# ABEL MINE

## AREA 1

## SUBSIDENCE MANAGEMENT PLAN APPLICATION

## WRITTEN REPORT

## December 2009

VOLUME 1

Appendix A Subsidence Predictions and Impact Assessment for the Proposed Pillar Extraction Panels at Abel Mine, Black Hill – DGS Report No ABL – 001/1 – December 2009- Ditton Geotechnical Services Pty Ltd

Appendix B Surface Water Assessment & Outline Water Management Plan – Evans & Peck

Appendix C Abel Coal Project Groundwater Assessment – Peter Dundon and Associates Pty Ltd

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# 1 LETTER OF APPLICATION

8 December 2009

Director Environment Sustainability
Industry & Investment NSW – Minerals and Energy
P O Box 344
**HUNTER REGION MAIL CENTRE NSW 2310**

**Attention: Mr Jonathon Smith**

Dear Sir,

**Subsidence Management Plan Application for Pillar Extraction from Area 1 at Abel Mine**

Abel Mine is an underground coal mine located approximately 23 km north-west of Newcastle in the Newcastle Coalfield of New South Wales.

In accordance with the *Guideline for Applications for Subsidence Management Approvals* dated December 2003 (SMP Guideline 2003) application is hereby made for approval to extract coal, in an area held under Mining Lease ML 1618 (Act 1992), by an underground mining method in the Upper Donaldson seam, which may potentially lead to subsidence of the land surface. The SMP application area is shown on the Subsidence Management Plan Approved Plan.

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.

The purpose of this application is to gain approval for mining of coal from the Upper Donaldson seam using pillar extraction mining methods. Extraction within this area is scheduled to commence in June 2010 however development of the panels is scheduled to commence during November 2009. This application area includes mining from pillar extraction panels Panel 1 to Panel 13 inclusive, plus one main heading development panel (East Mains) which will be extracted on retreat as shown on the attached SMP plans.

This application consists of a number of components detailed on the following pages.

If you require any further information or have any queries please do not hesitate to contact the undersigned.

Yours faithfully,

Tony Sutherland
**Technical Services Manager- Underground Operations**
**Donaldson Coal**
**Abel Mine**

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## Distribution list

Mr Jonathon Smith
Subsidence Executive Officer
**INDUSTRY & INVESTMENT NSW – MINERALS & ENERGY** – PO Box 344, HUNTER REGION MAIL CENTRE NSW 2310

Mr Greg Cole-Clark
Chief Executive Officer, Chair Inter Agency Committee
**MINE SUBSIDENCE BOARD** – PO Box 488G, NEWCASTLE NSW 2300

Mr Ian Landon-Jones
Executive Director Dam Safety
**SYDNEY CATCHMENT AUTHORITY** – PO Box 323, PENRITH NSW 2750

Mr Scott Carter
Senior Conservation Manager
**INDUSTRY & INVESTMENT NSW – FISHERIES** –Port Stephens Fisheries Centre, Private Bag 1, NELSON BAY NSW 2315

Mr David Hilyard
Project Officer,
Mining Regulation
**NSW DAMS SAFETY COMMITTEE** – PO Box 3720, PARRAMATTA NSW 2124

Mr Howard Reed
Manager- Mining and Extractive Industries
Major Development Assessments
**DEPARTMENT OF PLANNING** – GPO Box 39, SYDNEY NSW 2001

Mr Mark Mignanelli
Manager
Major Projects and Mining Assessment
**DEPARTMENT OF ENVIRONMENT CLIMATE CHANGE & WATER - NSW Office of Water**– PO Box 2213, DANGAR NSW 2309

Mr Grahame Clarke
Hunter Regional Manager
**DEPARTMENT OF ENVIRONMENT CLIMATE CHANGE & WATER** – PO Box 488G, NEWCASTLE NSW, 2300

Mr Damien Jaeger
Senior Development Officer- City West
**NEWCASTLE CITY COUNCIL –** PO Box 489, Newcastle, 2300

Mr Rod Sandell
Senior Planning Assessment Officer
**CESSNOCK CITY COUNCIL-** PO Box 152 Cessnock NSW 2325

Mr Damien Harrigan
Projects /OHS Officer - (Diocesan Sites & Parishes)
**CATHOLIC DIOCESE OF MAITLAND-NEWCASTLE-** PO Box 756 Newcastle NSW 2300.

Mr Sean Scanlon
Business Development Manager
**CATHOLIC DIOCESE OF MAITLAND-NEWCASTLE-** PO Box 756 Newcastle NSW 2300.

Mr Geoff Rock
Project Specialist - Land Development
Coal Development Group- Rio Tinto
**BLACK HILL LAND PTY LTD-** PO Box 267 Singleton NSW 2300

Mark Hickey
Acquisitions Manager
**HUNTER WATER CORPORATION-** PO Box 5171 HRMC NSW 2310

Bruce Fraser
Mains Manager / Northern Region
**TRANSGRID-** PO Box 93 Waratah NSW 2298

Greg Skinner
Area Manager- Lower Hunter
**ENERGY AUSTRALIA-** 145 Newcastle Road, Wallsend, NSW 2287

Mr Rick Griffiths
**MINDARIBBA LOCAL ABORIGINAL LAND COUNCIL-** 1a Chelmsford Drive, Metford NSW 2300

Committee Members
**ABEL COMMUNITY CONSULTATIVE COMMITTEE**

# 2 EXECUTIVE SUMMARY

This Subsidence Management Plan (SMP) application has been prepared to seek approval for the extraction of coal by pillar extraction mining methods from the Upper Donaldson coal seam in the north east area of Abel Mine. The SMP application consists of pillar extraction panels Panel 1 to Panel 13 inclusive, plus one main headings development panel (East Mains) to be extracted on retreat as shown on the attached SMP plans. The SMP application has been prepared in accordance with the NSW Department of Mineral Resources *New Approval Process for the Management of Coal Mining Subsidence* and SMP Guideline 2003.

Abel commenced coal production in May 2008 and will progressively increase production to 4.5mtpa. The SMP application area contains 200 ha, less than 8% of the current lease area of 2755 ha.

Mining will take place in the application area under a combination of land owned by Black Hill Land Pty Limited, the Catholic Diocese of Maitland and Newcastle and a narrow strip traversing the area owned by Hunter Water Corporation. The current application seeks approval to mine coal by the pillar extraction method from the Upper Donaldson Seam at depths of cover ranging generally from 50 to 135 metres.

The layout of the panels has been designed to provide management outcomes of subsidence impacts in line with the Statement of Commitments and Project Approval and to conduct the mining operations in a responsible manner, considering the existing and future environment and the community, while optimising resource recovery in the area in accordance with the principles of ecologically sustainable development. It is proposed to conduct mining in the proposed extraction panels bounded by the lease boundary / John Renshaw Drive and cover restrictions to the north, the lease boundary / F3 Newcastle to Sydney Freeway to the east and existing and proposed main underground development workings to the south and west.

Maximum subsidence predicted for the pillar extraction panels in the application area ranges between 870 mm and 1,760 mm. Maximum predicted strains from 4 to 33 mm/m and tilts from 15 to 76 mm/m excluding areas nominated to be protected.

The SMP application area surface is a combination of native bushland, cleared grazing land previously used for poultry farms and a small section of industrial land in the north east corner of the application area. Management measures are proposed to address any predicted environmental impacts for the surface above the application area.

Natural features are generally limited to Viney Creek, a Schedule 2 stream and associated tributaries. No Threatened Ecological Communities are located within the application area and no adverse impacts are predicted for flora and fauna. Proposed management measures of natural features are listed in Table 1.

Man – made features include:

- Boral Asphalt Plant;
- Transgrid 330kV power line;
- Energy Australia (EA) 132kV power line;
- EA rural 11kV power lines;
- Optus fibre optic cable;
- Redundant Telstra copper communication cables;
- Hunter Water Corporation water pipeline;
- Scattered aboriginal artefacts;
- Disused, unoccupied residences proposed for demolition;

- Stock water supply line;
- Access roads and tracks;
- Various fences; and
- One small disused dam.

Proposed management measures of man-made features are listed in Table 2.

**Table 1- Summary of Natural Features Impact Assessment SMP Area 1**

| Feature/s | Summary of feature/s | *Proposed Management Measures* |
|---|---|---|
| Creeks/surface water features | Viney Creek – Schedule 2 | Protected by Subsidence Control Zone |
| Creeks/surface water features | Ephemeral tributaries | Monitoring and remediation through Land Management Plan |
| Groundwater | Sub surface aquifer | Monitoring through Groundwater Management Plan |
| Ecology | Flora and Fauna | Monitoring through Integrated Environmental Management Plan |

**Table 2- Summary of Man-Made Features Impact Assessment SMP Area 1**

| Feature/s | Summary of feature/s | Proposed Management Measures |
|---|---|---|
| Buildings and associated plant | Boral BlackHill asphalt plant | Protected by Subsidence Control Zone |
| Electrical services, easements and towers | Transgrid 330kV power line | Tension tower protected by Subsidence Control Zone. Management actions and Plan being developed in consultation with Transgrid |
| Electrical services, easements and towers | EA 132kV power line | Management actions and Plan being developed in consultation with Energy Australia |
| Electrical services, easements and towers | EA rural 11kV power line | Management actions and Plan being developed in consultation with Energy Australia |
| Telecommunication cables | Optus fibre optic cable | Continuing consultation with Optus on options, including Management Plan. |
| Telecommunication cables | Telstra copper cables | Continuing consultation with Telstra. |
| Water pipelines and services | Hunter Water Corporation pipe line | Continuing consultation with HWC on options, including Management Plan. |
| Water pipelines and services | Stock water supply line | Continuing consultation with Catholic Diocese on options, including Management Plan. |
| Aboriginal heritage sites | Scatters only | Scatters not located in area to be impacted by subsidence. No |

| Feature/s | Summary of feature/s | Proposed Management Measures |
|---|---|---|
| | | further action required. |
| Residences | Disused, unoccupied | Not part of any development application at time of Project approval |
| General surface | Mixture of natural bushland and grazing land | Continuing consultation with Catholic Diocese and Black Hill Land on Management Plan. |
| Roads, tracks | Various sealed and unsealed – private | Continuing consultation with Catholic Diocese and Black Hill Land on Management Plan. |
| Fences | Various types | Continuing consultation with Catholic Diocese and Black Hill Land on Management Plan. |
| Dams | One small disused dam only | Not in use. Adjacent to Transgrid Tower T31B |

A subsidence monitoring program for the panels will be developed and implemented in consultation with the Principal Subsidence Engineer – DII (Mineral Resources).

A risk assessment, in which these predicted subsidence values were used, was conducted on 2 July 2009 to identify, assess and evaluate potential subsidence impacts to surface and sub-surface as a result of mining these future panels. The potential impact arising from maximum theoretical subsidence was also considered. The risk assessment concluded that any impacts were likely to be manageable. No high risk issues were identified, generally attributable to the mine design. Some agreed further actions were developed, that have either been established or are planned.

The risk assessment took account of matters raised during the community consultation process, which was conducted in June 2009. In particular, matters relating to groundwater, watercourses, Threatened and Protected Species and infrastructure were considered.

Community consultation during the preparation of the SMP application was undertaken in accordance with the Department of Mineral Resources *Guideline for Applications for Subsidence Management Approvals* and the *NSW Minerals Council Community Engagement Handbook Towards Stronger Community Relationships*.

A presentation was made to Department of Primary Industries – Mineral Resources (DPI – MR) on 26 May 2009 followed by a site inspection and presentation to identified potential stakeholders on 24 June 2009. Advertisements were placed in regional and State newspapers on 4 July 2009 to notify the community of Abel's intent to submit a SMP application. No submissions were received following this community consultation. Since this consultation the application area has been substantially reduced within the initial footprint due to a review of the proposed mine layout.

Continuing consultation has been carried out with the infrastructure owners, relating to potential impacts to the infrastructure, the management of these impacts by suitable mine plan design, remediation / mitigation and development of appropriate Management Plans. Similarly, consultation with the landholders has consisted of further presentation of mine design, information on subsidence and potential impacts with discussions continuing to develop an agreed Land / Property Management Plan to manage / mitigate / remediate any impacts.

Updates on the SMP development have also been presented to the Abel Community Consultative Committee at meetings held on 30 March, 29 June and 28 September 2009.

# 3 INTRODUCTION

## 3.1 BACKGROUND

Abel Mine is an underground coal mine operated by Donaldson Coal Pty Limited. The mine access, entries and primary surface facilities are located approximately 23 km north-west of Newcastle on John Renshaw Drive. The SMP application area is located approximately 0.8 km *North)* of Black Hill School with the mine entries within the former mining area of Donaldson Open Cut (See **Figure 1**).

The mine access, associated facilities and SMP area are located in the Hunter River Catchment.

Abel commenced operations in May 2008. The mine currently employs 132 personnel and currently produces approximately 0.52 million tonnes per annum (tpa), with a proposed maximum production of 4.5 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. Abel currently operates under a number of approvals relevant to this SMP, including:

- Project Approval (Development Consent) 05_0136 granted 7 June 2007;
- Mining Lease ML 1618;
- Abel Mine Mining Operations Plan accepted December 2008; and
- Environmental Protection Licence 12856 under the Protection of the Environment Operations Act 1997.

The key features of the Project Approval (Development Consent) 05_0136 for the mine include:

- Construction and operation of an underground coal mine.

**Obligations to Minimise Harm to the Environment**

1. The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

**Terms of Approval**

2. The Proponent shall carry out the project generally in accordance with the:
    a) EA;
    b) Statement of Commitments; and
    c) Conditions of this approval.
3. If there is any inconsistency between the above documents, the later document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.
4. The Proponent shall comply with any reasonable and feasible requirements of the Director-General arising from the Department's assessment of:
    (a) any reports, plans or correspondence that may be submitted in accordance with the conditions of this approval; and
    (b) the implementation of any actions or measures contained in these reports, plans or correspondence.

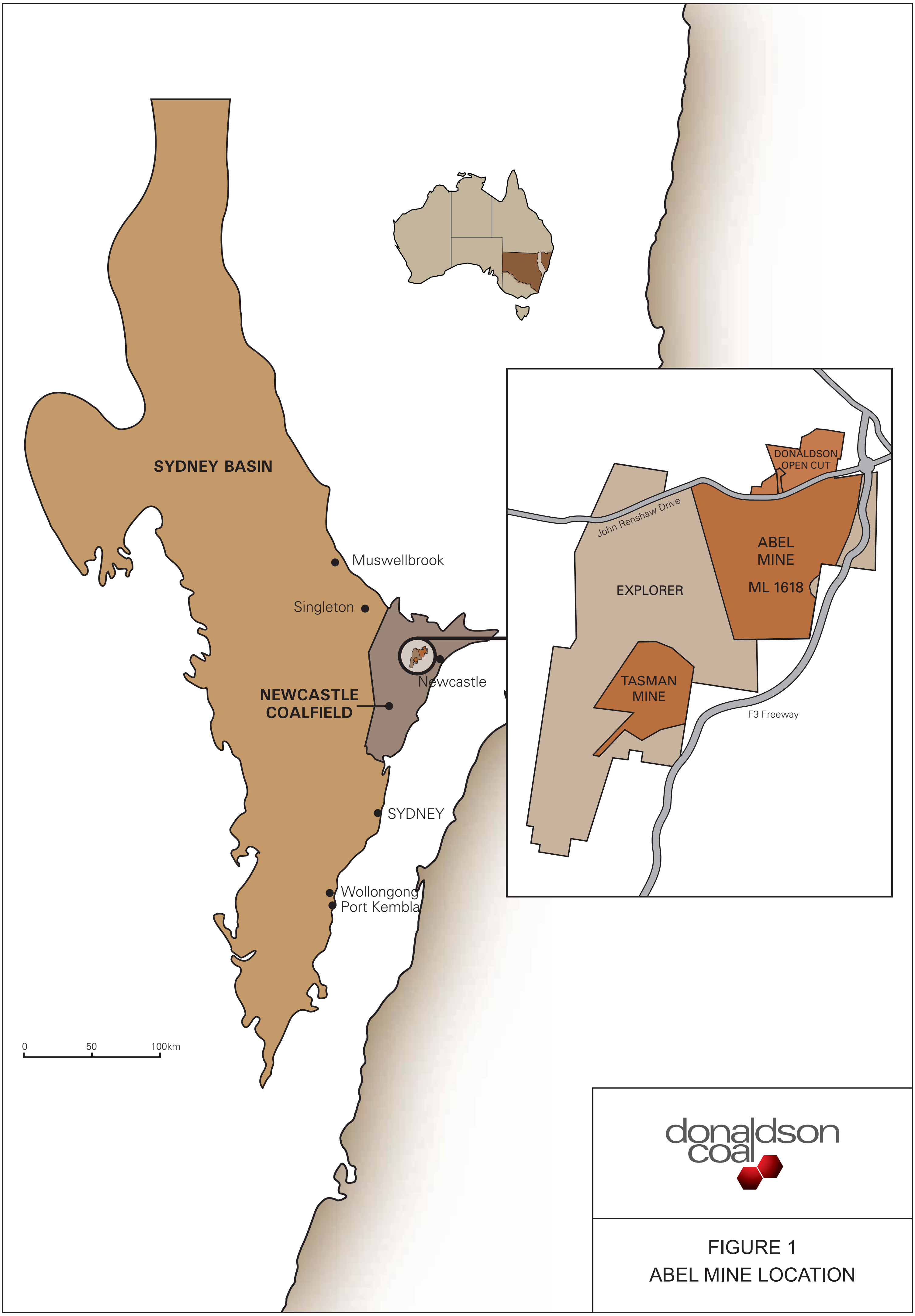



FIGURE 1
ABEL MINE LOCATION

**Limits of Approval**

5. Mining operations may take place until 31 December 2028 on the Abel site.
6. The Proponent shall not extract more than 4.5 million tonnes of ROM coal a year from the Abel site.
7. No more than 6.5 million tonnes of ROM coal may be processed a year on the Bloomfield site.
8. All product coal produced on the Bloomfield site shall be transported by rail via the rail loading facility on the Bloomfield site, except in an emergency. In an emergency, product coal may be transported from the Bloomfield site by road with the prior written approval of the Director-General, subject to any restrictions that the Director-General may impose.

The following subsidence related and monitoring / management consent conditions and Statement of Commitments items relevant to this SMP Application are noted in **Table 3**:

**Table 3- Summary of Project Approval Conditions and Statement of Commitments Relevant to SMP Area 1**

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| **Schedule 4 – Specific Environmental Conditions** | | |
| **Subsidence Impact Limits** | | |
| 1 | The Proponent shall ensure that the project does not result in any subsidence impacts on Pambalong Nature Reserve or the surface of the the F3 Freeway. | Pambalong Nature Reserve and F3 Freeway outside of SMP Application Area |
| 2 | The Proponent shall limit mining operations to first workings beneath and ensure that mining causes no subsidence impacts requiring mitigation works on, the following features:<br>(a) All principal residences located above the mining area;<br>(d) all Schedule 2 streams and rainforest areas located above the mining area. (*check on Blue Gum Creek Alluvium)* | (a) Only principal residences above the application area is the Boral Plant protected by a Subsidence Control Zone.<br>(d) Viney Creek (Schedule 2) first workings only and protected by Subsidence Control Zone |
| 3 | The Proponent shall ensure that the following sites are treated as "principal residences " under this approval:<br>(a) all buildings and structures on, or proposed to be constructed on, the Catholic High School site;<br>(b) all buildings and structures on the Boral | (a) Outside SMP Application Area<br>(b) Noted and treated as such. |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | Hotmix Asphalt Plant site | Subsidence Control Zone in place |
| 5 | Within 6 years of the Project Approval, the Proponent shall ensure that any subsidence caused by undermining the following land has been effectively completed:<br>(a) The Catholic Diocese of Maitland-Newcastle owned land; and<br>(b) Coal and Allied Operations (Now Black Hill Land Pty Limited) owned land. | (a) and (b) Noted and part of land included in this SMP Application Area |
| 6 | With the written agreement of the relevant landowner, the Proponent may:<br>(a) conduct additional mining operations and/or cause additional subsidence impacts beyond those permitted under conditions 2(a) or 3; and<br>(b) increase the time within which subsidence must be effectively completed under condition 5 | (a) and (b) noted but not relevant to this SMP application |
| **Subsidence Management Plan** | | |
| 7 | Prior to carrying out any underground mining operations that could cause subsidence, the Proponent shall prepare a Subsidence Management Plan (SMP) to the satisfaction of the Director-General of the DPI. This plan must be prepared in accordance with the:<br>(a) *New Approval Process for Management of Coal Mining Subsidence – Policy;* and<br>(b) *Guideline for Applications for Subsidence Management Approvals* (or the latest versions or replacements of these documents). | (a) and (b) This SMP application prepared in accordance with these documents. |
| 8 | In preparing the Subsidence Management Plan, the Proponent shall pay particular attention to assessing and limiting the potential subsidence impacts on all areas of the proposed underground mining area where:<br>(a) cover depths are less than 100 metres, or<br>(b) overlying abandoned mine workings occur (e.g. Stockrington Colliery and beneath BlackHill Quarry) | (a) Considered in SMP application<br>(b) No abandoned mine workings overlying or underlying proposed workings in this SMP application area. Ironbark Colliery drift/limited driveage from surface (not driven to seam) |
| **First Workings Hazard** | | |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| **Management Plan** | | |
| 9 | If the Proponent intends to carry out first workings under the following surface features, then it shall include a First Workings Hazard Management Plan for these workings, which describe in detail how these workings would be managed and monitored to ensure compliance with this approval and the contingency measures that would be implemented if the impact on these surface features are greater than predicted:<br>• all buildings and structures on the Black Hill Public School, Black Hill Church and cemetery, and Boral Hotmix Plant sites;<br>• all buildings and structures on, or proposed to be constructed on the Catholic High School site;<br>• all Schedule 2 streams , rainforest areas and the Blue Gum Creek alluvium. | • No first workings planned under Boral Asphalt Plant<br><br>• High School site not in application area<br><br>• Required for Viney Creek |
| **Water Management Plan** | | |
| 11 | The Proponent shall prepare and implement a Water Management Plan for the project to the satisfaction of the Director-General. To include Surface Water Monitoring Plan, and Groundwater Monitoring Program. | Submitted and approved |
| **Surface Water Monitoring Program** | | |
| 14 | The Surface Water Management and Monitoring Plan must include:<br>(a) detailed baseline data on surface water flows and quality in the creeks and other waterbodies that could be affected by the project;<br>(b) surface water impact assessment criteria;<br>(c) a program to monitor the impact of the project on surface water flows and quality;<br>procedures for reporting the results of this monitoring. | Submitted and approved |
| **Groundwater Monitoring Program** | | |
| 15 | The Groundwater Monitoring Program must include: | Submitted and approved |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | (a) further development of the regional and local groundwater model;<br>(b) detailed baseline data to benchmark the natural variation in groundwater levels, yield and quality (including at any privately owned bores in the vicinity of the site);<br>(c) groundwater impact assessment criteria;<br>(d) monitoring of the Pambalong Nature Reserve and the rainforest areas identified;<br>(e) a program to monitor the impact of the project on groundwater levels, yield and quality; and<br>(f) procedures for reporting the results of this monitoring. | |
| **Aboriginal Heritage Management Plan** | | |
| 28 | The Proponent shall not destroy any known Aboriginal objects (as defined in the *National Parks and Wildlife Act 1974)* without the written approval of the Director-General. | Noted – no subsidence impacts predicted for aboriginal artefacts identified in SMP Application area which are limited to scatter items |
| 29 | The Proponent shall prepare and implement an Aboriginal Heritage Management Plan for the project to the satisfaction of the Director-General. This plan must:<br>(a) be submitted to the Director-General within 6 months of this approval;<br>(b) be prepared in consultation with the DEC and the Mindaribba and Awabakal Local Aboriginal Land Councils;<br>(c) include a:<br>• comprehensive Aboriginal heritage surveys across both the Abel site and the Bloomfield site staged so as to be complete prior to any disturbance;<br>• salvage program for temporarily storing and then replacing retrieved material; and<br>• protocol for ongoing consultation and involvement of aboriginal communities in the conservation and management of Aboriginal heritage on site<br>(d) Describe the measures that would be implemented to protect Aboriginal sites on site, or if any new Aboriginal objects or skeletal remains are discovered during the project. | Submitted and approved<br>Two surveys have been undertaken by the property owners.<br>The area will be further inspected prior to secondary extraction. |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| **Schedule 5 – Environmental Management , Monitoring, Auditing and Reporting** | | |
| **Environmental Management Strategy** | | |
| 1 | The Proponent shall prepare and implement an Environmental Management Strategy for that project to the satisfaction of the Director-General within 6 months of this approval, and:<br>(a) provide the strategic context for environmental management of the project;<br>(b) identify the statutory requirements that apply to the project;<br>(c) describe in general how the environmental performance of the project would be monitored and managed;<br>(d) describe the procedures that would be implemented to:<br>• keep the local community and relevant agencies informed about the operation and environmental performance of the project;<br>• receive, handle, respond to and record complaints;<br>• resolve any disputes that may arise during the course of activities associated with the project;<br>• respond to any non-compliance<br>• manage cumulative impacts; and<br>• respond to emergencies; and<br>(e) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the project | Submitted and approved |
| **Environmental Monitoring Program** | | |
| 2 | The Proponent shall prepare and implement an Environmental Monitoring Program for the project to the satisfaction of the Director-General. This program must be submitted to the Director-General within 6 months of this approval, consolidate the various monitoring requirement sin Schedule 4 of this approval into a single | Prepared, submitted approved and implemented |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | document, and be integrated as far as practicable with the monitoring programs of the adjoining Bloomfield, Donaldson and Tasman mines. | |
| **Community Consultative Committee** | | |
| 8 | Within 3 months of this approval, the Proponent shall establish a Community Consultative Committee for the project. This committee shall:<br>(a) be comprised of:<br>• 2 representatives from the Proponent, including the person responsible for environmental management at the mine;<br>• at least 1 representative from Council (if available); and<br>• at least 3 representatives from the local community whose appointment has been approved by the Director-General;<br>(b) be chaired by an independent chairperson, whose appointment has been approved by the Director-General;<br>(c) meet at least four times per year during the construction phase and first year of mining operations, and thereafter at least twice per year;<br>(d) review the Proponent's performance with respect to environmental management and community relations;<br>(e) undertake regular inspections of mining operations;<br>(f) review community concerns or complaints about the mine operations, and the Proponent's complaints handling procedures;<br>(g) provide advice to:<br>• the Proponent on improved environmental management and community relations, including the provision of information to the community and the identification of community initiatives to which the Proponent could contribute;<br>• the Department regarding the conditions of this approval;<br>• the general community on the performance of the mine with respect to environmental management and community relations; and<br>(h) be operated generally in accordance with | Community Consultative Committee (CCC) has been established |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | any guidelines the Department may publish in regard to the operation of Community Consultative Committees for mining projects. | |
| 9 | The Proponent shall, at its own expense:<br>(a) ensure that 2 of its representatives attend CCC meetings;<br>(b) provide the CCC with regular information on the environmental performance of the project;<br>(c) provide meeting facilities for the CCC;<br>(d) arrange site inspections for the CCC, if necessary;<br>(e) respond to any advice or recommendations the CCC may have in relation to environmental management or community relations;<br>(f) take minutes of the CCC meetings;<br>(g) forward a copy of these minutes to the Director-General; and<br>(h) put a copy of these minutes on the website. | Updates on the SMP development have been presented to the Abel Community Consultative Committee at meetings held on 30 March, 29 June and 28 September 2009.<br><br>Copies of the CCC minutes are available on the Donaldson Coal web site. |
| **Access to Information** | | |
| 10 | Within 3 months of the approval of any plan/strategy/program required under this approval (or any subsequent revision of these plans/strategies/programs), or the completion of audits or AEMRs required under this approval, the Proponent shall:<br>(a) provide a copy of these relevant document/s to the relevant agencies;<br>(b) ensure that a copy of the relevant document/s is made publicly available at the mine; and<br>(c) put a copy of the relevant document/s on its website. | Copy of AEMR is available on Donaldson Coal web site |
| 11 | During the project, the Proponent shall:<br>(a) make a summary of monitoring results required under this approval to be publicly available at the mine and on its website; and<br>(b) update these results on a regular basis (at least every three months) | |
| **Statement of Commitments** | | |
| 5.1 Schedule I streams | (a) Schedule 1 streams (as defined in the DIPNR 2005 guideline, "Management of stream/aquifer systems in coal mining developments") will be managed via the implementation of mitigation | Management/ remediation as required |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | and remediation works where needed to ensure that:<br><br>stream stability is maintained where subsidence occurs<br>stream fractures are minimised<br>stream channels are maintained with minimal incision from bed grade change and<br>stream bed grade change minimised to provide stable stream length<br><br>(b) Where any stream stability controls are required they will be designed in accordance with the Rehabilitation Manual for Australian Streams (Land and Water Resources Research and Development Corporation, 2000) and will be provided primarily by vegetation. | |
| 5.2 Schedule 2 streams | (a) Schedule 2 streams (as defined by DIPNR, 2005) will be managed so as to ensure that:<br><br>• they maintain pre-mining course, and maintain bed channel gradients which do not initiate erosion;<br>• they maintain pool riffle sequences where they pre-existed, or have pool riffle sequences installed where appropriate;<br>• they maintain connectivity to underground workings, and flow loss to fracture zones in similar levels to pre-mining;<br>• they maintain geomorphic integrity of the stream;<br>• the ecosystem habitat values of the stream are protected;<br>• no significant alteration of the water quality occurs in the stream.<br><br>(b) The above commitments for Schedule 2 streams will be achieved by:<br><br>• the provision of a minimum barrier of 40m between the 20 millimetre line of subsidence and the bank of any Schedule 2 streams; or<br>• the carrying out of further detailed studies and the development of a Surface Water Management Plan for the Abel | Subsidence Control Zones |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | Underground Mine which clearly demonstrates that the above commitments can be met prior to any mining occurring which will impact on any Schedule 2 streams. | |
| **Subsidence Specific Commitments** | | |
| A. Principal Residences | The Company commits to producing and implementing a plan of management for each Principal Residence existing at the date of approval of this project. A Principal Residence is defined as an existing building capable of being occupied as a separate domicile and used for such purpose. The plan of management will be produced and implemented as follows:<br><br>1. Each Principal Residence will be individually assessed by the Mines Subsidence Board /structural engineer who will determine tolerable levels for individual subsidence parameters. Tolerable limits are those limits which will result in no mitigation works being required to the Principal Residence due to subsidence impacts from the Abel Underground Mine.<br><br>2. Each Principal Residence will have a pre-mining survey to identify and record pre-existing imperfections that will not be covered by the Mines Subsidence Board.<br><br>3. Such assessments will be done as and when the progression of the mining process dictates – i.e. mining may have commenced in other areas prior to the individual Principal Residence assessment being undertaken.<br><br>4. Tolerable levels will be set according to such factors as dwelling construction (e.g. brick veneer, clad), type (single, double storey), size (length and width), footings (slab, strip footings, piers), surface conditions (sand, rock, clay, steep slope) etc, with reference to the MSB Graduated Guidelines (compatible with AS 2870 and the Building Code of Australia). | The only principal residence is the Boral Asphalt Plant which is protected by a subsidence control zone |

| **Item / Condition** | **Description** | **Relevance to SMP Application Area/ Management Measure** |
|---|---|---|
| | 5. The mine plan in proximity to each Principal Residence will be modified by the Company to maintain subsidence parameters within the tolerable levels determined above for each Principal Residence.<br><br>6. The mine plan will be reviewed by the MSB and the DPI prior to any Subsidence Management Plan being approved under the relevant lease.<br><br>7. Each Principal Residence will have a specific subsidence monitoring plan to monitor subsidence impacts before and after mining at the Principal Residence and to ensure that tolerable limits are achieved in practice.<br><br>8. The Mines Subsidence Board has the responsibility to rectify any impacts to structures that may occur as a result of mining.<br><br>In cases where the owner of the Principal Residence and the Company can agree to terms which permit second workings under the Principal Residence greater than those permitted above, the Company agrees to negotiate a plan of management similar to that proposed in the section of this Statement of Commitments titled "All Other Surface Structures". | |
| B. Future Principal Residence | If there is no existing residence on a landholding and a residence is planned to be built, the site for this Future Principal Residence will be protected in the same way as that proposed above for Principal Residences. This commitment applies to a maximum of one Future Principal Residence per landholding.<br><br>NOTE: Once the Mine Subsidence District is declared for the area all Future Principal Residences will require approval from the Mine Subsidence Board and must comply with the *Mine Subsidence Compensation Act 1961.* | Not relevant to this SMP |

| **Item / Condition** | **Description** | **Relevance to SMP Application Area/ Management Measure** |
|---|---|---|
| E. All Other Surface Structure | "All Other Surface Structures" is defined as any building or structure impacted by mining-induced subsidence from the Abel Underground Mine Project which is not categorised as a Principal Residence, Future Principal Residence, Black Hill Church and Cemetery or Black Hill School.<br><br>The Company shall prepare and implement plans of management for the mitigation and remediation of any damage to All Other Surface Structures prior to any mining occurring that would impact on them.<br><br>The plan of management will include:<br><br>(a) pre-mining audit of the structure;<br>(b) the provision of a plan of management as part of the SMP approval process which requires the Company to mitigate/remediate any damage to improvements associated with the structure in conjunction with the Mines Subsidence Board;<br>(c) post-mining monitoring of the improvements associated with the Structure.<br><br>The mitigation/remediation measures to be undertaken will be related to the extent of damage experienced – see Schedule 1 for details. | Not relevant to this SMP |
| F. Dams | A Dam Monitoring and Management Strategy (DMMS) will be formulated for all dams prior to any mining occurring which will impact on the dams. The DMMS will provide for:<br><br>1. The individual inspection of each dam by a qualified engineer for:<br>• current water storage level;<br>• current water quality (EC and pH);<br>• wall orientation relative to the potential cracking;<br>• wall size (length, width and thickness);<br>• construction method and soil / fill materials;<br>• wall status (presence of rilling / piping / erosion / vegetation cover);<br>• potential for safety risk to people or | A Dam Monitoring and Management Strategy (DMMS) has been established but is not relevant to this SMP |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | animals;<br>• downstream receptors, such as minor or major streams, roads, tracks or other farm infrastructure; and<br>• potential outwash effects.<br><br>2. Photographs of each dam will be taken prior to and after undermining, when the majority of predicted subsidence has occurred.<br><br>3. Dam water levels, pH and EC will be monitored prior to and after undermining to assess the baseline and post mining dam water level and water quality in order to determine whether rehabilitation is required.<br><br>4. In the event that subsidence / crack development monitoring indicates a significant potential for dam wall failure, dam water will be managed in one of the following manners:<br><br>• pumped to an adjacent dam to lower the water level to a manageable height that reduces the risk of dam wall failure,<br>• discharged to a lower dam via existing channels if the water cannot be transferred, or<br>• not transferred if the dam water level is sufficiently low to pose a minor risk.<br><br>An alternate water supply will be provided to the dam owner until the dam can be reinstated.<br><br>5. In the event of subsidence damage to any dams the Company shall remediate the damage and reinstate the dam in conjunction with the Mine Subsidence Board. | |
| H. Powerlines | The Company shall prepare and implement a plan of management as part of the SMP process which will ensure the safety and serviceability of powerlines. | Management actions and Plan being developed in consultation with Energy Australia and Transgrid |
| L. Water Supply | In the event of interruptions to water supplies due to subsidence impacts on farm dams, water tank pipelines, water mains and irrigation systems within the application area, the Company commits to providing water supplies of equivalent quality and quantity to locations convenient to | Continuing consultation with Catholic Diocese on Management Plan. |

| Item / Condition | Description | Relevance to SMP Application Area/ Management Measure |
|---|---|---|
| | those affected until such time that the affected farm dams, water tanks, pipelines, water mains and irrigation systems are restored. | |
| M. General Surface Water Flow | The Company shall prepare and implement a plan of management to maintain the surface drainage of areas surrounding any dwellings and other structures or infrastructure, where required. This plan shall include but not be limited to monitoring, mitigation or remediation of mining-induced ponding, drainage pattern changes and any resulting serviceability difficulties and/or hazards to the public.<br><br>NOTE: Also see Water Supply. | |
| N. Public Safety | The Company shall prepare and implement a surface safety management program to ensure public safety in any surface areas that may be affected by subsidence arising from the proposed underground mining. This program shall include, but not be limited to, regular monitoring of areas posing safety risks, erection of warning signs, entry restrictions, backfilling of dangerous surface cracks and securing of unstable man-made structures or rockmass, where required and appropriate, and the provision of timely notification of mining progress to the community and any other relevant Stakeholders where management of public safety is required. | Public Safety Management Plan is included in SMP application. |

Additionally Mining Lease 1618 includes as the standard Condition 8 requiring the preparation of a Subsidence Management Plan prior to commencing any underground mining operations which will potentially lead to subsidence of the land surface which includes the pillar extraction proposed by Abel.

## 3.2 REPORT STRUCTURE

This application has been prepared in accordance with the NSW Department of Mineral Resources *New Approval Process for the Management of Coal Mining Subsidence* and SMP Guideline 2003.

The approval requirements have been addressed within this report and the relevant guideline and report references are listed below in **Table 4.**

**Table 4- SMP Guideline Requirements**

| Item | Guideline reference | Report reference |
|---|---|---|
| • Letter of application | Section 5 | Section 1 |
| • Mining system,<br>• Recovery,<br>• Statutory requirements,<br>• Expected subsidence,<br>• Potential subsidence impacts | Section 6.1 | Sections 3, 5, 10 and 11 |
| • Application area description | Section 6.2 | Section 4 |
| • Mining method,<br>• Mining system,<br>• Seam details,<br>• Recovery,<br>• Other seams | Section 6.3 | Section 5 |
| • Site conditions,<br>• Cover,<br>• Stratigraphy,<br>• Lithology & Geology | Section 6.4 | Section 7 |
| • Stability of workings,<br>• Working height,<br>• Detail of lithology,<br>• Geotechnical,<br>• Geology | Section 6.5 | Sections 5, 6 7 and plans |
| • Surface structures,<br>• Natural features,<br>• Monitoring,<br>• Identification | Section 6.6 | Sections 8 and 9 |
| • Subsidence predictions,<br>• Individual features subsidence | Section 6.7 | Section 10 |
| • Community consultation | Section 6.8 | Section 13 |
| • Legislation,<br>• Approvals,<br>• Licences | Section 6.9 | Section 15 |
| • Subsidence impacts,<br>• Impact on increased subsidence, Summary,<br>• Risk Assessment | Section 6.10 | Sections 11 and 12 |
| • Proposed Subsidence Management Plan | Section 7 | Separate document |
| • Plans | Section 9 | Section 17 and attachments |
| • Approved Plan | Section 10 | Section 17 and attachments |

# 4 THE APPLICATION AREA

## 4.1 APPLICATION AREA

The SMP application area is defined as the surface area enclosed by a 26.5 degree angle of draw from the limit of proposed mining, as defined in Section 6.2 in the SMP Guideline 2003 **(Plan 1)**.

The proposed mining layout, SMP area and lease boundaries are shown on **Plan 1**.

SMP Area 1 has a total area of 200 hectares within the full ML1618 area of 2,755 hectares (**Figure 2)**

The Upper Donaldson Seam mine workings in the SMP application area lie between 50 and 135 m below the surface **(Figure 3)**. The surface area consists of predominately native vegetation and grazing land.

## 4.2 LAND USES AND LAND OWNERSHIP

The entire surface of the SMP application area is contained within land owned by Black Hill Land Pty Limited, Catholic Diocese of Maitland and Newcastle and a narrow strip traversing the area owned by Hunter Water Corporation*.* **(Plan 5)**.

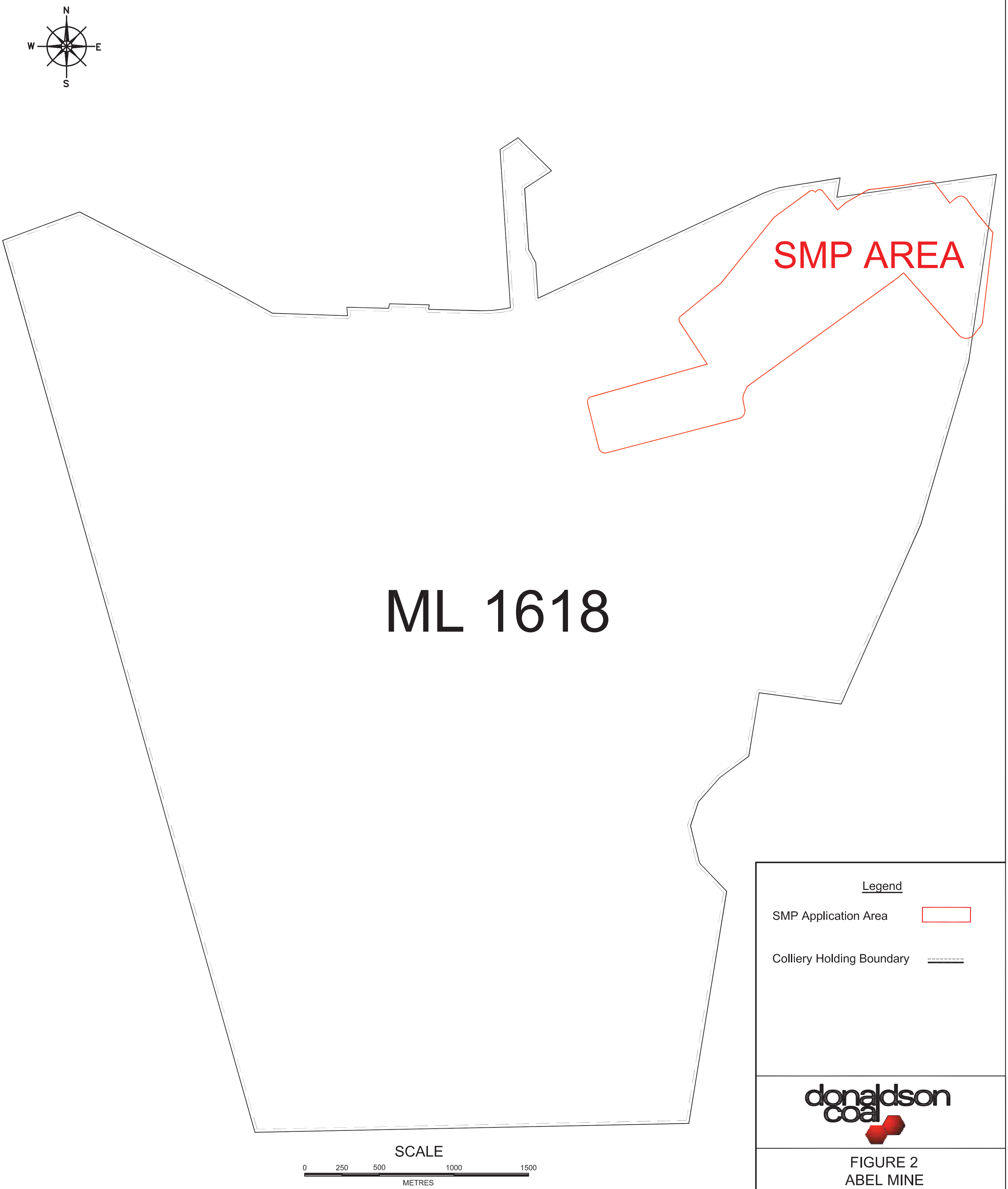
Land use in the area is a combination of the following:

- Native bushland;
- Grazing, and
- Industrial (Boral BlackHill asphalt plant in north eastern corner).

Infrastructure above the mining area consists of;

- Boral asphalt plant and associated infrastructure
- Transgrid 330kV transmission line;
- Energy Australia 132kV transmission line;
- Energy Australia 11 kV rural supply lines;
- Hunter District Water Board pipeline;
- Optus fibre optic cable;
- Redundant Telstra copper cables;
- Disused unoccupied residences*;*
- Stock water supply line;
- Access roads and tracks.
- Various fences; and
- One small disused dam.

Potential future development includes (but may not be limited to) an industrial subdivision of the Black Hill Pty Limited land (Lower Hunter Lands – Black Hill MP08_0124) and yet to be determined development of the Catholic Diocese land. This potential development and any infrastructure is not expected to be adversely impacted by any potential subsidence due to the requirement of the Project Approval that effective subsidence is required to be completed to these parcels of land by 7 June 2013 unless this time frame is increased with the written agreement of the relevant landowner.




Legend

SMP Application Area

Colliery Holding Boundary

FIGURE 2
ABEL MINE
ML1618 and SMP AREA

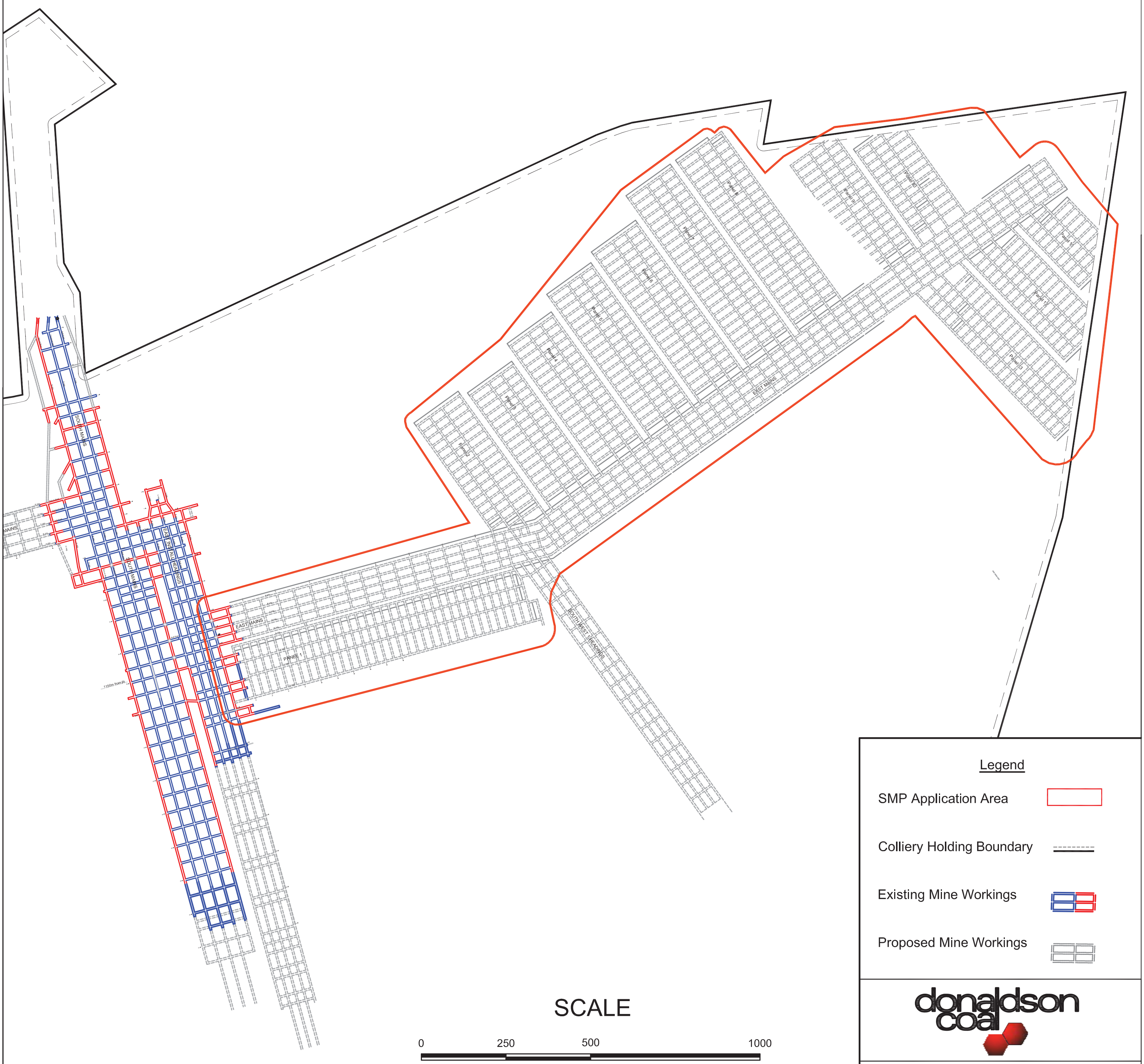



FIGURE 3
ABEL MINE
PROPOSED UPPER DONALDSON
SEAM WORKINGS

## 4.3 PROPERTY DESCRIPTION AND MINING TITLES

The SMP application area is located within land (*Lot 1131 DP 1057179 and Lot 30 DP 870411) within* the Parishes of Hexham and Stockrington County of Northumberland and the Cessnock and Newcastle local government areas. The relevant mining title is Mining Lease ML 1618. **(Plan 5)**.

# 5 MINING METHOD AND RESOURCE RECOVERY

## 5.1 PROPOSED 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 this application area.

The Upper Donaldson coal seam within the SMP application area of the Abel lease ranges from 1.8 to 3.4 metres in thickness. Abel currently mines up to 3.0m of the coal seam. The seam dips up to 1 in 12 generally towards the south within the SMP application area. Pillar extraction will take place generally in a west to east direction.

Secondary extraction Panel road 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 a combination of single and dual pass continuous miners. The Secondary extraction Panel pillars will typically be developed within a range of 45 to 65 metre centres and are proposed to be in the order of 19.5 metres wide (rib to rib).

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

## 5.2 MINE PLAN

### 5.2.1 Justification of the Mine Plan

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 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 prediction data have become available.

The resultant mine plan provided for optimum resource recovery within the bounds created by geological and surface constraints. It was deemed to be a layout which would result in subsidence being minimised in sensitive areas while allowing complete extraction and resultant subsidence to be completed in accordance with the Project Approval conditions relating to the Catholic Diocese and Black Hill Land Pty Limited land.

## 5.3 SCHEDULE OF PROPOSED MINING

The mining schedule plan for the SMP application area is shown on **Figure 4.** Pillar extraction will generally progress towards the South Mains or East Mains in each panel. Development rates are budgeted from 15 to 20 metres per shift dependent on geological conditions and support regime. Pillar extraction will typically produce in the order of 1,000 tonnes per shift.

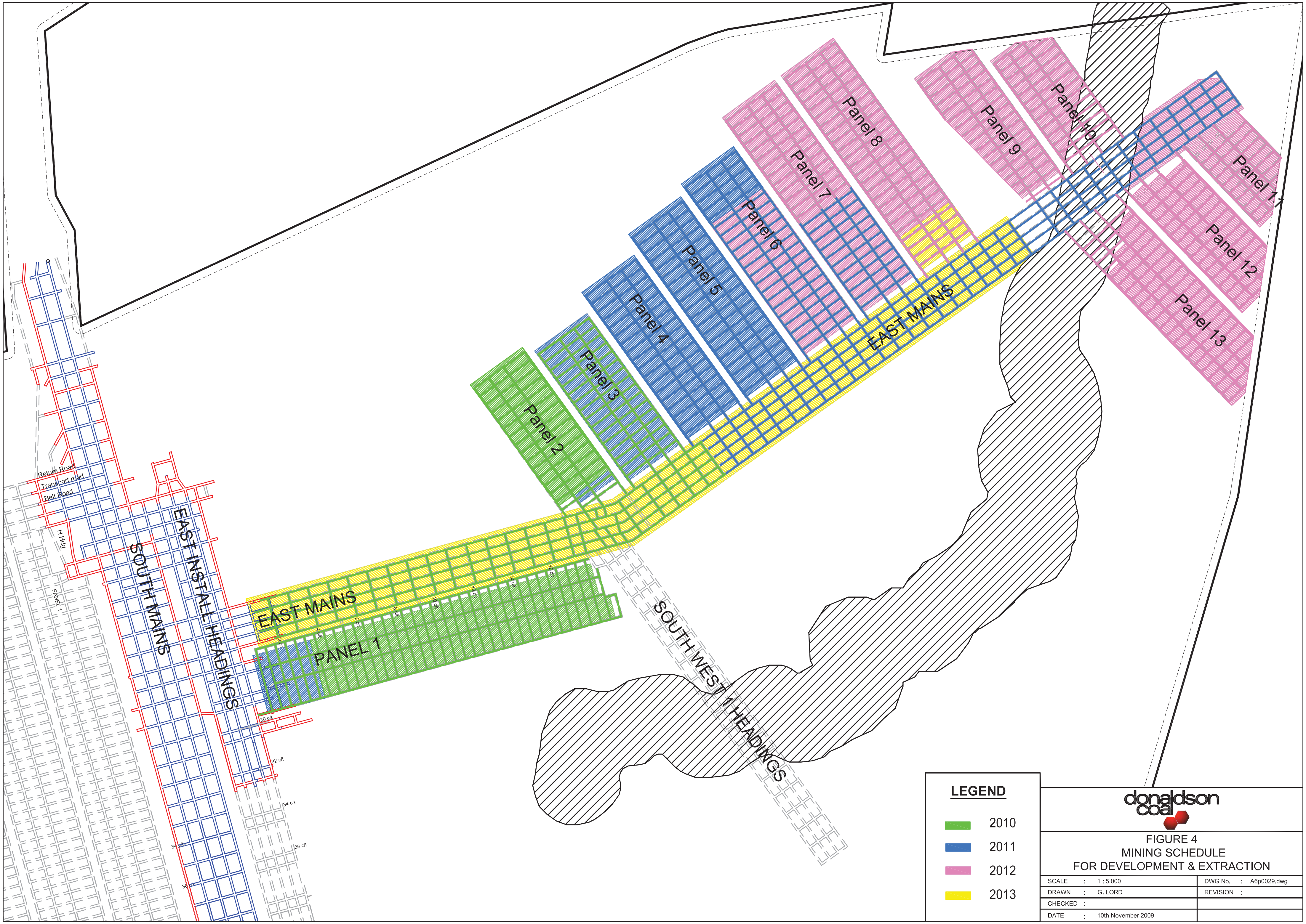
Normally operations are carried out 24 hours per day six days per week. Generally, only maintenance operations (e.g. stonedusting, roadway maintenance etc) are undertaken on Sundays.

Panel 1 extraction is scheduled to commence in June 2010 with Panel 13 scheduled to be completed in August 2012. Extraction of the east mains is scheduled for completion in June 2013. The proposed development and extraction schedule is shown in **Table 5**.

**Table 5- Development and Extraction Panel Timing**

| Panel | Development Timing (weeks) | Extraction Timing (weeks) | Start and Finish dates Development | Start and Finish dates Extraction |
|---|---|---|---|---|
| East Mains | 76 | 40 | January 2010 to June 2011 | September 2012 to June 2013 |
| Panel 1 | 33 | 27 | November 2009 to May 2010 | June 2010 to December 2010 |
| Panel 2 | 15 | 12 | June 2010 to August 2010 | August 2010 to December 2010 |
| Panel 3 | 15 | 12 | July 2010 to September 2010 | December 2010 to March 2011 |
| Panel 4 | 17 | 14 | September 2010 to December 2010 | December 2010 to April 2011 |
| Panel 5 | 19 | 15 | November 2010 to May 2011 | May 2011 to August 2011 |
| Panel 6 | 20 | 16 | December 2010 to April 2011 | April 2011 to August 2011 |
| Panel 7 | 23 | 18 | March 2011 to July 2011 | August 2011 to January 2012 |
| Panel 8 | 23 | 18 | April 2011 to August 2011 | September 2011 to February 2012 |
| Panel 9 | 15 | 12 | August 2011 to November 2011 | February 2012 to April 2012 |
| Panel 10 | 11 | 6 | September 2011 to November 2011 | March 2012 to April 2012 |
| Panel 11 | 9 | 7 | December 2011 to January 2012 | May 2012 to May 2012 |
| Panel 12 | 14 | 11 | December 2011 to March 2012 | June 2012 to August 2012 |
| Panel 13 | 18 | 13 | March 2012 to July 2012 | June 2012 to August 2012 |

**Figure 4** shows the current development and extraction Budget Plan for the mine.




**LEGEND**

- 2010
- 2011
- 2012
- 2013

donaldson coal

FIGURE 4
MINING SCHEDULE
FOR DEVELOPMENT & EXTRACTION

| | | | |
|---|---|---|---|
| SCALE | : 1 : 5,000 | DWG No. | : A6p0029.dwg |
| DRAWN | : G. LORD | REVISION | : |
| CHECKED | : | | |
| DATE | : 10th November 2009 | | |

## 5.4 ESTIMATED RECOVERY

As noted in **Section 5.1** the Upper Donaldson coal seam within the Abel lease is up to 3.4 metres in thickness. Abel currently mines between 2.2 and 3.0 metres of coal in development and 2.0 and 3.0 in extraction of the coal seam, the only marketable seam within the SMP application area.

The proposed panel layout for the SMP application area (as shown on **Plan 1**) will provide the following tonnages, based on an average working height of 2.4 metres development and extraction, development width of up to 5.5 metres and Relative Density of 1.5.

**Table 6- Development and Extraction Tonnages**

| Area | Panel Length (m) | Development (m) | Development Tonnes | Extraction Tonnes | Total Tonnes |
|---|---|---|---|---|---|
| East Mains | 2,850 | 19,181 | 369,225 | 733,146 | 1,102,371 |
| Panel 1 | 880 | 8,395 | 161,608 | 293,405 | 455,013 |
| Panel 2 | 400 | 3,816 | 73,458 | 132,631 | 206,089 |
| Panel 3 | 400 | 3,816 | 73,458 | 132,631 | 206,089 |
| Panel 4 | 450 | 4,293 | 82,640 | 149,821 | 232,461 |
| Panel 5 | 500 | 4,770 | 91,823 | 167,011 | 258,834 |
| Panel 6 | 525 | 5,009 | 96,414 | 175,606 | 272,020 |
| Panel 7 | 600 | 5,724 | 110,187 | 201,391 | 311,578 |
| Panel 8 | 600 | 5,724 | 110,187 | 201,391 | 311,578 |
| Panel 9 | 400 | 3,816 | 73,458 | 132,631 | 206,089 |
| Panel 10 | 294 | 2,805 | 53,992 | 70,403 | 124,395 |
| Panel 11 | 225 | 2,147 | 41,320 | 72,466 | 113,786 |
| Panel 12 | 375 | 3,578 | 68,867 | 124,036 | 192,903 |
| Panel 13 | 466 | 4,446 | 85,579 | 138,132 | 223,711 |
| | **TOTAL** | **77,520** | **149,2216** | **272,4701** | **4,216,917** |

The total resource within the SMP application area in the Upper Donaldson seam is 6,763,018 tonnes.

The total mineable tonnage from the SMP application area is 4,216,917 tonnes providing a resource recovery of 62%.

## 5.5 POSSIBLE EFFECTS ON OTHER SEAMS

Exploration drilling has encountered seams below the Upper Donaldson seam in the SMP area, including the Lower Donaldson and Ashtonfield seams. Other thin seams (0.5 to 1.0 metres) exist above the Upper Donaldson which are not 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.

As there are no other economically recoverable seams in the SMP application area there are no effects on potentially mineable coal seams.

## 5.6 FUTURE PLANS FOR MINING IN OTHER SEAMS

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

# 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. Detail on predicted subsidence impacts, the associated method of prediction and relevant subsidence parameters can be found in **Appendix A**.

Long term pillar stability is of concern only in relation to the remnant “barrier” pillars between extracted panels and between the panels and the mains.

Barrier pillars between production panels and the East Mains headings will generally have widths of 16.5 m and are expected to behave elastically in the long term (i.e. strain hardening characteristics are likely to develop if the pillars are overloaded).

The barriers between the extracted pillar panels will be 19.5 m wide and 300m to 800m long. The pillar height will range from 2.2 m to 3.0 m, depending on the seam thickness. The inter-panel barrier will have w/h ratios ranging from 7.5 to 8.5. These pillars are expected to yield gradually and strain-harden if the unlikely scenario of overloading occurs.

The East Mains will be developed as a 5 heading layout with pillars formed on 25 m wide x 45 m long centre spacing. The pillars will be lifted to a depth of 9.75 m on retreat after completion of mining in the production panels. The final rib-rib width of the Mains panels will be between 125 m and 131.25 m, with solid pillar barrier widths of 19.5 m left between the adjacent pillar extraction panels.

# 7 SITE CONDITIONS OF THE APPLICATION AREA

## 7.1 SURFACE TOPOGRAPHY

The surface above the proposed mining area is bounded to the north by John Renshaw drive and the east by the F3 Newcastle to Sydney Freeway and is currently owned by the Catholic Diocese, Black Hill Land Pty Limited and Hunter Water Corporation.

The land is semi-cleared, dry-sclerophyll forest, consisting of Lower Hunter Spotted Gum-Ironbark Forest and Coastal Plains Smooth-Barked Apple Woodland, with generally flat to gently undulated terrain. The Catholic Diocese land is presently used to graze cattle (and previously as intensive poultry farming). The Black Hill Land Pty Ltd land is currently partially developed with a Boral Asphalt plant in the north east section and the remediated Iron Bark Colliery pit top area.

The Black Hill Land Pty Ltd land is proposed to be re-developed into industrial lots with sealed access roads. An application to Planning (Lower Hunter Lands-Black Hill MP08_0124) has been lodged. No development applications have been lodged for the Catholic Diocese land at this stage.

The surface slopes range from $1^o$ to $10^o$ and steepen locally to $15^o$ along Viney Creek (a NSW Department of Environment, Climate Change and Water listed Schedule 2 Creek), which drains the site towards the north-east. Topographic relief ranges from 10 m AHD to 56 m AHD across the panels.

The majority of the area drains northwards in the form of a number of ephemeral creeks which drain to Viney Creek, flow to the north and eventually discharge into Woodberry Swamp, a wetland system of the Hunter River estuary.

The natural features of significance within the SMP area include:

- Gently undulating terrain and mild slopes.
- Headwaters of Viney Creek (A DECCW Schedule 2 Creek) and an unnamed drainage gully (A DECCW listed Schedule 1 watercourse).
- Sandy alluvial deposits (up to 3 m deep) exist along the lower reaches of the creek with no rock exposures evident.
- Silty sand and sandy clay surface soils present on the site are likely to be mildly to highly erosive / dispersive if exposed to concentrated runoff during storm flow events.
- Vegetation on the site consists of dense stands of dry schlerophyll forest with shrubs, ferns and grasses. The riparian zones along creeks have sparse to dense stands of melaleucas, vines and grasses.
- Common flora/fauna habitats within the SMP area

The prominent features are described in detail in **Section 8.4.1** to **8.4.8**.

## 7.2 DEPTH OF COVER

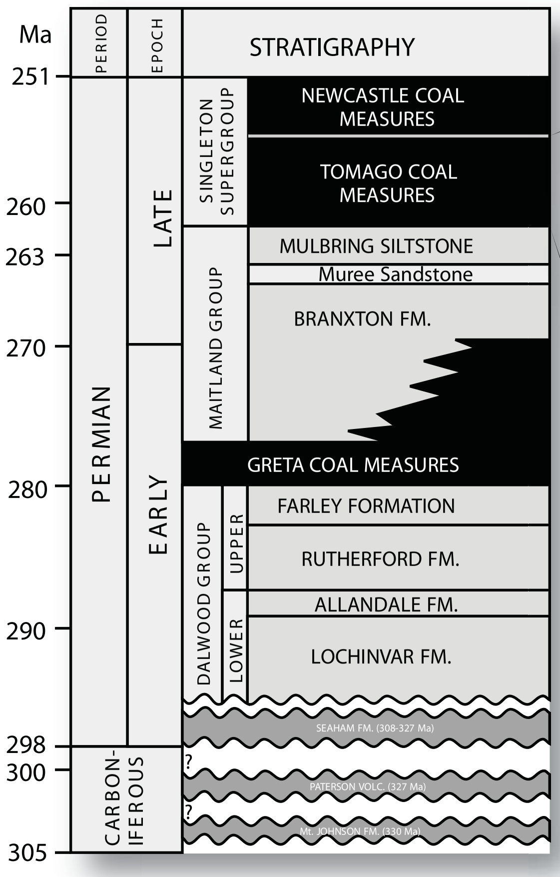
The depth of cover, in the pillar extraction area, varies from 50 to 135 metres over the application area. Details of cover and location of relevant natural features are included in **Plan 2.**

## 7.3 OVERBURDEN STRATIGRAPHY

The SMP application area lies in the Newcastle Coalfield within the Sydney Basin. The overburden comprises part of the Dempsey Formation, which is part of the Permian Aged, Tomago Coal Measures.

The overburden for the area consists of gently, south-west dipping (i.e. 2 to 5 degrees) sedimentary strata of the Tomago Coal Measures, which generally comprise interbedded sandstone, shale, carbonaceous mudstone, tuffaceous claystone and coal. The coal seams present in the overburden (in descending order in the SMP Area 1) include the Upper and Lower Buttai, Upper and Lower Donaldson, Big Ben and Ashtonfield Seams.

The generalised stratigraphy of the Tomago Coal measures (after Robinson 1969) is shown in **Figure 5**.




| Group | Subgroup | Formation | Coal Seam |
|---|---|---|---|
| Tomago Coal Measures | Hexham | Shortland | |
| | | Sandgate | Upper Sandgate<br>Lower Sandgate |
| | | Dempsey | |
| | Four Mile Creek | Ironbark | Upper Buttai<br>Lower Buttai<br>Beresfield<br>Upper Donaldson<br>Middle Donaldson<br>Lower Donaldson |
| | | Thornton Claystone | |
| | | Alnwick | Big Ben<br>Buchanan Maitland<br>Ashtonfields<br>Tomago Thin |
| | Wallis Creek | Stoney Pinch | |
| | | Scotch Derry | Scotch Derry |
| | | Surveyors Creek | |
| | | Rathluba | Upper Rathluba<br>Lower Rathluba |
| | | Metford | |
| | | Morpeth | Morpeth |
| | | Raworth Claystone | |
| | | Tenambit Sandstone | |

donaldson coal

Stratigraphy of the Tomago Coal Measures

**Figure 5**

## 7.4 LITHOLOGICAL AND GEOTECHNICAL CHARACTERISTICS

### 7.4.1 Overburden

The overburden comprises predominately sandstones and shales, interbedded with a number of coal seams including the Upper and Lower Donaldson seams.

Strength testing has been undertaken at selected horizons (**Table 7**).

**Table 7- Geotechnical Properties of Borehole C159R (Panel 3)**

| Depth From surface to strata unit | Strata Description | Modelled UCS Range (Mpa) |
|---|---|---|
| 0-5.8 | Sandstone | 2-30 |
| 5.8-7.2 | Shale | 10-30 |
| 7.2-8.7 | Coal (Upper Buttai Seam) | 10-20 |
| 8.7-12.6 | Sandstone and shale | 15-50 |
| 12.6-24.3 | Shale and claystone | 15-60 |
| 24.3-25.4 | Coal (Lower Buttai Seam) | 10-20 |
| 25.4-64.1 | Shale and sandstone with minor claystone bands | 15-80 |
| 64.1-64.6 | Coal | 10-20 |
| 64.6-84.1 | Sandstone and shale with minor claystone bands | 20-60 |
| 84.1-87.1 | **Coal (Upper Donaldson Seam)** | 10-15 |
| 87.1-87.6 | Sandstone | 40-90 |
| 87.6-87.9 | Coal | 10-20 |
| 87.9-92.2 | Sandstone and shale | 50-90 |
| 92.2-95.3 | Coal (Lower Donaldson Seam) | 10-20 |
| 95.3-96.3 | Sandstone and shale | 50-90 |

### 7.4.2 Roof and Floor

The immediate roof and floor of the proposed mining horizon will typically consist of 5 to 10 m or more of thin to medium interbedded shale and sandstone with low to medium strength (10 to 50 MPa). The weaker materials, such as carbonaceous mudstone, mudstone and claystone are very thin (< 0.1 m thick) and exist in both the roof and floor.

The immediate roof above the Upper Donaldson seam comprises shales and sandstones with localised variations where sandstones grade into shales, and shales grade into sandstones, with common changes in the thickness and areal extent of the bands or lenses of material. Thickly bedded or massive units are rare and have not been identified as existing in bands greater than two to three metres thickness.

Low strength immediate roof and floor materials were also generally noted in several boreholes in the north, where the cover depths are less than 40 m. This is also considered to be the depth of weathering on the Donaldson open cut mine to the north of the underground mining area. The sonic UCS results indicated thinly bedded strata with strengths ranging between 10 and 50 MPa and generally from 30 to 50 MPa for the overburden materials at depths > 40 m.

The UCS and stiffness properties of the immediate roof and floor materials have been derived from laboratory and point load strength test results from core taken from six boreholes and in-situ geophysical testing data. Good correlation was apparent between the laboratory derived and *in situ* sonic UCS results presented in the Environmental Assessment.

Estimates of the range of material strength and stiffness properties present in the roof and floor of the Upper Donaldson Seam are summarised in **Table 8**.

**Table 8- Strength Property Estimates for Upper Donaldson Seam, Roof and Floor Lithology**

| Lithology | Strata Thickness (m) | UCS Range+ [Average] (MPa) | Elastic Moduli Range* (GPa) | Average Moisture Sensitivity^ |
|---|---|---|---|---|
| Interbedded sandstone/ shale beds above the UD Seam | <10 | 10.5 - 93 [18 - 51] | 3 - 15 | Non-Sensitive to Moderately Sensitive |
| Upper Donaldson Seam | 2.0 - 3.2 | 5 - 15 | 2 - 4 | Non- Sensitive to slightly sensitive stone bands |
| Interbedded sandstone/ shale beds below the UD Seam | <10 | 11.5 - 130 [31 - 72] | 3 - 15 | Non-Sensitive to Slightly Sensitive |

Note:
+ - Unconfined Compressive Strength derived from point load testing to **ISRM, 1985** on bore core samples taken from SMP area.
* - Laboratory Young's Modulus (E) derived from laboratory and sonic UCS data, E = 300 x UCS (units are in MPa).
^ - Moisture sensitivity testing determined from the Immersion Test procedure presented in **Mark & Molinda, 1996**.

For further geotechnical details see **Table 7**.

## 7.5 EXISTENCE AND CHARACTERISTICS OF GEOLOGICAL STRUCTURES

The seam generally dips downwards at approximately 1 in 12 generally towards the south of the mining area.

Based on reference to the DMR Geological Sheet, there are several significant NW:SE striking geological structure zones (i.e. faults and dykes) which occur along Buttai Creek and Long Gully Creek to the west of the site, and also an 8 m throw reverse fault in the north-east corner of the SMP area on a north westerly strike. The south-eastern bedding dip across the site is associated with the southern arm of the Four Mile Creek Anticline, which is located to the west of the site.

Surface joint patterns measured on the sandstone cliff lines and outcrops to the south of the SMP area consist of a sub-vertical, widely spaced, planar to wavy, persistent joint sets striking between 025º and 035º (NNE to NE). A sub-vertical joint set striking at approximately 135º (NW:SE) is also present. The trends of the cliff faces are similar to the above joint sets.

The Upper Donaldson Seam has low strength with sonic derived unconfined compressive strength (UCS) values ranging from 5 to 15 MPa. Some medium to high strength stone bands up to 0.5 m thick are present within the coal seam, with UCS values ranging between 30 and 90 MPa.

# 8 IDENTIFICATION AND CHARACTERISATION OF SURFACE AND SUB-SURFACE FEATURES

## 8.1 MINE SUBSIDENCE DISTRICT

The SMP application area is not located within a current Mine Subsidence District but was previously located within the Ironbark Mine Subsidence District which was revoked in October 1994. Discussions have been held with the MSB relating to the future reclassification of the area as a Mine Subsidence District.

## 8.2 PROPOSED DEVELOPMENTS

Proposed and potential developments within or adjacent to the SMP application area includes (but may not be limited to):

1. an application for approval for a concept plan including an industrial subdivision of the Black Hill Pty Limited land (Lower Hunter Lands – Black Hill MP08_0124); and
2. a, yet to be determined, development of the Catholic Diocese land.

The Abel Project Approval Conditions reference this scenario thus:
“Within 6 years (June 2013) of this approval, the Proponent shall ensure that any subsidence caused by undermining the following land has been effectively completed:

- The Catholic Diocese of Maitland-Newcastle owned land; and
- Coal and Allied Operations (Now Black Hill Land) owned land;” and

“With the written agreement of the relevant landowner, the Proponent may:

- conduct additional mining operations and/or cause additional subsidence impacts beyond those permitted under conditions 2(a) or 3; and
- increase the time within which subsidence must be effectively completed under condition 5.”

## 8.3 GENERAL DESCRIPTION

The following sections identify and describe all the significant natural features and surface improvements that lie within the SMP application area, which is shown on **Plan 2**.

Reference to the SMP Guideline 2003 was made to assist in identifying these features that may be affected by mining. In addition to this, and as part of the Risk Assessment conducted on 2 July 2009, additional sources were used to confirm the features within the SMP application area.

These sources included:

- aerial photos;
- digital cadastral information also showing surface features;
- on site surveys by mine surveyors;
- field surveys by Donaldson Coal personnel and consultants, local knowledge of the area by mine personnel and various consultants; and
- Information provided by Public Utilities and landholders.
- Information from Abel EA and Black Hill Land Pty Limited EA.

## 8.4 NATURAL FEATURES

Natural features contained within the SMP application area are limited to the following as listed under **Appendix B** of the SMP Guideline 2003.

- Catchment areas – Hunter River catchment;
- Rivers and creeks – first and second order streams only. (**Section 8.4.1**);
- Aquifers, known groundwater resources – Various aquifers (**Section 8.4.2**);
- Land prone to flooding and inundation (**Section 8.4.3**);
- Swamps, wetlands, water related ecosystems (**Section 8.4.4**);
- Threatened and Protected Species – see also Flora and Fauna section. (**Section 8.4.5**); and
- Natural vegetation – Large section of application area contains native vegetation (**Section 8.4.5**).

Listed in the following Table is a check list of natural features from Appendix B of the SMP Guideline 2003.

**Surface and Sub-Surface features that may be affected by Underground Coal Mining.**

**Table 9- Item 1 – Natural Features**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Catchment areas and declared Special areas | Reviewed classification of catchment areas | |
| 2 | Rivers and creeks | Reviewed classification of catchment areas | No rivers. First and second order streams. Viney Creek, tributaries to Weakleys Flat Creek. |
| 3 | Aquifers, known groundwater resources | Hydrogeological assessment | Aquifers |
| 4 | Springs | Some ground truthing | Nil located |
| 5 | Sea / Lake | Reviewed aerial photo and topographical plan | Nil |
| 6 | Shorelines | Reviewed aerial photo and topographical plan | Nil |
| 7 | Natural dams | Reviewed aerial photo and topographical plan | Nil |
| 8 | Cliffs / Pagodas / Rock Formations | Reviewed aerial photo and topographical plan, targeted ground truthing | Nil |
| 9 | Steep slopes | Reviewed topographical plan, targeted ground truthing | Nil excluding creek banks |
| 10 | Escarpments | Reviewed Aerial photo and topographical plan | Nil |
| 11 | Land prone to flooding or inundation | Reviewed Aerial photo and topographical plan | Yes |
| 12 | Swamps, wetlands, water related ecosystems | Reviewed Aerial photo and topographical plan. Ground truthing, vegetation mapping | Yes but no wetlands, water related ecosystems |
| 13 | Threatened and protected species | Surveys, literature, ground truthing, monitoring | Yes |
| 14 | National parks | Reviewed NPWS website | Nil |
| 15 | State recreation areas | Reviewed NPWS website and plans | Nil |
| 16 | State Forests particularly area zoned Forestry Management Zones 1,2 or 3 | Obtained State Forest map. | Nil |
| 17 | Natural vegetation | Surveys, literature | Yes |
| 18 | Areas of significant geological interest | | Nil |
| 19 | Any other feature considered significant | | Nil |

### 8.4.1 Watercourses

Watercourses in the SMP application area consist of Viney Creek and various tributaries.

These are Order 1 and Order 2, Schedule 1 tributaries under the Strahler classification system used by the Department of Natural Resources (2002).

**Surface Water Catchments and Watercourses**

The Abel Underground Mine area is located within the lower section of the Hunter River catchment and consists of low undulating forested hills with patches of cleared land for rural/residential properties. A ridgeline associated with Black Hill runs east-west through the proposed underground mine area, with tributaries of Buttai Creek, Viney Creek, Weakleys Flat Creek and Four Mile Creek draining northwards from this ridgeline. Long Gully & Blue Gum Creek drain the southern side of the ridgeline eastwards towards Pambalong Nature Reserve. The only distinct sub-catchment area within the SMP Area 1 is described as follows:

The Weakleys Flat Creek (and Viney Creek) sub-catchment area drains northward into Woodberry Swamp prior to entering the Hunter River. The sub-catchment is approximately 935 hectares, which represents about 34 percent of the total underground mine area. A large portion of the sub-catchment area is cleared land that previously supported chicken production. The watercourses in this sub-catchment area are ephemeral.

**Surface Water Quality**

Surface water quality data has been collected from the main watercourses in each of the sub-catchment areas identified within the underground mine area.

Donaldson conducts a regular surface water monitoring program of the three main creeks (Scotch Dairy Creek, Weakley's Flat Creek and Four Mile Creek) that traverse the existing Donaldson Mine property. These creeks are sampled above and below the existing open cut mine site on a monthly basis for a suite of parameters. A baseline survey of these creeks was undertaken in 1997 and routine monitoring has been undertaken since June 2000.

Water quality data has been compared to the lower and upper limits of the default trigger values outlined for lowland rivers in south-east Australia (ANZECC 2000, Ch 3 – Aquatic Ecosystems). For Weakleys Flat Creek, Scotch Dairy Creek and Four Mile Creek substantial background data is available due to the long term monitoring undertaken by Donaldson. The average water quality data for these watercourses is within the range outlined by ANZECC, however, there is a wide range of variability in the water quality measured over time, including some exceedances of the upper limits outlined by ANZECC. For example, the maximum recorded values for pH, EC and TSS within Weakleys Flat Creek are all above the upper limits of the default trigger value range. The water quality samples obtained for Viney Creek and Blue Gum Creek are within the range outlined by ANZECC, with the one exception being TSS measured for Blue Gum Creek Upstream which is well above the upper limits outlined by ANZECC. Water quality samples have not been collected from Long Gully and Buttai Creek as there were no flows in the watercourses at the time of sampling.

The generally good water quality is a reflection of the relatively undisturbed catchments, however, the variability in the data suggests that a longer term monitoring period will need to be implemented in order to more fully describe the background water quality.

- The long term data collected by Donaldson and the data collected during the full suite analysis was also used to assess the source of the water within the watercourses. Based on the relative composition of the major ions the following interpretation has been made:

- The Blue Gum Creek Upstream sample appears to be predominantly surface runoff;

- The Blue Gum Creek Downstream and Viney Creek samples appear to be mostly surface runoff, but with some proportion of groundwater baseflow;

- The Weakleys Flat Creek has been sustained by groundwater baseflows over recent dry years; and

- The Four Mile Creek appears to be mostly surface runoff, but with some proportion of groundwater baseflow.

In all cases above, the groundwater is probably from the near surface zone (ie: alluvium/colluvium and/or weathered bed rock) and is not connected with deeper regional groundwater.

**Watercourse Characteristics**

In early 2006 a watercourse survey was undertaken to collect typical data for the watercourses throughout the Abel Underground Mine area. Information was collected on the following characteristics:

- Bed material type (grain size/depth etc);
- Notable stream features (exposed rock, bed controls, etc);
- Channel geometry;
- Existing erosion;
- General vegetation communities; and
- Flow & Ponding conditions.

A summary of the observations made during the watercourse survey for each sub-catchment area is presented as follows.

**Weakleys Flat Creek (and Viney Creek) sub-catchment**

Weakleys Flat Creek and Viney Creek were observed to have bed and bank material predominantly consisting of soil and gravel, with occasional outcropping sandstone. The channel widths generally ranged from 1.5 to 3 metres wide, and the channel height ranged from 0.5 to 1.5 metres. There was no flow in the creeks during the survey, but small ponds were observed. An inspection of Viney Creek conducted in March 2009 by Geoterra Pty Ltd showed that the creek is heavily vegetated and in places is almost fully choked with weeds and reeds. Where the creek isn't heavily vegetated with weeds/reeds, it has a high cover of natural forest / riparian shrub vegetation (with lesser, although prevalent weeds). The banks along the creek are predominantly composed of dark brown silty clay, which is eroded in places with vertical banks of up to 1.5-2.0m high, and the stream bed is composed of a sandy/small gravel alluvium resting on top of the incised silty clay stream bed.

Buttai Creek was observed to have bed material ranging from sand, gravel, soil, boulders and mud, and the bank materials predominantly consisted of soil. The channel width generally ranges from 1 to 3 metres wide, and the channel height ranges from 1 to 2 metres. There was no flow in Buttai Creek during the survey, but ponds were observed.

**Key Surface Water Features**

All watercourses within the underground mine area have been categorised as Schedule 1 or 2 Streams in accordance with the *Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR, 2005). No Schedule 3 Streams are present in the underground mine area. The significance of Schedule 1, 2 and 3 Streams has been previously described.

The Scheduled Stream within the SMP area (Viney Creek) is shown on Plan 2.

### 8.4.2 Aquifers and Groundwater Resources

**Explanation of terms**

"Aquifer" is a term generally applied to any stratum that has a high groundwater carrying capacity relative to the surrounding rocks.
"Aquicludes" and "Aquitards" are the terms used to describe the strata above and below the aquifer.
"Aquicludes" effectively seal off the aquifer so that groundwater flow is restricted to the aquifer.
"Aquitards" allow some minor leakage of groundwater from the aquifer either through the roof or floor.

**Summary**

**Study Objectives**

A groundwater investigation has been undertaken for the proposed Abel Underground Mine and is provided as **Appendix C**. A Peer Review of the groundwater study was also completed and is also provided as **Appendix C1**. The Peer Review found that the data and methods used were consistent with best practice approaches and that the arguments and conclusions were robust and appropriate.
The groundwater investigations aimed to:

- Assess and describe the existing groundwater environment in the vicinity of the proposed Abel Underground Mine;
- Identify potential risks to the environment from the proposal;
- Evaluate the potential impacts of the proposal on the regional and local groundwater resources, incorporating any necessary management and mitigation strategies; and
- Assess any residual post-project impacts and any ongoing management requirements.

The study has been undertaken with reference to the following relevant policies:

- NSW State Rivers and Estuaries Policy;
- NSW Wetlands Management Policy;
- NSW Groundwater Policy Framework Document – General;
- NSW Groundwater Quantity Management Policy;

- NSW Groundwater Quality Protection Policy; and
- NSW Groundwater Dependent Ecosystem Policy.

The following relevant best practice guidelines have been referenced:

- *Groundwater Flow Modelling Guideline* (Middlemis, 2001);
- *Independent Inquiry into the Hunter River System* (Healthy Rivers Commission, 2002);
- *Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR, 2005); and
- *Groundwater Monitoring Guidelines for Mine Sites within the Hunter Region (DIPNR, 2003).*

**Study Methodology**

A series of piezometers were installed across the proposed Abel Underground Mine area to enable separate sampling, testing and monitoring of the principal coal seams and the overburden and interburden sediments, both within the shallow northern part of the deposit, and downdip at the southern end. Some bores were also installed along the strike to the east. A number of shallow piezometers were also installed around the Pambalong Nature Reserve. The location of these piezometers and bores is shown on **Figure 6.** Piezometer design and testing details are provided in **Appendix C**.

A hydraulic testing program was carried out on the standpipe piezometers, comprising either slug tests or short duration pumping tests, to determine aquifer permeabilities. Water samples were also collected from each piezometer during hydraulic testing. The samples were submitted to a NATA-registered laboratory for comprehensive analysis of physical properties and the major inorganic parameters.

The specific investigations carried out for the Abel Underground Mine project were supplemented by relevant parts of earlier studies carried out for the Donaldson Open Cut Coal Mine. Ongoing monitoring of groundwater levels and groundwater and surface water quality have provided additional information.

A limited test program was also carried out on existing bores on the Bloomfield project site.

The hydrogeological investigations (including modelling) have also been undertaken with reference to the *Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DNR, 2005), with the model developed in accordance with the best practice guidelines on groundwater flow modelling (MDBC, 2001).

**Existing Hydrogeological Environment**

**Introduction**

A detailed description of the existing hydrogeological environment that interacts with or influences groundwater is provided in **Appendix C.** This includes:

- Climate – rainfall and evapotranspiration;
- Geology;
- Hydrogeology;
- Recharge and Discharge;

- Groundwater Quality; and
- Groundwater and Surface Water Interaction.

**Hydrogeology**

In the Abel Underground Mine area, permeability was found to be generally highest in the coal seams and areas of significant fracturing or faulting. However, overall the coal measures were found to be poorly permeable. The interbedded sandstones and siltstones are of lower permeability and offer very limited intergranular porosity and little secondary permeability and storage in joints.

Groundwater was also found to occur in the alluvial overburden, which comprises mainly swamp, floodplain and estuarine sediments. There is considered to be limited hydraulic connectivity between the alluvium and the coal measures.

**Recharge and Discharge**

Groundwater flow within the coal measures is controlled by the regional topography, with recharge occurring in areas of elevated terrain and then slow movement down-dip or along strike to areas of lower topography. There is considered to be a component of lateral flow in the coal measures out of the project area over the southern and eastern boundaries. This flow is believed to be limited due to the substantial overburden cover (up to several hundred metres).

Groundwater level contours for the Donaldson Seam show an overall pattern of flow to the east, south and west from a central ridge which extends southwards from the Donaldson Open Cut Mine. The flow pattern is largely independent of the local topography. The contours also show the influence of dewatering in the Donaldson Open Cut Mine area with a prominent cone of depression located to the north of John Renshaw Drive.

A similar flow pattern is apparent for the rest of the coal measures. Groundwater levels are about 5 to 10 metres higher in the overburden above the Donaldson Seam. There is a consistent pattern of lower pressure heads with depth.

Groundwater levels in the near surface material, which includes alluvium/colluvium and weathered bedrock, show a much closer relationship to the local topography. While groundwater levels in the deeper coal measures are not influenced by local topography, the surficial groundwater levels are locally influenced.

Groundwater flow within the deeper coal measures is therefore believed to be more regionally controlled, whereas flow within the near-surface material is subject to local topographic influences.

The alluvium around Hexham Swamp and the wetlands of Pambalong Nature Reserve is believed to be in hydraulic continuity with the swamp, but there is believed to be negligible hydraulic connection between the swamps and the deeper groundwater.

Rainfall recharge occurs to the coal seams where they outcrop and to the alluvial aquifers. The alluvial aquifers are likely to be in hydraulic continuity with Hexham Swamp in the east and Wallis Creek to the west of the Abel Underground Mine area. During periods of high stream flow, surface water courses are likely to contribute to this alluvial aquifer recharge. However, stream flows from rainfall runoff are reported to be short-lived after rainfall events.

The coal seams, where covered by overburden, are recharged mainly by flow along the bedding from elevated areas where the beds are exposed in outcrop, with minimal downward percolation through the overburden. After reaching the water table, flow is predominantly down-gradient along the more permeable horizons, but also with a component of continuing downward flow to recharge underlying coal seam aquifers. Rainfall recharge rates within the hard rock outcrop area are believed to be relatively low (below 10 mm/yr). However, where alluvial deposits occur, recharge rates may be as high as 100mm/yr.

Groundwater discharge occurs through evaporation, seepage and spring flow where the water table intersects the land surface, and through baseflow contributions to creeks, rivers and Hexham Swamp, including discharge to the alluvium where it occurs. There is almost no existing groundwater abstraction in the Abel Underground Mine area other than for coal mine dewatering at Donaldson Open Cut Mine and Bloomfield Colliery.

**Groundwater Quality**

The quality of groundwater sampled from within the Abel Underground Mine area is variable, with total dissolved solids (TDS) ranging from less than 518 mg/L to 13,000 mg/L. The highest salinities are reported from the surficial groundwater (i.e. the weathered Permian/alluvium-colluvium). The lowest reported salinity of 518 mg/L was from the Donaldson Seam.

The salinities reported from the Donaldson Open Cut Mine area are also variable. They represent a broad spectrum of lithologies, including the coal seams (Donaldson Seam and others above and below) and various levels within the coal measures overburden. Salinities ranged from 770 to 16,000 mg/L TDS with pH being close to neutral.

**Groundwater and Surface Water Interaction**

There is believed to be limited interaction between the surface drainage system and the deeper groundwater within the coal measures. The limited occurrences of localised surficial groundwater on the other hand are believed to be in reasonable hydraulic connection with the high level streams, and there is expected to be some interchange of water between the creek-beds and the shallow weathered bedrock beneath. These localised occurrences of surficial groundwater do not represent a significant or regionally extensive aquifer system, and should be considered to be an integral part of the surface water flow system.

## 8.4.3 Land Prone to Flooding and Inundation

Viney Creek and the tributary west of Viney Creek are considered areas where potential for flooding may occur.

The pre-mining 1 in 100 Year ARI flood levels for the Black Hill Pty Ltd were provided by the stakeholder to assess potential flooding impacts due to the proposed mining layout.

The post-mining 1 in 100 Year ARI flood levels will require a hydrological assessment based on the predicted surface levels prepared in this study. For indicative purposes, the worst-case flood levels have been estimated from the predicted post-mining contours, as shown in Figure 35a in Appendix A.

It is estimated that the areal extent of flooding due to the 1 in 100 year may increase by up to 5% for the subsided reaches of the un-named creek above Panel 8.

### 8.4.4 Swamps, Wetlands , Water Related Ecosystems

There is a small area of Viney Creek adjacent to John Renshaw Drive which is low lying and has ponded due to flow restrictions under John Renshaw drive resulting in a "swamp' type area. No identified Wetlands or Water Related Ecosystems are contained in the SMP area.

### 8.4.5 Flora, Fauna and Natural Vegetation

**Underground Mine Area**

This area consists of the land potentially subject to subsidence impacts over the underground mine, being approximately 1,900 hectares of relatively undisturbed vegetation and 900 hectares of fragmented vegetation in a farmland mosaic. The topography consists of a complex system of ridges (elevation around 300 metres) and steep gullies which drain across alluvial flats ultimately into the Hexham flood plain. Subsidence will be varied over the mine area due to factors such as depth of workings, geological conditions, surface features and slope. Therefore, not all surface areas will be subject to the same degree of subsidence, with some experiencing no change.

The SMP application area encompasses only 200 hectares. A baseline survey of the proposed mining area was undertaken as part of the EA process.

The complete flora and fauna lists and descriptions are provided as **Appendix D**.

**Methodology**

The investigation for this area was directed at classifying the various ecosystems extent across the area based on the vegetation, floristic content and structure. Habitat surrogates were used to develop a list of species of threatened flora and fauna that were considered likely to occur. Particular attention was given to the likelihood of species being present that were listed as rare or threatened from a local, State and Commonwealth perspective.

The vegetation communities present across the underground mining area were first assessed by ground-truthing. Summary data describing the composition and structure of the vegetation was collected at points across the area and this data was used to direct more detailed sampling of the variation found to be present. The summary data was obtained by driving all available tracks and by walking into areas not accessible by track.

Detailed sampling was in the form of standard 20mx20m floristic plots in which all species present were recorded using the modified Braun-Blanquet 6-point scale of cover-abundance. The data from these floristic plots was analysed against data from the wider region using PATN (Belbin 1989) in order to assess what groupings were present. The floristic content of the various groupings was then assessed against the vegetation communities detailed in the regional vegetation model as prepared by NPWS (2000).

Finally the ground-truthed data and the community classification data was combined and, using an extrapolation process in a GIS, a map of the vegetation communities extant over the area subject to potential subsidence impacts was prepared.

The available published data on the ecological requirements of species from a range of sources was used to determine which species of fauna were likely to be present in the vegetation communities mapped for the area.

### Results and Discussion

### Vegetation Communities

370 ground-truth data points and 31 detailed floristic plots were used to determine the vegetation communities extant across the Abel surface area. Analysis of the detailed floristic plots using PATN (Belbin 1989) showed 7 separate communities to be present (See **Appendix D** for detailed dendrogram).

**Table 10** lists the vegetation communities and their present area. Two listed and one preliminarily listed endangered ecological communities (EEC) were found to be present.

**Table 10- Vegetation Communities Mapped Across the Underground Mine Area**

| Map Unit | Description | Area (ha) |
|---|---|---|
| MU1a | **Sub-tropical Rainforest | 27 |
| MU5 | Alluvial Tall Moist Forest | 153 |
| MU12 | Hunter Valley Moist Forest | 174 |
| MU15 | Coastal Foothills Spotted Gum – Ironbark Forest | 593 |
| MU17 | *Lower Hunter Spotted Gum – Ironbark Forest | 643 |
| MU18 | Central Hunter Spotted Gum – Ironbark Forest | 20 |
| MU19 | *Hunter Lowlands Redgum Forest | 6 |
| MU30 | Coastal Plains Smooth-barked Apple Woodland | 108 |

*Endangered ecological community, **Preliminarily listed endangered ecological community.

A detailed description of each vegetation community listed above is provided in **Appendix D.**

### Groundwater Dependent Ecosystems

No Groundwater Dependent Ecosystems have been identified in the SMP Area.

### Flora

Over 350 species of flora were identified during the field assessment of the total Abel EA area. The full list can be found in **Appendix D.** There are no threatened flora species located within the SMP Area.

**Table 11** lists the significant species found during this investigation.

**Table 11- Significant Plant Species Found Across the Investigation Area.**

| Species | Status | Description | Habitat |
|---|---|---|---|
| *Arthropteris palisotii* | E | A climbing fern | One plant found in the Long Gully Sub-tropical Rainforest |
| *Tetratheca juncea* | V, C | A small wiry generally leafless plant with pink flowers | Restricted to the Smooth-barked Apple (MU30) vegetation |
| *Eucalyptus fergusonii* | R (2RC-) | An ironbark | MU15 and MU12 |

| Species | Status | Description | Habitat |
|---|---|---|---|
| *Callistemon shiressii* | R (3RC-) | A small paper bark tree with small cream 'bottle brush' flowers | Moist gullies (MU5) and rises (MU12) |

KEY: C = vulnerable Commonwealth EPBC Act, E = endangered NSW TSC Act, V = vulnerable NSW TSC Act, R = rare ROTAP (Briggs & Leigh 1995), 2RC- = geographic range <100k Rare Conserved but numbers unknown, 3RC- as for 2RC- but geographic range >100k.

## Fauna

The results of a database search of the Atlas of NSW Wildlife for an area within 5 kilometres of the boundary of the total Abel EA Investigation Area are shown in **Table 12**.

**Table 12- Threatened Fauna Species Recorded Within 5km Radius of EA Investigation Area**

| Family | Species | Common Name | Status |
|---|---|---|---|
| **Frogs** | | | |
| Hylidae | *Litoria aurea* | *Green and Golden Bell Frog | E1 |
| **Birds** | | | |
| Acanthizidae | *Pyrrholaemus sagittatus* | Speckled Warbler | V |
| Accipitridae | *Hamirostra melanosternon* | Black-breasted Buzzard | V |
| Accipitridae | *Lophoictinia isura* | Square-tailed Kite | V |
| Anatidae | *Stictonetta naevosa* | *Freckled Duck | V |
| Anseranatidae | *Anseranas semipalmata* | *Magpie Goose | E1 |
| Ardeidae | *Botaurus poiciloptilus* | *Australasian Bittern | V |
| Cacatuidae | *Calyptorhynchus lathami* | Glossy Black-Cockatoo | V |
| Ciconiidae | *Ephippiorhynchus asiaticus* | *Black-necked Stork | V |
| Climacteridae | *Climacteris picumnus* | Brown Treecreeper | V |
| Columbidae | *Ptilinopus magnificus* | Wompoo Fruit-Dove | V |
| Haematopodidae | *Haematopus longirostris* | *Pied Oystercatcher | V |
| Jacanidae | *Irediparra gallinacea* | *Comb-crested Jacana | V |
| Meliphagidae | *Melithreptus gularis gularis* | Black-chinned Honeyeater (eastern subsp.) | V |
| Meliphagidae | *Xanthomyza phrygia* | Regent Honeyeater | V |
| Petroicidae | *Melanodryas cucullata* | Hooded Robin | V |
| Psittacidae | *Lathamus discolor* | Swift Parrot | E1 |
| Psittacidae | *Neophema pulchella* | Turquoise Parrot | V |
| Rostratulidae | *Rostratula benghalensis australis* | *Painted Snipe (Australian subspecies) | E1 |
| Strigidae | *Ninox connivens* | Barking Owl | V |
| Tytonidae | *Tyto novaehollandiae* | Masked Owl | E1 |
| **Marsupials** | | | |
| Petauridae | *Petaurus australis* | Yellow-bellied Glider | V |
| Petauridae | *Petaurus norfolcensis* | Squirrel Glider | V |
| Phascolarctidae | *Phascolarctos cinereus* | Koala | V |
| **Megachiropteran Bats** | | | |
| Pteropodidae | *Pteropus poliocephalus* | Grey-headed Flying-fox | V |
| **Microchiropteran Bats** | | | |
| Emballonuridae | *Saccolaimus flaviventris* | Yellow-bellied Sheathtail-bat | V |
| Molossidae | *Mormopterus* | Eastern Freetail-bat | V |

| Family | Species | Common Name | Status |
|---|---|---|---|
| | *norfolkensis* | | |
| Vespertilionidae | *Chalinolobus dwyeri* | Large-eared Pied Bat | V |
| Vespertilionidae | *Falsistrellus tasmaniensis* | Eastern False Pipistrelle | V |
| Vespertilionidae | *Miniopterus australis* | Little Bentwing-bat | V |
| Vespertilionidae | *Miniopterus s chreibersii oceanensis* | Eastern Bent-wing Bat | V |
| Vespertilionidae | *Myotis adversus* | Large-footed Myotis | V |
| Vespertilionidae | *Scoteanax rueppellii* | Greater Broad-nosed Bat | V |

E1-Engangered, V-Vulnerable as per Schedule 2 of the *Threatened Species Assessment Act 1995.* * Species dependant on the Pambalong Nature Reserve or similar habitat.

During the field investigation a family of Powerful Owls (*Ninox strenua*), including adults and fledged young, were found in the rainforest gully at the southern part of the investigation area and a Sooty Owl (*Ninox tenebricosa*) was found in the Long Gully rainforest. A full list of fauna species considered likely to be present in the various habitat types across the area is provided in **Appendix D.**

## 8.5 MAN - MADE STRUCTURES

Man - made structures contained within the SMP application area are limited to the following:

- Roads (All types) - various private roads and access tracks (**Section 8.5.1**);
- Water supply pipelines – Hunter Water supply line, domestic and stock water pipelines (**Section 8.5.2**);
- Electricity transmission lines – Transgrid 330kV, Energy Australia 132kV and Energy Australia 11kV rural supply to various properties (**Section 8.5.3**);
- Telecommunication lines - Optus fibre optic and redundant Telstra copper cables (**Section 8.5.4**);
- Farm buildings, sheds - (**Section 8.5.5**);
- Fences - Various rural fences (**Section 8.5.6**);
- Farm dams - (one disused) (**Section 8.5.7**);
- Industrial, Commercial and Business Premises - Boral BlackHill Asphalt plant, workshop, minor fuel storage and offices (**Section 8.5.8**);
- Aboriginal Places, Archaeology and Heritage Sites - Aboriginal artefacts (**Section 8.5.9**); and
- Houses - six disused inhabitable houses. (**Section 8.5.10**);

Listed in **Tables 13** to **18 (inclusive)** is a check list of man - made structures from **Appendix B** in the SMP Guideline 2003.

**Man - Made Only Surface and Sub-Surface features that may be affected by Underground Coal Mining**

**Table 13- Item 2 - Public Utilities**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Railway | Reviewed aerial photo and topographical plan | Nil |
| 2 | Roads (all types) | Reviewed aerial photo and topographical plan | Various private roads and access tracks. |
| 3 | Bridges | Reviewed aerial photo and topographical plan | Nil |
| 4 | Tunnels | Reviewed aerial photo and topographical plan | Nil |
| 5 | Culverts | Reviewed aerial photo and topographical plan | One – Viney Creek |
| 6 | Water / gas / sewerage pipelines | Reviewed aerial photo. Dial Before You Dig website enquiry | Hunter Water pipeline, other domestic water pipelines for stock / domestic use |
| 7 | Liquid fuel pipelines | Reviewed aerial photo. Dial Before You Dig website enquiry | Nil |
| 8 | Electricity transmission lines (overhead / underground) and associated plants | Reviewed aerial photo. Dial Before You Dig website enquiry | Transgrid 330kV line, Energy Australia 132kV, Energy Australia 11kV, supply to individual properties. |
| 9 | Telecommunication lines (overhead / underground) and associated plants | Reviewed aerial photo. Dial Before You Dig website enquiry | Optus fibre optic, redundant Telstra copper services |
| 10 | Water tanks, water and sewerage treatment works | Reviewed aerial photo. Dial Before You Dig website enquiry. | *Nil* |
| 11 | Dams, reservoirs and associated works | Reviewed aerial photo and topographical plan | No reservoirs or substantial dams |
| 12 | Air strips | Reviewed aerial photo and topographical plan | Nil |
| 13 | Any other infrastructure items | Reviewed aerial photo and topographical plan | *Nil* |

**Item 3 - Public Amenities**

**Table 14- Item 3 – Public Amenities**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Hospitals | Reviewed aerial photo | Nil |
| 2 | Places of worship | Reviewed aerial photo | Nil |
| 3 | Schools | Reviewed aerial photo | Nil |
| 4 | Shopping Centres | Reviewed aerial photo | Nil |
| 5 | Community centres | Reviewed aerial photo | Nil |
| 6 | Office buildings | Reviewed aerial photo | Nil public |
| 7 | Swimming pools | Reviewed aerial photo | Nil |
| 8 | Bowling greens | Aerial photos, mine plans | Nil |
| 9 | Ovals and cricket grounds | Reviewed aerial photo | Nil |
| 10 | Race courses | Reviewed aerial photo | Nil |
| 11 | Golf courses | Reviewed aerial photo | Nil |
| 12 | Tennis courts | Reviewed aerial photo | Nil |
| 13 | Any other amenities considered significant | Reviewed aerial photo | Nil |

**Item 4 – Farm Land and Facilities**

**Table 15- Item 4 – Farm Land and Facilities**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Agricultural utilisation or agricultural suitability of farm land | Reviewed aerial photo | Yes |
| 2 | Farm buildings / sheds | Reviewed aerial photo | Yes |
| 3 | Gas and / or fuel storage | Reviewed aerial photo | No |
| 4 | Poultry sheds | Reviewed aerial photo | No |
| 5 | Glass houses | Reviewed aerial photo | No |
| 6 | Hydroponic systems | Reviewed aerial photo | No |
| 7 | Irrigation systems | Reviewed aerial photo | No |
| 8 | Fences | Aerial photos, mine plans | Yes, various |
| 9 | Farm dams | Reviewed aerial photo | Yes, one disused dam adjacent to Transgrid Tower T31B |
| 10 | Wells / bores | Consultant report | No |
| 11 | Any other feature considered significant | Catholic Diocese Water reticulation system for livestock | Yes |

**Table 16- Item 5 – Industrial, Commercial and Business Premises**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Factories | Reviewed aerial photo | Boral Plant |
| 2 | Workshops | Reviewed aerial photo | Boral Plant |
| 3 | Business or commercial premises | Reviewed aerial photo | Boral Plant |
| 4 | Gas and / or fuel storage and associated plants | Reviewed aerial photo | Minor fuel storage at Boral |
| 5 | Waste storages and associated plants | Reviewed aerial photo | Nil |
| 6 | Buildings, equipment and operations that are sensitive to surface movements | Reviewed aerial photo | Part of Boral Plant |
| 7 | Surface mining (open cut) voids and rehabilitated areas | Reviewed aerial photo | Nil |
| 8 | Mine infrastructure including tailings dams and emplacement areas | Aerial photos, mine plans | Nil |
| 9 | Any other feature considered significant | Reviewed aerial photo | Nil |

**Table 17- Items 6, 7 and 8 - Archaeological, Heritage, Architectural Significance**

| Item | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Areas of archaeological and / or heritage significance (including aboriginal) | Reviewed Aerial photo. Inspections of area conducted during various EA studies plus archaeological surveys by property owners | Yes |
| 2 | Items of Architectural significance | Reviewed Aerial photo. Inspections of area conducted during various EA studies. | Nil |
| 3 | Permanent survey control marks | Inquiry to Department of Lands Survey. Search of department of Lands website | Nil |

**Item 9 – Residential Establishments**

**Table 18- Item 9 – Residential Establishments**

| No. | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Houses | Reviewed aerial photo | Yes, three derelict inhabitable houses |
| 2 | Flats / Units | Reviewed aerial photo | Nil |
| 3 | Caravan Parks | Reviewed aerial photo | Nil |
| 4 | Retirement / aged care villages | Reviewed aerial photo | Nil |
| 5 | Associated structures such as workshops, garages, on-site waste water systems, water or gas tanks, swimming pools and tennis courts | Reviewed aerial photo | Nil |
| 6 | Any other feature considered significant | Reviewed aerial photo | Nil |

A review of aerial photographs confirmed that no Residential Establishments, as listed in **Appendix B** of the SMP Guideline 2003, with the exception of those identified as inhabitable are located within the SMP application area.

### 8.5.1 Roads (All Types)

There are no gazetted public roads, although several private roads and tracks cross the SMP application area. These access roads (sealed and unsealed) are located on land owned by the Catholic Diocese and Black Hill Land Pty Ltd. (See **Plan 2**)

### 8.5.2 Water Supply Pipelines

One buried 200mm diameter UPVC water supply pipeline (Hunter Water). The Hunter Water pipeline is buried within a trench that traverses the site above the proposed East Mains and Panel 1 pillar extraction panels (see **Plan 2**).

Buried water reticulation pipelines for livestock watering. The cattle grazing on the Catholic Diocese land are watered by a series of buried pipelines which supply several watering troughs.

### 8.5.3 Electricity Transmission Lines

Six 330kV Transgrid Transmission towers, including one tension tower No. 33B. The towers already have cruciform footings installed in the early 1980's in anticipation of future Underground Mining. From preliminary discussion with Transgrid the cruciform footings will be able to handle the expected levels of subsidence and strains.

A 132 kV transmission line suspended on eight pairs of timber poles (Energy Australia). There are eight pairs of timber power poles (EA1 to EA8) which will be within or just outside the zone of mine subsidence. The pole pairs are approximately 15 m high and 5 m apart. The pole pairs are connected by a galvanised steel brace between the top section of the poles. The pole pairs are spaced from 161 m to 269 m along the easement.

Domestic 11 kV suspended power lines (Energy Australia) cross the SMP area and feed the BlackHill Area.

### 8.5.4 Telecommunication Lines

An Optus fibre optic cable is buried within a shallow trench located within the Transgrid Powerline easement (see **Plan 2**).

Redundant Telstra domestic buried copper telephone lines approximately 1.5 km long formerly servicing the disused poultry farms on the Catholic Diocese land (see Plan 2). This local cable reticulation was used when the property was functioning as a chicken farm and the cable provided services to the individual properties located on the land. It has not been used for some time and the cable has fallen into disrepair due to lack of maintenance. As the only future Principal Residence listed on the Catholic Land at the time of Project Approval was the proposed school, the impact on the redundant copper cables within the SMP Area 1 has not be considered. There is live local copper cable feed to the residents along BlackHill Road which will not be affected from the mining within SMP Area.

### 8.5.5 Farm Buildings

Demolished chicken battery farm shed rubble (Catholic Diocese Land).

### 8.5.6 Rural Fences

Various rural type fences throughout SMP Area 1 including boundary fences between the neighbouring landholders, internal fences for stock control and boundary fences between the landholders and public roads.

### 8.5.7 Farm Dams

An abandoned earth embankment dam with < 1ML capacity (Black Hill Land Pty Limited Land) located to the Transgrid Tower 31B.

### 8.5.8 Industrial, Commercial and Business Premises - Boral Asphalt Plant

The Boral BlackHill Asphalt plant (Black Hill Land Pty Ltd) produces 40,000 tonnes/annum of hot asphalt and 5 Million litres/annum of sprayed bitumen seal for the Australian road construction industry. The site has the following sensitive items of infrastructure that will have very low differential settlement tolerances and represent a business, safety and environmental hazard:

- rotating drum burner to dry aggregate (340$^{o}$C operating temperature)
- 22 m high x 0.75 m stainless steel exhaust stack with guywires
- elevated diesel and bitumen storage tanks
- elevated conveyors and pipe network for materials transfer
- lime storage tank
- hot asphalt and spray-seal bitumen storage tanks (46,000 litres @ 170$^{o}$C operating temperature)
- diesel and CRS Emulsion tanks (27,000 and 15,000 litres)
- in-ground concrete oil separator pits
- weigh-bridge / loading bay
- kerosene and Elgas storage tanks with underground pipe lines
- workshops with concrete slab footings
- masonry block retaining walls
- Gravel hardstand equipment and transport vehicle storage areas
- Buried 100 mm Victaulic water supply pipeline

Other features on the site include staff offices, amenities buildings and car parking.

### 8.5.9 Aboriginal Places, Archaeological and Heritage Sites

Reference to three separate studies of the area (**Parsons Brinkerfhoff, 2003**, **South Eastern, 2006** and **ERM, 2008)** have identified three scattered Aboriginal artefact sites in SMP Area 1 (see **Plan 2**). The artefacts are listed as silcrete stone axe flakes and were identified by the Mindaribba Local Aboriginal Land Council, Awabakal Traditional Owners and Kukuyal Burritjapa.

The three scattered artefact sites identified within SMP Area 1 are located outside the zone of subsidence due to the proposed mining layout.

Further artefact sites may be present along Viney Creek which have yet to be identified (**ERM, 2008**). It is very unlikely that any unidentified sites located above Viney Creek will be affected or damaged by subsidence impacts such as surface cracking and increased erosion rates as Viney Creek is located within a Subsidence Protection Zone.

A further survey of the SMP area will be undertaken by Donaldson Coal in accordance with the approved Aboriginal Heritage Management Plan prior to secondary extraction being undertaken.

### 8.5.10 Houses

Disused uninhabited houses/ buildings. The previous land user buildings on the site are either in various stages of disrepair or have been demolished.

## 8.6 AREAS OF ENVIRONMENTAL SENSITIVITY

Section 6.6.3 of the SMP Guideline 2003 sets out a list of potentially environmentally sensitive areas that must be assessed as part of the SMP application. In **Table 19** below each item has been assessed with respect to the Abel SMP application area.

**Table 19- Assessment of Environmental Sensitivity**

| Item | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 1 | Land reserved as State Conservation Area under National Parks and Wildlife Act 1974 (NPWA74) | Reviewed National Parks database. Also Mineral Resources | Nil |
| 2 | Land reserved as an Aboriginal Place under NPW Act 74 | Review of Archaeological reports | Nil |
| 3 | Land identified as wilderness by the Director NPWS under the Wilderness Act 1987 | Reviewed National Parks database | Nil |
| 4 | Land subject to a conservation agreement under NPWA74 | Historic Knowledge, title search | Nil |
| 5 | Land acquired by Minister for the Environment under Part 11 NPWA74 | Reviewed National Parks website. | Nil |
| 6 | Land within State Forests mapped as Forestry Management Zones 1, 2 or 3 | No State Forests in SMP Area 1 | Nil |
| 7 | Wetlands mapped under SEPP14 – Coastal Wetlands | Internet search | Nil |
| 8 | Wetlands listed under the Ramsar Wetlands Convention | Website, internet search | Nil |
| 9 | Lands mapped under SEPP 26 – Coastal Rainforests | Website, internet search | Nil |
| 10 | Areas listed on the Register of National Estate | Reviewed by internet search | Nil |
| 11 | Areas listed under the Heritage Act 1977 for which a plan of management has been prepared | Reviewed Australian Heritage Register | Nil |
| 12 | Land declared as critical habitat under the Threatened Species Conservation Act 1995 | Reviewed NSW NPWS website | Nil |

| Item | Description | Method of Assessment | Items in SMP Application Area |
|---|---|---|---|
| 13 | Land within a restricted area prescribed by a controlling water authority | | Nil |
| 14 | Land reserved or dedicated under the Crowns Land Act 1989 for the preservation of flora, fauna, geological formations or other environmental protection purposes | Government Gazette searches | Nil |
| 15 | Significant surface watercourses and groundwater resources identified through consultation with relevant government agencies | Aerial photos, topo maps, some ground truthing. | Viney Creek Schedule 2 |
| 16 | Lake foreshores and flood prone areas | Cessnock and Newcastle City Council LEP | *Yes* |
| 17 | Cliffs, escarpments and other significant natural features | Aerial photographs, topographical maps, ground truthing | Nil in SMP Area 1 |
| 18 | Areas containing significant ecological values | Internet searches, review of websites. Also as part of other reviews within this section | Nil |
| 19 | Major surface infrastructure | Aerial photographs, topographical maps, ground truthing | None that were not previously identified |
| 20 | Surface features of community significance (including cultural, heritage or archaeological significance) | Reviewed by archaeological survey. Aerial photos, ground truthing | Nil |
| 21 | Any other land identified by the Department to the titleholder | | Nil |

# 9 BASELINE DATA AND MONITORING

Various monitoring programs have been conducted since Abel commenced production. Refer to **Figure 5** for location of current monitoring sites within and adjacent to the SMP application area. Monitoring programs currently in place are described in Sections 9.1 to 9.5.

## 9.1 SUBSIDENCE

No Subsidence monitoring has been conducted within the SMP Area. A subsidence Monitoring Program will be developed in consultation with the Principal Subsidence Engineer.

## 9.2 WATER

The location of the water quality sampling locations is shown on Figure 6.

Analytes measured in the laboratory include pH, Electrical Conductivity (EC), Total Dissolved Solids, Total Suspended Solids (TSS), Chloride, Sulfates, Alkalinity (Bicarbonate), Alkalinity (Carbonate), Calcium, Magnesium, Sodium and Potassium. Data for the main watercourses within the Abel underground mine area is presented in Table 20. This data has been sourced from sampling undertaken as part of the Abel Project and routine sampling undertaken by Donaldson Mine.

**Table 20- Background Surface Water Quality Data**

| Sample Site | | PH | EC µS/cm | Total Suspended Solids Mg/L |
|---|---|---|---|---|
| | | | | |
| Viney Creek | Max | 8.6 | 1,130 | 39 |
| | Min | 6.8 | 510 | 4 |
| | | | | |
| Buttai Creek | Max | 8.3 | 1,720 | 18 |
| | Min | 6.2 | 560 | 3 |

## 9.3 GROUNDWATER

Ongoing groundwater quality and level monitoring will be undertaken as part of the integrated network of monitoring bores for the Bloomfield, Abel, Donaldson and Tasman mines. Measurement of the quality and volume of inflow water to the underground workings is also undertaken. Results of the groundwater monitoring is shown in Table 21.

**Table 21- Groundwater Sampling results**

| Sample Site | | PH | EC µS/cm |
|---|---|---|---|
| Bartter South | Max | 8.2 | 19120 |
| | Min | 6.2 | 1120 |
| | Ave | 6.75 | 11316 |

## 9.4 FLORA

A program of vegetation monitoring has been introduced to assist in determination of the environmental effect of the mining operation on vegetation.

## 9.5 FAUNA

Long term fauna monitoring sites have been established to identify impacts (if any) of mining induced subsidence on native fauna.

## 9.6 MINE WATER MAKE

Pumping quantities from various mine pump lines are currently monitored with some water recycled for use within both the mine surface and underground. An underground mine water monitoring program is currently being developed to enable more detailed and accurate assessment of the actual water flows pumped into and out of the mine which, in conjunction with underground sump level monitoring, will provide more accurate information relating to potential ground water inflows.

All underground water is pumped to a sump in the Abel Mine box cut. Excess water from here is pumped to the Big Kahuna Dam (surface water dam located within ML 1461 for the Donaldson mine) for re use.

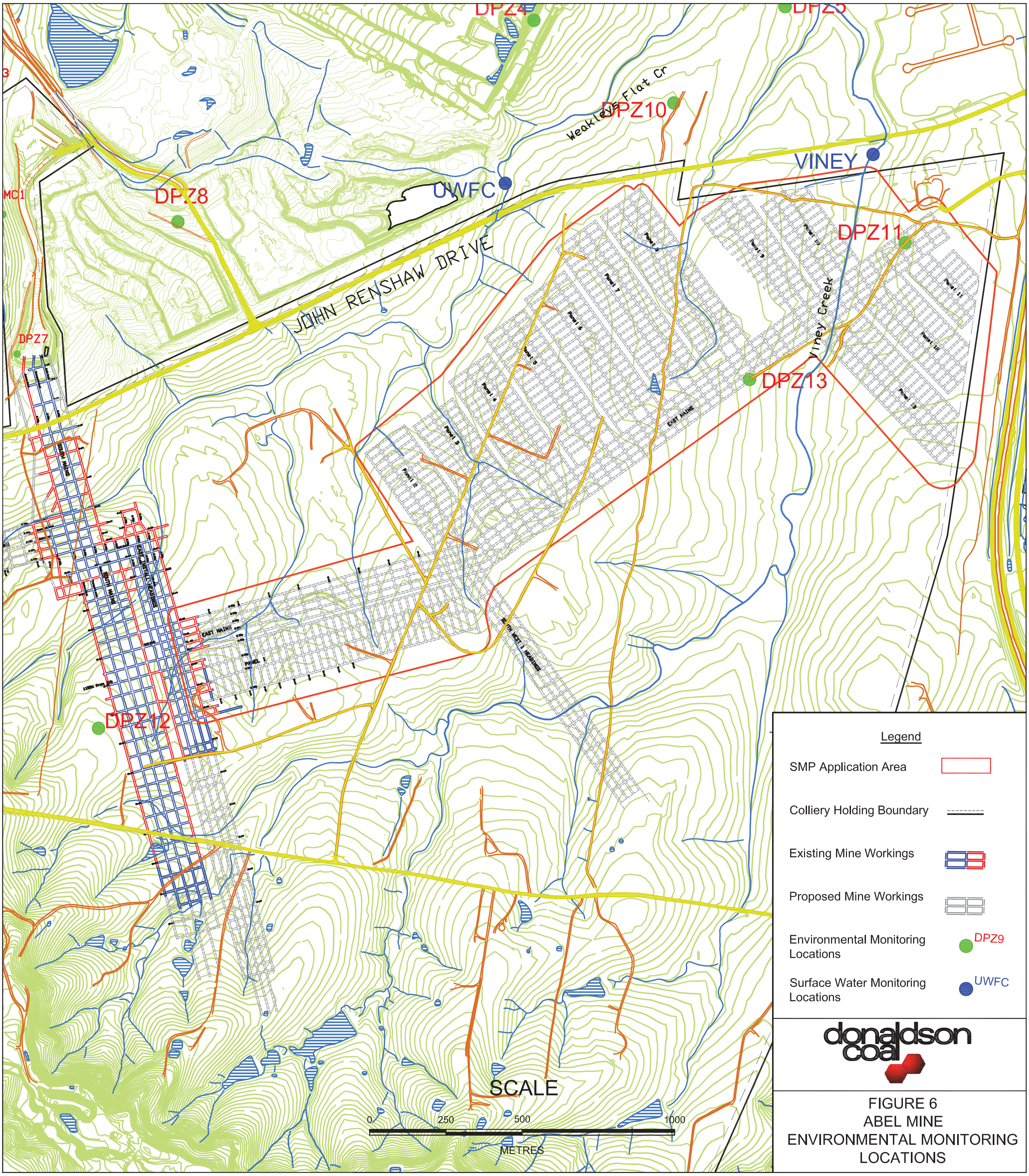



FIGURE 6
ABEL MINE
ENVIRONMENTAL MONITORING
LOCATIONS

# 10 SUBSIDENCE PREDICTIONS

## 10.1 GENERAL DESCRIPTION OF SUBSIDENCE FEATURES

Following is a general description of the type of subsidence effects associated with both development and pillar extraction mining within the SMP application area.

Development headings are first workings, involving the formation of a series of headings (tunnels) driven up to 5.5 metres wide and up to the full height of the coal seam. Development headings are designed to remain stable for extended periods of time. Consequently, no collapse of overlying rock strata into the area from which coal is extracted is anticipated. Subsequently, there are no subsidence impacts from first workings.

Pillar extraction mining within the SMP application area involves the progressive removal of substantial portions of the coal seam (the pillars formed during development), creating a void up to 160.5 metres wide. The extraction of this coal, and subsequent collapse of the immediate overlying strata, results in surface subsidence. Subsidence of the ground surface normally occurs to an extent less than the extracted seam thickness. The extent of the subsidence depends on a number of factors including the height and width of the coal seam extracted, characteristics of the overlying strata and the depth of mining.

In pillar extraction mining situations the roof is unable to support itself with the strata above subsequently fracturing and caving into the resultant void. The caved material fills the void (goaf) to a height dependent upon the bulking factor of the fractured / broken material, with the strata above lowering and settling onto the goaf. The settlement and bending of the strata to the surface is such that a subsidence trough develops that is wider than the actual coal that has been extracted.

The angle at which subsidence tapers out to the limit of subsidence at the surface is referred to as the angle of draw. The angle of draw is defined in the Department of Mineral Resources SMP Guideline 2003 as being 26.5 degrees from the vertical to the subsidence limit, which is taken to be a point where subsidence is equal to 20mm. This is also dependent on the strength of the strata, the lithology and other parameters.

### 10.1.1 Subsidence Parameters

Key parameters used in the description, prediction and assessment of surface movements resulting from underground mining are:

- Subsidence;
- tilt;
- strain;
- closure; and
- upsidence

### Subsidence

The general term "subsidence" is commonly used to describe the overall phenomenon of ground movement as a result of mining. Vertical subsidence is actually the vertical distance (usually measured in millimetres) that the ground surface lowers as a result of mining. Maximum subsidence generally occurs within the central portion of the depression in the surface profile, which occurs over the extracted panel or panels.

Ground strains and tilt are more critical parameters in terms of effects on watercourses, cliffs, rock formations, buildings or other surface infrastructure.

## Tilt

As noted above, subsidence develops in a typical profile that generally results in the land surface having different degrees of vertical subsidence. Tilt is calculated as the difference in subsidence between two points on the land surface, divided by the distance between those two points (that is, the change in slope of the surface landform as a result of mining). The maximum tilt, or the steepest portion of the subsidence profile, occurs at the point of inflection in the subsidence trough where the subsidence is roughly equal to one half of the maximum subsidence. Tilt is usually expressed in mm/m. The Mine Subsidence Board (1991) indicate that the surface features that are most likely to be affected by tilts are tall structures and structures that are dependent on gravity to operate such as gutters, drains, sewers and water and sewerage works.

## Strain

Strain is determined by calculating the horizontal change in length of a section of land surface and dividing this by the horizontal length of that section. The length of land (bay length) is also typically one twentieth of the depth of cover. If the section has been lengthened, the ground is in tension, referred to as tensile strain. Alternatively, if the section has been shortened, the ground is in compression, referred to as compressive strain. The unit adopted for strain is mm/m. The maximum strains coincide with the maximum curvature of the profile and hence the maximum tensile strains occur over the side of the panel whilst the maximum compressive strains occur towards the bottom of the subsidence profile.

## Closure

Closure is often associated with valley bulging, particularly in deep, steep sided valleys. Closure refers to the measured horizontal displacement of the flanking ridges towards the centre of the valley.

With predicted subsidence some closure is anticipated, however it will not be perceptible nor have a significant impact due to the nature of the ephemeral watercourses and topography.

## Uplift / Upsidence

Where a valley is undermined it is often observed that the valley floor subsides less than the surrounding ridge tops. This is known as bulging. While this term implies that the ground experiences an upward vertical movement, the normal vertical movement is still generally downwards. The difference in subsidence between the ridge top and floor in these cases is called “uplift”. In extreme cases the valley floor may actually rise rather than subside and the rise in the ground surface is known as “upsidence”.

## Scarp Development

Scarps refer to small steps in the surface that are the result of sub-vertical shear failure above the limits of total extraction and solid or partial extraction boundaries.

Where cover depths are less than 80 metres, only in the northern section of SMP Area 1, scarp development can be managed by leaving partial extraction zones between panel edges or repaired by filling cracks with self cementing materials and replacing the topsoil.

## 10.2 SUBSIDENCE PREDICTION METHOD AND ASSESSMENT CRITERIA

Due to the variability in rock strata composition, strength and behaviour, all subsidence assessments / predictions involve estimations based on historical data (empirical method) and may involve computer based mathematical modeling. Empirical subsidence estimation methods have been extensively documented and the accuracy of this method has been demonstrated, by monitoring to be in the order of +/-10%.

The subsidence study, conducted by Ditton Geotechnical Pty Ltd (Ditton), included the following activities and the application of several industry established empirical models to predict the 'mean' and 'credible worst-case' subsidence for a given mining layout:

(i) Development of a geotechnical model for the study area (i.e. mining geometry, geology,
material properties etc).

(ii) Calculation of maximum subsidence impact parameter predictions and representative parameter profiles using the **ACARP, 2003** and **Holla, 1987** empirical subsidence models and the mining geometries proposed.

(iii) Assessment of barrier and chain pillar stability, based on **ACARP, 1998a** and **ACARP, 1998b**.

(iv) Development and calibration of **SDPS®** models (using the subsidence, tilt and strain profiles from (ii)) to generate subsidence and associated impact parameter contours above the proposed mining layouts.

(v) Generation of subsidence, tilt, strain, horizontal displacement, post mining topography, potential cracking width, ponding location and surface slope gradient change contours for the proposed mining layouts using **Surfer8®** contouring software.

(vi) Estimation of sub-surface fracturing heights above the panels using empirically based models in **ACARP, 2003**, **Forster, 1995** and **Mark, 2007**.

(vii) Estimation of the extent and magnitude of far-field displacements (FFD) and strains (FFE), based on empirically based models developed from Newcastle Coalfield data by **DgS, 2008**.

The two subsidence predictions models used in this study are summarised below:

- **ACARP, 2003 -** An empirical model that was originally developed for predicting maximum single and multiple longwall panel subsidence, tilt, curvature and strain in the Newcastle Coalfield. The model database includes measured subsidence parameters and overburden geology data, which have been back analysed to predict the subsidence reduction potential (SRP) of massive lithology in terms of 'Low', 'Moderate' and 'High' SRP categories.

- The model database also includes chain or barrier pillar subsidence, inflexion point distance from panel edges, inflexion point subsidence, goaf edge subsidence and angle of draw prediction models. These models allow subsidence profiles to be generated for any number of panels within a range of appropriate statistical confidence limits. The mean and Upper 95% Confidence Limit

(U95%CL) values have been adopted in this study for predictions of the average and Credible Worst-Case values expected, due to the proposed mining activities.

The **ACARP, 2003** model may also be used for predicting maximum subsidence above pillar extraction panels by applying the 'effective' mining height principal (i.e. extraction ratio x mining height) defined in **Van de Merwe and Madden, 2002**. The principal allows for subsidence reducing effect of crushed out remnant coal that will be left behind in the workings.

Based on a comparison between high extraction panel and longwall panel subsidence databases in **ACARP, 2003** and **Holla, 1987**, a conservative extraction ratio of 95% and a maximum longwall panel subsidence of 58% of the mining height, give a maximum pillar extraction panel subsidence of 55% of the mining height.

A summary of the **ACARP, 2003** model, which defines the parameters and terms used, is presented in **Appendix A**.

- **SDPS®, 2007** - A US developed (Virginia Polytechnical Institute) influence function model for subsidence predictions above longwalls or pillar extraction panels. The model requires calibration to measured subsidence profiles to reliably predict the subsidence and differential subsidence profiles required to assess impacts on surface features.

- The model also includes a database of percentage of hard rock (i.e. massive sandstone / conglomerate) that effectively reduces subsidence above super-critical and sub-critical panels, due to either bridging or bulking of collapsed material. An extract from the **SDPS®** user manual defining the parameters and terms used is presented in **Appendix B**.

Overall, the SDPS® model should preferably be calibrated to measured subsidence profiles above pillar extraction workings with similar conditions as Abel. However, due to the lack of similar mining data, the calibration procedure applied in this study is considered best practice for a 'green fields' study. A re-calibration of the model may be necessary, however, if the predicted outcomes of this study are significantly different to measured ones.

The modifications to the **ACARP, 2003** model by DgS included adjustments to the following key parameters, which were made to improve compatibility between the two models used in this study:

- Chain (and barrier) pillar subsidence prediction is now based on pillar subsidence over extraction height ($S_p/T$) v. pillar stress (under double abutment loading conditions).

- Distance of the inflexion point from rib sides and inter-panel pillars in similar terms to **SDPS®** software (i.e. d/H v. W/H).

- The horizontal strain coefficient ($\beta_s$) is the linear constant used to estimate strain based on predicted curvature, and is equivalent to the reciprocal of the neutral axis of bending, $d_n$ used in **ACARP, 2003**. Based on NSW coalfield data, a value of $d_n$ = 7.3 m or a $\beta_s$ = 0.136 $m^{-1}$ has been applied to predict 'smooth' profile strains using the calibrated **SDPS®** model.

Multiple-panel effects are determined by the **ACARP, 2003** model by adding a proportion of the chain (or barrier) pillar subsidence to the predicted single panel subsidence. Estimates of first and final subsidence above a given set of pillar extraction panels use this general approach. The definition of First and Final $S_{max}$ is as follows:

First $S_{max}$ = the total subsidence after the extraction of a panel, including the effects of previously extracted panels adjacent to the subject panel;

Final $S_{max}$ = panels the total subsidence over an extracted panel, after at least three more have been extracted, or when mining is completed.

First and Final $S_{max}$ for a panel are predicted by adding 50% and 100% of the predicted subsidence over the respective barrier pillars (i.e. between the previous and current panel), less the goaf edge subsidence (which occurs before the barrier pillar is loaded from both sides). The maximum subsidence is limited to 58% of the effective mining height for the panels.

The subsidence above chain and barrier pillars has been defined in this study as follows:

First $S_p$ = subsidence over a pillar after panels have been extracted on both sides of the pillar;

Final $S_p$ = the total subsidence over a pillar after at least another three more panels have been extracted, or when mining is completed.

A conceptual model of the multiple panel subsidence mechanism is given in **Figure 4a of Appendix A**.

Residual subsidence above chain (and barrier) pillars and extracted panels tend to occur after mining of adjacent panels due to (i) increased overburden loading on the pillars, and (ii) on-going goaf consolidation or creep of the collapsed roof or goaf in the panel. The residual movements can increase subsidence by a further 10 to 30% above chain (and barrier) pillars after the first pillar subsidence occurs. Residual subsidence is likely to decrease exponentially as mining moves further away from a given panel.

A subsidence increase of 20% after double abutment loading occurs (i.e. First $S_p$) has been assumed in this study to allow for long-term loading effects (i.e. Final $S_p$).

Unless otherwise stated the predicted values presented in the following sections of this report are given as a range from the mean to the U95%CL values. The measured subsidence will be expected to be somewhere between these values.

Tilts and curvatures have been assessed using the empirical techniques presented in **ACARP, 2003** and by also taking first and second derivatives of the predicted subsidence profiles for comparative purposes.

Predictions of strain and horizontal displacement were made based on the relationship between the measured curvatures and tilt respectively as discussed in **ACARP, 1993** and **ACARP, 2003**.

Structural and geometrical analysis theories indicate that strain is linearly proportional to the curvature of an elastic, isotropic bending 'beam'. This proportionality actually represents the depth to the neutral axis of the beam, or in other words, half the beam thickness. **ACARP, 1993** studies returned strain over curvature ratios ranging between 6 and 11 m for NSW and Queensland Coalfields. Near surface lithology strata unit thickness and jointing therefore dictate the magnitude of the proportionality constant between curvature and strain. Similar outcomes are found for tilt and horizontal displacement.

**ACARP, 2003** continued with this approach and introduced the concept of secondary curvature and strain concentration factors due to cracking. The mean peak strain /

curvature ratio for the Newcastle Coalfield was assessed to equal 5.2 m with strain concentration effects increasing the ‘smooth-profile’ strains by 2 to 4 times. On-going review of the database has lead to the median value of 7.3 being adopted as a more appropriate value for impact prediction purposes.

A $d_n$ value of 7.3 m has therefore been applied to the predicted ‘smooth’ curvature and tilt profiles to estimate strain and horizontal displacement respectively above the proposed Abel panels. These values may then be compared to the empirical model outcomes to estimate localised, concentrated strain effects due to cracking. Cracking is expected to occur in zones of peak tensile (or compressive) strains when tensile and compressive strains exceed 1 to 2 mm/m respectively and where surface rock exposures are present.

For the Abel mining lease, the presence of deep alluvial soils are likely to reduce the potential for strain concentration, resulting in strain profiles close to the predicted ‘smooth’ subsidence profile strains presented herein.

Surface crack widths (in mm) may be estimated by multiplying the predicted strains by 10 which is an empirical relationship based on the distance between the pegs in the **ACARP, 2003** model database and the measured strains and crack widths above extracted panels.

## 10.3 PREDICTED SUBSIDENCE PARAMETERS

### 10.3.1 Introduction

The SMP application area (SMP Area 1) is that area considered as likely to be affected by the mining of Panels PE1 to PE13 inclusive plus the East Mains in the Upper Donaldson seam at Abel mine. SMP Area 1 is defined as the surface area enclosed by a 26.5 degree angle of draw from the limit of proposed mining as defined in **Section 6.2** in the SMP Guideline 2003.

The proposed panel layout, the SMP application area and the 20mm subsidence contour are shown on **Plan 1**.

The following sections describe the detailed subsidence predictions that have been made for Panels PE1 to PE13 inclusive, plus the East Mains, and include predicted subsidence parameters for all significant natural and man - made features within SMP Area 1. The predicted subsidence parameters outlined have been used in completing the subsidence impact assessments listed in **Section 11** of this document.

## 10.4 PREDICTED SUBSIDENCE PARAMETERS AREA 1

Subsidence predictions within the SMP application area have been provided by Ditton Geotechnical Services and a summary is provided for easy reference. Further detail can be found in **Appendix A.**

The pillar extraction panels will be 160.5 m wide, have cover depths ranging from 50 m to 135m (for pillar panels), and mining heights ranging from 2.0 to 3.2 m (i.e. equal to the seam thickness). The East Mains headings will also be extracted on retreat after the production panels are completed and will have panel void widths of 125 m to 131.25 m. The mining height in the East Mains panels will range from 2.0 m to 3.2 m.

Panel development headings will be 5.5 m wide and range from 2.2 m to 3.0 m high (depending on seam thickness).

Barrier pillars between production panels and the East Mains headings will generally have widths of 19.5 m and 16.5 m respectively and are expected to behave elastically in the long term (i.e. strain hardening characteristics are likely to develop if the pillars are overloaded).

The overburden comprises thinly bedded sandstone, siltstone and mudstones (shale) of the Dempsey Formation, which is part of the Permian Aged Tomago Coal Measures. A persistent geological structure (reverse fault) with an 8 m throw intersects the eastern SMP area on a north westerly strike.

The panel width to cover depth (W/H) ratios for the proposed 160.5 m wide pillar extraction panels will range from 1.19 to 2.92, indicating 'critical' to 'supercritical' subsidence behaviour, which are assumed to occur when panel W/H ratios are > 0.6 and >1.4 respectively.

The panel width to cover depth (W/H) ratios for the East Mains 125 m to 131.25 m wide panels will range from 1.31 to 1.75, indicating supercritical subsidence behaviour.

The following subsidence impact parameters for all proposed pillar extraction panels are predicted (**Table 222**):

- First and Final maximum panel subsidence ranging from 870 mm to 1760 mm (40% to 55% of the mining height).
- First and Final barrier pillar subsidence ranges from 30 mm to 260 mm due to total pillar stresses after mining of 1.7 MPa to 12.9 MPa.
- Final maximum panel tilt ranges from 15 mm/m to 76 mm/m.
- Final maximum panel hogging curvature ranges from 0.61 $km^{-1}$ to 3.61 $km^{-1}$.
- Final maximum panel sagging curvature will range from 0.77 $km^{-1}$ to 4.58 $km^{-1}$.
- Final tensile strains associated with the hogging curvatures will range from 4 mm/m to 26 mm/m.
- Compressive strains associated with the sagging curvatures will range from 6 mm/m to 33 mm/m.
- Final maximum panel horizontal displacement from 110 mm to 555 mm.

**Table 22- Maximum Predicted Subsidence Parameters**

| | SMP Area 1 |
|---|---|
| Depth Range (m) | 50 -135 |
| Panel Width (m) | 125 / 131.25 / 160.5 |
| Panel W/H Ratio Range | 1.23 to 2.92 |
| Maximum Subsidence (mm) | 870 to 1,760 |
| Barrier pillar subsidence (mm) | 30 to 260 |
| Horizontal Movements (mm) | 110 to 555 |
| Tensile Strain (mm/m) | 4 to 26 |

| | |
|---|---|
| Compressive Strain (mm/m) | 6 to 33 |
| Tilt (mm/m) | 15 to 76 |

## 10.5 PREDICTED SUBSIDENCE PARAMETERS SURFACE FEATURES

### 10.5.1 Natural Features

Subsidence predictions have been calculated for the natural features located within SMP Area 1 (**Table 233**). The general nature of the surface topography within the SMP application area at Abel means that the vertical subsidence, of itself, is of no particular significance. For all practical purposes vertical subsidence is imperceptible and does not impact significantly on gradients.

**Table 23- Predicted Maximum Subsidence Parameters for Natural Features**

| Item | Location | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm / m) | Maximum Predicted Tensile Strain (mm / m) | Maximum Predicted Compressive Strain (mm / m) |
|---|---|---|---|---|---|
| Watercourse – ephemeral tributaries | | 870 to 1,760 | 15 to 76 | 4 to 26 | 6 to 33 |
| Watercourses – Viney Creek | | Nil | Nil | Nil | Nil |
| Land prone to flooding | | Up to 1,000 | | | |
| Swamps, wetlands | Nil in area | | | | |
| Flora | | 870 to 1,760 | 15 to 76 | 4 to 26 | 6 to 33 |
| Fauna | | 870 to 1,760 | 15 to 76 | 4 to 26 | 6 to 33 |

### 10.5.2 Man – made Features

Subsidence predictions have been calculated for the man-made features located within SMP Area 1 (**Table 244**).

**Table 24- Predicted Maximum Subsidence Parameters for Man-made Features**

| Item | Location | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm / m) | Maximum Predicted Tensile Strain (mm / m) | Maximum Predicted Compressive Strain (mm / m) |
|---|---|---|---|---|---|
| **Roads (all types)** | | 870 to 1,760 | 15 to 76 | 4 to 26 | 6 to 33 |
| **Water Supply Lines** | | | | | |
| Hunter Water UPVC | | 1,070 to 1,500 | 18 to 28 | | |
| Catholic Diocese stock water | | Up to 1,690 | 3 to 32 | | |

| Item | Location | Maximum Predicted Subsidence (mm) | Maximum Predicted Tilt (mm / m) | Maximum Predicted Tensile Strain (mm / m) | Maximum Predicted Compressive Strain (mm / m) |
|---|---|---|---|---|---|
| **Electricity Transmission Lines** | | | | | |
| Transgrid 330kV tension tower | | Nil SCZ | | | |
| Transgrid 330kV towers | | 20 to 1,090 | Transient 4 to 33 Final 2 to 25 | Transient 0.5 to 5.5 Residual 1.5 to 3.5 | Transient 0.5 to 5.5 Residual 1.5 to 3.5 |
| Energy Australia 132kV timber poles | | 20 to 1,560 | 0 to 18 | | |
| Energy Australia 11kV timber poles | | 20 to 1,560 | 0 to 29 | | |
| **Telecom. cables** | | | | | |
| Optus fibre optic | | 0 to 1,530 | 0 to 21 | | |
| **Fences** | | 1,210 to 1,760 | 15 to 76 | 4 to 26 | 6 to 33 |
| **Dams** | | 870 to 1,760 | 15 to 76 | 4 to 26 | 6 to 33 |
| **Boral Asphalt Plant** | | Nil SCZ | | | |
| **Aboriginal Places** | | Nil outside of subsidence area | | | |
| **Houses** | | Nil | | | |

## 10.6 ESTIMATION OF THE RELIABILITY OF THE SUBSIDENCE PREDICTIONS

Though no history of subsidence monitoring or results is available for pillar extraction mining in the Abel SMP Area 1, substantial monitoring and subsidence history for this type of mining in similar conditions is available.

Several subsidence predictions models were used (see detail in **Section 10.2**) and based on a comparison between high extraction panel and longwall panel subsidence databases in **ACARP, 2003** and **Holla, 1987**, a conservative extraction ratio of 95% and a maximum longwall panel subsidence of 58% of the mining height, give a maximum pillar extraction panel subsidence of 55% of the mining height. This equates to maximum predicted subsidence of 1760mm. These models have been previously used with monitoring confirming subsidence and associated strains and tilts below predictions.

## 10.7 VERIFICATION OF SUBSIDENCE PREDICTIONS

Subsidence monitoring from other mines in the Newcastle Coalfield, is presented in Holla (1991). The experience of subsidence prediction and monitoring utilizing the predictions models has proven conservative at the neighbouring Tasman Mine. Subsidence monitoring proposed in the Abel SMP Area 1 will provide information on a panel by panel basis for site specific verification.

# 11 SUBSIDENCE IMPACTS AND MANAGEMENT STRATEGIES

## 11.1 ASSESSMENT FOR SUBSIDENCE IMPACTS

### 11.1.1 General Surface

#### 11.1.1.1 Surface Cracking

**Predicted Impacts**

The predicted panel subsidence magnitudes of 870 mm to 1,760 mm are likely to result in surface cracks developing within the limits of the extracted panels. It is very unlikely that surface cracks will develop above first workings pillars, where subsidence magnitudes of < 20 mm are expected.

Cracks are likely to develop in the tensile strain zones that will occur between 15 to 25 m in from the rib-sides of each total extraction panel. Crack widths of up to 10 mm may start to develop at the surface where tensile strains exceed 1 mm/m over a distance of 10 m. The maximum crack widths generally develop where maximum tensile strains occur.

Compressive strains can also cause cracking and upward ‘buckling’ of near surface rock beds due to low-angle shear failures. The compressive strains generally peak at one or two locations in the middle third area of the panels.

Based on the predicted range of maximum transverse tensile strains (i.e. 4 to 26 mm/m), maximum surface cracking widths of between 40 mm and 260 mm could occur within the limits of extraction (i.e. goaf), and soon after mining is completed beneath the area. The larger cracks are predicted in the shallow areas where cover depths are < 80 m.

Crack widths in the areas deeper than 80 m are likely to be in the order of 30 to 150 mm above pillar extraction panels. The tensile cracks will probably be tapered and extend to depths ranging from 5 to 10 m, and possibly deeper if near surface bedrock exposures are present.

For the case of the total pillar extraction panels, the predicted range of maximum transverse compressive strains (i.e. 5 to 33 mm/m) may result in shear displacements or 'shoving' of between 50 mm and 330 mm within the central limits of proposed panels.

Based on the strain contour figures, the location of the tensile cracking and total shear displacements for the proposed mining layout are shown in **Figure 28 of Appendix A**.

In addition, tensile cracks will probably develop up to 30 m behind the advancing goaf edge of the total pillar extraction panels. The majority of these cracks are transient however, and likely to be 10 mm to 50 mm wide. They also generally close in the central areas of the panels where permanent compressive strains develop after mining is completed.

**Impact Management Strategies**

Surface crack repair works (such as the pouring of cement-based grout or crushed, high strength rock into the larger, deep cracks) may need to be implemented around the affected low depth of cover areas of the site (i.e. < 80 m cover depth), and in particular, where access roads and ephemeral watercourses are present.

In regards to Viney Creek, surface cracking will be limited by the panel geometries and proposed first working buffer zones. It is considered unlikely that surface cracks will develop along the creek bed, however, if they do occur, the following remediation strategy may be adopted:

- Undertake pre-mining and post-mining inspections along the creek, with the results of these inspections communicated to the respective stakeholders. Should a significant impact be identified during these inspections, an appropriate remediation strategy will be developed.

- Consultation with DECCW has suggested that natural regeneration may be the favoured management strategy in most scenarios, due to the likely level of disturbance caused by other remediation strategies such as back filling with imported materials from haulage trucks.

## 11.1.1.2 Sub-Surface Cracking

**Sub-Surface Fracturing Zones**

The caving and subsidence development processes above a longwall or pillar extraction panel usually results in sub-surface fracturing and shearing of sedimentary strata in the overburden. The extent of fracturing and shearing is dependent on mining geometry and overburden geology.

International and Australian research on Longwall mining interaction with groundwater systems indicates that the overburden may be divided into essentially three or four zones of surface and subsurface fracturing. The zones are generally defined (in descending order) as:

- Surface Zone
- Continuous or Constrained Zone
- Fractured Zone
- Caved Zone

Starting from the seam level, the Caved Zone refers to the immediate mine workings roof above the extracted panel, which has collapsed into the void left after the coal seam has been extracted. The Caved Zone usually extends for 3 to 5 times the mining height above the roof of the mine workings.

The Fractured Zone has been affected by a high degree of bending deformation, resulting in significant fracturing and bedding parting separation and shearing. The Fractured Zone is supported by the collapsed material in The Caved Zone, which usually has a bulked volume equal to 1.2 to 1.5 times its undisturbed volume.

The Continuous or Constrained Zones refer to the section of overburden which has also been deformed by bending action, but to a lesser degree than the Fractured Zone below it.

The Surface Zone includes the tensile and compressive surface cracking caused by mine subsidence and is assumed to extend to depths of 5 to 10 m in the Newcastle Coalfield.

Based on reference to **Whittaker and Reddish, 1990** and **ACARP, 2003**, the impact of mining on the sub-surface aquifers and surface waters, requires an estimate of the

'Continuous' and 'Discontinuous' heights of fracturing or the A and B Zones (See **Figure 29 of Appendix A**)

*Continuous sub-surface fracturing* (A-Zone) refers to the zone of cracking above a longwall panel that is likely to result in a direct flow-path or hydraulic connection to the workings, if a sub-surface (or shallow surface) aquifer was intersected.

*Discontinuous sub-surface fracturing* (B-Zone) refers to the zone above the A-Zone where there could be a general increase in horizontal and vertical rock mass permeability, due to bending or curvature deformation of the overburden. This type of fracturing does not usually provide a direct flow path or connection to the mine workings like the A-Zone; however, it is possible that B-Zone fracturing may interact with surface cracks, joints, or faults. This type of fracturing can therefore result in an adjustment to surface and sub-surface flow paths, but may not result in a significant change to the groundwater or surface water resource in the long-term.

In regards to the general zones of fracturing mentioned earlier, the A-Zone may be assumed to include the Caved and Fractured Zones, and the B-Zone will develop in the Constrained Zone. Both A and B-Zones can extend to the Surface Zone and will depend on the mining height, cover depth, geology and panel width.

Two empirically-based models (**Forster, 1995** and **ACARP, 2003**) and have been used in this study to predict the A and B-Zone heights of sub-surface fracturing within the study area.

The **Forster, 1995** model was developed from deep multi-piezometer data from subsided overburden in the Central-Coast area of the Newcastle Coalfield and in-directly defines the A and B-Zones as a function of the mining height (the model refers to the A and B-Zones as the tops of the Fractured and Confined Zones respectively.

The **Forster, 1995** model predicts that the height of the Fractured or A-Zone will generally range between 21 and 33 times the mining height (T). The predicted extent or height of the Confined or B-Zone and its thickness will be dependent on the cover depth and height of A-Zone fracturing.

The **ACARP, 2003** model was derived from the **Forster, 1995** Model data, and supplemented with drilling fluid loss records from surface to seam drilling logs in subsided, fractured overburden from the NSW Southern Coalfield and Oaky Creek Mine in the Bowen Basin.

The **ACARP, 2003** model includes several of the key parameters defined by **Whittaker and Reddish, 1989** and referred to in **Mark, 2007**. The additional parameters include the panel width, cover depth, maximum single panel subsidence and geological conditions (i.e. Subsidence Reduction Potential). The mining height is not applied directly, but indirectly through the subsidence prediction (further model development details may be found in **Appendix A**).

The measured data in **ACARP, 2003** has been plotted as the height of A or B-Zone fracturing /cover depth v. $S_{max}$/Effective Panel Width$^2$. A log-normal regression line has subsequently been derived to give predictions of mean and U95%CL values for both fracture zones.

**Sub-Surface Fracture Height Predictions**

The predicted values for the **ACARP, 2003** model's continuous and discontinuous sub-surface fracturing heights above the proposed pillar extraction panels are summarised in **Table 25**.

## Table 25- Summary of Predicted Sub-Surface Fracturing Heights above the Proposed SMP Pillar Extraction Panels

| Panel No. | Cover Depth, H (m) | Panel Width, W (m) | Average Mining Height, T (m) | Single Panel $S_{max}$ (mean) (m) | Single Panel $S_{max}/W'^2$ (mean) (mm/m$^2$ or km$^{-1}$) | Predicted Fracture Heights (m) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Continuous (A Horizon) | | | | Discontinuous (B Horizon) | |
| | | | | | | ACARP, 2003 Model (mean - U95%CL) | | Forster, 1995) (21-33T') | | ACARP, 2003 Model (mean - U95%CL) | |
| **Pillar Extraction Panels P1 to P13** | | | | | | | | | | | |
| 1 | 85 | 160.5 | 2.5 | 1.30 | 0.088 | 49 | 72 | 48 | **75** | 82 | *97* |
| 1 | 95 | 160.5 | 3.2 | 1.54 | 0.065 | 48 | 74 | 48 | **75** | 87 | *104* |
| 1 | 95 | 160.5 | 2.4 | 1.08 | 0.087 | 54 | 80 | 64 | **100** | 92 | *108* |
| 2 | 55 | 160.5 | 2.3 | 1.27 | 0.214 | 36 | **51** | 46 | **72** | 57 | *66* |
| 2 | 65 | 160.5 | 2.6 | 1.43 | 0.173 | 45 | **62** | 52 | **82** | 68 | *80* |
| 2 | 75 | 160.5 | 2.9 | 1.60 | 0.145 | 52 | **72** | 58 | **91** | 79 | *92* |
| 2 | 85 | 160.5 | 3.2 | 1.66 | 0.117 | 54 | **77** | 64 | **100** | 87 | *101* |
| 3 | 55 | 160.5 | 2.7 | 1.49 | 0.251 | 38 | **53** | 54 | **85** | 58 | *68* |
| 3 | 65 | 160.5 | 2.8 | 1.54 | 0.186 | 46 | **63** | 56 | **88** | 69 | *81* |
| 3 | 75 | 160.5 | 2.8 | 1.54 | 0.140 | 51 | **71** | 56 | **88** | 79 | *92* |
| 3 | 85 | 160.5 | 3 | 1.56 | 0.110 | 53 | **76** | 60 | **94** | 86 | *100* |
| 4 | 55 | 160.5 | 2.5 | 1.38 | 0.232 | 37 | **52** | 50 | **78** | 57 | *67* |
| 4 | 65 | 160.5 | 2.6 | 1.43 | 0.173 | 45 | **62** | 52 | **82** | 68 | *80* |
| 4 | 75 | 160.5 | 2.8 | 1.54 | 0.140 | 51 | **71** | 56 | **88** | 79 | *92* |
| 4 | 85 | 160.5 | 2.8 | 1.45 | 0.103 | 52 | 75 | 56 | **88** | 85 | *99* |
| 5 | 55 | 160.5 | 2.3 | 1.27 | 0.214 | 36 | **51** | 46 | **72** | 57 | *66* |
| 5 | 65 | 160.5 | 2.4 | 1.32 | 0.160 | 43 | **61** | 48 | **75** | 67 | *79* |
| 5 | 75 | 160.5 | 2.6 | 1.43 | 0.130 | 50 | **70** | 52 | **82** | 78 | *91* |
| 5 | 85 | 160.5 | 2.7 | 1.40 | 0.099 | 51 | 74 | 54 | **85** | 84 | *99* |
| 6 | 55 | 160.5 | 2.2 | 1.21 | 0.204 | 36 | **50** | 44 | **69** | 56 | *66* |
| 6 | 65 | 160.5 | 2.3 | 1.27 | 0.153 | 43 | **60** | 46 | **72** | 67 | *78* |
| 6 | 75 | 160.5 | 2.4 | 1.32 | 0.120 | 48 | **69** | 48 | **75** | 77 | *90* |
| 6 | 85 | 160.5 | 2.7 | 1.40 | 0.099 | 51 | 74 | 54 | **85** | 84 | *99* |
| 7 | 55 | 160.5 | 2.3 | 1.27 | 0.214 | 36 | 51 | 46 | **72** | 57 | *66* |
| 7 | 65 | 160.5 | 2.3 | 1.27 | 0.153 | 43 | **60** | 46 | **72** | 67 | *78* |
| 7 | 75 | 160.5 | 2.4 | 1.32 | 0.120 | 48 | **69** | 48 | **75** | 77 | *90* |
| 7 | 85 | 160.5 | 2.6 | 1.35 | 0.095 | 50 | 73 | 52 | **82** | 84 | *98* |
| 8 | 55 | 160.5 | 2.4 | 1.32 | 0.223 | 37 | **51** | 48 | **75** | 57 | *67* |
| 8/9/10 | 65 | 160.5 | 2.4 | 1.32 | 0.160 | 43 | **61** | 48 | **75** | 67 | *79* |
| 8/9/10 | 75 | 160.5 | 2.4 | 1.32 | 0.120 | 48 | **69** | 48 | **75** | 77 | *90* |
| 8 | 85 | 160.5 | 2.4 | 1.24 | 0.088 | 49 | 72 | 48 | 75 | 82 | 97 |
| 11 | 105 | 160.5 | 2.4 | 1.08 | 0.050 | 47 | 75 | 48 | 75 | 92 | *110* |
| 12 | 105 | 160.5 | 2.5 | 1.12 | 0.052 | 48 | 76 | 50 | 78 | 92 | *111* |
| 13 | 110 | 160.5 | 2.3 | 1.00 | 0.042 | 45 | 74 | 46 | 72 | 93 | *112* |
| 13 | 125 | 160.5 | 2.4 | 0.95 | 0.031 | 47 | 80 | 48 | 75 | 103 | *125* |
| 13 | 125 | 160.5 | 2.4 | 0.95 | 0.031 | 47 | 80 | 48 | 75 | 103 | *125* |
| **East Mains Adjacent to Panel 1** | | | | | | | | | | | |
| EM1 | 75 | 131 | 2.1 | 1.03 | 0.094 | 44 | 64 | 42 | 66 | 73 | *87* |
| EM2 | 85 | 131 | 2.5 | 1.13 | 0.080 | 47 | 70 | 50 | 78 | 81 | *96* |
| EM3 | 95 | 131 | 3.2 | 1.34 | 0.076 | 52 | 77 | 64 | 100 | 90 | *107* |
| **East Mains Adjacent to Finishing Ends of Panels 2 and 13** | | | | | | | | | | | |

| Panel No. | Cover Depth, H (m) | Panel Width, W (m) | Average Mining Height, T (m) | Single Panel $S_{max}$ (mean) (m) | Single Panel $S_{max}/W'^2$ (mean) (mm/m$^2$ or km$^{-1}$) | Predicted Fracture Heights (m) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Continuous (A Horizon) | | | | Discontinuous (B Horizon) | |
| | | | | | | **ACARP, 2003** Model (mean - U95%CL) | | **Forster, 1995**) (21-33T') | | **ACARP, 2003** Model (mean - U95%CL) | |
| EM4 | 95 | 125 | 3.2 | 1.29 | 0.073 | 53 | 79 | 64 | 100 | 91 | *108* |
| EM5 | 85 | 125 | 2.9 | 1.27 | 0.090 | 49 | 72 | 58 | 91 | 83 | *98* |
| EM6 | 87 | 125 | 2.4 | 1.03 | 0.070 | 45 | 69 | 48 | 75 | 81 | *96* |
| EM7 | 92 | 125 | 2.1 | 0.87 | 0.052 | 43 | 68 | 42 | 66 | 82 | *98* |

Notes:
Single panel $S_{max}$ = f(effective mining height, W/H, H, W/t, y/H) (**ACARP, 2003**).
Heights of fracturing based on effective mining heights T'= 0.95T.
Effective Panel Width = lesser of actual width and 1.4H (i.e. the super-critical width).
**Bold -** Mean or U95%CL A-Horizon prediction is within 10 m of the surface.
*Italics* - Mean or U95%CL B-Horizon prediction is within 10 m of surface.

### Discussion of A-Zone Horizon Model Predictions Above Pillar Extraction Panels

The **ACARP, 2003** model's predictions for the mean A-Zone horizon above the proposed pillar extraction panels would be within 10 m of the surface if mining occurred at cover depths of < 50 m. It is considered that the potential for connective cracking to the surface is 'likely' for these scenarios, regardless of any adverse conditions (such as a fault) being present.

The predicted U95%CL A-Zone horizon values are within 10 m of the surface for panel cover depths of between 50 m and 80 m. It is considered that the potential for connective cracking to the surface is 'possible' for these scenarios.

Connective cracking to the surface is considered 'unlikely' for depths of cover between 80 m and 100 m, as the A-Zone Horizon is predicted to be between 10 m and 20 m from the surface.

Connective cracking is considered 'very unlikely' for depths of cover > 100 m, as the A-Zone Horizon is predicted to be > 20 m below the surface.

The results for the **Forster, 1995** model are also included and predict heights of fracturing above pillar extraction panels will generally range between 21 and 33 times the mining height (T), based on Newcastle - Central Coast Coalfield measurements. It is assumed that the fracture height in the **Forster, 1995** model is similar to the Height of Continuous Fracturing (A Zone Horizon) in the **ACARP, 2003** model. The **Forster, 1995** model indicates a similar range of connective cracking heights (46 m to 106 m).

A similar US version of the **Forster, 1995** model indicates that the height of continuous fracturing could range between 10T and 24T (26 m and 62 m) with discontinuous fracturing from 24 T to 60T (62 m to 156 m). A comment is made in a paper by **Mark, 2007**, that the "variation is also probably due to differences in geology and panel geometry".

**Discussion of B-Zone Horizon Model Predictions Above Pillar Extraction Panels**

The **ACARP, 2003** model predicts that the mean B-Zone Horizon values will occur within 10 m of the surface for cover depths < 100 m above the pillar extraction panels for the given mining geometries. *Discontinuous sub-surface fracturing* for these panels is considered 'likely' to interact with surface cracks.

In areas of shallow or exposed surface rock, creek flows may be re-routed to below-surface pathways and re-surfacing down-stream of the mining extraction limits in these areas.

The predicted U95%CL B-Horizon values are all within 10 m of the surface for cover depths < 130 m. It is therefore assessed that surface water impacts from *Discontinuous sub-surface fracturing* interaction will be 'possible' where cover depths range between 100 m and 140 m.

**Mark, 2007** indicates that the height of *Discontinuous fracturing* could range between 24T and 60T (112 m to 282 m).

**Discussion of Prediction Model Uncertainties**

Due to the complexity of the problem, it is difficult to ascertain which of the two Newcastle Coalfield based models is likely to be the most accurate. It has therefore been considered necessary to review the assumptions made in each model.

Both models indicate that the height of continuous fracturing is fairly insensitive to depth of cover. However, it is apparent that the **Forster, 1995** model predicts a higher A-Zone horizon than the **ACARP, 2003** model and predicts surface connection could occur for cover depths up to 100 m.

The height of continuous (and discontinuous) fracturing is also probably influenced by the panel width and overburden spanning capability to some degree. Other subsidence workers in the Southern Coalfield claim that fracture heights could extend as high as 1.4 x Panel Width, which would indicate a fracture height of 224 m is possible for the 160 m wide pillar extraction panels. This particular model however, does not distinguish between continuous and discontinuous fracturing, and is therefore considered to be a 'Discontinuous Fracture Height' model only.

The height of fracturing data presented in **Forster, 1995** and **ACARP, 2003** infers that the fracture height is not significantly influenced by the panel width alone.

This seems to contradict arching theory, where the height of the 'arch' or fractured zone would be expected to increase as the panel width increases. However, as the effective width of the panel decreases with increasing height above the workings, the spanning capability of the rock 'beams' will also increase and limit the height of continuous fracturing to the base of the spanning units, effectively.

Overall, based on experience at a nearby mine where cover depths ranged from 130 to 250 m above 178 m wide longwall panels with mining heights of 4.5 to 4.7 m, continuous or discontinuous fracturing has not affected the surface watercourses.

What is clear from the above exercise is that there a high degree of uncertainty in predicting the A and B-Zone horizons using any of the available models. The impact management strategies will therefore need to carefully consider the consequences of the predictions if they are exceeded.

### Impact on Rock Mass Permeability

In regards to changes to rock mass permeability, **Forster, 1995** indicates that horizontal permeabilities in the fractured zones above longwall mines could increase by 2 to 4 orders of magnitude (e.g. pre-mining $k_h = 10^{-9}$ to $10^{-10}$ m/s; post-mining $k_h = 10^{-7}$ to $10^{-6}$ m/s).

Vertical permeability's could not be measured directly from the boreholes but could be inferred by assuming complete pressure loss in the 'A-Zone', where direct hydraulic connection to the workings occurs. Only a slight increase in the 'B-Zone' or indirect / discontinuous fracturing develops (mainly due to increase in storage capacity) from bedding parting separation. It is possible however, that minor vertical flows will occur from B-Zone into the A-Zone (and workings) as well.

Discontinuous fracturing would be expected to increase rock mass storage capacity and horizontal permeability without direct hydraulic connection to the workings. Rock mass permeability is unlikely to increase significantly outside the limits of extraction.

### Impact Management Strategies

It is understood that there are no subsurface aquifers of potential resource significance within the overburden that could be affected by continuous and/or discontinuous fracturing above the extracted pillar panels. Subsequent groundwater and surface aquifer impact studies have considered the high level of uncertainty in regards to predicting the height of each zone of sub-surface fracturing.

Based on **Table 25**, the **ACARP, 2003** model outcomes have been assessed in accordance with the Likelihood of Occurrence that continuous fracturing will intersect with surface cracks that extend to 10 m depth below the surface. The results are summarised in **Table 26**.

**Table 26- Likelihood Assessment for Continuous Fracturing Extending from Mine Workings to Within 10 m of the Surface Above the Proposed Pillar Extraction Panels**

| Likelihood of Occurrence* | Mining Height Range | Cover Depth Range (m) | Probability of a Single Hazardous Event |
|---|---|---|---|
| Likely | 2.2 - 3.0 | < 40 | 50 - 75% |
| Possible | 2.2 - 3.0 | 40 - 80 | 5 - 50% |
| Unlikely | 2.2 - 3.0 | 80 - 100 | 5 - 10% |
| Very Unlikely | 2.2 - 3.0 | >100 | <5% |

* - refer to **Appendix A** for definitions of likelihood of occurrence.

Based on the above, SCZ options may be required in areas of the mining lease where cover depths are < 80 m below creeks or if connective cracking to the surface is an issue for the underground operations. Measurement of the A-Zone horizon may be attempted above panels with cover depths > 80 m and non-sensitive surface features exist (see monitoring suggestions).

Based on discussions with the specialist groundwater consultant for the project, the absence of significant surface alluvium and ephemeral nature of the creeks/gullies is unlikely to result in significant degradation of the creeks or inrush event into the underground workings should connective cracking to the surface occur. It is considered more likely that any re-directed surface flows will be manageable underground and cracks able to be repaired at the surface.

The above assessment is dependent on our limited understanding of the continuous fracture heights in this area of the mine until monitoring/measurement data becomes available.

#### 11.1.1.3 Scarp Development

**Potential Impacts**

It is possible that scarp development or surface steps up to 300 mm could develop above total extraction panels with a depth of cover < 80 m and a panel width/cover depth ratio > 2.

Similar sized steps have been observed above the old Great Northern Seam workings at Tasman Mine, ~10 km to the south-east of the proposed panels, however, the scarps occurred where massive conglomerate units were present in the overburden.

However, the deeper soil conditions above the Abel panels may not be conducive for scarp development due to the more 'flexible' overburden that is present near the surface.

**Impact Management Strategies**

Scarps will be remediated by the mine if and when they occur, based on consultation with relevant stakeholders. Remediation work would include the regrading and revegetation of affected areas with locally sourced materials.

#### 11.1.1.3 Slope Instability and Erosion

**Potential Impacts**

To-date, local Longwall mining experiences in undulating terrain with ground slopes up to $25^{o}$ has not resulted in any large scale, en-masse sliding instability due to mine subsidence (or other natural weathering processes etc). In general, it is possible that localised instability could occur where ground slopes are > 15°, if the slopes are also affected by mining-induced cracking and increased erosion rates.

The rate of erosion is expected to increase significantly in areas with exposed dispersive / reactive alluvial or residual soils or tuffaceous claystone and slope gradients are increased by more than 2% (>20 mm/m).

Based on the difference between the post and pre-mining surfaces presented earlier, the predicted increase or decrease in surface slope gradients after mining are presented in **Figures 37a** and **37b** of **Appendix A.**

The figures indicate that the maximum gradient changes will be located above Panels PE1 to PE13 and are likely to range between 1% and 4%. It is assessed that some erosion / sedimentation adjustments may develop at these locations where exposed soils are present.

The predicted changes in surface gradients along Viney Creek are unlikely to exceed 0.5% and therefore unlikely to cause any degradation to the creek.

**Impact Management Strategies**

To minimise the likelihood of slope instability and increased erosion potential due to cracking or changes to drainage patterns after mining, the following management strategies may be implemented:

(i) Surface slope monitoring (combined with general subsidence monitoring along cross lines and centre lines);

(ii) Placement of signs along public access ways warning of mine subsidence impacts.

(iii) Infilling of surface cracking to prevent excessive ingress of run-off into the slopes as soon as practicable and preferably after each panel is completed.

(iv) Slopes that are significantly affected by erosion after mining may need to be repaired and protected with mitigation works such as re-grading and re-vegetation of exposed areas, based on consultation with the relevant government agencies.

(v) On-going review and appraisal of any significant changes to surface slopes such as cracking, increased erosion, seepages and drainage path adjustments observed after each panel is extracted.

## 11.1.1.4 Valley Uplift and Closure

**Potential Impacts**

Valley uplift and closure movements may occur along the drainage gullies present above the proposed mining area, based on reference to **ACARP, 2002** and Southern Coalfield experience.

High horizontal stresses have been measured and uplift movements of about 230 mm have occurred along the F3 Freeway cuttings in ridges about 10 km to the south-east of the mine, where massive conglomerate strata existed at the surface.

However, due to the suspected (and observed) low horizontal stress regime in the Abel mine workings roof to-date (i.e. the Upper Donaldson Seam at this location is in relatively flat area with shallow cover), it is considered unlikely that similar magnitude movements will occur in the gullies / broad crested valleys above the proposed panels.

The lack of thick, massive beds of conglomerate and sandstone units along the creeks / valleys at the surface will also mean the development of these phenomena are likely to be limited to < 100 mm. Minor cracking in creek beds may cause some shallow sub-surface re-routing of surface flows due to the valley closure mechanism.

**Impact Management Strategy**

The impact of valley uplift closure effects due to mine subsidence may be managed as follows:

(i) Install and monitor survey lines along representative drainage gullies where considered appropriate and along gully crests during and after undermining. Combine with visual inspections to locate damage (cracking, uplift).

(ii) Review predictions of upsidence and valley crest movements after each panel is extracted.

(iii) Assess whether repairs to cracking, as a result of upsidence or gully slope stabilisation works are required to minimise the likelihood of long-term degradation to the environment or risk to personnel and the general public.

### 11.1.1.5 Far-Field Horizontal Displacements and Strains

**Background to Prediction Model Development**

Far-field displacements (FFDs) generally only have the potential to damage long, linear features such as pipelines, bridges and dam walls.

Horizontal movements due to Longwall mining have been recorded at distances well outside of the angle of draw in the Newcastle, Southern and Western Coalfields (**Reid, 1998, Seedsman and Watson, 2001**). Horizontal movements recorded beyond the angle of draw are referred to as far-field horizontal displacements.

For example, at Cataract Dam in the Southern NSW Coalfield, **Reid, 1998**, reported horizontal movements of up to 25 mm when underground coal mining was about 1.5 km away. Seedsman reported movements in the Newcastle Coalfield of around 20 mm at distances of approximately 220 m, for a cover depth ranging from 70 to 100 m and a panel width of 193 m. However, the results may have been affected by GPS baseline accuracy limitations.

Based on a review of the above information, it is apparent that this phenomenon is dependent on (i) cover depth, (ii) distance from the goaf edges, (iii) the maximum subsidence over the extracted area, (iv) topographic relief and (v) the horizontal stress field characteristics.

An empirical model for predicting far-field displacement (FFDs) in the Newcastle Coalfield indicates that measurable FFD movements (i.e. 20 mm) generally occur in relatively flat terrain for distances up to 3 to 4 times the cover depth.

The direction of the FFD movement is generally towards the extracted area, but can vary due to the degree of regional horizontal stress adjustment around extracted area and the surface topography. The movements also appear to decrease around the corners of longwall panels.

An empirical model for predicting far-field strains (FFSs) in the Newcastle Coalfield indicates that measureable (but diminishing) strains can also occur outside the limits of longwall extraction for distances up to one cover depth (based on the Upper 95% Confidence limit curve). It is assessed that strains will be <0.5 mm/m at a distance equal to 0.5 x cover depth.

It should be noted that the model was based on steel tape measurements which did not extend further than a distance equal to the 1.5 times the cover depth from the extraction limits. Any FFS predictions that are >1.5 times the cover depth from the panels in this report are therefore an extrapolation of the regression lines for the database and likely to be conservative.

## Potential Impacts

The surface features that have been assessed in this study for potential FFD and FFS (**Table 277**) impacts due to mining of the proposed pillar extraction panels include:

- Transgrid tension tower (No. 33B) and suspension towers 29B and 36B.
- F3 Freeway
- John Renshaw Drive and Hunter Water Pipeline (above ground)

A Subsidence Control Zone (SCZ) setback distance has been applied to the above items that will minimise the potential for significant FFD or FFS impact. The SCZ setbacks are not the same for each feature and have been determined based on conservative tolerance strain limit estimates (shown in brackets)

The design SCZ setback distances adopted are summarised below in terms of 'angle of draw' from the pillar extraction limits to the surface feature:

**Transgrid Tower No. 33B** (tensile strain < 0.3 mm/m) - 2 x cover depth (63.4$^o$ angle of draw), which gives a minimum set-back distance of 108 m for a cover depth of 54 m at the centre of the tower. The proposed panels P8 and P9 are 105 m and 165 m to the south east and south west of the tower respectively or 1.94 and 3.06 times the cover depth from the tower centre (i.e. 62.7$^o$ and 72$^o$ angle of draw).

**F3 Freeway** (tensile strain < 0.5 mm/m and lateral curvature radii > 200 km) - 1 x cover depth (45$^o$ angle of draw), which gives a minimum set-back distance of 110 m to 130 m from the freeway. The proposed panels P11 to P13 are approximately 150 m west of the freeway or 1.15 to 1.36 times the cover depth (i.e. 48$^o$ to 53$^o$ angle of draw).

**John Renshaw Drive and Hunter Water Pipeline** (tensile strain < 0.5 mm/m and lateral curvature radii > 200 km) - 1 x cover depth (45$^o$ angle of draw), which gives a minimum set-back distance of 50 m to 80 m from the road. The proposed Panels 7 to 10 are located approximately 85 m to 155 m south of the road or 1.55 to 3.1 times the cover depth (i.e. 59$^o$ to 72$^o$ angle of draw).

The suspension towers within the SMP area all have cruciform footings installed and will therefore tolerate significantly higher ground strains (e.g. > 10 mm/m).

Predictions of worst-case FFDs and FFSs are summarised in **Table 27**.

**Table 27- Summary of Far-Field Displacement and Strain Predictions for the Proposed Pillar Extraction Panels**

| Panel # | Feature | z (m) | H (m) | z/H | AoD (o) | Final $S_{max}$ (m) | FFD (mm) | FFS (mm/m) | Principal Movement Direction |
|---|---|---|---|---|---|---|---|---|---|
| 8 | Transgrid Tower B33 | 165 | 54 | 3.06 | 72 | 1.32 | 1 | 0.0 | SW |
| 9 | | 105 | 54 | 1.94 | 63 | 1.32 | 5 | 0.1 | SE |
| 7 | John Renshaw Drive/Hunter Pipeline | 150 | 50 | 3.00 | 72 | 1.27 | 1 | 0.0 | SE |
| 8 | | 90 | 55 | 1.64 | 59 | 1.32 | 8 | 0.1 | SE |
| 9 | | 150 | 60 | 2.50 | 68 | 1.32 | 2 | 0.0 | SE |
| 10 | | 130 | 65 | 2.00 | 63 | 1.27 | 5 | 0.1 | SE |
| 11 | F3 Freeway | 150 | 110 | 1.36 | 54 | 1.29 | 11 | 0.2 | W |

| Panel # | Feature | z (m) | H (m) | z/H | AoD (o) | Final $S_{max}$ (m) | FFD (mm) | FFS (mm/m) | Principal Movement Direction |
|---|---|---|---|---|---|---|---|---|---|
| 12 | Pavement | 150 | 125 | 1.20 | 50 | 1.30 | 14 | 0.3 | W |
| 13 | | 150 | 130 | 1.15 | 49 | 1.23 | 14 | 0.3 | W |
| East Mains | Tower B36 | 54 | 100 | 0.54 | 28 | 1.05 | 28 | 0.8 | W |
| | Tower B29 | 170 | 112 | 1.52 | 57 | 1.53 | 11 | 0.2 | NW |

Notes:
z = normal distance to feature from panel centreline.
H = Cover depth at panel end.
AoD = effective angle of draw.
Final Smax = Final maximum panel subsidence (mean values).
FFD = Predicted far-field displacement (mean value).
FFS = Predicted far-field strain (U99%CL value).

The results of the analysis indicate that the Transgrid tension tower (B33) displacements are unlikely to exceed 5 mm towards the mining area (SE and SW). Tensile strains are estimated to be < 0.1 mm/m. Towers B36 and B29 may be displaced west and north-west by 28 mm and 11 mm respectively, with tensile strains of 0.8 and 0.2 mm/m.

John Renshaw Drive and Hunter Water Pipeline may be displaced by up to 8 mm over 160.5 m towards the south-east, with tensile ground strains of < 0.2 mm/m across the features. It is estimated that approximately 1 km of the road and pipeline may be affected, with a minimum lateral curvature radius estimated to be in the order of 400 km.

The F3 Freeway may be displaced by up to 14 mm towards the west over a distance along the freeway of approximately 160.5 m, with tensile ground strains of < 0.3 mm/m. It is estimated that approximately 0.6 km of the freeway may be affected, with a minimum lateral curvature radius estimated to be in the order of 230 km.

It is considered that the impact of the predicted FFD and FFS values (**Table 277**) are within the tolerable limits of the features assessed. The set-back distances of the proposed mining layout are therefore considered reasonable at this stage.

**Impact Management Strategies**

The proposed set-back distances of total extraction mining to the sensitive features will reduce the potential for damage occurring to very low likelihoods (ie < 1% probability of occurrence). Monitoring of ground and feature movements as subsidence develops above the extracted panels may still be necessary however.

It should also be understood that the predicted displacements and strains are likely to be less than currently available survey accuracy limits and will therefore be practically immeasurable. The monitoring may therefore be limited to visual inspections during mining only.

Some monitoring of ground displacements may still be required at several mutually agreeable locations until the actual extent and magnitude of far-displacements described above can be confirmed. An 'early-warning' type monitoring program around panels in non-sensitive locations is suggested as a reasonable approach.

### 11.1.2 Watercourses

**Ponding**

**Potential Impacts**

Ponding refers to the potential for closed-form depressions to develop at the surface after mining of total extraction panels beneath gentle slopes and relatively flat terrain. Ponding could affect drainage patterns, flora, fauna and groundwater dependent ecosystems.

The actual ponding depths will depend upon several other factors, such as rain duration, surface cracking and effective percolation and evapo-transpiration rates.

The potential ponding depths and volumes for the proposed mining layout has been estimated from the 1 m post-mining topographic contours shown in **Figure 35a of Appendix A**. Based on this figure, it appears that a closed form depression could occur along the unnamed gully above the central area of Panel 8, with a maximum potential pond depth of 1.0 m. An area of approximately 5,000 $m^2$ may be affected, with the volume of the depression estimated to be 2,545 $m^3$. The depression will be located on the western edge of the Black Hill Land Pty Ltd land.

The 1 m pre-mining topographic contours are shown in **Figure 35b of Appendix A** for comparison.

The potential for ponding along Viney Creek is likely to be minimised where subsidence is limited to < 0.35 m. The pre-and post-mining surface profile along Viney Creek (with subsidence controls implemented) is shown in **Figure 36a of Appendix A.** The worst-case subsided profile predicted for the creek is shown in **Figure 36b of Appendix A.**

Overall, the impact of the increased ponding along the creek beds is likely to be 'in-channel' and therefore the potential effects on existing flora and fauna is likely to be minimal. Further discussion on the ponding impacts are provided in the specialist consultant's reports.

**Impact Management Strategies**

The minimisation of potential ponding areas may be achieved by adopting one of the SCZ options (such as partial pillar extraction panels) or managing any ponding impacts as described below.

An appropriate ponding management strategy would include:

(i) The development of a suitable monitoring and response plan, based on consultation with the DECCW and regulatory authorities to ensure ponding impacts on existing vegetation do not result in long-term environmental degradation.

(ii) The review and appraisal of changes to drainage paths and surface vegetation in areas of ponding development (if they occur), after each panel is extracted.

It is predicted that the impact on stream flows will be minor and there will be no requirement for any drainage works within SMP Area 1.

Based on an analysis of predicted subsidence it is considered that there will be no ponding in the watercourses proposed to be undermined.

For all practical purposes vertical subsidence is imperceptible and does not impact significantly on stream gradients. Slopes generally are predicted to change by less than 2%. Minor changes in velocity due to this change in gradient are considered unlikely to result in any bed scour or bank scour erosion.

### 11.1.3 Groundwater Resources

#### 11.1.3.1 Impact on Groundwater Supply

Within the SMP application area there are no known groundwater extraction licences issued by the Department of Environment Climate Change and Water (DECCW).

With the absence of any groundwater users in the SMP application area the development will not impact on groundwater users.

There are no dams in the SMP application area that collect water from shallower aquifers relying on groundwater for their water supplies.

As part of the SMP groundwater impact assessment it is necessary to assess the potential for future usage of the groundwater resources in the SMP application area.

It is unlikely that the aquifers identified contain significant groundwater resources that could be used in the future. There is no known current groundwater extraction usage over the SMP application area.

#### 11.1.3.2 Impact on Aquifers

Incremental impacts on a regional level are considered to be minimal.

Once mining is completed, and pumping from the mine ceases, the strata will re-pressurise as the mine fills with water. Previous experience indicates that the pre-mining hydrogeological conditions will eventually re-establish following mining.

#### 11.1.3.3 Mine Water Make

The impact of mining is expected to lead to a minor increase in water make in the mine. Groundwater is currently pumped from the mine at a rate of about 1.5Ml/week.

This increased water make will not impact on the surface environment of the SMP application area as mine water is pumped to the surface but not within the SMP application area.

### 11.1.4 Swamps, Wetlands and Water Related Ecosystems

Won’t be impacted

### 11.1.5 Flora and Fauna

As part of flora and fauna management plan

### 11.1.5.1 Impact on Flora Habitat

Some surface disturbance may occur within the SMP application area, but this would have a minor impact upon any flora.

Given the limited extent of weeds throughout SMP Area 1 and the levels of native vegetation cover, it is considered unlikely that the proposed development will result in a significant increase in weed infestations.

### 11.1.5.2 Impact on Threatened Flora Species

The Atlas of NSW Wildlife published by the National Parks and Wildlife Service indicates that only one plant species listed in schedules to the TSC Act 1995 have been recorded within a 5km radius of the study area. The field survey did not reveal any populations of any of this threatened plant species within the SMP Area 1.

As no confirmed specimens were found and the development is only likely to have a localised impact in terms of surface expression of subsidence, it is considered that there will no impact on this threatened species.

### 11.1.5.3 Impact on Fauna Habitat

Some surface disturbance may occur within the SMP application area, but this would have a minor impact upon any fauna.

Subsidence due to underground mining, may result in lowering of the surface. This can result in cracking of valley floors and creek lines and with subsequent effects on surface hydrology.

Subsidence may result in some changes to these formations, but the changes are those that occur naturally (i.e. creation of rock falls and cracks). Although there may be some small loss of existing habitat for some species, the new habitats created will allow animals dependent upon rock formations to continue to use the area.

Cattle will be fenced off out of the active pillar extraction area during mining. Post Mining inspections will be carried out prior to the re-use of the area.

There are no permanent watercourses or swamps within SMP Area 1 that will be subject to pillar extraction (Viney Creek is protected by a SCZ), and the ephemeral nature of these watercourses would not significantly change as a consequence of subsidence. Any cracks within a watercourse bed will be remediated.

The flora and fauna associated with the watercourses within SMP Area 1 are already adapted to intermittent dry conditions, so any changes to surface water flows should not affect plants and animals.

### 11.1.5.4 Impact on Threatened Fauna Species

Impacts on the threatened species are not likely, as habitat areas will not be significantly affected from mining induced subsidence. The predicted subsidence levels will not be sufficient to significantly alter potentially sensitive habitat.

Seven Part Tests of significance were undertaken for each of the species listed under the TSC Act to determine whether the species or their habitat would be significantly impacted by the Longwall mining. It was determined that none of the species would be significantly affected, either because subsidence would not have a significant impact, or because it was unlikely that the species occurs in the area due to lack of suitable habitat.

The ongoing effects of subsidence on threatened fauna will be monitored using systematic monitoring surveys in the SMP application area to detect any changes in species diversity and abundance.

#### 11.1.5.5 Endangered Ecological Communities

The only Threatened or Endangered Ecological Communities (EEC) within the SMP application area is the Lower Hunter Spotted Gum-Ironbark Forest. No significant impact is predicted.

### 11.1.6 Roads (All types)

**Potential Impacts**

A number of sealed and unsealed access roads and tracks (all private) are located across the surface of SMP Area 1.

The worst-case subsidence predictions along roads after mining is completed will be such that remediation work may be required. This remediation strategy will form part of the Land and Property Management Plan.

## 11.1.7 Water Supply Lines

## 11.1.7.1 Hunter Water Corporation UPVC Supply

**Potential Impacts**

The Hunter Water pipeline is buried within a trench that traverses the site above the proposed East Mains and Panel 2 pillar extraction panels (see **Plan 2**).

The worst-case subsidence predictions along the pipeline easement after mining is complete are presented in **Table 28**.

**Table 28- Worst-Case Subsidence Predictions for the Hunter Water Pipeline Easement**

| Panel | Chain Start (m) | Chain End (m) | Final Subsidence $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Curvature $C_{max}$ ($km^{-1}$) | | Final Horiz. Displacement (mm) | | Final Ground Strain (mm/m) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | In-line | Lateral | In-Line | Lateral | In-Line | Lateral |
| East Mains | 886 | 1,021 | 1.50 | 28 | 0.88/ -1.75 | 0.074/ -0.074 | 201 | 86 | 6/ -13 | 0.7/- 0.6 |
| P1 | 1,063 | 1,223 | 1.07 | 18 | 1.28/ -0.70 | 0.052/ -0.20 | 122 | 160 | 9/ -5 | 0.4/- 1.7 |

Based on reference to **Ho and Dominish, 2004**, the impact of the predicted subsidence movements will be dependent on the tolerable limits of the UPVC pipeline walls and rubberised ring joints to the induced bi-lateral curvatures and tensile/compressive strains acting along the pipeline. Both parameters are likely to increase or decrease the normal and shear stresses in the pipeline wall.

The generation of stress in the pipeline walls due to curvature in both the vertical and horizontal planes will be function of the pipe wall thickness, pipe diameter and Young's Modulus of the pipe material and internal operating pressures.

The transfer of strain (and stress) into the pipe wall will also be dependent on the depth of backfill over the pipe and the coefficient of friction between the trench backfill and the pipe wall.

The deformed shape of the pipeline after mining should therefore be assessed by Hunter Water Engineers in order to determine whether mitigation works will be required during subsidence development.

**Impact Management Strategies**

The proposed management strategies required to minimise impact on the pipeline due to subsidence are:

- Determine tolerable in-line and lateral pipeline deformation limits to be used for trigger action responses based on consultation with Hunter Water engineers.

- Install survey pegs and monitor the deformation of the ground surface along and across representative sections of the pipeline.

- Uncover the pipeline sections where deformations and strains have exceeded the tolerable or agreed trigger action response limits.

- Reduce subsidence above the East Mains and No. 2 Panel by mine design.

- Re-align the pipeline, replace damaged sections and backfill prior to re-commissioning.

## 11.1.7.2 Stock Water Supply Line

**Potential Impacts**

The cattle grazing on the Catholic Diocese land are watered by a series of buried pipelines which supply several watering troughs. The system was devised during the time when the chicken battery was operating and open water bodies such as farm dams were deemed a disease risk to the chickens.

There are three 75 mm diameter PVC pipelines (Lines 1 to 3) that provide stock water to 8 troughs around the Catholic Diocese Land, see **Plan 2**. One of the lines (Line 3) provides water to two residences to the south of the SMP area.

The pipelines are connected to the 200 mm diameter Hunter Water pipeline at different locations above the East Mains Panels and Panel 1. It will be necessary to ensure that the water supply will not be disrupted by mine subsidence effects.

The worst-case subsidence parameter predictions along the pipeline easements and Hunter Water mains connections after mining is complete are presented in **Table 29.**

**Table 29- Worst-Case Subsidence Predictions for the Stock Watering System on the Catholic Diocese Land**

| Line | Panel | Location | Final Subsidence $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Ground Strain $E_{max}$ (mm/m) | Final Curvature $C_{max}$ ($km^{-1}$) | Final Horiz. Displacement (mm) |
|---|---|---|---|---|---|---|---|
| 1 | 1 | HW | 0 | 0 | 0.0 | 0.00 | 0 |
| | 4 | T1.3 | 0.29 | 12 | 2.0 | 0.27 | 88 |
| | 5 | T1.2 | 1.38 | 7 | -3.0 | 0.41 | 51 |
| | 7 | T1.1 | 0.04 | 3 | 0.0 | 0.00 | 22 |
| 2 | 2 | Kink | 1.69 | 3 | -1.5 | -0.21 | 22 |
| | 2 | T2.2 | 0.68 | 20 | 1.0 | 0.14 | 146 |
| | 2/3 | T2.1 | 0.08-0.63 | 32 | 4.0 | 0.55 | 234 |
| | EM | HW | 0.040 | 4 | -4.0 | -0.55 | 29 |
| | EM | T2.3 | 0.15 | 5 | 0.2 | 0.03 | 37 |
| 3 | 1 | T3.1 | 0.29 | 7 | 4.5 | 0.62 | 51 |
| | EM | HW | 1.45 | 17 | -14.0 | -1.92 | 124 |

Notes:
EM = East Mains.
HW = Hunter water pipeline.
T1.3 = Trough #3 on Line # 1.
Kink = High angle change in pipeline direction.

Based on reference to the comments on the Hunter Water pipeline in **Section 11.1.7.1**, it is estimated that the smaller diameter pipeline in shallower trenches will have higher tolerable ground movement impact limits than the Hunter Water Pipeline. However, it is assessed that damage to joints/couplings along the pipelines and at connections between troughs and the mains should be anticipated during mining.

**Impact Management Strategies**

The above impacts may be managed with the rapid repair of surface cracking and damaged water supply pipes and fences. Relocation of livestock before mining impacts occur may also be undertaken in anticipation of fence failure or loss of water supply. In the event of a disruption to the water supply, the company will provide suitable temporary water supplies until the repairs/remediation is completed. A land and property management plan (LPMP) will be developed in consultation with the landowner to address these potential issues.

## 11.1.8 Electricity Transmission Lines

## 11.1.8.1 Transgrid 330Kv Transmission Tension Tower

The design SCZ setback distances adopted are summarised below in terms of 'angle of draw' from the pillar extraction limits to the surface feature:

**Transgrid Tower No. 33B** (tensile strain < 0.3 mm/m) - 2 x cover depth (63.4$^{o}$ angle of draw), which gives a minimum set-back distance of 108 m for a cover depth of 54 m at the centre of the tower. The proposed panels P8 and P9 are 105 m and 165 m to the south east and south west of the tower respectively or 1.94 and 3.06 times the cover depth from the tower centre (i.e. 62.7$^{o}$ and 72$^{o}$ angle of draw).

## 11.1.8.2 Transgrid 330kV Transmission Towers

**Potential Impacts**

Detailed descriptions and predictions of the worst-case transient and final subsidence related movements at eight Transgrid Towers (29B to 36B) are provided in a separate report (**DgS Report No. ABL-001/2** (dated 25/09/09)).

A summary of the subsidence prediction results for each tower are represented in **Tables 30** to **32**.

**Table 30- Tower Locations and Mining Geometry**

| Tower # | Panel # | Panel Width W (m) | Cover Depth Above Panel H (m) | Mining Height (m) | Panel $S_{max}$ (m) | Panel Length L (m) | Inflexion Point Distance from Panel Side d (m) | Tower Distance From Start $y^+$ (m) | Tower Distance from Panel Side x* (m) |
|---|---|---|---|---|---|---|---|---|---|
| 31B | 7 | 160.5 | 85 | 2.6 | 1.32 | 600 | 45 | 533 | 65 |
| 32B | 8 | 160.5 | 74 | 2.4 | 1.32 | 600 | 46 | 355 | 65 |
| 33B | 8<br>9 | 160.5<br>160.5 | 70<br>(54)<br>70<br>(54) | 2.4<br>2.4 | 1.32<br>1.32 | 600<br>400 | 22<br>25 | 70<br>-105 | -165<br>60 |
| 34B | 10 | 160.5 | 67 | 2.4 | 1.27 | 440 | 29 | 31 | 27 |
| 35B | East Mains | 125 | 91 | 2.1 | 1.05 | 2,000 | 35 | 18 | -9 |
| 36B | East Mains | 125 | 100 | 2.1 | 1.05 | 2,000 | 35 | -82 | -54 |
| 30B | East Mains | 125 | 99 | 2.8 | 1.53 | 2,000 | 33 | 1244 | 16 |
| 29 B | East Mains | 125 | 112 | 2.9 | 1.53 | 2,000 | 33 | 1,444 | -170 |

**+ -** positive distance measured from starting end of panel and within panel limits.
* - positive distance measured from nearest side of panel and within panel limits.
Negative values indicate tower is located outside of panel limits.
(54) - cover depth at Tower 33B

The location of the towers and graphical representation of the analysis results for each tower are given in the abovementioned report for the predicted subsidence, tilt, strain and horizontal displacement respectively. The results are associated with 'smooth' subsidence profile development and do not include discontinuous strata behaviour effects.

**Table 31- Transient* Subsidence Impact Parameter Development at the Transgrid Towers**

| Tower # | Final Tower Subsidence $S_{max}$ (m) | Maximum Tilt $T_{max}$ (mm/m) | | Maximum Horizontal Displacement $HD_{max}$ (mm) | | Initial Tower Movement Direction (grid bearing(°)) | Maximum Tensile Strain^ $+E_{max}$ (mm/m) | | Maximum Compressive Strain^ $-E_{max}$ (mm/m) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Face Retreat Rate: | | 25 m/wk | <10 m/wk | 25 m/wk | <10 m/wk | | 25 m/wk | <10 m/wk | 25 m/wk | <10 m/wk |
| 31B | 0.82 | 17 | 33 | 120 | 240 | 324 | 1.5 | 5 | 4 | 5 |
| 32B | 1.09 | 14.5 | 29.5 | 106 | 215 | 324 | 1.5 | 5.5 | 4 | 5.5 |
| 33B | 0.00 | 0 | 0 | 0 | 0 | 234 | 0 | 0 | 0 | 0 |
| 34B | 0.57 | 13 | 26 | 80 | 190 | 144 | 4 | 4 | 0 | 0 |
| 35B | 0.02 | 1.5 | 4.5 | 11 | 33 | 144 | 1 | 1 | 0 | 0 |
| 36B | 0.00 | 0 | 0 | 0 | 0 | 268 | 0 | 0 | 0 | 0 |
| 30B | 0.57 | 4 | 23 | 29 | 168 | 054 | 1 | 2 | 0 | 0 |
| 29B | 0.00 | 0 | 0 | 0 | 0 | 324 | 0 | 0 | 0 | 0 |

* - Refers to subsidence movements directly associated with the retreating extraction face.

^ - Maximum strains refer to major principal strains. Minor principle strains = 0.25 x major principle strains.

**Table 32- Final* Subsidence Impact Parameter Development at the Transgrid Towers**

| Tower # | Final Tower Subsidence $S_{max}$ (m) | Tilt $T_{max}$ (mm/m) | Horizontal Displacem't $HD_{max}$ (mm) | Final Tower Movement Direction grid bearing (°) | Total Tower Rotation# (°) | Major Principle Strain $E_{max}$ (mm/m) | Minor^ Principle Strain $e_{max}$ (mm/m) |
|---|---|---|---|---|---|---|---|
| 31B | 0.82 | 16 | 119 | 017 | 53 | -4.9 | -1.2 |
| 32B | 1.09 | 7 | 53 | 048 | 90 | -4.2 | -1.0 |
| 33B | 0.00 | 0 | *5* | 144 | 0 | *0.1* | *0.0* |
| 34B | 0.57 | 25 | 181 | 144 | 0 | -1.7 | 1.4 |
| 35B | 0.02 | 2 | 18 | 192 | 48 | 1.4 | 0.2 |
| 36B | 0.00 | 0 | *28* | 268 | 0 | *0.8* | *0.2* |
| 30B | 0.57 | 24 | 173 | 324 | -90 | 3.4 | 0.9 |
| 29B | 0.00 | 0 | *11* | 324 | 0 | 0.2 | 0.0 |

* - Refers to subsidence movements after mining of panel has stopped.
# - Clockwise rotation is positive.
^ - minor principle strains = 0.25 x major principle strains.
*Italics* - Far-field displacements and strains are Upper 99%CL values (refer to **DgS, 2009**).

**Towers above the Proposed Pillar Extraction Panels**

In summary, the five towers within the proposed limits of the pillar extraction panels are likely to be subjected to subsidence ranging from 0.02m to 1.1m at the tower centres.

Transient tilts above the pillar extraction panels are estimated to range from 4 to 33 mm/m for the possible range of retreat rates. Transient tensile and compressive strains are expected to range from 0.5 to 5.5 mm/m.

Final tower tilts will range between 2 mm/m and 25 mm/m. Horizontal displacements are estimated to range between 18 mm and 181 mm. Three of the tower locations will have residual compressive strains ranging from 4 mm/m to 5 mm/m, with the other two towers likely to have residual tensile strains ranging from 1.5 to 3.5 mm/m.

Surface cracking may increase the estimated 'smooth' profile values by 2 to 4 times, if shallow bedrock exists beneath the towers. Local tilts may exceed the smooth profile tilts by 1.5 times due to secondary surface 'hump' or scarp development.

**Towers Outside the Proposed Mining Limits**

The tension tower 33B is very unlikely to be directly impacted by subsidence or tilt, but may experience minor far-field movements, which are unlikely to exceed 5 mm horizontal displacement and 0.1 mm/m tensile strain.

The predicted FFDs and FFSs at Towers 29B and 36B are very unlikely to be > 28 mm, with FFSs not > 0.8 mm/m respectively.

**Impact Management Strategies**

Based on the predicted subsidence profiles for the eight transmission towers, it is assessed that cruciform footings or subsidence protection pillars would have been necessary above the proposed mining areas to mitigate subsidence impacts on the towers to tolerable limits.

The towers already have cruciform footings installed and Transgrid have indicated that they will be able to tolerate the predicted subsidence and strains.

Once the tower footings have been assessed and any necessary mitigation works have been completed, the following monitoring program may be implemented in accordance with a Tower SMP that will need to be prepared in consultation with Transgrid:

(i) Install a minimum of four stable survey pegs or stations in the ground adjacent to each tower leg and on the structure itself (including Tower 33B).

(ii) Determine 3-D coordinates (E, N, RL), levels and in-line strains between the pegs (perimeter distances only) with a minimum of two base-line surveys prior to mining. Survey accuracy should be within the limits discussed below.

(iii) Conduct visual inspections and measurement of subsidence, total horizontal displacements and in-line distances between ground and tower stations during mine subsidence development. Record and photograph details of any changes to the towers and adjacent ground (i.e. cracking).

(iv) Measure the vertical distance from the ground to the conductor catenaries between each tower before, during and after subsidence development.

(v) Prepare and distribute results of each survey to relevant stakeholders.

(vi) Review and implement any Trigger Action Response Plans.

Subsidence should be determined using precise levelling and total station techniques to determine 3-D coordinates.

Level measurements using spirit level should give subsidence to within +/- 3 mm. EDM and traverse techniques from a terrestrial base line is normally expected to be within +/- 10 mm for level and +/- 10 to 20 mm for horizontal displacement (i.e. a strain measurement accuracy of +/- 1 to 2 mm/m over a 10 m bay-length).

Strain measurements should be done using the steel tape techniques and would be expected to have an accuracy of +/- 2 mm (or 0.2 mm/m strain over 10 m).

Survey frequency will be dependent upon mine management requirements for subsidence development data in order to implement subsidence and mine operation management plans.

The above monitoring program proposed is intended to allow the comparison between predicted and measured subsidence impact parameters and provide data relevant for any Trigger Action Responses that may be required.

## 11.1.8.3 Energy Australia 132kV Transmission Timber Poles

### Potential Impacts

There are eight pairs of timber power poles (EA1 to EA8) which will be within or just outside the zone of mine subsidence. The pole pairs are approximately 15 m high and 5 m apart. The pole pairs are connected by a galvanised steel brace between the top section of the poles. The pole pairs are spaced from 161 m to 269 m along the easement, as shown on **Plan 2**.

Worst-case predictions of subsidence, tilt and strain at each pole are presented in **Table 33**. The predictions have been determined from the contour predictions presented in **Figures 22** to **25** of **Appendix A**.

**Table 33- Worst Case Subsidence Predictions for Energy Australia Power Poles**

| Pole Pair and Pole No. | Panel No. | Final Subs $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final Tilt Direction (grid bearing) (o) | Final Ground Strain (mm/m) | Final HD* Base (mm) | Final HD^ Top (mm) | Final Pole Pair Closure (mm) | Conductor Clearance Loss (m) |
|---|---|---|---|---|---|---|---|---|---|
| *1.1* | *8* | *0.00* | *0* | *234* | *0.1* | 0 | 0 | *0* | 0.52 |
| *1.2* | *8* | *0.00* | *0* | *234* | *0.1* | 0 | 0 | | 0.51 |
| 2.1 | 8 | -0.99 | 16 | 054 | -6.4 | 118 | 360 | 62 | 1.06 |
| 2.2 | 8 | -1.03 | 14 | 054 | -6.2 | 101 | 308 | | 1.02 |
| 3.1 | 7 | -1.13 | 16 | 054 | -6.2 | 117 | 358 | 63 | 1.16 |
| 3.2 | 7 | -1.16 | 14 | 054 | -6.2 | 103 | 313 | | 1.13 |
| 4.1 | 6 | -1.25 | 2 | 052 | -3.0 | 17 | 52 | 15 | 1.17 |
| 4.2 | 6 | -1.25 | 2 | 097 | -3.0 | 15 | 44 | | **1.18** |
| 5.1 | 5 | -1.26 | 15 | 235 | -5.0 | 113 | 345 | **70** | 0.64 |
| 5.2 | 5 | -1.19 | **18** | 235 | -4.6 | **131** | **400** | | 0.67 |
| 6.1 | 4 | -0.35 | 16 | 252 | **3.6** | 120 | 367 | 5 | 0.73 |
| 6.2 | 4 | -0.29 | 15 | 254 | 3.8 | 106 | 324 | | 0.73 |
| 7.1 | EM | **-1.56** | 6 | 256 | **-10.7** | 45 | 137 | 66 | 0.81 |
| 7.2 | EM | -1.54 | 8 | 304 | -10.2 | 61 | 186 | | 0.79 |
| 8.1 | EM | -0.05 | 4 | 320 | 1.8 | 28 | 84 | 17 | 0.02 |
| 8.2 | EM | -0.03 | 3 | 320 | 1.5 | 20 | 62 | | 0.02 |
| *9.1* | 1/EM | *0.00* | *0* | 300 | *1.3* | *47* | *47* | | *0* |
| *9.2* | 1/EM | *0.00* | *0* | 300 | *1.0* | *45* | *45* | -2 | *0* |

Notes:
* - HD Base = Absolute horizontal displacement of pole at ground level.
^ - HD top = Absolute horizontal displacement of pole at conductor level (assumed to be 15 m above the ground)
*Italics* - Far-field displacements and strains.
**Bold** - Maximum value.

Each of the power pole pairs will be subject to transient movements towards the retreating pillar extraction face. The poles will generally start moving towards the north and then 'swing' around (up to 90 degrees in bearing) to their final positions after subsidence is fully developed. The poles will also be subject to tensile and compressive strains associated with the subsidence 'wave' as it passes underneath the poles. The transient tilts and strains are expected to range from 50% to 100% of the final values, and will be dependent on face retreat rates.

During subsidence development the distance between the pole pairs will tend to close by between 5 and 70 mm (see **Table 33**). These movements are primarily due to the differential tilt between the poles that may be exacerbated or reduced by the ground strains.

Conductor clearances are estimated to be decreased by between 0.02 m and 1.17 m along the easement as shown in **Table 33**.

**Impact Management Strategies**

Appropriate impact management strategies for the Energy Australia powerline easement include:

(i) The development of a suitable monitoring and response plan based on consultation with the owners of the power line to ensure the impacts on the towers and powerlines do not result in unsafe conditions, bush fires or loss of serviceability during and after mining.

(ii) Management of impacts would include maintaining the integrity of the power poles and preventing potential damage to conductors and surrounding bush land (e.g. in the event of a conductor break sparking a bush fire) and/or providing an alternate supply of power to the communications towers until subsidence has fully developed.

(iii) Suitable responses to subsidence impacts to the power poles and conductors would be to provide appropriate sheathing on the poles to control the tension in the conductors during/after mining impacts.

(iv) Damage from subsidence (i.e. cracking and tilting) can manifest quickly after mining (i.e. within hours). The appropriate management plan will therefore need to consider the time required to respond to an impact exceedence if it occurs.

## 11.1.8.4 Energy Australia 11kV Transmission Timber Poles

There are twenty-three timber power poles (1 to 23) which will be within or just outside the zone of mine subsidence. The poles are approximately 15 m high and 90 m apart (distances vary from 31 m to 132 m) as shown in **Plan 2**.

The conductors are supported by relatively inflexible ceramic insulators that will probably not be able to tolerate the predicted pole movements.

Worst-case predictions of final subsidence, tilt, strain and final tilt direction at each pole are presented in **Table 34**. The predictions have been determined from the contour predictions presented in **Figures 22** to **25 of Appendix A**.

**Table 34- Worst-Case Final Subsidence Predictions for Energy Australia 11 kV Power Poles**

| Pole No. | Easting | Northing | Maximum Subsidence $S_{max}$ (m) | Final Tilt+ $T_{max}$ (mm/m) | Final Tilt Direction (grid bearing) (o) | Final Ground Strain& (mm/m) | Final HD* Base (mm) | HD^ Top (mm) | Conductor Clearance Loss (m) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 370798 | 6368197 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0.13 |
| 2 | 370820 | 6368126 | -0.3 | 22 | 149 | **7** | 158 | 482 | 0.16 |
| 3 | 370777 | 6368016 | -0.1 | 11 | 234 | 7 | 83 | 253 | 0.48 |
| 4 | 370753 | 6367997 | -0.9 | **29** | 234 | -5 | **211** | **643** | 0.99 |
| 5 | 370724 | 6367918 | -1.1 | 18 | 54 | **-8** | 131 | 400 | 0.88 |
| 6 | 370674 | 6367809 | -0.7 | **29** | 234 | -1 | 209 | 639 | 0.57 |
| 7 | 370631 | 6367696 | -0.5 | 26 | 54 | 3 | 188 | 573 | 0.83 |
| 8 | 370584 | 6367577 | -1.3 | 6 | 238 | -4 | 44 | 135 | 0.98 |
| 9 | 370553 | 6367510 | -0.8 | 25 | 53 | -3 | 182 | 555 | 0.53 |
| 10 | 370526 | 6367446 | -0.2 | 15 | 234 | 6 | 109 | 334 | 0.73 |
| 11 | 370495 | 6367377 | **-1.5** | 5 | 218 | -3 | 33 | 101 | **1.21** |
| 12 | 370479 | 6367313 | -1.0 | 25 | 54 | -2 | 181 | 552 | 0.57 |
| 13 | 370445 | 6367229 | -0.5 | 23 | 236 | 4 | 165 | 503 | 0.54 |
| 14 | 370405 | 6367131 | -0.6 | 21 | 343 | 3 | 156 | 478 | 0.49 |
| 15 | 370348 | 6367019 | -0.6 | 27 | 145 | 4 | 198 | 604 | 0.47 |
| 16 | 370295 | 6366898 | -0.3 | 17 | 343 | 4 | 122 | 374 | 0.55 |

Notes:
+ - Transient tilts due to travelling subsidence wave may be assumed to equal the final tilt magnitudes at a given location. Further analysis may be required if marginal conditions indicated.
& - Transient strains may be assumed to range from +/- Final Values.
* - HD Base = Absolute horizontal displacement of pole at ground level.
^ - HD top = Absolute horizontal displacement of pole at conductor level (assumed to be 15 m above the ground)
**Bold** - Maximum value.

The power poles will be subject to transient movements towards the retreating pillar extraction face. The poles will generally start moving towards the north and then 'swing' around (up to 90 degrees in bearing) to their final positions after subsidence is fully developed. The poles will also be subject to tensile and compressive strains associated with the subsidence 'wave' as it passes underneath the poles. The transient tilts and strains are expected to range from 50% to 100% of the final values, and will be dependent on face retreat rates.

Conductor clearances are estimated to be decreased by between 0.13 m and 1.21 m along the easement as shown in **Table 34**.

The impacts of the predicted movement and management strategies will require assessment by Energy Australia engineers.

**Impact Management Strategies**

Appropriate impact management strategies for the Energy Australia powerline easements include:

(i) The development of a suitable monitoring and response plan based on consultation with the owners of the power line to ensure the impacts on the poles and powerlines do not result in unsafe conditions, bush fires or loss of serviceability during and after mining.

(ii) Management of impacts would include replacement of damaged poles and preventing potential damage to conductors and surrounding bush land (e.g. in the event of a conductor break sparking a bush fire) and/or providing an alternate supply of power (if possible) until subsidence has fully developed. It is understood that poles may be sourced and replaced at short notice from the Thornton pole yard.

(iii) Suitable responses to predicted subsidence impacts to the power poles and conductors would be to provide appropriate sheathing on the poles to control the tension in the conductors during/after mining impacts.

(iv) Damage from subsidence (i.e. cracking and tilting) can manifest quickly after mining (i.e. within hours). The appropriate management plan will therefore need to consider the time required to respond to an impact exceedence if it occurs. The erection of temporary fencing in critical areas before subsidence develops may also need to be considered.

The impact management plan should include the following activities:

(i) Measurement of the vertical distance from the ground to the conductor catenaries between each pole pair before, during and after subsidence development.

(ii) Prepare and distribute results of each survey to relevant stakeholders.

(iii) Review and implement Trigger Action Response Plan.

### 11.1.9 Telecommunication Cables

#### 11.1.9.1 Optus Fibre Optic Cable

**Potential Impacts**

The Optus Fibre Optic cable is buried within a shallow trench that is located within the Transgrid Powerline easement (see **Plan 2**).

The worst-case subsidence predictions along the easement after mining are presented in **Table 35**.

**Table 35- Worst-Case Subsidence Predictions for the Optus Fibre Optic Cable Easement**

| Panel | Chain Start (m) | Chain End (m) | Final Subsidence $S_{max}$ (m) | Final Tilt $T_{max}$ (mm/m) | Final In-Line Ground Strain (mm/m) | | Final Principal Ground Strain (mm/m) | |
|---|---|---|---|---|---|---|---|---|
| EM | 1,455 | 1,632 | 1.53 | 21 | 2.5 | -5.1 | 5.6 | -10.1 |
| P7 | 1,665 | 1,880 | 0.93 | 12 | 2.0 | -5.2 | 4.2 | -5.2 |
| P8 | 1,908 | 2,135 | 1.14 | 17 | 3.8 | -2.3 | 5.8 | -5.3 |
| P10 | 2,600 | 2,767 | 0.92 | 16 | 2.7 | -4.2 | 6.1 | -5.5 |
| East Mains | 3,093 | 3,241 | 0.11 | 3 | 0.74 | -0.93 | 1.5 | -1.1 |

Graphical representation of the final subsidence, tilt and strain profiles along the Optus FOC easement are presented in **Figures 44a** to **44c of Appendix A**.

**Impact Management Strategies**

Based on discussions with Optus engineers, the following mitigation strategies are available to mitigate against cable impacts:

- Uncover and relocate the cable prior to mine subsidence impacts
- Uncover and place cable in conduit and re place in sand trench
- Re-route and replace the FOC after mine subsidence impact occurs
- Limit subsidence impacts to within tolerable limits (details were requested from Optus but were unavailable )
- Consultation with Optus as to the design tolerances, location and management options is ongoing

The tolerable limits of the FOC are likely to be dependent on the sheath reinforcement limits and/or strain transfer properties of the sheath and trench backfill.

It may therefore be necessary to re-route or replace the section of cable above the proposed pillar extraction panels.

### 11.1.10 Fences

**Potential Impacts**

The cattle grazing on the Catholic Diocese land are watered by a series of buried pipelines which supply several watering troughs. The land is also divided into grazing paddocks by series of fences and gates.

The impact of 1.21 m to 1.76 m of subsidence on the grazing of livestock and fencing could include the development of surface cracks and erosion, breakage of wire fencing strands and the possible failure of strainer posts.

Failure of fencing could allow livestock to get out of paddocks within the Catholic Land, but not from the site itself.

**Impact Management Strategies**

The above impacts may be managed with the rapid repair of surface cracking, damaged water supply pipes and fences. Relocation of livestock before mining impacts occur may also be undertaken in anticipation of fence failure or loss of water supply. A land and property management plan (LPMP) will be developed in consultation with the landowner to address these potential issues.

### 11.1.11 Dams

There are no dams in service on the SMP Area.

### 11.1.12 Boral Asphalt Plant

**Site Details and Potential Impacts**

The Boral Asphalt plant produces 40,000 tonnes/annum of hot asphalt and 5 Million litres/annum of sprayed bitumen seal for the Australian road construction industry. The site has the following sensitive items of infrastructure that will have very low differential settlement tolerances and represent a business, safety and environmental hazard:

- rotating drum burner to dry aggregate (340$^{o}$C operating temperature)
- 22 m high x 0.75 m stainless steel exhaust stack with guywires
- elevated diesel and bitumen storage tanks
- elevated conveyors and pipe network for materials transfer
- lime storage tank
- hot asphalt and spray-seal bitumen storage tanks (46,000 litres @ 170$^{o}$C operating temperature)
- diesel and CRS Emulsion tanks (27,000 and 15,000 litres)
- in-ground concrete oil separator pits
- weigh-bridge / loading bay
- kerosene and Elgas storage tanks with underground pipe lines
- workshops with concrete slab footings
- masonry block retaining walls
- Gravel hardstand equipment and transport vehicle storage areas
- Buried 100 mm Victaulic water supply pipeline

Other features on the site include staff offices, amenities buildings and car parking. Based on discussions with the site manager, the plant may be partially decommissioned in two to three years (2011 to 2012), however, until notice is given by Boral, it will be necessary to restrict subsidence to very low levels beneath the site by adopting an appropriate subsidence control zone.

The SCZ at this stage has been defined as a 26.5$^{o}$ angle of draw from the site boundary to the limits of secondary pillar extraction or Panel 11 (see **Plan 2**).

**Impact Management Strategies**

Impact management strategies for the Boral Asphalt plant will require the following:

(i) Dilapidation survey of site infrastructure prior to mining of Panel 11.

(ii) Installation of subsidence monitoring lines and stations at key site features to confirm performance of SCZ.

(iii) Monitoring of draw angle and surface impacts around Abel mine workings in non-sensitive areas prior to mining of Panel 11 to confirm or adjust minimum set-back distances from the site features of interest.

(iv) On-going consultation with stakeholder in regards to preparation of a subsidence management plan for minimising mine subsidence impacts within the site boundary. The stakeholder should be notified of mine subsidence survey results and mining activities in advance of subsidence development adjacent to the mine. The SMP should also include an emergency response plan to unanticipated mining related impacts.

## 11.1.13 Aboriginal Places, Heritage and Archaeological Sites

**Potential Impacts**

The previous studies of the sites by their owners identified a number of sites .The three scattered artefact sites exist within the Abel mine lease but outside the zone of subsidence due to the proposed mining layout. It is therefore very unlikely that the sites above the pillar extraction panels will be affected or damaged by surface cracking and increased erosion rates.

Further artefact sites may be present along Viney Creek which have yet to be identified (**ERM, 2008**).

**Impact Management Strategies**

In accordance with the approved Aboriginal Heritage management Plan, the area will be surveyed prior to secondary extraction being undertaken. Any additional sites identified will be treated in accordance with the approved Aboriginal Heritage Management Plan (AHMP).

### 11.1.14 Houses

**Disused Residences**

There are six disused residences that were occupied when the chicken farms were in operation.

**Potential Impacts**

The previous land user buildings on the site are either in various stages of disrepair or have been demolished and were not subject to any development application at the time of Abel Project approval.

Mine subsidence is likely to impact significantly on existing disused residences and structures above the proposed pillar extraction panels (based on damage criteria presented in **AS2870, 1996**).

### 11.1.15 Far Field Displacement F3 Freeway and John Renshaw Drive

**Potential Impacts**

John Renshaw Drive and the F3 Freeway are located well outside the angle of draw around the proposed mining areas. Far-field horizontal displacements of < 13 mm towards the mining area may occur along some sections of both roads adjacent to extracted panels 7 to 13.

Strains associated with the predicted FFDs, are likely to be < 0.3 mm/m and very unlikely to cause cracking or impact to the roads.

**Impact Management Strategies**

It is not considered necessary to monitor far-field movements along these roads as any movements that occur will probably be less than survey accuracy limits for horizontal displacement (i.e. <10 to 20 mm).

## 11.2 IMPACT ASSESSMENT BASED ON INCREASED SUBSIDENCE PREDICTIONS

**Section 8** of the report identifies and describes the major natural features and surface improvements within the SMP application area. **Section 10** of the report provides the predicted subsidence parameters at each of the natural features and surface improvements listed in **Section 8**. **Section 11** provides an impact assessment for each of the natural features and surface improvements listed in **Section 10**. **Sections 8, 10** and **11** of this report cover sections 6.6, 6.7 and 6.10.1, respectively of the SMP Guideline 2003.

A Risk Assessment (see **Section 12** of this report and **Appendix G**) and, in certain cases, an Impact Assessment based on Increased Subsidence Predictions are required under Sections 6.10.2 and 6.10.3 of the SMP Guideline 2003.

“Theoretical Worst Case” is considered to be 60 - 65% of the mined seam height. In the SMP application area this equates to 1920 to 2080 mm, slightly above the current maximum prediction of 1760 (55% of mined seam height).

It was therefore considered that the “Theoretical Worst Case” of subsidence would not affect the risk matrix due to the minor increase over predicted subsidence.

## 11.3 SUMMARY

**Comparison of Subsidence Profile Predictions to the Environmental Assessment**

For completeness the proposed SMP mining layout and impact predictions have been compared to the Environmental Assessment.

It is considered that whilst the proposed SMP layout is not dissimilar to the layout presented in the Environmental Assessment (EA) Report for the Abel Mining Lease Application, the predicted subsidence and associated impacts to the natural and man-made features will be similar in magnitude and location to the EA study outcomes.

A representative predicted subsidence profile across EA Panels (UD 15 to UD 6) with similar geometry to the SMP Panels P1 to P14 are presented **Figure 49c of Appendix A**, and has been compared to the predicted profiles for XL 1 in **Figure 49b of Appendix A**. The differences between the profiles are primarily due to the seam thickness differences along each crossline.

**Conclusion**

It is concluded that the assessed range of potential subsidence and far-field displacement impacts after the mining of the proposed pillar extraction panels will be manageable for the majority of the site features, based on the analysis outcomes and discussions with the stakeholders to-date.

It is considered that whilst the proposed SMP layout is not dissimilar to the layout presented in the Environmental Assessment (EA) Report for the Abel Mining Lease Application, the impacts to the natural and man-made features will be similar in magnitude and location to the EA study outcomes.

No practically measureable mine subsidence or far-field displacement movements or impacts are expected along John Renshaw Drive or the F3 Freeway due to the proposed mining layout.

Subsidence Control Zones (SCZ) have been proposed to limit impacts to within tolerable levels from the proposed mining layout at Abel for Viney Creek, the Transgrid tension tower No. B33 and the Boral Asphalt Plant. The proposed setback distances are considered conservative, however, they will still need to be confirmed as adequate through subsidence monitoring in less sensitive areas during mining.

The above subsidence impact limit criteria will be achieved in the SCZ with first workings only proposed at this stage. The potential exists however to implement a partial pillar extraction layout provided the long-term stability of remnant pillars and tolerable impacts to surface features can be demonstrated.

Provided the proposed impact management strategies are acceptable to the relevant stakeholders, the proposed mining layout is considered satisfactory at this stage.

If the estimated worst-case impacts cannot be reasonably managed in the event that exceedences occur (however unlikely), through mitigation or amelioration strategies, then it will be necessary to adjust the mining layout further to provide a more acceptable risk to the stakeholders.

The extent of mining layout adjustment will also require further discussions (and review of monitoring data) after the completion of a given panel with stakeholder and government agencies.

# 12 RISK ASSESSMENT

## 12.1 RISK ASSESSMENT AND SUMMARY

A risk assessment was conducted on 2 July 2009 to identify, assess and review any potential subsidence impacts to the surface and sub-surface as a result from the mining of the proposed SMP application area at Abel. A copy of the risk assessment is included in **Appendix G**.

The risk assessment was facilitated by HMS Consultants and involved a team with wide ranging experience. The team consisted of members of Abel staff and specialist consultants in subsidence, surface and groundwater.

A key step in the process was the gathering of the data related to the application to present to the team. Once the scope and mandate of the team was determined a number of tools were used to identify issues relating to the application and identify risks as a result of the mining process. The losses were ranked according to their likelihood and consequences with quantification where possible. Once this had been completed current and additional controls were identified to improve the quality of the proposed SMP.

In total thirty-five risks were identified. Of those risks assessed, there were nil “High” risks identified, and six (6) “Significant” risks identified by the risk assessment team. There were nil “Catastrophic” consequences identified and one (1) “Major” consequence identified by the risk assessment team. The “Significant” risks and “Major” consequence relate to Public Utilities and are listed in **Table 36**.

Since this Risk Assessment was conducted the SMP application area has been reduced from 260 Ha to 200 Ha.

**Table 36- Summary of Significant Risk Issues**

| Process | Subprocess | Risk Ref. | Risk Issue | Cause | Existing Controls |
|---|---|---|---|---|---|
| Public utilities | 2.01 – Roads (All types) | 2.01.02 | Damage to access road to Boral | 1. Subsidence | Low speed road |
| Public utilities | 2.03 – Water pipeline | 2.03.01 | Damage to HWC 200mm UPVC pipeline | 1. Subsidence | Nil identified |
| Public utilities | *2.04 – Electricity transmission lines (overhead / underground) and associated plants | 2.04.01 | Damage to 330kV Transgrid Powerline | 1. Subsidence | 1. Cruciform footings<br>2. Conductor strings |
| Public utilities | 2.04 – Electricity transmission lines (overhead / underground) and associated plants | 2.04.02 | Damage to 132kV Energy Australia Powerline | 1. Subsidence | Timber poles more resilient to subsidence impacts |
| Public utilities | 2.04 – Electricity transmission lines (overhead / underground) and associated plants | 2.04.03 | Damage to 11kV Energy Australia Powerline | 1. Subsidence | Timber poles more resilient to subsidence impacts |
| Public utilities | 2.05 – Telecommunication lines (overhead / underground) and associated plants | 2.05.01 | Damage to Optus optical fibre cables | 1. Subsidence | 1. Optus have own internal Management Plan.<br>2.Location of cable confirmed |

* Also Major Consequence

The risk assessment identified existing controls but also highlighted a number of additional controls or further actions that the team thought necessary to manage subsidence.

The further action items for Significant Risk Issues listed in **Table 37** and Other Further Actions listed in **Table 38** were generated from the risk assessment in order to control the associated risks. These actions are either proposed actions or actions in progress. The implementation of the further actions is to be reviewed and updated on a regular basis documenting the status of the implementation process.

The lack of any potential high risk issues is mostly attributable to the proposed mine design layout which includes Subsidence Protection Zones.

This approach provides a high level of confidence that the subsidence impacts to these features from pillar extraction will be minimal.

**Table 37- Summary of Further Actions for Significant Risk Issues**

| Risk Ref. | Risk Issue | Further Action | Current Status of Further Actions |
|---|---|---|---|
| 2.01.02 | Damage to access road to Boral | 1. Management Plan to be implemented | 1. No longer required as access road will no longer be undermined nor impacted by subsidence |
| 2.03.01 | Damage to HWC 200mm UPVC pipeline | 1. Continue dialogue with HWC to develop Management Plan | 1. In progress |
| 2.04.01 | Damage to 330kV Transgrid powerline | 1. Transgrid to review structural integrity and design of cruciforms.<br>2. Continue dialogue with Transgrid to develop Management Plan.<br>3. Investigate need for installation of pulleys on earth wires.<br>4. Check conductor clearance<br>5. Pre-mining surveys<br>6. Subsidence data from Panels 1-4 will be available prior to mining under Transgrid 330kV powerlines | 1. Complete. Transgrid have indicated that the cruciform footings will be abel to withstand the predicted subsidence and strain levels<br>2. In Progress<br>3. Not needed |
| 2.04.02 | Damage to 132kV Energy Australia powerline | 1 Check conductor clearance.<br>2 Survey pole locations.<br>3 Continue dialogue with Energy Australia to develop Management Plan.<br>4 Pre-mining surveys<br>5 Investigate need for installation of pulleys on earth wires | 1. scheduled<br>2. Complete<br>3. In progress |
| 2.04.03 | Damage to 11kV Energy Australia powerline | 1 Check conductor clearance.<br>2 Continue dialogue with Energy Australia to develop Management Plan.<br>3 Pre-mining surveys<br>4 Investigate need for installation of pulleys on earth wires<br>5 Energy Australia to review requirement for powerline | 1. In Progress<br>2. In progress |
| 2.05.01 | Damage to Optus optical fibre cables | 2 Assess Optus MP.<br>3 Investigate durability of Optus cable.<br>4 Subsidence data from Panels 1-4 will be available prior to mining under Optus optical fibre cable<br>5 Continue dialogue with Optus to confirm appropriate Management Plan. | 1. Completed<br>2. In progress<br>3. Confirmed<br>4. Ongoing |

## Table 38- Summary of Other Further Actions

| Risk Ref. | Risk Issue | Existing Controls | Risk Level | Further Actions | Current Status of Further Actions |
|---|---|---|---|---|---|
| 1.01.01 | Creeks - Disruption of stream flow to Viney Creek due to cracking of stream bed or development of ponding and storage areas | 1. Mine design and layout (1,2)<br>2. Provision of an exclusion zone (1,2)<br>3. Baseline stream monitoring as per Surface water management plan (EMP)<br>4. Natural healing of cracks<br>5. Size of cracks will be limited by soil cover | M | 1. Subsidence and stream flow monitoring<br>2. Refine model based on monitoring results<br>3. Consider Surveying creek location | 1. Proposed in SMP Application |
| 1.01.03 | Creeks - Erosion and bed and bank instability (Schedule 2) | 1. Dense native and introduced vegetation along creek beds<br>2. Mine design Schedule 2 (Viney Creek) | M | 1. Refine model based on monitoring results | 1. protected by SCZ |
| 4.03.01 | Boral Asphalt Plant - Damage to gas and fuel storages and associated plants as a result of exceeding tolerable limits set for Principal Residences | 1. Regarded as a Principal Residence under Project Approval | M | 1. Property Management Plan<br>2. Develop First Workings MP | 1. Subsidence Protection Zone – no predicted impacts |
| 4.04.01 | Boral Asphalt Plant - Damage to Oil separator as a result of exceed tolerable limits set for Principal Residences | 1. Regarded as a Principal Residence under Project Approval | M | 1. Property Management Plan<br>2. Develop First Workings MP | 1. Subsidence Protection Zone – no predicted impacts |
| 4.05.01 | Boral Asphalt Plant - Damage to buildings generally and Asphalt plant as a result of exceed tolerable limits set for Principal Residences | 1. Regarded as a Principal Residence under Project Approval | M | 1. Property Management Plan<br>2. Develop First Workings MP | 1. Subsidence Protection Zone – no predicted impacts |

| Risk Ref. | Risk Issue | Existing Controls | Risk Level | Further Actions | Current Status of Further Actions |
|---|---|---|---|---|---|
| 4.06.01 | Boral Asphalt Plant - Damage to items sensitive to surface movement (tower, burner, conveyors) as a result of exceed tolerable limits set for Principal Residences | 1. Regarded as a Principal Residence under Project Approval | **M** | 1. Property Management Plan<br>2. Develop First Workings MP | 1. Subsidence Protection Zone – no predicted impacts |
| 1.02.01 | Groundwater - Drainage of groundwater from perched regolith aquifer | 1. Monitoring<br>2. Mine design | **M** | 1. Continued Monitoring | 1. Established monitoring program |
| 1.05.01 | Swamps, wetlands, water related ecosystems - Increased inundation of swamp | 1. Mine design<br>2. Swamp is on the edge of the subsidence area | **M** | 1. Monitoring review *(Panel 13)* | Not impacted by Mining |
| 3.05.01 | Wells, Bores - Physical loss of monitoring bores | Nil identified | **M** | 1. Replace bores if required | No action at this stage |
| 1.05.01 | Creeks - Decline in water quality (Schedule 2) | 1. Dense native and introduced vegetation along creek beds<br>2. Mine design<br>3. Water quality monitoring | **L** | 1. Monitoring | 1. Established monitoring program |
| 1.02.01 | Groundwater - Depressurisation of coal measures aquifer impacting on groundwater users | 1. Remoteness from other users<br>2. High salinity of water<br>3. Low value groundwater resource | **L** | 1. Continued Monitoring | 1. Established monitoring program |
| 1.05.02 | Swamps, wetlands, water related ecosystems - Drainage of swamp | 1. Mine design<br>2. Swamp is on the edge of the subsidence area | **L** | | Not impacted by Mining |
| 2.01.01 | Public Roads - Damage to public road (F3 freeway, John Renshaw Drive) | 1. Roads outside angle of draw (1)<br>2. Roads outside area of measurable horizontal displacement (2)<br>3. Roads not within SMP area | **L** | 1. Investigate Monitoring of John Renshaw Dr and F3 as part of SMP approval monitoring process | Not considered necessary |

| Risk Ref. | Risk Issue | Existing Controls | Risk Level | Further Actions | Current Status of Further Actions |
|---|---|---|---|---|---|
| 3.02.01 | Internal access tracks - Cracking of road surface resulting in potential vehicle accident | 1. Speed limited road<br>2. Property Management Plan for the site<br>3. Restricted access | L | 1. Appropriate signage<br>2. Develop MP | 1. Management Plan in progress |
| 3.05.02 | Wells, Bores - Loss of water supply from bore (GW51353) | Nil identified | L | 1. Provide replacement water supply if needed | Outside of SMP Area |
| 4.01.01 | Boral Workshops - Damage to workshop structure as a result of exceeding tolerable limits set for Principal Residences | 1. Regarded as a Principal Residence under Project Approval | L | 1. Property Management Plan<br>2. Develop First Workings MP | 1. Subsidence Protection Zone – no predicted impacts |
| 5.01.01 | Areas of Archaeological and/or Heritage Significance - Loss or damage of scatter artefact | 1. Archaeological survey of SMP area conducted | L | 1. Review of Archaeological survey information<br>2. Locations plotted on SMP plans | 1 and 2 Completed |
| 1.01.02 | Creeks - Associated loss of flow to Weakley's Flat Creek | 1. Post mining remediation as per Project Approval<br>2. Natural healing of cracks<br>3. Size of cracks will be limited by soil cover<br>4. Sufficient surface gradients to minimise ponding potential and prevent stream capture<br>5. Baseline stream flow monitoring of Weakley's Flat Creek as per SWMP | L | 1. Refine model based on monitoring results | 1. Established monitoring program |
| 1.01.06 | Creeks - Decline in water quality (Schedule 1) | 1. Dense native and introduced vegetation along creek beds<br>2. Water quality monitoring | L | 1. Monitoring | 1. Established monitoring program |
| 3.01.01 | Agricultural utilisation or agricultural suitability of farm land - Temporary loss of access to grazing area | | L | 1. Review agistments arrangements within the Property Management Plan | 1. Property Management Plan being developed |

| Risk Ref. | Risk Issue | Existing Controls | Risk Level | Further Actions | Current Status of Further Actions |
|---|---|---|---|---|---|
| 3.03.01 | Fences become unserviceable due to damage | 1. Existing property management plan for the site | L | 1. Review agistments arrangements within the Property Management Plan | 1. Property Management Plan being developed |
| 3.07.01 | Water Reticulation systems - Temporary loss of water supply to particular areas | 1. Multiple troughs | L | 1. Sufficient repair supplies onsite | 1. Property Management Plan being developed |
| 4.02.01 | Boral Site offices - Damage to site offices as a result of exceeding tolerable limits set for Principal Residences | 1. Regarded as a Principal Residence under Project Approval | L | 1. Property Management Plan<br>2. Develop First Workings MP | 1. Subsidence Protection Zone – no predicted impacts |
| 1.04.01 | Land prone to flooding or inundation - Subsidence increases the extent of flooding | 1. Mine design | n/a | 1. Review flood studies undertaken by Coal & Allied | 1. Refer Section 8.4.3 |
| 1.06.01 | Threatened and protected species impact | | n/a | Investigate threatened and protected species in SMP Area 1 | 1. Completed |

# 13 COMMUNITY CONSULTATION

Community consultation during the preparation of the SMP was undertaken in accordance with the DPI – Mineral Resources *Guideline for Applications for Subsidence Management Approvals* dated December 2003 (SMP Guideline 2003) and the New South Wales Minerals Council *Community Engagement Handbook Towards Stronger Community Relationships*. The definition of "Community" adopted for the purpose of developing the SMP community consultation strategy is anyone with an interest in subsidence issues for the proposed SMP application.

## 13.1 CONSULTATION DURING THE PREPARATION OF THE SMP APPLICATION

**Stakeholder / Community Consultation**

Stakeholder / Community consultation conducted to date has consisted of:

1. Preliminary SMP presentation and meeting with Department of Primary Industries (now Industry & Investment – NSW) – Mineral Resources on 26 May 2009.
2. SMP Stakeholders presentation meeting and site inspection and submission process on 24 June 2009.
3. SMP Advertisements
4. Aboriginal Community Consultation as part of the Indigenous Heritage assessment.

A presentation was made to DPI (now I & I - NSW)– Mineral Resources on 26 May 2009 to outline the SMP process and progress to date, relating to mine design, environmental considerations and subsidence predictions and potential impacts.

A stakeholder's meeting was conducted on site, on 24 June 2009 to discuss the proposed SMP preparation. The day was structured as follows;

1 Introduction and Meeting Objectives

2 The SMP Process

3 Abel Mine

4 Background
- Mine Planning
- Mining Methods
- SMP Area Surface Environment Assessment
- Subsidence Assessment including historical subsidence
- Final Mine Plan
- Proposed Monitoring

5 Field Visit SMP Area

6 Questions, Summary and Future Process.

The objective of the meeting was to consult with interested parties (relevant stakeholders) to identify potential issues and relevant concerns to be considered and addressed in the preparation of the Subsidence Management Plan. A hard copy of the presentation was provided to all attendees.

Following this meeting a copy of the presentation was forwarded to all relevant stakeholders and placed on the company web site.

A list of relevant stakeholders and relevant details is provided in **Table 39.**

**Table 39- Stakeholder / Community Consultation Information**

| Stakeholder | Invitation to Consultation Meeting | Attendance | Apology |
|---|---|---|---|
| Dr Gang Li - Minerals and Energy | Yes | No | Yes |
| Ray Ramage – Minerals and Energy | Yes | No | Yes |
| Elise Newberry / Jonathon Smith – Minerals and Energy | Yes | No | Yes |
| Rod Sandell – Cessnock City Council | Yes | No | Yes |
| Brent Knowles - Newcastle City Council | Yes | No | Yes |
| Damien Harrigan - Catholic Diocese | Yes | Yes | |
| Julie Cox - Catholic Diocese | Yes | Yes | |
| Geoff Rock – Black Hill Land Pty Ltd | Yes | Yes | |
| Jennifer Anderson – Coal and Allied | Yes | No | Yes |
| Tony Seears – BlackHill Asphalt Plant | Yes | Yes | |
| Ian Landon-Jones – Sydney Catchment Authority | Yes | No | Yes |
| Scott Carter – DPI Fisheries | Yes | No | Yes |
| David Hilyard – Dam Safety Committee | Yes | No | Yes |
| Greg Cole-Clark – Mine Subsidence Board | Yes | No | Yes |
| Howard Reed – Department of Planning | Yes | No | Yes |

| Stakeholder | Invitation to Consultation Meeting | Attendance | Apology |
|---|---|---|---|
| Mark Mignanelli – Department of Water and Energy | Yes | No | Yes |
| Fergus Hancock – Department of Water and Energy | Yes | Yes | |
| Graeme Clarke– DECC | Yes | No | Yes |
| Brad Ure – Community Consultative Committee | Yes | Yes | |
| Alan Jennings – Community Consultative Committee | Yes | Yes | |
| Alan Brown – Community Consultative Committee | Yes | Yes | |
| Terry Lewin – Community Consultative Committee | Yes | No | Yes |
| Colin East – alternate for Terry Lewin - Community Consultative Committee | Yes | Yes | |
| Tony Seton – Community rep | Yes | Yes | |
| Rick Griffiths – Mindaribba Local Aboriginal Land Council | Yes | No | Yes |

**SMP Advertisement**

As per the SMP Guideline 2003, Abel prepared an advertisement to notify the community of the intention to submit an SMP application for approval. The advertisement stated:

*"Donaldson Coal is developing a Subsidence Management Plan to accompany an application to the Department of Primary Industries - Mineral Resources for Pillar extraction mining at Abel Mine in the application area outlined below. Once prepared, the draft Plan will be advertised and displayed for comment. Any person wishing to provide input to the preparation of the Plan can contact the mine on (02) 4015 1100. "*

The advertisement included a map of the SMP Area, mine lease boundaries, the existing workings and regional locality. Abel placed the advertisement in the Newcastle Morning Herald and the Sydney Morning Herald on 4 July 2009. Copies of the advertisements are in Appendix F.

## 13.2 RESULTS OF COMMUNITY CONSULTATION

A summary of any issues, relevant to this SMP Application raised by the stakeholders is included in **Table 40** below.

Additionally, **Table 40** lists continued correspondence and meetings with landholders and infrastructure owners relating to mine plan design, subsidence predictions and discussions relating to potential impacts, monitoring, remediation / mitigation and management proposals.

**Table 40- Community Consultation**

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| **Hunter Water** | | | |
| 01-06-09 | e-mail | To : Hunter Water | Request for Hunter Water to contact re – pipeline and SMP preparation |
| 04-06-09 | Call then e-mail | To : Greg Sivyer HWC | Request for meeting to discuss SMP |
| 12-06-09 | Call | Nathan Hayes | Request for meeting to discuss SMP |
| 30-06-09 | Meeting | T Sutherland and Nathan Hayes HWC | Outline of SMP process, possible subsidence impacts. Not seen as critical by HWC |
| 23-07-09 | Letter | To : Nathan Hayes HWC | Formal notification. Intention to prepare Management Plan. Request for tolerances to subsidence and strain |
| 28-07-09 | e-mail | From Nathan Hayes HWC | Notification that letter forwarded to property Group for formal response |
| 20-08-09 | Letter | From Mark Hickey HWC | Formal response. Advice that HWC will not provide technical advice re - tolerances. Referred to WSAA website |
| 26-10-08 | e-mail | To : WSAA | Requesting information on tolerances to subsidence and strain |
| 09-11-09 | e-mail | To : WSAA | Follow up on above |
| 13-11-09 | call | To : WSAA | No answer |
| 26-11-09 | call | To : WSAA | Request had been forwarded to Engineers. Surprised that Donaldson had not received a reply. |
| **Optus** | | | |
| 03/12-06-09 | call | To : Optus Network Operations | Enquiry re – fibre optic cable, subsidence, mine plan and SMP |
| 15-06-09 | fax | To : Optus Network Operations | Follow up on above |
| 17-06-09 | call | To : Inoke Katia ONO | Discussion on SMP and Optus Internal Management Plan |
| 18-06-09 | email | From : Inoke Katia ONO | Request for proposed mining area |
| 18-06-09 | email | From : Inoke Katia ONO | Request for details of bord and pillar Mining |
| 18-06-09 | email | To : Inoke Katia ONO | Proposed mining area forwarded |
| 18-06-09 | email | To : Inoke Katia ONO | Details forwarded on bord and pillar mining system |
| 22-06-09 | email | To : Inoke Katia ONO | Details forwarded on bord and pillar mining system |
| 29-06-09 | email | From : Inoke Katia ONO | ONO working on draft management plan |

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| 07-07-09 | email | From : Inoke Katia ONO | Draft ONO management plan forwarded |
| 01-09-09 | email | From : Inoke Katia ONO | Request for feedback on Management plan and request for meeting |
| 01-09-09 | email | To : Inoke Katia ONO | Update on management plan |
| 09-09-09 | email | To : Inoke Katia ONO | Request for meeting to discuss Management Plan |
| 10/15-09-09 | emails | From : Inoke Katia ONO<br>To: Inoke Katia ONO | Various emails to organise meeting |
| 21-09-09 | Meeting | Tony Sutherland and Inoke Katia (ONO), Les Cousins (ONO) and Trevor Ho (ONO). | Presentation by Tony Sutherland Discussion on SMP and Optus Internal Management Plan (provided) |
| 29-10-09 | e-mail | To : Inoke Katia ONO | Copy of presentation and mine plan forwarded |
| 30-09-09 | email | From : Inoke Katia ONO | Copy of existing agreements with mines to be forwarded. Diversion costings provided. Optus to reply on discussions with MSB prior to installation. |
| 10-11-09 | e-mail | From : Inoke Katia ONO | ONO unable to source any documents re discussions with MSB and advised that manufacturer of the cable is unable to provide any detail on the tolerance of the fibre optic cable. |
| **Telstra** | | | |
| 29-06-09 | letter | To : Colin Dove – Telstra consultant | Providing Tasman results and requesting meeting re – Abel SMP |
| 09-07-09 | e-mail | To : Raymond Munt– Telstra | Plan of SMP Area forwarded and request for meeting |
| 07-08-09 | e-mail | From : Colin Dove | Information provided on cables Inspection to be arranged |
| 29-10-09 | inspection | T Sutherland / C Dove | Inspection and testing of cables |
| 13-11-09 | letter | To : Colin Dove | Updated mine plan and subsidence summary provided |
| **Energy Australia** | | | |
| 01-06-09 | e-mail | To : Greg Skinner - EA | Mine plan and subsidence summary |
| 03-06-09 | meeting | T Sutherland / K Price / G Skinner | Discussions on mine plan and subsidence. Request for pole locations |
| 15-11-09 | e-mail | To : Greg Skinner - EA | Detail of change in mine plan and subsidence predictions, request for meeting |
| 20-11-09 | e-mail | From: Greg Skinner - EA | Confirmation of meeting and request for contour plan of clearances |
| 23-11-09 | Meeting | T Sutherland, Steve Ditton, Kevin Price and Greg Skinner (EA) | Presentation by T Sutherland |
| 25-11-09 | e-mail | To : Greg Skinner - EA | Copy of presentation forwarded and contour plan of conductor clearances |
| **Transgrid** | | | |
| 01-06-09 | Call then e-mail | To : Bruce Fraser - Transgrid | Initial contact providing mine plan and subsidence predictions. Arranged meeting |

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| 03-06-09 | e-mail | From : Bruce Fraser - Transgrid | Information on cruciform footings and requirements for notification and assessment |
| 05-06-09 | meeting | T Sutherland / P Brown / K Price / B Fraser / B Magin (Transgrid) | Discussion on mine plan, subsidence, SMP process. Cruciform footings date from about 1992, tolerances to subsidence impacts to be checked. MSB have advised Transgrid that they will no cover mitigation measures. |
| 05-06-09 | e-mail | From : Bruce Fraser - Transgrid | Minutes and action items from meeting 05-06-09 |
| 15-07-09 | letter | To : Bruce Fraser - Transgrid | Formal notification of SMP, request for additional information on cruciform footings and further meeting re – formulation of management plan |
| 26-10-09 | e-mail | From : Bruce Fraser - Transgrid | Copy of typical Management Plan provided |
| 16-10-09 / 09-11-09 | e-mails | To : Bruce Fraser - Transgrid | Follow up on acceptable levels of subsidence and strain from Transgrid engineers |
| 09-11-09 | e-mail | From : Bruce Fraser - Transgrid | Still awaiting advice from structural people. Will follow up. |
| 20-11-09 | Meeting | T Sutherland, Steve Ditton, Kevin Price & Brian Magin (Transgrid) | Presentation, update on mine plan, subsidence, requirements for management Plan. Feedback from Transgrid on footing design. Mining can proceed without any modification to cruciform footings. |
| 25-11-09 | e-mail | To : Bruce Fraser – Transgrid | Copy of presentation |
| **Catholic Diocese Maitland-Newcastle** | | | |
| 04-06-09 | Letter | To: Damien Harrigan– Catholic Diocese | Invite to Stakeholder meeting 24/6/9 |
| 24-06-09 | Meeting | | Abel SMP Stakeholder meeting (refer copy of presentation) |
| 25-06-09 | e-mail | From : Julie Cox – Catholic Diocese | Plan provided of stock water supply system and water meter locations |
| 29-10-09 | e-mail | To: Damien Harrigan– Catholic Diocese | Request for meeting to update Catholic Diocese on Abel SMP |
| 12-11-09 | meeting | T Sutherland / K Price / Damien Harrigan and Sean Scanlon (Catholic Diocese) | Presentation, update on mine plan, subsidence, requirements for management Plan |
| 12-11-09 | e-mail | To : Damien Harrigan, Sean Scanlon | Copy of presentation |
| Various dates July - Nov | e-mails | To : Damien Harrigan | Various arrangements for access to carry our surveys on Catholic land in relation to SMP |
| **Black Hill Land P/L** | | | |
| 04-06-09 | Letter | To : Geoff Rock – Black Hill | Invite to Stakeholder meeting 24/6/9 |
| 04-06-09 | Letter | To : Jennifer Anderson– Coal & Allied | Invite to Stakeholder meeting 24/6/9 |
| 11-06-09 | e-mail | From : Geoff Rock–Black Hill | Request for plan prior to the 24/06 meeting indicating the area within ML 1618 that will be the subject of the proposed SMP |
| 13-06-09 | e-mail | To : Geoff Rock – Black Hill | Copy of plans sent as requested |

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| 24-06-09 | meeting | | Stakeholder meeting and surface inspection |
| 24-06-09 | e-mail | To : Geoff Rock – Black Hill | Copy of presentation |
| 14-07-09 | e-mail | From : Geoff Rock–Black Hill | Request for subsidence information on Black Hill Land P/L |
| 14-07-09 | e-mail | To : Geoff Rock – Black Hill | Subsidence data supplied |
| 21-08-09 | e-mail | From : Geoff Rock–Black Hill | Request for pre and post mining contours |
| 21-08-09 | e-mail | To : Geoff Rock – Black Hill | Pre and post mining contours supplied |
| 23-07-09 | e-mail | From : Geoff Rock | Informal agenda for meeting on 30/06 |
| 30-07-09 | meeting | Geoffrey Rock, Keith Dedden, Mark McPherson and T Sutherland | Status of the SMP and the assessment of the subsidence impact on the proposed future development of the Coal & Allied Black Hill site |
| 05-08-09 | e-mail | From : Geoff Rock–Black Hill | Dxf of Black hill site supplied. Request for post mining surface contours on Black Hill site |
| 06-08-09 | e-mail | To : Geoff Rock – Black Hill | Pre and post mining contours supplied |
| 15-11-09 | e-mail | To : Geoff Rock – Black Hill | Update on SMP plan, request for meeting 20/11 |
| 20-11-09 | Meeting | Geoffrey Rock, Keith Dedden, Steve Ditton, Kevin Price and T Sutherland | Presentation on Abel SMP given by T Sutherland |
| 20-11-09 | e-mail | To : Geoff Rock – Black Hill | Copy of 20-11-09 presentation forwarded. Request for dxf plan referenced in the GHD flood study for the Lower Hunter Land Project |
| **Boral** | | | |
| 04-06-09 | e-mail | To : Tony Seears - Boral | Arranging site inspection for 11-06-09 |
| 04-06-09 | e-mail | From : Tony Seears - Boral | Site inspection confirmed for 11-06-09 |
| 09-06-09 | Letter | To : Tony Seears - Boral | Invite to Abel SMP Stakeholder meeting 24-06-09 |
| 11-06-09 | Inspection | T Sutherland and Steve Ditton | Site inspection of the Boral asphalt plant at Black Hill as part of SMP process |
| **Mine Subsidence Board** | | | |
| 20-05-09 | meeting | T Sutherland, Phil Alexander and Ian Bullen (MSB) | Discussions on subsidence district |
| 25-05-09 | e-mail | To : Phil Alexander and Ian Bullen | Mine plan and aerial photo supplied as requested |
| 04-06-09 | Letter | To : Greg Cole-Clark | Invite to SMP Stakeholder meeting 24-06-09 |
| 22-06-09 | e-mail | To : Greg Cole-Clark | Re – invitation to stakeholder meeting |
| 24-06-09 | e-mail | From : Greg Cole-Clark | Response |
| 25-06-09 | e-mail | To : Greg Cole-Clark | Copy of presentation and question on reclassification of Mine Subsidence District |
| 29-06-09 | e-mail | From : Greg Cole-Clark | Response – no specific timetable at this stage |
| 23-07-09 | e-mail | To : Phil Alexander and Ian Bullen | Updated Mine plan and aerial photo supplied |
| 04-12-09 | Meeting | Paul Gray | Discussed approvals for Optus and Transgrid |

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| **DPI-Mineral Resources** | | | |
| 31-03-09 | e-mail | To: Gang Li- DPI MR | Request for meeting to discuss Abel SMP |
| 03-04-09 | e-mail | From: Gang Li- DPI MR | To discuss meeting date |
| 25-05-09 | meeting | T Sutherland / Ray Ramage | Presentation on Abel Mine SMP |
| 04-06-09 | Letters | To Gang Li, Elise Newbury, Ray Ramage and Jonathon Smith | Invite to Abel SMP Stakeholder meeting |
| 09-06-09 | e-mail | From: Jonathon Smith- DPI MR | No one will be attending from DPI |
| 18-08-09 | Meeting | Ray Ramage, Gang Li, Kent McTyer & T Sutherland | Update on Abel SMP (as part of separate meeting) |
| **DPI-Fisheries** | | | |
| 04-06-09 | Letter | Scott Carter | Invite to Abel SMP Stakeholder meeting |
| 22-06-09 | email | To: Scott Carter | Re – invitation to stakeholder meeting |
| 16-06-09 | email | From: Scott Carter | Unable to attend |
| **Department of Planning** | | | |
| 04-06-09 | Letter | Howard Reid- Planning | Invite to Abel SMP Stakeholder meeting |
| 22-06-09 | email | To: Ian Langdon | Re – invitation to stakeholder meeting |
| 22-06-09 | email | From: Ian Langdon | No one from DoP will be attending |
| **Sydney Catchment authority** | | | |
| 04-06-09 | Letter | Ian Langdon Jones | Invite to Abel SMP Stakeholder meeting |
| 16-06-09 | mail | From: Ian Langdon Jones | No SCA rep to attend as it is outside of SCA's area of interest |
| **Department of Water & Energy** | | | |
| 04-06-09 | Letter | Fergus Hancock | Invite to Abel SMP Stakeholder meeting |
| 22-06-09 | email | To: Fergus Hancock | Re – invitation to stakeholder meeting |
| 23-06-09 | email | From: Fergus Hancock | Confirming attendance at meeting |
| **Department of Water & Energy** | | | |
| 04-06-09 | Letter | Mark Mignanelli | Invite to Abel SMP Stakeholder meeting |
| 22-06-09 | email | To: Mark Mignanelli | Re – invitation to stakeholder meeting |
| **Department of Environment and Climate Chnage** | | | |
| 04-06-09 | Letter | Grahame Clarke | Invite to Abel SMP Stakeholder meeting |
| 22-06-09 | email | To: Grahame Clarke | Re – invitation to stakeholder meeting |
| **Dam Safety Committee** | | | |
| 04-06-09 | Letter | David Hilyard | Invite to Abel SMP Stakeholder meeting |
| 10-06-09 | email | From: Heather Middleton | Request for SMP area and location of any dams |
| 15-06-09 | email | To: Heather Middleton | SMP area forwarded and information on small disused dam along Transgrid power line |
| 22-06-09 | email | To: David Hilyard | Re – invitation to stakeholder meeting |

| Date | Type | To / From / With | Subject |
|---|---|---|---|
| **Mindaribba Local Aboriginal Land Council** | | | |
| 04-06-09 | Letter | Rick Griffiths | Invite to Abel SMP Stakeholder meeting |
| **Abel Community Consultative Committee (CCC)** | | | |
| 04-06-09 | Letter | Alan Jennings | Invite to Abel SMP Stakeholder meeting |
| 22-06-09 | email | To: Allan Jennings | Re – invitation to stakeholder meeting |
| 24-06-09 | email | To: Allan Jennings | Copy of presentation |
| 04-06-09 | Letter | Alan Brown | Invite to Abel SMP Stakeholder meeting |
| 09-06-09 | email | From: Alan Brown | Confirming attendance at meeting |
| 24-06-09 | email | To: Alan Brown | Copy of presentation |
| 04-06-09 | Letter | Terry Lewin | Invite to Abel SMP Stakeholder meeting |
| 24-06-09 | email | To: Terry Lewin | Copy of presentation |
| 04-06-09 | Letter | Brad Ure | Invite to Abel SMP Stakeholder meeting |
| 24-06-09 | email | To: Brad Ure | Copy of presentation |
| **Other Landholders** | | | |
| 17-06-09 | Letter | David Allan | Invite to Abel SMP Stakeholder meeting |
| 17-06-09 | Letter/Fax | Tony & Rosalie Seton | Invite to Abel SMP Stakeholder meeting |

# 14 ECONOMIC AND SOCIAL IMPACTS AND BENEFITS

Abel currently has approximately 21 years of coal reserves within the current mining lease.

The majority of Abel's production is railed to Newcastle for the export market with a small amount to various local markets.

Abel provides valuable training and industry experience to apprentices and work experience to both local youth and university students (local and intrastate).

In the Abel Project Approval Statement of Commitments Donaldson Coal Pty Ltd committed to providing monetary contributions towards environmental and community enhancements. These Company Contribution Initiatives are listed in **Table 41**.

**Table 41- Company Contribution Initiatives**

| No. | Proposed Activities | Monetary Value |
|---|---|---|
| **1.** | **Conservation** The company will contribute $1,000,000 to be distributed over ten years by a community trust to be established for the purpose. These monies will be able to be expended by the trust on environmental education or research or environmental management works or activities in State Conservation Area lands or other environmentally valuable lands that lie within or above Donaldson's mining leases and exploration licences or other land owned by the company | $1,000,000 |
| **2.** | **Community Welfare** The company will contribute $250,000 over 5 years to be spent as decided by a community trust on educational needs, community works or other works or activities of benefit to the community within the Abel underground mine area. | $250,000 |
| 3. | **Road Safety** The company will contribute $250,000 towards the cost of upgrading the intersection of Black Hill Rd and John Renshaw Drive, provided that construction of the upgrade is initiated by June 2009 | $250,000 |

| No. | Proposed Activities | Monetary Value |
|---|---|---|
| 4. | **Employment Generation**<br>The Company also operates the **Donaldson Job Creation Trust,** a charitable trust already in operation set up to distribute $1,000,000 over ten years. Monies are expended on job training, job creation and Youth at Risk programs in the Lower Hunter. $500,000 of these monies remain to be spent | $500,000 |
| | | **$2,000,000** |

Abel currently employs 146 personnel and this will increase to 375 once full production level is reached. Town planning calculations anticipate that for each mine employee there are approximately 2.5 indirect employees retained in the community. Consequently the operation of Abel provides approximately 1,300 additional jobs within the local area.

Substantial industry expenditure occurs locally and both federal and state governments will continue to receive income by way of royalty, excise and various taxes.

# 15 STATUTORY REQUIREMENTS

## 15.1 PROJECT APPROVAL

The construction and operation of Abel mine was approved by The Minister for Planning on 7 June 2007, being Project Approval (Development Consent) 05_0136 and allowing mining operations to take place until 31 December 2028.

Abel commenced operations in May 2008. The mine currently employs 132 personnel and currently produces approximately 0.52 million tonnes per annum (tpa), with a proposed maximum production of 4.5 million tonnes of thermal / soft coking coal from the Upper Donaldson coal seam. Abel's production is railed to Newcastle for the export market.

The key features of the Project Approval (Development Consent) 05_0136 for the mine include:

- Construction and operation of an underground coal mine.

**Obligations to Minimise Harm to the Environment**

1. The Proponent shall implement all practicable measures to prevent and/or minimise any harm to the environment that may result from the construction, operation, or rehabilitation of the project.

**Terms of Approval**

2. The Proponent shall carry out the project generally in accordance with the:

   d) EA;
   e) Statement of Commitments; and
   f) Conditions of this approval.

3. If there is any inconsistency between the above documents, the later document shall prevail to the extent of the inconsistency. However, the conditions of this approval shall prevail to the extent of any inconsistency.
4. The Proponent shall comply with any reasonable and feasible requirements of the Director-General arising from the Department's assessment of:
   (c) any reports, plans or correspondence that may be submitted in accordance with the conditions of this approval; and\
   (d) the implementation of any actions or measures contained in these reports, plans or correspondence.

**Limits of Approval**

5. Mining operations may take place until 31 December 2028 on the Abel site.
6. The Proponent shall not extract more than 4.5 million tonnes of ROM coal a year from the Abel site.
7. No more than 6.5 million tonnes of ROM coal may be processed a year on the Bloomfield site.
8. All product coal produced on the Bloomfield site shall be transported by rail via the rail loading facility on the Bloomfield site, except in an emergency. In an emergency, product coal may be transported from the Bloomfield site by road with the prior written approval of the Director-General, subject to any restrictions that the Director-General may impose.

Subsidence related and monitoring / management consent conditions and Statement of Commitments items relevant to this SMP Application are noted in **Table 3** located earlier in this application.

Information regarding all Project Approval conditions is included in each Annual Environmental Management Report (AEMR) lodged with the DII – Minerals and Energy. An annual presentation on the previous year's results and AEMR is made to the DII – Minerals and Energy and other agencies.

## 15.2 MINING LEASE CONDITIONS

The Abel underground mine is accessed through ML 1618. Underground mining is currently undertaken only within this lease.

**Table 42: Abel Mine Mining Lease ML1618**

| Primary Facility (underground) | Expiry Date | Area (ha) |
|---|---|---|
| Mining Lease 1618 (Act 1992) | 15 May 2029 | 2,755 |

The relevant lease contains one condition relating to subsidence, being that relating to Subsidence Management, which is listed below.

**Subsidence Management**

(a) The lease holder shall prepare a Subsidence Management Plan prior to commencing any underground mining operations which will potentially lead to subsidence of the land surface.

(b) Underground mining operations which will potentially lead to subsidence include secondary extraction panels such as longwalls or miniwalls, associated first workings (gateroads, installation roads and associated main headings, etc), and pillar extractions, and are otherwise defined by the *Applications for Subsidence Management Approvals guidelines (EDG17)*

(c) The lease holder must not commence or undertake underground mining operations that will potentially lead to subsidence other than in accordance with a Subsidence Management Plan approved by the Director-General, an approval under the *Coal Mine Health and Safety Act 2002*, or the document *New Subsidence Management Plan Approval Process – Transitional Provisions (EDP09).*

(d) Subsidence Management Plans are to be prepared in accordance with the *Guideline for Applications for Subsidence Management Approvals*.

(e) Subsidence Management Plans as approved shall form part of the Mining Operations Plan required under Condition 2 and will be subject to the Annual Environmental Management Report process as set out under Condition 3. The SMP is also subject to the requirements for subsidence monitoring and reporting set out in the document *New Approval Process for Management of Coal Mining Subsidence - Policy*.

# 15.3 RELEVANT LEGISLATION

## 15.3.1 Commonwealth Legislation

**Environment Protection and Biodiversity Conservation Act 1999**

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires the approval of the Commonwealth Minister of the Environment, Water, Heritage and the Arts for actions that may have a significant impact on matters of National Environmental Significance (NES). Approval from the Commonwealth is in addition to approvals under the NSW legislation. However a bilateral agreement has been concluded between the NSW and Commonwealth government which provides for the accreditation of the NSW assessment and approvals process such that one approval may be granted covering both State and Commonwealth requirements.

The EPBC Act also provides for the identification, conservation and protection of places of National Heritage significance and provides for the management of Commonwealth Heritage places.

The EPBC Act lists seven matters of NES that must be addressed when assessing the impacts of a proposal which are:

- World Heritage Places;
- National Heritage places;
- RAMSAR wetlands (wetlands of international significance);
- Listed threatened species, critical habitats and ecological communities;
- Listed migratory species;
- Commonwealth land and marine areas or reserves; and
- nuclear actions (including uranium mining).

The flora and fauna study undertaken for the Abel Environmental Assessment considered RAMSAR wetlands, listed migratory species and listed threatened species and populations in accordance with the Commonwealth EPBC Act 1999. The flora and fauna study concluded that there would be no significant impact on these matters resulting from works associated the proposed development and mining. An assessment undertaken in accordance with the requirements of the EPBC Act concluded that the proposed mining will not result in a significant impact on the species' habitat. The proposed mining is therefore not a controlled action and approval from the Commonwealth Minister for the Environment and Heritage is not required.

## 15.3.2 State Legislation and Planning Policies

**Environmental Planning and Assessment Act 1979**

The *Environmental Planning and Assessment Act 1979* (EP & A Act) and the *Environmental Planning and Assessment Regulation 2000* (EP & A Regulation) provide the framework for environmental planning in NSW and include provisions to ensure that proposals which have the potential to impact the environment are subject to detailed assessment, and also provide opportunity for public involvement. is administered by the Department of Planning (DoP). It institutes a system of environmental planning and assessment for the State of New South Wales.

The objectives of the EP & A Act that are relevant to the proposed pillar extraction mining of SMP Area 1 are:

- the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, water, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment;
- the promotion and co-ordination of the orderly and economic use and development of land;
- public involvement;
- the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats; and
- ecologically sustainable development.

Abel has Project Approval 05_0136 granted 7 June 2007.

**Protection of the Environment Operations Act 1997**

The *Protection of the Environment Operations Act 1997* (POEO Act) is the principal NSW legislation relating to environmental regulation and in particular contains strict provisions regulating water, air, noise and land pollution. A key feature of the POEO Act is the requirement for certain '*Scheduled activities',* which are listed in Schedule 1 of the POEO Act to have an Environmental Protection Licence (EPL).

Clause 28 of Schedule 1 of the POEO Act relates to mining for coal and provides that coal mines with a capacity to produce more than 500 t of coal per day are classified as '*scheduled activities'*

Abel Mine has this capacity and currently holds EPL No.12856 under the POEO Act. No variation to this licence is required for the proposed extraction of the SMP Area 1.

**Threatened Species Conservation Act 1995**

The *Threatened S pecies Conservation A ct 19 95* (TSC Act) provides protection for threatened plants and animals native to NSW (excluding fish and marine vegetation which are protected under the *Fisheries Management Act 1994*). The Act integrates the conservation of threatened species into development approval processes under the EP & A Act. Under the EP & A Act, impacts on threatened species listed under the TSC Act are assessed by a seven-part test. Where a development is likely to have a significant impact on a threatened species, population or ecological community, the preparation of a Species Impact Statement (SIS) is required.

The results of the seven part tests conducted for threatened fauna species identified in the SMP application area conclude that the proposed pillar extraction mining operation is not likely to have a significant effect on these species based on predicted levels of subsidence. Similarly the effects on identified threatened flora species are considered to be minimal, if any.

**Mining Act 1992**

The *Mining Act 1992* (Mining Act) makes provision for a variety of mining authorities, including mining leases and exploration licences which are required for the prospecting and mining of minerals and coal. The Mining Act also makes provision for the protection of the environment in relation to mining activities, including rehabilitation of areas affected by mining activities.

Abel Mine currently holds a mining lease (ML 1618) over the SMP application area. A condition of this lease requires a Subsidence Management Plan to be prepared prior to the commencement of any mining operations which may potentially lead to subsidence.

Part 11 of the Mining Act deals with the protection of the environment and provides that conditions may be imposed upon a mining authority or mineral claim requiring that land affected by mining activities be rehabilitated. Standard conditions generally imposed upon a mining lease include requirements to submit a MOP prior to the commencement of mining operations as well as Annual Environmental Management Reports (AEMR). These documents form the Mining Rehabilitation and Environmental Management Process (MREMP)

The Mining Operations Plan (MOP) is systematically updated to cover the mining operations. The current MOP was accepted in December 2008 and will be modified to include the SMP application area. Environmental performance of the operation will be reported in the Annual Environmental Management Report (AEMR).

**Coal Mines Health and Safety Act 2002 and Coal Mine Health and Safety Regulation 2006**

The *Coal Mines Health and Safety Act 2002* (CMHS Act) operates in conjunction with the *Occupational Health and Safety Act 2000* (OH & S Act) and *Coal Mine Health and Safety Regulation 2006* (CMHS Regulation) with the key objects being:

- to assist in securing the objects of the *Occupational Health and Safety Act 2000* in relation to coal operations;
- to put in place special provisions necessary for the control of particular risks arising from the mining of or exploration for coal;
- to ensure that the effective provisions for emergencies are developed and maintained at coal operations or related places.

Part 5 of the CMHS Act sets out the duties of the mine operator in relation to health, safety and welfare at coal operations. The Act requires that the mine operator have a health and safety management system providing :

- the basis for the identification of hazards, and of the assessment of risks arising from these hazards, by the operator;
- for the development of controls for those risks; and
- for the reliable implementation of those controls.

The Act may also require the operator to have in place:

- Major hazard plan;
- Management structure;
- Contractor management plan; and
- Emergency management system.

These documents form part of the existing general health and safety system in place at Abel.

- Under Clause 88 of the *Coal Mine Health and Safety Regulation 2006* under the CHMSA, Abel must also submit an application for approval to the DII – Minerals and Energy prior to the commencement of secondary extraction.

**Mine Subsidence Compensation Act 1961**

The *Mine Subsidence Compensation Act 1961* (MSC Act) establishes a scheme for the payment of compensation for damage sustained to surface improvements by subsidence resulting from the mining of coal or shale.

Section 10 of the Act establishes the Mine Subsidence Compensation Fund. Colliery proprietors are required to make an annual contribution to this fund based upon the land value of the colliery. Under the Act, claims can be made against this fund for damage arising out of subsidence. Abel makes contributions, as appropriate and required under this Act.

Section 15 of the Act makes provision for the establishment of Mine Subsidence Districts (MSD) and requires that an application be lodged with the Mine Subsidence Board (MSB) for the erection or alteration of improvements or the subdivision of land within a mine subsidence district.

The SMP application area is not located within a current Mine Subsidence District but was previously located within the Ironbark Mine Subsidence District. Discussions have been held with the MSB relating to the reclassification of the area as a Mine Subsidence District.

**Water Management Act 2000**

The *Water Management Act 2000* (WM Act) is administered by the NSW Office of Water and provides for the regulation of access to water. The Act, as amended, came into force in July 2004.

The object of the Act is to ensure sustainable and integrated management of water in NSW for present and future generations and it is based on the concept of ecologically sustainable development.

Licensing and approval systems are in place over those areas of NSW subject to an operational water sharing plan. These plans have been compiled for most of the regulated river systems in NSW. The licensing system applies to both surface and groundwaters.

**Water Act 1912**

Licences under the *Water Act 1912* authorise the taking of water and the use of water. Abel currently holds a licence (**20BL171935 valid until 4 August 2013)** issued under the *Water Act 1912* for the purpose of mine dewatering.

The area of proposed extraction does not have any major rivers or streams running through it and the extraction should not require any additional water for processing. It is not anticipated that large volumes of groundwater will be encountered, however, if dewatering beyond licence requirements is required, an amendment to the existing water license would be pursued. It is therefore not anticipated that any new licenses would be required under the WMA 2000.

**State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Mining SEPP)**

*State Environmental Planning Policy (Mining, Petroleum Production and extractive Industries) 2007* (Mining SEPP) recognises the importance of mining, petroleum production and extractive industries and sets out activities which are permissible both with and without development consent, and also specifies prohibited development.

The proposed mining within the SMP application area is permissible with the existing Project Approval.

**Dams Safety Act 1978**

The SMP application area does not contain any dams (including stored waters and reservoirs) and / or structures referred to by the *Dams Safety Act 1978.*

**National Parks and Wildlife Act 1974**

The *National Parks and Wildlife Act 1974* (NP & W Act) provides for the establishment, care, control and management of national parks, historic sites, nature reserves, State Conservation Areas, Aboriginal areas and state game reserves.

The Act also provides for the protection of Aboriginal objects and the protection of native flora and fauna. A consent to destroy permit is required under Section 90 of the Act prior to the destruction of any known Aboriginal Archaeological sites. Aboriginal heritage assessments of the SMP application area have been conducted. Potential impacts to Aboriginal places and objects, native flora and native fauna have been considered in this SMP application with no significant impacts predicted.

**Heritage Act 1977**

The purpose of *Heritage Act 1977* (Heritage Act) is to protect and conserve on-aboriginal cultural heritage, including scheduled heritage items, sites and relics. The Heritage Act is administered by the NSW Heritage Office, which maintains the State Heritage Register, listing heritage items of State significance. The Act also requires that a permit be obtained prior to disturbance of any known heritage items (greater than 50 years old).

An assessment of European heritage has been conducted over SMP application area with no items located.

### 15.3.3 Local Planning

The Abel Underground Mine lease area is within Newcastle and Cessnock local government areas (LGAs). The majority of SMP application area is within Cessnock LGA with the eastern section within Newcastle LGA.

The area within Cessnock LGA is zoned 1(a) Rural A by the Cessnock Local Environment Plan 1989, which permits underground mining and associated surface activities with consent. The eastern section within Newcastle LGA is zoned 7(b) Environmental Investigation by the Newcastle Local Environment Plan 2003, which permits underground mining activities with consent.

The Abel pillar extraction within the SMP application area and permissible in all applicable local government area zonings.

# 16 REFERENCES

***Department of Infrastructure, Planning and Natural Resources 2002*** *– Draft Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region*

***Coal & Allied (2009)-*** *Part 3A application on Black Hill Land, [http://www.coalandallied.com.au/whatwedo/338_lower_hunter_lands_1105.asp]*

***Geoterra Pty Ltd (2009)-*** *Report on Inspection of Viney Creek*

***Harden G.J. ed. (1990)*** *- Flora of New South Wales Volume 1, NSW Uni Press, Kensington.*

***Harden G.J. ed. (1991)*** *- Flora of New South Wales Volume 2, NSW Uni Press, Kensington.*

***Harden G.J. ed. (1992)*** *- Flora of New South Wales Volume 3, NSW Uni Press, Kensington.*

***Harden G.J. ed. (1993)*** *- Flora of New South Wales Volume 4, NSW Uni Press, Kensington.*

***Harden G.J. ed. (2002)*** *- Flora of New South Wales Volume 2, Second Edition, NSW Uni Press, Kensington.*

***NSW Department of Mineral Resources (2003)*** *– Guideline for Applications for Subsidence Management Approvals.*

***NSW Department of Mineral Resources (2003)*** *– New Approval Process for the Management of Coal Mining Subsidence.*

***NSW Minerals Council*** *– Community Engagement Handbook Towards Stronger Community Relationships*

***ERM Pty Limited (2008)****- Lower Hunter Estates Development Heritage Impact Assessment Blackhill Estate [http://www.coalandallied.com.au/documents/Heritage_Report_Part_1.pdf]*

# 17 PLANS

| SMP guideline reference | Plan Name - Number |
|---|---|
| Plan 1 | Existing & Proposed Workings |
| Plan 2 | Natural & Man-made Features |
| Plan 3A | Depth of Cover Isopachs and Seam thickness |
| Plan 3B | Seam floor contours and geological structures |
| Plan 5 | Mining Titles & Land Ownership |
| Plan 6 | Geological Sections/Strata Profile |
| Plan 7 | Aerial Photograph |
| Approved Plan | SMP Approved Plan |

# 18 APPENDICES