Ironbark No. 1 Coal Mine – EA Amendment Application

Response to DES Additional Information Request

for Fitzroy Australia Resources Pty Ltd

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HANSEN
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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

Fitzroy (CQ) Pty Ltd (Fitzroy) submitted an Environmental Authority (EA) amendment application for the Ironbark No. 1 Mine on 24 March 2023. The EA amendment application relates to:

- A proposed minor increase in the mine surface infrastructure disturbance footprint; and
- A minor amendment of the underground mine layout.

The Department of Environment and Science (DES) issued an Information Request Notice for the EA amendment application on 10 May 2023 (Appendix A). This report provides Fitzroy's response to the Information Request.

The response has been prepared by Hansen Environmental Consulting on behalf of Fitzroy. The response includes specialist groundwater input from Australasian Groundwater & Environmental Consultants Pty Ltd (AGE) and specialist subsidence input from Gordon Geotechniques Pty Ltd.

The Information Request includes six (6) issues that are addressed in Section 2. Each DES issue is restated within Section 2 and is followed by Fitzroy's response.

2 RESPONSE TO INFORMATION REQUEST

2.1 SUBSIDENCE

2.1.1 DES ADDITIONAL INFORMATION REQUEST

DES Issue: *There is currently no Subsidence Management Plan, Rehabilitation Management Plan or approved PRCP schedule to explain in detail the potential impacts from subsidence (and subsidence repair) of the underground mining operation on environmental values and how these impacts will be avoided, mitigated, managed or offset.*

DES Request: *In the absence of these documents, describe in sufficient detail and quantify areas and locations (in figures) where possible, all potential above ground disturbance from the revised underground mine layout including gas drainage activities, subsidence (predicted ponding, cracking etc.), interference with watercourses/drainage lines, vegetation clearing and subsidence rehabilitation/repairs.*

2.1.2 RESPONSE

The potential impacts from subsidence and subsidence rehabilitation on environmental values for the current approved longwall layout were explained in detail in the EIS (Subsidence Assessment Report (Mine Subsidence Engineering Consultants (MSEC), 2012)) and in the information provided in support of the subsequent Environmental Authority (EA) application (draft Environmental Management Plan (EM Plan) (Hansen Bailey, 2017)).

As explained in Section 2.5.2 of the EM Plan, the key subsidence effects requiring management and/or rehabilitation are:

- Formation of surface tension cracks and the formation of surface buckling effects (which may require management in some instances);
- Ponding of water in shallow surface depressions caused by subsidence; and
- Potential instability and erosion in surface drainage lines.

The Environmental Assessment Report (EAR) submitted with this EA amendment application included a specialist subsidence assessment that compared the relative differences between the revised and approved longwall layout and the associated surface subsidence impacts and required management and mitigation measures.

The EAR subsidence assessment (Gordon Geotechniques, March 2023) concluded that the relatively minor changes in the aerial extent and orientation of the revised longwall layout are not likely to result in any material changes in the surface subsidence, subsidence effects and associated impacts on natural surface features predicted in the EIS (MSEC, 2012) for the approved longwall layout and that the existing EA conditions relevant to subsidence impacts would adequately address these minor changes.

Sections 2.5 and 2.6 of the EM Plan submitted with the original Ironbark No. 1 Mine EA application describe the potential impacts from subsidence for the approved longwall layout and the associated mitigation and management measures.

The following sections explain the potential subsidence effects, proposed management and rehabilitation for the revised longwall layout. These descriptions are based on relevant EIS and EA application information, the EAR specialist subsidence assessment and include additional information in relation to the subsidence predictions and impacts of the revised longwall layout.

The impacts of gas drainage disturbance are also discussed below.

SUBSIDENCE PREDICTIONS

Gordon Geotechniques Pty Ltd has developed subsidence predictions for the revised longwall layout (Appendix B). These predictions confirm that the levels of predicted subsidence are similar to the EIS subsidence predictions as concluded in the EAR subsidence assessment (EAR Appendix B, Section 2.1, Gordon Geotechniques, March 2023). The maximum predicted subsidence ranges from 0.9 m above the longwalls and 0.2 m above the chain pillars, above the deeper panels at the southern end of the mine site, to 2.7 m above the longwalls and 0.9 m above the chain pillars in the shallower panels at the northern end of the site.

SURFACE CRACKS

As explained in Section 2.5.2 of the EM Plan, subsidence may give rise to localised surface cracking above the longwall panels due to tensile strain on the ground surface. Residual tensile strain, and potential tension cracks, will occur around the perimeter of each underlying longwall panel, in the vicinity of the chain pillars and at each end of the panels. The exact location of individual surface cracks within the potential cracking zone is not predictable and can only be confirmed through monitoring following the completion of longwall mining in the area. The majority of the subsided surface area above a longwall panel will be unaffected by surface cracking. Residual tension cracks occur within a few weeks of an area being mined.

The extent and magnitude of tension cracks is dependent on the thickness of the near surface strata layers, the soil type, the mining depth and the level of residual tensile strain. As indicated in Section 2.2 of the EAR Subsidence Report (Gordon Geotechniques, March 2023), maximum surface crack widths of up to 100 mm were predicted for the EIS mine layout in the shallowest mining areas with reducing maximum crack widths of 10 – 50 mm in the deeper mining areas. As indicated in Section 4.1 of the EAR Subsidence Report (Gordon Geotechniques, March 2023), due to the relatively minor changes in the location and extent of the longwall layout, the extent and width of surface cracks for the revised longwall layout will not change from the EIS subsidence predictions.

Figure 1 shows the perimeter of each longwall panel in the revised mine layout where the zone of residual tensile strain and potential surface cracking will occur.

Although rare, buckling of surface soil may also occur in limited locations due to compressive strain on the ground surface due to subsidence. Buckling will potentially occur near the centre of the longwall panels in the zone of maximum compressive strain. Buckling typically results in low mounds of soil being produced in areas where transient tension cracks above the retreating longwall have over-closed.

Subsidence cracking itself is not likely to give rise to significant impacts on vegetation, but rehabilitation of subsidence cracks is necessary to prevent erosion and to alleviate safety risks associated with open cracks.

The proposed rehabilitation program for tension cracks, described in the EM Plan, is provided below. The approach involves monitoring areas potentially subject to tension cracking (and buckling) and repairing any individual cracks that develop. This targeted method of crack rehabilitation has been proposed in order to minimise disturbance of vegetation. It is consistent with the method used at a number of other operating longwall mines in Central Queensland.

The proposed subsidence crack rehabilitation program is as follows, and will be included in the Subsidence Management Plan required by EA Condition G2:

- A survey of potential subsidence cracking areas will be undertaken within six months of subsidence to locate individual cracks and assess the level of treatment required to rehabilitate each crack. Six months will allow sufficient time for the full effects of subsidence to take place and ensure that remedial works are not undertaken prematurely before the full development of all surface subsidence effects. Subsidence crack treatment will involve:
    - Ripping or ploughing minor cracks (<0.2 m width) using a small tractor or dozer. These areas will be allowed to regenerate naturally through inherent seed resources, vegetation propagation from rootstock and recruitment from adjoining undisturbed edges.
    - Stripping any larger cracks (>0.2 m width) of topsoil, excavating and backfilling the cracks with a backhoe or small excavator. Topsoil will then be replaced over the area and the site will be allowed to regenerate naturally from the seed bank and root stock in the topsoil. Areas disturbed as part of the crack rehabilitation program will generally comprise a narrow strip typically up to 2 to 3 m wide and for the length of the crack (typically up to a maximum of 50 m).
    - The subsidence crack rehabilitation work area will be clearly delineated in order to limit disturbance to the minimum area necessary and prevent unnecessary encroachment of disturbance. Disturbance of mature trees will be avoided, where possible. These requirements will be managed through the proponent's Permit to Disturb process.
- Erosion and sediment controls will be implemented in areas disturbed as part of the subsidence crack rehabilitation program. This may include the installation of minor diversion drains, hay bales and/or silt fences.
- Grazing pressure will be managed in areas that have been disturbed as part of the subsidence crack rehabilitation program. This may involve the temporary exclusion of stock through the use of fencing, if appropriate.
- Weed control measures will also be implemented for the project.
- A monitoring program will be established for areas that have been disturbed as part of the subsidence crack rehabilitation program. The program will initiate crack rehabilitation maintenance work, where necessary, and ensure that the cracks have been successfully rehabilitated and any disturbed vegetation is regenerating.
- The ultimate aim of the rehabilitation and monitoring program will be to confirm that any areas disturbed as part of the subsidence crack rehabilitation program are re-established with vegetation consistent with the pre-disturbance vegetation.
- Any buckling effects will be rehabilitated as required through re-grading any areas of buckling. Regeneration of vegetation and monitoring will be as per the tension crack rehabilitation plan described above.

It should be noted that the formation of subsidence cracks and associated rehabilitation will occur progressively over approximately 20 years of longwall mining. Only small areas of the mine site will, therefore, be disturbed by cracking and associated rehabilitation works, at any point in time.

Hansen Bailey Environmental Consultants has previously conducted detailed subsidence crack surveys at operating longwall mines in the Moranbah area in order to quantify the range of actual subsidence crack widths, lengths and depths that occur. These surveys were conducted as part of previous EA applications for longwall mines in order to inform estimates of the potential extent of vegetation disturbance associated with life-of-mine (LOM) subsidence crack rehabilitation. These surveys confirmed that a subsidence crack occurred in a range from 7 to 11 % of the perimeter of the panels at the two longwall mines surveyed.

Section 2.6.2 of the EM Plan explains that, based on a conservative assumption that 20% of the perimeter of each longwall panel will be subject to cracking and require rehabilitation, and that a 3 m wide disturbance width is required along the cracks to allow access for machinery to complete the crack rehabilitation, a total of 1.5 ha of remnant vegetation disturbance could occur over the LOM. It should be noted that the LOM vegetation disturbance area calculated is intended to provide indicative total disturbance area, rather than an accurate prediction of disturbance for each vegetation community as it is not possible to accurately predict the location of individual cracks prior to mining. This limitation has, however, been overcome by making use of a conservative prediction method, and assuming cracks along 20% of the perimeter of each longwall panel (compared to the surveyed range at operating mines of 7 to 11%).

The LOM vegetation disturbance area has been recalculated for the revised longwall layout using the same methodology and indicates that a total of 1.8 ha of remnant vegetation disturbance could occur for the revised longwall layout, beyond the approved disturbance areas (Figure 1).

As explained above, subsidence will occur progressively over the life of the mine and the area of disturbance at any point in time would be much less than the total LOM disturbance area. Crack rehabilitation will also occur progressively over the life of the mine, typically 12 months after cracking occurs. Hence, any vegetation disturbance due to subsidence crack rehabilitation is expected to be minor, and temporary in nature, and no significant residual impacts on vegetation, or any associated fauna habitat values, are anticipated.

PONDING IN SUBSIDENCE DEPRESSIONS

As explained in Section 2.5.2 of the EM Plan, subsidence can result in the formation of localised shallow surface depressions in the ground surface above the longwall panels. Runoff can accumulate and pond in these shallow surface depressions potentially impacting vegetation within the ponding area.

The location of the predicted ponding areas from the revised longwall layout is shown in Figure 2. These areas have been delineated based on a contour plan of the subsided surface. The ponding areas have been conservatively delineated based on the maximum potential ponding area and do not consider the depth or likely retention time of any ponded water. Overall, a total area of approximately 8.9 ha of ponding is predicted to occur outside of the approved disturbance area (Figure 2). The impacts from ponding on Matters of State Environmental Significance (MSES) are discussed in Section 2.3. The MSES impact areas are based on the conservative assumption that all vegetation within the ponding areas would be subject to die-off due to inundation.

EFFECTS ON DRAINAGE LINES

An assessment of the potential changes in the hydraulic properties of flows in the creeks and drainage lines traversing the subsidence area for the approved longwall layout and the associated morphologic response of the creeks is included in the EIS (Ellensfield Coal Mine – Revised Flood Study (URS, 2012)).

This assessment explains that the creeks traversing the mine site are generally high energy systems with considerable sandy bed loads and eroding banks. Additionally, sediment yields from the catchment appear high (and it is likely that the sediment load in the streams is transport limited as opposed to supply limited). The focus of the hydraulic assessment of the watercourse is based on maintaining the current sediment and erosion balance as indicated by the stream power within the channel. The assessment addressed the potential impacts on all drainage lines including the eastern tributary of Bullock Creek and the southern tributaries of Spade and Alpha Creeks.

The EIS assessment concluded that localised morphologic changes will be likely, however, the overall stability of the stream reaches are not expected to be significantly impacted. It also identified two specific areas in Spade Creek and the southern tributary of Alpha Creek where reprofiling of the creek beds would be required.

Section 2.5.2 of the EM Plan states that the proposed management of the subsidence of drainage lines and watercourses will include:

- Surveying of subsided reaches within 3 months of subsidence to accurately confirm any changes to pre-existing bed levels and to enable confirmation of any necessary proactive remedial drainage earthworks.
- Monitoring of subsided reaches for natural sedimentation of subsidence depressions, and erosion or instability requiring reactive erosion control works.
- Re-grading of subsided bed levels would only be conducted, if necessary, as a last resort. Any bed regrading works would be designed to avoid disturbance of any riparian vegetation, as far as possible. Any areas where riparian vegetation is disturbed would be revegetated using native species similar to the pre-existing vegetation.

Section 4.2 of the EAR Subsidence Report concludes that there is very little difference between the total length of subsided reaches of Spade and Alpha Creeks for the approved and revised longwall layouts. It also concludes that there would be no significant changes to the impacts to these creeks due to the revised longwall layout and that no additional management measures are warranted.

Figure 3 shows the creeks and tributaries traversing the mine site in relation to the approved and revised longwall layouts. This figure shows that the revised longwall layout will result in a small reduction in the total subsided reach length for the eastern tributary of Bullock Creek and the southern tributaries of Alpha Creek. It also shows that the subsided reach of the southern tributary of Spade Creek is unchanged.

Sections of the subsided creeks and drainage lines where elevated bed levels will occur due to subsidence have been identified based on a detailed review of the subsided surface contours. The areas are shown in Figure 3. The depression in the creek beds immediately upstream of these areas will naturally fill with sediment and the elevated bed areas will naturally erode during subsequent flow events to achieve a new bed level equilibrium. These areas will be carefully monitored as part of the monitoring program described above.

In the event that monitoring indicates that these areas are becoming unstable, reactive stabilisation works would be implemented. These could potentially include timber piles to stabilise creek banks.

GAS DRAINAGE ACTIVITIES

Disturbance areas for initial gas drainage activities have been included in the EA (EA Appendix 1). However, the total disturbance area for LOM gas drainage activities is not currently included in the approved disturbance footprint. The LOM gas drainage activities will include gas drainage bore holes and associated access tracks (i.e. 30 m x 30 m borehole pads and 5 m wide access tracks). The LOM gas drainage disturbance areas are shown in Figure 2.

The gas drainage access tracks have been located along existing access tracks where possible, to minimise the LOM gas drainage disturbance footprint. The total LOM gas drainage disturbance footprint outside the approved disturbance footprint is 23.7 ha. This disturbance will occur progressively over the mine life and completed areas will be progressively rehabilitated. The total area of gas drainage disturbance at any point in time will therefore be less than 23.7 ha. The impacts from the LOM gas drainage disturbance on MSES are discussed in Section 2.3.

2.2 SUBSIDENCE OF RIPARIAN AREAS

2.2.1 DES ADDITIONAL INFORMATION REQUEST

DES Issue: *Condition I1 of the EA currently permits the subsidence of Spade Creek, subject to conditions I1 to I13. The proposed underground mine layout involving longwall mining also occurs under Bullock Creek East and South Spade Creek / Alpha Creek. The EPBC approval requires that all management measures, monitoring, reporting and corrective actions regarding the subsidence of Spade Creek are also applied to Alpha Creek.*

DES Request: *Provide further information about the subsidence risk to Bullock Creek East and South Spade Creek / Alpha Creek.*

2.2.2 RESPONSE

As discussed above, in Section 2-1 "effects on drainage lines", Section 2.5.2 of the EM Plan states that the proposed management of the subsidence of drainage lines and watercourses will include:

- Surveying of subsided reaches within 3 months of subsidence to accurately confirm any changes to pre-existing bed levels and to enable confirmation of any necessary proactive remedial drainage earthworks.
- Monitoring of subsided reaches for natural sedimentation of subsidence depressions, and erosion or instability requiring reactive erosion control works.
- Re-grading of subsided bed levels would only be conducted, if necessary, as a last resort. Any bed regrading works would be designed to avoid disturbance of any riparian vegetation, as far as possible. Any areas where riparian vegetation is disturbed would be revegetated using native species similar to the pre-existing vegetation.

As discussed in Section 2.1, the length of the eastern tributaries of Bullock Creek and the southern tributaries of Spade Creek and Alpha Creek that will be subsided by the revised longwall layout are the same or less than the approved layout (Figure 3). Locations in the creeks where subsidence will result in elevated bed levels are also identified in Figure 3. These areas will be subject to erosion in order to reach a new equilibrium. The proposed management of subsidence of drainage lines, specially addresses monitoring and management of areas of potential creek instability.

Similar effects on the creeks and tributaries would result from the approved longwall layout that involved subsidence of the same reaches and hence the subsidence risk to these tributaries is similar to the approved longwall layout. Hence, the proposed management of drainage line subsidence remains applicable and appropriate for the revised longwall layout.

2.3 MNES AND MSES

2.3.1 DES ADDITIONAL INFORMATION REQUEST

DES Issue: *An ecology report was provided with the supporting documentation; however, it only addressed the ecology impacts associated with the additional surface disturbance areas. No ecological assessment was provided for the surface impacts relating to subsidence of the underground mining area, or for impacts from rehabilitation of subsided areas.*

DES Request: *Evaluate the impact of the revised project (both surface infrastructure and surface disturbance—including from rehabilitation activities—from the underground mine) on MNES and MSES and show in a table and figures.*

2.3.2 RESPONSE

The approved maximum disturbance areas for significantly impacted MSES for the Ironbark No. 1 Mine are listed in EA Table G1. These maximum disturbance areas were established during the original EA approval and some limits were modified during subsequent EA amendment approvals that related to changes in the surface infrastructure disturbance area (December 2018 and July 2019). During these subsequent EA amendments, the actual disturbance areas of the revised surface infrastructure footprint for some MSES were reduced below the approved maximum disturbance areas in EA Table G1. However, the approved maximum disturbance areas in EA Table G1 were not reduced as Fitzroy had already committed to providing offsets for the larger approved maximum disturbance areas. Consequently, the current approved surface infrastructure disturbance footprint (EA Appendix 1) results in less disturbance than the maximum disturbance areas listed in EA Table G1 for the majority of the MSES (Table 1).

In addition, the maximum approved MSES disturbance areas in EA Table G1 relate only to MSES that were previously determined to be a significant residual impact. EA Table G1 does not include MSES disturbance areas that have been previously assessed in EA approvals and not considered to be a significant residual impact.

A full reconciliation of the approved and previously assessed MSES disturbance area limits was provided in Table 4 of the EAR that was submitted in support of the most recent surface infrastructure relocation EA amendment application (Hansen Bailey, July 2019). Table 4 from the 2019 EAR is replicated in Table 1.

The approved and previously assessed MSES impacts listed in Table 1 were based on the approved ground-truthed vegetation mapping provided in the EIS.

TABLE 1 TABLE 4 FROM THE 2019 ENVIRONMENTAL ASSESSMENT REPORT

MSES	Approved Disturbance Areas (ha)	Proposed Surface Layout Disturbance Area (ha)	Balance Approved Disturbance Area (ha)
Dual Listed MSES approved under the EPBC Act			
Squatter Pigeon Habitat	83	39.5	43.5
Yakka Skink Habitat	74	0.0	N/A*
Brigalow Threatened Ecological Community	9.2	7.0	2.2
Residual MSES			
RE 11.3.4 – Of Concern RE under the VM Act	7.0**	5.9	1.1
RE 11.3.2 – Of Concern RE under the VM Act	0.8	0.6	0.2
RE 11.3.25 – REs within a defined distance from a watercourse	2.1**	0.9	1.2
RE 11.5.9 – REs within a defined distance from a watercourse	6.1**	1.2	4.9
RE 11.5.3 – REs within a defined distance from a watercourse	1.8	0.9	0.9
RE 11.3.4 – REs within a defined distance from a watercourse	1.3	0.7	0.6
RE 11.3.2 – REs within a defined distance from a watercourse	0.5	0.0	0.5

**DoEE has confirmed that there are no Yakka Skink in the impact area and no offsets are required.*
***Assessed to be a significant residual impact requiring offsets under the EO Act.*

The combined impacts from the approved disturbance area (EA Appendix 1), the additional surface infrastructure disturbance footprint, subsidence ponding and the LOM gas drainage disturbance areas are shown in Table 2. Figures showing the extent of, and impacts to, each MSES within the mine site are shown in Figure 4 to Figure 7.

Approved mapping of MNES is included in the Ironbark No. 1 Mine *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act) Approval. This approved mapping has been used for the assessment of impacts from project disturbance on MNES for this EA amendment application.

The EIS vegetation mapping is based on field surveys conducted in 2007 and 2008 (URS, 2009). Hence, Queensland Regional Ecosystem (RE) mapping (Figure 2) has been used for the assessment of impacts on residual MSES (MSES that are not dual listed MNES) from the additional disturbance areas for this EA amendment application, outside of the approved disturbance area (EA Appendix 1).

As explained in Section 2.1.2, and consistent with the original EA application, there are no significant impacts on MSES likely as a result of subsidence crack rehabilitation over the life of the mine. Hence, disturbance from subsidence crack rehabilitation is not included in Table 2.

TABLE 2 MSES IMPACT ASSESSMENT

Matters of State Environmental Significance (MSES)	EA Appendix 1 Disturbance Footprint (ha)	Additional Surface Infrastructure Disturbance Footprint (ha)	Life of Mine Gas Drainage Disturbance (ha)	Ponding Areas (ha)	Revised Total Disturbance Area (ha)	Approved/Previously Assessed Disturbance Areas	Balance Disturbance Area (ha)	Significant Impact (Y/N)
Dual listed MSES Approved under EPBC Act								
Squatter Pigeon Habitat	39.5	0.7	8.9	1.3	50.6	83.0[1]	32.4	N/A
Brigalow TEC	7.0	0.0	0.0	0.6	7.7	9.2[1]	1.6	N/A
Ornamental Snake	N/A	0.0	0.0	0.6	0.6	0.0	-0.6	No
Residual MSES								
Of Concern REs								
• 11.3.4	5.9	0.0	0.0	0.0	0.0	7.0[2]	1.1	N/A
• 11.3.2	0.6	0.0	0.0	0.0	0.0	0.8[3]	0.2	No
Vegetation in association with a watercourse/drainage line								
• RE 11.3.2	0.1	0.0	0.0	0.0	0.1	0.5[3]	0.4	No
• RE 11.3.4	0.7	0.0	0.0	0.0	0.7	1.3[3]	0.6	No
• RE 11.3.25	0.9	0.0	0.3	0.0	1.2	2.1[2]	0.9	N/A
• RE 11.5.3	0.9	0.0	0.04	0.0	0.9	1.8[3]	0.9	No
• RE 11.5.9	1.2	0.0	0.1	0.0	1.3	6.1[2]	4.8	N/A
• RE 11.7.2	0.0	0.0	0.02	0.0	0.0	0.0	-0.02	No
• RE 11.9.5	0.0	0.0	0.1	0.0	0.1	0.0	-0.1	No
Short-baked Echidna	48.4	0.2	10.9	2.4	61.9	48.4	-13.5	No
Connectivity	48.4	0.2	10.9	2.4	61.9	48.4	-13.5	No[4]
High Risk Area on the Flora Survey Trigger Map	0.0	0.0	0.0	0.0	0.0	0.0	0.0	No

[1] As listed in the Ironbark EPBC Act approval (EPBC 2007/3643)
[2] As listed in Ironbark EA (EA0001299) dated 1 September2022
[3] As listed in the Ironbark EA Amendment EAR dated 30 July 2019 and deemed not to be a significant impact
[4] As per the DES LFC Tool.

Overall, the results presented in Table 2 indicate that the MSES impacts for the revised total disturbance area are within the existing approved maximum disturbance area limits, within the previously assessed disturbance areas that were not considered to be significant, or are below significant impact thresholds. Consequently, there are no additional offsets required for the EA amendment.

2.4 CONSERVATION OF SIGNIFICANT SPECIES

2.4.1 DES ADDITIONAL INFORMATION REQUEST

DES Issue: *There is essential habitat (MSES) mapped on the ML for the ornamental snake, which is classified as Vulnerable under the EPBC Act (Cmwth) and NC Act (Qld). There is also a known record for this species within the ML.*

The supporting ecology report included the essential habitat map and table, however there was no further discussion on how this species may be impacted by the proposed amendment, or whether offsets may be required. There is currently no approved clearing for ornamental snake habitat addressed in Table G1 of the EA.

DES Request: *Provide details about:*

- *Potential impacts from the proposed amendment on this species*
- *Include any documentation provided to DCCEEW regarding this species*
- *Any offset requirement.*

2.4.2 RESPONSE

The Ornamental Snake was listed as Vulnerable under the Commonwealth EPBC Act on 16 July 2000 and is listed as Vulnerable under the *Nature Conservation Act 1992* (NC Act). The Ornamental Snake is, therefore, a dual listed MSES species.

The Ironbark EIS (formerly called the Ellensfield EIS) was referred to the Commonwealth Government on 16 August 2007, after the Ornamental Snake was listed under the EPBC Act. Section 14.4.3 of the EIS Update Report and Section 4.15 of the EIS Assessment Report both stated the potential EPBC Act listed species that were known and had the potential to occur within the Ironbark site. The Ornamental Snake was not in these lists and, therefore, was *not* considered to potentially occur within the Ironbark site, at that time. At the time of the EIS Assessment Report, this assessment was consistent with the EPBC Act Protected Matters Search Tool conducted for the EIS (EIS Update Report Section 14.4.3), which did not list the Ornamental Snake as being known or likely to occur within the Ironbark site.

The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) provided multiple submissions on the EIS during the submissions phase and finalised the EPBC Act approval in September 2017. DCCEEW did not raise the potential presence of the Ornamental Snake within the project site during the EIS or subsequent approval process. Hence, DEECCW did not consider that the project would potentially impact the Ornamental Snake at the time the EPBC Act approval was granted.

Impacts on Ornamental Snake habitat have been assessed for the increased disturbance footprint for the EA amendment (i.e. additional surface infrastructure, LOM gas drainage disturbance and ponding) (Table 2). This assessment has concluded that the total disturbance area is 0.6 ha. In accordance with the Commonwealth *Draft Referral Guidelines for the Nationally Listed Brigalow Belt Reptiles*, impacting less than 1 ha of

Ornamental Snake habitat has a low risk of significant impacts. Therefore, there are no significant impacts to the Ornamental Snake and offsets under the EPBC Act and/or the EO Act are not required.

2.5 ERA 63 – SEWAGE TREATMENT

2.5.1 DES ADDITIONAL INFORMATION REQUEST

DES Issue: *The supporting information states that an ERA amendment is also requested to change the sewage treatment capacity from 20 to 100EP (as currently permitted in the EA) to allow for 400EP.*

The applicable ERA threshold would be: (b) more than 100 but not more than 1,500EP.

This is not considered an administrative amendment.

DES Request: *Provide reference to the relevant sections of the EIS which justify the total daily peak design capacity of 400EP.*

Further discussion should also be provided regarding the expected volumes of treated sewage, specifications of the STP required and whether the irrigation area is suitable for the increased sewage treatment capacity.

Identify if any of the current sewage treatment conditions (e.g. C15) will need to be amended.

2.5.2 RESPONSE

EIS REFERENCES FOR THE SEWAGE TREATMENT PLANT DESIGN CAPACITY

The requested amendment to the Sewage Treatment ERA threshold currently listed in the EA (21 to 100 Equivalent Persons (EP)) relates to the correction of an error in the current threshold level that is not consistent with the EIS documentation. The EIS documentation clearly states the proposed Sewage Treatment Plant (STP) design capacity of 400 EP and the correct corresponding Environmentally Relevant Activity (ERA) threshold of "100 to 1,500 EP".

As stated in Section 3.1 of the EIS Assessment Report, the final EIS documentation provided by Ellensfield Coal Management Pty Ltd (Vale) (the proponent at the time of the EIS) was provided on 11 September 2012. The document provided on 11 September 2012 was the EIS Update Report.

Section 2.3.6.7 of the EIS Update Report states:

> *Based on staff numbers, assumed rainfall on the sewage dam and estimates of cleaning water, it is envisaged that the approximate sewage loading on the STP will be 5.5 kL/day plus a further 67 kL/day of grey water....The STP specification requires a plant capable of handling 80kL/day... Based on a design capacity of 80,000 litres per day, the **proposed STP has an EP of 400**, this will be discharges through an irrigation scheme and therefore equates to an environmental score of 27 (**Threshold 2(b)(i)**).*

The proposed Sewage Treatment ERA threshold of 2(b)(i) (highlighted in the EIS document extract above) is "more than 100 to 1,500 EP", based on the version of the *Environmental Protection Regulation* (EP Regulation) that was current at the time of the EIS Update Report, and is consistent with the proposed STP design capacity of 400 EP (also highlighted in the EIS document extract above).

The current EA Sewage Treatment threshold of "21 to 100 EP" is not consistent with the proposed STP design capacity of 400 EP or the corresponding Sewage Treatment ERA threshold of "100 to 1,500 EP" quoted in the

EIS. There were no concerns raised in relation to the STP design capacity during the original EA approval process and hence we suggest that the inconsistency in the ERA threshold is an administrative oversight and request that the threshold in the EA is amended to align with the design capacity assessed.

STP DESIGN SPECIFICATIONS

The proposed STP is an Activated Sludge Bed Bioreactor Plus (ASBR+). The STP specifications align with the existing limits in EA Table C1 including:

- A 5 day Biochemical oxygen demand (BOD) effluent level of 20 mg/L or less measured monthly;
- Total suspended solids (TSS) of 30 mg/L or less measured monthly;
- Nitrogen levels of 30 mg/L or less measured monthly;
- Phosphorous levels of 15 mg/L or less measured monthly;
- E.coli levels of 1,000 organisms/100mL or less measured monthly; and
- pH of 6.0 – 9.0 measured monthly.

Section 2.3.4.3 of the EIS Update Report states the following regarding the irrigation area for the STP:

> *'Based on this volume [80 kL/day] and the soils present in the proposed irrigation location, it has been calculated that an area of 1.5 ha (15,000 square metres) would be sufficient for the irrigation of the treated effluent.'*

Therefore, the 1.5 ha irrigation area specified in EA Condition C15, is consistent with the proposed 400 EP STP that has a design loading of 80 kL/day.

Hence, the existing EA Schedule C conditions related to sewage treatment are based on the originally proposed STP design and do not require any amendments.

2.6 GROUNDWATER

2.6.1 DES ADDITIONAL INFORMATION REQUEST

DES Issue: *Fitzroy have responded to an informal information request regarding groundwater queries relating to the application. The below item is outstanding and is required to be addressed.*

Item 2.2 of the informal IR requested drawdown contours for the Rewan Formation and the Regolith. These maps were provided for the 'Predicted drawdown'. Similar to Appendix C, Figure 7 of the supporting information with the application, DES requires three separate figures for Layer 2 (Rewan Formation), titled 'Approved drawdown', 'Proposed drawdown' and 'Incremental drawdown' (showing the difference between the two).

DES Request: *Provide three figures for the drawdown contours for the Rewan Formation, similar to Appendix C, Figure 7 of the application supporting information.*

2.6.2 RESPONSE

The three Rewan Formation drawdown contour figures have been produced by AGE and are included in Appendix C.

3 REFERENCES

Department of Climate Change, Energy, the Environment and Water (DCCEEW), Variation of Conditions Attached to Approval - Ironbark No. 1 Underground Mine (formerly known as Ellensfield), North Bowen Basin, Queensland (EPBC 2007/3643), 17 October 2022.

Department of Environment and Heritage Protection, EIS Assessment Report for the Ellensfield Coal Mine Project, 4 December 2012.

Fitzroy Australia Resources Pty Ltd, Ironbark No. 1 Coal Project Draft Environmental Management Plan, 31 October 2017.

Hansen Bailey, Ironbark No. 1 Coal Project Environmental Authority Amendment Application Environmental Assessment Report, 30 July 2019.

Hansen Bailey, Ironbark No. 1 Coal Project Environmental Authority Amendment Application Environmental Assessment Report, 4 December 2018.

Hansen Bailey, Ironbark No. 1 Coal Project Supporting Information for the Environmental Authority Application, 20 November 2017.

Hansen Environmental Consulting, Ironbark No. 1 Coal Mine Environmental Assessment Report, 24 March 2023.

Gordon Geotechniques Pty Ltd, Subsidence Assessment Report for the Ironbark No. 1 Underground Project, March 2023.

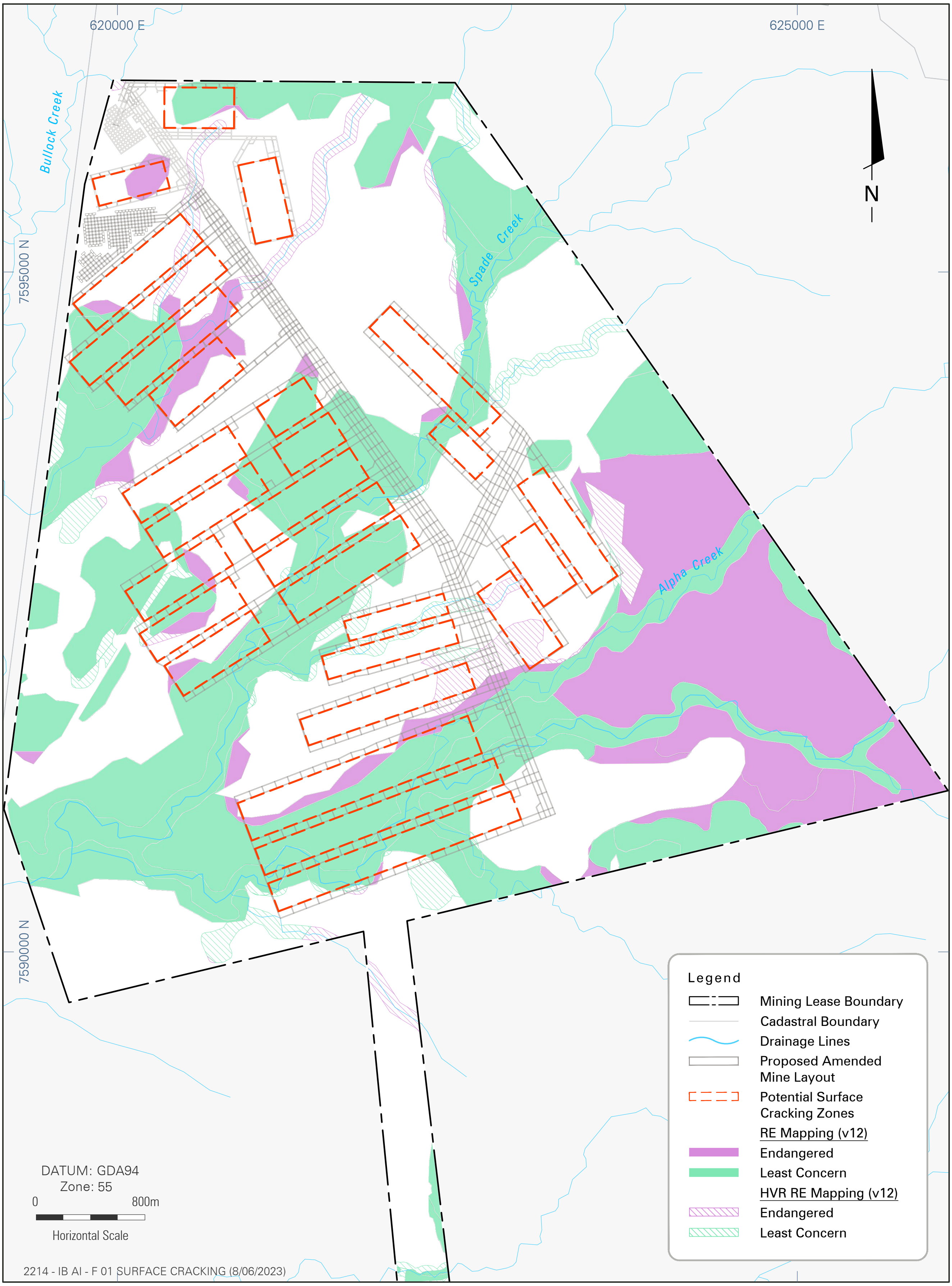
Mine Subsidence Engineering Consultants (MSEC), Ellensfield Coal Mine Project Ellensfield Longwalls 101A to 405: Subsidence Predictions and Impact Assessments for the Natural Features and Surface Infrastructure in Support of the Updated Environmental Impact Statement, 29 August 2012.

URS, Ellensfield Coal Mine – Revised Flood Study, 9 August 2012.

URS, Ellensfield Coal Mine Project Environmental Impact Statement, Section 14 – Nature Conservation, 9 April 2009.

URS, Ellensfield Coal Mine Project EIS Update, 7 September 2012.

FIGURES



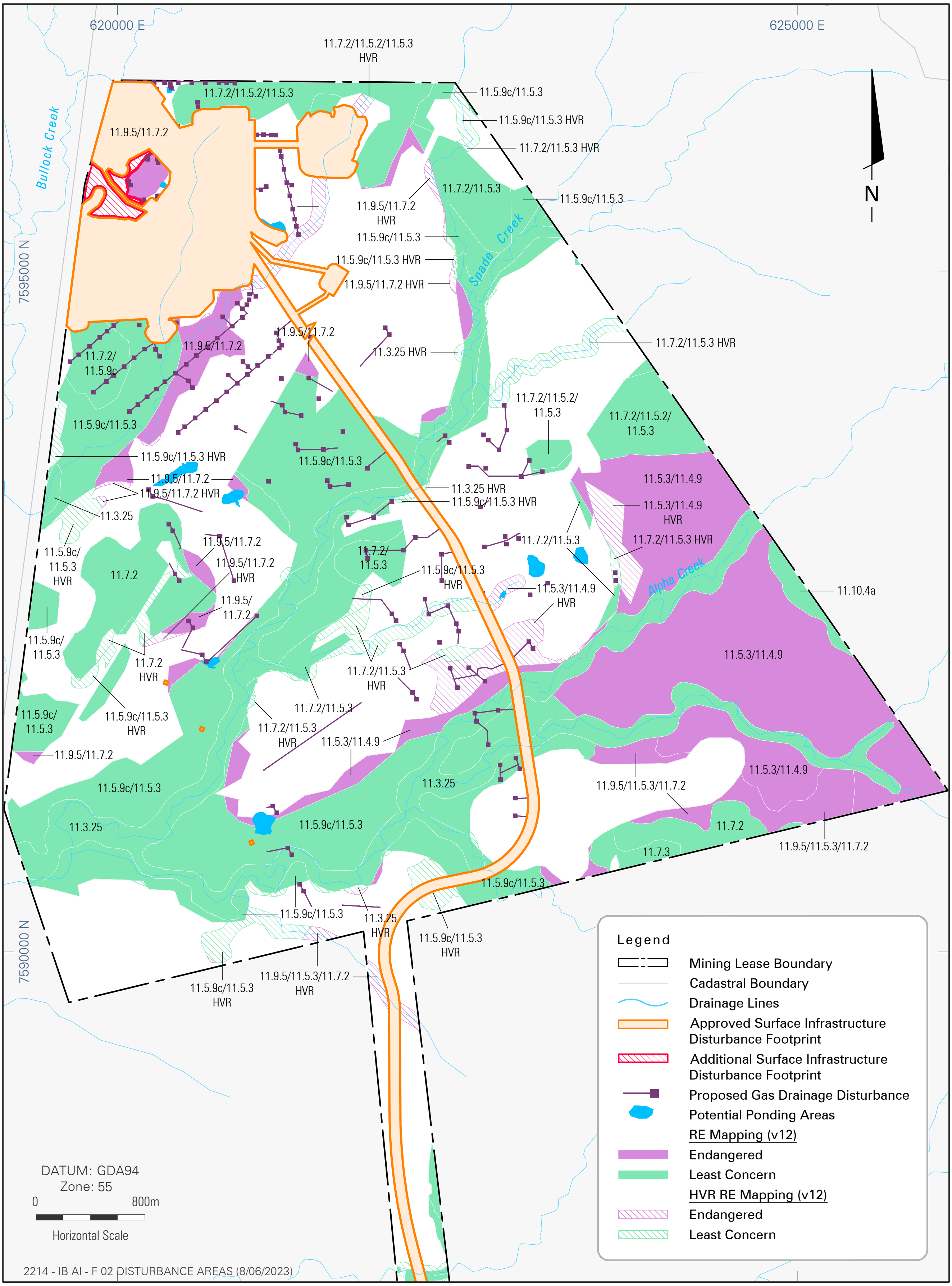
fitzroy australia resources

HANSEN ENVIRONMENTAL CONSULTING

IRONBARK NO.1 COAL PROJECT

Potential Surface Cracking Zones

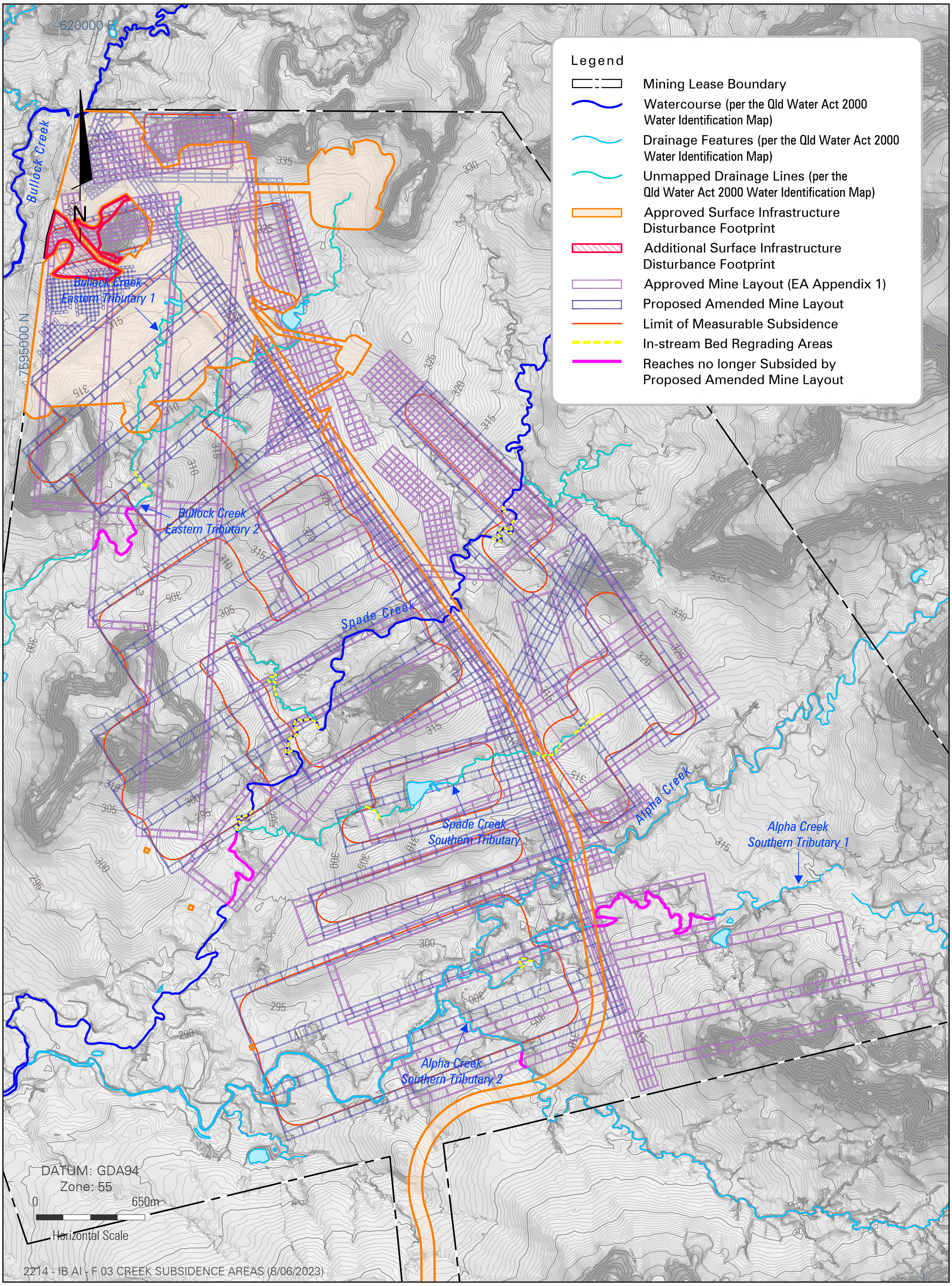
FIGURE 1



IRONBARK NO.1 COAL PROJECT

Disturbance Areas

FIGURE 2



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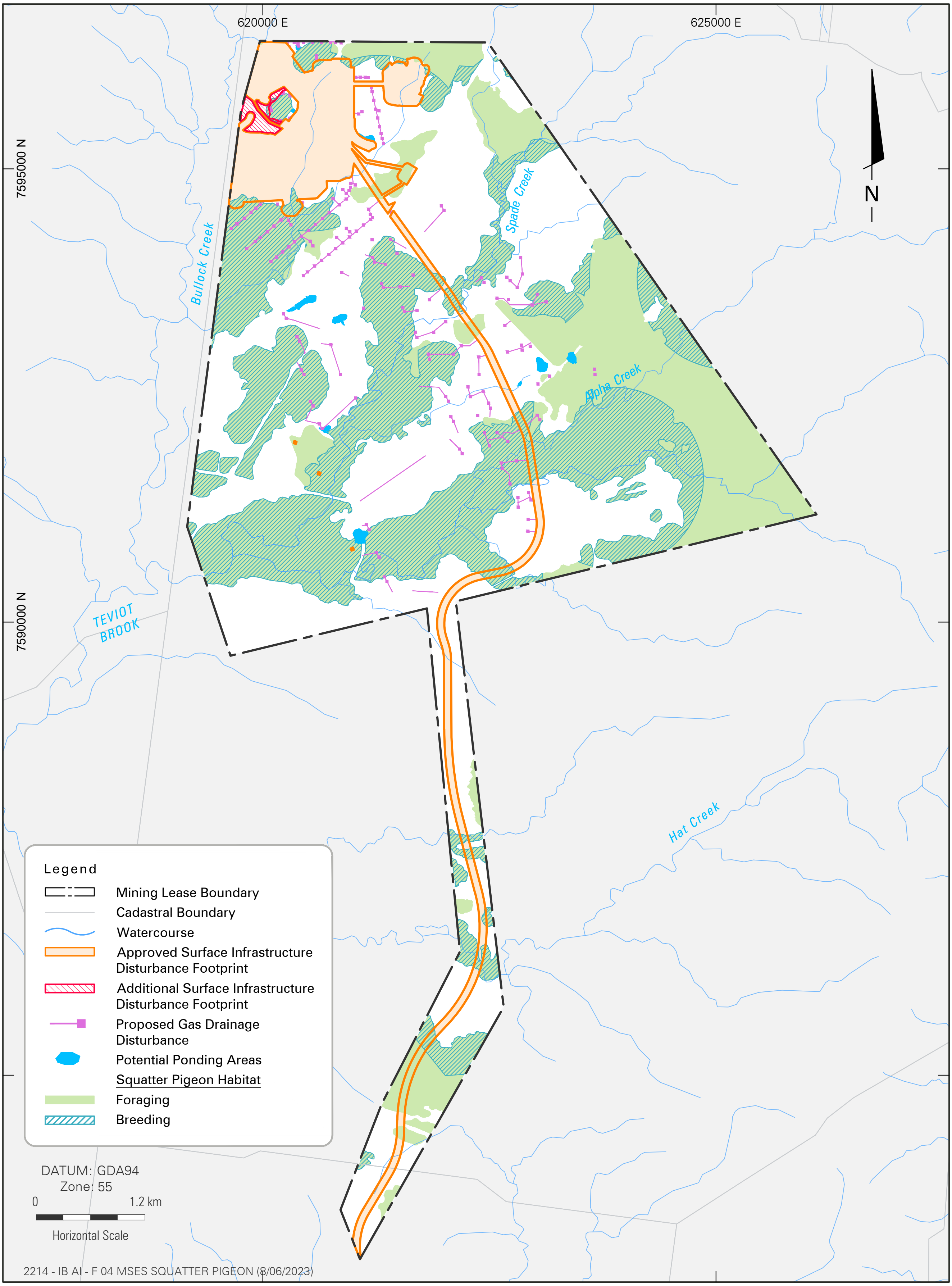
IRONBARK NO.1 COAL PROJECT

Creek Subsidence Areas

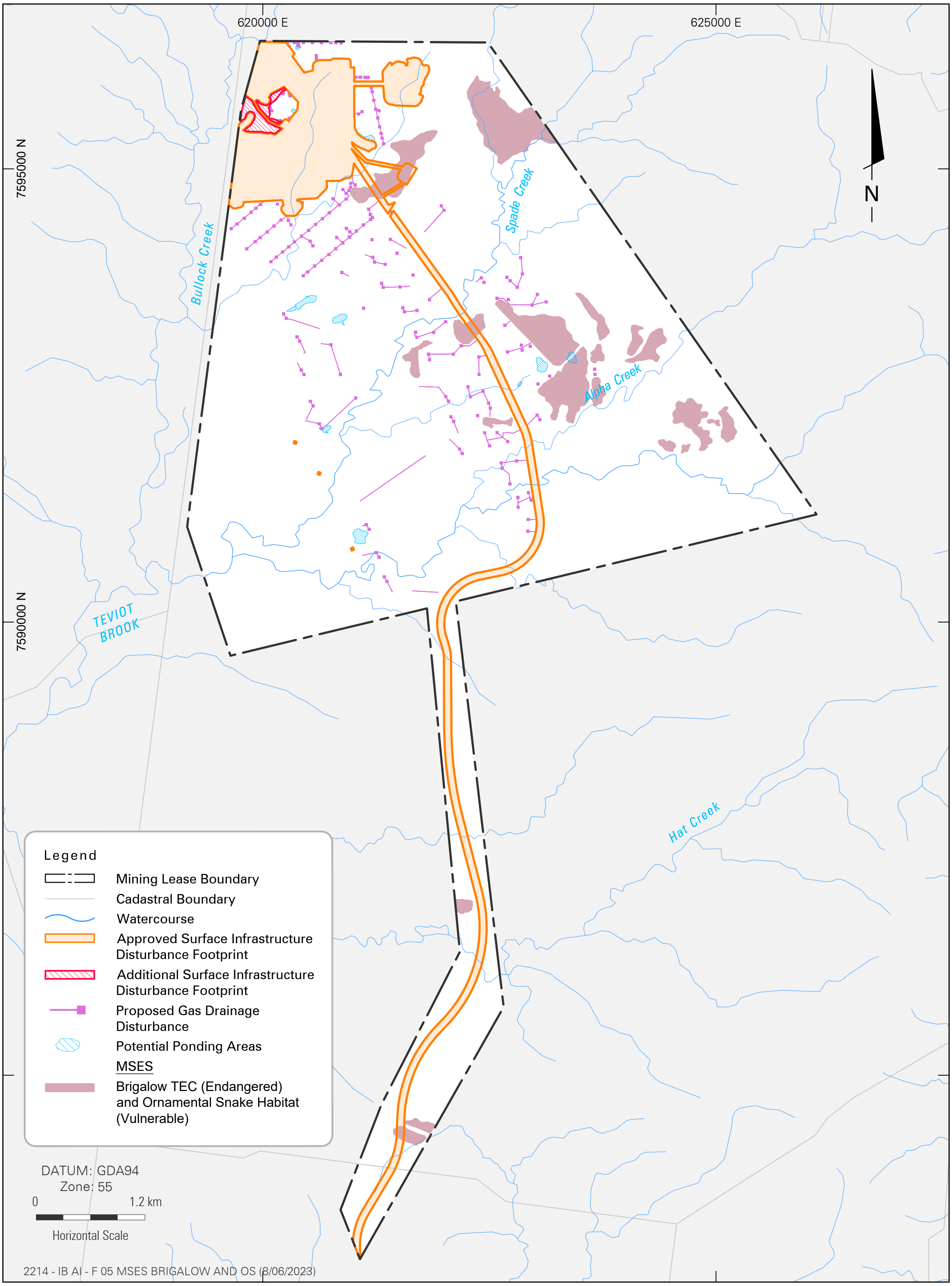
FIGURE 3



IRONBARK NO.1 COAL MINE

Dual Listed MSES
Squatter Pigeon Habitat Disturbance

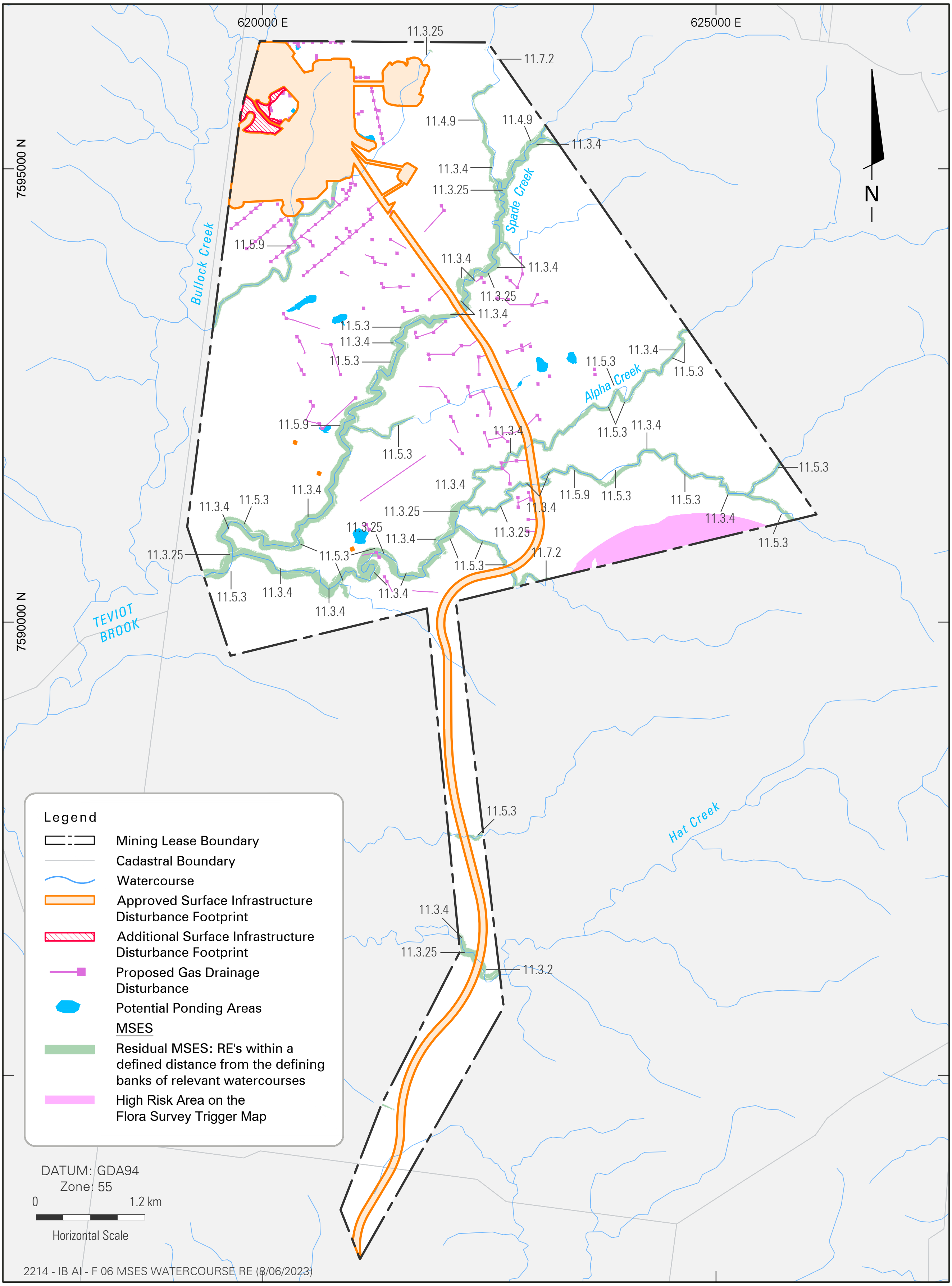
FIGURE 4



IRONBARK NO.1 COAL MINE

Dual Listed MSES
Brigalow TEC and Ornamental Snake Habitat Disturbance

FIGURE 5



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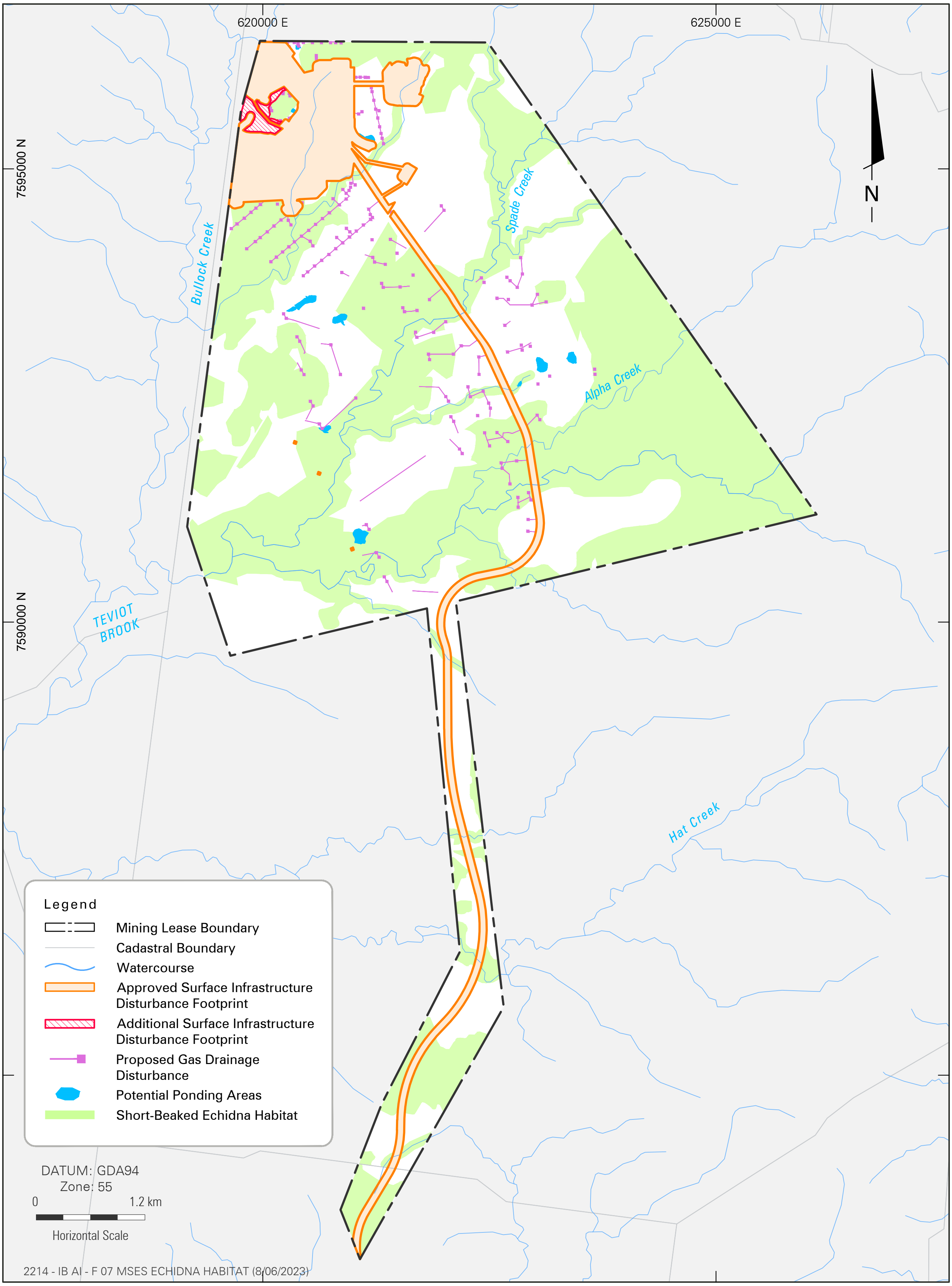
HANSEN ENVIRONMENTAL CONSULTING

IRONBARK NO.1 COAL MINE

Residual MSES – Vegetation in Association with a Watercourse / Drainage Line and High Risk Area on the Flora Survey Trigger Map

FIGURE 6



IRONBARK NO.1 COAL MINE

Residual MSES -
Short-Beaked Echidna Habitat Disturbance

FIGURE 7

APPENDIX A

DES Information Request Notice

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Notice

Environmental Protection Act 1994

Information request

This information request is issued by the administering authority under section 140 of the Environmental Protection Act 1994 *to request further information needed to assess an amendment application for a site-specific environmental authority.*

To: Fitzroy (CQ) Pty Ltd
Level 20, 324 Queen Street
Brisbane City Q 4000

ATTN: Sophie Bereyne

Email: sbereyne@fitzroyoz.com

Our reference: EA00001299

Further information is required to assess an amendment application for environmental authority

1. Application details

The amendment application for a site-specific environmental authority was received by the administering authority on 24 March 2023.

The application reference number is: A-EA-AMD-100405752.

Land description: ML700024.

2. Information request

The administering authority has considered the abovementioned application and is writing to inform you that further information is required to assess the application (an information request).

The information requested is outlined below in **Attachment 1.**

3. Actions

The abovementioned application will lapse unless you respond by giving the administering authority -

(a) all of the information requested; or
(b) part of the information requested together with a written notice asking the authority to proceed with the assessment of the application; or

(c) a written notice –
  i. stating that you do not intend to supply any of the information requested; and
  ii. asking the administering authority to proceed with the assessment of the application.

Should the information request require an EIS process or applicant to submit a progressive rehabilitation and closure (PRC) plan then it must be completed and submitted.

A response to the information requested must be provided by 9 November 2023 (the information response period). If you wish to extend the information response period, a request to extend the period must be made at least 10 business days before the last day of the information response period.

The response to this information request or a request to extend the information response period can be submitted to the administering authority by email to CRMining@des.qld.gov.au.

If the information provided in response to this information request is still not adequate for the administering authority to make a decision, your application may be refused as a result of section 176 of the *Environmental Protection Act 1994,* where the administering authority must have regard to any response given for an information request.

4. Human rights

A human rights assessment was carried out in relation to this decision and it was determined that **the decision is compatible with human rights.**

5. Review and appeal rights

You may apply to the administering authority for a review of this decision within 10 business days after receiving this notice. Information about your review rights is attached to this notice or search 'DES Internal review and appeals' at business.qld.gov.au. This information is guidance only and you may have other legal rights and obligations.

If you require more information, please contact Hayley Gottke on the telephone number listed below.

Signature	Date
	10/05/2023

Ben Byrd
Department of Environment and Science
Delegate of the administering authority
Environmental Protection Act 1994

Enquiries:
Coal Business Centre
PO Box 3028, Emerald QLD 4720
Phone: 07 3330 6283
Email: CRMining@des.qld.gov.au

Attachment 1: Additional information required

Item	Issue	Request
1. Subsidence	There is currently no Subsidence Management Plan, Rehabiltation Management Plan or approved PRCP schedule to explain in detail the potential impacts from subsidence (and subsidence repair) of the underground mining operation on environmental values and how these impacts will be avoided, mitgiatied, managed or offset.	In the absence of these documents, describe in sufficient detail and quantify areas and locations (in figures) where possible, all potential above ground disturbance from the revised underground mine layout including gas drainage activities, subsidence (predicted ponding, cracking etc.), interference with watercourses/drainage lines, vegetation clearing and subsidence rehabilitation/repairs.
2. Subsidence of riparian areas	Condition I1 of the EA currently permits the subsidence of Spade Creek, subject to conditions I1 to I13. The proposed underground mine layout involving longwall mining also occurs under Bullock Creek East and South Spade Creek / Alpha Creek. The EPBC approval requires that all management measures, monitoring, reporting and correcitive actions regarding the subsidence of Spade Creek are also applied to Alpha Creek.	Provide further information about the subsidence risk to Bullock Creek East and South Spade Creek / Alpha Creek.
3. MNES and MSES	An ecology report was provided with the supporting documentation; however, it only addressed the ecology impacts associated with the additional surface disturbance areas. No ecological assessment was provided for the surface impacts relating to subsidence of the underground mining area, or for impacts from rehabilitation of subsided areas.	Evaluate the impact of the revised project (both surface infrastructure and surface disturbance—including from rehabiliitation activites—from the underground mine) on MNES and MSES and show in a table and figures.
4. Conservation significant species	There is essential habitat (MSES) mapped on the ML for the ornamental snake, which is classified as Vulnerable under the EPBC Act (Cmwth) and NC Act (Qld). There is also a known record for this species within the ML. The supporting ecology report included the essential habitat map and table, however there was no further discussion on how this species may be impacted by the proposed amendment, or whether offsets may be required. There is currently no approved	Provide details about: • potential impacts from the proposed amendment on this species • include any documentation provided to DCCEEW regarding this species • any offset requirement.

	clearing for ornamental snake habitat addressed in Table G1 of the EA.	
5. ERA 63 – Sewage treatment	The supporting information states that an ERA amendment is also requested to change the sewage treatment capacity from 20 to 100EP (as currently permitted in the EA) to allow for 400EP. The applicable ERA threshold would be: (b) more than 100 but not more than 1,500EP. This is not considered an administrative amendment.	Provide reference to the relevant sections of the EIS which justify the total daily peak design capacity of 400EP. Further discussion should also be provided regarding the expected volumes of treated sewage, specifications of the STP required and whether the irrigation area is suitable for the increased sewage treatment capacity. Identify if any of the current sewage treatment conditions (e.g. C15) will need to be amended.
6. Groundwater	Fitzroy have responded to an informal information request regarding groundwater queries relating to the application. The below item is outstanding and is required to be addressed. Item 2.2 of the informal IR requested drawdown contours for the Rewan Formation and the Regolith. These maps were provided for the ‘Predicted drawdown’. Similar to Appendix C, Figure 7 of the supporting information with the application, DES requires three separate figures for Layer 2 (Rewan Formation), titled ‘Approved drawdown’, ‘Proposed drawdown’ and ‘Incremental drawdown’ (showing the difference between the two).	Provide three figures for the drawdown contours for the Rewan Formation, similar to Appendix C, Figure 7 of the application supporting information.

APPENDIX B
Subsidence Prediction Report

HANSEN
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CONSULTING

SUBSIDENCE PREDICTION REPORT FOR LONGWALLS 1-22 – IRONBARK MINE

Prepared for Fitzroy Australia Resources Pty Ltd

JUNE 2023

Mobile: 0428 186 255
Email: ggpl@hotkey.net.au

TABLE OF CONTENTS

List of Figures

1 INTRODUCTION

1.1 Introduction

Gordon Geotechniques Pty Ltd (GGPL) has been commissioned by Hansen Environmental Consulting Pty Ltd, on behalf of Fitzroy Australia Pty Ltd, to prepare a subsidence prediction report for the longwall layout at Ironbark underground mine (**Figure 1**).

The Ironbark No.1 project site is located 125 km south-west of Mackay and approximately 35 km north-east of Moranbah in the northern part of the Bowen Basin.

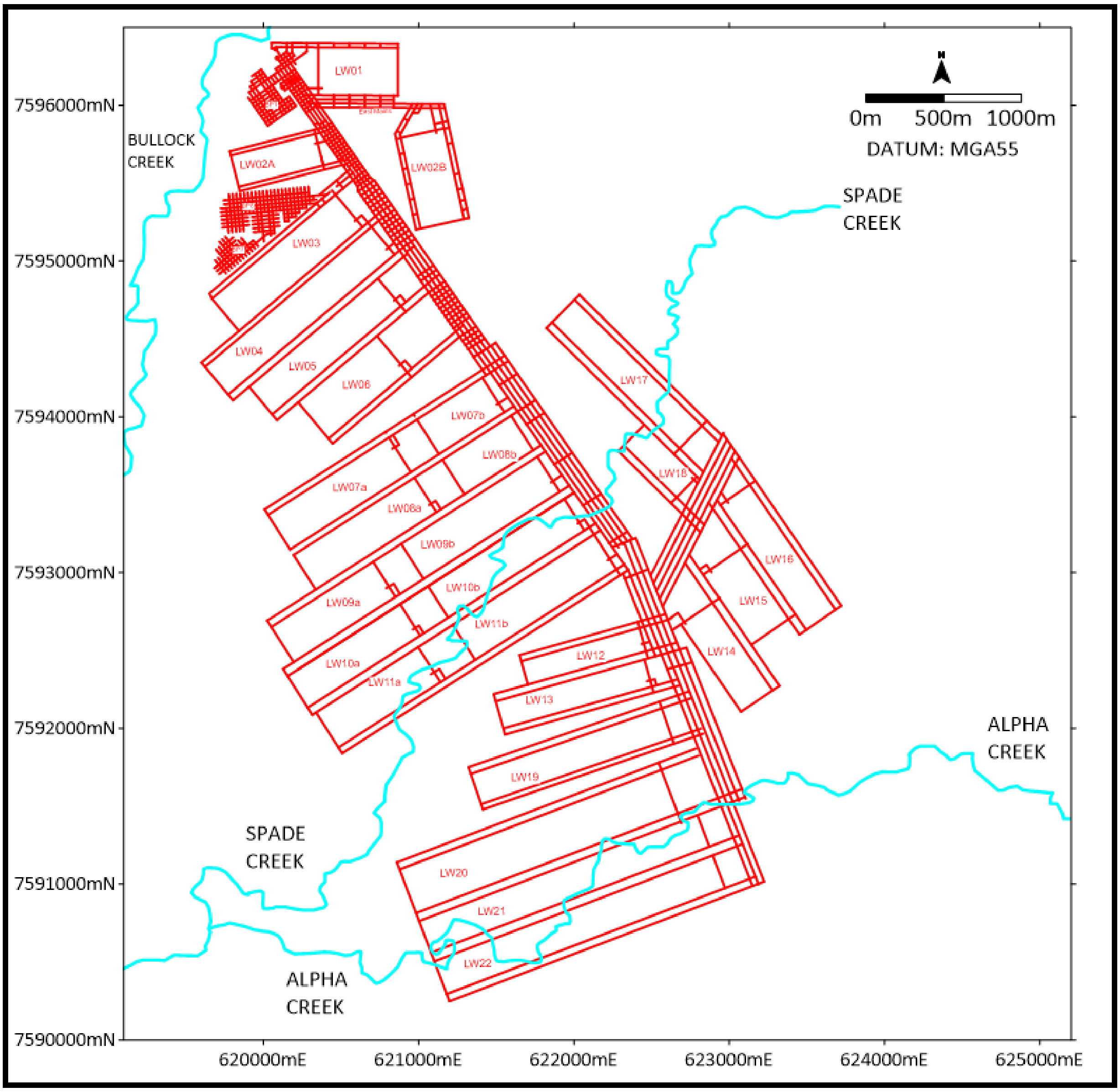

Figure 1. Ironbark Mine - Longwall Layout.

GGPL has extensive experience in the prediction of underground mine subsidence and subsidence effects in this part of the Bowen Basin including the bord and pillar and longwall layouts at Carborough Downs, which also mines the Leichhardt Seam to the south of the Ironbark No.1 project area (GGPL, 2018[1], 2021[2] and 2022[3]).

1.2 Scope of Work

This report includes the prediction of the subsidence for the proposed longwall mining layout at Ironbark mine using influence function subsidence modelling methods (**Figure 1**).

This modelling can visualise the resulting subsidence bowl of the longwall extraction and produce contours of the vertical subsidence, horizontal movement, strains and tilts at the surface (Section 4).

[1] GGPL (2018). Subsidence Report for the Carborough Downs Bord and Pillar Extension Project. Report No. Carborough18-R4.
[2] GGPL (2021). Subsidence Report for the Carborough Downs South Extension Project. Report No. Carborough21-R1.
[3] GGPL (2022). Subsidence Report for the Carborough Downs South Longwall Extension Project. Report No. Carborough22-R1.

2 ENGINEERING GEOLOGY

2.1 Mine Layout

The longwall panels in the Ironbark mining area will create a range of extraction voids between 164 m (Longwall 12) and 310 m (Longwalls 1 and 6). These longwall panels will be developed with two heading gateroads located along the panel length with chain pillar widths (solid dimension) between longwalls ranging from 30.7-54.5 m.

2.2 Seam Thickness

In the majority of the area, a maximum 4.5 m extraction height on the longwall face is anticipated (**Figure 2**).

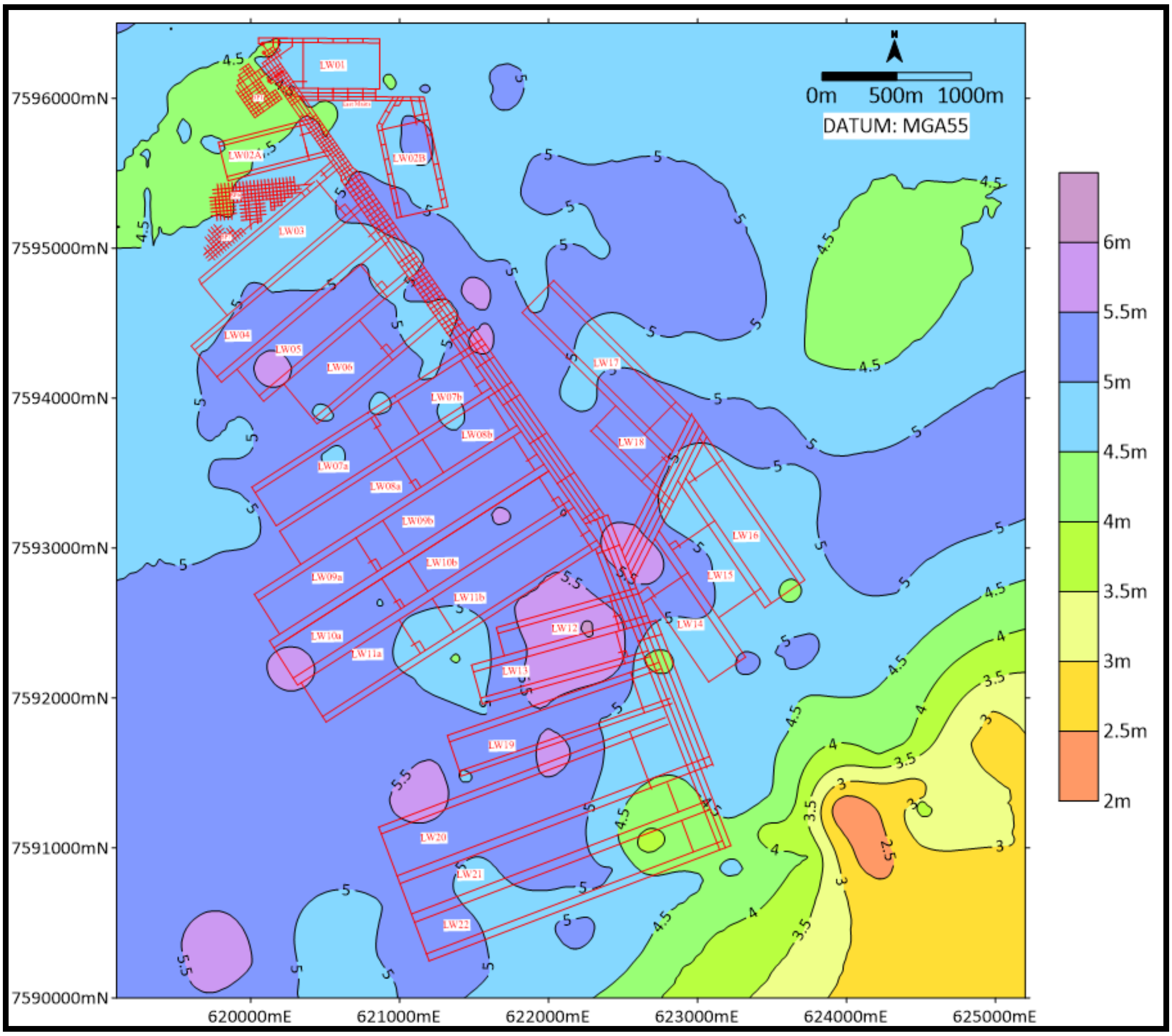

Figure 2. Leichhardt Seam Thickness (m).

2.3 Depth of Cover

The Leichhardt Seam is located at depths of 70-420 m in the proposed longwall area (**Figure 3**).

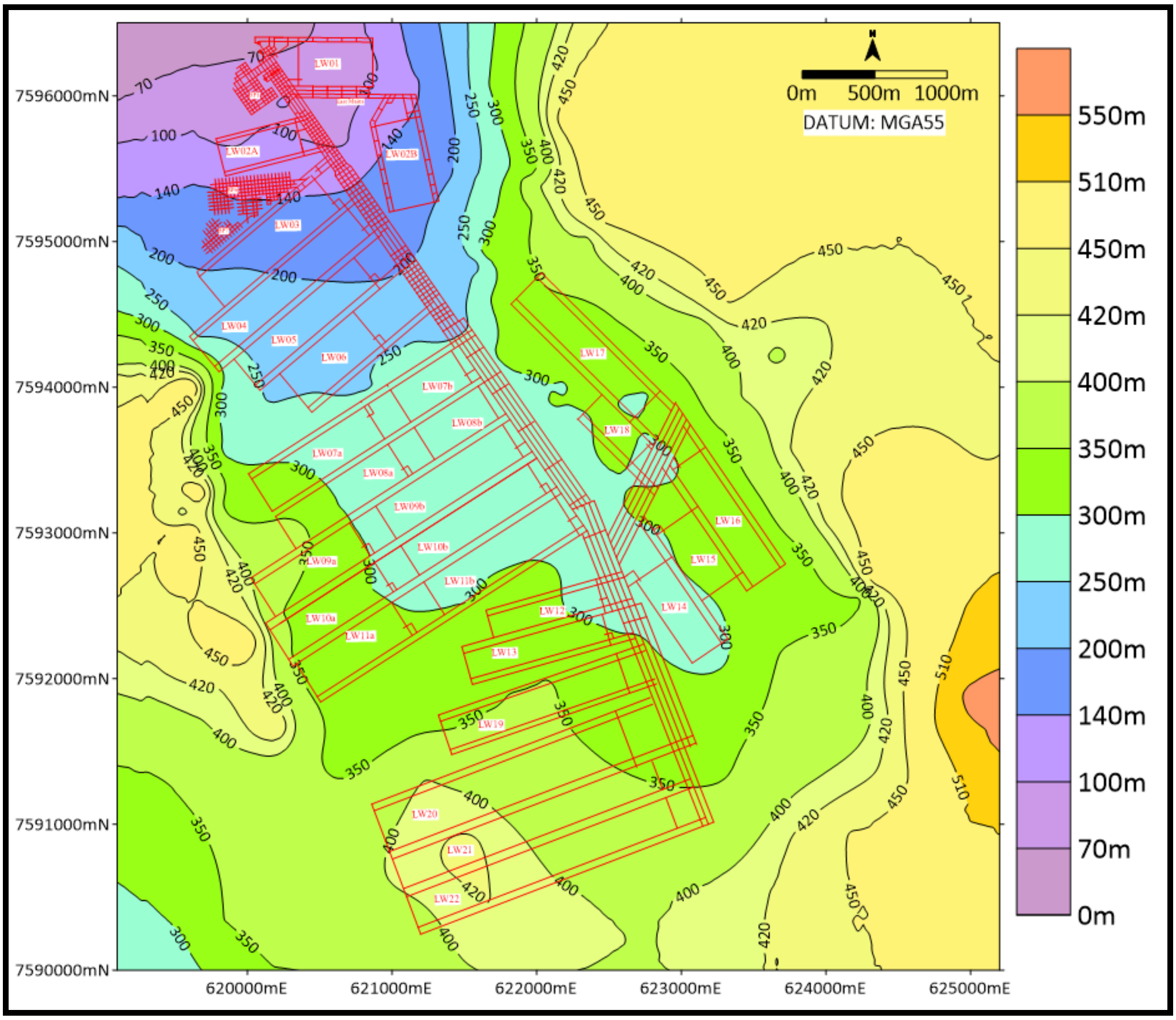

Figure 3. Leichhardt Seam Depth of Cover (m).

3 SUBSIDENCE PREDICTION METHODOLOGY AND RESULTS

3.1 SDPS Subsidence Modelling Method

GGPL has used the Surface Deformation Prediction System (SDPS) program (Carlson Software Inc[4]), to predict the subsidence that will occur due to longwall extraction of the Leichhardt Seam in the Ironbark underground mining area.

The SDPS program uses an influence function method that assumes the shape of a subsided surface can be modelled with a Gaussian (bell shaped) curve. This technique is a proven and reliable prediction methodology that is widely used throughout QLD and NSW to generate predictions of longwall mining subsidence effects and inform environmental impact and engineering assessments (Byrnes, 2003[5]). **Figure 4** illustrates how well SDPS can visualise the subsidence profile.

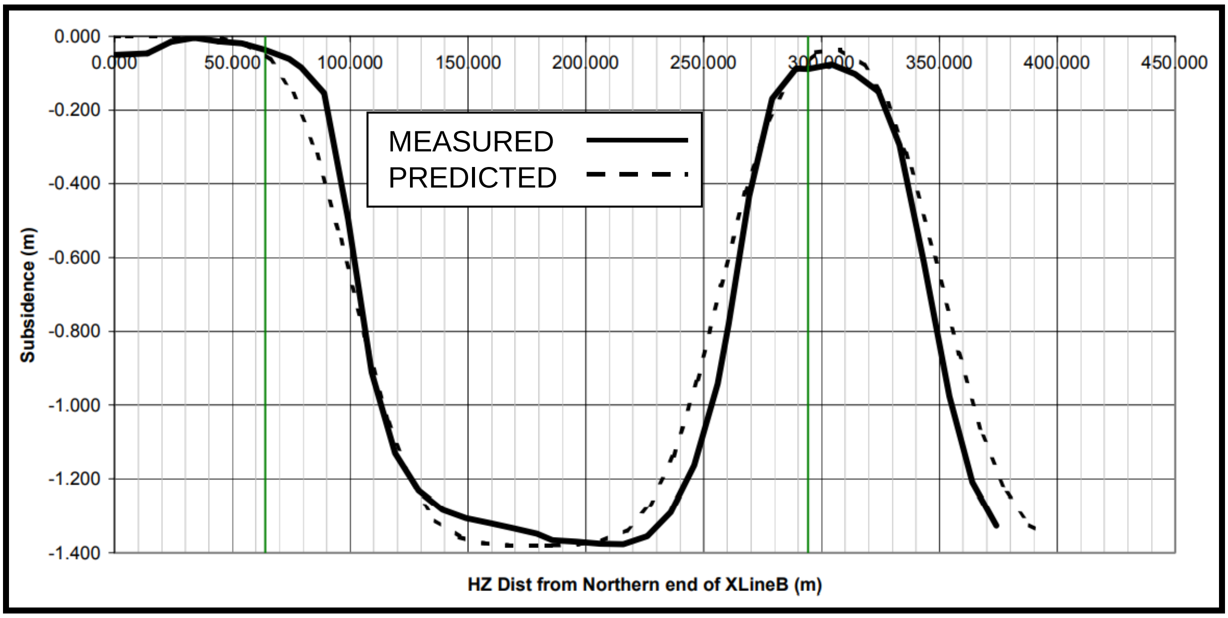

Figure 4. Comparison of Measured versus Predicted Subsidence (Byrnes, 2003).

The method requires calibration to existing survey data and mine geometry. The following inputs are required:

- Panel Layouts (corrected by the Panel Adjustment Factor).
- Seam Thickness.
- Depth of Cover.
- Influence Angle.

[4] Carlson Website - www.carlsonsw.com.
[5] Byrnes R. (2003). Case studies in the application of influence functions to visualising surface subsidence. COAL2003 - 4th Underground Coal Operators Conference. AusIMM Illawarra Branch.

- Subsidence Factor (maximum subsidence (S_{max})/extracted thickness ratio).
- Strain Coefficient.

It should be highlighted that the SDPS methodology can only predict the overall or systematic deformations. All subsidence surveys reveal small scale variations from the smooth profile predicted by this method. These deformations can be related to localised movements of blocky rock that are a feature of all coal mine overburdens.

Based on subsidence data from Carborough Downs where the Leichhardt Seam is also mined (GGPL, 2022), the following parameters were used for modelling in the Ironbark longwall mining area:

- Panel Adjustment Factor of 0.23.
- Influence Angle of 75^{o}.
- Subsidence Factor of 60%
- Strain Coefficient of 0.11.

3.2 Subsidence Modelling

3.2.1 Subsidence Behaviour

The subsidence above longwall panels is comprised of two main components namely sag and strata compression. Depending on the depth of cover and width of extraction, these components combine in various proportions (**Figure 5**). Subsidence monitoring at Carborough Downs indicates supercritical behaviour at ratios of around 0.8 and greater (GGPL, 2022).

In the Ironbark longwall area, the panel width: depth of cover ratios are typically >1 in the shallower part of the area (**Figure 6**). In the deeper mining areas, particularly where narrower longwall panels are planned, the panel width: depth ratios are as low as 0.5 (**Figure 6**).

In these deeper longwall mining areas, a larger component of the subsidence is anticipated to be from strata compression (**Figure 5**).

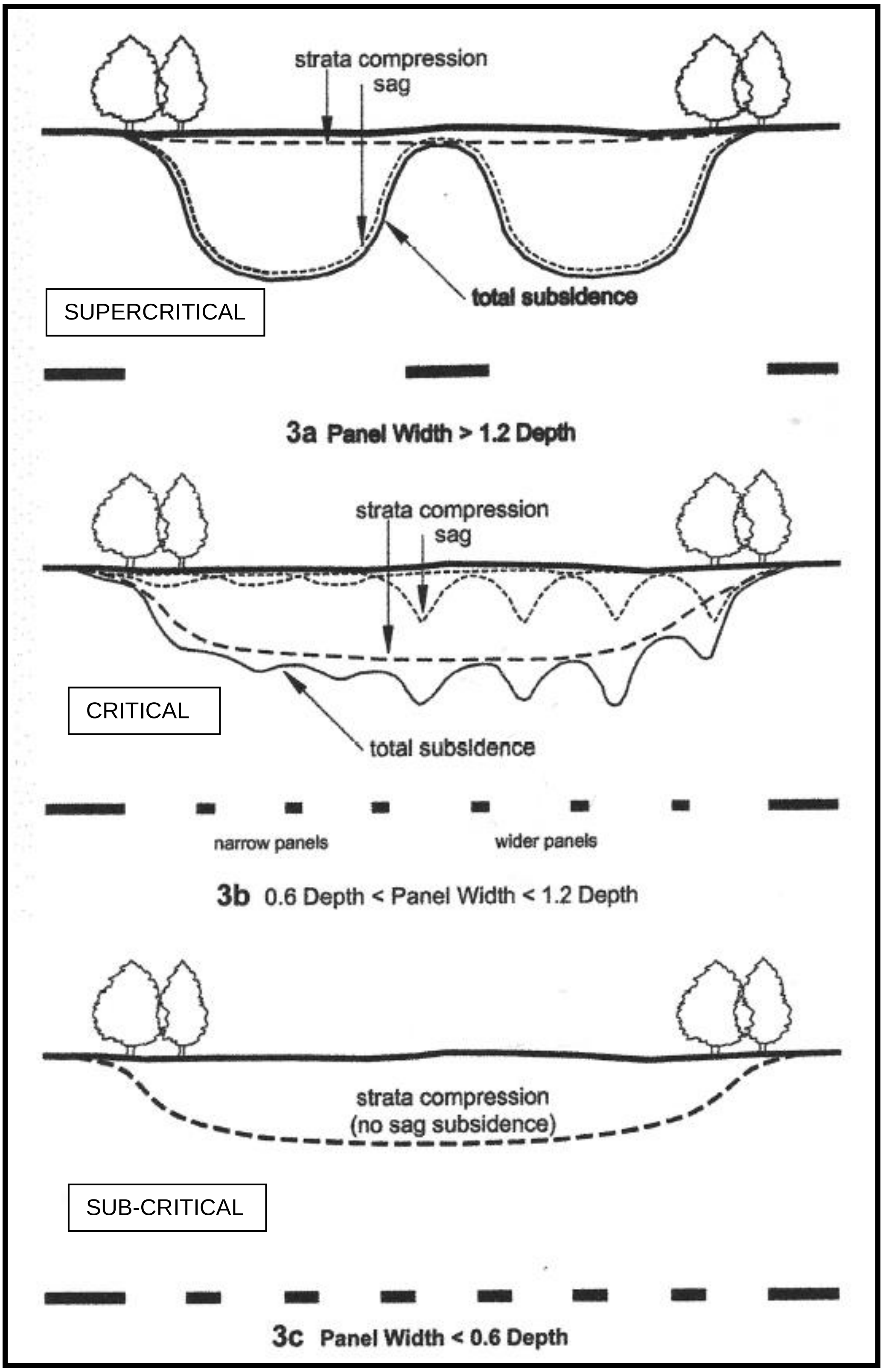

Figure 5. Effect of Panel Width (AUSIMM, 2009[6]).

[6] AUSIMM (2009). Australasian Coal Mining Practice – Monograph Series 12. Pp. 881.

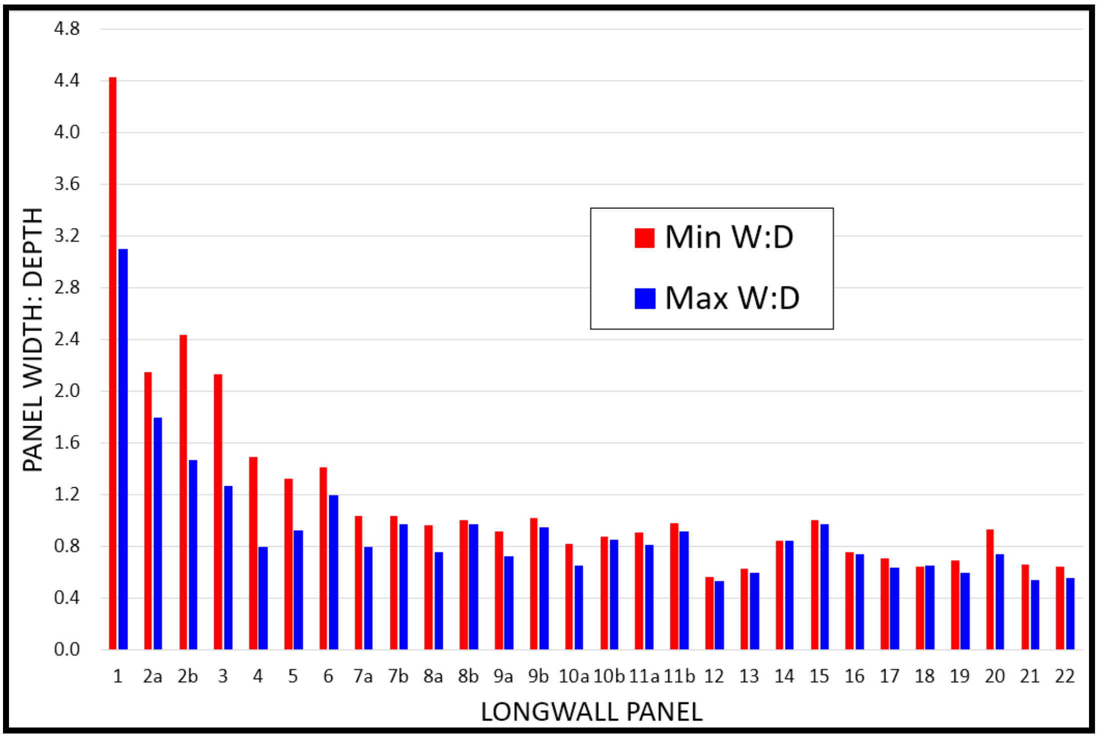

Figure 6. Panel Width: Depth Ratios.

The general shape of a cross section through a subsidence bowl (**Figure 7**) reveals a number of key features that can be used as a frame of reference:

- The areal extent of subsidence is defined by the angle of draw. The angle of draw is measured from the edge of the extraction void to the limit of measurable subsidence that can be distinguished from natural ground surface variations due to soil moisture changes. The guidance report by the Commonwealth of Australia (2015[7]) recommends a minimum value of 50 mm.
- Maximum tilt should correspond with zero strain.
- The subsidence at the point of maximum tilt and zero strain should be half the maximum vertical movement.
- The maximum tilts or strains do not necessarily correspond with the edge of the extraction.
- The typical subsidence profile is smooth over the cross section.

These parameters characterise the surface deformations above the extracted longwall panels and provide context to the resulting impacts.

SDPS models the extraction of each longwall panel using the projection of the points of inflexion, rather than the panel width. For wide extraction panels, the position of

[7] Commonwealth of Australia (2015). Management and monitoring of subsidence induced by longwall coal mining activity, prepared by Jacobs Group (Australia) for the Department of the Environment, Commonwealth of Australia, Canberra.

the inflexion points is a linear proportion of the depth of cover. The modelled and proposed extents of each longwall panel in the Ironbark area are shown in **Figure 8**.

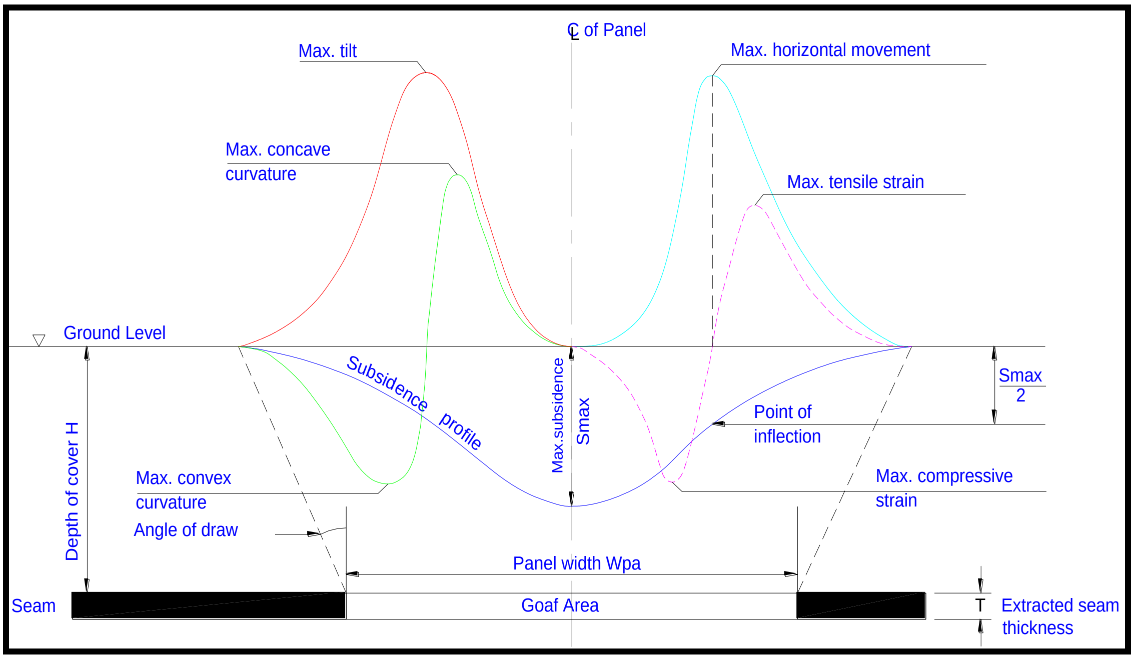

Figure 7. General Characterisation of a Subsidence Cross Line.

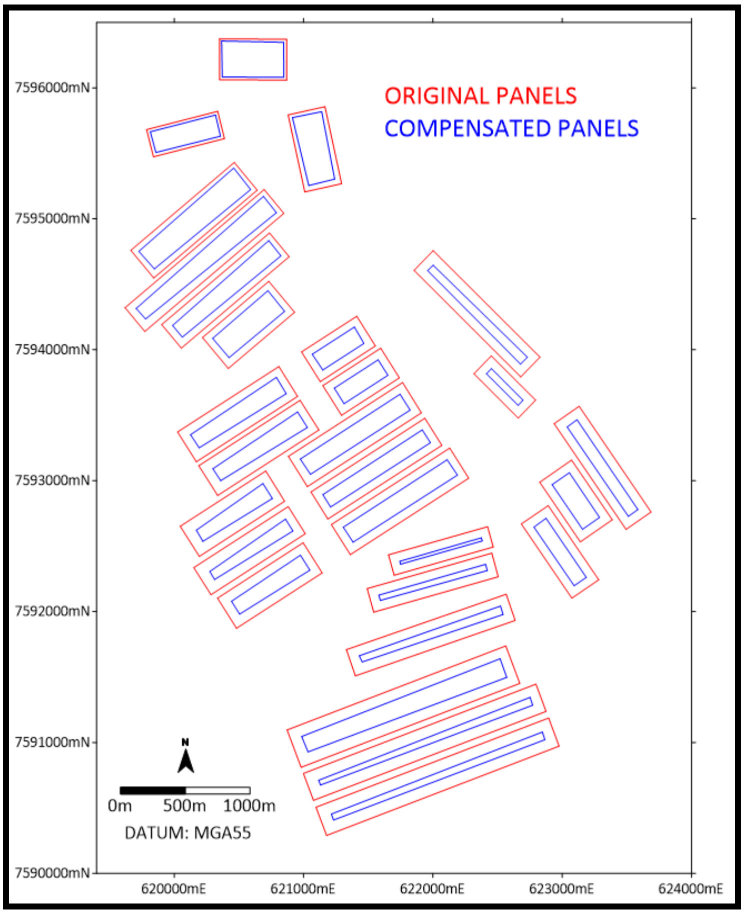

Figure 8. Original Longwall Panels and Compensated Panels.

3.3 Chain Pillar Deformation

The chain pillars at Ironbark will act to reduce the magnitude of subsidence deformation between each individual longwall panel and therefore the total subsidence over each series of panels.

Where the depth of cover increases along the length of the panels, the chain pillars may deform differently along their lengths and this will influence the total subsidence associated with each series of longwall panels. The key considerations in modelling the effects of chain pillar deformation on the total subsidence are discussed below in Sections 3.3.1 and 3.3.2.

3.3.1 Negative Pillar Subsidence Factor

In order to model the influence of the chain pillars, SDPS provides the ability to model each series of panels (also termed a super panel). In this mode, SDPS models the negative subsidence (upsidence) of the chain pillars instead of the panels. The SDPS model for the Leichhardt Seam layout at Ironbark is shown in **Figure 9**, where the super panel boundary is shown in purple and the chain pillar in green.

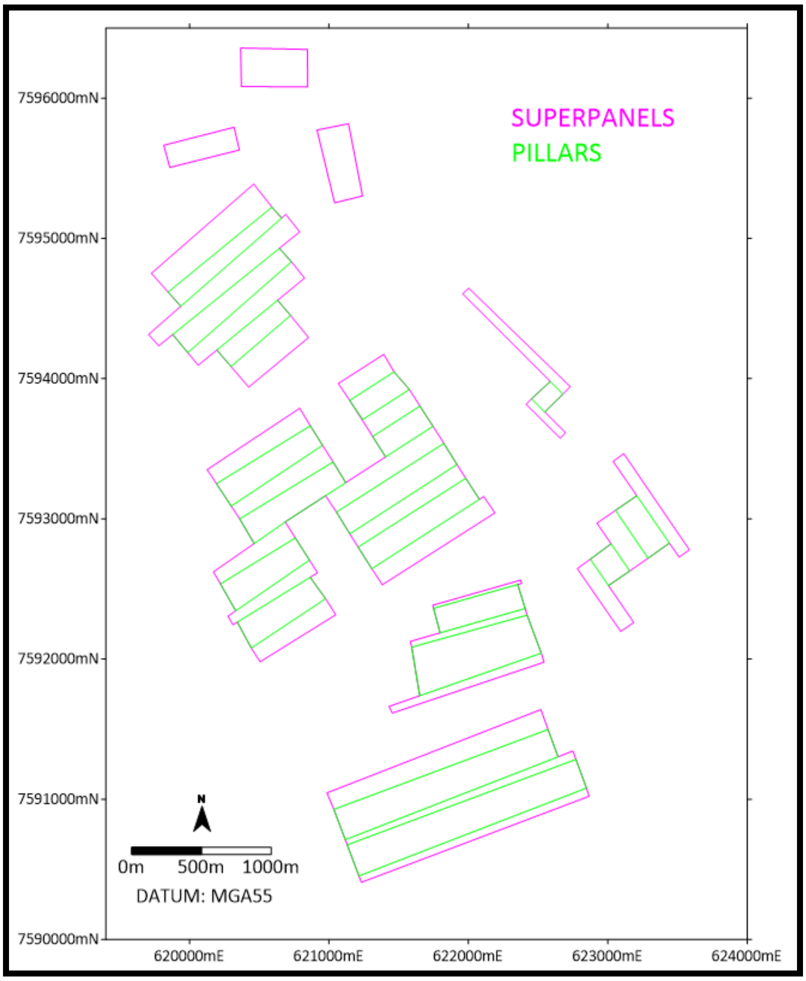

Figure 9. Super Panel and Active Pillar with Compensated Geometries.

The width of the active chain pillars is equal to the distance between the compensated panel boundaries. The feature of this method is that the chain pillars can be given their own negative subsidence factor in the prediction, allowing greater control over subsidence due to compression of the pillar system.

3.3.2 Stable Pillars to Yielding Pillars

When a longwall panel extracts the coal, the overburden load that was carried by coal is redistributed onto the chain pillars on either side of the longwall panel. With this increase in overburden load, the coal that forms the chain pillars in the Ironbark longwall mining area is expected to experience compression.

Analysis of the pillar stability using the ALPS methodology from NIOSH indicates that the chain pillars in the Ironbark mining area are not anticipated to yield significantly at the planned range of mining depths, with the majority of Factor of Safety values >1.2. No adjustment to the negative subsidence factor has therefore been required to account for additional movement above the chain pillars due to yielding.

3.3.3 Strata Compression

The induced surface deformation due to strata compression above the chain pillars has been estimated analytically by calculating the combined pillar, roof and floor compression using modulus values. This is discussed in the following sections.

3.3.3.1 Strength of the Stone Roof and Stone Floor

Typical average strength of the immediate roof and floor intervals in the Ironbark proposed longwall area range from 25-40 MPa and 10-30 MPa respectively (Blackrock, 2018[8]).

3.3.3.2 Coal Modulus

An in-situ modulus value of 1,500 MPa has been used for the Leichhardt Seam based on published coal seam modulus data (Seedsman et al, 2009[9]).

3.3.3.3 Compression Analysis

As part of the strata compression analysis, these strength values are converted to a laboratory modulus value based on the following correlation that fits the geotechnical testing data presented by SCT (2012[10]):

---

[8] Blackrock Mining Solutions Pty Ltd (2018). Geotechnical Assessment of Ironbark Number 1 Underground Mine for Fitzroy Australia Resources.

[9] Seedsman, R.W., Gordon, N. and Aziz, N (2009). Analytical Tools for Managing Rock Fall Hazards in Australian Coal Mine Roadways. ACARP Project C14029.

[10] SCT (2012). Geotechnical Characterisation for Ellensfield Coal Underground Feasibility. Report No. ELC3340A.

Laboratory Modulus (GPa) = 300 * Strength (MPa)

The methodology of Hoek and Diederichs (2006[11]) was then used to reduce the roof and floor laboratory modulus values (E_i) to rock mass values (E_{rm}), to consider the discontinuities in the rock mass.

$$E_{rm} = E_i * \{0.02 + (1-D/2)/ (1 + \exp((60+15D–GSI)/11))\}$$

The laboratory modulus values are reduced using a Disturbance Factor (D) of 0 and representative Geological Strength Index (GSI) values for the roof and floor (**Figure 10**).

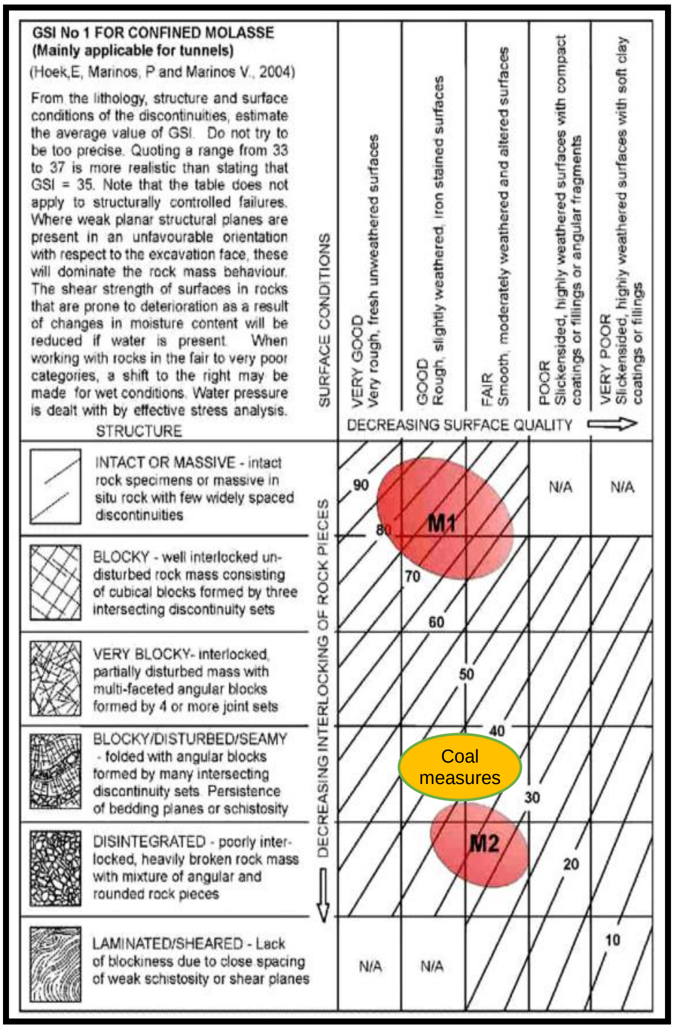

Figure 10. Determination of the Geological Strength Index (GSI).

Based on the lithological and bedding characteristics of the roof and floor strata in the Ironbark mining area, GSI values of 50 and 45 have been applied to the roof and floor strata.

[11] Hoek, E. and Diederichs, M. (2006). Empirical Estimates of Rock Mass Modulus. International Journal of Rock Mechanics and Mining Sciences, 43, 203-215.

The amount of pillar, roof and floor compression has been calculated for the Ironbark longwall area from these reduced moduli values, using a 21^{o} abutment angle and an abutment factor of 2 and negative subsidence factors of -42% to -56% have been applied.

4 SUBSIDENCE PREDICTIONS

4.1 Subsidence

The predicted total subsidence from mining of the Leichhardt Seam longwall panels is shown in **Figure 11**. The vertical subsidence predicted for a maximum extraction height of 4.5 m, ranged from 0.93 m above the narrower longwall panels in the deeper part of the area, up to 2.7 m in the shallower part of the area (**Figure 11**). The subsidence above the chain pillars between the longwall panels is between 0.2-0.9 m.

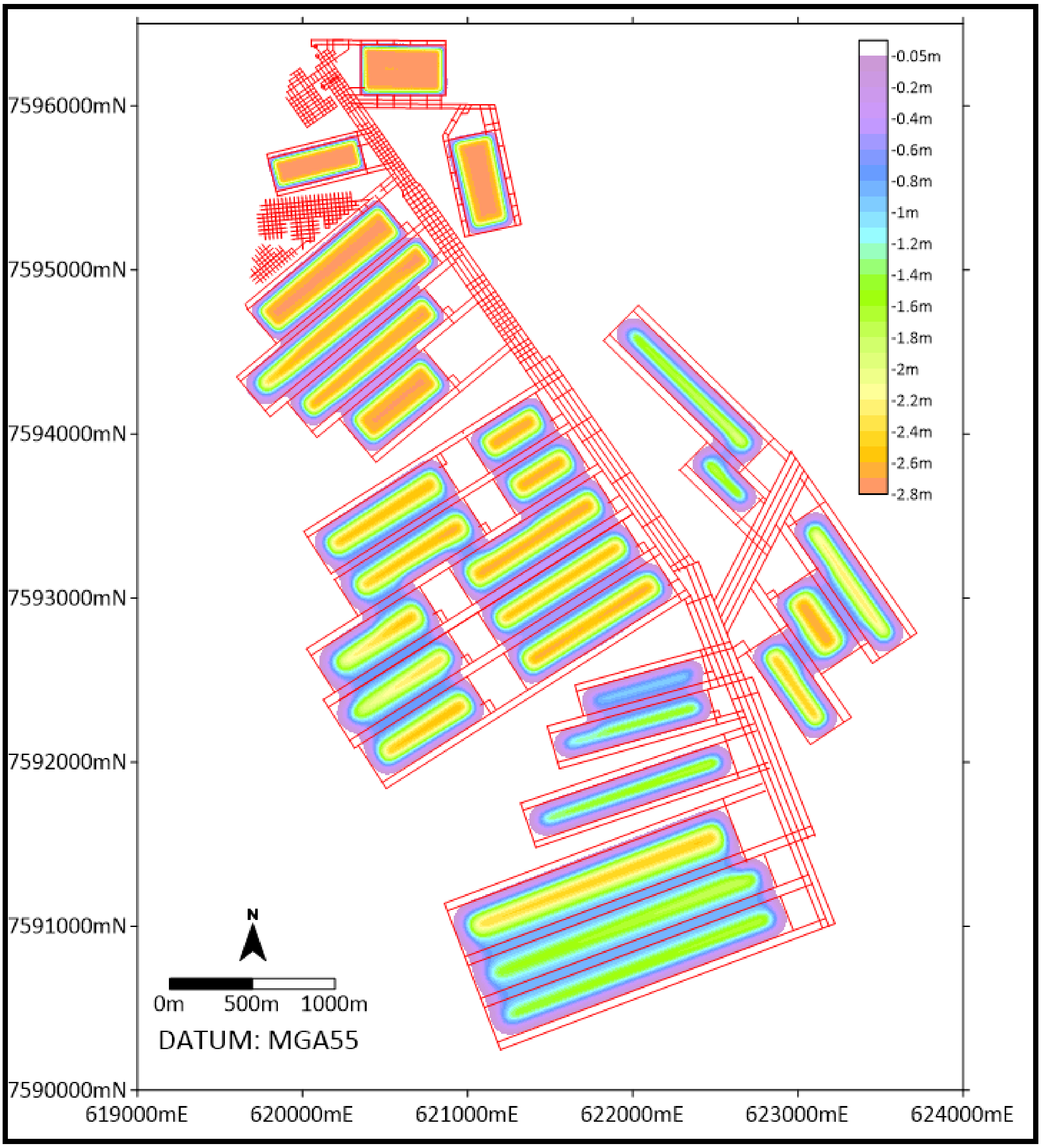

Figure 11. Subsidence (m).

4.2 Subsided Topography

Figure 12 shows the predicted topographic surface over the Ironbark area at the completion of longwall mining, with a z axis exaggeration of 20. The distinct ridges above the chain pillars and troughs over the goaf areas are evident in this figure, particularly in the shallower, northern part of the area (**Figure 12**).

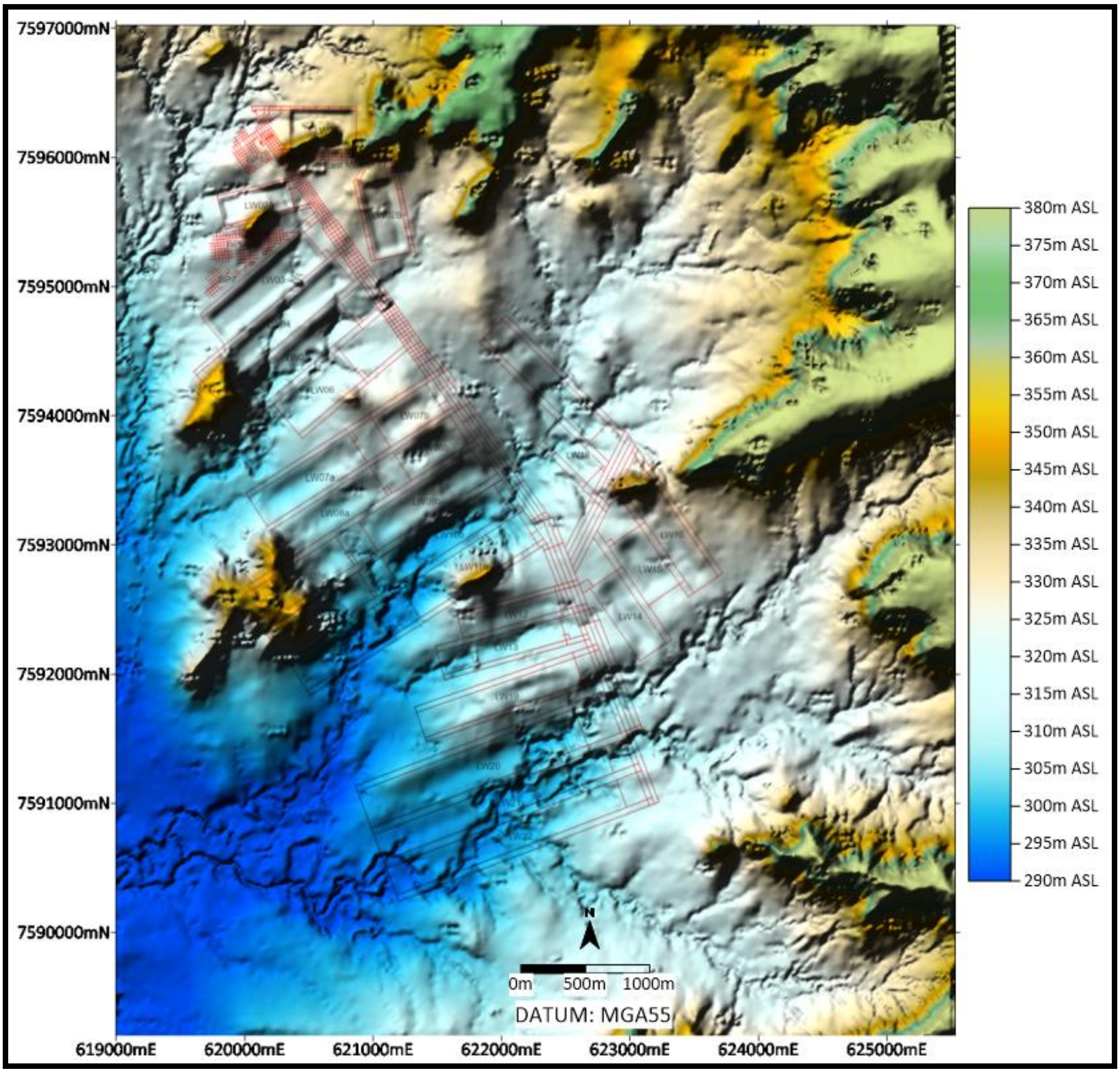

Figure 12. Post-Mining Topography (Z=20).

4.3 Horizontal Movements

As well as vertical movement, horizontal ground movements also occur at the surface due to underground mining. These movements are more relevant if key surface infrastructure is located above the longwall extraction area.

The maximum horizontal ground movements predicted at the surface above the Ironbark longwall area are less than 0.3 m (**Figure 13**).

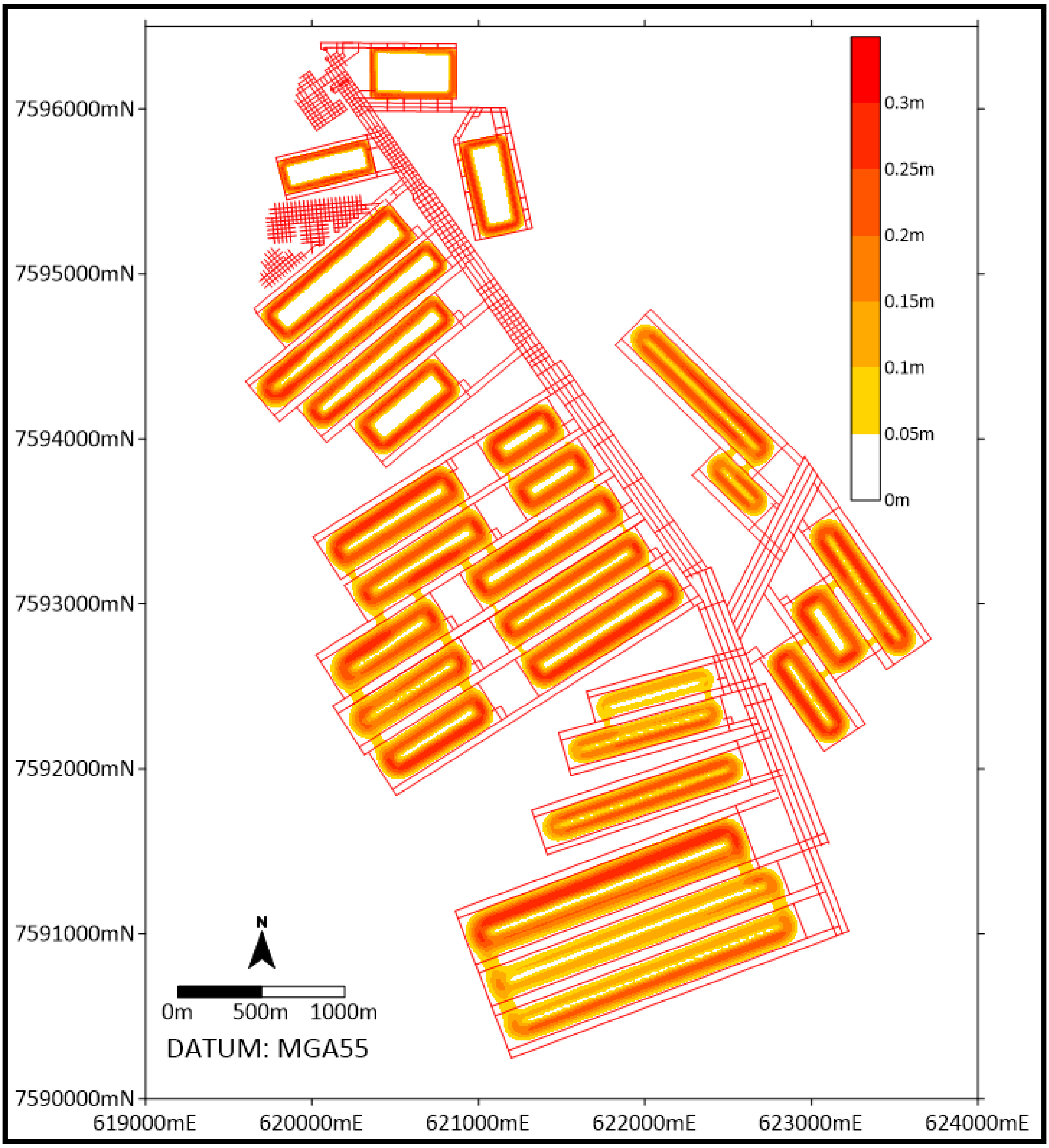

Figure 13. Horizontal Movement (m).

4.4 Strain

Surface strain is caused by bending and horizontal movements in the strata. Measured strain is determined from monitored survey data by calculating the horizontal change in length of a section of a subsidence profile and dividing this by the initial horizontal length of that section.

The maximum tensile strains due to extraction in the Ironbark longwalls, range in magnitude up to 18 mm/m (**Figure 14**). Maximum compressive strains also range up to 18 mm/m (**Figure 14**). As anticipated, the strains decrease in the deeper part of the area.

Figure 14. Strain (mm/m).

4.5 Tilt

Tilt is the slope of subsided land over a given distance and is calculated by determining the change in subsidence between two points and dividing this by the distance between those points. The physical result of this is that post mining surface slopes become steeper in localized areas along the edges of the subsidence troughs.

The maximum tilts developed due to longwalling in the Ironbark area range up to 11% or 110 mm/m in the shallower part of the area (**Figure 15**). Tilts in the deeper part of the area are typically <5% (**Figure 15**).

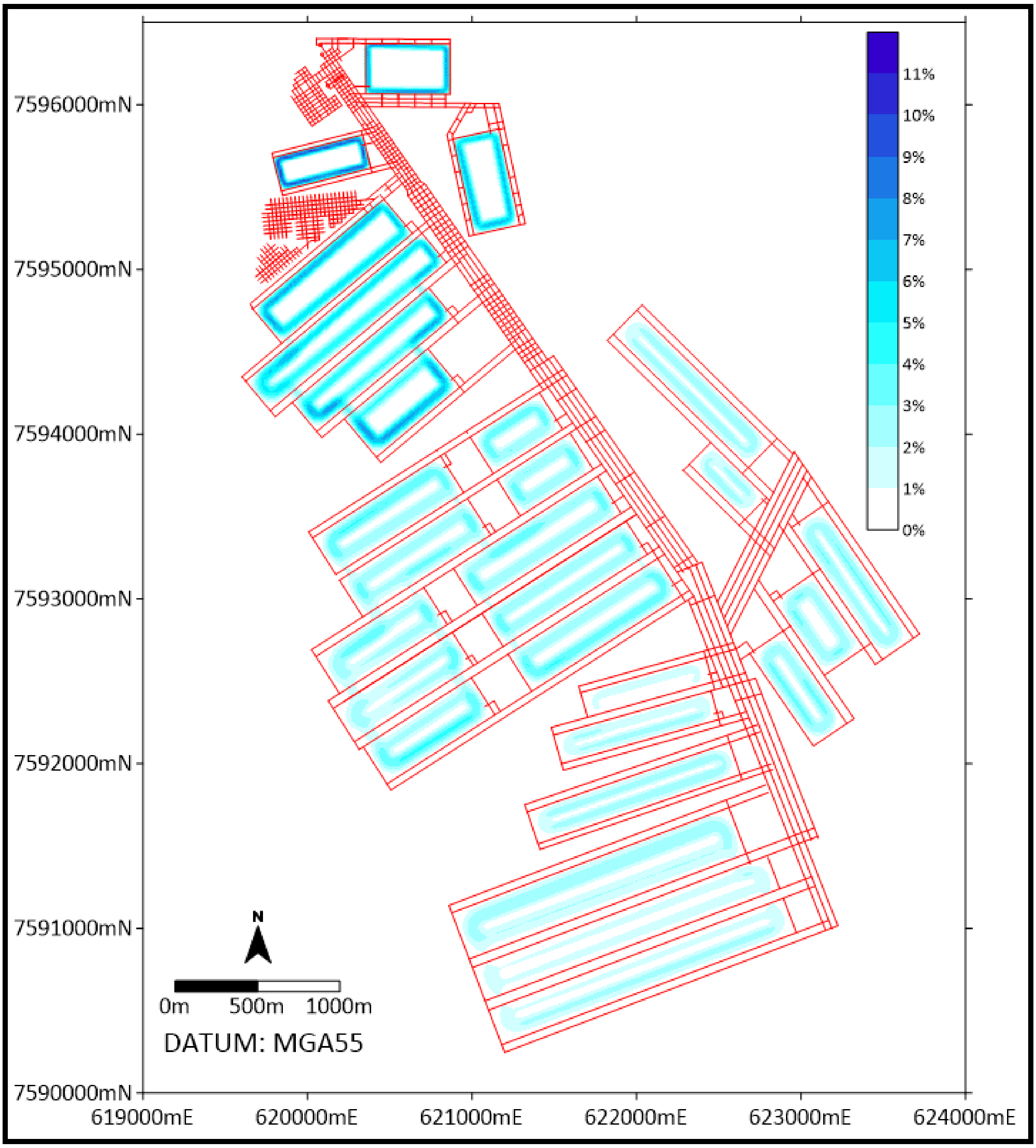

Figure 15. Tilt (%).

4.6 Limitations of the Subsidence Predictions

The subsidence predictions are final subsidence values after longwall mining is completed. The nature of the longwall mining method means that subsidence does not increase further over time. Based on subsidence monitoring at other mines in the Bowen Basin typically greater than 97% of the maximum subsidence will occur within 6 weeks after longwall mining is completed, assuming an industry average retreat rate of 100 m/week.

Based on the available data for the Ironbark longwall mining area, there are no localised features or variations in the geology, geotechnical conditions or surface topography that are considered likely to result in any significant deviations from the subsidence predictions presented in this report.

Overall, the subsidence predictions are based on well-established methodologies that have been proven to provide reliable predictions at numerous similar mining operations. In any areas of uncertainty, conservative assumptions have been applied. The predictions are therefore considered suitable for assessing the potential significant impacts of subsidence on the environment.

Similar magnitudes of vertical subsidence, strain, tilt and horizontal displacement were also predicted by MSEC (2012) as part of the EIS study.

5 CONCLUSIONS

The key conclusions from this report include:

1. Based on subsidence data from Carborough Downs, where the Leichhardt Seam is also mined, the following parameters were used for modelling in the proposed Ironbark longwall mining area:

    - Panel Adjustment Factor of 0.23.
    - Influence Angle of 75^{o}.
    - Subsidence Factor of 60%.
    - Strain Coefficient of 0.11.

2. The maximum vertical surface subsidence is predicted to be 2.7 m.

3. The maximum tensile strains due to longwall extraction range in magnitude up to 18 mm/m. Maximum compressive strains range up to 18 mm/m.

4. The maximum tilts developed range up to 11% or 110 mm/m, which is equivalent to a change in slope of 6.3 degrees.

5. Based on subsidence monitoring at other Bowen Basin longwall mines, greater than 97% of the maximum subsidence will typically occur within 6 weeks after longwall mining is completed, assuming an industry average retreat rate of 100 m/week.

6. There is confidence in the subsidence predictions due to the amount of information available from other Bowen Basin mines, including Carborough Downs. This data has allowed a good calibration to be achieved and provided a sound basis to enable conservative prediction of potential environmental impacts due to subsidence effects. It is not considered that there will be significant deviations from the current predictions due to topographic, geological or geotechnical variations.

Yours truly,

N.G.Gordon.

Nick Gordon

RPEQ No. 9855

APPENDIX C

Rewan Formation Groundwater Drawdown Contours

HANSEN ENVIRONMENTAL CONSULTING

11 May 2023

Hansen Environmental Consulting Pty Ltd
Level 15, 215 Adelaide Street
Brisbane, Qld, 4000

Attention: Peter Hansen
via email: phansen@hansenec.com.au

Dear Peter,

Ironbark Mine Plan Amendment – Groundwater Assessment – Response to DES Additional Information Request

1 Introduction

Fitzroy Australia Resources Pty Ltd (Fitzroy Resources) are planning for the commencement of longwall mining at the Ironbark No. 1 Project (the project) in the Bowen Basin, Central Queensland. Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) was commissioned by Hansen Environmental Consulting Pty Ltd on behalf of Fitzroy Resources to assess the groundwater impacts associated with a proposed amendment to the project's mine plan. The results of the groundwater assessment are described in AGE (2023)[1]. Representatives of the Queensland Department of Environment and Science (DES) have reviewed the groundwater assessment report and requested some more information which was provided by AGE in a letter dated 5 April 2023[2]. In response representatives of DES requested some additional information which is provided within this letter.

[1] Australasian Groundwater and Environmental Consultants Pty Ltd (2023). Ironbark Mine Plan Amendment – Groundwater Assessment, Project No, IRB5000.001, dated 15 March 2023

[2] Australasian Groundwater and Environmental Consultants Pty Ltd (2023). Ironbark Mine Plan Amendment – Groundwater Assessment, Response to DES Additional Information Request - Project No, IRB5000.001, dated 5 April 2023

2 Further information

Request: *"Provide figures with predicted drawdown contours, similar to Appendix C Figure 7, separately for the Rewan Formation and the Regolith (layer 1). Please also provide information in regard to the modelled thickness of the Regolith.*

The existing Appendix C Figure 7, was referenced as an example of the format. That format was considered a useful additional way to compare the impacts of the two mine plans. In that figure there are 3 separate contours provided.

The first is the predicted drawdown under the existing mine plan. The second is the predicted drawdown under the proposed mine plan. The third is the difference between the two predicted drawdown contours.

The intent had been to provide this range of figures for layer 1 and the Rewan. DES accepts that there is very limited drawdown predicted under the new mine plan in layer 1, so no further figures are required for it.

DES had assumed that the Rewan would be some form of combination of all the layers to produce drawdowns but consider it ok to go with layer 2 if we can get the three options as provided in the existing Appendix C Figure 7."

Response: The predicted drawdown within model layer 2 (Rewan Formation) for the approved and proposed mine plans is provided in Figure 1 below. The difference in the drawdown is also shown on Figure 1 in the right side window. There are some areas where drawdown is not predicted because layer 2 is dry in the model, and the water table occurs within a deeper underlying model layer. The Rewan Formation is represented by model layers 2 to 21 in the model, and therefore the predicted drawdown will change through the model layers based on the hydraulic properties and proximity to mining. Layer 2 drawdown was provided because it represents the upper zone of the Rewan Formation closest to the land surface. Figure 1 indicates there is likely to be limited difference in impacts at the surface due to proposed changes to the mine plan.

Yours sincerely,

James Tomlin
Principal/Director
Australasian Groundwater and Environmental Consultants Pty Ltd

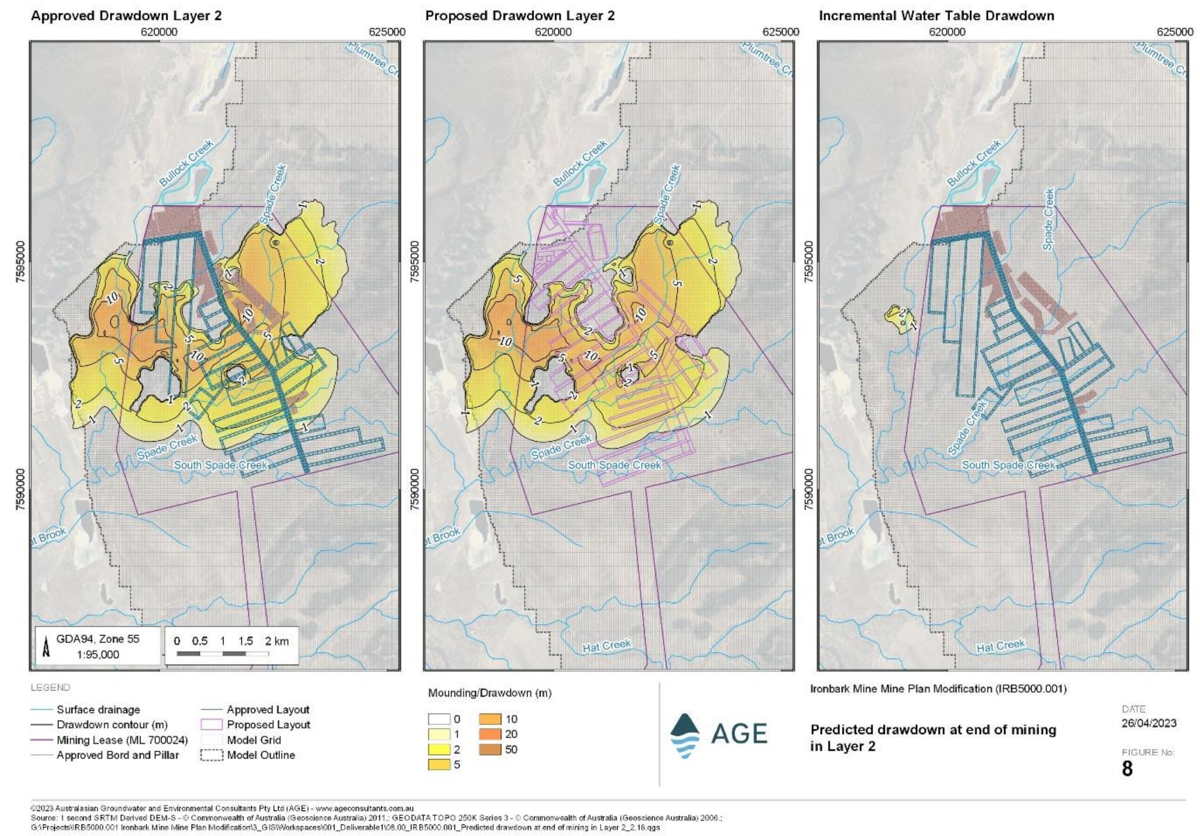

Figure 1 Predicted drawdown at end of mining in Layer 2