APA Group

Soil Assessment Report

Reedy Creek to Wallumbilla Pipeline

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1			Optional alignment removed from report
2			Separate track strip depth included

** Use after Rev. 0*

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1 Introduction

This soil assessment report provides information on the spatial distribution of soils and recommendations for their management for the Reedy Creek to Wallumbilla Pipeline project (the Project). An overview of the proposed pipeline alignment project area is presented in **Figure 1-1**.

1.1 Project Description

The APA Group are developing a high pressure gas pipeline from Reedy Creek to Wallumbilla in Western Queensland. The length of the proposed pipeline (Revision 3) is approximately 48.7 km.

The construction of the high pressure gas pipelines will involve the following activities to be undertaken in a sequential manner:

- Establishment of access
- Fencing
- Clear and grade of the right of way (RoW)
- Pipe stringing and bending
- Pipe welding, non-destructive testing and joint coating
- Trenching
- Padding
- Pipe placement in the trench (lowering in and laying)
- Backfilling and compaction
- Hydro static testing
- Rehabilitation.

1.2 Purpose and Scope

This soil management plan has been prepared to:

- Provide detailed characterisation of the current condition of the land and soils (as per relevant guidelines)
- Assess potential impacts to Strategic Cropping Land (SCL) and justification as to whether the impacts are likely to be significant or permanent (as per relevant guidelines)
- Recommend measures for soil management measures to be implemented over the life of the Project including:
    - Soil stripping, stockpiling and reinstatement
    - Ameliorants and application rates
    - Reinstatement seed mixes
- Describe proposed monitoring and completion criteria
- Support the application for development approval under *Regional Planning Interests Act 2014* (RPI Act).

1.3 Abbreviations and Descriptions

The abbreviations outlined in **Table 1-1** are used within this report.

Table 1-1 Abbreviations and Descriptions

Abbreviation	Description
ASC	Australian Soil Classification (Isbell, 2002)
BGL	Below Ground Level
Ca	Calcium
CEC	Cation Exchange Capacity
Cl	Chloride
EA	Environmental Authority
EC	Electrical Conductivity

Abbreviation	Description
ESP	Exchangeable Sodium Percentage
GPS	Global Positioning System
K	Potassium
Mg	Magnesium
N	Nitrogen
Na	Sodium
P	Phosphorus
PSD	Particle size distribution
Qa	Geological unit - Quaternary alluvium and lacustrine deposits
RPI Act	*Regional Planning Interests Act 2014*
RPI Regulation	*Regional Planning Interests Regulation 2014*
RoW	Right of Way
S	Sulfur
SCL	Strategic Cropping Land
SSA	Soil Science Australia
UMA	Unique Mapping Areas
µm	Microns (micrometres)
DEHP	Queensland Department of Environment and Heritage Protection
DERM	Queensland Department of Environment and Resource Management
PAWC	Plant available water capacity

APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 1-1
Overview

WORK REQUEST NUMBER: 652790

DATA SOURCES:
Alignment, DEM - APA
DEM. DCDB, SCL, Geology - DERM
World Base Map Copyright © 2015 DeLorme

LEGEND

RWP Alignment
DCDB

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
26/04/2017	MG	SP	SP	1	Issued for Use
15/03/2017	MG	SP	SP	0	Issued for Use

amec foster wheeler

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0 1.5 3
Kilometres

1:175,000

(A4) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENAPT Management Services Pty Ltd\652490 - Reedy Creek to Wallumbilla Pipeline\2.0_Project_Delivery\GIS\Mapping\Stage 2 Report\Fig1-1_Overview_Rev1.mxd

2 Soil Survey Methodology

A soil survey was undertaken to map the soils along the proposed Reedy Creek to Wallumbilla pipeline.

The soil survey was designed to identify and assess soil types and soil characteristics to ensure the implementation of appropriate soil management measures during construction to minimise environmental harm and to meet the final land use objectives.

The soil survey for the Project was designed to address relevant Australian soil survey guidelines and standards, and Strategic Cropping Land (SCL) condition assessments.

2.1 Desktop Review

Baseline soils information was established by conducting:

- A desktop review of existing soils and landform information relevant to the Project area
- A detailed field assessment in accordance with sampling intensities recommended in McKenzie *et al.* (2008), including soil descriptions (The National Committee on Soil and Terrain, 2009), classification (Isbell, 2002), and the Soil Science Australia (SSA) (2015) *Guidelines for Soil Sampling along Linear Features*
- Laboratory analysis of representative soil samples for physical and chemical properties.

To determine baseline soil conditions within the Project area, including soil management data, the following was undertaken prior to the soil survey:

- Review of available and potentially relevant soils and land resource information from CSIRO publications
- Review of regional geological mapping generated by Bureau of Mineral Resources, *Geology and Geophysics: Roma 1:250,000 Geological Map Sheets* SG/55-12 (1971)
- Interpretation of project area aerial photography to identify sites for field assessment that are representative of soil/landscape units throughout the Project area.

Note that a contaminated land assessment has not been undertaken as part of this project.

2.2 Field Assessment

The field component of the soil survey was undertaken between 29 November and the 2 December 2016. The survey was undertaken by Shane Pointon who is a soil scientist (CPSS Stage 2) with over 20 years' experience in soil survey and land resource assessment.

2.2.1 Sampling Intensity

The surveyed area is approximately 48 km of pipeline RoW access tracks and associated construction workspaces. A total of 46 soil investigation sites were surveyed along the proposed pipeline RoW, which is one site per 1,040 m.

The rationale for this survey intensity and mapping scale is provided in the *Guidelines for Soil Survey along Linear Features* (SSA, 2015). The guideline recommends for major disturbances in non-urban areas where the disturbance is close (< 500 m) to numerous sensitive receivers, a site intensity ranging from one site per 200 m to a maximum of one site per 500 m, and when not close (> 500 m) to sensitive receivers, a site intensity ranging from one site per 500 m to a maximum of one site per 1,000 m.

2.2.2 Site Descriptions

Soil site descriptions were undertaken in accordance with the *Australian Soil Survey and Land Survey Field Handbook 3rd edition* (The National Committee on Soil and Terrain, 2009) and classified using *The Australian Soil Classification* (Isbell, 2002). Soil site descriptions include a soil profile description and site observations at each location.

Site observations include descriptions of:

- Landform (including slope)
- Geology
- Surface characteristics (e.g. gilgai and rockiness)

- Vegetation.

Soil profile descriptions include (where applicable) details of:

- Horizon depths and designation
- Boundary distinctness
- Field texture
- Colour
- Mottles
- Coarse fragments
- Structure
- Segregations
- Field tests (e.g. pH, salinity).

2.2.3 Soil Sampling Methods

Field sampling procedures conformed to Amec Foster Wheeler Quality Assurance/Quality Control (QA/QC) protocols to minimise the potential for cross contamination and to preserve the sample integrity. **Table 2-1** provides a summary of soil sampling activities.

Table 2-1 Soil Sampling Activities

Activity	Details
Soil core locations (sites)	Sampling locations were recorded with a Garmin etrex 20 handheld Global Positioning System (GPS) unit with an accuracy of generally +/-4 m.
Soil coring	Hand augering was undertaken with the use of either a 50 mm or 75 mm Jarret auger. Soil cores were extended to a maximum of 1.2 m below ground level (BGL).
Abandonment	Soil cores were backfilled to the existing natural ground level using soil retrieved during soil coring.
Decontamination	Prior to commencing each soil core, bulk soil material was removed from the auger head.
Soil logging	Soil characteristics were described and profiles classified in accordance with the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain, 2009) and the Australian Soil Classification (Isbell, 2002) respectively. In addition to soil descriptions, the associated landscape features, including terrain, land use, areas of degradation, slopes and vegetation were recorded and photographed. Field pH tests were also conducted on nominal 0.3 m intervals down the soil profile at each site.
Soil sampling	Soil samples, approximately 500 g in volume, were obtained directly from the auger at nominal depths of 0–0.1 m, 0.2–0.3 m, 0.5–0.6 m, 0.8–0.9 m and 1.1–1.2 m, depending on sample site depth. These depths sometimes varied to accommodate horizon boundaries. Discrete soil samples were collected and placed into resealable plastic bags for dispatch to the laboratory.
Labelling	Sample bags were labelled with the sample site number and depth. For instance, a sample collected at site APA1 at a depth of 0–10 cm BGL was labelled as follows: APA 1, 0-10 cm.
Dispatch	Samples were stored out of direct sunlight and transported by road for analysis at Nutrient Advantage Laboratory Services (Incitec Pivot, Werribee, Victoria).

2.3 Laboratory Analysis

From the 14 sites selected for soil sample analysis, a total of 54 soil samples were analysed.

Analyses undertaken by Nutrient Advantage Laboratory Services, Incitec Pivot (ASPAC and NATA accredited laboratory in Werribee, Victoria) included:

- Sample depth 0.0–0.1m – pH; EC; Cl^- (1:5); exchangeable cations (Ca, Mg, Na, K, Al) and CEC (NH_4Cl or Ammonium Acetate); OC (Walkley and Black) and OM (calculation); PSD (< 2µm, 2–20µm, 20–50µm, 0.05–2mm); Colwell P; Sulfate Sulfur (MCP); Total P, Total N, nitrate N, Ammonium N, micro nutrients (Boron (B), Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn)); ESP: Emerson dispersion.
- Sample depths 0.1–0.2m, 0.2–0.3m, 0.5–0.6m, 0.8–0.9m, 1.1–1.2m – pH, EC, Cl^- (1:5); exchangeable cations (Ca, Mg, Na, K, Al) and CEC (NH4Cl or Ammonium Acetate); PSD (<2µm, 2–20µm, 20–50µm, 0.05–2.0mm); ESP, and Emerson dispersion.

3 Soil Survey Results

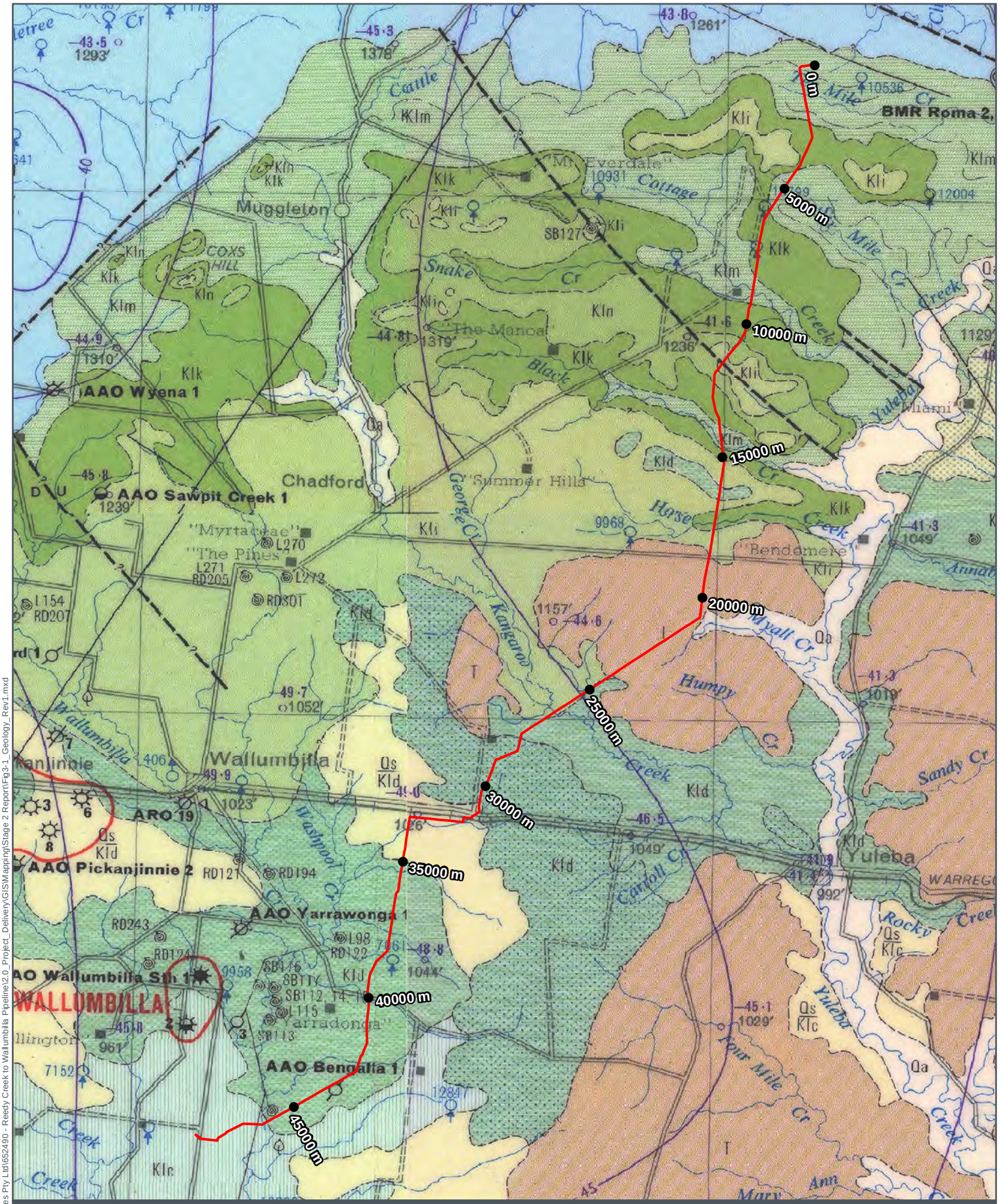
3.1 Geology and Landform

The geology along the RoW has been mapped by the Bureau of Mineral Resources Geology and Geophysics at a scale of 1:250,000 on the Roma map sheet and are presented in **Figure 3-1**.

The soils present in the Project area have formed from a variety of recent alluvium and older sedimentary geological units with a range of lithology as follows:

- Quaternary Alluvium (Qa) (alluvium)
- Quaternary Sediments (Qs) (sand, gravel, soil with gravel)
- Tertiary sediments (T) (quatzose sandstone, conglomerate)
- Early Cretaceous Wallumbilla Formation made up of:
    - Coreena Member (Klc) (glauconitic siltstone, mudstone, very fine grained sandstone. Shelly fossils)
    - Doncaster Member (Kld) (mudstone, some siltstone, quartzose sandstone and coquinite. Shelly fossils) Parts of the Doncaster Member unit have been chemically altered (kaolinised, silicified and ferruginised)
- Early Cretaceous Bungil Formation (Kly) (sandstone, siltstone and mudstone) with the following subunits:
    - Kli – Minmi member (glauconitic lithic to quartzose sandstone, siltstone, mudstone bioturbites. Shelly fossils)
    - Kln – Nullwart Sandstone member (quartzose to labile sandstone, siltstone, mudstone)
    - Klk – Kingull Member (clayey sandstone, carbonaceous mudstone)
- Early Cretaceous Mooga sandstone (Klm) (quartzose to labile sandstone, some clayey; some sandstone, conglomerate).

The landforms in the north of the proposed corridor are comprised of rises and low hills predominantly on Early Cretaceous Mooga sandstone and Bungil Formation. A section of Tertiary geological unit is present in the middle of the alignment on gently undulating rises and low hills, while the southern section is flatter consisting of gently undulating rises and plains on the Wallumbilla Formation and Quaternary sediments.



APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-1
Geology

WORK REQUEST NUMBER: 652790

DATA SOURCES:
Alignment, DEM - APA
DEM. DCDB, SCL, Geology - DERM
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LEGEND

- RWP KP Marker
- RWP Alignment

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
26/04/2017	MG	SP	SP	1	Issued for Use
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0 1.5 3
Kilometres
1:175,000
(A4) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENAPT Management Services Pty Ltd\652490 - Reedy Creek to Wallumbilla Pipeline\2.0_Project_Delivery\GIS\Mapping\Stage 2 Report\Fig3-1_Geology_Rev1.mxd

3.2 Land use

The land use along the proposed pipeline alignment is predominately grazing of native and improved pastures for beef cattle production along the northern section of the pipeline alignment. The first 6 km is a mix of forest and regrowth vegetation. The country has been more consistently cleared south of this apart from isolated areas and low hills between KPs 11-12 and 16-17. An area of old cultivation is evident around KP10, but cropping really doesn't start to occur until south of KP18. South of this point, cropping and grazing are the dominant land uses.

3.3 Soil Mapping

The soils of the project area are mapped into nine soil mapping units. **Table 3-1** presents the ASC and a basic soil description of these mapped units. The soil units are presented in **Figure 3-2**; **Figure 3-3** presents the mapped SCL in the Project area.

In addition to mapping soil units, individual Unique Mapping Areas (UMAs) were also identified for differences in observed topsoil depth, overall profile depth, rockiness and geological unit. A table of the UMAs which contains the soil types, characteristics and management recommendations is presented in **Table 4-2**.

The soils present in the Project area have formed from a variety parent materials as presented in **Section 3.1**. Subdivisions of the soil mapping units have primarily been made according to the geological unit from which the soil have formed, and landforms on which they occur. Interpretation of the morphological descriptions and the laboratory data has identified soils types with similar characteristics that have formed from different geological units (with similar lithology and landform). As a result, soils with similar characteristics (morphological and chemical) from different geological units (with similar lithology and landform) have been grouped together into a single soil mapping unit. The mapping still retains the subdivisions of the different geological units to enable interrogation.

The following is a brief description of the soil mapping units and their parent geological units.

Stratified and uniform textured soils formed from Quaternary alluvium (Qa)

Two soil units have been identified in this geological unit and are formed from recent alluvium (Qa) closely associated with drainage features and waterways. These soils have limited spatial extent and occupy only thin areas within and adjacent to drainage features and waterways. Vegetation growing on these soils includes river red gum, silver leaved ironbark, poplar box, cypress pine and boonaree, however substantial clearing has generally been undertaken. Slopes in the location of these soils is level to very gently undulating, with flooding a common occurrence.

Soil **Qa-TE** is an association of Stratic Rudosols and Orthic Tenosols formed from relatively recently deposited alluvium. The soils are either layered, indicating repeated deposition of sediments of varying particle size, or the soils have a somewhat amorphous profile, indicating either the deposition of similar sediments over time or a large single depositional event. In either case, the soils are relatively young with dominantly sandy textures throughout and have undergone minimal pedological development apart from the accumulation of organic material in the topsoil or *Tenic* subsoil development. The soil is often loose or weakly coherent (including the soil surface) and prone to entrainment in concentrated water flows (**Plate 3-2**).

Soil depth exceeded the depth of investigation on all occasions (i.e.1.2m) and while the soil is located on level to gently undulating plains, the deep sandy nature of the soil contributes to a well to rapidly drained status. The soil is commonly located within drainage channels, on channel benches and occupies terraces of streams draining landforms with quartzose lithologies (i.e. Kli, Klm, and Kln) (**Plate 3-2**). Chemically, the soil is relatively benign with low CEC, neutral to slightly acidic pH, low salinity levels, non-sodic throughout, and low fertility levels in the topsoil. Land use on these soils are dominated by grazing.

Plate 3-1 Soil profile at site #10 with surface top right in 30 cm sections to 1.2 m, showing deep sandy apedal profile

Plate 3-2 Landscape photo at site #10 with stream channel (Cottage Ck) in the background lined with riparian vegetation of river red gum and poplar box

Soil **Qa-DE** are Dermosol soils located on level to gently undulating terraces and alluvial plains of drainage features and waterways (**Plate 3-3**). The soil is formed from deposited sediments derived from upstream landforms of lithic or labile sandstones, siltstones and mudstones that have weathered to fine textured soil (i.e. loam and clay). This soil has moderate to strong subsoil structure with sandy clay loam to light clay textures throughout and a firm to hardsetting surface (**Plate 3-4**). Profile depth exceeded depth of investigation on all occasions (i.e. 1.2m) while local soil wetness conditions are moderately-well to well-drained. Laboratory results identified that the analysed soil is neutral in the topsoil and strongly alkaline in the subsoil, non-saline and non-sodic throughout, with moderate fertility in the topsoil. Land use for this soil type is dominated by grazing, however some small areas are cultivated for fodder/forage or grain production.

Plate 3-3 Location of site #35 showing small incised stream channel (tributary of Wallumbilla Ck) and relatively flat landform

Plate 3-4 Soil profile at site #35 surface top right, 30 cm sections to 1.2 m, showing deep moderate to well-structured Brown Dermosol

Uniform textured rigid soils formed from Cretaceous sediments (Klm, Klk, Kln, Kli, Kly, Kld, and Klc) and Quaternary sediments (Qs)

Three non-cracking uniform textured profile soil units are identified and have formed from predominantly Cretaceous sediments. At a section of the proposed alignment just to the south of the Warrego Highway crossing, the Cretaceous sediments are overlain by Quaternary sediments, this area has consistent

presence of up to 20% cobble and stone on the soil surface (**Plate 3-5**). This area has been included in the alkaline Dermosols (C-DEal) soil mapping unit (**Plate 3-6**) with the surface rock identified. Surface cobble was identified on the other Dermosol units (i.e. C-DEal and C-DEal) but less consistent. These soil units have largely formed from components of the Cretaceous geological units that weather to predominantly clay sized particles (i.e. siltstone, mudstone, clayey and labile sandstone).

Plate 3-5 Landscape at site #29 showing stone on the soil surface

Plate 3-6 Soil profile at site #29, surface top left, 30 cm sections to 1.2 m. Brown Dermosol

Soil **C-DEal** are Dermosol soils located on very gently to gently inclined slopes and crests of rises and low hills (**Plate 3-7**). This soil has a firm to hardsetting surface with clay loam to light clay textures, overlying brown (most common), black or grey subsoil with moderate to strong structure, light to light medium clay textures and commonly with gypsum segregations (**Plate 3-8**). Some described sites had pH inversion where the surface and upper subsoil was neutral to alkaline, changing to acidic to strongly acidic in the lower subsoil. Local soil wetness conditions are imperfect to moderately-well drained. The sites with this pH inversion appeared to occur randomly throughout this soil mapping unit with no obvious pattern to the distribution, therefore these soils have been included in this **C-DEal** unit. Land use on this soil type is dominated by grazing on largely cleared lands, with only small areas cultivated. Remnant vegetation includes brigalow, belah, poplar box, wilga and false sandalwood. Described sites identified profile depth ranges from 45 cm on more inclined upper slopes to greater than 1.2 m (most common) in the flatter landforms. Laboratory analysis revealed the subsoil material has very high chloride concentration (maximum of 1400 mg/kg at 50-60 cm of site #42), is strongly alkaline and sodic to strongly sodic. Topsoil fertility is low.

Plate 3-7 Landscape at site#14 with a mix of brigalow, poplar box and wilga vegetation on gently undulating rise landform

Plate 3-8 Soil profile at site #14, surface top left, 30 cm sections to 1.2 m. alkaline Brown Dermosol

Soil **C-DEac** is a Dermosol with similar characteristics as **C-DEal** with the primary difference being a consistent acidic reaction trend down the profile (**Plate 3-9**). This soil is identified on the Nullawurt Sandstone and Doncaster members of the Cretaceous sediments. Landforms were this soil occurs are very gently to gently undulating rises and low hills (**Plate 3-10**). Profile characteristics are similar to the alkaline Dermosol soil, with firm to hardsetting clay loam to light clay surface, overlying black to brown light medium clay subsoil, with profiles extending beyond 1.2 m. Local soil wetness condition is moderately well drained. Land use on this soil type is predominantly grazing of largely cleared land with remnant vegetation including poplar box, belah, narrow leaved ironbark and false sandalwood. Laboratory analysis identified the subsoil is non-saline, non-sodic, with low to moderate CEC and dominated by aluminium. Topsoil fertility is low to moderate.

Plate 3-9 Soil profile at site #23, surface top left, 30 cm sections to 1.2 m. acidic Brown Dermosol

Plate 3-10 Landscape at site#23 on gently undulating rise landform

Soil **C-DEka** is a Dermosol identified in one location along the proposed alignment on a small plateau formed from Doncaster Member (mudstone, siltstone and quartzose sandstone) (**Plate 3-11**). While this soil has been classified as a Dermosol (B2 structure more developed than weak), this soil has affinities with Kandosols. This is due to the gradual texture change from clay loam fine sandy in the surface to fine sandy light clay at depth, and the structure in the subsoil ranges from weak to moderate (**Plate 3-12**). The soil has a hardsetting surface, and the described profile extended beyond 1.2 m. Local soil wetness is moderately well drained. Current land use for this soil type is grazing of largely cleared land with remnant vegetation

including narrow leaved ironbark, broad leaved ironbark, mountain coolibah and poplar box. Laboratory analysis reveal high salinity levels in the lower subsoil, strongly acidic pH throughout, low CEC and low fertility in the topsoil.

Plate 3-11 Landscape at site#25 on a plateau with very gently undulating terrain

Plate 3-12 Soil profile at site #25, surface top right, 30 cm sections to 1.2 m. Brown Dermosol with weak to moderate structure in the subsoil

Uniform textured cracking soil formed from Cretaceous sediments (Klk and Kld) and Jurassic sediments (Ji)

Soil **C-VE** is a Vertosol soil with cracking and sometimes mulching surface. The Vertosols described and analysed from each of the geological units along the proposed corridor had very similar characteristics, both morphologically and chemically, and as such have been grouped into the one soil mapping unit. Lithology of parent material is dominated by the finer and easily weathered components of the Cretaceous and Tertiary sediments (i.e. mudstone, carbonaceous mudstone, siltstone; lithic, labile and clayey sandstone). The subdivision of the **C-VE** mapping polygons remains for the different geological units to enable interrogation.

This soil is predominately utilised for agricultural production of grazing and cropping and land with this soil type are regularly classified as Strategic Cropping Land. Areas used for grazing often have exotic pasture species such as buffel grass introduced following clearing. Vegetation growing on this soil is dominated by brigalow, belah, wilga and lime bush. The soil is located on very gently to gently inclined slopes and crests of rises and low hills (**Plate 3-13** and **Plate 3-14**). The soil has clay textures throughout ranging from light medium clay to medium clay, brown (most common), black or grey subsoil colours, moderate to strong structure throughout and moderate to deep profile depth (**Plate 3-15** and **Plate 3-16**). The profiles that were described predominantly continued beyond depth of observation (1.2 m), except at site #38 where weathered parent material was encountered at 0.75 cm. Up to 20-50% surface gravel and cobble was identified at locations corresponding with this soil type.

Plate 3-13 Landscape at site#8

Plate 3-14 Landscape at site#38

Plate 3-15 Soil profile at site #8, surface top left, 30 cm sections to 1.2 m. Brown Vertosol with grey surface

Plate 3-16 Soil profile at site #38, surface top left, 30 cm sections to 0.9 m. Brown Vertosol overlying weathered mudstone at 0.75 cm

Laboratory analysis revealed that the Vertosols from the different geological units had very similar chemical characteristics, most had elevated salinity levels in the subsoil, with a maximum chloride content of 1500 mg/kg at 110-120 cm of site #16. The remaining **C-VE** sample sites ranged from 800 mg/kg to 1300 mg/kg maximum chloride in the subsoil. There was a general correlation between EC and Chloride concentrations in most samples, except those where gypsum segregations where identified (increasing the EC above what would be expected from soils with Chloride dominated salts). Soil reaction trends were commonly alkaline to strongly alkaline, however numerous described sites became acidic in the lower subsoil (i.e. pH inversion) with a corresponding decrease in CEC. Clay content ranged from 29% to 49% and clay activity ratio generally greater than 0.5 indicating predominantly expanding clay mineralogy. ESP ranged from 2% to 15% in the surface, and 10% to 31% in the subsoil. Topsoil fertility was generally low to moderate.

Texture contrast soils formed from Cretaceous sediments (Klm, Klk, Kli, and Kld)

Two texture contrast soil units were identified along the proposed corridor formed from Cretaceous sediments. These soils were subdivided on soil reaction trend (i.e. acidic and alkaline).

Soil **C-KU** has an acidic soil reaction trend and was identified in one location, approximately 2.5kms south of Kangaroo Creek Road. Gully erosion was evident in this location (**Plate 3-17**). This soil is located at the boundary of the altered (ferruginised) Kld geological unit and the non-altered Kld geological unit, corresponding with a steeper slope leading to an elevated plateau area (site #25). Vegetation is composed

of narrow leaved ironbark, poplar box, broad leaved ironbark, and mountain coolibah and largely remains intact in extended sections along the boundary between geological units.

Site #24 was described in a gully exposure, with sandy clay loam surface and bleached subsurface overlying grey sandy light medium clay subsoil with coarse columnar structure distinct orange mottles. The gully had eroded down to sandstone parent rock at approximately 1.2 m (**Plate 3-18**).

Laboratory analysis highlighted the strongly acidic soil reaction trend, extremely saline subsoil, high aluminium (23% in the surface) and magnesium saturation (60% in the subsoil) and very low CEC throughout.

Plate 3-17Gully erosion at site #24 showing sandstone parent material exposed at its base

Plate 3-18 Soil profile at site #24 with sandy clay loam surface over columnar structured subsoil

Soil **C-SO** is primary distributed in the northern half of the proposed corridor formed from siliceous components of the Cretaceous sediments (i.e. quartzose sandstone). The **C-SO** soil occurs on gently inclined slopes and crests of rises and low hills (**Plate 3-19** and **Plate 3-20**). Gully erosion was evident where runoff water had concentrated throughout this soil unit (i.e. vehicle and cattle tracks) (**Plate 3-21** and **Plate 3-22**). Land use was mostly grazing within uncleared vegetation communities. Vegetation is dominated by cypress pine, black wattle, narrow leaved ironbark and Clarkson's bloodwood. Local soil wetness conditions were imperfect to moderately-well drained. Soil **C-SO** commonly has fine sandy clay loam surface and bleached subsurface overlying moderately structured grey, black or brown light medium clay subsoil. Profile depth ranged from 80 cm to greater than 1.2 m to weathered sandstone.

Plate 3-19 Landscape at site #1

Plate 3-20 Landscape at site #2

Laboratory analysis of the subsoil material revealed moderate to high salinity with a maximum EC of 0.56 µS/cm, neutral to alkaline pH, chloride levels up to 670 mg/kg, and low CEC dominated by magnesium and sodium. Fertility of the topsoil is very low to low.

Plate 3-21 Gully erosion between Sites #1 and #2

Plate 3-22 Gully erosion between Sites #1 and #2

Shallow rocky soil formed from Cretaceous sediments (Klm, Klk, Kln, Kli, Kly, Kld, and Klc)

The **C-RU** Rudosol units identified are located on the Kli and Kld geological units but observations of small areas of shallow soils were made in numerous locations along the proposed corridor. In most cases, the scale of mapping precluded the delineation of these small areas as a mapping polygon, however notes were made on site sheets to record areas where these shallow soils occur. The **C-RU** soils are largely located on crests and upper slopes where erosion has been the dominant landscape process. The soil material in these locations consists of a rocky sandy loam topsoil overlying weathered sandstone parent material. Profile development is often minimal, however some areas have soils with a slightly deeper profile and subsoil development but the dominant soil has only rudimentary profile development.

Plate 3-23 Soil profile at site #13, surface left hand side, excavation stopped by weathered sandstone

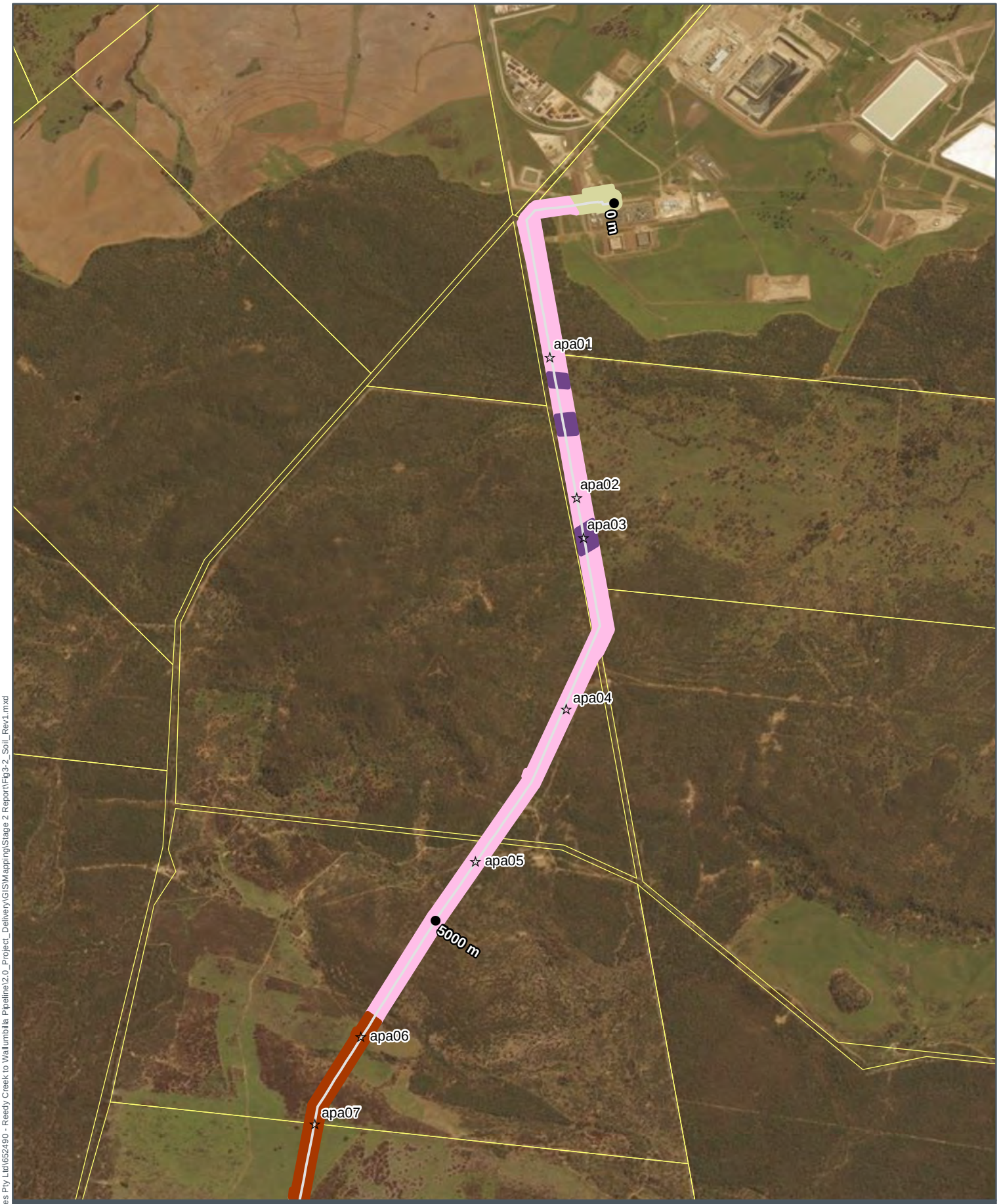
Plate 3-24Exposed sandstone near site #13

No laboratory analysis was conducted on these soils, but the topsoil characteristics would be similar to that of the C-SO soil with fertility low to very low.

Table 3-1 Soil Mapping Units

Soil Unit	ASC	Geology	Soil Description
Qa-TE	Tenosols and Rudosols	Qa	Deep stratified soil closely associated with drainage features and waterways, located on channel benches and terraces, well to rapidly drained, neutral to slightly acidic pH throughout, non-saline, non-sodic. River red gum and poplar box vegetation
Qa-DE	Dermosols	Qa	Deep uniform textured soil with moderate to strong structure in the subsoil, sandy clay loam to light clay textures throughout, located on terraces and plains adjacent to drainage features and waterways, neutral to strongly alkaline pH, non-saline, non-sodic. River red gum and poplar box vegetation
C-SO	Sodosols	Kli, Klk, Klm, Kld	Texture contrast soil with moderate to thick (>30 cm) sandy loam to sandy clay loam surface and bleached subsurface, overlying alkaline, strongly sodic, moderately saline subsoil formed from Cretaceous sediments. Cypress pine, narrow leaf ironbark and black wattle vegetation
C-DEal	Dermosols	Klc, Kld, Kly, Kli, Kln, Klk, Klm	Non-cracking uniform textured soil with moderate to well-structured brown, black or grey subsoil with strongly alkaline pH, formed from Cretaceous sediments. Some profiles become acidic in the lower subsoil (>60 cm) (i.e. pH inversion). Surface cobble may occur
C-DEac	Dermosols	Klc, Kld, Kly, Kli, Kln, Klk, Klm	Non-cracking uniform textured soil with moderate to well-structured brown, black or grey subsoil with acidic pH, formed from Cretaceous sediments. Surface cobble may occur
C-DEka	Dermosols	Kln	Non-cracking uniform textured soil with moderate to weak structured brown, subsoil with acidic pH, formed from quartzose to labile chemically altered Cretaceous Nullawurt Sandstone. This soil has affinities with Kandosols due to the moderate to weak structure in the subsoil.
C-KU	Kurosols	Kln	Texture contrast soil with moderate to thick sandy clay loam surface and bleached subsurface, overlying strongly acidic, strongly sodic, extremely saline subsoil formed from quartzose to labile chemically altered Cretaceous Nullawurt Sandstone.

Soil Unit	ASC	Geology	Soil Description
C-VE	Vertosols	T, Klc, Kld, Kly, Kli, Kln, Klk, Klm	Deep to moderate uniform textured clay soil with cracking surface and well-structured brown, black or grey subsoil with alkailine pH, formed from Tertiary and Cretaceous sediments. Some profiles become acidic in the lower subsoil (>60 cm) (i.e. pH inversion). Surface cobble may occur. Brigalow and belah vegetation dominates
C-RU	Rudosols	Klc, Kld, Kly, Kli, Kln, Klk, Klm	Very shallow rocky soil located on steep slopes and crests, formed from cretaceous sediments, neutral to acidic pH. Lancewood and broad leaved ironbark vegetation



APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-2
Soil Units

WORK REQUEST NUMBER: 652790

DATA SOURCES:
Alignment, DEM - APA
DEM. DCDB, SCL, Geology - DERM
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LEGEND

- ☆ Soil survey sites
- ● RWP KP Marker
- RWP Alignment
- DCDB

Soil Unit

- C-DEal
- C-SO
- C-VE
- Qa-TE

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26/04/2017	MG	SP	SP	1	Issued for Use
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amec foster wheeler

N

0 0.25 0.5
Kilometres
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(A4) GCS GDA 1994

LOCATION DIAGRAM

Sheet 1
Sheet 2
Sheet 3
Sheet 4
Sheet 5
Sheet 6
Sheet 7
Sheet 8

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APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-2
Soil Units

WORK REQUEST NUMBER: 652790

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LEGEND

- Soil survey sites
- RWP KP Marker
- RWP Alignment
- DCDB

Soil Unit
- C-DEac
- C-DEal
- C-RU
- C-SO
- C-VE
- Qa-TE

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APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-2
Soil Units

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LEGEND

- Soil survey sites
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Soil Unit

- C-DEac
- C-DEal
- C-RU
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- C-VE
- Qa-DE

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Sheet 7
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APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-2
Soil Units

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LEGEND

- Soil survey sites
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- RWP Alignment
- DCDB

Soil Unit

- C-DEal
- C-SO
- C-VE
- Qa-DE

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Figure 3-2
Soil Units

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LEGEND

- Soil survey sites
- RWP KP Marker
- RWP Alignment
- DCDB

Soil Unit

- C-DEac
- C-DEal
- C-DEka
- C-KU
- C-RU
- C-VE
- Qa-DE

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Kilometres
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LOCATION DIAGRAM

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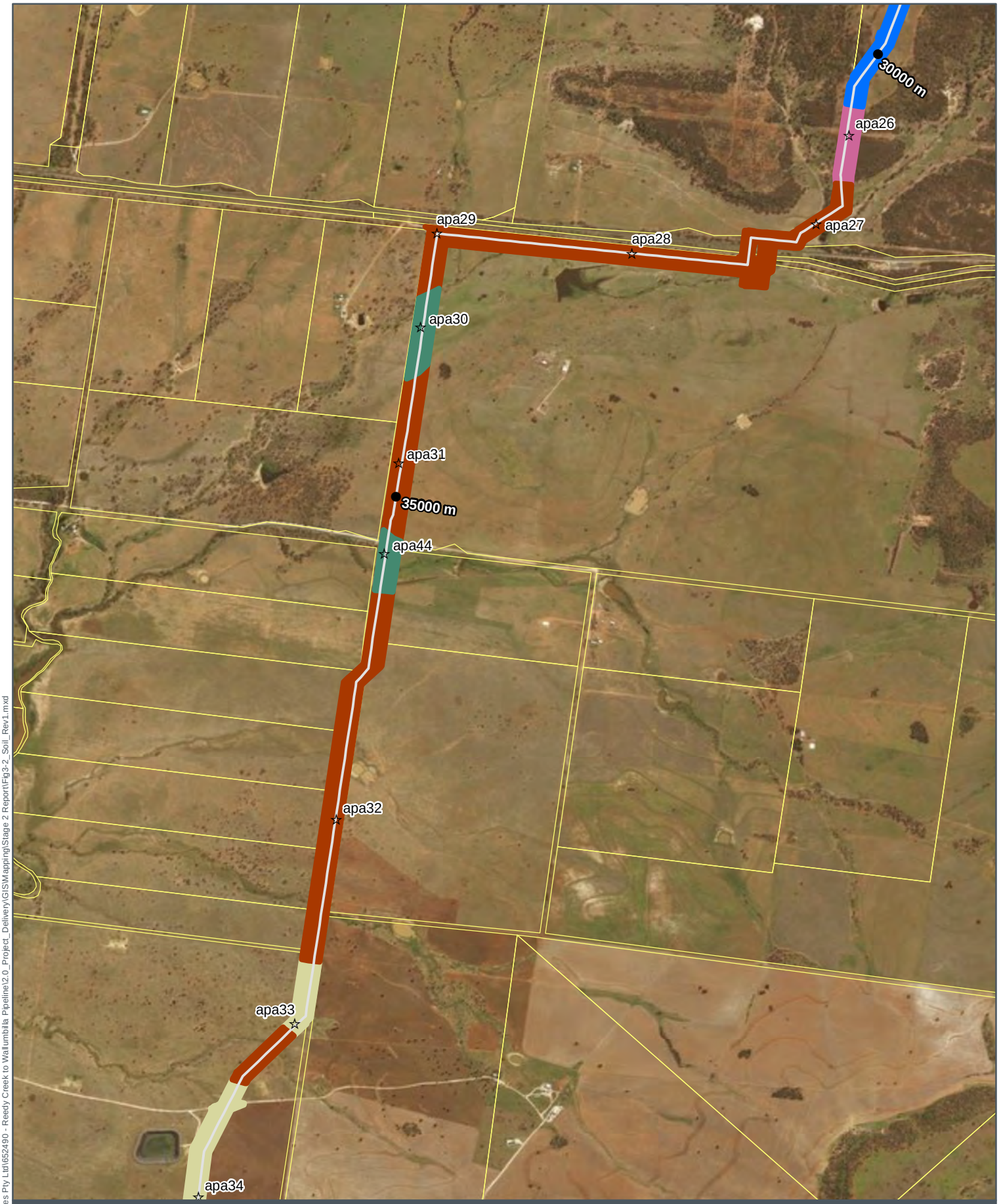

APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-2
Soil Units

WORK REQUEST NUMBER: 652790

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LEGEND

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Soil Unit

- C-DEal
- C-DEka
- C-RU
- C-VE
- Qa-DE

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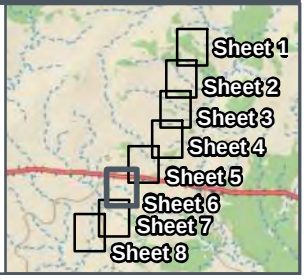
LOCATION DIAGRAM



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APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-2
Soil Units

WORK REQUEST NUMBER: 652790

DATA SOURCES:
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LEGEND

- Soil survey sites
- RWP KP Marker
- RWP Alignment
- DCDB

Soil Unit

- C-DEal
- C-VE
- Qa-DE

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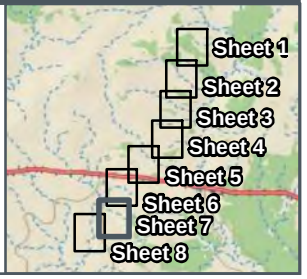
LOCATION DIAGRAM



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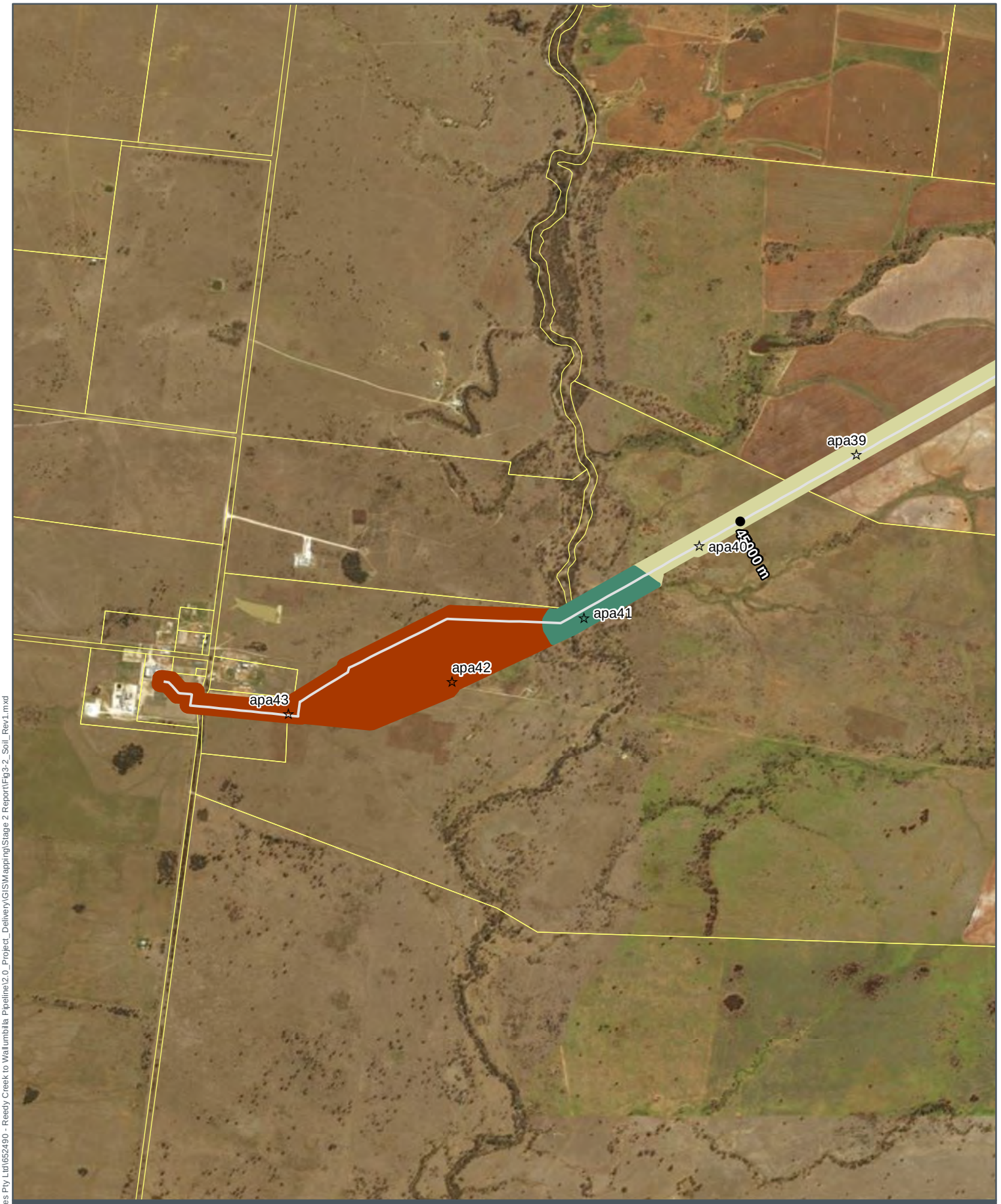

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Figure 3-2
Soil Units

WORK REQUEST NUMBER: 652790

DATA SOURCES:
Alignment, DEM - APA
DEM. DCDB, SCL, Geology - DERM

LEGEND

- Soil survey sites
- RWP KP Marker
- RWP Alignment
- DCDB

Soil Unit

- C-DEal
- C-VE
- Qa-DE

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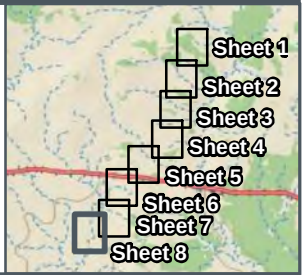

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APA - 652490 - Reedy Creek to Wallumbilla Pipeline

Figure 3-3
Strategic Cropping Land (RPI Act 2014)

WORK REQUEST NUMBER: 652790

DATA SOURCES:
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LEGEND

- RWP KP Marker
- RWP Alignment
- DCDB
- Strategic Cropping Land (RPI Act 2014)

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LOCATION DIAGRAM

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Table 3-2 Ratings of Topsoil Attributes in Soil Mapping Units Identified for the Reedy Creek to Wallumbilla Pipeline

Mapped Soil Unit	Topsoil Fertility (~100 mm bgl)									
	Total Nitrogen	Available Nitrogen	Phosphorus	Exchangeable Potassium	Sulfur	Zinc	Manganese	Copper	Total Carbon	Erosion Potential
Qa-TE	Very Low	Very Low	Low	Moderate	Very Low	Low	Moderate	Low	Very Low	Low
Qa-DE	Low	Very Low	Low	High	Moderate	Low	Moderate	Moderate	Low	Moderate
C-SO	Low	Very Low	Very Low	Moderate	Very Low	Low - Moderate	Moderate	Low - Moderate	Very Low	Moderate
C-DEal	Low	Very Low	Low	High - Very high	Very Low - Low	Low	Moderate	Low - Moderate	Low	Low
C-DEac	High	Very Low	Very Low	Very high	Low	High	High	Low	High	Low
C-DEka	Low	Very Low	Very Low	Moderate	Low	Moderate	Moderate	Low	Low	Low
C-KU	Low	Moderate	Very Low	Low	Low	Very Low	Moderate	Low	Low	Low
C-VE	Low - Moderate	Very Low	Very Low - Low	High - Very high	Very low - High	Very Low - Moderate	Moderate	Moderate	Low - Moderate	Moderate
C-RU	Similar to C-SO									

Table 3-3 Ratings of Subsoil Attributes in Soil Mapping Units Identified for the Reedy Creek to Wallumbilla Pipeline

Mapped Soil Unit	Subsoil Parameters (~600mm bgl)					Deeper Subsoil Parameters (up to 1,500mm bgl)				
	Sodicity	Ca:Mg Ratio	Salinity	Dispersion Potential	Erosion Potential	Sodicity	Ca:Mg Ratio	Salinity	Dispersion Potential	Erosion Potential
Qa-TE	Non-Sodic	High	Very Low	Low	Low	Non-Sodic	Moderate	Very Low	Moderate	Low
Qa-DE	Non-sodic	High	Low	Moderate	Low	Non-Sodic	High	Low	Moderate	Low
C-SO	Sodic - Strongly Sodic	Low - Moderate	Low - Moderate	Moderate - High	Moderate - High	Strongly Sodic	Low	Moderate - High	Moderate – High	Moderate – High
C-DEal	Sodic - Strongly Sodic	Moderate	Very High	Moderate	Moderate	Strongly Sodic	Low – Moderate	Extreme	Moderate	Moderate
C-DEac	Non-Sodic	Low	Very Low	Moderate	Moderate	Non-Sodic	Low	Very Low	Moderate	Moderate
C-DEka	Strongly Sodic	Low	High	Moderate	Moderate	Strongly Sodic	Low	High	Moderate	Moderate
C-KU	Strongly Sodic	Very Low	Extreme	Moderate	High	Strongly Sodic	Very Low	Extreme	Moderate	High
C-VE	Strongly Sodic	Low	Very High - Extreme	Moderate	Moderate	Strongly Sodic	Low - Moderate	Very High - Extreme	Moderate	Moderate
C-RU	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

4 Soil Management

This section contains specific soil type management recommendations for soils located in the project area. The general soil management requirements for the proposed works will follow the Australian Pipeline Industry Association (APIA) 'Code of Environmental Practice: Onshore Pipelines' (2013) standards and requirements. The minimum requirements are outlined in Section 9.6 and Appendix 4 of the Code of Environmental Practice.

The main objective of the soil management approach is to reinstate disturbed areas to as near as practical to pre-existing environmental conditions by:

- Avoiding, minimising or mitigating impacts to soils
- Maintaining topsoil quantity and quality
- Restoring land to its pre-activity use but that it is also returned to its pre-activity productive capacity or potential productive capacity
- Returning the land to a stable landform (i.e. no subsidence or major erosion) with no greater management inputs than those required prior to land disturbance

4.1 Topsoil Management

Topsoil depth was observed, described and mapped for all surveyed areas. Topsoil stripping is based on a risk assessment of potential impacts. High risk activities such as trenching will be stripped to the largest depth compared to access tracks where there will be no disturbance to subsoil horizons. An alternative stripping approach would be to strip the entire ROW to the depth for high risk activities. Topsoil will be stripped to a maximum of 300 mm in SCL areas and 200 mm in non-SCL areas. It is important to note that boundaries between soil units are based on field observations at approximately 1,000 m intervals, desktop digital aerial photographs and LiDAR interpretation. Boundaries between soil units can be abrupt (within 10 m) or diffuse (> 50 m) or somewhere in between. Due to this natural variability between soil type boundaries and variability of topsoil depth within the soil types, stripping depths should be adjusted as necessary depending on actual topsoil depths encountered.

Initially vegetative material will be grubbed and removed from the RoW. Stockpiling and final use/disposal of removed vegetation and woody debris will be subject to landholder agreement.

The objective of topsoil management is to:

- Preserve as much of the topsoil as possible
- Ensure topsoil is not degraded during construction and following reinstatement
- Ensure topsoil is not contaminated with other soil and spoil materials

Topsoil management measures include:

- Contractor Site Environmental Advisor to identify, record and indicate (to plant operators) the stripping depth
- Where available, topsoil will be stripped to a minimum depth of 100 mm but may extend to 300 mm if suitable reserves are available in SCL areas
- Stripped topsoil along the RoW will be stored in a stockpile separately from woody material and subsoil stockpiles
- Stripped topsoil at isolated work sites (i.e. 'borrow pits', 'turnaround areas') will be stockpiled separately from woody material and subsoil stockpiles
- Removal of groundcover vegetative material from the RoW prior to construction and reinstate following construction to provide seed stock and/or organic matter to assist revegetation
- Vegetation that is cleared and mulched may be used to provide a thin surface mulch to protect the topsoil and mitigate erosion hazards
- Care will be taken during stripping, stockpiling and/or re-spreading to ensure that structural degradation/soil compaction of the soil is minimal
- Topsoil stockpiles recommended not exceed 2 m in height to minimise degradation of topsoil, maintain biological capital and maintain fertility
- Gaps will be left between stockpiles at appropriate intervals to allow for drainage, and permit the movement of vehicles and fauna

- Stockpiles will be placed away from water discharge zones where they are not disturbed by other activities; topsoil should not be stockpiled against fences or vegetation and should be retained separately from mulch (apart from a surface layer)
- Weeds on the stockpiles should be monitored and controlled to prevent establishment and spread control should not reduce vegetative cover such that the stockpile erodes due to exposure of the soil
- Topsoil stockpiles (particularly silty soil materials) may be sprayed with a soil binding agent to stabilise the surface against rain or wind erosion
- Effort should be made to reduce the time between excavation and backfill with stockpiles preferably not be stored for periods greater than 3 months
- Control of weeds on the stockpiles needs to be carefully managed so as to prevent significantly reducing vegetative cover and exposing stockpiled soils to erosion
- Topsoil will be placed following subsoil reinstatement and will be re-spread to the topsoil strip depth so that there is no exposed sub-surface material
- The topsoil will be respread to a minimum depth of 0.1 m of cover over the entire disturbed area to be reinstated
- Soil compaction will be removed by cultivation prior to spreading topsoil and following spreading topsoil.

4.2 Subsoil Management

The objective of subsoil management is to:

- Prevent contamination of topsoil
- Prevent degradation of the subsoil structure
- Avoid or ameliorate subsoil constraints immediately below topsoils
- Ensure reinstatement of soil horizons in the correct order and depths.

Subsoil management measures include:

- Subsoil will be removed and stockpiled separately from topsoil to prevent mixing with topsoil and, ideally, stockpiles should be located close to where they are sourced
- Subsoil material reinstated will be adequately compacted within the trench to ensure minimal subsidence
- Ripping or cultivation of the reinstated subsoil may be required to overcome any compaction that occurs during stockpiling and the reinstatement procedure
- Excess subsoil will be stockpiled separately for disposal by burial in borrow pits or quarries, or as fill on the property owner's land if requested by the property owner, or for other infrastructure uses. However, prior to the use as fill or for other infrastructure uses that may expose the material to erosion, the material should be analysed to assess its suitability for the purpose
- Monitoring for dispersion and erosion, particularly of exposed sodic subsoils. Any evidence of erosion may require the addition of ameliorants such as gypsum or lime. The type of ameliorant used should be decided by the pH of the exposed material and the quantity should be decided by the amount of exchangeable sodium. Refer to **Table 4-1** for an estimation of the rate of gypsum/lime addition required for each soil mapping unit

4.3 Soil Amelioration and Fertilisers

Recommended soil amelioration and fertiliser rates to mitigate potential impacts to soils during the Project construction activities are presented in **Table 4-1**. Soil amelioration rates for all soils within the Project area are presented in **Table 4-1**. Subsoil gypsum or lime is to be applied to all areas of disturbed subsoil and is to be applied post trenching rather than incorporated through all subsoil during reinstatement.

4.3.1 Fertiliser Application

Fertiliser is used to provide a readily-available source of nutrients to supplement the natural soil fertility to maximise the growth of seeded areas following reinstatement. Fertiliser rates have been developed based on the laboratory results of topsoil fertility. Fertiliser should be applied at the time of seeding to limit the amount of nutrient loss associated with leaching, loss to atmosphere, or uptake by undesirable plant species. Landholders may request a fertiliser rate or type is different from that specified in this plan.

4.3.2 Gypsum and Lime Application

Gypsum is used to ameliorate sodic soil material which has been disturbed or exposed during construction activities. The amelioration is required to facilitate effective erosion and sediment control and the successful rehabilitation of disturbed land.

The calculated rate for the Project uses a target Exchangeable Sodium Percentage (ESP) of 5%, 75% gypsum purity and an 80% efficiency factor (these values are toward the low end of recommended ranges). The method used to determine the subsoil gypsum rate involves the calculation of the individual gypsum treatment rate for each sampled depth down the subsoil profile for a particular sample site, then averaging these rates to determine an overall treatment rate for the subsoil at a site (this assumes the mixing of the full subsoil profile).

The gypsum treatment rate for each soil type is based on the maximum gypsum application rate for sites within specific soil groups. Gypsum treatment rates have only been calculated based on ameliorating sodicity. Recommended gypsum application rates for the soil units occurring within the Project area are presented in **Table 4-1** and have been calculated using laboratory analysis results for all sites across the Project area.

The use of lime is used to ameliorate highly acid soils where the pH may limit rehabilitation outcomes. The liming rate is estimated for each soil type is based on the texture and chemical characteristics of the soils. Recommended lime application rates for the soil units occurring within the Project area are presented in **Table 4-1**.

Gypsum is to be applied to:

- Topsoil prior to stripping (where required, **Table 4-2**), unless agricultural lime is specified;
- Trench areas where topsoil has been stripped and subsoil with a required gypsum application rate is disturbed or where runoff with high turbidity needs to be controlled. To assist sediment flocculation during the construction phase (1t/ha)
- Reinstated subsoil on trench RoW (**Table 4-2**)
- Any areas of disturbed subsoil (refer to **Table 4-2** for rate).

Where access tracks require levelling and are on Vertosols with gilgai, gypsum is to be applied to the topsoil pre-stripping and to the subsoil following levelling and prior to topsoil respreading (refer to **Table 4-2** for rates).

4.3.3 Gypsum Application on Melonhole Gilgai Soils

The Vertosols with gilgai (VEg) can have some highly saline and sodic conditions near the surface in natural conditions. At the surface, mounds generally have low to moderate salt levels and are sodic to strongly sodic. Just below the surface (commonly within 100 mm) these levels increase rapidly, and salt in particular will be a limiting factor for plant growth. At the surface, depressions generally have low salt levels which commonly increase to high below 300 mm depth. The depressions are generally sodic in the surface increasing to strongly sodic below 100 mm.

Construction activities on Vertosols with gilgai (VEg) will generally require levelling to be conducted. In these areas, topsoil is stripped (refer to **Section 4.1**) and then the subsoil levelled.

Table 4-1 Soil Management Recommendations

Soil unit	ASC	Topsoil amelioration	Rate (t/ha)	Subsoil amelioration	Rate (t/ha)	Fertiliser	Rate (kg/ha)
Qa-TE	Tenosols and Rudosols	Gypsum	1	Nil	-	MAP or equivalent	60
Qa-DE	Dermosols	Gypsum	1	Gypsum	3	MAP or equivalent	80
C-SO	Sodosols	Gypsum	1	Gypsum	3	MAP or equivalent	80
C-DEal	Dermosols	Gypsum	2	Gypsum	5	MAP or equivalent	100

Soil unit	ASC	Topsoil amelioration	Rate (t/ha)	Subsoil amelioration	Rate (t/ha)	Fertiliser	Rate (kg/ha)
C-DEac	Dermosols	Lime	2	Lime	2	MAP or equivalent	100
C-DEka	Dermosols	Lime	1	Lime	1	MAP or equivalent	80
C-KU	Kurosols	Lime	2	Lime	2	MAP or equivalent	80
C-VE	Vertosols	Gypsum	1	Gypsum	5	MAP or equivalent	100
C-RU	Rudosols	Gypsum	1	Nil	-	MAP or equivalent	60

4.4 Post Construction Rehabilitation and Clean-up

Rehabilitation will be undertaken in accordance with the Australian Pipeline Industry Association (APIA) 'Code of Environmental Practice: Onshore Pipelines' (2013) and in consultation with landholders including:

- Compaction relief shall be undertaken, as required, by ripping or scarifying soils along the contours
- As necessary, the pipeline corridor shall be re-profiled to original or stable contours, re-establishing surface drainage lines and other land features
- Where topsoil has been removed, it shall be respread, or clean topsoil imported where there are insufficient stockpiles. Biosecurity measures shall be applied to imported topsoil
- Erosion and sediment control measures shall be installed as necessary to manage the disturbed area whilst revegetation occurs (**Section 4.6**)
- Seed stock (grubbed material) should be respread and/or pasture and cover crop sown in accordance with the rehabilitation plan to assist natural regeneration. Surface roughness is encouraged when spreading topsoil in order to trap water and seeds
- The cleared RoW will be re-profiled to a stable landform consistent with the surrounding area by establishing drainage lines and slopes with low erosive potential, replacing topsoil evenly over subsoil and establishing a protective vegetative cover by seeding with grass species.
- Reinstatement of the RoW will not result in permanent settlement mounds being left. Temporary raised profile (camber) over the trench may be present temporally between backfilling and compaction and will be levelled off during compaction.

Establishing vegetation as an effective ground cover is a key element of stabilising soils and landscapes. Grasses are particularly effective because of their fibrous root systems. Progressive rehabilitation is standard following pipeline construction, generally commencing as soon as all pipeline infrastructure is in place and continuous access along the easement is no longer required.

Temporary facilities (including construction gates) required for construction will be removed and the areas restored to equal or better condition. The use of soil binder and seeding may be carried out in areas at risk of erosion.

All waste materials will be removed from the work area, and recycled, or disposed of.

Areas required to remain open for ongoing operational access for project operations (access tracks and areas above pipelines) will be revegetated with pasture grasses (where grazing and cropping is the final land use), or native grasses and ground cover species (where native vegetation is the final land use).

4.4.1 Seeding at Reinstatement

Seeding requirements are to be selected based on the final land use and may be subject to change by the landholders. The seeding mixes included in this plan have been chosen based on the following:

- Species adapted to local soils and rainfall
- Range of species to allow flexibility depending on seed availability
- Legumes included to improve long term growth
- Mix of species to encourage persistence
- Species include stoloniferous and tussock grasses to provide good cover

- Species are desirable for the land use
- Cover crop with seasonal specific species for quick cover establishment.

The following seed mixes, cover crops and associated application rates are to be applied when rehabilitating disturbed areas. The cover crops are to be applied to all seed mixes taking into consideration seasonality:

- Summer – Japanese millet or French millet at 20 kg/ha
- Winter – Barley, oats, wheat or rye grass (Italian or perennial) at 20 kg/ha

Pasture heavy soils (Vertosols and Dermosols)

- *Seed mix* – Biloela Buffel (30%), Creeping Blue Grass (Bissett Hatch) (20%), Katambora Rhodes (20%), Indian Blue Grass (10%), Bambatsii Panic (10%), Burgundy Bean (10%)
- *Application rate* – 10 kg/ha

Pasture light soils (Tenosols, Rudosols, Sodosols, Kandosols)

- *Seed mix* – USA buffel (25%), Gayndah buffel (25%), Creeping Blue Grass (Bissett Hatch) (10%), Indian Blue Grass (10%), Siran stylo (10%), Amiga stylo (10%), Wynn Cassia (10%)
- *Application rate* – 10 kg/ha

Remnant vegetation

- Natural regeneration is the preferred option, with use of mulch as cover for erosion protection
- Any groundcover vegetative material (grubbed material) removed from the RoW prior to construction is to be respread following construction to provide natural seed stock and/or organic matter to assist revegetation
- Any mulched vegetation is to be respread across the RoW following construction
- If there is insufficient mulch, seed with cover crop

Cultivated areas

- Cover crop or as directed by landholder.

4.5 Erosion and Sediment Control

The erosion and sediment control measures for the proposed works will follow the Australian Pipeline Industry Association (APIA) 'Code of Environmental Practice: Onshore Pipelines' (2013) standards and requirements. The minimum requirements are outlined in Section 9.7 and Appendix 4 of the Code of Environmental Practice. Where mulch is available, it should be used to form filtration berms and for erosion control.

4.6 Soil Management Measures

Key general soil management measures for the Reedy Creek to Wallumbilla Pipeline are listed below and recommended soil management measures for specific pipeline segments are presented in **Table 4-2**.

- Minimise major soil disturbance during those periods with a high risk of erosive rainfall events and monitor weather conditions to be prepared in advance for storm events at any time.
- All soils have the potential to produce dust depending on moisture content, vegetative cover and vehicular traffic. Soils with high silt and fine sand contents are likely to be more susceptible than those with medium to coarse sand and clay. Minimise dust production on susceptible soils by regular watering during construction activities and through traffic management.
- High intensity of trench breakers may be required on sloping land where rocky/highly permeable or strongly sodic subsoil material.

Table 4-2 Soil Management Measures for the Reedy Creek to Wallumbilla Pipeline

Approx. chainage (m)			Approx. co-ordinates		Soil Type			Topsoil surface amelioration pre-stripping (A horizon)		Observed topsoil depth (mm)	Track topsoil strip (mm)	Topsoil strip (mm)	Subsoil amelioration pre-topsoil respreading (B horizon)		Rehabilitation fertiliser		Rehabilitation seeding	Mapped SCL	Evidence of cropping	Surface rock	Erosion	Geology	Comments
start	finish	distance	Start	Finish	Soil unit	Gilgai	ASC	Type	Rate (t/ha)				Type	Rate (t/ha)	Type	Rate (kg/ha)						
0.0	249.2	249.2	737543 7082670	737313 7082657	C-VE		VEAD	Gypsum	1	100	100	100	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Ji	Geol unit mapped as Klm should be Ji, Grey Vertosol, subdominant Dermosol
249.2	362.7	113.6	737313 7082657	737201 7082643	C-SO		SOAD	Gypsum	1	300	100	300	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		sheet and gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
362.7	394.7	31.9	737201 7082643	737169 7082640	C-SO		SOAD	Gypsum	1	300	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		sheet and gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
394.7	417.1	22.4	737169 7082640	737147 7082637	C-SO		SOAD	Gypsum	1	300	100	200	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No		sheet and gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
417.1	424.9	7.8	737147 7082637	737139 7082636	C-SO		SOAD	Gypsum	1	300	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		sheet and gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
424.9	607.3	182.4	737139 7082636	737074 7082497	C-SO		SOAD	Gypsum	1	300	100	300	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		sheet and gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
607.3	1469.6	862.2	737074 7082497	737197 7081644	C-SO		SOAD	Gypsum	1	300	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		sheet and gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
1469.6	1540.5	70.9	737197 7081644	737207 7081573	Qa-TE		TEIO	Gypsum	1	450	100	200	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Qa	All profile suitable, acidic pH, sandy alluvium out of Klm
1540.5	1722.0	181.5	737207 7081573	737233 7081394	C-SO		SOAD	Gypsum	1	300	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		gully erosion	Klm	Suitable material 150 to 350mm, fine sandy clay loam surface, sporadic to conspicuous bleached A2, neutral to acidic pH, some areas of DE near facility
1722.0	1831.2	109.3	737233 7081394	737249 7081286	Qa-TE		TEIO	Gypsum	1	450	100	200	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Qa	All profile suitable, acidic pH, sandy alluvium out of Klm
1831.2	2402.0	570.7	737249 7081286	737330 7080721	C-SO		SOAE	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		gully erosion	Klm	Fine sandy clay loam surface, acidic (5.5) subsoil over weathered sandstone at 60cm. subdominant Kurosols
2402.0	2546.5	144.5	737330 7080721	737351 7080578	Qa-TE		TEIO	Gypsum	1	450	100	200	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Qa	all profile suitable, slightly acidic pH throughout, narrow alluvial area out of Klm
2546.5	3051.9	505.4	737351 7080578	737398 7080081	C-SO		SOAB	Gypsum	1	100	100	100	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		gully erosion	Klk	fine sandy clay loam surface, neutral pH, large gullies where concentrated flows
3051.9	4286.3	1234.4	737398 7080081	736881 7078963	C-SO		SOAB	Gypsum	1	100	100	100	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No		gully erosion	Klk	fine sandy clay loam surface, neutral pH, large gullies where concentrated flows
4286.3	4362.8	76.5	736881 7078963	736839 7078899	C-SO		SOAB	Gypsum	1	100	100	100	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		gully erosion	Klk	fine sandy clay loam surface, neutral pH, large gullies where concentrated flows
4362.8	5264.1	901.3	736839 7078899	736356 7078139	C-SO		SOAD	Gypsum	1	550	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Klm	Shallow TE and RU in parts, fine sandy loam surface, neutral to acidic
5264.1	5617.8	353.7	736356 7078139	736176 7077835	C-SO		SOAD	Gypsum	1	550	100	300	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Klm	Shallow TE and RU in parts, fine sandy loam surface, neutral to acidic
5617.8	5627.7	9.9	736176 7077835	736171 7077826	C-SO		SOAD	Gypsum	1	550	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Klm	Shallow TE and RU in parts, fine sandy loam surface, neutral to acidic
5627.7	5665.1	37.4	736171 7077826	736151 7077794	C-SO		SOAD	Gypsum	1	550	100	200	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No			Klm	Shallow TE and RU in parts, fine sandy loam surface, neutral to acidic
5665.1	5673.5	8.4	736151 7077794	736147 7077787	C-SO		SOAD	Gypsum	1	550	100	300	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	No			Klm	Shallow TE and RU in parts, fine sandy loam surface, neutral to acidic

Approx. chainage (m)			Approx. co-ordinates		Soil Type			Topsoil surface amelioration pre-stripping (A horizon)		Observed topsoil depth (mm)	Track topsoil strip (mm)	Topsoil strip (mm)	Subsoil amelioration pre-topsoil respreading (B horizon)		Rehabilitation fertiliser		Rehabilitation seeding	Mapped SCL	Evidence of cropping	Surface rock	Erosion	Geology	Comments
start	finish	distance	Start	Finish	Soil unit	Gilgai	ASC	Type	Rate (t/ha)				Type	Rate (t/ha)	Type	Rate (kg/ha)							
5673.5	5676.0	2.5	736147 7077787	736146 7077785	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	No	2-10% 60-200mm		Klk	suitable up to 200mm, VEAB subdominant
5676.0	6847.7	1171.7	736146 7077785	735728 7076709	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No	2-10% 60-200mm		Klk	suitable up to 200mm, VEAB subdominant
6847.7	8699.1	1851.3	735728 7076709	735453 7074888	C-VE	Gilgai	VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Klk	suitable 100 to 150mm, DEAB subdominant
8699.1	8997.8	298.8	735453 7074888	735405 7074593	Qa-TE		RUER	Gypsum	1	200	100	200	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	all profile suitable for use, large alluvial terrace
8997.8	9034.6	36.8	735405 7074593	735399 7074557	Qa-TE		RUER	Gypsum	1	200	100	200	Nil	0	MAP or equivalent	60	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	No			Qa	all profile suitable for use, large alluvial terrace
9034.6	9425.4	390.8	735399 7074557	735309 7074181	Qa-TE		RUER	Gypsum	1	200	100	200	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	all profile suitable for use, large alluvial terrace
9425.4	10540.8	1115.4	735309 7074181	735049 7073109	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Possible old cultivation			Klk	sandy clay loam over light clay, alkaline, poplar box
10540.8	10698.1	157.3	735049 7073109	734971 7072973	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		Possible old cultivation			Klk	sandy clay loam over light clay, alkaline, poplar box
10698.1	11039.4	341.3	734971 7072973	734764 7072701	C-DEac		DEAE	Lime	2	700	100	200	Lime	2	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		sheet and gully erosion	Kln	Colluvial deposition from Kln and Kli, acidic, weak to moderate structure
11039.4	11087.3	47.9	734764 7072701	734735 7072663	C-DEac		DEAE	Lime	2	700	100	200	Lime	2	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch		No		sheet and gully erosion	Kln	Colluvial deposition from Kln and Kli, acidic, weak to moderate structure
11087.3	11267.3	180.0	734735 7072663	734625 7072521	C-DEac		DEAE	Lime	2	700	100	200	Lime	2	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		sheet and gully erosion	Kln	Colluvial deposition from Kln and Kli, acidic, weak to moderate structure
11267.3	11818.4	551.1	734625 7072521	734312 7072067	C-DEac		DEAE	Lime	2	700	100	200	Lime	2	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch		No		sheet and gully erosion	Kln	Colluvial deposition from Kln and Kli, acidic, weak to moderate structure
11818.4	11978.9	160.4	734312 7072067	734211 7071947	C-RU		RUCY	Gypsum	1	100	100	100	Nil	0	MAP or equivalent	60	Mulch or Cover crop (20kg/ha) if insufficient mulch		No			Kli	topsoil nil to 100mm, exposed sandstone bedrock
11978.9	12056.9	78.1	734211 7071947	734186 7071873	C-RU		RUCY	Gypsum	1	100	100	100	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Kli	topsoil nil to 100mm, exposed sandstone bedrock
12056.9	12190.3	133.4	734186 7071873	734165 7071742	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Klk	brigalow regrowth and bottle tree, some VE areas, alkaline subsoil
12190.3	13495.8	1305.5	734165 7071742	734235 7070455	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Klk	brigalow regrowth and bottle tree, some VE areas, alkaline subsoil
13495.8	13599.6	103.8	734235 7070455	734271 7070357	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Klk	brigalow regrowth and bottle tree, some VE areas, alkaline subsoil
13599.6	14538.4	938.8	734271 7070357	734356 7069424	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Klk	brigalow regrowth and bottle tree, some VE areas, alkaline subsoil
14538.4	14645.2	106.8	734356 7069424	734366 7069317	Qa-DE		DEAB	Gypsum	1	300	100	300	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	neutral throughout, moderate structure, terrace flat
14645.2	14764.1	118.9	734366 7069317	734377 7069199	Qa-DE		DEAB	Gypsum	1	300	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Qa	neutral throughout, moderate structure, terrace flat
14764.1	14774.9	10.8	734377 7069199	734378 7069188	Qa-DE		DEAB	Gypsum	1	300	100	300	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	neutral throughout, moderate structure, terrace flat
14774.9	15295.8	520.9	734378 7069188	734413 7068676	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Klk	Similar soils to #45, some areas of VEAB,

Approx. chainage (m)			Approx. co-ordinates		Soil Type			Topsoil surface amelioration pre-stripping (A horizon)		Observed topsoil depth (mm)	Track topsoil strip (mm)	Topsoil strip (mm)	Subsoil amelioration pre-topsoil respreading (B horizon)		Rehabilitation fertiliser		Rehabilitation seeding	Mapped SCL	Evidence of cropping	Surface rock	Erosion	Geology	Comments
start	finish	distance	Start	Finish	Soil unit	Gilgai	ASC	Type	Rate (t/ha)				Type	Rate (t/ha)	Type	Rate (kg/ha)							
15295.8	15887.2	591.3	734413 7068676	734318 7068092	C-SO		SOAB	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		Sheet and gully erosion	Kli	Exposed bedrock in parts, small areas with deeper soils in mid/lower slope positions
15887.2	16134.6	247.4	734318 7068092	734279 7067848	C-SO		SOAB	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		Sheet and gully erosion	Kli	Exposed bedrock in parts, small areas with deeper soils in mid/lower slope positions
16134.6	16193.2	58.6	734279 7067848	734269 7067790	C-SO		SOAB	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No		Sheet and gully erosion	Kli	Exposed bedrock in parts, small areas with deeper soils in mid/lower slope positions
16193.2	16421.2	228.1	734269 7067790	734233 7067565	C-RU		RUCY	Gypsum	1	150	100	150	Nil	0	MAP or equivalent	60	Mulch or Cover crop (20kg/ha) if insufficient mulch		No	bedrock and 20-50% 20-60mm	sheet and gully erosion	Kld	Shallow rocky soil, cobble common on surface and throughout, exposed sandstone bedrock
16421.2	16546.8	125.6	734233 7067565	734212 7067441	C-RU		RUCY	Gypsum	1	150	100	150	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	bedrock and 20-50% 20-60mm	sheet and gully erosion	Kld	Shallow rocky soil, cobble common on surface and throughout, exposed sandstone bedrock
16546.8	16704.0	157.2	734212 7067441	734187 7067286	C-SO		SOAB	Gypsum	1	100	100	100	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		sheet and gully erosion	Kli	Surface cobble common, some eroded areas
16704.0	16768.9	65.0	734187 7067286	734177 7067222	C-SO		SOAB	Gypsum	1	100	100	100	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		sheet and gully erosion	Kli	Surface cobble common, some eroded areas
16768.9	17409.0	640.1	734177 7067222	734074 7066590	C-DEal		DEAB	Gypsum	2	100	100	100	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Klk	Box and brigalow regrowth, alkaline at depth, clay loam surface
17409.0	17458.8	49.8	734074 7066590	734066 7066541	Qa-DE		DEAB	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		stream bank	Qa	Small alluvial plain, RUER in parts
17458.8	17528.9	70.1	734066 7066541	734055 7066471	C-SO		SOAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Old cultivation			Kli	sandy loam surface over light clay subsoil, alkaline with carbonate at depth over sandstone
17528.9	17835.2	306.3	734055 7066471	734006 7066169	C-SO		SOAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	Old cultivation			Kli	sandy loam surface over light clay subsoil, alkaline with carbonate at depth over sandstone
17835.2	18254.2	419.1	734006 7066169	733938 7065755	C-SO		SOAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Old cultivation			Kli	sandy loam surface over light clay subsoil, alkaline with carbonate at depth over sandstone
18254.2	19321.1	1066.9	733938 7065755	733737 7064708	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - against edges			T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
19321.1	19826.3	505.1	733737 7064708	733670 7064207	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
19826.3	19852.6	26.3	733670 7064207	733666 7064181	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
19852.6	21459.3	1606.7	733666 7064181	732934 7062905	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
21459.3	21494.2	34.9	732934 7062905	732905 7062885	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
21494.2	21532.5	38.3	732905 7062885	732874 7062863	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
21532.5	21561.6	29.1	732874 7062863	732850 7062847	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts

Approx. chainage (m)			Approx. co-ordinates		Soil Type			Topsoil surface amelioration pre-stripping (A horizon)		Observed topsoil depth (mm)	Track topsoil strip (mm)	Topsoil strip (mm)	Subsoil amelioration pre-topsoil respreading (B horizon)		Rehabilitation fertiliser		Rehabilitation seeding	Mapped SCL	Evidence of cropping	Surface rock	Erosion	Geology	Comments
start	finish	distance	Start	Finish	Soil unit	Gilgai	ASC	Type	Rate (t/ha)				Type	Rate (t/ha)	Type	Rate (kg/ha)							
21561.6	22113.1	551.5	732850 7062847	732397 7062531	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - against edges	10-20% 20-60mm		T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
22113.1	23615.4	1502.2	732397 7062531	731165 7061672	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - against edges			T	observed from 100-150mm, 200 suitable, pH inversion, common surface cobble in parts
23615.4	24304.0	688.6	731165 7061672	730600 7061278	C-DEal		DEAB	Gypsum	2	200	100	200	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Old cultivation - on edge			Kld	occasional surface cobble, pH inversion, gypsum
24304.0	24847.9	543.9	730600 7061278	730154 7060967	C-VE		VEAD	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Old cultivation - on edge			Kld	Strong cracking and surface mulch, check observation only, near boundary between Kld and T
24847.9	26298.4	1450.5	730154 7060967	728964 7060137	Qa-DE		DEAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	Small areas of Kld in this unit, Kangaroo Creek, alkaline at depth, A1 silty?
26298.4	26389.1	90.7	728964 7060137	728890 7060085	Qa-DE		DEAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No			Qa	Small areas of Kld in this unit, Kangaroo Creek, alkaline at depth, A1 silty?
26389.1	26476.6	87.5	728890 7060085	728818 7060035	Qa-DE		DEAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	Small areas of Kld in this unit, Kangaroo Creek, alkaline at depth, A1 silty?
26476.6	26989.6	513.0	728818 7060035	728397 7059742	C-DEac		DEAB	Lime	2	100	100	100	Lime	2	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No	2-10% 20-60mm		Kld	acidic at depth, 150mm suitable, very gently sloping plain landform
26989.6	27567.9	578.3	728397 7059742	727923 7059411	C-DEac		DEAB	Lime	2	100	100	100	Lime	2	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	2-10% 20-60mm		Kld	acidic at depth, 150mm suitable, very gently sloping plain landform
27567.9	27569.3	1.4	727923 7059411	727922 7059410	C-DEac		DEAB	Lime	2	100	100	100	Lime	2	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch		No	2-10% 20-60mm		Kld	acidic at depth, 150mm suitable, very gently sloping plain landform
27569.3	28028.8	459.6	727922 7059410	727768 7058997	C-DEac		DEAB	Lime	2	100	100	100	Lime	2	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	2-10% 20-60mm		Kld	acidic at depth, 150mm suitable, very gently sloping plain landform
28028.8	28152.7	123.8	727768 7058997	727741 7058877	C-KU		KUAD	Lime	2	300	100	200	Lime	2	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	2-10% 20-60mm	gully erosion	Kld	A2j development, pH 4.5 at depth, common surface rock in parts, gully erosion
28152.7	28265.8	113.1	727741 7058877	727716 7058766	C-KU		KUAD	Lime	2	300	100	200	Lime	2	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No	2-10% 20-60mm	gully erosion	Kld	A2j development, pH 4.5 at depth, common surface rock in parts, gully erosion
28265.8	28449.1	183.3	727716 7058766	727553 7058688	C-KU		KUAD	Lime	2	300	100	200	Lime	2	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	2-10% 20-60mm	gully erosion	Kld	A2j development, pH 4.5 at depth, common surface rock in parts, gully erosion
28449.1	30345.2	1896.1	727553 7058688	726529 7057244	C-DEka		DEAB	Lime	1	150	100	150	Lime	1	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No			Kld	200mm suitable, clay loam surface over light clay subsoil, weak to moderate structure only - KAAB?
30345.2	30546.9	201.6	726529 7057244	726497 7057045	C-RU		RUCY/ DEAB	Gypsum	1	150	100	150	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	bedrock and <2% 20-60mm	gully erosion	Kld	topsoil ranges from nil to 150mm, exposed sandstone bedrock common, acidic pH
30546.9	30800.1	253.3	726497 7057045	726463 7056794	C-RU		RUCY/ DEAB	Gypsum	1	150	100	150	Nil	0	MAP or equivalent	60	Mulch or Cover crop (20kg/ha) if insufficient mulch		No	bedrock and <2% 20-60mm	gully erosion	Kld	topsoil ranges from nil to 150mm, exposed sandstone bedrock common, acidic pH
30800.1	30804.9	4.8	726463 7056794	726463 7056789	C-RU		RUCY/ DEAB	Gypsum	1	150	100	150	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No	bedrock and <2% 20-60mm	gully erosion	Kld	topsoil ranges from nil to 150mm, exposed sandstone bedrock common, acidic pH
30804.9	30824.0	19.1	726463 7056789	726464 7056770	C-RU		RUCY/ DEAB	Gypsum	1	150	100	150	Nil	0	MAP or equivalent	60	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No	bedrock and <2% 20-60mm	gully erosion	Kld	topsoil ranges from nil to 150mm, exposed sandstone bedrock common, acidic pH
30824.0	31034.4	210.4	726464 7056770	726406 7056593	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qs	200mm suitable, poly a mix of Qa and QS, scale too small to split, Qa neutral, Qs pH inversion with gypsum
31034.4	31141.0	106.5	726406 7056593	726319 7056532	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch	SCL	No			Qs	200mm suitable, poly a mix of Qa and QS, scale too small to split, Qa neutral, Qs pH inversion with gypsum
31141.0	33039.8	1898.9	726319 7056532	724628 7056463	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qs	200mm suitable, poly a mix of Qa and QS, scale too small to split, Qa neutral, Qs pH inversion with gypsum
33039.8	33765.4	725.6	724628 7056463	724217 7056146	C-DEal		DEAB	Gypsum	2	100	100	100	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No	20-50% 20-200mm		Qs	150mm suitable, pH inversion, gypsum, common surface cobble

Approx. chainage (m)			Approx. co-ordinates		Soil Type			Topsoil surface amelioration pre-stripping (A horizon)		Observed topsoil depth (mm)	Track topsoil strip (mm)	Topsoil strip (mm)	Subsoil amelioration pre-topsoil respreading (B horizon)		Rehabilitation fertiliser		Rehabilitation seeding	Mapped SCL	Evidence of cropping	Surface rock	Erosion	Geology	Comments
start	finish	distance	Start	Finish	Soil unit	Gilgai	ASC	Type	Rate (t/ha)				Type	Rate (t/ha)	Type	Rate (kg/ha)						
33765.4	34252.6	487.1	724217 7056146	724143 7055665	Qa-DE		DEAB	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	A2 present, 200mm suitable, alkaline at depth
34252.6	35226.5	973.9	724143 7055665	723978 7054706	C-DEal		DEAB	Gypsum	2	100	100	100	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Old cultivation	10-20% 60-200mm		Qs	150mm suitable, alkaline with gypsum, common surface cobble
35226.5	35571.8	345.4	723978 7054706	723925 7054364	Qa-DE		DEAB	Gypsum	1	100	100	100	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	150mm suitable, alkaline, alluvial area
35571.8	37844.1	2272.2	723925 7054364	723529 7052141	C-DEal		DEAA	Gypsum	2	100	100	100	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	On edge of cultivation for part	20-50% 20-60mm		Kld	150mm suitable, common surface rock QZ, IS
37844.1	38308.6	464.5	723529 7052141	723386 7051717	C-VE		VEAE	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	On edge of cultivation	10-20% 20-60mm		Kld	Large cracks, pH inversion with gypsum, common surface QZ, IS
38308.6	38710.6	402.0	723386 7051717	723116 7051422	C-DEal		DEAB	Gypsum	2	150	100	150	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Kld	No site here, identified by drive through, small alluvial area plus lower slope similar to #32
38710.6	39930.2	1219.6	723116 7051422	722845 7050254	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Cultivation - mostly on edge			Kld	pH inversion, gypsum, large cracks
39930.2	40112.0	181.8	722845 7050254	722857 7050073	Qa-DE		DEAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Cultivation half			Qa	Alluvial area crosses road, neutral with alkaline at 120cm, fine sandy clays throughout
40112.0	40199.0	87.0	722857 7050073	722863 7049986	Qa-DE		DEAB	Gypsum	1	200	100	200	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		Cultivation half			Qa	Alluvial area crosses road, neutral with alkaline at 120cm, fine sandy clays throughout
40199.0	40208.1	9.1	722863 7049986	722864 7049977	C-VE	Gilgai	VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Mulch or Cover crop (20kg/ha) if insufficient mulch		Active cultivation - along edge	10-20% (20-50% in parts) 20-60mm		Kld	relict gilgai in trees, cultivated out, 20-50% surface rock in parts
40208.1	42356.3	2148.2	722864 7049977	722512 7047887	C-VE	Gilgai	VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - along edge	10-20% (20-50% in parts) 20-60mm		Kld	relict gilgai in trees, cultivated out, 20-50% surface rock in parts
42356.3	42477.6	121.3	722512 7047887	722474 7047772	C-VE		VEAD	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No			Qa	alkaline, narrow alluvial area
42477.6	45610.1	3132.4	722474 7047772	719898 7046061	C-VE		VEAB	Gypsum	1	150	100	150	Gypsum	5	MAP or equivalent	100	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	Active cultivation - apart from southern section	2-20% (20-50% in parts) 20-60mm		Kld	observed topsoil 100-200mm, alkaline, #39 pH inversion with gypsum
45610.1	46000.5	390.4	719898 7046061	719564 7045860	Qa-DE		DEAD	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		stream bank	Qa	alkaline at 600mm, avail material to 200mm. weak A2 dev.
46000.5	46056.7	56.3	719564 7045860	719516 7045831	Qa-DE		DEAD	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		stream bank	Qa	alkaline at 600mm, avail material to 200mm. weak A2 dev.
46056.7	46109.8	53.1	719516 7045831	719470 7045804	Qa-DE		DEAD	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Mulch or Cover crop (20kg/ha) if insufficient mulch		No		stream bank	Qa	alkaline at 600mm, avail material to 200mm. weak A2 dev.
46109.8	46128.3	18.6	719470 7045804	719454 7045794	Qa-DE		DEAD	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)		No		stream bank	Qa	alkaline at 600mm, avail material to 200mm. weak A2 dev.
46128.3	46232.1	103.8	719454 7045794	719354 7045788	Qa-DE		DEAD	Gypsum	1	150	100	150	Gypsum	3	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No		stream bank	Qa	alkaline at 600mm, avail material to 200mm. weak A2 dev.
46232.1	47784.1	1552.0	719354 7045788	718011 7045261	C-DEal		DEAB	Gypsum	2	100	100	100	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No	10-20% (20-50% in parts) 20-60mm		Klc	~20-50% Ferruginised silcrete/sandstone cobble on surface, subdominant VEAB.
47784.1	48634.2	850.1	718011 7045261	717287 7045468	C-DEal		DEAB	Gypsum	2	100	100	100	Gypsum	5	MAP or equivalent	80	Pasture seed mix (10kg/ha) & Cover crop (20kg/ha)	SCL	No	10-20% (20-50% in parts) 20-60mm		Klc	~20-50% Ferruginised silcrete/sandstone cobble on surface, subdominant VEAB.

5 Strategic Cropping Land Assessment

The strategic cropping area (SCA) is an area of regional interest under the RPI Act. The SCA consists of the areas shown on the SCL Trigger Map as strategic cropping land (SCL).

SCL is defined by the Queensland Government as a scarce natural resource identified by soil, climatic and landscape features that make it highly suitable for crop production. Through the RPI Act, the government is seeking to manage the impact of resource activities on the SCA. It should also be noted that "the trigger maps are not a definitive measure of the extent of SCL" (DERM 2011). The SCL mapping and the proposed pipeline alignment is presented in **Figure 1-1**.

In accordance with recommendations outlined in RPI Act Guideline 9/14 this plan has been prepared by people with 'proven competencies in land and soil resource issues'. The following sections provide additional detail addressing the requirements of this Guideline, including information required to be presented in a Restoration Plan.

5.1 Impact of Proposed Pipeline

Whether or not an activity is likely to have a significant impact on the SCA depends on the scale and the effect of the impact on the SCA. Schedule 2 of the *Regional Planning Interests Regulation 2014* (RPI Regulation) provides criteria for assessment or decision of a proposed activity in the SCA. These criteria require an applicant to identify whether an activity will have a permanent impact on SCL. These criteria are further described in RPI Act Guideline 03/14 'Carrying out resource activities in the Strategic Cropping Area'.

An activity is considered to have a permanent impact on SCL if, because of the carrying out of the activity, the land cannot be restored to its pre-activity condition. Restoring the land means that the land is not only returned to its pre-activity use but that it is also returned to its pre-activity productive capacity or potential productive capacity.

Many of the soils within the Pipeline RoW have physical and chemical properties that make them particularly susceptible to disturbance. These include silt and fine sand in surface horizons (dust and surface condition issues), and subsoils that may be strongly acid, sodic and saline. Based on the proposed construction activities, the following impacts may occur without appropriate mitigation measures:

- Topsoil included in windrows of cleared vegetation making it unavailable for further use
- Compacted areas caused by vehicular traffic or inappropriate reinstatement of topsoil may not revegetate adequately unless ripped
- Shallow depth to subsoil material caused by inappropriate soil segregation or inadequate topsoil cover. This may lead to poor establishment of vegetation, high salinity/acidity/sodicity levels in surface or near surface soils favouring different plant species to those occurring nearby and poor ground cover that increases the potential for sediment losses
- Reduced fertility from nutrient leaching and loss of biological capital if soils are stockpiled (without vegetative cover) for extended periods
- Rill and sheet erosion of topsoils caused by inappropriate runoff control such as poor/delayed establishment of vegetative cover, topsoils left loose and incoherent, runoff allowed to concentrate and form channels on unprotected topsoils or in wheel ruts (i.e. inappropriate runoff control techniques and structures)
- Erosion and gullying of subsoil materials will occur if highly susceptible soils are not identified and appropriate erosion control measures used
- Erosion and gullying along pipeline with inappropriate backfill, compaction and rehabilitation
- Reduced water quality from increased loads of sediment and nutrients
- Physical barriers to overland flow (flooding) from excavated soil material left above ground
- Generation of dust through the degradation of soil structure caused by vehicle movement and inappropriately managed earthworks
- Loss of SCL.

5.1.1 Impact of Construction Activities

The total construction time for the Project is anticipated to take approximately 3-4 months. Any section or property with SCL may be under construction for between 1 week and 1 month, with access requirements to a particular section extending beyond this until hydrotesting and commissioning of the pipeline takes place. During this period, access and usage of the RoW may be restricted, and cropping may not be possible.

Recommended soil management measures presented in **Section 4** have been developed to minimise any potential impacts to the land and soil and return them to their pre-activity condition.

Management measures that mitigate potential construction impacts include:

- Removal of vegetative material from the RoW prior to construction and reinstatement following construction of any grubbed and mulched vegetation to provide seed stock and/or organic matter to assist revegetation and erosion protection
- Topsoil reserves identified, stripped, segregated and reinstated to similar depth to preserve soil depth and maintain soil structural condition, biological capital, fertility and overall productive potential
- Subsoil removed and stockpiled separately to prevent degrading topsoil reserves and reinstated to a similar bulk density of the surrounding soil to limit preferential drainage into the trenched areas
- Soil returned in the same order in which they have been removed and at similar depths to pre disturbance soil conditions
- Compaction relief conducted in areas compacted by construction activity to return the soil to comparable pre-construction conditions
- Construction period restricted to limit topsoil fertility decline from leaching and loss of biological capital
- Erosion and sediment control measures installed to reduce the loss of soil during the construction period, maintain soil volume, maintain the productive potential of adjacent land, and maintain water quality in nearby drainage features and waterways
- Use of soil binder and/or water trucks to reduce the generation of dust through the degradation of soil structure caused by vehicle movement and earthworks
- Use of fertiliser and gypsum to ameliorate natural soil conditions to optimise revegetation potential, enhance erosion mitigation and assisting in returning soils to their previous capability

5.1.2 Impact of Operational Activities

As the pipeline will be buried at depth, normal land use (as described in **Section 3.2**) can be resumed during operation of the gas pipeline and. No permanent impacts to SCL from operational activities should therefore occur. Even though operation of the completed pipeline will not have a permanent impact to SCL, the alignment and design of the infrastructure has been located to avoid or has been located on the edge of cropped areas to minimise disruption to cropping activities.

5.1.3 Impact of Decommissioning

There will be no impact in the decommissioning of the pipeline which will involve filling with inert material and leaving in situ.

5.2 Pre-activity Condition

The pre-activity condition of the land's soil (as required outlined in the RPI Act Guideline 9/14) is presented in **Section 3**.

5.3 Monitoring and Restoration Criteria for SCL

The primary objective of monitoring in the soil management plan is to ensure soil has been appropriately managed during all activities associated with the construction of the pipeline. This includes adopting appropriate remediation where environmental targets are not met.

Monitoring immediately post reinstatement

The purpose of post reinstatement monitoring is to identify if soil handling and management measures have been appropriately implemented.

- The quantities of rehabilitation topsoil should be balanced against stored stockpile inventories.
- Topsoil should be reinstated to pre-disturbance depths or to at least topsoil strip depths.
- No subsoil material at depths shallower than the topsoil strip depth.
- Structures designed to control runoff and trap sediment are functioning correctly
- No evidence of accelerated erosion.

Monitoring two years post reinstatement

The purpose of the post reinstatement monitoring is to assess if the soil amelioration and reinstated soil has reached the required equilibrium value so as to not pose a greater constraint compared to pre-activity levels. The reason for the proposed two-year timeframe is to allow for rainfall to leach salts and dissolve ameliorants such as gypsum/lime and reactions with the soil exchange to occur.

- Describe, sample and analyse sites to 0.6m to ensure that chemical constraints such as sodicity, salinity (Chloride) and acidity are not greater than pre-activity levels as per the SCL criteria. One site will be sampled per soil unit polygon that lies within mapped SCL areas, where the polygon is predominantly SCL. Comparisons will be made to soil laboratory results from site locations in this report
- Analyse topsoil to maintain levels of P, K and S.

A further monitoring event may be required if there has been low rainfall during the reinstatement monitoring period or if high rates of gypsum have been applied.

Corrective action

Corrective actions will be identified from the non-conformities of the reinstatement monitoring undertaken for the project.

6 Conclusions

A soil survey of the Reedy Creek to Wallumbilla pipeline project area was undertaken between 29 November and the 2 December 2016 which involved the description of 46 soil investigation sites. The survey was undertaken by a soil scientist experienced in soil survey and land resource assessment.

Of the 46 investigation sites, 14 sites were sampled and 54 soil samples were subsequently submitted for laboratory analysis.

The soils were mapped into nine soil types across the Project area. In addition to mapping soil types, individual UMAs were identified for observed topsoil depth and areas of gilgai to inform appropriate topsoil stripping depths. Soil management measures were developed for all soil units to minimise impacts to soil and land due to the proposed construction activities with a particular focus on SCL and areas at risk of erosion or other degradation processes. Gypsum and lime treatment rates were calculated to assist in the amelioration of sodicity and acidity of these soils. Suggested seeding mixes are included in the plan (subject to landholder agreement) to stabilise the land and return it to its pre-activity land use.

7 References and Additional Reading

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Appendix A – Representative Soil Profile Sites

SITE DESCRIPTION Soil Unit: Klm-CH Site: APA-1

Co-ordinates:	**Easting:** 737172	**Northing:** 7081748	**Zone:** 55	**Datum:** GDA94
ASC Soil Order:	Grey Chromosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	4%	**Runoff:**	Moderately rapid
Morphological type:	Mid-Slope	**Permeability:**	Slowly permeable
Landform element:	Hillslope	**Drainage:**	Moderately well drained
Landform pattern:	Rises	**Surface condition:**	Hardsetting
Relief modal class:	Undulating Rises	**Disturbance:**	Extensive to limited clearing
Coarse fragments:	Few medium ironstone and sandstone fragments	**Rock outcrop:**	Nil
Geology:	Mooga Sandstone (Klm) Quartzose to labile sandstone, some clayey; some sandstone, conglomerate		
Vegetation:	Cypress pine, soap box, Clarkson's Bloodwood, black wattle		

Site APA-1 landscape

Site APA-1 soil profile, surface at top left, 30cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.00-0.20	Brown (7.5YR 4/3); sandy clay loam texture; massive structure; pH 6.0; gradual change to -
A2e	0.20-0.35	Dull yellowish brown (10YR 5/3) to dull yellow orange (10YR 6/3); moist sandy clay loam texture; massive structure; pH 6.0; abrupt diffuse change to -
B21	0.35-0.85	Grayish brown (7.5YR 4/2); few medium distinct brown mottles; sandy loam medium clay texture; moderate subangular block structure; pH 6.5; gradual diffuse change to -
BC	0.85-1.20	Brownish grey (10YR 4/1); faint brown mottles; sandy clay loam; pH 7.0

Site: APA-1

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
6	<5.0	1.7	0.047	0.088	2	0.62	0.36	0.14	15.00	15.00	0.24

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0-0.1	8.8	7.1	73.2	10.9	6	0.01	VL	<10	0.21	0.75	0.33	0.31	<0.022	1.6	1.37%	NS	8	2.27
0.2-0.3	11.9	7.5	70.4	10.2	6.7	0.02	VL	13	<0.10	0.75	0.58	0.33	0.083	1.8	4.6%	NS	8	1.29
0.5-0.6	34.7	5	52.3	8	7.1	0.16	L	190	<0.10	0.85	1.6	0.27	0.52	3.3	15.8%	SS	2	0.53
0.85-0.95	28.8	8	55.6	8.2	8	0.28	M	340	<0.10	0.5	1.1	0.16	0.48	2.3	20.9%	SS	2	0.45
1.10-1.20	28.9	9.4	54.8	6.9	7.7	0.41	M	510	<0.10	1.4	3.2	0.41	1.7	6.8	25.0%	SS	2	0.44

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Klk-CH Site: APA4

Co-ordinates: **Easting:** 737227 **Northing:** 7079625 **Zone:** 55 **Datum:** GDA94

ASC Soil Order: Brown Chromosol **Sampler:** S. Pointon

LANDFORM

Slope:	2-3%	**Runoff:**	Rapid
Morphological type:	Mid-slope	**Permeability:**	Moderately permeable
Landform element:	Hill slope	**Drainage:**	Moderately well drained
Landform pattern:	Rises	**Surface condition:**	Hardsetting
Relief modal class:	Gently undulating rises	**Disturbance:**	Limited clearing
Coarse fragments:	Few medium sub-rounded sandstone and ironstone fragments	**Rock outcrop:**	Nil

Geology: Bungil Formation, Kingull Member (Klk) Clayey sandstone, carbonaceous mudstone

Vegetation: False sandalwood, popular box, cypress, Baradine red gum, carbeen

Site APA-4 landscape

Site APA-4 soil profile, surface at top right, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.00-0.10	Brownish black (10YR 3/2); fine sandy clay loam; massive structure, pH 5.5; clear change to -
B21	0.10-0.20	Brownish black (7.5YR 2/2); light medium clay; strong 10-20mm subangular block structure; pH 6.0; gradual change to -
B22	0.20-0.70	Dark brown (7.5YR 3/3); light medium clay; strong 10-20mm subangular block structure; pH 7.0; diffuse change to -
B23	0.70-1.20	Greyish brown (7.5YR 4/2); few medium distinct pale mottles; fine sandy light clay; massive 5-10mm subangular block structure; pH 7.0

Site: APA-4

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
6.4	9.8	1.1	0.065	0.21	2.9	1.2	0.67	0.39	39	47	2.1

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	16.3	12.1	65.2	6.4	6.4	0.03	VL	12	<0.10	1.8	1.8	0.35	0.2	4.3	4.7%	NS	2	1.00
0.2-0.3	44.9	8.6	42.7	3.8	7.5	0.27	M	320	<0.10	1.7	4.8	0.34	1.1	8	13.8%	S	2	0.35
0.5-0.6	36.1	8.3	50.8	4.8	8.1	0.39	M	470	<0.10	0.75	3.6	0.19	1.2	5.8	20.7%	SS	2	0.21
0.8-0.9	31.2	7.3	56	5.5	7.9	0.56	H	670	<0.10	0.8	4.2	0.2	1.6	6.9	23.2%	SS	1	0.19
1.1-1.2	31.1	9.8	53.8	5.3	6	0.56	H	650	<0.10	0.2	1.7	0.13	0.78	2.9	26.9%	SS	8	0.12

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Klk-VE Site: APA-8

Co-ordinates: **Easting:** 735635 **Northing:** 7076041 **Zone:** 55 **Datum:** GDA94

ASC Soil Order: Brown Vertosol **Sampler:** S. Pointon

LANDFORM

Slope:	2-3%	**Runoff:**	Moderately rapid
Morphological type:	Upper slope	**Permeability:**	Moderately permeable
Landform element:	Rise slope	**Drainage:**	Imperfectly drained
Landform pattern:	Rises	**Surface condition:**	Cracking/ self-mulching
Relief modal class:	Gently undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	Few angular cobble sandstone fragments	**Rock outcrop:**	-

Geology: Bungil Formation, Kingull Member (Klk) Clayey sandstone, carbonaceous mudstone

Vegetation: Brigalow, belah, buffel grass

Site APA-8 landscape

Site APA-8 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0-0.15	Greyish yellow brown (10YR 4/2); light medium clay; strong 5-10mm subangular block structure; 20-50mm calcareous with soft segregations of 2-6mm; pH 8.5; clear change to -
B21	0.15-0.50	Dull yellowish brown (10YR 5/3); very few medium faint pale mottles; light medium clay; strong 10-20mm subangular block structure; 2-10% calcareous with soft segregations of 2-6mm; pH 8.5; gradual change to -
B22	0.50-1.0	Dull yellowish brown (10YR 5/4); very few medium faint brown mottles; light medium clay; strong 10-20mm subangular block structure; <2% calcareous with soft segregations of 2-6mm; pH 8.5; gradual change to -
B23	1.0-1.2	Yellowish brown (10YR 5/6); light medium clay; strong 20-50mm angular block/lenticular structure; 2% calcareous with soft segregations 2-6mm; pH 8.5

Site: APA-8

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
8.7	5.6	2.1	0.16	1.2	6.1	2.4	1.4	0.42	8.4	6.6	0.31

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.-0.1	42.7	9.6	37.1	10.6	8.7	0.17	L	26	-	14	7.3	0.69	0.32	22	1.5%	NS	7	1.92
0.2-0.3	29.1	7.4	55.3	8.2	9	1.19	E	1000	-	9	13	0.23	4.4	27	16.3%	SS	6	0.69
0.5-0.6	33.6	9.8	47.7	8.9	9.2	0.48	H	340	-	11	12	0.22	2.8	26	10.8%	S	6	0.92
0.8-0.9	26.4	4.9	60.6	8.1	9.1	1.22	E	1100	-	7.5	12	0.28	4.8	25	19.2%	SS	2	0.63
1.1-1.2	32.9	9.6	50.1	7.4	9.1	1.25	E	1100	-	7	13	0.36	5.2	26	20.0%	SS	2	0.54

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Qa-RU Site: APA-10

Co-ordinates:	**Easting: 735424**	**Northing: 7074711**	**Zone:** 55	**Datum:** GDA94
ASC Soil Order:	Rudosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	0-1%	**Runoff:**	Very slow
Morphological type:	Flat	**Permeability:**	Rapidly permeable
Landform element:	Terrace Flat	**Drainage:**	Well-drained
Landform pattern:	Terrace (alluvial)	**Surface condition:**	Firm, loose
Relief modal class:	Level plain	**Disturbance:**	Extensive clearing
Coarse fragments:	-	**Rock outcrop:**	-
Geology:	Quaternary (Qa) Alluvium		
Vegetation:	River red gum, boonaree, popular box, cypress pine		

Site APA-10 landscape

Site APA-10 soil profile, surface at top right, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0-0.20	Dull yellowish brown (10YR 4/3); fine sandy loam; massive structure; pH 6.0; diffuse change to -
D	0.20-1.20	Dull yellowish brown (10YR 5/4); fine sandy loam; massive structure; pH 6.0

Site: APA-10

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
6.8	11	0.95	0.045	0.076	1.4	0.46	0.27	0.13	18	14	0.35

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0-0.1	5.7	3.8	67	23.5	6.8	0.02	VL	<10	<0.10	1.8	0.58	0.35	<0.022	2.9	0.0%	NS	7	3.10
0.5-0.6	4.4	5	59.9	30.7	7	0.02	VL	<10	<0.10	1.1	0.49	0.22	<0.022	1.9	0.0%	NS	8	2.24
1.1-1.2	5.6	6.3	69	19.1	7	0.02	VL	10	<0.10	1	0.58	0.22	<0.022	1.9	0.0%	NS	2	1.72

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Kln-DE Site: APA-12

Co-ordinates:	**Easting: 734439**	**Northing: 7072271**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Black dermosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	1-2%	**Runoff:**	Moderately rapid
Morphological type:	Open depression	**Permeability:**	Moderately permeable
Landform element:	Drainage depression	**Drainage:**	Imperfectly drained
Landform pattern:	Rises	**Surface condition:**	Firm
Relief modal class:	Gently undulating rises	**Disturbance:**	Grazing only
Coarse fragments:	Very few fine gravelly angular sandstone fragments	**Rock outcrop:**	-
Geology:	Bungil Formation, Nullawurt Sandstone Member (Kln) Quartzose to labile sandstone, siltstone, mudstone		
Vegetation:	Alectron		

Site APA-12 landscape

Site APA-12 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A11	0.0-0.40	Black (10YR 2/1); clay loam fine sandy; few fine gravelly anugular sandstone course fragments; moderate 5-10mm subangular block structure; pH 6.0; gradual change to -
A12	0.40-0.70	Brownish black (10YR 3/2); clay loam fine sandy; weak subangular block structure; pH 5.5; gradual change to -
B21	0.70-1.10	Brownish black (7.5YR 2/2); light clay; moderate 3-10mm subangular block structure; pH 5.5; gradual change to -
B22	1.10-1.20	Dull yellowish brown (10YR 4/3); light clay; very few medium gravelly anugular sandstone course fragments; moderate to weak 5-10mm subangular block structure; pH 5.0

Site: APA-12

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
5.7	9.9	2.2	0.26	0.49	5.4	5.2	3	0.26	90	68	6.1

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	24.9	17.9	52.5	4.7	5.7	0.03	VL	12	0.25	7.5	5.2	2	0.042	15	0.3%	NS	7	1.44
0.8-0.9	29.4	13.2	50.7	6.7	5.3	0.03	VL	15	6.7	1.2	4.1	0.84	0.41	13	3.2%	NS	2	0.29

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Klk-DE Site: APA-14

Co-ordinates:	**Easting: 734140**	**Northing: 7066976**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown dermosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	2-3%	**Runoff:**	Moderately rapid
Morphological type:	Mid-slope	**Permeability:**	Moderately permeable
Landform element:	Rise slope	**Drainage:**	Moderately well-drained
Landform pattern:	Rises	**Surface condition:**	Hard setting
Relief modal class:	Undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	Few medium gravelly rounded ironstone, quartz and other fragments	**Rock outcrop:**	-
Geology:	Bungil Formation, Kingull Member (Klk) Clayey sandstone, carbonaceous mudstone		
Vegetation:	Popular box, brigalow, belah, wilga, false sandlewood, limebush, buffel grass		

Site APA-14 landscape

Site APA-14 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.10	Brownish black (7.5YR 3/2); clay loam sandy; few medium gravelly subrounded quartz course fragements; weak 5-10mm subangular block structure; pH 7.0; clear change to -
B21	0.10-0.40	Dull yellowish brown (10YR 4/3); light medium clay; strong 10-20mm subangular block structure; pH 7.0; gradual change to -
B22	0.40-0.80	Brown (7.5YR 4/4); light medium clay; strong20-50mm subangular block structure; pH 7.0; diffuse change to -
BC	0.80-1.20	Yellowish brown (10YR 5/6); sandy clay loam; moderate 5-10mm subangular block structure; 2-10% calcareous soft segregations of 2-6mm; pH 8.5

Site: APA-14

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
7.7	10	0.92	0.12	0.35	1.6	1.9	1.1	0.19	8.9	10	0.51

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	17.5	7.5	58.3	16.7	7.7	0.04	VL	<10	-	7.5	1.6	0.69	0.036	9.8	0.4%	NS	8	4.69
0.8-0.9	25	7.5	59.7	7.8	8.2	1.84	E	640	-	9.5	8	0.14	1.7	19	8.9%	S	6	1.19

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: T-VE Site: APA-16

Co-ordinates:	**Easting: 733784**	**Northing: 7064754**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Black vertosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	2-3%	**Runoff:**	Moderately rapid
Morphological type:	Upper slope	**Permeability:**	Moderately permeable
Landform element:	Rise slope	**Drainage:**	Moderately well-drained
Landform pattern:	Rises	**Surface condition:**	Cracking, self-mulching
Relief modal class:	Gently undulating rises	**Disturbance:**	Cultivation and extensive clearing
Coarse fragments:	Very few coarse gravelly rounded sandstone fragments	**Rock outcrop:**	-
Geology:	Tertiary (T) Quartzose sandstone, conglomerate		
Vegetation:	Brigalow, wilga		

Site APA-16 landscape

Site APA-16 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.15	Brownish black (10YR 3/2); light medium clay; very few medium gravelly rounded sandstone course fragments; strong 5-10mm subangular block structure; pH 6.5; gradual change to -
B21	0.15-0.45	Brownish black (10YR 3/1); light medium clay; strong 10-20mm subangular block structure; <2% calcareous soft segregations of 2-6mm; pH 8.5; gradual change to -
B22	0.45-0.70	Brownish black (10YR 3/2); light medium clay; strong 10-20mm subangular block structure; pH 6.5; gradual change to -
B23	0.70-1.20	Dark brown (10YR 3/3); light medium clay; strong 10-20mm subangular block structure; pH 6.5

Site: APA-16

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
6.2	18	2	0.18	0.89	12	2.8	1.6	0.49	52	43	0.93

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	35.6	8.5	45.9	10	6.2	0.12	L	45	-	8	5.6	1.6	0.57	16	3.6%	NS	3	1.43
0.2-0.3	40.9	8.5	39.7	10.9	8.2	0.65	H	670	-	9.5	8.2	0.74	1.9	20	9.5%	S	6	1.16
0.5-0.6	43.3	10	38.4	8.3	7.4	0.82	H	920	-	7	11	0.54	4	23	17.4%	SS	2	0.64
0.8-0.9	46	7.4	36.7	9.9	4.8	0.93	H	1300	1.9	1.6	3.9	0.19	1.8	9.4	19.1%	SS	2	0.41
1.1-1.2	48.8	8.4	35.6	7.2	4.6	1.12	VH	1500	2.7	2.3	5.2	0.29	2.9	13	22.3%	SS	2	0.44

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Kld-f-KU Site: APA-24

Co-ordinates:	**Easting: 727566**	**Northing: 7058752**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Grey kurosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	1-2%	**Runoff:**	Moderately rapid
Morphological type:	Upper slope	**Permeability:**	Slowly permeable
Landform element:	Hillslope	**Drainage:**	Imperfectly drained
Landform pattern:	Low hills to Rises	**Surface condition:**	Hard setting
Relief modal class:	Gently undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	Few course gravelly rounded ironstone, quartz and sandstone fragments	**Rock outcrop:**	-
Geology:	Wallumbilla Formation, Doncaster Member (Kld) Mudstone, some siltstone, quartzose sandstone and coquinite. Shelly fossils.		
Vegetation:	Lancewood, Popular box, broad leaf ironbark, wilga, quinine, few/occasional belah		

Site APA-24 landscape

Site APA-24 soil profile

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0-0.25	Dull yellowish brown (10YR 4/3) moist soil; sandy clay loam; few fine gravelly rounded ironstone and quartz fragments; massive structure; pH 5.5; gradual change to -
A2j	0.25-0.30	Light grey (10YR 8/1) to dull yellowish brown (10YR 5/3) dry to moist soil; sandy clay loam; few medium gravelly rounded ironstone and quartz fragments; massive structure; pH 5.5; sharp change to -
B2	0.30-1.20	Greyish yellow brown (10YR 5/2) moist soil; common course distinct orange mottles; sandy light medium clay; few medium gravelly rounded ironstone and quartz fragments; strong 20-50mm columnar structure; pH 5.0; diffuse change to -
C	1.20-2.00	Common course distinct orange mottles, pH 4.5

Site: APA-24

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
4.9	<5.0	15	0.086	0.27	6.7	1.7	0.99	0.15	180	7.1	0.11

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	12	10.1	44.4	33.5	4.9	0.07	L	39	0.45	1	0.4	0.15	<0.022	2	1.1%	NS	7	2.50
0.5-0.6	35.9	4.9	32	27.2	4.1	3.03	E	5000	0.48	0.14	2.2	0.041	0.83	3.7	22.4%	SS	2	0.06

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Kld-f-DE Site: APA-25

Co-ordinates:	**Easting: 726828**	**Northing: 7057911**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown dermosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	1-2%	**Runoff:**	Slow
Morphological type:	Upper slope	**Permeability:**	Moderately permeable
Landform element:	Hillslope	**Drainage:**	Moderately well-drained
Landform pattern:	Low hills to rises	**Surface condition:**	Hard setting
Relief modal class:	Gently undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	Few medium gravelly rounded ironstone fragments	**Rock outcrop:**	-
Geology:	Wallumbilla Formation, Doncaster Member (Kld) Mudstone, some siltstone, quartzose sandstone and coquinite. Shelly fossils.		
Vegetation:	Belah, narrow leaf ironbark, popular box, broad leafed ironbark, silver leafed ironbark, mountain coolabah, brigalow, buffel grass, limebush		

Site APA-25 landscape

Site APA-25 soil profile, surface at top right, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.15	Dark brown (7.5YR 3/3); clay loam fine sand; very few medium gravelly rounded ironstone fragments; massive structure; pH 6.5; clear change to -
B21	0.15-0.65	Dull yellowish brown (10YR 4/3); fine sandy clay loam; moderate 10-20mm subangular block structure; pH 6.0; gradual change to -
B22	0.65-1.0	Greyish yellow brown (10YR 4/2); fine sandy clay loam; moderate 5-10mm subangular block structure; pH 6.0; gradual change to -
B23	1.00-1.20	Greyish brown (7.5YR 4/2); fine sandy clay loam; weak to moderate 5-10mm subangular block structure; pH 6.0

Site: APA-25

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
5.1	5.3	3	0.11	0.62	9	2.1	1.2	0.23	110	22	0.52

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	19.6	12.7	59.6	8.1	5.1	0.05	VL	28	1.6	1.2	1.4	0.4	0.087	4.7	1.9%	NS	7	0.86
0.8-0.9	33.3	9.7	51.3	5.7	5	0.58	H	770	1.1	0.055	2	0.023	0.74	3.9	19.0%	SS	2	0.03

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: QS/Kld-DE Site: APA-29

Co-ordinates:	**Easting: 724274**	**Northing: 7056512**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown dermosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	2%	**Runoff:**	Moderately rapid
Morphological type:	Simple slope	**Permeability:**	Moderately permeable
Landform element:	Rise slope	**Drainage:**	Moderately well-drained
Landform pattern:	Rises	**Surface condition:**	Hard setting
Relief modal class:	Gently undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	Moderately/common stony angular sandstone/ironstone fragments	**Rock outcrop:**	-
Geology:	Quaternary (QS) Sand, gravel, soil with gravel / Wallumbilla Formation, Doncaster Member (Kld) Mudstone, some siltstone, quartzose sandstone and coquinite. Shelly fossils.		
Vegetation:	Popular box, brigalow, false sandalwood		

Site APA-29 landscape

Site APA-29 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.10	Dark brown (10YR 3/3); fine sandy light clay; moderate 5-10mm subangular block structure; pH 7.0; clear change to -
B21	0.10-0.50	Dark brown (7.5YR 3/4); light medium clay; strong 10-20mm subangular block structure; pH 8.0; gradual change to -
B22	0.50-0.80	Brown (7.5YR 4/6); light medium clay; strong 5-10mm subangular block structure; 2-10% gypseous crystals; pH 8.0; gradual change to -
B23	0.80-1.20	Reddish brown (5YR 4/6); few medium faint yellow mottles; light medium clay; strong 5-10mm subangular block structure; pH 6.0

Site: APA-29

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
7.4	14	2.9	0.11	0.61	4.6	1.7	0.97	0.58	27	58	0.96

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	39.7	13.9	37.9	8.5	7.4	0.08	VL	36	-	4.1	7.3	1.6	1.6	15	10.7%	S	8	0.56
0.2-0.3	36.7	8.4	50.3	4.6	8.8	0.97	VH	810	-	6.5	16	0.24	4.8	28	17.1%	SS	2	0.41
0.5-0.6	33	7.2	52.9	6.9	8	3.46	E	1000	-	13	16	0.17	3.5	33	10.6%	S	6	0.81
0.8-0.9	27	7.5	62.5	3	5.1	1.83	E	1000	-	3.8	12	0.22	3.9	20	19.5%	SS	6	0.32
1.1-1.2	37.2	12.6	48.5	1.7	5	1.16	E	900	1	4.3	16	0.37	7.4	29	25.5%	SS	6	0.27

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Kld-VE Site: APA-34

Co-ordinates:	**Easting: 722878**	**Northing: 7050731**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown vertosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	0-1%	**Runoff:**	Slow
Morphological type:	Simple slope	**Permeability:**	Moderately permeable
Landform element:	Rise slope	**Drainage:**	Imperfectly drained
Landform pattern:	Rises	**Surface condition:**	Cracking
Relief modal class:	Gently undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	-	**Rock outcrop:**	-
Geology:	Wallumbilla Formation, Doncaster Member (Kld) Mudstone, some siltstone, quartzose sandstone and coquinite. Shelly fossils.		
Vegetation:	Brigalow, belah, bauhinia, popular box, limebush		

Site APA-34 landscape

Site APA-34 soil profile, surface at top right, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.15	Brownish black (10YR 3/2); light medium clay; strong 5-10mm subangular block structure; pH 7.5; clear change to -
B21	0.15-0.50	Dark brown (10YR 3/3); light medium clay; strong 10-20mm subangular block structure; pH 8.0; gradual change to -
B22	0.50-0.80	Brown (7.5YR 4/4); light medium clay; strong 10-20mm subangular block structure; 2-10% gypseous crystals 2-6mm in size; pH 7.0; gradual change to -
B23	0.80-1.20	Brown (7.5YR 4/6); 2-10% of 5-15mm dark grey mottles; light medium clay; strong 10-20mm subangular block structure; <2% gypseous crystals 2-6mm in size; pH 6.0

Site: APA-34

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
7.3	<5.0	1	0.082	1.1	45	1.6	0.91	0.61	17	39	0.15

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	39.8	13.9	43.8	2.5	7.3	0.37	M	310	-	9.5	9.1	0.56	3.3	22	15.0%	S	2	1.04
0.2-0.3	39.7	13.4	45.1	1.8	8.1	0.96	VH	1000	-	9.5	9.9	0.33	4.8	25	19.2%	SS	8	0.96
0.5-0.6	44.9	8.6	41.5	5	6.4	3.91	E	1100	-	25	9.1	0.33	2.5	37	6.8%	S	6	2.75
0.8-0.9	28.2	8.8	61.9	1.1	4.6	1.96	E	1300	-	8	8.2	0.38	4.4	21	21.0%	SS	6	0.98
1.1-1.2	29.5	11.3	58.5	0.7	4.6	1.27	E	1300	-	7	8.2	0.33	5.7	21	27.1%	SS	3	0.85

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Qa-DE Site: APA-35

Co-ordinates:	**Easting: 722829**	**Northing: 7050098**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown dermosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	0-1%	**Runoff:**	Slow
Morphological type:	Flat	**Permeability:**	Rapidly permeable
Landform element:	Terrace flat	**Drainage:**	Moderately well-drained
Landform pattern:	Terrace	**Surface condition:**	Hard setting
Relief modal class:	Level plain	**Disturbance:**	Limited to extensive clearing
Coarse fragments:	-	**Rock outcrop:**	-
Geology:	Quaternary (Qa) Alluvium		
Vegetation:	Popoular box, belah, false sandalwood		

Site APA-35 landscape

Site APA-35 soil profile, surface at top right, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.20	Dark brown (10YR 3/3); fine sandy light clay; moderate 5-10mm subangular block structure; pH 7.0; gradual change to -
B21	0.20-0.80	Dark brown (10YR 3/3); fine sandy light clay; moderate 10-20mm subangular block structure; pH 7.0; gradual change to -
B22	0.80-1.20	Dull yellowish brown (10YR 4/3); few medium faint brown mottles; fine sandy light clay; moderate 10-20mm subangular block structure; pH 7.5

Site: APA-35

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
6.8	16	3	0.1	0.67	15	1.9	1.1	0.74	22	40	0.31

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	26.1	19.4	50.8	3.7	6.8	0.12	L	51	-	9	4.2	0.97	0.21	14	1.5%	NS	2	2.14
0.5-0.6	32.8	8.3	54.8	4.1	8.2	0.06	VL	14	-	9	3.4	0.25	0.24	13	1.8%	NS	2	2.65
1.1-1.2	27.2	5.1	44.8	22.9	8.8	0.17	L	46	-	9	3.8	0.15	0.25	13	1.9%	NS	2	2.37

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Kld-VE Site: APA-38

Co-ordinates:	**Easting: 721847**	**Northing: 7047246**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown vertosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	1-2%	**Runoff:**	Moderately rapid
Morphological type:	Simple slope/mid-slope	**Permeability:**	Moderately permeable
Landform element:	Riseslope	**Drainage:**	Moderately well-drained/imperfectly drained
Landform pattern:	Rises	**Surface condition:**	Recently cultivated/cracking
Relief modal class:	Gently undulating rises	**Disturbance:**	Cultivation; rainfed
Coarse fragments:	Very few course gravelly subrounded ironstone fragments. Parts with common course gravelly subrounded ironstone fragments	**Rock outcrop:**	-

Geology: Wallumbilla Formation, Doncaster Member (Kld) Mudstone, some siltstone, quartzose sandstone and coquinite. Shelly fossils.

Vegetation: Belah, brigalow, old wheat crop

Site APA-38 landscape

Site APA-38 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.20	Dark brown (10YR 3/3); faint sandy light clay; strong 5-10mm and 2-5mm subangualr block structure; pH 8.5; clear change to -
B2	0.20-0.75	Dark brown (10YR 3/4); light medium clay; strong 10-20m subangular block structure; <2% calcareous soft segregations of 6-20mm; pH 8.0; clear change to -
C	0.75-0.90	Yellowish brown (10YR 5/6); few medium distinct orange mottles; pH 8.5

Site: APA-38

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
8.8	7.6	2.6	0.082	0.9	1.9	1.3	0.73	0.61	5.4	6.9	0.15

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0-10	39.6	8.5	48.7	3.2	8.8	0.14	L	11	-	15	3.5	0.64	0.65	20	3.3%	NS	3	4.29
0.1-0.2	35.1	8.6	53.4	2.9	8.8	0.17	L	<10	-	16	4	0.64	1	22	4.5%	NS	2	4.00
0.2-0.3	32.2	8.5	56.3	3	9.3	0.23	M	29	-	15	5.1	0.23	2.3	23	10.0%	S	8	2.94
0.5-0.6	33.8	10	53.6	2.6	9.1	0.67	H	480	-	13	7.2	0.11	6.1	26	23.5%	SS	2	1.81
0.8-0.9	17.5	16.3	63.4	2.8	9.3	0.87	VH	800	-	10	5.7	0.79	7.4	24	30.8%	SS	2	1.75

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable

SITE DESCRIPTION Soil Unit: Klc -DE Site: APA-42

Co-ordinates:	**Easting: 718844**	**Northing: 7045439**	**Zone: 55**	**Datum:** GDA94
ASC Soil Order:	Brown dermosol	**Sampler:**	S. Pointon	

LANDFORM

Slope:	1-3%	**Runoff:**	Moderately rapid
Morphological type:	Lower slope	**Permeability:**	Moderately permeable
Landform element:	Riseslope	**Drainage:**	Imperfectly drained/moderately well-drained
Landform pattern:	Rises	**Surface condition:**	Hard setting
Relief modal class:	Gently undulating rises	**Disturbance:**	Extensive clearing
Coarse fragments:	-	**Rock outcrop:**	-
Geology:	Wallumbilla Formation, Coreena Member (Klc) Glauconitic siltstone, mudstone, very fine-grained sandstone. Shelly fossils.		
Vegetation:	Popular box, boowaree, false sandalwood, limebush		

Site APA-42 landscape

Site APA-42 soil profile, surface at top left, 30 cm sections

SOIL DESCRIPTION

Horizon	Depth (m)	Description
A1	0.0-0.10	Brownish black (10YR 3/2); fine sandy light clay; weak 10-20mm subangular block structure; pH 7.5; clear change to -
B21	0.10-0.50	Dark brown (10YR 3/3); light medium clay; strong 5-10mm subangular block structure; <2% gypseous crystals 6-20mm in size; pH 7.5 gradual change to -
B22	0.50-0.75	Dark brown (7.5YR 3/4); light medium clay; strong 5-10mm subangular block structure; <2% gypseous crystals 2-6mm in size; pH 7.5; diffuse change to -
c	0.75-1.20	Yellowish brown (10YR 5/8); ironstone; pH 7.5

Site: APA-42

Surface (0–10 cm) Chemistry Data

pH (H_2O)	Bicarbonate extr. P (Colwell) (mg/kg)	Nitrate nitrogen (mg/kg)	Total nitrogen (%)	Boron (mg/kg)	Sulfate sulfur (mg/kg)	Organic matter (%)	Total organic carbon (%)	Trace Elements			
								Copper (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
7.9	11	2.8	0.14	1.1	7.3	2.4	1.4	0.66	18	19	0.34

Soil Profile Chemistry Data

Depth (m)	Particle size (%)*				pH (H_2O)	EC (dS/m)	EC rating (VL, L, M, H, VH, E)	Cl^- (mg/kg)	Exchangeable cations (meq/100 g)						ESP (%)	Sodicity (NS, S, SS)	Emerson class	Ca:Mg ratio
	Clay	Silt	Fine sand	Coarse sand					Al^{2+}	Ca^{2+}	Mg^{2+}	K^+	Na^+	CEC				
0.0-0.1	30	10	56.2	3.8	7.9	0.18	L	100	-	8.5	4.9	1.1	1.5	16	9.4%	S	8	1.73
0.2-0.3	35	10	53.6	1.4	8.8	1.2	VH	1300	-	11	11	0.21	5.7	28	20.4%	SS	2	1.00
0.5-0.6	50	7.5	39.6	2.9	8.2	3.44	E	1400	-	16	9.1	0.19	3.4	29	11.7%	S	6	1.76
0.8-0.9	32.5	12.5	54.2	0.8	8.8	1.39	E	1100	-	8	7.1	0.24	3.9	19	20.5%	SS	2	1.13
1.1-1.2	33.8	15	49.7	1.5	8.7	0.96	VH	990	-	7.5	8	0.28	4.8	21	22.9%	SS	2	0.94

Notes:

* Coarse sand (>2 mm), Fine sand (0.02-2 mm), Silt (2-20 µm), Clay (<2 µm) ID Indeterminable