INDEPENDENT EXPERT ADVISORY PANEL FOR MINING

ADVICE RE:

HUNTER VALLEY OPERATIONS CONTINUATION PROJECT (SSD-11826681 and 11826621)

July 2024

Advice No: IEAPM 202407-2

EXECUTIVE SUMMARY

On 5 March 2024, the NSW Department of Planning, Housing and Infrastructure (DPHI) requested advice from the Independent Expert Advisory Panel for Mining (IEAPM – the Panel) in relation to the Hunter Valley Operations (HVO) Continuation Project (the Continuation Project) comprising a Development Application for the HVO North Continuation Project (SSD-11826621) and a Development Application for the HVO South Continuation Project (SSD-11826621) lodged by HV Operations Pty Ltd (HVOPL).

The Scope of Advice stated that:

The Department requests that the Panel provide advice targeting the following:

- *the scale and likelihood of potential water-related impacts and environmental consequences on key water features in the vicinity of the project area, including the Hunter River;*
- *whether the proposed water-related mitigation and monitoring measures would adequately minimise any environmental consequences on significant water features; and*
- *whether the GHG avoidance and mitigation measures proposed by the Applicant are considered to be sufficient, including the reliance on availability of carbon offsets in the future.*

The Panel should also feel free to provide any other advice it considers would assist the Department in assessing the project.

HVO is an established multi-pit open cut coal mining complex approximately 24 km north-west of Singleton in the Hunter Valley of New South Wales. It comprises two mining sites separated by the Hunter River, these sites being HVO North and HVO South. The Continuation Project involves continuation of mining at both sites, which are currently approved under two separate development consents but operated as a single mining complex. It aims to optimise resource recovery from the existing operation, predominantly by extracting coal from deeper seams at HVO North, which includes removing spoil (overburden dumps) covering target seams in some areas, and extending the HVO South site. The mining operations are complex, involving simultaneously extracting up to 15 main coal seams which, in turn, could comprise up to 150 extractable coal plies ranging in thickness from the order of 0.3 m to 2 m.

The protection of the Hunter River has been a key issue for other projects in the Hunter Valley, particularly the surface and groundwater interactions. Given the proposed proximity of mining to the Hunter River, the Department considers water-related impacts, including potential impacts on groundwater dependent ecosystems, are a key technical issue for the project, including whether suitable measures have been proposed to proactively manage these impacts.

Associated GHG emissions are another key technical issue. The GHG assessment predicts that the gross Scope 1 and 2 emissions from the project would be approximately 29.6 Mt CO2-e (comprising approximately 50% fugitive emissions and approximately 50% diesel fuel emissions) of which the Applicant is proposing to rely on carbon offsets to abate 11.7 Mt CO2-e. Three gas domains have been identified by HVO, being Domain 2 associated with exiting operations as HVO North, Domain 1 in the new mining area in HVO North, and Domain three at HVO South. Within each Domain, up to five characteristic gas content zone have been identified, starting with Zone 0 near the surface.

Based on the material presented to the Panel and the supplementary information provided by HVO, the Panel has drawn the following conclusions and recommendations in addressing the Department's request for advice.

Conclusions and Recommendation

Surface and Groundwater

Summary Conclusions

1. In relation to water-related impacts, there is no reason why the Continuation Project should not be conditionally approved.

2. *Erosion and sediment control during mining operations* is manageable by a suitable Erosion and Sediment Control Plan as proposed by HVOPL.

3. *Loss of downstream flows due to baseflow loss and leakage* as predicted is not of concern. Refinements to groundwater and surface water monitoring would assist future assessment of river-aquifer exchanges.

4. *Loss of downstream flows due to interception of runoff and extractions from water courses during mining operations*; and *Loss of downstream flows due to interception of runoff and groundwater post-closure*. Assuming licensing issues are successfully resolved, these are not impacts of concern.

5. *Flooding impacts on properties, mine operations and stability of the channel*. There are risks associated with erosion and performance of levees, which are manageable by good design and performance monitoring. The flood modelling undertaken for the Project has been peer reviewed and appears to be appropriate for the purpose of the Project.

6. *Impacts to Groundwater Dependent Ecosystems (GDEs)* are not expected to be significant. However, the long-term monitoring and assessment of risks to the GDEs would benefit from: Updates to the assessment of the sensitivity of plant species within the Hunter River GDEs to groundwater level declines; appropriate thresholds for water level decline that are specific to each GDE; and extended groundwater modelling uncertainty analyses.

7. *Water overflows and discharges during operations* are manageable under the Hunter River Salinity Trading Scheme and Environmental Protection Licence. The existing Water Management Plan does not clearly specify how both volume and quality of discharges and overflows are monitored. The presentation of predicted discharges and overflows could be improved by showing the full range of predicted site water storage values; and use of a stochastic rainfall model would provide more robust confidence limits on stored and discharged water volumes.

8. *Water overflows and discharges from the final landform* are a potential source of contamination that will need detailed consideration in closure and rehabilitation planning. Further work is needed to better define the long-term risks of contamination to the alluvial aquifer and Hunter River from leakages from the spoil. Clarification of the applicable spoil properties governing recharge, interflow and deep percolation, supported as necessary by additional field and laboratory testing of spoil properties is required. Future updating of the groundwater model and the uncertainty analysis with the updated spoil properties would allow the risks of alluvial and surface water contamination to be addressed.

9. *Carrington West Wing barrier wall installation* prior to mining encroaching the paleo-alluvial channel is expected to be beneficial for mitigating drawdown in the Hunter River alluvium. Appropriate risk assessment and related modelling is required to support development of the planned Trigger Action Response Plan (TARP) for the wall and the associated monitoring design.

10. *Cumulative impacts* have been given little attention in the surface water assessments. The Panel agrees with the approach because the controls on extractions and discharges are designed to manage cumulative impacts; and because the history of land use in this area makes it difficult to define a useful baseline.

11. *Surface and groundwater monitoring.* Extending the monitoring that is currently in place, including continuous water level measurements that allow variations in the pressure gradient from the Hunter River to the alluvial groundwater to be accurately measured, would provide valuable data on stream aquifer interactions. This would be beneficial for updating TARPs for the alluvial aquifer and for improving the assessment of risks to the Hunter River GDEs. Regularly updating the water monitoring plan is necessary to meet the future requirements of progressive rehabilitation and closure planning.

12. *Groundwater modelling* for the Continuation Project is generally fit for purpose. However, there are areas where the modelling and its presentation could be improved in future assessments to support interpretation of, and increase confidence in, the model results:

    a. detailing a local water balance for the alluvial aquifer in the vicinity of the Carrington West Wing barrier wall.

    b. better linking calibration hydrographs to their monitoring location to aid the interpretation of the modelling results.

    c. showing how the final calibrated model parameter values compare with the prior ranges for the parameters and providing the basis for the prior ranges selected.

    d. demonstrating the groundwater model's goodness of fit is appropriate for the objectives of the modelling. In particular, the quality of the model fit for the quaternary alluvium should be assessed for quality of model fit independently from the rest of the model given the objectives of assessing mining impacts on both the alluvium and related GDEs.

    e. clearly differentiating between model results that are additional to groundwater impacts previously approved under the existing mining approvals and those that include groundwater impacts previously approved.

Summary Recommendations

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Prepare an updated Water Management Plan, incorporating a Water Monitoring Plan, within 6 months of approval that includes the following:

    a. If applicable, any modelled exceedances of the total site storage capacity should be reported (modelled frequency and volume) rather than only showing the 95% bound. As part of the update, more robust confidence limits on stored and discharged water volumes should be provided by use of a stochastic rainfall model.

    b. A plan for continuous monitoring of water levels in the Hunter River that allows accurate measurement of the hydraulic gradient from the river to the alluvial groundwater, as part of a monitoring transect from the river to the Carrington West Wing barrier wall, and to assist with estimating the downward hydraulic gradient to the Permian units.

    c. A TARP for the Carrington West Wing barrier wall and associated groundwater monitoring. To develop the TARP, groundwater modelling should be undertaken in support of a risk assessment, first, to assess what constitutes an unacceptable barrier wall failure in terms of groundwater impacts and, second, to assess options for groundwater monitoring to identify such a wall failure. Non-invasive methods of monitoring such as surface electrical resistivity surveys should be investigated as an alternative to, or an adjunct to, groundwater monitoring using nested piezometers. If HVOPL does not proceed with these methods, sufficient justification must be provided.

d. To improve plans for unexpected changes in surface and groundwater results, uncertainty analyses should be extended to assess the long-term risks to the GDEs. Steps to identify the sensitivity of plant species within the Hunter River GDEs to groundwater level declines should be established. The goal is to develop appropriate thresholds for water decline that are specific to each GDE for the risk assessment and groundwater TARPs.

e. Plans for continuous monitoring of flow, EC, pH and total suspended solids (e.g. as turbidity) at identified discharge and overflow points (as well as the existing grab samples).

f. Plans for monitoring and investigation that inform predictions of spoil hydrology, geochemistry and seepage, in order to support progressive rehabilitation and closure planning (in the initially updated Water Management Plan, this may be in general terms and made more specific as rehabilitation and closure planning progresses).

g. Updated requirements for groundwater model review and reporting covering:

   i. detailing a local water balance for the alluvial aquifer in the vicinity of the Carrington West Wing barrier wall.

   ii. better linking of calibration hydrographs to their location to aid interpretation of the modelling results.

   iii. showing how the final calibrated model parameter values compare with the prior ranges for the parameters and providing the basis for the prior ranges selected.

   iv. demonstrating the groundwater model's goodness of fit is appropriate for the objectives of the modelling. Specifically, the quality of the model fit for the quaternary alluvium should be assessed separately from the full model given the objectives of assessing mining impacts on both the alluvium and related GDEs.

   v. clearly differentiating between model results that are additional to groundwater impacts previously approved under the existing mining approvals and those that include groundwater impacts previously approved. Documenting both contributions is required.

   vi. re-evaluation of the physical and environmental mechanisms governing the health of the GDEs and description of their significance for GDE health; and improved use of the groundwater modelling results to explore and explain the relevant GDE impacts.

2. Within 12 months of approval, have the updated Water Management Plan peer reviewed by a party approved in writing by the Secretary. The review should address the adequacy of monitoring and mitigation measures.

3. Future progressive rehabilitation and closure plans should include ongoing assessment of the sensitivity of groundwater modelling results to spoil properties and geometries to assess the risks of poor-quality spoil water entering the alluvial aquifer or Hunter River.

GHG Emissions

Summary Conclusions

The Panel has confined its advice to fugitive emissions and to the diesel fuel component of fossil fuel emissions given that these two sources account for around 99% of the Project's GHG emissions.

Sufficiency of Offsets

1. HVOPL's offset projections make no allowance for future avoidance and mitigation technologies over which it currently has 'no direct line of sight'.
2. Currently, there are no measures available to HVOPL to reduce GHG emissions other than to change the mine design and/or mine production targets.
3. HVOPL is entitled to offset all its GHG emissions and is currently proposing to do so, at least until alternative and cheaper mitigation options become available.
4. There are no definitive answers to concerns about the availability of offsets in the long term, however, it appears reasonable to expect that:
    a. When offsets are available then market forces should prevail and drive a reduction in GHG emissions if offsets become prohibitively expensive.
    b. If offsets become unavailable then regulatory forces should prevail to prevent emissions that can no longer be offset.
5. If the cost of offsets becomes prohibitively expensive or offsets become unavailable in the future, then there may be no option for managing GHG emissions but to modify the mine plan at that time, which could include early mine closure.
6. Modifying the mine plan in a manner that reduces production achieves both a reduction in fugitive emissions and a reduction in fossil fuel emissions, which are predominantly diesel fuel emissions and which constitute around 60% of GHG emissions up to 2040.
7. Technological developments in mitigating GHG emissions in the interim could have significant positive impacts on the scale and cost of offsetting and, therefore, on the extent of any changes to the current mine plan.
8. Analysis of the distribution of both gas contents and volumes in the proposed mining areas, review of the nature and status of potential and emerging mitigation measures, and assessment of the nature, potential success and impact of some existing and likely future opportunities for avoiding and mitigating GHG emissions provides a basis for the Department to formulate its views on the sufficiency of avoidance and mitigation measures, including offsets.
9. The analysis, review and assessment can be broken into two elements, being fugitive GHG emissions and diesel fuel GHG emissions.

Fugitive Emissions

Avoidance

1. The only fugitive emissions avoidance measure available is mine planning that restricts the areal extent of mining and/or the depth of mining.
2. A significant fugitive emissions avoidance measure at HVO would be not to mine Zones 2, 3 and 4 in Domain 1.
3. If Zones 2, 3 and 4 in Domain 1 were not to be mined and the current mine plan was not to be revised, mining would effectively cease at the end by 2044, some 6 years earlier than planned. However, it is possible that mining may cease before that date due to the impacts and consequences of such a decision on the viability of mining just Zone 1.

4. If Zones 2, 3 and 4 in Domain 1 were not to be mined, a revised mine plan may result in the remaining mining in Domain 3 being completed earlier than 2044.
5. If consideration is to be given to these types of options, the options should be put through a mine planning process to verify the merits and impacts of the options and properly inform decision making.

Mitigation:

1. The first 16 years of the Continuation Project to 2039 account for ~50% of fugitive emissions over the life of the Continuation Project, with the majority of the fugitive emissions coming from mining the deeper Zones 3 and 4 in Domain 3.
2. The remaining ~50% of fugitive emissions are produced in the last 11 years of the Continuation Project, primarily from mining Zones 2, 3 and 4 in Domain 1.
3. The potential to mitigate fugitive emissions is dependent on the technical and economic feasibility of each stage of a two-stage process, being:
    - Capture of coal seam gas; and
    - Conversion of captured coal seam gas into less potent forms of greenhouse gas

Capture

a. Gas pre-drainage is the only technology currently available which has potential for capturing coal seam gas.

b. The effectiveness of gas pre-drainage as the first stage of the process for mitigating fugitive emissions in open-cut mining is as yet unproven.

c. Gas drainage at HVO is constrained by reservoir characteristics and the geographical extent, complexity and dynamic state of surface mining activities.

d. Based on the Panel's analysis, if pre-drainage proves to be technically feasible it could potentially capture 30% to 50% of coal seam gas in Zones 3 and 4 in Domain 3 at HVO.

e. Assuming complete combustion of captured coal seam, 30% to 50% drainage of Zones 3 and 4 in Domain 3 would result in a reduction of ~17% to 34% CO_2-e to the atmosphere over the period from 2025 to 2040; however, that reduction will be less because of the time required to 1) develop and commission pre-drainage technologies; 2) pre-drain areas; and 3) develop and commission gas conversion technologies.

f. HVOPL's existing commitment to investigate and undertake pilot trials of gas drainage should the Continuation Project be approved is critical if fugitive emissions are to be mitigated.

g. Pre-drainage trials should be prioritised in Zones 3 and 4 in Domain 3, and not in Domain 1 as currently proposed by HVOPL.

Conversion

a. The potential to flare and/or utilise captured coal seam gas at HVO in order to reduce its CO_2-e contribution is still to be determined.

b. Should the Continuation Project be approved, there is a need for research to also be undertaken into GHG conversion at HVO and for this research to be supported by field trials in conjunction with the gas pre-drainage pilot testing.

Diesel Fuel Emissions

Avoidance of diesel fuel emissions

1. HVOPL's assessment of the current technology readiness and commercial readiness of alternative power sources to diesel for its mining operations is a fair and balanced appraisal of the current status of these options and their potential for application at HVO.
2. HVOPL is positioned to stay abreast of developments in technology to avoid diesel fuel usage and their implementation.
3. In the interim, the only option for significantly reducing diesel fuel emissions is to modify the mine plan, which is likely to result in a significant reduction in recoverable coal over the life of the Continuation Project.

Mitigation of diesel fuel emissions

1. There is little that can be done to mitigate diesel GHG emissions. They are a product of combustion for which no viable technology is available or emerging to mitigate the emissions prior to their release directly to atmosphere.
2. Marginal benefits may be obtained from using higher quality fuels and additives.

Summary Recommendations

Fugitive Gas Emissions

Gas Reservoir Assessment

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Conduct testing within 3 years to confirm the degree to which nitrogen (N_2) in gas determinations is naturally occurring in coal at HVO or is a contaminant introduced during gas determination testing, or a combination of both;
2. Subject to the outcomes of testing to confirm the source/s of N_2 in gas determinations, modify GHG emissions assessments accordingly; and
3. Within 3 years, drill and test an additional borehole approximately 400 m north west of the Hunter Valley Dyke to support the quality of *in situ* gas evaluation within the Low Gas Zone in Domain 2.

Avoidance

1. If modifications are to be made to the mine design for the purpose of avoiding GHG emissions, they should include a focus on assessing the impacts in Domain 1 of not extracting Zone 2 (low gas concentration but high volume) and/or Zone 3 (high gas concentration and significant volume) and/or Zone 4 (high gas concentration and significant volume).

Mitigation

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Undertake a desktop modelling assessment of potentially drainable coal seams to assess the effect on reducing the peak emissions. That should aid in driving the targets, the drilling/drainage method/s and the required extent of pre-drainage
2. Evaluate the gas reservoir in greater detail and design drilling/drainage options that suit the mining/geology at HVO
3. Conduct pilot trials of gas pre-drainage within Domain 3.

4. Instigate research into GHG conversion at HVO and for this research to be undertaken in conjunction with the pilot trials
5. Embed in the GHG Management Plan, 3-year action plans (updated every 3 years) for investigating, trialling and implementing all reasonable and feasible technologies:
   a. for conducting gas drainage at HVO, and
   b. for converting CH_4 contained in gas drainage streams to reduce its greenhouse potency.
6. Produce reports every three years that have been peer reviewed by a party approved in writing by the Secretary and that detail:
   a. the state of development and implementation of technologies for undertaking gas drainage at surface mines and the actions undertaken by HVOPL to evaluate and utilise these technologies
   b. the state of development and implementation of technologies for converting CH_4 contained in gas drainage streams to reduce its greenhouse potency and the efforts made by HVOPL to evaluate and utilise these technologies.

Diesel fuel emissions

Avoidance

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Undertake a review every three years and produce a report that has peer reviewed by a party approved in writing by the Secretary and that details:
   a. the international status of technologies that provide the opportunity to reduce diesel GHG emissions at HVO
   b. the status of initiatives by HVO to implement technologies for avoiding fossil fuel emissions

GLOSSARY

AEP	Annual Exceedance Probability
ACCU	Australian Carbon Credit Units
CCA	Climate Change (Net Zero Future) Act 2023
CER	Clean Energy Regulator
CH_4	Methane Gas
CO_2	Carbon Dioxide Gas
CO_2-e	CO_2 equivalent
DCCEEW	Department of Climate Change, Energy, Environment and Water
DPHI	Department of Planning, Housing and Infrastructure
EIS	Environmental Impact Statement
Gas Basis	The basis on which gas content is reported either "as received" at "sample ash" or calculated to a stated "seam ash" or presented on a dry ash free basis
GHG	Greenhouse Gas
GDE	Groundwater dependent ecosystems
GWP	Global Warming Potential which is currently estimated at 28x CH_4 for CO_2-e, up from 25 and 21 since beginning of NGER
HVO	Hunter Valley Operations
HVOPL	HV Operations Pty Ltd
IEAPM	Independent Expert Advisory Panel for Mining
LGA	Local Government Area
LGZ	Low Gas Zone
Mtpa	Million tonnes per annum
m^3/t	Common metric for gas content stating volume/mass
N_2	Nitrogen Gas
NGER	National Greenhouse and Energy Reporting
OEM	Original Equipment Manufacturers
ROM	Run of mine
SM	Safeguard Mechanism
TARP	Trigger Action Response Plans

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1.0 SCOPE OF WORKS

The NSW Department of Planning, Housing and Infrastructure (DPHI) has established the Independent Expert Advisory Panel for Mining (the Panel) to give DPHI and the Independent Planning Commission access to expert advice when assessing mining proposals under the *Environmental Planning and Assessment Act 1979*.

On 27 February 2023, HV Operations Pty Ltd (HVOPL – the Applicant) submitted an application to DPHI for the Hunter Valley Operations (HVO) Continuation Project (the Continuation Project) comprising a Development Application for the HVO North Continuation Project (SSD-11826621) and a Development Application for the HVO South Continuation Project (SSD-11826621). On 5 March 2024, DPHI requested advice from the Panel *on the scale, likelihood and consequences of the project's impacts on water resources and greenhouse gas (GHG) emissions.*

Specifically, the required Scope of Advice stated that:

The Department requests that the Panel provide advice targeting the following:

- *the scale and likelihood of potential water-related impacts and environmental consequences on key water features in the vicinity of the project area, including the Hunter River;*
- *whether the proposed water-related mitigation and monitoring measures would adequately minimise any environmental consequences on significant water features; and*
- *whether the GHG avoidance and mitigation measures proposed by the Applicant are considered to be sufficient, including the reliance on availability of carbon offsets in the future.*

The Panel should also feel free to provide any other advice it considers would assist the Department in assessing the project.

The Chair of the IEAPM (Em. Professor Jim Galvin) convened the following Panel for this purpose:

- Em. Professor Jim Galvin – Chair – Subsidence and Mining
- Em. Professor Rae Mackay – Groundwater
- Professor Neil McIntyre – Surface Water
- Dr Ray Williams – Greenhouse Gas
- Dr Tim A. Moore – Greenhouse Gas
- Em. Professor Joan Esterle – Greenhouse Gas

HVO is an established multi-pit open cut coal mining complex, consisting of two mining sites, being HVO North and HVO South. HVO is approximately 24 km north-west of Singleton in the Hunter Valley of New South Wales. It is predominately within the Singleton LGA, with a small section within the Muswellbrook LGA. The Continuation Project involves continuation of mining at both HVO North and HVO South, which are currently approved under two separate development consents, but are operated as a single mining complex. HVOPL has prepared a single EIS to cover both applications. The Continuation Project proposal seeks the continuation of each mining complex as per the following:

- Continuation of mining at the HVO North open cut coal mining complex until 2050, including extension of approved mining areas, mining of deeper coal seams and realignment of Lemington Road.

- Continuation of mining at the HVO South open cut mining complex until 2045, including a reduction in maximum extraction rate (from 20 Mtpa to 18 Mtpa).

The location of each mining complex and proposed extension area is detailed in Figure 1.

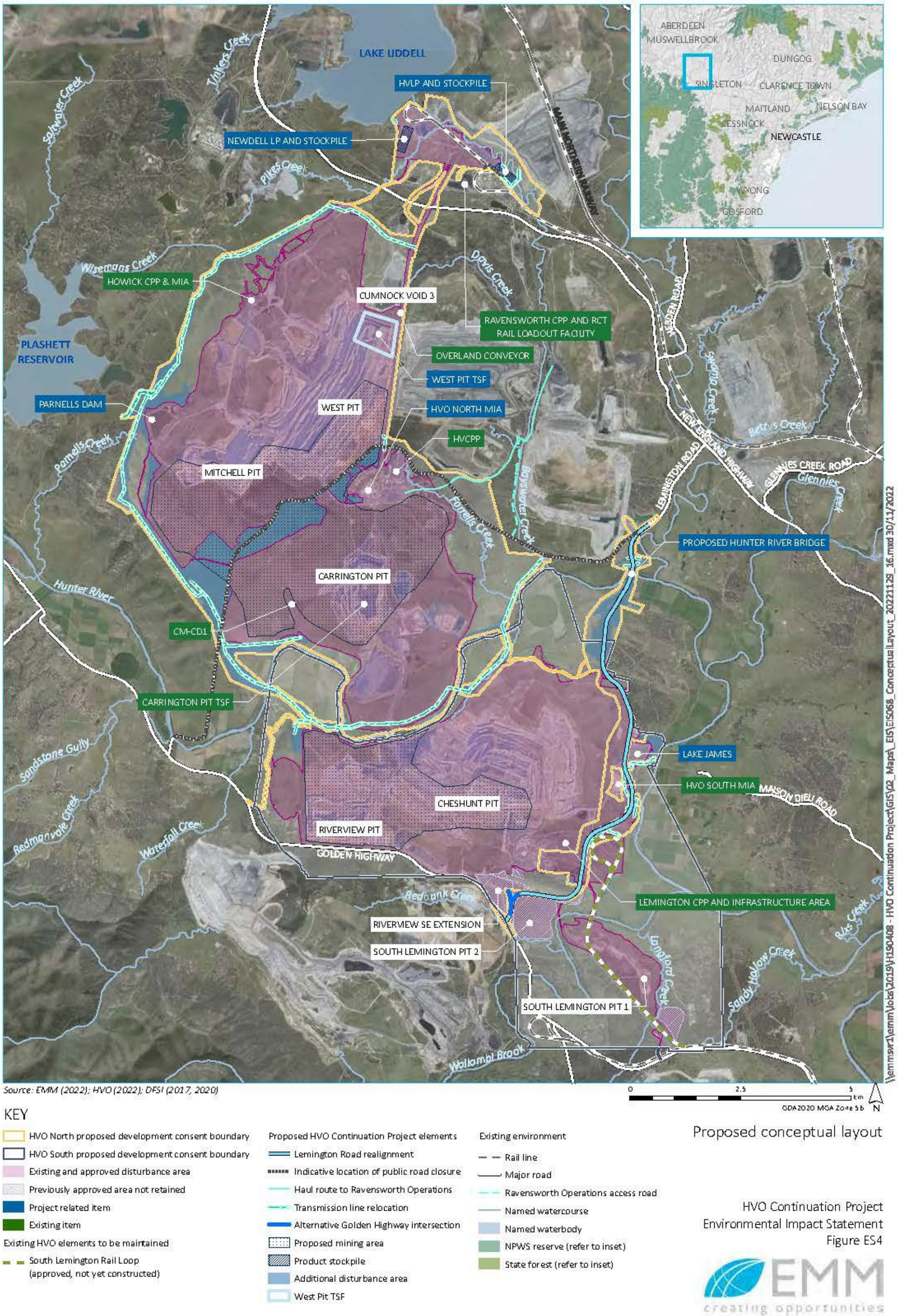

Figure 1 Existing consent boundary and proposed extension for HVO.

2.0 METHOD OF OPERATION

The Panel convened by videoconference during the preparation of its advice and was administratively supported by the Panel Secretariat staff provided by the DPHI - Major Projects Advisory.

Numerous key documents were provided through DPHI to support the Panel in preparing this Advice Report. These documents are listed in Table 1. A range of documents that the Panel has had regard to in compiling this Advice are also recorded under References.

Table 1: Key documents provided to the Panel

Document Reference	Document Name
Documents provided by DPHI	**EIS:** • HVO Continuation Project EIS - Main Report • HVO Continuation Project EIS – Appendix F Statutory Compliance Table • HVO Continuation Project EIS - Appendix H Air Quality and GHG Assessment • HVO Continuation Project EIS – Appendix K Water Assessment • HVO Continuation Project EIS – Appendix M Aquatic Ecology and Groundwater Dependent Ecosystem Assessment • HVO Continuation Project EIS – Appendix T Mine Closure and Rehabilitation Strategy **Submissions Report:** • HVO Continuation Project Submissions Report – Main Report • HVO Continuation Project Submissions Report – Appendix D Water Licencing Strategy • HVO Continuation Project Submissions Report – Appendix E Surface Water Model Review • HVO Continuation Project Submissions Report – Appendix M Coal bed Report **Amendment Report:** • HVO Continuation Project Amendment Report – Main Report • HVO Continuation Project Amendment Report – Appendix B Description of Amended Project • HVO Continuation Project Amendment Report – Appendix D Statutory Compliance Table (revised) • HVO Continuation Project Amendment Report – Appendix F GHG Emissions by Activity (revised) **Agency Advice:** • DCCEEW Water Advice on EIS • DCCEEW Water Additional Advice on EIS • DCCEEW Water Advice on Submissions Report • DCCEEW - Departments Climate and Atmospheric Science Branch – Advice on EIS

Document Reference	Document Name
Additional documentation provided by HVO	• 0723 HVO type holes gas reports • HVO NGER reports • HVO Gas Borehole Collars – July 2023 • Gas Desorption Analysis Report 09012013 • HVO Air Quality Management Plan v3.5 • HVO Overview IEAPM Presentation Final • HVO Overview IEAPM Presentation Requested Slides • IEAPM Flood Response

2.1. Site Visit

On 16 April 2024, the Panel undertook a site inspection of the HVO Mine under the guidance of HVO staff. The Panel inspected points of interest including the West Pit, the Hunter River monitoring site and the Carrington Billabong. The Panel returned the following day and split into technical groups to separately discuss water and greenhouse gas subject matter relating to the proposal.

2.2. Meetings

The Panel convened multiple times by video conference over the course of preparing its advice, with some of these meetings being discipline specific. DPHI was invited to the initial meeting to brief the Panel on the Continuation Project. Table 2 summarises the chronology of formal meetings.

Table 2: Schedule of formal meetings involving the Panel.

Meeting Date	Meeting Information
22 March 2024	Panel - DPHI Briefing
29 April 2024	Panel Meeting - GHG
9 May 2024	Panel Meeting - GHG
19 June 2024	Panel Meeting – Groundwater and Subsurface Water
20 June 2024	Panel Meeting – GHG

3.0 SURFACE AND GROUNDWATER

3.1. BASIS OF THIS ADVICE

The DPHI requested the IEAPM to address the following with respect to the Continuation Project:

- *the scale and likelihood of potential water-related impacts and environmental consequences on key water features in the vicinity of the Continuation Project area, including the Hunter River.*
- *whether the proposed water-related mitigation and monitoring measures would adequately minimise any environmental consequences on significant water features.*

The Request for Advice noted that: *'HVO North and HVO South are separated by the Hunter River. The protection of Hunter River and the Hunter River alluvium has been a key issue for other projects in the Hunter Valley. Given the proposed proximity of mining to the Hunter River, the Department considers water-related impacts, including potential impacts on groundwater dependent ecosystems, are a key technical issue for the Continuation Project, including whether suitable measures have been proposed to proactively manage these impacts.'*

The Continuation Project proposes *'continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 2025 and 2030 respectively, to the end of 2050 at HVO North and the end of 2045 at HVO South. The continuation of mining across the HVO Complex will optimise resource recovery from the existing operation, predominantly by extracting coal from deeper seams at HVO North by mining through previously mined areas and within the existing mining tenements. At HVO South, an extension to the life of the mine is proposed to facilitate improved mining sequence outcomes.'* (EMM, 2022a pp. P, ES.1).

While mining is planned to go deeper and will connect previous pit areas through the removal of adjoining pit walls, only limited changes are expected to the lateral extent of the Continuation Project's development consent area and the overall footprint of the mine area. Indeed, for HVO South removal of mining of the previously approved southern pits, namely River View South East Extension, South Lemington Pit 1 and South Lemington Pit 2 will reduce the planned mining footprint from its previously approved extent.

Given the planned changes under the Continuation Project, the current advice addresses the additional impacts to key water features arising from the Continuation Project beyond those already accepted under the existing mining approvals.

3.2. SURFACE WATER

3.2.1.Context

The surface water context is described in Section 2 of Surface Water Impact Assessment (Engeny 2022), which is Appendix B of the Water Assessment (EMM 2022b), and in the Briefing to the Panel provided by the DPHI. Key points of context with respect to the DPHI Request for Advice are:

- The Continuation Project lies in a highly developed part of the catchment, with the HVO North and HVO South areas enveloping the Hunter River, plus several operational coal mines in the vicinity and upstream in the catchment. The primary surface watercourses potentially impacted by the Continuation Project are the Hunter River and its tributary, Wollombi Brook. The Hunter River has an average annual flow of 320,400 ML/yr (10.2 m^3/s) with annual average of 26 zero or near-zero flow days at the Maison Dieu gauge. The Hunter River hydrology is impacted by mining, power generation and agriculture, and is regulated by the Glenbawn Dam. Wollombi Brook has an average flow of 174,500 ML/yr (5.5 m^3/s) and 52 zero or near-zero flow days per year. It is a largely natural catchment dominated by forest and bushland, with some private residences. In addition to these two watercourses, ten small tributaries of the Hunter River have been considered by Engeny (2022) as potentially impacted by the Continuation Project. The largest of these is Bayswater Creek with an estimated average flow of 1,480 ML/yr (0.047 m^3/s). The Hunter River is strongly connected to the Hunter River alluvial aquifer, so that any depressurisation or diversion of flow from the alluvial aquifer will almost immediately reduce groundwater flow to or draw water from the river.

- The Hunter River water quality is described by DCCEEW (2024) as "poor" both upstream and downstream of the HVO mine, and "moderate" in Wollombi Brook. This is due to discharges of naturally high salinity water from Permian units into the river, and also due to mining, power generation and agriculture (DCCEEW 2024). The salinities of all water sources within the mine boundary are considerably worse than the Hunter River (e.g. Fig 2.28 of Engeny 2022). The Hunter River Salinity Trading Scheme (HRSTS) regulates discharges of saline water from mines and power stations, limiting total loads of salt, and requiring discharges to occur when high dilution will be achieved. All sites sampled in the aquatic macroinvertebrate survey indicated moderate to severe pollution (Section 6.2 of EMM 2022c).
- Minor changes are proposed to the HVO South mining area and its surface water catchments, with a net reduction in the total disturbed area of approximately 118 Ha to 3,242 Ha (Table 4.2 of EMM 2022a). Changes include a dam enlargement, final landform modifications and new flood levees. At HVO North, a net increase in total disturbed area of 926 Ha is proposed (Table 4.1 of EIS), giving a total disturbed area of 5,891 Ha, less than 1% of the upstream Hunter River catchment area. Proposed disturbances to the Hunter River catchment include extension of the mining area, extension to stockpiles, the Lemington Road diversion, new and enlarged dams within the Continuation Project area, the new Carrington West Wing levee and changes to the final landform including reducing the number of final voids/lakes from three to one.
- No changes to existing licenses or approvals for mine water discharge under the HRSTS are envisaged. Environmental Protection License (EPL 640) conditions for water discharges are expected to be modified if the Continuation Project is approved. The Executive Summary of the Water Assessment (EMM 2022b, ES4.4) notes that HVO has the necessary licenses for predicted water take (licenses are listed in T1-1 of Engeny 2022).

3.2.2. Assessment of Potential Surface Water Impacts

Surface water impacts and their proposed management are summarised in Table 1 of the Surface Water Impact Assessment (Engeny, 2022). Impact types considered in this advice are:

- *Erosion and sediment control during mining operations*.
- *Loss of downstream flows due to baseflow loss and leakage*.
- *Loss of downstream flows due to interception of runoff and extractions from water courses during mining operations*.
- *Loss of downstream flows due to interception of runoff and groundwater post-closure*.
- *Flooding impacts on properties, mine operations and stability of the channel.*
- *Water overflows and discharges during operations.*
- *Water overflows and discharges from the final landform and void.*
- *Cumulative impacts.*

Erosion and sediment control during mining operations. Sediment runoff from the mining area during construction and operations can be managed by standard good practice including appropriate design of sediment basins and a Sediment and Erosion Control Plan, as is proposed. This is not commented on further.

Loss of downstream flows due to baseflow loss and leakage. It is expected that flow in the Hunter River and other watercourses will be impacted due to increased leakage to the mine void and the Permian strata and due to reduced inflows from groundwater (i.e. reduced baseflow). Table D-16 of the Groundwater Impact Assessment (AGE, 2022a) shows the modelled maximum loss of flow (leakage plus baseflow) due to the Continuation Project from the Hunter Regulated River is predicted to be approximately 584 ML/year in the year 2035, reducing to 567 ML/year by 2151. For Wollombi Brook water source the losses in the same years are 21 ML/year and 27 ML/year. This is relative to the average flows of 320,400 ML/year (Hunter River at the Maison Dieu gauge) and 174,500 ML/yr (Wollombi Brook at the Warkworth gauge). The Water Assessment (EMM 2022b) (Section 6.8.1) implies that the predicted maximum cumulative loss (due to all mining since 2009) in the Hunter River is 200 ML/yr, but that value is not referred to in AGE (AGE, 2022a). Hence there appears to be some ambiguity about the exact volume of predicted losses. Nevertheless, the Panel considers these predicted flow losses to be small compared to the average flows. Losses from the Hunter River will probably not be detectable by the flow gauges due to accuracy limitations of the gauges. As proposed in Section 11.2 of the AGE (2022a), losses should be assessed by nested groundwater monitoring bores and groundwater modelling (see comments below on monitoring), in addition to considering gauged flow data (as in the existing Water Management Plan, HVO 2018).

Loss of downstream flows due to interception of runoff and extractions from water courses during operations. Interception of runoff is licensed, with some water stores exempt from a license requirement as described in Section 11.3 of EMM (2022b). The Executive Summary of the Water Assessment (EMM 2022b, ES4.4) notes that HVO has the necessary licenses for predicted water take (licenses are listed in T1-1 Engeny 2022). Section 11.3.1 of EMM (2022b) indicates that in the Hunter Unregulated River Water Sources trading will be required to meet predicted dry weather requirements and that exemptions or new licenses will be applied for, and that post-closure licensing will later be discussed with the NSW Government. The response to supplementary advice (EMM 2024) notes that further, relatively minor entitlements will need to be obtained on the open market for groundwater take from Jerrys Water Source (operational period) and Hunter Regulated River Alluvial Water Source (post-closure period). The Panel notes these issues but has not reviewed the licensing situation in detail.

Loss of downstream flows due to interception of runoff post-closure. The Panel notes that evaporative losses of 1,200-1,300 ML/year are expected from the final void lakes after they reach equilibrium (or approximately 4,100ML/year from T2.2 of EMM 2024). These values include direct precipitation, surface water and groundwater diverted to the final void lake and may be considered as an approximate estimate of the annual average net loss of flow from the catchment. These values may increase if seepage from the final landform is diverted to the void to avoid contamination of the Hunter River (as considered in Section 13.1 of EMM 2022a) The Panel does not consider the post-closure loss of flow will have a material impact if adequate licenses can be obtained.

Flooding impacts on properties, mine operations and stability of channel banks. Under the Continuation Project, flood risk to mine infrastructure is reported to reduce compared to baseline (Table 6-2 of Engeny 2022), with the exception of an increased likelihood of a flood overflow into the North Pit during operations, although this is under only the most extreme modelled flood event (< 0.1% Annual Exceedance Probability). Assuming appropriate design and construction of the proposed levees and landforms, monitoring and emergency contingencies, the Panel does not consider this to be a concern. The Continuation Project, including the construction of the Carrington West Wing levee, the road diversion, and the landforms to the west of the Mitchell Pit, will alter the flood plain. Thirteen properties are modelled to have increased flood inundation under the 1% Annual Exceedance Probability (AEP) flood event, on average an increase in flooded area (all of which is grazing and cropping) of 0.15% of the total property area. Changes in duration of flooding, results for other AEPs, results at the worst-affected properties, or landowner consultation outcomes are not commented on in Engeny (2022), which concludes negligible impact. The resulting flood maps do not extend to Singleton for reasons expressed in Section 3.5 of the Flood Assessment Technical Report (Appendix C of Engeny 2022). The Panel agrees that the maps should not include Singleton because the model is not designed for this purpose; in particular, the model results at Singleton are sensitive to the model's assumed downstream boundary condition. The flood modelling has been peer reviewed by BMT and feedback has been acted on (Appendix F of Engeny 2022). The Panel notes that localised increases in flow velocity are expected with potential consequences for erosion, and that these will need to be addressed during detailed design, and integrity of the levees will need to be monitored, as is proposed. Engeny (2022) does not include sensitivity analysis to quantify uncertainty due to assumed roughness coefficients and energy loss coefficients, which would usually be considered good practice. Further information provided to the Panel (Engeny 2024) reported that sensitivity analysis had been undertaken using a previous (2019) version of the model, including using a conservative increase in Manning's n values. The further information also noted that the sensitivity assessment had been presented to the Peer Reviewer and no further sensitivity assessment was requested.

Water overflows and discharges during operations. Discharges of contaminated water are expected at specified discharge points as shown in Fig. 3.21 to 3.24 of Engeny (2022). The SILO data used for stochastic water balance modelling is only up to 2012. This should be updated. Referring to the total site water inventory in Fig. 4.2 of Engeny (2022), since the time frame is up to 2050, it is quite likely the 95% upper bound of site storage will be exceeded at least once. Therefore, by itself Fig. 4.2 does not give confidence that there will be no unlicensed discharges. If there are any modelled exceedances of the total storage capacity then their modelled volumes, qualities and frequency should be reported. The "time-shifting" method of resampling historical rainfall, although common practice in the mining industry, to a large extent repeats the same rainfall inputs multiple times and so does not provide robust confidence limits. More robust confidence limits on stored and discharged water volumes would, for future assessments, be provided by use of a stochastic rainfall model.

Impacts from predicted water overflows and discharges are proposed to be managed by the HRSTS and a modified EPL. As required under the existing EPL, monitoring of contaminant concentration and volumes will be required (see further comments below on monitoring), as well as TARPs for discharge management.

Discharges from the final landform and void. There may be water quality impacts due to runoff or seepage of contaminated water from waste rock dumps and tailings storages. Figure 9.3 of the Groundwater Impact Assessment shows that post-mining groundwater flows are towards the void. In contrast much of the surface runoff from the rehabilitated waste rock dumps is shown to be directed to the Hunter River (Figure 4.1 of the Mine Closure and Rehabilitation Strategy (EMM, 2022d)). Under that plan, groundwater expressing to the surface from waste rock dumps would be directed to the Hunter River. This is acknowledged in Section 13.1 of EMM (EMM, 2022b), where it is proposed that interception channels may be required to divert seepage into the void. The Panel considers that long-term, post-closure water quality impacts are a concern, which should be managed by appropriate closure planning, landform design, progressive rehabilitation, monitoring and adaptive management, potentially including diversion channels and other water quality contingencies. A sufficient water balance analysis has been conducted for the final voids, as well as salt balances and a geochemistry model. The Panel agrees that there is negligible risk of spills to the surface from the final void.

Cumulative impacts. Cumulative impacts on water resources are required to be assessed by the SEARs. T6.6 of EMM (2022b) declines to assess cumulative impacts on water quality. The Panel agrees with this approach, since the HRSTS is an overarching framework for managing cumulative impacts of controlled discharges on Hunter River water quality, supplemented by the EPL conditions. Overflows during extreme wet weather may occur simultaneously at multiple mines creating cumulative impacts, however this would be during high flows in the Hunter River with high dilution. Similarly, for water resources, the Water Sharing Plan and licensing system negate the need for a cumulative impacts assessment for this project. T6.6 of EMM (EMM, 2022b) also declines to assess cumulative flood risks with the explanation '*No change to Hunter River flood characteristics in the area of interest as a result of cumulative impacts identified*'. This statement is not well justified considering that the baseline for the flood modelling included all impacts previous to the proposed Continuation Project, i.e. cumulative impacts were not assessed. Nevertheless, due to the long history of mining and other development, it is likely that a baseline for a cumulative impacts assessment would necessarily be arbitrary and not help with the Continuation Project assessment, hence the Panel agrees with the approach. T6.6 recognises the need for a cumulative impacts assessment of baseflow impacts and river leakage. This is done using the groundwater model, which the Panel agrees is the best practicable approach. The baseline groundwater model represents the scenario that mining in the region did not proceed beyond 2009 (when the Hunter Unregulated Water Sharing Plan commenced). Results for water resources (Section 6.8.1 of

Engeny 2022) indicate that cumulative water resources impacts due to the Continuation Project will likely be negligible and manageable by the Water Sharing Plan and licensing systems.

3.3. GROUNDWATER

3.3.1. Context

The remining of HVO North through the Carrington Pit will impact the Hunter River and the alluvial aquifer unless suitable mitigation action is taken. The Continuation Project proposes to mitigate the impact by introducing a new barrier wall to the north of the Hunter River (the Carrington West Wing barrier wall). The new wall will prevent significant lateral groundwater flows from the aquifer into Carrington Pit. Previous barrier walls have been installed to the east of the planned new wall both to prevent excess outflow to the pits from the alluvium during and post mining and to prevent long-term poor-quality groundwater flows towards the alluvium from the spoil heaps post mining. The final void for the remined pit will lie to the east of the new barrier wall and to the north of the adjacent old barrier wall. The long-term integrity of both the new and old walls is important for preventing significant alluvial groundwater flows to the final void. It is not expected that groundwater flows post mining will reverse through the old barrier wall over the long term but given the planned height of the backfilled area north of the new barrier wall poor quality water seepage via interflow and surface flows from the mined area to the alluvium are potentially possible. During mining a flood protection levee is proposed to lie roughly on the line of the new barrier wall to prevent flood losses to the pit. In the long term the levee will not be needed and stream flows from the rehabilitated landform will discharge to the Hunter River.

The remining of HVO South will not intersect the Hunter River alluvial aquifer so no mitigation measures are proposed for the alluvial aquifer south of the river. Flood protection levees are planned to the south of the river to prevent overflows to the mined area in the event of extreme flooding.

As both the final voids for the North and South mining areas will lie in proximity to the Hunter River and the alluvial aquifer, groundwater losses through the base of the alluvial aquifer to the final voids are a potential issue. Understanding the plans for monitoring the impacts of groundwater losses from the aquifer is consequently important.

The Wollombi brook lies to the south of HVO South. Three of the four GDEs identified by the Continuation Project lie in the vicinity of the brook. However, impacts on the brook and adjacent shallow groundwater resources are expected to be less than those previously approved with the planned reduction in mining extent at the southern limit of HVO South.

3.3.2. Groundwater Modelling

The current groundwater model used for the Continuation Project draws on an extensive program of modelling for the region since 2011. Progressive updating of the regional groundwater modelling has occurred since 2011 with refinements being made both to the representations of hydrogeological features included in the model and to the procedures used for calibration of both the historical steady conditions pre-mining and the transient period since the commencement of mining. In the most recent developments, the stated changes in the groundwater modelling technical report include (AGE, 2022b):

- a reduced extent of the model, now centred on the HVO operations to limit the computational burden while retaining the impacts of adjacent mining through appropriate boundary conditions.
- updated HVO mining sequences.
- revisions to the extent of the Quaternary Alluvium along the Hunter River.
- revisions to pit lake areas and adjusted river depths along the Hunter River.
- controlled water levels representing ongoing dewatering of the Lemington underground mine and,
- recalibration of both steady state and transient periods using pilot points.

Other changes were apparently made to bring together previous model data sets for different parts of the model area for computational and consistency reasons.

The model is built using the well-tested and verified USGS groundwater modelling code, MODFLOW-USG.

AGE (AGE, 2022b) provides the technical details for the development of the model including parameter identification, calibration, and uncertainty and sensitivity analysis. Comparison of the model results with the available field observations provides evidence that the model is fit for the purposes of assessing impacts of the mining on the quaternary alluvium and associated GDEs. The technical report specifically explores aspects of the model development and results that are relevant to the groundwater issues explored in the next section of this advice. For the purposes of the current advice the groundwater model results provide useful indicators of potential changes to river baseflows, vertical losses from the alluvial aquifer to the underlying Permian formations, the likelihood of flows to the alluvium from the spoil following mining, and potential impacts on GDEs connected with the quaternary alluvium. However, the groundwater modelling reported in the Continuation Project documentation is based on the now superseded proposal to construct the Carrington West Wing barrier wall after mining and prior to emplacement of spoil. The revised proposal to construct the barrier wall prior to the mine encroaching within 100m of the limit of the paleo alluvial channel can be expected to reduce the impacts on the alluvium compared to the original plan. The Panel does not consider that further modelling is necessary for it to assess the revised plans from the perspective of impacts.

However, the groundwater model has not been used to develop trigger action response plans to support future monitoring objectives including the assessment of the performance of the barrier wall and the overall reliability of the groundwater level predictions for the sustainability of the GDEs. For these reasons, further groundwater modelling using the updated amendments to the proposed HVO Continuation Project is warranted.

While the Panel does not recommend further groundwater modelling is undertaken prior to determination of the Continuation Project, the Panel does support the ongoing improvement of the modelling in connection with future monitoring and assessment of the Continuation Project impacts. For future groundwater modelling exercises, it would be appropriate for adjustments to be made to the presentation of the groundwater model results to support their interpretation. The following general adjustments are suggested.

1. A detailed local water balance be provided for the quaternary alluvium between HVO North and South mining areas approximately between Easting 307215 and Easting 313215 to provide information on both the lateral and vertical flows within the alluvium. This will provide a better understanding of the significance of downward flows to the Permian formations below the alluvium between the mining areas as well as improving understanding of the local impacts to river-aquifer exchanges.
2. That presentation of calibration hydrographs is supported by grouping hydrographs by location and providing maps showing the areal location and depth of the observations. While many hydrographs can be linked to location from the Borehole Monitoring network details in Table B.1 (AGE 2022c), others cannot be found and are unlocated. The inability to connect the data spatially makes interpretation of the quality of the model fit difficult. This will become more important if the recommendations for monitoring presented towards the end of the current advice are adopted.
3. Since calibration is based on varying both model inflows (groundwater recharge) and hydraulic properties, it is appropriate to compare the relationship between the *a priori* range of modelled inflows adopted for the different recharge zones with the final calibrated model inflows. Allowing both model inflows and hydraulic properties to be variable allows for a potentially wide range of model fits (i.e. a large degree of freedom in the model fitting) with possible implications for interpretation of model sensitivity and output. As an example, the seemingly low recharge rate identified by the model for the spoil areas in comparison to the alluvium recharge rate has

implications both for the interpretation of final void lake levels as well as for the potential for low quality groundwater to flow from the spoil to the alluvium in the long term.

Model fitting is assessed through statistical methods including plotting the observed versus the modelled hydraulic heads for the whole model. For the HVO model the hydrogeological characteristics of the quaternary alluvium are rather different to the characteristics of the underlying Permian formations. Even though plots of observed versus modelled heads for the different formations are presented on the same graphical range to indicate the performance of the model for each formation the statistical quality of the model for the individual formations is not shown (Figures D17 and D18, (AGE, 2022b)). Given that the objectives of the modelling are strongly directed towards the impacts of mining on the quaternary alluvium and related GDEs, it would be valuable to confirm that the local model fit for this formation is appropriate for the stated objectives.

Further adjustments tailored to specific questions are addressed under the assessment of potential groundwater impacts below.

3.3.3. Assessment of Potential Groundwater Impacts

The key groundwater features for assessment by the Panel are:

- *Integrity and monitoring of the new Carrington West Wing barrier wall.*
- *Uncertainty in the estimation of the downward losses from the alluvial aquifer to the mine voids.*
- *Potential impacts to GDEs along the Hunter River, and*
- *Likely risks of poor-quality groundwater seeping into the alluvial aquifer from the final landform for HVO North.*

Evaluation of the groundwater model results, and the model's sensitivity underpins these four areas of assessment.

Carrington West Wing barrier wall. Groundwater modelling illustrates clearly that a significant impact on the groundwater levels in the quaternary alluvium of the Hunter River can be expected without the construction of a barrier wall to minimise lateral flow from the alluvium towards the pit both during and after mining.

The barrier wall amendment proposed by HVO in consultation with DCCEEW Water (EMM, 2023a) requires installation of the barrier wall prior to mining encroaching within 100m of the limit of the remnant paleo channel. This wall can be expected to mitigate mining impacts on the alluvial groundwater. The predicted maximum drawdowns in the vicinity of the wall presented for the Project as shown in Figure 12.6 of the HVO Continuation Project Environmental Impact Statement (EMM, 2022a) should be much lower for the amended proposal for wall installation.

The amended installation is expected to be undertaken though the construction of a narrow *in situ* slurry cut-off wall excavated to two metres below the base of either the upper permeable alluvial aquifer or the base of sub cropping coal seams. This is a different construction method to that originally intended. The original construction method would have built the barrier wall on the exposed surface of the Permian formation on the upper bench of the mine prior to backfilling with spoil. The alluvium would have been permitted to laterally drain to the pit prior to barrier wall installation.

The amended installation should be as stable and as permanent as the original wall proposal. However, given the installation method, confirmation of the integrity of the wall cannot be fully determined during construction and must be confirmed subsequently through monitoring.

As part of preparations for the installation of the wall a trigger, action, response plan (TARP) is planned. To be effective this plan would need to identify what constitutes a failure of the barrier wall and what monitoring will allow a failure to be identified. As the wall is expected to be over one kilometre long, the likelihood is that any failure will be localised and not identifiable from regional water level measurements.

The Panel recommends that, prior to finalising the TARP and monitoring plan, groundwater modelling is undertaken, first, to assess what constitutes an unacceptable wall failure in terms of groundwater impacts and, second, to assess options for groundwater monitoring to identify such a wall failure. In relation to the latter, the Panel recommends that non-invasive methods of monitoring such as surface electrical resistivity surveys are investigated as an alternative to, or an adjunct to, groundwater monitoring using nested piezometers.

Downward flows from the Alluvium to the Permian. Groundwater modelling results indicate that the reduction in baseflows to and increases in leakage from the Hunter River are almost entirely due to downward flow into the Permian caused by mining. However, it is unclear whether the data on baseflow reductions presented in Table D.16 of AGE (AGE, 2022b) are baseflow changes due to the Continuation Project relative to the existing mining approvals or whether these are total reductions relative to pre-mining conditions. Clarification of the baseline for the changes presented is required. However, as noted in the surface water advice, the predicted changes to baseflow and leakage are small relative to the surface flows of the Hunter River and are unlikely to be significant from this standpoint, irrespective of the baseline. The primary effect will be a general change to the water table level in the alluvium. While this is expected to be small it should nevertheless be presented appropriately to inform the consideration of impacts to GDEs linked to the alluvium. In AGE (AGE, 2022a) on page 85 it is stated that *"the groundwater table in the alluvium is currently disconnected from the groundwater in the shallow coal seams which are already depressurised by historical mining."* It is unclear what the term disconnected means in this context as reduced baseflow to the river due to downward seepage to the coal seams confirms a connection. Nevertheless, the statement that the shallow coal seams are already depressurised by historical mining approvals is relevant as it reinforces the need to be clear on both the cumulative impacts from all historical mining as well as the additional impacts predicted for the Continuation Project.

The groundwater modelling report does not provide detailed information on the distribution of baseflow reductions along the river or much detail on the uncertainty of the estimate of vertical losses to the Permian. Figure 8.3 of AGE (AGE, 2022a) shows saturated thickness of the alluvium for four time periods for the baseline model. Apart from the observation that the scale of the figures makes it very difficult to assess meaningfully the changes in the saturated thickness over the life of mining, it is not clear why saturated thickness has been adopted as an appropriate measure for determining impact on GDEs given the strong connection between the river and the alluvium. The hydraulic connection with the river is not likely to admit drying out of the alluvium. In this case, saturated thickness seems unlikely to be the only or primary control on the functioning of a GDE. The Panel recommends that as part of future assessments of the potential impacts to GDEs that each of the physical and environmental mechanisms governing the health of a GDE are identified and their significance for GDE health described. From this basis the groundwater modelling results can then be used to explore and better explain the relevant GDE impacts.

Model uncertainty analysis has been undertaken to investigate the likelihood of an exceedance of 2 m drawdown in the alluvium. While 2 m drawdown is a recognised threshold for assessing water resources impacts, it is not clear that it is the most appropriate measure for the uncertainty analysis. A more appropriate measure would be the likelihood of water table level changes anticipated to impact the known GDEs. The sensitivity of plant species within the GDEs to groundwater level declines should be assessed and appropriate thresholds for water level decline established that are specific to each GDE.

From a water resource perspective, the seepage to the Permian is unlikely to be of concern based on the available evidence. It appears that appropriate consideration has been taken of the requirement for water licences to cover for the additional take arising from the mining. As direct measurements of groundwater take by the mines are impractical the estimates of water take determined from the groundwater modelling are considered by the Panel to be appropriate for the purposes of licensing.

Potential impacts to GDEs. GDEs in the Continuation Project area are identified to be:

- Carrington billabong adjacent to the Hunter River;
- River red gums along the Hunter River and Wollombi Brook;

- Stygofauna in the alluvium along the Hunter River, Bowmans Creek, Glennies Creek and Wollombi Brook;
- River Oak Grassy Riparian Woodland of the Hunter River riparian zone; and
- Warkworth Sands Woodland.

Impacts of the Continuation Project on the Wollombi Brook, Bowmans Creek, and Glennies Creek are predicted to be less for the Continuation Project than for the previously approved mining. For this reason, the GDEs along these water courses are not considered in this advice.

Groundwater levels adjacent to the Hunter River are strongly controlled by river levels. Since mining is highly unlikely to impact river levels measurably no further consideration of the River Oak Grassy Riparian Woodland is required by the Panel from a water availability perspective.

Further, as the Warkworth Sands groundwater is perched it is not expected to be impacted by mining and therefore mining impacts on the Warkworth Sands Woodland can be assumed to be negligible.

The remaining GDEs are of interest for the Panel, namely:

- Carrington Billabong adjacent to the Hunter River.
- River red gums along the Hunter River.
- Stygofauna in the alluvium along the Hunter River.

EMM (EMM, 2022c) identifies the Stygofauna to have high ecological value but the River Red Gums including Carrington Billabong to be highly disturbed and to have moderate ecological value. Rehabilitation and Restoration plans for the Red Gums are in place.

The groundwater modelling suggests that impacts to the Red Gum GDEs from the Continuation Project should be small. However, as noted in the previous section, the groundwater modelling uncertainty analysis completed for the Continuation Project does not address the likelihood of lower groundwater tables impacting these GDEs for other plant species. While it seems unlikely on the available evidence that impacts to the GDEs will be significant based on the groundwater modelling base case, it would still be beneficial for the uncertainty analysis to be extended as part of future modelling updates to address the potential for greater impacts to the GDEs to quantify the risks.

Impacts on Stygofauna from the Continuation Project are considered unlikely given the low likelihood of dewatering of the alluvium in the vicinity of the Continuation Project.

Future risks of low-quality groundwater flows from the mine spoil to the alluvium. The risks of low-quality groundwater flows into the alluvium are controlled by the predicted long-term height of the water table in the spoil adjacent to the alluvium. As part of the groundwater modelling, sensitivity studies were undertaken for the Continuation Project to assess the likelihood of raised water tables in the spoil due to uncertainties in the spoil hydraulic property estimates. The sensitivity studies examined possible reductions in both the hydraulic properties of the spoil and increases in the spoil recharge rates. A factor of ten reduction in horizontal hydraulic conductivity but only a 30% reduction in vertical hydraulic conductivity were introduced to the model. An increase of a factor of five in rainfall recharge rate was also adopted. The magnitudes for recharge reported appear to be a factor of 100 too low and are assumed to be a presentational error in the selection of the units in the report. Nevertheless, it is not clear on what basis the factors for hydraulic conductivity were chosen. The result of applying the chosen factors implies that there is low likelihood of flow from the spoil towards the alluvium. Unfortunately, the lack of justification for the adopted reduction factors, in particular the very small change for vertical hydraulic conductivity, diminishes the Panel's confidence in the result.

In addition to understanding the implications to changes to bulk groundwater flows in the spoil, it would also be beneficial to examine the risks of shallow interflow in the spoil leading to low quality discharges to adjacent surface water courses as discussed in the assessment of surface water impacts.

The presence of the barrier walls should mitigate the risks of flow from the spoil to the alluvium unless surface and near-surface spoil flows arise. However, to confirm that surface flows from the spoil are unlikely to receive spoil groundwater discharges the sensitivity studies should be reviewed to ensure that the sensitivity factors are well justified and that the lower limits for the spoil hydraulic properties and the upper limits for recharge to the spoil that could lead to surface water seepage are determined for comparison. Further assessment of the sensitivity of spoil groundwater discharges to spoil properties is recommended as part of future modelling updates.

3.3.4. Monitoring

The Surface Water monitoring figure (Fig 2-26) provided in Engeny report (Engeny, 2022) does not clearly show the monitoring locations, and the Panel has instead considered Figure 1 and Table 1 of the available Water Management Plan (HVO 2018), Appendix C. Dams and major rivers are sampled quarterly with measurements of basic water quality parameters (electrical conductivity, total dissolved solids, total suspended solids and pH), plus annual sampling (proposed to be increased to 6-monthly under the Continuation Project) with measurement of a full suite of parameters. Ephemeral creeks are sampled after large rainfall events at maximum twice per quarter.

The Panel has not noted any issues with the frequencies, parameters or locations for surface water quality monitoring during current mine operations. HVO (2018) provides detail of surface water quality baselines and monitoring; however, no details are provided on flow measurements. The updated Water Management Plan should demonstrate sufficient monitoring to determine flow impacts (see previous comments regarding methods of monitoring flow impacts). This should include continuous water level measurements that will allow the pressure gradient from the Hunter River to alluvial groundwater to be accurately measured.

The Panel recommends that groundwater monitoring is structured to provide better information on the connectivity of the Hunter River with the Hunter River alluvium through the installation of piezometer transects north and south of the river in the vicinity of the Carrington West Wing barrier wall that are aligned with continuous river water level monitoring locations. Piezometers should be fitted with continuous recording devices that can permit logging at hourly or shorter intervals to assess the dynamics of the response to both rainfall recharge and river stage.

Depending on the recommended analysis of risks of failure of the Carrington West Wing barrier wall to prepare the TARP for the wall, additional groundwater monitoring is also recommended in the vicinity of the wall to monitor for unacceptable flows through or beneath the wall.

The baseline water quality in the Hunter River is moderate-to-poor and variability of the measured parameters is high (see figures in Appendix F of (Engeny, 2022). It is therefore appropriate, as included in HVO (2018), that professional judgement of trends is considered as well as measured deviations from the mean. Additionally, sufficient monitoring of volume and quality at discharge points is important, as well as performance indicators and measures for volume and quality at discharge points. Continuous monitoring of flow, EC, pH and total suspended solids (turbidity) at identified discharge and overflow points is recommended as well as the existing grab samples.

The adequacy of monitoring and mitigation measures may depend on the detail of the updated Water Management Plan, and it is recommended that this is independently reviewed. Additional monitoring will be required to understand the post-closure water balance (including *in situ* measurements of evaporation) and contamination impacts, to identify and monitor seepage points and other discharges. This monitoring should evolve with and inform progressive rehabilitation. It is recommended that a water monitoring plan is developed as part of a progressive rehabilitation and closure plan.

3.3.5.Conclusions

The Panel concludes that:

1. In relation to water-related impacts, there is no reason why the Continuation Project should not be conditionally approved.

2. *Erosion and sediment control during mining operations* is manageable by a suitable Erosion and Sediment Control Plan as proposed by HVOPL.

3. *Loss of downstream flows due to baseflow loss and leakage* as predicted is not of concern. Refinements to groundwater and surface water monitoring would assist future assessment of river-aquifer exchanges.

4. *Loss of downstream flows due to interception of runoff and extractions from water courses during mining operations*; and *Loss of downstream flows due to interception of runoff and groundwater post-closure*. Assuming licensing issues are successfully resolved, these are not impacts of concern.

5. *Flooding impacts on properties, mine operations and stability of the channel*. There are risks associated with erosion and performance of levees, which are manageable by good design and performance monitoring. The flood modelling undertaken for the Project has been peer reviewed and appears to be appropriate for the purpose of the Project.

6. *Impacts to Groundwater Dependent Ecosystems (GDEs)* are not expected to be significant. However, the long-term monitoring and assessment of risks to the GDEs would benefit from: Updates to the assessment of the sensitivity of plant species within the Hunter River GDEs to groundwater level declines; appropriate thresholds for water level decline that are specific to each GDE; and extended groundwater modelling uncertainty analyses.

7. *Water overflows and discharges during operations* are manageable under the Hunter River Salinity Trading Scheme and Environmental Protection Licence. The existing Water Management Plan does not clearly specify how both volume and quality of discharges and overflows are monitored. The presentation of predicted discharges and overflows could be improved by showing the full range of predicted site water storage values; and use of a stochastic rainfall model would provide more robust confidence limits on stored and discharged water volumes.

8. *Water overflows and discharges from the final landform* are a potential source of contamination that will need detailed consideration in closure and rehabilitation planning. Further work is needed to better define the long-term risks of contamination to the alluvial aquifer and Hunter River from leakages from the spoil. Clarification of the applicable spoil properties governing recharge, interflow and deep percolation, supported as necessary by additional field and laboratory testing of spoil properties is required. Future updating of the groundwater model and the uncertainty analysis with the updated spoil properties would allow the risks of alluvial and surface water contamination to be addressed.

9. *Carrington West Wing barrier wall installation* prior to mining encroaching the paleo-alluvial channel is expected to be beneficial for mitigating drawdown in the Hunter River alluvium. Appropriate risk assessment and related modelling is required to support development of the planned Trigger Action Response Plan (TARP) for the wall and the associated monitoring design.

10. *Cumulative impacts* have been given little attention in the surface water assessments. The Panel agrees with the approach because the controls on extractions and discharges are designed to

manage cumulative impacts; and because the history of land use in this area makes it difficult to define a useful baseline.

11. *Surface and groundwater monitoring.* Extending the monitoring that is currently in place, including continuous water level measurements that allow variations in the pressure gradient from the Hunter River to the alluvial groundwater to be accurately measured, would provide valuable data on stream aquifer interactions. This would be beneficial for updating TARPs for the alluvial aquifer and for improving the assessment of risks to the Hunter River GDEs. Regularly updating the water monitoring plan is necessary to meet the future requirements of progressive rehabilitation and closure planning.

12. *Groundwater modelling* for the Continuation Project is generally fit for purpose. However, there are areas where the modelling and its presentation could be improved in future assessments to support interpretation of, and increase confidence in, the model results:

    a. detailing a local water balance for the alluvial aquifer in the vicinity of the Carrington West Wing barrier wall.

    b. better linking calibration hydrographs to their monitoring location to aid the interpretation of the modelling results.

    c. showing how the final calibrated model parameter values compare with the prior ranges for the parameters and providing the basis for the prior ranges selected.

    d. demonstrating the groundwater model's goodness of fit is appropriate for the objectives of the modelling. In particular, the quality of the model fit for the quaternary alluvium should be assessed for quality of model fit independently from the rest of the model given the objectives of assessing mining impacts on both the alluvium and related GDEs.

    e. clearly differentiating between model results that are additional to groundwater impacts previously approved under the existing mining approvals and those that include groundwater impacts previously approved.

3.3.6.Recommendations

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Prepare an updated Water Management Plan, incorporating a Water Monitoring Plan, within 6 months of approval that includes the following:

    a. If applicable, any modelled exceedances of the total site storage capacity should be reported (modelled frequency and volume) rather than only showing the 95% bound. As part of the update, more robust confidence limits on stored and discharged water volumes should be provided by use of a stochastic rainfall model.

    b. A plan for continuous monitoring of water levels in the Hunter River that allows accurate measurement of the hydraulic gradient from the river to the alluvial groundwater, as part of a monitoring transect from the river to the Carrington West Wing barrier wall, and to assist with estimating the downward hydraulic gradient to the Permian units.

    c. A TARP for the Carrington West Wing barrier wall and associated groundwater monitoring. To develop the TARP, groundwater modelling should be undertaken in support of a risk assessment, first, to assess what constitutes an unacceptable barrier wall failure in terms of groundwater impacts and, second, to assess options for groundwater monitoring to identify such a wall failure. Non-invasive methods of monitoring such as surface electrical resistivity surveys should be investigated as an alternative to, or an adjunct to, groundwater monitoring using nested piezometers. If HVOPL does not proceed with these methods, sufficient justification must be provided.

d. To improve plans for unexpected changes in surface and groundwater results, uncertainty analyses should be extended to assess the long-term risks to the GDEs. Steps to identify the sensitivity of plant species within the Hunter River GDEs to groundwater level declines should be established. The goal is to develop appropriate thresholds for water decline that are specific to each GDE for the risk assessment and groundwater TARPs.

e. Plans for continuous monitoring of flow, EC, pH and total suspended solids (e.g. as turbidity) at identified discharge and overflow points (as well as the existing grab samples).

f. Plans for monitoring and investigation that inform predictions of spoil hydrology, geochemistry and seepage, to support progressive rehabilitation and closure planning (in the initially updated Water Management Plan, this may be in general terms and made more specific as rehabilitation and closure planning progresses).

g. Updated requirements for groundwater model review and reporting covering:

    i. detailing a local water balance for the alluvial aquifer in the vicinity of the Carrington West Wing barrier wall.

    ii. better linking of calibration hydrographs to their location to aid interpretation of the modelling results.

    iii. showing how the final calibrated model parameter values compare with the prior ranges for the parameters and providing the basis for the prior ranges selected.

    iv. demonstrating the groundwater model's goodness of fit is appropriate for the objectives of the modelling. Specifically, the quality of the model fit for the quaternary alluvium should be assessed separately from the full model given the objectives of assessing mining impacts on both the alluvium and related GDEs.

    v. clearly differentiating between model results that are additional to groundwater impacts previously approved under the existing mining approvals and those that include groundwater impacts previously approved. Documenting both contributions is required.

    vi. re-evaluation of the physical and environmental mechanisms governing the health of the GDEs and description of their significance for GDE health; and improved use of the groundwater modelling results to explore and explain the relevant GDE impacts.

2. Within 12 months of approval, have the updated Water Management Plan peer reviewed by a party approved in writing by the Secretary. The review should address the adequacy of monitoring and mitigation measures.

3. Future progressive rehabilitation and closure plans should include ongoing assessment of the sensitivity of groundwater modelling results to spoil properties and geometries to assess the risks of poor-quality spoil water entering the alluvial aquifer or Hunter River.

4.0 GREENHOUSE GAS EMISSIONS

4.1. FOUNDATION INFORMATION

4.1.1. Request for Advice

The Department requested advice from the Panel *'on the scale, likelihood, and consequences of the Continuation Project's impacts on water resources and greenhouse gas (GHG) emissions'*. Its request went on to state that:

> *'The GHG assessment predicts that the gross Scope 1 and 2 emissions from the project would be approximately 29.6 Mt CO_2-e (approximately 50% of which would be fugitive emissions), while the net emissions are predicted to be 17.9 Mt CO_2-e. Noting that the Applicant is proposing to rely on carbon offsets under the Safeguard Mechanism to abate the difference of 11.7 Mt CO_2-e.*
>
> *With this in mind, the Department requests that the Panel provide advice targeting…:*
>
> - *whether the GHG avoidance and mitigation measures proposed by the Applicant are considered to be sufficient, including the reliance on availability of carbon offsets in the future.*

The request for advice also states that:

> *The Panel should also feel free to provide any other advice it considers would assist the Department in assessing the project.*

The Department's presentation to the Panel on 22 March 2024 had a particular focus on two plots of projected GHG emissions, reproduced for purpose of this advice as Figure 2 and in a subsequently modified form as Figure 3[1]. In expanding on its written request for advice, the Department noted:

- *In 2045, maximum GHG emissions of 1.7 Mt CO_2-e will consist of:*
  - *76% fugitive, and 23% diesel usage; and be*
  - *23% total NSW coal emissions and ~3% total NSW emissions.*
- *Glencore will need to reduce total GHG emissions by 11.7 Mt CO_2-e through purchase of ACCUs or SMCs – feasibility concerns* [is this feasible][2]*?*
- *After offsets, net GHG emissions are 17.9 Mt CO_2-e* [over project life].
- *Would require a further 2.9Mt CO_2-e reduction* [over project life] *to meet NSW targets.*
- *Concerns around the use of offsets, considering the number of offsets that will be required (up to 90% of emissions in some years).*
- *Commonwealth Safeguard Mechanism has soft 30% cap on offsets*[3]

[1] The order in which HVOPL now present fugitive emissions and fossil fuel emissions is reversed in Figure 3 to that in DPHI's presentation.
[2] Text inside square brackets [ ] here and later has been added by the Panel to improve clarity
[3] The Panel acknowledges that HVOPL do not accept the term 'cap'.

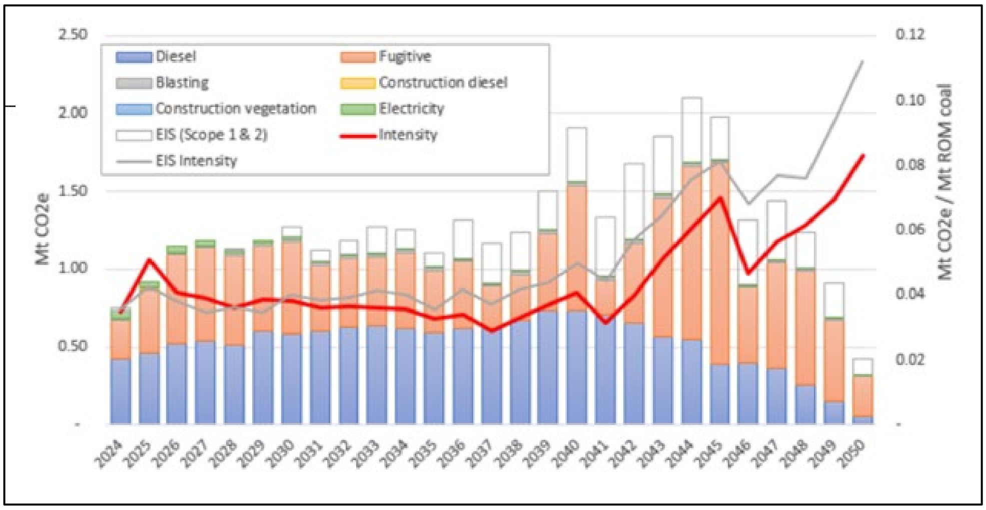

Figure 2: Plot showing breakdown of predicted GHG emissions and intensity factors (Figure 4.1 of HVOPL's Submissions Report (EMM, 2023)).

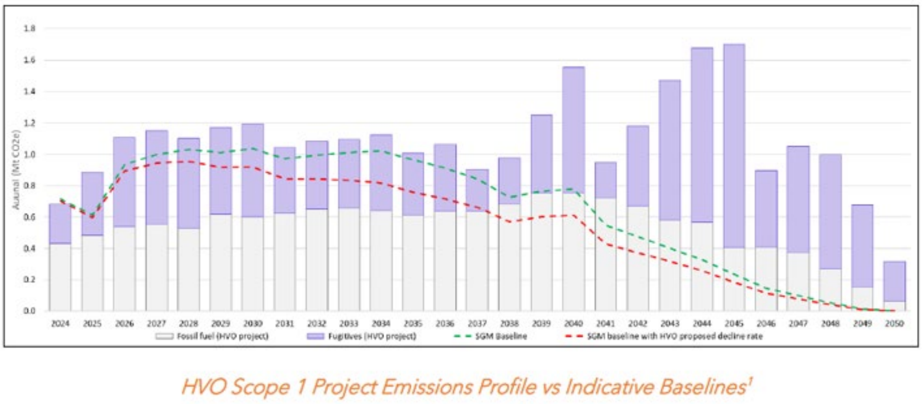

Figure 3: Plot showing total GHG emissions and CO_2-e offset thresholds (HVOPL, 3/6/24).

The Panel has confined its advice to fugitive emissions and to the diesel fuel component of fossil fuel emissions given that these two sources account for around 99% of the Continuation Project's GHG emissions.

In order to assist non-specialist end-users in understanding the Panel's advice, some sections of this Advice Report are premised on presenting basic technical principles that inform the advice in those sections.

4.1.2.Sufficiency of Offsets

Based on the current mine plan, more than 85% of the offsets under the Safeguard Mechanism baseline scheme and more than 75% under the NSW decline rate scheme are only required in the period 2039 to 2050. HVOPL has advised the Panel that its offset projections, presented in Figure 3, make no allowance for future avoidance and mitigation technologies over which it currently has 'no direct line of sight'. Currently, there are no measures available to HVOPL to reduce GHG emissions other than to change the mine design and/or mine production targets. HVOPL is entitled to offset all its GHG emissions and that is what it is currently proposing to do, at least until alternative and cheaper mitigation options become available.

There are no definitive answers to concerns about the availability of offsets in the long term. However, it appears reasonable to expect that:

1. When offsets are available then market forces should to prevail and drive a reduction in GHG emissions if offsets become prohibitively expensive.
2. If offsets become unavailable, then regulatory forces should prevail prevent emissions that can no longer be offset.
3. If the cost of offsets becomes prohibitively expensive or offsets become unavailable in the future, then there may be no option for managing GHG emissions at the time other than to modify the mine plan, which could include early mine closure. Technological developments in mitigating GHG emissions in the interim could have significant positive impacts on the scale and cost of offsetting and, therefore, on the extent of any changes to the current mine plan.

A change or changes in mine plan at various stages in the life of the Continuation Project can provide the opportunity to avoid zones containing high volumes of coal seam gas. This could be expected to result in reduced annual production and/or shortened mine life. The Panel's analysis of the distribution of gas contents and volumes in the proposed mining areas and its summary review of the nature and status of potential and emerging mitigation measures in following sections provide the basis for its advice on the nature, potential success and impact of some existing and future opportunities for avoiding and mitigating GHG emissions at HVO. This is intended to assist the Department in forming its own views on the sufficiency of avoidance and mitigation measures, including offsets, associated with the Project.

4.1.3. Mine Design and Operation

HVOPL's mining operations are a form of surface mining in which overburden is progressively stripped from one side of an excavation, or pit, in order to expose a coal seam and then dumped on the other side of the pit to fill in the void created by previous coal extraction. HVOPL's operations are a complex version of this process because they involve simultaneously extracting up to 15 main coal seams which, in turn, could comprise up to 150 extractable coal plies ranging in thickness from the order of 0.3 m to 2 m. This results in the coal extraction side of the pit consisting of a series of terraces formed in the process of mining from the surface down to the deepest extraction horizon.

Overburden is transported from the coal extraction side of the pit by dump trucks that have a payload capacity of the order of 300 t. For reasons of working space, logistics, safety, efficiency and cost, mine planning is based on maximising the time that overburden dump trucks operate on near-level access roads from the coal faces to the dump sites on the other side of the pit. Overburden placement is effectively the reverse of the coal extraction process, with overburden being placed as a series of terraces that are constructed from the bottom of pit working up.

Coal is also transported by dump trucks from the coal face to the processing plant located on the surface. These dump trucks have a payload closer to 200 t because a tonne of coal occupies a considerably greater volume than a tonne of typical overburden. Hence, the specifications of dump trucks intended primarily for coal haulage are different to those intended primarily for overburden haulage, resulting in HVO having two different fleets of dump trucks comprising some 90 vehicles in total.

Dump trucks are loaded by excavators and operations are supported by bulldozers, graders, drill rigs, water carts and other specialised vehicles. Because HVO is extracting coal from multiple terraces, most mobile plant is required to relocate to different workplaces on a frequent basis.

The scheduling of mining operations given the number of seams is complex and time consuming. Numerous interacting factors need to be considered, scheduled, and integrated into the mine plan. These include, to name just a few: coal quality; coal thickness; road and ramp construction; drilling and blasting; overburden removal in time for coal extraction; water management; noise and dust management; coal clearance (train scheduling); dump stability; rehabilitation; and economic return. The net impact of these factors is that the overall (macro) mine plan is relatively inflexible to change and is associated with considerable lead-in time. Selective extraction of seams can only be achieved by treating unsuitable seams as overburden or ceasing mining before reaching the uppermost seam not targeted for extraction.

4.1.4.Unknown and Changing Circumstances

Both the state and federal regulatory environment in regard to GHG emissions, avoidance, mitigation and offsetting is evolving and is likely to continue to do so for some time to come. The state of knowledge of coal seam and overburden properties and environmental and mining conditions on large and complex mine sites like HVO is also evolving over time. Hence, it is unrealistic for HVOPL to have available today all the information required to inform evolving GHG emissions performance measures out to 2050. This is a common situation for long term projects such as mining, where the physical and regulatory environments are not fully characterised ahead of time.

Should the HVOPL Continuation Project be approved, some elements of the approval may need to be conditioned to address any significant deviations between predicted and measured performance and to respond at a later date to advances in knowledge, technology and experience bases. The Panel has relied on this approach in some aspects of its advice. It notes that HVOPL has already committed to:

- an Air Quality and GHG Management Plan (AQGHGMP) including a 3-year action plan, updated every 3 years, for investigating and implementing all reasonable measures to minimise GHG emissions (EMM, 2022)
- a gas pre-drainage trial in an area with higher potential for pre-drainage in order to investigate its feasibility and effectiveness and to develop the scope of the trial in consultation with relevant stakeholders to the satisfaction of the Planning Secretary (EMM, 2023)

4.2. FUGITIVE EMISSIONS

4.2.1.Scope

The Submissions Report (EMM, 2023b) includes the gas model used by HVO to estimate fugitive emissions and provides context for the Panel's advice on fugitive emissions. The Panel's evaluation is made in light of the current National Greenhouse and Energy Reporting scheme (NGER). The NGER is the controlling statute and it has regard to the *ACARP Guidelines for estimating GHG emissions from open cut coal mines* (ACARP 2011).

4.2.2.Statutory Requirements

Australia has been estimating and reporting fugitive Greenhouse Gas (GHG) emissions from its surface coal mines since the early 1990's, first utilising tiered CO_2 equivalent (CO_2-e) emissions factors at global, country, state and basin levels assigned to coal production tonnages. As knowledge developed, the various State emissions factors were regularly updated. However, the variability in gas contents *in situ* within basins and between coalfields, mining leases and coal seams prompted a move towards measurement and determination to develop gas-in-place models to inform estimated emissions against production on an annual basis. The *National Greenhouse and Energy Reporting (NGER) (Measurement) Determination 2008* was designed to report emissions within the context of the National Greenhouse and Energy Reporting Act 2007. It has been updated annually to reflect updates to emissions factors, improvements to estimation methods and responses to consultation feedback. The administration of the NGER sits under the Australian Government Clean Energy Regulator (CER).

Companies are still permitted to utilise a state-based emission factor for methane (Section 3.2 of the NGER Measurement Determination) multiplied by the annual production in tonnes, but HVOPL has elected to report against *in situ* estimations since FY 2015/2016, as evidenced in the EIS (EMM, 2022a) and Submissions report (EMM, 2023b pp. 31-41, 51-56). This approach is based on laboratory testing of coal core to determine *in situ* gas content and on subsequent gas modelling that uses that data to assign a gas content to the tonnes of coal projected to be mined within a given year.

Typical reporting activities based on CER 2023 guidelines for site specific *in situ* gas modelling are[4]:

- Run-of-Mine (ROM) coal production,
- A gas volume assignment model/GHG emissions factor for each ton of coal mined that is based on in situ sampling of all gas-bearing strata disturbed/extracted in a given year, and
- An estimation of parameter uncertainty.

Good practice NGER reporting in coal mining has the following guiding principles:

- Transparency
- Comparability
- Accuracy
- Completeness

Evaluation against NGER must address the following requirements:

1. Assessment of data for completeness, representation and lack of bias. It is stipulated that there needs to be at least 3 boreholes in each domain covering the range of overlying gas-bearing strata and below the seam floor to 20 m;
2. Errors must be avoided in gas sampling and testing, e.g. due to samples being sourced from heat affected areas or leakage in laboratory gas testing canisters;
3. There should be exclusion of any invalid or contaminated data sets;
4. The determination of gas domains uses all validated data (historical and NGER specific);
5. Assessment of volumes should take a modelling approach, which is unbiased and well documented with a full geological model, even for unmineable seams- i.e. assignment of gas to all extracted strata with a bulk density of ≤1.95 g/cm;
6. Estimates must include pit floor gas assessment (but this is only estimated in the year of production and excluded from the next cut);
7. When applicable, establishment of "low gas zones" (LGZ) as per section 3.25C of NGER. This needs to be fully explained and justified with substantial information around how it was assigned and modelled;
8. The competency of the estimator needs to be established.

4.2.3.Coal Seam Gas Basics

Unlike conventional natural gas reservoirs where gas is stored in the pores of rocks, gas in coal is primarily stored in an adsorbed state. That is, the gas is chemically bound to the coal. The gas is released from within the coal when fluid pressure in the seam is reduced, usually through drawdown of the water. Reduction of pressure can occur from the use of dewatering boreholes or through the mining process. The timescale of pressure reduction, and thus release of gas, is highly variable and may take hours or years depending on the permeability of the coal seam and the rate of water removal.

The adsorbed gas in a coal seam is mostly CH_4 and/or CO_2 (some higher hydrocarbons can also be present). The gas adsorption characteristics differ markedly according to gas type. An important gas reservoir parameter is gas content, which is a measure of the quantity of gas adsorbed in the coal per unit mass. It is only stored in the carbonaceous component of the coal. Coal also consists of varying amounts of moisture and mineral matter and these components do not store gas. Thus, it is important to know on what basis a gas content is reported. *In situ* gas resources are always determined on an 'as-received' basis, which takes into account the amount of moisture and inorganic material (ash yield). Sometimes gas content is reported on a moisture-free, inorganic-free basis or corrected to some selected level of the two (e.g. cubic metres per tonne of coal (m^3/t) at stated ash yield). This is performed to help in understanding depth and/or rank[5] relationships with gas content and definition of gas domains.[6]

In Australia, it is recommended that gas content determinations follow the Australian Standard 3980-1999. As defined by the standard, the Measured Gas Content, Qm, is the sum of:

---

[4] For NGER Methods 2 and 3

[5] Coal rank is a coal quality measure of thermal maturity which influences both gas generation and adsorption capacity.

[6] A gas domain is an area where gas content and composition follow a predictive relationship with depth.

- Q1, which is the calculated lost gas that occurs between the time when the sample has left its *in situ* position at depth to when it is sealed within a desorption gas canister.
- Q2, which is the gas desorbed from the intact coal inside the canister. Since the standard is a guideline and is not prescriptive, desorption times can vary between hours ("fast desorption method") and months ("slow desorption method").
- Q3, which is the gas desorbed upon crushing the coal. This step is conducted to aid release of remaining gas trapped inside the coal[7].

A fundamental property in gas assessment, and in any gas mitigation consideration, is determination of gas saturation. A laboratory test termed an *adsorption isotherm* is used to determine the maximum gas holding capacity at various pressure steps for any particular coal sample under constant temperature conditions. Since pressure in an adsorption isotherm can be related to depth, the actual measured gas content can be compared to a coal's maximum gas holding potential. If the gas content is only 50% of the maximum for the ambient pore pressure, then it is referred to as 50% saturated. The lower the gas saturation the more difficult it is to flow gas from the coal seam. Depending upon the permeability, below approximately 70% gas saturation, gas flow may be insufficient for cost-effective drainage.

Permeability is another fundamental property to be assessed when addressing both gas flow from a coal seam and any mine gas mitigation plans. Permeability in a coal seam is controlled by many factors but the two most important are the number and connectivity of fractures (and/or 'cleats') and the depth from surface of the coal seam. In general, the deeper the coal seam the lower the permeability as a function of stress. The fracture system is important because it provides the pathways through which the gas moves. The fewer pathways there are, the slower the gas flow. In cases of low permeability, the reservoir can be stimulated to assist flow.

For all coals at atmospheric pressure/in contact with air, it is assumed that all the gas in the coal will desorb. This is why NGER does not try to account for any gas retained in the coal after open cut mining, processing, and shipment to customer.

4.2.4. Geology

Hunter Valley Operations is a multi-seam operation, as shown in Figure 4. The coal seams occur on a south westward plunging synform (the Bayswater Syncline) that is dissected by faults and dykes that displace the seams locally. HVO is separated into a northern and southern area by the Hunter River that only incises a portion of the upper seams and has deposited an alluvium. A paleo alluvial channel formed along a previous alignment of the river intersects the alluvium and lies within HVO's mining area. There are also several known major faults and dykes within the HVO mining area.

[7] The Total Gas Content Qt is the sum of Qm and Q3' which is the gas remaining adsorbed in the coal at the end of Q3 crushing. For HVO, gas content testing has been carried out by both the fast and slow desorption methods. For the fast desorption method Q3' can be significant requiring that quantity to be calculated or directly determined. For slow desorption testing, Q3' is small and ignored.

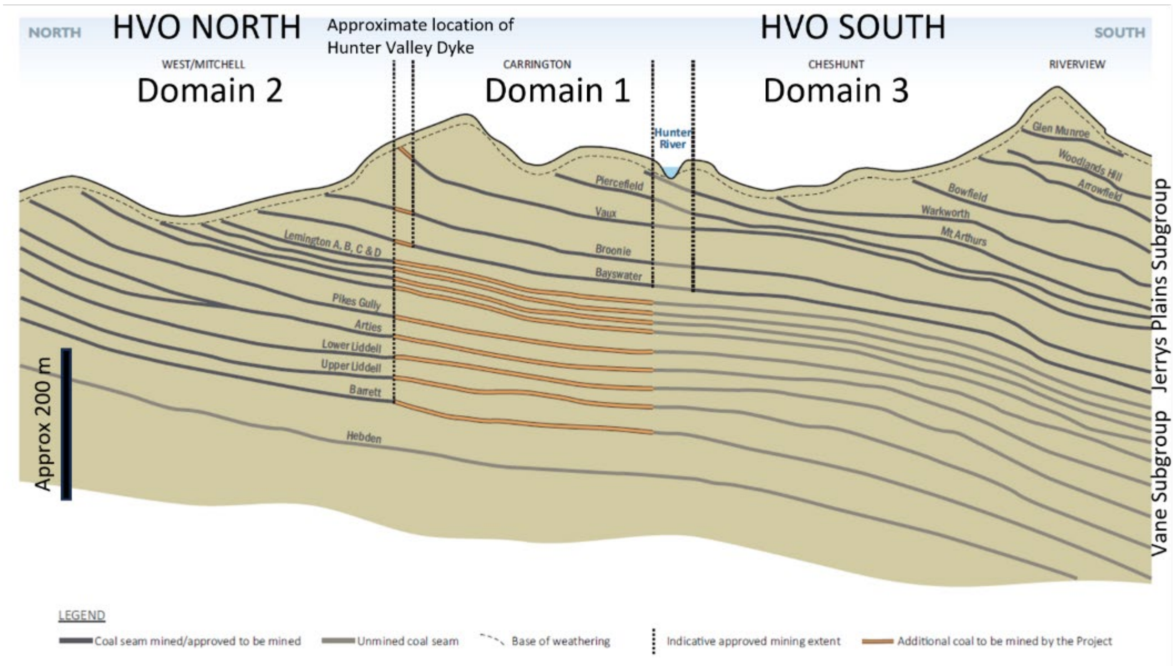

Figure 4: Schematic cross section through the coal measures stratigraphy of HVO. Not to scale. Adapted from EMM, 2022.

4.2.5. Gas Models and Associated Emissions

The estimation of the location, composition and quantity of fugitive emissions that could result from coal extraction informs the potential for avoidance and mitigation measures and is based on assigning gas contents to strata that will be disturbed by mining. Gas contents and composition vary within HVO, and across the Hunter Coalfield more broadly (EMM, 2023b) and have been investigated on many occasions in the past. These studies adopted a "domain approach" in which gas content and/or composition follow a consistent relationship, often with depth and sometimes related to geological features. The Environmental Impact Statement for the Continuation Project is based on three gas domains at HVO, referred to as Domain 1, Domain 2 and Domain 3, shown in Figure 5 (EMM, 2022a). A persistent dyke, named the Hunter Valley Dyke, separates Domain 1 from Domain 2, while Domain 3 is south of the Hunter River.

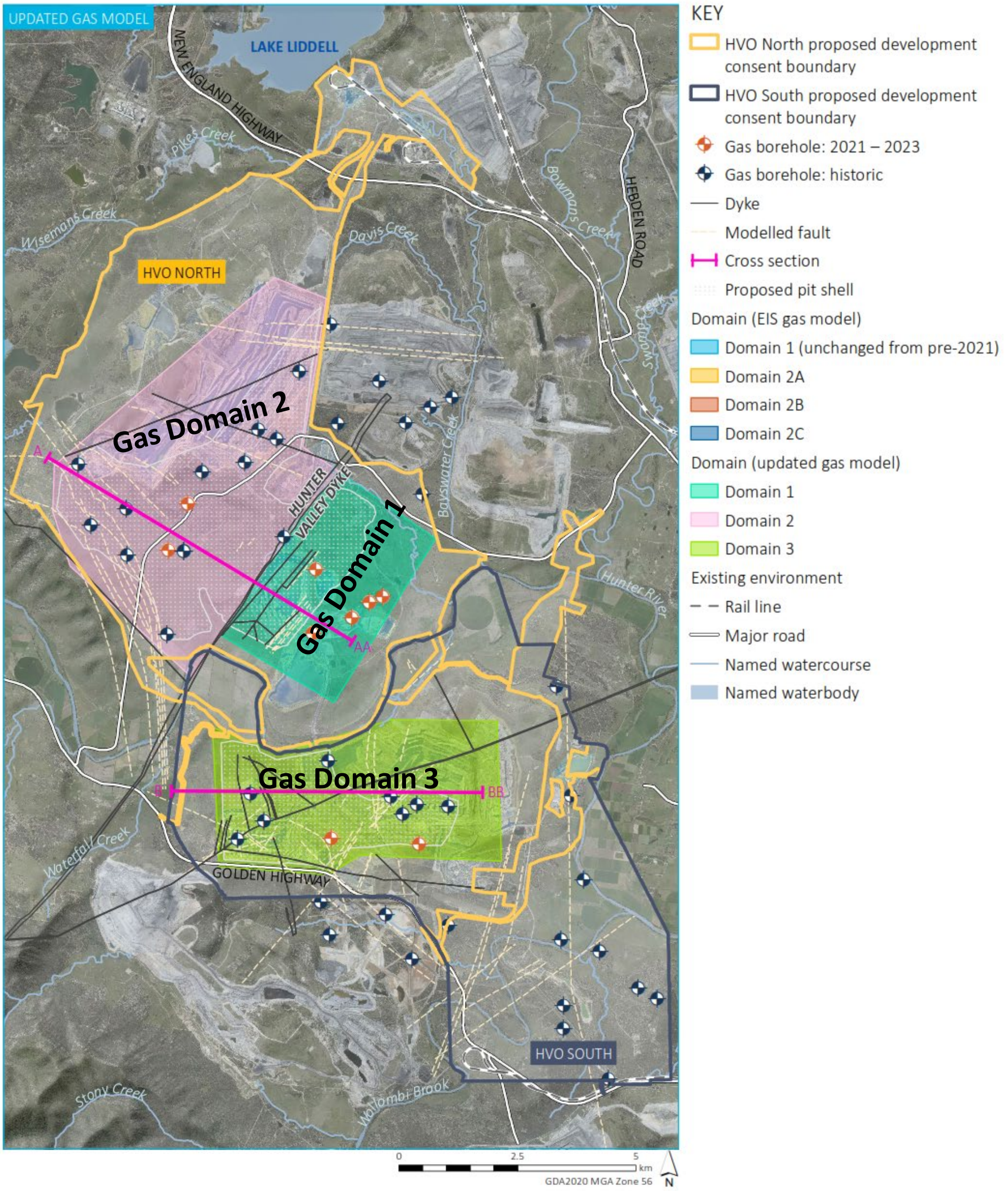

Figure 5: Gas domains within HVO showing the location of gas test boreholes (section lines shown on the figure are not presented in this advice report) (EMM, 2023b)

Within each gas domain, stratigraphic gas zones have been delineated covering a near surface "low gas zone", with increasing gas contents in Zones 1 to 4, as shown in Table 3. Note that the gas content within these zones varies within the different Domains. The delineation of these stratigraphic gas zones is a convenient way of presenting the gas model and its application to GHG emissions. Gas-bearing strata within these zones are assigned a gas content accordingly.

Table 3: Gas Domain Properties – HVO Fugitive Gas Assignment Model (Table 4.6, EMM (2023)).

	Domain 1 - HVON				Domain 2 - HVON				Domain 3 - HVOS			
	Depth (m)	Gas Content (m3/t)	CH4 (%)	CO2 (%)	Depth (m)	Gas Content (m3/t)	CH4 (%)	CO2 (%)	Depth (m)	Gas Content (m3/t)	CH4 (%)	CO2 (%)
LGZ/Zone 0**	0 to 70	0.3	-	50%	0 to 70	0.3	0%	50%	0 to 90	0.7	31%	40%
Z1	70 to 120	1.4	62%	18%	Below LGZ to Pit Floor*	2.3	86%	7%	90 to 120	1.2	56%	22%
Z2	120 to 150-300	3.1	91%	5%					120 to 130-200	2.5	82%	17%
Z3	150-300 to 330	5.3	95%	3%					130-200 to 250	6.1	59%	41%
Z4	Below Z3 to Pit Floor*	6.8	94%	4%					Below Z3 to Pit Floor*	4.4	55%	45%
20m below floor	-	2.8	90%	4%	-	0.2	4%	22%	-	2.2	55%	45%

Notes * where zones do not extend to pit floor

** Zone 0 in Domain 3 only

The most notable aspects of the gas zones within each gas domain are:

- Domain 1 - a "Low Gas Zone" (Zone 0) (~0.3 m³/t, 0% CH_4, 50% CO_2) down to a depth of 70 m and then increasing gas content with depth to a maximum of 6.8 m³/t, with CH_4 increasing to >90% and CO_2 decreasing to 3% to 5%.
- Domain 2 – "Low Gas Zone" (~ 0.3 m³/t comprising 0% CH_4 and 50% CO_2) to 70 m depth and projected for the majority of the pit.
- Domain 3 – A "Low Gas Zone" (~0.7 m³/t comprising 31% CH_4 and 40% CO_2) down to a depth of 90 m then increasing gas content with depth, peaking in Zone 3 in a depth interval of 130 m to 250 m at 6.1 m³/t with a corresponding gas composition of 59% CH_4 and 41% CO_2.

The greatest contrast is between Domains 1 and 2, where the relatively high gas content coals of Domain 1 change to low gas content coals in Domain 2, the boundary being the Hunter Valley Dyke. Domain 3 has similar gas content variation to Domain 1 but elevated levels of CO_2 by comparison.

HVO North is currently mining in Domain 2 and seeking approval to extend mining operations into Domain 1. The current and future mining operations of HVO South are all within Domain 3, with operations progressively becoming deeper and, therefore, extending into higher gas content areas.

Figure 6 shows ROM coal production in relation to domain and gas zone while Figure 7 shows fugitive gas emission predictions by domain and gas zone from 2025 to 2050. Although the majority of ROM tonnes out to 2040 are from the low gas zone of Domain 2, mining in Domain 3 will also occur in this period with the effect of being the dominant source of GHG emissions. Mining in Domain 1 will ramp up after 2040 to become the main mining area.

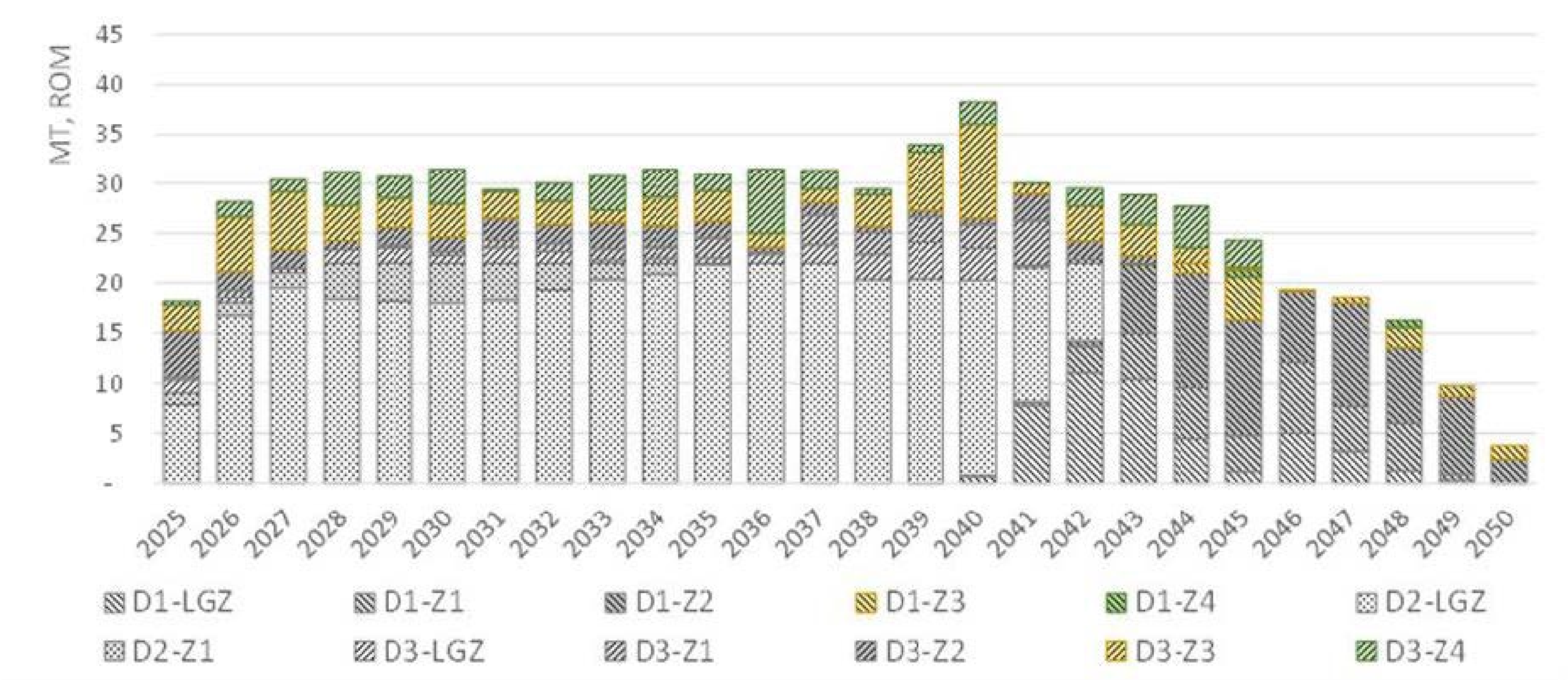

Figure 6 ROM coal production over the life of the Continuation Project (Figure 4.13 of *Submissions Report - (EMM, 2023)*)

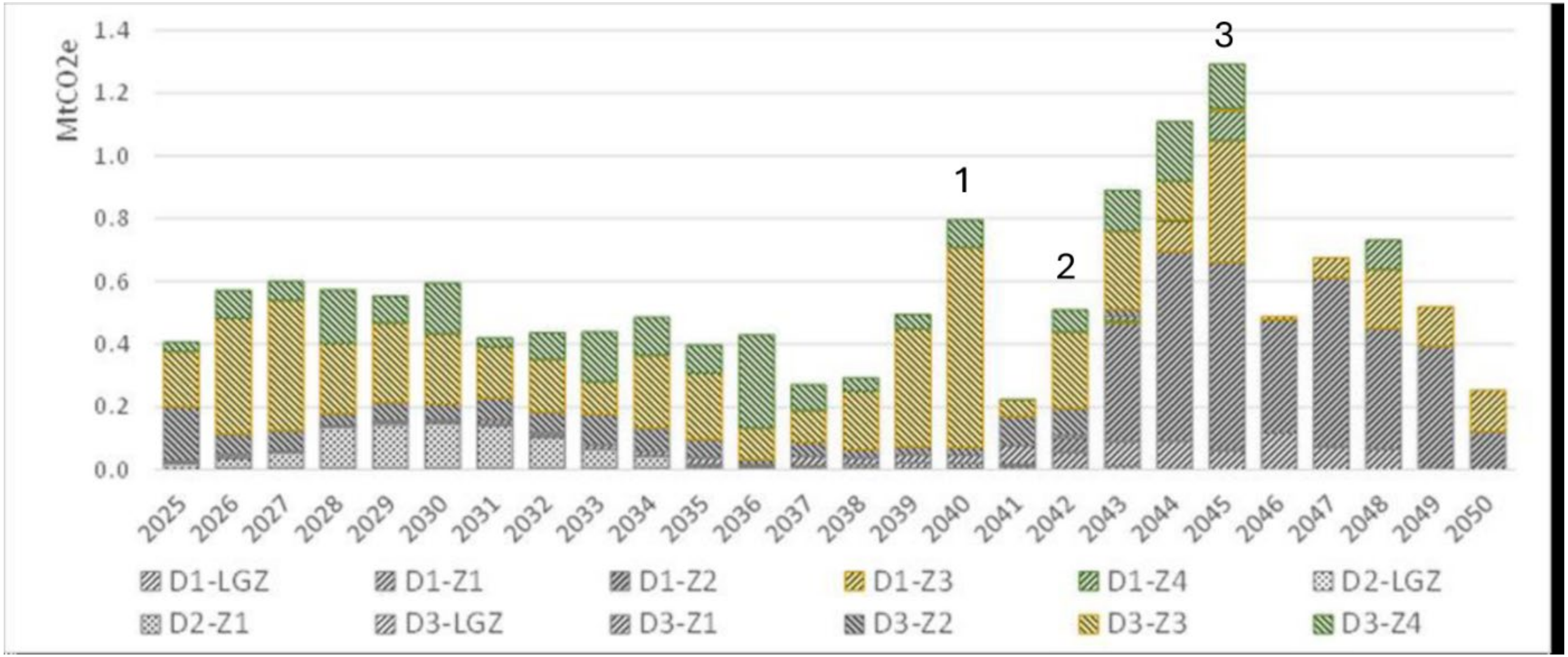

Figure 7: Breakdown of fugitive emissions by Domain (D) and Zone (Z) over the life of the Continuation Project (Figure 4.14 of *Submissions Report - (EMM, 2023)*)

In undertaking its assessment, the Panel identified two ancillary matters that it considers should be addressed going forward. These are:

1. The source of nitrogen (N_2) in HVO's reported gas content test results and its significance. The concentrations of GHG fugitive emissions as reported in Table 3 do not add up to 100% because N_2 content is also being included in the gas compositions reported by HVO. The Panel notes that the treatment of N_2 is not explicit within NGER and that HVO's approach aligns with a CSIRO research study (A Saghafi, 2012). The source of N_2 determined from laboratory gas testing is a contentious issue in many cases; the N_2 may be present in the coal being tested, or it can be an artifact of the gas testing technique, or a combination of the two. Depending on how the N_2 is treated in reporting, emissions may be underestimated. For the moment, the uncertainty surrounding the source of the N_2 and its impact on GHG emissions assessment at HVO is not critical because it has a corresponding impact on the calculation of Safeguard Mechanism baselines. However, it could become significant for gas utilisation and if absolute GHG emissions, rather than relative to a baseline, become a measure.

2. The gas content test boreholes drilled northwest of the Hunter Valley Dyke in Domain 2 are all designated as being in a "Low Gas Zone". While regional gas content testing supports the view that the gas content is low in all of Domain 2, there is an approximately 2 km gap between the dense drilling in Domain 2 and the Hunter Valley Dyke, with the borehole adjacent to the north west side of the dyke (see Figure 5) potentially being compromised by heat effects from the dyke. The Panel is of the view that while it is likely the Hunter Valley Dyke is the boundary between Domain 1 and Domain 2, there may be some doubt about the robustness of the gas data derived from the borehole immediately adjacent to the dyke. It is recommended, therefore, that an additional borehole is drilled approximately 400 m northwest of the dyke to ensure quality in gas evaluation.

The Panel recommends that:

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Conduct testing within 3 years to confirm the degree to which nitrogen (N_2) is naturally occurring in coal at HVO or as a contaminant introduced during gas determination testing, or a combination of both;

2. Subject to the outcomes of testing to confirm the source/s of N_2 in gas determinations, modify GHG emissions assessments accordingly; and

3. Within 3 years, drill and test an additional borehole approximately 400 m north west of the Hunter Valley Dyke to support quality *in situ* gas evaluation within the Low Gas Zone in Domain 2.

4.2.6. Avoidance of Fugitive Emissions

The projected spike in emissions in 2040, labelled '1' in Figure 7, corresponds to predicted ROM coal production peaking that year and to an increased ratio of deeper seams being mined in HVO South. These deeper seams are associated with higher gas contents in Domain 3 as shown in Table 3.

The projected spike in emissions in 2042, labelled '2' in Figure 7, corresponds to when mining in HVO North starts to progress into the methane dominated seams in Domain 1. By 2045, all mining in HVO North is scheduled to occur in Domain 1, accounting for the spike in fugitive emissions, labelled '3'. Here there is both an increase in emissions in Zones 3 and 4 and significant emissions from the less gassy Zone 2.

Significance points of notes in respect of Domain 1 are:

1. Zones 2, 3 and 4 in Domain 1 all contain significant proportions of CH_4 (Table 3).
2. Zone 2 has a low gas content (2.5 m^3/t, Table 3) but a high gas volume (Figure 7).
3. Due its low gas content of 2.5 m^3/t, it is unlikely that Zone 2 is suitable for pre-drainage.
4. Zone 3 and Zone 4 have high gas contents (6.1 m^3/t and 4.4 m^3/t, respectively, Table 3) but each zone contains typically less than half the gas emissions of Zone 2 (Figure 7).
5. Zone 3 and Zone 4 have potential for gas-drainage (discussed in more detail in Section 4.2.7).
6. From 2043 forward, Zone 2 accounts for at least 50% of annual CO_2-e fugitive emissions (Figure 7).
7. From 2043 forward, the annual CO_2-e fugitive emissions from Zone 2 alone are of a similar magnitude to annual CO_2-e fugitive emissions of the Continuation Project up to that point in time (Figure 7).
8. From 2042 to 2050, there is over a 200% increase in the emissions intensity factor, notwithstanding that ROM production and associated diesel fuel emissions taper off to zero (Figure 2).

One effect of these factors is that the first 16 years of the Continuation Project account for ~50% of fugitive emissions over the life of the Continuation Project, whilst the remaining ~50% of fugitive emissions is produced in the just the last 11 years of the Continuation Project. Fugitive emissions in the period 2044 to 2046, alone, account for 22% of the total fugitive emissions for the Continuation Project.

On the basis of the breakdown of sources of annual production and annual fugitive emissions displayed in Figure 6 and Figure 7, the Panel concludes that:

1. The only fugitive emissions avoidance measure available is mine planning that restricts the areal extent of mining and/or the depth of mining.
2. A significant fugitive emissions avoidance measure at HVO would be not to mine Zones 2, 3 and 4 in Domain 1.
3. If Zones 2, 3 and 4 in Domain 1 were not to be mined and the current mine plan was not to be revised, mining would effectively cease at the end by 2044, some 6 years earlier than planned. However, it is possible that mining may cease before that date due to the impacts and consequences of such a decision on the viability of mining just Zone 1.
4. If Zones 2, 3 and 4 in Domain 1 were not to be mined, a revised mine plan may result in the remaining mining in Domain 3 being completed earlier than 2044.
5. If consideration is to be given to these types of options, the options should be put through a mine planning process in order to verify the merits and impacts of the options and properly inform decision making.

The Panel recommends that:

1. If modifications are to be made to the mine design for the purpose of avoiding GHG emissions, they should focus on assessing the impacts in Domain 1 of not extracting Zone 2 (low gas concentration but high volume) and/or Zone 3 (high gas concentration and significant volume) and/or Zone 4 (high gas concentration and significant volume).

4.2.7. Mitigation of Fugitive Emissions

4.2.7.1. Steps in the Mitigation Process

The potential to mitigate fugitive emissions at HVO is dependent on the feasibility and success of a two-stage process. Stage 1 is concerned with the reduction of *in situ* gas (being predominantly CH_4 and CO_2) in the coal seam prior to mining (i.e. before the coal seam is exposed to the atmosphere). Having reduced the gas content through gas drainage, Stage 2 is concerned with converting the CH_4 to CO_2. Success is dependent on both stages being technically and economically feasible[8].

To date:

- Drainage of fugitive emissions ahead of mining in surface coal mines has not been employed in Australia[9].
- Detailed studies have not been undertaken to confirm that the composition and concentration of captured fugitive emissions at HVO will be suitable for utilisation or for converting the CH_4 component into CO_2 through combustion[10].

Drainage of coal seams is well established in the underground coal mining sector and the coal seam gas sectors. These sectors employ two basic techniques for accessing coal seams in order to drain them, one being vertical boreholes (wells) and the other directional drilling of long surface to in-seam (SIS) boreholes. However, there are multiple impediments to automatically applying these to surface coal mining operations and to them being successful, especially in multi-seam seam operations such as those at HVO. These include the ongoing disturbance of the surface, the constantly changing in-pit geometry, the active mining of seams above those targeted for drainage, blasting impacts, and the location and thickness of spoil piles. These factors as well as scheduling of mining operations also impact on surface reticulation systems required to transport gas to processing facilities.

A multi-seam environment favours the use of vertical boreholes, but these will almost certainly require stimulation, even with favourable gas saturation and permeability. SIS boreholes would not require stimulation but would limit target seams to a minimum thickness of ~1.4 m and may require a long lead time to pre-drain seams.

One potential advantage in areas affected already impacted by mining operations is that the pore pressure may have already been altered to be near or at gas desorption. That advantage may be offset by decrease in permeability as a result of this pore pressure reduction but could also be substantially increased due to blasting-induced fracturing of the target coal seam/s.

A possible option for gas drainage in areas already affected by mining could involve the drilling of angled/directional boreholes from the highwall to run below the seams to be mined. These boreholes would not produce gas unless permeability was significantly high, either naturally or stimulated from encroaching mining.

Against this background, the current state of knowledge is such that it is not possible to say with any certainty that gas drainage is or is not feasible at HVO. Investigations to clarify the potential for gas pre-drainage, which HVO has committed to, therefore need to be a high priority.

Whatever the method of gas pre-drainage and gas capture, a reticulation system will be required to take the gas from the drill site to a point of utilisation or combustion. Such a system would need to be designed to fit into the mine geometry and schedule.

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[8] Given the current challenges of adopting carbon sequestration in Australia and the practical limitations and time constraints associated with utilising this technology during the life of the Project, this concept for mitigating GHG emissions at HVO has not been considered by the Panel.

[9] The Panel is also unaware of any instances of this occurring in overseas operations

[10] Advice during site visit.

4.2.7.2. CoalBed Energy Study

In response to matters raised by the Climate and Atmospheric Science Division of the then Department of Planning and Environment, HVOPL commissioned CoalBed Energy to undertake a study into the feasibility of pre-drainage capture at HVO. This study constitutes Appendix M of the Submissions Report (EMM, 2023b)

The CoalBed Energy report approached the feasibility of pre-drainage at HVO by familiarisation with the HVO greenhouse gas assignment model, mine plan and gas reservoir database. It identified the following fundamental characteristics of the reservoir that are relevant to pre-drainage capture:

- Gas content
- Gas composition
- Gas saturation
- Permeability
- Net coal

The study stressed that for successful and commercially viable gas extraction from coal, all these factors must be favourable. The study report's conclusions include:

- *The measured relationship at HVO in regard to coal seam gas content appears to fall in the typical range for many Sydney Basin coals of similar rank.*
- *The dominant coal seam gas [at depth] is generally methane.*
- *The gas content and composition data from HVO in the gas emission model suggests that the deeper parts of the proposed mine potentially contain enough gas for pre-drainage.*
- *Domain 1 shows some potential for pre-drainage within Zone 3 and Zone 4, which represents <10% of the ROM Coal modelled in Domain 1.*
- *Domain 2 shows the least potential for pre-drainage, due to its low gas content.*
- *Domain 3 may show some potential for gas drainage within Zone 3 and Zone 4 over the deepest (~ 50%) of the deposit, with the proviso that the CO_2 gas composition modelled is high compared to Domain 1.*
- *The coals within the pit shell at HVO are anticipated to be variably saturated.*
- *The overall gas saturation condition at HVO is challenging for pre-drainage.*
- *Limited permeability data has been supplied from HVO which, alongside analogue data from the public record, suggests that permeability will be low at the depths most suitable for pre-drainage. This is challenging for pre-drainage at HVO.*
- *Vertical holes are the simplest and most cost-effective way to extract gas from coal seams although there are no known open cut coal mining operations currently utilising this method.*
- *Surface to inseam drilling works best with one or two thick and gassy target horizons - not a multi seam environment such as HVO.*
- *A practical constraint will be drill-pad access for pre-drainage wells due to the dynamic nature of an active open-cut mining operation, and significant historic mining activity. The presence of previously emplaced spoil, tailings dams, rehabilitation areas, and the complex effect of the advancing highwall must be considered in evaluating the effectiveness of pre-drainage at HVO.*
- *Further work is needed, but as an indicative estimate, it is likely that a recovery of 65% of the potential gas available per well should be considered a good result even in the most optimum locations at HVO, given the reservoir fundamentals.*
- *Low gas content, a high proportion of CO_2, low permeability and variable gas undersaturation may limit successful pre-drainage. An added complication is the presence of spoil covering much of the site, the complexity of an advancing highwall operation, potentially adding to drilling costs and increasing risk.*
- *The cost of extraction is likely to be high due to the multiple gas reservoir issues already raised and drilling will be affected by historical and active site disturbance.*
- *The amount of gas that may be captured and the likely cost of drilling needs to be investigated through a targeted study, including a trial program, in an area with a higher potential, to determine the practicality and effectiveness of pre-drainage at HVO.*

- *Technical limitations similar to the ones discussed above have prevented successful long-term pre-drainage to date for existing open-cut operations in NSW and QLD. However, due to recent Safeguard Mechanism reforms and ongoing efforts to mitigate GHG emissions to meet reduction targets, there is increasing study into the development of cost effective mitigation measures including consideration of pre-drainage across the open-cut coal mining sector.*

4.2.7.3. Panel Assessment

Using data requested from HVOPL, the Panel undertook its own evaluation of the gas reservoir properties and an analysis of uncertainty to assist in informing its advice on the feasibility of mitigating fugitive emissions. The gas content data examined is of high quality and the Panel's assessment is essentially consistent with the HVO gas model. Assessment of gas saturation supports HVO's contention that the gas saturation is sub-optimal. The uncertainty in the assessment is high.

However, based on the Panel's knowledge of permeability data in the region, the Panel is of the view that:

1. Permeability is most likely higher than HVO believes and may indeed be adequate for gas pre-drainage at such sub-optimal levels of gas saturation.
2. Gas pre-drainage of coal down to a content of ~3 m^3/t may well be achievable in coals with sub-optimal gas saturation provided the permeability is high enough and industry best practice is applied in assessment, modelling, design and implementation.

This means that targets for gas pre-drainage are Zones 3 and 4 in both Domains 1 and 3.

Based on Figure 7, the Panel has calculated that 30% to 50% pre-drainage of Zones 3 and 4 in Domain 3 would result in a reduction of GHG emissions to the atmosphere of 17% to 34%, assuming complete combustion of CH_4 if implemented successfully from the start of the Continuation Project.

Mining is currently occurring in Domain 3 and this will generate the bulk of GHG emissions to 2040. HVO has indicated that it intends to undertake its initial pre-drainage trial in Domain 1 where it considers that gas reservoir properties are likely to be more favourable. The Panel is concerned with this proposal because mining in Domain 1 is only scheduled for post 2040. The Panel is of the view that assessment of Zones 3 and 4 in Domain 3, with the view to conducting pre-drainage trials in these zones, is a higher priority.

The current state of knowledge of the HVO gas reservoir is such that it is not possible to say with any certainty that gas drainage is or is not feasible. Investigations to clarify the potential for gas pre-drainage needs to be a high priority.

The Panels concludes that:

1. The first 16 years of the Continuation Project to 2039 account for ~50% of fugitive emissions over the life of the Continuation Project, with the majority of the fugitive emissions coming from mining the deeper Zones 3 and 4 in Domain 3.
2. The remaining ~50% of fugitive emissions are produced in the last 11 years of the Continuation Project, primarily from mining Zones 2, 3 and 4 in Domain 1.
3. The potential to mitigate fugitive emissions is dependent on the technical and economic feasibility of each stage of a two-stage process, being:
    - Capture of coal seam gas; and
    - Conversion of captured coal seam gas into less potent forms of greenhouse gas

Capture

a. Gas pre-drainage is the only technology currently available which has potential for capturing coal seam gas.

b. The effectiveness of gas pre-drainage as the first stage of the process for mitigating fugitive emissions in open-cut mining is as yet unproven.

c. Gas drainage at HVO is constrained by reservoir characteristics and the geographical extent, complexity and dynamic state of surface mining activities.

d. Based on the Panel's analysis, if pre-drainage proves to be technically feasible it could potentially capture 30% to 50% of coal seam gas in Zones 3 and 4 in Domain 3 at HVO.

e. Assuming complete combustion of captured coal seam gas, 30% to 50% drainage of Zones 3 and 4 in Domain 3 would result in a reduction of ~17% to 34% CO_2-e to the atmosphere over the period from 2025 to 2040; however, that reduction will be less because of the time required to 1) develop and commission pre-drainage technologies; 2) pre-drain areas; and 3) develop and commission gas conversion technologies.

f. HVOPL's existing commitment to investigate and undertake pilot trials of gas drainage should the Continuation Project be approved, is critical if fugitive emissions are to be mitigated.

g. Pre-drainage trials should be prioritised in Zones 3 and 4 in Domain 3, and not in Domain 1 as currently proposed by HVOPL.

Conversion

a. The potential to flare and/or utilise captured coal seam gas at HVO in order to reduce its CO_2-e contribution is still to be determined.

b. Should the Continuation Project be approved, there is a need for research to also be undertaken into GHG conversion at HVO and for this research to be supported by field trials in conjunction with the gas pre-drainage pilot testing.

The Panel recommends that:

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Undertake a desktop modelling assessment of potentially drainable coal seams to assess the effect on reducing the peak emissions. That should aid in driving the targets, the drilling/drainage method/s and the required extent of pre-drainage
2. Evaluate the gas reservoir in greater detail and design drilling/drainage options that suit the mining/geology at HVO
3. Conduct pilot trials of gas pre-drainage within Domain 3.
4. Instigate research into GHG conversion at HVO and for this research to be undertaken in conjunction with the pilot trials
5. Embed in the GHG Management Plan, 3-year action plans (updated every 3 years) for investigating, trialling and implementing all reasonable and feasible technologies:
    a. for conducting gas drainage at HVO, and
    b. for converting CH_4 contained in gas drainage streams to reduce its greenhouse potency.
6. Produce reports every three years that have been peer reviewed by a party approved in writing by the Secretary and that detail:

a. the state of development and implementation of technologies for undertaking gas drainage at surface mines and the actions undertaken by HVOPL to evaluate and utilise these technologies

b. the state of development and implementation of technologies for converting CH_4 contained in gas drainage streams to reduce its greenhouse potency and the efforts made by HVOPL to evaluate and utilise these technologies.

4.3. DIESEL FUEL EMISSIONS

4.3.1. Avoidance

Avoidance of fossil fuel emissions at HVO is dominated by a focus on measures to reduce and/or transition away from the consumption of diesel fuel. Figure 3 shows a steady rise in diesel emissions to 2040, followed by a steady decline until the end of the Continuation Project in 2050. Diesel emissions account for approximately 50% of Scope 1 and Scope 2 emissions at HVO over the proposed Project life and for ~60% of these emissions up to 2040. Stationary and off-road equipment account for approximately 98% of diesel emissions each year of operation, with the trend in emissions correlating reasonably well with ROM production, which is not unexpected. The principal contributors to the diesel GHG emissions are dump trucks, which number about 90 and have gross weights of 400 to 500 t, depending on whether they haul coal or overburden.

There is a limited number of original equipment manufacturers (OEMs) of heavy earth moving equipment, with most serving an international market. The challenges associated with addressing GHG emissions from this type of equipment are universal and outside the capacity and influence of individual operators such as HVO to address. Hence, HVOPL through its Joint Venture partners' membership of the International Council on Mining and Metals (ICMM)[11] is represented in an international joint industry initiative which aims to solve constraints to the development of emissions reduction technologies in mining equipment.

The EA, Submission Report and HVOPL's presentation to the Panel have identified a range of potential alternative means for powering heavy earth moving equipment and have assessed both their technology readiness and commercial readiness for introduction into HVOPL. The assessment, which was peer reviewed, takes into account both the technology readiness of each alternative option and its commercial readiness. Four technologies were identified as being at the right technology readiness level for implementation to reduce diesel consumption in the mining earthmoving sector, these being grid supplied catenary systems for diesel-electric powered trucks, electric machines supplied from the grid through tethered cables, bio-diesel 20% and diesel.

HVOPL has concluded that there are limited opportunities for overhead catenary systems to support diesel-electric trucks in its fleet because of:

- Low differential height for haul routes
- Highly variable mining sequence
- Inability to maintain road condition variability to high tolerances
- Limited number of trucks that can be operated at once
- High potential for electric wheel motor overheating and failure

Electric machines powered from the grid through tethered cables are proven in surface mining operations but there is limited potential for them in fluid and variable working environments such as at

[11] The International Council on Mining and Metals (ICMM), founded in 2001 as a CEO-led leadership organisation on the premise of improving sustainable development in the mining and metals industry

HVO. Equipment that is tethered to a trailing cable is constrained in its flexibility and mobility at the working face and is not amenable to mine layouts which require equipment to be frequently relocated.

Biodiesel is a suitable alternative fuel to diesel but it only goes some way to mitigating diesel related GHG emissions rather than eliminating them. HVOPL also reports that there is a shortage of biofuel, that its burn rate is higher than diesel and that Tier IV engines are not compatible with biofuels.

HVOPL's assessment has also identified a number of emerging technologies that have promising potential. The assessment concurs with the Panel's knowledge and experience of diesel and diesel-electric powered heavy earth moving equipment and confirms its findings that development of some technologies, such as hydrogen and battery powered dump trucks, are still in development and yet to reach proof of concept stage. This is consistent with press releases just as this advice report was being finalised that BHP is to trial first CAT Early Learner battery-electric haul truck at one of its iron ore operations in Western Australia (Szabo, 2023); an electric rail-powered heavy vehicle system is being trialled at a southeast Queensland operation (BHP, 2024); and a trial of battery -electric dump trucks and a joint study into dual fuel (ethanol and diesel) dump trucks in Brazil (Engineering and Mining Journal, May 2024.

HVOPL has stated that it is in a position to stay abreast of developments in technology and its implementation. The Panel agrees. In the meantime, the situation apparently remains as reported in the EIS (EMM, 2022a), being:

> *As diesel fuel consumption represents almost half of estimated direct capitals GHG emissions, measures to minimise GHG emissions at HVO are generally focused on the efficient use of diesel, by:*
>
> - *optimising the design of haul roads to minimise the distance travelled;*
> - *using a fleet management system where required to optimise the efficient use of machinery;*
> - *minimise the re-handling of material (ie coal, overburden and topsoil);*
> - *maintaining the mobile fleet in good operating order; and*
> - *explore options for fuel switching, as well as alternative electricity sources and battery storage*

The Panel notes that these actions are similar (and verbatim in some respects) to those of some other surface coal mining operations in the Hunter Valley[12]. Furthermore, they are implemented in any case at most mining operations for reasons of safety, efficiency and economic performance.

The Panel concludes that:

Avoidance of diesel fuel emissions

1. HVOPL's assessment of the current technology readiness and commercial readiness of alternative power options to diesel for its mining operations is a fair and balanced appraisal of the current status of these options and their potential for application at HVO.
2. HVOPL is positioned to stay abreast of developments in technology to avoid diesel fuel usage and their implementation.
3. In the interim, the only option for significantly reducing diesel fuel emissions is to modify the mine plan, which is likely to result in a significant reduction in recoverable coal over the life of the Continuation Project.

[12] Reference, for example, *Mount Pleasant Operation – 2022 Annual Review*

The Panel recommends that:

If the Continuation Project is to be approved:

1. HVOPL should be required to undertake a review every three years and produce a report that has peer reviewed by a party approved in writing by the Secretary and that details:
    a. the international status of technologies that provide the opportunity to reduce diesel GHG emissions at HVO
    b. the status of initiatives by HVO to implement technologies for avoiding fossil fuel emissions

4.3.2. Mitigation

The Panel concludes that:

Mitigation of diesel fuel emissions

1. There is little that can be done to mitigate diesel GHG emissions. They are a product of combustion for which no viable technology is available or emerging to mitigate the emissions prior to their release directly to atmosphere.
2. Marginal benefits may be obtained from using higher quality fuels and additives.

5.0 CONCLUSIONS AND RECOMMENDATION

5.1. SURFACE AND GROUNDWATER

5.1.1.Summary Conclusions

1. In relation to water-related impacts, there is no reason why the Continuation Project should not be conditionally approved.

2. *Erosion and sediment control during mining operations* is manageable by a suitable Erosion and Sediment Control Plan as proposed by HVOPL.

3. *Loss of downstream flows due to baseflow loss and leakage* as predicted is not of concern. Refinements to groundwater and surface water monitoring would assist future assessment of river-aquifer exchanges.

4. *Loss of downstream flows due to interception of runoff and extractions from water courses during mining operations*; and *Loss of downstream flows due to interception of runoff and groundwater post-closure*. Assuming licensing issues are successfully resolved, these are not impacts of concern.

5. *Flooding impacts on properties, mine operations and stability of the channel*. There are risks associated with erosion and performance of levees, which are manageable by good design and performance monitoring. The flood modelling undertaken for the EIS has been peer reviewed and appears to be appropriate for the purpose of the EIS.

6. *Impacts to Groundwater Dependent Ecosystems (GDEs)* are not expected to be significant. However, the long-term monitoring and assessment of risks to the GDEs would benefit from: Updates to the assessment of the sensitivity of plant species within the Hunter River GDEs to groundwater level declines; appropriate thresholds for water level decline that are specific to each GDE; and extended groundwater modelling uncertainty analyses.

7. *Water overflows and discharges during operations* are manageable under the Hunter River Salinity Trading Scheme and Environmental Protection Licence. The existing Water Management Plan does not clearly specify how both volume and quality of discharges and overflows are monitored. The presentation of predicted discharges and overflows could be improved by showing the full range of predicted site water storage values; and use of a stochastic rainfall model would provide more robust confidence limits on stored and discharged water volumes.

8. *Water overflows and discharges from the final landform* are a potential source of contamination that will need detailed consideration in closure and rehabilitation planning. Further work is needed to better define the long-term risks of contamination to the alluvial aquifer and Hunter River from leakages from the spoil. Clarification of the applicable spoil properties governing recharge, interflow and deep percolation, supported as necessary by additional field and laboratory testing of spoil properties is required. Future updating of the groundwater model and the uncertainty analysis with the updated spoil properties would allow the risks of alluvial and surface water contamination to be addressed.

9. *Carrington West Wing barrier wall installation* prior to mining encroaching the paleo-alluvial channel is expected to be beneficial for mitigating drawdown in the Hunter River alluvium.

Appropriate risk assessment and related modelling is required to support development of the planned Trigger Action Response Plan (TARP) for the wall and the associated monitoring design.

10. *Cumulative impacts* have been given little attention in the surface water assessments. The Panel agrees with the approach because the controls on extractions and discharges are designed to manage cumulative impacts; and because the history of land use in this area makes it difficult to define a useful baseline.

11. *Surface and groundwater monitoring.* Extending the monitoring that is currently in place, including continuous water level measurements that allow variations in the pressure gradient from the Hunter River to the alluvial groundwater to be accurately measured, would provide valuable data on stream aquifer interactions. This would be beneficial for updating TARPs for the alluvial aquifer and for improving the assessment of risks to the Hunter River GDEs. Regularly updating the water monitoring plan is necessary to meet the future requirements of progressive rehabilitation and closure planning.

12. *Groundwater modelling* for the Continuation Project is generally fit for purpose. However, there are areas where the modelling and its presentation could be improved in future assessments to support interpretation of, and increase confidence in, the model results:

    a. detailing a local water balance for the alluvial aquifer in the vicinity of the Carrington West Wing barrier wall.

    b. better linking calibration hydrographs to their monitoring location to aid the interpretation of the modelling results.

    c. showing how the final calibrated model parameter values compare with the prior ranges for the parameters and providing the basis for the prior ranges selected.

    d. demonstrating the groundwater model's goodness of fit is appropriate for the objectives of the modelling. In particular, the quality of the model fit for the quaternary alluvium should be assessed for quality of model fit independently from the rest of the model given the objectives of assessing mining impacts on both the alluvium and related GDEs.

    e. clearly differentiating between model results that are additional to groundwater impacts previously approved under the existing mining approvals and those that include groundwater impacts previously approved.

5.1.2. SUMMARY RECOMMENDATIONS

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Prepare an updated Water Management Plan, incorporating a Water Monitoring Plan, within 6 months of approval that includes the following:

    a. If applicable, any modelled exceedances of the total site storage capacity should be reported (modelled frequency and volume) rather than only showing the 95% bound. As part of the update, more robust confidence limits on stored and discharged water volumes should be provided by use of a stochastic rainfall model.

    b. A plan for continuous monitoring of water levels in the Hunter River that allows accurate measurement of the hydraulic gradient from the river to the alluvial groundwater, as part of a monitoring transect from the river to the Carrington West Wing barrier wall, and to assist with estimating the downward hydraulic gradient to the Permian units.

c. A TARP for the Carrington West Wing barrier wall and associated groundwater monitoring. To develop the TARP, groundwater modelling should be undertaken in support of a risk assessment, first, to assess what constitutes an unacceptable barrier wall failure in terms of groundwater impacts and, second, to assess options for groundwater monitoring to identify such a wall failure. Non-invasive methods of monitoring such as surface electrical resistivity surveys should be investigated as an alternative to, or an adjunct to, groundwater monitoring using nested piezometers.

d. To improve plans for unexpected changes in surface and groundwater results, uncertainty analyses should be extended to assess the long-term risks to the GDEs. Steps to identify the sensitivity of plant species within the Hunter River GDEs to groundwater level declines should be established. The goal is to develop appropriate thresholds for water decline that are specific to each GDE for the risk assessment and groundwater TARPs.

e. Plans for continuous monitoring of flow, EC, pH and total suspended solids (e.g. as turbidity) at identified discharge and overflow points (as well as the existing grab samples).

f. Plans for monitoring and investigation that inform predictions of spoil hydrology, geochemistry and seepage, in order to support progressive rehabilitation and closure planning (in the initially updated Water Management Plan, this may be in general terms and made more specific as rehabilitation and closure planning progresses).

g. Updated requirements for groundwater model review and reporting covering:

   i. detailing a local water balance for the alluvial aquifer in the vicinity of the Carrington West Wing barrier wall.

   ii. better linking of calibration hydrographs to their location to aid interpretation of the modelling results.

   iii. showing how the final calibrated model parameter values compare with the prior ranges for the parameters and providing the basis for the prior ranges selected.

   iv. demonstrating the groundwater model's goodness of fit is appropriate for the objectives of the modelling. Specifically, the quality of the model fit for the quaternary alluvium should be assessed separately from the full model given the objectives of assessing mining impacts on both the alluvium and related GDEs.

   v. clearly differentiating between model results that are additional to groundwater impacts previously approved under the existing mining approvals and those that include groundwater impacts previously approved. Documenting both contributions is required.

   vi. re-evaluation of the physical and environmental mechanisms governing the health of the GDEs and description of their significance for GDE health; and improved use of the groundwater modelling results to explore and explain the relevant GDE impacts.

2. Within 12 months of approval, have the updated Water Management Plan s reviewed by a party approved in writing by the Secretary. The review should address the adequacy of monitoring and mitigation measures.

3. Future progressive rehabilitation and closure plans should include ongoing assessment of the sensitivity of groundwater modelling results to spoil properties and geometries to assess the risks of poor-quality spoil water entering the alluvial aquifer or Hunter River.

5.2. GHG EMISSIONS

5.2.1.GHG SUMMARY CONCLUSIONS

The Panel has confined its advice to fugitive emissions and to the diesel fuel component of fossil fuel emissions given that these two sources account for around 99% of the Project's GHG emissions.

SUFFICIENCY OF OFFSETS

1. HVOPL's offset projections make no allowance for future avoidance and mitigation technologies over which it currently has 'no direct line of sight'.

2. Currently, there are no measures available to HVOPL to reduce GHG emissions other than to change the mine design and/or mine production targets.

3. HVOPL is entitled to offset all its GHG emissions and is currently proposing to do so, at least until alternative and cheaper mitigation options become available.

4. There are no definitive answers to concerns about the availability of offsets in the long term, however, it appears reasonable to expect that:

   a. When offsets are available then market forces should prevail and drive a reduction in GHG emissions if offsets become prohibitively expensive.

   b. If offsets become unavailable then regulatory forces should prevail to prevent emissions that can no longer be offset.

5. If the cost of offsets becomes prohibitively expensive or offsets become unavailable in the future, then there may be no option for managing GHG emissions but to modify the mine plan at that time, which could include early mine closure.

6. Modifying the mine plan in a manner that reduces production achieves both a reduction in fugitive emissions and a reduction in fossil fuel emissions, which are predominantly diesel fuel emissions and which constitute around 60% of GHG emissions up to 2040.

7. Technological developments in mitigating GHG emissions in the interim could have significant positive impacts on the scale and cost of offsetting and, therefore, on the extent of any changes to the current mine plan.

8. Analysis of the distribution of both gas contents and volumes in the proposed mining areas, review of the nature and status of potential and emerging mitigation measures, and assessment of the nature, potential success and impact of some existing and likely future opportunities for avoiding and mitigating GHG emissions provides a basis for the Department to formulate its views on the sufficiency of avoidance and mitigation measures, including offsets.

9. The analysis, review and assessment can be broken into two elements, being fugitive GHG emissions and diesel fuel GHG emissions.

FUGITIVE EMISSIONS

Avoidance

1. The only fugitive emissions avoidance measure available is mine planning that restricts the areal extent of mining and/or the depth of mining.

2. A significant fugitive emissions avoidance measure at HVO would be not to mine Zones 2, 3 and 4 in Domain 1.

   a. If Zones 2, 3 and 4 in Domain 1 were not to be mined and the current mine plan was not to be revised, mining would effectively cease at the end by 2044, some 6 years earlier than planned. However, it is possible that mining may cease before that date due to the impacts and consequences of such a decision on the viability of mining just Zone 1.

   b. If Zones 2, 3 and 4 in Domain 1 were not to be mined, a revised mine plan may result in the remaining mining in Domain 3 being completed earlier than 2044.

   c. If consideration is to be given to these types of options, the options should be put through a mine planning process to verify the merits and impacts of the options and properly inform decision making.

Mitigation:

1. The first 16 years of the Continuation Project to 2039 account for ~50% of fugitive emissions over the life of the Continuation Project, with the majority of the fugitive emissions coming from mining the deeper Zones 3 and 4 in Domain 3.
2. The remaining ~50% of fugitive emissions are produced in the last 11 years of the Continuation Project primarily from mining Zones 2, 3 and 4 in Domain 1.
3. The potential to mitigate fugitive emissions is dependent on the technical and economic feasibility of each stage of a two-stage process, being:

- Capture of coal seam gas; and
- Conversion of captured coal seam gas into less potent forms of greenhouse gas

Capture

a. Gas pre-drainage is the only technology currently available which has potential for capturing coal seam gas.

b. The effectiveness of gas pre-drainage as the first stage of the process for mitigating fugitive emissions in open-cut mining is as yet unproven.

c. Gas drainage at HVO is constrained by reservoir characteristics and the geographical extent, complexity and dynamic state of surface mining activities.

d. Based on the Panel's analysis, if pre-drainage proves to be technically feasible it could potentially capture 30% to 50% of coal seam gas in Zones 3 and 4 in Domain 3 at HVO.

e. Assuming complete combustion of captured coal seam gas, 30% to 50% drainage of Zones 3 and 4 in Domain 3 would result in a reduction of ~17% to 34% CO_2-e to the atmosphere over the period from 2025 to 2040; however, that reduction will be less because of the time required to 1) develop and commission pre-drainage technologies; 2) pre-drain areas; and 3) develop and commission gas conversion technologies.

f. Pre-drainage trials should be prioritised in Zones 3 and 4 in Domain 3, and not in Domain 1 as apparently proposed by HVOPL.

Conversion

a. The potential to flare and/or utilise captured coal seam gas at HVO in order to reduce its CO_2-e contribution is still to be determined.

b. Should the Continuation Project be approved, there is a need for research to also be undertaken into GHG conversion at HVO and for this research to be supported by field trials in conjunction with the gas pre-drainage pilot testing.

Diesel Fuel Emissions

Avoidance of diesel fuel emissions

1. HVOPL's assessment of the current technology readiness and commercial readiness of alternative power sources to diesel for its mining operations is a fair and balanced appraisal of the current status of these options and their potential for application at HVO.
2. HVOPL is positioned to stay abreast of developments in technology to avoid diesel fuel usage and their implementation.
3. In the interim, the only option for significantly reducing diesel fuel emissions is to modify the mine plan, which is likely to result in a reduction in recoverable coal over the life of the Continuation Project.

Mitigation of diesel fuel emissions

1. There is little that can currently be done to mitigate diesel GHG emissions. They are a product of combustion for which no viable technology is available or emerging for mitigating the emissions prior to their release directly to atmosphere.
2. Marginal benefits may be obtained from using higher quality fuels and additives.

5.2.2.GHG SUMMARY RECOMMENDATIONS

Fugitive Gas Emissions

Gas Reservoir Assessment

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Conduct testing within 3 years to confirm the degree to which nitrogen (N_2) in gas determinations is naturally occurring in coal at HVO or as a contaminant introduced during gas determination testing, or a combination of both;
2. Subject to the outcomes of testing to confirm the source/s of N_2 in gas determinations, modify GHG emissions assessments accordingly; and
3. Within 3 years, drill and test an additional borehole approximately 400 m north west of the Hunter Valley Dyke to support the quality of *in situ* gas evaluation within the Low Gas Zone in Domain 2

Avoidance

1. If modifications are to be made to the mine design for the purpose of avoiding GHG emissions, they should include a focus on assessing the impacts in Domain 1of not extracting Zone 2 (low gas concentration but high volume) and/or Zone 3 (high gas concentration and significant volume) and/or Zone 4 (high gas concentration and significant volume).

Mitigation

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Undertake a desktop modelling assessment of potentially drainable coal seams to assess the effect on reducing the peak emissions. That should aid in driving the targets, the drilling/drainage method/s and the required extent of pre-drainage
2. Evaluate the gas reservoir in greater detail and design drilling/drainage options that suit the mining/geology at HVO
3. Conduct pilot trials of gas pre-drainage within Domain 3.
4. Instigate research into GHG conversion at HVO and for this research to be undertaken in conjunction with the pilot trials
5. Embed in the GHG Management Plan, 3-year action plans (updated every 3 years) for investigating, trialling and implementing all reasonable and feasible technologies:
    a. for conducting gas drainage at HVO, and
    b. for converting CH_4 contained in gas drainage streams to reduce its greenhouse potency.
6. Produce reports every three years that have been peer reviewed by a party approved in writing by the Secretary and that detail:
    a. the state of development and implementation of technologies for undertaking gas drainage at surface mines and the actions undertaken by HVOPL to evaluate and utilise these technologies
    b. the state of development and implementation of technologies for converting CH_4 contained in gas drainage streams to reduce its greenhouse potency and the efforts made by HVOPL to evaluate and utilise these technologies.
    c. for reducing the greenhouse potency (CO_2-e) of CH_4 contained in gas drainage streams.

<u>Diesel fuel emissions</u>

Avoidance

If the Continuation Project is to be approved, approval conditions should require HVOPL to:

1. Undertake a review every 3 years that have been peer reviewed by a party approved in writing by the Secretary and that details:
    a. the international status of technologies that provide the opportunity to reduce diesel GHG emissions at HVO
    b. the status of initiatives by HVO to implement technologies for avoiding diesel fuel emissions

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APPENDIX A - DPHI Request for Advice

Emeritus Professor Jim Galvin
Chair - Independent Expert Advisory Panel for Mining

By email: j.galvin@bigpond.net.au

Dear Prof Galvin

Request for Advice

Hunter Valley Operations Continuation Project

I am writing to you to request advice from the *Independent Expert Advisory Panel for Mining* (the Panel) in relation to the Hunter Valley Operations (HVO) Continuation Project (the project). The Department is currently undertaking a detailed assessment of the project, in consultation with other key government agencies.

For context, HV Operations (the Applicant) has lodged two Development Applications (DAs), one for the HVO North Continuation Project (SSD-11826681) and a second for the HVO South Continuation Project (SSD-11826621). The project involves continuation of mining at both HVO North and HVO South, which are currently approved under two separate development consents, but are operated as a single mining complex. Importantly, HV Operations has prepared a single Environmental Impact Statement (EIS) to cover both applications.

To assist it in assessing the project, the Department requests advice from the Panel on the scale, likelihood, and consequences of the project's impacts on water resources and greenhouse gas (GHG) emissions. A copy of the EIS and relevant assessment documents are provided as attachments to this letter.

The project involves the continuation of the life of HVO North and HVO South, from the current approved mining completion dates of 2025 and 2030 respectively, to the end of 2050 at HVO North and the end of 2045 at HVO South. Continuation of mining across the HVO Complex would optimise resource recovery from the existing operation, predominantly by extracting coal from deeper seams at HVO North, by mining through previously mined areas. At HVO South, an extension to the life of the mine is proposed to facilitate improved mine sequencing outcomes.

The project is proposing to extract a further 400 million tonnes (Mt) of run-of-mine (ROM) coal from HVO North. In addition to this, it is important to note that there is approximately 320 Mt of ROM coal previously approved to be extracted under the existing consents which has not yet been mined. As such, the SSDs (if approved) would result in approximately 720 Mt of additional coal being extracted from the complex.

HVO North and HVO South are separated by the Hunter River. The protection of this feature has been a key issue for other projects in the Hunter Valley, particularly the surface and groundwater interactions. Given the proposed proximity of mining to the Hunter River, the Department considers water-related impacts, including potential impacts on groundwater dependent ecosystems, are a key technical issue for the project, including whether suitable measures have been proposed to proactively manage these impacts.

Further to this, given the quantity of coal proposed to be extracted, the Department considers that the associated GHG emissions are also a key technical issue. The GHG assessment predicts that the gross Scope 1 and 2 emissions from the project would be approximately 29.6 Mt CO2-e (approximately 50% of which would be fugitive emissions), while the net emissions are predicted to be 17.9 Mt CO2-e. Noting that the Applicant is proposing to rely on carbon offsets under the Safeguard Mechanism to abate the difference of 11.7 Mt CO2-e.

With this in mind, the Department requests that the Panel provide advice targeting the following:

- the scale and likelihood of potential water-related impacts and environmental consequences on key water features in the vicinity of the project area, including the Hunter River;
- whether the proposed water-related mitigation and monitoring measures would adequately minimise any environmental consequences on significant water features; and
- whether the GHG avoidance and mitigation measures proposed by the Applicant are considered to be sufficient, including the reliance on availability of carbon offsets in the future.

The Panel should also feel free to provide any other advice it considers would assist the Department in assessing the project.

It would be appreciated if the Panel can provide initial advice on the project by 19 April 2024, subject to any additional information requirements that may be requested by the Panel.

The Department can arrange a briefing for the Panel as soon as practicable and to provide any further information or assistance required by the Panel. The Department can also arrange a briefing with the Applicant and its consultants, or a site visit if this assists in the review. Please contact Joe Fittell on (02) 4908 6896 or joe.fittell@planning.nsw.gov.au

Yours sincerely,

5 March 2024

Steve O'Donoghue
Director Resource Assessments

Attachments:

1. HVO Continuation Project EIS – Main Report
2. HVO Continuation Project EIS – Appendix F Statutory Compliance Table
3. HVO Continuation Project EIS – Appendix H Air Quality and GHG Assessment
4. HVO Continuation Project EIS – Appendix K Water Assessment
5. HVO Continuation Project EIS – Appendix M Aquatic Ecology and Groundwater Dependent Ecosystem Assessment
6. HVO Continuation Project EIS – Appendix T Mine Closure and Rehabilitation Strategy
7. HVO Continuation Project Submissions Report – Main Report
8. HVO Continuation Project Submissions Report – Appendix D Water Licencing Strategy
9. HVO Continuation Project Submissions Report – Appendix E Surface Water Model Review
10. HVO Continuation Project Submissions Report – Appendix M Coal Bed Report
11. HVO Continuation Project Amendment Report – Main Report
12. HVO Continuation Project Amendment Report – Appendix B Description of Amended Project
13. HVO Continuation Project Amendment Report – Appendix D Statutory Compliance Table (revised)
14. HVO Continuation Project Amendment Report – Appendix F GHG Emissions by Activity (revised)
15. DPE Water Advice on EIS
16. DPE Water Additional Advice on EIS
17. DPE Water Advice on Submissions Report
18. Department’s Climate and Atmospheric Science Branch – Advice on EIS

The above documents (along with the other reports prepared for the EIS) are all available at the below link: https://www.planningportal.nsw.gov.au/major-projects/projects/hvo-north-open-cut-coal-continuation-project