



APPENDIX 21 – ASSESSMENT OF POTENTIAL FOR STYGOFAUNA RETENTION AND OPERATIONAL PHASE STYGOFAUNA MONITORING PROGRAM

NEW LENTON COAL PTY LTD
NEW LENTON COAL PROJECT

To: C/O Richard Oldham

From: Ben Cook

Company: Bowen Coking Coal

SLR Consulting Australia

Date: 5 August 2024

Project No. 635.000077.00001

RE: New Lenton Mine: Assessment of Potential for Stygofauna Retention and Operational Phase Stygofauna Monitoring Program

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1.0 Background

New Lenton Coal Pty Ltd (NLC), a wholly owned subsidiary of BCC, holds 90% controlling interest in the Lenton Joint Venture (LJV), with the remaining 10% held by MPC Lenton Pty Ltd (MPC). The Project is a proposed open-cut coal mine consisting of two pits (Lenton West and Lenton East) located within the northern part of the Bowen Basin; approximately 20 km south of Glenden and 120 km southwest of Mackay.

An assessment of stygofauna completed in 2022 (frc environmental 2023) for the Public Environmental Report (PER) indicated that shallow groundwater of the Project area within alluvial and regolith lithologies in close proximity to the Isaac River area has moderate stygofauna values, based on the presence of a stygobitic species and suitable hydrogeological conditions for stygofauna. There was also a moderate diversity of stygoxene taxa. A single stygoxene taxon (i.e. a mite) was also found in regolith adjacent to Hill Creek, a tributary of the Isaac River, and in shallow coal seams at bores relatively close to the Isaac River. The survey results are presented in Table 1.1.

The groundwater study completed for the PER (SLR Consulting 2023) indicated that development and operation of the Project would cause drawdown of shallow groundwater along and adjacent to the Isaac River, including groundwaters from which stygofauna were recorded. The groundwater study indicated further that groundwater drawdown caused by the Project would not recover at post-mining equilibrium (i.e. 730 years post mining), because the final voids would function as evaporative sinks for surrounding shallow groundwater.

Consequently, the stygofauna study indicated that impacts to stygofauna would be 'moderate' due to likely localised loss of stygofauna, while assuming that the same stygofauna taxa would be present in shallow groundwaters further upstream and/or downstream along the Isaac River, outside of groundwater impact areas.

Following their review of the PER documentation, the Independent Expert Scientific Committee (IESC) have requested an assessment of the potential for stygofauna recovery in shallow groundwaters that will be impacted by drawdown. However, the groundwater study (SLR Consulting 2023) predicted that there would continue to be localised areas where there would not be recovery in groundwater levels post mining; therefore, there will be localised areas where recovery of stygofauna post mining will not occur.

Based on the modelling undertaken for the groundwater study (SLR, 2023) the saturated thickness of shallow groundwater is shown in:

- Attachment 1 for pre-mining
- Attachment 2 for end of mining; and
- Attachment 3 for post mining.

As per the findings of the groundwater study (SLR, 2023), these attachments show an overall contraction of areas where saturated thickness is >2 m along the Isaac River adjacent to the Project disturbance area. A comparison of Attachment 2 and Attachment 3 demonstrates that there is minimal recovery in saturated thickness post mining when compared to at the end of mining. Never-the-less areas of saturated thickness >2m remain along the Isaac River post mining. The attachments show a relatively small area (approximately 1 km in length) along the Isaac River immediately adjacent to the Project disturbance area where residual saturated thickness in shallow groundwater is 0-2 m post-mining (i.e. effective localised loss of shallow groundwater in alluvium). Outside of this localised area, shallow groundwater is expected to persist, with the ability to retain stygofauna.

There will be negligible opportunities for recovery of stygofauna in the small extent of shallow groundwater that will be lost and unlikely to recover along the Isaac River (i.e. 1 km localised section) adjacent to the Project disturbance area. However, areas of drawdown where residual saturated thickness in alluvium is predicted to be >2 m (see Attachment 2 and Attachment 3) presents the possibility of retention of stygofauna in these areas post-mining.

The purpose of this memorandum is to present an assessment of ecological values of stygofauna of the Project area, and an operational phase stygofauna monitoring program for assessment of retention of stygofauna in areas where mining-related drawdown is predicted to occur but where shallow groundwater will persist.



Table 1.1 Results of the 2022 Stygofauna Survey

Bore	Stygofaunal Taxon	Count	Class
GW06	Acarina sp. 2 (mite) Oligochaeta (segmented worm)	1 1	stygoxene stygoxene
GW07	Acarina sp. 1 (mite)	1	stygoxene
GW10	–	–	–
GW11	–	–	–
GW13	–	–	–
GW19	–	–	–
GW29a	Acarina sp. 1 (mite)	1	stygoxene
GW30b	–	–	–
GW30c	Acarina sp. 1 (mite)	2	stygoxene
GW31a	–	–	–
GW31b	Acarina sp. 1 (mite)	1	stygoxene
DDH6	Acarina sp. 1 (mite)	3	stygoxene
GW19_33	Bathynellidae sp. 1 (syncarida) Harpacticoid sp.1 (copepoda) Acarina sp. 1 (mite)	1 2 1	stygobite stygoxene stygoxene
GW19_36	–	–	–
GW19_37a	Acarina sp. 1 (mite)	3	stygoxene
– no stygofauna caught			

2.0 Ecological Values of Stygofauna of the Project Area

2.1 Approach Towards Environmental Value Assessment of Stygofauna

Stygofauna taxa are grouped into one of several classes based on the degree of their requirement for subterranean life (Tomlinson & Boulton 2008). For the purpose of this assessment, two classes of stygofauna are considered:

- stygobites: obligate groundwater aquatic fauna that have specialised adaptations (e.g. lack of eyes and pigmentation, elongated appendages for tactile sensing of surrounds, etc) to underground life and that live within groundwater systems for their entire life
- stygoxenes: aquatic fauna that facultatively use groundwater ecosystems, but are not dependent on groundwater to complete their life cycle, and are commonly found in surface water habitats.

Stygobites generally comprise taxa with narrower distributional ranges than stygoxenes (many stygobites are narrow range endemics) (Finston et al. 2007; Hancock & Boulton 2008; Eberhard et al. 2009; Cook et al. 2012; Hose et al. 2015; Little et al. 2016), and this coupled with their higher degree of specialisation for subterranean life, suggests that subterranean aquatic ecosystems inhabited by stygobites have higher Environmental Value than those inhabited by stygoxenes only.



Therefore, the environmental values of stygofauna of the Project and surrounds were determined using the following criteria:

- high value: threatened species listed under State or National legislation
- moderate value: non-listed stygobites and / or suitable habitat for stygofauna present, and
- low value: only non-listed stygoxenes and / or potentially suitable habitat for stygofauna present.

Stygofauna were assessed in December 2022 using a desktop review and field survey at 15 bores (Attachment 1), as described for a stygofauna pilot study in the Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DoSITIA 2015). Full methods and results of the stygofauna pilot study are presented in frc environmental (2023), with the results summarised below.

2.2 Environmental Values of Stygofauna of the Project Area

Review of the lithology, water quality and depth to water table of groundwater of the Project area indicated that groundwaters underlying the Project area, especially shallow groundwaters, have characteristics that are consistent with characteristics of other groundwater systems known to support diverse stygofauna communities. Therefore, groundwaters underlying the Project area, especially shallow groundwaters, were considered to be suitable for supporting stygofauna on the basis of favourable hydrogeological characteristics.

Results of the 2022 stygofauna survey indicated (Table 1.1):

- a total of five stygofauna taxa were recorded, with one stygobite (i.e. Bathynellidae) and four stygoxene taxa
- the stygobite was recorded at bore GW19-33 that targeted alluvium/regolith, with two stygoxene taxa also found at this bore (i.e. bore GW19-33 had the highest diversity of stygofauna).
- bores GW19-33 and GW06 that both targeted shallow alluvium/regolith each had two stygofauna taxa that were not found at any other bore (i.e. 4 of the 5 taxa were found at only two bores)
- the stygoxene taxon *Acaina* sp. 1 was the most widespread species, occurring at seven (47%) of the bores, and
- only bores targeting alluvium or regolith had stygofauna, and all bores at which stygofauna were recorded, except bore GW31b, were in close proximity to the Isaac River.

Therefore, shallow groundwater of the Project area within alluvial and regolith lithologies in close proximity to the Isaac River area has moderate stygofauna values, based on the presence of a stygobitic species and suitable hydrogeological conditions for stygofauna. There was also a moderate diversity of stygoxene taxa. A single stygoxene taxon (i.e. a mite) was also found in regolith adjacent to Hill Creek, a tributary of the Isaac River, and in shallow coal seams at bores relatively close to the Isaac River.

The available survey data indicates stygofauna were generally not recorded from areas that were not in close proximity to the Isaac River, and so these areas are considered to have low ecological value with respect to stygofauna.



3.0 Derivation Stygofauna Triggers

Of the 15 bores surveyed for stygofauna in December 2022, stygobitic stygofauna were recorded at one bore (1/15 = 7% of bores), and stygoxenes were recorded at eight bores (8/15 = 53% of bores). These percentages represent trigger values for detection rates of stygobites and stygoxenes, respectively, per monitoring event.

A single stygobitic taxon was recorded in 2022 (Bathynellidae sp. 1), while three stygoxene taxa were recorded. Ongoing monitoring is intended to demonstrate no reduction in the diversity or species composition of stygobites and stygoxenes over time.

4.0 Operational Phase Monitoring Program

4.1 Monitoring Program Design

Annual monitoring of stygofauna at the 11 bores listed in Table 4.1 and shown in the attachments will be implemented in the dry season (notionally September or October) each year. All bores target alluvium or alluvium/regolith geological units.

The full water column in each bore will be sampled using six hauls of a weighted phreatobiological net (similar to a plankton net) that has a 50 µm mesh size. Samples will be preserved in 100 per cent ethanol and transported to a reputable biological laboratory where stygofaunal specimens will be identified to Order or Family using available taxonomic keys. Each specimen will then be identified to morpho-species by trained ecologists as taxonomic keys are not available for species-level identification of stygofauna, and anatomical features (e.g. lack of eyes and pigmentation, etc) will be used to assign each taxon as either stygobite or stygoxene. A reference collection will be established to enable taxonomic alignment across surveys.

Table 4.1 Bores for Annual Operational Phase Stygofauna Monitoring

Pre-mining Residual Thickness	Residual Saturated Thickness	Bore Name	Easting	Northing
>10 m	>2 m	New bore 2	618120	7614864
>10 m	>2 m	GW07	618097	7616723
>10 m	>2 m	GW06	617640	7613075
>10 m	>2 m	GW09	617525	7614070
>5 m	>2 m	New bore 1	618250	7616030
<2 m	>2 m	GW08	617041	7613900
<2 m	>2 m	GW01	617299	7618210
<2 m	>2 m	GW30c	618094	7617368
<2 m	<2 m	GW03	618094	7612389
<2 m	<2 m	GW19_33	618664	7617348
<2 m	<2 m	GW26	619185	7616679

Note: Bore GW19_33 targets shallow groundwater in both alluvium and regolith.



4.2 Data Analyses and Reporting

An annual stygofauna monitoring report is to be prepared each year, presenting the methods and results of the stygofauna monitoring event. Stygofauna are to be classed as stygobite or stygoxene, using nomenclature of the baseline stygofauna pilot study.

The annual stygofauna monitoring report is also to assess the monitoring results with reference to:

- the stygofauna triggers, and present conclusions whether the stygofauna triggers were exceeded, and
- the classes of residual thickness, and present conclusions about the groundwater characteristics within which stygofauna are retained.

4.3 Trigger Exceedance Responses

Where the routine stygofauna monitoring results indicate an exceedance of the triggers, then review of the most recent groundwater monitoring results is to be implemented to determine if there are unexpected changes to groundwater levels. If groundwater changes that are unexpected have occurred, then review the suitability of the bores surveyed for the stygofauna monitoring program.

If two consecutive years of annual monitoring both indicate an exceedance of the triggers, then a supplemental monitoring event is to be implemented in the following wet season to verify results. Where the repeat survey continues to indicate an exceedance of the stygofauna triggers, then an investigation is to be implemented into the reasons why the repeat monitoring results exceeded the trigger levels.

4.4 Quality Assurance Protocols

Stygofauna monitoring is to use the above-described methods in accordance with the Guideline for the Environmental Assessment of Subterranean Aquatic Fauna (DoSITI 2015; see also DES 2018).

Laboratory processing of stygofauna samples is to use cross-checking of both picking of samples and identification of specimens by a second suitable qualified person for 10% of the samples collected on each monitoring event. Where errors are <5% then quality assurance is achieved (refer to DES 2018). However, where errors are >5%, then sample picking and specimen identification is to continue until errors are <5%.

5.0 Conclusions

Drawdown of shallow groundwater due to operation of the Project will reduce saturated thickness along a relatively small stretch of the Isaac River, likely causing localised loss of suitable habitat for stygofauna. However, within the extent of drawdown, areas where residual saturated thickness that is >2 m will be retained in the post-mining scenarios, suggesting that stygofauna could be retained in these areas.

The development of stygofauna triggers and design of the operational phase monitoring program presented in this memo will facilitate operational phase environmental management of stygofauna within the Project area.



6.0 Attachments

- Attachments
- Attachment 1: Predicted Pre-mining Saturated Thickness of Groundwater in Alluvium.
 - Attachment 2: Predicted Post-mining Residual Saturated Thickness of Groundwater in Alluvium.
 - Attachment 3: Predicted Post-mining Saturated Thickness of Groundwater in Alluvium, at Equilibrium.

7.0 References

- Cook, B, Abrams, K, Marshall, J, Perna, C, Choy, S, Guzik, M & Cooper, S 2012, 'Species diversity and genetic differentiation of stygofauna (Syncarida: Bathynellacea) across an alluvial aquifer in north-eastern Australia', *Australian Journal of Zoology*, vol. 60, pp. 152-158.
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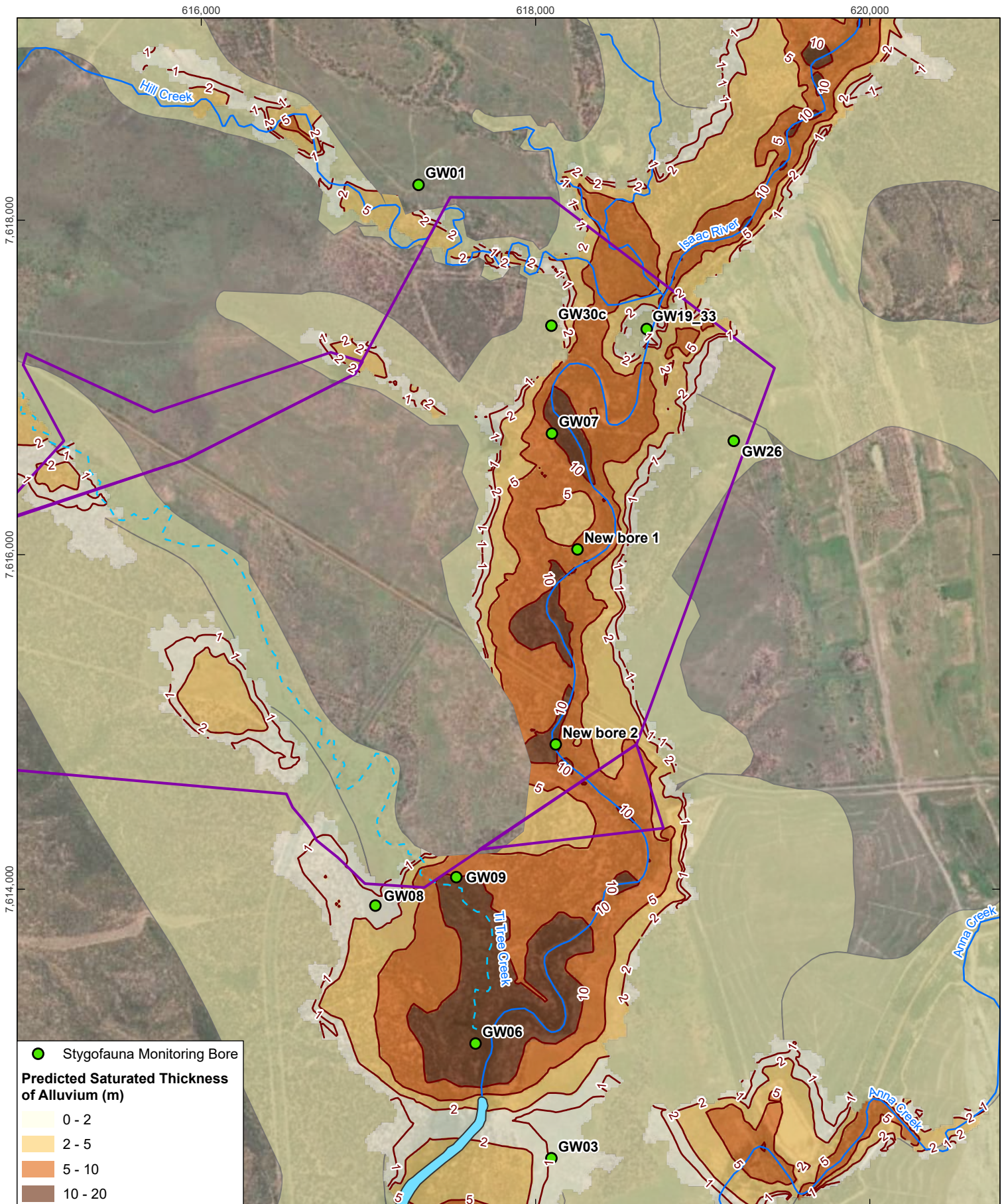
Attachment 1: Predicted Pre-mining Saturated Thickness of
Groundwater in Alluvium.

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Attachment 1: Predicted Pre-mining Saturated Thickness of Groundwater in Alluvium.





● Stygofauna Monitoring Bore
Predicted Saturated Thickness of Alluvium (m)
 0 - 2
 2 - 5
 5 - 10
 10 - 20

0 0.5 1 km
 Coordinate System: GDA2020 MGA Zone 55
 Scale: 1:30,000 at A4
 Project Number: 620.31367.00000
 Date Drawn: 25-Jul-2024
 Drawn by: RB

LEGEND

- Major Watercourse
- - - Non-designated Watercourse
- Predicted Saturated Thickness of Alluvium Contour (m)

- New Lenton Mining Lease
- Burton Gorge Dam
- Modelled Extent of Alluvium

**NEW LENTON COAL PROJECT
PER GROUNDWATER
ASSESSMENT**

**PREDICTED ALLUVIUM
SATURATED THICKNESS –
PRE-MINING**

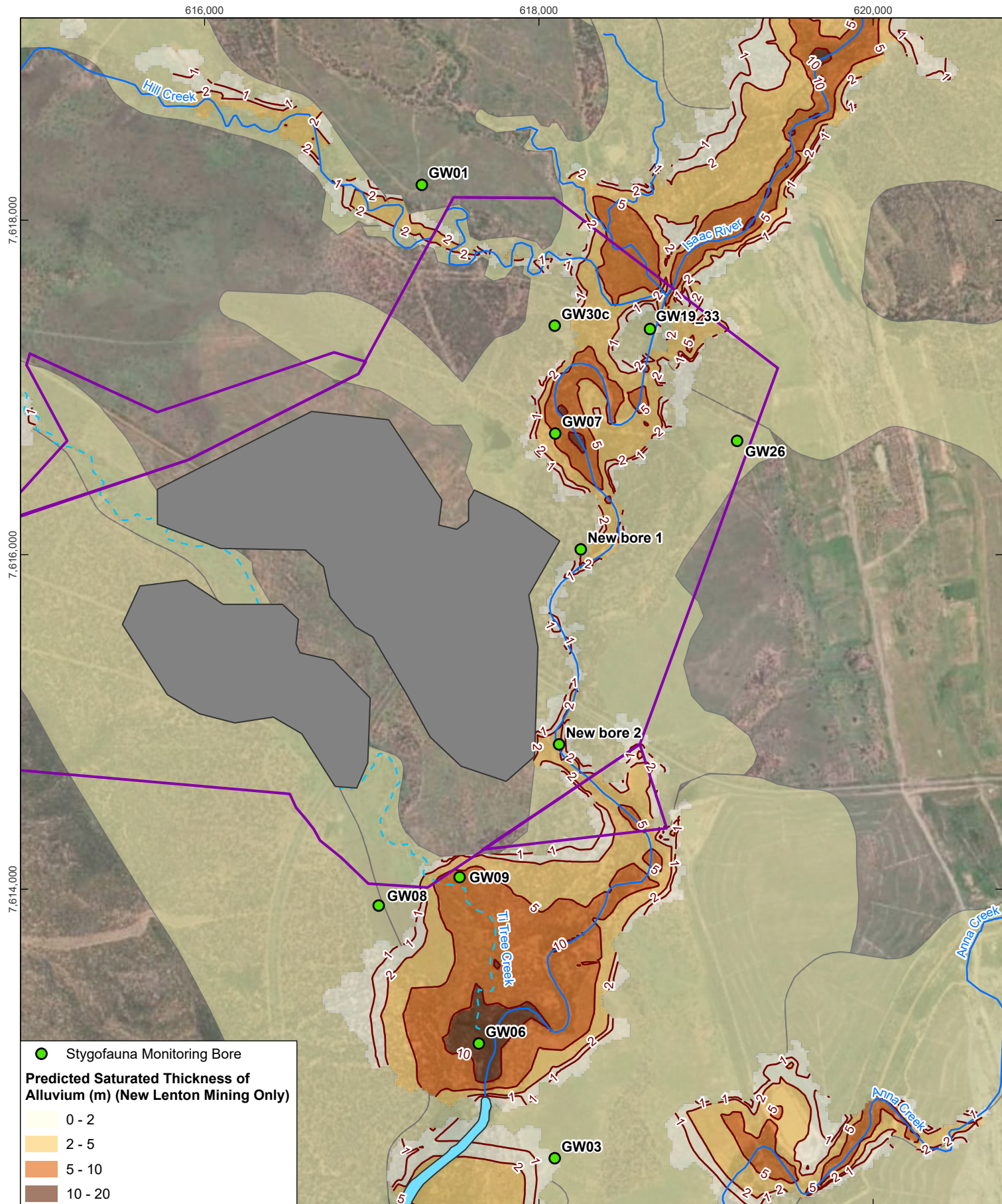


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FIGURE 1

Attachment 2: Predicted Post-mining Residual Saturated Thickness of Groundwater in Alluvium





Stygofauna Monitoring Bore

Predicted Saturated Thickness of Alluvium (m) (New Lenton Mining Only)

0 - 2

2 - 5

5 - 10

10 - 20

0 0.5 1 km

Coordinate System: GDA2020 MGA Zone 55

Scale: 1:30,000 at A4

Project Number: 620.31367.00000

Date Drawn: 25-Jul-2024

Drawn by: RB

LEGEND

- Major Watercourse

Non-designated Watercourse

Predicted Saturated Thickness of Alluvium Contour (m) (New Lenton Mining Only)
- New Lenton Mining Lease

New Lenton Pit Extent

Burton Gorge Dam

Modelled Extent of Alluvium

NEW LENTON COAL PROJECT PER GROUNDWATER ASSESSMENT

PREDICTED ALLUVIUM SATURATED THICKNESS – END OF MINING (2040)



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FIGURE 2

Attachment 3: Predicted Post-mining Saturated Thickness of Groundwater in Alluvium, at Equilibrium.



