CENTER for SCIENCE in PUBLIC PARTICIPATION

"Technical Support for Grassroots Public Interest Groups"

July 26, 2022

RE: COMMENTS ON THE HAZELWOOD MINE CLOSURE PROPOSAL

A. About the Reviewer

David Chambers has 45 years of experience in mineral exploration and development – 15 years of technical and management experience in the mineral exploration industry, and for the past 30+ years he has served as an advisor on the environmental effects of mining projects both nationally and internationally. He has a Professional Engineering Degree in physics from the Colorado School of Mines, a Master of Science Degree in geophysics from the University of California at Berkeley, and is a registered professional geophysicist in California (# GP 972). Dr. Chambers received his Ph.D. in environmental planning from Berkeley. His recent research focuses on tailings dam failures, and the intersection of science and technology with public policy and natural resource management.

B. Site Background

The Latrobe Valley's three coal mines – Hazelwood, Yallourn and Loy Yang, all located on privately owned land – are being studied by the Victorian State Government to consider future rehabilitation options for the mines. Flooding of the mine pits is being proposed as a closure option for all three mines. Technical studies have concluded that it is likely that if a water-based mine rehabilitation approach were taken, it would take many decades to fill or partially fill the voids with water (Victoria 2020).

The Latrobe Valley has predominantly experienced drying conditions since 1997, which is consistent with what has been experienced across Victoria over the same time period, and surface water availability in the Latrobe River system has decreased from a longer-term average of about 800 gigalitres (GL) a year to about 600 GL a year. The mean annual water availability in the Latrobe River under a dry climate scenario is projected to further decline to approximately 467 GL a year by 2050, and 334 GL by 2080. Under such a scenario, water from the Latrobe River system would not be available for mine rehabilitation because it would have unacceptable impacts on other existing entitlement holders and minimum environmental flows. Should a water-based mine rehabilitation approach be taken for all three mines, the study further found that the ongoing volume of water needed to maintain water levels in the mine voids to offset evaporation is estimated to be around 15 GL per year, but could be higher depending on the future climate. In comparison, water supplied to towns (excluding industry) across Central Gippsland totaled approximately 13 GL per year in 2017–18. The availability of water to provide a cover for mine closures is a significant issue, especially in the long term. (Victoria 2020).

The Hazelwood Mine Fire Inquiry Report (Board of Inquiry 2016) is a study conducted in response to the major fire in the Hazelwood mine over February-March 2014, caused by embers spotting into the Hazelwood mine from bushfires burning in close proximity to the mine. The fire burned for 45 days, sending smoke and ash over Morwell and surrounding areas. Preventing mine fires is also one of the major goals for closure design.

C. Project Description and Context

Australian Power Partners, Hazelwood Churchill Pty Ltd, Hazelwood Pacific Pty Ltd, and National Power Australia Investments are the four legal entities that make up the partnership Hazelwood Power Partners. These four entities jointly occupy the Hazelwood Power Complex. The mine void is in the centre of the Hazelwood Power Complex and covers an area of approximately 1,266 hectares.

ENGIE Hazelwood (ENGIE 2020) propose to rehabilitate the mine void by flooding it with water to form a pit lake to a depth that would result in the flooding of most of the pit and waste disposal areas. The primary goals are to stabilize the pit walls, prevent the coals seams from catching fire, and isolate the waste with a water cover.

D. Sources of contamination

1. Ash Waste

The Hazelwood Ash Retention Area, located in the eastern area of the mine void, is a clay-lined storage area and EPA-licenced landfill for ash generated by the Hazelwood Power Complex. It covers an area of approximately 35 hectares and contains approximately 1.5 million cubic metres of ash.

The ash facilities are Hazelwood Ash Pond 1 (HAP1), Ash Pond 2 (HAP2), Ash Pond 3a (HAP3a), Ash Pond 3b (HAP3b), Ash Pond 4 (HAP4), and Hazelwood Ash Retention Area (HARA). (AECOM 2017). These facilities can be seen in ERM Figure F1 Site Locality Plan and Layout, attached to this document.

The ash is categorised by the Victorian Environment Protection Authority as industrial waste and characterised by the presence of a variety of contaminants of concern including metals (e.g., barium, boron, chromium, copper, lead, mercury, nickel, selenium, zinc), hydrocarbons (e.g., TRH C10-C40), and inorganics (e.g., chloride, fluoride). The ash leachate has been shown to be highly alkaline (pH 12.3-12.7) and saline (up to 16,000 mg/L). The ash has the potential to leach major ions (sulphate, sodium, chloride, calcium, and potassium), metals (aluminium, boron, copper, cobalt, iron, manganese, molybdenum, nickel, selenium), fluoride, and trace concentrations of other contaminants into groundwater. (EPA 2021)

The potential for ash contamination to affect surface waters is probably greatest if the pit-flooding scheme is adopted, since pit lake water would cover the Hazelwood Ash Retention Area and could potentially be contaminated by groundwater from the Ash Ponds, which are immediately hydraulically upgradient from the proposed lake. If the pit lake water were to become contaminated, then the Morwell River could be affected by this contamination.

Recent investigations show that the ash waste present in the HARA is likely affecting groundwater quality in the aquifers below the mine void (EPA 2021). Even though the ash ponds are clay-lined, the clay is not providing a sufficient barrier to prevent leaching of incident precipitation into groundwater.

The EPA (2021) has stated a "*… reasonable belief that the storage of ash waste in the Hazelwood Ash Retention Area has given rise to circumstances which are likely to cause harm to the environment …*" The success of the present closure proposal of flooding the pits and the ash-containing waste will depend on both an adequate supply of water to maintain a lake/flooded conditions, and that the lake will not be contaminated by the flooded waste. It is known that the ash will leach contaminants, and that the existing liners are not sufficient to stop this contamination. Flooding, although probably the lowest cost approach, has several potential fatal flaws that could lead to the need to adopt a completely different closure approach 10 to 50 years in the future.

Because of the contaminants associated with virtually all coal ash waste, and the now well-documented propensity of coal ash waste in general to leach the contaminants out of the waste into groundwater, it is now becoming widely accepted to place all coal ash into lined repositories that will prevent leaching into groundwater. In locations where leaching of existing unlined ash waste ponds has had a significant negative effect on groundwater, it is also becoming common practice to relocate the ash to a lined facility. Even though this is expensive, it can be the most cost efficient and effective way to prevent groundwater contamination.

The EPA has required that the mine owners produce an environmental audit report by January 2023. It will be important that this report determine the present size of the contaminated groundwater plume, the potential for this contamination to increase, and what groundwater resources can be impacted.

It is not likely that any additional action or commitments will be made until the environmental audit report has been received and digested.

2. Asbestos

The asbestos facilities are: Asbestos Dump 1 (ASB1), Dump 2 (ASB2), and Asbestos Dump No.3 (ASB3). These dumps historically received all asbestos wastes and potentially other waste, such as chromium refractory waste, where it may have been contaminated by asbestos (AECOM 2017). These facilities can be seen in ERM Figure F1 Site Locality Plan and Layout, attached to this document.

The primary threat from asbestos fibers is that if they become airborne they can become embedded in the lungs. From a water quality standpoint there is little risk from asbestos. Asbestos waste should be buried so that it cannot be exposed and mobilized.

However, it is noted that the Hazelwood asbestos storage areas might also contain chromium refractory waste. As a result, groundwater testing beneath the asbestos dumps should be done to determine whether chromium, or other heavy metals, have been leached into groundwater beneath the asbestos dumps.

E. Water Closure Issues

The Hazelwood Mine Fire Inquiry Report (2016) Board stated that it was persuaded by the expert evidence that a lake/flooded pit option was considered the most viable rehabilitation approach for each mine. This opinion was based on the ongoing significant fire and stability risks to be managed following cessation of mining, and the technical and financial aspects of the rehabilitation works. However, the Board also accepted that there were many unresolved issues about how a waterbody option could be achieved.

The Regional Water Synopsis Report found that up to 3,000 gigalitres (GL) of water could be needed to completely fil all mine voids to their crests, and 15 GL of water would be required annually to replace evaporation losses. If the mine voids were only partially filled with water to prevent floor heave, the volume of water collectively required by the three mines would be approximately 1,600 GL (Victoria 2020, Regional Water Study Synopsis Report).

Climate change must also be a major consideration in driving the choice of a closure approach. In the Water Study it is noted, "*Under a dry climate, flow in the Latrobe system could decline significantly by 2060 to about 400 GL/y on average. Such a decline would drive an incremental change in character for the Latrobe River system, and would require re-assessment of the minimum environmental flow requirements for the system*." (Victoria 2020). Given what we know today about the direction of climate change, this is probably an understatement. The water closure options are using water as a weight to provide pit batter[1] and floor stability. Water is a very valuable resource, and to use water for this purpose could be construed as extravagant, if not wasteful.

1. Pit Floor Heave and Batter Collapse

One of the reasons for using water to fill the mined-out pit is to avoid pit floor heave and batter collapse. While adding a pit lake would lessen both pit floor heave and batter collapse stresses, it would also raise the water table in the pit walls that are not submerged in the lake, which would increase the likelihood of batter collapse for those unflooded batters. This effect is illustrated in Figure 2 (Narendranathan 2021)

[1] Batter refers to the stepped walls of a mine pit.

below. This is only an illustration, not a depiction of actual conditions, but note the phreatic surface (i.e., the groundwater level, the red dashed line) that has been raised to meet the surface of the lake. Whether this rise in the phreatic surface will be problematic will depend on the actual steepness of the slope of the unsubmerged pit, and the saturated and unsaturated strength of the pit wall materials.

A pit lake could have both positive and negative implications for batter collapse. The fundamental closure decision with regard to pit backfill to mitigate floor heave and batter collapse is what to use as backfill – water or solid waste. It is obviously much less expensive to use water, and that is the only solution that appears to have been seriously analyzed at this time. Water availability and potential water contamination from the mine and mine waste are potential fatal flaws to a lake-fill closure approach.

Figure 2 from Narendranathan 2021

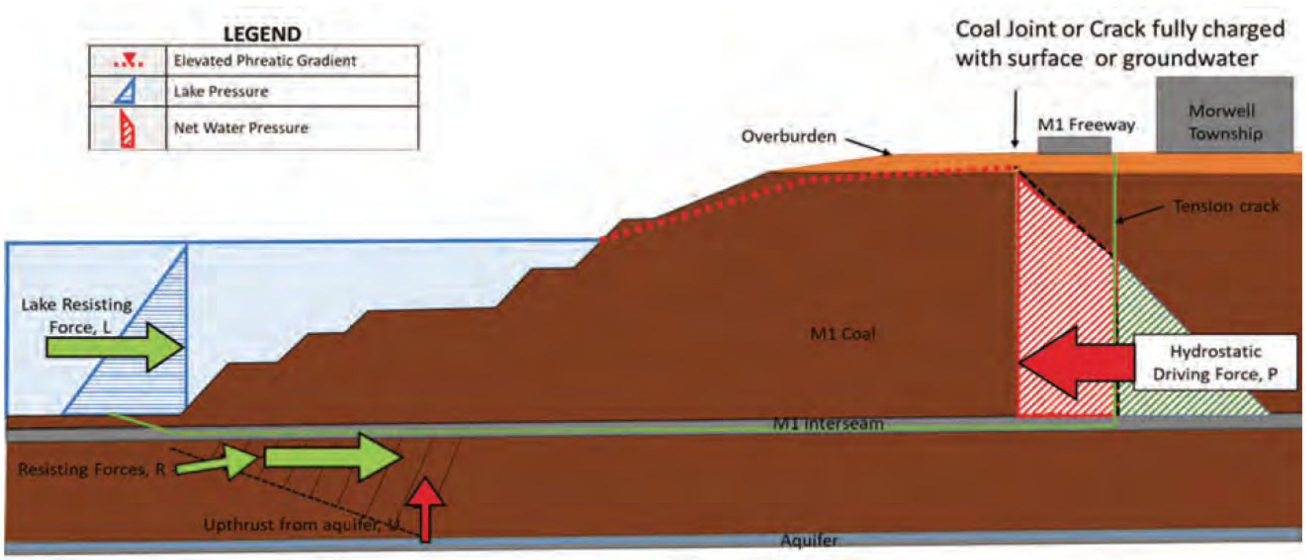

Figure 2 Coal Block Sliding Mechanism

2. Partial Pit Backfill Closure

Backfilling the pit with mine waste would provide more weight and horizontal support per unit volume than water to prevent pit heave and batter collapse, without raising the water table. In addition, if the slope of the pit walls was reduced by pushing or placing this material in the pit itself, then pit backfill material becomes readily available. A backfilled mine pit would need to have a floor that extended above the natural groundwater level in order to avoid long-term water loss due to evaporation, and to increase batter stability. Cost is probably the main flaw associated with using solid waste as a backfill approach. The amount of material that would need to be moved, and the sources of this material, have not been analyzed.

A downside to reducing the slope as a part of a backfill approach is that the size of the pit would need to be increased in order to provide the lower slope. In some locations, for example where the pit is near a road or waterway, slope reduction may not be practicable for portions of the pit (but pit wall buttressing is still possible), however backfilling in general is possible.

The option of partially backfilling the pit to a level higher than the post-closure groundwater level is never discussed, and importantly the cost of doing this is not disclosed. Backfilling the pit with mine waste is probably not being discussed because it would be more expensive than a water-fill approach. Even though backfilling with mine waste is more expensive, it is not cost-prohibitive, especially if it has significant benefits, like reducing water loss.

It is important that partial pit backfill be evaluated as a closure option because the amount of water required for a water closure is significant even now, and with likely increases in other demands for water related to climate change and increased per capita human utilization, demand for water is very likely to become an even more important issue in the future.

3. Ash Relocation or Removal

The ash ponds will continue to leach contaminants into groundwater if they remain in their present condition. The ash ponds are reportedly clay lined. If they had performed as designed, lining the ponds with clay should have provided some seepage protection for groundwater. However, groundwater contamination has been reported, so the clay liners are evidently not working as intended. It is not practical to repair existing clay liners. It is important to determine whether the present rate of groundwater contamination from the ash ponds is great enough to threaten groundwater uses in the area, as well as whether contamination of the proposed lake is a potential. It appears this analysis has not yet taken place.

If the Hazelwood Ash Retention Area is covered with water, the leaching of contaminants to groundwater will continue, but a new leakage rate has not been calculated. After inundation with water, if the HARA continues to leach contaminants into groundwater or lake water, it is likely the ash would then require relocation. If the ash were flooded, it would be even more costly to relocate the ash.

If a dry closure is chosen, then analysis of the risk associated with existing and future groundwater contamination is required. Capping the ash ponds with synthetic liners might provide adequate isolation from infiltration, but it is more likely that relocation of the ash ponds to a properly lined facility may be required.

F. Data Gaps

1. Projected water quality of post-closure lake at Hazelwood

The replacement water required for the pit lake will both dilute and carry off contaminants from mine waste and mine facilities, which would otherwise build up and potentially lead to long-term contamination issues. It was noted that, "*Although no significant water quality risks were identified at a high level, the potential for water quality risks needs to be studied in detail at the end of mining operations based on reliable and representative data*." (Victoria 2020, Regional Water Study Synopsis Report)

Contaminants in the lake water could have a negative impact on both the potential uses for the lake (e.g., recreation limitations), and on costs for any water treatment that would be required. Water treatment, if required, is typically the largest cost item associated with a mine closure. In the Water Study it was also noted, "*Any releases from the pit lakes would need to meet applicable water quality standards, and the final landforms should be configured to allow releases to be ceased or controlled*." (Victoria 2020) The Victorian State Government is obviously aware this could be an issue.

In the Water Study it is also noted, "*A pit lake model is needed to integrate water from surface water, evaporation and groundwater. The pit lake and surface water models need to synchronise volume and rate data from surface water sources to the pit lakes, and the pit lake model and groundwater model fluxes will need to be reconciled*." (Victoria 2020)

2. Projected post-closure groundwater quality related to present ash ponds

In the Water Study (Victoria 2020) it was noted, "*Additional groundwater quality monitoring near the mine pits is expected to be required only if a water quality issue in a pit lake is identified. No such issues are predicted*."

It is not clear that the potential effects of seepage from the waste has been modeled, or even investigated. The analyses needed to make this prediction has not been provided in the report, so it has not been demonstrated that groundwater contamination might not continue, and that lake water would not be contaminated. It is also not clear whether existing data is sufficient to support a modeling effort. An evaluation of existing data for its adequacy in supporting further analysis should be an early step in future environmental analyses.

3. Hazelwood groundwater level post-mining

There is discussion of groundwater rebound when pumping ceases, and perhaps there has been hydrologic modeling associated with water quality prediction analyses, but there is no clear statement of what groundwater levels post-pumping / post-closure will be required to determine the minimum amount of mine waste that must be moved into the pit under a partial backfill option.

4. Chromium refractory waste groundwater contamination

It has been noted that the asbestos dumps might contain waste from a chromium refractory that was also contaminated with asbestos fibers. Chromium is a dangerous contaminant that is toxic at extremely low-levels, if Cr^{+6} is present. Groundwater sampling beneath the asbestos dumps should be undertaken to determine whether chromium contamination has occurred. Much more information about the chromium refractory wastes is necessary to determine the level of risk from chromium.

G. Summary

The most environmentally (water loss and water contamination) and socially (local jobs) beneficial closure approach would probably involve filling the mine pits with solid material, instead of water, to a level where the pit floor would remain well above the natural groundwater level, and relocating the ash waste to a lined pit where precipitation would not be able to infiltrate through the ash and leach into groundwater. This maximizes the long-term stability of the pit floor and batters, minimizes water loss because it requires no water use, and provides protection for groundwater, which is currently being impacted by contaminants leaching from the existing ash ponds, and that contamination will continue unless the ash is moved.

In the Latrobe Valley Regional Rehabilitation Strategy (Victoria 2020), it is noted: "*The original concept of all three coal mines being flooded with water to create artificial lakes may not be viable in light of changing environmental and regulatory constraints. Without certainty around this issue, it is difficult for the Board to determine, other than to confirm that without reliable sources of water, the pit lake option will be unviable and unsustainable*."

This statement provides clear insight into the direction mine closure for all three mines should be moving – a dry closure scenario. Water closure of the pits is being proposed largely because it is the least expensive way to stabilize the pits. It appears that analyzing partial pit backfill with mine waste has been assiduously avoided in the options discussion. The reason for this is obviously that backfill with mine waste would be considerably more expensive than backfill with water. However, water backfill, while the least costly option for the mine owners, might impose a huge long-term cost on the region in terms of future liability for water contamination, water shortages, long-term maintenance of water levels, and water availability in general.

The primary cost of partial waste backfill would be associated with moving backfill into the pit, and in repositioning the ash to a new location. From an economic standpoint, these moving costs would have a significant positive local economic effect, since most of the jobs required for this work should be easily supplied by local labor with skills gained by working at the existing mine. The use of mine waste to partially backfill the pits is also the best approach for long-term water availability.

Sincerely;

David M. Chambers, Ph.D., P.Geop

References

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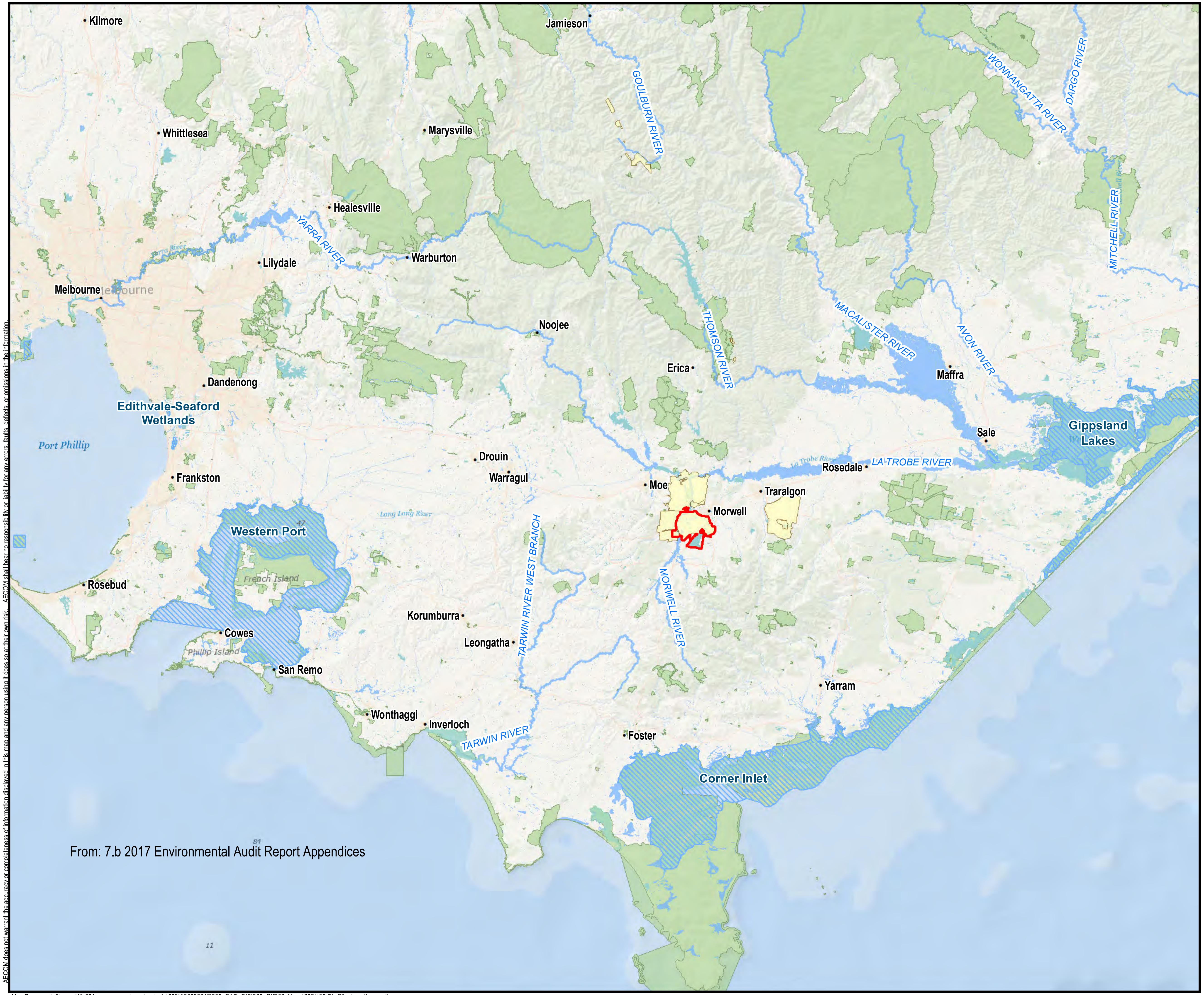

From: 7.b 2017 Environmental Audit Report Appendices

PROJECT ID XXXXXXXX
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Coordinate System: GDA 1994 MGA Zone 55

0 6,250 12,500 25,000
metres

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LEGEND

- Project Area
- Localities
- Ramsar
- Latrobe Valley mines
- Park & Reserve
- Wetlands
- Waterbodies
- Watercourses

Project Location

ENGIE Hazelwood

Hazelwood Rehabilitation Project

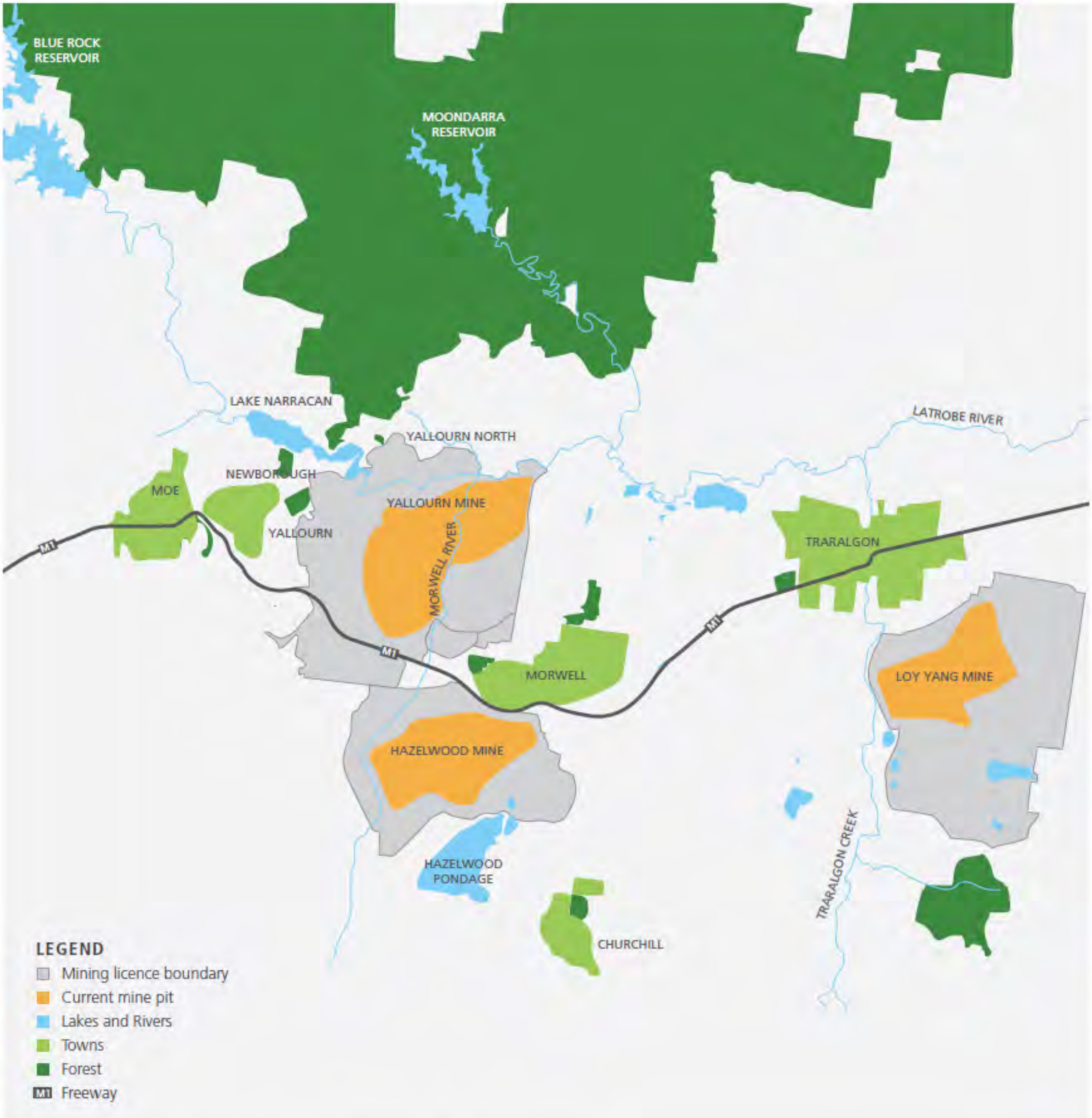
Brodribb Rd, Hazelwood VIC

Figure

F1

Map Document: (\\aumel1fp001.au.aecomnet.com\projects\606X\60668312\900_CAD_GIS\920_GIS\02_Maps\2021\09\F1_Site_Location.mxd)

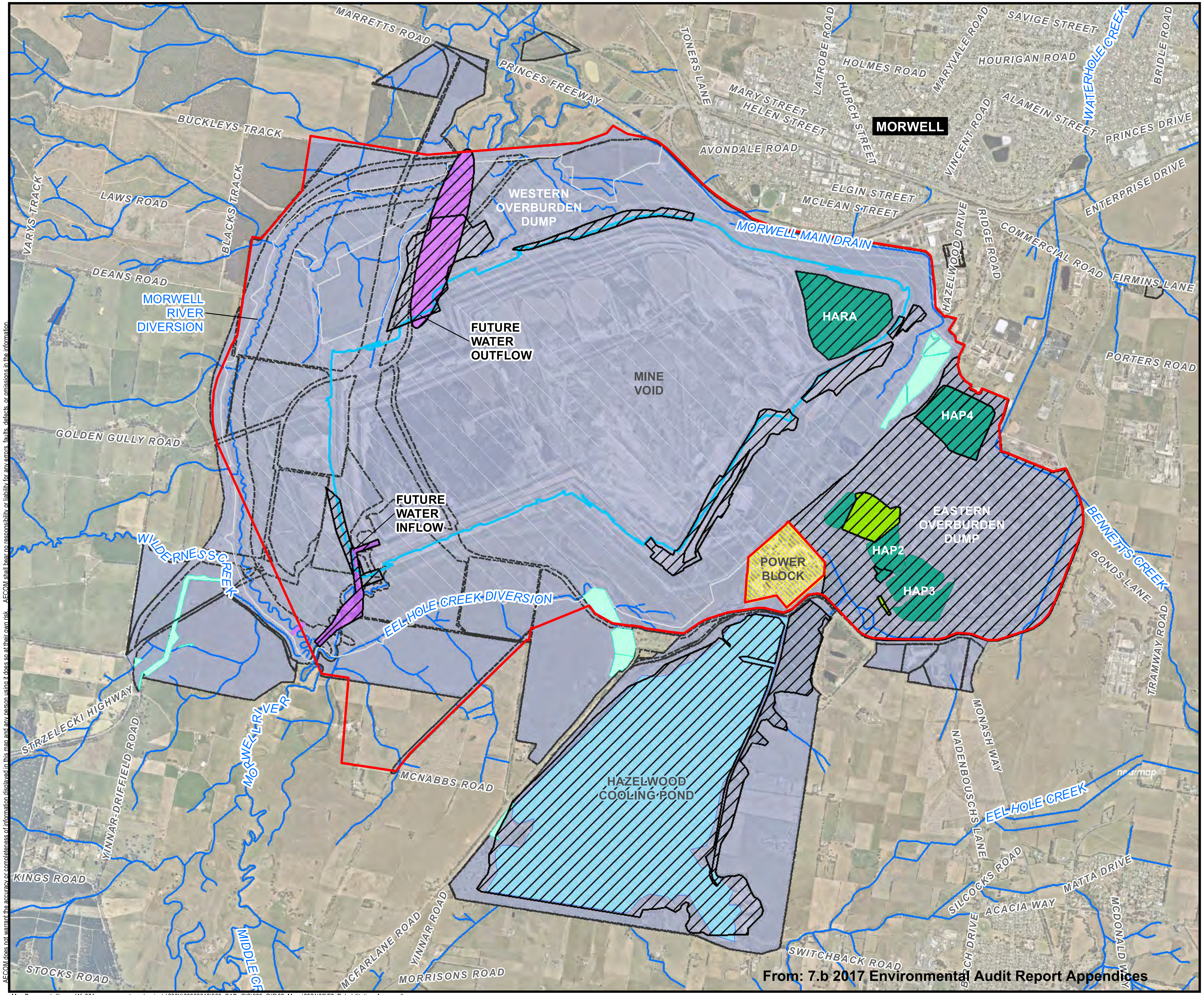
Figure 1. Map of the Latrobe Valley



Source: Adapted from GeoVic, Department of Economic Development, Jobs, Transport and Resources

From: 27. Hazelwood Mine Fire Inquiry Report 2015-16 - Mine Rehabilitation.pdf

ERM Figure F1 - Site Locality Plan and Layout



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Coordinate System: GDA 1994 MGA Zone 55

0 312.5 625 1,250 metres

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LEGEND

- Mine Licence Boundary
- Project Area
- Property Boundary
- Hazelwood Cooling Pond
- Power Block
- Indicative area to be rehabilitated
- Proposed Mine lake RL+45m AHD
- Proposed Morwell River inflow and outflow
- Active landfill
- Closed landfill
- Conservation areas
- Disturbed area

Hazelwood Rehabilitation Project - Indicative areas to be rehabilitated

ENGIE ANZ

Hazelwood Rehabilitation Project

Brodribb Rd, Hazelwood VIC

Figure

F5

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