

IN THE MATTER OF  
THE HAZELWOOD MINE FIRE INQUIRY  
STATEMENT OF RAE MACKAY

I, Rae Mackay of 15 Lang Way, Tyers, Victoria 3844, say as follows:

**Professional Background**

1. I hold a degree in civil engineering and a PhD in hydrogeology. I was Professor of Hydrogeology and Head of the Hydrogeology Research Group at Birmingham University in the UK prior to relocating to Australia in 2011. In 2011 I was appointed as Director of the Geotechnical and Hydrogeological Engineering Research Group at Monash University (“GHERG”). I have been a Board member of the Technical Review Board (“TRB”) since 2011 and have been a member of the Coal Resources Victoria Advisory Group (formerly Clean Coal Victoria Advisory Group) from 2013 to 2015 (**CV Attached**).

**GHERG**

2. GHERG was established at Monash University’s Gippsland Campus in 2009 with project funding of \$3.25 million from the Victorian Department of Primary Industries. The initial funding covered the period until 30 June 2014. Further funding of \$2.47 million has been provided for the period until 30 June 2019. The first research staff member was recruited in mid-2010 and GHERG commenced its research program in 2011. (**GHERG Overview Notes attached**)

3. The objectives in 2009 for GHERG were:

- *To address the issue of insufficient expertise and skill shortage by providing broad range geotechnical and hydrogeological research and development support to the Latrobe Valley brown coal mines (“the mines”);*
- *To foster research and innovation in coal geotechnical and hydrogeological engineering, particularly in the areas of mine stability, mine monitoring systems and interpretation, ground subsidence, effect on rigid structures such as infrastructure, ground and surface water control in mines, and evaluation of models used in practice;*
- *To review and develop a systems modelling approach to planning that takes into account issues such as mine water quality and quantity, surface and groundwater contamination, ground subsidence, safety risks and bushfires;*
- *To provide support to the TRB, which will review all mining operations and their potential impacts; and*
- *To develop training programs for mine personnel through short courses presented by members of the research group, as well as local or international academic and industrial experts.*

These were slightly revised in 2014. The third bullet point was removed. This revision reflects the continuing focus of GHERG’s research program on long term mining induced ground movements, both before and after mine closure.

4. The aim of all research undertaken by GHERG’s staff and students is to advance understanding of ground movements associated with the Latrobe Valley brown coal mines. A significant body of knowledge describing the processes affecting ground movements in the coal mines is located in the historical records for these mines. These records have been used by GHERG as the starting point for its research. GHERG has created a database containing the majority of the information available prior to privatisation of the mines in 1995.
5. The proximity of the mines to people and infrastructure, the specific geotechnical characteristics of the geological materials, the geological setting, climate, hydrology and

the significant thickness of the coal seams are some of the factors that do not make it possible to rely on translating research from elsewhere without first testing and tailoring the research findings to the specifics of the Latrobe Valley.

### **Mine Rehabilitation and Knowledge Gaps**

6. GHERG's current research program covers some aspects of mine rehabilitation. Through my membership of the TRB, I am aware of each mine's rehabilitation plan, as provided in their work plans. These plans are largely conceptual and, therefore, only constitute an early first step in developing the final designs. There is a significant body of work that needs to be completed before there is adequate knowledge of the requirements for safely rehabilitating the mines and, hence, for developing these conceptual plans into successful operational plans.
7. In particular, there are significant gaps in knowledge about the future conditions that will influence the safety and stability of the mines over the long term. Some of these gaps relate to the long term changes in behaviour of the geological materials, the understanding of the interactions between ground movements and groundwater pressures, and the time dependent development of hazards (such as sinkholes) that are initiated by early mining movements but which may take a long time to become apparent. Therefore, rehabilitation plans must allow for an extended period of monitoring and maintenance in order to effectively manage both expected and unexpected changes to conditions.
8. For example, current plans assume that a pit lake will be formed by initially introducing an artificially-accelerated water inflow into the pit. Once the lake achieves a particular water level, further changes in water level will then be determined by natural inflows and outflows. This concept means that lake water level and, hence, the zone of pit walls exposed to wave erosion is likely to continue to change over an extended period of time. In turn, uncontrolled erosion can result in instability of pit walls. Therefore, erosion control measures will be required, with the performance of these measures needing to be

monitored over time in order to respond to changing water levels and to maintain the controls in a fit-for-purpose condition.

9. Another example of the need for long term monitoring and management relates to the control of groundwater pressures due to groundwater drainage into the mine. There is evidence that the current horizontal boreholes, which are used to prevent build-up of excessive groundwater pressures, can deform and cease to be effective over time. An array of these boreholes will be required to control groundwater pressures during the filling of the pit lakes and to ensure stability of the pit walls around the mines. Experienced staff, funding and equipment will be required to monitor these bores and to rehabilitate or replace them as required. The ongoing assessment of the locations where horizontal boreholes are needed, the monitoring requirements to confirm the operation of the bores and the assessment of the reliability of the bores are all necessary to inform rehabilitation planning and design.
10. In my opinion, the complexities of designing a realistic rehabilitation plan in light of the knowledge gaps are increasingly appreciated both by Government and the mines. Work is underway at all mines and by GHERG and other research groups to acquire the new knowledge to support future rehabilitation planning. I am not aware at this stage of any clear statement about what is meant by the term safe and stable for the final rehabilitation form and whether there are clear criteria for the mines to demonstrate long term safety and stability.
11. There is an ongoing need to identify all long-term risks associated with mine rehabilitation and closure and to determine how these risks can be managed.
12. A key example relates to groundwater pressure within the batters. At this stage, there is insufficient knowledge of the time dependent processes that influence groundwater pressures in mine batters. If monitoring is inadequate or ceases before a proper understanding has been developed at a site, there is a risk of unexpected ground movements occurring, with adverse consequences. The close proximity of communities and infrastructure to the mines is an important consideration in this regard.

13. In my opinion, the issues to be resolved in order to achieve stability of the final landform, the current state of knowledge about the future risks of ground movements, and the long term quality of waters are matters that have not been sufficiently communicated to the community. There may be long term risks of ground movements that will constrain future land uses. Similarly long term water quality changes can affect potential uses for the lakes. Work needs to be undertaken to scope these uses and to communicate the limitations that may be placed on these for reasons of ground stability and water quality.
14. There are opportunities for significant benefits to the community if the mines are successfully rehabilitated. Water scarcity may potentially be an issue in the future and the mine lakes could present a valuable resource in this respect. However, research is needed to determine how water quality can be maintained for water resource uses. Further, the implications for ground stability of significant water level changes during exploitation of the lake water will need careful consideration. A benefit of such a use of the mines is the opportunity to finance the ongoing monitoring and management necessary for delivering the required outcomes for water quality and stability. Water management must involve the relevant government departments.
15. In going forward, it is appropriate for all relevant parties to build a consensus view on what the rehabilitate mines should look like and how they should operate in the future. Time and resources should be invested by all parties in exploring the options for achieving desirable and beneficial rehabilitation outcomes.

### **Some Promising Developments**

16. There is useful research work that is already happening or should be commencing soon. One example is the planned Batter Stability Project funded by the Department for Economic Development, Jobs, Transport and Resources, which will undertake significant field investigations at Yallourn mine and will examine the way the ground stresses and movements have evolved over time. This project should provide valuable evidence about how mine batters may move under the changes that will be imposed by rehabilitation. It

should also help with understanding the way that water movements through the joints in the coal can change over time. This information will assist in better determining the extent to which ground movements may continue over time. An objective is to derive the likelihood of instabilities in the future.

17. Additionally, the Batter Stability Project will assist with understanding how the near surface soils are impacted by the coal movements arising during mining. This will provide data that can be used to estimate the likelihood of sinkhole formation outside of the mine perimeter after mining has ceased.
18. AGL Loy Yang is presently commencing a significant research program involving Monash University and Federation University that is focused on testing alternative approaches to rehabilitating the batters at Loy Yang mine. AGL Loy Yang has also been funding students to study the potential to build artificial soils for use in covering the batters, as well as the management and environmental implications of power station ash disposal into the mine void as one component of the backfill to control mine floor heave.

### **The Way Forward**

19. In my opinion it will be important for all relevant agencies and departments that can affect and be affected by the rehabilitation of the mines to work both together and with the mine owners to deliver a beneficial outcome. Management of the interactions between the mines and the regional environment and population will involve significant planning decisions with wide-ranging implications for the Latrobe Valley. One example is water allocation. There do need to be decisions made by planning authorities around the issue of water allocation and water quality management to achieve the goals of rehabilitation.
20. There are considerable benefits to be gained from establishing an open access knowledge management system and data base that is accessible by all parties and into which all new data can be entered. This should integrate the existing databases held by the government departments, the mines, the consultants and GHERG and should be maintained as part of

a wider consortium agreement covering knowledge management and mine rehabilitation closure planning.

21. There is also value in similarly integrating the required program of research and development through a planning and oversight group that comprises a membership drawn from all stakeholders.
22. As a minimum, there needs to be a mechanism that permits a common vision of the combined outcomes of the rehabilitation and closure plans for the three mines and the investigations needed to deliver these outcomes. The mines are sufficiently close to each other that an integrated plan for all mines is desirable.



Signature:

Date: 27/11/2015