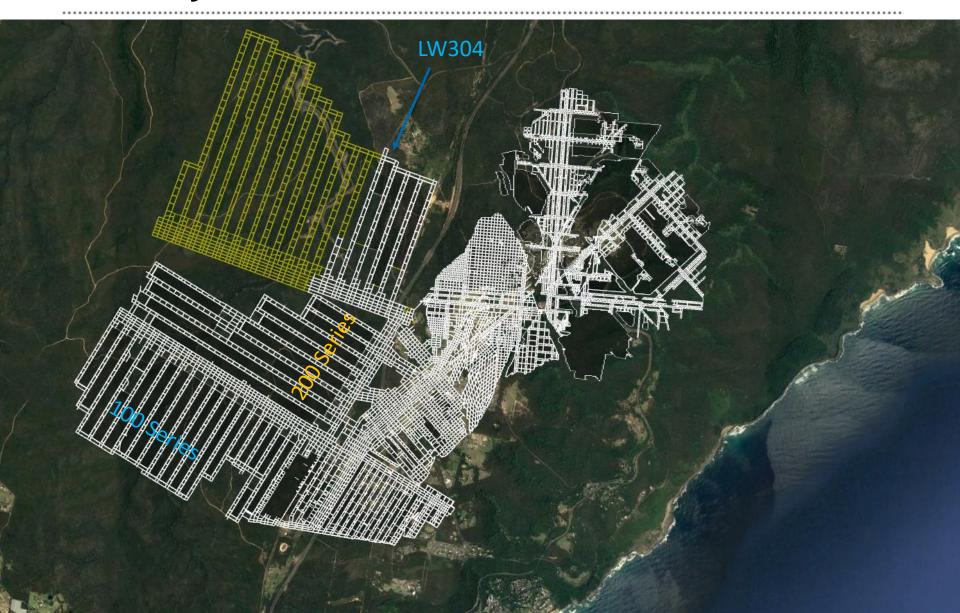
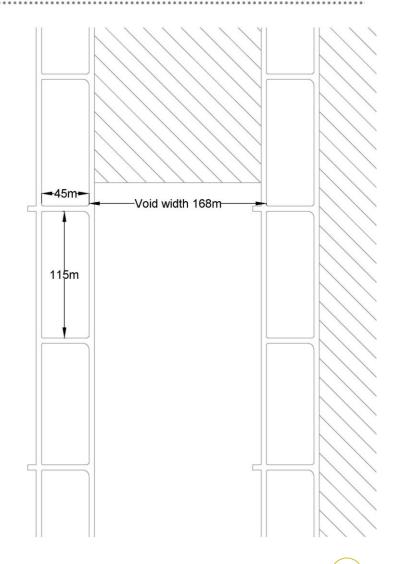


Mine Layout



Panel Geometry

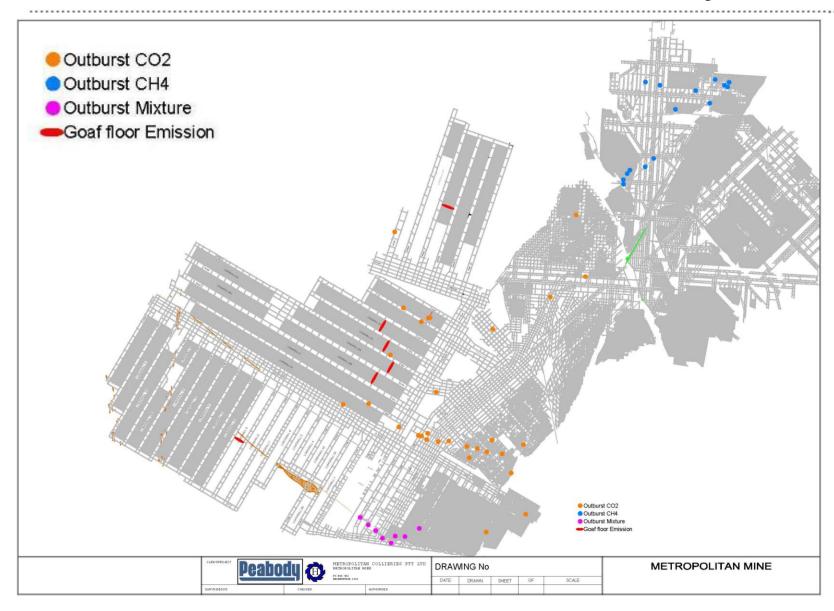
- Longwall face width 153m
- Chain pillars 45m x 115m (solids)
- Roadways 5.2m wide and 3.3m high
- Joy Longwall
- 89 face supports
- Support capacity 1170 Tonnes



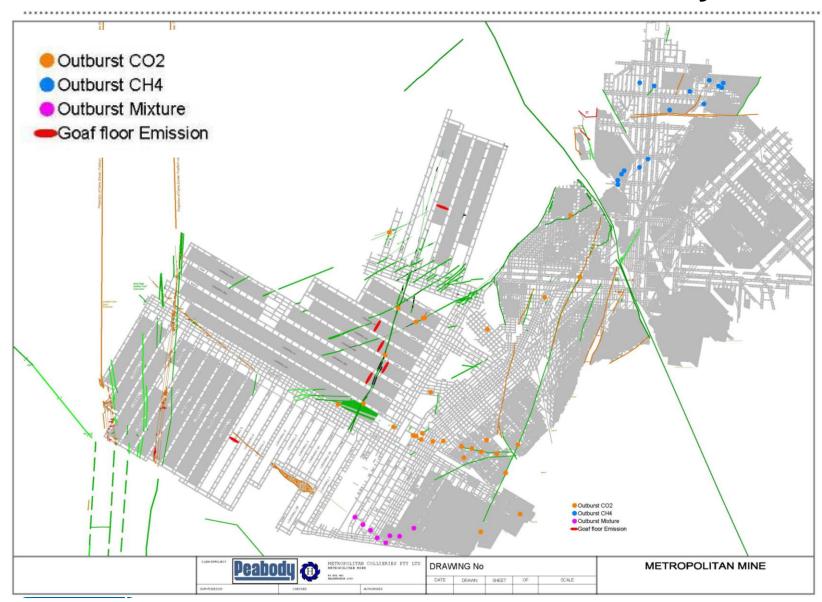


Resource Regulator Video summary of LW303 floor break

Outburst and Goaf Floor Emission History

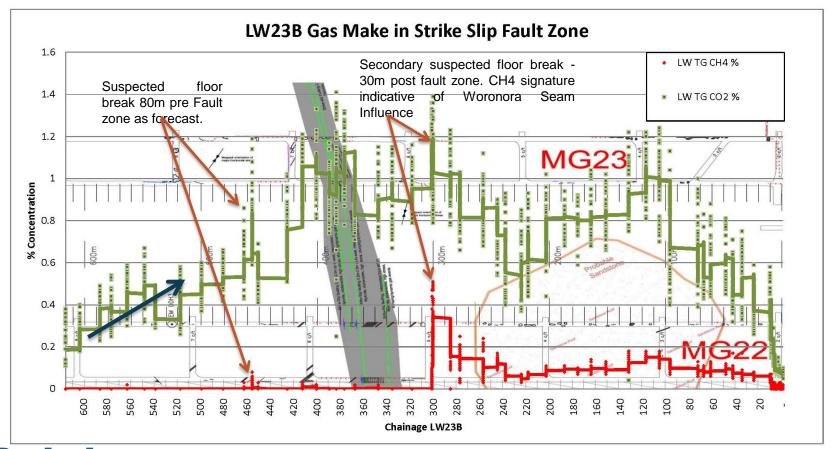


Outburst and Goaf Floor Emission History



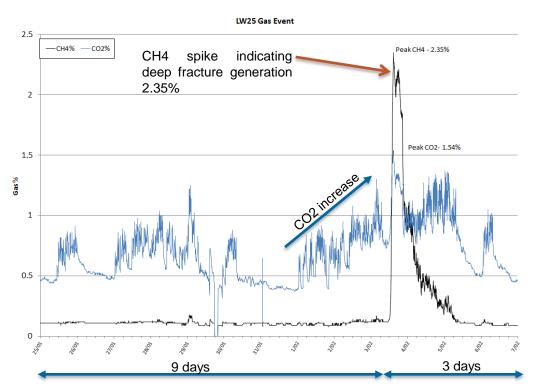
Historic Goaf Floor Break -LW23 B

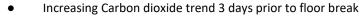
- Increasing Carbon dioxide trend 10 days prior to first break
- Carbon dioxide levels increased 80m from structure coincides with a small spike of Methane
- Secondary suspected floor break 30m post strike slip fault zone combined with a Methane signature for deep fracture and connectivity to lower coal measures



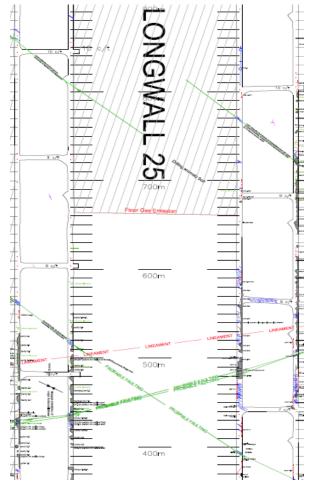


Historic Goaf Floor Break -LW25





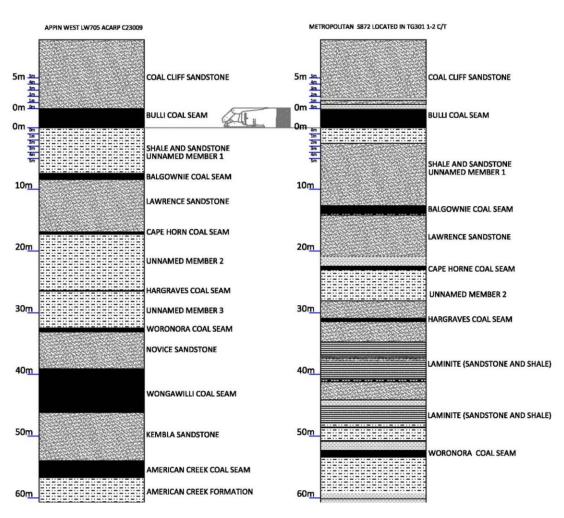
- Methane spike and signature for deep fracture and connectivity to lower coal measures
- Gas concentrations peaked at 2.35% CH4 and 1.54% CO2
- Associated with geological structure
- Common to all events is vertical geological structures extending to lower seams and have an impact on regular strata behaviour mechanics





Lithology below Bulli Seam

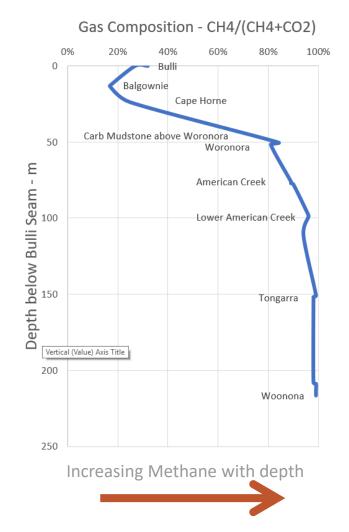
- Unique lithological sequence when compared to adjacent mines
- Diagram shows section below LW705 Appin West compared to current mining area Metropolitan
- Wongawilli Seam not continuous at Metropolitan
- Woronora Seam and overlying carbonaceous units within fracture envelope of Longwall





Vertical Distribution of Gas

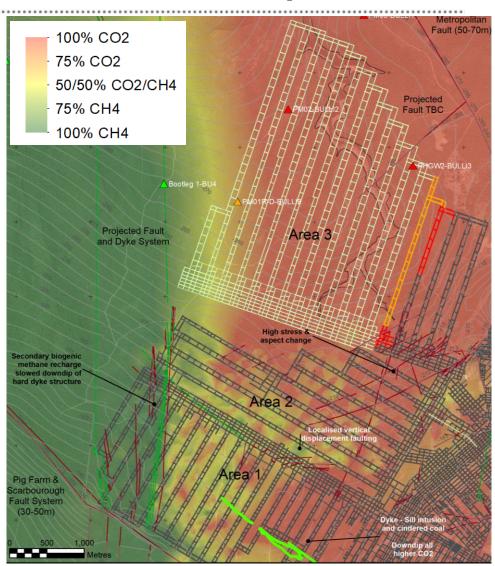
- Trend of increasing methane composition with depth
- The transition from Carbon dioxide to methane occurs approximately 30 to 50m below the Bulli Seam
- Numerical Modelling indicates depth of softening 40 to 50m
- At Metropolitan Methane is a signature for deep softening and connectivity to lower gas reservoirs





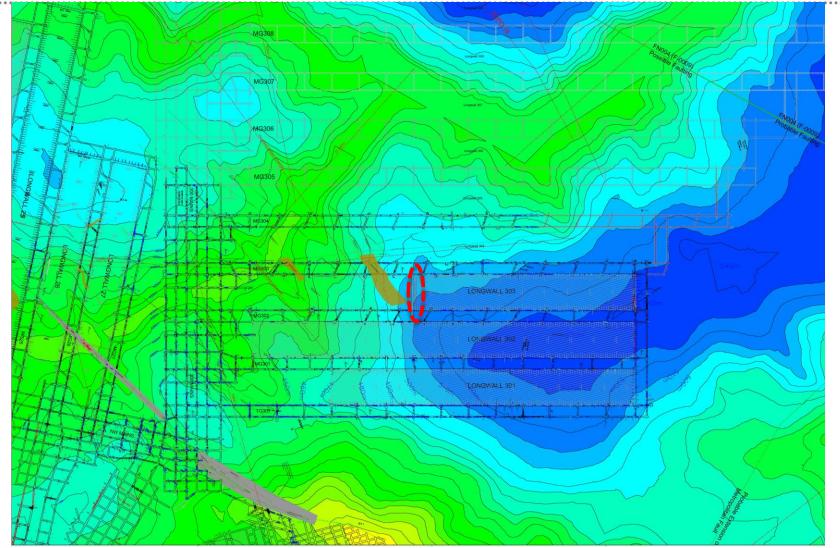
Lateral distribution Bulli Seam Gas Composition

- Lateral gas composition controlled by geological structure (North/south trending Dyke/fault zone)
- Current mining area (Area 3) predominately CO² with virgin core results 90-100% CO² at 13-18m3/t



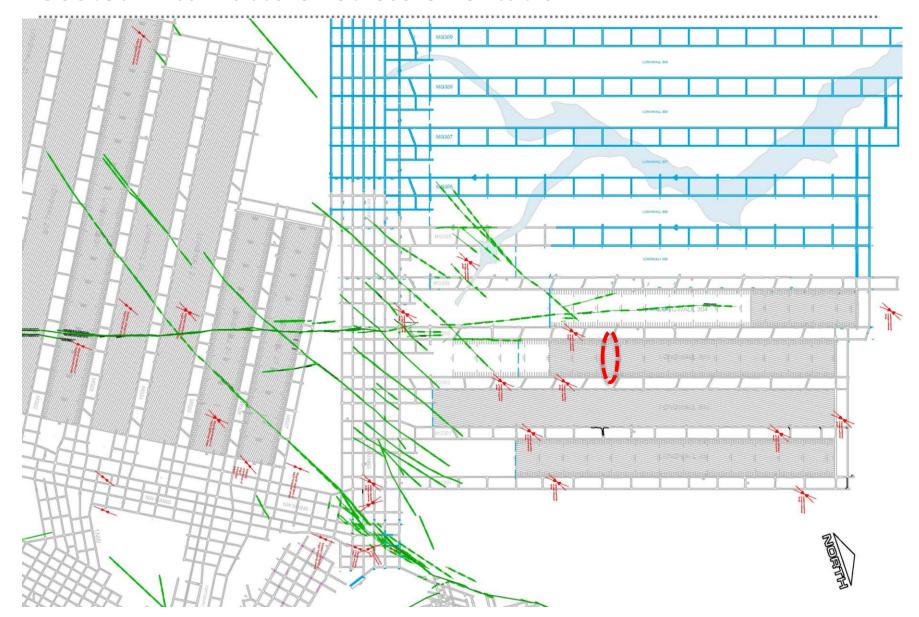


Geotechnical Factors - Depth of Cover

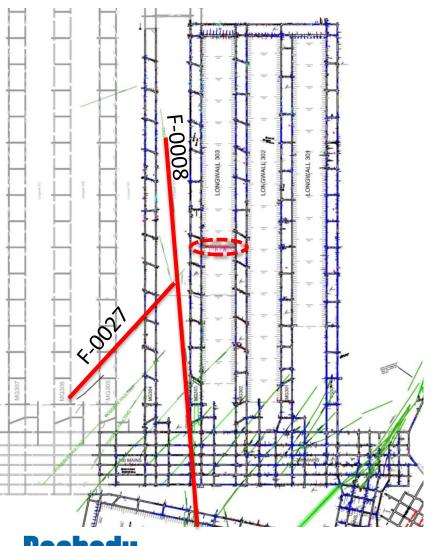




Geotechnical Factors – Stress Orientation



Geotechnical Factors - Geological Structure



 2 significant strike-slip faults in adjacent LW304

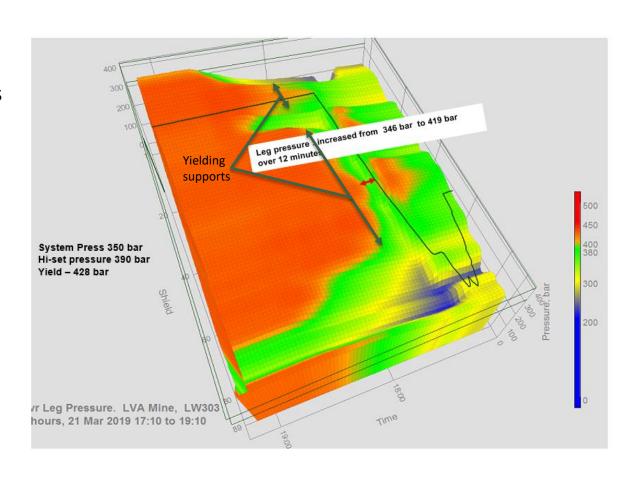
1. F-0008 strike slip fault zone

- 3 x outbursts
- 3x Floor breaks
- 2. F-0027 strike slip fault zone was first intersected during the development of MG304. There was no evidence of F-0027 during MG303 development or in the subsequent geological mapping for LW303. This fault has now been intersected in MG305 and associated with 1 potential outburst event
- No apparent faulting in the Bulli Seam LW303



Longwall Visual Analysis

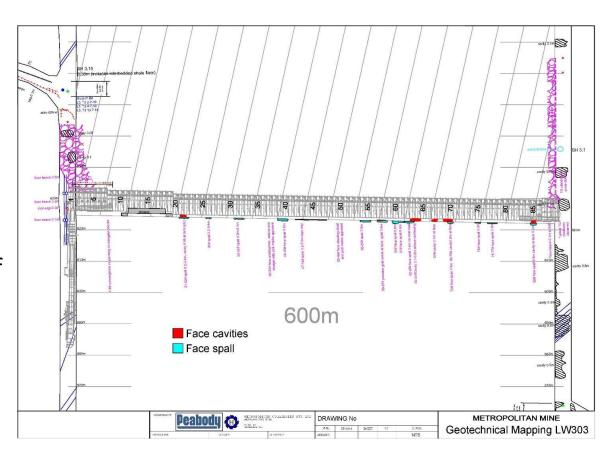
- Face loading
 - over 12 minutes
 - not abnormal
- 2 distinct zones of yielding chocks
 - 8 to 20
 - 30 to 65
- Shearer stopped in MG





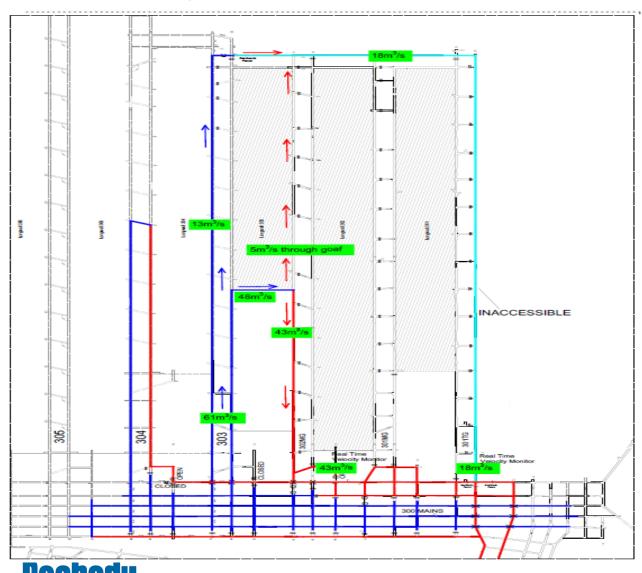
Longwall Face Mapping - Post Event

- Longwall standing for 6 days
- Face conditions typical of normal mining
- MG and TG conditions typical of normal mining
- No evidence of geological structure in the Bulli Seam



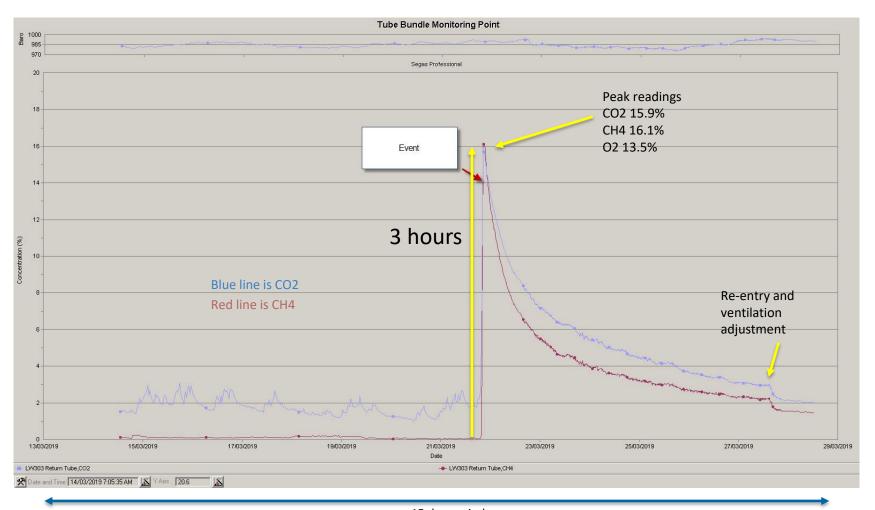


Ventilation quantities at the time on the inundation.



- LW intake 61m³Sec
- LW face 48m³Sec
- LW return 43m³Sec
- LW Bleeder 18m³Sec with 5 m³Sec bleeding through the goaf.
- Main vent system consists of 2 x
 Faktwoods fans in parallel with a total quantity of 280m³Sec at a collar pressure of 3.4Kpa.

Tube Bundle Monitoring LW303 Return





Identifying likely source of gas

- ~3 Million m3 of gas released in first week
- To identify the likely source of gas several assumptions were made including:
 - Depth of Fracture
 - Fracture Profile
 - Gas in Coal
 - Gas in interburden between coal seams



Identifying likely source of gas

- Depth of fracture and fracture geometry was based on numerical modelling both specific to Metropolitan with consideration to work at neighboring mines.
- Gas composition and content for coal seams including interburden between seams was based on: 1) gas samples retrieved during cross measure drilling; and 2) gas sampled obtained from surface to seam bores.

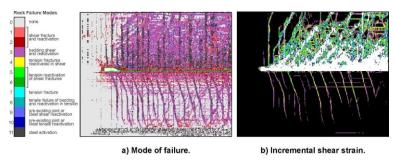
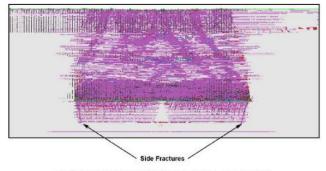


Figure 1: Computer model of cyclic floor fractures below a longwall panel.



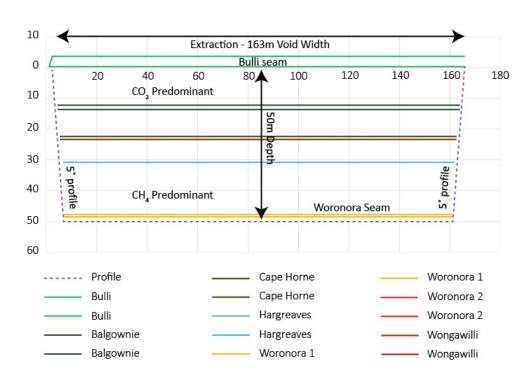
a) Cross section of fractures on the panel edge.

Coal Seam	Thickness (m)	Distance from Bulli Seam Floor (m)	Gas Content m³/t	Gas composition (CH4/CH4 +CO2)
Bulli	2.9m	0m	10.5	0.3
Balgownie	1.57 (net coal 1.48)	11.9	8.6	0.17
Cape Horne	0.8 (net coal 0.8)	22.9	10.3	0.25
Hargraves	0.445 (net coal 0.345)	29.1	10.0	0.25
Woronora Coal (upper split)	0.75 (net coal 0.0)	49.3	1.78	0.84
Woronora Coal (Lower split)	1.01 (net coal 0.71)	50.4	10.5	0.81
Wongawilli	3.24 (net coal 2.485)	74.8	7.3	0.9



Identifying likely source of gas - Calculation

Longwall 303 Floor Break Conceptual fracture profile below longwall



- The gas composition and content data was applied to a conceptual profile of softening and fracture below the longwall
- The softened zone may be imagined to resemble a bath tub sitting below the longwall. The length of the tub is estimated at approximately 100m with consideration to goaf reloading
- Based on this information we were unable to quantify all gas coming from coal seams alone

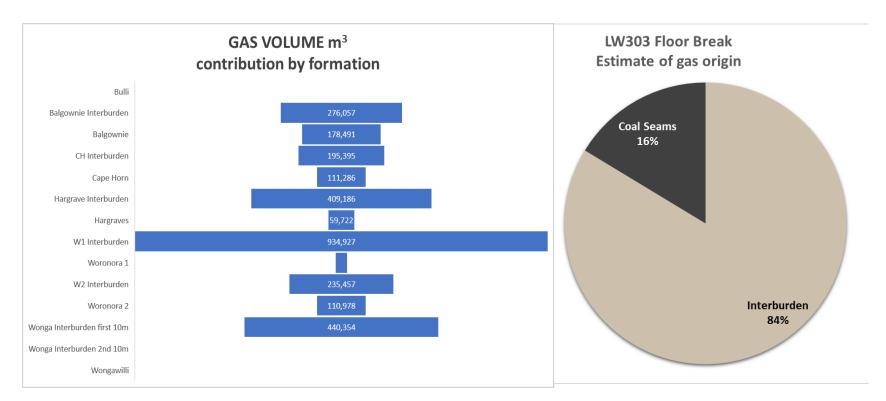


Figure 3: Model interpretation of mining induced floor fractures.



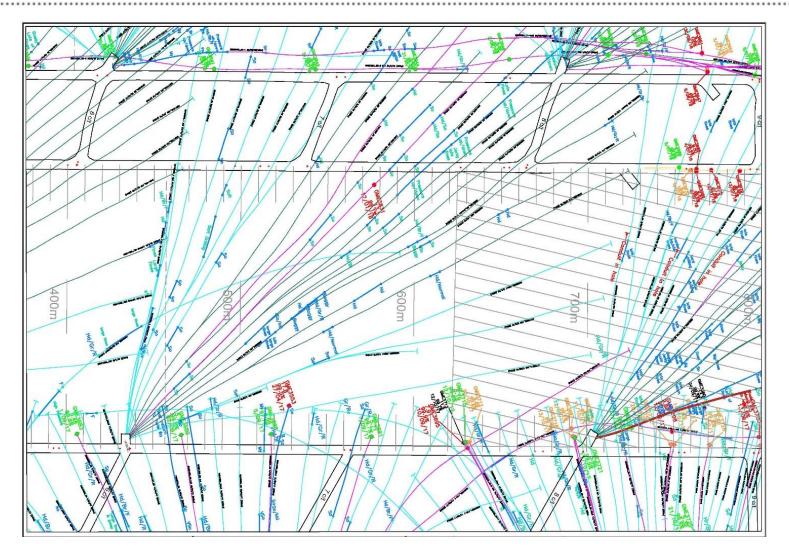
Identifying likely source of gas

- The conclusion is that a large portion of the total gas released is contained in the interburden between the coal seams in particular interburden above Woronora.
- The total interburden accounts for 84% of the gas with only 16% in coal seams





Bulli Seam Gas Drainage





Cross measure Drainage Patterns

- Designed to maximise the number of intersections with LW mining induced floor fractures
- Designed to reach 50m depth and the Woronora Coal Seam
- Fracture characterisation based on Strata Control Technologies numerical modelling work

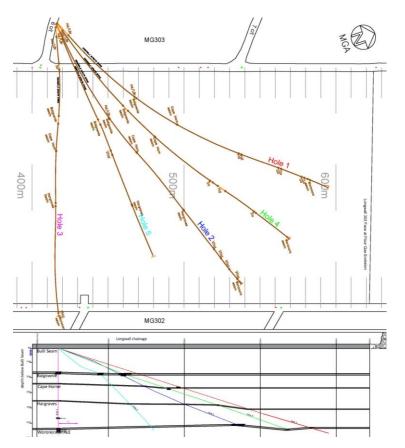




Figure 3: Model interpretation of mining induced floor fractures.

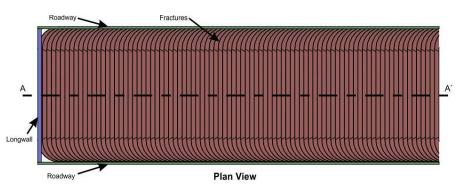


Figure 4: Plan view of cyclic floor fractures below panel.



Longwall 304 Hazard Prediction Plan

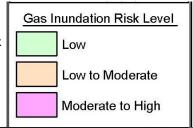
Gas Inundation risk ranked using a colour code system

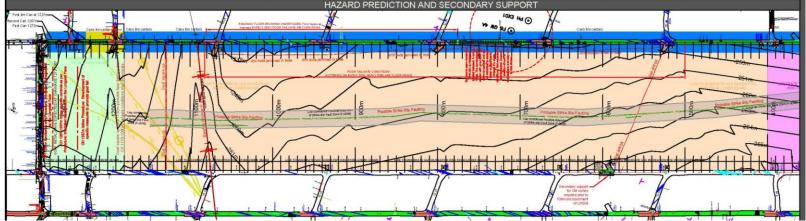
The drivers used for changing gas inundation likelihood include:

- The occurrence and nature of geological structure (faults and dykes)
- Proximity to historic events (LW303);
- Depth of cover
- Goaf square up and development of full abutment loads
- Stress notches, stress pinch points or high stress zones

Controls

- LOW: Remote mining not required. No access to LW return network
- MODERATE: Remote mining in place and cross measure drainage holes, No access to LW return network
- HIGH: Remote mining in place, cross measure drainage holes and increased awareness for signs and symptoms, mine personnel refresher on zone, No access to LW return network







Remote Mining Preparation LW304



- 1. Design and Implementation of Longwall Camera Network
- 2. Upgrade Longwall PC's
- 3. Purchase and implementation of KMC Pitch Steer Software and supporting hardware
- 4. Crew training for Pitch Steer



Longwall Cameras











Production Rates

- Despite challenges with horizon control, strata control and wait times to access face the experience so far with remote longwall mining is considered successful.
- The graph below presents cycle time (minutes/shear) for both LW303 and LW304
- Remote longwall mining generally reduces hazard exposure (dust, strata, gas).





Longwall 303 Gas Emission

Questions?

References:

Gale. W, Rippon. A, Black. B, 'Improved Efficiency of Gas Capture from Boreholes Under Active Longwall Panels' ACARP Project C23009, published 14/06/2017

Heritage. Y, Gale. W, Rippon. A, 2017, 'Connectivity of Mining Induced Fractures below Longwall Panels: A Modelling Approach'

Faiz. M.M, Hutton. A.C, 1995, 'Geological Controls on the distribution of CH4 and CO2 in coal seams of the Southern Coalfields, NSW, Australia.

Bunny. M.R, 1970, 'Geological and Coal Resources of the Southern Catchment Coal Reserve, Southern Sydney Basin, New South Wales.

Booth. P, Ren. T, Nemcik. J, 'A study of Hard-to-Drain Areas in future development of Metropolitan Colliery

