Coal Resource Recovery Plan LW107 to LW110

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Contents

Tables

Figures

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1 INTRODUCTION

1.1 Introduction

This Coal Resource Recovery Plan (CRRP) has been prepared as part of the Extraction Plan for Longwalls Panels LW107 – LW110 in the Hoskissons Seam at the Narrabri Mine. This plan has been prepared to demonstrate effective recovery of available resources obtained through underground mining activities at the Narrabri Mine for the extraction of LW107 – LW110.

A general description of the site locality and Extraction Plan area is provided in Section 1.1 of the Extraction Plan. The Extraction Plan describes the operation of the underground mine to date, and the proposed extraction of LW107 – LW110.

An updated assessment of potential subsidence movements related to the Hoskissons Seam and LW107 – LW110 has been prepared by Ditton Geotechnical Services (DGS, 2017). These subsidence predictions have been used as a basis for the updated assessment of impacts contained within the Extraction Plan. DGS's analysis and results are contained, in full, as an appendix to the Extraction Plan.

This CRRP has been prepared in accordance with Condition 4(g) of Project Approval (PA) 08_0144, which requires that a CRRP be prepared that demonstrates the effective recovery of the available coal resource.

The Extraction Plan also includes supporting information regarding details of coal resource, existing and proposed workings, and impacted surface features in the form of Plans 1 to 8 prepared in accordance with the Department of Planning and Environment (DP&E) '*Guidelines for the Preparation of Extraction Plans*'.

1.2 Scope

This CRRP has been developed to describe the proposed resource recovery for secondary extraction of LW107 – LW110 in the Hoskissons Seam (HS). In order to enable compliance with the statutory requirements outlined in Section 1.2, this CRRP provides a description of the:

- Coal resource available;
- Proposed mining method, schedule and mine plan;
- Resource recovery and effects on future mining; and
- Justification for the proposed mine plan.

1.3 Statutory Requirements

This document has been prepared in accordance with PA 08_0144, relevant legislation and guidelines, and in consultation with relevant government agencies and affected infrastructure owners as discussed below. This plan has been prepared in accordance with the relevant legislation and guidelines.

1.3.1 Project Approval

PA 08_0144 requires that NCOPL prepare a CRRP to the satisfaction of the Division of Resources and Energy (DRE). Specifically, Condition 4(g) of Schedule 3, states inter alia:

4 The Proponent shall prepare and implement Extraction Plans for the second workings to be mined to the satisfaction of the Secretary. Each Extraction Plan must:

(g) Include the following to the satisfaction of DRE:

- *a Coal Resource Recovery Plan that demonstrates effective recovery of the available resource.*

1.3.2 Mining Lease

This report has also been prepared to also address statutory requirements of the Mining Lease (ML) 1609 with regard to the preparation of an Extraction Plan.

1.4 Extraction Plan Guideline – Plans 1-8

Information contained in this report is supported / presented in a series of detailed drawings as required by the Department of Planning and Environment (DP&E) '*Guidelines for the Preparation of Extraction Plans*' in A0 size. Reduced-size (A3) versions are attached as Attachment 1 to the Extraction Plan.

2 GEOLOGICAL AND GEOTECHNICAL SETTING

2.1 Regional Geology

The Narrabri Mine is located within the Permo-Triassic Gunnedah Basin, which forms the central part of the north-south elongate Sydney-Gunnedah-Bowen Basin system. The Narrabri Mine is located in the near the north western boundary of the Gunnedah Basin and the eastern margin of the Surat Basin, a sub-basin of the larger Great Artesian Basin. Hence, the rocks and sediments beneath and surrounding the mine can be grouped into:

- Undifferentiated Quaternary sediments;
- Jurassic Surat Basin sequence; and
- The Gunnedah Basin sequence.

The Boggabri Ridge, comprising Early Permian volcanic rocks, forms the basement of the Gunnedah Basin and divides the basin into two parts, the Maules Creek sub-basin to the east, and the Mullaley Sub-basin to the west.

The Narrabri Mine is located within the Mullaley Sub-basin which contains Permian and Triassic sedimentary and volcanic rocks. The rocks strike approximately north-south and dip to the west at an angle of less than 10°. In the area of ML 1609, adjacent to the Boggabri Ridge, there is a local angular unconformity between the Late Permian Black Jack Group and the overlying Triassic Digby Formation.

The western part of ML 1609 is overlain by Jurassic sedimentary and volcanic rocks along the eastern margin of the Oxley Embayment, a part of the Surat Basin.

2.2 Local Geology and Stratigraphy

The rocks throughout ML 1609 strike north-south and dip gently to the west. Minor variations to the north-south strike may be the result of variable thickness and compaction of the sedimentary units being draped over the faulted and uneven surface on the underlying Boggabri Volcanics. To the east of ML 1609, the Boggabri Volcanics have been uplifted and faulted along a north-south trending anticline structure, the Boggabri Ridge. The proximity of ML 1609 to the Boggabri Ridge is a major control on the outcrop and structure of the local geology.

The stratigraphic sequence at the Narrabri Mine is illustrated in a representative east-west cross section Figure 1. Each unit in the sequence depicted is further described below.

Quaternary Sediments

Undifferentiated Quaternary alluvial gravel, sand silt and clay overly the Jurassic and Triassic rocks. Whilst not apparent in the cross section depicted in Figure 1, these sediments are present in the east and northeast of the mine site associated with the Namoi River, which lies downstream and to the east of the Narrabri Mine.

Surat Basin (Great Artesian Basin) Sequence (Jurassic)

The Pilliga Sandstone crops out along the western margin of ML 1609. It is up to 60m thick, (DME Narrabri DDH-30), and consists of medium bedded, cross-bedded, well sorted, and fine to coarse grained quartz sandstone.

The Purlawaugh Formation is up to 140m thick and crops out over the western half of ML 1609. It consists of thinly bedded, generally fine grained, silty lithic sandstone, siltstone and minor claystone. Thin stony coal seams are present in the lower part of the unit.

The Garrawilla Volcanics unconformably overlie the Triassic Napperby Formation or the Deriah Formation where it is present. The volcanics consist mainly of alkali basalt flows with very minor intervening mudstone and clastic rocks. The Garrawilla Volcanics are up to 40m thick.

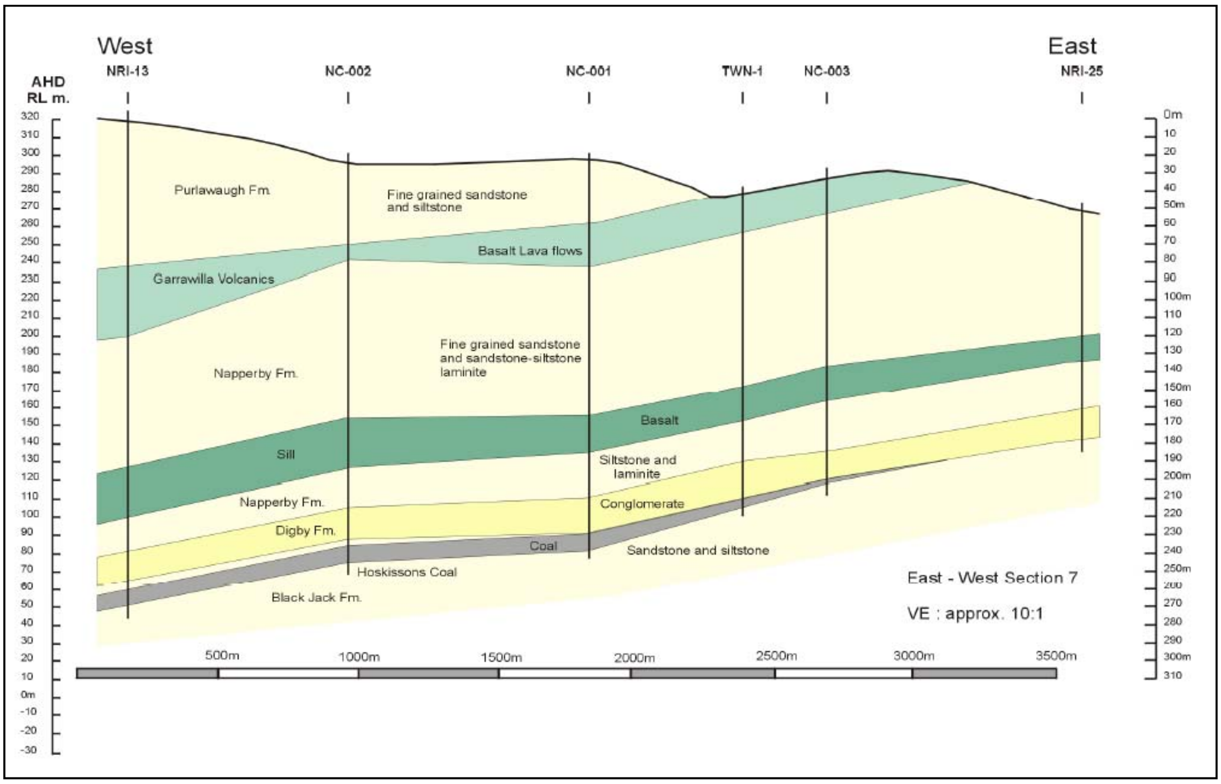

Figure 1: Representative Section (East – West) of the Narrabri Mine (Source: DGS, 2011)

Gunnedah Basin Sequence (Permian to Triassic)

The Napperby Formation is up to 140m thick. It consists of a coarsening-up sequence of siltstone, sandstone / siltstone laminite, and fine to medium grained quartz-lithic sandstone.

An intrusive Basalt Sill is present in the lower part of the Napperby Formation in ML 1609. It varies in thickness from 0 to 30m but is typically 15m to 20m thick. It occurs approximately 30m to 35m above the base of the Napperby Formation. It is dark green alkali basalt and is almost certainly related to the Garrawilla Volcanics. The basalt typically has strongly developed sub-vertical fractures infilled with secondary chlorite and zeolite minerals. The fractures do not continue into the enclosing rocks and may be related to cooling shrinkage.

The Digby Formation is divided into two units, the lower Digby Conglomerate and the overlying Ulinda Sandstone. The Ulinda Sandstone is either not present in ML 1609 or the boundary between these units is not clear with interbedded conglomerate and sandstone common in the top of the conglomerate. Consequently, the whole unit is referred to as the Digby Conglomerate in this area.

The Digby Conglomerate unconformably overlies the coal-bearing Black Jack Group. The unit consists mainly of thickly bedded, polymictic, lithic, pebble conglomerate with clasts of volcanic, meta-sediment and jasper in a lithic rich matrix. Minor finely to medium bedded, lithic sandstone beds are present towards the top of the unit. The Digby Formation is typically 15m to 20m thick in ML 1609. The boundary with the underlying Black Jack Group is an angular unconformity. In the east of ML 1609, it cuts the Hoskissons Seam at a depth of approximately 130m to 160m below the land surface. In the west, over a distance of approximately 5km, there is up to 20m of the Black Jack Group remaining above the Hoskissons Seam.

The Black Jack Group consists of lithic sandstone, siltstone, claystone and coal with minor tuff. It is up to 70m thick in the western part of the ML 1609 but is less than 40m thick in the east due to the low angle unconformity with the overlying Digby Formation. The Hoskissons Seam and the Melville Seam are present within ML 1609. Thickness and quality characteristics are such that only the Hoskissons Seam is currently considered to contain coal resources with mining potential.

Throughout ML 1609, the Black Jack Formation includes the following strata:

- Arkarula Formation – quartzose sandstone and siltstone. Typically the upper 10m of the Black Jack Formation over the Mine Site;
- Brigalow Formation – coarse sandstone and conglomerate interbedded with the coal seam and grades laterally into the Arkarula Formation, thickening to the west across the Mine Site from 2m to 19m; and
- Pamboola Formation – lithic sandstone, siltstone, claystone and coal. Continuous over the Mine Site below the Arkarula Formation and Brigalow Formation with a thickness of between 55m and 75m.

2.2.1 Geological Structure and Geotechnical Attributes

As noted previously, the major structural elements of the site geology are influenced by the proximity of the Boggabri Ridge. Regional aeromagnetic data indicates a strong northwest structure trend with northwest trending fault blocks in the basement. Exploration has identified one major fault in the northern area of the Mine Lease and two fault zones in the southern area of the Mine Lease. Each of these structures is oriented in a NW-SE direction. The northern structure truncates LW101-103 and decreases in magnitude towards the west. Further exploration is required to determine the magnitude and potential impact of the structures in the South that will be intercepted much later in the mine life. The geotechnical attributes of the various overlying units, the seam and seam floor is discussed in Table 1.

Table 1: Roof and Floor Strata Features by Geological Unit

Unit	Description	Comments
Napperby Formation	Comprises mudstones, siltstones, sandstones and sandstone/siltstone laminites. Some units very weak, particularly along bedding planes and laminae.	This unit is not significant operationally. However, the drifts and ventilation shaft pass through the formation for the majority of their length. Excavation was relatively easy, however some sections required high density support and in these areas the depth of cut before supporting was restricted. This unit is expected to behave favourably in relation to longwall mining.
Dolerite Sill	Basalt sill 40m to 60m above the coal seam which is very strong.	Operational impact is expected to be slight due to the amount of interburden together with its fractured nature.
Digby Formation	Weakly cemented conglomerate with high matrix to pebble ratio. Strength tests indicate moderate strength.	Operational impact is not expected to be as severe as other NSW conglomerates but the unit would behave massively, possibly more like a massive sandstone. Consequently, difficulty in achieving first cave and periodic weighting is anticipated. Stress tests indicate it is highly stressed relative to strength which should help the unit to cave following mining.
Benelabri Formation	These sandstone, sandstone/siltstone layers are not always present. They increase in thickness towards the west, separating the coal from the conglomerate. Moderate strength.	As significant thickness of roof coal is to be carried, these layers are not of great importance in terms of roof behaviour. However, by increasing the separation between the working section and the base of the conglomerate at the face start positions in the west, they would positively influence the potential for windblasts.
Roof Coal	Generally, greater than 1m of clean coal in immediate roof.	The roof coal is expected to form a good roof on development with low stress as a result of shielding by the overlying conglomerate, such that roof support densities on development would be towards the lower end of those commonly found in other coal regions. Higher levels of secondary support may be required on retreat as a result of the altered stress field.
Working Section	Not heavily cleated. Extent of jointing not known.	Refer to Section 3.5 for assessments of stability of underground workings.
Arkarula / Brigalow Formation	Tests indicate moderate strength floor with no slaking tendency.	Floor problems are not anticipated.

3 MINING SYSTEM AND RESOURCE RECOVERY

3.1 Coal Resource

The coal resource at the Narrabri Mine consists of the Hoskissons Seam, which within the extents of LW107 – LW110 ranges from 5m to 9.8m thick. The Hoskissons Seam strikes generally north-south and dips gently to the west.

The lower portion of the seam contains low-ash coal suitable for thermal applications, whilst the upper section contains high-ash stony coal and tuffaceous claystone bands that will remain in the roof where the seam thickness exceeds 4.3m (the target mining height).

3.2 Mine Design, Geometry and Depth of Cover

Using the knowledge gained during exploration, the mine plan has been designed to maximise resource recovery in those areas which appear to be free of major structural disturbance and which would support a high production longwall operation. The proposed layout of LW107 – LW110 in the Hoskissons Seam is shown in Plan 3. The total depth of cover ranges from 220 to 340 m.

The location of the longwall panels (refer to Plan 1) has been defined to correspond with areas where the coal seam thickness exceeds 5m. Longwall panels are oriented in a north-south pattern, radiating from a central set of mains headings (the West Mains or 100 Panel) which are oriented east-west.

A summary of proposed longwall panel dimensions and depth of cover is provided in Table 2.

Table 2: Proposed Longwall Panel Dimensions

Panel	Depth of Cover (range) (m)	Gate Roads (nominal) (m)	Maingate Pillar Width Rib to Rib (m)	LW Void Width (m)	LW Length (m)
107	220 – 290	5.4	30	408.9	2,875
108	240 – 310	5.4	33	408.9	3,604
109	260 – 330	5.4	34	408.9	3,656
110	280 – 340	5.4	36	408.9	4,027

3.3 Mining Method

The NCOPL underground operation utilises the retreating longwall method for secondary extraction. Construction of the main headings (West Mains) and gate roads is currently being undertaken using continuous miners. Development and extraction will involve the following sequential steps:

- Development of the gate road headings (maingate and tailgate) approximately 398.1 m apart and oriented perpendicularly to the West Mains on both sides of the proposed longwall void;
- Establishment of an installation road to link the maingate and tailgate at the furthest point from the West Mains;
- Installation of the longwall equipment; and

- Recovery of coal as the longwall unit retreats back towards the West Mains.

Coal is transferred via a conveyor system to the Pit Bottom Area for transfer to the surface via the conveyor drift.

3.4 Schedule

NCOPL's underground mining operations and associated surface support activities will be conducted seven days a week, 24 hours a day on a rotating shift basis. Surface operations not required specifically for underground mining (e.g. administration) operate during standard business hours.

The headings of the West Mains is being developed by the continuous miners at a potential rate of approximately 120m per week, with the gate road headings developed at a rate of approximately 240-280m per week. It takes approximately 6 weeks to install the longwall unit or move the longwall unit from one panel to the next. With a nameplate capacity of 5,000tph, the longwall mining rate is forecast to be approximately 190,000 tonnes per week. The maximum annual mining rate would not exceed 11Mt.

Anticipated and actual start and completion dates are summarised in Table 3, dependent on relevant mining constraints and status of subordinate approvals.

Table 3: Proposed Mining Schedule (Secondary Extraction)

Longwall Panel	Start Date	Duration	Completion Date
107	April 2017	11 Months	February 2018
108	March 2018	13 Months	March 2019
109	April 2019	16 Months	July 2020
110	August 2020	15 Months	October 2021

3.5 Stability of Underground Workings

Narrabri Mine commissioned the following initial assessments of roadway support requirements, pillar sizes etc:

- Estimated Roof and Rib Support Requirements during Roadway Development and Longwall Retreat (Strata Engineering, 2009); and
- Geotechnical Review of Roadway Support and Caving Conditions at Narrabri No. 1 Mine (SCT Operations Pty Ltd, 2010).

These reports note that horizontal stress directions over the mine area occur predominantly in the NE-SW direction. The longwall layout is such that the roadways are driven at approximately 40-60 degrees to the maximum horizontal stress field. Therefore their stability will be largely controlled by the magnitude of the maximum horizontal stress (SCT, 2010).

SCT assessed the stability of roadways by developing a computer model of the strata section and simulating the behaviour under a range of stresses anticipated to occur during longwall retreat. The analysis indicates that the horizontal stress level at which deformation of the roof strata will start to occur (therefore requiring secondary reinforcement) is 6.5MPa.

This is anticipated to occur at approximately 300m depth in development drivage (possibly shallower depths about structured zones). Rib deformation is likely to be initiated at a depth of 250m for normal ground conditions with rib slabbing possibly under shallower depths (particularly around structured zones). Floor deformation is likely to initiate between 200 and 250m depth under the upper range of the stress field.

SCT also considered the roadway stability during longwall extraction of both LW101 and LW102, noting that:

- Roof displacement initiates approximately 20-30m outbye of the face and increased to be greater than 80mm at the faceline;
- Floor deformation initiates at approximately 40m outbye of the face; and
- Rib yield initiates approximately 20-30m ahead of the faceline.

Recommendations of SCT's analysis include cabling or standing support to support the roof in Tailgate 1 which will be subject to concentration of the NE-SW major horizontal stress.

Details on the proposed support requirements are provided in SCT's report (2010).

The impact of gas drainage on the stability of the workings was also considered by SCT. They noted that gas drainage prior to extraction will generally assist roof stability, but will not provide any significant impact on the floor and rib stability.

Pillar strength estimates by SCT for the Hoskissons Seam are based on a combination of empirical formulae and computer modelling. Pillar dimensions and gateroads have been designed based on maintaining a factor of safety at the tailgate of at least 1.3. Minimum factor of safety on the main pillar widths are in excess of 2.43, based on the smallest pillar and exceed 3.05 for the large pillars.

As the mine progresses updated reports will be commissioned to meet the mining geological conditions.

3.6 Future Mining

Following completion of LW107 – LW110, extraction will progress to LW111, with subsequent longwalls being mined in sequential numerical order: LW111 through LW120. It is intended that longwalls will be extracted sequentially along the northern side of the main headings working inbye then along the southern side of the main headings working outbye.

Subsequent Extraction Plans will be prepared for groups of longwall panels based on mine forecasting information that will become available in the future as operations progress.

3.7 Resource Recovery

The mining layout has been optimised to achieve maximum resource recovery within the lease boundary, based on the geological constraints discovered to date and the proposed extraction method (longwall). Expected resource recovery from LW107 – LW110 is shown in Table 4.

Table 4: Reserves and Resource Recovery

LW Panel	*Insitu* Tonnes (Including Roof Coal)	Recovered Coal	Recovery
	Tonnes	Tonnes	%
107	19,171,144	7,700,044	40.2
108	23,074,294	9,563,129	41.4
109	24,141,172	10,047,703	41.6
110	26,016,250	10,668,751	41.0

As a result of proposed mining, there will be some subsidence impacts on the overlying strata. However, the overlying strata contain no currently identified viable coal seams within the geographical and depositional constraints of the deposit. Within the Hoskissons Seam, the top 4m of the seam generally contain bedded tuffaceous bands that significantly reduce the quality of this upper resource. The proposed mining layout provides for the best resource recovery for LW107 – LW110 utilising proven conventional longwall mining techniques, however it is noted that the operation will not recover the lower quality roof coal within the Hoskissons Seam.

Stress related impacts will occur with the overburden however there are no overlying seams that will be impacted. Some stress may occur to the floor immediately below the extraction areas however this will not impact on the viability of any underlying seams.

3.8 Justification

The mine plan (Plan 1) has been developed based on extensive drilling, groundwater modelling, environmental investigation and assessment and consultation with relevant authorities, as described in the EA. Longwall boundaries are primarily constrained by the geology and characteristics of the Hoskissons Seam, and the mine plan has been developed to maximise resource recovery and allow for a high production longwall operation.

The subsidence monitoring program contained within the Extraction Plan summarises the overall monitoring of mining impacts on the natural and built environments, with management actions detailed in the relevant environmental management plan(s) or Built Features Management Plan (refer to Plan 2).

Further detailed information and project justification for the NCOPL operation is provided in the Environmental Assessment for the Narrabri Coal Mine Stage 2 Longwall Project (R.W. Corkery & CO. Pty Ltd., 2009) and the Environmental Assessment for the Narrabri Mine increased longwall width and production rates (Resource Strategies, 2015). The proposed monitoring and management of subsidence impacts associated with secondary extraction, in order to minimise impacts to surface features at the Narrabri Mine is documented in the Extraction Plan and associated sub-plans.

4 REFERENCES

Department of Mineral Resources (2003) Guideline for Applications for Subsidence Management Approvals (EDG17).

Ditton Geotechnical Services (DGS) (July 2011) Mine Subsidence Effect Predictions and Impact Assessment for the Proposed Longwalls 1 to 5 at the Narrabri Coal Mine, Narrabri.

Ditton Geotechnical Services (DGS) (2017) Mine Subsidence Assessment for the Proposed LW107 to LW110 Extraction Plan at the Narrabri Mine

Resource Strategies (2015) Narrabri Mine Modification 5 Environmental Assessment

RW Corkery & Co. Pty Ltd (November 2009) Environmental Assessment for the Narrabri Coal Mine Stage 2 Longwall Project, Project Application No:MP08_0144.

SCT Operations Pty Ltd (2010) Geotechnical Review of Roadway Support and Caving Conditions at Narrabri No. 1 Mine.

Strata Engineering (2009) Estimated Roof and Rib Support Requirements during Roadway Development and Longwall Retreat.