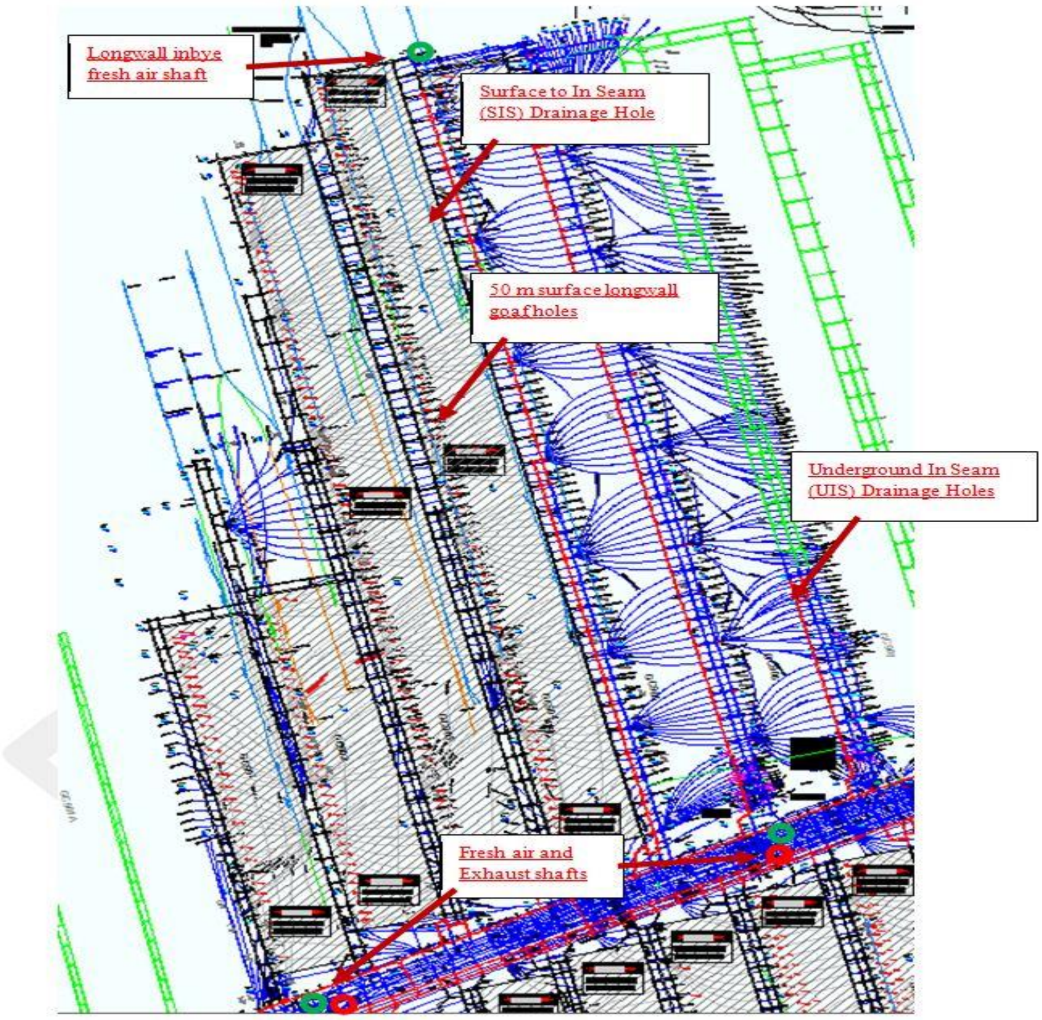
Case study: High performance longwall operations in areas with high gas emissions – Australia

Initial conditions: A new series of longwall blocks is located in a 2.8 m-high seam with methane contents ranging from 8 to 14 m^3/t. Depth of cover is 250 m to 500 m with surface access generally unconstrained by surface features. In situ gas content must be reduced to or below 7.5 m^3/t to satisfy the *outburst prevention code*. There is a single floor seam and eight roof seams containing 10 m to 15 m of coal within the nominal caving zone. Longwall blocks are 350 m wide and up to 3.6 km in length (Figure 1), with a planned production rate of 200,000 tonnes per week.

Figure 1. Mine layout plan showing ventilation and gas drainage systems



(Source: Belle, 2016)

High potential gas emission values led the mine to develop three-heading gate roads on longwalls from the outset in order to provide a high volumetric capacity ventilation system for gas dilution. A three-heading gate road allows substantially more air to be provided for gas dilution to the return end of a longwall face, without increasing face air velocities, compared with a conventional U-ventilated system. This is currently the only mine in Australia to employ three-heading gate roads.

Gas control problems: Gas emission predictions indicate likely specific emissions of 15 to 30 m^3/t from coal seam sources. At planned production rates, this would equate to 3,500 to 7,000 l/s CH_4, generally increasing with depth. However, previous studies at an adjacent mine demonstrated substantial extraneous gas which could significantly increase the total emission rates. Emissions from the first three longwalls were controllable within the existing design but were higher than expected for the relatively shallow depths. Extrapolation to the deeper longwalls indicated feasibility stage predictions would be exceeded with emissions possibly reaching 9,500 l/s.

Solutions: Development phase outburst and frictional ignition limits are reached using a combination of surface to inseam medium radius drilling (MRD) techniques supplemented with underground directional holes and compliance holes that are cored for gas content testing. The initial pit bottom area was pre- drained with tight radius drilling (TRD) techniques.

The original plan to employ three-heading gate roads was correct in providing a longwall ventilation circuit capacity of 100 to 120 m^3/s (2,000 to 2,400 l/s CH_4 at the return limit of 2.0%). It is important to note that, following the Moura disaster of 1994 where 11 miners died, coal mine regulations, guidelines, and custom and practice in Queensland prevent mines from employing a full U.S.-style flood ventilation bleeder system. However, controlled bleed with due consideration to the location of potentially explosive mixtures and control of spontaneous combustion is possible.

The realistic dilution capacity of a bleeder system in these blocks is well below total longwall gas emission rates and alternative strategies are required. To date, the mine has successfully employed conventional surface to goaf drainage holes (300 millimetre diameter at 50 m spacing located on the tailgate return side) to reduce the gas emission load on the ventilation system. This strategy has achieved an average 80% capture (goaf drainage plus ventilation) with peaks of about 85% at high gas stream purity (>90% CH_4).

The gas collection infrastructure is on the surface, using 450 millimetre diameter pipes, including that from vertical connections to underground directional holes. All surface gas streams from underground predrainage, surface MRD predrainage, and goaf holes are exhausted to a mobile goaf drainage plant and central pump station from where about 2,200 l/s of gas is discharged to 16 x 2.0 MW gas engines with the balance flared. The site policy is to avoid direct discharge of captured gas if at all possible.

Recognising that, in future blocks, gas emission to ventilation net of 85% goaf capture will still prove problematic for the ventilation system, the mine is now attempting to also pre-drain thicker roof target seams using approximately 2.0 km long holes drilled along longwall axes. These holes will serve initially as predrainage and after under-working as goaf drainage holes targeting close face gas emission. Conventional multiple seam completion frac wells may also be considered should additional predrainage be required above future deeper workings.