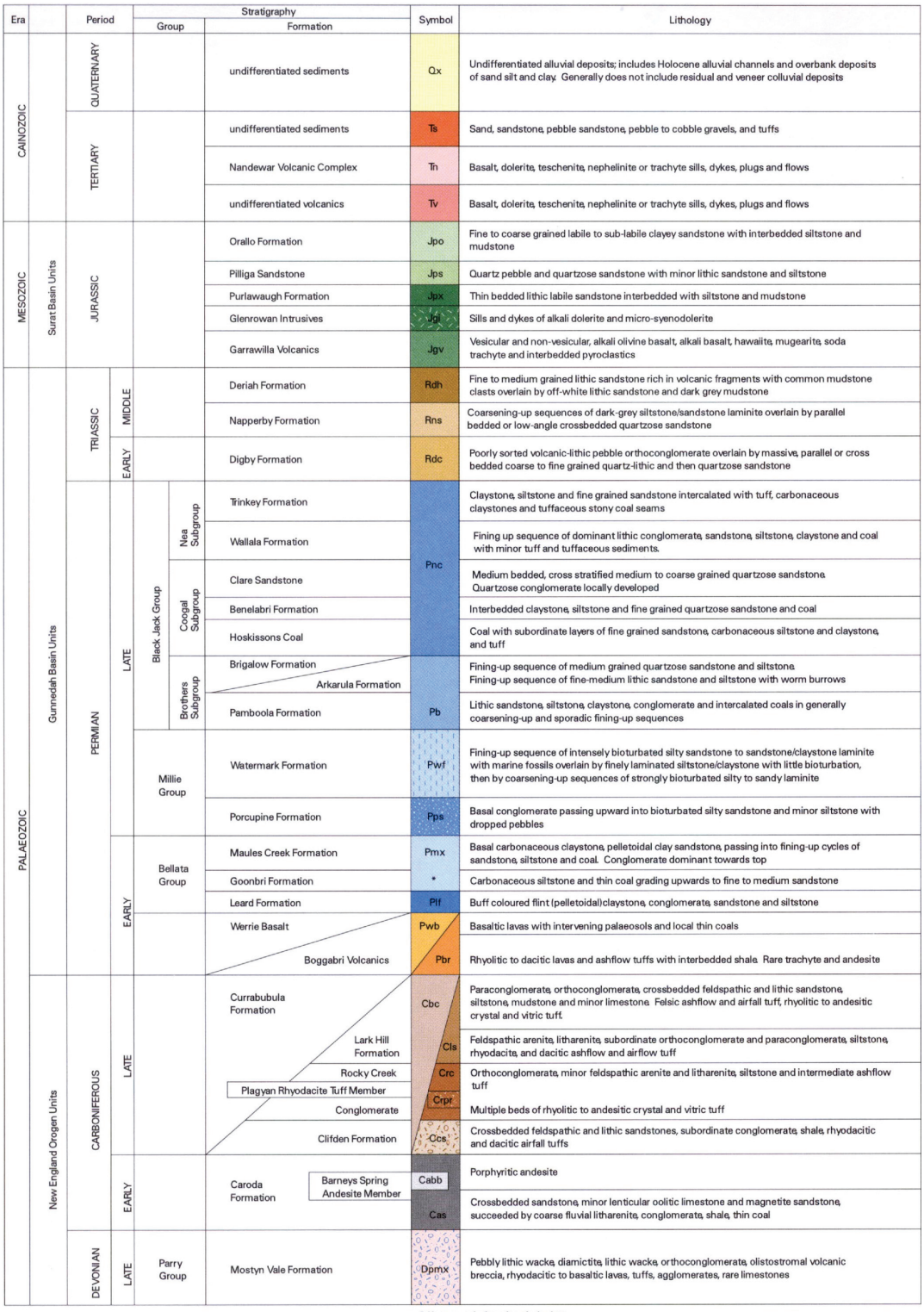

Era		Period	Stratigraphy: Group	Stratigraphy: Formation	Symbol	Lithology
CAINOZOIC		QUATERNARY		undifferentiated sediments	Qx	Undifferentiated alluvial deposits; includes Holocene alluvial channels and overbank deposits of sand silt and clay. Generally does not include residual and veneer colluvial deposits
CAINOZOIC		TERTIARY		undifferentiated sediments	Ts	Sand, sandstone, pebble sandstone, pebble to cobble gravels, and tuffs
CAINOZOIC		TERTIARY		Nandewar Volcanic Complex	Tn	Basalt, dolerite, teschenite, nephelinite or trachyte sills, dykes, plugs and flows
CAINOZOIC		TERTIARY		undifferentiated volcanics	Tv	Basalt, dolerite, teschenite, nephelinite or trachyte sills, dykes, plugs and flows
MESOZOIC	Surat Basin Units	JURASSIC		Orallo Formation	Jpo	Fine to coarse grained labile to sub-labile clayey sandstone with interbedded siltstone and mudstone
MESOZOIC	Surat Basin Units	JURASSIC		Pilliga Sandstone	Jps	Quartz pebble and quartzose sandstone with minor lithic sandstone and siltstone
MESOZOIC	Surat Basin Units	JURASSIC		Purlawaugh Formation	Jpx	Thin bedded lithic labile sandstone interbedded with siltstone and mudstone
MESOZOIC	Surat Basin Units	JURASSIC		Glenrowan Intrusives	Jgi	Sills and dykes of alkali dolerite and micro-syenodolerite
MESOZOIC	Surat Basin Units	JURASSIC		Garrawilla Volcanics	Jgv	Vesicular and non-vesicular, alkali olivine basalt, alkali basalt, hawaiite, mugearite, soda trachyte and interbedded pyroclastics
PALAEOZOIC	Gunnedah Basin Units	TRIASSIC – MIDDLE		Deriah Formation	Rdh	Fine to medium grained lithic sandstone rich in volcanic fragments with common mudstone clasts overlain by off-white lithic sandstone and dark grey mudstone
PALAEOZOIC	Gunnedah Basin Units	TRIASSIC – MIDDLE		Napperby Formation	Rns	Coarsening-up sequences of dark-grey siltstone/sandstone laminite overlain by parallel bedded or low-angle crossbedded quartzose sandstone
PALAEOZOIC	Gunnedah Basin Units	TRIASSIC – EARLY		Digby Formation	Rdc	Poorly sorted volcanic-lithic pebble orthoconglomerate overlain by massive, parallel or cross bedded coarse to fine grained quartz-lithic and then quartzose sandstone
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Nea Subgroup	Trinkey Formation	Pnc	Claystone, siltstone and fine grained sandstone intercalated with tuff, carbonaceous claystones and tuffaceous stony coal seams
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Nea Subgroup	Wallala Formation	Pnc	Fining up sequence of dominant lithic conglomerate, sandstone, siltstone, claystone and coal with minor tuff and tuffaceous sediments.
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Coogal Subgroup	Clare Sandstone	Pnc	Medium bedded, cross stratified medium to coarse grained quartzose sandstone. Quartzose conglomerate locally developed
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Coogal Subgroup	Benelabri Formation	Pnc	Interbedded claystone, siltstone and fine grained quartzose sandstone and coal
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Coogal Subgroup	Hoskissons Coal	Pnc	Coal with subordinate layers of fine grained sandstone, carbonaceous siltstone and claystone, and tuff
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Brothers Subgroup	Brigalow Formation / Arkarula Formation	Pnc	Fining-up sequence of medium grained quartzose sandstone and siltstone. Fining-up sequence of fine-medium lithic sandstone and siltstone with worm burrows
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Black Jack Group – Brothers Subgroup	Pamboola Formation	Pb	Lithic sandstone, siltstone, claystone, conglomerate and intercalated coals in generally coarsening-up and sporadic fining-up sequences
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Millie Group	Watermark Formation	Pwf	Fining-up sequence of intensely bioturbated silty sandstone to sandstone/claystone laminite with marine fossils overlain by finely laminated siltstone/claystone with little bioturbation, then by coarsening-up sequences of strongly bioturbated silty to sandy laminite
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – LATE	Millie Group	Porcupine Formation	Pps	Basal conglomerate passing upward into bioturbated silty sandstone and minor siltstone with dropped pebbles
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – EARLY	Bellata Group	Maules Creek Formation	Pmx	Basal carbonaceous claystone, pelletoidal clay sandstone, passing into fining-up cycles of sandstone, siltstone and coal. Conglomerate dominant towards top
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – EARLY	Bellata Group	Goonbri Formation	*	Carbonaceous siltstone and thin coal grading upwards to fine to medium sandstone
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – EARLY	Bellata Group	Leard Formation	Plf	Buff coloured flint (pelletoidal) claystone, conglomerate, sandstone and siltstone
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – EARLY		Werrie Basalt	Pwb	Basaltic lavas with intervening palaeosols and local thin coals
PALAEOZOIC	Gunnedah Basin Units	PERMIAN – EARLY		Boggabri Volcanics	Pbr	Rhyolitic to dacitic lavas and ashflow tuffs with interbedded shale. Rare trachyte and andesite
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – LATE		Currabubula Formation	Cbc	Paraconglomerate, orthoconglomerate, crossbedded feldspathic and lithic sandstone, siltstone, mudstone and minor limestone. Felsic ashflow and airfall tuff, rhyolitic to andesitic crystal and vitric tuff.
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – LATE		Lark Hill Formation	Cls	Feldspathic arenite, litharenite, subordinate orthoconglomerate and paraconglomerate, siltstone, rhyodacite, and dacitic ashflow and airflow tuff
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – LATE		Rocky Creek	Crc	Orthoconglomerate, minor feldspathic arenite and litharenite, siltstone and intermediate ashflow tuff
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – LATE		Plagyan Rhyodacite Tuff Member	Crpr	Multiple beds of rhyolitic to andesitic crystal and vitric tuff
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – LATE		Conglomerate	Ccs	Crossbedded feldspathic and lithic sandstones, subordinate conglomerate, shale, rhyodacitic and dacitic airfall tuffs
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – LATE		Clifden Formation		
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – EARLY		Caroda Formation – Barneys Spring Andesite Member	Cabb	Porphyritic andesite
PALAEOZOIC	New England Orogen Units	CARBONIFEROUS – EARLY		Caroda Formation	Cas	Crossbedded sandstone, minor lenticular oolitic limestone and magnetite sandstone, succeeded by coarse fluvial litharenite, conglomerate, shale, thin coal
PALAEOZOIC	New England Orogen Units	DEVONIAN – LATE	Parry Group	Mostyn Vale Formation	Dpmx	Pebbly lithic wacke, diamictite, lithic wacke, orthoconglomerate, olistostromal volcanic breccia, rhyodacitic to basaltic lavas, tuffs, agglomerates, rare limestones

* Known only from borehole data

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Source: Department of Mineral Resources NSW (2006)

Note: Refer Figure 4a for Regional Surface Geology Mapping.

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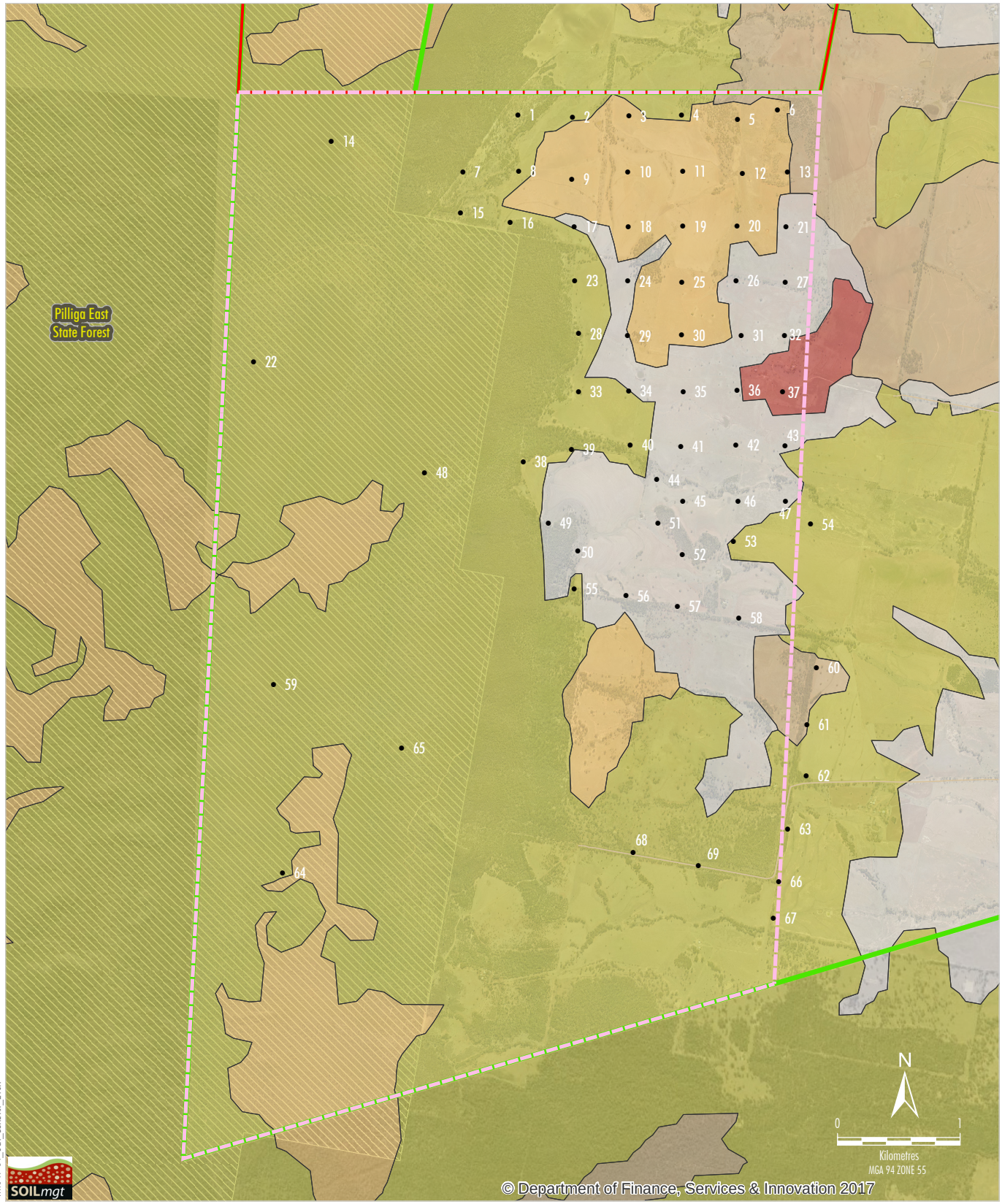
Regional Surface Geology Legend

Figure 4b



WHC17-54_GCA_BSAL AR_210A

LEGEND

- State Forest
- Mining Lease Boundary (ML 1609)
- Exploration Licence (EL 6243)
- Gateway Certificate Application Area
- Soil Test Pit

Dominant Australian Soil Classification (ASC) - Order

- Chromosols
- Ferrosols
- Rudosols and Tenosols
- Sodosols
- Vertosols

Source: Orthophotos - Whitehaven Coal (2017); R.W. Corkery & Co Pty Ltd (2009); NSW Trade & Investment (2017); NCOPL (2017); OEH (2012)

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Regionally Mapped Australian Soils Classification within the Gateway Certificate Application Area

Figure 5

Land and Soil Capability

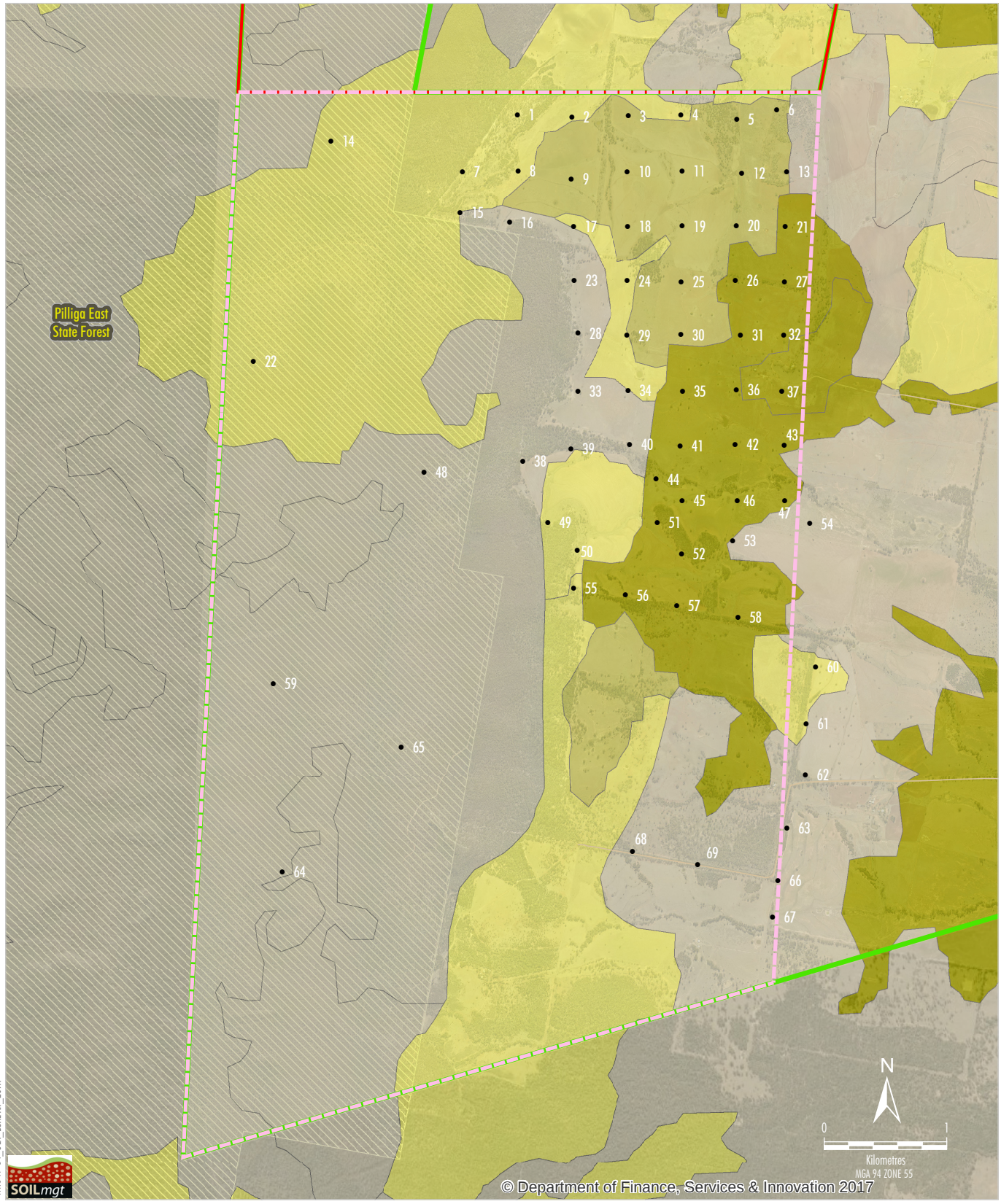
The LSC Assessment Scheme uses the biophysical features of the land and soil including landform position, slope gradient, drainage, climate, soil type and soil characteristics to derive detailed rating tables for a range of land and soil hazards (OEH, 2012). The LSC class gives an indication of the land management practices that can be applied to a parcel of land. The LSC classes are outlined in Table 1 (OEH, 2012).

Table 1. Land and Soil Capability Class Definitions

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

Regional LSC mapping available on the NSW OEH website is shown on Figure 6. This mapping identifies Class 3, Class 4, Class 5 and Class 7 land in the Gateway Certificate Application Area.

The LSC classification for each test pit in the Gateway Certificate Application Area was investigated. The classifications of each test pit are discussed in Section 6.



WHC17-54_GCA_BSAL AR_209A

LEGEND

- State Forest
- Mining Lease Boundary (ML 1609)
- Exploration Licence (EL 6243)
- Gateway Certificate Application Area
- Soil Test Pit

LSC Classes

- 3
- 4
- 5
- 7

Source: Orthophotos - Whitehaven Coal (2017); R.W. Corkery & Co Pty Ltd (2009); NSW Trade & Investment (2017); NCOPL (2017)

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Regionally Mapped Land and Soil Capability Classes within the Gateway Certificate Application Area

Figure 6

3 BIOPHYSICAL STRATEGIC AGRICULTURAL LAND FRAMEWORK

The *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) Amendment 2013* requires certain types of developments to verify whether the proposed site is on BSAL. The Interim Protocol (NSW Government, 2013) provides a framework for verifying whether or not land mapped as BSAL meets the BSAL criteria.

The initial steps for verifying BSAL and the sections of this report that describe the relevant outcomes are outlined in Table 2.

Table 2. Initial Steps to Verify BSAL

Step	Description[1]	Section
1: Identify the project area which will be assessed for BSAL	The assessment area should include the entire project area and include at least a 100 m buffer to take into account minor changes in design, surrounding disturbance and minor expansion. If BSAL is part of a larger contiguous mass of BSAL then the boundary of this area must also be identified.	4.1
2: Confirm access to a reliable water supply	BSAL lands must have access to a "reliable water supply". All of the area in the Upper Hunter and the New England North West Strategic Regional Land Use Plans has access to a "reliable water supply".	4.2
3: Choose the appropriate approach to map the soils information	Access to the project area will define the level of investigation that the proponent can undertake.	4.3
4: Risk assessment	The proponent should undertake a risk assessment as this may influence the required density of soil sampling sites.	4.4

[1] Description provided as per the Interim Protocol.

If the initial steps (Table 2) indicate that BSAL may be present, more detailed soil and landscape verification criteria are considered. Ten soil and landscape verification criteria are identified in the Interim Protocol. A reconciliation of these criteria and the relevant sections of this report is provided in Table 3.

Table 3. Soil and Landscape Verification Criteria

Step	Description[1]	Section
1: Slope	Slope is the upward or downward incline of the land surface, measured in per cent. BSAL soils must have a slope of less than or equal to 10 %.	5.3
2: Rock Outcrop	BSAL must have less than 30 % rock outcrop. Rocks hinder cultivation operations (e.g. damage to machinery).	5.4
3: Surface Rockiness	Rockiness refers to the presence of unattached coarse rock fragments on the soil surface and to rock outcrops at the soil surface. BSAL soils have minimal surface rockiness where no more than 20 % of an area has unattached rock fragments greater than 60 mm diameter.	5.5
4: Gilgai	BSAL must be free of gilgais with a height difference between depressions and mounds of more than 500 mm.	5.6
5: Soil Type	BSAL requires an ASC that is associated with naturally high, moderately high or moderate fertility.	5.7
6: Effective Rooting Depth to a Physical Barrier	Physical barriers include bedrock, weathered rock, hard pans and continuous gravel layers. BSAL soils cannot have impedance of root growth by a physical barrier within 750 mm of the soil surface.	5.8
7: Drainage	Waterlogging can severely reduce crop productivity. It is caused by poor drainage that generally is associated with low-lying landscape positions, or by drainage restrictions such as shallow rock and sodic/compacted subsoil. Poorly drained soils usually have subsoil mottling and are not BSAL.	5.9
8: Soil pH	Soil pH refers to the acidity or alkalinity of the soil. BSAL soils range from acidic to alkaline soil conditions within the range of 5.0 – 8.9 when measured in water or 4.5 – 8.1 when measured in calcium chloride, within the uppermost 600 mm of the soil profile.	5.10
9: Soil Salinity	Soil salinity refers to the concentration of soluble salts in a soil. BSAL soils have a level of soil salinity where electrical conductivity in a saturated extract (ECe) is less than or equal to 4 deciSiemens per metre (dS/m) or, if gypsum is present, chlorides are less than 800 milligrams per kilogram (mg/kg). These thresholds apply to the uppermost 600 mm of the soil profile.	5.11
10: Effective Rooting Depth to a Chemical Barrier	Chemical barriers to root growth, in addition to pH extremes and salinity, include dispersion associated with sodicity and low calcium to magnesium ratios. BSAL soils cannot have a chemical barrier within 750 mm of the soil surface.	5.12

[1] Description provided as per the Interim Protocol.

If the initial steps and all soil and landscape verification criteria are met, a site is considered to be BSAL.

4 INITIAL STEPS TO VERIFY BIOPHYSICAL STRATEGIC AGRICULTURAL LAND

4.1 Project Area

The Gateway Certificate Application Area is shown on Figure 3 and includes at least a 100 m buffer from the proposed longwalls.

Regionally mapped BSAL in the Gateway Certificate Application Area is shown on Figure 3.

4.2 Access to Reliable Water Supply

As described in the Interim Protocol, all of the area in the *New England North West Strategic Regional Land Use Plan* (Department of Planning and Infrastructure, 2012) is considered to have access to a "reliable water supply". This is because there is either rainfall of 350 mm or more per annum in 9 out of 10 years, or the land is underlain by a groundwater aquifer with a bore yield rate greater than 5 litres per second and total dissolved solids of less than 1,500 milligrams per litre.

The Gateway Certificate Application Area is located in the New England North West Region, and is, therefore, considered to have access to a reliable water supply.

4.3 Site Access and Mapping Approach

NCOPL has sought access agreements with landholders and the Forestry Corporation of NSW where their lands lie within the Gateway Certificate Application Area.

Where access was made available, NCOPL has undertaken an on-site soil assessment for BSAL verification in accordance with the Interim Protocol.

Access was not made available by three landholders in the southern portion of the Gateway Certificate Application Area.

The lack of detailed information about the underlying geology – particularly the Garawilla Volcanics unit with its very diverse range of parent material for soil formation – means that prediction of soil conditions and BSAL status for these inaccessible areas via modelling would be of limited accuracy. The only option, therefore, was to accept that existing NSW Government mapping of BSAL in the inaccessible area is correct until proven otherwise.

4.4 Risk Assessment / Soil Sampling Intensity

In order to identify the potential impact on agricultural resources and the appropriate level of soil survey required, an evaluation of potential risks to agricultural resources and enterprises has been undertaken. This risk assessment was based on the process outlined in Appendix 3 of the Interim Protocol. The outcome of the risk assessment was:

- The Project was considered to pose a low risk to agricultural resources in the western section of the Gateway Certificate Application Area (Figure 3), as:
    - No agricultural land uses exist as this is a densely forested area.
    - No BSAL was identified in the regional mapping.
    - The land is on Pilliga Sandstone and is highly unlikely to be BSAL.
    - The Project is an extension to an existing underground mine and would result in minor direct disturbance to the surface, as well as potential indirect impacts caused by subsidence. As there are no existing agricultural land uses in this section, this is considered to be a low risk.
- The Project was considered to pose a moderate to high risk to agricultural resources (in the context of the Interim Protocol) in the eastern section of the Gateway Certificate Application Area (Figure 3), as:
    - Agricultural land uses currently exist.
    - There is regionally mapped BSAL within this section of the Gateway Certificate Application Area (Figure 3).
    - The Project is an extension to an existing underground mine and would result in minor direct disturbance to the surface, as well as potential indirect impacts caused by subsidence. As there are existing agricultural land uses and regionally mapped BSAL in this section, this is considered to be a moderate to high risk (i.e. in the context of the Interim Protocol).

In consideration of the above risk rankings, and in consideration of the Interim Protocol, a sampling density of 1 site per 400 hectares (ha) was considered appropriate in the western section of the Gateway Certificate Application Area, and a sampling density of 1 site per 20 ha was considered appropriate in the eastern section of the Gateway Certificate Application Area.

The soil pits were located in a way that covered as many of the major variations in elevation and landforms as possible. The 425 m pit spacing (i.e. approximately one pit per 18 ha) in the eastern area of the Gateway Certificate Application Area allowed an assessment to determine whether it met the minimum area requirement of 20 ha, as described in the Interim Protocol:

- One pit on its own that satisfied Steps 1 to 12 of the BSAL criteria – represented approximately 18 ha, i.e. not above the BSAL threshold of 20 ha.
- Two pits together that satisfied Steps 1 to 12 of the BSAL criteria – represented approximately 36 ha, i.e. almost certainly above the BSAL threshold of 20 ha.

In the western section of the Gateway Certificate Application Area, where broader pit spacing was used, enough soil pits were present to satisfy the minimum Interim Protocol requirement of three detailed soil pits per soil type. All of the <10% slope field sites with a soil depth >75 centimetres (cm) required laboratory analysis to determine whether or not each site had BSAL characteristics. Key soil factors such as salinity, sodicity and cation exchange capacity (CEC) cannot be measured or predicted accurately in the field.

5 SOILS AND LANDSCAPE VERIFICATION

5.1 Biophysical Strategic Agricultural Land Assessment

The Interim Protocol was used to assess the presence/absence of BSAL within the Gateway Certificate Application Area. A flow chart showing the Interim Protocol BSAL assessment criteria (Steps 1 to 12) is provided in Figure 7.

5.2 Soil Survey Methodology

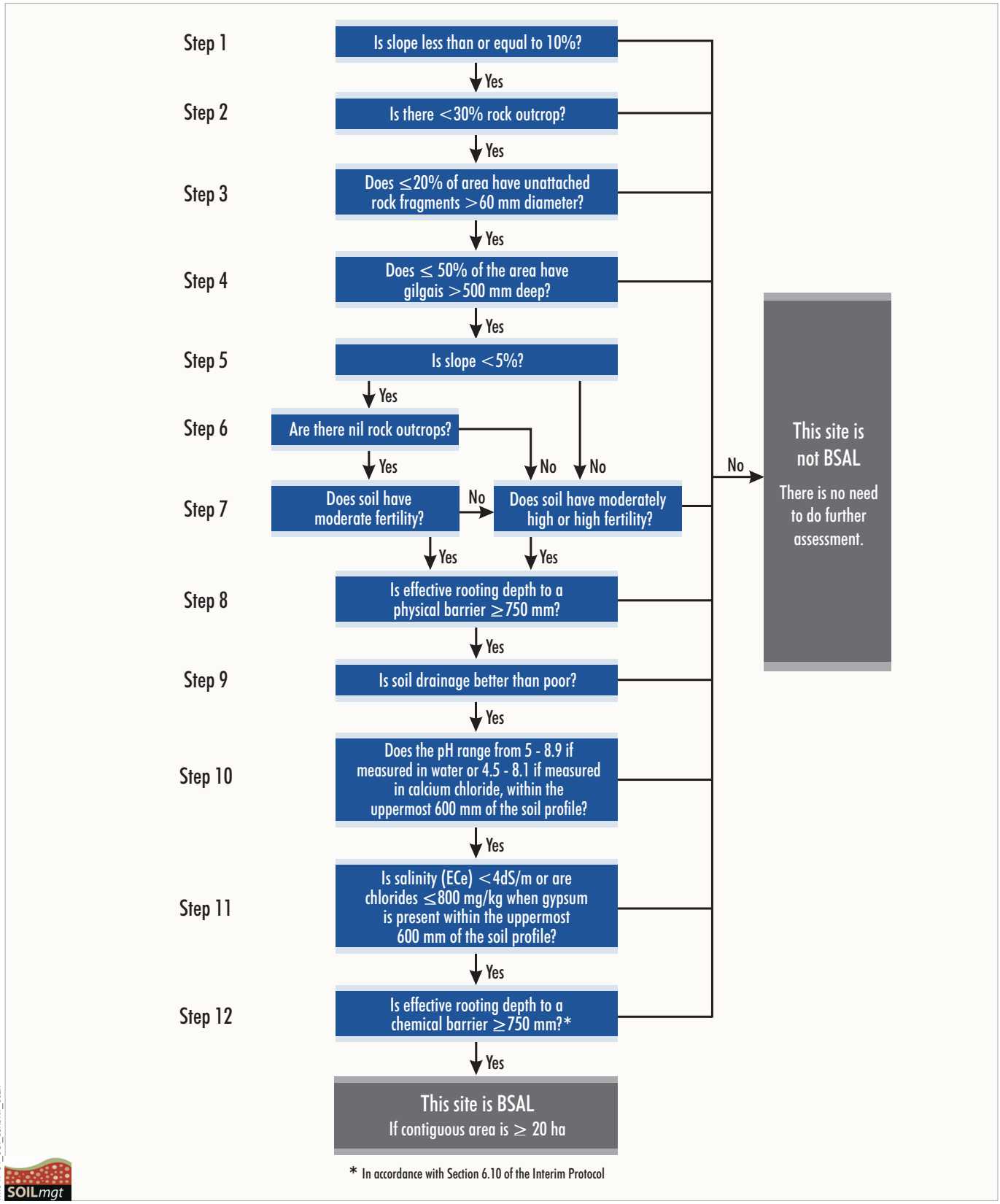
A soil survey was conducted by Soil Management Designs under moist conditions on 22 May, 31 May to 9 June and 14 June 2017. Additional survey work was undertaken on 14 September 2017.

The main aim of this study has been to identify any BSAL within the Gateway Certificate Application Area (Figure 2). BSAL verification within the Gateway Certificate Application Area has been conducted in accordance with the Interim Protocol. However, the following soil information is regarded by Ward (1998) as being important for soil assessment associated with mine site reclamation, and has been incorporated into the methodology for this assessment:

- Classification (structure, texture, etc.): allows existing data and experience on managing similar soils elsewhere to be applied.
- Dispersion index and particle size analysis: indicates soil structural stability and erodibility.
- pH: need to identify extreme ranges for treatment of lime or selection of suitable plant species.
- Electrical conductivity (EC): indicates soluble salt status.
- Macro- and micro-nutrients.

The NSW Government requires proponents of new mining and coal seam gas projects in NSW to consider the potential impacts of projects on agricultural resources up-front in the project assessment process. To satisfy this requirement, existing soil profiles have to be described in a way that allows the productivity of crops, pasture and trees to be predicted accurately, as well as assisting with prediction of impacts of mining on agriculture, and provision of information about soil materials that will assist with any mine rehabilitation activities that are required. Therefore, in addition to following the BSAL identification process described in the Interim Protocol, the soil survey methodology for intensive agricultural developments described by McKenzie *et al.* (2008) and McKenzie (2013) also has been taken into account when planning the Gateway Certificate Application soil survey. The combination of techniques from this variety of sources, and its compatibility with requirements of the Interim Protocol, is described in the following sections.

Relevant field observations and laboratory data for all observation sites were submitted to the NSW OEH via its Electronic Digital Regolith Tool (eDIRT) application in mid-August 2017 and late October 2017.



WHC-17-54_GCA_BSAL AR_002A

SOILmgt

Source: After NSW Government (2013)

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Flow Chart for Site, Soil and Landscape Verification Criteria

Figure 7

Soil Survey

The soil survey of the Gateway Certificate Application Area involved a survey of 69 detailed soil pit profiles dug with a backhoe (approximately 1.4 m deep; shallower where hard rock was encountered). Soil pit locations are shown on Figure 3.

The field description methods were as described in the '*Australian Soil and Land Survey Field Handbook*' (National Committee on Soil and Terrain, 2009) and the '*Guidelines for Surveying Soil and Land Resources, Chapter 29*' (McKenzie *et al*., 2008). The soil profiles have been classified according to the ASC (Isbell, 2002).

The soil survey was carried out by Dr David McKenzie. He has Certified Professional Soil Scientist (CPSS; Specialist Competency in Australian Soil Survey) accreditation from Soil Science Australia and a PhD in soil science. Dr McKenzie also has 'Chartered Scientist' accreditation with the British Society of Soil Science. Assistance with field work was provided on 22 May to 2 June 2017 by Dr Nilantha Hulugalle (CPSS).

Soil Pit Locations

The methodology used to define soil pit intensities is described above in Section 4.4.

To comply with landholder requests at the Hudson property, several of the soil pits (e.g. Pits 38, 39, 44, 49, 51, 50, 52 and 54) had to be moved to avoid damage to recently sown winter crops. This meant that land quality at the Hudson property may have been under-estimated. Discussions with Mr Hudson indicated that soil in the zone between Pits 38,39 and 49 has had significant inputs of nutrients and gypsum that may have created better conditions for crop growth than the pasture zones next to the cropping paddocks where the soil pits were located.

Access was not available to conduct soil investigations for several parts of the Gateway Certificate Application Area between August and October 2017. NCOPL endeavours to gain access to these areas to conduct soil investigations, with the results of any additional work to be presented in the Agricultural Resource Assessment for the Environmental Impact Statement.

Soil Landscape Units

Soil Landscape Units identified in the Gateway Certificate Application Area that host the soil types described in the next section, are described in Table 4 and presented in Figure 8. Soil Landscape Units are associations of soils described and delineated by means of landforms (Dent and Young, 1981). Names of the Soil Landscape Units are consistent with terminology used on the geology map. At least three detailed sites were investigated for all of the soil landscape units recorded in the Gateway Certificate Application Area.

Table 4. Soil Types Associated with the Soil Landscape Units

Soil Landscape Unit	Number of Detailed Sites	Map Code	Dominant Soil Type[1]	Sub-Dominant Soil Types[1]	Additional Comments
Pilliga Sandstone	9	**P**	Orthic Tenosol	Sodosol, Dermosol	Acidic sandy soil – poor fertility for agricultural crops.
Garawilla Volcanics - Calcic	3	**GV-C**	Vertosol	Dermosol	High quality clay-rich soil that is suitable for a broad range of agricultural crops and pasture.
Garawilla Volcanics - Intermediate	19	**GV-I**	Dermosol	Chromosol, Kandosol, Rudosol	High quality soil that is suitable for a broad range of agricultural crops and pasture following amelioration.
Garawilla Volcanics - Sodic	24	**GV-S**	Sodosol	Dermosol, Kandosol, Leptic Tenosol, Calcarosol	Poor root growth in subsoil due to sodicity.
Garawilla Volcanics – Sodic/Vertosols	8	**GV-S/V**	Vertosol		Poor root growth in subsoil due to sodicity, but a favourable ability to regenerate soil structural form through shrink-swell processes.
Napperby Siltstone	6	**N**	Sodosol	Rudosol	Poor root growth in subsoil due to sodicity.

[1] Section 9.6.2 of the Interim Protocol contemplates more than one soil type occurring in a single soil landscape unit.

WHC17-54_GCA_BSAL AR_205A

SOILmgt

LEGEND

- State Forest
- Mining Lease Boundary (ML 1609)
- Exploration Licence (EL 6243)
- Gateway Certificate Application Area
- Soil Test Pit

Soil Units

- Pilliga Sandstone (P)
- Garawilla Volcanics - Calcic (GVC)
- Garawilla Volcanics - Intermediate (GV-I)
- Garawilla Volcanics - Sodic (GV-S)
- Garawilla Volcanics - Sodic/Vertosols (GV-S/V)
- Napperby Siltstone (N)
- Unmapped (UM)

Source: Orthophotos - Whitehaven Coal (July 2017); R.W. Corkery & Co Pty Ltd (2009), NSW Trade & Investment (2015); NCOPL (2017); McKenzie Soil Management (2017)

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Soil Landscape Units

Figure 8