PEMBROKE

Olive Downs Coking Coal Project

Draft Environmental Impact Statement

Attachment 4

Peer Review Letters

KALF AND ASSOCIATES Pty Ltd
Hydrogeological, Numerical Modelling Specialists

Pembroke Olive Downs Pty Ltd

Olive Downs Coking Coal Project
Final Peer Review of HS
Groundwater Assessment and Modelling

Dr F. Kalf
B.Sc. M.App.Sc PhD
27 July 2018

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Background and Key Issues Summary

This report is the Kalf and Associates Pty Ltd (KA) peer review commissioned by Pembroke Olive Downs Pty Ltd for the Olive Downs Coking Coal Project groundwater and modelling assessment conducted by HydroSimulations for incorporation into the broader Environmental Impact Statement (EIS). It follows from an earlier KA assessment with suggested inclusions and clarifications.

For the modelling review herein, the available Modelling Guideline documents (NWC 2012, MDBC 2001) content have been taken into consideration in this assessment. A modelling appraisal checklist is provided herein as an attached Appendix.

The Olive Downs Coking Coal Project is an open cut coal mine in the northern Bowen Basin in Central Queensland. Several mining pits, within the MLA1 and 2 boundaries (Figure 1-2 HS 2018), are to be constructed over a period of 70 years with ultimately a total of 400 Mt of coal extraction from two coal seams, the Leichardt and Vermont, within the Rangal Coal Measures. The project will include the establishment of a range of infrastructure and storage facilities for waste rock and water dams, treatment plants with four voids in the post-closure landscape.

This groundwater report together with geotechnical and environmental reports have been prepared in accordance with the Queensland Government's Commonwealth Environment Protection and Biodiversity Conservation (EPBC Act) 1999.

The Bowen Basin geological profile comprises Early to Late Permian sedimentary sequence, and above those units the Triassic and Cainozoic stratigraphy overlain by Quaternary alluvium surficial cover along the Isaac River (clays, sandy clays, sand and gravel HS Figure 4-4). The Rangal Coal Measures are situated at the top of the Late Permian sequence and comprises coal seams, carbonaceous shale, mudstones, and siltstones with carbonaceous plant material (Figure 4-8 HS 2018). The coal seams of the Rangal Coal Measures sub-crop lie beneath the alluvium and regolith at an elevation of about 165mAHD dip at an average 7^{o} although this dip angle is variable toward the east (within a regional plunging syncline). Within the section depicted in Figure A below, ground surface is for the most part at about 180mAHD rising locally to about 190mAHD. The proposed open cut mining of the two coal seams is to be extracted to a depth of about 0mAHD (Figure HS 4-6, see the proposed pit stippled outline in Figure A below).The lower Leichardt seam is comprised of three splits (1m; 2.5m and 1.7m) and lie between 25m to 317m below ground surface, whilst the Vermont seam below it is between 3.8m to 5.1m thick (HS Figure 4-8).

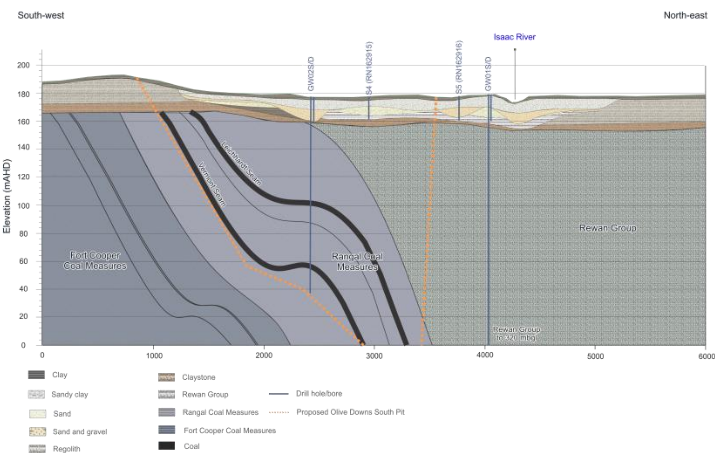

Figure A. (From HS Figure 4-6) Section indicating dipping Leichardt and Vermont coal seams and outlined open pit extent to a final depth of about 0mAHD.

Groundwater occurs within the entire geological profile that is monitored by numerous bores (21) and five vibrating wire piezometers (with 20 sensors) (HS Figure 5-1).

Groundwater flow in the Permian strata follows the downstream gradient of the Isaac River in a southeast direction. Permian groundwater water level elevations vary between 130mAHD and 170mAHD (HS Figure 5-13). The Isaac River is considered to be mainly a losing stream with stream-stage elevation situated above the underlying shallow groundwater water table.

With regard to recharge and discharge the following is relevant. Monitoring has indicated that much of the alluvium along upper reaches of creeks is mostly dry no doubt due to the ephemeral conditions of those streams. This also applies to the Regolith (15m to 45m thick) that is also, for the most part, unsaturated. Within influence of the Isaac River the alluvium remains saturated with the greatest thickness along the alignment of the river confirming that it is a losing stream. In general the watertable is at a depth of between 10m to 20m below the ground surface and about 3m below the river. Recharge due to direct rainfall is not substantial and is restricted by clayey sediments at the surface and rocks of low hydraulic conductivity together with infiltration removed by evapotranspiration. The report has also referred to the likely existence of perched water tables because of these hydrological conditions. For the lower Rewan Group (Early Triassic sedimentation above the Permian) monitoring indicates groundwater flow is downward although it is restricted with the Rewan Group which acts as an aquitard.

Depending on location, groundwater quality varies considerably over the region as follows: Isaac River (>0 to 500 mg/L); Alluvium (201 to 3,430 mg/L); Regolith (1,460 to 18,600 mg/L); Interburden (421 to 18,400mg/l); Coal (2,544 to 14,700 mg/L) (HS Figure 5-23).

Numerical model predictions indicate that inflows into the open cut would peak in year 2037 at 4.5 ML/day (1,636 ML/yr) with an average of about 1.7 ML/day (638 ML/yr) during mine operation.

Predicted drawdowns due to mining the open cut (decreasing exponentially with distance to 1m) extend up to 4 km north and 5 km south of the proposed pit (HS Figure 6-3). Drawdown in the Leichardt and Vermont seams are shown in HS Figures 6-4 and 6.5 for contours greater than about 5m.

The model has predicted an average increase in river water capture at 2.6 ML/day representing a reduction of 0.5% in surface flow.

Final voids would remain within the topography with a post closure long time loss of baseflow of 1.9 ML/day predicted.

Specific tests have been conducted on the likely future spoil infill material that includes non-carbonaceous and carbonaceous, claystone, sandstone and siltstone. The test have shown low sulphur content, EC in the range 158 µS/cm to 1,050 µS/cm, low aluminium and arsenic and metals below laboratory limits.

Peer Review Assessment

Previous Studies and Reviews

Previous studies of the site have been by conducted by Ausenco-Norwest, 2012; DPM EnviroScience's (2018a&b); IMC Mining Group Pty Ltd, 2014; JB Mining Services, 2016; KCB, 2016. These references are available in the HS (2018) report.

Hydrogeological and Modelling Description

The hydrogeological description of the region and modelling work as described in the report HS (2018) is detailed and comprehensive. The report contents and figures, tables and Appendices are set out in pages ii, ii, iii, iv and v of the HS report and cover the important and expected range of items.

The report also includes a more detailed Appendix A that deals with available groundwater data, and Appendix B describing the numerical modelling used in this Project.

Model Conceptualisation, Model Code and Simulation Methods

Conceptualisation for the HS model is considered suitable as shown in the sections of the syncline geological structure (Figure 5-34 and 5-35) (HS 2018).

HS has developed the model using Graphic Information Systems (GIS) together with the more recent MODFLOW-SURFACT-USG[1] (MS-USG) groundwater and associated surface water computer code that has allowed a model mesh of variable cell size and orientation and the ability to include structures of variable orientation,(HS Figure 6-4). Also the model can be and has been run using variably saturated conditions.

The Pembroke numerical model comprises 14 layers representing all the geological units comprising 91,806 cells per layer. Many of these cells are "pinched out" reducing active cell numbers to 966,821. Cell sizes (50m, 100m to 200m) and model extent provides more than an adequate resolution for the proposed simulation (HS Figure 6-3 HS) as well as being desirable in reducing computational effort. Model Layers and thicknesses are presented in Table 2-1 in HS 2018b Appendix B. For cumulative assessment the longwall mining in adjacent mines have had regular square cells applied to represent 375m and 400m longwall panels,(HS 2018b, Appendix B, Figure 2-1).

The model cell domain also has sufficient area coverage to minimise the external boundaries influence on drawdown. The Isaac River has been modelled using the MS-USG more advanced 'Stream Flow Routing' package, which allows routing of stream flow down the stream channel while other streams have utilised the standard 'River' package with the ability to set stage heights (HS Table 2-2 Appendix B) such that the creeks can act either as a gaining or losing streams. These model assignments are considered suitable for the area. As well as the depicting various ephemeral and perennial stream channels the model also includes representation of faults.

Both a "no flow" boundary and General Head B (GHB) boundary conditions have been applied in the model to account for higher head inflow using GHB. This is considered suitable.

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[1] USG – 'Un-Structured Grid' using Veronoi model cells.

Rainfall recharge amount was applied depending on the relevant geological unit and was controlled by the calibration process. Evapotranspiration was set to an average of 600mm/yr and extinction depth of 2m below ground surface.

Open cut mining has been simulated using the drain option in MS-USG applied to all layers from the ground surface to the base of the lowest coal seam. For cumulative analysis the drain cells were set based on EIS information and aerial photography.

For the backfilling sequence of mined out pits, these were filled with simulated spoil; and waste rock and assigned a hydraulic conductivity of 2 x 10^{-1} m/day and specific yield of 0.05 and rainfall recharge rate of 1%.

Hydraulic Parameters & Model Calibration

Initial hydraulic parameters were based on hydraulic tested values (slug, packer and airlift yields) as well as core samples for vertical and horizontal hydraulic conductivity (Section 5.2 HS 2018).Detailed data is provided in Section 4 HS (2018a).

In-situ faults have variable hydraulic conductivity with Coffey consultants having determined conductivity dependent on depth (HS Figure 5-4). However, overall faults act more as barriers (much lower conductivity than host rock) except at shallow depths that TEM surveys have shown are associated with saline groundwater.

Steady-state simulation was used to set up initial conditions (pre 2006) in the HS model combined with transient calibration (2006 to 2017). This is a suitable and desirable methodology. Open-cut mining was simulated using the standard 'drain' methodology with subsequent spoil infilling and changes in hydraulic parameters and rainfall recharge. Model water balance for steady state and transient calibration are presented in Tables 2-4 and 2-7 (HS Appendix B).

Both manual and Parameter Estimation (PEST) computer code were used for calibration. Calibrated steady state parameters were adopted in the transient calibration with only specific storage and specific yield varied in the transient case. The steady state calibration produced an 8.7% scaled root mean squared (SRMS) error while the transient calibration yielded a 7.9% SRMS error. Both results lie within the 10% acceptable limit. Section 2.8 and Table 2-8 (HS 2018 Appendix B) lists the calibrated hydraulic parameters.

Model Predictions and Influence

Prediction runs were conducted to determine both the proposed mining including the surrounding mines over the period 1 January 2018 to 31 December 2095 as a cumulative assessment. Three different scenarios were modelled. These included a 'Null' run with no future mining; an 'Approved' and foreseeable mining period and a 'Modification' run with 'Approved' and foreseeable mining plus the Olive Downs Coking Coal Project.

Maximum drawdown was obtained by comparison of 'Approved' and 'Modification' simulation. Drawdowns are depicted in HS Figure 6-3 in the regolith and alluvium with the 1m drawdown extending several kilometres from the Project mining. In the mined out seams depressurisation contours are shown in HS Figures 6-4 and 6-5 for greater than 5m for the western depressurisation extent.

The drawdown results indicate that water levels in private bores[2] in the alluvium and Permian strata will be affected by the Project. The predicted drawdowns in private bores due to the Project are summarised in HS Table 7-1. This table indicates two bores with

[2] See also Section 6 'Landholder Bore Census' HS(2018a)

drawdown influence of between 1.6m and 3.6m in the alluvium and two bores in the Permian with 11.5m drawdown influence and one with 14.4m drawdown influence due to the Project. The HS report has outlined specific conditions under which the drawdown influence will vary over time. But clearly any significant loss of yield experienced in these bores would need to be rectified by *"making good"* any such loss. Potential make good measures are outlined in HS Section 8.1.2.

The DPM have indicated that: *"…….should the Project result potential impacts to the riparian vegetation mapped in these areas (RE 11.3.25), they are known to occur more extensively along the extent of the Isaac River and Ripstone Creek and as such the community (as a whole) is unlikely to be significantly impacted.*

As described in Section 5.9, the terrestrial riparian vegetation associated with North Creek and Cherwell Creek may also be a GDE. The terrestrial riparian vegetation and aquatic habitats along North Creek and Cherwell Creek are located outside the area of potential drawdown associated with the Project (HydroSimulations 2018). As such, these features are unlikely to be impacted by the Project."

The modelling results indicate that the rate of seepage from the Isaac River due to Project drawdown would increase by an average of 2.6 ML/day representing a 0.5% reduction in river flow over the full period of mining. Post mining loss to baseflow is predicted to be 1.9 ML/day after equilibrium is established after water level recovery in association with the final voids within two areas (ODS3 and ODS7/ODS8) separated by waste rock. Recovery equilibrium levels within the pits are expected to be respectively 65m to 140m below pre-mining groundwater levels. Within the Willunga domain the final void would have a pit lake level of about 63mAHD that is a level about 77m below the pre-mining groundwater level. The voids will act as "sinks" in perpetuity and therefore no contained water of whatever quality would escape into the surrounding groundwater system.

Sensitivity Analysis

Sensitivity analysis was conducted that included changes to a range of key parameters and model assumptions. In particular it included specific yield, spoil hydraulic parameters and fault hydraulic properties (HS Section 5, Appendix B).

Uncertainty Analysis

The Uncertainty Analysis has been conducted using the Monte Carlo stochastic methodology with regard to hydraulic conductivity and specific yield. That is, using alternative sets of input parameters in a separate set of computer simulations and then using statistical methods to assess the results. HS have implemented a new propriety method to achieve the analysis using their *'AlgoCompute'* software cloud computing algorithms that allow simultaneous (255) model runs in association with uncertainty quantification software and the pilot point method. Additional details and procedures are fully explained in Section 6.1 (HS 2018b Appendix B).

The results from 312 accepted model runs provided likelihood of exceedance values of stream flow influence and water capture (HS Appendix B, Table B6-4). In addition the probability of exceedance of 1m drawdown of the water table is also presented (HS 2018b Figure B6-9 Appendix B) including leakage from the Isaac River and other streams (HS 2018b Figures B6-11, B6-12). In addition the probability of exceedance of direct and indirect alluvial water capture is presented as well as baseflow from the Isaac River.

Groundwater Monitoring and Mitigation

The groundwater level monitoring will be maintained according to the HS report (Section 8.2.1 and HS Figure 8-1, HS 2018). This would also include water quality sampling. HS Table 8-1 lists the proposed site monitoring details type with site location, screen depth, monitored geological unit; and standing water level measurement frequency. Detailed data is provided in Tables A3-1 and A3-2 HS 2018a Appendix A.

HS has also outlined the Data Management and Reporting as follows:

"*Routine groundwater monitoring will be conducted on a quarterly basis….. Data will be stored within a consolidated groundwater database. Quality assurance and quality control procedures will be put in place to help ensure the accuracy of data entered within the database. Prior to commencement of coal extraction, groundwater quality triggers will be established…….*

When coal extraction commences at site, findings from the quarterly monitoring events will be presented in a factual quarterly monitoring report. The quarterly review will include identification of any groundwater quality trigger exceedances. Where a trigger exceedance is identified, the regulator will be notified within 28 days. Investigation into the cause of the exceedance will also be conducted by suitably qualified personnel. The groundwater database and factual quarterly reports will be available for provision to the regulator upon request.

Each year an annual review of groundwater level and quality trends will be conducted by a suitably qualified person and provided to the regulator. The review will assess the change in groundwater level and quality over the year, compared to historical trends and impact assessment predictions. The annual review will discuss any groundwater trigger exceedances or where trends show potential for environmental harm."

While no specific mitigation strategies have been outlined for individual bores, potential options are outlined and may include deepening a bore to increase its pumping capacity, constructing a new water supply bore, providing water from an alternative source or financial compensation (HS Section 8.1.2). Remediation of bore loss of pre-mining yield that has been proven to be influenced by mining drawdown would need to be addressed.

Conclusions

This peer review has assessed the adequacy of the hydrogeological data and the numerical model for predicting the drawdown influences of the proposed Olive Downs Coking Coal Project. The conceptualisation, numerical model set up, calibration phase and predictions are considered to have been conducted in a professional manner. HS has also introduced in this project the use of new innovative computational method for uncertainty analysis using the Monte Carlo method.

The overall results of the assessment and numerical modelling indicate that the model is "Fit-for-purpose".

In addition to the annual review noted in the last paragraph quoted in the text above, the monitoring results should be compared to the numerical model predictions after 5 years of mining and the model recalibrated if required.

References

HydroSimulations 2018. *Olive Downs Project. Groundwater Modelling and Assessment. Pembroke Resources Pty Ltd. Project No PEM002. Report HC2018/26. July.*

HydroSimulations 2018a *Olive Downs South and Willunga. Appendix A. Modelling Appendix Pembroke Resources Pty Ltd. May.*

HydroSimulations 2018b *Olive Downs South and Willunga. Appendix B. Modelling Appendix Pembroke Resources Pty Ltd. July.*

National Water Commission (NWC) 2012 *Australian Groundwater Modelling Guidelines. Report prepared by Barnett, B., et. al. Waterlines Report Series No 82, June.*

Murray Darling Basin Commission (MDBC) 2001. *Groundwater Flow Modelling Guideline. Report prepared by Middlemis, H., Merrick, N., and Ross, J., Jan.*

APPENDIX

MODEL APPRAISAL

	ISSUES	Not applicable or Unknown					COMMENTS
1.0	**THE REPORT**						
1.1	Is there a clear statement of project objectives in the modelling report?		Missing	Deficient	Adequate	Very good	
1.2	Is the level of model complexity clear or acknowledged?		Missing	No	Yes		
1.3	Is a water or mass balance reported?		Missing	Deficient	Adequate	Very good	
1.4	Has the modelling study satisfied project objectives?		Missing	Deficient	Adequate	Very good	
1.5	Are the model results of any practical use?			No	Maybe	Yes	
2.0	**DATA ANALYSIS**						
2.1	Has hydrogeology data been collected and analysed?		Missing	Deficient	Adequate	Very good	
2.2	Are groundwater contours or flow directions presented?		Missing	Deficient	Adequate	Very good	
2.3	Has all relevant potential recharge data been collected and analysed?		Missing	Deficient	Adequate	Very good	
2.4	Has all relevant potential discharge data been collected and analysed?		Missing	Deficient	Adequate	Very good	
2.5	Have the recharge and discharge datasets been analysed for their groundwater response?		Missing	Deficient	Adequate	Very good	
2.6	Are groundwater hydrographs used for calibration?			No	Maybe	Yes	
2.7	Have consistent data and standard elevation units been used?			No	Yes		
3.0	**CONCEPTUALISATION**						
3.1	Is the conceptual model consistent with project objectives and the required model complexity?		Unknown	No	Maybe	Yes	
3.2	Is there a clear description of the conceptual model?		Missing	Deficient	Adequate	Very good	
3.3	Is there a graphical representation of the modeller's conceptualisation?		Missing	Deficient	Adequate	Very good	
3.4	Is the conceptual model unnecessarily simple or unnecessarily complex?			Yes	No		
4.0	**MODEL DESIGN**						
4.1	Is the spatial extent of the model appropriate?			No	Maybe	Yes	
4.2	Are the applied boundary conditions plausible and unrestrictive?		Missing	Deficient	Adequate	Very good	
4.3	Is the software appropriate for the objectives of the study?			No	Maybe	Yes	
5.0	**CALIBRATION**						
5.1	Is there sufficient evidence		Missing	Deficient	Adequate	Very	

	provided for model calibration?					good	
5.2	Is the model sufficiently calibrated against spatial observations?		Missing	Deficient	Adequate	Very good	
5.3	Is the model sufficiently calibrated against temporal observations?		Missing	Deficient	Adequate	Very good	
5.4	Are calibrated parameter distributions and ranges plausible?		Missing	No	Maybe	Yes	
5.5	Does the calibration statistic satisfy agreed performance criteria?		Missing	Deficient	Adequate	Very good	
5.6	Are there good reasons for not meeting agreed performance criteria?		Missing	Deficient	Adequate	Very good	Performance criteria have been met
6.0	**VERIFICATION**						
6.1	Is there sufficient evidence provided for model verification?		Missing	Deficient	Adequate	Very good	All data used for calibration Verification with ongoing monitoring
6.2	Does the reserved dataset include stresses consistent with the prediction scenarios?		Unknown	No	Maybe	Yes	
6.3	Are there good reasons for an unsatisfactory verification?		Missing	Deficient	Adequate	Very good	
7.0	**PREDICTION**						
7.1	Have multiple scenarios been run for climate variability?		No	Deficient	Adequate	Very good	
7.2	Have multiple scenarios been run for operational management alternatives?		No	Deficient	Adequate	Very good	
7.3	Is the time period for prediction comparable with the duration of the calibration period?		Missing	Greater than	Similar to	Less than	
7.4	Are the model predictions plausible?			No	Maybe	Yes	
8.0	**SENSITIVITY ANALYSIS**						
8.1	Is the sensitivity analysis sufficiently intensive for key parameters/		Missing	Deficient	Adequate	Yes	
8.2	Are sensitivity results used to qualify the reliability of model calibration?		Missing	Deficient	Adequate	Yes	
8.3	Are sensitivity or uncertainty results used to qualify the accuracy of model prediction?		Missing	Deficient	Adequate	Yes	
9.0	**UNCERTAINTY ANALYSIS**						
9.1	If required by the project brief, is uncertainty quantified in any way?		Missing	No	Adequate	Yes	
9.2	**Is the model 'fit-for-purpose'?**			No		Yes	

27 July 2018

Development Manager
Pembroke Resources Pty Ltd
Level 21
50 Bridge Street
Sydney NSW 2000
Attention: Blair Richardson

Blair,

Re: Olive Downs Coking Coal Project EIS – Surface Water Assessment Peer Review

I have reviewed and commented on the Surface Water Assessment for the Olive Downs Coking Coal Project (the Project) Environmental Impact Statement (EIS) prepared by Hatch. This included progressive review of the methodology, a review of the preliminary technical findings and Revision 6 of the Surface Water Assessment report dated 26th July 2018 as well as earlier revisions.

In undertaking the review I have checked that the Surface Water Assessment report addresses the surface water resources related requirements for information, analysis and assessment set out in the final Terms of Reference for the Olive Downs Project EIS issued on 28th June 2017[1]. These are summarised in Section 2 of the Surface Water Assessment report.

Through the peer review process I have made a number of requests for clarification and suggestions for modifications to the methodology and reporting. The majority of these were resolved to my satisfaction. It is concluded that the assessment as it stands is sufficient and fit for purpose for the EIS, in terms of the assessment of surface water-related impacts as it has:

- adequately described the existing surface water environment in the vicinity of the Project, and the relevant environmental values;
- developed and described a proposed comprehensive water management system and demonstrated through modelling that such a system is predicted to operate adequately under a range of climatic scenarios; and

[1] Department of State Development (2017). "Terms of reference for an environmental impact statement: Olive Downs Project". Queensland Government Coordinator General, June.

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- assessed the potential impacts on relevant environmental values due to the development of the Project.

During the review of the project water balance modelling it was noted that a number of assumptions and considerations were made (with justification), however it is recommended that further analysis be conducted during subsequent studies or detailed design to refine the design of the water management infrastructure. In summary, the recommendations for further analysis were as follows:

- daily evaporation rates should be used in model simulations;

- improved catchment yield (flow) modelling of the Isaac River using streamflow data from the Deverill gauging station; and

- review of the proposed design criteria for the sizing of final void upslope drains (to confirm the drains would meet the desired objectives - i.e. to minimise the surface catchment reporting to the final voids).

Notwithstanding the above, this further analysis is considered unlikely to significantly affect the modelling outcomes/conclusions and therefore assessment of potential impacts already described in the Surface Water Assessment.

Please contact the undersigned if you require further information.

Yours faithfully,

Tony Marszalek
Director

27 July 2018

Development Manager
Pembroke Resources Pty Ltd
Level 21
50 Bridge Street
Sydney NSW 2000
Attention: Blair Richardson

Blair,

Re: Olive Downs Project EIS – Flood Assessment Peer Review

I have reviewed and commented on the flood assessment for the Olive Downs Project Environmental Impact Statement (EIS) prepared by Hatch. This included progressive review of the methodology, preliminary technical findings and of Revision 1 of the Flood Assessment report dated 25th July 2018 as well as earlier revisions.

In undertaking the review I have checked that the Flood Assessment report addresses the relevant (flood-related) requirements for information, analysis and assessment set out in the final Terms of Reference for the Olive Downs Project EIS issued on 28th June 2017[1]. These are summarised in Section 2 of the Flood Assessment report.

Through the peer review process I have made a number of requests for clarification and suggestions for modifications to the methodology and reporting. The majority of these were resolved to my satisfaction. The following specific issues relating to Isaac River modelling were noted during the review:

- the use of widely varying loss values on hydrological model calibration;
- hydrological model simulation of no less than 12 hour duration rainfall events for higher annual exceedance probability (AEP) events – particularly the 50% AEP; and
- the method used in the flood model to account for sediment build-up at the Deverill Gauging Station.

It was resolved that the modelling as it stands is sufficient and fit for purpose for the EIS, in terms of the assessment of relative flood impacts, and that the above should be addressed as part of model review, update and refinement during the project design phase.

[1] Department of State Development (2017). "Terms of reference for an environmental impact statement: Olive Downs Project". Queensland Government Coordinator General, June.

Please contact the undersigned if you require further information.

Yours faithfully,

Tony Marszalek
Director

Nigel Holmes

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23 July 2018

Pembroke Olive Downs Pty Ltd,
Level 19 Gateway Building
1 Macquarie Place
Sydney NSW 2000

Attention: Blair Richardson (Development Manager)

Dear Blair,

Peer Review of "Air Quality and Greenhouse Gas Assessment of the Olive Downs Coking Coal Project"

As requested, I have completed a peer review of the "Air Quality and Greenhouse Gas Assessment for the Olive Downs Coking Coal Project" prepared by Katestone Environment Pty Ltd. My review has focussed on the following:

1. Basic methodology - including the choice of dispersion model, meteorological data used in the assessment, years/periods selected for assessment, the assessment criteria used, methods used to account for existing background levels of particulate matter, choice of sensitive receptors, appropriateness of mitigation measures, etc.
2. Emissions inventories and methods used to calculate emissions
3. Methods used to estimate greenhouse gas emissions
4. Review of draft assessment report including the logic and robustness of arguments used in the reports, and clarity of the arguments, etc.

I note that the report does not provide sufficiently detailed data to reproduce all the calculations in the report. However, the emission factors used and the methods described in the report are sound and I have satisfied myself that the estimated emissions of particulate matter and greenhouse gas emissions are reasonable, by checking that the overall emissions of total suspended particulate matter and the mass of greenhouse gases liberated per tonne of run of mine coal produced are plausible and consistent with coal industry norms.

My review has included several iterations, following which I provided a series of comments and suggestions. I am satisfied that these have been adequately addressed.

Please contact me if you have any queries.

Yours sincerely
Nigel Holmes

N.E. Holmes

Nigel Holmes PhD
Atmospheric Physicist

LEADERS IN MINING GEOCHEMISTRY

4 June 2018
Dr. Ian Swane
Director/Principal
Terrenus Earth Sciences
PO Box 132 Wilston QLD 4051 Australia

RE: Peer Review of Geochemical Assessment Report for the Olive Downs Coking Coal Project

Dear Ian,

In my capacity as Director/Principal Geochemist of RGS Environmental Pty Ltd as Trustee for the RGS Environmental Family Trust (ABN 25 924 595 681), I completed a Peer Review of the Geochemical Assessment Report on Potential Spoil and Coal Reject Materials associated with the Olive Downs Coking Coal Project. I was requested to complete the Peer Review based on my 25 years of experience completing similar geochemical assessment projects in Australia and other parts of the world.

The Peer Review included some minor comments on the Geochemical Assessment Report and concluded that the report effectively covers the key requirements of a geochemical assessment process for the proposed coal mining operation in Queensland. The Geochemical Assessment Report also met the requirements of Queensland (DME, 1995[1], DEHP, 2013[2]), Australian (DIIS, 2016[3]) and International (INAP, 2009[4]) guidelines associated with geochemical assessments at proposed and existing mining operations.

Based on the information presented in the Geochemical Assessment Report, I endorse the report conclusions and management recommendations, as presented.

Yours sincerely,

Dr. Alan M Robertson

Director/ Principal Geochemist – RGS Environmental Pty Ltd ATF RGS Environmental Family Trust

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[1] DME (1995). [Queensland Department of Mines and Energy]. *Draft Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland, Technical Guideline – Assessment and Management of Acid Drainage*. Queensland Department of Minerals and Energy (DME).

[2] DEHP (2013). *Application Requirements for Activities with Impacts to Land Guideline.* Queensland Department of Environment and Heritage Protection.

[3] DIIS (2016) [Department of Industry, Innovation and Science]. Leading Practice Sustainable Development Program for the Mining Industry. *Preventing Acid and Metalliferous Drainage*. September, Canberra ACT.

[4] INAP (2009). Global Acid Rock Drainage Guide (GARD Guide). Document prepared by Golder Associates on behalf of the International Network on Acid Prevention (INAP). June (http://www.inap.com.au/).

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