HORSE PIT EXTENSION EPBC ACT REFERRAL

APPENDIX F – PART 7 OF 9

Groundwater Impact Assessment Report 2021
Predicted Water Level within Quaternary Alluvium (Layer 1) at End of Mining – Cumulative Mining Scenario

FIGURE 3-5
Predicted Water Level within Regolith (Layer 2) at End of Mining – Cumulative Mining Scenario

**Legend**

- Water Level Contours (mAHD)
- Major Drainage
- Model Boundary
- Project Mining Lease Boundary
- Surrounding Mines

**Water Level (mAHD)**

- 25
- 50
- 80
- 100
- 110
- 125
- 135
- 145
- 155
- 175
- 220

**Scale**: 1:500,000

GDA 1994 MGA Zone 55

FIGURE 3-6
FIGURE 3-7

Predicted Water Level within Permian Coal Measures (Layer 12) at End of Mining – Cumulative Mining Scenario
3.4 Maximum Predicted Drawdowns

3.4.1 Incremental Drawdown

The process of mining directly removes water from the groundwater system and reduces water levels in surrounding groundwater units. The extent of the zone affected is dependent on the properties of the aquifers/aquitards and is referred to as the zone of drawdown. Aquifer drawdown is greatest at the working coalface and decreases with distance from the mine.

Maximum incremental drawdown refers to the drawdown impact associated with the Project and is obtained by comparing the difference in predicted aquifer groundwater levels for the Approved model scenario and the Cumulative model scenario at matching times. The maximum drawdown represents the maximum drawdown values recorded at each model cell at any time over the model duration. Predicted drawdown figures (Figure 3-9 to Figure 3-20) show where maximum drawdown impacts are predicted to exceed 1 m.

Figures include the locations of known water supply and stock bores within the model domain. In the 2020 CVM bore census, three active water supply and stock bores were identified near the Project (SLR, 2021a). These bores are Grosvenor Downs 1, Coolibah Downs 01 and Winchester Downs 01 located less than 7 km to the east of the Project area. Grosvenor Downs 1 is installed in the alluvium while the other two bores access the Fort Cooper Coal Measures. None of these bores are predicted to be impacted as a result of mining activities at the Project.

No incremental drawdown impacts are predicted for the Quaternary alluvium as a result of mining at the Project. This predicted drawdown extent is consistent with the GHD (2017) model where no water table drawdown was predicted due to the mining at CVM.

For a discussion on the potential incidental water impacts on the Quaternary alluvium, see Section 3.6.1.

The maximum predicted incremental drawdowns associated with the Project within the regolith is shown in Figure 3-9. The incremental drawdown extent within the regolith (Layer 2) is largely confined to the Project area and is influenced by the distribution of predicted saturated zones in the regolith. At the northern end of the CVM mining lease, 1 m drawdown influence is predicted to extend 2.9 km north of the mining lease boundary.

The coal seams of the Moranbah Coal Measures are the primary groundwater bearing strata targeted by mining at the Project and will experience drawdowns as a direct result of mining at the Project. Groundwater level drawdown within the mined coal seams is influenced by unit structure and is confined to unit extents. Figure 3-9 to Figure 3-12 show the maximum predicted incremental drawdown for Q, P, H and D seam in the Moranbah Coal Measures. The figures show the extent of maximum predicted depressurization of the Permian coal measures is limited to the west of the Project area due to the structural geology (i.e. coal seams subcrop). The extents of maximum predicted incremental drawdown in the Moranbah coal seams are between 10 to 12 km to the east and northeast of the Project mining lease. The cone of depression is predicted to be steepest at the working coalface. The predicted drawdown extents are consistent with the previous predictions by GHD (2017) for the CVM operations.
3.4.2 Cumulative Drawdown

The simulated cumulative drawdown presented in this section show the impacts on different aquifers due to the existing approved works and entitlements within the model domain. The simulated cumulative drawdown also shows whether the zone of impact from the approved neighbouring operations is predicted to interact with the zone of impact from the Project in different aquifers.

Maximum cumulative drawdown impacts in proximity to the Project are shown in Figure 3-13 to Figure 3-20. Maximum cumulative drawdown predictions covering the entire model domain are provided in Appendix D. These drawdowns represent the total impact to modelled groundwater levels resulting from all mining within the model domain, by comparing the maximum difference in aquifer groundwater levels for the Cumulative model scenario with those in a theoretical “No Mining” or Null Run scenario, for all times during the predictive model period. The vast majority of these predicted cumulative drawdown impacts are not related to the Project but result from existing and approved mining activities represented in the model.

There are no cumulative drawdown impacts predicted for the Quaternary alluvium within or around the CVM area (Figure 3-13). Cumulative impacts within the regolith can be seen connecting the Project-related drawdown to the drawdown impacts at Peak Downs, south of the Project (Figure 3-14). For the Leichhardt and Vermont coal seams, there was no drawdown interaction between the Project and the neighbouring mines that both target the Rangal Coal Measures which are not present in the CVM area (Figure 3-15 and Figure 3-16).

Figure 3-17 to Figure 3-20 show the maximum predicted cumulative drawdown in Q, P, H and D seams in the Moranbah Coal Measures. As shown in the figures the cumulative drawdown is predicted to interact with zone of impact from the Peak Downs open pits, Saraji open cut, Eagle Downs and Grosvenor underground operations. The extents of maximum predicted incremental drawdown in the Moranbah coal seams are approximately 13 km to the East and 10 km to the north of the Project mining lease.
Maximum Incremental Drawdown in Regolith (Layer 2)

Legend:
- HPE Bore Census (2021) - Water Supply and Stock
- ODS Bore Census (2017) - Water Supply and Stock
- Drawdown Contours (m)
- Major Drainage
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- Horse Pit Extension Project Area

Maximum Drawdown:
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200

FIGURE 3-8
FIGURE 3-9

Maximum Incremental Drawdown in Q Seam (Layer 12)

LEGEND
- HPE Bore Census (2021) - Water Supply and Stock
- ODS Bore Census (2017) - Water Supply and Stock
- Drawdown Contours (m)
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- Horse Pit Extension Project Area

Maximum Drawdown
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200

Solid Geology
- Ki-CQ (Ki)
- Bundarra Granodiorite (Kgb)
- Clematis Group (Re)
- Rewan Group (Rr)
- Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (Pwj)
- Fair Hill Formation, Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Blackwater Group (Pw)
- German Creek Formation (Pbd)
- Back Creek Group (Pb)

Legend Source: HPE Bore Census (2021) - Water Supply and Stock

GDA 1994 MGA Zone 55
Scale 1:200,000
25 August 2021
620.13593
Maximum Incremental Drawdown in P Seam (Layer 14)

**LEGEND**

- **Maximum Drawdown**
  - 1 - 2
  - 2 - 5
  - 5 - 10
  - 10 - 20
  - 20 - 50
  - 50 - 100
  - 100 - 200

- **Solid Geology**
  - Ki-CQ (Ki)
  - Bundarra Granodiorite (Kgb)
  - Clematis Group (Re)
  - Rewan Group (Rr)
  - Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (PwJ)
  - Fair Hill Formation, Fort Cooper Coal Measures (Pwt)
  - Moranbah Coal Measures (Pwb)
  - Blackwater Group (Pw)
  - German Creek Formation (Pbd)
  - Back Creek Group (Pb)

- **Model Grid**
- **Model Boundary**
- **Project Mining Lease Boundary**
- **Surrounding Mines**
- **Horse Pit Extension Project Area**

**Drawdown Contours (m)**

WS Bore Census (2019) - Water Supply and Stock
ODS Bore Census (2017) - Water Supply and Stock
HPE Bore Census (2021) - Water Supply and Stock

**Model Grid**

**Model Boundary**

**Project Mining Lease Boundary**

**Surrounding Mines**

**Horse Pit Extension Project Area**

**Scale:** 1:500,000

GDA 1994 MGA Zone 55

25 Aug 2021

620.13593
FIGURE 3-11

Maximum Incremental Drawdown in H Seam (Layer 16)

Legend:
- **HPE Bore Census (2021)** - Water Supply and Stock
- **WS Bore Census (2019)** - Water Supply and Stock
- **ODS Bore Census (2017)** - Water Supply and Stock

Legend for Drawdown Contours (m):
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200

Legend for Solid Geology:
- **Ki-CQ (Ki)**
- **Bundarra Granodiorite (Kgb)**
- **Clematis Group (Re)**
- **Rewan Group (Rr)**
- **Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (Pwj)**
- **Fair Hill Formation, Fort Cooper Coal Measures (Pwt)**
- **Moranbah Coal Measures (Pwb)**
- **Blackwater Group (Pw)**
- **German Creek Formation (Pbd)**
- **Back Creek Group (Pb)**

Model Boundary
Model Grid
Project Mining Lease Boundary
Surrounding Mines
Horse Pit Extension Project Area

Legend for Contours:
- **Model Boundary**
- **Model Grid**
- **Project Mining Lease Boundary**
- **Surrounding Mines**
- **Horse Pit Extension Project Area**

Maximum Drawdown

Scale: 1:500,000
GDA 1994 MGA Zone 55

25 Aug 2021
620.13593
Maximum Cumulative Drawdown in Quaternary Alluvium (Layer 1)

FIGURE 3-13

Maximum Drawdown (m)

- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200

LEGEND
- HPE Bore Census (2021) - Water Supply and Stock
- ODS Bore Census (2017) - Water Supply and Stock
- Major Drainage
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- CVM Horse Pit
- CVM Heyford Pit
- Inferred Alluvium Extent
- Alluvium Extent
Maximum Cumulative Drawdown in Regolith (Layer 2)
Maximum Cumulative Drawdown in Leichhardt Seam (Layer 5)

FIGURE 3-15
FIGURE 3-16

Maximum Cumulative Drawdown in Vermont Seam (Layer 7)

**Legend**
- Maximum Drawdown (m)
  - 1 - 2
  - 2 - 5
  - 5 - 10
  - 10 - 20
  - 20 - 50
  - 50 - 100
  - 100 - 200
- Solid Geology
  - Ki-CQ (K)
  - Bundarra Granodiorite (Kgb)
  - Clematis Group (Re)
  - Rewan Group (Rr)
  - Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (Pw)
  - Fair Hill Formation, Fort Cooper Coal Measures (Pwt)
  - Moranbah Coal Measures (Pwb)
  - Blackwater Group (Pw)
  - German Creek Formation (Pbd)
  - Back Creek Group (Pb)
- HPE Bore Census (2021) - Water Supply and Stock
- ODS Bore Census (2017) - Water Supply and Stock
- Drawdown Contours (m)
- Major Drainage
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- CVM Heyford Pit
- CVM Horse Pit
- Major Drainage
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- CVM Heyford Pit
- CVM Horse Pit
- Major Drainage
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- CVM Heyford Pit
- CVM Horse Pit

Scale: 1:175,000
GDA 1994 MGA Zone 55

25-Aug-2021
620.13593

© SLR

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SLR.
FIGURE 3-17

Maximum Cumulative Drawdown in Q Seam (Layer 12)
FIGURE 3-18

Maximum Cumulative Drawdown in P Seam (Layer 14)
Maximum Cumulative Drawdown in H Seam (Layer 16)

**LEGEND**
- HPE Bore Census (2021) - Water Supply and Stock
- ODS Bore Census (2017) - Water Supply and Stock
- Drawdown Contours (m)
- Major Drainage
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
  - CVM Heyford Pit
  - CVM Horse Pit

**Solid Geology**
- KI-CQ (Ki)
- Bundarra Granodiorite (Kgb)
- Clematis Group (Re)
- Rewan Group (Rr)
- Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (Pwj)
- Fair Hill Formation, Fort Cooper Coal Measures (Pwf)
- Moranbah Coal Measures (Pwb)
- Blackwater Group (Pw)
- German Creek Formation (Pbd)
- Back Creek Group (Pb)

**Maximum Drawdown (m)**
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 20
- 20 - 50
- 50 - 100
- 100 - 200

**Extent of Maximum Predicted 5m Drawdown - Project Only (refer Figure 3-11)**

**FIGURE 3-19**

H:Projects-SLR\620-BNE\620-BNE\620.13593 BHP - Horse Pit Approvals\07 CADGIS\ArcGIS\HPE Groundwater Modelling Report\62013593 F 3-19 Maximum Cumulative Drawdown in H Seam (Layer 16)_revC.mxd
Maximum Cumulative Drawdown in D Seam (Layer 18)

LEGEND

- HPE Bore Census (2021) - Water Supply and Stock
- ODS Bore Census (2017) - Water Supply and Stock
- Drawdown Contours (m)
- Major Drainage
- Model Grid

Maximum Drawdown (m)
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
50 - 100
100 - 200

Solid Geology
- Ki-CQ (Ki)
- Bundarra Granodiorite (Kgb)
- Clematis Group (Re)
- Rewan Group (Rr)
- Rangal Coal Measures, Bandanna Formation, Baralaba Coal Measures (Pwj)
- Fair Hill Formation, Fort Cooper Coal Measures (Pwt)
- Moranbah Coal Measures (Pwb)
- Blackwater Group (Pw)
- German Creek Formation (Pbd)
- Back Creek Group (Pb)

Major Drainage
- Model Boundary
- Model Grid
- Project Mining Lease Boundary
- Surrounding Mines
- CVM Heyford Pit
- CVM Horse Pit

Extent of Maximum Predicted 5m Drawdown - Project Only (refer Figure 3-12)
3.5 Predicted Groundwater Interception

Project mine pit inflow volumes have been calculated as time weighted averages of the outflow reported by ZoneBudget software for Project drain cells. The predicted inflows for Approved mining at Horse Pit and the Project, and the total combined (Approved + Project) inflows are presented in Figure 3-21. The predicted average future total Horse Pit inflow rate over the duration of mining (Approved + Project) is 198.1 ML/year (0.55 ML/day). For reference, as reported in the Groundwater Impact Assessment Report (SLR, 2021a) BMA’s annual Associated Water Take reporting for CVM reported an annual groundwater inflow estimate to Horse Pit of 865 ML/year (2.4 ML/day) for 2018/2019, using a simpler and more conservative water balance approach.

As shown in Figure 3-21, inflows due to the Project are predicted to reach a maximum peak in year 2044, with 275.2 ML inflow predicted for the year (0.75 ML/day). The average inflow rate due to the Project is 133.9 ML/year (0.36 ML/day).

The GHD (2017) model for CVM predicted an average inflow of 1,461 ML/year (4.0 ML/day) which is higher than the predicted inflows in the current model. The difference in the predicted inflows may relate to updates to the model structure from site geological information, the updates to the calibrated hydraulic properties based on more recent observation data and the implementation of the coal depth dependence function in the current model (see Section 2.7).

The Water Plan (Fitzroy Basin) 2011 groundwater area consists of the following:

- Groundwater Unit 1 (containing aquifers of the Quaternary alluvium); and
- Groundwater Unit 2 (sub-artesian aquifers).

Planned mining operations at the Project will not intercept Quaternary alluvium at any of the proposed pits. As such, all direct groundwater take predicted by the model is from Groundwater Unit 2.
Figure 3-21 Predicted Horse Pit Groundwater Inflows
3.6 Incidental Water Impacts

3.6.1 Influence on Alluvium

The change in alluvial water resources was estimated by comparing water budgets for alluvial zones using the Approved and Cumulative scenarios of the predictive model that excluded and included the Project. Interference of the alluvial groundwater can occur due to increased leakage to the underlying Permian coal measures that are depressurised as a result of mining activities. Over the extent of Quaternary alluvium, there is an insignificant predicted loss of water from the alluvium as a result of the Project.

3.6.2 Groundwater – Surface Water Interaction

The change in river leakage due to the Project was calculated by comparing the river flow budgets for Isaac River in the Cumulative scenario against the Approved scenario. This calculation showed that over the life of mine, the change in the Isaac River to the alluvium is insignificant which is consistent with the predicted water balance in Section 3.2.

As discussed in Section 2.4.2, Harrow Creek and Cherwell Creek located within the Project area are both set up with a stage height of 0.0 which means they are simulated as gaining systems (i.e., negative net flow). Comparing the river flow budgets for Harrow Creek and Cherwell Creek in the Cumulative against the Approved Case indicated no change in the net flow in these two creeks due to the Project.
4 Recovery Model

The potential post mining impacts of the Project were investigated with a recovery model, commencing at the end of mining at the Project and run for 200 years. A transient model was created to ascertain post-mining inflows, with all predictive model drain cells removed. All drain cells in the Study Area were removed at the start of the recovery period to allow groundwater levels to equilibrate. At the end of mining at the Project, the properties of the final void cells were converted to values representative of a void. The void cells were assigned high horizontal and vertical hydraulic conductivities (1000 m/day) and storage parameters based on the compressibility of water (specific yield of 1.0, storage coefficient of 5.0 × 10⁻⁶ m⁻¹), to simulate free water movement within the final void. This approach is often referred to as a ‘high-K’ lake. The location of the final void at the Project is provided in Figure 4-1.

Groundwater inflows to the final void during recovery were incorporated in the site water balance model for the Project’s Surface Water Assessment (SLR, 2021b). The pit lake recovery level and timings were predicted by the surface water balance modelling. These elevation and recovery timing derived from the surface water modelling was replicated within the numerical groundwater model using the time variant constant head boundary condition. This recovery model was then re-run for 200 years to maintain consistency with the Surface Water and Flooding Assessment prepared for the Project. Predictions from the re-run recovery model are presented within the main Groundwater Impact Assessment report (SLR, 2021a). A hydrograph for pit water level is provided as Figure 4-2. As shown in the figure, the average predicted equilibrated final void water level in Horse Pit final void was 120 mAH. The post-mining recovery model was then run and results presented for up to 500 years with the predicted final groundwater inflows and lake stage elevations presented in Table 4-1.

<table>
<thead>
<tr>
<th>Post-Mining Recovery Year</th>
<th>Lake Stage (mAH)</th>
<th>Average Groundwater Flow to the Void (ML/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After 20 Years</td>
<td>105</td>
<td>0.52</td>
</tr>
<tr>
<td>After 40 Years</td>
<td>110</td>
<td>0.32</td>
</tr>
<tr>
<td>After 60 Years</td>
<td>113</td>
<td>0.25</td>
</tr>
<tr>
<td>After 80 Years</td>
<td>115</td>
<td>0.20</td>
</tr>
<tr>
<td>After 100 Years</td>
<td>118</td>
<td>0.18</td>
</tr>
<tr>
<td>After 140 Years</td>
<td>119</td>
<td>0.18</td>
</tr>
<tr>
<td>After 200 Years</td>
<td>120</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Table 4-1 Final Model Predicted Stage Groundwater Inflows to the Void