COWAL GOLD OPERATIONS
SOIL STRIPPING MANAGEMENT PLAN

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1 INTRODUCTION

The Cowal Gold Operations (CGO) is located approximately 38 kilometres (km) north-east of West Wyalong in New South Wales (NSW) (Figure 1). Evolution Mining (Cowal) Pty Limited (Evolution) is the owner and operator of the CGO. Development of the CGO occurs within Mining Lease (ML) 1535.

Development Consent (DA 14/98) for the CGO (including the Bland Creek Palaeochannel Borefield water supply pipeline) was granted by the Minister for Urban Affairs and Planning under Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 February 1999. Development Consent (DA 2011/64) for the operation of the Eastern Saline Borefield was granted by the Forbes Shire Council on 20 December 2010.

The Minister for Planning's delegate granted approval to modify Development Consent (DA 14/98) for the *Cowal Gold Operations Underground Development Project as State Significant Development No. 10367 under section 4.38(2)*, of the EP&A Act on 30 September 2021 and to modify DA 14/98 through Modification No. 16 (herein referred to as Mod 16) under section 4.55(2) of the EP&A Act. SSD 10367 was modified on 7 November 2022, to reflect minor changes in the underground mining method, through Mod 1 (Optimisation Modification).

DA 14/98 generally allows:

- Mining operations until 2040.

Ore

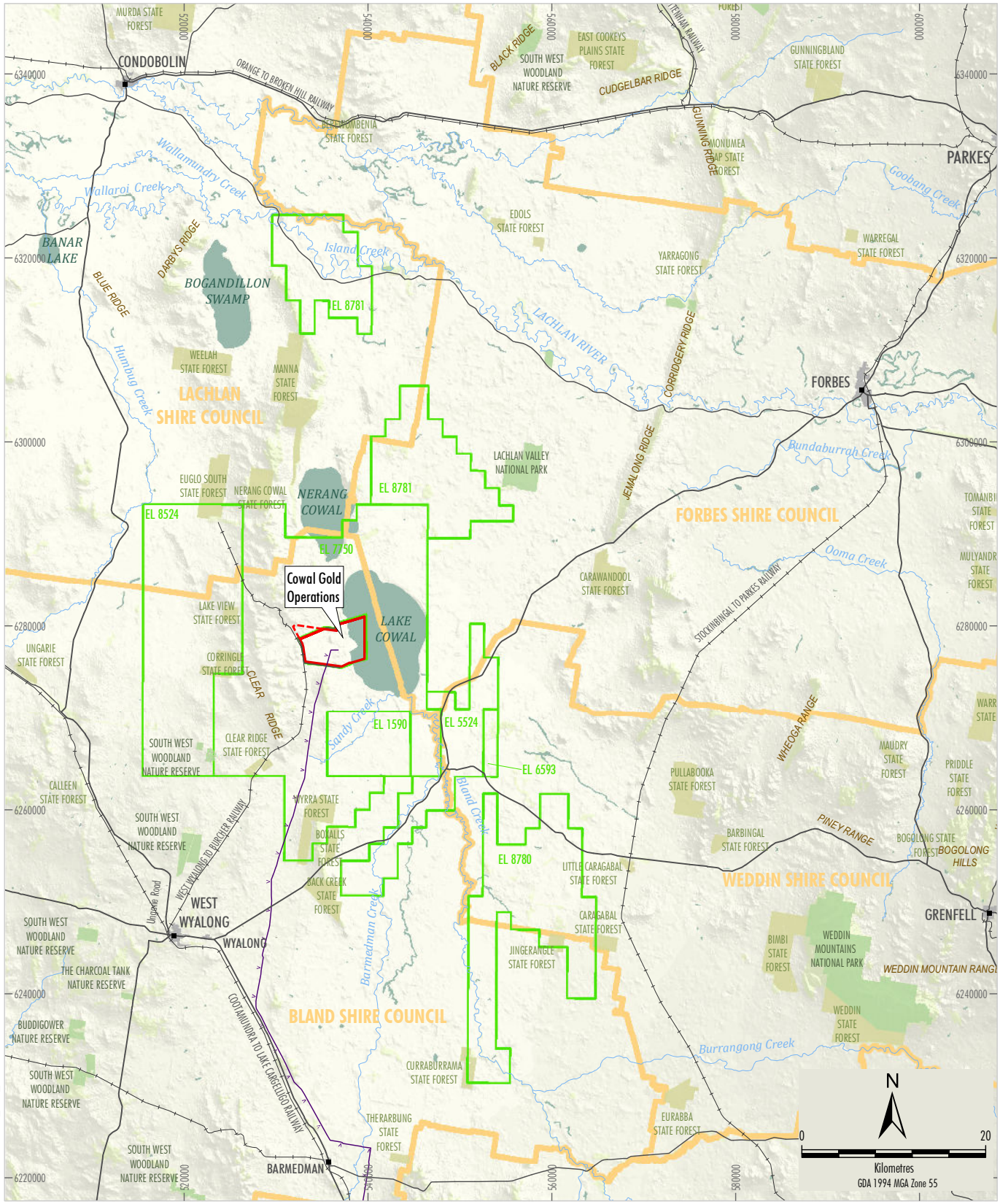
- Processing at rate of 9.8Mtpa
- Tailings and Waste rock emplacement on site.
- Operation of a range of ancillary mining infrastructure.

SSD 10367 generally allows:

- Underground stope mining until 2040.
- Backfilling the stopes with cemented paste made from tailings.
- Development of ancillary infrastructure including a box-cut to the underground mine and a paste fill plant.

The general arrangement of the approved CGO is provided in Figure 2.

This Revised SSMP has been prepared to reflect the conditions of DA 14/98 and SSD 10367, as approved on 30 September 2021 and 7 November 2022, and supersedes all former versions of the SSMP. Copies of the approved Development Consents for Mod 16 and SSD 10367 are available on Evolution's website (www.evolutionmining.com.au).



HAL-18-43 CGO MP2018_SSMP_201A

LEGEND

- Mining Lease Boundary (ML 1535)
- Mining Lease Boundary (ML 1791)
- Exploration Licence (EL) National Park & Nature Reserve State Forest
- Local Government Area Boundary Electricity
- Transmission Line Railway

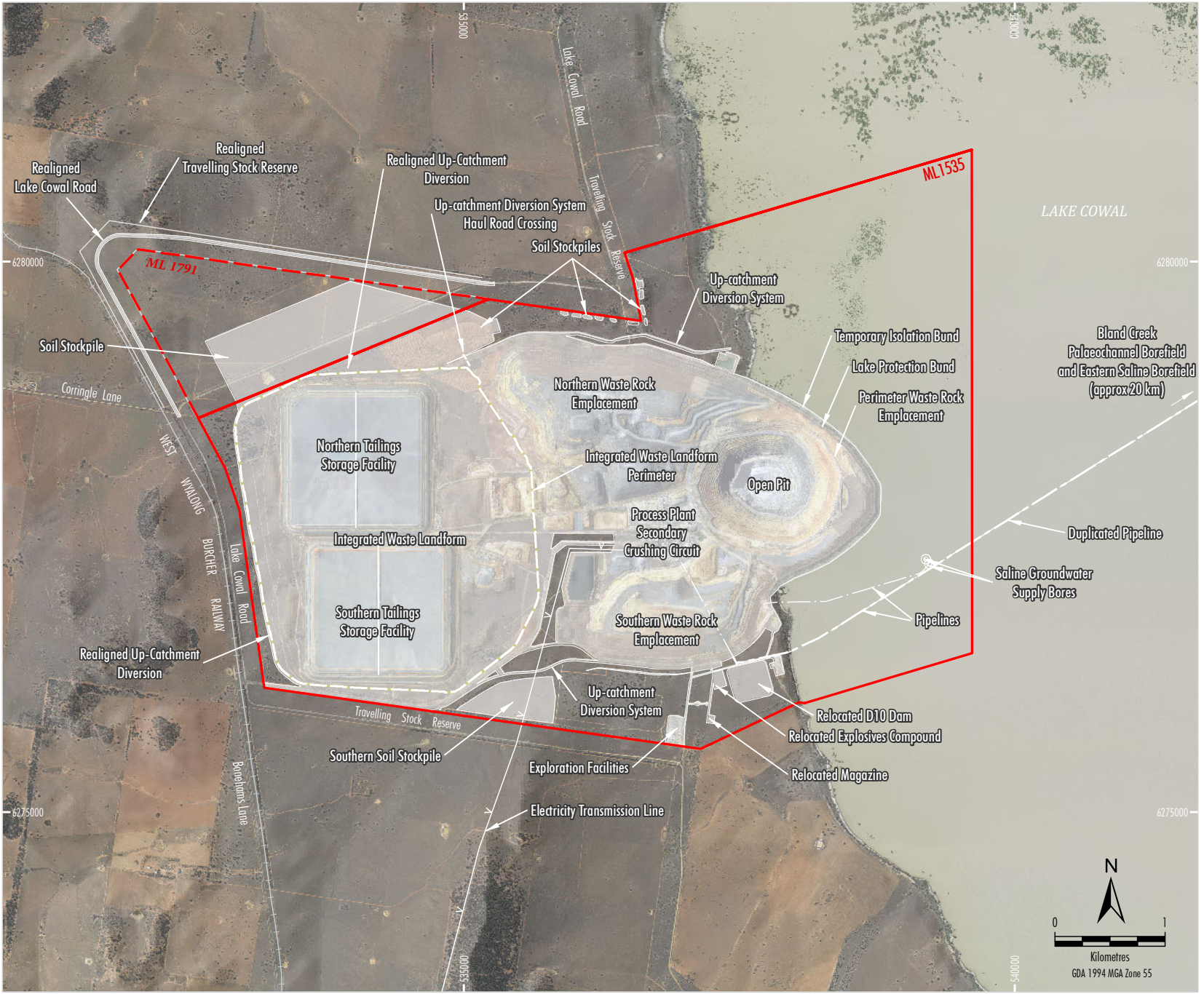
Source: © NSW Department of Finance, Services & Innovation (2017); Office of Environment & Heritage NSW (2017)

Evolution Mining Cowal

SOIL STRIPPING MANAGEMENT PLAN

CGO Locality

Figure 1



Source: Evolution (2018); © NSW Department of Finance, Services & Innovation (2017)
Orthophoto: Evolution (Oct 2017)

Evolution Mining Cowal

SOIL STRIPPING MANAGEMENT PLAN

General Arrangement of Approved CGO

Figure 2

1.1 OBJECTIVES AND SCOPE OF THIS SSMP

Objectives

In accordance with Development Consent Condition 3.5(b), the objectives of this SSMP are to:

- provide details on the soil stripping techniques and scheduling implemented at the CGO;
- detail the soil stockpile management measures utilised on (including the amelioration of soil resources); and
- outline a programme for reporting on the effectiveness of the soil stripping methods and performance against objectives contained in this plan.

Scope

This SSMP has been prepared to reflect DA 14/98 approved 30 September 2021 and SSD 10367 approved 7 November 2022 (in accordance with the revision requirements of Condition 9.1 of the Development Consent).

The remainder of the SSMP is structured as follows:

Section 2: Presents the statutory requirements relevant to this SSMP and soil management.

Section 3: Provides a description of existing soil resources at the CGO including soil types and stockpiled resources.

Section 4: Outlines the soil management measures including soil stripping practices, scheduling and soil stockpile management.

Section 5: Describes the CGO's rehabilitation programme key principles, objectives and measures relevant to this SSMP.

Section 6: Presents the community consultation requirements including the Community Environmental Monitoring and Consultative Committee (CEMCC) which provides opportunities for landholders or community members to discuss specific issues of concern, and details complaint recording and reporting procedures.

Section 7: Details the Independent Environmental Audit requirements and review procedures.

Section 8: Outlines the reporting and notification of incidents and non-compliances at the CGO.

Section 9: Presents the Annual Review reporting procedures and the requirements for review of this SSMP.

Section 10: Lists the references cited in this SSMP.

Section 11: Lists the abbreviations and acronyms used in this SSMP.

2 STATUTORY REQUIREMENTS

2.1 DEVELOPMENT CONSENT CONDITIONS

This SSMP has been prepared in accordance with the requirements of Development Consent Condition 3.5(b) and to reflect the approved CGO. The requirements of Condition 3.5(b) and where they are addressed in this SSMP are outlined in Table 1 below.

Table 1
Development Consent Conditions Relevant to this SSMP

Development Consent Condition	Section
3.5 Prevention of Soil Erosion	
The Applicant shall prepare and implement the following plans to the satisfaction of the Secretary:	
...	
(b) a soil stripping management plan for the site which shall include, but not be limited to:	This SSMP
(i) details of the management of soil stockpiles, soil stripping techniques and scheduling;	Section 4
(ii) any further requirements of Resources Regulator; and	Section 2.3
(iii) a program for reporting on the effectiveness of the soil stripping methods and performance against objectives contained in the soil stripping management plan, and EIS.	Sections 8 and 9

In addition to the above, the following Development Consent Conditions are also relevant to this SSMP:

- Condition 2.4(b) states the requirements for site rehabilitation, including the requirement to rehabilitate progressively and minimise the total exposed area for dust generation at any time. This condition is addressed in Sections 4 and 5.
- Condition 3.1(a) requires management of aboriginal objects that may be uncovered during earthworks, this condition is discussed in Section 4.3.
- Condition 3.2(a)(ii) requires that no disturbance occurs within the areas of Weeping Myall Open Woodland identified in Appendix 4 of the Development Consent, This condition is discussed in Section 4.3.
- Condition 3.2(a)(iii) requires that no disturbance occurs within the areas of the Belah Woodland identified in Appendix 4 of the Development Consent. This condition is discussed in Section 4.3.
- Conditions 9.1(b) and 9.1(c) establish the reporting and review requirements for this SSMP and are reproduced in full and discussed in Sections 8 and 9.
- Condition 9.1(d) establishes the requirements for the CEMCC and is reproduced in full and addressed in Section 6.
- Conditions 9.2(a) and 9.2(b) establish the requirements for an Independent Environmental Audit. These conditions are reproduced in full and discussed in Section 7.
- Conditions 9.3(a) and (b) detail the incident and non-compliance notification requirements of the Development Consent. These conditions are addressed in Section 8.
- Condition 9.4(a)(v) outlines the requirements for a complaints register. This condition is reproduced in full and discussed in Section 6.

2.2 ENVIRONMENT PROTECTION LICENCE CONDITIONS

Condition O3 of EPL 11912 is relevant to the requirement to carry out activities at the CGO, in a manner that will minimise the generation of dust. The requirements of Condition O3 are consistent with the requirements of Development Consent Condition 2.4(b).

The soil management measures described in Section 4 of this SSMP, in particular the erosion and dust control measures described in Section 4.5.2, address the requirements of Condition O3 of EPL 11912.

2.3 CONDITIONS OF AUTHORITY ML 1535

The NSW Resources Regulator administers the Conditions of Authority for ML 1535 which includes requirements that relate to soil stripping activities and rehabilitation at the CGO. Relevant Conditions of Authority for ML 1535 include:

Rehabilitation

12. (a) Land disturbed must be rehabilitated to a stable and permanent form suitable for a subsequent land use acceptable to the Director-General and in accordance with the Mining Operations Plan so that:-

- *there is no adverse environmental effect outside the disturbed area and that the land is properly drained and protected from soil erosion.*
- *the state of the land is compatible with the surrounding land and land use requirements.*
- *the landforms, soils, hydrology and flora require no greater maintenance than that in the surrounding land.*
- *in cases where revegetation is required and native vegetation has been removed or damaged, the original species must be re-established with close reference to the flora survey included in the Mining Operations Plan. If the original vegetation was not native, any re-established vegetation must be appropriate to the area and at an acceptable density.*
- *the land does not pose a threat to public safety.*

(b) Any topsoil that is removed must be stored and maintained in a manner acceptable to the Director-General.

This condition is addressed in Section 5.

Prevention of Soil Erosion and Pollution

14. Operations must be carried out in a manner that does not cause or aggravate air pollution, water pollution (including sedimentation) or soil contamination or erosion, unless otherwise authorised by a relevant approval, and in accordance with an accepted (Mining Operations Plan), now replaced by the forward program and rehab reform regulations and reporting. For the purpose of this condition, water shall be taken to include any watercourse, waterbody or groundwaters. The lease holder must observe and perform any instructions given by the Director-General in this regard.

This condition is addressed in Section 4.5.2.

The *Cowal Gold Operations Mining Operations Plan (ML 1535) 1 January 2019 – 31 December 2019* relevant to the commencement of development of the approved Processing Rate Modification activities (including soil stripping activities), was approved by the Resources Regulator on 23 January 2019. Rehab reform guidelines now require operations to submit RMP, operational disturbance areas and forward program through the form and way forms on the Resources regulator online platform,

which has now replaced the MOP. This new system has been implemented for conditions of consent for the relevant current approvals DA 14/98 and SSD 10367.

Notwithstanding, this SSMP will be prepared in consultation with the Resources Regulator to confirm any further requirements the agency may have, in accordance with Development Consent Condition 3.5(b)(ii).

Condition of Authority 28 for ML 1535 includes environmental performance reporting requirements associated with an Annual Environmental Management Report (AEMR). The Annual Review (Section 8) will address the AEMR requirements of ML 1535 Condition of Authority 28.

A mining lease has now been granted for the ML 1791 area, and any soil stripping or soil management requirements of the new tenement authority will be incorporated into a revised version of this SSMP (as required).

3 EXISTING SOIL RESOURCES

3.1 SOIL TYPES

As a part of the *Cowal Gold Project Environmental Impact Statement* (EIS) (North Limited, 1998) a *Soils, Agricultural Suitability/Land Capability and Soil Resources* assessment was undertaken for proposed disturbance areas within ML 1535 (Department of Conservation and Land Management [CaLM], 1994 and Resource Strategies, 1997). The assessment included identification of soil types, general characterisation of suitable stripping depths for rehabilitation activities and formulation of soil stripping and soil stockpiling strategies.

The major soil types identified within ML 1535 disturbance areas (CaLM, 1994) (Figure 3) were:

- hard pedal red duplex soils;
- grey, brown and red cracking clays;
- hill soils; and
- lacustrine (lake) sediments.

The *Soils, Agricultural Suitability/Land Capability and Soil Resources* assessment comprises two parts:

- *Soil Survey Report and Results of Analyses* (CaLM, 1994); and
- *Agricultural Suitability/Rural Land Capability and Soil Resources* (Resource Strategies, 1997).

General soil profile descriptions for these soil types as described by CaLM (1994) and Resource Strategies (1997) is provided below. An indication of the suitability of the soil type for rehabilitation purposes is also provided.

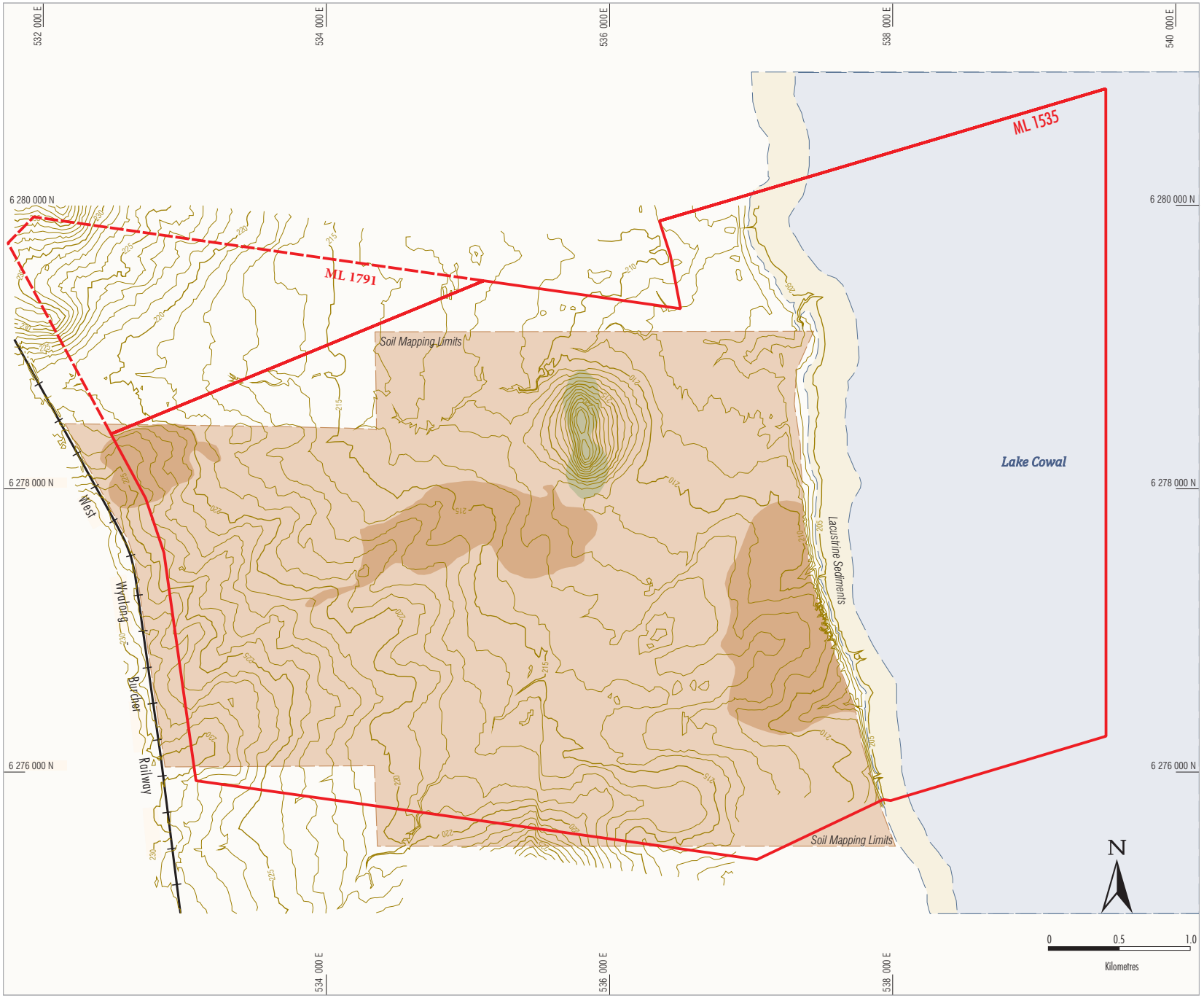
Hard Pedal Red Duplex Soils (Soil Map Unit A) (Figure 3)

These soils mainly occur on very gently sloping (i.e. 1% slope), stagnant alluvial plains. A distinct texture contrast exists between the topsoil and subsoil. Topsoils are thin, less than or equal to 0.1 metres (m) thick, dull reddish brown and have a fine sandy loam to clay loam texture. Upper subsoils meanwhile are dark reddish brown to dull brown, medium clays with moderate to strong pedality. Below approximately 1 m, the soils are bright reddish brown to dull yellow orange, medium clays, extending to at least 2 m depth (CaLM, 1994).

The hard pedal red duplex soils are widespread and represent the vast majority of CGO area soils. This material is considered the most appropriate medium for rehabilitation. The top 0.35 m is also considered suitable “topsoil” for rehabilitation works (Resource Strategies, 1997).

Grey, Brown and Red Cracking Clays (Soil Map Unit B) (Figure 3)

These soils occur in three distinct pockets within the CGO area *viz.* close to the lake, in the central CGO area, and in the west of ML 1535 (Figure 3). They consist of uniform fine-textured profiles that crack periodically upon drying. Similar to hard pedal red duplex soils, they occur on very gently sloping, stagnant alluvial plains. The topsoil is typically 0.05-0.1 m deep, moderate to strongly structured and has a medium clay texture. Colour varies from greyish olive brown to dark, reddish brown. There is a clear to gradual change to the underling strongly pedal, medium to heavy clay textured subsoil (CaLM, 1994).



LEGEND

Mining Lease Boundary (ML 1535)

Mining Lease Boundary (ML 1791)

Soil Map Unit A
Hard pedal red duplex soils

Soil Map Unit B
Grey, brown & red cracking clay

Soil Map Unit C
Hill soils

Source: CaLM (1994)

Evolution MINING Cowal

SOIL STRIPPING MANAGEMENT PLAN

Soil Map Units

Figure 3

HAL-18-43 CGO MP2018_SSMP_001B

The topsoil is considered as a moderately suitable rehabilitation medium, with the only limitations being moderate structural and salinity features (CaLM, 1994). Erosion hazard could be high if used on sloping batters. This topsoil is considered the second most appropriate material for rehabilitation works, and the top 0.1 m is suitable for use as topsoil.

Hill Soils (Soil Map Unit C) (Figure 3)

These soils are confined to the low hill in the north of the CGO area which has since been covered by the development of the Northern Waste Rock Emplacement (Figure 3). Uniform coarse textured soils occur on the gently sloping (i.e. 5-6 % slope) ridges and upper hill slopes. They are typically dark reddish brown to reddish brown with a sandy loam to clayey sand texture and massive to weak pedality. High to very high amounts of coarse fragments up to 0.2 m diameter occur throughout the soil profile. The soils are slightly acidic at the surface, becoming moderate to strongly acidic with depth (CaLM, 1994).

Topsoils are approximately 0.5-0.6 m deep, very dark to dark reddish brown with sandy loam texture and massive structure. The underlying soils are a dull orange to dull reddish brown with a medium clay texture (CaLM, 1994).

The main limitations of these soils are poor water retention and acidity (CaLM, 1994). Therefore they are of low suitability as revegetation soils.

Lacustrine Sediments (Figure 3)

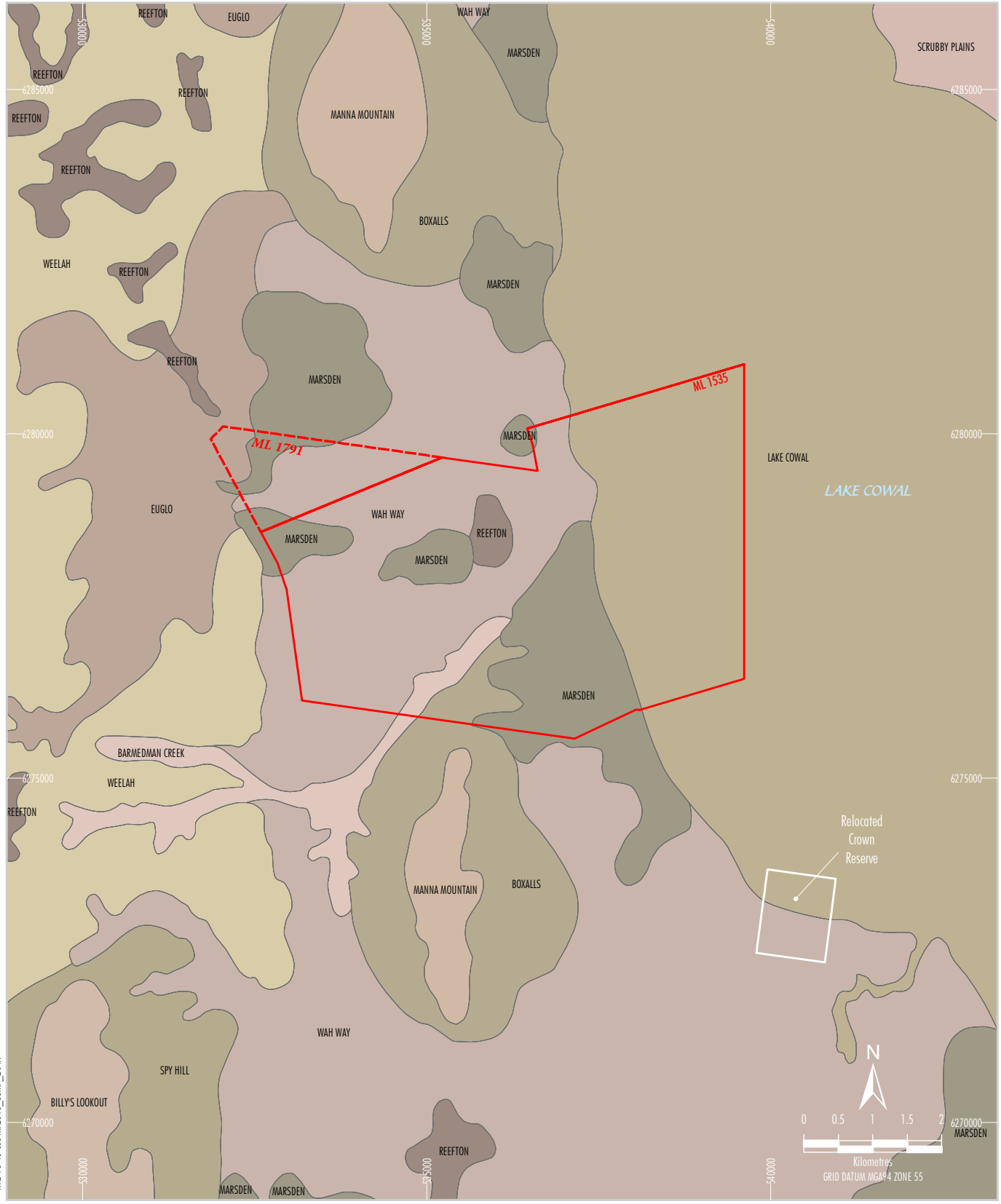
These sediments are confined to areas below the Lake Cowal high water mark. Textures vary widely, with no relationship to material type except for the occurrence of sand and gravel bands in the transported material. Field textures are commonly medium clays, silty light clays and silty clay loams (CaLM, 1994).

The pH varies widely within layers of otherwise similar material. Sediments are usually neutral to slightly alkaline (i.e. pH_w 6.7-7.8), but moderately to strongly alkaline sediments (i.e. pH_w 7.9-9.0) also occur (CaLM, 1994). Sediments up to 0.3 m can be stripped and stockpiled as a topsoil resource (Resource Strategies, 1997). Deeper subsoil resources can also be stripped as required and stockpiled for use in construction and in landform reconstruction works (as subsoil beneath re-spread topsoil) (Resource Strategies, 1997).

3.2 SOIL LANDSCAPES

Soil landscapes within ML 1535 include the Lake Cowal, Marsden, Barmedman Creek, Boxalls, Wah Way and Reefton landscapes (Figure 4).

Soil Management Designs (2017) conducted a soil survey of a portion of the ML 1791 area (as part of the Site Verification Certificate process for the Processing Rate Modification). The survey verified the soil landscapes within this portion as Sodosol Zone and Gilgai Complex (Figure 5). The dominant soil types of Sodosol Zone and Gilgai Complex are red sodosol and kandosols, respectively (Figure 5). The remainder of the ML 1791 area consists of Wah Way, Marsden and Euglo soil landscapes (King 1998). Further assessments conducted for SSD 10367 EIS provide further documentation regarding subsidence and Erosion risks which must be mitigated during operations and post closure to ensure safe, stable, non-polluting landforms.



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LEGEND

Mining Lease Boundary (ML 1535)

Mining Lease Boundary (ML 1791)

BOXALLS Soil Landscape

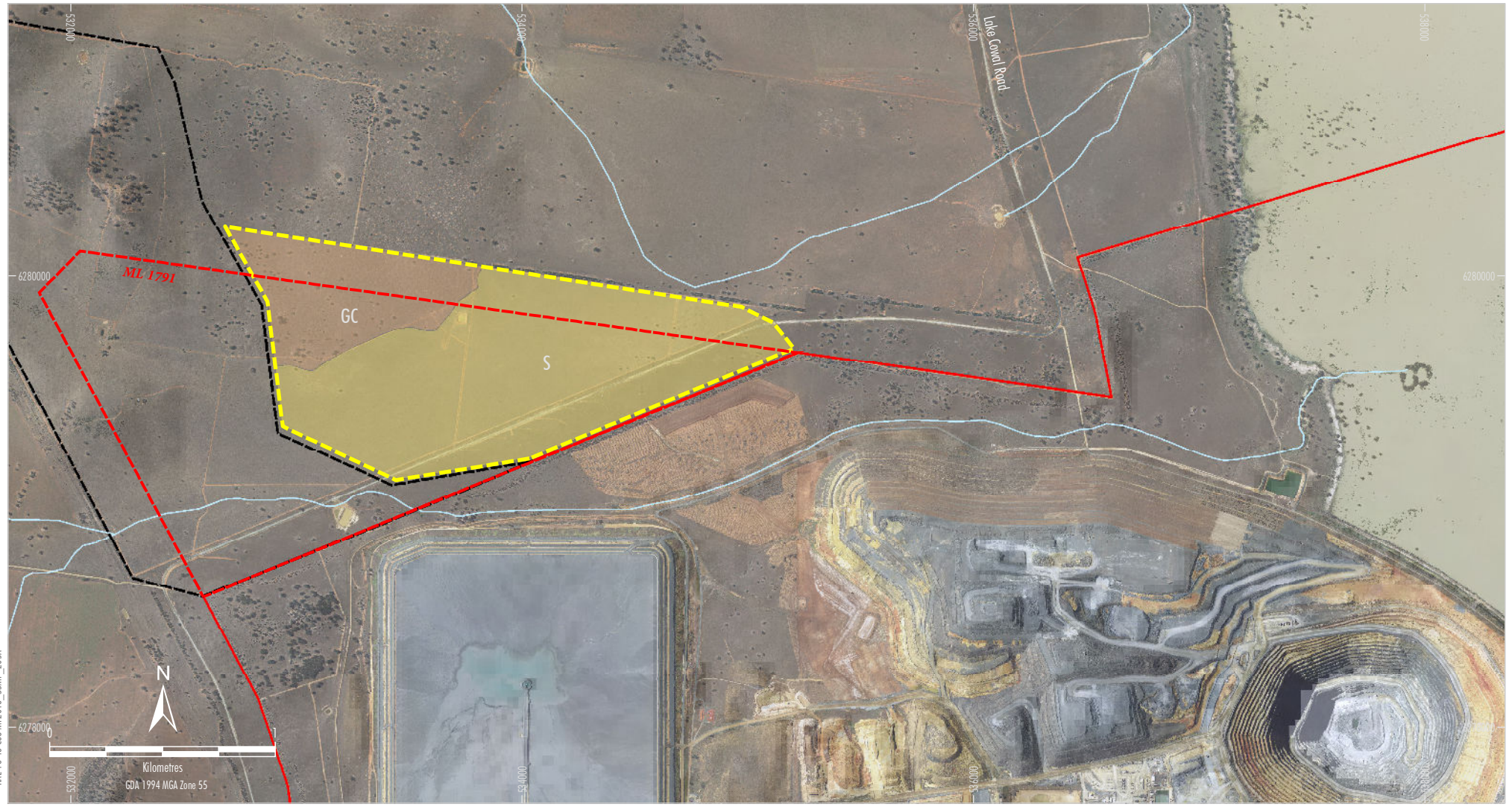
Source: Evolution (2018); © NSW Department of Finance, Services & Innovation (2017); King (1998)
Orthophoto: Evolution (Oct 2017)

Evolution MINING Cowal

SOIL STRIPPING MANAGEMENT PLAN

Soil Landscapes

Figure 4



LEGEND

- Mining Lease (ML 1535)
- Mining Lease Boundary (ML 1791)
- Western Site Verification Certificate Area
- Eastern Site Verification Certificate Area

Verified Soil Landscape Units

- Gilgai Complex (GC)
- Sodosol Zone (S)

Source: Evolution - Orthophoto (October 2017); Department of Industry (2016); Land and Property Information (2016); Department of Primary Industries - Water (2017); NSW Office of Water (2014); Soil Management Design (2017)

Evolution MINING Cowal

SOIL STRIPPING MANAGEMENT PLAN

Verified Soil Landscape Within ML 1791

Figure 5

3.3 SOIL STOCKPILE RESOURCES

CGO Soil Stockpile Characterisation

A comprehensive sampling programme of the CGO's stockpiled topsoil and subsoil resources commenced in 2012 to characterise the available soil resources, assess their suitability for rehabilitation use and to determine the most effective amelioration or treatment measures required to improve the soil for rehabilitation use.

Dr David McKenzie (a leading certified professional soil scientist in NSW) of McKenzie Soil Management Pty Ltd was engaged to conduct and interpret the results from the sampling programme. McKenzie Soil Management's (2013) Soil Stockpile Characterisation Assessment provides a detailed description of the soil stockpile sampling programme and its results, and is provided in Appendix A.
A summary of the characteristics of stockpiled topsoil and subsoil resources and McKenzie Soil Management's (2013) recommendations for improving the soil for rehabilitation use is provided below. Figure 6 shows the indicative locations of the CGO's existing topsoil and subsoil stockpiles (as at January 2019). Following Mod 14 and the IWL construction, topsoil and subsoil stockpiles were required to be relocated along with additional soil stripping activities due to the additional disturbance footprint which has resulted in larger grouped stockpiles which are managed in accordance with CGO Soil Stripping Management Plan (SSMP), Land Management Plan (LMP), and Rehabilitation Management Plan (RMP). The new stockpiles may have further soils stockpile characterisation assessments conducted prior to use on rehabilitation areas to ensure appropriate amelioration preparation to improve rehabilitation success.

Topsoil

The majority of stockpiled topsoil resources at the CGO reflect the hard pedal red duplex soils associated with the majority of the Mining Lease area. The soils have a fine sandy clay loam to medium heavy clay loam texture and are hard setting (Appendix A). These soils are dispersive (where non-saline), have variable pH, are partially Phosphorus deficient, range from non-saline to strongly saline and are sodic (Appendix A). Compaction was also observed in numerous topsoil stockpiles.

Some topsoil stocks show physical and chemical characteristics typical of subsoil and have been recommended for inclusion with subsoil stocks to be treated with gypsum (i.e. Topsoil Stockpile 19 and Topsoil Stockpile 10) (Figure 6) (Appendix A).

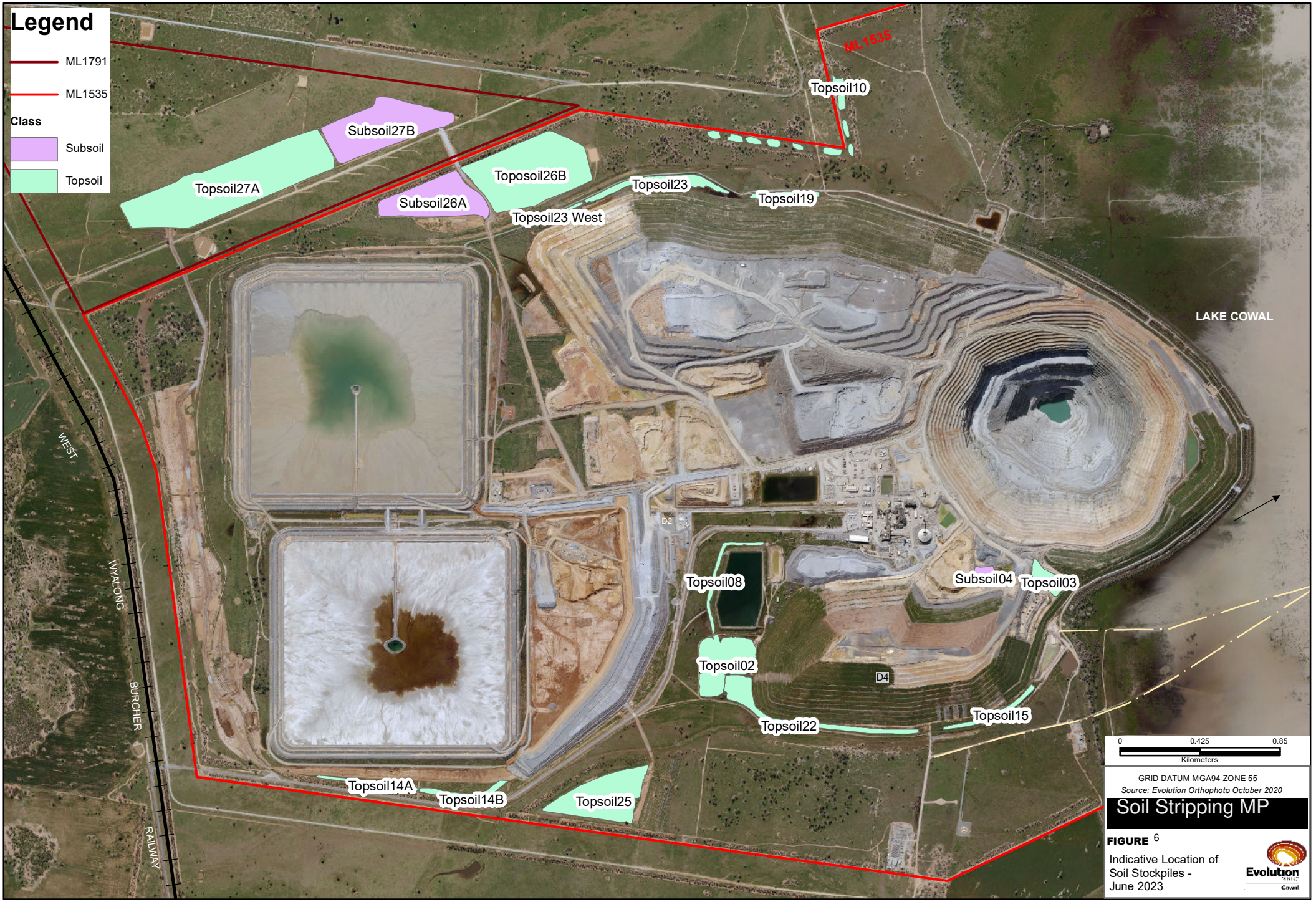
To enhance the suitability of topsoil stocks for plant growth, gypsum application rates ranging between 0 and approximately 35 tonnes per hectare per metre (t/ha/m) have been recommended by McKenzie Soil Management (2013), except for Topsoil Stockpile 19 and Topsoil Stockpile 10 which have been recommended for inclusion with subsoil stocks (and consequently are referred to as subsoils in this plan). These stocks have been assessed by McKenzie Soil Management (2013) as requiring approximately 74 and 73 t/ha/m gypsum respectively.

Subsoil

The majority of stockpiled subsoil resources also reflect the hard pedal red duplex soils associated with the majority of the ML 1535 area. The soils have a light medium clay texture and are extremely hard when dry (Appendix A). The subsoil stocks are dispersive, strongly saline, strongly sodic, Phosphorus deficient and have variable pH ranging from neutral to alkaline (Appendix A). Compaction was also observed in some areas of Subsoil Stockpile 02 (Figure 6).

To enhance the suitability of subsoil stocks for plant growth, gypsum application rates ranging between approximately 91 and 153 t/ha/m have been recommended by McKenzie Soil Management (2013).

Based on the soil analysis results and approximate gypsum application rates, McKenzie Soil Management (2013) proposed various soil management and amelioration methods. These methods are described in Section 4.6.


Legend
ML1791
ML1535
Class
Subsoil
Topsoil
ML1535
Topsoil10
Subsoil27B
Topsoil27A
Subsoil26A
Toposoil26B
Topsoil23
Topsoil19
Topsoil23 West
LAKE COWAL
WEST
WYALONG
BURCHER
RAILWAY
D2
D4
Topsoil08
Subsoil04
Topsoil03
Topsoil02
Topsoil22
Topsoil15
Topsoil14A
Topsoil14B
Topsoil25
0
0.425
0.85
Kilometers
GRID DATUM MGA94 ZONE 55
Source: Evolution Orthophoto October 2020
Soil Stripping MP
FIGURE 6
Indicative Location of Soil Stockpiles - June 2023
Evolution

4 SOIL MANAGEMENT

The general strategy of soil resource management at the CGO will be to strip suitable soil resources from the proposed disturbance areas within the ML areas and directly replace on rehabilitation areas or store in dedicated stockpiles for re-use during progressive rehabilitation works.

The strategies/objectives for management of CGO soil resources include:

- characterisation of the suitability of the material for rehabilitation purposes prior to stripping where possible;
- soil resources are stripped and stored selectively and managed according to their suitability for rehabilitation purposes where possible;
- sufficient subsoil and stable topsoil are available for rehabilitation purposes;
- progressive rehabilitation of final landforms is conducted as soon as practical after completion of the landforms or when areas are no longer required; and
- soil resources are stripped and stored in such a manner that their long-term viability is maintained.

The measures and procedures that will be undertaken to achieve these strategies/objectives are detailed in the subsections below.

4.1 SOIL STRIPPING SCHEDULING

Prior to soil stripping, testing of soil profiles will be undertaken where necessary to confirm the precise depths of suitable soil and any requirements for amelioration at the time of soil stockpiling. Stakes may be used to delineate soil boundaries and to identify suitable stripping depths for equipment operators.

Disturbance areas will be stripped progressively, to reduce potential erosion and sediment generation, and to minimise the extent of topsoil stockpiles and the period of soil storage.

Soil stripping scheduling and details regarding the volume of topsoil proposed to be stripped will continue to be provided in the Forward Program.

Soil stripping practices are detailed in Section 4.3.

4.1.1 Meteorological Monitoring

In accordance with Development Consent Condition 6.2, data from the meteorological station that is maintained on-site along with Bureau of Meteorology weather forecasts will be used to determine whether soil moisture conditions are suitable for soil stripping activities and hence contribute to soil stripping scheduling. Where practicable, if current or predicted weather conditions are unsuitable (e.g. during particularly wet periods) soil stripping activities will be delayed until weather conditions improve.

4.2 SOIL STRIPPING QUANTITIES/DEPTHS

Soil stripping depths will reflect the intended use of the stripped soil in the CGO's rehabilitation programme (Section 5).

Consistent with the approved strategy of soil resource management, disturbance areas will be clearly delineated and stripped of soil resources including topsoil, followed by the separate removal of subsoil (where subsoil is deemed suitable for rehabilitation purposes). Stripped soils would be either directly replaced on rehabilitation areas or stored in dedicated soil stockpiles. Existing soil stockpile locations (as at end 2021) are shown on Figure 6. The approved new soil stockpiles associated with development of the approved CGO (located within the ML 1791 area and south-east of the IWL) are shown on Figure 2.

Typical soil stripping depths based on the survey results of the original soil profile are outlined in Table 2.

Table 2
Typical Soil Stripping Depths

Soil Type (Unit)	Topsoil Stripping Depth (m)	Low Salinity Subsoil Stripping Depth (m)	Gypsum Treated Subsoil Stripping Depth (m)
Hard Pedal Red Duplex Soils (A)	0-0.1 and 0.1-0.35	0.35-0.9	0.9-2
Grey, Brown and Red Cracking Clays (B)	0-0.1	0.1-0.5	0.5-2
Hill Soils (C) [1]	0-0.5	0.5-0.8	-
Lacustrine Sediments	0.1-0.3	0.3-5.3	5.3-27.5

Source: CaLM (1994) and Resource Strategies (1997)

[1] Note: Soil Map Unit C (Hill Soils) has been covered by development of the Northern Waste Rock Emplacement.

The typical stripping depths above are based on the assessment of soil suitability for rehabilitation (including fertility and stability considerations) included in the *Soils, Agricultural Suitability/Land Capability and Soil Resources* assessment (Department of Conservation and Land Management [CaLM], 1994 and Resource Strategies, 1997) provided in Appendix B of the EIS (Section 3.1).

A review of the quantity and suitability of soil required for rehabilitation activities will be conducted prior to soil stripping to guide soil stripping depth requirements. If deeper stripping is required (i.e. if an increased depth of soil cover is required for rehabilitation activities), stripping depths may be increased and/or some subsoil resources may be treated/ameliorated for use as a topsoil growth medium (Section 4.6).

4.3 SOIL STRIPPING PRACTICES

Prior to Stripping
Cultural Heritage Inspection

Soil stripping activities within ML 1535 (including preliminary soil testing) will comply with the existing requirements of the NPWS Section 87 permits and Section 90 consents granted under the *National Parks and Wildlife Act, 1974* (NPW Act). These permits and consents allow both the collection of visible artefacts prior to soil stripping and also the collection of unknown artefacts that may be contained within the soil profile. In accordance with Condition 11 of the Section 87 permit, "*all areas where soil stripping occurs shall be further inspected following this operation in the event that datable materials might be revealed*".

An Aboriginal Heritage Impact Permit (AHIP) application for the ML 1791 area was lodged with the NSW Office for Environment and Heritage (OEH) under Section 90A of the NPW Act. AHIP Permit 1467 was approved on 31 March 2022. All disturbance activities within ML 1791 will be undertaken in accordance with requirements of the AHIP.

A comprehensive Ground Disturbance Permit process is in place at the CGO. All land disturbance activities will only take place in approved surface disturbance areas. Wiradjuri Cultural Heritage Monitors will complete a visual inspection with an archaeologist or a suitably qualified representative (as required by the current Section 80 and Section 90 consents and permits) during salvage activities.

The permit clearly defines the location and nature of the earthworks activity, with steps required to enable ground survey by Wiradjuri monitors and/or an archaeologist or suitably qualified representative. There are two steps to the process:

- A surface cultural heritage clearance survey, which is designed to inspect the relevant land and identify surface objects from which a representative sample would be collected prior to disturbance taking place.
- A sub-surface cultural heritage clearance survey, which allows for inspection once the grass layer has been removed. Typically at the CGO, this is accomplished by grading several centimetres of topsoil to enable identification of objects and other items (kept with the soil) for collection and storage.

The rationale for this is based on the original archaeological assessments, where it was deemed necessary to verify that no sites or features might be unwittingly destroyed. Standard test-pit excavation by hand was not considered a feasible strategy to deliver this certainty for Wiradjuri.

Flora and Fauna Inspections

A Vegetation Clearance Protocol (VCP) and a Threatened Species Management Protocol (TSMP) have been developed for the CGO and are detailed in the CGO's Flora and Fauna Management Plan (FFMP).

The VCP and TSMP outline measures to be undertaken prior to clearing of vegetation at the CGO. These measures include:

- a pre-clearance survey for flora and fauna, including a targeted survey for any threatened species recorded in the mine site area; and
- preliminary and secondary fauna habitat assessments including identification of any fauna habitat resources/features that could be salvaged for use in the rehabilitation programme.

In accordance with Development Consent Condition 3.2(a)(iii), no disturbance of the remaining Belah Woodland or Weeping Myall Open Woodland, as identified in Appendix 4 of the Development Consent is permitted and hence no soil stripping practices will be undertaken within these areas. These Woodland areas are shown in Figure 6.

Soil Amelioration Prior to Stripping

Consistent with McKenzie Soil Management's soil amelioration recommendations (Section 4.6), gypsum may be applied to the soil surface of proposed disturbance areas (where necessary) prior to soil stripping. This method has been recommended by McKenzie Soil Management (2013) as the most effective technique for ameliorating/improving soil structure (Appendix A). Soil sampling and testing will be undertaken by a suitably qualified person prior to stripping to characterise the soil and determine appropriate gypsum application rates. Where appropriate soil sampling may be repeated after placement in stockpiles to verify suitability for rehabilitation and amelioration specifications.

Stripping Methodology

As required by Development Consent Condition 3.2(a)(i), disturbance areas and the removal of trees and other vegetation from the mine site will be restricted to the minimum required. Once cleared of woody vegetation, soils will typically be stripped using a grader, scraper or bulldozer. Scrapers may be used to strip soils where areas become too large for effective dozer or grader stripping.

Soil will be stripped by the separate removal of topsoil, followed by removing subsoil. Stripped soils would be either directly replaced on rehabilitation areas or stored in separate topsoil or subsoil stockpiles. Where re-handling is necessary, this will typically be undertaken using excavators and dump trucks.

Prior to initiation of soil stripping activities, the Sustainability Manager (or delegate) will ensure that the appropriate protocols have been followed and the recommended stripping depths are confirmed ahead of stripping (Section 4.2).

Through all stages of soil stripping earthworks, soil stockpiling and re-application for rehabilitation, operations will be closely supervised to maintain correct recovery depths of suitable soils based on results of soil testing or typical stripping depths (Section 4.2). The Sustainability Manager (or delegate) in consultation with the Mining manager will direct and control the recovery, handling and management of site soils. Responsibilities will include:

- delineation of areas to be stripped;
- delineation of suitable stockpile areas;
- direction of soil collection/haulage equipment to designated stockpile locations according to soil type;
- recording of volumes stored (including date, location, soil type, volume and descriptions of any ameliorants added to stockpiled materials for recording in the soils database); and
- installation of signposts for all soil stockpiles with the date of construction and type of soil.

4.4 SOIL STRIPPING ACTIVITIES

The following subsections provide a general description of the soil stripping areas associated with development of the approved CGO.

ML 1535 and ML 1791

Soil stripping activities associated with development of the approved CGO would primarily involve the following within the approved surface disturbance areas (Figure 2):

- IWL footprint;
- contained water storage D10 footprint;
- relocated magazine and explosives compound footprints;
- southern soil stockpile footprint (south-east of the IWL); and
- soil stockpile footprint within the ML 1791
- Paste Plant precinct (located on the already disturbed area of the PWRE)

Lake Cowal Road Realignment

A 3.3. km portion of Lake Cowal Road has been realigned around ML 1791 (Figure 2). The road realignment was constructed to the same standard as the existing Lake Cowal Road (i.e. an unsealed rural road in the order of 6 m wide).

The road realignment and associated soil stripping activities were conducted in consultation with the Bland Shire Council (BSC) and in accordance with relevant approvals.

Pipeline Duplication

Construction of the existing Bland Creek Palaeochannel (BCPC) pipeline and borefield, the Eastern Saline Borefield and saline borefield within ML 1535 are complete, and were undertaken in accordance with this SSMP. The following section is relevant to the pipeline duplication construction works associated with development of the approved CGO.

Duplication of the existing Bland Creek Paleochannel pipeline up to Bore 4 of the BCPC borefield would be undertaken for the approved CGO. The pipeline would be constructed within the existing 40 m pipeline corridor, with a nominal diameter of up to 600 millimetres and buried to a nominal depth of approximately 1 m. Disturbance associated with the pipeline duplication would be limited within the existing corridor with additional disturbance within occasional laydown areas.

Given the pipeline traverses Lake Cowal (Figure 2), the construction methodology would be dependent on the water level in the lake. The lake was dry at the time of construction, thus the pipeline was buried as described above

Soil stripping activities within the pipeline corridor, were overseen by the Sustainability Manager (or delegate) which ensured the appropriate protocols (e.g. heritage and land clearance requirements in accordance with Development Consent Conditions 3.1 and 3.2(c)) were followed and the recommended stripping depths confirmed ahead of stripping (Section 4.2).

Soil stripping and soil stockpiling activities within the pipeline corridor would be generally minor and of a shorter term, in comparison to activities in the ML areas.

During pipeline burial, soil will be removed to one side of the pipeline trench alignment. Topsoil and subsoil (where present and identifiable) will be separately stockpiled. Pipeline burial was conducted progressively, with each section completed and backfilled as the next section is excavated.

Upon completion of each section of the trench works, subsoils was replaced in the trench, followed by topsoil.

The control of soil erosion and dust along the pipeline corridor was undertaken in accordance with the Erosion and Sediment Control Management Plan (ESCMP) and Air Quality Management Plan (AQMP) and will include the adoption of measures such as:

- Delineating the boundary of the 40 m pipeline corridor.
- Restricting soil stripping and excavations works to the pipeline corridor.
- Watering of works areas when necessary (including unsealed access roads and trafficked areas if necessary).

- Installation of soil/sediment control measures where necessary (e.g. the installation of silt fencing).
- Regular inspection of works and stockpile areas and enactment of any remedial or response measures with respect to dust and soil/sediment control.
- Upon completion of construction, revegetation (seeding) of disturbance areas within the pipeline corridor to minimise dust generation would be undertaken where necessary.

Soil stockpiles will be short term features during pipeline burial and soils will be promptly replaced during the progressive rehabilitation of the pipeline burial route.

4.5 SOIL STOCKPILE MANAGEMENT

In accordance with Development Consent Condition 3.5(b)(i), the general protocol for the management of soil stockpiles is presented below and includes soil handling measures that optimise the retention of soil characteristics (in terms of nutrients and micro-organisms) favourable to plant growth:

- leave the surface of the completed soil stockpiles in a “rough” condition to help promote water infiltration and minimise erosion prior to vegetation establishment;
- deep-rip soil stockpiles and seed (if necessary) to maintain soil organic matter levels, soil structure and microbial activity;
- treat soil stockpiles with gypsum to reduce dispersiveness during stockpiling;
- install signposts for all soil stockpiles with the date of construction and type of soil; and
- record details of all soil stockpiles on a site database which includes the location and volume of each stockpile and the stockpile maintenance records (e.g. ameliorative treatment, weed control, seeding) (Section 4.5.3).

Where practicable, soil will be stripped from one area and immediately transferred to an active rehabilitation area for direct placement. This will reduce the size of soil stockpiles and optimise soil fertility for rehabilitation (Section 5).

Following construction and if adequate unassisted revegetation has not occurred, soil stockpiles may be sown with suitable annual or select grass and legume species to maintain soil condition for future rehabilitation works, to minimise erosion and wind-blown dust and discourage opportunistic weed growth. Soil treatment/amelioration methods may be undertaken prior to the use of soil for rehabilitation. These methods are detailed in Section 4.6.

4.5.1 Long-term Soil Stockpile Management

Where required to improve structural and fertility characteristics prior to application, soil stockpiles will be deep-ripped to establish aerobic conditions (Resource Strategies, 1997). All soil stockpiles will have sediment control measures installed in accordance with the requirements of the ESCMP. The control measures used will depend on the size and location of each stockpile.

Long-term topsoil stockpiles will continue to be constructed up to 3 m in height with slopes at a maximum acceptable angle to resist erosion. Subsoil stockpiles will vary in height as determined by storage volumes and available space within the footprint of approved disturbance areas.

A general purpose starter fertiliser may be applied to all soil stockpiles following construction. Fertiliser use and mix will depend on soil tests on stockpiled soil and proposed use of the soil.

The soil stockpiles will be inspected by the Sustainability Manager or their delegate on an annual basis, with regard to vegetation cover, weed and erosion and sedimentation issues.

The following soil stockpile maintenance procedures will be conducted where on-going monitoring indicates the need:

- fertiliser application;
- deep-ripping to improve aerobic conditions;
- additional erosion control and stabilisation;
- supplementary seeding with a select cover species; and
- weed control as necessary.

Soil Stockpile Stripping Procedure

Based on McKenzie Soil Management's (2013) recommendations, to improve long-term viability of soil stocks and long-term revegetation/rehabilitation performance, the general procedure for using soil stockpiles will involve stripping the surface layer (up to approximately 1 m deep) for rehabilitation purposes, and then deep-ripping the new surface of the stockpile with gypsum (at approximately 10 t/ha or a rate determined from soil testing results). This process would be repeated until all soil within the stockpile has been treated.

This process aims to minimise the variability of soil applied to rehabilitation areas and effectively treat the entire depth of stockpiled soil resources (not just the surface layer).

4.5.2 Erosion and Dust Control Measures

During soil stripping operations, dust control and management measures will be implemented in accordance with the AQMP. In accordance with Development Consent Condition 2.4(b), all reasonable and feasible measures will be taken to minimise the total area exposed for dust generation at any time. Erosion control of bare and working areas forms a component of the ESCMP which details procedures for effective erosion and site sediment management.

Measures to control wind-borne dust and soil sediment runoff from soil stockpiles in accordance with the AQMP and ESCMP include the following:

- avoiding stripping and placement of soil stockpiles during particularly wet or dry periods whenever possible;

- watering of soil stockpiles during construction when conditions indicate the need (i.e. dry conditions when excessive dust is being generated);
- the stabilisation of completed soil stockpiles and monitoring the revegetation of soil stockpiles (either unassisted or assisted, via the application of seed, fertiliser and water) to promote cover and, as a consequence, erosion control;
- use of silt fences and sediment traps to minimise soil movement;
- construction of soil stockpiles of appropriate height and batter angles; and
- minimisation of runoff from soil stockpile areas by using diversion channels or banks to divert surface water around soil stockpiles.

4.5.3 Soil Stockpile Register

An aerial survey will generally be conducted annually to confirm approximate volume of soil resource stocks. Details of estimated soil resource accounting (availability and requirements) will continue to be provided in the Forward Program. A detailed soil stockpile register will be maintained to track soil resource use and availability and to record soil treatments applied to each soil stockpile (e.g. gypsum or lime application rates).

4.6 SOIL AMELIORATION MEASURES

The main limitations of the existing soil resources at the CGO include structural limitations associated with the dispersive properties of the soils (CaLM, 1994). Gypsum application is a proven ameliorant for this limitation and was recommended in the EIS studies (CaLM, 1994) and more recently by McKenzie Soil Management (2013) (Appendix A).

The majority of stockpiled soil resources at the CGO are typically sodic and dispersive and therefore require treatment with gypsum to improve the soil structure and suitability for plant growth (some soil stocks however require treatment with lime or a gypsum-lime blend to reduce the acidity of the soil) (Appendix A).

To enhance the suitability of topsoil stocks for plant growth, gypsum application rates ranging between zero and approximately 35 t/ha/m have been recommended (Appendix A). To enhance the suitability of subsoil stocks for plant growth, gypsum application rates ranging between approximately 73 and 153 t/ha/m have been recommended (Appendix A). Details of the recommended treatment rates for each soil stockpile are provided in McKenzie Soil Management's *Cowal Gold Operations Soil Stockpile Characterisation Assessment* (Appendix A). Soil stripping activities and stockpile relocations conducted due to the additional approved disturbance has changed some existing locations, volumes, and possibly overall soil analysis due to the blending of some previously segregated topsoil stockpiles, thus further testing and mapping will be conducted to update registers and possibly amelioration rates.

Various methods have been recommended by McKenzie Soil Management to apply the required gypsum (or lime or gypsum-lime blend) to existing soil stocks or to soil about to be stripped from disturbance areas. These methods include (Appendix A):

- deep-ripping and applying gypsum (or other relevant treatments) to existing and proposed soil stockpiles;
- treating strongly sodic and dispersive soil stocks with gypsum, or acidic soils with lime or a gypsum-lime blend, in a dedicated soil amelioration farm;
- applying gypsum to soil during re-application on rehabilitation areas; and
- spreading gypsum on the surface of original soil profiles prior to soil stripping.

These measures are detailed below.

Treatment of Soil Stockpiles

As described in Section 4.5.1, to improve long-term viability of soil stocks and long-term revegetation/rehabilitation performance, soil stockpiles will be stripped of the surface layer (up to approximately 1 m deep) and used for rehabilitation purposes (Appendix A). The new surface of the stockpile would then be deep ripped with gypsum (at approximately 10 t/ha or a rate determined from soil testing results). This process would be repeated until all soil within the stockpile has been treated (Appendix A).

Treatment of Soil on Rehabilitation Areas

Consistent with current rehabilitation procedures at the approved CGO, gypsum will continue to be applied to soil used on rehabilitation areas. The rate of gypsum application will be based on soil testing results and would consider the prior treatment of the soil (i.e. while stockpiled or within the soil amelioration farm).

In addition to soil treatment, soil re-application measures may include (Appendix A):

- minimising compaction of restored soil profiles by deep-ripping the soil surface; and
- applying native pasture hay to protect the surface soil and to encourage vigorous native plant growth.

Treatment of Original Soil Profile

McKenzie Soil Management has indicated that the most effective way of ameliorating soil is by spreading gypsum on the surface of original soil profiles prior to soil stripping (Appendix A). Accordingly, and as described in Section 4.3, prior to soil stripping, gypsum may be spread on proposed disturbance areas at locations and at a rate determined by soil testing.

Soil Amelioration Farm

As recommended by McKenzie Soil Management (2013), a soil amelioration farm may be used to treat/ameliorate strongly sodic and dispersive soils over a period of time to reduce the sodicity and dispersiveness of the soil (and to improve other chemical characteristics). An area located on top of the southern waste rock emplacement may be used for soil farming or an alternative location may be identified. The preliminary design concepts for the soil farm (as recommended by McKenzie Soil Management [2013]) are outlined below (Appendix A).

The soil farm would be approximately 0.5 m deep. The surface would be deep-ripped with gypsum to a depth of approximately 450 millimetres to incorporate as much gypsum through the soil profile to optimise the calcium/sodium exchange process. A soluble fine-grade gypsum would be used to provide a consistent cover of gypsum across the soil surface.

Should monitoring results indicate that rainfall is insufficient a spray irrigation system may be installed to enhance drainage through the soil profile to expedite the calcium/sodium exchange process. If the soil farm is not located on top of a waste rock emplacement, the topsoil of the ground surface would be stripped prior to placement of the strongly sodic soil and a drainage collection system (including a toe drain around the perimeter of the farm, a seepage collection dam and a pump system) would be installed to collect and transfer sodium rich drainage water to an appropriate contained water storage within ML 1535.

Vegetation would be established on the soil surface to assist in increasing infiltration of water into the soil profile (via formation of shrinkage cracks) to encourage drainage of sodium salts and facilitate the calcium/sodium exchange process. A thick application of hay mulch with some vegetation cover would likely be the most desirable soil surface cover. Hay mulch and vegetation establishment would also improve other soil characteristics such as organic carbon content, structural stability, biological activity and promote development of the soil seed bank.

The term of treatment would vary depending on approximate gypsum requirement, the amount of rainfall (or irrigation water) and on-going soil testing results. If the farm is irrigated, the soil would require a drying period prior to rehandling the material.

The design concepts of the soil farm described above are provisional, with detailed design concepts to be developed as a result of research including simulation modelling of quantitative predictions of water and gypsum requirements.

An annual soil sampling programme would be implemented to assess the performance of the farm and to inform the requirements for additional treatment measures. Soil samples would be taken at consistent locations across the soil farm area to the depth of the soil profile. Analysis of the soil samples would focus on exchangeable cations, electrical conductivity, pH and dispersibility of the soil.

Soil stocks requiring the highest gypsum application would be ameliorated first as these soils would likely involve the longest treatment period.

Once soil test results indicate the soils are likely suitable for rehabilitation use, the soil would be removed from the farm and placed directly on rehabilitation areas or stockpiled separately. The soil farm establishment process would then be repeated using the next volume of soil stocks requiring amelioration.

Soils ameliorated within the farm are anticipated to improve revegetation outcomes for the CGO final landforms (due to improved soil properties for plant growth) and may increase the number and diversity of revegetation species able to be used in the CGO rehabilitation programme (i.e. additional species could be used that are typically less tolerant to deficient soils) (McKenzie Soil Management, 2013).

Detail regarding the design, implementation and management of the soil amelioration farm would be included in the RMP and developed in consultation with the Resources Regulator and other relevant regulatory authorities, if implementation of the soil farm is considered necessary.

5 REHABILITATION

The approved CGO rehabilitation philosophy is to operate as a non-intrusive land user and to create stable rehabilitated landforms that increase the areas of endemic vegetation in the mine area and the status of land-lake habitats (Evolution, 2018). This philosophy has led to the rehabilitation principles and objectives as described below.

The rehabilitation programme would be undertaken in accordance with Development Consent Condition 2.4 and would include the following general principles (Evolution, 2013):

- The rehabilitation of landforms is to be progressive (where possible) and conducted in accordance with approved plans.
- Final landforms are to be stable in the long-term and include native and/or endemic vegetation characteristic of remnant vegetation within the surrounding landscape.
- Native and/or endemic groundcover, understorey and tree species are to be used in the rehabilitation programme.
- Rehabilitation concepts are to be flexible to allow for adjustments, based on investigations and trials, to improve the rehabilitation programme.
- The annual rehabilitation programme and budget is to be prepared by a site team incorporating senior management representatives.

The rehabilitation objectives for the CGO's rehabilitation programme include (Evolution, 2018):

- The water quality of Lake Cowal is not detrimentally affected by the CGO landforms.
- Revegetating the CGO landforms with selected native and/or endemic vegetation that are suited to the physiographic and hydrological features of each landform, and which expand on the areas of remnant endemic vegetation in the surrounding landscape.
- Designing final landforms so that they are stable and include revegetation growth materials that are suited to the landform and support self-sustaining vegetation.
- The placement (wherever possible) of soils on final landforms to enable the progressive establishment of vegetation.
- The expansion of habitat opportunities for wetland and terrestrial fauna species. This includes the design and implementation of rehabilitation works at the New Lake Foreshore in a manner consistent with the *NSW Wetlands Policy* (Department of Environment, Climate Change and Water, 2010).
- The selection of revegetation species in accordance with accepted principles of long-term sustainability (e.g. genotypic variation, vegetation succession, water/drought tolerances).
- Grazing of land within ML 1535 and ML 1791 to be excluded during operations and during rehabilitation of the mine site. At lease relinquishment, rehabilitated final landforms are excluded from grazing, with some areas suitable for grazing surrounding the rehabilitated final landforms.

Measures to Minimise Soil Loss

Interim rehabilitation measures that will be implemented to minimise the area exposed for dust generation will include the establishment of a cover crop and seeding of desired vegetation types on newly rehabilitated landforms/areas and on long-term soil stockpiles. Rock mulch will also be applied as soon as practicable following the completion of shaping of the waste rock emplacement and tailings storage facility/IWL batters to minimise the potential for windblown dust from the surface, in accordance with the rehabilitation concepts described in the RMP.

Furthermore, following re-profiling works and rock mulch and topsoil application, native pasture hay (or straw hay) may be applied on northern and western facing landform slopes (as these aspects are subject to prevailing conditions), to assist with stabilising and minimise the loss topsoil resources.

Numerous rehabilitation investigations and trials have been undertaken at the CGO to determine the most appropriate and effective rehabilitation methods, rehabilitation materials and revegetation species likely to achieve the rehabilitation objectives for the CGO's final landforms (Evolution, 2013).

Rehabilitation investigations and trials that have been undertaken since 2005 have included material characterisation assessments and investigation of the most suitable amelioration methods.

Specifically, investigations have been conducted into the chemical and physical properties of topsoil and subsoil resources and the optimum rates of gypsum application to improve suitability for plant growth and use on rehabilitation areas (Section 4.6 and Appendix A).

Ongoing research of the effectiveness of the soil amelioration methods will continue to be conducted. Rehabilitation concepts and measures are described in detail in the CGO's Rehabilitation Management Plan (RMP). Progressive rehabilitation works and proposed soil stripping works and areas will be detailed in the Forward Program in accordance with the requirements of the Conditions of Authority for ML 1535 and the Resources Regulator Rehab Reform Guidelines.

6 COMMUNITY CONSULTATION AND COMPLAINTS REGISTER

Community Environmental Monitoring and Consultative Committee (CEMCC)

A CEMCC has been established for the CGO in accordance with Development Consent Condition 9.1(d). Development Consent Condition 9.1(d) is reproduced below:

> ***9.1 Environmental Management***
>
> *(d) Community Environmental Monitoring and Consultative Committee*
>
> *(i) The Applicant shall establish and operate a Community Environmental Monitoring and Consultative Committee (CEMCC) for the development to the satisfaction of the Secretary. This CEMCC must:*
>
> - *be comprised of an independent chair and at least 2 representatives of the Applicant, 1 representative of BSC, 1 representative of the Lake Cowal Environmental Trust (but not a Trust representative of the Applicant), 4 community representatives (including one member of the Lake Cowal Landholders Association);*
> - *be operated in general accordance with the Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects (Department of Planning, 2007, or its latest version).*
> - *monitor compliance with conditions of this consent and other matters relevant to the operation of the mine during the term of the consent.*
>
> *Note: The CEMCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Applicant complies with this consent.*
>
> *(ii) The Applicant shall establish a trust fund to be managed by the Chair of the CEMCC to facilitate the functioning of the CEMCC, and pay $2000 per annum to the fund for the duration of gold processing operations. The annual payment shall be indexed according to the Consumer Price Index (CPI) at the time of payment. The first payment shall be made by the date of the first Committee meeting. The Applicant shall also contribute to the Trust Fund reasonable funds for payment of the independent Chairperson, to the satisfaction of the Secretary*

As required, the CEMCC is comprised of:

- four community representatives (including one member of the Lake Cowal Landholders Association);
- one representative of the Lake Cowal Foundation;
- one representative of the Wiradjuri Condobolin Corporation;
- a representative of the Bland Shire Council, Lachlan Shire Council and Forbes Shire Council;
- an independent chairperson; and
- two representatives of Evolution.

The CEMCC will continue to provide opportunities for members of the community to attend CEMCC meetings to discuss specific issues relevant to them. This will be achieved by landholders making a request to the CEMCC regarding a particular issue, or by the landowner registering a complaint in the complaints register. Landowners who register complaints may be invited to join in discussion of the issue at the next CEMCC meeting.

The CEMCC meets quarterly and the meeting minutes are provided on Evolution's website (www.evolutionmining.com.au).

Complaints Register

A complaints register will be maintained by the Sustainability Manager (or delegate) in accordance with Environment Protection Licence Condition M5.1.

Information recorded in the complaints register with respect to each complaint will include:

- date of complaint;
- the method by which the complaint was made;
- any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that fact;
- nature of complaint;
- the action(s) taken by Evolution in relation to the complaint, including any follow-up contact with the complainant; and
- if no action was taken by Evolution, the reasons why no action was taken.

An initial response will be provided to the complainant within 24 hours. Preliminary investigations into the complaint will commence within 48 hours of complaint receipt.

A summary of the complaints register will be displayed on the Evolution's website in accordance with Development Consent Condition 9.4(a)(v) and will be updated on a monthly basis.

Dispute Resolution

In the event that dispute resolution is necessary, the resolution process will be one of informed discussion involving the complainant and Evolution. Evolution may also refer the dispute (with the complainant's agreement) to the CGO's CEMCC for mediation. In the event that the complainant is still dissatisfied, the matter may be referred to the DPIE for consideration of further measures. Every effort will be made to ensure that concerns are addressed in a manner that results in a mutually acceptable outcome.

7 INDEPENDENT ENVIRONMENTAL AUDIT

Independent Environmental Audit

An Independent Environmental Audit (IEA) will be conducted in accordance with Development Consent Condition 9.2. Development Consent Condition 9.2 is reproduced below:

> ***9.2 Independent Auditing and Review***
>
> *(a) Independent Environmental Audit*
>
> *(i) By the end of July 2016, and every 3 years thereafter, unless the Secretary directs otherwise, the Applicant shall commission and pay the full cost of an Independent Environmental Audit of the development. This audit must:*
>
> - *Be conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Secretary;*
> - *Include consultation with relevant regulatory agencies, BSC and CEMCC;*
> - *Assess the environmental performance of the development and assess whether it is complying with the requirements in this consent and any other relevant approvals (such as environment protection licences and/or mining lease (including any assessment, plan or program required under this consent);*

- *Review the adequacy of any approved strategy, plan or program required under this consent or the abovementioned approvals; and*
- *Recommend measures or actions to improve the environmental performance of the development, and/or strategy, plan or program required under this consent.*

Note: This audit team must be led by a suitably qualified auditor, and include ecology and rehabilitation experts, and any other fields specified by the Secretary.

(ii) Within 3 months of commissioning this audit, or as otherwise agreed by the Secretary, the Applicant shall submit a copy of the audit report to the Secretary, together with its response to any recommendations contained in the audit report, and a timetable for the implementation of these recommendations as required. The applicant must implement these recommendations, to the satisfaction of the Secretary.

8 REPORTING AND NOTIFICATION

Incident Notification and Reporting

Incidents are defined in the Development Consent as:

> *A set of circumstances that causes or threatens to cause material harm to the environment, and/or breaches or exceeds the limits or performance measures/criteria in this consent.*

In accordance with Development Consent Condition 9.3(a), Evolution will notify the DPIE in writing to compliance@planning.nsw.gov.au, and any other relevant agencies, immediately after becoming aware of an incident. Evolution will provide the relevant agencies with a detailed report on the incident, and any further reports that may be requested. These reports will outline as a minimum, the development (including the development application number), the location and the nature of the incident which has occurred.

Non-Compliance Notification and Reporting

A non-compliance is defined within the Development Consent as:

> *An occurrence, set of circumstances, or development, which is a breach of the Development Consent but is not an incident.*

In accordance with Development Consent Condition 9.5(b), Evolution will notify the DPIE in writing to compliance@planning.nsw.gov.au within seven days after becoming aware of any non-compliance with the Development Consent Conditions. Evolution will provide in writing to the DPIE a detailed report of the non-compliance which identifies, the development application number for the CGO, the Development Consent Condition of which the CGO is non-compliant, the way in which the CGO does not comply and the reason for the non-compliance. The CGO will also provide details around any actions which have been or will be taken, to address the non-compliance.

Annual Review

An Annual Review will be prepared in accordance with the requirements of Development Consent Condition 9.1(b) and will be submitted to the Secretary of the DPIE by the end of July each year, or as otherwise agreed with by Secretary. Development Consent Condition 9.1(b) is reproduced below:

> **9.1 Environmental Management**
>
> *b) Annual Review*

By the end of July each year, or as otherwise agreed with the Secretary, the Applicant shall review the environmental performance of the development to the satisfaction of the Secretary. This review must:

(i) describe the development that was carried out in the previous calendar year, and the development that is proposed to be carried out over the next year;

(ii) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, which includes a comparison of these results against the:

- *the relevant statutory requirements, limits or performance measures/criteria;*
- *the monitoring results of previous years; and*
- *the relevant predictions in the EIS;*

(iii) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;

(iv) identify any trends in the monitoring data over the life of the development,

(v) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and

(vi) describe what measures will be implemented over the next year to improve the environmental performance of the development.

The Annual Review will also address the Annual Environment Report requirements of Condition 26 of the Conditions of Authority for ML 1535. The requirements of Condition 26 are detailed below.

Annual Environmental Management Report (AR)

26. (1) Within 12 months of the commencement of mining operations and thereafter annually or, at such other times as may be allowed by the Director-General, the lease holder must lodge an Annual Environmental Management Report (AR) with the Director-General.

(2) The AR must be prepared in accordance with the Director-General's guidelines current at the time of reporting and contain a review and forecast of performance for the preceding and ensuing twelve months in terms of:

(a) the accepted Mining Operations Plan;

(b) development consent requirements and conditions;

(c) Environment Protection Authority and Department of Land and Water Conservation licences and approvals;

(d) any other statutory environmental requirements;

(e) details of any variations to environmental approvals applicable to the lease area; and

(f) where relevant, progress towards final rehabilitation objectives.

(3) After considering an AR the Director-General may, by notice in writing, direct the lease holder to undertake operations, remedial actions or supplementary studies in the manner and within the period specified in the notice to ensure that operations on the lease area are conducted in accordance with sound mining and environmental practice.

(4) The lease holder shall, as and when directed by the Minister, cooperate with the Director-General to conduct and facilitate review of the AR involving other government agencies and the local council.

In accordance with Development Consent Condition 3.5(b)(iii), the Annual Review will report on the following soil related issues:

- soil stripping activities undertaken;
- effectiveness of soil stripping methods and soil stockpile management measures;

- soil amelioration measures undertaken and the effectiveness of the measures implemented;
- dust mitigation, erosion and sediment control measures implemented; and
- proposed improvements to soil stripping methods and other soil management practices.

9 REVIEW OF THIS SSMP

In accordance with Condition 9.1(c) of the Development Consent, this SSMP will be reviewed, within three months of the submission of:

- an Annual Review under Condition 9.1(b);
- an incident report under Condition 9.3(a);
- an audit under Condition 9.2(a);
- an Annual State of the Environment Report under Condition 9.2(b);
- the approval of any modification to the conditions of the Development Consent; or
- any direction of the Secretary under Condition 1.1(c).

Where this review leads to revisions of the SSMP, then within four weeks of the review, the revised SSMP will be submitted for the approval of the Secretary of the DPIE (unless otherwise agreed with the Secretary). The revision status of this SSMP is indicated on the title page of each copy.

This SSMP will be made publicly available on Evolution's website (www.evolutionmining.com.au), in accordance with Condition 9.4(a)(iii) of the Development Consent. A hard copy of the SSMP will also be kept at the CGO.

10 REFERENCES

Barrick (Cowal) Limited (2013) *Cowal Gold Mine Extension Modification Environmental Assessment*.

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McKenzie Soil Management Pty Ltd (2013) *Cowal Gold Mine Soil Stockpile Characterisation Assessment.*

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Soil Management Designs (2017) *Site Verification Report: Cowal Gold Operations, Lake Cowal, New South Wales.*

11 LIST OF ABBREVIATIONS AND ACRONYMS

AR	Annual Environmental Management Report
AQMP	Air Quality Management Plan
CaLM	Department of Conservation and Land Management
CEMCC	Community Environmental Monitoring and Consultative Committee
CGO	Cowal Gold Operations
DA 14/98	Development Consent for the CGO including the Bland Creek Palaeochannel Borefield water supply pipeline
DA 2011/64	Development Consent for the operation of the Eastern Saline Borefield
DLWC	NSW Department of Land and Water Conservation (former)
DoP	NSW Department of Planning (former)
DoI	NSW Department of Industry
DPIE	NSW Department of Planning industry and Environment
DRG	Division of Resources and Geoscience within the NSW Department of Planning and Environment
EIS	*Cowal Gold Project Environmental Impact Statement* (North Limited, 1998)
EPA	NSW Environment Protection Authority
EP&A Act	NSW *Environment Planning and Assessment Act, 1979*
ESCMP	Erosion and Sediment Control Management Plan
Evolution	Evolution Mining (Cowal) Pty Limited
FFMP	Flora and Fauna Management Plan
IEA	Independent Environmental Audit
IWL	Integrated Waste Landform
km	kilometre
m	metre
ML	Mining Lease
MLA	Mining Lease Application
MOP	Mining Operations Plan
NSW	New South Wales

RMP	Rehabilitation Management Plan
SSMP	Soil Stripping Management Plan
TSMP	Threatened Species Management Protocol
t/ha	tonnes per hectare
t/ha/m	tonnes per hectare per metre
VCP	Vegetation Clearance Protocol

APPENDIX A

COWAL GOLD MINE SOIL STOCKPILE CHARACTERISATION ASSESSMENT

MCKENZIE SOIL MANAGEMENT (2013)

August 2013

Cowal Gold Mine Soil Stockpile Characterisation Assessment

Prepared for Barrick (Cowal) Limited in conjunction with Carnegie Natives Pty Ltd and Resource Strategies Pty Ltd

Dr. David McKenzie
McKenzie Soil Management Pty. Ltd.
Orange NSW

COWAL GOLD MINE

SOIL STOCKPILE CHARACTERISATION ASSESSMENT

MCKENZIE SOIL MANAGEMENT PTY LTD

AUGUST 2013
Project No. HAL-02-07
Document No. 00541561

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1 INTRODUCTION

The Cowal Gold Mine (CGM) (including Mining Lease [ML] 1535) is located approximately 38 kilometres (km) north-east of West Wyalong, New South Wales (NSW) (Figure 1). Barrick (Cowal) Limited (Barrick) owns and operates the CGM. Mining operations commenced at the CGM in April 2005 and ore processing commenced in April 2006.

1.1 BACKGROUND

North Limited commenced exploration along the western side of Lake Cowal in 1981. North Limited received development consent for the Cowal Gold Project in February 1999. North Limited was later acquired by Rio Tinto which subsequently sold the Project to Homestake Australia Limited. In December 2001 Barrick Australia Limited acquired Homestake and continued the drilling programme and development of the Project.

In 1994 North Limited commissioned the former Department of Conservation and Land Management (DCLM) to conduct a soil survey of the area and undertake an assessment of the suitability of the soils for revegetation. This assessment was included in the *Cowal Gold Project Environmental Impact Statement* (North Limited, 1998) (the EIS). Further detail regarding this assessment is provided in Section 1.3.

As a result of construction of the CGM, topsoil and subsoil resources stripped from disturbance areas have been stored in stockpiles within ML 1535 for re-use during rehabilitation of the CGM (Figure 2).

In accordance with the CGM's Development Consent Condition 8.8(b) an Independent Monitoring Panel (IMP) has been established to regularly review all environmental monitoring procedures and monitoring results (among other things) and provide an annual report on the performance of the CGM. A recommendation provided within the IMP's (2011) *Seventh Annual Report of the Independent Monitoring Panel for the Cowal Gold Project – October 2011* stated:

> *CGM should undertake analysis of the properties of the current soil stockpiles to further assist in the planning for future rehabilitation.*

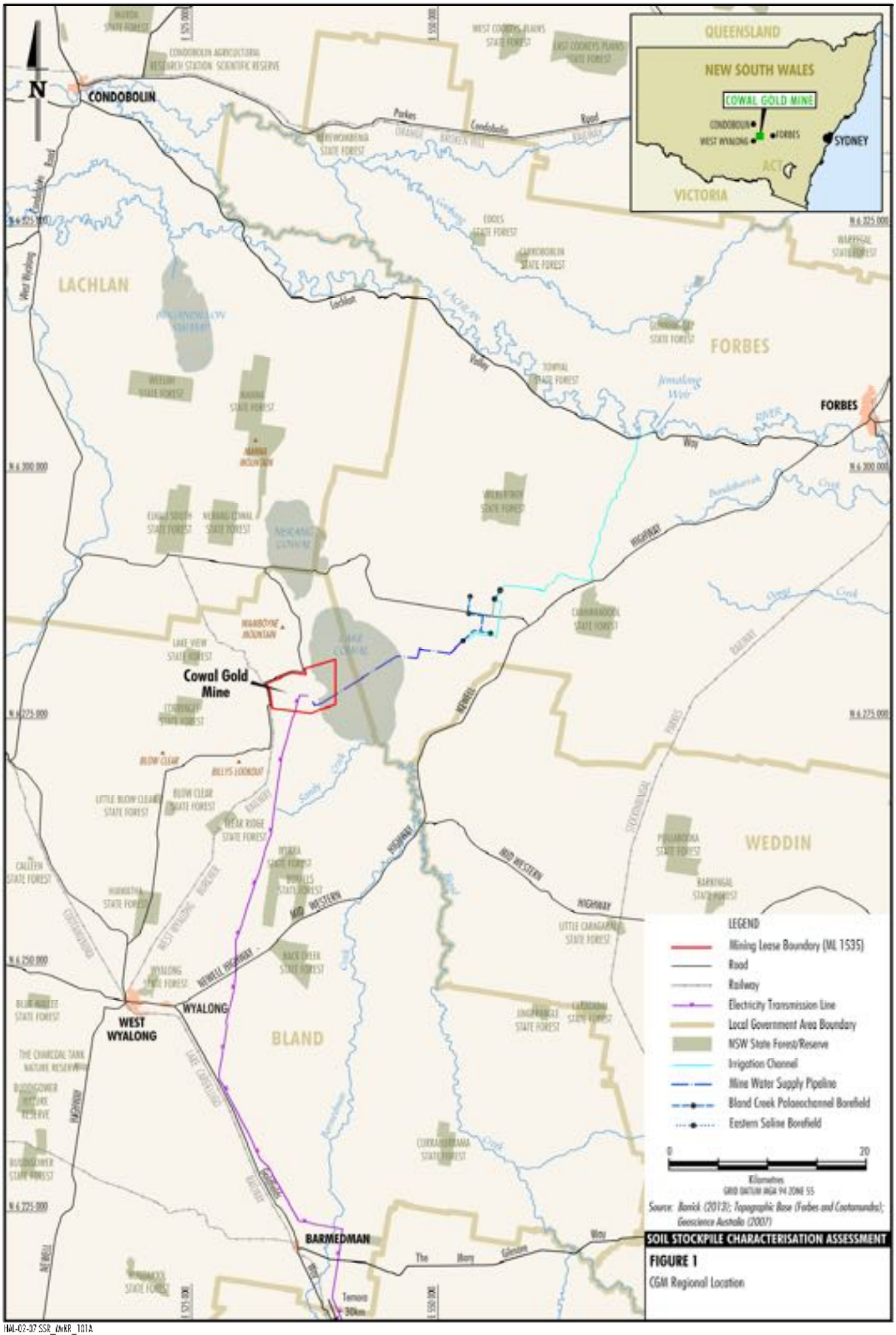
In addition, the IMP also recommended in their 2011 Report:

> *CGM should continue to evaluate the future needs for cover materials for rehabilitation including the subsoil material previously selected and stored for future use. ... Additionally CGM should attempt to obtain an estimate of the salinity range of materials previously saved for rehabilitation; this data will assist the site in calculating the volumes and planning appropriate layering of satisfactory materials for root zone construction through to mine closure.*

Accordingly Barrick engaged Dr David McKenzie of McKenzie Soil Management Pty Ltd and Mr. Malcolm Carnegie of Carnegie Natives Pty Ltd to undertake a sampling and characterisation programme of the CGM's soil stockpiles.

1.2 SCOPE AND OBJECTIVES

The scope of this report is to provide a description of the soil stockpile sampling programme, present the sampling programme results, provide an interpretation of the results relevant to the CGM's rehabilitation programme (i.e. suitability of soils for rehabilitation of the CGM) and provide recommendations for management of stockpiled soil resources at the CGM.



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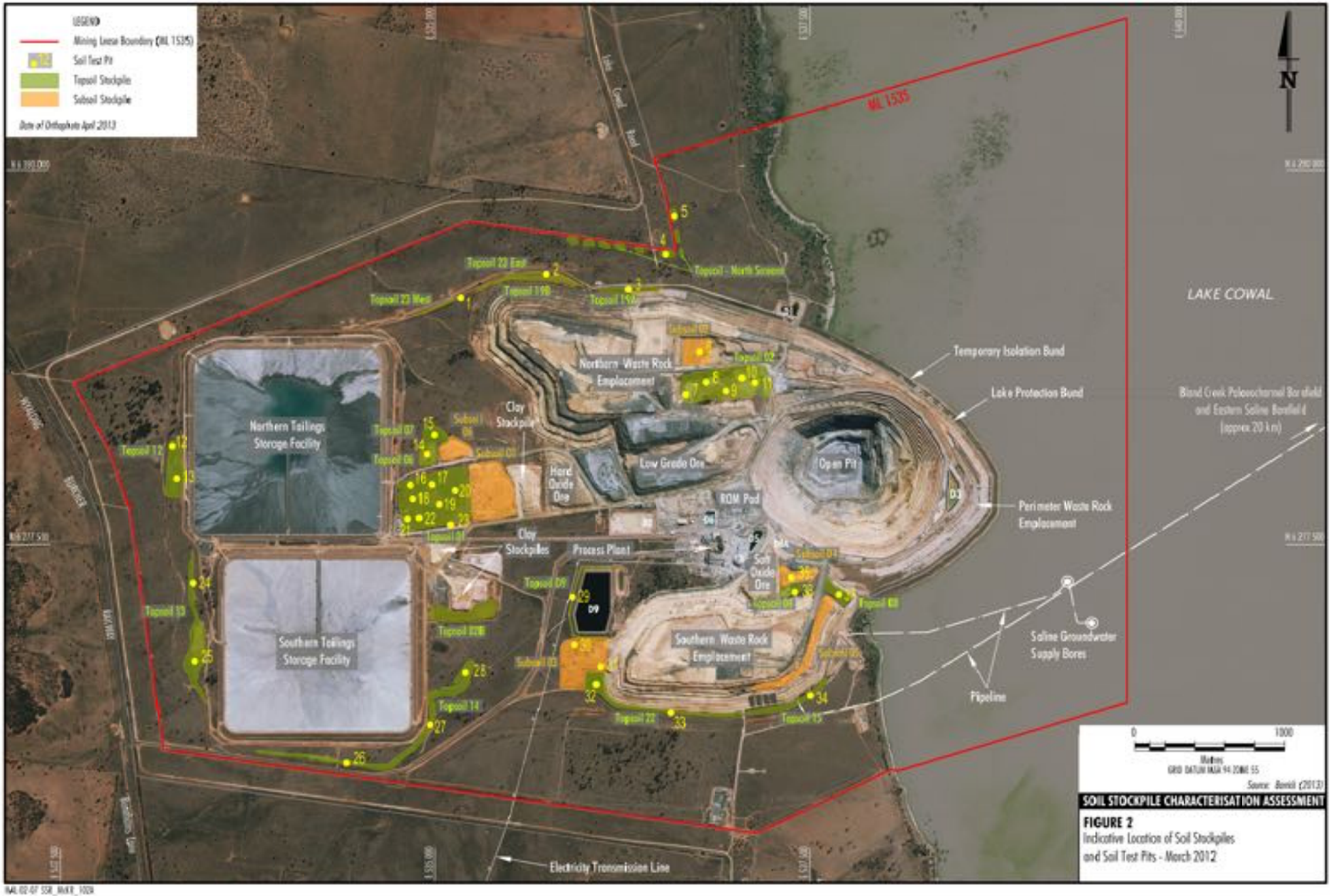
LEGEND
Mining Lease Boundary (ML 1535)
Soil Test Pit
Topsoil Stockpile
Subsoil Stockpile
Date of Orthophoto April 2013
ML 1535
LAKE COWAL
Temporary Isolation Bund
Lake Protection Bund
Blind Creek Paleochannel Borefield and Eastern Saline Borefield (approx 20 km)
Northern Tailings Storage Facility
Southern Tailings Storage Facility
Northern Waste Rock Emplacement
Southern Waste Rock Emplacement
Perimeter Waste Rock Emplacement
Open Pit
Low Grade Ore
Hard Oxide Ore
Soft Oxide Ore
ROM Pad
Process Plant
Clay Stockpile
Clay Stockpiles
Saline Groundwater Supply Bores
Pipeline
Electricity Transmission Line
Topsoil 22 East
Topsoil 22 West
Topsoil - North Seepage
Topsoil 07
Topsoil 06
Topsoil 12
Topsoil 01
Topsoil 09
Topsoil 13
Topsoil 14
Topsoil 15
Topsoil 02
Subsoil 01
Subsoil 02
Subsoil 03
Subsoil 04
Subsoil 05
N
0
1000
Metres
GRID DATUM WGS 84 ZONE 55
Source: Bemiil (2013)
SOIL STOCKPILE CHARACTERISATION ASSESSMENT
FIGURE 2
Indicative Location of Soil Stockpiles and Soil Test Pits - March 2012

The objectives of the soil stockpile sampling and characterisation programme were to:

- obtain samples from all soil stockpiles at the CGM for laboratory assessment of soil conditions for plant growth;
- determine suitability of the stockpiled soils for use in the CGM rehabilitation programme;
- obtain an estimate of the volume of soil resources available for future rehabilitation of the CGM; and
- detail recommended amelioration strategies and measures to improve available soil resources for use in the CGM's rehabilitation programme.

1.3 EXISTING INFORMATION

As described in Section 1.1, a soils survey of the CGM area and an assessment of soil types and suitability for revegetation was undertaken to assist preparation of the EIS (North Limited, 1998), viz. *Cowal Gold Project Soil Survey Consultancy Report for North Mining Limited* (DCLM, 1994). The major soil types identified in the CGM area (DCLM, 1994) were:

- hard pedal red duplex soils;
- grey, brown and red cracking clays;
- hill soils; and
- lacustrine (lake) sediments.

Sodicity and salinity limitations in the subsoils were described by DCLM's (1994).

An *Agricultural Suitability/Rural Land Capability and Soil Resources* (Resource Strategies, 1997) assessment was also prepared for the EIS. The soil resource component of this assessment provided a general soil resource management strategy for the Project including a description of the potential suitability of the soils for rehabilitation use and management practices for the Project's stockpiled topsoil and subsoil resources.

Australian National University PhD student Jessica Drake conducted sampling and characterisation of the CGM's soil stockpiles during 2009 and 2010 as a component of her thesis All mixed up: *Considering enhanced small-scale variation of mine soils in mine rehabilitation activities* (Drake, 2012). Ms Drake's study described soil fertility results from the upper layers of the of the soil stockpiles (to a depth of up to 50 cm below the surface) and described the variability of selected soil characteristics within the CGM soil stockpiles. Drake's research focussed on suitability of analytical techniques for the assessment of carbon, nitrogen, sulphur, phosphorus, electrical conductivity and pH of mine soils.

2 SOIL STOCKPILE CHARACTERISATION

2.1 METHODOLOGY

Field Survey

The field survey and sampling of the CGM soil stockpiles was undertaken between 22 and 24 February 2012, and on 19 to 23 March 2012 following a large amount of rainfall. Thirty-seven pits were excavated across sixteen topsoil and three subsoil stockpiles located within ML 1535. The location of the test pits and indicative location of the soil stockpiles are shown on Figure 2.

Some soil stockpiles were unable to be accessed during the sampling programme undertaken in February-March 2012 due to operational constraints or equipment inaccessibility. These stockpiles include Topsoil 04, Subsoil Stockpiles 01, 04, 05 and 06 (Figure 2). It is recommended that soil samples be taken from these stockpiles to characterise these stocks prior to rehabilitation use and to complete this assessment.

A 'Magellan Explorist 210' GPS instrument with an accuracy of about ±4 m was used to record the pit co-ordinates (Appendix A).

The test pits were dug to the depth of the soil stockpile (up to approximately 4 m) using a backhoe.

Field Soil Observations

The following characteristics were assessed for the layers identified in each of the soil profiles of the soil test pit:

- thickness of each layer (horizon);
- soil moisture status at the time of sampling;
- pH (using Raupach test kit);
- colour of moistened soil, including the degree of mottling (using Munsell reference colours);
- pedality of the soil aggregates;
- amount and type of coarse fragments (gravel, rock, manganese oxide nodules);
- texture (proportions of sand, silt and clay), estimated by hand;
- presence/absence of free lime and gypsum;
- root frequency; and
- dispersibility and the degree of slaking in deionised water (after 10 minutes).

Soil dispersibility, as measured by the Aggregate Stability in Water (ASWAT) test (Field *et al*. 1997), was assessed by McKenzie Soil Management in Orange. An advantage of the ASWAT test is that the results can be linked with management issues such as the need for gypsum application. The relationship between the ASWAT test and Emerson aggregate classes is shown in Table 1.

Table 1
Relationship between ASWAT Scores and Dispersivity (Hazelton and Murphy, 2007)

Dispersivity	Emerson Aggregate Classes	Probable Score for the ASWAT Test (Field *et al.,* 1997)
Very high	1 and 2(3)	12-16
High	2(2)	10-12
High to moderate	2(1)	9-10
Moderate	3(4) and 3(3)	5-8
Slight	3(2), 3(1) and 5	0-4
Negligible/aggregated	4, 6, 7, 8	0

Hand texturing provides an approximation of the clay content of a soil. In conjunction with the estimation of coarse fragment (gravel) content, it provides a low-cost and rapid alternative to particle size analysis.

Laboratory Testing

Soil samples for laboratory testing were taken at the following depths of the soil test pit:

- 0 – 15 centimetres (cm);
- 15 – 30 cm;
- 30 – 60 cm;
- 60 – 90 cm;
- 90 – 120 cm;
- 2 metres (m);
- 3 m; and (if relevant)
- 4 m.

Soil samples were dispatched to the Incitec Pivot Laboratory, Werribee Vic. for soil chemical analysis and to McKenzie Soil Management Pty Ltd for ASWAT dispersion testing.

The parameters analysed by the Incitec Pivot Laboratory were:

- Exchangeable cations (calcium, magnesium, potassium, sodium, aluminium);
- Salinity (electrical conductivity);
- Chloride and boron concentrations;
- Organic carbon;
- Plant-available phosphorus and sulphate concentrations; and
- Micro elements (zinc and copper).

An ammonium acetate method was used for the extraction of exchangeable calcium, magnesium, potassium and sodium; a KCl technique was used for exchangeable aluminium. The cation exchange capacity (CEC) values are the sum of these exchangeable cations. Phosphorus was determined using the Colwell method, sulphur by the CPC method, boron by a calcium chloride ($CaCl_2$) extraction and zinc/copper by a DTPA extraction (see Rayment and Lyons [2011] for further details).

2.2 SOIL STOCKPILE SAMPLING LOCATIONS, TYPE AND DEPTH

The location of the topsoil and subsoil stockpiles and the soil test pits excavated during the field survey are shown on Figure 2. A summary of the soil stockpile types (i.e. topsoil or subsoil), the relevant test pits excavated within each stockpile, the depth of the stockpile and co-ordinates of the soil test pits is provided in Appendix A.

2.3 PHYSICAL CHARACTERISTICS

Layer data and soil structure details for each soil test pit are presented in Appendices B and C. Photographs of the soil profiles of each soil test pit are provided in Appendix D.

Topsoil Stockpiles

Texture

Most stockpiles contained contrasting textures, ranging from fine sandy clay loam to medium heavy clay.

Degree of stratification

Some sites had up to 15 separate layers to a depth of 140cm; others only had 3 distinct deposition layers.

Compaction Status

Some stockpiles had distinct compaction layers that were restricting water penetration and root growth, others were well structured throughout.

Depth of water penetration

Maximum depth of water penetration was approx. 100cm, despite heavy rain shortly before sampling. A small number of pits had a strong swampy smell associated with lateral seepage of water into the base of topsoil stockpiles.

Other factors

Many of the deep loamy layers were dry and dusty, with large clumps of undecomposed straw and in some cases signs of water repellence.

Subsoil Stockpiles

Texture

All of the stockpiled subsoil under consideration was clay-rich with evidence of shrink-swell potential.

Degree of stratification

There was no evidence of stratification in the subsoil stockpiles.

Compaction Status

Compaction was observed in one of the three subsoil profiles.

Depth of water penetration

Poor water penetration was evident in the subsoil stockpiles.

2.4 CHEMICAL CHARACTERISTICS

Agronomic/fertility analysis results for each sample taken within each soil test pit are presented in Appendix E.

Topsoil Stockpiles

Salinity

A broad range of salt concentrations was observed within the topsoil stockpiles – from non-saline to strongly saline. Some of the saline sites also had boron toxicity (B concentrations greater than 2 mg/kg).

Sodicity

Much of the soil was dispersive and sodic.

pH

Most of the soil was alkaline, but two of the stockpiles (represented by Pits 1 and 2) were acidic and in need of lime application.

Phosphorus

Most of the soil was P deficient but there were pockets of stockpiled topsoil that did not require addition of P fertilisers.

Organic Carbon

Most of the organic carbon values were low.

Subsoil Stockpiles

Salinity

The subsoil stockpiles were strongly saline.

Sodicity

The subsoil was sodic, with dispersion aggravated by low Ca/Mg ratios.

pH

All subsoil samples were alkaline.

Phosphorus

All subsoil samples were very deficient in phosphorus.

Organic Carbon

The stockpiled subsoil had very low concentrations of organic carbon.

2.5 SUITABILITY OF SOILS FOR REHABILITATION

Based on the physical and chemical characteristics of the stockpiles topsoil and subsoil described in Sections 2.3 and 2.4, an assessment of the suitability of the soil for plant growth has been undertaken.

Table 2 summarises the key soil factors, limitations and amelioration requirements for each of the topsoil and subsoil stockpiles.

Table 2
Summary of Soil Characteristics, Limitations and Suitability for Rehabilitation

Stockpile Number and Type	Soil Test Pit(s)	Soil Characteristics/Limitations	Suitability for Rehabilitation
Topsoil 01	16 to 23	• Fine sandy clay loam to medium heavy clay • Neutral to alkaline • Non-saline to strongly saline • Mostly sodic; dispersive where non-saline • Compaction observed at some sites • Mostly P deficient	Soil suitable for plant growth with gypsum application of approximately 26t/ha/m (refer Table 3 in Section 3). Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 02	7 – 11	• Fine sandy clay loam to medium clay • Neutral to alkaline • Non-saline to strongly saline • Mostly sodic; dispersive where non-saline • Compaction observed at some sites • P deficient	Discard strongly saline upper 30cm of soil at Site 8. Soil suitable for plant growth with gypsum application of approximately 29t/ha/m (refer Table 3 in Section 3). Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 04	36	• Light clay to medium clay • Alkaline • Moderately to strongly saline • Mostly sodic; dispersive where non-saline • P deficient	Soil suitable for plant growth with gypsum application of approximately 29t/ha/m (refer Table 3in Section 3).
Topsoil 06	14	• Light clay • Acidic to neutral • Non-saline to moderately saline • Sodic and dispersive • Partially P deficient	Discard small patches with scalded saline material. Soil suitable for plant growth with application of a gypsum-lime blend at a rate of approximately 18t/ha/m (refer Table 3 in Section 3).
Topsoil 07	15	• Fine sandy clay loam to medium clay • Neutral to alkaline • Non-saline to moderately saline • Mostly sodic; dispersive where non-saline • Partially P deficient	Soil suitable for plant growth with application of gypsum at a rate of approximately 23t/ha/m (refer Table 3 in Section 3).
Topsoil 08	37	• Light clay to medium clay • Alkaline • Moderately to strongly saline • Mostly sodic; dispersive where non-saline • Partially P deficient	Soil suitable for plant growth with application of gypsum at a rate of approximately 28t/ha/m (refer Table 3 in Section 3).

Table 2 (continued)
Summary of Soil Characteristics, Limitations and Suitability for Rehabilitation

Stockpile Number and Type	Soil Test Pit(s)	Soil Characteristics/Limitations	Suitability for Rehabilitation
Topsoil D9	29, 30	• Fine sandy clay loam to medium heavy clay • Neutral to alkaline • Non-saline to strongly saline • Sodic; dispersive where non-saline • Compaction observed at some sites • Mostly P deficient	Soil suitable for plant growth with gypsum application of approximately 33t/ha/m (refer Table 3 in Section 3). Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 12	12, 13	• Fine sandy clay loam to medium heavy clay • Acidic to alkaline • Non-saline to moderately saline • Mostly sodic and dispersive • Compaction observed at some sites • Partially P deficient	Soil suitable for plant growth with gypsum application of approximately 26t/ha/m (refer Table 3 in Section 3). Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 13	24, 25	• Light clay to medium heavy clay • Neutral to alkaline • Moderately to strongly saline • Mostly sodic; dispersive where non-saline • Partially P deficient	Soil suitable for plant growth with gypsum application of approximately 35t/ha/m (refer Table 3 in Section 3).
Topsoil 14	26 - 28	• Clay loam to medium clay • Neutral to alkaline • Moderately to strongly saline • Mostly sodic; dispersive where non-saline • Compaction observed at some sites • Partially P deficient	Soil suitable for plant growth with gypsum application of approximately 27t/ha/m (refer Table 3 in Section 3). Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 15	34	• Light clay to light medium clay • Alkaline • Moderately to strongly saline • Mostly sodic; dispersive where non-saline • P deficient	Soil suitable for plant growth with gypsum application of approximately 23t/ha/m (refer Table 3 in Section 3).

Table 2 (continued)
Summary of Soil Characteristics, Limitations and Suitability for Rehabilitation

Stockpile Number and Type	Soil Test Pit(s)	Soil Characteristics/Limitations	Suitability for Rehabilitation
Topsoil 19A	3	• Light clay to light medium clay • Strongly alkaline • Moderately to strongly saline • Mostly strongly sodic; dispersive where non-saline • Compaction observed at some sites • P deficient	Soil suitable for plant growth with gypsum application of approximately 74t/ha/m (refer Table 3 in Section 3) – consider inclusion with subsoil requiring gypsum treatment. Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 19B	2	• Fine sandy clay loam • Acidic to neutral • Non saline • Not strongly sodic but dispersive because of a lack of electrolyte • Compaction observed at some sites	Soil suitable for plant growth with lime application of approximately 3t/ha/m. Recommend soil stockpile also be deep ripped to alleviate compaction and incorporate the lime.
Topsoil 22	32, 33	• Silty clay loam to medium heavy clay • Neutral to alkaline • Non-saline to strongly saline • Mostly sodic; dispersive where non-saline • Compaction observed at some sites • Partially P deficient	Soil suitable for plant growth with gypsum application of approximately 19t/ha/m (refer Table 3 in Section 3). Recommend soil stockpile also be deep ripped to alleviate compaction.
Topsoil 23 East and West	1	• Fine sandy clay loam to sandy light clay • Acidic to neutral • Non-saline • Sodic and dispersive • Partially P deficient	Soil suitable for plant growth with a gypsum-lime blend of approximately 5t/ha/m.
North Screens (Topsoil)	4, 5	• Fine sandy clay loam to medium heavy clay • Neutral to alkaline • Non-saline to strongly saline • Strongly sodic; dispersive where non-saline • Compaction observed at some sites • P deficient	Soil suitable for plant growth with gypsum application of approximately 73t/ha/m (refer Table 3 in Section 3) – consider inclusion with subsoil requiring gypsum treatment. Recommend soil stockpile also be deep ripped to alleviate compaction.

Table 2 (continued)
Summary of Soil Characteristics, Limitations and Suitability for Rehabilitation

Stockpile Number and Type	Soil Test Pit(s)	Soil Characteristics/Limitations	Suitability for Rehabilitation
Subsoil 02	6	• Light medium clay • Alkaline • Strongly saline • Strongly sodic and dispersive • Compaction observed at some sites • P deficient	Soil suitable for plant growth with gypsum application of approximately 91t/ha/m (refer Table 3 in Section 3) Recommend soil stockpile also be deep ripped to alleviate compaction.
Subsoil 03	31	• Alkaline • Strongly saline • Strongly sodic • P deficient	Soil suitable for plant growth with gypsum application of approximately 153t/ha/m (refer Table 3 in Section 3)
Subsoil 04	35	• Neutral to alkaline • Strongly saline • Strongly sodic • P deficient	Soil suitable for plant growth with gypsum application of approximately 93t/ha/m (refer Table 3 in Section 3)

3 SOIL AMELIORATION REQUIREMENTS

Based on the analysis and assessment of the stockpiled soils provided in Section 2, an estimate of the average gypsum application rates likely to be required has been undertaken to improve the soil properties so that the soil may be suitable for rehabilitation use. A summary of the average gypsum requirements for the test pits and soil stockpiles is provided in Table 3.

Table 3
Summary of Average Gypsum Requirements for Test Pits and Soil Stockpiles

Stockpile Number and Type (Figure 2)	Pit Number (Figure 2)	Approximate Pit Depth (cm)	Average Gypsum Requirement for Pit (t/ha/m)	Average Gypsum Requirement for Stockpile (t/ha/m)
Topsoil Stockpiles				
Topsoil 01	16	380	5	26
	17	380	20	
	18	250	16	
	19	420	76	
	20	410	37	
	21	340	42	
	22	430	13	
	23	330	12	
Topsoil 02	7	300	16	29
	8	300	53	
	9	350	30	
	10	310	21	
	11	>420	24	
Topsoil 04	36	410	29	29
Topsoil 06	14	330	18	18
Topsoil 07	15	320	23	23
Topsoil 08	37	350	28	28
Topsoil D9	29	260	34	33
	30	260	32	
Topsoil 12	12	290	34	26
	13	320	18	
Topsoil 13	24	240	56	35
	25	440	13	
Topsoil 14	26	330	29	27
	27	260	43	
	28	460	10	
Topsoil 15	34	210	23	23
Topsoil 19A	3	380	74	74
Topsoil 19B	2	240	0	0
Topsoil 22	32	330	26	19
	33	250	12	
Topsoil 23 East and West	1	190	5	5
North Screens (Topsoil)	4	280	77	73
	5	410	69	

Table 3 (continued)
Summary of Average Gypsum Requirements for Test Pits and Soil Stockpiles

Stockpile Number and Type (Figure 2)	Pit Number (Figure 2)	Approximate Pit Depth (cm)	Average Gypsum Requirement for Pit (t/ha/m)	Average Gypsum Requirement for Stockpile (t/ha/m)
Subsoil Stockpiles				
Subsoil 02	6	200	91	91
Subsoil 03	31	120	153	153
Subsoil 04	35	400	93	93

Without gypsum, the sodic soil under consideration will have the following problems:

- Separation of dispersed clay from the sand and silt particles leads to blockage of pores and inadequate water intake when rain falls.
- Conditions for plant growth in sodic soil often are poor because of waterlogging under moist conditions and excessive hardness when dry.
- Rainfall tends to be lost via runoff and evaporation, rather than infiltrating deeply and being stored in the root zone.
- Sodic soil is very prone to loss by water erosion.

Gypsum Calculation Methodology

When gypsum (calcium sulphate) is applied to sodic soil, two beneficial processes occur (Loveday, 1976). Exchange of undesirable sodium ions on the clay particles with calcium from gypsum creates a permanent improvement in soil structural stability. An associated short-term process is the electrolyte effect whereby gypsum dissolved in the soil solution prevents dispersion. In agriculture, the usual scenario with gypsum application is rapid improvement in soil structural stability through the electrolyte effect, followed by longer term improvement associated with displacement of exchangeable sodium by calcium – a typical initial gypsum application rate is 3 t/ha, with a focus on improvement of the topsoil.

Estimates for the gypsum requirement of stockpiled topsoil and subsoil at Cowal Mine were calculated by referral to the paper by Awad and Abbott (1976), which is based on the procedures of Richards (1954). The aim with this approach is to achieve permanent improvement in soil structural stability (i.e. target ESP of approx. 3), which is slightly less than the sodicity threshold of 6 for Australian soils.

The formula from Awad and Abbott (1976) is as follows:

> Gypsum requirement = [Exch. Na (meq/100g soil) – 0.5] × soil bulk density (g/cm^3) × soil depth to be treated (cm) × 0.086.

This formula assumes that the beneficial exchange of calcium for sodium is 100% efficient and that exchangeable magnesium is irrelevant. These assumptions will not be fully met at the CGM given uncertainties about processes such as interactions with carbonates and potential precipitation losses of calcium. As a result, the gypsum tonnages recommended are only a first approximation of gypsum requirements and may be inaccurate. Nevertheless, we can be confident that sodicity of the stockpiles topsoil and subsoil will be substantially reduced by the recommendations that have been provided. Regular monitoring of progress following gypsum application will allow fine-tuning of the recommendations.

A finely-divided gypsum product with a relatively high solubility should be selected to maximise the rate of entry of calcium ions into stockpiles via the wetting front.

4 ESTIMATE OF SOIL RESOURCE

Table 4 provides a summary of the estimated volume of topsoil and subsoil resources available for future rehabilitation use at the CGM as at August 2013. The soil resource estimate has been based on results of a recent aerial survey (April 2013) undertaken of the CGM by Barrick. The estimated total soil resource available for rehabilitation provided in Table 4 assumes all stockpiled soil resources at the CGM are suitable for rehabilitation use. It should be noted that due to operations since March 2012 (when the soil stockpile sampling programme commenced) some soil stockpiles have been moved and/or used on rehabilitation areas. As a result, the numbering of some of the soil stockpiles (as shown in Table 4) has changed from what was sampled in March 2012 and shown on Figure 2.

Table 4
Soil Resource Estimate (August 2013)

Soil Stockpile	Approximate Volume (m^3)[1]
Topsoil Stockpiles	
Topsoil 01	497,775
Topsoil 02A (formerly Topsoil 02)	241,434
Topsoil 02B (formerly Topsoil 02)	141,033
Topsoil 02C (formerly Topsoil 02)	20,303
Topsoil 03	61,963
Topsoil 04	63,874
Topsoil 06	14,891
Topsoil 07	31,374
Topsoil 08 (formerly Topsoil D9)	17,165
Topsoil 10 (formerly Topsoil North Screens)	28,958
Topsoil 12	93,377
Topsoil 13	134,627
Topsoil 14A	9,323
Topsoil 14B	106,261
Topsoil 15	29,439
Topsoil 19 (formerly Topsoil 19A and 19B)	39,899
Topsoil 22	116,118
Topsoil 23 (formerly Topsoil 23 East)	53,331
Topsoil 23 West	6,269
Estimated Total Topsoil Resource	**1,707,414**
Subsoil Stockpiles	
Subsoil 01	1,139,457
Subsoil 02	231,398
Subsoil 03	76,578
Subsoil 04	192,026
Subsoil 05	104,324
Subsoil 06	247,624
Estimated Total Subsoil Resource	**1,991,407**
Estimated Total Soil Resource Available for Rehabilitation	**3,698,821**

[1] Source: pers.comm., Garry Pearson (Barrick Cowal Gold Mine Environmental Department), August 2013.

5 SOIL MANAGEMENT RECOMMENDATIONS

Gypsum (calcium sulphate) is the favoured ameliorant for improvement of sodic soil in NSW. It is readily available in western NSW from lakebed deposits (McKenzie *et al.* 1995). Gypsum-lime blends are sometimes used in areas close to lime deposits (low transport costs) where topsoil pH is acidic or neutral.

As outlined in Section 3, an average gypsum requirement has been calculated for each topsoil and subsoil stockpile with requirements ranging from 0 to approximately 74 t/ha/m for topsoil stockpiles and approximately 91 to 153 t/ha/m for subsoil stockpiles. Barrick should consider whether soil stocks identified as requiring very high gypsum applications (e.g. within Subsoil Stockpile 03 where soil may require a gypsum requirement of up to 153 t/ha/m), should be discarded.

Various methods may be undertaken to apply the required gypsum (or lime or gypsum-lime blend) to existing soil stocks or to soil about to be stripped from disturbance areas. These methods include:

- deep-ripping and applying gypsum (or lime or gypsum-lime blend) to existing and proposed soil stockpiles;
- placing and treating strongly sodic and dispersive soil stocks with gypsum in a dedicated soil amelioration farm; and
- applying gypsum to soil during re-application on rehabilitation areas.

Additionally, it is recommended that the most effective way of ameliorating soil is by spreading gypsum on the surface of original soil profiles prior to soil stripping.

A description of these measures is provided in the subsections below.

5.1 TREATMENT OF SOIL STOCKPILES

Soil stockpiles should be deep ripped with gypsum applied at the approximate rates relevant to each soil stockpile (Table 3). However, lime or a gypsum-lime blend should be applied to Topsoil Stockpile 19B and Topsoil Stockpile 23 (East and West) respectively (Table 3). Strongly sodic and dispersive soil stocks should be placed and treated in the soil amelioration farm (described below).

It is recommended that ongoing treatment of the soil stockpiles be achieved by applying gypsum (or other relevant treatment) at the recommended rate (Table 3) to the surface layer of the soil stockpile, then stripping the surface soil (up to approximately 1 m deep) once soil testing indicates the soil is suitable for rehabilitation use. The new surface of the stockpile should then be deep ripped with gypsum (or other relevant treatment) at an application rate determined from soil testing results. This process should then be repeated until all soil within the stockpile has been treated.

The recommended surface soil stripping depth of approximately 1 m is based on the observed depth of water penetration in the soil stockpiles in early 2012.

5.2 SOIL AMELIORATION FARM

For soil stocks which require high gypsum application rates it is recommended Barrick consider implementation of a “soil amelioration farm”. The soil amelioration farm would involve a dedicated stockpile where strongly sodic and dispersive soils would be treated/ameliorated over a period of time to reduce the sodicity and dispersiveness of the soil (and to improve other chemical characteristics).

The term of treatment would vary depending on approximate gypsum requirement, the amount of rainfall (or irrigation water [if required]) and on-going soil testing results. Once soil tests indicate the soils are suitable for rehabilitation use, the soil would be removed from the farm (following drying by plants grown on the stockpiles) and placed directly on rehabilitation areas or stockpiled within soil stockpiles with similar soil characteristics/properties.

Soil is likely to be spread across the farm up to a depth of approximately 0.5 m. The soil would then be ripped to a depth of 450 mm with gypsum to incorporate as much gypsum as possible through the soil profile to optimise the calcium/sodium exchange process. Ripping will also be valuable in terms of its ability to overcome water penetration problems associated with the observed textural stratification within the stockpiles. If the soil is too wet for successful ripping, gypsum will still be effective without mechanical disturbance; it is sufficiently soluble to move with infiltrating water and reduce sodicity.

Several significant challenges exist when the sodic soil is stripped and stockpiled (without gypsum application) and then requires gypsum treatment at a later date. This is because as the soil solution enriched with dissolved gypsum (calcium sulphate) leaches down through the sodic stockpile, it becomes enriched with sodium and depleted in calcium. A point is reached where the dissolved sodium salts need to be flushed from the stockpiles so that the desired exchange of sodium by calcium can re-commence in an efficient manner.

An associated challenge is to supply sufficient water to the soil amelioration farm so that deep leaching of desirable and undesirable salts can take place. It was observed that the depth of water penetration in the soil stockpiles in early 2012 was only about 1 metre, despite above average rainfall prior to the soil pit inspections. Therefore, it is recommended that a spray irrigation system be used to supply sufficient water for successful amelioration.

A drainage system would be required to direct or transfer sodium rich drainage water to an appropriate contained water storage within ML 1535. This system may include a toe drain around the perimeter of the farm, a sediment retention dam and a pump system. Similar to the design of the waste rock emplacements, the floor/base of the farm may be constructed to slope towards the open pit and to assist preferential flow and collection of drainage water. The stripped topsoil and subsoil should be retained and placed within a suitable stockpile.

This proposed concept is provisional. The design needs to be confirmed through the use of simulation modelling that provides quantitative predictions of water and gypsum required to reclaim soil to a pre-determined level of salinity and sodicity. Dr Donald Suarez and colleagues from US Salinity Laboratory have proposed a one-dimensional multicomponent transport model, UNSTACHEM, that can achieve this objective (Simunek & Suarez 1997). It is recommended that Dr Suarez be invited to join the project team so that this critically important modelling exercise can be completed. It is also recommended that a post-doctoral fellow with specialisation in the chemistry of sodic-saline soil be engaged to assist ongoing research and provide high-quality supervision of the soil improvement programme.

Prediction of the depth of soil that can be treated with gypsum in a single amelioration event (and design of the irrigation system and its operating protocols [if determined necessary]), cannot be completed until Dr Suarez's modelling procedures have been implemented.

A possible alternative to gypsum (calcium sulphate) is the use of calcium chloride (Richards 1954, Gharaibeh *et al*. 2009). Calcium chloride is about 400 times more soluble than gypsum (Aylward and Findlay 1974), meaning that it has the potential to treat a sodic soil much more quickly than gypsum using only a fraction of the water. Calcium chloride is rarely used in Australia for sodic soil management because it apparently is a lot more expensive to purchase than gypsum (and possibly is more difficult to handle), but it may be the best choice at the Barrick Cowal site given the likely high cost of water should a spray irrigation system be used.

Establishment of vegetation on the surface of the soil amelioration farm may assist in increasing infiltration of rainfall (and/or irrigation water) into the soil profile to enhance the calcium/sodium exchange process and to encourage drainage of sodium salts. However, dense vegetation cover is considered undesirable as the vegetation would likely consume considerable amounts of water that otherwise would be flushing salts from the root zone. A thick application of hay mulch with limited vegetation cover would likely be the most desirable soil surface cover while soil amelioration is taking place. Hay mulch and vegetation establishment would also improve other soil characteristics such as organic carbon content, structural stability, biological activity and promote development of the soil seed bank.

An annual (possibly 6-monthly) soil sampling programme should be implemented to assess the performance of the farm and to inform the requirements for additional treatment measures. Soil samples need to be taken at consistent locations across the soil farm area to the depth of the soil profile. Analysis would focus on exchangeable cations, electrical conductivity, pH and dispersibility of the soil samples.

It is recommended that soil stocks requiring the highest gypsum application be ameliorated first as these soils would likely involve the longest treatment period.

Once soil testing results indicate the soils within the farm are likely suitable for rehabilitation use, it is recommended these soils be placed directly (at an appropriate moisture content) on rehabilitation areas or stockpiled within soil stockpiles with similar soil characteristics/properties. The application process would then be repeated using the next volume of soil stocks requiring amelioration.

Soils ameliorated within the proposed farm is likely to provide a growth medium for a broader range of plant species for rehabilitation of the CGM final landforms than the existing stockpiled soil.

5.3 TREATMENT OF SOIL ON REHABILITATION AREAS

Consistent with current rehabilitation procedures, gypsum should continue to be applied to soil used on rehabilitation areas. The rate of gypsum application should be based on soil testing results and consider the prior treatment of the soil (i.e. while stockpiled or within the soil amelioration farm).

5.4 TREATMENT OF ORIGINAL SOIL PROFILE

As mentioned above, the most effective way of ameliorating soil is by spreading gypsum on the surface of original soil profiles prior to soil stripping (including new soil stockpiles areas). It is recommended this occur (where practicable) prior any future soil stripping activities at the CGM.

5.5 SOIL STOCKPILE MAINTENANCE MEASURES

Current soil stockpile maintenance measures undertaken at the CGM should be continued and should include:

- restricting topsoil stockpiles to a maximum height of 3 m (preferably 2 m if there is enough room);
- deep ripping (under appropriate moisture conditions) of the soil stockpiles to assist with the creation of aerobic conditions;
- leaving the surface of stockpile in a rough condition to reduce erosion hazard, increase drainage and promote revegetation; and
- fertilizing and seeding the soil stockpiles with native pasture and legume species to improve soil organic matter levels, promote soil structure and maintain microbial activity.

5.6 SOIL STRIPPING AND RE-APPLICATION PROCEDURES

When stripping the soil stockpiles and re-applying this material to the rehabilitation areas, ensure that the restored soil profiles are not severely compacted by earthmoving machinery (Ramsey 1986).

An option to consider is application of seed bearing native pasture hay to protect the surface soil and provide slow-release nutrients to encourage vigorous plant growth, consistent with the results from rehabilitation trials undertaken at the CGM.

The degree of success of soil improvement through gypsum application (using procedures described above) will vary because of a diverse range of initial ESP values. A final surface application (on rehabilitation areas) of coarse grade gypsum is recommended at a rate of about 5 t/ha as a safeguard measure. The use of coarse-grade gypsum will provide a prolonged source of electrolyte to minimise surface dispersion for as long as possible and assist with the revegetation process (by contrast, a more soluble fine-grade gypsum needs to be used in the soil amelioration farm).

It is important to note that the soil assessment described in this report only provides a first approximation of the conditions that exist in the Barrick Cowal stockpiles of topsoil and subsoil. It is recommended that further testing be carried out in between the existing soil pit sites to improve accuracy of the estimates of key soil factors and the associated amelioration and stripping / re-application plans.

Techniques such as Landscape Function Analysis (Tongway and Ludwig 2011) are available to assist with the ongoing monitoring and adaptive management of the rehabilitated landscape in the years that follow mine closure.

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APPENDIX A

SUMMARY OF SOIL STOCKPILE TYPES AND DEPTH AND LOCATION OF TEST PITS

Table A - Summary of Soil Stockpile Types and Depth and Location of Test Pits

Pit No.	Topsoil / Subsoil	Easting (WGS84)	Northing (WGS84)	Approx. depth of buried soil surface (m)	Gypsum requirement average for pit (t/ha/m depth)
1	Topsoil	535172	6279148	1.9	5
2	Topsoil	535739	6279306	2.4	0
3	Topsoil	536290	6279205	3.8	74
4	Topsoil	536538	6279439	2.8	73
5	Topsoil	536596	6279694	4.1	73
6	Subsoil	536764	6278788	2.0	91
7	Topsoil	536671	6278502	3.0	16
8	Topsoil	536806	6278585	3.0	53
9	Topsoil	536940	6278526	3.5	30
10	Topsoil	537048	6278612	3.1	21
11	Topsoil	537134	6278582	>4.2	24
12	Topsoil	533247	6278157	2.9	34
13	Topsoil	533277	6277941	3.2	18
14	Topsoil	534946	6278104	3.3	18
15	Topsoil	534997	6278233	3.2	23
16	Topsoil	534836	6277897	3.8	5
17	Topsoil	534980	6277901	3.8	20
18	Topsoil	534853	6277805	2.5	6
19	Topsoil	535030	6277769	4.2	76
20	Topsoil	535133	6277862	4.1	37
21	Topsoil	534817	6277671	3.4	42
22	Topsoil	534895	6277678	4.3	13
23	Topsoil	535105	6277631	3.3	12
24	Topsoil	533384	6277243	2.4	56
25	Topsoil	533394	6276721	4.4	13
26	Topsoil	534409	6276043	3.3	29
27	Topsoil	534968	6276296	2.6	43
28	Topsoil	535203	6276646	4.6	10
29	Topsoil	535913	6277149	2.6	34
30	Topsoil	535927	6276832	2.6	32
31	Subsoil	536104	6276684	1.2	153
32	Topsoil	536076	6276566	3.3	26
33	Topsoil	536573	6276377	2.5	12
34	Topsoil	537503	6276492	2.1	23
35	Subsoil	537376	6277281	4.0	93
36	Topsoil	537402	6277183	4.1	29
37	Topsoil	537692	6277167	3.5	28

APPENDIX B

LAYER DATA

Table B - Summary of Layer Data

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
1	A1	45	Sandy light clay	6.0	7.5YR3/4	Dark brown	–	1.6	–	3	Moist	–	–	2
1	2A	60	Fine sandy clay loam	5.5	7.5YR3/3	Dark brown	–	0.7-1.3	–	1	Moist	–	–	2
1	3A	110	Fine sandy clay loam	6.0	7.5YR3/4	Dark brown	–	1.2	–	2	Moist (65-100)	–	–	2
1	4A	140+	Fine sandy clay loam	6.0	7.5YR4/6	Strong brown	–	1.1	–	2	Dry	–	–	2
Deeper layers: dusty red-brown loam 1.4-1.9m														
Approx. 20% straw in 4A														
2	A1	45	Fine sandy clay loam	5.5	7.5YR3/3	Dark brown	–	0.8	2	3	Moist	–	–	2
2	2A	90	Fine sandy clay loam	5.5	7.5YR3/3	Dark brown	–	1.4	15	2	Moist	–	–	2
2	3A	140+	Fine sandy clay loam	5.0	7.5YR3/3	Dark brown	–	1.2	10	1	Moist	–	–	2
Deeper layers: dusty red-brown loam 1.4-2.4m														
Swampy smelling in root zone														
3	A1	25	Medium heavy clay	10.0	5YR4/4	Reddish brown	–	0.7	–	3	Wet	5	D	2
3	2A	60	Medium clay	9.0	7.5YR3/3	Dark brown	–	1.1	–	3	Moist	1	D	2
3	3B	120	Light medium clay	9.0	5YR4/4	Reddish brown	–	0.4	–	0	Moist	15	N/D	1 (70)
3	4A	140+	Light clay	7.0	7.5YR5/4	Brown	–	1.0	–	1	Dry	–	–	0
Deeper layers: dusty red-brown loam 1.4-3.8m														
25mm thick lens of 3B at a depth of 50cm (discontinuous)														
4	A11	1	Fine sandy loam	6.0	7.5YR4/4	Brown	–	0.2	–	1	Moist	2	N	1
4	A12	10 (5-15)	Light clay	6.0	7.5YR4/4	Brown	–	1.2	–	1	Moist	2	N	1
4	2B	65	Medium heavy clay	8.5	10YR5/2	Greyish brown	–	1.0	–	0	Moist	3	N	1
4	3B	80	Medium clay	8.5	7.5YR4/6	Strong brown	–	0.7	–	0	Dry	1	N	1
4	4B	140+	Light clay	8.5	10YR5/2	Greyish brown	–	0.5	–	0	Dry	1	N	1 (110)
Deeper layers: grey clay 1.4-2.8m														

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
Scalded platy surface (sodic)														
2B also contains 10YR4/2 fragments														
5	A1	18 (20-35)	Medium clay	6.0	7.5YR3/3	Dark brown	–	0.8	2	3	Moist	–	–	2
5	2B	65	Medium heavy clay	9.0	10YR4/3	Brown	–	1.2	2	1	Moist	3	D	1
5	3B	85	Light medium clay	8.0	2.5Y4/1	Dark grey	–	0.7	–	0	Moist	–	–	1
5	4B	105	Light clay	8.0	10YR5/3	Brown	–	1.0	–	0	Dry	0.5	N	0
5	5B	140+	Light medium clay	8.0	10YR5/4	Yellowish brown	–	0.2	–	1	Dry	–	–	0
Deeper layers: grey-brown clay 1.4-4.1m														
Aprox. 10% bare soil, rill erosion														
2B also contains 2.5Y5/2 fragments														
6	1	15	Light medium clay	8.0	10YR6/4	Brownish yellow	orange	1.3	–	0	Moist	–	–	1
6	2	30	Light medium clay	8.0	10YR6/4	Brownish yellow	orange/grey	0.9	–	0	Moist	–	–	1
6	3	60	Light medium clay	8.0	10YR5/4	Yellowish brown	strong grey	0.8	–	0	Moist	–	–	1 (40)
6	4	140+	Light medium clay	8.0	10YR5/4	Yellowish brown	strong grey	1.1	–	0	Moist	–	–	0
No obvious horizons; assessed via set depth intervals														
Aprox. 70% bare dispersed subsoil with cracks														
7	A1	15	Fine sandy clay loam	6.5	5YR3/3	Dark reddish brown	–	1.2	1	3	Moist	–	–	2
7	2A	55	Light clay	6.0	7.5YR4/3	Brown	–	1.2	1	1	Moist	–	–	2
7	3A	90	Light medium clay	6.0	7.5YR5/4	Brown	–	0.2	–	1	Moist (65)	–	–	1 (65)
7	4A	110	Light clay	6.5	7.5YR5/6	Strong brown	–	1.5	–	2	Dry	–	–	0
7	5A	140+	Light clay	6.0	7.5YR4/3	Brown	–	0.2	–	2	Dry	–	–	0
Deeper layers: red-brown clods & dust 1.4-3.0m														
8	A1	40	Light clay	6.5	7.5YR4/6	Strong brown	–	1.8	10	0	Moist	–	–	0.5
8	2A	50	Light clay	6.5	7.5YR5/6	Strong brown	–	0.7	–	0	Moist	–	–	0.5
8	3A	55	Silty clay loam	7.0	7.5YR5/4	Brown	–	0.6	–	2	Moist	–	–	0.5

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
8	4A	60	Light clay	8.5	7.5YR4/6	Strong brown	–	0.8	–	0	Dry	1	N	0
8	5A	65	Silty clay loam	6.0	7.5YR5/4	Brown	–	1.0	–	0	Dry	–	–	0
8	6A, 8A	65-105	Light clay	7.5	7.5YR3/4	Dark brown	–	1.4	–	0	Dry	–	–	0
8	7A, 9A	65-105	Silty clay loam	6.0	7.5YR5/4	Brown	–	1.0	–	0	Dry	–	–	0
8	10A	140+	Light clay	7.5	7.5YR4/6	Strong brown	–	0.3	5	0	Dry	–	–	0
Deeper layers: red-brown clods & dust 1.4-3.0m														
90% bare sodic surface; scattered clumps of fleabane														
4A: approx. 5% straw														
9	A1, 3A, 5A	0-60	Silty clay loam	6.0	7.5YR4/3	Brown	–	0.8	–	3	Moist	–	–	2
9	2A, 4A, 6A	0-60	Light medium clay	6.0	7.5YR3/2	Dark brown	–	1	–	3	Moist	–	–	2
9	7A, 9A	60-95	Silty loam	7.5	7.5YR5/3	Brown	–	1.1	–	0	Dry	–	–	1 (70)
9	8A, 10A	60-95	Silty loam	7.5	7.5YR4/3	Brown	–	1.1	5	0	Dry	–	–	0
9	11A, 13A, 15A	95-140+	Silty clay loam	7.0	7.5YR5/4	Brown	–	0.9	–	1	Dry	–	–	0
9	12A, 14A	95-140+	Silty clay loam	7.0	7.5YR4/4	Brown	–	1	–	0	Dry	–	–	0
Deeper layers: dusty red-brown loam 1.4-3.5m														
85-95cm: 20% straw, water repellent														
10	A1	10 (5-15)	Light clay	7	7.5YR3/2	Dark brown	–	0.8	–	3	Moist	–	–	2
10	2B	35	Medium clay	7.5	2.5Y5/2	Greyish brown	–	1.4	–	2	Moist	–	–	2
10	3A	70	Silty clay loam	5.5	7.5YR4/4	Brown	–	1.2	–	3	Moist	–	–	2
10	4A	100	Silty loam	5.5	7.5YR4/6	Strong brown	–	1.1	–	0	Moist	–	–	2
10	5A	140+	Silty clay loam	6.5	7.5YR4/4	Brown	–	1.6	–	2	Moist	–	–	2
Deeper layers: dusty red-brown loam 1.4-3.1m														
Numerous ants (several species)														
11	1	15	Light medium clay	8.5	10YR4/3	Brown	grey	1.0	1	3	Moist	2	D	1
11	2	30	Medium clay	8.0	2.5Y4/1	Dark grey	–	0.7	1	3	Moist	–	–	2

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
11	3	60	Medium clay	8.0	10YR4/4	Dark yellowish brown	grey	1.3	1	2	Moist	–	–	2
11	4	90	Light medium clay	7.5	10YR4/3	Brown	grey	0.8	1	0	Moist (95)	–	–	2
11	5	140+	Light clay	7.5	10YR4/2	Dark greyish brown	–	1.0	2	1	Dry	–	–	3
No obvious horizons; assessed via set depth intervals														
Aprox. 10% bare slightly dispersed soil														
12	A1	25	Medium heavy clay	7.5	7.5YR3/3	Dark brown	–	0.7	–	3	Moist	–	–	2
12	2A	62	Clay loam	5.5	7.5YR3/4	Dark brown	–	0.9	–	3	Moist	–	–	1
12	3A	70	Medium heavy clay	6.5	7.5YR3/3	Dark brown	–	0.5	–	3	Dry	–	–	1
12	4A	140+	Light medium clay	6.5	7.5YR5/4	Brown	–	1.3	–	2	Dry	–	–	1
Deeper layers: swampy-smelling grey clay to 2.4m; red-brown loam 2.4-2.9m														
13	A1	27	Fine sandy loam	5.5	5YR4/3	Reddish brown	–	1.4	–	1	Moist	–	–	2
13	2A	40	–	8.5	–	–	–	–	–	–	Moist (35)	2	N	2
13	3A	47	–	8.5	–	–	–	–	–	–	Slight	2	N	2
13	4A	60	Light clay	7.0	7.5YR3/3	Dark brown	–	0.9	2	2	Slight	–	–	2
13	5A	70	Light clay	8.0	7.5YR4/2	Brown	–	0.7	–	3	Slight	1	N	2
13	6A	85	Medium clay	9.0	7.5YR3/3	Dark brown	–	1.0	–	3	Dry	15	N	1
13	7A	95	–	8.0	–	–	–	–	–	–	Dry	2	N	1
13	8A	140+	Light medium clay	7.0	5YR5/4	Reddish brown	–	0.8	–	3	Dry	–	–	0
Deeper layers: grey-brown clay to 3.2m; very compacted at 2.2m with a strong swampy smell														
14	A1	25	Light clay	5.0	7.5YR3/3	Dark brown	–	1.7	–	1	Moist	–	–	3
14	2A	90	Light clay	6.5	7.5YR3/4	Dark brown	–	0.9	–	2 & 3	Slight	–	–	3
14	3A	140+	Light clay	5.0	7.5YR4/6	Strong brown	–	0.3	–	0 & 1	Slight	–	–	2
Deeper layers: red-brown loam to 2.9m, platy clay 2.9-3.3m, swampy smell														
20-25cm, 2A (10%), 3A (40%): disconnected lenses of compacted darker clay														
15	A1	25	Medium clay	8.0	7.5YR3/3	Dark brown	–	1.3	–	3	Moist	–	–	3

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
15	2A	75	Fine sandy clay loam	6.0	7.5YR3/4	Dark brown	–	1.3	–	1	Slight	–	–	2
15	3A	140+	Silty clay loam	6.0	7.5YR3/4	Dark brown	–	0.8	–	3	Slight	–	–	1 (95)
Deeper layers: red loam 1-4-2.7m, harder grey clays to 4m, strong swampy smell														
2A: scattered grey clay clods present, pH = 4.5														
3A: 30mm thick bands of grey clay, SOILpak score = 0.4														
16	A1	15	Light clay	8.0	7.5YR3/3	Dark brown	–	1.6	–	3	Moist	–	–	3
16	2A	55	Fine sandy clay loam	5.5	7.5YR3/4	Dark brown	–	0.4	2	2	Slight	–	–	2
16	2B	140+	Light clay	7.0	7.5YR3/3	Dark brown	–	1.3	–	1	Slight	–	–	1 (130)
Deeper layers: red/brown clay loam to 3.8m, cracking clay pocket 25cm wide at 15-25cm														
17	A1	30	Medium heavy clay	8.5	10YR4/3	Brown	light grey	0.8	–	2	Moist	–	–	1
17	2A	40	Light clay	6.0	7.5YR3/3	Dark brown	–	1.1	–	1	Dry	–	–	0.5
17	3A	50	Medium clay	6.5	7.5YR4/2	Brown	–	0.2	–	2	Dry	–	–	0.5
17	4A	110	Light clay	6.0	7.5YR3/3	Dark brown	–	1.1	–	1	Dry	–	–	0.5
17	5A	140+	Light medium clay	6.0	7.5YR4/4	Brown	–	1.1	–	1	Dry	–	–	0.5
Deeper layers: loose brown loam 1.4-2.5m, platy brown loam with strong swampy smell 2.5-3.8m														
2A & 3A: water repellent														
18	A1	10	Light clay	7.5	7.5YR3/3	Dark brown	–	1.2	–	1	Moist	–	–	3
18	2A	40	Light medium clay	6.5	7.5YR4/4	Brown	–	0.9	–	3	Slight	–	–	2
18	3A	75	Light clay	7.0	7.5YR5/4	Brown	–	1.0	15	1	Slight	–	–	1
18	4A	140+	Light medium clay	6.0	7.5YR5/4	Brown	–	1.7	–	1	Slight/Moist	–	–	1
Deeper layers: brown clay loam to 2.5m														
19	A1, 3A, 5A	0-60	Medium heavy clay	9.0	7.5YR4/4	Brown	–	0.8	–	3	Moist (30)	2	D	3 (25)
19	2A, 4A, 6A	0-60	Light medium clay	7.0	7.5YR3/3	Dark brown	–	0.2	–	0	Slight (60)	–	–	2
19	7A	60-100	Light clay	7.0	7.5YR4/4	Brown	–	1.6	–	0	Dry	2	P	0.5
19	8A	140+	Light medium clay	7.0	7.5YR4/6	Strong brown	–	1.3	–	0	Dry	–	–	0

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
yers: red-brown clay 1.4-4.2m														
Slightly scalded surface														
2A, 4A, 6A: 3 bands; 12-16cm, 34-40cm, 48-60cm														
20	A1	20	Medium clay	8.5	7.5YR3/3	Dark brown	–	1.5	5	1	Moist	–	–	2
20	2A	80	Light clay	7.0	7.5YR3/4	Dark brown	–	1.3	25	0	Slight	–	–	2
20	3A	140+	Fine sandy clay loam	9.0	7.5YR4/4	Brown	–	1.3	15	2	Slight	3	D	2
Deeper layers: gravelly grey-brown loam 1.4-3.4m, red-brown loam to 4.1m														
2A: 10-25mm thick gravelly-limey veins; water repellent & dusty														
21	A1	60	Medium clay	8.5	5YR5/3	Reddish brown	–	1.8	–	2	Moist	–	–	3
21	2A	140+	Light medium clay	7.5	5YR4/3	Reddish brown	–	1.4	–	0	Slight	–	–	3
Deeper layers: cracking clay to 3.4m														
2A: 25% dry OM clumps														
Shrinkage cracks to 60cm														
22	A1	10	Light clay	7.5	7.5YR3/4	Dark brown	–	1.7	–	2	Moist	–	–	3
22	2A	60	Light clay	6.0	5YR3/4	Dark reddish brown	–	1.2	–	3	Moist (25)	–	–	3
22	3A	140+	Clay loam	6.0	5YR4/4		–	1.2	–	0	Slight	–	–	3
Deeper layers: brown loam 1.4-2.3m, grey clay to 4.3m														
Slight shrinkage cracks 0-1.4m														
23	A1	30	Light clay	8.0	7.5YR3/3	Dark brown	–	1.7	–	2	Moist	–	–	2
23	2A	100/140	Light medium clay	6.5	7.5YR4/4	Brown	–	1.3	–	0	Slight	–	–	2
32	3A	140+	Silty clay loam	5.5	7.5YR3/4	Dark brown	–	1.0	–	2	Dry	–	–	2
Deeper layers: red-brown dusty loam with straw 1.4-3.3m														
3A: water repellent, approx. 30% straw														
24	A1	23	Medium clay	7.5	7.5YR3/3	Dark brown	–	1.4	1	3	Moist	–	–	2
24	2A	34	–	7.5	–	–	–	–	–	–	Slight/Moist	–	–	2

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
24	3A	38	–	9.0	–	–	–	–	–	–	Slight	15	N	2
24	4A	50	–	7.5	–	–	–	–	–	–	Slight	–	–	2
24	5A	58	–	9.0	–	–	–	–	–	–	Slight	10	N	2
24	6A	62	–	7.0	–	–	–	–	–	–	Slight	–	–	2
24	7A	92	Light medium clay	9.0	10YR6/3	Pale brown	–	1.2		1	Slight	10	N	1
24	8A	103	–	7.0	–	–	–	–	–	–	Dry	–	–	1
24	9A	112	–	9.0	–	–	–	–	–	–	Dry	5	N	1
24	10A	140+	Light medium clay	7.0	5YR5/4	Reddish brown		1.0		1	Dry	–	–	1
Deeper layers: red-brown loam 1.4-2.4m														
25	A1	8	Light clay	7.0	10YR3/3	Dark brown	–	1.2	–	2	Moist	–	–	2
25	2A	20	Light medium clay	7.5	7.5YR3/3	Dark brown	grey pockets	1.6	–	1	Moist	–	–	2
25	3A	28	–	–	–	–	–	–	–	–	–	–	–	–
25	4A	42	–	–	–	–	–	–	–	–	–	–	–	–
25	5A	58	Light clay	7.5	10YR4/4	Dark yellowish brown	–	1.5	–	3	Moist	–	–	2
25	6A	62	–	–	–	–	–	–	–	–	–	–	–	–
25	7A	92	Medium heavy clay	8.5	5YR3/3	Dark reddish brown	–	1.4	–	2	Moist	–	–	2
25	8A	110	–	–	–	–	–	–	–	–	–	–	–	–
25	9A	140+	Light clay	7.0	7.5YR3/3	Dark brown	–	1.5	–	3	Moist	–	–	1
Deeper layers: red-brown clay loam 1.4-2.5m, grey-brown loam with straw 2.5-4.4m														
26	A1	60	Light medium clay	8.0	7.5YR3/3	Dark brown	–	1.6	–	1	Slight/Moist	–	–	2
26	2Aa	140+	Clay loam	7.0	7.5YR4/3	Brown	–	1.0	–	2	Slight	–	–	2
26	2Ab	140+	Light clay	7.0	5YR4/4	Reddish brown	–	1.5	–	0	Slight	–	–	2
Deeper layers: red-brown loam 1.4-3.3m														
A1: cracking clay (vertical cracks 20 cm apart, 7mm wide)														

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
2Aa = 4 layers, 2Ab = 3 layers (see photo)														
27	A1	35	Light medium clay	8.0	7.5YR3/3	Dark brown	–	1.7	–	2	Moist	–	–	3
27	2A	42	Light clay	7.5	5YR4/4	Reddish brown	–	0.3	–	3	Moist	–	–	3
27	3A	70	Light medium clay	7.5	7.5YR3/4	Dark brown	–	1.0	–	0	Moist	–	–	2
27	4A	90	Light clay	7.0	7.5YR3/3	Dark brown	–	1.2	–	0	Slight	–	–	2
27	5A	120	Light medium clay	7.0	5YR4/4	Reddish brown	–	0.5	–	0	Slight	–	–	1
27	6A	140+	Light clay	7.0	7.5YR4/4	Brown	–	0.9	–	0	Dry	–	–	0
Deeper layers: brown dusty loam 1.4-2.6m														
28	A1	30	Medium clay	6.0	7.5YR3/3	Dark brown	–	1.1	–	2	Moist	–	–	2
28	2A	60	Light medium clay	7.5	7.5YR4/4	Brown	–	1.3	–	1	Moist	–	–	1
28	3A	110	Light clay	5.5	7.5YR4/6	Strong brown	–	1.6	–	1	Moist (105)	–	–	1
28	4A	140+	Clay loam	6.0	7.5YR4/4	Brown	–	1.0	–	0	Slight	–	–	1
Deeper layers: red-brown dusty loam with straw 1.4-4.6m														
A1: shrinkage cracks														
29	A1	20	Light medium clay	7.5	7.5YR4/3	Brown	–	0.6	–	2	Moist	–	–	2
29	2A	50	Light clay	7.5	7.5YR4/4	Brown	–	1.1	–	1	Moist (45)	–	–	1
29	3A	70	Light clay	7.5	7.5YR4/4	Brown	–	1.2	–	0	Dry	–	–	1
29	4A	95	Light clay	6.5	7.5YR5/4	Yellowish brown	–	1.2	–	0	Dry	–	–	1
29	5A	140+	Silty clay loam	5.5	7.5YR4/3	Brown	–	1.0	–	0	Dry	–	–	2
Deeper layers: dry grey clay fragments & dust 1.4-2.6m														
4A: straw-rich band														
30	A1	15	Light medium clay	6.0	7.5YR3/3	Dark brown	–	0.7	–	3	Moist	–	–	2
30	2A	30	Medium clay	8.0	10YR5/4	Yellowish brown	–	0.8	–	1	Moist	–	–	1
30	3A	55	Medium heavy clay	8.5	7.5YR4/3	Brown	–	0.7	–	2	Moist	–	–	2
30	4A	70	Light clay	7.5	7.5YR3/4	Dark brown	–	1.5	–	0	Slight	–	–	2

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
30	5A	100	Light clay	8.5	7.5YR4/4	Brown	–	1.2	5	1	Slight	2	N/P	2
30	6A	140+	Fine sandy clay loam	6.0	7.5YR4/6	Dark brown	–	1.1	–	0	Slight	–	–	2
Deeper layers: dry grey clay fragments & dust 1.4-2.6m														
6A: water repellent														
31														
Steep lower edge of large subsoil stockpile														
Alkaline cracking clay throughout														
32	A1	15	Light clay	6.5	7.5YR3/4	Dark brown	–	1.5	–	1	Moist	–	–	2
32	2Aa	15-70	Light clay	8.0	7.5YR4/3	Brown	–	1.8	–	2	Moist	–	–	2
32	2Ab	15-70	Light clay	8.0	2.5Y5/2	Greyish brown	–	1.8	–	2	Moist	–	–	2
32	3A	85	Light medium clay	8.5	10YR4/4	Dark yellowish brown	–	1.6	–	1	Moist	5	D	0
32	4Aa	85-140+	Light medium clay	7.5	7.5YR3/3	Dark brown	–	1.6	–	0	Moist	–	–	0
32	4Ab	85-140+	Light medium clay	7.5	2.5Y5/1	Grey	–	1.6	–	0	Moist	–	–	0
Deeper layers: grey & brown clay 1.4-3.3m														
Wetting front 1.5-2.5m														
33	A1a	0-50	Medium heavy clay	6.0	7.5YR3/3	Dark brown	–	0.4	–	3	Moist	–	–	2
33	A1b	0-50	Light clay	6.0	7.5YR3/4	Dark brown	–	1.1	–	2	Moist (60)	–	–	2
33	2A	100	Light clay	6.0	7.5YR3/4	Dark brown	–	1.2	–	3	Slight	–	–	2
33	3A	140+	Silty clay loam	6.5	7.5YR4/3	Brown	–	1.5	–	3	Slight	–	–	1
Deeper layers: swampy smelling clay 1.4-2.5m														
A1a: dark fragments (30%)														
A1b: light fragments (70%)														
34	A1	35	Light clay	8.5	7.5YR3/3	Dark brown	–	1.5	–	0	Moist	1	D	2
34	2A	70	Light medium clay	8.5	10YR4/2	Dark greyish brown	–	1.1	2	3	Moist	1	D	2
34	2B	140+	Light medium clay	8.5	10YR5/4	Yellowish brown	–	0.2	–	0	Dry	2	N/D	2

Pit No.	Horizon	Depth (cm)	Texture	pH (water)	Moist soil colour (munsell)	Colour	Mottles	SOILpak compaction score	Gravel fragements (%)	Dispersion (10 minutes)	Moisture	Lime		Root score
												%	Type	
Deeper layers: dusty red-brown loam 1.4-2.1m														
Blue-grey clods at depths of 50cm and 90cm														
35														
Top of subsoil stockpile														
Strongly compacted moist clay throughout														
Aprox. 98% bare dispersed subsoil with cracks														
Indistinct horizons														
36	1	15	Light medium clay	7.5	7.5YR4/3	Brown	–	1.5	2	1	Moist	–	–	2
36	2	30	Light medium clay	8.0	7.5YR4/3	Brown	–	1.2	2	2	Moist	2	D	2
36	3	60	Light clay	8.5	7.5YR4/3	Brown	–	1.6	–	2	Moist	5	D	2
36	4	90	Medium clay	8.5	7.5YR3/3	Dark brown	–	1.2	–	1	Moist	2	D	2
36	5	140+	Light medium clay	8.0	7.5YR3/3	Dark brown	–	1.3	–	2	Moist	1	D	2
No obvious horizons; assessed via set depth intervals														
Deeper layers: brown clay loam 1.4-4.1m														
Wetting front, 1.7m														
37	A1	30	Medium clay	8.5	10YR4/3	Brown	–	1.0	–	2	Moist	1	D	3
37	2A	70	Medium clay	8.5	7.5YR3/3	Dark brown	–	1.7	1	1	Moist (55)	2	N/D	2
37	3A	140+	Light clay	8.0	7.5YR4/3	Brown	–	1.3	–	1	Dry	1	D	1
Deeper layers: brown clay & loam 1.4-3.5m (straw bands to 2.5m)														
3A: approx. 2% straw, water repellent														
Wetting front, 0.55m														

APPENDIX C

SOIL STRUCTURE DATA

Table C – Soil Structural Form Data

Pit No.	Horizon	Depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak compaction score
			Grade	Type	Size (mm)			
1	A1	45	M	SB	8	RP	2	1.6
1	2A	60	M	AB	20	E	4	0.7-1.3
1	3A	110	W	LE	10	E	2	1.2
1	4A	140+	W	PO	8	E	2	1.1
2	A1	45	M	AB	25	E	3	0.8
2	2A	90	M	PO	8	E	2	1.4
2	3A	140+	M	PO	12	E	1	1.2
3	A1	25	W	LE	15	RP	3	0.7
3	2A	60	M	PO	12	RP	3	1.1
3	3B	120	M	LE	15	RP	5	0.4
3	4A	140+	M	PO	10	RP	4	1.0
4	A11	1	S	PL	10	E	3	0.2
4	A12	10 (5-15)	M	PO	12	RP	3	1.2
4	2B	65	M	PO	15	RP	3	1.0
4	3B	80	M	LE	10	RP	4	0.7
4	4B	140+	W	LE	17	RP	5	0.5
5	A1	18 (20-35)	M	LE	12	RP	3	0.8
5	2B	65	M	PO	10	RP	2	1.2
5	3B	85	M	LE	12	RP	4	0.7
5	4B	105	M	LE	10	RP	3	1.0
5	5B	140+	W	LE	25	RP	5	0.2
6	B1	15	M	PO	8	RP	2	1.3
6	B21	30	M	PO	15	RP	3	0.9
6	B23	60	M	LE	15	RP/SP	2	0.8
6	B23	140+	M	LE	10	RP/SP	2	1.1
7	A1	15	S	PO	12	E	3	1.2
7	2A	55	M	PO	10	RP	4	1.2
7	3A	90	W	LE	40	RP	6	0.2
7	4A	110	M	PO	8	RP	2	1.5
7	5A	140+	W	LE	40	RP	6	0.2
8	A1	40	S	PO	5	RP	1	1.8
8	2A	50	M	LE	12	RP	4	0.7
8	3A	55	W	LE	15	E	3	0.6
8	4A	60	M	LE	10	E	4	0.8
8	5A	65	W	LE	12	E	2	1
8	6A, 8A	65-105	M	PO	8	E	3	1.4
8	7A, 9A	65-105	W	LE	12	E	2	1

Pit No.	Horizon	Depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak compaction score
			Grade	Type	Size (mm)			
8	10A	140+	W	LE	20	RP	5	0.3
9	A1, 3A, 5A	0-60	W	AB	18	E	3	0.8
9	2A, 4A, 6A	0-60	W	LE	12	E	3	1.0
9	7A, 9A	60-95	W	PO	7+dust	E	0	1.1
9	8A, 10A	60-95	W	PO	7+dust	E	0	1.1
9	11A, 13A, 15A	95-140+	M	AB	15	E	1	0.9
9	12A, 14A	95-140+	M	PO	12	E	0	1.0
10	A1	10 (5-15)	W	AB	18	RP	3	0.8
10	2B	35	M	PO	7	RP	2	1.4
10	3A	70	M	PO	10	E	3	1.2
10	4A	100	M	LE	12	E	0	1.1
10	5A	140+	M	PO	5	RP	2	1.6
11	A1	15	W	LE	10	RP	2	1.0
11	2A	30	M	LE	15	RP/SP	3	0.7
11	3A	60	M	PO	7	RP/SP	2	1.3
11	4A	90	M	LE	12	RP/SP	3	0.8
11	5A	140+	M	PO	10	RP	2 & 5	1.0
12	A1	25	W	LE	20	RP	2	0.7
12	2A	62	M	LE	12	RP	3	0.9
12	3A	70	W	AB	20	RP	3	0.5
12	4A	140+	M	PO	8	RP	3	1.3
13	A1	27	M	AB	7	E	3	1.4
13	2A	40	–	–	–	–	–	–
13	3A	47	–	–	–	–	–	–
13	4A	60	M	LE	12	RP	6	0.9
13	5A	70	S	AB	15	RP	6	0.7
13	6A	85	M	LE	12	RP	4	1.0
13	7A	95	–	–	–	–	–	–
13	8A	140+	W	LE	18	RP	3	0.8
14	A1	25	M	SB	7	E	2	1.7
14	2A	90	M	PO	15	E	6	0.9
14	3A	140+	M	LE	15	RP	5	0.3
15	A1	25	M	PO	12	RP	3	1.3
15	2A	75	M	PO	8	E	4	1.3
15	3A	140+	M	LE	15	E	3	0.8
16	A1	15	M	SB	7	RP	2	1.6
16	2A	55	W	AB	15	E	6	0.4
16	2B	140+	M	PO	8	E	2	1.3

Pit No.	Horizon	Depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak compaction score
			Grade	Type	Size (mm)			
17	A1	30	W	PO	8	RP	2	0.8
17	2A	40	M	PO	12	RP	3	1.1
17	3A	50	W	LE	20	RP	7	0.2
17	4A	110	M	LE	12	RP	3	1.1
17	5A	140+	M	LE	10	RP	4	1.1
18	A1	10	W	PO	12	RP	2	1.2
18	2A	40	W	LE	15	RP	4	0.9
18	3A	75	M	LE	20	RP	3	1
18	4A	140+	M	PO	5	RP	2	1.7
19	A1, 3A, 5A	0-60	W	PO	15	RP	2	0.8
19	2A, 4A, 6A	0-60	W	E	30	RP	7	0.2
19	7A	60-100	M	PO	8	RP	2	1.6
19	8A	140+	M	PO	10	RP	3	1.3
20	A1	20	M	PO	7	RP	2	1.5
20	2A	80	W	PO	5	E	2	1.3
20	3A	140+	W	PO	3	E	2	1.3
21	A1	60	S	SB	5	RP	2	1.8
21	2A	140+	M	PO	8	RP	3	1.4
22	A1	10	M	PO	7	RP	2	1.7
22	2A	60	M	PO	15	RP	4	1.2
22	3A	140+	W	PO	10	E	4	1.2
23	A1	30	M	PO	5	RP	2	1.7
23	2A	100/140	M	PO	15	RP	4	1.3
23	3A	140+	apedal - dusty					
24	A1	23	M	PO	10	RP	2	1.4
24	2A	34	–	–	–	–	–	–
24	3A	38	–	–	–	–	–	–
24	4A	50	–	–	–	–	–	–
24	5A	58	–	–	–	–	–	–
24	6A	62	–	–	–	–	–	–
24	7A	92	M	PO	12	RP	4	1.2
24	8A	103	–	–	–	–	–	–
24	9A	112	–	–	–	–	–	–
24	10A	140+	M	PO	3 to 20	RP	5	1
25	A1	8	M	PO	10	RP	3	1.2
25	2A	20	S	PO	7	RP	2	1.6
25	3A	28	–	–	–	–	–	–
25	4A	42	–	–	–	–	–	–
25	5A	58	M	PO	8	RP	3	1.5
25	6A	62	–	–	–	–	–	–

Pit No.	Horizon	Depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak compaction score
			Grade	Type	Size (mm)			
25	7A	92	S	PO	10	RP	3	1.4
25	8A	110	–	–	–	–	–	–
25	9A	140+	M	LE	8	RP	2	1.5
26	A1	60	S	PO	8	RP	3	1.6
26	2Aa	140+	clods (15mm diam.) + dust					1
26	2Ab	140+	M	PO	8	RP	3	1.5
27	A1	35	S	PO	7	RP	2	1.7
27	2A	42	W	LE	15	RP	7	0.3
27	3A	70	S	PO	8	RP	4	1
27	4A	90	M	PO	6	RP	4	1.2
27	5A	120	W	LE	15	RP	5	0.5
27	6A	140+	M	PO	12	RP	6	0.9
28	A1	30	M	LE	12	RP	3	1.1
28	2A	60	M	LE	10	RP	2	1.3
28	3A	110	M	PO	8	RP	2	1.6
28	4A	140+	W	PO	3	E	1	1
29	A1	20	M	AB	15	RP	4	0.6
29	2A	50	M	LE	10	RP	3	1.1
29	3A	70	M	PO	8	RP	3	1.2
29	4A	95	M	PO	8	RP	3	1.2
29	5A	140+	M	PO	10+dust	E	4	1.0
30	A1	15	W	LE	12	RP	3	0.7
30	2A	30	W	LE	10	RP	3	0.8
30	3A	55	M	LE	12	RP	3	0.7
30	4A	70	M	PO	8	RP	2	1.5
30	5A	100	M	PO	10	RP	3	1.2
30	6A	140+	M	PO	10	E	4	1.1
31	n/a							
32	A1	15	M	PO	7	RP	2	1.5
32	2Aa	15-70	S	SB	4	RP	2	1.8
32	2Ab	15-70	S	SB	4	RP	2	1.8
32	3A	85	M	PO	7	RP	2	1.6
32	4Aa	85-140+	M	PO	7	RP	2	1.6
32	4Ab	85-140+	M	PO	7	RP	2	1.6
33	A1a	0-50	S	Bl	18	RP	5	0.4
33	A1b	0-50	M	PO	10	RP	3	1.1
33	2A	100	M	PO	8	RP	3	1.2
33	3A	140+	M	PO	5	E	2	1.5
34	A1	35	M	PO	7	RP	2	1.5

Pit No.	Horizon	Depth (cm)	PEDALITY			FABRIC	CONSISTENCE	SOILpak compaction score
			Grade	Type	Size (mm)			
34	2A	70	M	Bl	15	RP	3	1.1
34	2B	140+	W	LE	25	RP	6	0.2
35	n/a							
36	1	15	S	PO	7	RP	2	1.5
36	2	30	S	LE	12	RP	3	1.2
36	3	60	S	PO	6	RP	2	1.6
36	4	90	M	PO	10	RP	3	1.2
36	5	140+	M	PO	10	RP	2	1.3
37	A1	30	M	LE	12	RP	3	1.0
37	2A	70	M	PO	6	RP	2	1.7
37	3A	140+	M	PO	8+ dust	E	2	1.3

Note: Refer to Appendix F Glossary of Terms

Grade: M – Moderate W – Weak M – Moderate S – Strong

Type: PL – Platy AB – Angular blocky SB – Subangular blocky PO – Polyhedral LE – Lenticular

Fabric: RP – Rough ped SP – Smooth ped E - Earthy

APPENDIX D

PHOTOGRAPHS OF PROFILES OF SOIL STOCKPILE TEST PITS

Table D-1
Soil Test Pit Photographs

Test Pit #	Photograph	Test Pit #	Photograph	Test Pit #	Photograph
1		2		3	
4		5		6	
7		8		9	
10		11		12	

Test Pit #	Photograph	Test Pit #	Photograph	Test Pit #	Photograph
13		14		15	
16		17		18	
19		20		21	
22		23		24	

Test Pit #	Photograph	Test Pit #	Photograph	Test Pit #	Photograph
25		26		27	
28		29		30	
31		32		33	
34		35		36	

Test Pit #	Photograph
37	

APPENDIX E

LABORATORY DATA

Table E-1: Laboratory Data

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
1	TS	0-15	7.7	6.7	0.08	0.69	10	5.5	4.2	1.5	0.7	0.0
1	TS	15-30	7.0	5.3	0.04	0.34	10	3.1	3.1	0.6	1.0	0.1
1	TS	30-60	7.1	5.5	0.05	0.43	10	3.8	4.0	0.7	1.2	0.0
1	TS	60-90	6.1	4.9	0.08	0.69	15	3.1	2.4	1.0	0.6	0.1
1	TS	90-120	6.7	5.6	0.12	1.03	120	3.5	3.6	0.9	0.9	0.0
1	TS	120-150	6.9	5.8	0.15	1.29	140	3.6	4.6	1.0	1.3	0.0
2	TS	0-15	6.1	5.1	0.06	0.52	10	3.5	2.3	1.1	0.1	0.1
2	TS	15-30	6.5	5.3	0.05	0.43	10	4.0	2.9	0.9	0.3	0.1
2	TS	30-60	6.7	5.5	0.06	0.52	10	4.5	3.2	1.4	0.4	0.0
2	TS	60-90	6.4	5.2	0.06	0.52	10	4.1	2.0	1.1	0.4	0.1
2	TS	90-120	6.0	4.9	0.07	0.60	17	3.9	1.8	1.1	0.3	0.1
2	TS	200	5.9	4.9	0.07	0.60	35	3.0	1.3	0.9	0.2	0.1
3	TS	0-15	9.3	8.5	0.21	1.58	17	20.0	12.0	0.9	2.1	0.0
3	TS	15-30	9.6	8.7	0.33	2.48	17	16.0	12.0	0.4	4.4	0.0
3	TS	30-60	9.5	8.6	0.44	3.30	140	9.0	8.2	0.4	5.7	0.0
3	TS	60-90	9.0	8.6	1.63	14.02	2000	18.0	15.0	0.3	10.0	0.0
3	TS	90-120	8.9	8.5	1.74	14.96	2300	18.0	16.0	0.4	10.0	0.0
3	TS	200	9.1	8.4	0.82	7.05	760	11.0	9.9	0.4	6.5	0.0
3	TS	300	9.0	8.4	0.96	8.26	980	13.0	11.0	0.4	6.5	0.0
4	TS	0-15	6.8	6.2	0.58	4.99	480	5.0	6.5	0.7	3.5	0.0
4	TS	15-30	8.8	8.3	1.10	8.25	390	19.0	11.0	0.6	6.1	0.0
4	TS	30-60	8.7	8.3	1.79	13.43	1500	20.0	12.0	0.6	8.7	0.0
4	TS	60-90	8.9	8.5	1.48	11.10	990	18.0	14.0	0.6	8.7	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
4	TS	90-120	8.8	8.3	1.21	10.41	1100	16.0	14.0	0.9	8.3	0.0
4	TS	200	8.7	8.3	1.17	10.06	770	18.0	11.0	0.6	6.1	0.0
5	TS	0-15	8.2	7.5	0.25	1.88	55	8.5	5.7	0.6	1.7	0.0
5	TS	15-30	7.5	6.2	0.12	0.90	67	3.6	4.0	0.5	1.8	0.0
5	TS	30-60	9.1	8.4	0.65	4.88	320	14.0	7.7	0.4	4.8	0.0
5	TS	60-90	8.3	8.0	1.76	15.14	1500	14.0	9.9	0.7	6.5	0.0
5	TS	90-120	9.1	8.5	0.90	7.74	560	16.0	9.9	0.4	6.1	0.0
5	TS	200	8.9	8.3	1.04	8.94	750	20.0	11.0	0.7	6.5	0.0
5	TS	300	8.9	8.3	1.05	9.03	740	19.0	11.0	0.6	6.1	0.0
5	TS	400	8.3	8.1	2.87	24.68	2200	14.0	13.0	0.6	13.0	0.0
6	Subsoil	0-15	8.4	8.0	1.55	13.33	740	6.0	9.1	0.8	9.1	0.0
6	Subsoil	15-30	8.7	8.2	1.26	10.84	780	7.5	8.0	0.7	7.0	0.0
6	Subsoil	30-60	8.7	8.3	1.39	11.95	1000	7.5	8.0	0.8	8.3	0.0
6	Subsoil	60-90	8.7	8.2	1.50	12.90	1000	8.0	9.1	0.8	8.7	0.0
6	Subsoil	90-120	8.4	8.0	1.73	14.88	1500	6.5	11.0	0.9	10.0	0.0
6	Subsoil	200	8.4	8.0	1.25	10.75	1100	5.5	7.3	0.6	7.4	0.0
7	TS	0-15	8.0	6.9	0.07	0.60	10	5.0	5.4	1.1	0.5	0.0
7	TS	15-30	8.0	6.7	0.08	0.69	26	6.5	5.2	0.4	1.9	0.0
7	TS	30-60	7.9	6.9	0.16	1.38	140	10.0	6.9	0.6	1.8	0.0
7	TS	60-90	7.4	6.3	0.15	1.29	69	6.0	5.8	0.6	1.7	0.0
7	TS	90-120	8.1	6.8	0.13	1.12	39	4.8	5.8	0.3	2.3	0.0
7	TS	200	7.7	6.4	0.15	1.29	110	3.8	5.1	0.5	2.0	0.0
7	TS	300	7.5	6.4	0.17	1.46	120	3.9	5.3	0.6	2.0	0.0
8	TS	0-15	8.6	8.3	2.84	24.42	3400	9.5	12.0	0.4	14.0	0.0
8	TS	15-30	8.9	8.5	1.69	14.53	1900	12.0	12.0	0.4	10.0	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
8	TS	30-60	9.1	8.5	1.05	9.03	990	13.0	12.0	0.4	8.3	0.0
8	TS	60-90	8.7	7.9	0.42	3.61	370	6.0	9.1	0.4	4.8	0.0
8	TS	90-120	8.6	7.7	0.43	3.70	360	5.0	7.6	0.5	4.0	0.0
8	TS	200	8.6	8.0	0.36	3.10	330	5.5	7.7	0.4	4.1	0.0
8	TS	300	8.5	7.7	0.36	3.10	210	8.5	8.2	0.6	3.3	0.0
9	TS	0-15	8.3	7.6	0.23	1.98	24	9.5	5.9	0.6	1.4	0.0
9	TS	15-30	7.7	6.6	0.10	0.86	44	5.5	7.2	0.4	3.0	0.0
9	TS	30-60	7.2	6.0	0.18	1.55	180	3.9	5.5	0.3	2.5	0.0
9	TS	60-90	8.5	7.9	0.50	4.75	340	19.0	7.2	0.7	2.4	0.0
9	TS	90-120	8.2	7.3	0.54	4.64	540	6.0	8.2	0.3	5.2	0.0
9	TS	200	7.9	7.0	0.38	3.27	320	6.5	6.6	0.4	3.5	0.0
9	TS	300	7.1	5.8	0.15	1.29	120	4.4	4.4	0.5	1.8	0.0
10	TS	0-15	8.2	7.1	0.09	0.77	10	9.0	5.7	0.9	1.2	0.0
10	TS	15-30	8.7	8.2	0.17	1.28	10	11.0	5.5	1.3	1.2	0.0
10	TS	30-60	7.5	6.3	0.11	0.95	11	4.0	5.0	0.6	1.7	0.0
10	TS	60-90	6.1	5.1	0.22	2.09	49	2.4	2.8	0.6	1.3	0.1
10	TS	90-120	6.2	5.4	0.33	2.84	90	4.2	5.8	0.6	2.2	0.1
10	TS	200	8.3	7.7	0.54	4.64	340	11.0	7.3	0.7	2.9	0.0
10	TS	300	8.3	7.8	0.62	5.33	360	16.0	8.2	0.8	3.3	0.0
11	TS	0-15	9.0	8.2	0.23	1.98	38	13.0	6.6	1.2	1.6	0.0
11	TS	15-30	9.2	8.6	0.24	2.06	12	11.0	5.8	0.8	2.6	0.0
11	TS	30-60	9.0	8.3	0.46	3.96	140	11.0	6.0	0.8	3.3	0.0
11	TS	60-90	8.3	8.0	1.50	12.90	1600	13.0	8.1	0.9	5.2	0.0
11	TS	90-120	8.6	8.1	0.73	6.28	490	12.0	6.9	0.8	3.5	0.0
11	TS	200	8.6	8.0	0.47	4.04	200	10.0	6.4	1.2	2.5	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
11	TS	300	8.4	7.8	0.48	4.13	230	9.5	5.8	1.0	2.2	0.0
11	TS	400	7.0	6.0	0.19	1.63	88	3.4	2.7	0.4	1.0	0.0
12	TS	0-15	8.6	7.4	0.11	0.83	12	10.0	8.1	0.9	2.0	0.0
12	TS	15-30	8.6	7.1	0.09	0.68	19	5.5	5.3	0.5	2.2	0.0
12	TS	30-60	7.2	5.6	0.08	0.69	34	3.0	4.0	0.5	2.1	0.0
12	TS	60-90	7.5	6.4	0.11	0.83	31	6.5	9.1	0.6	3.2	0.0
12	TS	90-120	6.9	5.7	0.20	1.72	150	3.9	5.0	0.5	2.3	0.0
12	TS	200	8.1	7.2	0.36	3.10	360	7.0	9.9	0.6	4.4	0.0
12	TS	300	8.3	7.5	0.56	4.82	600	6.0	9.1	0.6	5.2	0.0
13	TS	0-15	7.9	7.0	0.10	1.38	18	7.5	4.9	3.3	0.1	0.0
13	TS	15-30	6.0	4.9	0.04	0.55	10	2.5	1.8	1.0	0.1	0.1
13	TS	30-60	8.7	8.0	0.17	1.46	10	20.0	6.5	1.1	0.9	0.0
13	TS	60-90	9.1	8.3	0.24	1.80	30	24.0	8.0	1.0	2.3	0.0
13	TS	90-120	7.8	6.8	0.19	1.63	99	6.5	4.9	0.4	2.0	0.0
13	TS	200	7.9	7.0	0.28	2.41	240	4.8	5.0	0.7	2.2	0.0
13	TS	300	8.7	7.9	0.41	3.53	380	8.0	7.3	0.6	3.5	0.0
14	TS	0-15	5.7	4.9	0.19	1.63	88	2.4	2.6	1.3	0.8	0.1
14	TS	15-30	6.9	5.5	0.07	0.60	31	6.0	6.4	0.6	1.6	0.0
14	TS	30-60	7.8	6.4	0.09	0.77	40	6.0	7.7	0.4	2.7	0.0
14	TS	60-90	7.6	6.6	0.28	2.41	190	7.5	9.1	0.5	4.0	0.0
14	TS	90-120	6.7	5.9	0.38	3.27	250	6.0	7.0	0.5	3.0	0.0
14	TS	200	6.9	5.9	0.17	1.46	70	3.9	3.3	0.9	1.1	0.0
14	TS	300	7.6	6.5	0.17	1.46	180	3.6	5.3	0.6	1.9	0.0
14	TS	0-15	8.7	8.3	1.53	13.16	1100	10.0	8.2	0.4	8.3	0.0
15	TS	0-15	7.1	6.5	0.11	0.83	11	7.5	4.7	1.2	0.5	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
15	TS	15-30	7.2	5.7	0.07	0.53	21	4.3	5.0	0.5	1.5	0.0
15	TS	30-60	6.5	5.8	0.32	2.75	140	4.2	4.6	0.7	1.6	0.0
15	TS	60-90	6.6	6.0	0.44	3.78	57	6.5	2.9	1.9	0.7	0.0
15	TS	90-120	6.2	5.4	0.20	1.72	77	4.5	2.9	0.9	1.0	0.1
15	TS	200	7.2	6.1	0.20	1.72	150	5.5	7.7	0.7	3.0	0.0
15	TS	300	7.5	6.6	0.27	2.32	270	4.4	5.7	0.7	2.5	0.0
15	TS	400	8.9	8.2	0.66	5.68	480	14.0	11.0	0.7	6.1	0.0
16	TS	0-15	7.6	6.9	0.23	1.98	130	7.0	4.5	0.6	1.2	0.0
16	TS	15-30	6.8	5.8	0.13	1.12	36	4.4	3.7	0.5	1.0	0.0
16	TS	30-60	6.7	5.8	0.16	1.38	110	5.0	4.0	0.6	1.0	0.0
16	TS	60-90	7.7	6.9	0.18	1.55	72	6.0	5.2	0.6	1.3	0.0
16	TS	90-120	7.8	7.2	0.18	1.55	63	8.0	5.5	0.6	0.8	0.0
16	TS	200	7.2	6.3	0.13	1.12	69	4.7	3.4	0.6	0.9	0.0
16	TS	300	6.2	5.2	0.14	1.20	85	3.9	2.9	0.8	0.8	0.1
16	TS	400	7.7	6.6	0.13	1.12	73	9.0	5.3	0.7	1.4	0.0
17	TS	0-15	9.2	8.4	0.27	2.03	72	18.0	9.9	0.9	2.6	0.0
17	TS	15-30	8.7	8.4	1.46	10.95	790	15.0	11.0	0.7	8.7	0.0
17	TS	30-60	7.1	6.7	0.85	7.31	490	10.0	7.1	1.0	2.8	0.0
17	TS	60-90	7.2	6.8	0.49	4.21	110	8.0	5.3	1.2	1.2	0.0
17	TS	90-120	7.6	7.2	0.51	4.39	120	10.0	5.3	1.4	1.4	0.0
17	TS	200	7.3	6.3	0.21	1.81	170	4.5	5.2	0.7	1.9	0.0
17	TS	300	8.1	7.1	0.22	1.89	200	5.0	6.0	0.6	2.3	0.0
17	TS	400	8.5	7.9	0.39	3.35	250	10.0	7.9	1.1	2.4	0.0
18	TS	0-10	7.2	6.2	0.07	0.60	10	5.0	2.8	1.1	0.2	0.0
18	TS	15-30	7.8	6.5	0.06	0.52	10	5.5	4.3	0.5	0.7	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
18	TS	40-60	8.7	7.8	0.19	1.63	77	5.0	4.7	0.5	2.4	0.0
18	TS	60-90	7.8	7.1	0.45	3.87	280	5.5	4.9	0.6	3.0	0.0
18	TS	90-120	6.8	6.4	0.62	5.33	510	6.5	5.2	0.8	2.0	0.0
18	TS	200	6.6	5.7	0.26	2.24	150	4.3	4.6	0.6	1.7	0.0
19	TS	0-15	9.5	8.9	0.24	1.80	38	9.5	7.7	0.6	3.2	0.0
19	TS	15-30	9.7	9.0	0.40	3.00	120	9.0	9.1	0.4	6.1	0.0
19	TS	30-60	8.4	8.1	1.92	14.40	1400	12.0	12.0	0.5	11.0	0.0
19	TS	60-90	8.8	8.1	0.97	8.34	1300	6.5	9.1	0.3	7.4	0.0
19	TS	90-120	8.9	8.4	0.80	6.88	940	7.0	9.9	0.4	7.0	0.0
19	TS	200	9.2	8.6	0.86	7.40	840	8.0	9.9	0.4	7.4	0.0
19	TS	300	9.2	8.7	0.82	7.05	650	11.0	9.9	0.4	7.0	0.0
19	TS	400	8.8	8.3	1.10	9.46	920	11.0	9.9	0.5	7.4	0.0
20	TS	0-15	8.3	7.6	0.18	1.35	41	7.5	6.3	1.5	0.9	0.0
20	TS	15-30	9.0	8.4	0.35	3.01	110	11.0	9.1	1.3	3.3	0.0
20	TS	30-60	8.1	7.6	0.89	7.65	940	10.0	6.7	0.8	4.3	0.0
20	TS	60-90	8.6	7.8	0.60	5.16	520	7.0	7.0	0.9	5.2	0.0
20	TS	90-120	8.4	8.1	1.57	13.50	2000	12.0	11.0	1.2	7.8	0.0
20	TS	200	8.3	7.8	0.63	5.42	460	11.0	7.7	1.0	3.3	0.0
20	TS	300	7.7	7.1	0.48	4.13	400	6.0	5.3	0.7	2.5	0.0
20	TS	400	7.8	7.2	0.44	3.78	250	10.0	6.5	0.9	2.3	0.0
21	TS	0-15	8.8	8.0	0.21	1.58	16	14.0	9.1	1.2	1.2	0.0
21	TS	15-30	8.8	7.9	0.22	1.65	40	12.0	9.1	1.2	1.7	0.0
21	TS	30-60	8.7	8.0	0.32	2.40	130	13.0	9.9	1.0	2.8	0.0
21	TS	60-90	8.8	8.1	0.56	4.82	360	12.0	9.1	0.8	4.0	0.0
21	TS	90-120	8.3	7.6	0.44	3.78	310	10.0	8.1	1.1	2.4	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
21	TS	200	9.0	8.3	0.73	6.28	540	19.0	13.0	0.5	5.7	0.0
21	TS	300	9.2	8.5	0.75	6.45	560	22.0	14.0	0.6	6.1	0.0
22	TS	0-15	7.6	6.4	0.11	0.95	33	4.5	5.3	0.9	1.4	0.0
22	TS	15-30	7.6	6.4	0.11	0.95	66	6.0	4.7	0.7	1.4	0.0
22	TS	30-60	7.7	6.6	0.12	1.03	48	7.5	5.3	1.0	1.5	0.0
22	TS	60-90	7.5	6.1	0.09	0.77	21	5.0	5.2	0.8	1.7	0.0
22	TS	90-120	7.5	6.1	0.09	0.77	33	4.9	5.2	0.7	1.6	0.0
22	TS	200	8.1	7.1	0.16	1.38	63	7.5	6.4	0.7	1.9	0.0
22	TS	300	7.9	7.4	0.36	3.10	110	11.0	5.1	1.0	1.4	0.0
22	TS	400	6.9	6.2	0.29	2.49	130	6.5	5.5	0.9	1.7	0.0
23	TS	0-15	8.5	7.8	0.15	1.29	10	11.0	6.8	1.2	0.4	0.0
23	TS	15-30	8.6	7.9	0.21	1.81	64	10.0	6.3	1.1	0.9	0.0
23	TS	30-60	9.0	8.1	0.23	1.98	10	14.0	8.2	1.0	2.2	0.0
23	TS	60-90	9.0	8.2	0.35	3.01	180	14.0	9.9	0.9	3.1	0.0
23	TS	90-120	6.8	6.0	0.14	1.20	96	5.5	4.3	1.9	0.6	0.0
23	TS	200	7.3	6.5	0.15	1.29	83	6.5	4.5	1.5	0.8	0.0
23	TS	300	8.0	7.3	0.43	3.70	400	7.5	7.3	0.8	3.4	0.0
24	TS	0-8	8.7	8.0	0.17	1.28	10	16.0	8.2	1.5	0.6	0.0
24	TS	15-28	9.3	8.3	0.21	1.58	10	23.0	9.9	0.9	2.4	0.0
24	TS	30-58	9.6	8.7	0.35	3.01	120	22.0	12.0	1.0	4.8	0.0
24	TS	60-90	8.6	8.1	0.91	7.83	1200	17.0	8.2	1.0	5.2	0.0
24	TS	92-120	9.2	8.5	0.78	6.71	630	12.0	11.0	0.8	6.5	0.0
24	TS	150	9.2	8.6	0.98	8.43	830	14.0	16.0	0.9	8.7	0.0
24	TS	200	9.2	8.5	0.62	5.33	450	17.0	13.0	0.6	5.7	0.0
25	TS	0-15	8.4	7.8	0.18	1.55	10	18.0	7.4	2.1	0.2	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
25	TS	15-30	8.9	8.1	0.17	1.46	10	19.0	9.9	1.2	0.8	0.0
25	TS	30-60	9.1	8.2	0.23	1.98	10	21.0	9.9	1.6	2.4	0.0
25	TS	60-90	9.2	8.3	0.26	1.95	10	17.0	9.9	1.4	3.1	0.0
25	TS	90-120	8.1	6.7	0.15	1.29	57	6.0	7.9	0.6	3.3	0.0
25	TS	150	7.3	6.5	0.28	2.41	260	6.5	6.2	1.0	2.2	0.0
25	TS	200	7.1	6.0	0.14	1.20	74	6.5	6.3	1.1	1.3	0.0
25	TS	300	7.0	6.0	0.14	1.20	58	7.0	6.9	1.2	1.3	0.0
25	TS	400	7.4	6.6	0.18	1.55	80	8.0	6.6	1.2	1.3	0.0
26	TS	0-15	8.7	8.1	0.18	1.55	10	21.0	9.1	1.6	0.5	0.0
26	TS	15-30	9.2	8.3	0.25	2.15	11	23.0	11.0	0.9	2.7	0.0
26	TS	30-60	9.1	8.3	0.48	4.13	340	20.0	12.0	0.8	4.2	0.0
26	TS	60-90	8.9	8.2	0.53	4.56	450	19.0	12.0	0.9	4.0	0.0
26	TS	90-120	8.8	8.0	0.39	3.35	230	16.0	9.9	1.0	3.1	0.0
26	TS	200	9.0	8.3	0.40	3.44	240	20.0	12.0	1.0	3.4	0.0
26	TS	300	7.8	7.0	0.21	1.81	84	9.5	6.4	1.0	1.6	0.0
27	TS	0-15	9.1	8.2	0.18	1.55	14	13.0	11.0	0.7	1.4	0.0
27	TS	15-30	9.4	8.8	0.36	3.10	81	13.0	12.0	0.5	3.7	0.0
27	TS	35-42	8.7	8.0	0.53	4.56	330	9.0	9.9	0.7	3.8	0.0
27	TS	60-90	8.5	7.9	0.61	5.25	560	9.0	9.9	0.5	3.3	0.0
27	TS	90-120	9.3	8.7	0.55	4.73	320	15.0	14.0	0.3	4.8	0.0
27	TS	150	8.8	8.1	0.50	4.30	270	13.0	12.0	0.6	3.9	0.0
27	TS	200	9.2	8.6	0.78	6.71	610	12.0	12.0	0.5	6.5	0.0
28	TS	0-15	7.6	7.0	0.18	1.35	10	11.0	7.7	1.6	0.5	0.0
28	TS	15-30	8.7	7.9	0.21	1.58	10	14.0	8.0	0.8	1.5	0.0
28	TS	30-60	7.8	6.9	0.17	1.46	24	8.0	5.6	1.1	1.5	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
28	TS	60-90	6.0	5.5	0.45	3.87	170	7.0	5.7	1.3	1.3	0.0
28	TS	90-120	6.4	5.7	0.25	2.15	150	7.5	6.3	1.2	1.0	0.0
28	TS	200	8.1	7.4	0.27	2.32	140	10.0	7.7	0.9	2.1	0.0
28	TS	300	7.5	6.9	0.20	1.72	59	9.5	5.5	1.1	1.0	0.0
28	TS	400	7.7	7.0	0.23	1.98	62	11.0	6.3	1.2	1.1	0.0
29	TS	0-15	8.8	7.9	0.17	1.46	17	11.0	7.5	0.8	1.6	0.0
29	TS	15-30	8.3	7.2	0.15	1.29	42	8.5	6.9	0.7	2.2	0.0
29	TS	30-60	8.7	8.2	0.86	7.40	520	12.0	9.1	0.5	5.2	0.0
29	TS	60-90	8.9	8.2	0.75	6.45	440	8.5	8.2	0.4	6.1	0.0
29	TS	90-120	7.3	6.2	0.12	1.03	78	7.0	6.8	0.8	1.3	0.0
29	TS	200	8.9	8.1	0.55	4.73	350	11.0	9.9	0.6	4.8	0.0
30	TS	0-15	7.5	6.3	0.08	0.69	14	6.5	7.2	1.0	1.4	0.0
30	TS	15-30	9.4	8.5	0.31	2.33	22	18.0	12.0	0.6	3.2	0.0
30	TS	30-60	9.0	8.3	0.24	1.80	50	8.0	11.0	0.4	4.8	0.0
30	TS	60-90	8.4	8.0	1.02	8.77	820	14.0	11.0	0.7	4.8	0.0
30	TS	90-120	6.6	5.8	0.33	2.84	290	3.8	3.9	0.6	1.6	0.0
30	TS	200	8.6	8.1	0.91	7.83	580	16.0	9.9	1.0	4.3	0.0
31	Subsoil	0-15	8.7	8.2	1.32	9.90	1100	7.5	9.1	0.5	10.0	0.0
31	Subsoil	30-60	8.5	8.1	1.58	11.85	1200	7.0	9.1	0.4	9.6	0.0
31	Subsoil	90-120	7.8	7.6	2.96	22.20	3400	9.0	12.0	0.4	14.0	0.0
32	TS	0-15	7.9	7.5	0.31	2.67	61	12.0	5.8	1.6	0.6	0.0
32	TS	15-30	8.8	8.1	0.19	1.63	10	13.0	6.5	1.4	1.2	0.0
32	TS	30-60	9.1	8.2	0.26	2.24	10	13.0	7.8	1.0	2.7	0.0
32	TS	60-90	9.1	8.3	0.32	2.75	94	15.0	8.2	0.8	2.5	0.0
32	TS	90-120	8.7	8.1	0.53	4.56	370	15.0	7.2	1.0	3.1	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
32	TS	200	8.2	7.9	1.13	9.72	1100	15.0	9.1	1.5	3.9	0.0
32	TS	300	8.4	7.8	0.38	3.27	280	12.0	5.8	1.0	1.7	0.0
33	TS	0-15	8.2	7.0	0.10	0.75	16	6.0	7.7	0.7	1.6	0.0
33	TS	15-30	7.5	6.1	0.10	0.75	47	3.8	5.6	0.6	1.7	0.0
33	TS	30-60	6.6	5.4	0.11	0.83	93	3.0	4.5	0.6	1.2	0.1
33	TS	60-90	7.1	6.0	0.18	1.55	140	4.2	6.9	0.7	2.1	0.0
33	TS	90-120	7.7	6.5	0.10	0.86	72	2.1	2.8	0.6	0.9	0.0
33	TS	200	7.4	6.2	0.15	1.29	120	4.5	7.6	0.8	2.2	0.0
34	TS	0-15	8.6	8.0	0.18	1.55	24	18.0	6.6	2.4	0.3	0.0
34	TS	15-30	8.9	8.1	0.18	1.55	11	20.0	7.4	0.7	1.0	0.0
34	TS	30-60	9.1	8.3	0.43	3.70	170	16.0	9.1	0.9	3.4	0.0
34	TS	60-90	8.3	8.0	1.11	9.55	960	19.0	9.1	0.8	3.7	0.0
34	TS	90-120	8.6	8.1	0.69	5.93	330	20.0	8.2	0.8	3.1	0.0
34	TS	200	8.4	7.9	0.51	4.39	180	17.0	6.5	0.8	1.8	0.0
35	Subsoil	0-15	8.3	8.0	1.52	11.40	1700	3.9	5.8	0.3	8.3	0.0
35	Subsoil	30-60	8.8	8.5	1.40	10.50	1600	7.0	7.9	0.3	8.7	0.0
35	Subsoil	90-120	8.2	7.8	1.57	11.78	1800	3.6	5.7	0.2	7.8	0.0
35	Subsoil	200	8.3	7.9	1.97	14.78	2400	6.0	9.1	0.3	11.0	0.0
35	Subsoil	300	8.1	7.8	1.71	12.83	2300	4.2	7.3	0.3	9.6	0.0
35	Subsoil	400	8.3	8.0	1.76	13.20	2200	4.9	7.4	0.3	9.6	0.0
36	TS	0-15	9.0	8.2	0.18	1.55	17	19.0	7.3	2.2	1.1	0.0
36	TS	15-30	9.1	8.3	0.19	1.63	12	20.0	7.3	0.7	1.9	0.0
36	TS	30-60	9.2	8.3	0.26	2.24	70	20.0	7.4	0.7	2.4	0.0
36	TS	60-90	9.2	8.3	0.25	1.88	12	21.0	9.1	0.8	2.7	0.0
36	TS	90-120	9.1	8.3	0.25	2.15	37	21.0	8.2	0.8	2.4	0.0

Pit No.	Topsoil/ Subsoil	Depth (cm)	pH (water)	pH (CaCl2)	EC 1:5 (dS/m)	ECe (dS/m)	Cl (mg/kg)	Exchangeable cations, meq/100g				
								Ca	Mg	K	Na	Al
36	TS	200	8.6	8.1	0.61	5.25	340	22.0	9.1	0.8	3.3	0.0
36	TS	300	8.6	8.1	0.61	5.25	330	22.0	9.1	0.9	3.3	0.0
36	TS	400	8.6	8.1	0.84	7.22	520	21.0	9.1	0.8	4.8	0.0
37	TS	0-15	8.7	8.0	0.15	1.13	14	16.0	6.8	1.3	0.7	0.0
37	TS	15-30	9.2	8.3	0.25	1.88	21	19.0	8.2	0.8	2.7	0.0
37	TS	30-60	8.4	8.1	1.24	9.30	840	18.0	9.1	1.0	5.2	0.0
37	TS	60-90	8.4	8.1	1.17	10.06	970	20.0	12.0	1.1	6.1	0.0
37	TS	90-120	8.6	8.0	0.60	5.16	460	18.0	8.2	1.0	3.3	0.0
37	TS	200	8.4	7.9	0.47	4.04	270	14.0	6.7	1.0	2.2	0.0
37	TS	300	8.3	7.7	0.42	3.61	230	13.0	6.6	1.2	2.0	0.0

Table E-2: Laboratory Data

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
1	11.9	5.9	0.01	1.31	12	7	14	1	0.94	0.24	1.20	0.73
1	7.9	12.6	0.00	1.00	15	5	11	1	1.00	0.12	0.86	0.70
1	9.7	12.4	0.00	0.95	15	4	16	4	1.00	0.14	0.88	0.72
1	7.2	8.5	0.01	1.29	12	14	17	14	1.00	0.19	0.75	0.80
1	8.9	10.2	0.01	0.97	7	5	16	6	1.30	0.31	0.79	0.86
1	10.5	12.4	0.01	0.78	6	16	18	4	1.50	0.24	1.00	0.77
2	7.1	1.1	0.05	1.52	11	17	15	3	1.20	0.35	0.64	0.92
2	8.2	4.0	0.01	1.38	11	11	12	3	1.60	0.26	0.86	0.93
2	9.5	4.5	0.01	1.41	13	8	19	6	2.50	0.34	0.88	1.10
2	7.7	4.8	0.01	2.05	13	5	21	8	0.82	0.18	0.77	0.92
2	7.2	4.2	0.02	2.17	13	10	12	14	1.30	0.16	0.68	0.86
2	5.5	4.2	0.02	2.31	14	8	20	6	0.65	0.29	0.57	0.90
3	35.0	6.0	0.04	1.67	13	3	5	2	0.57	0.09	2.90	0.43
3	32.8	13.4	0.02	1.33	15	1	5	4	0.76	0.04	4.50	0.35
3	23.3	24.5	0.02	1.10	13	2	5	20	1.30	0.04	2.20	0.45
3	43.3	23.1	0.07	1.20	0	1	5	160	0.50	0.03	6.30	0.18
3	44.4	22.5	0.08	1.13	0	4	5	130	0.49	0.03	5.80	0.26
3	27.8	23.4	0.04	1.11	0	5	5	65	0.86	0.10	3.70	0.45
3	30.9	21.0	0.05	1.18	0	5	5	75	0.89	0.08	4.10	0.35
4	15.7	22.3	0.03	0.77	0	56	9	50	1.20	0.09	1.20	0.57
4	36.7	16.6	0.07	1.73	11	8	5	370	0.87	0.08	3.90	0.33
4	41.3	21.1	0.08	1.67	0	26	5	460	0.94	0.29	3.80	0.34
4	41.3	21.1	0.07	1.29	0	19	5	330	0.92	0.05	6.30	0.20

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
4	39.2	21.2	0.06	1.14	0	22	5	100	1.00	0.08	3.80	0.31
4	35.7	17.1	0.07	1.64	0	25	5	180	1.10	0.15	3.30	0.41
5	16.5	10.3	0.02	1.49	10	10	5	8	1.30	0.14	0.83	0.52
5	9.9	18.2	0.01	0.90	13	10	5	4	1.20	0.35	0.79	0.57
5	26.9	17.8	0.04	1.82	3	13	5	120	1.00	0.06	1.90	0.36
5	31.1	20.9	0.08	1.41	0	120	5	220	0.97	0.06	1.70	0.41
5	32.4	18.8	0.05	1.62	0	33	5	110	0.82	0.03	4.10	0.15
5	38.2	17.0	0.06	1.82	0	23	5	140	0.95	0.05	3.40	0.48
5	36.7	16.6	0.06	1.73	0	13	5	170	1.20	0.04	3.40	0.30
5	40.6	32.0	0.09	1.08	0	74	5	950	0.80	0.03	5.60	0.16
6	25.0	36.4	0.04	0.66	1	1	5	570	0.37	0.09	1.90	0.15
6	23.2	30.1	0.04	0.94	1	1	5	360	0.47	0.04	2.40	0.15
6	24.6	33.8	0.04	0.94	10	1	5	320	0.43	0.07	1.80	0.15
6	26.6	32.7	0.05	0.88	10	1	5	320	0.41	0.03	2.00	0.15
6	28.4	35.2	0.05	0.59	11	1	5	420	0.24	0.03	1.50	0.15
6	20.8	35.6	0.04	0.75	13	1	5	230	0.38	0.15	1.10	0.15
7	12.0	4.3	0.02	0.93	9	2	6	2	1.10	0.56	0.96	0.63
7	14.0	13.6	0.01	1.25	14	1	5	8	0.96	0.10	1.20	0.47
7	19.3	9.3	0.02	1.45	6	5	5	7	1.10	0.07	1.50	0.38
7	14.1	12.0	0.01	1.03	10	27	6	8	1.10	0.09	1.40	0.43
7	13.2	17.4	0.01	0.83	12	21	5	8	0.80	0.07	1.30	0.27
7	11.4	17.5	0.01	0.75	11	8	5	8	1.20	0.13	1.40	0.49
7	11.8	16.9	0.01	0.74	11	8	5	9	1.20	0.16	1.30	0.62
8	35.9	39.0	0.07	0.79	0	37	5	400	0.62	0.05	2.20	0.15
8	34.4	29.1	0.06	1.00	0	13	5	140	0.70	0.10	3.10	0.15

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
8	33.7	24.6	0.04	1.08	0	10	5	80	0.97	0.08	3.20	0.21
8	20.3	23.6	0.02	0.66	3	7	5	11	1.00	0.09	2.80	0.47
8	17.1	23.4	0.02	0.66	3	11	5	13	1.10	0.58	3.50	0.58
8	17.7	23.2	0.02	0.71	6	6	5	11	0.83	0.12	3.10	0.54
8	20.6	16.0	0.02	1.04	8	5	5	14	1.30	0.31	2.10	0.76
9	17.4	8.0	0.03	1.61	11	4	8	2	1.20	0.39	1.30	0.70
9	16.1	18.6	0.01	0.76	14	1	5	2	1.80	0.07	0.63	0.59
9	12.2	20.5	0.01	0.71	6	2	5	15	1.30	0.04	0.59	0.54
9	29.3	8.2	0.06	2.64	0	8	11	18	1.40	0.31	0.93	0.91
9	19.7	26.4	0.02	0.73	11	4	5	30	1.30	0.05	0.96	0.50
9	17.0	20.6	0.02	0.98	11	4	7	13	1.60	0.12	0.87	0.65
9	11.1	16.2	0.01	1.00	13	3	11	6	1.50	0.20	0.49	0.77
10	16.8	7.1	0.01	1.58	13	10	15	4	1.10	0.26	0.66	0.71
10	19.0	6.3	0.03	2.00	13	8	5	9	1.70	0.16	0.80	0.64
10	11.3	15.1	0.01	0.80	15	8	11	15	1.50	0.14	0.69	0.47
10	7.2	18.1	0.01	0.86	13	58	8	29	1.30	0.12	0.37	0.49
10	12.9	17.1	0.02	0.72	5	100	5	26	1.30	0.05	0.45	0.51
10	21.9	13.3	0.04	1.51	2	9	13	75	1.60	0.28	0.97	0.75
10	28.3	11.7	0.05	1.95	4	10	14	74	1.40	0.28	1.00	0.92
11	22.4	7.1	0.03	1.97	13	8	5	5	0.97	0.27	0.97	0.48
11	20.2	12.9	0.02	1.90	15	5	5	6	1.20	0.22	1.10	0.38
11	21.1	15.6	0.03	1.83	12	11	7	69	1.20	0.34	1.10	0.40
11	27.2	19.1	0.08	1.60	0	18	6	220	1.00	0.19	0.81	0.38
11	23.2	15.1	0.05	1.74	0	24	7	82	1.20	0.21	1.20	0.44
11	20.1	12.4	0.04	1.56	10	49	5	37	1.30	0.11	1.10	0.35
11	18.5	11.9	0.04	1.64	2	38	6	39	1.20	0.14	0.89	0.38
11	7.5	13.3	0.01	1.26	7	28	12	13	1.60	0.31	0.39	0.51

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
12	21.0	9.5	0.01	1.23	15	10	6	3	0.98	0.10	2.10	0.75
12	13.5	16.3	0.01	1.04	15	4	6	2	0.82	0.06	1.80	0.55
12	9.6	21.9	0.00	0.75	13	2	17	9	1.40	0.16	0.89	0.61
12	19.4	16.5	0.01	0.71	14	2	8	20	1.30	0.07	1.30	0.57
12	11.7	19.7	0.01	0.78	12	23	14	31	1.10	0.15	1.10	0.59
12	21.9	20.1	0.02	0.71	12	10	9	13	2.00	0.13	1.40	0.61
12	20.9	24.9	0.02	0.66	11	1	6	20	2.20	0.12	1.80	0.60
13	15.8	0.9	0.11	1.53	11	19	18	3	0.70	0.15	1.00	0.84
13	5.5	2.0	0.02	1.39	11	10	15	2	0.71	0.16	0.55	0.67
13	28.5	3.2	0.05	3.08	5	3	12	5	1.10	0.16	2.10	0.70
13	35.3	6.5	0.04	3.00	10	5	7	9	1.00	0.11	2.00	0.65
13	13.8	14.5	0.01	1.33	14	6	8	22	1.10	0.09	0.95	0.53
13	12.7	17.4	0.02	0.96	14	5	30	9	2.30	0.70	1.00	0.95
13	19.4	18.0	0.02	1.10	13	2	13	8	2.30	0.18	1.20	0.73
14	7.2	10.8	0.02	0.92	10	58	46	9	0.99	0.42	0.72	0.96
14	14.6	11.0	0.01	0.94	12	5	10	3	1.50	0.11	1.20	0.64
14	16.8	16.1	0.01	0.78	13	3	5	3	1.60	0.06	1.50	0.59
14	21.1	19.0	0.01	0.82	12	45	5	7	1.40	0.07	1.30	0.57
14	16.5	18.1	0.02	0.86	3	96	9	10	1.40	0.09	1.20	0.60
14	9.2	12.0	0.01	1.18	12	14	22	17	1.30	0.46	0.68	0.83
14	11.4	16.7	0.01	0.68	12	1	18	7	2.20	0.30	0.66	0.58
14	26.9	30.9	0.05	1.22	0	9	5	470	0.70	0.05	2.70	0.15
15	13.9	3.7	0.03	1.60	10	9	10	4	1.10	0.19	1.20	0.90
15	11.3	13.3	0.01	0.86	13	4	12	4	1.40	0.10	1.10	0.63
15	11.1	14.5	0.02	0.91	6	110	18	19	1.60	0.17	0.86	0.54
15	12.0	5.8	0.08	2.24	6	120	52	53	1.10	1.30	0.93	1.20

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
15	9.4	10.2	0.02	1.55	5	69	11	11	1.20	0.29	0.87	0.76
15	16.9	17.7	0.01	0.71	13	18	24	13	2.10	0.16	1.90	0.69
15	13.3	18.8	0.01	0.77	14	1	42	10	3.50	0.54	1.50	0.85
15	31.8	19.2	0.03	1.27	0	1	5	50	2.10	0.04	3.70	0.40
16	13.3	9.0	0.03	1.56	13	12	5	31	0.75	0.14	1.00	0.62
16	9.6	10.4	0.01	1.19	10	3	7	41	0.95	0.14	0.82	0.69
16	10.6	9.5	0.02	1.25	4	28	8	19	0.90	0.19	0.70	0.65
16	13.1	9.9	0.02	1.15	4	24	6	18	0.68	0.15	1.40	0.62
16	14.8	5.3	0.03	1.45	3	28	5	7	0.73	0.06	1.60	0.47
16	9.5	9.1	0.01	1.38	5	16	7	7	0.75	0.09	0.74	0.59
16	8.5	9.8	0.01	1.34	6	21	14	13	0.86	0.29	0.69	0.80
16	16.4	8.5	0.02	1.70	6	16	8	7	0.84	0.12	0.99	0.66
17	31.4	8.3	0.03	1.82	13	15	5	6	0.59	0.09	2.60	0.46
17	35.4	24.6	0.06	1.36	10	32	5	460	0.74	0.05	3.70	0.33
17	20.9	13.4	0.06	1.41	0	210	14	64	0.84	0.21	1.40	0.92
17	15.7	7.6	0.06	1.51	0	180	39	36	1.30	0.42	1.00	0.87
17	18.1	7.7	0.07	1.89	0	130	32	39	1.20	0.32	1.30	0.93
17	12.3	15.4	0.01	0.87	12	5	32	14	1.40	0.33	0.90	0.93
17	13.9	16.5	0.01	0.83	11	2	24	10	1.70	0.27	0.91	0.72
17	21.4	11.2	0.03	1.27	10	18	27	18	2.10	0.31	1.40	0.86
18	9.1	2.6	0.03	1.79	13	21	8	4	0.58	0.20	0.72	0.66
18	11.0	5.9	0.01	1.28	14	6	5	4	0.81	0.30	0.91	0.61
18	12.6	19.1	0.01	1.06	13	6	5	26	0.75	1.00	1.20	0.51
18	14.0	21.4	0.02	1.12	10	40	5	99	0.72	0.31	1.00	0.70
18	14.5	13.8	0.04	1.25	0	110	6	39	0.71	0.13	0.68	0.66
18	11.2	15.2	0.02	0.93	3	64	7	14	1.00	1.30	1.00	0.68
19	21.0	15.2	0.02	1.23	14	16	5	4	0.69	0.10	2.20	0.38

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
19	24.6	24.8	0.02	0.99	14	2	5	18	0.85	0.05	3.10	0.33
19	35.5	31.0	0.06	1.00	0	1	5	580	0.81	0.04	2.80	0.53
19	23.3	31.7	0.03	0.71	0	3	5	67	0.74	0.03	2.90	0.41
19	24.3	28.8	0.03	0.71	10	3	5	39	0.76	0.03	3.10	0.42
19	25.7	28.8	0.03	0.81	10	4	5	77	0.68	0.04	3.50	0.26
19	28.3	24.8	0.03	1.11	12	9	5	98	0.84	0.05	2.50	0.40
19	28.8	25.7	0.04	1.11	0	39	5	250	0.80	0.05	2.80	0.37
20	16.2	5.4	0.03	1.19	10	17	9	7	2.80	0.21	1.50	0.89
20	24.7	13.4	0.03	1.21	12	14	7	11	2.90	0.15	2.70	0.69
20	21.8	19.7	0.05	1.49	1	3	13	63	1.70	0.33	2.20	1.20
20	20.1	25.8	0.02	1.00	10	5	17	58	1.80	0.40	3.00	1.40
20	32.0	24.4	0.06	1.09	0	14	7	130	2.40	0.17	2.50	0.65
20	23.0	14.4	0.04	1.43	0	66	9	40	1.60	0.21	1.80	0.80
20	14.5	17.2	0.03	1.13	0	61	9	37	1.30	1.70	1.20	0.65
20	19.7	11.7	0.04	1.54	0	91	7	17	0.92	0.58	1.50	0.72
21	25.5	4.7	0.04	1.54	11	23	10	4	2.10	0.15	1.60	0.90
21	24.0	7.1	0.03	1.32	11	11	5	5	1.80	0.09	1.40	0.92
21	26.7	10.5	0.03	1.31	7	6	5	15	2.40	0.11	1.20	1.00
21	25.9	15.5	0.04	1.32	0	16	5	29	3.20	0.17	1.80	0.82
21	21.6	11.1	0.04	1.23	0	42	6	8	2.70	0.18	1.50	0.95
21	38.2	14.9	0.05	1.46	0	6	5	27	0.90	0.04	2.90	0.51
21	42.7	14.3	0.05	1.57	0	8	5	33	0.75	0.04	4.60	0.49
22	12.1	11.5	0.01	0.85	14	17	9	5	1.30	0.14	0.96	0.60
22	12.8	11.0	0.01	1.28	13	9	11	7	1.00	0.19	1.20	0.94
22	15.3	9.8	0.01	1.42	12	1	14	5	1.10	0.22	1.30	0.91
22	12.7	13.4	0.01	0.96	14	6	8	4	1.80	0.15	0.99	0.64
22	12.4	12.9	0.01	0.94	14	6	7	4	1.70	0.11	1.00	0.71

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
22	16.5	11.5	0.01	1.17	10	17	7	6	1.20	0.15	1.30	0.67
22	18.5	7.6	0.05	2.16	2	40	10	16	1.30	0.30	1.00	1.00
22	14.6	11.7	0.02	1.18	10	55	21	19	1.60	0.61	1.10	0.89
23	19.4	2.1	0.07	1.62	1	26	15	2	1.30	0.24	1.30	0.84
23	18.3	5.0	0.04	1.59	0	28	7	3	1.70	0.18	1.60	0.81
23	25.4	8.7	0.03	1.71	10	9	8	3	2.10	0.14	2.00	0.85
23	27.9	11.1	0.03	1.41	4	11	5	5	2.20	0.07	2.40	0.58
23	12.3	4.6	0.03	1.28	6	7	24	5	2.40	0.98	0.74	1.50
23	13.3	5.9	0.03	1.44	10	14	17	5	2.00	0.56	1.30	1.20
23	19.0	17.9	0.02	1.03	10	15	6	25	1.30	0.21	2.00	0.85
24	26.3	2.3	0.07	1.95	2	17	12	2	0.65	0.12	1.40	0.76
24	36.2	6.6	0.03	2.32	12	3	5	1	0.77	0.06	1.80	0.62
24	39.8	12.1	0.03	1.83	13	2	5	12	0.86	0.06	4.70	0.39
24	31.4	16.6	0.05	2.07	0	25	6	52	1.20	0.17	2.10	0.64
24	30.3	21.4	0.04	1.09	0	21	5	75	0.93	0.07	4.10	0.27
24	39.6	22.0	0.04	0.88	0	27	5	110	0.68	0.05	6.00	0.25
24	36.3	15.7	0.04	1.31	10	33	5	41	1.00	0.07	2.90	0.43
25	27.7	0.7	0.25	2.43	2	19	30	3	0.79	0.27	1.40	1.10
25	30.9	2.5	0.07	1.92	12	5	5	2	0.64	0.09	2.10	0.63
25	34.9	6.9	0.03	2.12	14	6	18	4	0.69	0.37	2.80	1.20
25	31.4	9.9	0.03	1.72	15	3	11	5	0.69	0.14	2.70	0.77
25	17.8	18.5	0.01	0.76	15	12	15	11	0.70	0.20	1.30	0.70
25	15.9	13.8	0.02	1.05	13	28	50	21	1.00	0.57	0.93	1.30
25	15.2	8.6	0.02	1.03	13	12	23	5	0.95	0.45	1.10	1.40
25	16.4	7.9	0.02	1.01	11	14	36	5	0.88	0.59	1.20	1.40
25	17.1	7.6	0.02	1.21	11	19	30	6	0.88	0.70	1.30	1.20
26	32.2	1.5	0.12	2.31	0	14	15	5	0.62	0.15	1.40	0.77

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
26	37.6	7.2	0.03	2.09	12	3	5	4	0.73	0.06	2.50	0.68
26	37.0	11.4	0.04	1.67	0	5	5	17	0.58	0.07	2.10	0.65
26	35.9	11.1	0.05	1.58	0	16	5	5	0.59	0.04	1.90	0.63
26	30.0	10.4	0.04	1.62	11	9	5	5	0.67	0.07	1.50	0.78
26	36.4	9.3	0.04	1.67	1	10	5	5	0.78	0.06	1.80	0.71
26	18.5	8.6	0.02	1.48	5	7	18	5	0.74	0.27	1.30	0.90
27	26.1	5.4	0.03	1.18	12	4	5	2	0.91	0.08	2.10	0.52
27	29.2	12.7	0.03	1.08	3	1	5	27	0.78	0.04	4.30	0.22
27	23.4	16.3	0.03	0.91	0	1	5	92	0.90	0.06	1.90	0.47
27	22.7	14.5	0.04	0.91	0	1	7	31	0.83	0.06	1.90	0.58
27	34.1	14.1	0.04	1.07	0	4	5	30	0.90	0.03	4.50	0.22
27	29.5	13.2	0.04	1.08	10	10	7	20	0.98	0.07	3.00	0.51
27	31.0	21.0	0.04	1.00	0	10	5	77	0.87	0.04	4.70	0.22
28	20.8	2.5	0.07	1.43	11	24	17	4	0.63	0.31	0.98	0.96
28	24.3	6.2	0.03	1.75	14	5	5	2	0.61	0.29	1.20	0.78
28	16.2	9.3	0.02	1.43	12	17	18	10	0.85	0.30	1.10	1.00
28	15.3	8.5	0.05	1.23	0	160	29	14	0.76	0.36	0.97	1.20
28	16.0	6.0	0.04	1.19	4	69	21	4	0.90	0.53	0.96	1.30
28	20.7	10.1	0.03	1.30	12	8	13	4	0.89	0.30	1.40	0.92
28	17.1	5.8	0.03	1.73	14	16	16	7	1.20	0.83	1.20	1.20
28	19.6	5.6	0.04	1.75	12	18	23	8	1.20	0.39	1.30	1.20
29	20.9	7.7	0.02	1.47	11	2	12	2	1.10	0.36	1.70	0.47
29	18.3	12.0	0.01	1.23	12	3	15	7	1.10	0.37	1.90	0.63
29	26.8	19.4	0.04	1.32	0	93	7	71	0.92	0.31	2.40	0.36
29	23.2	26.3	0.03	1.04	3	36	5	78	0.70	0.13	2.00	0.22
29	15.9	8.2	0.01	1.03	10	4	5	3	1.70	0.20	1.40	0.54
29	26.3	18.2	0.03	1.11	0	18	5	25	1.40	0.12	4.10	0.40

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
30	16.1	8.7	0.01	0.90	11	3	5	4	1.50	0.17	1.30	0.71
30	33.8	9.5	0.03	1.50	12	2	5	9	0.77	0.20	4.60	0.29
30	24.2	19.9	0.01	0.73	12	2	5	10	1.00	0.03	2.30	0.57
30	30.5	15.7	0.06	1.27	0	23	5	140	1.10	0.09	2.40	0.48
30	9.9	16.2	0.02	0.97	5	44	8	11	1.20	0.27	0.87	0.90
30	31.2	13.8	0.07	1.62	0	68	8	100	0.87	0.17	3.10	0.63
31	27.1	36.9	0.04	0.82	10	10	5	230	0.88	0.09	2.60	0.15
31	26.1	36.8	0.04	0.77	0	7	5	410	0.69	0.09	2.20	0.15
31	35.4	39.5	0.07	0.75	0	16	5	530	0.75	0.07	2.40	0.15
32	20.0	2.9	0.11	2.07	6	48	22	9	0.99	0.31	1.50	0.85
32	22.1	5.4	0.03	2.00	13	4	7	3	0.89	0.16	2.40	0.84
32	24.5	11.0	0.02	1.67	13	6	5	10	1.00	0.12	2.20	0.75
32	26.5	9.4	0.03	1.83	11	9	9	22	1.10	0.12	2.00	0.59
32	26.3	11.8	0.04	2.08	3	21	7	54	1.20	0.16	1.80	0.79
32	29.5	13.2	0.09	1.65	0	120	10	75	1.10	0.13	1.80	0.72
32	20.5	8.3	0.05	2.07	3	11	17	23	0.95	0.37	1.30	1.00
33	16.0	10.0	0.01	0.78	10	3	5	2	1.60	0.19	1.70	0.66
33	11.7	14.6	0.01	0.68	15	1	5	3	1.60	0.11	1.50	0.67
33	9.4	12.7	0.01	0.67	13	6	14	7	1.90	0.20	1.10	0.77
33	13.9	15.1	0.01	0.61	13	15	6	8	1.70	0.09	1.80	0.61
33	6.4	13.6	0.01	0.75	11	1	14	5	2.10	0.41	0.63	0.77
33	15.1	14.6	0.01	0.59	13	4	5	7	2.30	0.08	1.20	0.63
34	27.3	1.0	0.18	2.73	10	7	11	2	0.87	0.22	1.80	0.88
34	29.1	3.3	0.05	2.70	12	3	5	3	0.89	0.12	2.10	0.83
34	29.4	11.6	0.04	1.76	13	4	5	53	1.10	0.11	3.00	0.57
34	32.6	11.4	0.10	2.09	0	96	8	150	1.00	0.14	2.20	0.72
34	32.1	9.7	0.07	2.44	2	52	5	130	1.40	0.11	2.50	0.52

Pit No.	CEC	ESP	ESI	Ca:Mg	ASWAT (score)	NO3-N (mg/kg)	Colwell P (mg/kg)	SO4-S (mg/kg)	DTPA-Cu (mg/kg)	DTPA-Zn (mg/kg)	Boron (mg/kg)	Org C (%)
34	26.1	6.9	0.07	2.62	4	150	8	17	1.00	0.13	1.30	0.67
35	18.3	45.4	0.03	0.67	0	5	5	310	0.29	0.03	1.70	0.15
35	23.9	36.4	0.04	0.89	0	3	5	140	0.18	0.02	2.00	0.15
35	17.3	45.0	0.03	0.63	0	2	5	170	0.14	0.02	1.40	0.15
35	26.4	41.6	0.05	0.66	0	2	5	340	0.34	0.02	2.80	0.15
35	21.4	44.8	0.04	0.58	1	3	5	180	0.23	0.02	2.00	0.15
35	22.2	43.3	0.04	0.66	0	3	5	210	0.32	0.02	2.30	0.15
36	29.6	3.7	0.05	2.60	10	5	9	4	1.10	0.34	1.70	0.72
36	29.9	6.4	0.03	2.74	11	3	6	5	1.00	0.13	1.70	0.67
36	30.5	7.9	0.03	2.70	13	4	5	10	0.94	0.12	1.90	0.61
36	33.6	8.0	0.03	2.31	13	4	7	15	1.00	0.10	2.10	0.52
36	32.4	7.4	0.03	2.56	13	6	7	16	0.96	0.10	1.90	0.63
36	35.2	9.4	0.07	2.42	0	95	9	42	1.00	0.12	2.00	0.64
36	35.3	9.4	0.07	2.42	0	97	7	41	1.00	0.10	2.10	0.60
36	35.7	13.4	0.06	2.31	0	63	8	150	1.10	0.15	2.50	0.54
37	24.8	2.6	0.06	2.35	5	5	13	4	0.99	0.31	1.40	0.81
37	30.7	8.8	0.03	2.32	13	2	5	7	1.10	0.21	3.00	0.65
37	33.3	15.6	0.08	1.98	0	52	11	370	1.10	0.17	2.20	0.79
37	39.2	15.6	0.08	1.67	0	74	8	140	1.30	0.17	3.70	0.69
37	30.5	10.8	0.06	2.20	2	15	8	43	1.10	0.21	1.80	0.95
37	23.9	9.2	0.05	2.09	3	57	13	33	1.30	0.23	1.80	0.87
37	22.8	8.8	0.05	1.97	5	52	23	28	1.40	0.38	1.60	1.20

APPENDIX F

GLOSSARY OF TERMS

GLOSSARY OF TERMS

ASWAT

Aggregate Stability in Water test. Measure of soil dispersibility based on immersion of soil in water for 10 minutes, and for two hours, with and without remoulding when moist. It allows for the determination of management measures such as gypsum treatment.

Consistence

Consistence refers to the strength of cohesion and adhesion in soil. Strength will vary according to soil water status.

Depth to Lime

Depth at which free lime (usually naturally occurring calcium carbonate) was encountered in the soil profile. Types of lime in subsoil include nodules (rounded mineral aggregates) and diffuse lime (not easily seen visually but it has strong effervescence when dilute acid is applied to the soil).

Dispersion (10 minutes) Score

Provides an indication as to how stable the soil is after being immersed in water for 10 minutes. Dispersion is the separation of soil micro-aggregates into sand, silt and clay particles, which tend to block soil pores and create problems with poor aeration. It can potentially reduce root growth and adversely affect profitability of most crop and pasture enterprises. Soil prone to dispersion is more likely to be lost by water erosion than stable soil. Dispersion is usually associated with sodicity, and is aggravated by a lack of electrolyte in the soil solution. The 10 minute dispersion test is a quick field procedure that is refined via use of the ASWAT test (see above).

Fabric

Describes the appearance of soil material (under X10 hand lens). Differences in fabric are associated with the presence of absence of peds, the lustre of lack of lustre of the ped surfaces, and the presence, size and arrangement of pores in the soil mass.

Horizon

A layer of soil with distinctive texture, structure and color within a soil profile.

Mottled Layer

Mottles are blotches of sub-dominant colours different to the general soil colour (e.g. grey or yellow blotches within a reddish-brown soil) and are an indication of waterlogging. Waterlogging is associated with a lack of oxygen in the soil, can cause large losses of soil nitrogen to the atmosphere (due to anaerobic conditions) and is a sign of inefficient water storage when observed near the surface.

Munsell Soil Colour System

Colour scale used to describe soil colour.

pH

A measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral, and 14 is most basic (alkaline).

Root Score

The frequency of plant roots on the face of a trimmed soil pit is assessed using a scale of zero (no roots observed) to 4 (prolific root growth).

Salinity

The content of dissolved solids in groundwater or surface water, commonly expressed as electrical conductivity of the soil solution (dS/m). When a soil is referred to as being saline, there is an excess of soluble salts in the soil solution. The soil solution is the liquid located between aggregates of soil. If the concentration of salts in the soil solution exceeds the salt concentration inside plant roots, water tends to move out of the roots via a process called osmosis and plants wilt because of a shortage of water, even though the soil remains moist.

Sodicity

A sodic soil has too much sodium associated with the negatively charged clay particles. Too much sodium leads to excessive swelling of the soil, which may result in a structural collapse referred to as dispersion (see above).

SOILpak Compaction Score

Compaction can strongly restrict plant growth because of poor water entry, poor efficiency of water storage, waterlogging when moist, and poor access to nutrients by plant roots. The soil structure is assessed using a numerical scale of 0.0 to 2.0, with a score of 0.0 indicating very poor structure for crop root growth and water entry/storage. Ideally a SOILpak score of the root zone should be in the range of 1.5 to 2.0.

Soil structural form (Pedality)

Soil structural form refers to the distinctness, size and shape of the peds. A ped is an individual natural soil aggregate consisting of a cluster of primary particles and separates from adjoining peds by surfaces of weakness that are recognisable as natural voids or by the occurrence of cutans.

Subsoil

Soil layers (horizons) that underlie the top layer of soil, typically having lower levels of organic matter and associated micro-organisms than in topsoil.

Topsoil

The upper or top layer of soil, that typically has higher levels of organic matter and associated micro-organisms.

Wetting Front

The boundary between soil moistened by downward flowing water and underlying dry layers of soil.