Table 2.2 (Cont'd)
Geotechnical Attributes of the Mine Stratigraphy

Page 2 of 2

Unit	Description	Comments
Roof Coal	Generally, greater than 1m of clean coal in immediate roof.	The roof coal is expected to form a good roof with low stress such that roof support densities on development and during retreat would be towards the lower end of those commonly found in other coal regions.
Working Section	Not heavily cleated. Extent of jointing not known.	The actual rib support required can only be determined once the seam is accessed. At this stage, rib support is expected to be similar that generally used within the industry.
Arkarula Formation/ Brigalow Formation	Tests indicate moderate strength floor with no slaking tendency.	Floor problems are not anticipated. This is a positive outcome as there are significantly fewer effective strategies for dealing with weak floors than there are for weak roofs.

2.2.4 Exploration

Exploration Licence (EL) 6243 (see **Figure 2.5**) was granted to Narrabri Coal Pty Ltd in May 2004 and covers an area of 113km^2. The area incorporating EL 6243 was initially explored by Pacific Power in the 1980s using widely spaced drilling.

The Proponent would continue its exploration activities in the southern half of EL 6243 over the next few years. Any coal mining proposal within that area would depend upon the quantity and quality of coal identified, technical and economic factors and environmental constraints. In any event, any proposal would be the subject of a separate application for project approval.

Coal exploration commenced in July 2004 and has, to date, entailed:

- drilling of in excess of 190 drill holes, 120 of which have been cored, and the majority of which have been geophysically logged (**Figure 2.5**);
- ply-by-ply quality analysis of a number of the 120 cores recovered from the coal seam;
- Uniaxial Compressive Strength (UCS) determination for roof and floor strata;
- slake durability testing of floor strata;
- specialist analysis of regional aeromagnetic data and data from a high resolution (low height) aeromagnetic survey of the EL area which was conducted in September 2005;
- specialist assessment of gas make and nature particularly in the initial longwall area;
- specialist "televiewer" reports on 25 deep holes for evidence of stress-related breakout;
- specialist assessment permeability and porosity of strata;
- geotechnical review of data with emphasis on assessment of likely mining conditions; and
- specialist investigations of the coal for spontaneous combustion.

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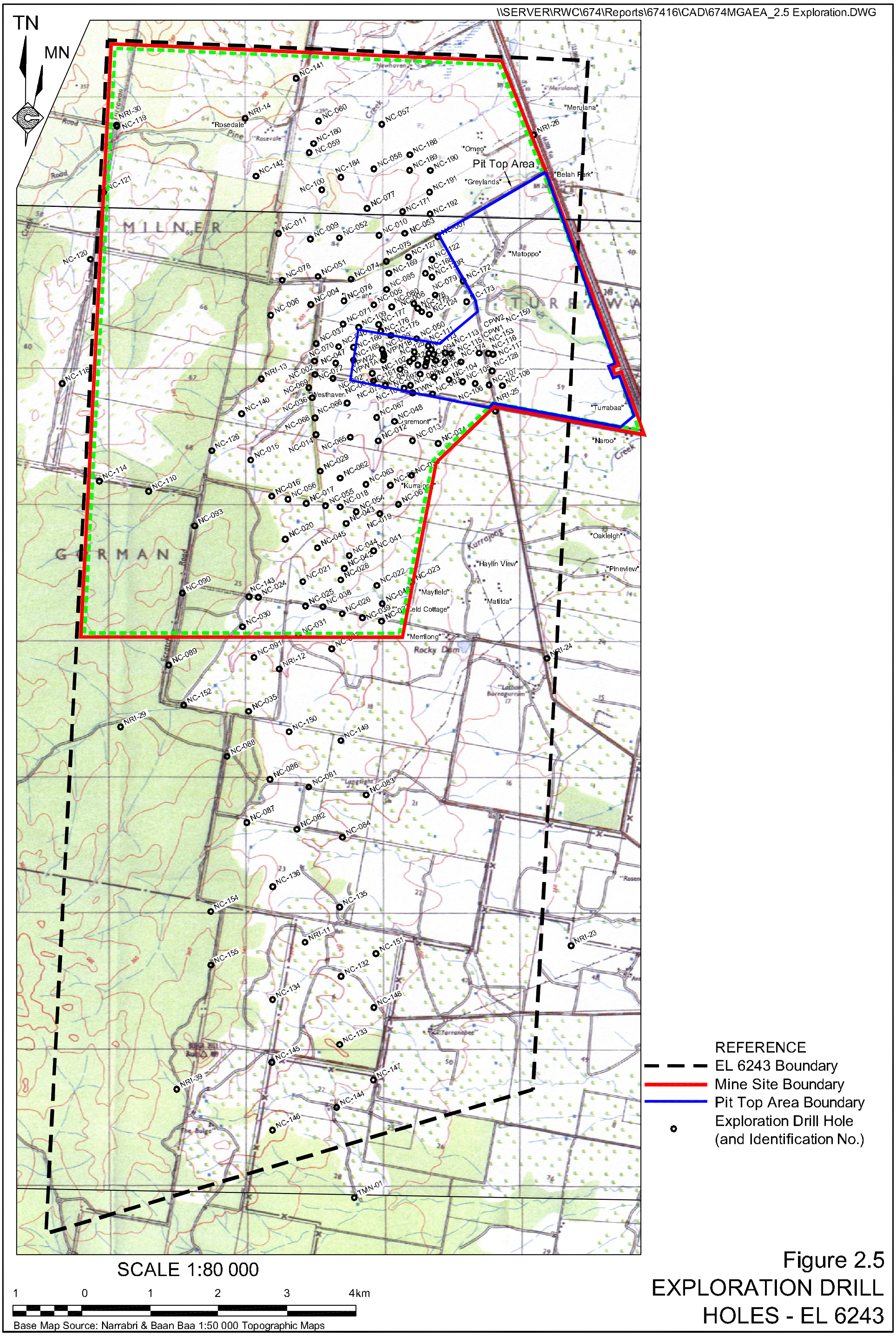

Base Map Source: Narrabri & Baan Baa 1:50 000 Topographic Maps

Figure 2.5
EXPLORATION DRILL HOLES - EL 6243

2.2.5 Coal Resources and Reserves

The coal resource of the Narrabri Coal Mine is contained within the Hoskissons Coal Seam and the results of the exploration activity have confirmed seam characteristics of the Hoskissons Coal Seam within ML 1609 as follows.

- The Hoskissons Coal Seam is between 8m and 10m thick over the western half of ML 1609.
- In the eastern half of ML 1609, the seam is cut off at a depth of approximately 160m by a low angle unconformity between the coal seam and the overlying Digby Formation.
- The coal seam strikes generally north-south, and dips gently to the west.
- The levels of the floor of the coal seam below surface and the variations in overall seam thickness are displayed in **Figure 2.6**.

The Hoskissons Coal Seam comprises two plies, (referred to as the **H**oskissons **C**oal Seam Ply **1** (HC1) and Ply **2** (HC2). The lower part of the Hoskissons Coal Seam, the HC2 ply, contains low ash coal suitable for thermal applications and therefore is suitable for recovery by underground mining methods. The lower approximately 4.0m to 4.2m of HC2 is the targeted working section for longwall mining. A working section height of approximately 4.2m is the optimum limit for safe, productive continuous miner operations and is towards the upper end of single-pass longwall technology. The upper section of the seam, the HC1 ply, contains high ash stony coal and tuffaceous claystone bands that would remain in the roof where the seam thickness exceeds 4.2m.

Based on an average working section of 4.2m, it has been calculated that 230 million tonnes of coal occurs within the lower HC2 ply, ie. the in-situ coal of the Narrabri Coal Mine within ML 1609. An assessment of the recoverable coal resources of the Mine Site conducted by SRK Consulting (SRK) established that 65.5% of the coal or approximately 150 million tonnes could be recovered by a longwall mining operation.

Table 2.3 provides a summary of the measured, indicated and inferred coal resources within ML 1609 drawn from the Joint Ore Resources Code (JORC) assessment conducted by SRK Consulting.

Table 2.4 provides a summary of the current coal reserves within ML 1609 drawn from the Joint Ore Resources Code (JORC) assessment conducted by Minarco – Mineconsult during 2007. This reserve does not include areas of inferred coal resources in the western part of the lease and thus, would increase to the 150Mt as assessed by SRK subject to further drilling.

Table 2.3
Coal Resources within ML 1609

Coal Ply	Resource Category	Seam Thickness (m)	Coal Tonnage (Mt)
HC2	Measured	4.11	88.64
	Indicated	4.12	81
	Inferred	4.13	60
	Total		**229.64**
Source: SRK (2007)			

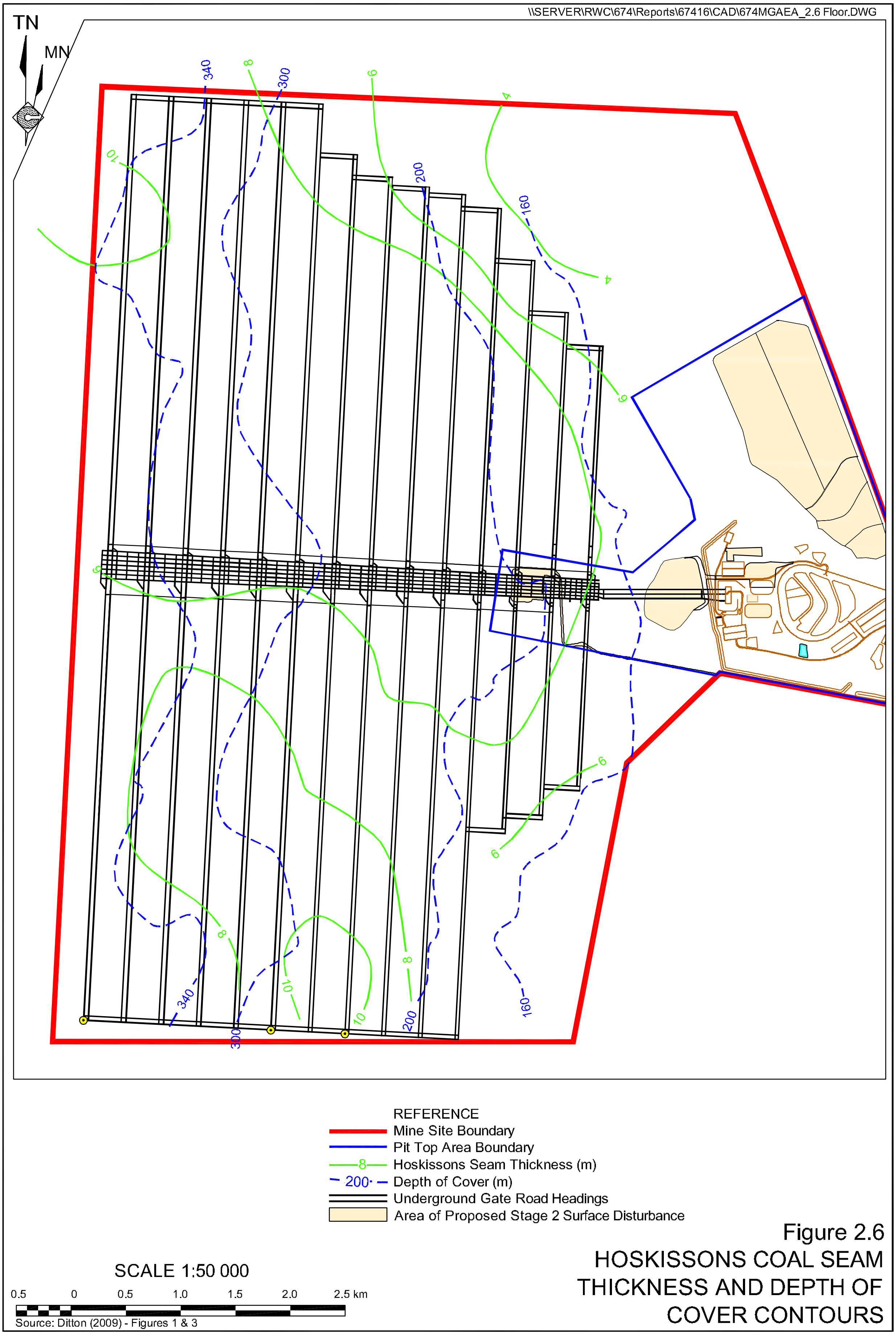

Figure 2.6
HOSKISSONS COAL SEAM THICKNESS AND DEPTH OF COVER CONTOURS

Table 2.4
Coal Reserves within ML 1609

Coal Reserves (Mt)	**Marketable Reserves (Mt)**		
Proved+Probable	Proved	Probable	**Total**
112.0	51.1	51.6	102.7

Table 2.5 lists various parameters contributing to the assessment of coal quality. Invariably, there is considerable similarity between the results for the measured, indicated and inferred resources.

Table 2.5
Coal Quality

Resource Category	**Seam Thickness (m)**	**Inherent Moisture**	**Volatile Matter**	**Ash**	**Sulphur**	**Specific Energy**	**Relative Density**
Measured	4.11	4.3	28.3	9.7	0.36	29.0	1.42
Indicated	4.12	4.3	27.9	10.7	0.36	29.1	1.43
Inferred	4.13	4.4	27.7	11.0	0.36	29.1	1.44
Total	**4.12**	**4.33**	**28.0**	**10.5**	**0.36**	**29.1**	**1.43**
Source: SRK (2007)							

2.2.6 Spontaneous Combustion Potential

A spontaneous combustion assessment completed for the Hoskissons Coal Seam by Dr Basil Beamish, whilst not providing quantitative data on the heating characteristics of the coal, provided an analysis of the spontaneous combustion potential of the coal to be mined. The similarity of Hoskissons Coal Seam to that of Dartbrook Colliery's Wynn Seam was noted. Standard laboratory testing of core samples by Uniquest indicated that the Hoskissons Coal Seam has a moderate to high propensity to spontaneous combustion and confirmed the similarity to the Wynn Seam at Dartbrook (which displays the following properties).

- An R70 rate of 2^{o}C to 5^{o}C per hour.
- A cross-over temperature range of 130^{o}C to 150^{o}C.
- A self-heating temperature of 86^{o}C to 90^{o}C.
- Low rank/high volatile coal.

Based on the properties described above, and the mining method to be implemented which would leave up to 5m of inter-bedded low quality broken coal in the goaf, spontaneous combustion has been identified as a medium to high risk at the Narrabri Coal Mine.

Section 2.4.7 provides a description of how the spontaneous combustion risk is to be managed.

2.3 MINE PLANNING

2.3.1 Introduction

From the outset of mine planning for the Stage 1 operation, it was recognised the coal resource may be suitable for extraction by longwall mining methods, however, given the absence of any experience with longwall mining in the Narrabri area, the Proponent favoured a staged approach to enable further assessment of ground, mining and groundwater conditions. Mine planning for Stage 2 commenced almost immediately following the granting of PA 05_0102,

considering economic, geological, geotechnical and environmental issues. The reasons for accelerating the planning for Stage 2 have previously been discussed in Section 1.4.4. Details of the various considerations are set out in the following subsections followed by an overview of the staged approach to mining the defined coal reserve.

2.3.2 Economic Considerations

In assessing the economic issues relevant to the design of the Longwall Project, the Proponent has drawn on experience gained by an associated company, Namoi Mining Pty Ltd, which mined the Hoskissons Coal Seam with continuous miners at Gunnedah Colliery from 1996 to early 2000. This experience has provided a high level of confidence with respect to productivity levels that can be expected from the proposed longwall mining operations within similar seam conditions.

Although the Mine Site is 382km from Port Newcastle and the cost of rail freight would be significantly higher than that for miners in the Hunter Valley, a number of economic considerations offset this disadvantage.

The low ash, low sulphur quality of in-situ coal in the proposed 4.2m thick working section would minimise the proportion of coal requiring washing to produce thermal coal products for sale into the export market. The high quality ensures that there would be a ready market for the coal.

ML 1609 is located in close proximity to the North Western Branch Railway Line, which limited the length of track work required to construct the Mine Site rail loop.

Finally, the Proponent has an existing rail allocation for the North Western Branch Railway Line and Main Northern Railway Line, ensuring that the coal produced is able to be transported to Port Newcastle for export.

2.3.3 Geological Considerations

The exploration results identified that the coal resource includes large areas which appear to be free of major structural disturbance and accordingly these areas would support a high production longwall mining operation. The longwall panels of the underground have been defined to correspond with the limit of where the coal seam thickness is at least 4m or greater (see **Figure 2.6**).

The geological data compiled enabled the eastern-most and shallowest area where the Hoskissons Coal Seam is present to be defined. This area then contributed to defining the locations of the box cut and portals for the transport drift and conveyor drift, ie. based on a 1:8 (V:H) gradient and the need to locate the base of the drifts (the Pit Bottom Area) centrally within the resource area.

2.3.4 Geotechnical Considerations

A range of geotechnical studies have been undertaken to assist in the design of the longwall mining operations. These studies have provided important information used in the planning of both the Stage 1 continuous miner operation (initially) and more recently the proposed longwall mining operation and include the following.

- Geophysical logging of drill holes by GroundSearch Australia.
- Detailed regional aeromagnetic survey by SRK Consultants.
- Geological modelling by JB Mining Services to assess structural, stratigraphic and coal seam data.
- Geotechnical testing of the rocks / strata which overly the coal seam by Australia Soil Laboratories.
- Stress direction testing by Sigra Pty Ltd.
- Coal seam gas analysis by Earth Data Geological Consultants.
- A geotechnical assessment of the Stage 1 Narrabri Coal Project completed by Mining Geotechnical Services Pty Limited in October 2006.
- Assessment of the spontaneous combustion potential of the Hoskissons Coal Seam (Beamish, 2006).
- Assessment and design of pillars completed by Pacific International Mining Solutions in January 2009.
- Subsidence Assessment by Ditton Geotechnical Services Pty Ltd (DGS, 2009).

The critical geotechnical parameter influencing the design and development of the longwall mining operations, as opposed to the approved Stage 1 continuous miner operations, was the predicted subsidence and possible impacts of this subsidence both underground and at surface. The complete report of Ditton Geotechnical Services Pty Ltd (DGS, 2009) is provided as Part 1 of the *Specialist Consultant Studies Compendium* that accompanies this *Environmental Assessment*, with a detailed summary of the predicted subsidence levels and impacts included as Section 4B.1. The following provides a brief description of the causes and effects of subsidence, local conditions with the potential to affect subsidence and impacts on the proposed longwall mining plans.

In most cases immediately after extraction in a longwall panel, the immediate mine roof usually collapses into the void left in the seam behind the roof supports. The overlying strata or overburden then sags down onto the collapsed material, resulting in settlement of the surface. The maximum subsidence occurs in the middle of the extracted panel and is dependent on the following.

- The height of extraction in the longwall panel: which determines the height of the initial collapse. The longwall panels extraction height would be 4.2m while the gate road headings and chain pillars between the panels would be 3.5m in height.
- The depth below surface of longwall panel: with the influence of rock fracture, swelling and bridging reducing the effect of the initial collapse with height. Cover depths range from 160m up to 380m with a single row of chain pillars to be left between the extracted longwall blocks. The widths of the chain pillars would increase with cover depth from 24.6m to 37.6m.

- The geological properties of the strata above the collapse including any massive structures above the longwall panel: influencing the bulking characteristics of the collapsed strata as well as any 'bridging' by the massive units over collapsed rock beneath it. Three geological units above the coal seam have been assessed for their potential for bridging behaviour. DGS (2009) has determined, based on strength testing, empirical data base and an analytical Voussoir Beam model, that only the Garrawilla Volcanics have the potential to reduce subsidence.
- Features of surface geology and topography: which may exacerbate the impacts of surface subsidence through cracking or impacts on structurally vulnerable features such as creeks, caves, overhangs etc. The terrain is generally flat in the east with two low-level ridges with moderate slopes in the west. The ephemeral watercourses of Pine and Kurrajong Creeks and their tributaries drain the Mine Site towards the north-east.

Modelling completed by DGS (2009) has predicted that subsidence of up to 2.44m would be experienced, resulting in:

- surface cracking of between 20mm and 190mm;
- altered surface gradients of up to 6% (3^o) along creeks;
- potential ponding depths of between 0.5m and 1.5m within the watercourses in the flatter areas of the site; and
- possible impacts on subsurface aquifers within 110m to 180m above the proposed panels as a result of direct hydraulic connection to the workings.

Based on the above assessment of potential subsidence, the impacts would be limited to the Mine Site, the majority of which is owned by the Proponent. The impacts of up to 2.44m of subsidence have been considered by each of the specialist consultants commissioned as part of the *Environmental Assessment*, with the recommended amelioration and/or mitigation measures to be implemented by the Proponent. Any impact on ground or surface water availability has also been carefully evaluated with appropriate licences and contingency strategies developed to address any impacts should they occur.

2.3.5 Environmental Considerations

The Narrabri Coal Mine would continue to operate as an underground operation. The primary environmental considerations have therefore revolved around any additional surface disturbance required for the Stage 2 longwall operations, subsidence-related impacts on the surface and potential impacts on local ground and surface water resources. The following provides a summary of the main environmental issues considered during the design of the Longwall Project.

- <u>Vegetated Land / Agricultural Land</u>

  The Longwall Project would require the establishment of Reject Emplacement Area to the immediate west of the Pit Top Area (see **Figure 2.2**). While the exact area covered by the Reject Emplacement Area would be dependent on the coal quality, ie. proportion of stone and/or oversize material within the ROM coal, as well as the amount of coal to be washed, the Proponent has allocated an area of

25ha based on the assumption that the quantity of waste represents 5% of the ROM coal feed. Notably, initial waste stream calculations completed following the completion of coal washability tests on selected coal samples calculated waste would be 2.2% of ROM coal feed. Therefore, the allocated area may be at least double the required size, catering for increased volumes of waste should coal quality decrease as the underground is developed to the west and south where coal quality data is more limited.

The impact of the Reject Emplacement Area on current and future land capability and land use is the subject of a Soil and Land Capability Assessment for the Longwall Project undertaken by Geoff Cunningham Natural Resource Consultants Pty Ltd (GCNRC). The complete report of GCNRC (2009b) is provided as Part 9b of the *Specialist Consultant Studies Compendium* that accompanies this *Environmental Assessment*, with a detailed summary of the predicted subsidence levels and impacts included as Section 4B.9.

- Ecological Considerations

  In order to install the proposed ventilation and gas drainage system for the Longwall Project, access roads, power lines and drill sites would be constructed along the alignment above the West Mains and goaf drainage access roads displayed on **Figure 2.1**. Underground communication (PED) lines would also be installed along the same corridor. These access tracks, drill sites and shaft construction sites would be aligned over both cleared agricultural lands, as well as within woodland vegetation located across the western portion of the Mine Site. The Proponent, in consultation with Ecotone Ecological Consultants Pty Ltd (Ecotone), has committed to aligning these surface activities to minimise disturbance to the remnant vegetation and the preparation of a flora and fauna management plan or strategy to provide for regular re-assessment of the ecological value(s) of the areas to be disturbed and management practices to minimise any impacts.

  Subsidence also has the potential to impact on the flora and fauna of the Mine Site, primarily as a result of surface cracking and/or changes to local drainage. An ecological assessment completed by Ecotone (2009), which is provided as Part 4 of the *Specialist Consultant Studies Compendium*, has determined that the proposed surface disturbance and predicted subsidence is unlikely to have a detrimental impact on local ecology. Section 4B.4 provides a summary of the assessment and conclusions of Ecotone (2009).

- Aboriginal Heritage

  Similar to the potential impacts on local ecological values, the surface disturbance associated with the installation of the mine ventilation and gas drainage systems and mine subsidence has the potential to impact on sites or artefacts of Aboriginal heritage significance that may occur throughout ML 1609. In recognition of this potential impact, an archaeologist from Archaeological Surveys and Reports Pty Limited (ASR) and representatives of the local Aboriginal community undertook surveys of the proposed and likely areas of impact.

  An initial detailed survey of the proposed disturbance corridors above Longwall Panels 1 to 7 (which would take approximately 7 years to complete) identified

43 Indigenous sites and/or artefacts. These sites and artefacts were found almost exclusively within 25m of the creeks and creek tributaries which traverse the Mine Site. The Proponent has committed to avoiding the four sites identified as having scientific significance. The Proponent would also avoid the remaining identified sites unless this is impracticable for mine safety reasons. Notably, the alignment of proposed surface disturbing activities has been modified, where possible, to avoid a number of the sites identified by ASR and the Aboriginal community as being of greatest significance. In the event that a site cannot be avoided, the artefact(s) would be salvaged in accordance with a site salvage protocol currently being developed in consultation with the registered Aboriginal stakeholders.

A further reconnaissance survey of the remaining Mining Area (Longwall Panels 8 to 26) has also been completed over those areas considered as having the highest probability for site occurrence and discovery, eg. creek tributaries, rock shelfs and overhangs. The findings of this survey were very similar (with respect to site type and distribution) to those of the detailed Panels 1 to 7 Survey Area survey and indicated that the cumulative impact of the proposed Longwall Project on the archaeological record would be minimal and would not constrain the conversion of the mine to a longwall operation.

The Proponent would also abide by the provisions of the *National Parks and Wildlife Act 1974* in relation to the identification of additional Indigenous archaeological sites following the approval and commencement of the Longwall Project. Section 4B.5 and Part 5 of the *Specialist Consultant Studies Compendium* provide further detail on the type, location and management of the identified sites.

- <u>Water Resources</u>

  The groundwater that would be encountered by the underground workings is saline with an average total dissolved solids concentration of between 6 000mg/L and 8 000mg/L (depending on the sample size used). Based on groundwater modelling undertaken by Aquaterra Consulting Pty Ltd (see Part 2 of the *Specialist Consultant Studies Compendium*), it is predicted that dewatering requirements of the Longwall Project would steadily increase (by adopting the base case) from 0.2ML/day (78MLpa) in the first year of longwall mining to 3.89ML/day (1 419MLpa) after approximately 18 years before decreasing over the remaining life of the remaining life of the Longwall Project (as a significant volume of the inflowing water can be retained in completed goaf areas which are down-dip of the active panels). Section 4B.2 considers the impact of the proposed dewatering on the local groundwater aquifers, as well as any impacts (if any) on the availability of this water to local groundwater users.

  Due to the saline nature of the groundwater, it would require storage and segregation from natural surface water drainage on the Mine Site. The surface water storage structures designed and constructed for Stage 1 would be retained, with treatment of this water by ultra-filtration and reverse osmosis already approved should the volume dewatered from the underground workings approach 0.88ML/day. The treated water would be re-used underground for dust suppression and equipment cooling purposes, or if surplus to operational requirements discharged from the Pit Top Area to the Namoi River. A by-product of the water treatment would be the generation of significant volumes of brine,

ie. saline water, with approximately 20ML generated for every 100ML of raw water treated. The current proposal for managing this brine is to store it at surface for the life of the mine before progressively pumping it back into the goaf and retained gate roads of the underground workings. Section 4B.3 and Part 3 of the *Specialist Consultant Studies Compendium* (WRM, 2009) provide further detail on the management of water resources (including brine) at surface for the development and operations of the Longwall Project.

In addition to the above, progression to a longwall mining operation would increase the operational demand for water by up to approximately 1.7ML/day (Section 2.7.2 provides further detail on the annual water requirements of the Longwall Project). Section 4B.3 and Part 3 of the *Specialist Consultant Studies Compendium* (WRM, 2009) also provide a detailed review of the daily and annual water requirements of the Mine Site and available sources.

- Noise

  Monitoring of noise levels during the Stage 1 construction period has identified that inversion conditions much stronger than originally anticipated occur during winter mornings near the Mine Site and these inversions have resulted in elevated noise levels being received at some residences surrounding the Pit Top Area.

  These local conditions are now better understood and have been incorporated into a revised noise modelling study for the proposed longwall mining operations conducted by Spectrum Acoustics (Spectrum, 2009). In order to comply with noise criteria nominated in accordance with the DECCW's Industrial Noise Policy (INP), there would be some restrictions placed on construction activities within the Pit Top Area and during the excavation of the ventilation shafts and other infrastructure within the central corridor. Section 4B.7 presents these restrictions, based on the recommendations of Spectrum Acoustics (2009), which is provided as Part 6 of the *Specialist Consultant Studies Compendium*.

2.4 LONGWALL MINING OPERATION

2.4.1 Mine Design and Mining Method

Mining would involve the sequential development of gate road headings approximately 305m apart and oriented north-south from the West Mains to define a total of 26 longwall panels (LW1 to LW26) (see **Figure 2.7**). Two gate road headings would be developed by continuous miner to the north initially (to develop LW1 to LW13) and then south (to develop LW14 to LW26) to a point set back from the lease boundary or the Hoskissons Coal Seam where it is at least 4.0m thick (see **Figure 2.6**). The width of the retained chain pillar between the longwall panels would increase from 24.6m for LW1 to LW4, to 29.6m (for LW5 to LW8), then 34.6m (for LW9 to LW10) and finally 37.6m (for LW11 to LW13) (see **Figure 2.7**). The chain pillar width of LW14 to LW26 would reflect that of the corresponding panel to the north of the West Mains, eg. LW14 corresponds with LW13, LW19 corresponds with LW8, etc.

Once the two gate road headings are established on both sides of each longwall panel, the longwall equipment would be installed within an installation road driven between the main and tailgate roads and the coal recovered as the longwall unit retreats back towards the West Mains. All coal would be conveyed back to the Pit Bottom Area for transfer to the surface via the conveyor drift.

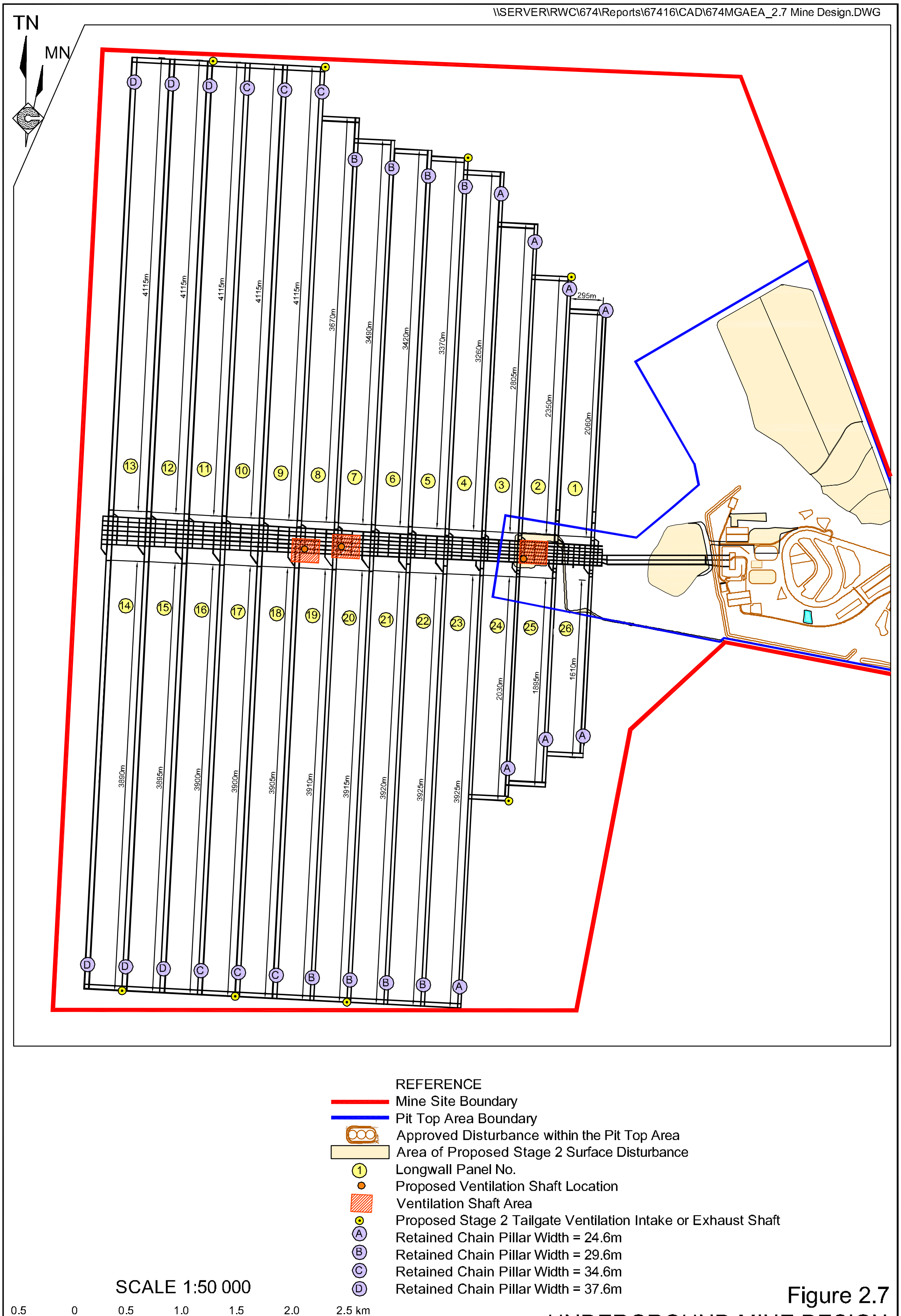

Figure 2.7
UNDERGROUND MINE DESIGN

Figure 2.7 illustrates the mine design of the proposed Stage 2 of the Narrabri Coal Mine, including the following design features.

- The longwall panels would progressively increase in length in from approximately 2.1km (LW1) to 4.1km (LW9 to LW18) and would generally be 295m in width (total void width would increase to approximately 305m once the gate road either side of the panel is incorporated as the longwall unit retreats).
- The longwall panels are located at depths increasing from approximately 160m below surface over the eastern section of the Mine Site to 380m below surface as the Hoskissons Coal Seam dips to the west (see **Figure 2.6**).
- Thirteen panels (LW1 to LW13) would be formed towards the north from centrally located main headings and thirteen panels (LW14 to LW26) would be formed towards the south from the mains.
- The longwall panels would have an average face extraction height of 4.2m taken from the floor of the seam (which is between 4.6m to 10m thick). The face height would be ramped back to the gate roads at a height of 3.5m at the maingate and tailgate ends.
- The single chain pillar formed between each longwall panel would be 3.5m high with the pillar widths increasing as noted above.
- The longwall panel width to height (W/H) ratio for the proposed mining layout would range from 0.80 to 1.91. The chain pillar W/H ratio would increase from 7.0 to 10.7.

Plate 2.1 presents an artist's impression of the main components of the proposed longwall mining operation at the Narrabri Coal Mine.

2.4.2 Equipment

The longwall design would be based on proven technology with an emphasis on reliability of equipment. The principal components of the system would include:

- double-ended ranging drum shearer rated at 3 000tph with full horizon control (**Plate 2.2**);
- an armoured face conveyor rated at 3 000tph with provision for single tailgate drive and dual maingate drives (**Plate 2.2**);
- Beam Stage Loader rated at 3 500tph; and
- high capacity two leg chocks (**Plate 2.2**) shields with shearer initiation, base lift and high set functions.

Additional underground mining equipment to be used in association with the longwall mining unit is listed in **Table 2.6**.

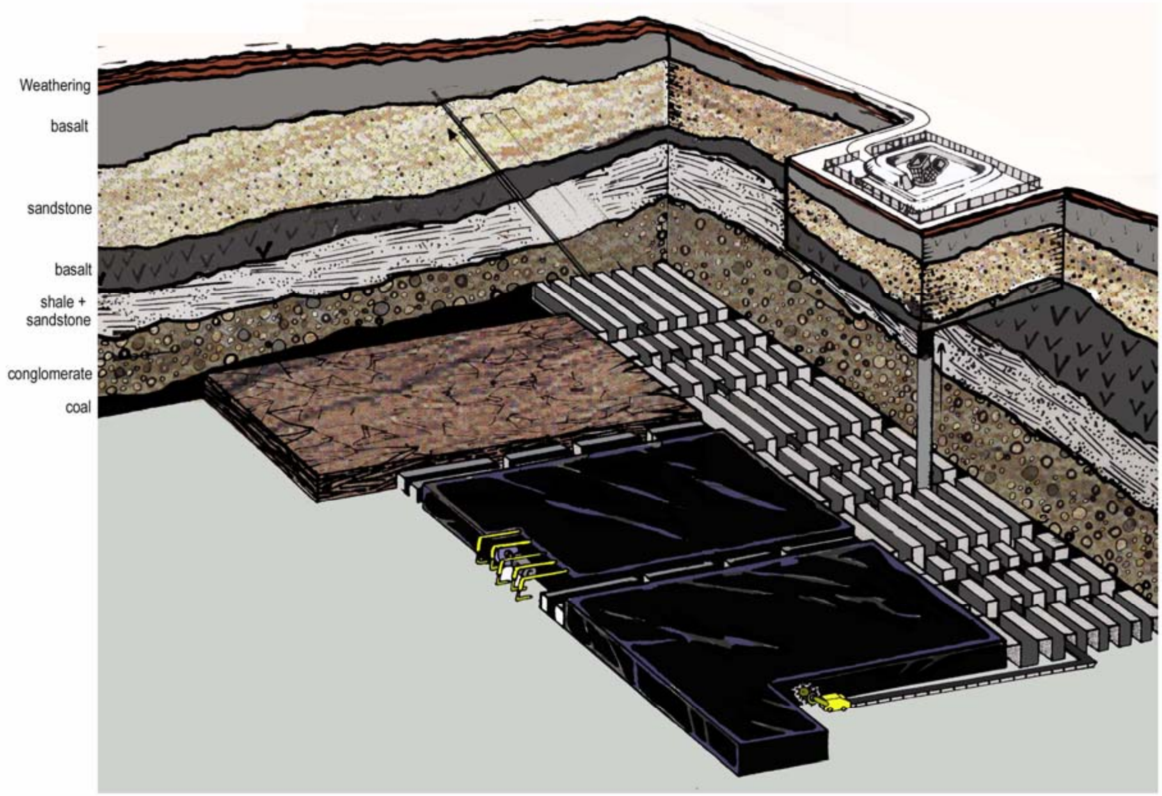

Plate 2.1
Artist's Impression of Longwall Mining Operation

Plate 2.2
Thick Seam Longwall Coal Mining Operation

With respect to the underground equipment, there would be regular movements of the man transport vehicles between the surface and underground, while the Load / Haul / Dump (LHD) vehicles would be on the surface at various times intermittently during operations for loading and unloading. The remaining equipment listed in **Table 2.6** would remain underground at all times unless major maintenance is required.

Table 2.6
Indicative Underground Operational Equipment

Indicative Equipment	No.	Use
Continuous miner	3	Underground primary and secondary mining
Shuttle cars	6	Transfer of coal from continuous miner to breaker feeder
Breaker Feeder	3	Breaking of coal
LHD vehicle	6	Material transport
Man transport vehicle	7	Personnel transport
Roof bolting machine	3	Roof bolting
Panel conveyor belt	3	Transfer of coal from breaker feeder to transport drift conveyor
Source: Narrabri Coal Operations Pty Ltd		

2.4.3 Mining Sequence

The Proponent intends to adopt the following indicative mining sequence for the Stage 2 longwall operations presented in **Figure 2.7**. The panels have been numbered LW1 to LW26 to illustrate the sequence of development, ie. LW1 would be developed and mine initially followed by LW2, then LW3 and so on.

The initial mining sequence would be the same as for the approved Stage 1 operations, ie. following the connection of the drifts to the coal seam, a continuous miner unit would be deployed to form the Pit Bottom Area and then commence driveage of the headings within the West Mains towards the west. At the same time, the first ventilation shaft would be constructed from surface and would be completed prior to the development of mains headings to this point to enable the headings of the West Mains to intersect the completed shaft.

Once the Pit Bottom has been established, a second and third continuous miner would be deployed to develop the gate road headings from the West Mains to the extent shown for LW1. Once each set of gate road headings are fully developed, the longwall equipment would be installed and the coal recovered as the longwall unit retreats back towards the West Mains. All coal would be conveyed back to the Pit Bottom Area for transfer to the surface via the conveyor drift.

Additional small scale (approximately 1.5m to 2m diameter) ventilation shafts would be constructed at the limit of every third or fourth longwall panel and would act as either in-take or exhaust points from the underground mine (see **Figure 2.7**). **Figure 2.7** also identifies the proposed location of the three primary ventilation shafts to be constructed from surface into the West Mains. While the exact location of these would be determined by the ventilation requirements of the mine, based on a conservative assessment of ventilation requirements, it is anticipated that ventilation shafts would be constructed adjacent to Maingates 2, 7 and 8.

2.4.4 Mining Rate

The headings of the West Mains would be developed by the continuous miners at a rate of approximately 140m per week, with the gate road headings developed at a rate of approximately 200m per week. On completion of the gate road headings, it would take approximately 6 weeks to install the longwall unit within LW1 or move the longwall unit from one panel to the next. With a nameplate capacity of 3 000tph and once fully operational, the longwall mining rate is forecast to be approximately 140 000 tonnes per week (up to a maximum daily rate of 50 000 tonnes). The maximum annual mining rate would not exceed 8Mt.

The indicative coal production schedule for the life of the mine is displayed in **Table 2.7**.

Table 2.7
Indicative Coal Production Schedule

Year	Development*	Longwall	Total
1	61 000	-	61 000
2	590 000	-	590 000
3	478 000	6 160 000	6 638 000
4	465 000	6 160 000	6 625 000
5	457 000	6 160 000	6 617 000
6	457 000	6 160 000	6 617 000
7	457 000	6 160 000	6 617 000
8	457 000	6 160 000	6 617 000
9	299 000	6 238 000	6 537 000
10	267 000	6 921 000	7 188 000
11	266 000	6 160 000	6 426 000
12	272 000	6 160 000	6 432 000
13	266 000	6 160 000	6 426 000
14	480 000	6 160 000	6 640 000
15	312 000	6 160 000	6 472 000
16	266 000	6 806 000	7 072 000
17	267 000	6 353 000	6 620 000
18	266 000	6 160 000	6 426 000
19	266 000	6 160 000	6 426 000
20	266 000	6 160 000	6 426 000
21	266 000	6 160 000	6 426 000
22	266 000	6 160 000	6 426 000
23	266 000	6 160 000	6 426 000
24	272 000	6 799 000	7 071 000
25	261 000	6 360 000	6 621 000
26	187 000	6 160 000	6 347 000
27	-	5 320 000	5 320 000
28	-	6 132 000	6 132 000
Total	**8 433 000t**	**161 809 000t**	**170 242 000t**

Modified after Palaris Mining * Using Continuous Miners

2.4.5 Mine Ventilation and Gas Drainage

2.4.5.1 Introduction

Gas emissions during longwall extraction and ventilation / gas drainage requirements would be dependent on the size of the gas reservoir contained in coal seams and porous interburden adjacent to the working section, the gas composition of the reservoir and the desorption rate of the reservoir.

Tests conducted by Geogas Pty Ltd established that while gas compositions within the Hoskissons Coal Seam vary considerably, the predominant gas is CO_2 (~90%) with concentrations of CH_4 and N_2 also present in varying proportions. The results of gas desorption tests established the total desorbable gas content within the mine would vary from 3.87m^3/t to 7.03m^3/t on a dry, ash free basis. Considering these parameters, and based on the extraction of 4.2m of coal from the seam of 9m average thickness, the Proponent expects that gas emissions during development could reach 1 200L/s CO_2 in deeper horizons if high permeability persists at depth.

In order to minimise the potential for outburst, which for CO_2 rich environments requires gas content to be less than 6.0m^3/t, and to ensure safe working conditions underground, the initial gas content from the exposed coal would be drained, ventilation would be established and goaf gas drained from the extracted sections of each longwall panel. The following sections summarise a ventilation and gas management strategy to be adopted for the Longwall Project.

2.4.5.2 Mine Ventilation

The ventilation of the mine would be progressively established to maintain the general body CO_2 concentration well below the statutory requirement of 1.25%. This would involve the progressive establishment of three ventilation shafts from the West Mains as well as at the rear of the eight longwall panels, which could operate as ventilation intakes or exhausts.

The principal stages of mine ventilation establishment would be as follows.

- Initial mine development from pit bottom to the first main ventilation shaft (including the development of Tailgate (TG)1 and Maingate (MG)1) would be ventilated by two axial fans located within the box cut, using one of the three drifts as a return airway.
- The first exhaust shaft located at (MG2) would have an internal diameter of approximately 5.5m and be developed as a blind bore from the ventilation shaft area (see **Figure 2.1**). The shaft would be concrete lined and associated surface fans commissioned prior to the commencement of longwall mining. On commissioning of the fans for the MG2 exhaust shaft, the fans in the box cut would be removed with the three drifts becoming intake airways.
- The development and extraction of the northern longwall blocks would progress inbye with the mine being ventilated by four intake and three return main headings (inbye the shaft located opposite MG2).

- An intake shaft and a second 5.5m diameter concrete lined exhaust shaft at approximately MG7 and MG8 respectively would be commissioned to reduce the ventilation load on outbye intake and return main headings.
- Twin return roadways would be employed on the southern side of the West Mains with one on the northern side to minimise overcast construction in the northern headings of the West Mains, with up to four sets of cross-mains overcasts used throughout the life of the mine to share the ventilation load between the northern and southern returns.

Figure 2.8 presents an illustration of the mine ventilation system illustrating the development of mine ventilation as described above (as the longwall unit retreats southwards within LW5 and the West Mains are developed to the maingate of LW7). The ventilation points identified are identified by the panel and gate type where each is to be established, ie. MG2 refers to the maingate of LW2 and TG5 refers to the tailgate of LW5.

Using a two heading gate road configuration, the main ventilation issue for a single roadway tailgate would be maintaining the general body CO_2 concentration below the statutory requirement of 1.25%.

Sources of CO_2 reporting to the tailgate ventilation would include cut coal at the longwall face, from remnant coal in the active goaf and also the adjacent goaf if there is leakage through the chain pillar seals.

The mine ventilation network has been modelled with a longwall face ventilation quantity of $80m^3/s$, all of which would report to the tailgate. Pre- and goaf gas drainage techniques would be used to maintain average tailgate CO_2 concentrations below 1% to allow for peaks in gas emissions (see Section 2.4.5.3).

2.4.5.3 Gas Drainage

2.4.5.3.1 Pre-Drainage

Pre-drainage would be provided for the control of rib emissions, mitigation of the risk of outburst and reduction of post-mining goaf gas emissions. It is noted that gas reservoirs containing CO_2 rich seam gas at the gas contents and fluid pressure present within the Hoskissons Coal Seam are more difficult to pre-drain than methane rich seam gas. This is due to the large reduction in pressure required to promote desorption and the difficulty of keeping water out of down dip holes. As a result, Surface to In-Seam (SIS) pre-drainage, which in contrast to conventional underground in-seam gas drainage allows the Proponent to pre-drain the coal seam prior to establishment of the underground gate roads, is currently being trialled. It is considered likely that once underground mining commences, pre-drainage operations would revert to conventional underground in-seam methods, which requires far less area of surface disturbance. Given the likely use of both methods of pre-drainage, both are considered and described.

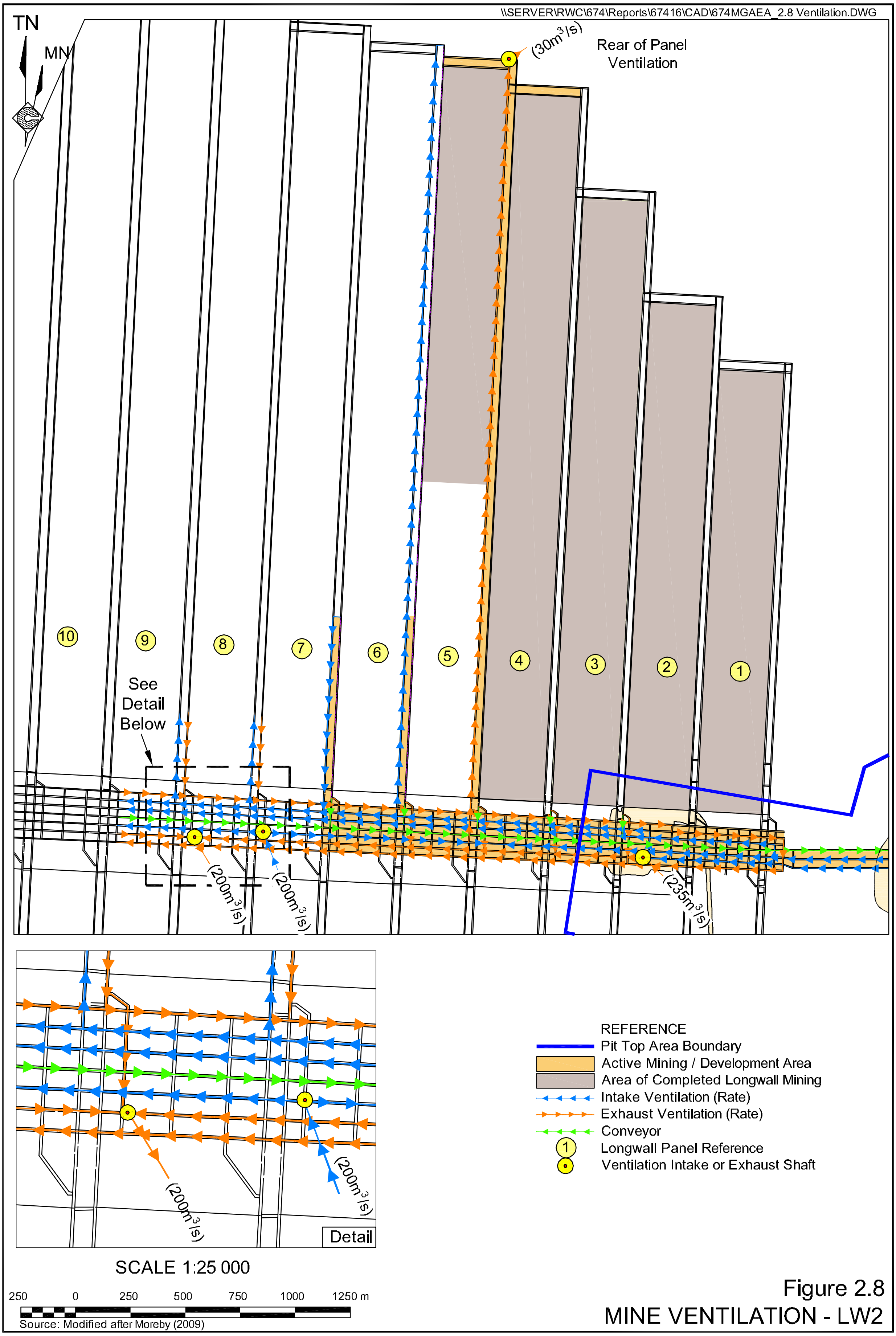

Figure 2.8
MINE VENTILATION - LW2

Surface to In-seam Pre-drainage

Surface to In-Seam pre-drainage using medium radius drilling involves drilling from surface into and along the coal seam (up to 2.5km). The gas (as well as water) is then drawn from the seam using a vacuum pump and either dispersed to the atmosphere or collected for power generation or flaring. Due to the very low methane concentration within the gas, power generation or flaring of the gas is not feasible and so the predominantly CO_2 would be dispersed. The water pumped to the surface would be piped to the Pit Top Area for storage in one of the Water Storage / Evaporation Ponds[2]. SIS pre-drainage provides a significant advantage over conventional in-seam pre-drainage in low desorption underground environments as the coal can be drained well in advance of mining. This form of pre-drainage requires the development of gate road headings of a particular panel prior to the commencement of pre-drainage. Further detail on the proposed location and disturbance associated with the SIS Surface to In-seam pre-drainage is provided in Section 2.4.9.8.

For gas reservoirs, such as that of the Hoskissons Coal Seam which are CO_2 rich, under saturated with significant fluid pressure reduction required for effective pre-drainage, SIS pre-drainage allows commencement of pre-drainage well in advance of mine development. This reduces the possibility that mine development may be held up by underground pre-drainage requirements.

In addition to pre-drainage, SIS holes drilled in the roof of the working section can also serve as goaf drainage holes. The location of these holes is particularly important in thick seams where significant gas emission can originate in close proximity to the face line and cannot therefore be captured by conventional vertical goaf holes.

Conventional Underground In-seam Pre-drainage

The conventional underground in-seam pre-drainage method of pre-drainage is undertaken by drilling from the developed gate road heading into the longwall panel area with the gas collected. The gas is then pumped to the surface from an exhaust pipe range for dispersion, flaring or other use such as power generation. While the conventional underground in-seam pre-drainage method is proven technology, and would not require additional surface disturbance, the rate of drainage would be slow for the CO_2 rich, under saturated with high fluid pressure gas reservoir of the Hoskissons Coal Seam. As noted above, this could potentially delay the commencement of longwall mining in the initial and/or future panels while gas levels are reduced to $<6.0m^3/t$.

2.4.5.3.2 Goaf Gas Drainage

As each longwall panel is completed, the remaining coal above the section mined would continue to desorb gas. In order to maintain all ventilation roadways within the legal compliance limit of 1.25%, current studies indicate that post drainage of the caved (goaf) area would be required to evacuate the CO_2 desorbed from the remaining caved roof. This can only be achieved by post mining goaf drainage via holes drilled from the surface.

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[2] The dewatering associated with the pre-drainage is provided for by the mine dewatering predictions provided by the modelling of Aquaterra (2009). That is, this water is not additional to the predictions included in Section 2.4.8.