

# **Appendix L**

## **Coal Resources Recovery Plan**

# **DONALDSON COAL PTY LIMITED**

## **ABEL MINE**

### **Appendix L**

## **Coal Resource and Recovery Plan**

### **EP / SMP Area 4**

**May 2014**

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## Document Control

### Description

<b>Document No.</b>	Abel EP / SMP Area 4
<b>Title</b>	Coal Resources and Recovery Plan
<b>General Description</b>	This Coal Resource Recovery Plan has been prepared to demonstrate effective recovery of available resource obtained through underground mining activities at Abel Mine.
<b>Key Support Documents</b>	Abel Mine EP / SMP Area 4

### Approvals

<b>ORIGINATOR</b>	Matt Wright	Position Registered Mine Surveyor	Signed	Date
<b>REVIEWED</b>	John Krick	Position Geotechnical Engineer	Signed	Date
<b>APPROVED</b>	Tony Sutherland	Position Technical Services Manager	Signed	Date

### Revisions

Version #	Date	Description	By	Checked	Approved	
					Name	Signed
1	May 2014					

The nominated Coordinator for this document is	Technical Services Manager
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## 1 INTRODUCTION

Donaldson Coal Pty Ltd (Donaldson) a subsidiary of Yancoal Australia Pty Limited (Yancoal), operates Abel Mine, an underground coal mine located approximately 23 kilometres north-west of Newcastle in the Newcastle Coalfield of New South Wales. Abel Mine has successfully undertaken pillar extraction mining using the Bord and Pillar system within the Upper Donaldson seam since 2010 in Abel's SMP Areas 1, 2 and 3.

Project Approval 05\_0136 (Development Consent) for the mine was granted by the Department of Planning on 7 June 2007. Mining (first workings and pillar extraction, subject to an SMP approval) is presently approved under the Project Approval, Mining Operations Plan and lease conditions to take place within Mining Lease ML 1618. Project Approval 05-0136 was modified (MOD 3) under delegated authority of the Minister for Planning and Infrastructure on 4 December 2013 to allow the method of extraction to include shortwall and longwall as well as bord and pillar extraction methods in the Upper and Lower Donaldson Seams and an increase in ROM coal extraction at Abel Mine.

Abel Mine commenced coal production in May 2008. The Mine currently employs approximately 360 personnel (including contractors) and current produces approximately 2.5 million ROM tonnes per annum (tpa), with a proposed maximum production of 6.1 million tonnes of thermal / soft coking coal from the Upper and Lower Donaldson coal seams. Abel's production is railed to Newcastle for the export market.

### 1.1 SCOPE & OBJECTIVE

The objective of this Coal Resource Recovery Plan (CRRP) has been prepared to demonstrate the effective recovery of the available resource in Panels 27 to 35 within the Upper Donaldson Seam at Abel Mine using bord and pillar techniques. See **Figure 1**.

This Coal Resource Recovery Plan has been prepared in accordance with Condition 4 of Schedule 3 of the Project Approval (PA05\_0136 (MOD 3) as a component of the Abel Mine EP / SMP Area 4 Panels 27 to 35. This plan has also been prepared to meet (in part) the conditions of the Abel Mining Lease with regards to the preparation and approval of a Subsidence Management Plan (SMP).

Therefore, this report provided a description of the:

- Coal resources available within the Area 4
- Proposed Mining Method, Schedule and mine plan
- Resource recovery and effects on future mining and
- Justification for the mine plan

**Plans 1 – 6** and the **Approved Plan** (included in **Appendix A**) provide supporting information and provide details coal resource, existing and proposed workings, and impacted surface features. The plans have been prepared in accordance with the Division of Resources and Energy (DRE) Guideline for Application for Subsidence Management Approvals (Department of Mineral Resources, 2003

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## 2 RESOURCE DESCRIPTION

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### 2.1 SITE CONDITIONS

The Abel Underground Mine lies in the Newcastle Coalfield, within the Northern Sydney Basin. Donaldson Coal is proposing to extract Panels 27 – 35 in the EP / SMP Area 4 using bord and pillar total extraction methods within the Upper Donaldson Seam. The Extraction Plan area is bounded by the depth of cover and the mining lease to the North, the previously approved SMP Area 3 to the East and by resource thickness / quality of the Upper Donaldson seam to the South.

### 2.2 OVER BURDEN STRATIGRAPHY

The EP / SMP Area lies in the Newcastle Coalfield, within the Northern Sydney Basin. A typical stratigraphic section of the Newcastle Coalfield (after Ives et al, 1999, Moelle and Dean-Jones, 1995, Loehe and Dean-Jones, 1995, Loehe and Allan, 1995) is shown in **Table 1**, (*below*). The strata shown in this table were laid down between the Early Permian and the Middle Triassic Periods.

The panels are proposed to be extracted in the Upper Donaldson Seam, which is located within the Permian Tomago Coal Measures. The overburden comprises of frequently interbedded sandstone, shale, carbonaceous mudstone, tuffaceous claystone and coal. The overlying Waratah Sandstone separates the Tomago Coal and the Newcastle Coal Measures.

The available boreholes indicate that the strata layers are frequently bedded having thickness up to approximately 10 metres. There were no massive sandstone or conglomerate units identified from this information.

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**Table 1 Stratigraphy of the Newcastle Coalfield**

Stratigraphy			Lithology
Group	Formation	Coal Seams	
Narrabeen Group	Clifton		Sandstone, siltstone, mudstone, claystone
Newcastle Coal Measures	Moon Island Beach	Vales Point Wallarah Great Northern	Sandstone, shale, conglomerate, claystone, coal
		Awaba Tuff	Tuff, tuffaceous sandstone, tuffaceous siltstone, claystone, chert
	Boolaroo	Fassifern Upper Pilot Lower Pilot Hartley Hill	Conglomerate, sandstone, shale, claystone, coal
		Warners Bay Tuff	Tuff, tuffaceous sandstone, tuffaceous siltstone, claystone, chert
	Adamstown	Australasian Montrose Wave Hill Fern Valley Victoria Tunnel	Conglomerate, sandstone, shale, claystone, coal
		Nobbys Tuff	Tuff, tuffaceous sandstone, tuffaceous siltstone, claystone chert
	Lambton	Nobbys Dudley Yard Borehole	Sandstone, shale, minor conglomerate, claystone, coal
		Waratah Sandstone	Sandstone
Tomago Coal Measures	Dempsey		Shale, siltstone, fine sandstone, coal, and minor tuffaceous claystone
	Four Mile Creek	Upper Donaldson Lower Donaldson	
	Wallis Creek		
Maitland Group		Mulbring Siltstone	Siltstone
		Muree Sandstone	Sandstone
	Branxton		Sandstone, and siltstone
Greta Coal Measures	Paxton	Pelton	Sandstone, conglomerate, and coal
	Kitchener	Greta	
	Kurri Kurri	Homeville	
		Neath Sandstone	Sandstone
Dalwood Group	Farley		Shale, siltstone, lithic sandstone, conglomerate, minor marl and coal, and interbedded basalts, volcanic breccia, and tuffs
	Rutherford		
	Allandale		
	Lochinvar		
Seaham Formation			

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## 2.3 LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS (IMMEDIATE ROOF STRATA)

The immediate roof of the Upper Donaldson seam within the EP / SMP Area is comprised primarily of shales interbedded with sandstones. The UCS of shale units typically range from 15 – 30MPa while sandstone units typically range from 30 -80MPa. Mining experience at Abel Mine has shown that, distal to geologically disturbed ground, the roof tends to be competent except at low depths of cover, where confining stresses in the roof are reduced.

## 2.4 LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS (IMMEDIATE FLOOR STRATA)

The near seam floor strata of the Upper Donaldson seam within the EP / SMP area is generally comprised of carbonaceous shale, siltstones and sandstones which form the interburden between the Upper and Lower Donaldson seams. Floor strength ranges from carbonaceous shale (approximate UCS of 10MPa) to sideritic sandstone (approximate UCS of >80MPa). Floor condition is expected to be poor in areas where the seams converge and to improve where the seams become distal to one another.

## 2.5 EXISTENCE AND CHARACTERISTICS OF GEOLOGICAL STRUCTURE

A North-South oriented dyke crosses the Southern part of the proposed Panel 34 and is located immediately to the West of the proposed Panel 32. A second dyke also crosses the Southern end of the proposed Panel 32 and immediately to the west of the historic workings in the overlying Borehole Seam. The two dykes are expected to be sub-vertical and approximately 10m thick. Testing of previously encountered dykes in the area has defined them as being comprised of teschenite. Previous experience has shown them to be generally weak when weathered and quite strong when encountered at depth.

A series of NNE – SSW trending faults is located at the Northern end of the proposed Panel 27. The largest of these faults has a throw of up to 0.6 metres with a sub-vertical dip. The proposed panels are supercritical in this location and, therefore, are predicted to achieve the maximum subsidence for single-seam mining conditions. The presence of these faults, therefore, is unlikely to affect the subsidence predictions and, hence, impact assessments.

The geological features, projected at seam level, are shown in **SMP Plan 3**.

## 2.6 STABILITY OF UNDERGROUND WORKINGS

The proposed pillars in the application area are designed to provide stable underground workings for the period of development and subsequent extraction. As such, pillars are designed with an appropriate Factor of Safety and width to height ratio for their purpose. Barrier pillars have been designed to a Factor of Safety in excess of 2.11 (less than 1 in 1 million chance of failure) and a width to height ratio of greater than 5.

The barriers between the extracted pillar panels will generally have widths of between 25m and 35m and be 450m to 1,100m long. The pillar height will range from 2.0m to 3.2m, depending on the seam thickness. The inter-panel barrier will have w/h ratios ranging from 7.6 to 15.8. These pillars are expected to yield gradually and behave elastically (strain-harden if the unlikely scenario of overloading occurs).

A solid barrier between the finishing ends of Panels 27 to 35 and the adjacent West Mains Headings will be from 19.5m to 35.5m wide (with pillar width/height ratios of 8.1 to 10.4) and are also expected to behave elastically in the long term.

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Detail on predicted subsidence impacts, the associated method of prediction and relevant subsidence parameters can be found in the Extraction Plan main report.

Subsidence control zones (SCZ's) have been established around each principal residence, based on 26.5 degree angle of draw lines to protect the dwellings from subsidence impacts. These principal residences are predicted to experience less than 20mm of vertical subsidence and it is unlikely, that the principal residences would be adversely impacted even if the predictions were exceeded by a factor of 2 times.

Accompanying the designed mining layout is a monitoring program whose objective is to monitor roadways, pillars and panel performance, to ensure the adequacy of the design. The monitoring program comprises a combination of tell-tales, borescopes, and visual inspections. Monitoring is conducted during development and secondary extraction and following the completion of mining where possible.

### 3 MINING SYSTEM AND RESOURCE RECOVERY

#### 3.1 MINING GEOMETRY

The layouts of the proposed Panels 27 to 35 within the Upper Donaldson Seam are shown in the **Approved Plan**. A summary of the proposed dimensions of these panels is provided in Table 2.

**Table 2 Geometry of the Proposed Panels 27 to 35**

Panel	Overall Void Length Including First Workings (m)	Overall Void Width Including First Workings (m)	Solid Barrier Pillar Width (m)
Panel 27	1,110	190	27
Panel 28	1,110	170	26
Panel 29	450	180	-
Panel 30	1,110	170	35
Panel 31	540	170	25
Panel 32	1,050	170 / 230	35
Panel 33	600	170	25
Panel 34	630	170	35
Panel 35	630	170	25

It is noted, that secondary extraction will not be undertaken within the *Subsidence Control Zones* (SCZs) around each of the principal residences (i.e. houses). The SCZs have been based on 26.5 degree angle of draw lines around the perimeters of the principal residences.

There are historical workings in the Borehole Seam which are partially located above the Southern end of Panel 32. The record tracings indicate that the majority of the pillars in this area have been extract

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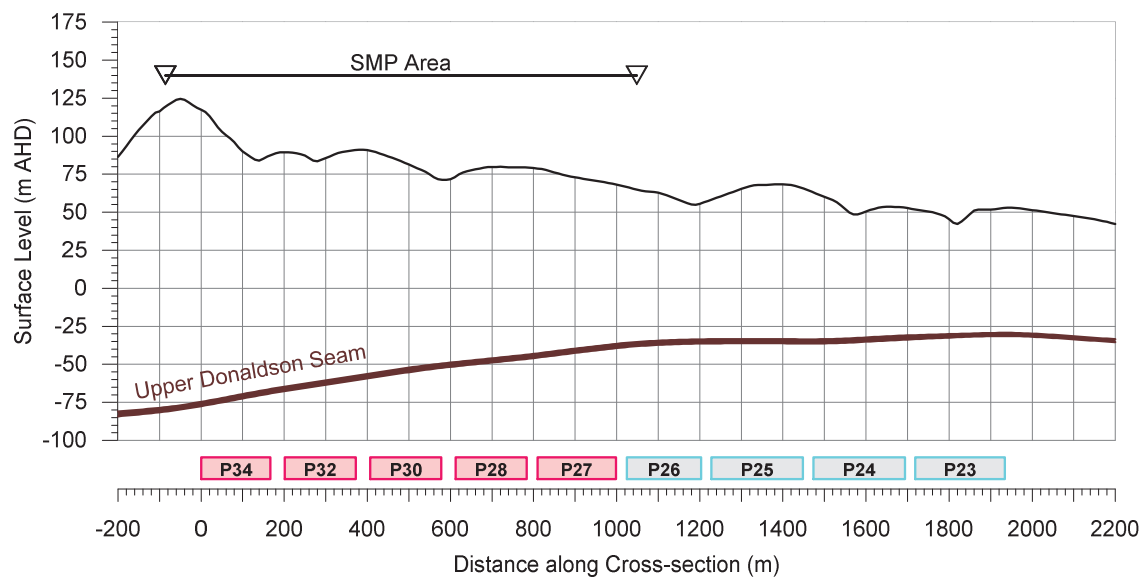
### 3.2 DEPTH OF COVER

The depths of cover directly above the proposed Panels 27 to 35 vary between a minimum of 50 metres above the northern end of the proposed Panel 29, and a maximum of 280 metres above the southern end of the proposed Panel 34.

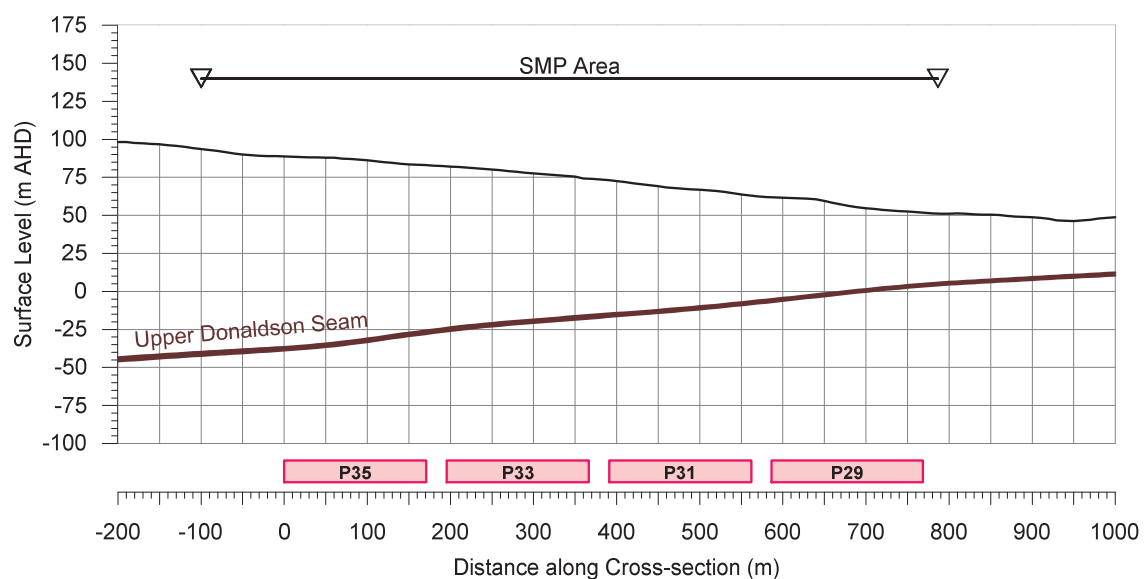
The seam floor falls from the north-east to the south-west within the proposed mining area. The grade of the seam within the extents of the proposed panels is approximately 7 % (i.e. 1 in 14).

The variations in the surface and seam levels across the mining area are illustrated along Cross-sections 1 and 2 in

**Figure 2** and **Figure 3**, respectively.



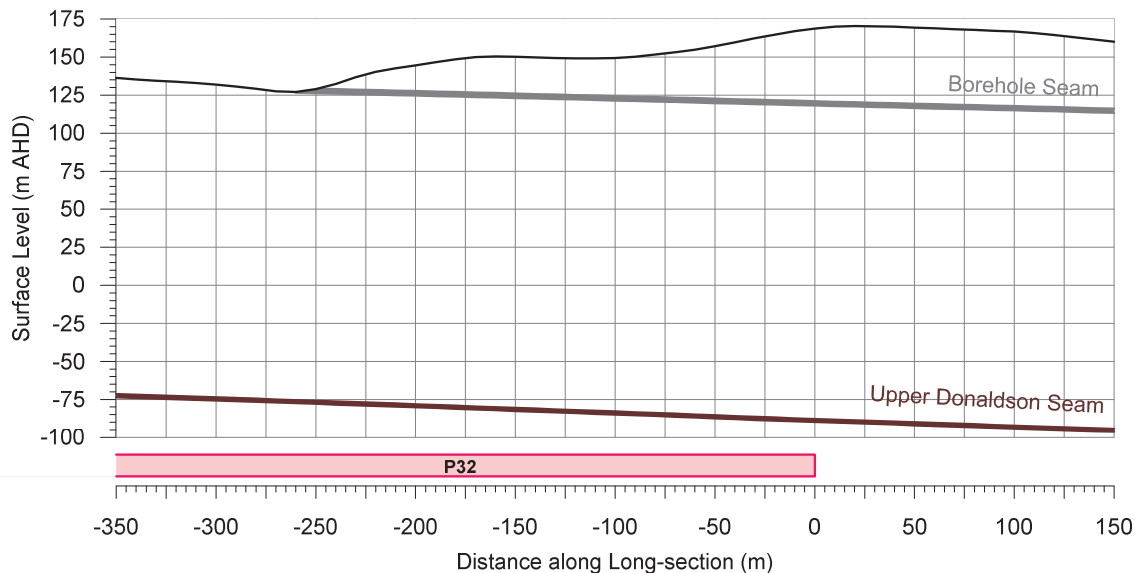
**Figure 2** Surface and Seam Levels along Cross-section 1 (MSEC report)



**Figure 3** Surface and Seam Levels along Cross-section 2 (MSEC Report)

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There are historical workings in the Borehole Seam which are partially located above the southern end of Panel 32. The record tracings indicate that the majority of the pillars in this area have been extracted. The surface and seam levels along Long-section 1, taken through the southern end of Panel 32, are illustrated in **Figure 4**.



**Figure 4 Surface and Seam Levels along Long-section 1 (MSEC Report)**

It can be seen in the above figure, that the Borehole Seam outcrops above the proposed Panel 32.

### 3.3 MINING METHOD

Abel will use the bord and pillar method of mining with pillar extraction as the secondary working method in the Upper Donaldson seam within the application area.

The Upper Donaldson coal seam within the application area of the Abel lease ranges from 1.4 to 3.4 metres in thickness. Abel currently mines up to 2.8m of the coal seam. The seam dips generally 1 in 14 towards the south west within the application area. Pillar extraction will take place generally in a south to north / north to south direction towards the West Mains Headings.

Secondary extraction panel pillars are designed to exceed one tenth the overburden depth while long term mains development pillars (located outside the current application area) are designed to be long term stable and hence not cause subsidence, thus rendering the roads serviceable for the life of the mine.

Development roads will nominally be driven at a width of up to 5.5 metres using single and dual pass continuous miners. The secondary extraction panel pillars will typically be developed within a range of 45 to 120.5 metre centres and are proposed to be in the order of 24.5 metres wide (rib to rib).

The purpose of the development is to form pillars suitable to be extracted on the retreat.

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### 3.4 SCHEDULE

The mining schedule plan for the SMP application area is shown on **Figure 5**. Pillar extraction will generally progress in a direction towards the West Mains Headings in each Panel. Development rates are budgeted from 18 to 25 metres per continuous miner shift dependent on geological conditions and support regime. Pillar extraction will typically produce in the order of 1,000 tonnes per shift.

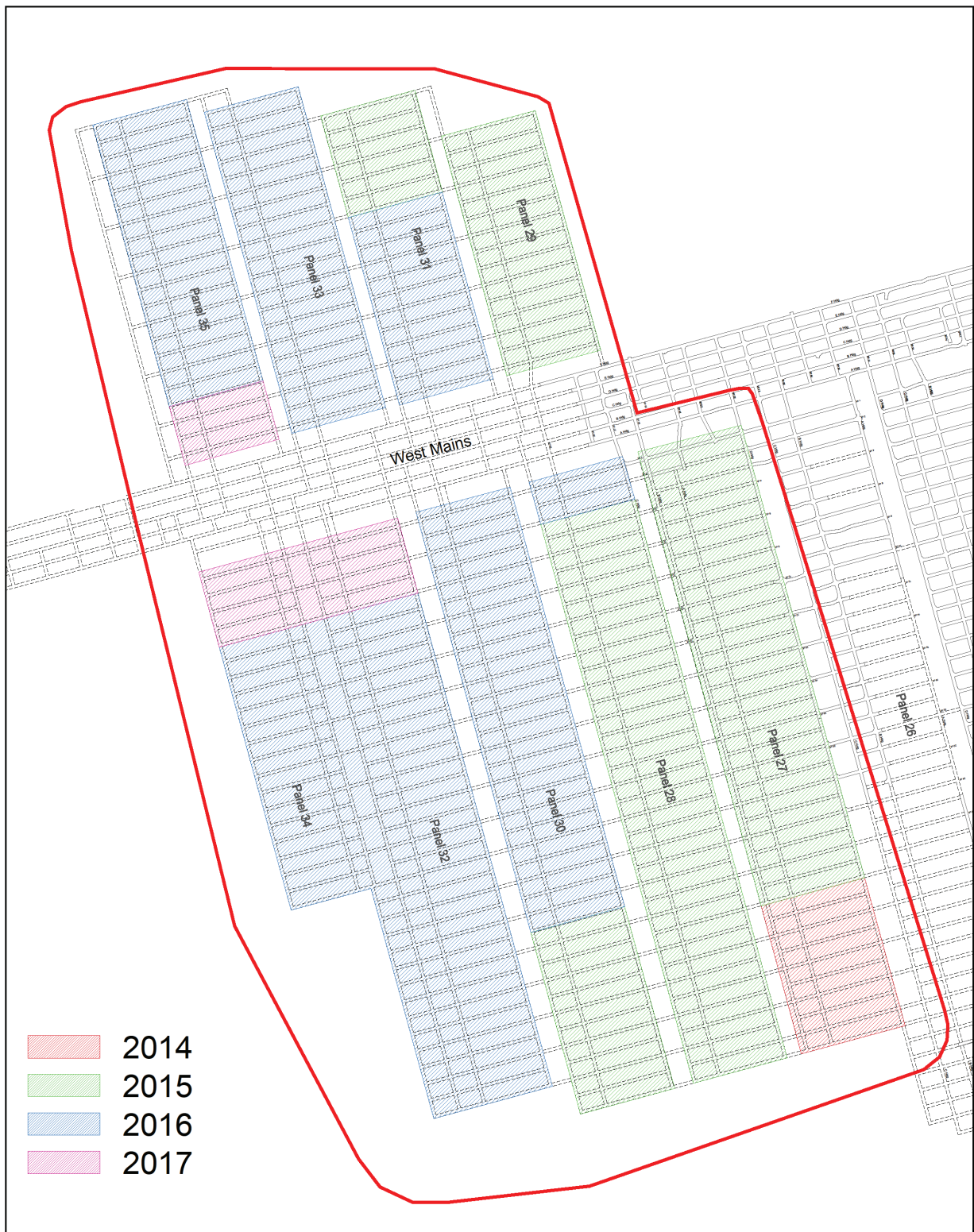
Normally operations are carried out 24 hours per day seven days per week. Generally maintenance operations (e.g. stonedusting, roadway maintenance etc) are undertaken on Sundays.

The anticipated start and completion dates are summarised in **Table 3**,

**Table 3 Panel Extraction Rate and Sequence**

Panel	Start Date	End Date	Estimate Duration (Days)
Panel 27	September 2014	August 2015	335
Panel 28	April 2015	January 2016	260
Panel 29	July 2015	October 2015	120
Panel 30	September 2015	June 2016	280
Panel 31	November 2015	April 2016	155
Panel 32	March 2016	June 2017	450
Panel 33	January 2016	June 2016	165
Panel 34	October 2016	June 2017	245
Panel 35	August 2016	February 2017	240

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**Figure 5 – Mining Schedule**

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### 3.5 FUTURE MINING

Exploration drilling has encountered seams below the Upper Donaldson seam in the EP / SMP area, including the Lower Donaldson and Ashtonfield seams. Other thin seams (0.5 to 1.0 metres) exist above the Upper Donaldson, however these seams are not considered economically mineable by underground methods.

The Lower Donaldson is positioned only a few metres below the Upper Donaldson and is effectively sterilised in this application area, while the Ashtonfield seam is non-economic in the application area.

There are no future plans for mining these other seams in the EP / SMP application area due to the currently non-economic nature of these seams.

### 3.6 RESOURCE RECOVERY

The method of extraction selected allows for maximum resource recovery whilst providing enhanced safety for the workforce. The layout and method also provide an extraction layout which provides flexibility in extraction, allowing areas to be left for support of sensitive surface features thus limiting surface subsidence effects where appropriate. Subsidence effects are dependent on extraction thickness and width, depth of cover and strata conditions. There are no significant environmental impacts that preclude pillar extraction within the current EP / SMP application area.

In the initial planning of the area an option study was conducted whereby a number of alternative mine plans were considered having regard to the lease boundaries, exploration geological data and initial environmental assessment details. The plan and layout have been continually reassessed and reviewed as additional exploration, geological, environmental and subsidence monitoring data from SMP Areas 1, 2 and 3 have become available.

The resultant mine plan provides for optimum resource recovery within the bounds created by geological and surface constraints. It is considered to be a layout which will result in subsidence being minimised in sensitive areas while allowing total extraction and resultant subsidence to be completed in accordance with the Project Approval conditions.

The estimated recovery of the resource for the Application Area is provided in **Table 4**.

**Table 4 Extraction Plan Area Estimated Resource Recovery**

Total tonnes of coal (Resource within extraction area)	7.6Mt (based on angle of draw)
Total tonnes extracted through development	1.4Mt
Tonnes extracted by pillar extraction	3.06Mt
Percentage recovery	59%

Particulars relating to each Panel is given in **Table 5**.

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**Table 5 Estimated Individual Panel Tonnages**

Panel	Panel Length (m)	Panel Width (void m)	Panel Development Tonnes (t)	Panel Extraction Tonnes (t)
Panel 27	1110	190	222, 438	536, 545
Panel 28	1110	170	197, 410	415, 469
Panel 29	450	180	93, 659	207, 969
Panel 30	1110	170	197, 584	431, 639
Panel 31	540	170	191, 796	243, 488
Panel 32	1050	170/230	216, 308	453, 641
Panel 33	600	170	117, 583	276, 549
Panel 34	630	170	36, 966	158, 611
Panel 35	630	170	118, 381	334, 743

### 3.7 JUSTIFICATION

The layout, as indicated on the **Approved Plan (Appendix A)**, has been developed based on extensive drilling, groundwater modelling, environmental investigation and assessment and consultation with relevant authorities.

The layout and method also provide an extraction layout which provides flexibility in extraction, allowing areas to be left for support of sensitive surface features thus limiting surface subsidence effects where appropriate. There are no significant environmental impacts that preclude pillar extraction within the current EP / SMP application area.

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.

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## 4 REFERENCES

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Department of Mineral Resources (2003) **Guidelines for Application for Subsidence Management Approvals** (EDG17)

MSEC, 2014, Abel Underground Mine: EP / SMP Are 4 – Proposed Panels 27 to 35, ***Subsidence Predictions and Impact Assessments for the Natural and Built Features in Support of the EP / SMP Application***, Report No. MSEC676

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