
Logged by: PJH Datum: WGS 84
Easting: 539917 Northing: 6275612
Surface Elevation(m): 60.5
Equipment: Christie

Australian Soil Class: Hypocalcic Calcarosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 54
Drainage: Moderately well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with weak grade of subangular blocky structure. Soil is slightly dispersive, partially slakes	8.5	Dry	Very high			
	B1		Red silt loam with weak grade of angular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high		1.3	
50	B22k		Red silt loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	40% Carb		
100	B23k		Red silt loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	20% Carb	10.5	
150			COMMENTS: Small patch with loose surface soil and dead trees. Surface condition - weak crust. Bottom of hole at 130						

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Cannonball, dead belah, some medic

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Cr 481

TEST HOLE SC2013

Date Excavated: 8/4/22
Logged by: PJH Datum: WGS 84
Easting: 538641 Northing: 6276196
Surface Elevation(m): 60.4
Equipment: Christie

Australian Soil Class: Hypocalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 79
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with weak grade of subangular blocky structure. Soil is slightly dispersive, completely slakes	8	Dry	Very high			
	A3		Red silt loam with moderate grade of angular blocky structure. Soil is slightly dispersive, completely slakes	8	Dry	Very high		0.9	
50	B1k		Red sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high	20% Carb		
100	B2		Red sandy clay loam with moderate grade of angular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high	5% Carb	8.5	
			COMMENTS: Sand built up around dead blue bush. Surface condition - weak crust. Bottom of hole at 130						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Dead pearl bluebush, corkscrew grass, medic

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Cr 481

TEST HOLE SC2014

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 533866 Northing: 6280534
Surface Elevation(m): 27.4
Equipment: Christie

Australian Soil Class: Red Kandosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 63
Drainage: Imperfectly drained
Estimated Permeability: 50 to 500 mm/day

Geology: Yamba Formation - saline lakes
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Brown loamy sand with weak grade of polyhedral structure. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has many roots present.	8	Dry	High			
	A3		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes, has a poor to moderate SOILpak score and has many roots present.	8	Dry	High		0.6	
50	B1		Red sandy loam with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake, has a moderate SOILpak score and has few roots present.	8	Dry	Moderate	2% Carb		
	B2		Brown loam, fine sandy with weak grade of polyhedral structure. With 30%r mottle. Soil is not dispersive, doesn't slake, has a poor to moderate SOILpak score and has few roots present.	8	Trace	Nil	5% Gyp	0.5	
100									
			COMMENTS: Small levee in depression. Landform element - Levee. Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Ridge
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Water weed?, Heliotrope

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TEST HOLE SC2015

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 529566 Northing: 6283271
Surface Elevation(m): 27.9
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 34
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Nil			
	A3		Red loamy sand with weak grade of angular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Nil		9.6	
50	B21y		Red loam with moderate grade of polyhedral structure. Soil is not dispersive, doesn't slake	7	Dry	Very high	80% Gyp		
	B22y		Red sandy clay with strong grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Trace	Nil	80% Gyp	13.3	
100									
150			COMMENTS: Edge small depression. Bottom of hole at 140						

Landscape Properties

Landscape position: Lower Slope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Corkscrew grass, saltbush?

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TEST HOLE SC2016

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 529691 Northing: 6283126
Surface Elevation(m): 29.3
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 49
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7	Dry	Nil			
	A3		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Dry	Nil		6.2	
50	B22y		Red silt loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Nil	80% Gyp		
100	B23y		Brown silt loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Nil	80% Gyp	15	
150			COMMENTS: Surface 20% cryptogram crust, 80% weak surface crust. Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, medic

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TEST HOLE SC2017

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 531395 Northing: 6282191
Surface Elevation(m): 52.3
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 60
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high			
50	B1k		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high	10% Carb	4.8	
	B2k		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Dry	High	20% Carb		
100	B3y		Red silty clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Trace	Nil	50% Gyp	16	
150			COMMENTS: Elevated plain. Bottom of hole at 110						

Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Corkscrew grass, medic, bluebush

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TEST HOLE SC2018

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 531691 Northing: 6282020
Surface Elevation(m): 54.1
Equipment: Christie

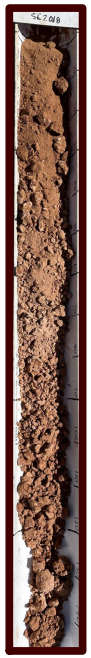
Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 70
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Dry	High			
	A12		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Dry	High		2	
50	B22tk		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Dry	High	20% Carb		
100	B23tk		Red light clay with strong grade of angular blocky structure. Soil is slightly dispersive, completely slakes	8.5	Dry	High	10% Carb	3.7	
150			COMMENTS: Surface 50% surface crust, 50% loose. Foot of ridge. Bottom of hole at 140						

Landscape Properties

Landscape position: Lower Slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Corkscrew grass, medic, copperburr, scattered dead pearl bluebush



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TEST HOLE SC2019

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 531695 Northing: 6281567
Surface Elevation(m): 56.4
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 61
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Dry	Slight			
	A12		Red silt loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Dry	Very high		0.8	
50	B21k		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	20% Carb		
100	B22k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	8.5	Dry	High	20% Carb	8.4	
150			COMMENTS: Sand built up around Bluebush. Surface 60% loose, 40% crust. Top of slope down to lake.						

Bottom of hole at 140

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Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, saltbush, medic, small corkscrew grass

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Cr 481

TEST HOLE SC2020

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 531973 Northing: 6281386
Surface Elevation(m): 53.4
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 57
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Dry	Slight			
	A3		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Dry	High		1	
50	B1		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	10% Carb		
100	B2		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	10% Carb	11.1	
150			COMMENTS: Surface 80% loose, 20% crust. 2% Ironstone in depth to 140 cm layer. Ironstone nodules most likely relict.						

Bottom of hole at 140

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush regrowing, corkscrew grass, medic. Belah nearby

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Cr 481

TEST HOLE SC2021

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 531509 Northing: 6281231
Surface Elevation(m): 55.0
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 70
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Dry	High			
	A12		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	High		2.8	
50	B1		Red silt loam with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	9	Dry	Moderate	10% Carb		
100	B2k		Red fine sandy clay loam with weak grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	Very high	40% Carb	8.3	
150			COMMENTS: Surface 80% loose, 20% surface crust. Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind

Vegetation: Corkscrew grass, medic, few pearl bluebush regrowing

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TEST HOLE SC2022

Date Excavated: 9/4/22
Logged by: PJH Datum: WGS 84
Easting: 531012 Northing: 6281255
Surface Elevation(m): 55.6
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 49
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Dry	Very high			
	A12		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Dry	Very high		3.8	
50	B21		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	10% Carb		
100	B22		Red fine sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Moderate	10% Carb	14.5	
150			COMMENTS: Surface 5% cryptogram crust, 50% surface flake, 45% loose. Bottom of hole at 130						

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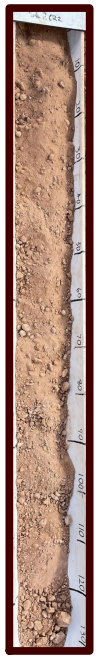
Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Belah/Pearl bluebush/corkscrew grass



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TEST HOLE SC2023

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 531211 Northing: 6280413
Surface Elevation(m): 33.7
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 65
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Dry	Nil			
	A3		Red sandy loam with strong grade of angular blocky structure. Soil is not dispersive, doesn't slake	8	Trace	Nil		24.5	
50									
	B2t		Red sandy clay with strong grade of polyhedral structure. Soil is not dispersive, doesn't slake	8.5	Trace	Very high	5% Gyp	25.2	
100									
			COMMENTS: Surface 80% surface crust, 20% cryptogram crust. Bottom of hole at 140						
150									

Landscape Properties

Landscape position: Lower Slope
Microrelief: No microrelief
Erosion: Active Gully

Vegetation: Scattered pearl bluebush, saltbush, medic, corkscrew grass

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TEST HOLE SC2024

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 529890 Northing: 6281614
Surface Elevation(m): 45.7
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 84
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is slightly dispersive, completely slakes	8	Dry	Very high			
	A3		Red loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	9	Dry	High		16.8	
50	B22		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	High	5% Carb		
	B23		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Moderate	10% Carb	24	
100									
			COMMENTS: Soil built up around base of bluebush. 2% Ironstone in B23 Layer. Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Belah pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2025

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 529049 Northing: 6279273
Surface Elevation(m): 30.2
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 34
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Dry	Nil			
	A3		Red loam, fine sandy with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Dry	Nil		24	
50	B22		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Trace	Moderate	10% Carb		
	B23y		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Moist	High	20% Gyp	49.5	
100									
			COMMENTS: Erosion type - Gully/Rill. Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No microrelief
Erosion: Partly stabilised Gully
Vegetation: Saltbush, corkscrew grass, medic

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TEST HOLE SC2026

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 529784 Northing: 6278038
Surface Elevation(m): 26.3
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 15
Plant Available Water (mm): 21
Drainage: Poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown light sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake	8.5	Trace	Slight			
	B1		Brown sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Trace	Nil		64.5	
50	B22y		Brown sandy clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7	Moist	Nil	50% Gyp		
	B23y		Brown sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7	Moist	Nil	40% Gyp	68	
100			COMMENTS: Saturated at 100, soil below 100 grey SiC. Bottom of hole at 100						
150									

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Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Saltbush

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TEST HOLE SC2027

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 529308 Northing: 6278051
Surface Elevation(m): 26.3
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 10
Plant Available Water (mm): 9
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: 2% fine gravel carbonate
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Yellow loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	7	Dry	Slight			
50	B21y		Brown fine sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Trace	Nil	30% Gyp		
	B22y		Grey fine sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Wet	Nil	50% Gyp	54.5	
100			COMMENTS: Salt efflorescence on surface. B22 moisture S - Saturated. Bottom of hole at 100						
150									

Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Pigface, samphire

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TEST HOLE SC2028

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 529511 Northing: 6278652
Surface Elevation(m): 26.4
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 35
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown sandy loam with moderate grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Trace	Nil			
50	B1y		Brown loam, fine sandy with moderate grade of subangular blocky structure. Soil is slightly dispersive, completely slakes	7.5	Trace	Nil	80% Gyp	48	
100	B2y		Brown sandy clay loam with moderate grade of polyhedral structure. With 10%O mottle. Soil is not dispersive, completely slakes	8.5	Wet	Nil	50% Gyp	64	
150			COMMENTS: Top soil structure is good. Small rise of wind blown sand in closed depression. Landform element - small rise. Bottom of hole at 120						

Landscape Properties

Landscape position: Hillock
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pigface, samphire

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TEST HOLE SC2029

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 529658 Northing: 6278830
Surface Elevation(m): 26.4
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 31
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red silt loam with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	5.5	Dry	Nil			
	A3y		Brown sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Trace	Nil	70% Gyp	48	
50	B2y		Brown light clay with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Wet	Nil	40% Gyp		
	B3y		Grey sandy clay loam with moderate grade of polyhedral structure. With 20%R mottle. Soil is not dispersive, partially slakes	8.5	Wet	Nil	30% Gyp	90	
100									
			COMMENTS: Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Pigface, saltbush, samphire

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TEST HOLE SC2030

Date Excavated: 10/4/22
Logged by: PJH Datum: WGS 84
Easting: 533241 Northing: 6280684
Surface Elevation(m): 32.9
Equipment: Christie

Australian Soil Class: Red Arenosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 86
Drainage: Rapidly drained
Estimated Permeability: > 500 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand. Soil is not dispersive, completely slakes	7	Dry	Nil			
	A3		Red loamy sand. Soil is not dispersive, completely slakes	8	Dry	Nil		4.6	
50	B2		Red loamy sand. Soil is not dispersive, completely slakes	8.5	Dry	Very high			
	B3		Red loamy sand. Soil is not dispersive, completely slakes	8.5	Dry	Very high		3.5	
100									
			COMMENTS: Moving sand dune. Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Active Wind
Vegetation: Cannonball, corkscrew grass

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TEST HOLE SC2031

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 530646 Northing: 6279768
Surface Elevation(m): 32.5
Equipment: Christie

Australian Soil Class: Red Kandosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 86
Drainage: Rapidly drained
Estimated Permeability: > 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Nil			
	A3		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Nil		0.8	
50	B1		Brown loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Moderate			
100	B2		Red loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	8.5	Dry	Very high	2% Carb	2.2	
			COMMENTS: Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Rill
Vegetation: Pearl bluebush, medic, corkscrew grass, belah

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TEST HOLE SC2032

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 529927 Northing: 6279149
Surface Elevation(m): 26.7
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 25
Plant Available Water (mm): 22
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Trace	Nil			
50	B11y		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Trace	Nil	80% Gyp	40.2	
	B12y		Brown fine sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Moist	Nil	80% Gyp		
100	B2ty		Brown silty clay with strong grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Wet	Nil	20% Gyp	66.5	
150			COMMENTS: Topsoil is silty despite LS texture. Landform element - small rise. Bottom of hole at 140						

Landscape Properties

Landscape position: Hillock
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pigface, saltbush

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TEST HOLE SC2033

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 529972 Northing: 6277400
Surface Elevation(m): 27.3
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 44
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Dry	Nil			
	B2y		Red loam, fine sandy with strong grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Dry	Moderate	20% Gyp	11.9	
50									
	B31y		Brown fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Trace	Slight	50% Gyp		
100	B32t		Brown light medium clay with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Nil		36.4	
150			COMMENTS: Depositional site. B2 on structure and colour. Bottom of hole at 150						

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Saltbush, medic, corkscrew grass

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TEST HOLE SC2034

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 531015 Northing: 6276569
Surface Elevation(m): 35.3
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 60
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Surface Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	8	Dry	Very high			
50	A12		Red loam, fine sandy with moderate grade of subangular blocky structure. Soil is not dispersive, completely slakes	9	Dry	Very high		33	
	B2		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Trace	Moderate	5% Gyp		
100	Cy		Grey silt loam with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	6.5	Trace	Nil	100% Gyp	24	
			COMMENTS: Surface - 80% Surface flake, 20% Cryptogram Crust. Copi hill. Landform element - Mesa						
150			Bottom of hole at 140						

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Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, corkscrew grass, some medic

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TEST HOLE SC2035

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 531427 Northing: 6276437
Surface Elevation(m): 33.0
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 20
Plant Available Water (mm): 3
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: 20% Copi

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
0	B1y		Yellow silt loam with moderate grade of polyhedral structure. Soil is not dispersive, doesn't slake	6.5	Trace	Nil	90% Gyp		
50	B21y		Red silt loam with moderate grade of polyhedral structure. Soil is not dispersive, doesn't slake	7	Trace	Nil	90% Gyp	21	
100	B22y		Red loamy sand with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Trace	Nil	90% Gyp	25.8	
150			COMMENTS: Sporadic 1 cm thick layer of topsoil. Copi. Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Stabilised

Vegetation: Poor pearl bluebush, saltbush, corkscrew grass, medic

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TEST HOLE SC2036

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 531608 Northing: 6277851
Surface Elevation(m): 26.6
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 15
Plant Available Water (mm): 15
Drainage: Poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Pigface, samphire, saltbush

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red clayey sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Moist	Very high			
50	By		Brown fine sandy loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Nil	50% Gyp	69.5	
	2A		Yellow sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Nil	5% Gyp		
100	2B		Grey light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Nil			
150			COMMENTS: Yellow /green colour consistent with Blanchetown clay Bottom of hole at 140						

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TEST HOLE SC2037

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 532432 Northing: 6278749
Surface Elevation(m): 27.2
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 20
Plant Available Water (mm): 17
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: 20% fine - medium gravel - angular cemented soil
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Yellow loamy sand with weak grade of angular blocky structure. Soil is not dispersive, completely slakes	6	Dry	Nil			
	A12y		Brown loamy sand with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	6	Trace	Nil	10% Gyp	37.2	
50	A13y		Brown loamy sand with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Trace	Nil	40% Gyp		
	B1y		Brown sandy clay loam with weak grade of polyhedral structure. With 10% Bl mottle. Soil is not dispersive, partially slakes	8	Moist	Nil	30% Gyp		
100	B2y		Grey light clay with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake	8	Wet	Nil	30% Gyp	55	
150			COMMENTS: Much of surface 60 cm is salt. Landform element - Plain in Closed Depression. Microrelief - Monster Gilgai. B2 moisture S - saturated.						

Bottom of hole at 140

Landscape Properties

Landscape position: Closed depression
Microrelief: Normal gilgai
Erosion: Stabilised
Vegetation: Samphire

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TEST HOLE SC2038

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 531828 Northing: 6280265
Surface Elevation(m): 25.5
Equipment: Christie

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 44
Drainage: Poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation - saline lakes
Landuse: Rangeland Grazing
Surface condition: Poached
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Grey light medium clay with strong grade of angular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Moderate	2% Carb		
50	B2		Red silty clay with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Dry	Slight		57	
	2A		Yellow sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Moist	Nil			
	3A		Brown light medium clay with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake	8	Wet	Nil		42.7	
100			COMMENTS: Drainage would be very poor in a wetter climate Bottom of hole at 100						
150									

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Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Samphire

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TEST HOLE SC2039

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 532859 Northing: 6279766
Surface Elevation(m): 27.4
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 57
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Samphire

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	1A		Brown sandy clay loam with strong grade of subangular blocky structure. Soil is not dispersive, doesn't slake	8.5	Dry	Moderate			
	2A		Brown loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Dry	High		40.2	
50	2B1y		Brown loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Nil	10% Gyp		
	2B2y		Brown sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Trace	Nil	50% Gyp	100	
100									
150			COMMENTS: Small lunette downwind of closed depression. Soil Classification based on second profile.						

Bottom of hole at 140

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TEST HOLE SC2040

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 535650 Northing: 6279034
Surface Elevation(m): 45.7
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 84
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with moderate grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Nil			
	A3		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	High		4	
50	B2k		Red silt loam with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Dry	Moderate	20% Carb		
100	B3y		Red silt loam with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake	8.5	Dry	Slight	80% Gyp	13	
			COMMENTS: Less eroded than SC2041. B3 looks like Copi. Bottom of hole at 120						
150									

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Rill
Vegetation: Poor pearl bluebush, medic, corkscrew grass

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TEST HOLE SC2041

Date Excavated: 11/4/22
Logged by: PJH Datum: WGS 84
Easting: 535536 Northing: 6279087
Surface Elevation(m): 41.6
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 62
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: 1% medium gravel rounded carbonate
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes	8	Dry	Very high			
50	B1		Red silty clay loam with weak grade of angular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes	8	Dry	Very high	5% Carb	2.2	
	B2k		Red silty clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes	8.5	Dry	Very high	20% Carb		
100	2A		Red sandy clay with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes	8.5	Dry	Very high	5% Carb	4	
150			COMMENTS: Second profile has medium sand. Note - photo is 2040 - timestamp ~3:30						

Bottom of hole at 140

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Active Rill
Vegetation: Poor pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2042

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 534812 Northing: 6278182
Surface Elevation(m): 35.7
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 90
Plant Available Water (mm): 115
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red silt loam with moderate grade of angular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high			
	A3		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high		1	
50	B22tk		Red light clay with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	25% Carb		
100	B23y		Red light medium clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Slight	20% Gyp	9.1	
150			COMMENTS: Gypsum is crystalline rather than Copi Bottom of hole at 140						

Landscape Properties

Landscape position: Open Depression
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Pearl bluebush, medic, corkscrew grass

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TEST HOLE SC2043

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 536371 Northing: 6278312
Surface Elevation(m): 50.6
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 108
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: 2% medium gravel rounded carbonate
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loam, fine sandy with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes	8.5	Dry	Very high			
	A3		Red sandy loam with moderate grade of angular blocky structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high	5% Carb	6.7	
50									
	B1k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	20% Carb		
100	B2tk		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	30% Carb	7.7	
			COMMENTS: Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2044

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 535543 Northing: 6277307
Surface Elevation(m): 54.8
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 73
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Dry	Very high			
50	B1		Red sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Moderate	2% Carb	0.8	
	B2		Red sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Moderate	5% Carb		
100	B3k		Red silty clay loam with weak grade of polyhedral structure. Soil is strongly dispersive, completely slakes	8.5	Dry	Very high	50% Carb	4	
150			COMMENTS: Lee of dune. Erosion starts with sheep pads. Dead belah nearby. Bottom of hole at 140						

Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Rill
Vegetation: Poor pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2045

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 534412 Northing: 6276849
Surface Elevation(m): 34.2
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 35
Plant Available Water (mm): 47
Drainage: Moderately well drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Slight	2% Carb		
	B22		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Moderate	10% Carb	23	
50	B23k		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	30% Carb		
100	B3y		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Trace	Moderate	50% Gyp	43.5	
150			COMMENTS: Looks like topsoil is subsoil exposed by erosion. Bottom of hole at 140						

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Active Sheet
Vegetation: Poor pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2046

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 534191 Northing: 6276777
Surface Elevation(m): 33.5
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 133
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red silty clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	High			
50	B1		Red silty clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	5% Carb	3	
100	B2k		Red silty clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	20% Carb		
	B3y		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Moderate	60% Gyp	9.5	
150			COMMENTS: Surface condition - 60% Cryptogram crust, 40% hardset. Some shrinkage cracks nearby.						

Bottom of hole at 140

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush (healthy), corkscrew grass, medic

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TEST HOLE SC2047

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 533828 Northing: 6278132
Surface Elevation(m): 38.3
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 40
Plant Available Water (mm): 9
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Crest
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Sparse pearl bluebush, corkscrew grass, belah nearby

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with massive grade of structure and ped size of 0.5. Soil is not dispersive, doesn't slake, has a poor to moderate SOILpak score and has an average number of roots present.	8.5	Dry	Moderate	90% Gyp	22.5	
	B21y		Yellow silt loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Dry	Nil			
50									
	B22y		Yellow silt loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Dry	Nil	90% Gyp		
100									
	B23y		Yellow loamy sand with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Trace	Nil	80% Gyp	19.8	
150			COMMENTS: Surface condition - 70% hardset, 30% cryptogram crust. Copi Hill' Bottom of hole at 140						

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TEST HOLE SC2048

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 534927 Northing: 6278563
Surface Elevation(m): 35.0
Equipment: Christie

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 106
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red loamy sand with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	8.5	Dry	High			
50	A31		Red sandy loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	8.5	Dry	High		4.2	
	A32		Red sandy loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes	8.5	Dry	High	2% Carb		
100	Bk		Red silty clay loam with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes	8.5	Dry	Very high	50% Carb	10	
150			COMMENTS: Surface condition - 40% cryptogram crust, 30% loose, 30% hardset. Bottom of hole at 140						

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Rill
Vegetation: Poor pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2049

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 534915 Northing: 6279666
Surface Elevation(m): 35.7
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 99
Drainage: Moderately well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with single grained grade of structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high			
	A3		Red silt loam with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Dry	Very high		1.1	
50	B1k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, partially slakes	8.5	Dry	Very high	30% Carb		
100	B2tk		Red light clay with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Trace	Very high	50% Carb	11.6	
150			COMMENTS: Rosewood 50 m SW Bottom of hole at 140						

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Partly stabilised Rill

Vegetation: Poor pearl bluebush, saltbush, medic, corkscrew grass.

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TEST HOLE SC2050

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 535046 Northing: 6279890
Surface Elevation(m): 35.5
Equipment: Christie

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 92
Drainage: Moderately well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	High			
	A3		Red sandy loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	High		27.5	
50	B1k		Yellow silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Trace	High	20% Carb		
100	B2k		Red silty clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Trace	High	30% Carb	23	
150			COMMENTS: Surface condition - 50% loose, 40% hardset, 10% crytogram crust. Carbonate appears to be sheet.						

Bottom of hole at 140

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Rill
Vegetation: Poor pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2051

Date Excavated: 12/4/22
Logged by: PJH Datum: WGS 84
Easting: 536931 Northing: 6278672
Surface Elevation(m): 53.4
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 68
Drainage: Moderately well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	9	Dry	Very high			
	A3		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	2% Carb	2.2	
50	B22k		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	20% Carb		
100	B23k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	Very high	40% Carb	13	
150			COMMENTS: Belah and rosewood nearby Bottom of hole at 140						

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Corkscrew grass, medic, cannonball.

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TEST HOLE SC2052

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 521621 Northing: 6285110
Surface Elevation(m): 36.9
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 90
Plant Available Water (mm): 116
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Nil			
50	B21t		Brown light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Moderate	5% Carb	13.7	
100	B22t		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Moderate	10% Carb		
	B3y		Grey light medium clay with strong grade of polyhedral structure. With 10% R mottle. Soil is not dispersive, partially slakes	6.5	Dry	Slight	20% Gyp	19.6	
150			COMMENTS: Bottom of hole at 140						

Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Active Gully

Vegetation: Scattered pearl and black bluebush, medic, corkscrew grass

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TEST HOLE SC2053

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 521332 Northing: 6284890
Surface Elevation(m): 41.3
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 75
Plant Available Water (mm): 92
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Dry	Moderate			
50	B2		Red sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	2% Carb	2.2	
	B31		Red loamy sand with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	5% Carb		
100	B32k		Red loamy sand with moderate grade of polyhedral structure. Soil is moderately dispersive, completely slakes	8.5	Dry	Very high	50% Carb	4.9	
150			COMMENTS: Footslopes of dune that appears to be moving northward. Landform element - Footslope						

Bottom of hole at 140

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Landscape Properties

Landscape position: Lower slope
Microrelief: No Microrelief
Erosion: Partly stabilised Wind

Vegetation: Medic, corkscrew grass. Range of shrubs - hopbush? Belah, rosewood, saltbush

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TEST HOLE SC2054

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 520671 Northing: 6284808
Surface Elevation(m): 55.6
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 109
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	8.5	Dry	Slight			
	A2		Red loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	7.5	Dry	Slight	5% Carb	1	
50	B22		Red silt loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	High	10% Carb		
100	B23k		Red silt loam with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	Very high	20% Carb	3.8	
150			COMMENTS: Just on lee side of crest Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Medic, corkscrew grass, unknown broadleafs

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Cr 481

TEST HOLE SC2055

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 520317 Northing: 6283903
Surface Elevation(m): 61.2
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 82
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Slight			
50	B11		Red sandy loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	2% Carb	2.8	
100	B12k		Red loam, fine sandy with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	20% Carb		
	B2		Red sandy clay loam with weak grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	Very high	10% Carb	10	
150			COMMENTS: Sand in B2 textures as medium sand. Appears to be subangular to subrounded fine quartz sand under hard lens. Rosewood and belah nearby Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Medic, some corkscrew grass, unknown dicots.

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TEST HOLE SC2056

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 518787 Northing: 6283911
Surface Elevation(m): 49.2
Equipment: Christie

Australian Soil Class: Brown Chromosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 97
Drainage: Imperfectly drained
Estimated Permeability: < 5 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: 20% rounded carbonate medium gravel
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	1A		Brown silt loam with moderate grade of subangular blocky structure. Soil is not dispersive, completely slakes	9	Dry	Very high			
	1B		Brown light medium clay with strong grade of polyhedral structure. With 10% G mottle. Soil is not dispersive, completely slakes	8.5	Dry	Slight	10% Carb	9.8	
50									
	2A		Red sandy clay loam with strong grade of angular blocky structure. With 10% G mottle. Soil is not dispersive, completely slakes	9	Dry	Slight			
100	2By		Red light clay with strong grade of polyhedral structure. With 10% G mottle. Soil is not dispersive, completely slakes	9	Dry	Slight	20% Gyp	21	
			COMMENTS: Topsoil changes from carbonate to sand 30 m to west. Bottom of hole at 140						
150									

Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Active Sheet
Vegetation: Medic, scattered corkscrew grass

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TEST HOLE SC2057

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 519779 Northing: 6284874
Surface Elevation(m): 60.2
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 76
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: 1% rounded carbonate medium gravel
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Dry	Very high			
	A12		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Dry	Very high	5% Carb	4.4	
50	B1k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	8.5	Dry	Very high	30% Carb		
	B2k		Red light clay with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	High	20% Carb	10.5	
100			COMMENTS: Edge of Scald. Refusal @ 110 cm. Bottom of hole at 110						
150									

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Copperburr, medic

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Cr 481

TEST HOLE SC2058

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 519847 Northing: 6286143
Surface Elevation(m): 52.7
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 41
Drainage: Imperfectly drained
Estimated Permeability: < 5 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red silty clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	8.5	Dry	High	5% Carb		
	B		Red light clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	8.5	Dry	High	10% Carb	41	
50									
	2By		Grey medium heavy clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	7	Trace	Nil	20% Gyp	49	
100									
			COMMENTS: Gypsum in 2B in layers 2 cm thick interbedded with 10 cm grey soil. Slickensides in 2B. Surface condition - Friable.						
150									

Bottom of hole at 140

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Landscape Properties

Landscape position: Open Depression
Microrelief: No Microrelief
Erosion: Active Sheet
Vegetation: Black bluebush. Sparse medic

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TEST HOLE SC2059

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 519815 Northing: 6286485
Surface Elevation(m): 50.1
Equipment: Christie

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 102
Drainage: Poorly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red silt loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Moist	Slight			
50	B1		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, partially slakes	8.5	Moist	High	2% Carb	2.2	
	B22		Red light medium clay with strong grade of angular blocky structure. Soil is not dispersive, completely slakes	9	Dry	Moderate	5% Carb		
100	B23		Red light medium clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Moderate	10% Gyp	18.6	
150			COMMENTS: Edge of closed depression on lower slope. Seedlings of medic and some broadleafs. Roots in B22 growing in fissures between rough faced peds. Bottom of hole at 140						

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Landscape Properties

Landscape position: Closed Depression
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Black bluebush that is regrowing. Sparse medic

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TEST HOLE SC2060

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 520088 Northing: 6287202
Surface Elevation(m): 46.6
Equipment: Christie

Australian Soil Class: Stratic Rudosol
Annual Crop Rootzone (cm): 110
Plant Available Water (mm): 138
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown Clay
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	1A		Red sandy loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	9	Moist	Very high			
	2A		Red sandy loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	8	Moist	Very high		1	
50									
	3A		Red sandy clay loam with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes	8	Moist	Very high			
100									
	3Bk		Brown light clay with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes	9	Dry	Very high	20% Carb	1.1	
150			COMMENTS: May contain silt from diversion of runoff to dam. Really a buried Calcarosol.						

Bottom of hole at 140

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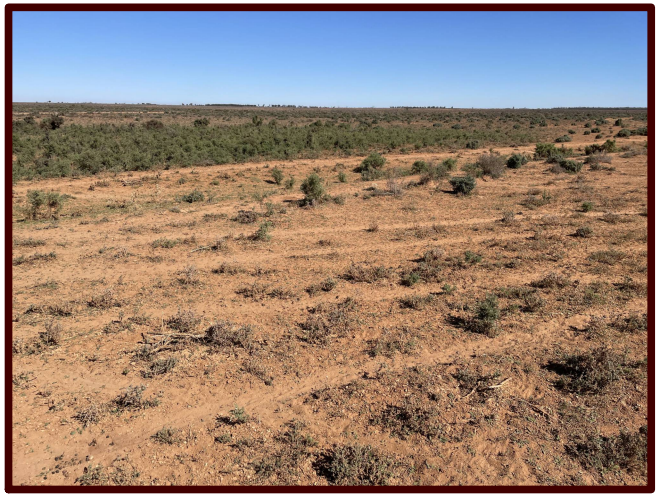
Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Succulent shrub, medic seedling



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TEST HOLE SC2061

Date Excavated: 13/4/22
Logged by: PJH Datum: WGS 84
Easting: 521461 Northing: 6287682
Surface Elevation(m): 50.4
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 90
Plant Available Water (mm): 93
Drainage: Well drained
Estimated Permeability: > 500 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	8	Dry	Slight			
50	B11		Red sandy loam with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Dry	Very high	5% Carb	5.5	
	B12		Red sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, partially slakes	9	Dry	Very high	10% Carb		
100	B2		Red sandy clay with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	9	Dry	Slight	10% Carb	6.9	
150			COMMENTS: Dune. Bottom of hole at 140						

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Corkscrew grass, medic, copperburr and mulga and rosewood

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TEST HOLE SC2062

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 531326 Northing: 6276005
Surface Elevation(m): 33.2
Equipment: Christie corer

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 75
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red silt loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Moist	Nil			
	A3		Red silt loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Moist	Nil		6.9	
50	B22y		Red silt loam with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake	6.5	Dry	Nil	90% Gyp		
100	B23y		Red silt loam with weak grade of polyhedral structure. Soil is not dispersive, partially slakes	8	Dry	Nil	90% Gyp	24.5	
150			COMMENTS: Southern end Copi ridge. Bottom of hole at 140						

Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Bladder saltbush, medic, cannonball, corkscrew grass

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TEST HOLE SC2063

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 531327 Northing: 6276096
Surface Elevation(m): 33.1
Equipment: Christie corer

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 128
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red fine sandy loam with moderate grade of prismatic structure. Soil is not dispersive, partially slakes	7.5	Moist	Nil			
	A3		Red fine sandy loam with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Moist	Nil		31.5	
50	B22y		Red fine sandy clay loam with moderate grade of polyhedral structure. With 20% R mottle. Soil is not dispersive, partially slakes	8	Dry	Very high	20% Gyp		
100	B23y		Grey silt loam with weak grade of polyhedral structure. Soil is not dispersive, doesn't slake	8	Dry	Moderate	90% Gyp	23	
150			COMMENTS: Strong Bottom of hole at 140						

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Landscape Properties

Landscape position: Open Depression
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Bladder saltbush, cannonball, medic, corkscrew grass

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TEST HOLE SC2064

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 532690 Northing: 6277189
Surface Elevation(m): 26.6
Equipment: Christie corer

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 20
Plant Available Water (mm): 29
Drainage: Very poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Saline
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown silt loam with weak grade of subangular blocky structure. Soil is not dispersive, doesn't slake	8	Moist	Nil	2% Gyp		
	B1y		Brown silty clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Moist	Nil	60% Gyp	46	
50	B2y		Brown light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Moist	Nil	20% Gyp		
100	C		Grey light medium clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Moist	Nil	10% Gyp	43.8	
150			COMMENTS: Landform element - Level Bottom of hole at 140						

Landscape Properties

Landscape position: Flat
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Pigface, poppy saltbush

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TEST HOLE SC2065

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 532817 Northing: 6277756
Surface Elevation(m): 27.0
Equipment: Christie corer

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 23
Drainage: Very poorly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Saline
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loam, fine sandy with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Moderate	10% Gyp		
50	B1y		Brown loam, fine sandy with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	6	Moist	Nil	50% Gyp	100	
	B2y		Brown light clay with strong grade of polyhedral structure. Soil is not dispersive, partially slakes	7.5	Moist	Nil	20% Gyp		
100	B3y		Grey light clay with strong grade of polyhedral structure. With 10% R mottle. Soil is not dispersive, completely slakes	7.5	Wet	Nil	30% Gyp	57.8	
150			COMMENTS: Surface condition - salty (salt efflorescence) Bottom of hole at 140						

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Landscape Properties

Landscape position: Flat
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Pigface, poppy saltbush, samphire

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TEST HOLE SC2066

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 532823 Northing: 6278973
Surface Elevation(m): 28.3
Equipment: Christie corer

Australian Soil Class: Hypersalic Hydrosol
Annual Crop Rootzone (cm): 5
Plant Available Water (mm): 1
Drainage: Very poorly drained
Estimated Permeability: < 5 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Saline
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	Ay		Yellow silt loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	6.5	Moist	Nil	90% Gyp		
50	B22y		Brown silt loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Nil	30% Gyp	55.5	
100	B23y		Red light clay with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Slight	30% Gyp	37.5	
150			COMMENTS: Discharge area. A horizon is Copi. Surface condition - salt efflorescence						

Bottom of hole at 140

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Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Samphire

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TEST HOLE SC2067

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 534198 Northing: 6279376
Surface Elevation(m): 34.3
Equipment: Christie corer

Australian Soil Class: Lithocalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 90
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Trace	Very high			
	A3		Red loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Trace	Very high		4.8	
50	B2		Red loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	10% Carb		
	B3k		Grey loam with weak grade of prismatic structure. Soil is not dispersive, completely slakes	8	Dry	High	90% Carb	15.5	
100			COMMENTS: Surface condition - 20% cryptogram crust, 60% hardset, 20% loose. Carbonate is sheet (rock). Bottom of hole at 100						
150									

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Pearl bluebush, cannonball, corkscrew grass, medic

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Cr 481

TEST HOLE SC2068

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 534655 Northing: 6276852
Surface Elevation(m): 41.1
Equipment: Christie corer

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 74
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red silt loam with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	8.5	Trace	Very high			
50	B2y		Brown sandy clay loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Dry	High	50% Gyp		
	A3y		Red silt loam with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Trace	Very high	70% Gyp	3.6	
100	B3		Brown sandy clay loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7	Dry	Slight	80% Gyp	7.1	
150			COMMENTS: Surface condition - 40% hardset, 60% cryptogram crust. B2 - subplastic LS to SCL. B3 - subplastic LS to SCL - looks like Gypsum						

Bottom of hole at 140

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Pearl bluebush, medic, corkscrew grass

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TEST HOLE SC2069

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 536544 Northing: 6276493
Surface Elevation(m): 50.2
Equipment: Christie corer

Australian Soil Class: Hypocalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 96
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy clay loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a terrible SOILpak score and has many roots present.	8	Moist	Nil			
50	B1		Red sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a terrible SOILpak score and has an average number of roots present.	8	Moist	Slight	2% Carb		
100	B2k		Red sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a terrible SOILpak score and has no roots present.	8	Dry	Very high	20% Carb		
	B3k		Red sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a terrible SOILpak score and has no roots present.	8	Dry	High	60% Carb		
150			COMMENTS: Bottom of hole at 140						

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, medic, corkscrew grass

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TEST HOLE SC2070

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 520420 Northing: 6284594
Surface Elevation(m): 61.7
Equipment: Christie corer

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 76
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Blanchetown clay
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Black sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	9	Moist	Slight			
	B1		Red fine sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Trace	Very high		0.9	
50	B21k		Red light clay with strong grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	Very high	30% Carb		
	B22		Red light medium clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Moderate	2% Carb	6	
100									
			COMMENTS: Bottom of hole at 140						
150									

Landscape Properties

Landscape position: Crest
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Black bluebush (sites to west similar), medic, grass seedlings, Belah nearby

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TEST HOLE SC2071

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 519950 Northing: 6287523
Surface Elevation(m): 46.9
Equipment: Christie corer

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 25
Plant Available Water (mm): 37
Drainage: Imperfectly drained
Estimated Permeability: < 5 mm/day

Geology: Blanchetown clay
Landuse: Rangeland Grazing
Surface condition: Surface Flake
Surface gravel: 20% fine rounded carbonate gravel
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red light clay with strong grade of prismatic structure. Soil is not dispersive, completely slakes	8.5	Trace	Very high	2% Carb		
	B1		Brown light medium clay with strong grade of prismatic structure. Soil is not dispersive, completely slakes	8	Trace	Very high		23.1	
50	B22		Grey light medium clay with strong grade of prismatic structure. With 20% R mottle. Soil is not dispersive, completely slakes	8	Trace	Very high	2% Carb		
100	B23		Grey light medium clay with strong grade of prismatic structure. With 5% R mottle. Soil is not dispersive, completely slakes	8	Trace	Nil	2% Carb	21.7	
150			COMMENTS: Slickensides in B horizon. Some mangans in B1. Erosion - Water Bottom of hole at 140						

Landscape Properties

Landscape position: Lower Slope
Microrelief: No Microrelief
Erosion: Active
Vegetation: Sparse copperburr

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TEST HOLE SC2072

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 521975 Northing: 6287726
Surface Elevation(m): 55.7
Equipment: Christie corer

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 60
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	1A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8.5	Moist	High			
	1A3		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8.5	Moist	Very high			
50	2A		Red fine sandy clay loam with weak grade of subangular blocky structure. Soil is slightly dispersive, completely slakes	9	Dry	Very high	2% Carb	8.8	
	2B1k		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	30% Carb		
100	2B2		Red sandy clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	High	10% Carb	10.9	
150			COMMENTS: Surface condition - 60% hardset, 40% loose. Bottom of hole at 140						

Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Copperburr, some cannonball, medic

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TEST HOLE SC2073

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 521501 Northing: 6287034
Surface Elevation(m): 57.1
Equipment: Christie corer

Australian Soil Class: Hypocalcic Calcarosol
Annual Crop Rootzone (cm): 100
Plant Available Water (mm): 86
Drainage: Rapidly drained
Estimated Permeability: > 500 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Moist	High			
50	A3		Red loamy sand with weak grade of subangular blocky structure. Soil is slightly dispersive, completely slakes	8	Moist	High		1.6	
100	B		Red loamy sand with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	9	Dry	Very high	5% Carb	4.6	
150			COMMENTS: Looks like sand is moving. Belah 20 m away Bottom of hole at 120						

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Medic, copperburr

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TEST HOLE SC2074

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 529070 Northing: 6282348
Surface Elevation(m): 42.4
Equipment: Christie corer

Australian Soil Class: Red Arenosol
Annual Crop Rootzone (cm): 140
Plant Available Water (mm): 126
Drainage: Rapidly drained
Estimated Permeability: > 500 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	6.5	Moist	Nil			
50	B22		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Moist	Nil		0.5	
100	B23		Red loamy sand with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Trace	Nil			
	B3		Grey sandy loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Nil		3.1	
150			COMMENTS: Sand more consolidated than SC2073 Bottom of hole at 140						

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Landscape Properties

Landscape position: Ridge
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Mallee, wilga, rosewood, cannonball, corkscrew grass

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TEST HOLE SC2075

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 529338 Northing: 6282739
Surface Elevation(m): 31.0
Equipment: Christie corer

Australian Soil Class: Red Arenosol
Annual Crop Rootzone (cm): 140
Plant Available Water (mm): 144
Drainage: Rapidly drained
Estimated Permeability: > 500 mm/day

Geology: Aeolian lunette
Landuse: Rangeland Grazing
Surface condition: Firm
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	1A		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	6	Moist	Nil			
50	2A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	6	Moist	Nil		0.2	
	2B1		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Trace	Nil			
100	2B2		Red sandy loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5	Dry	Slight		3.1	
150			COMMENTS: Sand coarse in 2A. Landform element - Dune near closed depression, Wilga nearby						

Bottom of hole at 140

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Landscape Properties

Landscape position: Hillock
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Pearl and black bluebush, medic, corkscrew grass

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TEST HOLE SC2076

Date Excavated: 9/5/22
Logged by: PJH Datum: WGS 84
Easting: 529108 Northing: 6281781
Surface Elevation(m): 39.9
Equipment: Christie corer

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 89
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red fine sandy clay loam with moderate grade of subangular blocky structure. Soil is slightly dispersive, completely slakes	7.5		Very high			
50	B1k		Red light clay with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8		Very high	20% Carb	1.2	
	B2k		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8.5		Very high	30% Carb		
100	B3		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8		Slight	5% Carb	4.4	
150			COMMENTS: Bottom of hole at 140						

Landscape Properties

Landscape position: Open Depression
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Pearl bluebush, belah, corkscrew grass, some medic

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TEST HOLE SC2077

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 530080 Northing: 6279014
Surface Elevation(m): 26.6
Equipment: Christie corer

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 35
Drainage: Imperfectly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Rangeland Grazing
Surface condition: Firm
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	7	Moist	Nil			
50	B2y		Red sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	7	Moist	Nil	80% Gyp	32.5	
	B23y		Brown sandy loam with moderate grade of polyhedral structure. With 10% R mottle. Soil is not dispersive, completely slakes	7	Moist	Slight	20% Gyp		
100	B3y		Grey sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	7	Wet	Nil	60% Gyp	44	
150			COMMENTS: Small rise in lake floor. Bottom of hole at 140						

Landscape Properties

Landscape position: Hillock
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Pigface, samphire

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TEST HOLE SC2078

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 529670 Northing: 6276293
Surface Elevation(m): 31.0
Equipment: Christie corer

Australian Soil Class: Red Kandosol
Annual Crop Rootzone (cm): 120
Plant Available Water (mm): 127
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A11		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	8	Moist	Nil			
50	A12		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7.5	Moist	High		2.4	
	A2		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, partially slakes	7.5	Moist	High			
100	By		Red sandy loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	7.5	Dry	Very high	50% Gyp	5.7	
150			COMMENTS: Gypsite north on lower level. Bottom of hole at 140						

Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Stabilised
Vegetation: Black bluebush, some corkscrew grass

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TEST HOLE SC2079

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 530136 Northing: 6275837
Surface Elevation(m): 36.8
Equipment: Christie corer

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 95
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red light sandy clay loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Moist	Very high			
50	A3		Red light sandy clay loam with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Moist	Very high		1	
	B22		Red silty clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	10% Carb		
100	B23k		Red silty clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	20% Carb	2.2	
150			COMMENTS: Bottom of hole at 140						

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Pearl bluebush, belah, cannonball, corkscrew grass, medic

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TEST HOLE SC2080

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 539701 Northing: 6277015
Surface Elevation(m): 58.0
Equipment: Christie corer

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 76
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loam, fine sandy with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Moist	High			
50	B21k		Red sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Moist	Very high	30% Carb		
	B22k		Red sandy clay loam with strong grade of polyhedral structure. Soil is slightly dispersive, completely slakes	8	Dry	Very high	20% Carb		
100	B23		Red sandy clay loam with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	10% Carb		
150			COMMENTS: Rough surface. Scald moving? Bottom of hole at 140						

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Landscape Properties

Landscape position: Flat
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush, medic, corkscrew grass

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TEST HOLE SC2081

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 531488 Northing: 6281073
Surface Elevation(m): 52.0
Equipment: Christie corer

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 92
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Firm
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	7.5	Moist	Nil			
50	A3		Red sandy loam with moderate grade of subangular blocky structure. Soil is not dispersive, completely slakes	8.5	Moist	High			
	B2k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, doesn't slake	8.5	Dry	High	20% Carb		
100	B23		Red sandy clay loam with moderate grade of polyhedral structure. Soil is slightly dispersive, completely slakes	9	Dry	Moderate	10% Carb		
			COMMENTS: Bottom of hole at 140						
150									

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Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Belah, pearl bluebush, corkscrew grass, medic

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TEST HOLE SC2082

Date Excavated: 10/5/22
Logged by: PJH Datum: WGS 84
Easting: 531838 Northing: 6281224
Surface Elevation(m): 52.6
Equipment: Christie corer

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 65
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Firm
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red sandy loam with weak grade of subangular blocky structure. Soil is not dispersive, completely slakes	7	Moist	Nil			
50	B22k		Red sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Moderate	30% Carb		
100	B23k		Red sandy clay loam with weak grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Moderate	20% Carb		
150			COMMENTS: Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Partly stabilised Sheet
Vegetation: Pearl bluebush, medic, corkscrew grass

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TEST HOLE SC2083

Date Excavated: 19/5/22
Logged by: PJH Datum: WGS 84
Easting: 528830 Northing: 6280450
Surface Elevation(m): 48.1
Equipment: Christie corer

Australian Soil Class: Calcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 104
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Moist	Very high			
50	A3		Red loam with moderate grade of subangular blocky structure. Soil is not dispersive, partially slakes	8	Moist	Very high	5% Carb	5.3	
	B22k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	20% Carb		
100	B23k		Red sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	8	Dry	Very high	20% Carb	10	
150			COMMENTS: Northern aspect. Scattered black bluebush. Bottom of hole at 140						

Landscape Properties

Landscape position: Midslope
Microrelief: No Microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush, Belah, Cannonball

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TEST HOLE SC2084

Date Excavated: 19/5/22
Logged by: PJH Datum: WGS 84
Easting: 528831 Northing: 6280005
Surface Elevation(m): 51.1
Equipment: Christie corer

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 116
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loam, fine sandy with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes	8	Moist	Very high			
	B1		Red loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, doesn't slake	8	Moist	Very high	2% Carb	19.5	
50	B21k		Red fine sandy clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	9	Dry	Very high	50% Carb		
100	B22tk		Red light clay with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes	9	Dry	Very high	60% Carb	12.6	
150			COMMENTS: 100 m north of crest, Belah around this patch that was scalded now stabilised.						

Bottom of hole at 140

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Medic, corkscrew grass, cannonball, pearl bluebush

RZ Resources Copi
Cr 481

TEST HOLE SC2085

Date Excavated: 19/5/22
Logged by: PJH Datum: WGS 84
Easting: 530828 Northing: 6282278
Surface Elevation(m): 47.4
Equipment: Christie corer

Australian Soil Class: Supracalcic Calcarosol
Annual Crop Rootzone (cm): 60
Plant Available Water (mm): 47
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Rangeland Grazing
Surface condition: Cryptogram Crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Moisture	Efferves-cence	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loam, fine sandy with weak grade of angular blocky structure. Soil is not dispersive, completely slakes	8	Moist	Very high			
50	B22k		Red fine sandy clay loam with moderate grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	50% Carb	10	
100	B23k		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	High	20% Carb		
	B3y		Red light clay with strong grade of polyhedral structure. Soil is not dispersive, completely slakes	9	Dry	Very high	50% Gyp	14	
150			COMMENTS: Surface condition - 60% Cryptogram Crust, 40% Hardset. Bottom of hole at 140						

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Landscape Properties

Landscape position: Upper Slope
Microrelief: No Microrelief
Erosion: Stabilised

Vegetation: Medic, corkscrew grass, poor pearl bluebush

RZ Resources Copi
Cr 481

TEST HOLE SC2090

Date Excavated: 15/11/23
Logged by: PJH Datum: WGS 84
Easting: 531072 Northing: 6275727
Surface Elevation(m): 30.4
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 145
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red fine sandy loam. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	6	N			0.5	
	A3		Red fine sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	6	N				
50	B11		Red sandy clay loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	8.5	Very high		2% Carb		
	B12k		Red sandy clay loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5	Very high		20% Carb	10	
100			COMMENTS: Edge of Copi dune. Copi 50 cm deep upslope, 100 cm downslope. Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Stabilised

Vegetation: Speargrass, black bluebush, sandalwood, bladder saltbush, medic

RZ Resources Copi
Cr 481

TEST HOLE SC2091

Date Excavated: 15/11/23
Logged by: PJH Datum: WGS 84
Easting: 531230 Northing: 6275393
Surface Elevation(m): 33.2
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 140
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red fine sandy loam with weak grade of subangular blocky structure and ped size of 2 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has many roots present.	7.5	N				
	B1		Red fine sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	8	Very high			2.5	
50	B22k		Red sandy clay loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8	Very high		20% Carb		
	B23k		Red sandy clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5	Very high		50% Carb	4.5	
100			COMMENTS: Track 20 m east eroded Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Stabilised

Vegetation: Belah, rosewood, speargrass, copperburr, medic, bladder saltbush, black bluebush, ragodia

RZ Resources Copi
Cr 481

TEST HOLE SC2092

Date Excavated: 15/11/23
Logged by: PJH Datum: WGS 84
Easting: 531048 Northing: 6274832
Surface Elevation(m): 33.3
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 41
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Stabilised

Vegetation: Speargrass, pearl bluebush, few sandalwood, mallee that are dying

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red sandy clay loam with moderate grade of subangular blocky structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a good SOILpak score and has abundant roots present.	9	Very high				
	A3		Brown sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	9	Very high		10% Carb	3.5	
50	B21k		Brown silty clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	9	Very high		30% Carb		
	B22k		Brown silty clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	9	Very high		40% Carb	21	
100			COMMENTS: Similar to pearl bluebush land on Warwick north of saline lake. Carbonate in vertical macropores in B22. Bottom of hole at 120						
150									

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TEST HOLE SC2093

Date Excavated: 15/11/23
Logged by: PJH Datum: WGS 84
Easting: 530434 Northing: 6274687
Surface Elevation(m): 37.2
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 77
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Aeolian sand plain
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red fine sandy loam. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8	High				
	B1		Brown light sandy clay loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		10% Carb	12	
50	B22k		Brown sandy clay with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5	Very high		60% Carb		
100	B23k		Brown sandy clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5	Very high		20% Carb	4.9	
150			COMMENTS: Medic sparser than SC2090, 91, 92 Bottom of hole at 110						

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Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Canonball copperburr and copperburr, bladder saltbush, speargrass, medic

RZ Resources Copi
Cr 481

TEST HOLE SC2094

Date Excavated: 15/11/23
Logged by: PJH Datum: WGS 84
Easting: 530129 Northing: 6274805
Surface Elevation(m): 44.9
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 150
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian sand plain
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red fine sandy loam. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	7.5	Slight				
	B1		Red fine sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		2% Carb	1.5	
50	B22k		Red fine sandy loam with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		10% Carb		
	B23k		Brown sandy clay with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	High		40% Carb	6	
100			COMMENTS: Roots in macropores in B23. Small gully (10 cm deep, 1 m wide) to east of site. Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Sheet
Vegetation: Blue blackbush, belah, some speargrass, little medic

RZ Resources Copi
Cr 481

TEST HOLE SC2095

Date Excavated: 15/11/23
Logged by: PJH Datum: WGS 84
Easting: 533347 Northing: 6275670
Surface Elevation(m): 34.1
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 70
Drainage: Well drained
Estimated Permeability: 50 to 500 mm/day

Geology: Aeolian lunette
Landuse: Naturalised pasture
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8	N				
50	B1		Red fine sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		5% Carb	1.5	
	B2k		Red light sandy clay loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8.5	Very high		20% Carb		
100	B3y		Red light sandy clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	7.5	Very high		50% Gyp	31	
			COMMENTS: Copi from 80 to 120 cm Bottom of hole at 120						
150									

Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Stabilised

Vegetation: Black bluebush, copse of rosewood, speargrass, medic

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RZ Resources Copi
Cr 481

TEST HOLE SC2096

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 532674 Northing: 6272835
Surface Elevation(m): 39.2
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 87
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red fine sandy loam with moderate grade of polyhedral structure and ped size of 3 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has abundant roots present.	8	High				
	A3		Red silt loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	8.5	Very high		5% Carb	14	
50	B22k		Red light medium clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has few roots present.	8.5	Very high		50% Carb		
100	B23k		Red light medium clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	8.5	High		60% Carb	18.6	
150			COMMENTS: Valley. Most clay of the sites so far. Bottom of hole at 120						

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Landscape Properties

Landscape position: Lower slope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Belah, cannonball copperburr, speargrass, medic, wards weed

RZ Resources Copi
Cr 481

TEST HOLE SC2097

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 533273 Northing: 6274335
Surface Elevation(m): 31.5
Equipment: Christie

Australian Soil Class: Brown Kandosol
Annual Crop Rootzone (cm): 30
Plant Available Water (mm): 24
Drainage: Well drained
Estimated Permeability: > 500 mm/day

Geology: Aeolian lunette with kopi
Landuse: Naturalised pasture
Surface condition: Hardset
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Grey sandy loam. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has many roots present.	8	High				
50	B21y		Yellow sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8	High		90% Gyp	26	
	B22y		Brown sandy loam with weak grade of subangular blocky structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	7	High		80% Gyp		
100	B23y		Red loamy sand. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has no roots present.	8	High		80% Gyp	30.6	
			COMMENTS: Copi 20 to 100. Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Canonball copperburr, speargrass, black bluebush, medic

RZ Resources Copi
Cr 481

TEST HOLE SC2098

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 533026 Northing: 6274608
Surface Elevation(m): 27.4
Equipment: Christie

Australian Soil Class: Hypergypsic Calcarosol
Annual Crop Rootzone (cm): 20
Plant Available Water (mm): 17
Drainage: Imperfectly drained
Estimated Permeability: < 5 mm/day

Geology: Yamba Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loam, fine sandy with moderate grade of polyhedral structure and ped size of 5 cm breaking to 1 cm. Soil is slightly dispersive, doesn't slake, has a poor to moderate SOILpak score and has abundant roots present.	6	N				
50	B11y		Brown loam with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	8	Very high		50% Gyp	90	
	B12y		Brown clay loam with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has no roots present.	7.5	Moderate		50% Gyp		
100									
			COMMENTS: Lake floor. Samphire/Pop saltbush to North. Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Flat
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Copperburr, black bluebush, salt tolerant succulent, speargrass

RZ Resources Copi
Cr 481

TEST HOLE SC2099

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 537330 Northing: 6278749
Surface Elevation(m): 50.7
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 103
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Brown silt loam with weak grade of subangular blocky structure and ped size of 3 cm breaking to 0.5 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8.5	Very high				
	A3		Red silty clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		5% Carb	3.5	
50	B1k		Red light clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8.5	High		20% Carb		
100	B2k		Red light medium clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a poor to moderate SOILpak score and has few roots present.	7	High		30% Carb	6.7	
150			COMMENTS: Near ponded part of closed depression. Bottom of hole at 120						

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Landscape Properties

Landscape position: Closed depression
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Black bluebush, canonball copperburr, speargrass, medic

RZ Resources Copi
Cr 481

TEST HOLE SC2100

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 537409 Northing: 6279547
Surface Elevation(m): 52.9
Equipment: Christie

Australian Soil Class: Brown Chromosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 58
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Loose
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure and ped size of 5 cm breaking to 0.5 cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has abundant roots present.	8	N		2% Carb		
50	B2k		Red loam, fine sandy with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	9	Very high		10% Carb	2.4	
	2B22k		Brown light sandy clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	9	Very high		30% Carb		
100	2B23k		Red light sandy clay loam with weak grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	9	Very high		50% Carb	3	
			COMMENTS: Suspect B2 blown over top of 2B22 Bottom of hole at 120						
150									

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Landscape Properties

Landscape position: Crest
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Rosewood, speargrass, black bluebush

RZ Resources Copi
Cr 481

TEST HOLE SC2101

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 537949 Northing: 6279950
Surface Elevation(m): 48.0
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 108
Drainage: Poorly drained
Estimated Permeability: < 5 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red light clay with strong grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has abundant roots present.	9	Very high				
	B1		Brown light clay with strong grade of prismatic structure and ped size of cm breaking to cm. Soil is slightly dispersive, completely slakes, has a moderate to good SOILpak score and has an average number of roots present.	8.5	Very high		5% Carb	6	
50	B22		Red light medium clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		20% Carb		
	B23		Brown light medium clay with strong grade of polyhedral structure and ped size of cm breaking to cm. With 10% G mottle. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has no roots present.	8	Very high		20% Gyp	18.9	
100			COMMENTS: Slickensides in B23. Trace mangans in B23. Only B23 is poorly drained. Site in floor of broad drainage line. Bottom of hole at 120						
150									

Sustainable Soils Management
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Landscape Properties

Landscape position: Lower slope
Microrelief: No microrelief
Erosion: Stabilised
Vegetation: Speargrass, black bluebush, medic, canonball copperburr

RZ Resources Copi
Cr 481

TEST HOLE SC2102

Date Excavated: 16/11/23
Logged by: PJH Datum: WGS 84
Easting: 538933 Northing: 6280166
Surface Elevation(m): 56.4
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 74
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A1		Red loamy sand with weak grade of subangular blocky structure and ped size of 10 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has abundant roots present.	8.5	High				
	B1		Red light sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has many roots present.	9	Very high		2% Carb	4.5	
50	B22k		Red fine sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is moderately dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	9	Very high		30% Carb		
100	B23k		Red clay loam with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is slightly dispersive, partially slakes, has a moderate SOILpak score and has few roots present.	8	Very high		25% Carb	10.5	
150			COMMENTS: Trace gypsum in B23. Near ridge crest. Bottom of hole at 120						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Black bluebush, speargrass, medic

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Cr 481

TEST HOLE SC2103

Date Excavated: 17/11/23
Logged by: PJH Datum: WGS 84
Easting: 538687 Northing: 6278335
Surface Elevation(m): 55.4
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 70
Plant Available Water (mm): 119
Drainage: Moderately well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red fine sandy loam with weak grade of subangular blocky structure and ped size of 5 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has many roots present.	8	N				
50	B1		Red sandy clay loam with strong grade of prismatic structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate to good SOILpak score and has many roots present.	8.5	Moderate			5	
	B22k		Red sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8.5	Very high		30% Carb		
100	B23k		Red light clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8.5	Moderate		20% Carb	8.8	
			COMMENTS: Near broad drainage line and midslope Bottom of hole at 120						
150									

Landscape Properties

Landscape position: Midslope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Speargrass, black bluebush, medic

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TEST HOLE SC2104

Date Excavated: 17/11/23
Logged by: PJH Datum: WGS 84
Easting: 539215 Northing: 6280261
Surface Elevation(m): 55.9
Equipment: Christie

Australian Soil Class: Red Chromosol
Annual Crop Rootzone (cm): 80
Plant Available Water (mm): 78
Drainage: Imperfectly drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Red loamy sand with weak grade of subangular blocky structure and ped size of 2 cm breaking to 1 cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has many roots present.	8	Very high				
	B1		Red fine sandy clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate to good SOILpak score and has many roots present.	8	Very high		30% Carb	5.5	
50	B22k		Red sandy clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has an average number of roots present.	8	Very high		30% Carb		
100	B23		Red sandy clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, partially slakes, has a moderate SOILpak score and has few roots present.	8	Very high		20% Carb	9.5	
150			COMMENTS: Trace mangans along root channels in B22 and B23 Bottom of hole at 130						

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Landscape Properties

Landscape position: Upper slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush and black bluebush, speargrass, copperburr, medic

RZ Resources Copi
Cr 481

TEST HOLE SC2105

Date Excavated: 17/11/23
Logged by: PJH Datum: WGS 84
Easting: 538737 Northing: 6280375
Surface Elevation(m): 52.1
Equipment: Christie

Australian Soil Class: Hypercalcic Calcarosol
Annual Crop Rootzone (cm): 50
Plant Available Water (mm): 50
Drainage: Well drained
Estimated Permeability: 5 to 50 mm/day

Geology: Woorinen Formation
Landuse: Naturalised pasture
Surface condition: Cryptogram crust
Surface gravel: None
Outcrop: None

DEPTH (centimetres)	Horizon	GRAPHIC LOG	PROFILE DESCRIPTION	Field pH	Effervescence	Carbonate Class	Approximate Concretions	Field ECe (dS/m)	SAMPLE
	A		Brown light sandy clay loam with weak grade of subangular blocky structure and ped size of 5 cm breaking to 0.5 cm. Soil is not dispersive, partially slakes, has a poor to moderate SOILpak score and has many roots present.	8	Very high				
50	B21		Red light clay with moderate grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8	Very high		50% Carb	8.4	
	2A		Red silty clay loam with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has an average number of roots present.	8	Very high		50% Carb		
100	2B		Red sandy clay with strong grade of polyhedral structure and ped size of cm breaking to cm. Soil is not dispersive, completely slakes, has a moderate SOILpak score and has few roots present.	8	Very high		20% Carb	13	
150			COMMENTS: Above scalded drainage lines that channel water towards Lake Floor East Bottom of hole at 120						

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Landscape Properties

Landscape position: Lower slope
Microrelief: No microrelief
Erosion: Partly stabilised Wind
Vegetation: Pearl bluebush, speargrass, copperburr, medic

APPENDIX II:

Results of Soil Tests from Nutrient Advantage Laboratories.

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
31/1/20	SC001	523172	6285797	0	15	Sandy Loam	7.7	6.9		12	1	51				0.07	0.4	13																11	4	26	59	<0.75
31/1/20	SC001	523172	6285797	15	30	Sandy Loam	8.5	7.6		4	<1	100				0.06	0.3	<10																14	5	27	54	<0.75
31/1/20	SC001	523172	6285797	30	60	Sandy Clay Loam	8.8	8		6	<1	15				0.12	0.6	20																23	4	27	46	8.1
31/1/20	SC001	523172	6285797	60	100	Unknown	9.1	8.3		5	<1	10				0.11	0.6	12																3	3	27	48	12
31/1/20	SC002	523814	6285271	0	15	Sand	6.8	6.1		6	2	60				0.13	1.6	120																5	3	7	86	<0.75
31/1/20	SC002	523814	6285271	15	30	Sand	7.3	6.8		2	1	110				0.61	8.7	690																3	0	7	90	<0.75
31/1/20	SC002	523814	6285271	30	60	Sandy Loam	8.6	8.2		3	1	450				2.89	36.4	3700																12	0	9	79	<0.75
31/1/20	SC002	523814	6285271	60	100	Sand	8.1	7.9		2	1	480				2.66	38.8	3400																5	1	3	91	<0.75
31/1/20	SC003	524483	6285188	0	15	Sandy Clay Loam	8.6	8.5		2	<1	2500				3.92	34.2	3100																20	3	27	50	1.7
31/1/20	SC003	524483	6285188	15	30	Sandy Loam	8.4	8		7	1	180				0.87	13.9	1500																9	3	24	65	<0.75
31/1/20	SC003	524483	6285188	30	60	Sand	7.2	7		19	1	9				0.58	8.2	700																5	2	22	71	<0.75
31/1/20	SC003	524483	6285188	60	100	Sand	7.3	6.5		16	2	11				0.11	1.0	59																6	4	22	68	<0.75
31/1/20	SC004	524923	6284883	0	15	Sandy Loam	8.2	8		21	4	2000				1.53	6.0	36																10	6	42	42	1.7
31/1/20	SC004	524923	6284883	15	30	Silty Loam	8.7	8.6		13	<1	7200				3.53	31.1	1800																8	43	37	13	1.7
31/1/20	SC004	524923	6284883	30	60	Silty Loam	8.8	8.6		5	<1	6900				3.59	35.4	2500																9	43	36	13	2
31/1/20	SC004	524923	6284883	60	100	Silty Loam	8.8	8.7		3	<1	6300				2.88	29.1	2200																10	29	51	10	1.7
31/1/20	SC005	525369	6284308	0	15	Sandy Loam	7.8	7.1		13	4	140				0.18	1.2	50																11	5	40	44	<0.75
31/1/20	SC005	525369	6284308	15	30	Sandy Loam	7.7	7.2		5	1	31				0.26	1.1	<10																10	5	43	42	<0.75
31/1/20	SC005	525369	6284308	30	60	Sandy Clay Loam	9	8.2		4	1	52				0.21	1.3	68																21	6	34	39	1.7
31/1/20	SC005	525369	6284308	60	100	Loamy Sand	8.2	8.1		2	<1	5300				2.8	18.1	510																6	23	35	36	4.2
31/1/20	SC006	526208	6284453	0	15	Sandy Loam	9	7.7		6	3	30				0.11	0.7	25																10	4	49	37	<0.75
31/1/20	SC006	526208	6284453	15	30	Loamy Sand	8.9	8.1		2	<1	440				0.55	2.2	<10																6	5	58	31	1.1
31/1/20	SC006	526208	6284453	30	60	Loamy Sand	8.2	8.2		1	<1	5800				2.28	7.3	<10																9	20	31	41	<0.75
31/1/20	SC006	526208	6284453	60	100	Sandy Clay Loam	8.3	8.1		1	<1	1700				2.06	11.7	510																22	4	42	32	<0.75
31/1/20	SC007	527433	6283516	0	15	Sandy Loam	9.1	8.3		5	1	29				0.16	1.0	30																10	8	23	59	7.9
31/1/20	SC007	527433	6283516	15	30	Sandy Loam	9.1	8.3		5	<1	30				0.23	2.7	260																13	6	23	58	11
31/1/20	SC007	527433	6283516	30	60	Sandy Clay Loam	9.4	8.5		3	<1	390				1.43	13.1	1300																21	5	25	50	19
31/1/20	SC007	527433	6283516	60	100	Loamy Sand	8.5	8.2		1	<1	6400				3.17	23.9	1000																7	22	29	41	19
31/1/20	SC008	527953	6283281	0	15	Sandy Loam	9	8.1		2	2	13				0.09	0.5	<10																9	5	22	65	6.1
31/1/20	SC008	527953	6283281	15	30	Sandy Loam	8.7	8.1		2	<1	310				0.62	4.7	290																15	9	24	52	18
31/1/20	SC008	527953	6283281	30	60	Loamy Sand	8.3	8.2		2	<1	5700				2.43	14.6	340																6	17	28	49	17
31/1/20	SC008	527953	6283281	60	100	Loamy Sand	8.4	8.2		1	<1	6200				1.56	8.2	130																6	6	20	68	2.1
31/1/20	SC009	528497	6283133	0	15	Sandy Loam	8.7	8		3	<1	80				0.07	0.4	<10																10	3	19	69	<0.75
31/1/20	SC009	528497	6283133	15	30	Sandy Loam	9	8.3		2	<1	7				0.14	1.2	72																9	3	20	69	2.1
31/1/20	SC009	528497	6283133	30	60	Sandy Loam	9.2	8.3		1	<1	24				0.4	4.1	370																14	3	25	59	4.7
31/1/20	SC009	528497	6283133	60	100	Sandy Clay Loam	9.1	8.3		1	<1	130				0.98	9.6	1000																20	5	17	58	16
31/1/20	SC010	529908	6282076	0	15	Sand	8.4	7.5		12	1	9				0.09	0.5	13																8	3	27	63	<0.75
31/1/20	SC010	529908	6282076	15	30	Sandy Loam	9	8.3		10	1	10				0.13	0.7	17																11	3	25	62	1.6
31/1/20	SC010	529908	6282076	30	60	Sandy Loam	9.2	8.3		10	<1	41				0.16	0.7	11																16	4	24	56	7.5
31/1/20	SC010	529908	6282076	60	100	Sandy Loam	9.9	8.6		4	<1	47				0.56	4.5	340																18	8	21	54	14
31/1/20	SC011	530575	6281800	0	15	Sandy Loam	9.1	8.3		5	1	11				0.11	0.5	<10																15	8	24	53	6.4
31/1/20	SC011	530575	6281800	15	30	Sandy Loam	9	8.2		6	1	6				0.12	0.6	17																20	8	24	48	13
31/1/20	SC011	530575	6281800	30	60	Sandy Clay Loam	9.5	8.3		6	<1	16				0.26	1.8	130																24	5	24	47	17
31/1/20	SC011	530575	6281800	60	100	Sandy Clay Loam	9.8	8.5		3	<1	86				0.78	6.2	650																28	6	21	44	21
31/1/20	SC012	532415	6280204	0	15	Sand	8.4	7.5		5	2	10				0.09	0.7	32																4	5	22	69	<0.75
31/1/20	SC012	532415	6280204	15	30	Sand	9.1	7.9		2	1	27				0.2	2.5	200																6	3	24	67	<0.75
31/1/20	SC012	532415	6280204	30	60	Sandy Clay Loam	8.8	8.5		3	<1	1300				2.82	24.1	2200																21	6	37	36	2
31/1/20	SC012	532415	6280204	30	100	Sandy Loam	8.6	8.5		1	<1	5100				3.81	33.5	2200																11	4	20	66	0.83
31/1/20	SC013	531247	6280507	0	15	Loamy Sand	8.2	7.3		6	2	21				0.14	1.4	78																5	5	42	48	<0.75
31/1/20	SC013	531247	6280507	15	30	Sandy Loam	8.3	7.3		6	1	17				0.43	5.3	500																10	5	36	49	<0.75
31/1/20	SC013	531247	6280507	30	60	Sandy Clay Loam	9.2	8.6		4	1	83				1.54	14.7	1700																24	3	34	40	1.3
31/1/20	SC013	531247	6280507	60	100	Sandy Loam	9.4	8.8		3	<1	120				1.63	18.5	2100																18	5	36	42	3.3
31/1/20	SC014	531708	6280085	0	15	Loamy Sand	8.8	7.7		13	4	39				0.33	3.6	270																7	5	28	61	<0.75
31/1/20	SC014	531708	6280085	15	30	Sandy Clay Loam	8.4	7.4		9	2	14				0.68	7.2	840																21	4	31	44	<0.75
31/1/20	SC014	531708	6280085	30	60	Sandy Clay Loam	8.9	8.5		3	1	420				3.43	36.0	5100																28	4	26	42	0.83
31/1/20	SC014	531708	6280085	60	100	Sandy Clay Loam	8.7	8.5		2	1	1100				3.59	33.3	3500																22	4	39	35	1.3

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
3/2/20	SC015	532090	6279906	0	15	Sandy Loam	8.3	8.2		<1	<1	1600				8.5	108.5	10000																9	1	36	55	<0.75
3/2/20	SC015	532090	6279906	15	30	Sandy Clay Loam	8.4	8.3		1	<1	1700				4.85	90.8	14000																19	0	20	61	<0.75
3/2/20	SC015	532090	6279906	30	60	Sandy Loam	8.1	8		1	1	1400				7.8	94.6	11000																17	1	19	63	<0.75
3/2/20	SC015	532090	6279906	60	100	Sandy Clay Loam	7.9	7.7		<1	<1	850				7.64	95.1	12000																19	3	16	63	<0.75
3/2/20	SC016	533456	6279593	0	15	Sandy Loam	8.2	8.1		13	1	5800				2.13	7.2	20																13	11	32	44	4.8
3/2/20	SC016	533456	6279593	15	30	Loamy Sand	8.3	8.2		7	2	5000				2.24	12.8	310																9	14	36	41	3
3/2/20	SC016	533456	6279593	30	60	Loamy Sand	8.2	8.1		3	1	4300				3.84	36.8	2600																10	14	37	40	<0.75
3/2/20	SC016	533456	6279593	60	100	Loam	8.6	8.5		3	1	4700				5.72	58.2	4800																12	15	27	47	3.2
3/2/20	SC017	534290	6278951	0	15	Sandy Loam	9	7.8		10	2	17				0.15	1.1	48																11	7	28	54	<0.75
3/2/20	SC017	534290	6278951	15	30	Clay Loam	9.5	8.4		6	1	110				0.4	1.7	42																31	9	29	31	5.6
3/2/20	SC017	534290	6278951	30	60	Clay	9.4	8.5		3	1	150				1.25	10.0	1300																36	8	26	31	12
3/2/20	SC017	534290	6278951	60	100	Clay	8.4	8.3		1	1	3800				4.04	24.1	1700																32	6	25	37	17
3/2/20	SC018	534585	6278237	0	15	Clay Loam	8.8	8.1		10	2	43				0.17	0.7	<10																25	10	26	40	15
3/2/20	SC018	534585	6278237	15	30	Clay Loam	8.8	8.1		10	<1	110				0.35	2.0	120																32	13	22	34	24
3/2/20	SC018	534585	6278237	30	60	Clay	9.3	8.3		6	1	91				0.76	5.1	520																36	10	23	31	26
3/2/20	SC018	534585	6278237	60	100	Silty Loam	8.3	8.2		4	1	6300				3.16	23.0	860																6	27	23	44	6.3
3/2/20	SC019	535385	6278434	0	15	Sandy Loam	8.8	8.2		8	1	90				0.22	0.9	<10																15	9	24	52	6.6
3/2/20	SC019	535385	6278434	15	30	Sandy Loam	8.9	8.1		12	1	30				0.16	0.7	13																18	7	22	53	11
3/2/20	SC019	535385	6278434	30	60	Sandy Clay Loam	8.9	8.1		5	1	50				0.17	0.9	30																21	6	25	47	15
3/2/20	SC019	535385	6278434	60	100	Loamy Sand	8.1	8		2	1	4200				2.32	10.4	81																5	17	21	57	3.4
3/2/20	SC020	536267	6277854	0	15	Loamy Sand	9.1	8.4		4	1	6				0.08	0.5	<10																8	5	21	66	2.8
3/2/20	SC020	536267	6277854	15	30	Sandy Clay Loam	9.2	8.3		3	<1	5				0.09	0.4	<10																18	1	25	56	9.5
3/2/20	SC020	536267	6277854	30	60	Sandy Loam	9.2	8.3		4	1	15				0.12	0.7	25																14	5	27	54	13
3/2/20	SC020	536267	6277854	60	100	Sandy Clay Loam	9.8	8.6		3	<1	140				0.79	6.6	590																21	5	29	45	22
3/2/20	SC021	535629	6277596	0	15	Sandy Loam	9	8.2		11	2	47				0.14	0.6	<10																14	4	26	57	7.6
3/2/20	SC021	535629	6277596	15	30	Sandy Loam	9.2	8.3		23	<1	12				0.13	0.6	<10																16	4	27	54	11
3/2/20	SC021	535629	6277596	30	60	Sandy Clay Loam	9.3	8.3		6	<1	6				0.16	1.0	45																21	5	27	47	16
3/2/20	SC021	535629	6277596	60	100	Clay Loam	9.4	8.6		2	<1	260				0.69	4.4	300																26	9	26	39	29
3/2/20	SC022	536232	6277527	0	15	Sandy Loam	9	8.2		7	1	36				0.12	0.5	<10																18	8	26	49	8.7
3/2/20	SC022	536232	6277527	15	30	Sandy Clay Loam	9	8.2		4	<1	160				0.13	0.7	26																21	5	30	44	12
3/2/20	SC022	536232	6277527	30	60	Sandy Clay Loam	9.4	8.3		2	<1	9				0.4	3.7	400																24	6	27	43	18
3/2/20	SC022	536232	6277527	60	100	Clay Loam	9.7	8.5		1	1	84				0.79	6.2	660																30	8	25	37	27
3/2/20	SC023	537078	6277355	0	15	Sandy Loam	9.1	8.2		11	1	8				0.12	0.5	<10																18	8	25	50	9.6
3/2/20	SC023	537078	6277355	15	30	Sandy Clay Loam	9	8.2		8	<1	8				0.2	1.5	120																23	7	29	41	16
3/2/20	SC023	537078	6277355	30	60	Clay Loam	9.5	8.4		3	1	52				0.53	4.2	420																27	7	27	39	18
3/2/20	SC023	537078	6277355	60	100	Sandy Clay Loam	8.5	8.3		3	1	3000				2.86	15.1	580																24	6	29	41	15
3/2/20	SC024	538054	6276447	0	15	Sandy Loam	8.9	8.2		8	2	28				0.13	0.6	11																16	3	30	52	3.8
3/2/20	SC024	538054	6276447	15	30	Sandy Clay Loam	9.1	8.2		5	1	9				0.12	0.5	<10																26	6	30	38	11
3/2/20	SC024	538054	6276447	30	60	Sandy Clay Loam	9.7	8.4		6	1	8				0.25	1.1	25																30	5	27	38	17
3/2/20	SC024	538054	6276447	60	100	Silty Loam	8.3	8.2		3	1	4700				3	13.9	170																10	33	22	35	6.6
3/2/20	SC025	538796	6276019	0	15	Sandy Loam	9	8.3		6	2	5				0.09	0.5	<10																9	4	29	59	1.5
3/2/20	SC025	538796	6276019	15	30	Sandy Loam	9	8.3		9	1	5				0.09	0.5	<10																12	4	28	56	4.3
3/2/20	SC025	538796	6276019	30	60	Sandy Loam	9	8.3		8	1	52				0.14	0.6	<10																14	8	26	53	9
3/2/20	SC025	538796	6276019	60	100	Sandy Clay Loam	9.6	8.4		2	1	14				0.25	1.5	72																21	4	27	48	15
13/4/22	SC2001	535298	6278373	0	15	Sandy Loam	9	8.2		6.8	1.2	12				0.13	0.7	28																19	7	25	48	8
13/4/22	SC2001	535298	6278373	15	30	Sandy Clay Loam	9	8.1		5.5	0.8	7				0.19	1.4	110																24	7	26	43	13
13/4/22	SC2001	535298	6278373	30	60	Clay Loam	9.1	8.1		3.6	0.8	22				0.4	3.0	300																30	10	20	40	19
13/4/22	SC2001	535298	6278373	60	100	Clay	8.6	8.4		3.3	0.7	1700				1.81	9.4	530																36	7	23	33	20
13/4/22	SC2002	535769	6278156	0	15	Sandy Loam	8.8	8.2		4.5	1.9	86				0.23	1.2	21																11	1	33	55	4
13/4/22	SC2002	535769	6278156	15	30	Sandy Loam	9.1	8.3		3	1.2	8				0.17	1.5	110																14	5	34	48	6
13/4/22	SC2002	535769	6278156	30	60	Sandy Loam	9.4	8.5		3.8	1.7	46				0.45	4.0	370																19	5	29	48	12
13/4/22	SC2002	535769	6278156	60	100	Clay Loam	9.8	8.5		2.9	0.6	35				0.73	10.4	1600																23	10	29	38	27
13/4/22	SC2003	519077	6285247	0	15	Sandy Loam	8.7	8.1		6.3	1.6	58				0.19	0.9	16																12	7	33	48	<1
13/4/22	SC2003	519077	6285247	15	30	Clay	9.2	8.2		14	1.3	11				0.25	1.2	59																36	9	26	29	5
13/4/22	SC2003	519077	6285247	30	60	Clay	9.8	8.8		4.1	<0.6	14				0.65	4.3	470																41	6	21	32	11
13/4/22	SC2003	519077	6285247	60	110	Clay	9.3	8.8		2	0.8	1100				2	12.4	1300																43	6	23	28	8

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
13/4/22	SC2004	518734	6284988	0	15	Sandy Loam	8.7	8.1		3.3	1.2	120				0.24	1.3	36																16	9	38	38	3
13/4/22	SC2004	518734	6284988	15	30	Clay Loam	9.6	8.2		4.4	0.7	21				0.46	3.4	340																31	9	29	31	15
13/4/22	SC2004	518734	6284988	30	60	Clay	9.9	9.5		2.4	0.6	110				1.08	7.6	900																39	6	19	36	8
13/4/22	SC2004	518734	6284988	60	100	Clay Loam	8.6	8.5		1	0.7	6400				4.47	26.8	1600																27	10	36	27	15
13/4/22	SC2005	518095	6283938	0	15	Sandy Clay Loam	9.4	8.3		4.1	0.8	10				0.16	0.9	43																23	4	24	50	9
13/4/22	SC2005	518095	6283938	15	30	Sandy Clay Loam	9.1	8.2		2.6	0.9	11				0.11	0.5	<10																19	5	27	49	8
13/4/22	SC2005	518095	6283938	30	60	Sandy Clay Loam	9.8	8.3		5.5	1	11				0.28	2.0	140																23	4	24	49	12
13/4/22	SC2005	518095	6283938	60	100	Sandy Clay Loam	10.1	8.7		3.6	0.8	48				0.56	4.1	330																24	5	20	51	17
13/4/22	SC2006	517872	6283534	0	15	Clay	9.3	8.5		24	0.9	29				0.77	6.0	920																44	5	23	28	6
13/4/22	SC2006	517872	6283534	15	30	Clay	9.4	8.7		14	0.8	110				1.47	10.5	1400																43	9	19	30	9
13/4/22	SC2006	517872	6283534	30	60	Clay	9.1	8.7		7.6	0.9	840				1.94	13.9	1900																44	5	20	31	6
13/4/22	SC2006	517872	6283534	60	100	Clay	8.3	8.2		5.6	0.6	8000				5.26	28.9	2100																39	16	13	32	4
13/4/22	SC2007	516652	6284324	0	15	Sand	8.9	8.2		1.6	1.1	11				0.09	0.5	<10																7	3	21	70	<1
13/4/22	SC2007	516652	6284324	15	30	Sandy Loam	9	8.3		2	0.6	14				0.13	0.9	35																9	0	22	69	2
13/4/22	SC2007	516652	6284324	30	60	Sandy Loam	9.5	8.4		1	<0.6	8				0.21	1.8	130																13	3	23	61	6
13/4/22	SC2007	516652	6284324	60	100	Sandy Loam	9.6	8.4		0.8	<0.6	39				0.41	4.0	360																16	7	25	52	20
13/4/22	SC2008	517281	6284666	0	15	Sandy Loam	9	8.2		14	0.9	3				0.13	0.8	29																18	6	26	50	7
13/4/22	SC2008	517281	6284666	15	30	Sandy Loam	8.8	8.1		31	2.7	7				0.17	1.1	48																13	5	28	54	3
13/4/22	SC2008	517281	6284666	30	60	Sandy Clay Loam	9.4	8.3		8.9	0.7	13				0.26	1.8	140																26	6	27	42	17
13/4/22	SC2008	517281	6284666	60	100	Clay	9.9	9		7.9	<0.6	150				0.85	6.1	620																32	6	27	35	28
13/4/22	SC2009	517875	6285767	0	15	Sandy Loam	8.8	8.1		2.9	1.1	3				0.12	0.7	23	21	2	0.91	0.25	<0.1	24.2	87%	8%	4%	1%	0%	10.5				13	5	31	51	1
13/4/22	SC2009	517875	6285767	15	30	Sandy Loam	8.9	8.2		11	2	29				0.31	2.9	260	23	2.4	0.63	1.2	<0.1	27.2	84%	9%	2%	4%	0%	9.6				16	7	29	49	4
13/4/22	SC2009	517875	6285767	30	60	Sandy Clay Loam	9.3	8.4		2.9	0.6	48				0.84	8.0	930	23	4.5	0.35	4.7	<0.1	32.6	71%	14%	1%	14%	0%	5.1				24	6	29	41	15
13/4/22	SC2009	517875	6285767	60	100	Clay	9.5	8.6		1.1	1.1	160				1.01	8.6	1100	21	5.5	0.45	6.6	<0.1	33.6	63%	16%	1%	20%	0%	3.8				32	6	23	39	23
13/4/22	SC2010	521229	6283280	0	15	Sandy Clay	9.1	8.3		6.2	1.7	180				0.96	6.8	670	23	4	0.7	5.2	<0.1	32.9	70%	12%	2%	16%	0%	5.8				32	5	28	36	12
13/4/22	SC2010	521229	6283280	15	30	Clay	8.4	8.3		5.3	0.8	3300				3.67	20.9	1500	46	5	0.36	9.3	<0.1	60.7	76%	8%	1%	15%	0%	9.2				36	5	26	33	11
13/4/22	SC2010	521229	6283280	30	60	Clay	8.4	8.3		3.6	1	7200				4.24	23.9	2000	160	5.5	0.39	11	<0.1	176.9	90%	3%	0%	6%	0%	29.1				42	5	30	24	4
13/4/22	SC2010	521229	6283280	60	100	Clay	8.1	8		2.7	1.7	6200				5.5	34.2	3500	120	8.5	0.67	19	<0.1	148.2	81%	6%	0%	13%	0%	14.1				42	10	22	26	<1
13/4/22	SC2011	540742	6275866	0	15	Sandy Clay Loam	9.1	8.3		5.2	0.9	11				0.14	0.6	<10	23	3	1.4	0.68	<0.1	28.1	82%	11%	5%	2%	0%	7.7				22	9	28	42	3
13/4/22	SC2011	540742	6275866	15	30	Clay Loam	9.4	8.3		1.8	1.2	8				0.16	0.6	<10	24	3.6	1.1	1.4	<0.1	30.1	80%	12%	4%	5%	0%	6.7				28	8	30	35	8
13/4/22	SC2011	540742	6275866	30	60	Clay	9.8	8.4		2.4	<0.6	17				0.37	1.7	69	23	5.8	0.65	4.1	<0.1	33.6	69%	17%	2%	12%	0%	4.0				38	9	23	31	16
13/4/22	SC2011	540742	6275866	60	100	Clay	8.6	8.5		12	1.1	4200				3.22	17.7	1200	42	7.3	0.44	13	<0.1	62.7	67%	12%	1%	21%	0%	5.8				37	11	24	28	10
13/4/22	SC2012	539917	6275612	0	15	Sandy Loam	9.4	8.5		9.9	0.9	11				0.19	0.8	<10	22	1.8	1.2	0.8	<0.1	25.8	85%	7%	5%	3%	0%	12.2				17	5	27	51	6
13/4/22	SC2012	539917	6275612	15	30	Sandy Clay Loam	9.3	8.3		24	0.9	59				0.24	1.2	28	23	2.5	0.66	1.4	<0.1	27.6	83%	9%	2%	5%	0%	9.2				20	6	28	46	9
13/4/22	SC2012	539917	6275612	30	60	Sandy Clay Loam	9.2	8.4		31	0.6	35				0.36	2.6	200	21	3.8	0.38	2.6	<0.1	27.8	76%	14%	1%	9%	0%	5.5				24	5	29	42	13
13/4/22	SC2012	539917	6275612	60	100	Clay	9.5	8.5		12	<0.6	310				0.93	7.3	830	21	5.7	0.3	6.3	<0.1	33.3	63%	17%	1%	19%	0%	3.7				32	7	26	35	26
13/4/22	SC2013	538641	6276196	0	15	Sandy Loam	9	8.3		9	1.3	15				0.12	0.6	<10																15	4	30	51	5
13/4/22	SC2013	538641	6276196	15	30	Sandy Clay Loam	8.8	8		12	1	7				0.13	0.6	<10																22	6	26	46	8
13/4/22	SC2013	538641	6276196	30	60	Sandy Clay Loam	9.1	8.2		13	<0.6	9				0.12	0.5	16																29	5	26	40	14
13/4/22	SC2013	538641	6276196	60	100	Clay	9.7	8.3		16	<0.6	15				0.29	1.7	110																33	7	20	39	22
13/4/22	SC2014	533866	6280534	0	15	Loam	9	8.2		3.4	0.8	18				0.14	0.6	<10																21	10	31	38	4
13/4/22	SC2014	533866	6280534	15	30	Sandy Clay Loam	9	8.2		2.5	<0.6	13				0.14	0.6	<10																20	6	34	40	5
13/4/22	SC2014	533866	6280534	30	60	Clay Loam	9.1	8.3		2.6	0.8	11				0.11	0.6	23																22	10	26	42	5
13/4/22	SC2014	533866	6280534	60	100	Sandy Clay Loam	9.2	8.4		0.7	<0.6	46				0.14	0.7	20																24	4	19	54	5
13/4/22	SC2015	529566	6283271	0	15	Sand	8.3	7.8		5.8	1.9	83				0.28	1.3	<10																4	5	50	42	<1
13/4/22	SC2015	529566	6283271	15	30	Loamy Sand	8.9	8.2		5.9	1.6	170				0.3	1.3	<10																6	8	51	35	<1
13/4/22	SC2015	529566	6283271	30	60	Clay	8.3	8.2		3.7	<0.6	8700				2.36	7.0	30																35	5	51	9	2
13/4/22	SC2015	529566	6283271	60	100	Clay Loam	8.5	8.4		1.4	<0.6	9200				4.14	26.4	2000																30	15	46	9	1
13/4/22	SC2016	529691	6283126	0	15	Sandy Loam	7.8	7.6		3.6	1.1	840				0.66	3.6	72	7.2	0.8	0.62	0.81	<0.1	9.4	76%	8%	7%	9%	0%	9.0				9	4	33	55	<1
13/4/22	SC2016	529691	6283126	15	30	Sandy Loam	7.8	7.6		2.3	1.2	560				0.56	2.8	46	8.3	1	0.41	0.64	<0.1	10.4	80%	10%	4%	6%	0%	8.3				10	4	36	50	<1
13/4/22	SC2016	529691	6283126	30	60	Sandy Clay Loam	8.1	7.9		1.3	0.7	4000				2.47	8.7	85	150	2.2	0.28	1.4	<0.1	153.9	97%	1%	0%	1%	0%	68.2				30	5	32	33	3
13/4/22	SC2016	529691	6283126	60	100	Sandy Clay	8.3	8		1.4	0.8	4200				2.56	10.3	290	130	1.7	0.16	2	<0.1	133.9	97%	1%	0%	1%	0%	76.5				40	0	26	34	1
13/4/22	SC2017	531395	6282191	0	15	Sandy Loam	8.5	8.1		34	1.7	240				0.44	1.9	25																18	6	29	47	7
13/4/22	SC2017	531395	6282191	15	30	Sandy Clay Loam	8.5	8		23	0.8	260				0.51	2.6	97																26	7	23	43	13
13/4/22	SC2017	531395	6282191	30	60	Clay	9.3	8.3		6.8	0.6	140				0.75	5.2	510																33	6	26	35	24
13/4/22	SC2017	531395	6282191	60	100	Clay Loam	8.4	8.2		1.5	<0.6	6300				3.15	17.5	810																25	20	22	33	15

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
13/4/22	SC2018	531691	6282020	0	15	Sandy Loam	8.8	8.1		6.3	1.6	21				0.14	0.7	<10																12	7	32	48	1
13/4/22	SC2018	531691	6282020	15	30	Sandy Clay Loam	9	8.2		3.3	0.7	11				0.12	0.6	12																19	4	34	43	5
13/4/22	SC2018	531691	6282020	30	60	Clay Loam	9.3	8.1		10	0.6	26				0.24	1.3	75																32	9	27	33	12
13/4/22	SC2018	531691	6282020	60	100	Clay	10	8.7		13	1.2	28				0.63	3.9	380																41	11	21	26	29
13/4/22	SC2019	531695	6281567	0	15	Sandy Loam	8.6	8		14	2.5	62				0.2	0.9	11																11	9	35	45	1
13/4/22	SC2019	531695	6281567	15	30	Sandy Loam	8.7	8.1		30	1	54				0.18	1.0	34																19	9	36	37	5
13/4/22	SC2019	531695	6281567	30	60	Clay Loam	9.5	8.2		12	<0.6	35				0.23	1.1	41																29	8	29	35	18
13/4/22	SC2019	531695	6281567	60	100	Clay	9	8.3		1.4	1.3	750				0.83	3.7	130																36	9	25	31	24
13/4/22	SC2020	531972.8	6281386	0	15	Sandy Loam	8.8	8.1		6.3	2.5	19				0.12	0.6	<10																15	6	30	49	1
13/4/22	SC2020	531972.8	6281386	15	30	Sandy Loam	9	8.2		6.8	1.1	39				0.13	0.7	22																16	9	34	41	3
13/4/22	SC2020	531972.8	6281386	30	60	Sandy Clay Loam	9.2	8.3		7.2	<0.6	28				0.41	3.9	410																21	9	32	38	12
13/4/22	SC2020	531972.8	6281386	60	100	Clay	9.7	8.6		2.7	<0.6	230				0.94	7.4	900																34	9	25	33	21
13/4/22	SC2021	531509	6281231	0	15	Sandy Loam	9.1	8.3		8.3	0.8	8				0.11	0.6	<10																11	7	27	55	1
13/4/22	SC2021	531509	6281231	15	30	Sandy Loam	9	8.2		12	1	13				0.15	0.9	34																13	4	33	50	3
13/4/22	SC2021	531509	6281231	30	60	Sandy Clay Loam	9.5	8.4		17	1.1	16				0.34	2.4	180																23	4	31	43	12
13/4/22	SC2021	531509	6281231	60	100	Clay	9.9	8.6		2.3	1.1	130				0.78	5.1	440																32	8	24	37	25
13/4/22	SC2022	531012	6281255	0	15	Sandy Loam	8.9	8.1		2.4	1.1	10				0.11	0.5	10	23	1.6	0.65	0.2	<0.1	25.5	90%	6%	3%	1%	0%	14.4				12	6	34	48	4
13/4/22	SC2022	531012	6281255	15	30	Sandy Loam	9.1	8.2		1.7	0.7	10				0.22	1.9	150	24	2.6	0.92	0.93	<0.1	28.5	84%	9%	3%	3%	0%	9.2				16	5	36	44	8
13/4/22	SC2022	531012	6281255	30	60	Sandy Clay Loam	9.4	8.3		2	0.7	75				0.72	6.1	690	21	4.7	0.86	4	<0.1	30.6	69%	15%	3%	13%	0%	4.5				28	4	31	37	19
13/4/22	SC2022	531012	6281255	60	100	Clay	9.4	8.5		1.3	<0.6	340				0.9	7.7	1100	21	4.9	0.79	6	<0.1	32.7	64%	15%	2%	18%	0%	4.3				36	8	25	32	26
13/4/22	SC2023	531211	6280413	0	15	Sand	9.3	8.5		3.5	1.9	17				0.19	1.6	74																6	4	39	52	<1
13/4/22	SC2023	531211	6280413	15	30	Sandy Clay Loam	9.4	8.6		2.8	1.4	56				1.15	11.9	1400																22	3	35	41	<1
13/4/22	SC2023	531211	6280413	30	60	Sandy Clay Loam	9.3	8.7		3.6	1.2	190				2.03	20.2	2500																25	3	31	41	1
13/4/22	SC2023	531211	6280413	60	100	Sandy Clay Loam	8.8	8.6		1.5	0.7	1600				2.88	23.6	2100																22	4	31	43	3
13/4/22	SC2024	529890	6281614	0	15	Sandy Loam	8.8	8.1		3.3	0.9	23				0.37	4.1	460																18	8	23	51	11
13/4/22	SC2024	529890	6281614	15	30	Sandy Clay Loam	8.7	8.2		4.1	1.4	44				1.11	12.8	1700																23	6	27	44	18
13/4/22	SC2024	529890	6281614	30	60	Clay Loam	9.2	8.4		2.7	<0.6	250				1.32	13.8	1900																27	9	21	44	21
13/4/22	SC2024	529890	6281614	60	100	Clay	9.2	8.5		1.7	<0.6	360				1.84	15.3	2000																34	11	17	38	30
13/4/22	SC2025	529049	6279273	0	15	Sand	9	8.3		3.6	1.4	10				0.22	2.2	120																3	3	34	61	<1
13/4/22	SC2025	529049	6279273	15	30	Sandy Loam	9.4	8.7		1.9	0.7	64				0.74	7.3	540																10	3	33	54	<1
13/4/22	SC2025	529049	6279273	30	60	Sandy Loam	9.3	8.6		4	0.7	130				2	23.2	2600																17	8	29	47	1
13/4/22	SC2025	529049	6279273	60	100	Sandy Clay Loam	9.1	8.7		2.2	<0.6	1100				3.29	32.8	3600																21	5	20	55	5
13/4/22	SC2026	529784	6278038	0	15	Clay	8.4	8.3		9.9	1.7	7000				8.01	62.5	9800																45	5	46	4	<1
13/4/22	SC2026	529784	6278038	15	30	Clay	8.3	8.1		8.8	1	8900				7.58	51.8	8600																56	0	40	5	1
13/4/22	SC2026	529784	6278038	30	60	Clay	8.3	8.2		1.2	0.7	5700				8.76	58.9	8400																50	10	28	13	1
13/4/22	SC2026	529784	6278038	60	100	Clay Loam	8.1	8		0.6	<0.6	8200				11.1	87.9	11000																35	15	28	22	2
13/4/22	SC2027	529308	6278051	0	15	Clay	8.4	8.3		23	1.2	7800				11.03	88.5	16000																50	10	33	7	1
13/4/22	SC2027	529308	6278051	15	30	Sandy Clay	8.3	8.2		9.6	1.2	6700				7.53	56.7	8500																45	0	50	5	<1
13/4/22	SC2027	529308	6278051	30	60	Clay	8.2	8.2		4.2	<0.6	5400				5.23	35.7	4100																40	15	40	5	1
13/4/22	SC2027	529308	6278051	60	100	Clay	8.3	8.2		2.4	0.7	6100				9.57	66.3	11000																55	10	32	4	1
13/4/22	SC2028	529511	6278652	0	15	Sandy Loam	7.8	7.7		9.1	3	2400				6.62	70.7	7100	19	5.8	0.97	20	<0.1	45.8	42%	13%	2%	44%	0%	3.3				16	7	56	20	<1
13/4/22	SC2028	529511	6278652	15	30	Sandy Loam	8.1	8		8.4	2.6	5600				7.39	83.2	8500	40	8.6	1.4	28	<0.1	78.0	51%	11%	2%	36%	0%	4.7				15	10	54	21	1
13/4/22	SC2028	529511	6278652	30	60	Clay	8.5	8.4		4.1	0.7	5900				6.24	44.7	6100	140	5.8	0.41	20	<0.1	166.2	84%	3%	0%	12%	0%	24.1				44	15	35	6	1
13/4/22	SC2028	529511	6278652	60	100	Clay	8.3	8.2		2	<0.6	8300				5.37	34.0	3900	130	4	0.34	13	<0.1	147.3	88%	3%	0%	9%	0%	32.5				45	10	43	2	<1
13/4/22	SC2029	529658	6278830	0	15	Loam	7.9	7.8		7.4	3.4	7200				6.4	58.7	5500																19	16	54	11	2
13/4/22	SC2029	529658	6278830	15	30	Clay Loam	8.3	8.3		6.3	1.4	6900				5.45	52.8	7700																32	15	45	8	2
13/4/22	SC2029	529658	6278830	30	60	Clay	8.3	8.3		1.9	0.6	6900				6.23	43.7	5500																42	10	43	5	1
13/4/22	SC2029	529658	6278830	60	100	Clay	8.3	8.3		1.7	<0.6	7100				7.71	60.1	9000																43	10	44	4	<1
13/4/22	SC2030	533241	6280684	0	15	Sand	8.8	8.2		4.2	1.3	71				0.21	1.8	89																7	3	21	70	<1
13/4/22	SC2030	533241	6280684	15	30	Sand	9	8.3		1.8	1.2	16				0.11	1.0	51																7	0	20	73	<1
13/4/22	SC2030	533241	6280684	30	60	Sandy Loam	9.1	8.4		2	0.8	9				0.11	0.9	53																8	0	21	71	1
13/4/22	SC2030	533241	6280684	60	100	Sandy Loam	9.1	8.4		2.2	<0.6	25				0.21	1.2	28																11	1	27	62	3
13/4/22	SC2031	530646	6279768	0	15	Sandy Loam	8.9	8.1		3.8	1.8	6				0.09	0.5	<10																9	1	28	62	<1
13/4/22	SC2031	530646	6279768	15	30	Sandy Loam	9.1	7.8		1.6	0.8	2				0.05	0.3	<10																9	3	24	65	<1
13/4/22	SC2031	530646	6279768	30	60	Sandy Loam	9.1	8.4		2.7	0.7	19				0.14	0.7	<10																11	1	25	64	<1
13/4/22	SC2031	530646	6279768	60	100	Sandy Loam	9.1	8.4		2.9	0.8	6				0.18	0.8	12																13	1	30	56	1

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
13/4/22	SC2032	529927	6279149	0	15	Sandy Loam	8.3	8.2		15	3.9	1500				6.08	72.9	8400																17	8	36	40	1
13/4/22	SC2032	529927	6279149	15	30	Sandy Loam	8.4	8.3		14	2.6	6700				7.58	79.5	8100																17	10	43	30	3
13/4/22	SC2032	529927	6279149	30	60	Clay Loam	8.3	8.2		7.1	1.5	8000				5.52	43.5	5000																32	10	46	13	1
13/4/22	SC2032	529927	6279149	60	100	Clay	8.4	8.3		1.9	<0.6	7500				5.7	41.0	5500																43	10	36	11	1
13/4/22	SC2033	529972	6277400	0	15	Loamy Sand	8.6	8		4.9	1.5	260				0.34	2.7	120																6	8	48	39	<1
13/4/22	SC2033	529972	6277400	15	30	Sandy Clay Loam	8.3	8.2		3.9	1.6	830				1.7	10.7	580																21	6	40	33	1
13/4/22	SC2033	529972	6277400	30	60	Clay	8.3	8.2		3.5	1.1	5100				2.42	16.1	1500																34	6	29	31	2
13/4/22	SC2033	529972	6277400	60	100	Loam	8.5	8.4		1.1	1.5	9400				5.43	44.6	3100																15	15	34	36	1
13/4/22	SC2034	531015.1	6276569	0	15	Sandy Loam	8.8	8.2		4.3	1.4	51				0.25	2.6	210																11	8	44	37	2
13/4/22	SC2034	531015.1	6276569	15	30	Sandy Loam	8.6	8.2		6.7	1.5	160				1.5	17.1	1700																14	10	42	34	4
13/4/22	SC2034	531015.1	6276569	30	60	Sandy Loam	8.5	8.3		5	1.7	1400				3.03	33.8	3300																14	9	47	30	6
13/4/22	SC2034	531015.1	6276569	60	100	Loam	8.5	8.4		7.3	1.2	6300				5.15	47.2	3700																14	14	47	25	4
13/4/22	SC2035	531427	6276437	0	15	Clay	8.1	7.9		3.3	1.7	7800				2.26	7.1	49																37	5	33	25	4
13/4/22	SC2035	531427	6276437	15	30	Clay	8.3	8.2		3.2	2	10000				2.46	11.2	540																43	5	37	16	2
13/4/22	SC2035	531427	6276437	30	60	Clay	8.5	8.3		3.2	0.8	9100				4.13	24.2	2200																42	5	32	21	1
13/4/22	SC2035	531427	6276437	60	100	Sandy Clay	8.6	8.5		1.3	0.9	8200				3.48	20.0	1600																39	0	28	33	1
13/4/22	SC2036	531608	6277851	0	15	Loam	8.4	8.3		4.1	2.4	1400				12.31	147.6	17000																17	20	53	10	8
13/4/22	SC2036	531608	6277851	15	30	Loam	8.4	8.4		1.1	1.1	4900				8.94	92.9	11000																22	20	46	12	7
13/4/22	SC2036	531608	6277851	30	60	Loam	8.4	8.4		0.7	0.8	8500				7.99	89.0	8100																12	20	56	12	10
13/4/22	SC2036	531608	6277851	60	100	Loam	8.2	8.1		0.5	0.9	4000				8.34	97.5	11000																17	25	49	9	17
13/4/22	SC2037	532432	6278749	0	15	Clay	6.9	6.9		1.9	1.9	6500				4.36	26.9	3800																56	5	34	6	<1
13/4/22	SC2037	532432	6278749	15	30	Clay	7	7		0.7	1.8	6500				3.3	21.7	3000																50	5	43	1	<1
13/4/22	SC2037	532432	6278749	30	60	Clay	7.2	7.2		0.6	1.4	6900				5.1	32.6	3800																45	10	43	3	<1
13/4/22	SC2037	532432	6278749	60	100	Clay	8	7.9		0.6	0.7	7700				5.82	45.9	7300																45	5	42	8	<1
13/4/22	SC2038	531828	6280265	0	15	Silty Clay	8.2	8.1		5.1	2.3	5500				6.07	41.8	5500																45	35	17	3	4
13/4/22	SC2038	531828	6280265	15	30	Silty Clay	8.3	8.2		1.5	1.8	6200				4.21	29.3	4400																50	35	12	3	2
13/4/22	SC2038	531828	6280265	30	60	Clay	8.4	8.3		0.7	1.8	7100				4.67	35.8	5500																45	10	18	27	4
13/4/22	SC2038	531828	6280265	60	100	Sandy Clay Loam	8.5	8.4		<0.5	1.2	2200				5.2	57.0	7500																24	6	12	58	12
13/4/22	SC2039	532859	6279766	0	15	Loam	8.1	7.9		13	5.7	4300				1.63	8.3	290																24	21	49	5	3
13/4/22	SC2039	532859	6279766	15	30	Clay Loam	8	7.9		7.6	2.6	5500				3.18	18.3	1100																30	25	30	16	5
13/4/22	SC2039	532859	6279766	30	60	Silty Clay Loam	8.1	8.1		5.6	1.4	5900				3.51	22.1	2200																40	30	19	11	5
13/4/22	SC2039	532859	6279766	60	100	Clay	8.1	7.9		2.2	0.8	4800				3.11	16.5	1300																45	10	37	9	1
13/4/22	SC2040	535650	6279034	0	15	Sandy Clay Loam	8.5	8.1		2.5	1.7	650				0.51	2.1	32	25	1.2	0.87	0.27	<0.1	27.3	91%	4%	3%	1%	0%	20.8				21	4	21	54	6
13/4/22	SC2040	535650	6279034	15	30	Sandy Clay Loam	8.3	8		9.1	1	880				0.79	3.6	88	28	1.7	0.57	0.34	<0.1	30.6	91%	6%	2%	1%	0%	16.5				24	6	22	48	11
13/4/22	SC2040	535650	6279034	30	60	Clay Loam	8.1	8		4.5	0.8	4000				2.23	8.2	100	150	1.9	0.32	0.34	<0.1	152.6	98%	1%	0%	0%	0%	78.9				30	20	20	29	11
13/4/22	SC2040	535650	6279034	60	100	Clay Loam	8.3	7.9		10	0.7	470				0.81	3.7	110	31	2.4	0.44	0.23	<0.1	34.1	91%	7%	1%	1%	0%	12.9				30	8	20	43	16
13/4/22	SC2041	535536	6279087	0	15	Sandy Clay Loam	8.8	8.2		5.4	0.8	120				0.26	1.2	24																19	5	22	54	7
13/4/22	SC2041	535536	6279087	15	30	Sandy Clay Loam	8.3	7.9		11	0.9	420				0.6	3.0	100																24	6	22	48	12
13/4/22	SC2041	535536	6279087	30	60	Clay Loam	8.6	8.1		4.3	0.9	340				0.55	3.3	210																29	9	22	40	19
13/4/22	SC2041	535536	6279087	60	100	Clay	9.4	8.5		1.7	0.6	150				0.73	5.2	530																33	9	21	38	20
13/4/22	SC2042	534812	6278182	0	15	Clay Loam	8.9	8.2		4	1.6	92				0.22	0.8	<10																29	9	22	41	11
13/4/22	SC2042	534812	6278182	15	30	Clay	8.7	8.1		2.6	1.2	240				0.36	1.2	<10																34	11	23	31	16
13/4/22	SC2042	534812	6278182	30	60	Clay	9.7	8.1		1.1	0.7	47				0.36	1.1	<10																44	14	18	25	27
13/4/22	SC2042	534812	6278182	60	100	Clay	9.8	8.9		2.4	0.9	270				0.75	2.6	59																51	12	16	21	23
13/4/22	SC2043	536371	6278312	0	15	Sandy Clay Loam	8.7	8.1		4.4	1	110				0.29	1.3	27																24	6	23	47	8
13/4/22	SC2043	536371	6278312	15	30	Loam	8.9	8.2		16	1	85				0.4	3.4	250																16	19	23	42	12
13/4/22	SC2043	536371	6278312	30	60	Clay	9.2	8.4		9.1	0.7	230				0.95	6.9	730																34	9	20	38	18
13/4/22	SC2043	536371	6278312	60	100	Clay	9.4	8.6		1.8	<0.6	310				1.29	9.4	1100																37	12	17	33	30
13/4/22	SC2044	535543	6277307	0	15	Sandy Loam	8.9	8.1		3.8	0.9	33				0.14	0.7	<10																12	7	23	58	5
13/4/22	SC2044	535543	6277307	15	30	Sandy Loam	8.8	8.1		1.2	0.6	46				0.17	0.7	11																18	4	30	48	9
13/4/22	SC2044	535543	6277307	30	60	Sandy Clay Loam	9.1	8.2		1	<0.6	36				0.13	0.6	<10																23	5	28	44	13
13/4/22	SC2044	535543	6277307	60	100	Clay Loam	9.4	8.2		1.8	<0.6	81				0.22	0.9	12																27	7	25	41	19
13/4/22	SC2045	534412	6276849	0	15	Clay	8.5	8.2		77	3.3	66				2.35	21.6	3300																36	14	26	25	7
13/4/22	SC2045	534412	6276849	15	30	Clay	8.6	8.2		53	2.5	120				2.15	21.9	4400																44	15	24	17	16
13/4/22	SC2045	534412	6276849	30	60	Clay	9	8.4		29	1	130				2.93	23.8	4200																48	15	27	11	24
13/4/22	SC2045	534412	6276849	60	100	Silty Clay	8.6	8.3		21	0.7	860				4.02	28.8	4400																49	27	15	9	19

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
13/4/22	SC2046	534191	6276777	0	15	Clay	8.9	8.1		8.5	2.5	60				0.19	0.7	13																39	14	27	20	8
13/4/22	SC2046	534191	6276777	15	30	Clay	9.2	8.2		3.7	1	25				0.2	0.7	<10																42	15	26	17	10
13/4/22	SC2046	534191	6276777	30	60	Clay	9.6	8.2		1.9	<0.6	31				0.31	0.9	<10																52	15	21	12	25
13/4/22	SC2046	534191	6276777	60	100	Clay	9.6	8.2		1.2	0.7	180				0.56	1.6	10																53	14	20	13	24
13/4/22	SC2047	533828	6278132	0	15	Clay	8.3	8.1		12	1.4	7400				2.04	5.8	28	160	0.6	0.35	0.28	<0.1	161.2	99%	0%	0%	0%	0%	266.7				46	15	30	8	3
13/4/22	SC2047	533828	6278132	15	30	Clay	8.4	8.2		20	1	6700				0.99	5.5	520	150	1	0.55	2.2	<0.1	153.8	98%	1%	0%	1%	0%	150.0				47	20	22	11	2
13/4/22	SC2047	533828	6278132	30	60	Clay	8.8	8.7		6.1	<0.6	6600				3.83	19.5	1700	150	2.3	1	8.8	<0.1	162.1	93%	1%	1%	5%	0%	65.2				52	5	30	13	2
13/4/22	SC2047	533828	6278132	60	100	Clay	8.7	8.6		4.5	<0.6	10000				3.57	18.5	1200	150	2.7	0.58	8.5	<0.1	161.8	93%	2%	0%	5%	0%	55.6				40	5	47	8	1
13/4/22	SC2048	534927	6278563	0	15	Sandy Loam	9	8.2		4.7	1.3	180				0.1	0.5	<10																9	1	27	64	<1
13/4/22	SC2048	534927	6278563	15	30	Sandy Loam	9	8.3		3.4	<0.6	77				0.2	0.9	<10																10	3	32	55	1
13/4/22	SC2048	534927	6278563	30	60	Sandy Loam	9.4	8.5		6.9	<0.6	19				0.2	1.3	45																12	3	26	59	3
13/4/22	SC2048	534927	6278563	60	100	Sandy Loam	9.5	8.5		6	<0.6	60				0.32	2.6	180																15	3	21	62	5
13/4/22	SC2049	534915	6279666	0	15	Sandy Loam	9	8.2		5.4	1.4	13				0.15	0.7	<10																11	5	31	54	1
13/4/22	SC2049	534915	6279666	15	30	Sandy Loam	9.1	8.2		3.6	0.8	19				0.12	0.6	<10																12	4	36	49	3
13/4/22	SC2049	534915	6279666	30	60	Sandy Clay Loam	9.3	8.3		2.8	0.8	6				0.12	0.5	<10																24	5	25	45	10
13/4/22	SC2049	534915	6279666	60	100	Clay Loam	9.1	8.2		13	<0.6	12				0.35	2.0	120																29	7	26	38	20
13/4/22	SC2050	535046	6279890	0	15	Sandy Loam	9.8	8.8		5.9	1.5	8				0.26	1.5	51																16	8	29	47	1
13/4/22	SC2050	535046	6279890	15	30	Sandy Clay Loam	9.7	8.8		6.2	1	20				0.65	5.9	610																22	6	28	43	3
13/4/22	SC2050	535046	6279890	30	60	Clay	9	8.4		10	0.7	200				2.33	20.7	2900																34	7	23	37	12
13/4/22	SC2050	535046	6279890	60	100	Clay	9.1	8.5		2.5	<0.6	370				2.65	22.7	3300																37	9	27	28	27
13/4/22	SC2051	536931	6278672	0	15	Sandy Loam	9.1	8.3		6.7	1	8				0.1	0.5	<10																17	4	24	56	10
13/4/22	SC2051	536931	6278672	15	30	Sandy Clay Loam	9.1	8.1		12	0.8	12				0.12	0.5	<10																19	5	26	49	13
13/4/22	SC2051	536931	6278672	30	60	Sandy Clay Loam	9.2	8.2		43	0.9	11				0.25	1.8	130																24	8	25	44	21
13/4/22	SC2051	536931	6278672	60	100	Clay Loam	9.7	8.3		18	0.6	90				0.6	4.5	460																31	8	23	39	27
13/4/22	SC2052	521621	6285110	0	15	Sandy Clay Loam	9.3	8.5		5.9	1.7	6				0.12	0.5	<10																19	5	25	51	1
13/4/22	SC2052	521621	6285110	15	30	Sandy Clay Loam	9.2	8.4		8.5	1	13				0.37	3.0	290																24	5	26	46	2
13/4/22	SC2052	521621	6285110	30	60	Sandy Clay	9.3	8.5		6.2	1	38				1.06	8.8	1100																33	5	21	41	5
13/4/22	SC2052	521621	6285110	60	100	Clay	9.6	8.6		3.1	0.7	140				1.57	13.4	1800																34	6	19	40	8
13/4/22	SC2053	521332	6284890	0	15	Loamy Sand	9	8.2		5.5	0.7	7				0.12	0.6	<10																8	4	28	60	<1
13/4/22	SC2053	521332	6284890	15	30	Sandy Loam	9.4	8.6		7.1	1.1	4				0.18	0.9	19																16	3	30	52	1
13/4/22	SC2053	521332	6284890	30	60	Sandy Clay Loam	10	8.5		13	<0.6	9				0.28	1.4	55																25	5	18	51	9
13/4/22	SC2053	521332	6284890	60	100	Sandy Clay Loam	10.2	8.9		3.1	<0.6	19				0.33	2.3	150																21	3	24	53	8
13/4/22	SC2054	520671	6284808	0	15	Sandy Loam	9	8.2		4.2	1.1	4				0.1	0.5	10																13	5	29	53	2
13/4/22	SC2054	520671	6284808	15	30	Sandy Loam	9.1	8.4		3.4	1	7				0.09	0.5	12																14	6	35	44	4
13/4/22	SC2054	520671	6284808	30	60	Sandy Loam	9.4	8.4		5.5	0.9	3				0.15	0.6	<10																19	6	29	45	9
13/4/22	SC2054	520671	6284808	60	100	Sandy Clay Loam	10	8.6		3.8	<0.6	29				0.43	2.0	65																28	6	23	43	17
13/4/22	SC2055	520317	6283903	0	15	Sandy Loam	9	8.3		5.2	1	5				0.11	0.6	<10	19	1.4	1	0.11	<0.1	21.5	88%	7%	5%	1%	0%	13.6				9	3	28	61	2
13/4/22	SC2055	520317	6283903	15	30	Sandy Loam	9.3	8.4		3.7	0.9	4				0.09	0.5	<10	23	1.4	1.1	0.29	<0.1	25.8	89%	5%	4%	1%	0%	16.4				11	3	28	59	3
13/4/22	SC2055	520317	6283903	30	60	Sandy Loam	9.3	8.3		8.8	1.1	5				0.18	1.4	84	23	2.5	0.9	0.93	<0.1	27.3	84%	9%	3%	3%	0%	9.2				16	5	30	50	8
13/4/22	SC2055	520317	6283903	60	100	Sandy Clay Loam	9.8	8.2		5.5	<0.6	110				0.78	6.4	590	19	4.2	0.61	4.8	<0.1	28.6	66%	15%	2%	17%	0%	4.5				23	5	26	47	16
13/4/22	SC2056	518787	6283911	0	15	Sandy Clay Loam	9.1	8.2		4.9	1	8				0.23	2.0	180																21	5	24	50	10
13/4/22	SC2056	518787	6283911	15	30	Sandy Clay Loam	9.4	8.3		6.4	1.4	44				0.68	5.5	540																26	6	25	43	14
13/4/22	SC2056	518787	6283911	30	60	Sandy Clay	9.5	8.5		1.8	0.7	190				1.49	8.6	560																32	5	19	45	13
13/4/22	SC2056	518787	6283911	60	100	Sandy Clay	9.5	8.8		2.8	1.2	410				1.74	14.7	1800																31	4	19	46	5
13/4/22	SC2057	519779	6284874	0	15	Sandy Loam	9.1	8.2		8.2	1.2	9				0.15	1.0	41																15	6	29	51	8
13/4/22	SC2057	519779	6284874	15	30	Sandy Loam	8.9	8.2		15	1.5	42				0.41	3.9	380																19	8	31	43	12
13/4/22	SC2057	519779	6284874	30	60	Sandy Clay Loam	9.4	8.4		6	1	190				1.18	10.7	1300																28	6	26	40	21
13/4/22	SC2057	519779	6284874	60	100	Clay	9.5	8.6		3.1	1.2	410				1.33	10.8	1300																32	6	25	37	25
13/4/22	SC2058	519847	6286143	0	15	Clay	9.2	8.4		8.7	0.7	84				1.16	8.9	1200																39	9	25	28	13
13/4/22	SC2058	519847	6286143	15	30	Clay	9.1	8.4		6.1	0.7	310				1.26	10.7	1800																44	6	23	27	14
13/4/22	SC2058	519847	6286143	30	60	Clay Loam	8.2	8.1		2.2	0.8	6200				2.87	19.2	1700																32	24	29	15	6
13/4/22	SC2058	519847	6286143	60	100	Clay	8.3	8.2		1.5	1.4	11000				4.84	29.6	2800																40	15	26	18	5
13/4/22	SC2059	519815	6286485	0	15	Clay Loam	9	8.2		2.5	0.7	7				0.1	0.4	<10																29	9	16	46	4
13/4/22	SC2059	519815	6286485	15	30	Clay	9.2	8.2		2.3	0.7	7				0.11	0.4	<10																36	6	17	41	13
13/4/22	SC2059	519815	6286485	30	60	Clay	9.7	8.5		3.1	<0.6	28				0.33	1.2	20																39	7	16	38	18
13/4/22	SC2059	519815	6286485	60	100	Clay	9.8	9.3		1.3	0.9	210				1.11	6.5	620																44	10	18	28	18

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
13/4/22	SC2060	520088	6287202	0	15	Sandy Clay Loam	9.1	8.3		4.8	1.3	9				0.13	0.5	<10																26	4	19	51	3
13/4/22	SC2060	520088	6287202	15	30	Clay	8.9	8.2		3.7	0.7	52				0.18	0.7	18																40	6	27	28	4
13/4/22	SC2060	520088	6287202	30	60	Sandy Clay Loam	9.1	8.3		6.5	0.6	18				0.15	0.6	10																28	4	31	37	6
13/4/22	SC2060	520088	6287202	60	100	Clay	9.5	8.3		4.3	0.7	34				0.24	0.9	13																32	6	23	39	8
13/4/22	SC2061	521461	6287682	0	15	Sand	9.3	8.5		24	0.8	12				0.17	1.0	21																8	1	26	65	1
13/4/22	SC2061	521461	6287682	15	30	Sandy Loam	9	8.3		15	0.7	12				0.22	1.9	120																10	1	27	62	2
13/4/22	SC2061	521461	6287682	30	60	Sandy Loam	9.2	8.4		9.5	<0.6	14				0.47	4.9	420																12	4	25	59	6
13/4/22	SC2061	521461	6287682	60	100	Sandy Clay Loam	9.9	9		2.9	<0.6	180				0.98	8.5	880																24	4	19	53	14
10/5/22	SC2062	531326	6276005	0	15	Sandy Loam	8.4	7.9		4.1	1.3	41				0.16	0.7	<10																15	8	39	39	<1
10/5/22	SC2062	531326	6276005	15	30	Clay Loam	8.8	8		3	1	86				0.19	0.8	17																28	9	30	34	<1
10/5/22	SC2062	531326	6276005	30	60	Sandy Loam	8.1	8		20	1	3700				3.15	23.3	1300																14	11	47	28	9
10/5/22	SC2062	531326	6276005	60	100	Clay	8.4	8.2		2.3	1	6000				2.87	15.8	1800																56	5	22	18	8
10/5/22	SC2063	531327	6276096	0	15	Sandy Loam	8.4	7.3		5.5	1.1	94				0.24	1.9	110																13	8	43	38	<1
10/5/22	SC2063	531327	6276096	15	30	Loam	8.2	7.9		32	1.3	180				3.24	44.9	4900																12	12	54	21	1
10/5/22	SC2063	531327	6276096	30	60	Clay	8.3	8.3		6.9	1.2	6500				7.23	56.9	6700																33	8	38	21	4
10/5/22	SC2063	531327	6276096	60	100	Clay	8.4	8.1		2.3	1.4	6100				4.96	32.4	4300																49	8	26	17	5
10/5/22	SC2064	532690	6277189	0	15	Loam	8.4	8.3		8.6	2.9	6800				6.54	56.0	4800																19	19	48	15	2
10/5/22	SC2064	532690	6277189	15	30	Clay	8.5	8.4		7.1	0.8	9100				7.06	45.3	6400																53	4	29	14	1
10/5/22	SC2064	532690	6277189	30	60	Clay	8.4	8.4		2.2	0.8	8500				5.17	48.6	7600																36	8	36	20	1
10/5/22	SC2064	532690	6277189	60	100	Clay	8.4	8.3		0.6	0.9	9600				8.45	60.9	8400																44	8	28	20	2
10/5/22	SC2065	532817	6277756	0	15	Loam	8.9	8.8	0.4	11	1.1	9100	76	330	390	7.8	82.6	7400	100	15	0.78	28	<0.1	143.8	70%	10%	1%	19%	0%	6.7	0.38	2.3	1.2	13	15	53	20	3
10/5/22	SC2065	532817	6277756	15	30	Clay	8.7	8.6	0.3	10	1	9200	29	230	230	11.28	86.2	12000	120	15	0.55	43	<0.1	178.6	67%	8%	0%	24%	0%	8.0	0.37	2.3	0.5	41	8	42	9	2
10/5/22	SC2065	532817	6277756	30	60	Clay	8.4	8.3		3.3	1	7200				8.54	63.1	8800	130	11	0.24	30	<0.1	171.2	76%	6%	0%	18%	0%	11.8				43	4	40	13	1
10/5/22	SC2065	532817	6277756	60	100	Clay	8.3	8.2		1	1	9700				5.4	50.9	11000	110	15	0.72	39	<0.1	164.7	67%	9%	0%	24%	0%	7.3				51	8	26	15	2
10/5/22	SC2066	532823	6278973	0	15	Clay	8.5	8.4		1.6	1	3800				2.48	9.9	500																60	4	28	8	<1
10/5/22	SC2066	532823	6278973	15	30	Sandy Clay	8.3	8.2		3	1	4600				5.23	33.7	4400																49	0	31	20	<1
10/5/22	SC2066	532823	6278973	30	60	Clay	8.6	8.5		1.1	1.1	4000				7.53	53.2	8000																49	4	32	15	2
10/5/22	SC2066	532823	6278973	60	100	Clay	8.7	8.6		0.8	1	5700				7.12	46.2	6100																49	8	21	22	1
10/5/22	SC2067	534198	6279376	0	15	Sandy Clay Loam	9	8.2	0.6	5.3	1.1	63	16	59	140	0.26	1.2	29	27	1.4	1.5	0.53	<0.1	30.4	89%	5%	5%	2%	0%	19.3	0.66	3.2	2	22	7	24	46	10
10/5/22	SC2067	534198	6279376	15	30	Clay Loam	8.4	8	0.4	53	1.1	53	7	23	210	1.22	11.1	1400	28	1.9	1.1	2.9	<0.1	33.9	83%	6%	3%	9%	0%	14.7	0.98	2.7	2.3	29	9	22	41	8
10/5/22	SC2067	534198	6279376	30	60	Clay	8.5	8.2		9.7	0.9	360				1.78	16.1	2600	28	4.1	0.25	6.3	<0.1	38.7	72%	11%	1%	16%	0%	6.8				39	9	23	30	27
10/5/22	SC2067	534198	6279376	60	100	Clay	8.5	8.4		2.6	0.9	5400				3.4	16.8	1200	140	2.3	0.09	4.3	<0.1	146.7	95%	2%	0%	3%	0%	60.9				48	8	20	23	14
10/5/22	SC2068	534655	6276852	0	15	Sandy Loam	8.5	8.1	0.4	2.4	1	310	9	63	200	0.49	1.7	<10	27	1.1	1.2	0.3	<0.1	29.6	91%	4%	4%	1%	0%	24.5	0.64	2.7	2.1	19	5	18	59	5
10/5/22	SC2068	534655	6276852	15	30	Sandy Clay Loam	8.6	8	0.3	16	1	250	<5	41	270	0.54	2.0	18	29	0.9	0.85	0.74	<0.1	31.5	92%	3%	3%	2%	0%	32.2	0.97	3.1	2	24	5	18	54	9
10/5/22	SC2068	534655	6276852	30	60	Sandy Clay	8.1	7.8		11	1.3	5100				2.29	7.3	66	140	1.1	0.41	0.42	<0.1	141.9	99%	1%	0%	0%	0%	127.3				40	0	26	34	10
10/5/22	SC2068	534655	6276852	60	100	Sandy Clay	8.4	8.2		3.1	1	5100				2.24	7.8	150	130	1.2	0.28	0.61	<0.1	132.1	98%	1%	0%	0%	0%	108.3				48	0	12	40	3
10/5/22	SC2069	536544	6276493	0	15	Sand	9	8.3	<0.2	2.5	1	13	6	12	44	0.09	0.5	<10	4.4	1.2	0.65	0.21	<0.1	6.5	68%	19%	10%	3%	0%	3.7	0.3	2.6	1.8	8	3	24	66	<1
10/5/22	SC2069	536544	6276493	15	30	Sandy Loam	9.6	8.7	0.2	3.2	0.8	68	<5	9	52	0.27	1.1	<10	7.8	2.8	0.72	1.9	<0.1	13.2	59%	21%	5%	14%	0%	2.8	0.81	4	1.3	17	3	25	55	<1
10/5/22	SC2069	536544	6276493	30	60	Sandy Clay Loam	9.9	9		13	1.4	45				0.68	4.6	280	18	5.2	0.6	5	<0.1	28.8	63%	18%	2%	17%	0%	3.5				20	3	16	61	2
10/5/22	SC2069	536544	6276493	60	100	Sandy Clay Loam	9.3	8.6		2.8	0.9	330				0.98	7.4	540	25	5.3	0.54	5.4	<0.1	36.2	69%	15%	1%	15%	0%	4.7				20	3	20	57	7
10/5/22	SC2070	520420	6284594	0	15	Sandy Loam	9.1	8.3	0.4	3.3	1.2	28	17	61	110	0.15	0.7	<10	26	2.4	1.3	0.47	<0.1	30.2	86%	8%	4%	2%	0%	10.8	0.7	3	1.9	14	6	31	49	3
10/5/22	SC2070	520420	6284594	15	30	Sandy Clay Loam	9.3	8.3	0.2	2.7	0.8	16	8	47	140	0.17	0.7	<10	26	3.4	0.79	1.1	<0.1	31.3	83%	11%	3%	4%	0%	7.6	0.97	3.8	1.3	20	5	28	47	6
10/5/22	SC2070	520420	6284594	30	60	Sandy Clay Loam	9.5	8.5		16	1.2	120				0.81	6.0	580	23	5.3	0.51	5	<0.1	33.8	68%	16%	2%	15%	0%	4.3				30	6	24	40	17
10/5/22	SC2070	520420	6284594	60	100	Clay	9.7	8.8		2.7	0.8	250				1.09	6.5	590	24	7.1	0.43	8.9	<0.1	40.4	59%	18%	1%	22%	0%	3.4				40	6	17	37	18
10/5/22	SC2071	519950	6287523	0	15	Clay	9.5	8.8	0.2	16	0.9	530	<5	<5	150	2.01	12.6	1500	21	7.1	0.75	14	<0.1	42.9	49%	17%	2%	33%	0%	3.0	1.3	5.3	0.5	47	9	14	30	23
10/5/22	SC2071	519950	6287523	15	30	Clay	9.5	9.1	0.2	22	1.1	900	<5	<5	120	3.45	23.2	3300	21	9.5	0.74	21	<0.1	52.2	40%	18%	1%	40%	0%	2.2	0.75	7	0.3	50	5	15	30	17
10/5/22	SC2071	519950	6287523	30	60	Clay	9.3	8.6		20	1.1	740				3.48	24.4	3700	20	11	0.9	24	<0.1	55.9	36%	20%	2%	43%	0%	1.8				50	4	13	34	8
10/5/22	SC2071	519950	6287523	60	100	Clay	9.1	8.7		24	1.1	610				3.93	28.7	4700	19	12	1	26	<0.1	58.0	33%	21%	2%	45%	0%	1.6				51	3	15	32	3
10/5/22	SC2072	521975	6287726	0	15	Sandy Loam	9.2	8.2		2.9	1.1	3				0.1	0.5	<10																11	5	22	61	4
10/5/22	SC2072	521975	6287726	15	30	Sandy Loam	9.1	8.2		6.3	1	10				0.28	2.6	220																16	4	22	59	7
10/5/22	SC2072	521975	6287726	30	60	Clay Loam	9.4	8.5		11	0.7	170				1.19	9.7	1100																30	7	19	44	22
10/5/22	SC2072	521975	6287726	60	100	Clay	9.7	8.6		5.5	0.7	180				1.08	8.5	950																31	6	20	43	20
10/5/22	SC2073	521501	6287034	0	15	Sandy Loam	9.1	8.4		2.7	1.1	7				0.09	0.5	<10																9	0	20	71	<1
10/5/22	SC2073	521501	6287034	15	30	Sandy Loam	9.3	8.4		2.3	0.8	6				0.08	0.4	<10																10	0	17	73	<1
10/5/22	SC2073	521501	6287034	30	60	Sandy Loam	9	8.4		7.8	0.9	13				0.31	1.3	14																15	0	16	69	3
10/5/22	SC2073	521501	6287034	60	100	Sandy Loam	9.9	8.7		6.4	1	15				0.38	3.3	240																15	1	16	69	3

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
10/5/22	SC2074	529070	6282348	0	15	Sand	8.3	7.5	0.2	1.6	1.4	4	6	12	18	0.05	0.3	<10	2.3	0.5	0.32	0.06	<0.1	3.2	72%	16%	10%	2%	0%	4.6	0.18	3.1	1.6	6	1	17	76	<1
10/5/22	SC2074	529070	6282348	15	30	Sand	8.6	7.4	<0.2	0.7	0.8	2	<5	7	21	0.03	0.2	<10	2.4	0.6	0.39	0.06	<0.1	3.5	70%	17%	11%	2%		4.0	0.21	3.1	1.4	5	3	18	75	<1
10/5/22	SC2074	529070	6282348	30	60	Sand	9	7.8		0.9	1	<1				0.03	0.2	<10	2.3	0.5	0.31	0.26	<0.1	3.4	68%	15%	9%	8%	0%	4.6				3	1	19	78	<1
10/5/22	SC2074	529070	6282348	60	100	Sand	9.4	8.5		4.1	0.9	5				0.09	0.6	19	7.8	0.7	0.22	0.29	<0.1	9.0	87%	8%	2%	3%	0%	11.1				5	0	17	78	<1
10/5/22	SC2075	529338	6282739	0	15	Sand	8.2	7.3		3.1	1.3	4				0.06	0.4	<10																5	3	23	70	<1
10/5/22	SC2075	529338	6282739	15	30	Sand	7.8	6.9		1.3	1.5	3				0.03	0.2	<10																6	1	18	75	<1
10/5/22	SC2075	529338	6282739	30	60	Sand	8.1	7.1		1	0.9	4				0.03	0.4	35																5	0	22	74	<1
10/5/22	SC2075	529338	6282739	60	100	Sand	9.7	8.3		1.4	0.9	16				0.21	2.1	150																8	1	23	68	<1
10/5/22	SC2076	529108	6281781	0	15	Sandy Loam	9.3	8.2		4.2	1.1	4				0.1	0.5	<10																17	9	25	49	9
10/5/22	SC2076	529108	6281781	15	30	Clay Loam	9.4	8.2		5.6	1.3	7				0.15	0.6	<10																27	9	23	41	16
10/5/22	SC2076	529108	6281781	30	60	Clay	9.9	8.3		7.7	1.2	6				0.32	1.7	92																34	11	21	35	25
10/5/22	SC2076	529108	6281781	60	100	Clay	10	8.6		1.6	0.9	29				0.67	4.3	420																37	11	20	32	23
10/5/22	SC2077	530080	6279014	0	15	Sandy Loam	8.2	7.9		2.4	1.4	660				1.32	10.0	490																10	9	53	28	<1
10/5/22	SC2077	530080	6279014	15	30	Clay Loam	8.6	8.5		4.3	1	3800				9.19	79.9	9300																28	14	46	12	3
10/5/22	SC2077	530080	6279014	30	60	Clay	8.7	8.6		2	1.2	6200				6.79	48.2	7300																49	4	23	24	2
10/5/22	SC2077	530080	6279014	60	100	Clay	8.5	8.4		0.8	1.1	6900				4.67	35.5	5900																49	8	23	20	1
10/5/22	SC2078	529670	6276293	0	15	Sandy Loam	8.1	7.8		3.7	1.4	180				0.41	2.1	35																10	3	21	66	<1
10/5/22	SC2078	529670	6276293	15	30	Sandy Loam	8.5	7.9		1.2	1.6	210				0.23	1.0	<10																10	4	20	67	<1
10/5/22	SC2078	529670	6276293	30	60	Sandy Loam	8.9	8.1		2.1	0.9	27				0.12	0.6	<10																14	3	21	63	2
10/5/22	SC2078	529670	6276293	60	100	Sandy Loam	8.6	8.2		5.8	0.9	220				0.4	1.7	19																17	4	21	58	6
10/5/22	SC2079	530136	6275837	0	15	Sandy Loam	9.3	8.3	0.3	2.4	1.3	9	10	120	140	0.1	0.5	<10	24	1.1	0.95	0.22	<0.1	26.3	91%	4%	4%	1%	0%	21.8	0.62	2.7	2.5	12	3	19	66	3
10/5/22	SC2079	530136	6275837	15	30	Sandy Loam	9.2	8.2	0.3	2.6	0.8	9	8	120	370	0.11	0.5	<10	25	1.2	0.5	0.35	<0.1	27.1	92%	4%	2%	1%	0%	20.8	1	2.8	2.2	16	3	21	61	7
10/5/22	SC2079	530136	6275837	30	60	Sandy Clay Loam	9	8.2		22	1	10				0.14	0.7	24	24	2.5	0.51	0.43	<0.1	27.4	87%	9%	2%	2%	0%	9.6				20	4	21	55	10
10/5/22	SC2079	530136	6275837	60	100	Sandy Clay Loam	9.7	8.3		6	1	9				0.21	1.2	66	21	4.3	0.74	1	<0.1	27.0	78%	16%	3%	4%	0%	4.9				24	5	22	50	13
10/5/22	SC2080	539701	6277015	0	15	Sandy Loam	9.1	8.2		2.8	1.1	5				0.09	0.5	<10																15	4	29	53	4
10/5/22	SC2080	539701	6277015	15	30	Sandy Clay Loam	9.1	8.1		8.1	1.2	4				0.11	0.5	<10																23	4	28	46	9
10/5/22	SC2080	539701	6277015	30	60	Sandy Clay	9.5	8.2		4.8	1.2	12				0.18	1.0	60																30	4	24	43	17
10/5/22	SC2080	539701	6277015	60	100	Clay Loam	9.9	8.3		5.5	0.7	76				0.71	5.4	580																31	6	21	42	20
10/5/22	SC2081	531488	6281073	0	15	Sand	8.5	7.6		2	1.2	14				0.05	0.3	<10																7	4	27	62	<1
10/5/22	SC2081	531488	6281073	15	30	Sandy Loam	8.8	8.2		2	1.1	43				0.1	0.5	<10																10	3	34	53	<1
10/5/22	SC2081	531488	6281073	30	60	Sandy Loam	9.1	8.3		3.7	0.8	9				0.1	0.5	<10																11	3	31	55	1
10/5/22	SC2081	531488	6281073	60	100	Sandy Loam	9.7	8.6		4.4	0.8	26				0.34	2.8	170																11	5	30	54	7
10/5/22	SC2082	531838	6281224	0	15	Sandy Loam	8.8	7.9		1.5	1.7	8				0.11	0.6	<10																11	4	31	55	<1
10/5/22	SC2082	531838	6281224	15	30	Sandy Loam	9.1	8.1		3.4	1.6	5				0.13	0.6	11																14	5	33	48	2
10/5/22	SC2082	531838	6281224	30	60	Sandy Loam	9.3	8.4		7.3	1.9	18				0.5	5.1	460																14	5	33	48	8
10/5/22	SC2082	531838	6281224	60	100	Sandy Clay Loam	8.9	8.3		2	1.2	660				0.99	8.5	910																26	5	23	46	13
19/5/22	SC2083	528830	6280450	0	15	Sandy Loam	9.2	8.3		1.3	1.1	4				0.09	0.5	<10																13	4	20	64	2
19/5/22	SC2083	528830	6280450	15	30	Sandy Loam	9.4	8.3		1.7	1	9				0.13	0.7	20																16	4	29	51	6
19/5/22	SC2083	528830	6280450	30	60	Sandy Clay Loam	9.3	8.4		4.5	1	50				0.69	7.0	820																22	4	23	51	10
19/5/22	SC2083	528830	6280450	60	100	Sandy Clay Loam	9.4	8.5		0.9	0.9	190				0.92	7.4	750																27	5	22	46	15
19/5/22	SC2084	528831	6280005	0	15	Sandy Loam	9.1	8.2		1.9	1	17				0.12	0.5	<10																19	6	25	51	10
19/5/22	SC2084	528831	6280005	15	30	Sandy Clay Loam	9.3	8.3		7.4	1.1	14				0.18	1.0	48																23	7	26	43	12
19/5/22	SC2084	528831	6280005	30	60	Clay Loam	9	8.4		46	1	90				1.56	14.6	1900																29	8	22	42	18
19/5/22	SC2084	528831	6280005	60	100	Clay	9	8.7		13	0.9	570				2.26	16.8	2100																38	8	20	35	25
19/5/22	SC2085	530828	6282278	0	15	Sandy Clay Loam	9.2	8.1		1.8	0.8	6				0.1	0.5	<10																22	5	24	49	11
19/5/22	SC2085	530828	6282278	15	30	Clay Loam	9.1	8.2		17	0.8	16				0.49	4.1	480																29	8	23	41	18
19/5/22	SC2085	530828	6282278	30	60	Clay	9.6	8.4		4.3	0.8	99				0.84	6.6	790																34	8	20	39	24
19/5/22	SC2085	530828	6282278	60	100	Clay	9.6	8.6		1.5	0.7	210				1.17	9.2	1100																34	9	19	39	21
16/11/2023	SC2090	531072	6275727	0	15	Loamy Sand	8.5	7.7	0.3	2.2	0.8	30	11	21	32	0.14	0.7	<10	4.5	0.7	0.65	0.08	<0.1	5.9	76%	12%	11%	1%	0%	6.4	0.5	4.4	4.1	3	6	37	54	<1
16/11/2023	SC2090	531072	6275727	15	30	Loamy Sand	8.7	7.9	0.2	0.9	<0.6	26	6	15	29	0.11	0.6	<10	6	0.8	0.54	0.11	<0.1	7.5	81%	11%	7%	1%	0%	7.5	0.68	3.2	2.6	3	8	36	54	<1
16/11/2023	SC2090	531072	6275727	30	60	Sandy Loam	8.6	8		<0.5	<0.6	160				0.27	1.1	<10	22	1.4	0.47	0.1	<0.1	24.0	92%	6%	2%	0%	0%	15.7				13	1	32	54	2
16/11/2023	SC2090	531072	6275727	60	100	Loamy Sand	8.2	8		0.6	<0.6	5100				2.19	7.1	<10	85	1.7	0.4	0.09	<0.1	87.2	97%	2%	0%	0%	0%	50.0				7	14	28	51	7
16/11/2023	SC2091	531230	6275393	0	15	Loamy Sand	8.8	8	0.6	1.4	0.7	9	11	24	59	0.12	0.6	<10	13	1.2	1.1	0.28	<0.1	15.6	83%	8%	7%	2%	0%	10.8	0.67	3.5	4.2	5	11	28	56	1
16/11/2023	SC2091	531230	6275393	15	30	Sandy Loam	9.1	8.2	0.5	0.7	0.6	9	7	24	87	0.13	0.7	18	22	1.3	0.87	0.37	<0.1	24.5	90%	5%	4%	2%	0%	16.9	0.91	2.7	3.5	12	5	25	58	2
16/11/2023	SC2091	531230	6275393	30	60	Sandy Loam	9.3	8.2		1.1	<0.6	11				0.13	0.6	<10	25	1.9	0.8	0.61	<0.1	28.3	88%	7%	3%	2%	0%	13.2				16	5	25	54	6
16/11/2023	SC2091	531230	6275393	60	100	Sandy Clay Loam	9.4	8.2		0.8	<0.6	26				0.33	2.8	270	23	3.2	0.54	1.8	<0.1	28.5	81%	11%	2%	6%	0%	7.2				24	6	25	44	16

Laboratory results from soil samples collected from Copi Mineral Sands Project from 2020 to 2023

Date	SiteID	Easting	Northing	Upper_depth	Lower_depth	Texture	pH_Water	pH_CaCl2	Organic_Carbon_(%)	Nitrate_(ppm)	Ammonium Nitrogen	Sulfate_KCl_(ppm)	P_Colwell_(ppm)	Phosphorus - BSES	Phosphorus Buffer Index	EC_1:5_dS/m	ShawECe	Cl_(ppm)	Ex_Ca	Ex_Mg	Ex_K	Ex_Na	ExAl	E.C.E.C.	ECaP	EMgP	EKP	ESP	EAlP	Ca/Mg	Cu_DTPA	Fe_DTPA	Mn_DTPA	LabClay	Silt	Fine_Sand	Coarse_Sand	Calcium Carbonate
16/11/2023	SC2092	531048	6274832	0	15	Sandy Clay Loam	9.2	8.1	0.6	0.8	1.4	12	8	14	190	0.13	0.6	<10	25	1.7	1.2	0.43	<0.1	28.3	88%	6%	4%	2%	0%	14.7	0.9	3.2	3.1	21	7	26	45	9
16/11/2023	SC2092	531048	6274832	15	30	Sandy Clay Loam	9.8	8.3	0.4	0.6	<0.6	11	<5	<5	290	0.26	1.3	46	25	2.8	0.89	2.3	<0.1	31.0	81%	9%	3%	7%	0%	8.9	1.1	2.9	1.7	25	8	29	38	17
16/11/2023	SC2092	531048	6274832	30	60	Clay	9.7	8.4		0.8	0.8	150				0.89	6.6	740	22	4	0.63	6.2	<0.1	32.8	67%	12%	2%	19%	0%	5.5				35	8	22	36	25
16/11/2023	SC2092	531048	6274832	60	100	Clay	8.6	8.3		0.8	<0.6	1700				2.54	16.1	1500	34	4.3	0.57	9.2	<0.1	48.1	71%	9%	1%	19%	0%	7.9				37	5	22	36	29
16/11/2023	SC2093	530434	6274687	0	15	Loamy Sand	8.9	8	0.3	1	<0.6	5	<5	13	52	0.12	0.6	<10	22	1.6	1.1	0.29	<0.1	25.0	88%	6%	4%	1%	0%	13.8	0.95	2.7	3.3	8	10	31	52	2
16/11/2023	SC2093	530434	6274687	15	30	Sandy Clay Loam	9.4	8.3	0.2	0.7	<0.6	5	<5	<5	360	0.15	0.9	35	25	2.9	0.55	0.98	<0.1	29.4	85%	10%	2%	3%	0%	8.6	1.3	3.4	2.1	20	6	28	46	8
16/11/2023	SC2093	530434	6274687	30	60	Clay	9.2	8.6		1.3	<0.6	330				1.34	10.2	1200	22	3.7	0.49	6.9	<0.1	33.1	66%	11%	1%	21%	0%	5.9				35	5	26	35	22
16/11/2023	SC2093	530434	6274687	60	100	Sandy Clay Loam	9.4	8.3		0.9	<0.6	72				0.55	4.7	480	21	3.5	0.46	3.4	<0.1	28.4	74%	12%	2%	12%	0%	6.0				25	5	24	46	14
16/11/2023	SC2094	530129	6274805	0	15	Loamy Sand	8.9	8.1	0.4	1.1	<0.6	3	8	33	34	0.1	0.6	10	15	1.3	0.89	0.18	<0.1	17.4	86%	7%	5%	1%	0%	11.5	0.68	2.9	3.8	3	11	27	59	1
16/11/2023	SC2094	530129	6274805	15	30	Sandy Loam	9.3	8.3	0.3	0.9	<0.6	2	6	26	140	0.13	0.7	15	22	1.7	0.84	0.52	<0.1	25.1	88%	7%	3%	2%	0%	12.9	1.1	1.5	2.1	10	5	27	58	4
16/11/2023	SC2094	530129	6274805	30	60	Sandy Clay Loam	9.9	8.6		0.7	<0.6	6				0.22	1.0	14	21	2.6	0.56	1.7	<0.1	25.9	81%	10%	2%	7%	0%	8.1				18	1	27	54	9
16/11/2023	SC2094	530129	6274805	60	100	Sandy Clay Loam	9.9	8.3		0.8	<0.6	66				0.54	4.0	340	19	3.3	0.47	3.8	<0.1	26.6	72%	12%	2%	14%	0%	5.8				25	5	25	45	18
16/11/2023	SC2095	533347	6275670	0	15	Sand	8.9	8.1	0.2	0.9	0.7	6	5	9	17	0.09	0.5	<10	6.7	0.6	0.55	0.06	<0.1	7.9	85%	8%	7%	1%	0%	11.2	0.43	1.5	2.4	5	5	28	62	<1
16/11/2023	SC2095	533347	6275670	15	30	Loamy Sand	9.1	8.2	0.2	<0.5	<0.6	5	<5	15	150	0.09	0.5	12	21	1	0.42	0.1	<0.1	22.5	93%	4%	2%	0%	0%	21.0	0.52	1.9	2.5	7	5	27	61	2
16/11/2023	SC2095	533347	6275670	30	60	Sandy Loam	9.1	8.2		<0.5	<0.6	12				0.1	0.5	<10	21	1.3	0.47	0.06	<0.1	22.8	92%	6%	2%	0%	0%	16.2				10	3	27	60	3
16/11/2023	SC2095	533347	6275670	60	100	Loamy Sand	8.2	8		<0.5	<0.6	5800				2.25	7.2	<10	90	1.5	0.66	0.23	<0.1	92.4	97%	2%	1%	0%	0%	60.0				8	14	31	48	6
16/11/2023	SC2096	532674	6272835	0	15	Sandy Clay Loam	9.2	8.1	0.5	1.8	1	27	7	14	190	0.18	0.8	15	25	2.3	1.4	0.89	<0.1	29.6	84%	8%	5%	3%	0%	10.9	1.2	3.1	3.8	22	9	26	43	9
16/11/2023	SC2096	532674	6272835	15	30	Clay Loam	9.7	8.3	0.3	1.4	<0.6	29	7	<5	200	0.49	3.6	350	23	4.3	1.1	3.5	<0.1	31.9	72%	13%	3%	11%	0%	5.3	1.7	4	2.3	31	9	22	39	17
16/11/2023	SC2096	532674	6272835	30	60	Clay	9.4	9.1		2.2	<0.6	260				1.39	10.5	1300	22	5.7	0.81	8.2	<0.1	36.7	60%	16%	2%	22%	0%	3.9				37	12	22	29	32
16/11/2023	SC2096	532674	6272835	60	100	Clay	9	8.6		2.9	<0.6	570				2.01	14.2	1800	22	7.3	0.76	10	<0.1	40.1	55%	18%	2%	25%	0%	3.0				42	11	21	26	25
16/11/2023	SC2097	533273	6274335	0	15	Sand	8.1	7.8	0.5	4.2	1	1000	15	200	130	1.23	4.3	<10	29	0.6	0.73	0.26	<0.1	30.6	95%	2%	2%	1%	0%	48.3	0.5	2.7	3.7	8	3	28	62	3
16/11/2023	SC2097	533273	6274335	15	30	Loamy Sand	8.1	7.9	0.4	3.6	<0.6	5600	9	140	700	2.19	8.3	28	85	0.4	0.36	0.29	<0.1	86.1	99%	0%	0%	0%	0%	212.5	0.49	0.9	1.2	5	8	33	55	8
16/11/2023	SC2097	533273	6274335	30	60	Sandy Loam	8.2	7.9		7.1	<0.6	6000				2.21	7.8	25	86	0.6	0.23	0.2	<0.1	87.0	99%	1%	0%	0%	0%	143.3				11	10	37	42	4
16/11/2023	SC2097	533273	6274335	60	100	Loamy Sand	8.4	8.2		11	<0.6	5900				2.23	9.6	65	91	1.1	0.34	0.28	<0.1	92.7	98%	1%	0%	0%	0%	82.7				6	8	27	59	3
16/11/2023	SC2098	533026	6274608	0	15	Sandy Loam	8.2	7.9	0.3	9.8	4.1	680	11	24	46	3.98	46.6	4600	5.2	6.2	1.3	20	<0.1	32.7	16%	19%	4%	61%	0%	0.8	0.26	2.5	1.9	13	11	49	27	<1
16/11/2023	SC2098	533026	6274608	15	30	Loamy Sand	8.4	8.2	0.5	21	3.3	5500	17	70	310	9.41	119.7	11000	61	12	1.6	41	<0.1	115.6	53%	10%	1%	35%	0%	5.1	0.58	2.5	0.6	9	12	48	31	7
16/11/2023	SC2098	533026	6274608	30	60	Silty Loam	8.6	8.4		13	0.8	6500				8.41	128.9	14000	88	10	0.88	38	<0.1	136.9	64%	7%	1%	28%	0%	8.8				10	28	41	22	7
16/11/2023	SC2098	533026	6274608	60	100	Silty Loam	8.5	8.4		5.5	<0.6	6900				9.82	120.6	12000	93	12	1.4	45	<0.1	151.4	61%	8%	1%	30%	0%	7.8				12	37	32	19	8
16/11/2023	SC2099	537330	6278749	0	15	Sandy Clay Loam	9.1	8.1	0.4	6.9	0.7	67	13	32	170	0.25	1.1	19	24	1.5	1.1	1.1	<0.1	27.7	87%	5%	4%	4%	0%	16.0	0.86	4.1	3.5	21	9	24	46	11
16/11/2023	SC2099	537330	6278749	15	30	Clay Loam	9.2	8.1	0.4	7.6	<0.6	32	9	<5	390	0.19	0.9	27	26	2.7	0.6	0.97	<0.1	30.3	86%	9%	2%	3%	0%	9.6	1.2	3.5	2.2	25	10	25	40	20
16/11/2023	SC2099	537330	6278749	30	60	Clay Loam	9.7	8.3		3.8	<0.6	13				0.19	0.7	15	25	4.7	0.32	1.4	<0.1	31.4	80%	15%	1%	4%	0%	5.3				34	14	20	33	31
16/11/2023	SC2099	537330	6278749	60	100	Clay	10	8.9		1.4	<0.6	39				0.43	1.9	68	24	7.6	0.39	4.5	<0.1	36.5	66%	21%	1%	12%	0%	3.2				37	9	19	35	20
16/11/2023	SC2100	537409	6279547	0	15	Sandy Loam	8.3	7.8	0.2	<0.5	0.8	260	5	13	35	0.57	2.2	<10	12	1.2	0.69	0.12	<0.1	14.0	86%	9%	5%	1%	0%	10.0	0.53	2.9	2.2	10	3	25	63	<1
16/11/2023	SC2100	537409	6279547	15	30	Sandy Loam	9.2	8.3	<0.2	0.5	<0.6	9	<5	18	66	0.11	0.5	<10	21	2	0.66	0.34	<0.1	24.0	88%	8%	3%	1%	0%	10.5	0.67	2.6	1.8	12	1	27	60	2
16/11/2023	SC2100	537409	6279547	30	60	Sandy Loam	9.7	8.5		<0.5	<0.6	5				0.18	0.8	14	22	3.1	0.5	1.2	<0.1	26.8	82%	12%	2%	4%	0%	7.1				17	3	22	59	7
16/11/2023	SC2100	537409	6279547	60	100	Sandy Loam	9.9	8.6		<0.5	<0.6	9				0.23	1.0	17	21	3.5	0.38	1.6	<0.1	26.5	79%	13%	1%	6%	0%	6.0				19	6	22	53	16
16/11/2023	SC2101	537949	6279950	0	15	Clay Loam	9	8.2	0.3	5.1	1	190	7	19	100	0.62	4.0	310	27	6.4	1.2	4.8	<0.1	39.4	69%	16%	3%	12%	0%	4.2	1	5.7	3.3	30	8	24	39	3
16/11/2023	SC2101	537949	6279950	15	30	Clay	9.9	8.8	0.3	2.3	0.9	12	<5	<5	110	0.42	1.8	63	24	7.1	0.42	6.1	<0.1	37.6	64%	19%	1%	16%	0%	3.4	1.1	5	1.3	40	6	19	34	12
16/11/2023	SC2101	537949	6279950	30	60	Clay	10	8.4		1.9	<0.6	18				0.61	3.6	310	24	7.3	0.33	7.5	<0.1	39.1	61%	19%	1%	19%	0%	3.3				40	9	17	35	16
16/11/2023	SC2101	537949	6279950	60	100	Clay	8.8	8.6		3.4	0.8	840				2.62	18.1	2000	29	8.4	0.38	13	<0.1	50.8	57%	17%	1%	26%	0%	3.5				38	10	21	32	17
16/11/2023	SC2102	538933	6280166	0	15	Sandy Loam	8.9	8	0.4	2.4	1.2	4	12	110	280	0.11	0.5	<10	25	1.7	0.84	0.09	<0.1	27.6	90%	6%	3%	0%	0%	14.7	0.78	3.1	4.7	13	5	29	53	6
16/11/2023	SC2102	538933	6280166	15	30	Sandy Loam	9.2	8.1	0.3	1.7	0.7	2	9	25	370	0.12	0.6	<10	24	2.4	0.56	0.56	<0.1	27.5	87%	9%	2%	2%	0%	10.0	1.2	2.8	3.2	16	6	29	49	10
16/11/2023	SC2102	538933	6280166	30	60	Sandy Clay Loam	9.9	8.4		3	0.6	9				0.32	2.0	120	23	3.9	0.48	2.7	<0.1	30.1	76%	13%	2%	9%	0%	5.9				25	5	26	44	19
16/11/2023	SC2102	538933	6280166	60	100	Clay Loam	9.8	8.6		2.1	<0.6	150				1.11	10.0	1200	22	5.6	0.42	7.7	<0.1	35.7	62%	16%	1%	22%	0%	3.9				28	8	22	43	21
16/11/2023	SC2103	538687	6278335	0	15	Sandy Clay Loam	9	8.1	0.4	3.3	0.8	3	7	10	65	0.13	0.6	<10	11	2.9	1.2	0.92	<0.1	16.0	69%	18%	7%	6%	0%	3.8	0.74	4.1	3.1	23	5	31	41	<1
16/11/2023	SC2103	538687	6278335	15	30	Clay Loam	9.4	8.3	0.2	5.1	<0.6	1	6	8	79	0.21	0.8	15	27	5.2	1	2.5	<0.1	35.7	76%	15%	3%	7%	0%	5.2	1.2	5	1.4	31	8	28	34	2
16/11/2023	SC2103	538687	6278335	30	60	Clay	9.4	8.3		7.4	<0.6	5				0.31	1.8	140	28	5.7	0.79	3.6	<0.1	38.1	74%	15%	2%	9%	0%	4.9				35	6	29	29	8
16/11/2023	SC2103	538687	6278335	60	100	Clay	9.7	8.3		2.6	0.7	59				0.58	3.7	410	26	5.5	0.43	5.4	<0.1	37.3	70%	15%	1%	14%	0%	4.7				43	8	22	28	18
16/11/2023	SC2104	539215	6280261	0	15	Sandy Loam	9	8.1	0.5	3.9	1	3	12	99	160	0.12	0.5	<10	25	2.1	1	0.22	<0.1	28.3	88%	7%	4%	1%	0%	11.9	0.79	3.3	4.4	18	5	30	47	6
16/11/2023	SC2104	539215	6280261	15	30	Sandy Clay Loam	9.5	8.3	0.3	3.5	<0.6	4	6	7	310	0.16	0.7	11	23	3	0.43	1.1	<0.1	27.5	84%	11%	2%	4%	0%	7.7	1.2	3.3	2.1	26	5	26	43	14
16/11/2023	SC2104	539215	6280261	30	60	Sandy Clay Loam	9.7	8.4		3.6	<0.6	48				0.3	1.7	86	22	4.8	0.37	2.3	<0.1	29.5	75%	16%	1%	8%	0%	4.6				25	6	25	44	18
16/11/2023	SC2104	539215	6280261	60	100	Sandy Clay	9.7	8.7		6.8	<0.6	130				1.17	9.1	1100	21	8.2	0.39	9.8	<0.1	39.4	53%	21%	1%	25%	0%	2.6				35	4	20	41	9
16/11/2023	SC2105	538737	6280375	0	15	Sandy Clay Loam	9	8.1	0.4	1.1	0.7	33	8	16	240	0.23	1.4	72	25	1.9	0.81	0.72	<0.1	28.4	88%	7%	3%	3%	0%	13.2	1.1	2.9	3.1	23	6	27	44	11
16/11/2023	SC2105	538737	6280375	15	30	Clay Loam	9.4	8.2	0.3	1.1	<0.6	23	<5	<5	320	0.32	2.3	230	25	3.1	0.39	2	<0.1	30.5	82%	10%	1%	7%	0%	8.1	1.4	2.6	1.5	32	8	26	35	22
16/11/2023	SC2105	538737	6280375	30	60	Clay	9.7	8.5		1.2	<0.6	120				0.78	5.6	670	21	4.6	0.35	5.4	<0.1	31.4	67%	15%	1%	17%	0%	4.6				38	9	21	33	29
16/11/2023	SC2105	538737	6280375	60	100	Clay	9.2	8.7		1.2	<0.6	620				1.62	10.9	1100	23	5.8	0.44	8.8	<0.1	38.0	60%	15%	1%	23%	0%	4.0				36	5	20	39	20

APPENDIX III:

Coverage of Planning Secretary's Environmental Assessment Requirements.

Appendix 3: Coverage of Planning Secretary's Environmental Assessment Requirements.

Table A.3.1
Coverage of SEARs and Other Government Agency Requirements related to Soils

Relevant Requirement		Relevant Section(s)
Secretary's Environmental Assessment Requirements		
Land and Soil		
• an assessment of the likely impacts of the development on the soils and land capability of the site and surrounds, and a description of the mitigation and management measures to prevent, control or minimise impacts of the development and to inform progressive rehabilitation;		9
• an assessment of the likely impacts of the development on agriculture, including measures to manage biosecurity matters including spread of weeds;		10
• the likely impact of the development on landforms (topography), including the long-term geotechnical stability of any new landforms on site; and		RZ
• the compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements of Part 2.3 of *State Environmental Planning (Resources and Energy) 2021*, paying particular attention to the agricultural land use in the region;		11
• consideration of potential land contamination consistent with the requirements of Chapter 4 Remediation of Land of the *State Environment Planning Policy (Resilience and Hazards) 2021*;		
Other Government Agencies		
Land Resources		
Department of Primary Industries – Agriculture 02/05/2022	Land and soil assessment to inform the progressive rehabilitation of the project area.	2 to 8
	Assessment of agricultural impacts from the development on current and future agriculture.	11
	Identification and management of biosecurity matters, e.g. measures to prevent the introduction and spread of weeds that could impact on grazing systems during construction, operation and rehabilitation.	10
NSW Environment Protection Authority 04/05/2022	The following potential environmental impacts of the project need to be assessed, quantified and reported on. (d) Land; The Environmental Assessment (EA) should address how the required environmental goals outlined below will be met for each potential impact. The EA should describe mitigation and management options that will be used to prevent, control, abate or mitigate identified potential environmental impacts associated with the project and to reduce risks to human health and prevent the degradation of the environment.	
	Potential impacts on land The goals of the project should include the following.	

Relevant Requirement		Relevant Section(s)
	• No pollution of land, except to the extent authorised by the EPA (i.e. in accordance with an Environment Protection Licence);	10
	• The potential impact of land erosion from the development is mitigated;	
	• That landscapes impacted by mining activities and vehicle movements are appropriately monitored and managed in accordance with relevant EPA guidelines.	
	The EA should document the measures that will achieve the above goals and should include the proposed rehabilitation measures that will be implemented to restore the mining pathway.	10