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Memo

To	Veronica Campagna	Company	JBS&G
From	Alex Storey / Emma Bolton	Job No.	171Y
Date	5/11/2024	Doc No.	505b
Subject	Mulga Downs Iron Ore Mine – Revised Troglofauna Habitat Assessment		

Veronica,

We are pleased to present our revised assessment of the potential impact on troglofauna habitat around the proposed Mulga Downs Iron Ore Mine.

1. INTRODUCTION

HanRoy Iron Ore Projects Pty Ltd (HanRoy) on behalf of Hancock Prospecting Pty Ltd (HPPL) is proposing to develop the Mulga Downs Iron Ore Mine (the Project) located in the Pilbara region of Western Australia, approximately 210 km south of Port Hedland. JBS&G are currently assisting HanRoy to prepare an Environmental Review Document (ERD) for the Project.

To support the initial ERD (for a 20 Mtpa Project), AQ2 completed a subterranean fauna habitat assessment in May 2022 (AQ2 ref. 371b) using Leapfrog 3D modelling software to assess the extent, continuity and volume losses of geological units potentially habitable to troglofauna.

HanRoy have recently amended the proposed Project (to a ~12 Mtpa Project), as such, the groundwater management requirements have now been revised. AQ2 have been engaged by JBS&G to assess the impacts of the currently proposed mining activities (i.e., the direct removal of habitat from mining and the reduction in habitat associated with groundwater mounding from managed aquifer recharge (MAR) by re-injection). The proposed open cut pit footprints, referenced as MDE_LOM_20_F_20240805 (MDE_LOM_20), are shown in Figure 1.1, together with the modelled (i.e. nominal) locations for MAR bores.

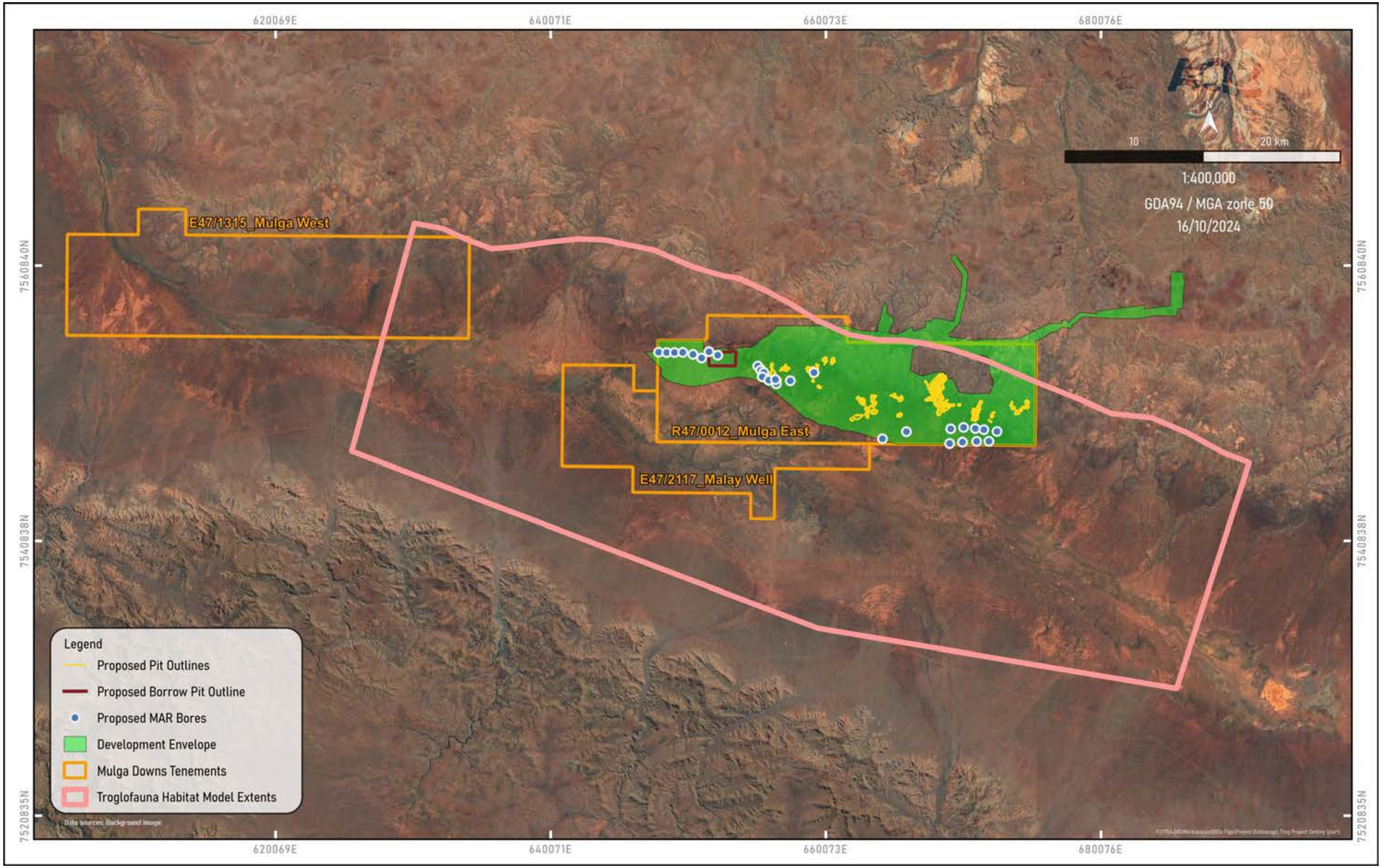

Figure 1.1 Project Outline

2. BACKGROUND

2.1 Regional Setting

The Project area is located within the Chichester Range, on the northern flanks of the Fortescue Valley. The Chichester Range comprises low-lying hills which rise approximately 30 to 40 m above the level of the river flood plain. The hills are cross-cut by narrow, steep-sided gullies, with colluvium and alluvial fans extending from the hills across the valley floor where drainages flow into the Fortescue Valley.

The bedrock within the Project area consists of south-westward dipping, northwest-southeast striking Banded Iron Formation (BIF), shale, chert and dolomite sequences of the Hamersley and Fortescue Groups (refer Table 2.1). The Jeerinah Formation and Marra Mamba Iron Formation (Marra Mamba Formation) outcrop in the Chichester Range on the northern side of the Fortescue Valley. The Marra Mamba Formation and Wittenoom Formation subcrop beneath the valley floor within Mulga Downs tenements, with the overlying Mt Sylvia and Mt McRae Shale Formations occurring to the south. The Brockman Iron Formation forms the Hamersley Range on the southern side of the Fortescue Valley.

The valley is infilled by Tertiary and Quaternary deposits. The Tertiary deposits are collectively referred as “detritals”, they comprise pisolite, clay and calcrete; there is also lateritic hardcap development of Tertiary age and that may be ferricrete (goethite) and calcrete / silcrete on basement rocks. The Quaternary deposits comprise alluvium and colluvium.

The mineralisation within the Project area is primarily associated with the Nammuldi Member of the Marra Mamba Formation (that outcrops along the lower flanks of the Chichester Range), although there is also mineralisation in the overlying Tertiary detrital deposits.

Table 2.1 Regional Stratigraphic Sequence within the Project Area

Group	Formation	Member	Lithological Description
Recent Alluvium / Colluvium			Unconsolidated silt, sand and gravel (clay near pans)
Tertiary Detritals (TD)	TD3		Red haematitic scree on valley sides. Increasing silt / clay content with distance from slopes / fans Increasing pisolitic content with depth
	TD2		Silcrete, calcrete (Oakover Formation), Channel Iron Deposit (CID), mottled clay
?*	?*	Pinjan Chert	Siliceous sediment with alternating laminated chert
Hamersley Group	Wittenoom Formation	Bee Gorge Member	Graphitic shale with minor sequences of carbonate, chert, volcaniclastic rock and Banded Iron Formation (BIF)
		Paraburdoo Member	Dolomite with minor amounts of chert and shale
		West Angela Member	Dolomite, dolomitic / manganese-rich shale, BIF and chert
	Marra Mamba Iron Formation	Mt Newman Member	BIF with minor shale
		MacLeod Member	Shale, chert and BIF
		Nammuldi Member	BIF, chert and shale
Fortescue Group	Jeerinah Formation	Roy Hill Shale Member	Dark grey to black graphitic shale with chert; locally pyritic
		Warrie Member	Grey dolomite with inter-bedded chert (locally ferruginous), shale and mudstone

*Age of the Pinjan Chert is uncertain

2.2 Previous Troglofauna Habitat Assessment

The following troglofauna habitat assessments have been completed to date:

- An initial assessment of potential troglofauna habitat was completed in 2021 (Strategen JBS&G, 2021) by comparing stratigraphy and textural core logging from diamond holes closest to where troglofauna were encountered. Subsequently, the extents of potential troglofauna habitats were assessed by compiling multiple cross sections across the Project area.
- To support the initial ERD, AQ2 completed a subterranean fauna habitat assessment in May 2022, using Leapfrog 3D modelling software. The habitat assessment utilised the existing hydrogeological model and a habitat classification framework developed in conjunction with Bennelongia Environmental Consultants (BEC).

3. HABITAT ASSESSMENT & MODEL DEVELOPMENT

3.1 Habitat Criteria

For this study, the troglofauna habitat assessment has been developed based on the following criteria:

- Troglofauna inhabit air filled voids and/or vugs within the vadose zone (above water table) of a geological environment.
- The groundwater level represents the lower limits of possible troglofauna habitat.
- The areal and vertical extent of vuggy rock (above the groundwater level) represent further limits on possible troglofauna habitat.
- Burrowing is not a characteristic of troglofauna, meaning any matrix-supported sediments, clay zones or clay filled voids will be unhabitable.

3.2 Data Used

The habitat assessment model was developed using Leapfrog Geo 3D modelling software (Seequent, 2022).

A range of data sets were supplied by HPPL, Bennelongia Environmental Consulting (BEC), JBS&G and Groundwater Consulting (GWC), and used in conjunction with data from AQ2's hydrogeological investigations to date (AQ2, 2024) to develop the habitat model. These data included:

- Topographic surface – used to define the topographic setting and upper boundary to the model. NASA's Shuttle Radar Topography Mission (SRTM) data was used for the Leapfrog model to be consistent with the topographic surface used in the numerical groundwater model.
- Drill hole data (including collar/lithology data and core photos) - used to identify potential habitat based on lithology and stratigraphy (i.e. where the geology may naturally include interconnected vugs and pores that could form habitat). It should be noted that no drill hole data is available outside of the HPPL tenements, therefore data outside of these areas have been inferred.
- Troglofauna sampling data - troglofauna survey/sampling results supplied by JBS&G / BEC (Ref: BEC_MULGA_SUBFAUNA_July2024_MGA94.shp), outlining drill/bore holes where troglofauna species were identified.
- "No Development" groundwater level surface supplied by GWC (Ref: PT42-NoDev_Transient Maximum.shp) – used to define the base of the potential troglofauna habitat without the influence of mining. This surface was derived from the numerical groundwater model from the maximum predicted groundwater level at any point over the modelled area, for a 17-year climate sequence to simulate the likely natural climate variability over the Project duration.
- "With Development" groundwater level surface supplied by GWC (Ref: 09-PT51_Predicted_Maximum_Heads_Over_LoM_SP61-246_Jan2027-June2042.shp) – used to define the potential extents of the habitat impacted by groundwater level changes associated with mining. This

surface, also derived from the numerical groundwater model, comprised the predicted maximum groundwater level at any point, over the proposed duration of the Project, taking into account groundwater level changes from dewatering (i.e. drawdown), MAR (i.e. mounding) and natural seasonal variations of groundwater levels. The model prediction was based on the HanRoy mine schedule referenced as MDE_LOM_20, with a 15.5 year life of mine (GWC, 2024).

- Final pit shells (LOM_20_PitDesigns.dxf) - used to define zones of potential habitat loss due to the direct removal of material.
- Proposed borrow pit outline (Borrow_Pits_20240808) – used to define zones of potential habitat loss due to direct removal of material. Note that a 3D shell of the borrow pit was not provided. As such, a volume was determined by assuming a constant 5 m depth from topography (SRTM). It should also be noted that all borrow pits proposed to be excavated outside of the habitat extents were not included in the assessment (i.e. those proposed to be excavated to the north of the Project area).

3.3 Lithological Groupings

On the basis of geological logging by HPPL and AQ2 (AQ2, 2024), core photos and troglofauna survey results, lithological units have been grouped based on the potential to support a troglofauna habitat. This grouping is summarised in Table 3.1 with potential habitat categories comprising non-habitat, unlikely habitat, possible habitat and likely habitat. Key points are as follows:

- Likely habitats comprise the Upper Calcrete and Channel Iron Deposits (CID) / Pisolite of the Tertiary sequence and mineralised / hydrated Marra Mamba bedrock, inclusive of the hardcap which can be very vuggy.
- Between the Upper Calcrete and CID / Pisolite is a unit of Undifferentiated Tertiary which is considered a possible habitat in areas where the clay content is lower.
- The shaley, Unmineralised Marra Mamba is considered an unlikely habitat. Although there is the potential for vugs / voids in the oxidised zone, when the results of the troglofauna surveys associated with this unit were assessed, in consultation with BEC (on 21/3/23), it was determined to be an unlikely habitat.
- The Jeerinah Formation is considered a non-habitat as it is dominated by low porosity shale.
- The lowermost Tertiary unit (the Basal Crete) and all other bedrock units with the Project area occur below the groundwater level are therefore considered non-habitats.

3.4 Model Boundaries

The extents of the habitat model were identified using the following:

- Laterally, the model domain was defined by the extents of all available lithological / geological data. The extent of the model is shown in Figure 1.1.
- The SRTM topographic surface was used to define the top of the model and potential habitat.
- The base of the potential habitat was defined by the maximum predicted groundwater level over the duration of the Project (i.e. No Development and With Development groundwater level surfaces described above).

Table 3.1 Lithological Groupings with respect to Potential Troglofauna Habitats

Habitat Stratigraphy	HPPL Geological Codes	Lithology/Member	Stratigraphy	Habitat Probability	Reasoning
Alluvium	ALU	Alluvium	Recent Alluvium / Colluvium	Unlikely Habitat	This unit typically has a clay dominant matrix with low potential for porosity.
Upper Calcrete	CC	Upper Calcrete	Tertiary Detritals	Likely Habitat	This unit typically has a high primary porosity.
Undifferentiated Sediments	ALU	Undifferentiated Sediments		Possible Habitat	Areas of lower clay content have the potential for high porosity.
CID / Pisolite	CIDO, CIDW, DCL, SCR	CID / Pisolites		Likely Habitat	CID unit is often vuggy, while pisolitic units typically have high primary porosity.
-	CC	Basal Crete (Calcrete / Silcrete)		Non-Habitat	Unit always encountered below water table within project area.
Jeerinah	JER, JRS, JRD	Jeerinah Shale	Jeerinah Formation	Non-Habitat	Unit is dominated by shales with a low primary porosity.
Mineralised Marra Mamba	HNAM, HNEW, HMNAM, MNAO, TMNAM, TMAC, TMM, TNAM, OMM, HMM, ONEW, HOSAM, OMAC, TNEW, ONAM, OSAM, HMAC	Mineralised / Hydrated BIF	Marra Mamba Formation	Likely Habitat	Units likely to have enhanced secondary porosity due to weathering/mineralisation processes.
Shaley / Unmineralised Marra Mamba	SOMM, SMM, MM, DMM	Undifferentiated	Marra Mamba Formation	Unlikely Habitat	Vugs/voids possible down to base of oxidation but unlikely due to shale content and more localised zones enhanced porosity.
	MNAM, NAM, SNAM, DNAM, SONAM, FNAM	Nammuldi Member			
	SMAC, SOMAC, MAC, DMAC	MacLeod Member			
	SNEW, NEW, SONEW	Mt Newman Member			
-	-	West Angela Member	Wittenoom Formation	Unlikely Habitat	Vugs/voids possible down to base of oxidation. Unit is encountered below water table around project area.
-	-	Paraburdoo Member		Non-Habitat	Units dominated by dolomite and dolomitic shales- low porosity even after weathering. Unit is encountered below water table around project area.
-	-	Bee Gorge Member			

4. MODELLING RESULTS

4.1 Potential Habitat

Figures 4.1, 4.2 and 4.3 show geological cross-sections of the modelled distribution of potential troglofauna habitat with proposed pit outlines and modelled groundwater level surfaces. The locations of the cross sections are displayed on Figure 4.4.

Troglofauna sampling was undertaken by BEC using scrapes (near surface) and traps set at different depths within selected drillholes. It is understood that troglofauna tend to migrate within the open drill hole, meaning trap depths are not necessarily representative of the habitat location of the sampled troglofauna. Significant troglofauna species have been identified in mineral drillholes both within the extents of the proposed pit footprints and away from the areas of proposed Project development. Salient points from the habitat modelling include:

- The model indicates that the likely troglofauna habitats of Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range, with the CID / Pisolite continuous over the Project area and Mineralised Marra Mamba occurring as discontinuous pods associated with the mineralisation.
- The likely habitat of Upper Calcrete is modelled to exist from the western side of proposed pits, and extend south, covering much of the Fortescue Valley, and west towards the Mulga West tenement. All troglofauna samples collected toward the valley centre were from drillholes within the Upper Calcrete unit. Where the Upper Calcrete occurs below the water table (i.e. within the Fortescue Valley), troglofauna species are less likely to occur.
- The possible troglofauna habitat of Undifferentiated Tertiary extends across the entire Project area along the slopes of the Chichester Range and is continuous in nature.

4.2 Habitat Impact Assessment

Impacts on potential troglofauna habitat resulting from mining and excavation of the borrow pit (i.e. direct removal of material) and MAR (i.e. loss of habitat due to rising groundwater levels) have been assessed as part of this study. It is understood that dewatering, and the associated changes of humidity/moisture levels in the vadose zone, also has the potential to impact troglofauna environments. However, the potential impacts associated with the lowering of the groundwater level (from dewatering) have not been assessed in this study.

Figure 4.4 shows the areal extent of potential habitat that is predicted to be impacted by mining (i.e. the proposed pit footprints) and MAR whilst Figures 4.1, 4.2 and 4.3 show the predicted impact in cross-section. Historical long-term hydrographs from the Project area (AQ2, 2024) indicate that seasonal responses to rainfall events have the potential to result in groundwater level variations of up to 1 m. As such, the predicted extent of 1 m drawup/mounding throughout the life of the Project has been used as the extent of habitat impact resulting from MAR.

Table 4.1 summarises the predicted loss of troglofauna habitat for each of the rankings of potential (i.e. Likely, Possible and Unlikely) habitat. Of the total volume of potential habitat that is predicted to be impacted (i.e., 854,497,900 m3), 13% is due to the removal of material from within the proposed pit areas and 87% is related to groundwater mounding resulting from MAR. 23% of the total predicted impact volume is within lithological units considered to be likely habitats for troglofauna, 33% for possible habitat units and the remaining 44% for unlikely habitat units.

The percentage of habitat lost for each lithological unit within the predicted area of impact has been calculated and is presented in Table 4.2. It can be seen that 37% of the likely Upper Calcrete habitat, 26% of the likely CID/Pisolite habitat and 70% of the likely Mineralised Marra Mamba within the predicted impact area is anticipated to be lost as a result of mining and MAR.

It should be noted that by using the maximum predicted groundwater level over the entire duration of the Project, it assumes the potential habitat is lost even when groundwater levels recover back to natural (no development levels). In reality, when MAR ceases either in certain areas during the life of mine or across the entire Project area at the completion of mining, groundwater levels will, over time, recover to pre-mining natural conditions, presumably allowing troglofauna habitats to re-establish. As such, the volumes of potential habitat impacted by MAR are not permanently lost and the impacted assessment results should be considered as worst-case.

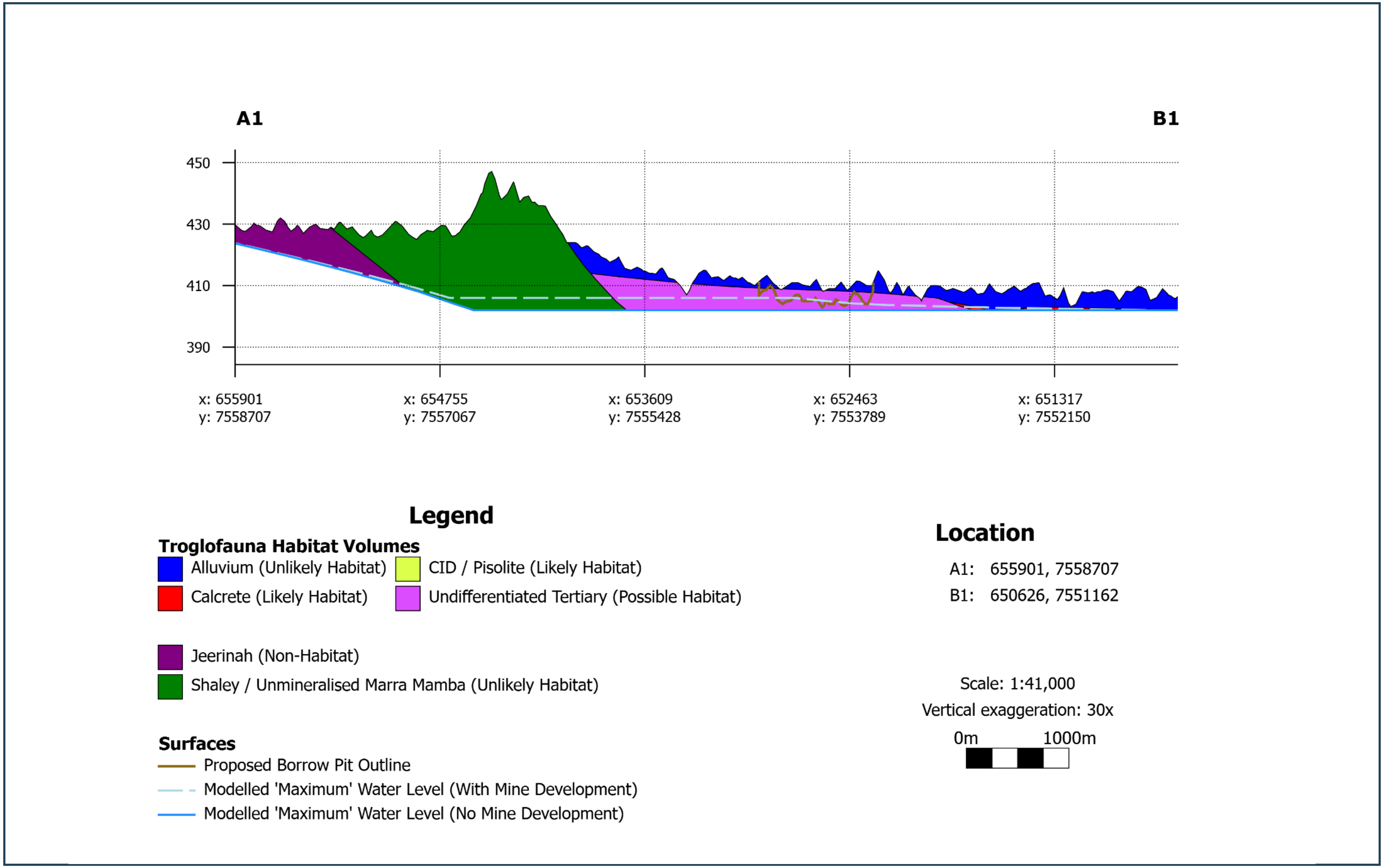

Figure 4.1 Cross Section 1

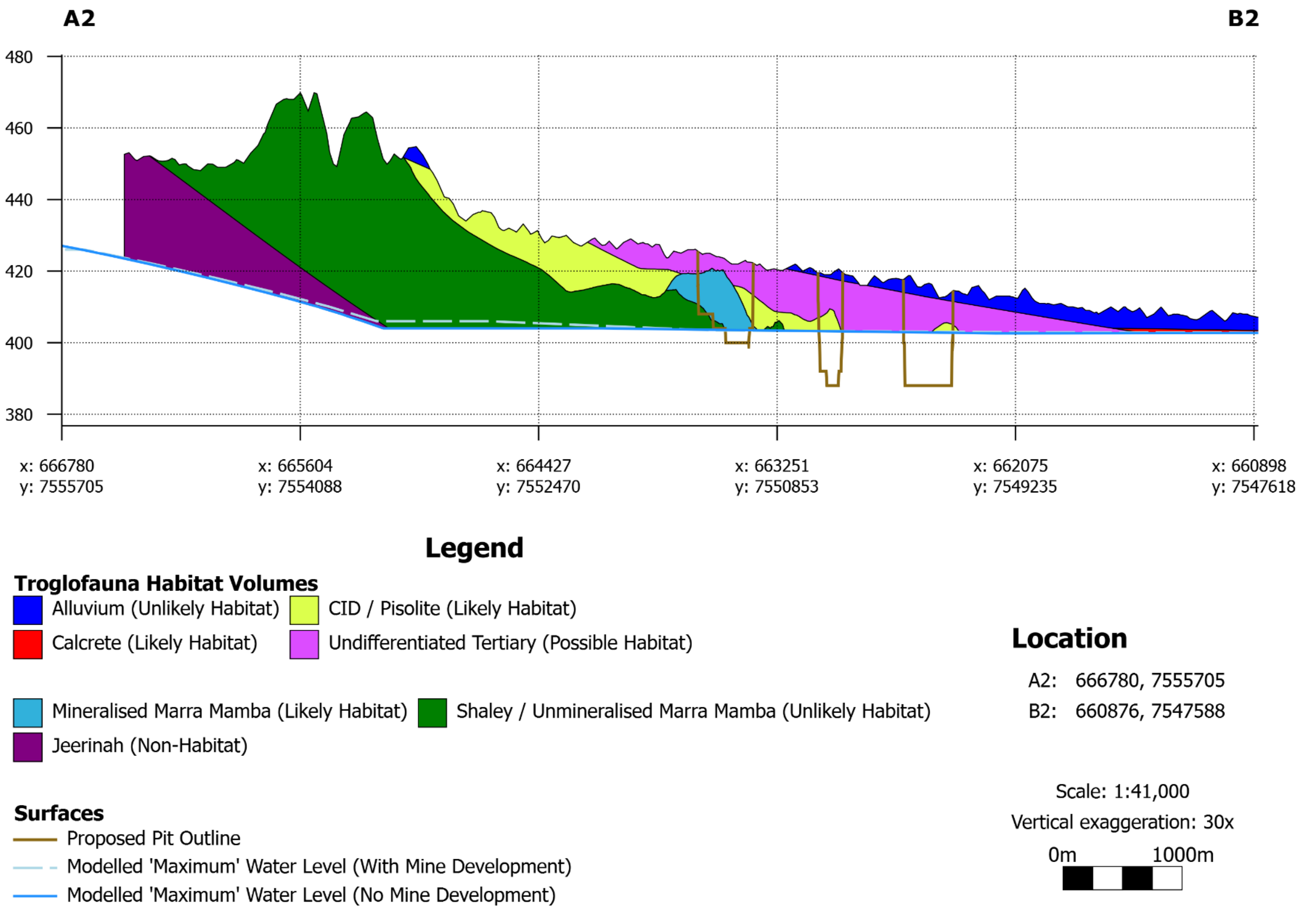

Figure 4.2 Cross Section 2

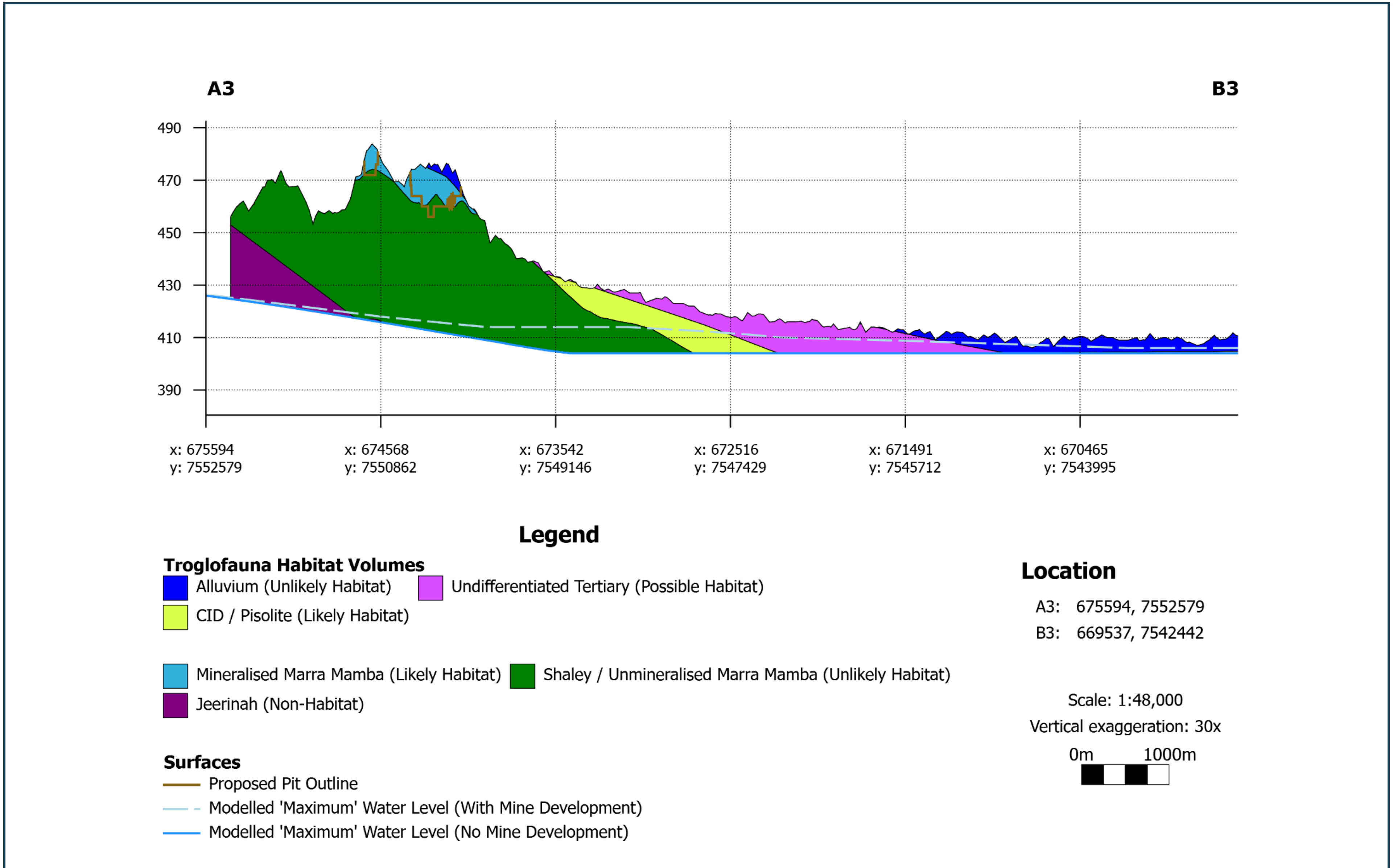

Figure 4.3 Cross Section 3

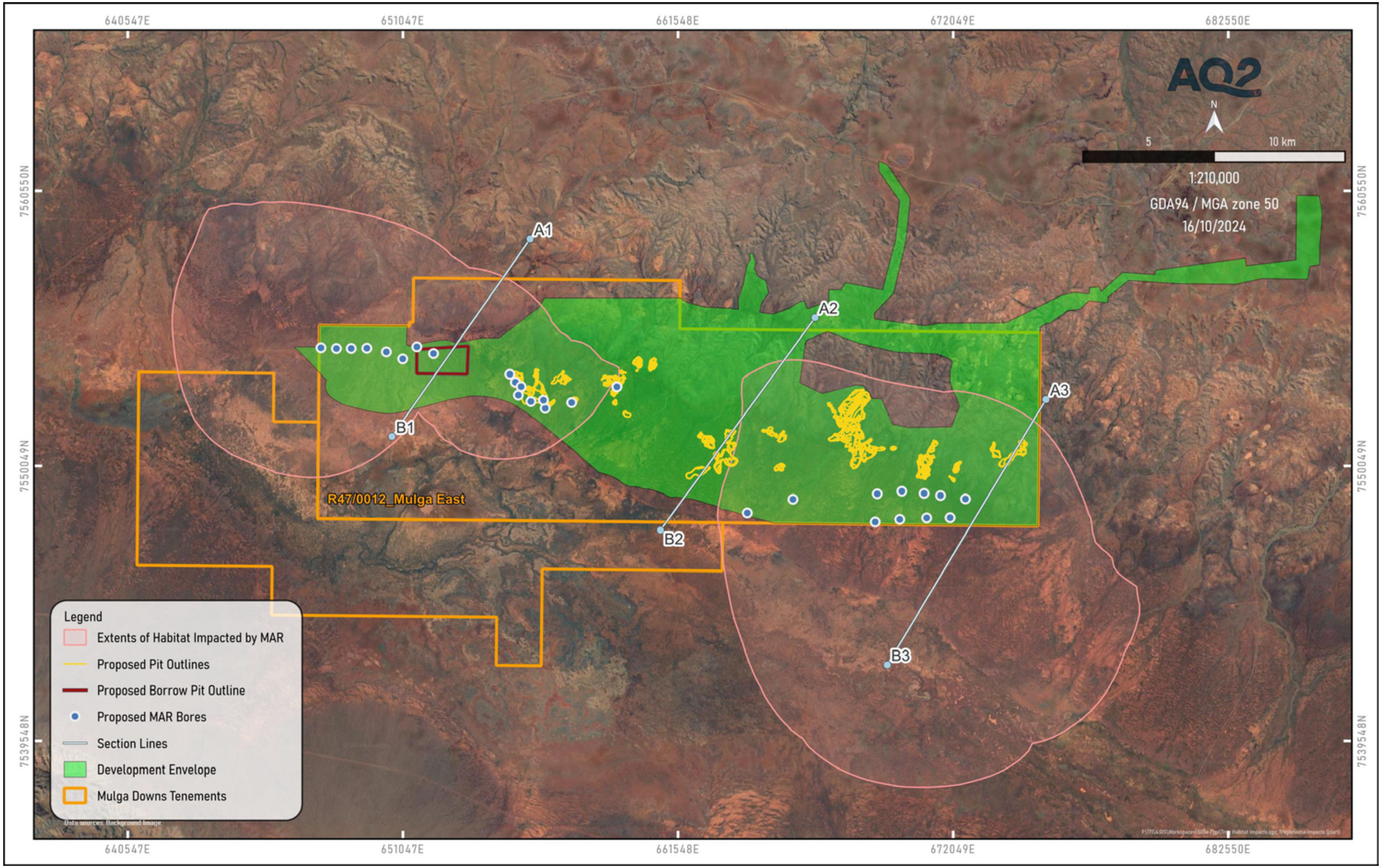

Figure 4.4 Predicted Areal Extent of Impact to Potential Troglofauna Habitat

Table 4.1 Potential Troglofauna Habitat Loss During Mining

Troglofauna Habitat	Habitat Likelihood	Predicted Volume Impacted by Mining (m³) (Permanent Loss)[1]	Predicted Volume Impacted by MAR (m³) (Temporary Impact)[2]	Total Predicted Volume Impacted (m³)
Upper Calcrete	Likely	374,740	71,185,000	195,127,440
CID / Pisolite		12,275,000	53,598,000	
Mineralised Marra Mamba		54,082,000	3,612,700	
Undifferentiated Tertiary	Possible	25,833,000	259,740,000	285,573,000
Alluvium	Unlikely	11,922,000	90,168,000	373,795,500
Shaley / Unmineralised Marra Mamba		7,895,500	263,810,000	
Total		112,382,240	742,113,700	854,495,940

[1] Direct (permanent) removal of material
[2] Non-permanent (temporary) impact resulting from rise in groundwater levels associated with MAR.

Table 4.2 Predicted Percentage of Habitat Lost within the Area of Impact

Stygofauna Habitat	Habitat Likelihood	Total Pre-mining Habitat Volume Within the Predicted Area of Impact (m³)	Predicted Volume Impacted by Mining & MAR (m³)	Predicted Percentage of Habitat Lost within the Area of Impact
Alluvium	Unlikely	839,190,000	102,090,000	12%
Upper Calcrete	Likely	193,130,000	71,559,740	37%
Undifferentiated Tertiary	Possible	1,036,600,000	285,573,000	28%
CID / Pisolite	Likely	255,490,000	65,873,000	26%
Mineralised Marra Mamba	Likely	82,491,000	57,694,700	70%
Shaley / Unmineralised Marra Mamba	Unlikely	2,178,600,000	271,705,500	12%
Total		4,585,501,000	854,495,940	19%

5. SUMMARY

Based on the troglofauna surveys conducted to date and available geological / lithological logging of drillholes, potential troglofauna habitats are inferred in several lithological units within the Project area. These units are areally extensive and continuous over a wide area.

A Leapfrog model has been developed to assess the potential loss of troglofauna habitat caused by both the removal of material from within the proposed pit footprints and from the predicted mounding of groundwater associated with MAR, noting that the impacts from MAR do not result in a permanent loss of habitat as groundwater levels will, over time, return to pre-mining conditions.

Regards,

Alex Storey *Emma Bolton*

Hydrogeologist Consulting Hydrogeologist

Author: ATS (5/11/24)
Checked: EJB (5/11/24)
Reviewed: EJB (5/11/24)

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Memo

To	Veronica Campagna	Company	JBS&G
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1. INTRODUCTION

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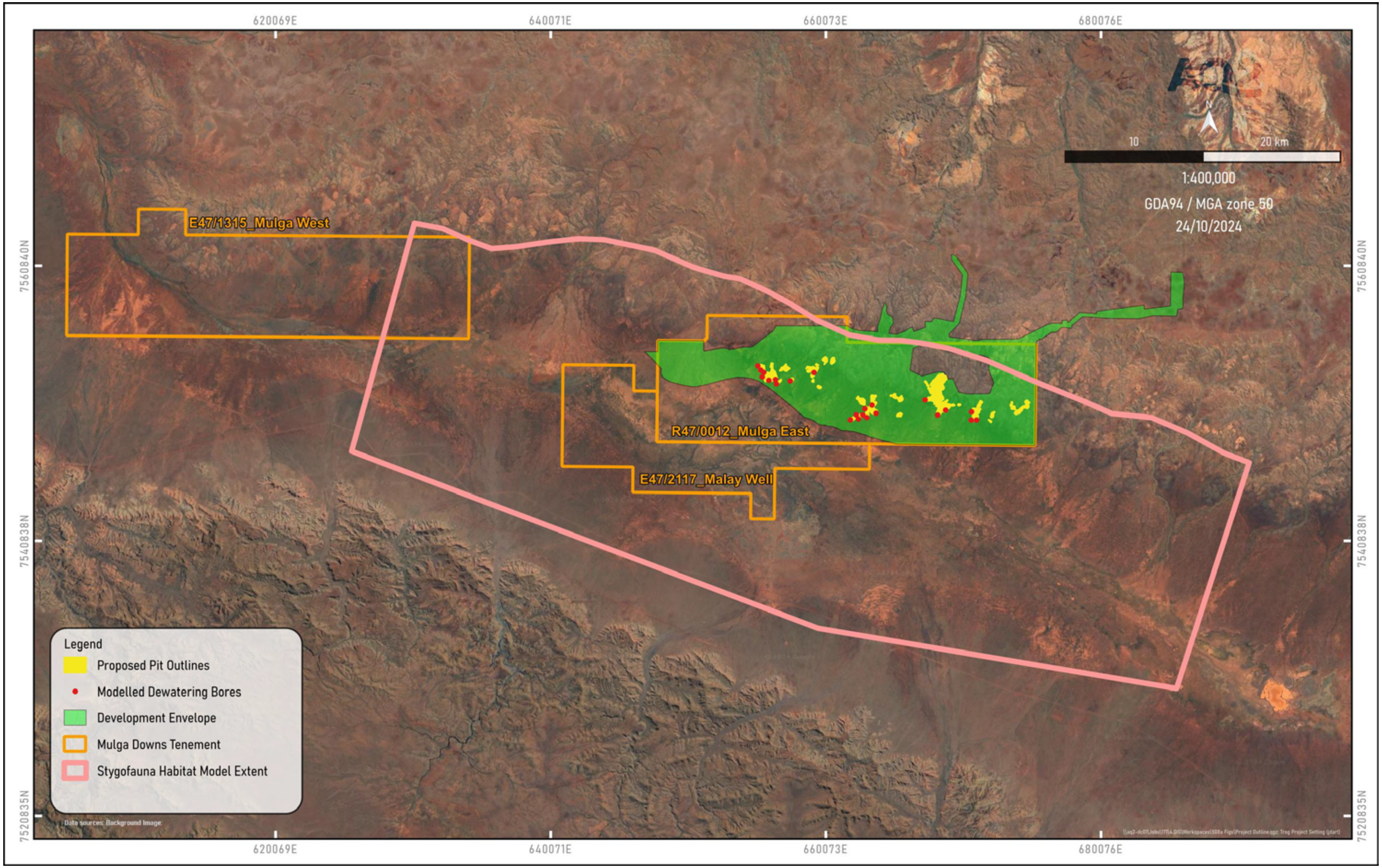
AQ2 have been engaged by JBS&G to complete a subterranean fauna habitat assessment using Leapfrog 3D modelling software to assess:

- The extent and continuity of geological units that are potentially habitable to stygofauna.
- The losses in stygofauna habitat resulting from groundwater level drawdown associated with dewatering.

The proposed open cut pit footprints, referenced as MDE_LOM_20_F_20240805 (MDE_LOM_20), are shown in Figure 1.1, together with the modelled (i.e. nominal) locations for dewatering bores.



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2.1 Regional Setting

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*Age of the Pinjan Chert is uncertain

3. HABITAT ASSESSMENT & MODEL DEVELOPMENT

3.1 Habitat Criteria

For this study, the stygofauna habitat assessment has been developed based on the following criteria:

- Stygofauna inhabit permeable/porous material within the phreatic zone (below water table) of a geologic environment.
- The water table represents the upper limits of possible stygofauna habitat.
- The permeable/porous material (below water table) represent further limits on possible stygofauna habitats.

3.2 Data Used

The habitat assessment model was developed using Leapfrog Geo 3D modelling software (Seequent, 2022).

A range of data sets were supplied by HPPL, Bennelongia Environmental Consulting (BEC), JBS&G and Groundwater Consulting (GWC), and used in conjunction with data from AQ2's hydrogeological investigations to date (AQ2, 2024) to develop the habitat model. These data included:

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- "With Development" groundwater level surface supplied by GWC (Ref: 08-PT51_Predicted_Minimum_Heads_Over_LoM_SP61-246_Jan2027-June2042.shp) – used to define the potential extents of the habitat impacted by groundwater level changes associated with mining. This surface, also derived from the numerical groundwater model, comprised the predicted minimum groundwater level at any point, over the proposed duration of the Project, taking into account groundwater level changes from dewatering (i.e. drawdown), MAR (i.e. mounding) and natural seasonal variations of groundwater levels. The model prediction was based on the HanRoy mine schedule referenced as MDE_LOM_20, with a 15.5 year life of mine (GWC, 2024).

3.3 Lithological Groupings

On the basis of geological logging by HPPL and AQ2 (AQ2, 2024), core photos and stygofauna survey results, lithological units have been grouped based on the potential to support a stygofauna habitat. This grouping is summarised in Table 3.1 with potential habitat categories comprising non-habitat, unlikely habitat, possible habitat and likely habitat. It should be noted that the classifications of habitat potential presented below differ slightly to those identified by BEC (2024); as they are based only on lithological characterisation, with no consideration of the depth of the unit below the water table, as this may be variable across the Project area. For example, on the valley slopes, the CID/Pisolite occurs at shallower depths below the water table than in the valley areas. Key points regarding the assessment of the lithological units as potential stygofauna habitats are as follows:

- Likely habitats comprise the Upper Calcrete and Channel Iron Deposits (CID) / Pisolite units of the Tertiary sequence and mineralised / hydrated Marra Mamba bedrock, inclusive of the hardcap which can be very vuggy.
- Between the Upper Calcrete and CID / Pisolite is a unit of Undifferentiated Tertiary which is considered a possible habitat in areas where the clay content is lower.
- The lowermost Tertiary unit (the Basal Crete) is also considered a possible habitat. It is variable in both composition and nature but can be brecciated, weathered and / or vuggy.
- The shaley, Unmineralised Marra Mamba is considered an unlikely habitat. Although there is the potential for vugs / voids in the oxidised zone, the same habitat potential as has been adopted for the previous troglofauna habitat assessment, in consultation with BEC (on 21/3/23), has been assigned to this unit. Given the shaley nature of the West Angela Formation, but the potential for mineralisation or vugs / voids in the oxidised zones this unit has also been identified as an unlikely habitat.
- The Jeerinah Formation is considered a non-habitat as it is dominated by low porosity shale.
- Other bedrocks units are not impacted by the predicted drawdown.

3.4 Model Boundaries

The extents of the habitat model were identified using the following:

- Laterally, the model domain was defined by the extents of numerical groundwater model, with lithological / geological data inferred outside of the HPPL tenement boundaries. The extent of the model is shown in Figure 1.1.
- The top of the potential habitat was defined by the minimum predicted groundwater level, over the LOM duration, with No Development.
- An RL of 320 m defines the base of the model. As the sampling methods for stygofauna does not allow for the determination of the specific depth of the stygofauna occurrence (refer Section 4.1), the base of the potential habitat has not been defined.

Table 3.1 Lithological Groupings with respect to Potential Stygofauna Habitats

Habitat Stratigraphy	HPPL Geological Codes	Lithology/Member	Stratigraphy	Habitat Probability	Reasoning
Alluvium	ALU	Alluvium	Recent Alluvium / Colluvium	Unlikely Habitat	This unit typically has a clay dominant matrix with low potential for porosity. Where drill data is available it predominantly occurs above the water table
Upper Calcrete	CC	Upper Calcrete	Tertiary Detritals	Likely Habitat	This unit typically has a high primary porosity.
Undifferentiated Sediments	ALU	Undifferentiated Sediments		Possible Habitat	Areas of lower clay content have the potential for high porosity.
CID / Pisolite	CIDO, CIDW, DCL, SCR	CID / Pisolites		Likely Habitat	CID unit is often vuggy, while pisolitic units typically have high primary porosity.
Basal Crete	CC	Basal Crete (Calcrete / Silcrete)		Possible	Unit always encountered below water table within project area.
Jeerinah	JER, JRS, JRD	Jeerinah Shale	Jeerinah Formation	Non-Habitat	Unit is dominated by shales with a low primary porosity.
Mineralised Marra Mamba	HNAM, HNEW, HMNAM, MNAO, TMNAM, TMAC, TMM, TNAM, OMM, HMM, ONEW, HOSAM, OMAC, TNEW, ONAM, OSAM, HMAC	Mineralised / Hydrated BIF	Marra Mamba Formation	Likely Habitat	Units likely to have enhanced secondary porosity due to weathering/mineralisation processes.
Shaley / Unmineralised Marra Mamba	SOMM, SMM, MM, DMM	Undifferentiated	Marra Mamba Formation	Unlikely Habitat	Vugs/voids possible down to base of oxidation but unlikely due to shale content and more localised zones enhanced porosity.
	MNAM, NAM, SNAM, DNAM, SONAM, FNAM	Nammuldi Member			
	SMAC, SOMAC, MAC, DMAC	MacLeod Member			
	SNEW, NEW, SONEW	Mt Newman Member			
West Angela Member	-	West Angela Member	Wittenoom Formation	Unlikely Habitat	Vugs/voids possible down to base of oxidation.
-	-	Paraburdoo Member		Non-Habitat	Units dominated by dolomite and dolomitic shales- low porosity even after weathering. Unit is not impacted by drawdown.
-	-	Bee Gorge Member			

4. MODELLING RESULTS

4.1 Potential Habitat

Figures 4.1 to 4.4 show geological cross-sections of the modelled distribution of potential stygofauna habitat with proposed pit outlines and modelled groundwater level surfaces. The locations of the cross sections are displayed on Figure 4.5.

Stygofauna sampling was undertaken by BEC by means of net hauls (BEC, 2024). The method involves a phreatic net being hauled from the base of the sampled drillholes / bores, with collection throughout the entire water column. As such, the depth that the stygofauna occupied at the time of collection is unknown. Unless a bore is screened over a certain interval, assumptions regarding the depth of the collected stygofauna are made based on subterranean ecology. Below a certain depth (~30 to 40 m below the water table), low carbon and nutrient inputs are expected to severely limit the occurrence of subterranean fauna (Halse et al., 2014). The geological cross-sections (Figures 4.1 to 4.4) therefore show a depth of 30 m below the predicted minimum No Development groundwater level to indicate the "preferential conditions" above this level.

Stygofauna species have been identified in drillholes / bores both within the extents of the proposed pit footprints and away from the areas of proposed Project development. Salient points from the habitat modelling include:

- The likely stygofauna habitat of Upper Calcrete is continuous unit that occurs to the south of the proposed mining area and extends both across the Fortescue Valley and along the strike of the valley.
- The model indicates that the likely stygofauna habitats of Mineralised Marra Mamba and CID / Pisolite extend over much of the Chichester Range, with the CID / Pisolite continuous over the Project area and Mineralised Marra Mamba occurring as discontinuous pods associated with the mineralisation.
- The possible stygofauna habitat of Undifferentiated Tertiary is both continuous and extensive, covering both the lower slopes of the Chichester Range and extending across the Fortescue Valley.
- The possible stygofauna habitat of Basal Crete is continuous across the Fortescue Valley area, although generally occurs at depths in excess of 30 m below the water table.

As documented in AQ2's Baseline Assessment Report (AQ2, 2024), hydraulic connection between the different lithological / hydrostratigraphic units is evident both laterally (from the groundwater level contours) and vertically (from the cluster bore data and limited clay / low permeability horizons). Vertical gradients (and reduced hydraulic connection) are only evident at a few cluster and paired bore locations where saprolitic clays or thin intervals of more clayey Tertiary materials are present. On an area wide scale, it is likely the valley aquifers are in vertical hydraulic connection, with local areas of separation caused by low permeability intermediating units (such as the saprolitic clay).

4.2 Habitat Impact Assessment

Impacts on potential stygofauna habitat resulting from mining (i.e. loss of habitat due to direct removal of material) and dewatering (i.e. loss of habitat due to lowering groundwater levels) have been assessed as part of this study. Although, the disposal of excess dewatering discharge via managed aquifer recharge (MAR), by reinjection, may provide additional stygofauna habitat, this has not been assessed in the study. The only influence of MAR included in the study, is its limiting effect on the predicted drawdown.

Figure 4.5 shows the areal extent of potential habitat that is predicted to be impacted by mining activities (proposed pit outlines) and dewatering. Historical long-term hydrographs from the Project area (AQ2, 2024) indicate that seasonal responses to rainfall events have the potential to result in groundwater level variations of up to 1 m. As such, the predicted extent of the 1 m drawdown contour, throughout the life of the Project, has been used to define the extent of habitat impact.

The predicted loss of stygofauna habitat for each of the rankings of potential (i.e. Likely, Possible and Unlikely) habitat is presented in Table 4.1. Of the total volume of potential habitat that is predicted to be impacted (i.e., 1,686,509,590 m3), 30% of the total predicted impact volume is within the lithological unit considered to be a likely habitat for stygofauna, 26% for possible habitat units and the remaining 44% for unlikely habitat units.

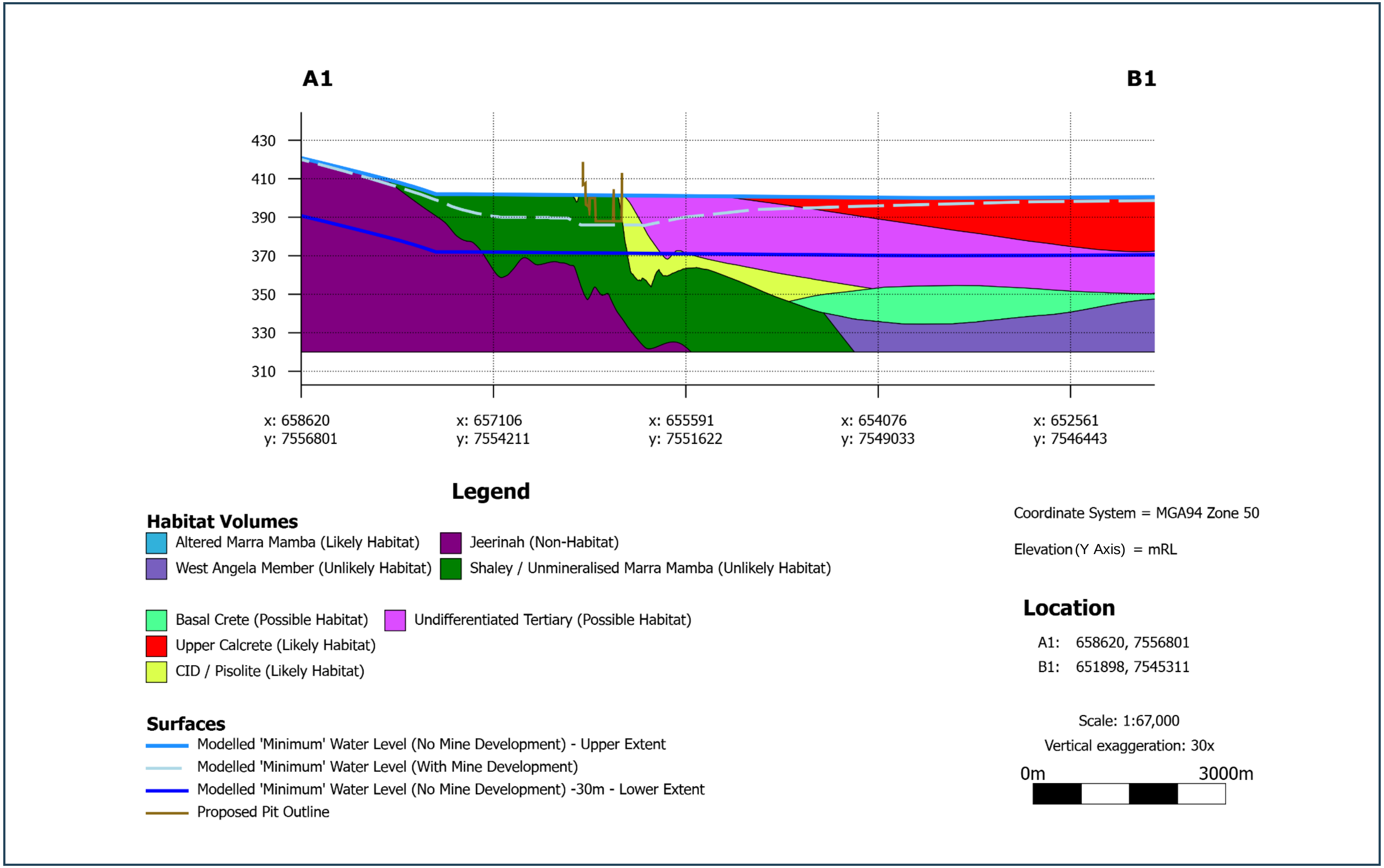


Figure 4.1 Cross Section 1

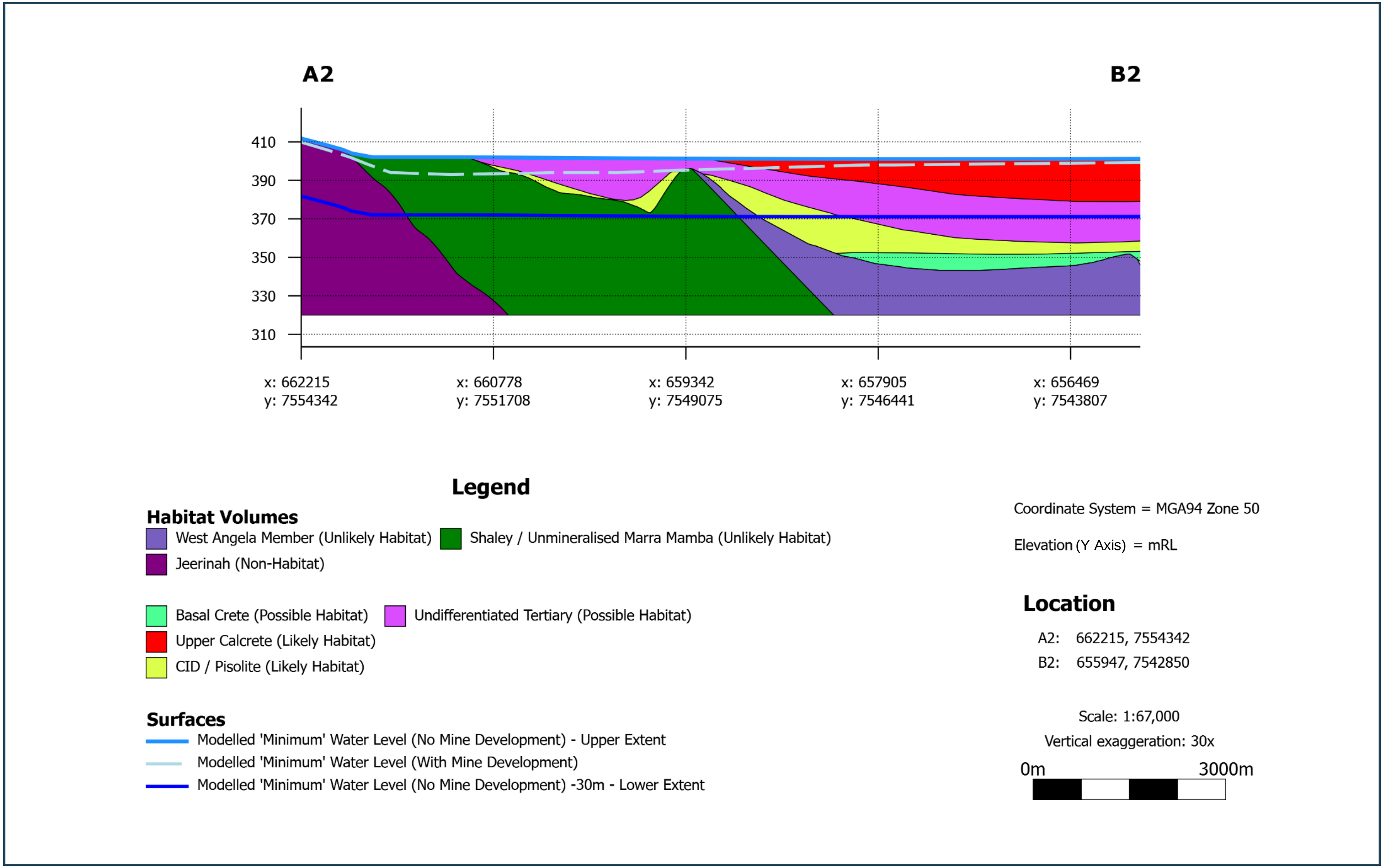
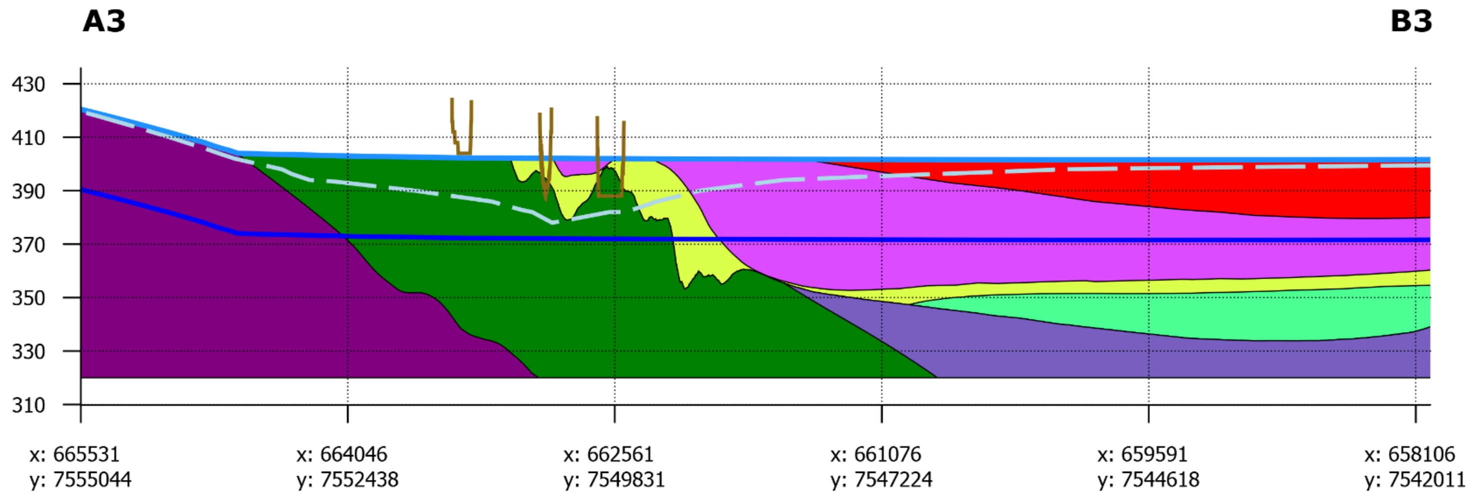


Figure 4.2 Cross Section 2



Legend

Habitat Volumes

- West Angela Member (Unlikely Habitat)
- Shaley / Unmineralised Marra Mamba (Unlikely Habitat)
- Jeerinah (Non-Habitat)

- Basal Crete (Possible Habitat)
- Undifferentiated Tertiary (Possible Habitat)
- Upper Calcrete (Likely Habitat)
- CID / Pisolite (Likely Habitat)

Surfaces

- Modelled 'Minimum' Water Level (No Mine Development) - Upper Extent
- Modelled 'Minimum' Water Level (With Mine Development)
- Modelled 'Minimum' Water Level (No Mine Development) -30m - Lower Extent
- Proposed Pit Outline

Coordinate System = MGA94 Zone 50

Elevation (Y Axis) = mRL

Location

A3: 665531, 7555044

B3: 658023, 7541866

Scale: 1:67,000

Vertical exaggeration: 30x

0m 3000m

Figure 4.3 Cross Section 3

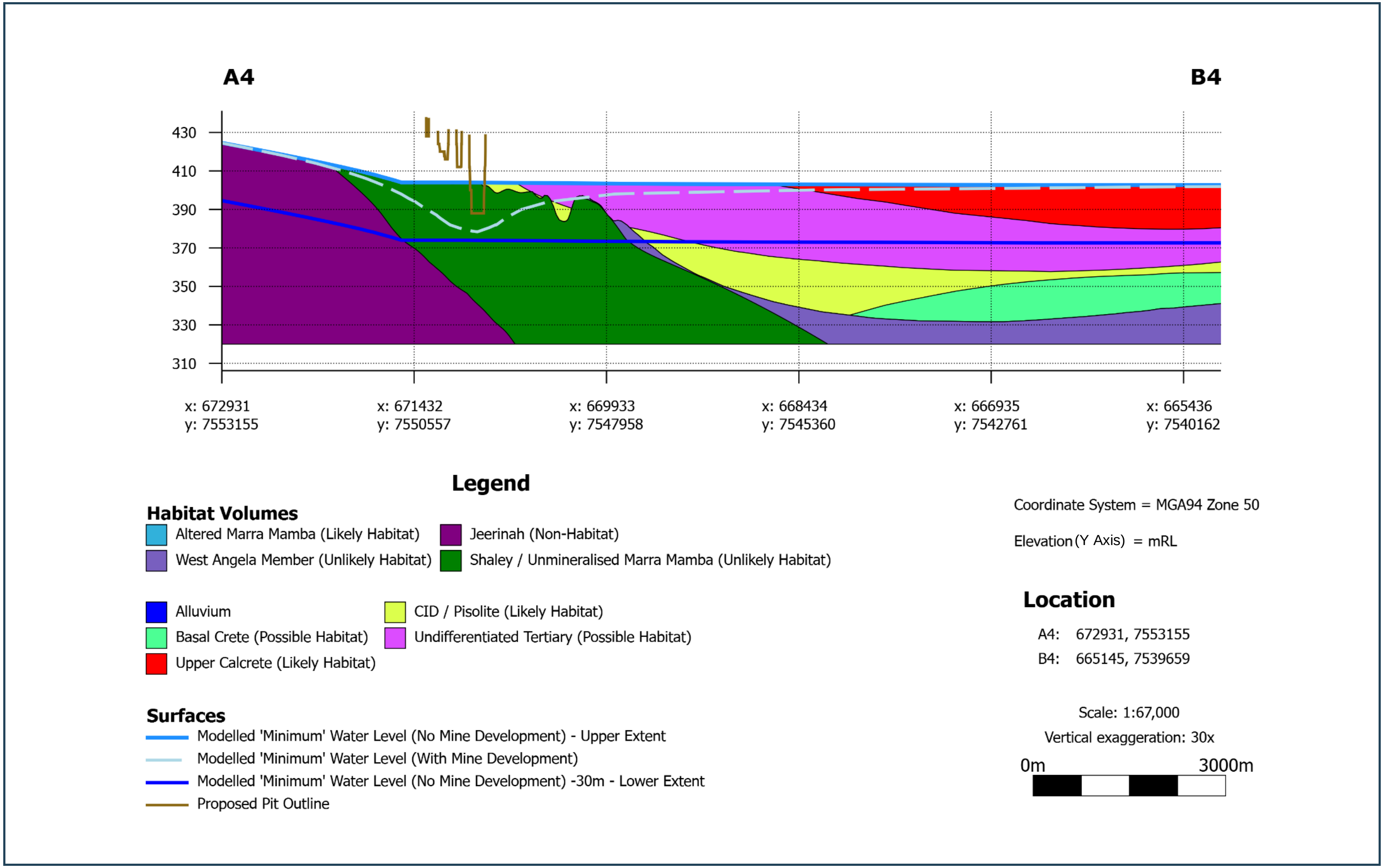


Figure 4.4 Cross Section 4

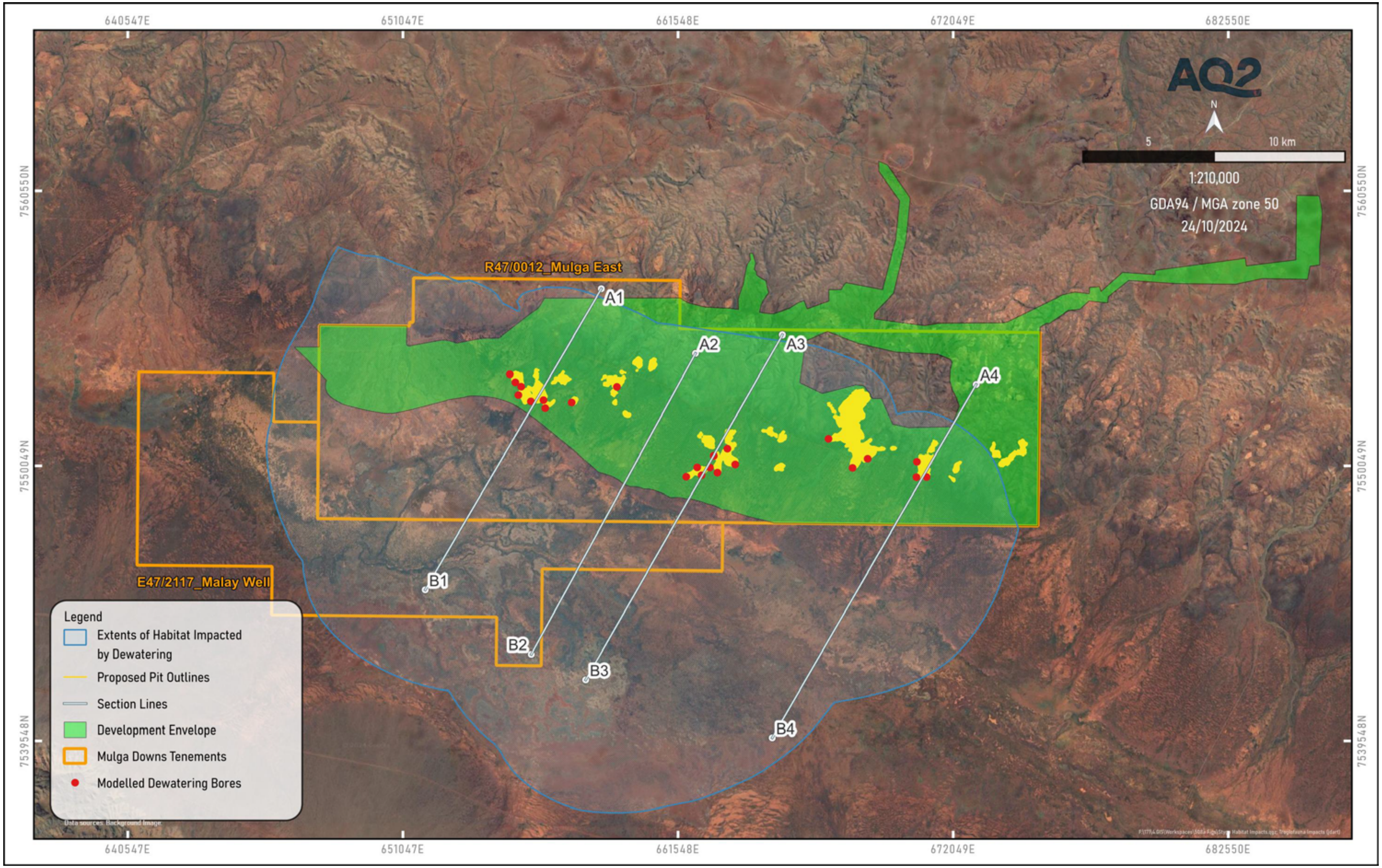


Figure 4.5 Predicted Areal Extent of Impact to Potential Stygofauna Habitat

For the Tertiary units, with a defined base, the percentage of habitat lost within the predicted area of impact has been calculated and is presented in Table 4.2. It should be noted that the percentage of habitat lost within the area of impact can not be calculated for the bedrock units (i.e. Mineralised Marra Mamba, Shaley / Unmineralised Marra Mamba and West Angela Member) as the base of these units extends below the model domain, meaning that a total 'static' (unimpacted) volume can not be determined.

From Table 4.2, it can be seen that only 16% of the likely Upper Calcrete habitat and 4% of the likely CID/Pisolite habitat within the predicted impact area is anticipated to be lost as a result of dewatering. This is because, despite the areal extent of predicted drawdown, the vertical loss of potential habitat is minimal in the valley areas, away from the immediate mining / dewatering areas, as shown in the cross-sections (Figures 4.1 to 4.4). The cross-sections also show that much of the zone of "preferential conditions" (i.e. the 30 m thick zone below the No Development groundwater level) remains as a potential habitat despite dewatering drawdown.

The proposed pit voids will be backfilled after mining. Although the backfill material has the potential to allow stygofauna to reinhabit the pit areas, it is assumed that impacts relating to the direct removal of material are permanent in nature. Conversely, when dewatering ceases, groundwater levels will, over time, recover to pre-mining natural conditions, presumably allowing stygofauna habitats to re-establish. As such, the volumes of potential habitat impacted by dewatering are not permanently lost and the impact assessment results should be considered as worst-case.

Table 4.1 Potential Stygofauna Habitat Loss During Mining

Stygofauna Habitat	Habitat Likelihood	Predicted Volume Impacted by Mining (m^3) (Permanent Loss)[1]	Predicted Volume Impacted by Dewatering (m^3) (Temporary Impact)[2]	Total Predicted Volume Impacted (m^3)
Upper Calcrete		0	556,380,000	
CID / Pisolite	Likely	3,273,500	109,496,500	670,449,100
Mineralised Marra Mamba		550,280	748,820	
Undifferentiated Tertiary	Possible	1,415,200	481,514,800	482,930,000
Basal Crete		0	0	
Alluvium		0	3,776	
West Angela Member	Unlikely	11,438	79,052	533,134,266
Shaley / Unmineralised Marra Mamba		13,937,000	519,103,000	
Total		19,187,418	1,667,325,948	1,686,513,366

[1] Permanent impact resulting from direct removal of habitat associated with extracting ore.
[2] Non-permanent (temporary) impact resulting from drawdown in groundwater levels associated with dewatering.

Table 4.2 Predicted Percentage of Habitat Lost within the Area of Impact

Stygofauna Habitat	Habitat Likelihood	Total Pre-mining Habitat Volume Within the Predicted Area of Impact (m^3)	Predicted Volume Impacted by Dewatering (m^3)	Predicted Percentage of Habitat Lost within the Area of Impact
Alluvium	Unlikely	3,776	3,776	100%
Upper Calcrete	Likely	3,554,200,000	556,380,000	16%
Undifferentiated Tertiary	Possible	7,687,100,000	482,930,000	6%
CID / Pisolite	Likely	2,978,200,000	112,770,000	4%
Basal Crete	Possible	2,151,500,000	0	0%
Total		16,371,003,776	1,152,083,776	10%

5. SUMMARY

Based on the stygofauna surveys conducted to date and available geological / lithological logging of drillholes, potential stygofauna habitats are inferred in several lithological units within the Project area. These units are areally extensive and continuous over a wide area.

A Leapfrog model has been developed to assess the potential loss of stygofauna habitat that results from the direct removal of material associated with mining, and predicted drawdown of groundwater levels associated with dewatering. Impacts from mining are assumed to be permanent, while impacts from dewatering are non-permanent as groundwater levels will, over time, return to pre-mining conditions.

Regards,

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Author: ATS (18/12/24)
Checked: EJB (18/12/24)
Reviewed: EJB (18/12/24)

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